Solutions to the 1000 star maps

Cheng Ian and Kane

October 2024

1 Introduction

This document is our (Cheng Ian and Kane) attempt at doing 1000 star maps by hand. The star maps are sourced from `https://tinyurl.com/sidpro1000`, made by Sidharth a while back. In case this link goes dead, you can use `https://github.com/pgot/1000-star-maps/raw/main/1000%20star%20maps.pdf`; most of the resources for this document are on the same repository (`https://github.com/pgot/1000-star-maps`). If you want to generate these charts yourself, you can use `https://www.fourmilab.ch/cgi-bin/Yoursky`, setting the colour to black on white, and unchecking all the display options.

2 How to read the charts

2.1 Before starting

Before starting to mark out the charts, there's a couple of things to note. For the basics, each dot represents a star, with larger dots representing brighter stars, from magnitude 5.5 and below. Notably, *planets are not shown.*

The circle is a stereographic projection of the sky at some random location, and exactly half the sky is shown. The cardinal points are also shown on the outer rim of the circle, and North-South *always* runs up-down on the page.

2.2 Markings

There are several types of marks on the charts. These include constellation lines, constellation labels (some), equator/ecliptic/galactic great circles (some), Deep Sky Object (DSO) markings, and star designations.

Constellation lines are drawn as solid lines, and always stay within constellation boundaries (notably except β Tauri and α Andromedae, but these stars were ambiguous in their naming and which constellation they'd belong). Some dim constellations (e.g. Mensa, Sextans, Camelopardalis) are not drawn with constellation lines sometimes, due to the stars involved being to dim to be notable. The constellation lines are not agreed upon absolutely, and can vary from source to source. These lines are based on the constellation lines in Stellarium. Some of these constellations may be labeled with their names or their 3-letter IAU abbreviations, especially for star maps closer to the beginning.

DSOs are marked by a cross at their locations, with their catalog number above them. If there are many notable DSOs at a particular location, these may be condensed with the use of commas, giving up some accuracy of location for readability. We note down DSOs from the Messier Catalog and notable objects from the Caldwell catalog (for some). Objects from the Messier catalog are listed as their catalog number without prefix, while Caldwell catalog objects are listed with the prefix "C". When condensing objects from different catalogs, Messier objects are listed first, followed by the prefix "C" and the Caldwell catalog numbers (e.g. 103, C8, 10, 13 means Messier 103, Caldwell 8, Caldwell 10, Caldwell 13). Some notable New General Catalog objects are noted with NGC, although we don't note virtually all of them (except #813).

Star designations are noted with their catalog number/Bayer designation written next to the star without any crosses/marks. Bayer designations are (as usual) Greek letters, and numbers without prefix are Flamsteed designations. Stars noted that do not fall into these catalogs are noted with their well-known catalog abbreviations (e.g. HIP, HD).

3 Final notes

This attempt used 500 sheets of paper, with work done from March 2022 to August 2024. We recommend doing less than 1000, and preferably digitally, so that paper is not wasted in large amounts like in our case.

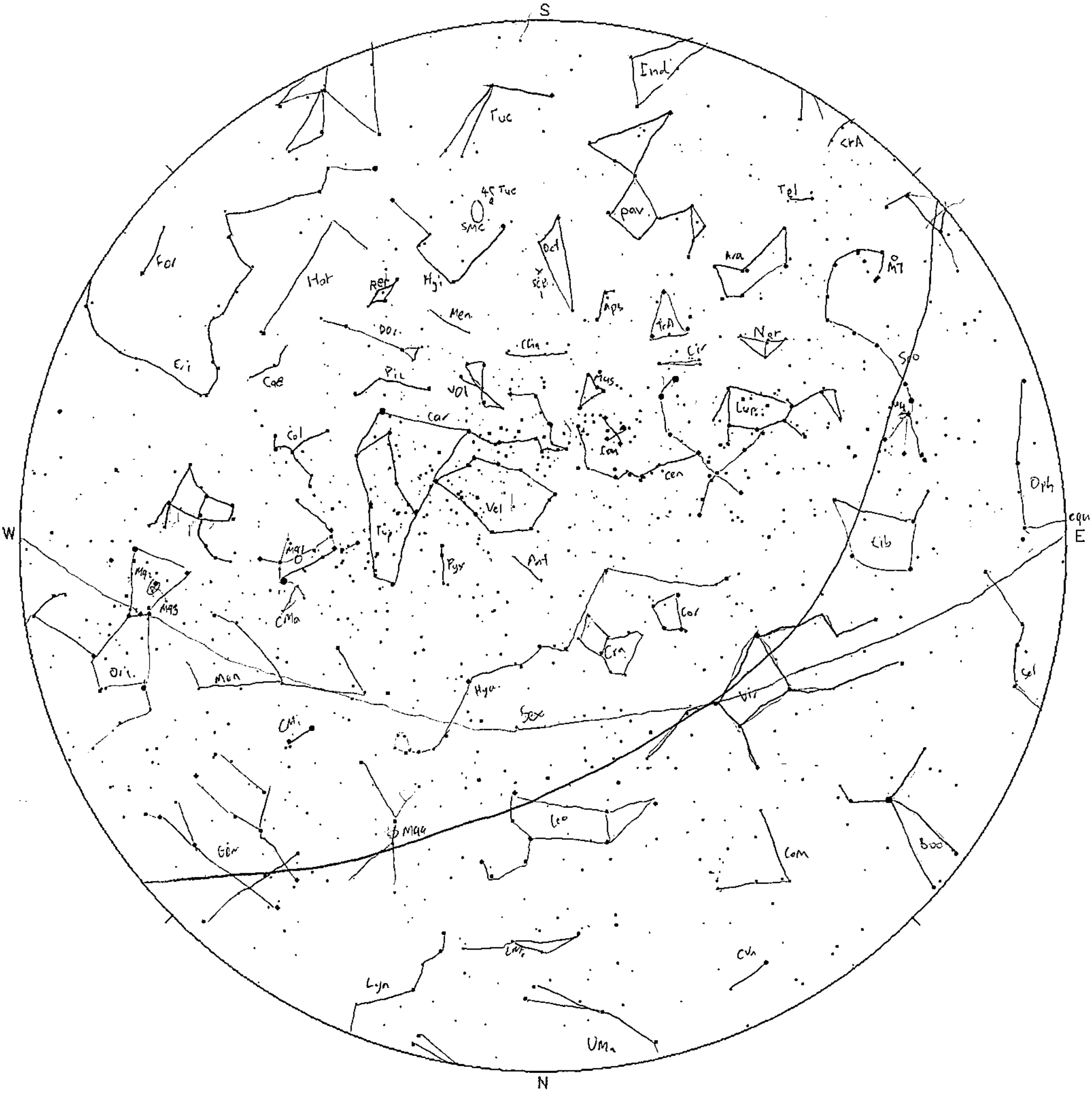
Importantly, **not everything important may be marked, and not everything marked is correct**.This was a hobby project both of us did in our free time, which stemmed from planning to revise after the Singapore Astronomy Olympiad was over. Most of this free time was from being bored and sleepy in class, leaving up the potential for errors to appear and persist through multiple star maps.

Some arguably important objects, constellations and stars may not be labeled as well. We apologize for the lack of completeness.

Also, some of these papers were used for other purposes (such as scratch paper for homework), and may have lots of other stuff written on them. This includes the derivation of the Friedmann equations through general relativity, nim-values for the impartial knight (and other derivations from combinatorial game theory), the Heart Sutra and rock-paper-scissors-101 among other things. Some of the drawings below the star maps, e.g. on #1000, are from our friend Greene, although the markings on the star maps are mostly from us.

These star maps have also traveled with us to Switzerland, Poland and Brazil, and some contestants in the 2023 IOAA have done some small parts of these. One of the star maps has been taken to Saudi Arabia by one of their contestants who was keen to try one.

We would like to thank everyone who made this possible, from Sidharth making the original document, NUS High for providing a ream of paper and mass printing and scanning capabilities, all the people we've met at IOAA, and everyone else who was at least tolerant of us doing this.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E
Vel
Pup
Lib
M41
Pyx
Ant
M42
M43
CMa
Cor
Cra
Ori
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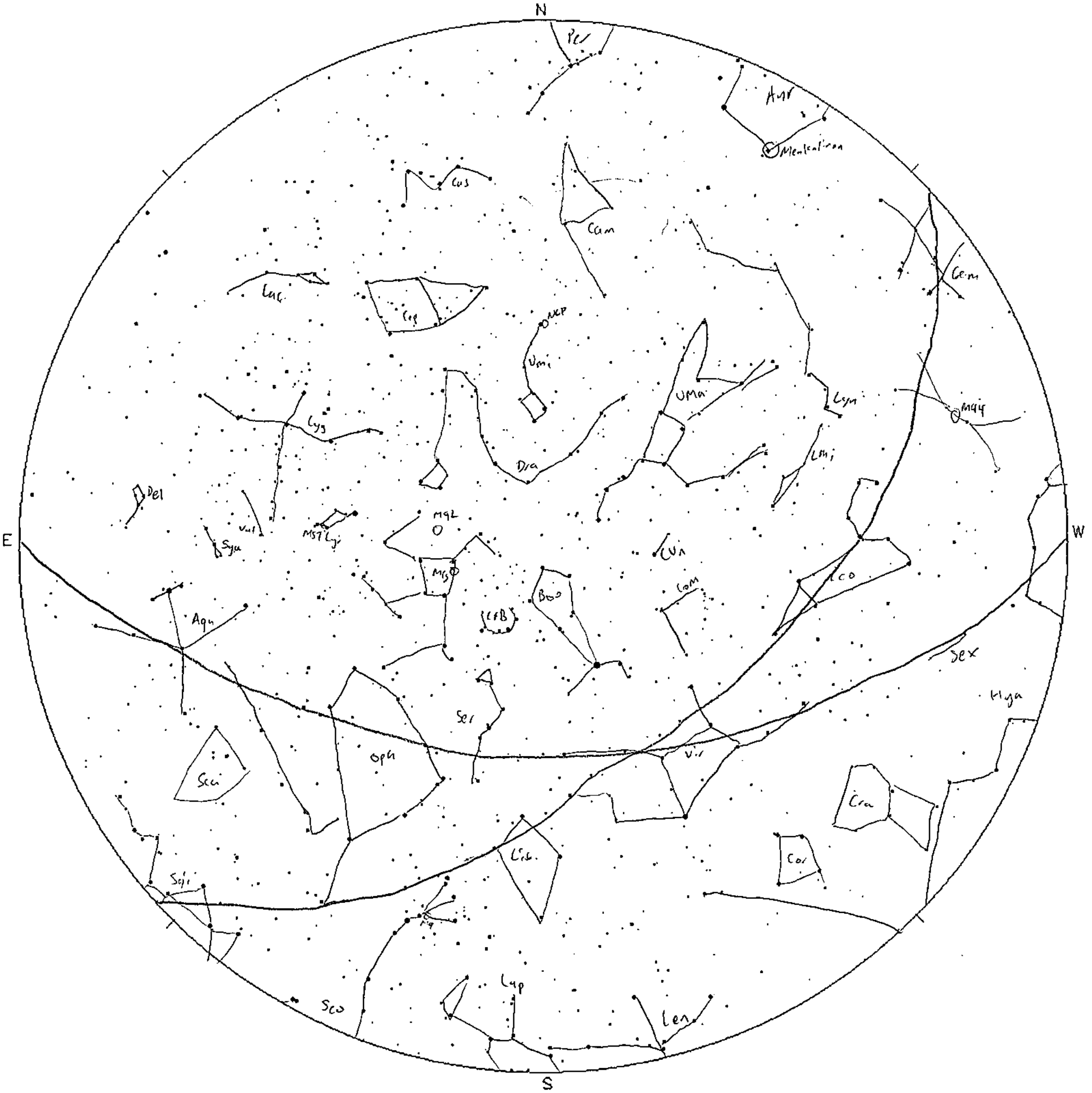
Lyn
UMa
N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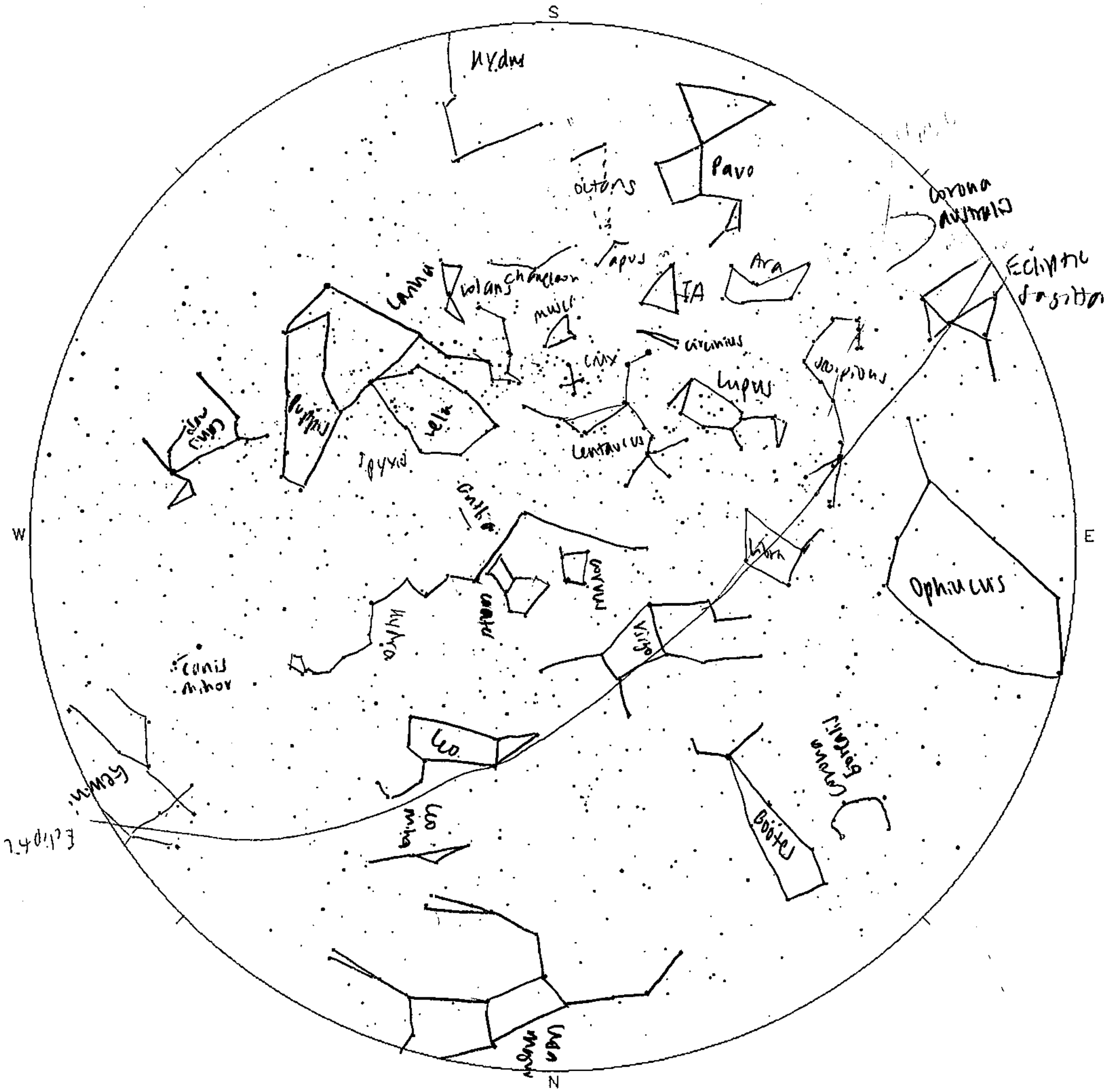
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Pavo
Octans
Corona Australis
Apus
Ara
TA
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Sagittarius
Carina
Volans
Chameleon
Musca
Circinus
Crux
Scorpius
Lupus
Puppis
Canis Major
Vela
Centaurus
Pyxis
W
E
Antlia
Libra
Corvus
Crater
Ophiucus
Hydra
Virgo
Canis Minor
Corona Borealis
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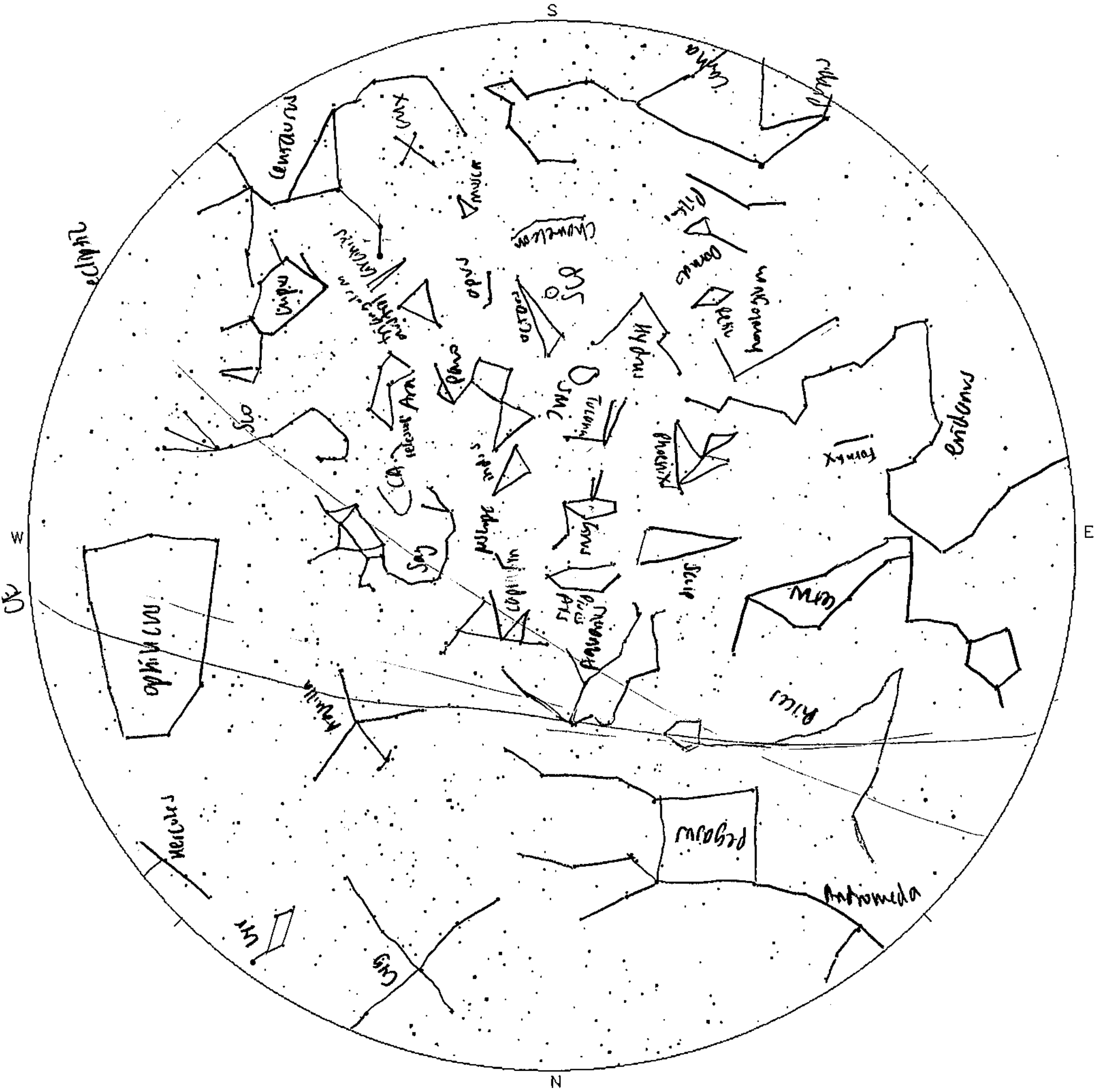
Gemini
Ecliptic
Leo Minor
Boötes
Ursa Major
N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Musca
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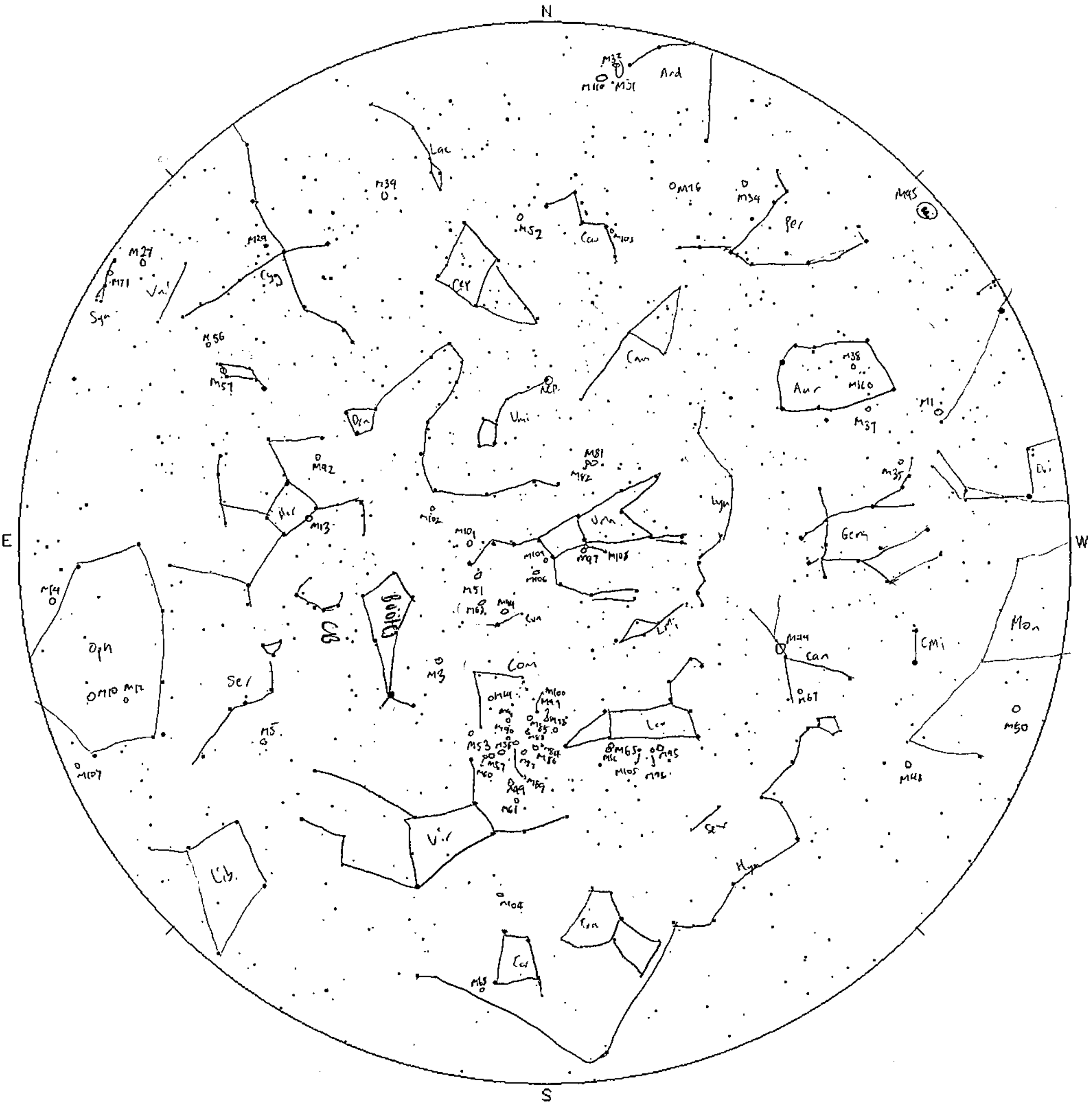
Lupus
Triangulum Australe
Apus
Octans
LMC
Dorado
Reticulum
Horologium
Eridanus
Hydrus
SMC
Pavo
Ara
Telescopium
CrA
Indus
Tucana
Phoenix
Fornax
Sco
Sag
Microscopium
Grus
Sculp
Capricornus
Piscis Austrinus
Aquarius
Mira
Pisces
Ophiuchus
Aquila
Hercules
Lyr
Cyg
Pegasus
Andromeda

4/100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Vul
M29
Cyg
Cep
M56
M57
Cam
Aur
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M36
M37
M1
M35
Ori
Gem
Lyn
Dra
Umi
NCP
M81
M82
M92
Her
M13
M102
M101
M51
M63
M94
CVn
M106
M109
UMa
M97
M108
CrB
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Ser
M3
Com
M4
Oph
M10
M12
M5
M107
M53
M64
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M91
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M58
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M84
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M60
M59
M49
M61
M66
M65
M95
M105
M96
Leo
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Crt
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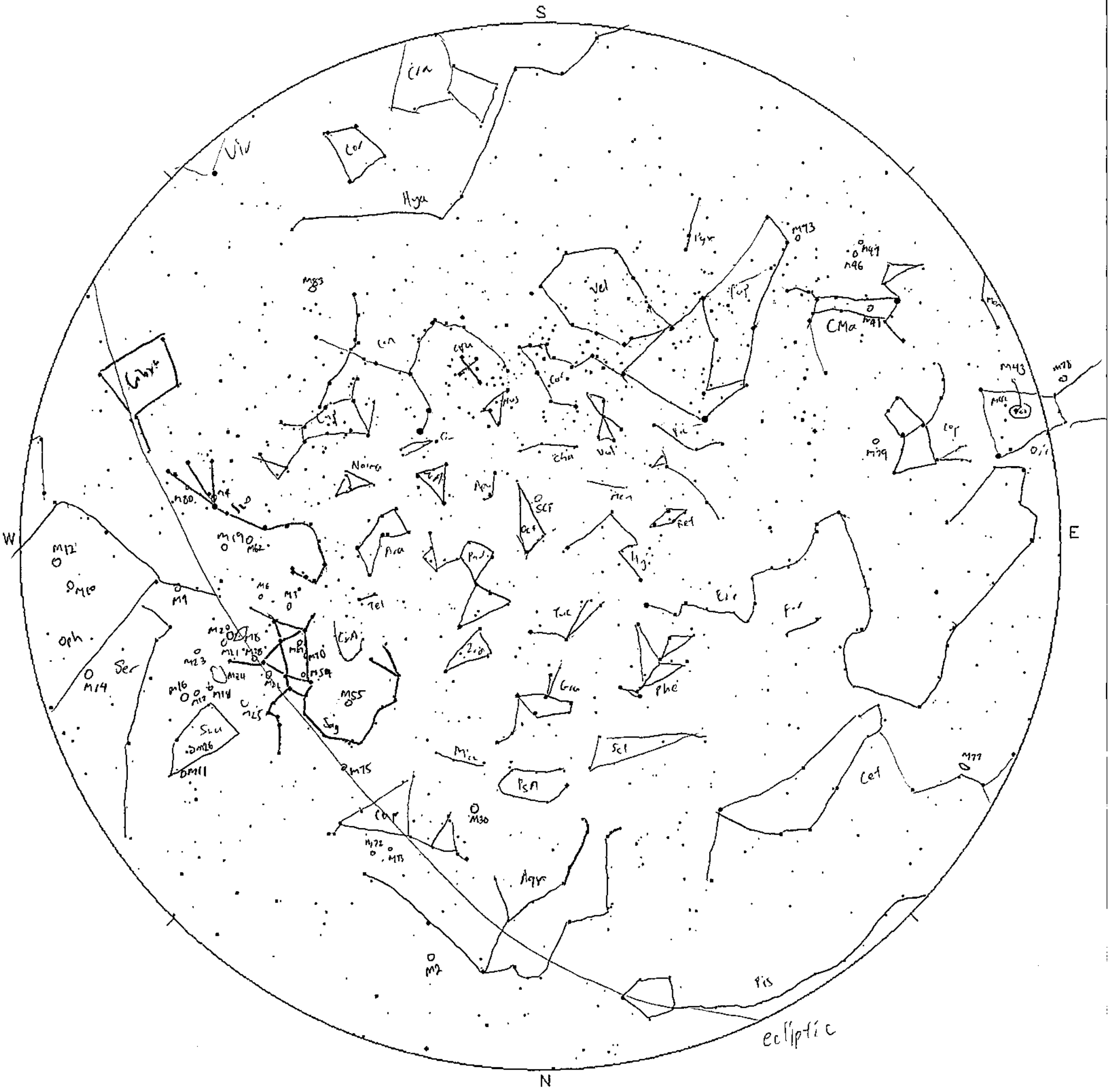
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Ori
Lep
M79
Cen
Cru
Car
Mus
Libr
Lup
Cir
Norma
TrA
Aps
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Men
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Hyi
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Sag
Scu
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M11
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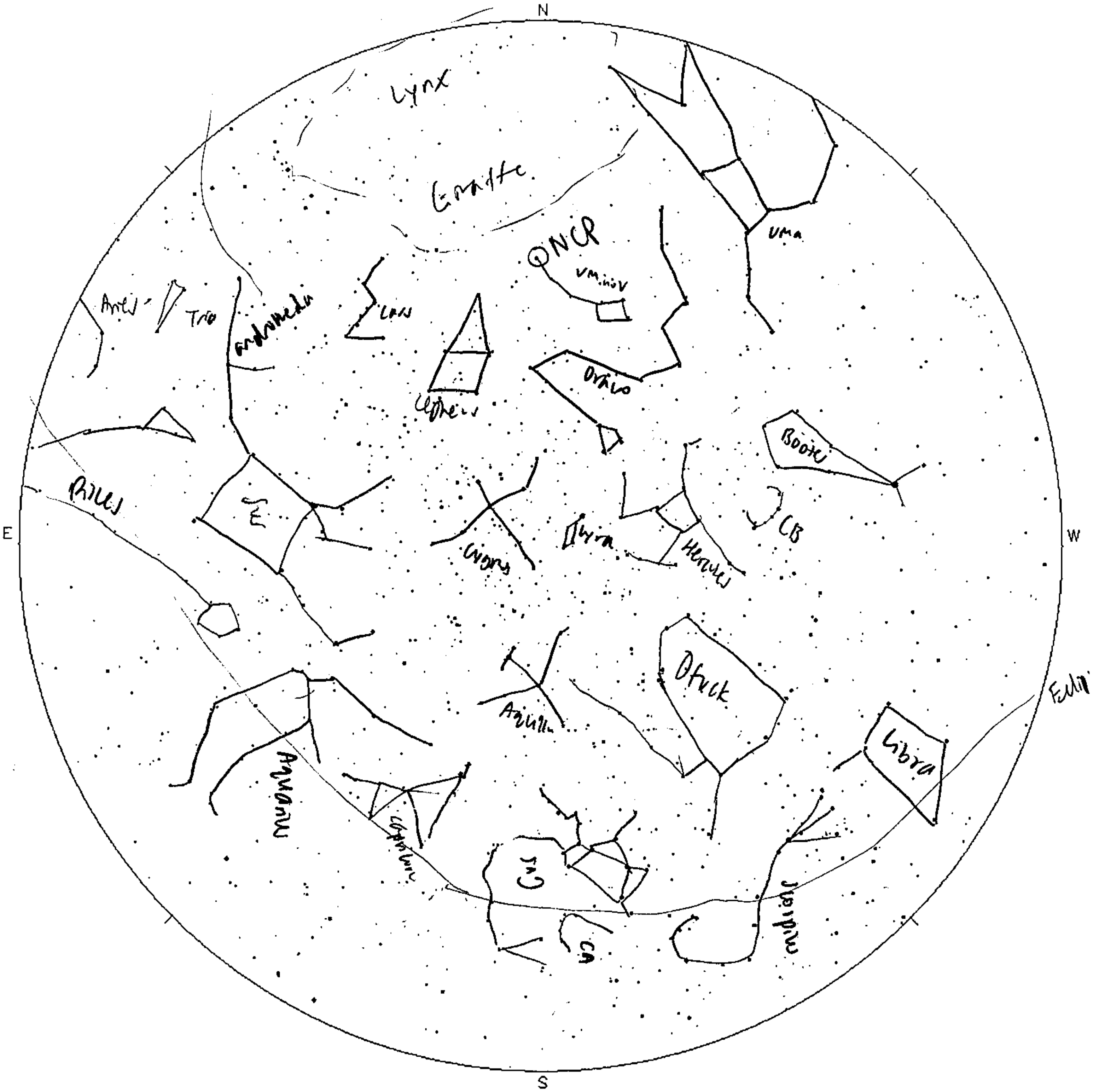
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Draco
Bootes
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Pisces
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Hercules
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Libra
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Scorpius
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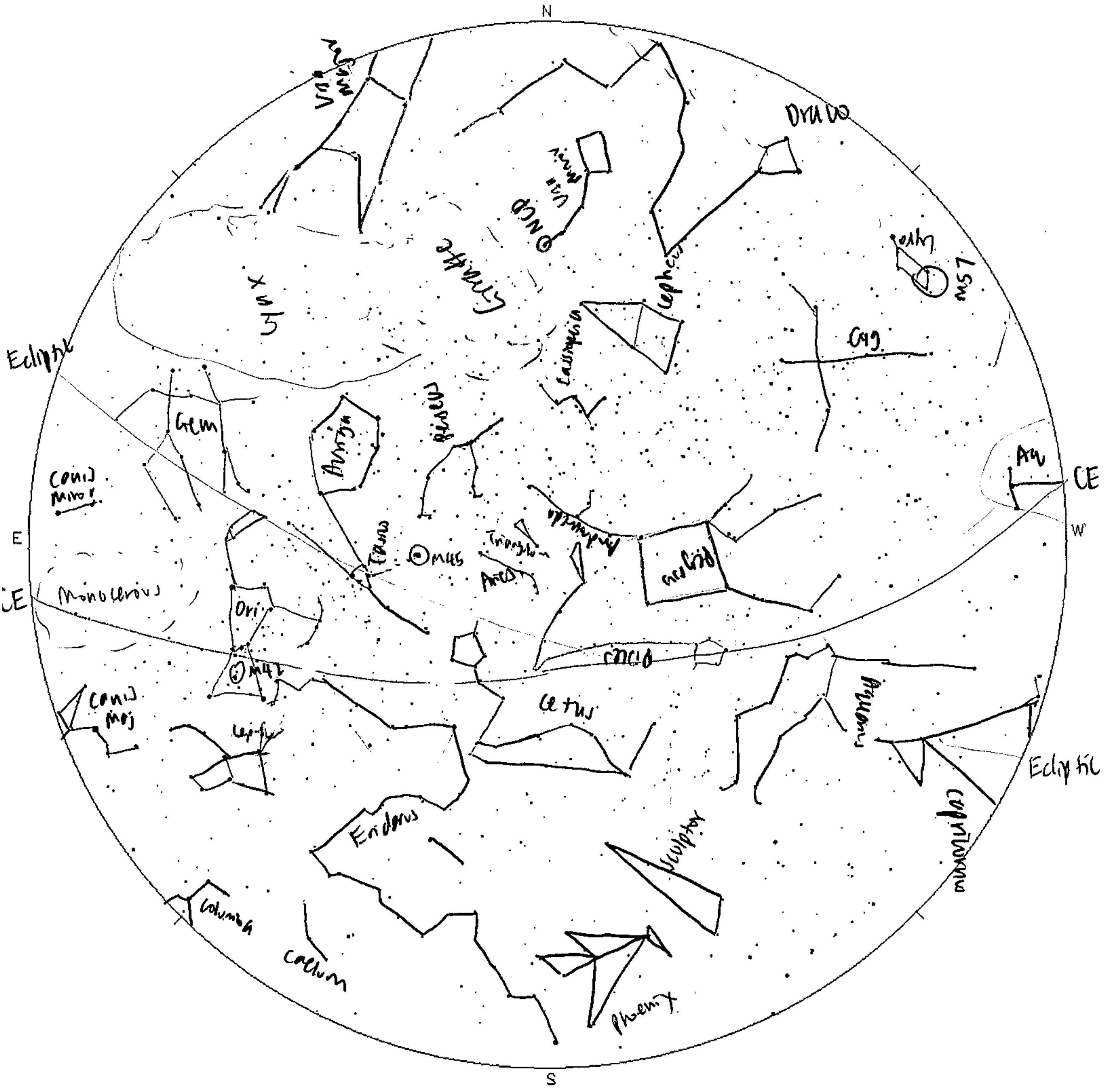
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Ursa Minor
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Cyg
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Gem
Canis Minor
Auriga
Perseus
Aq
CE
W
E
Taurus
M45
Triangulum
Aries
Andromeda
Pegasus
CE
Monoceros
Ori
Pisces
M42
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Aquarius
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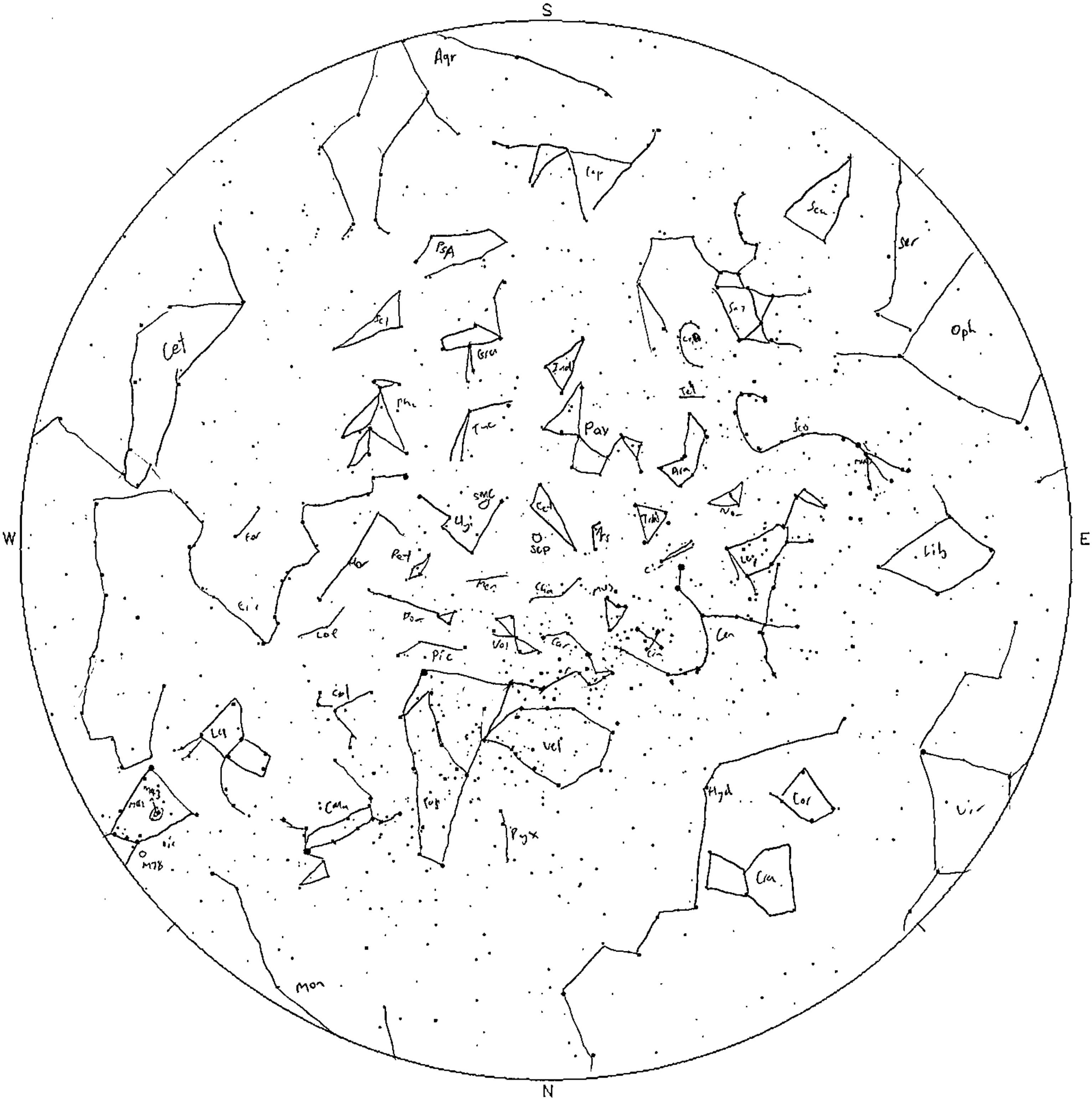
Capricornus
Eridanus
Sculptor
Columba
Caelum
Phoenix
S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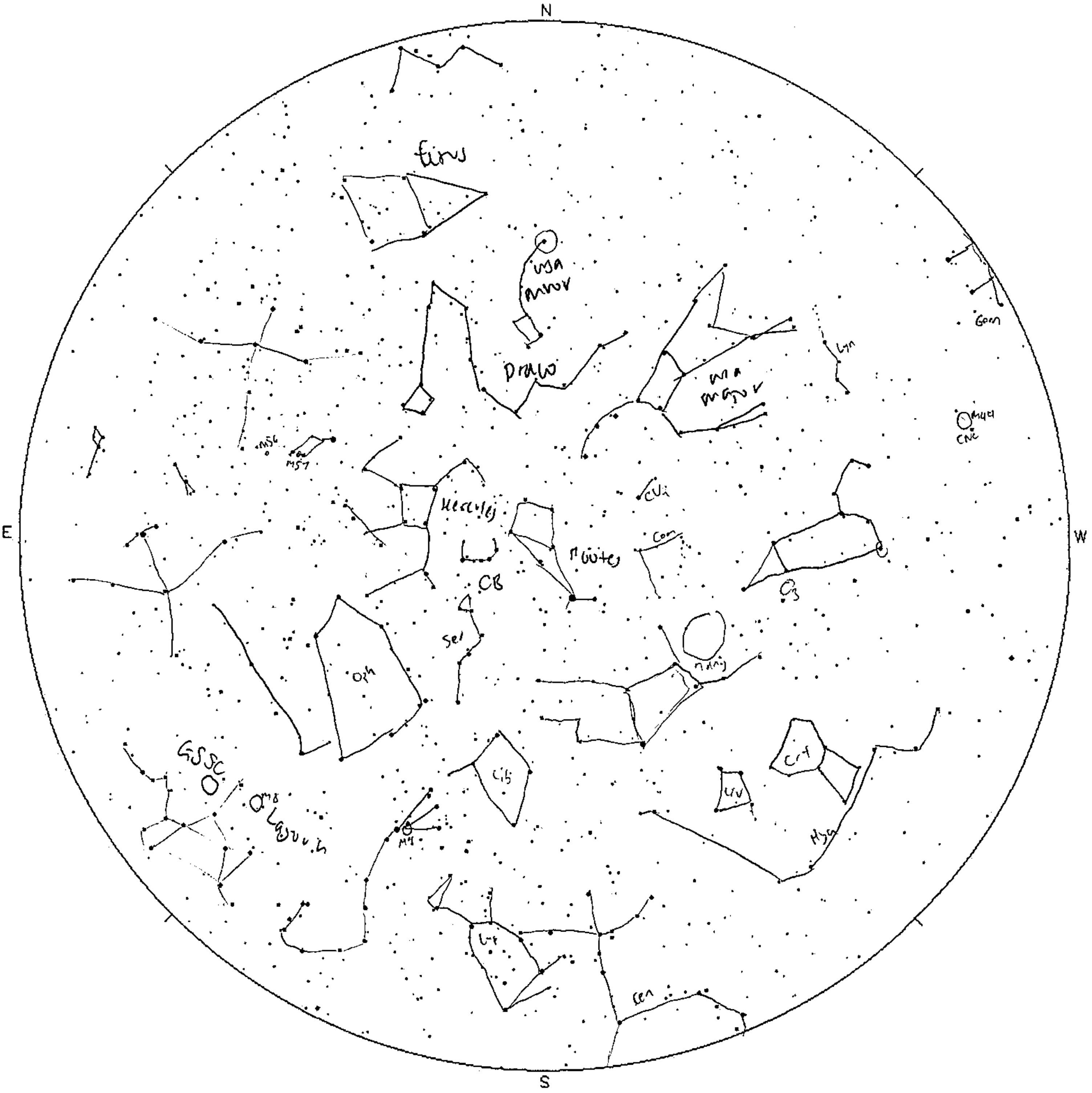
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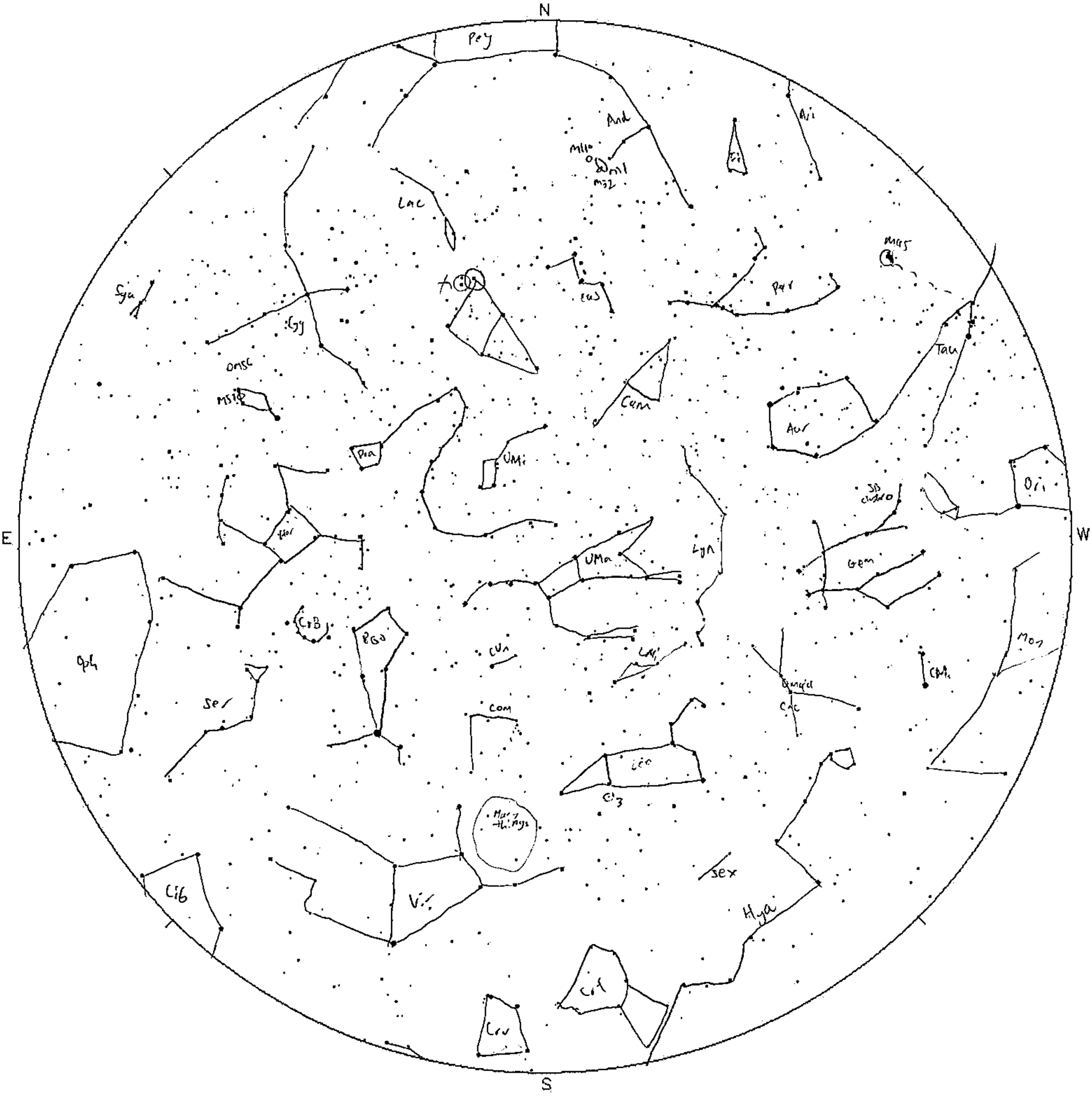
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Gem
CrB
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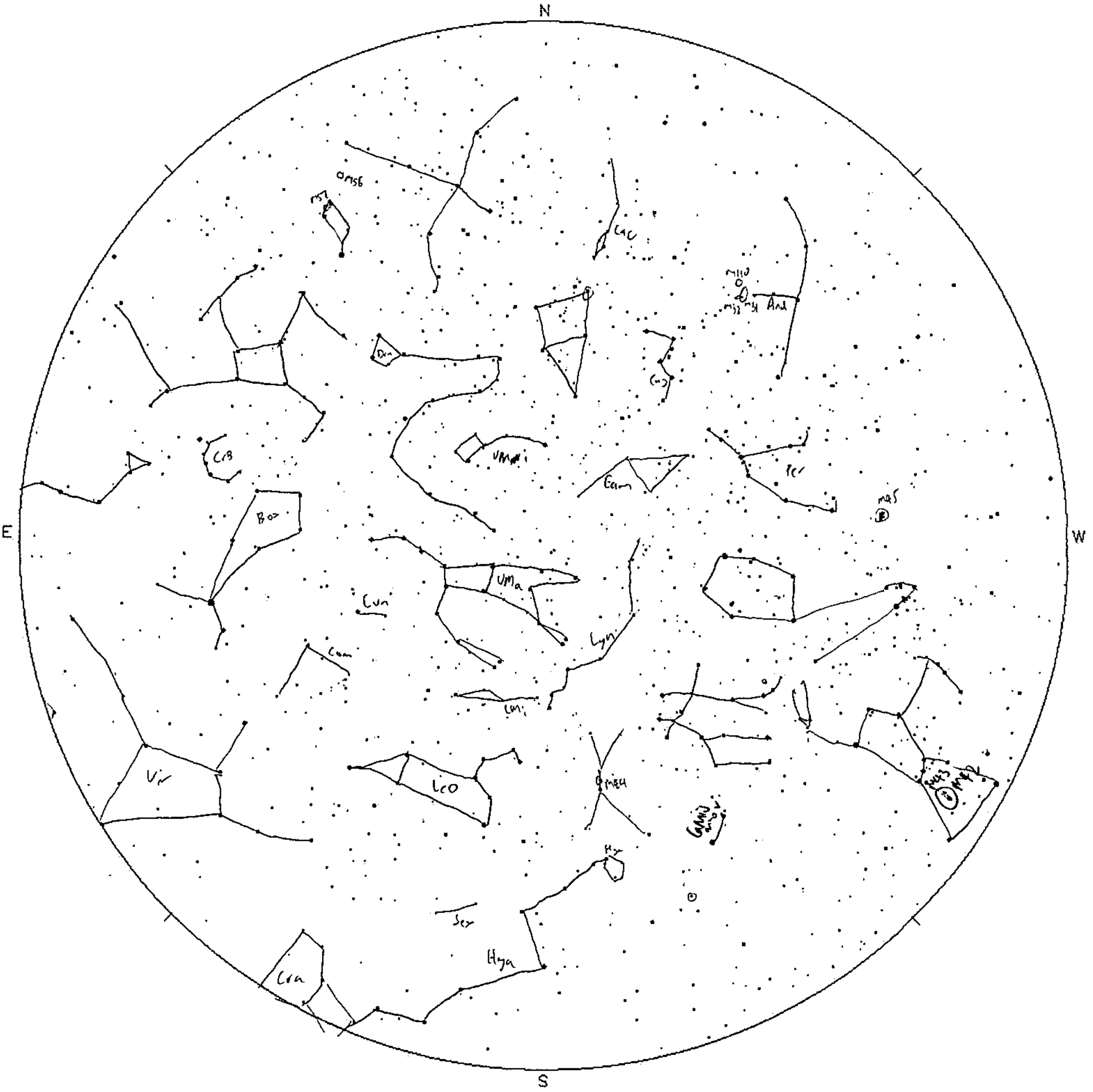
Crv
S

12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CVn
UMa
Lyn
Com
LMi
Vir
Leo
M44
M43
M42
Hya
Sex
Crt


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Boo
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CVn
Lyr
Dra
UMa
Sge
UMi
Cyg
Leo
LMi
Cep
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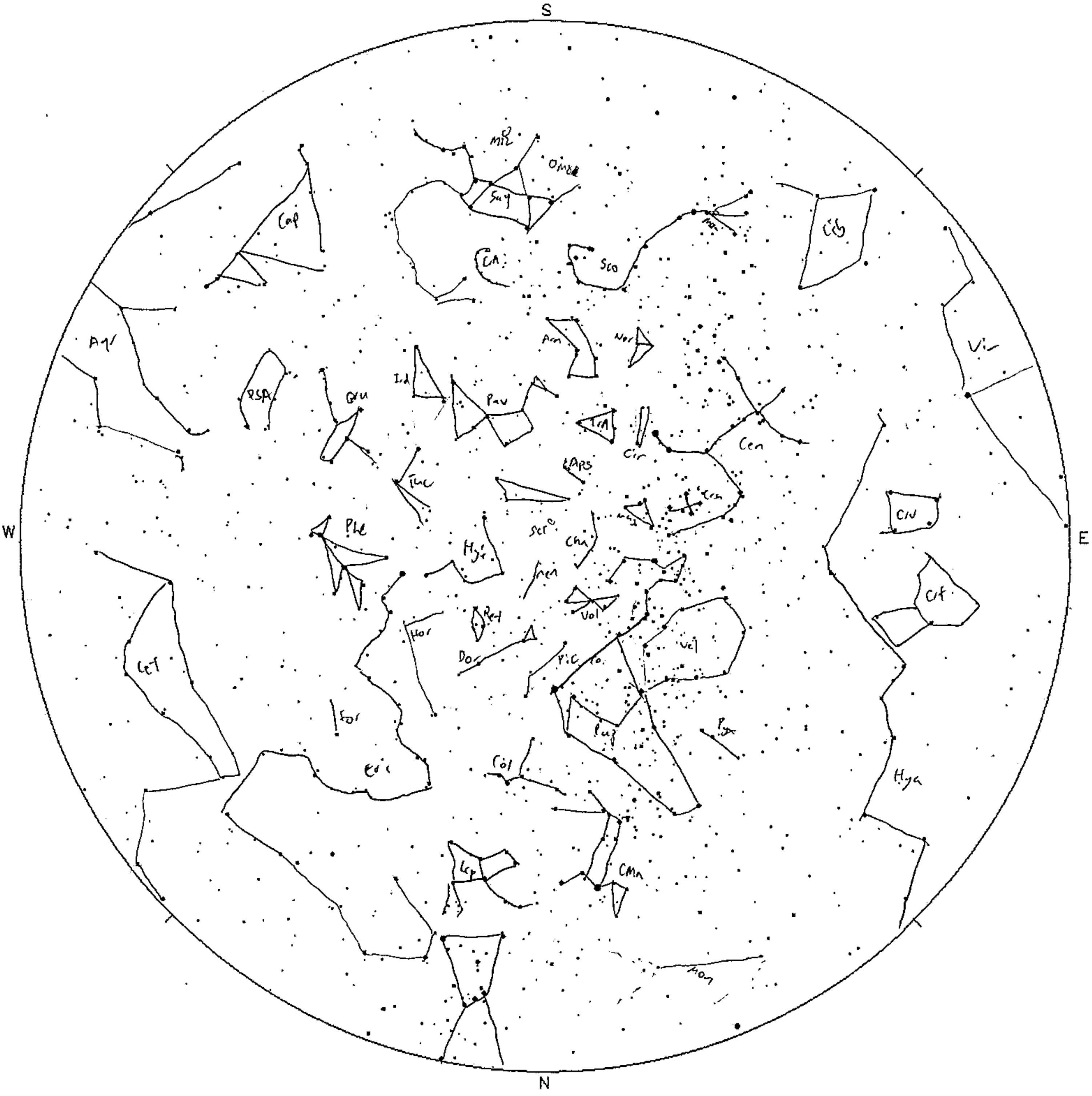
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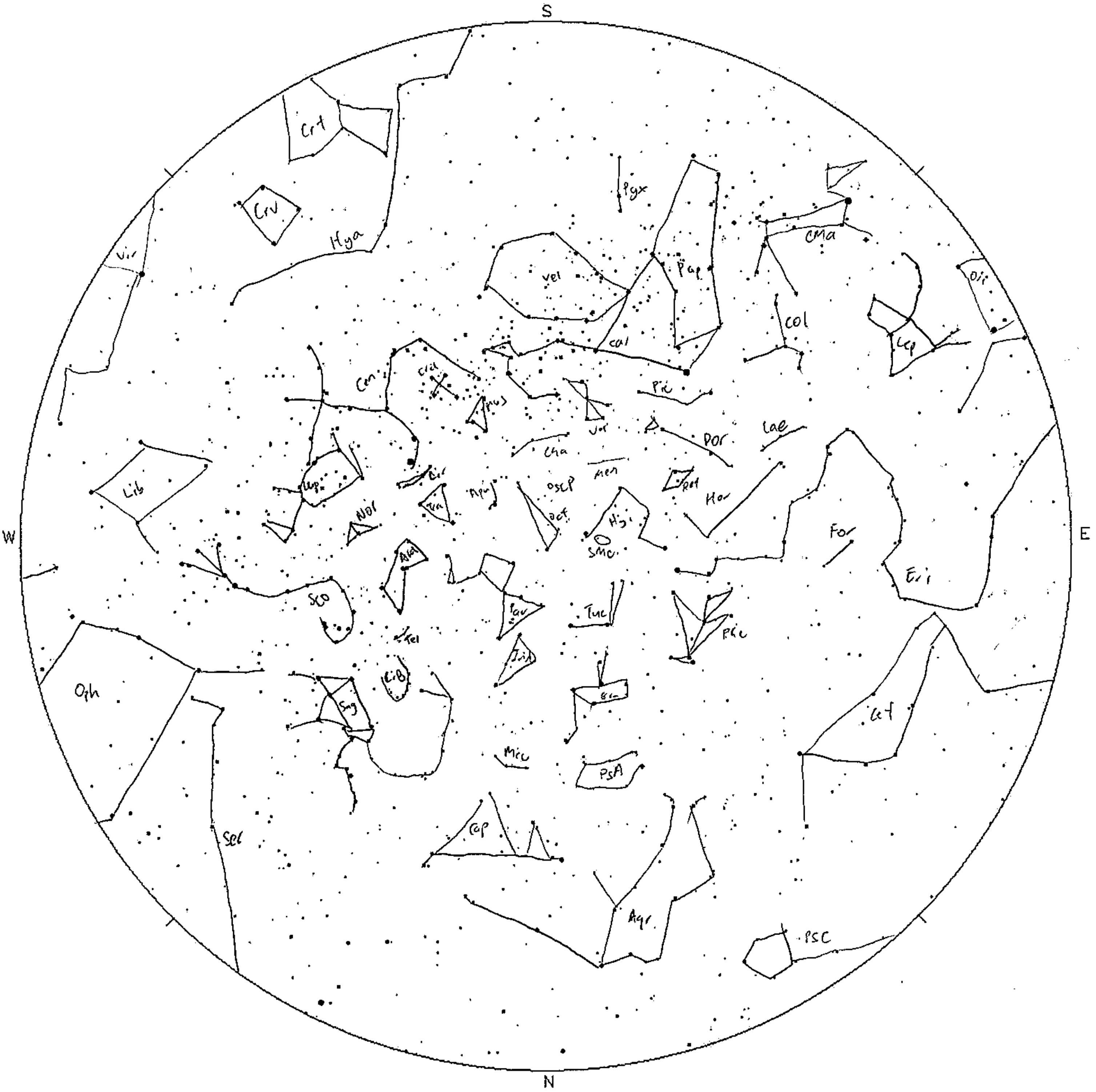
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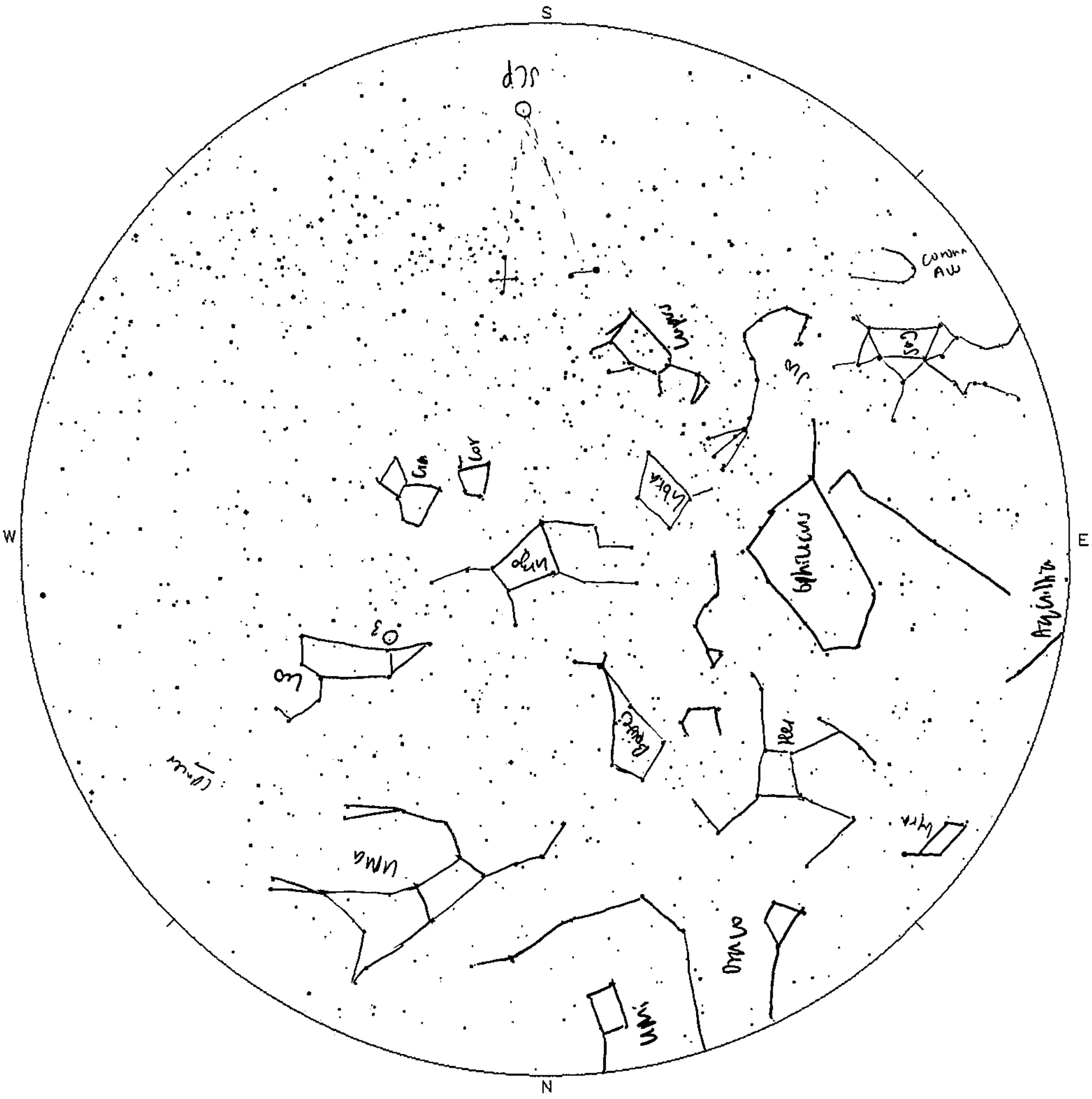
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Sco
Sgr
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Crv
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Virgo
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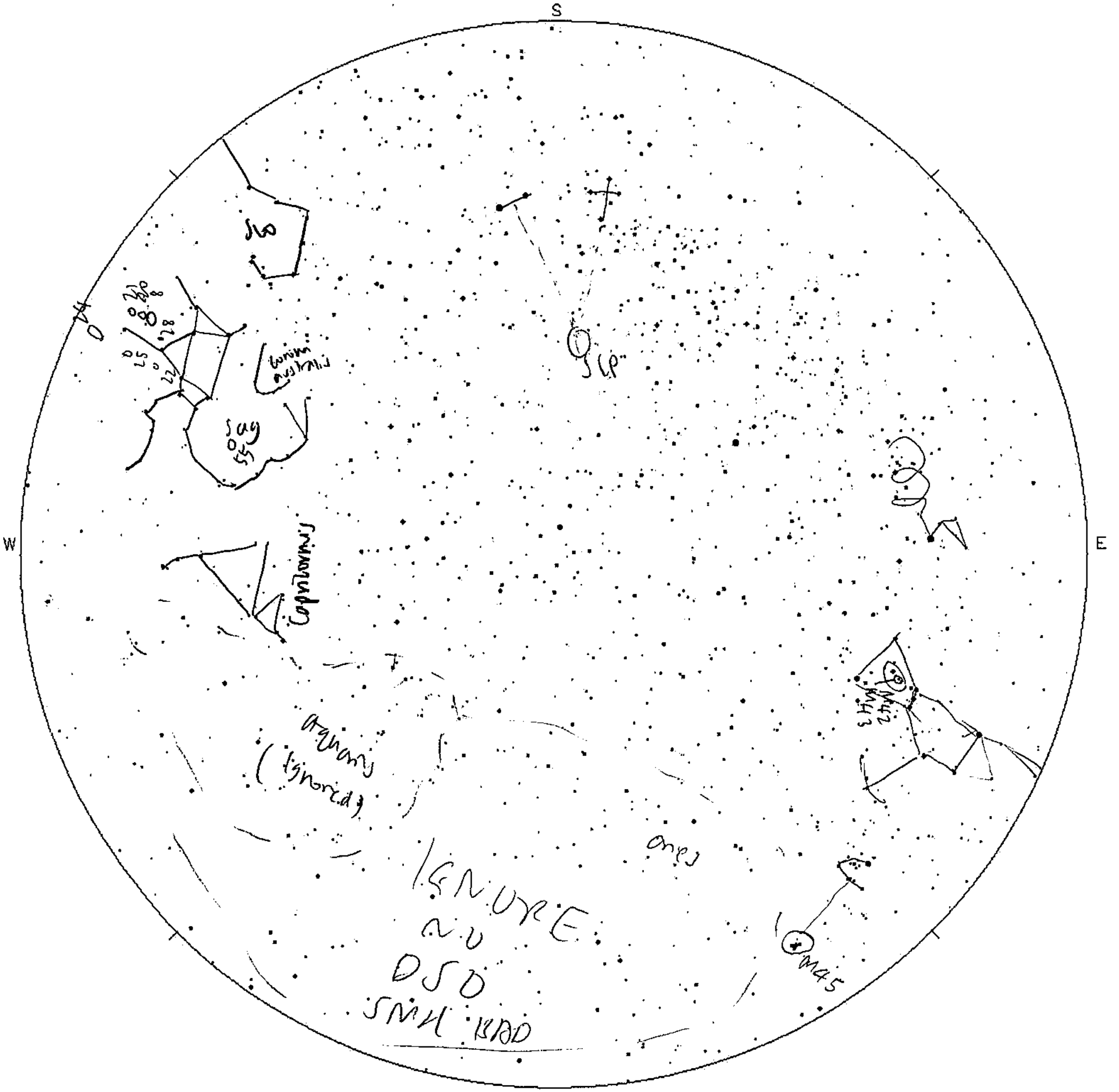
Aquila
Leo
Bootes
Her
Cancer
UMa
Lyra
Draco
UMi
N


S
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M7
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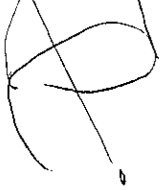
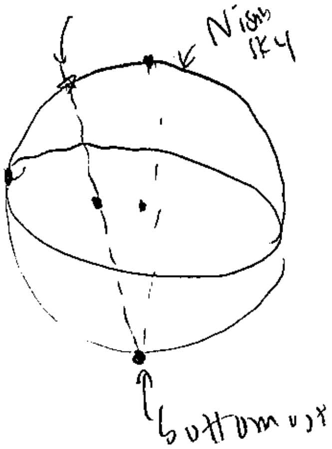
8
28
25
22
corona australis
Sag
55
Capricornus
aquarius
(ignored)
SCP
aries
M42
M43
M45
IGNORE
all
DSO
SMH BAD

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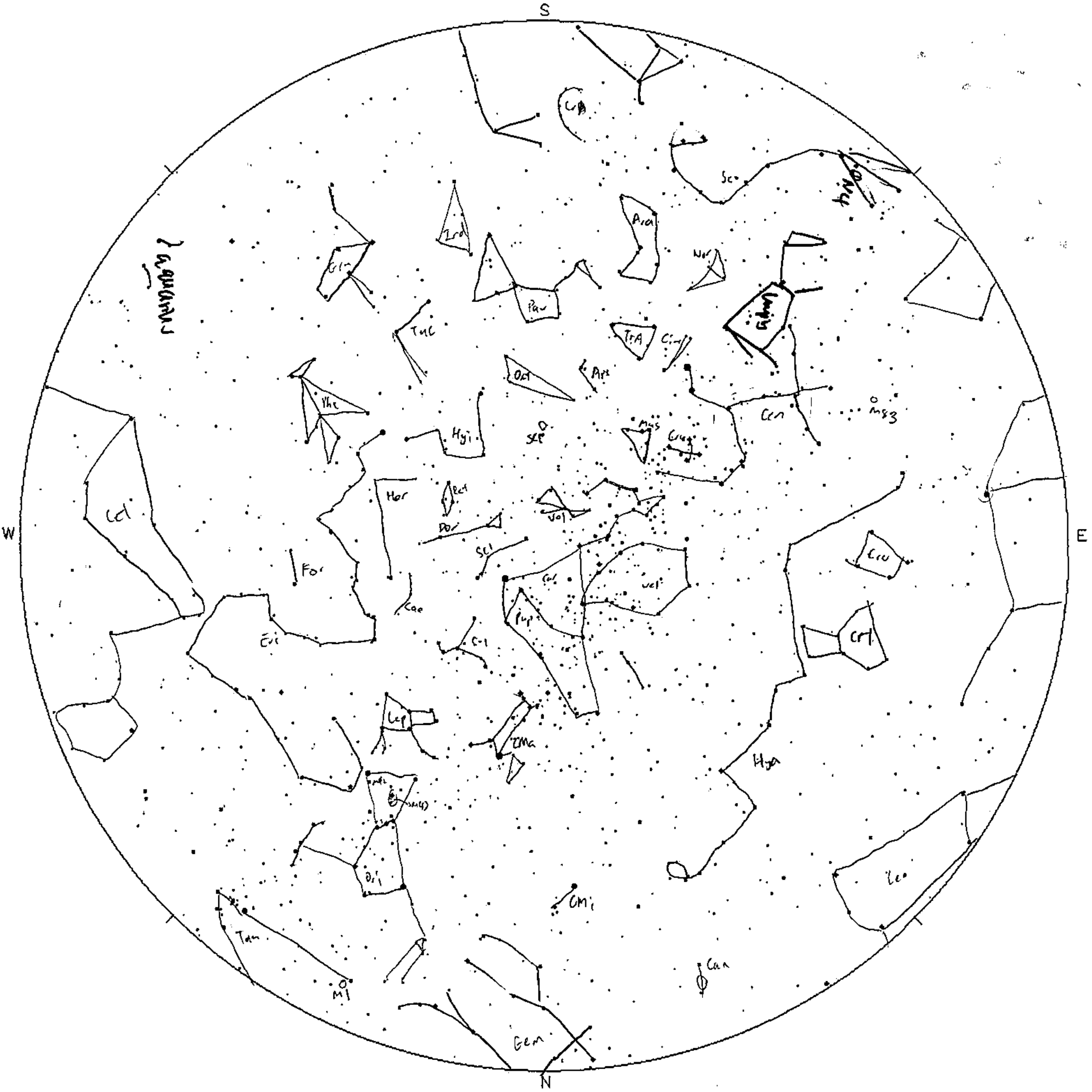
sky
bottommost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Aquarius
CrA
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Aps
Oct
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M83
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SCP
Mus
Crux
Cet
Hor
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M1
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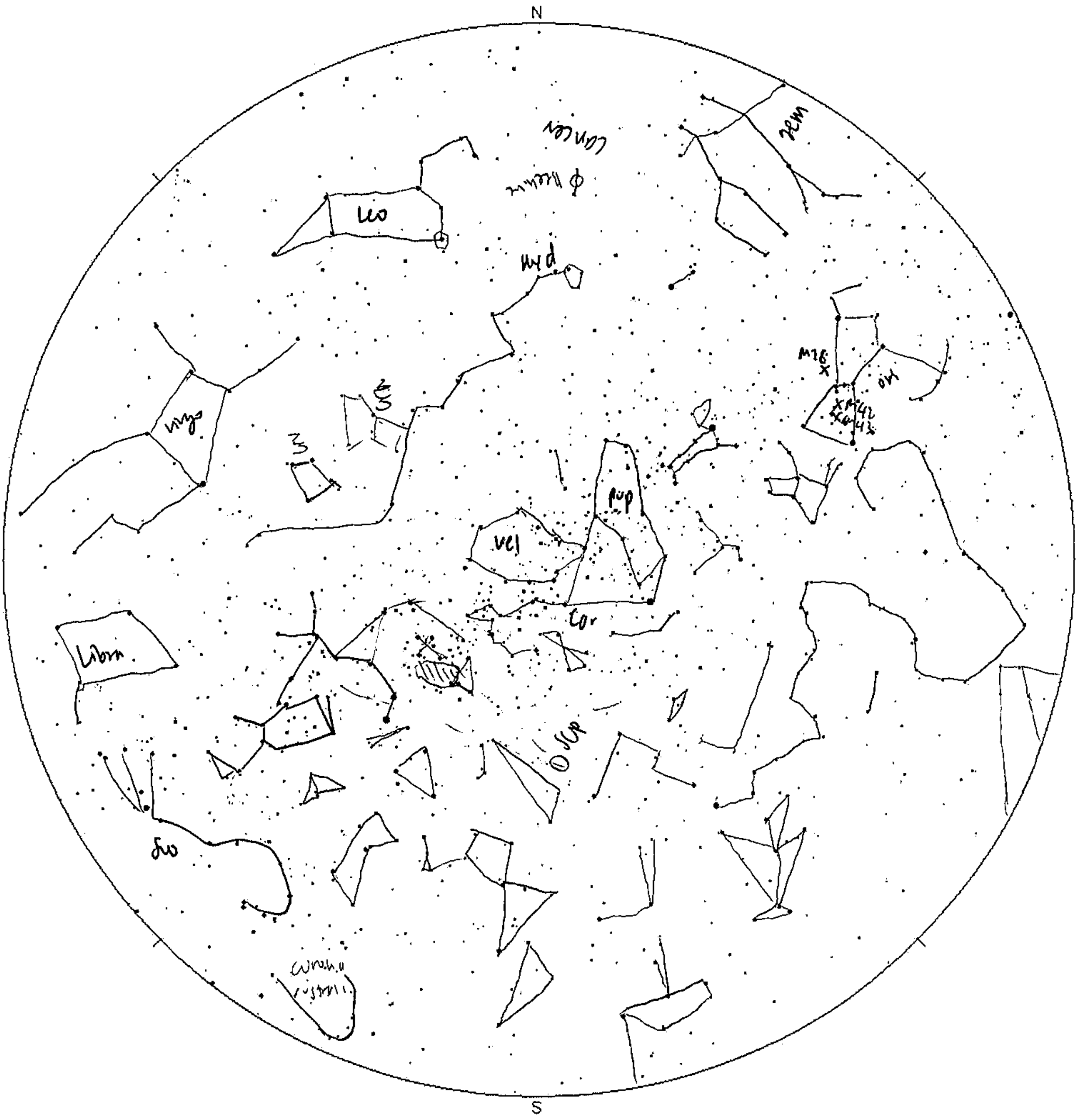
Gem

20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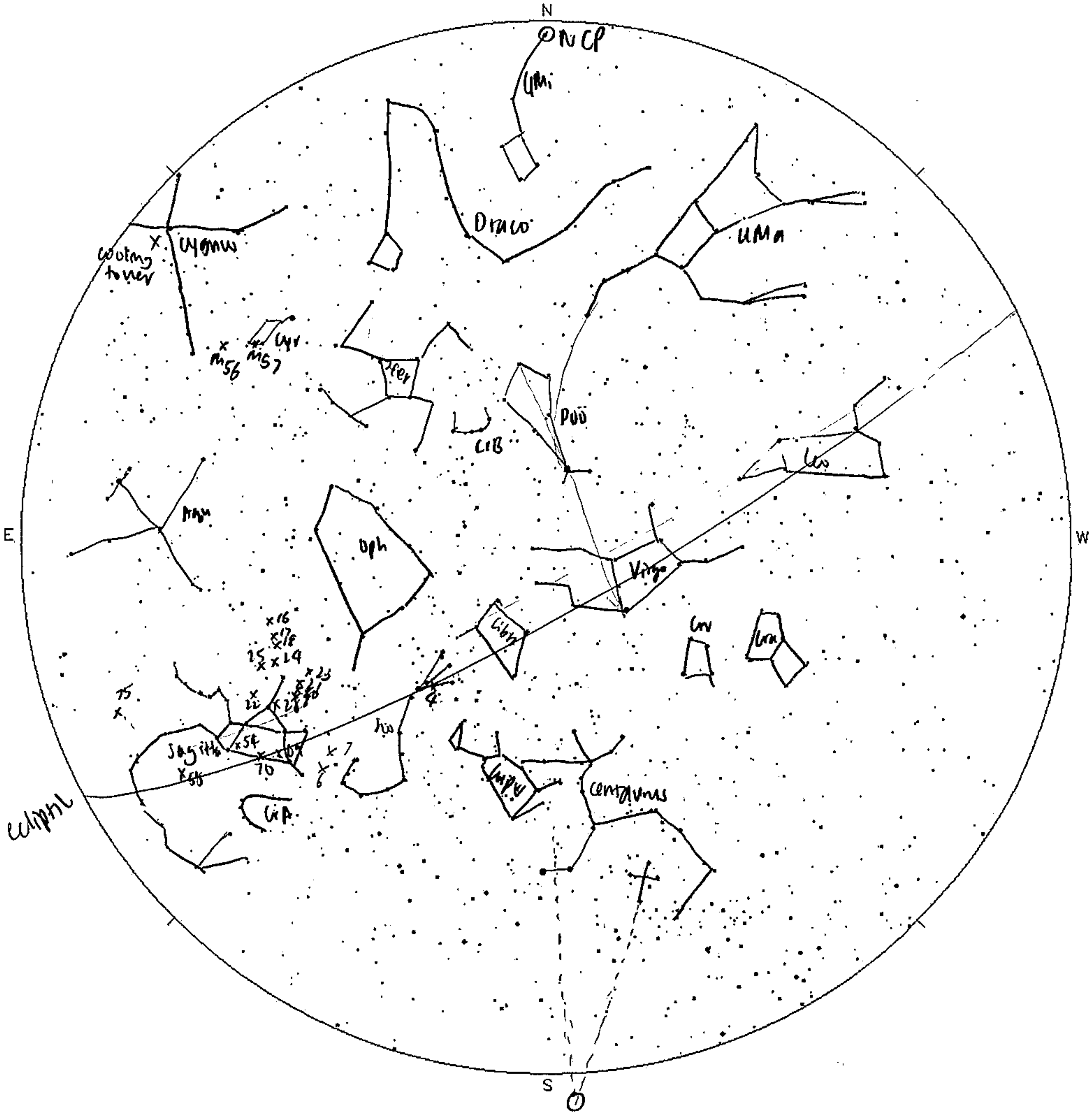
N
NCP
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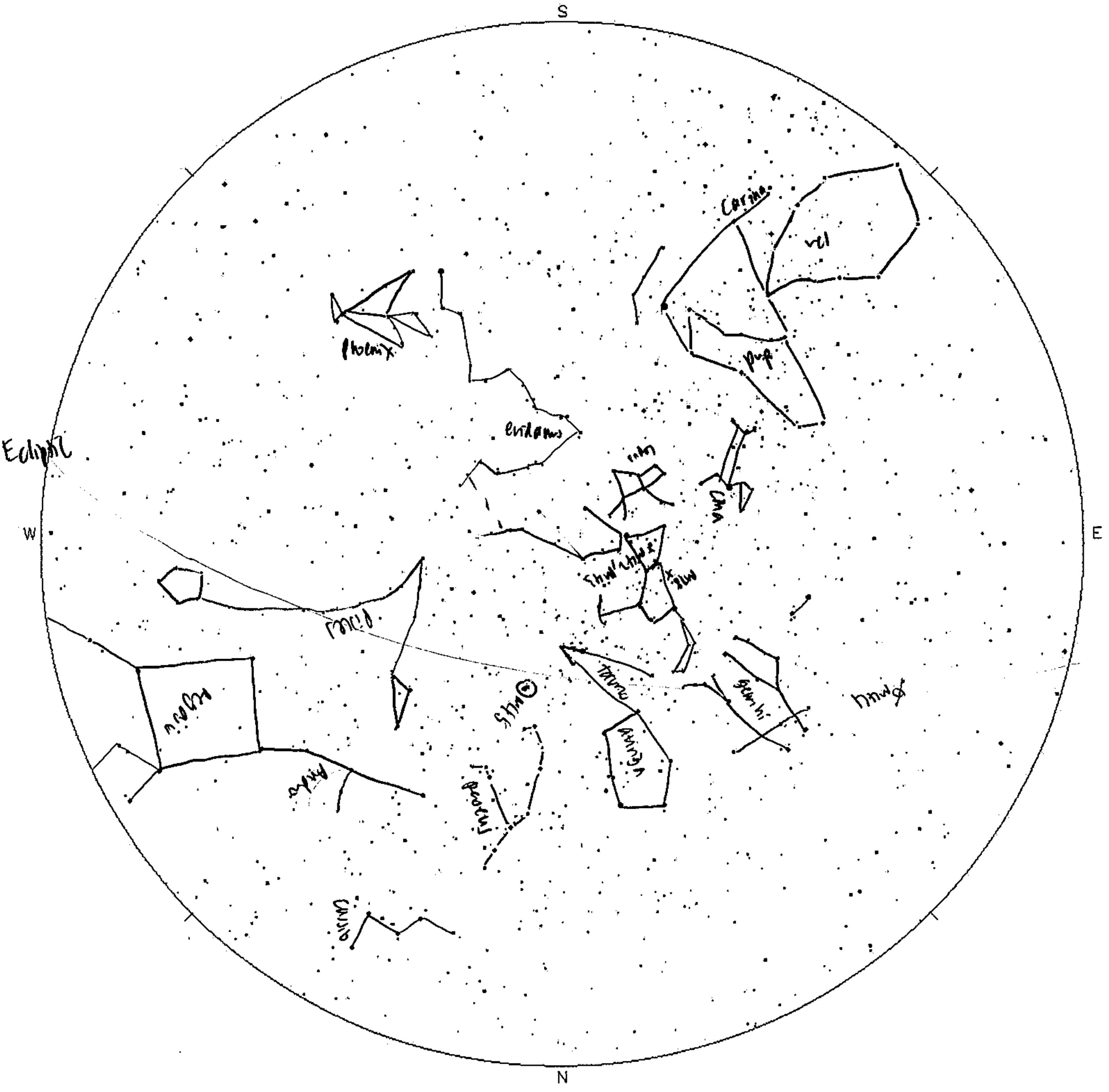
Draco
UMa
Cygnus
X cooling tower
x M56
x M57
Lyr
Her
CrB
Boo
Leo
E
W
Aql
Oph
Virgo
Libra
Crv
Crt
x16
x17
x18
25
x 24
x 23
x 22
x 28
x 21
20
75
x
x 54
70
x 69
Sagitta
x 55
x 7
x 6
Q
Sco
CrA
Lupus
Centaurus
ecliptic
S
O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Carina
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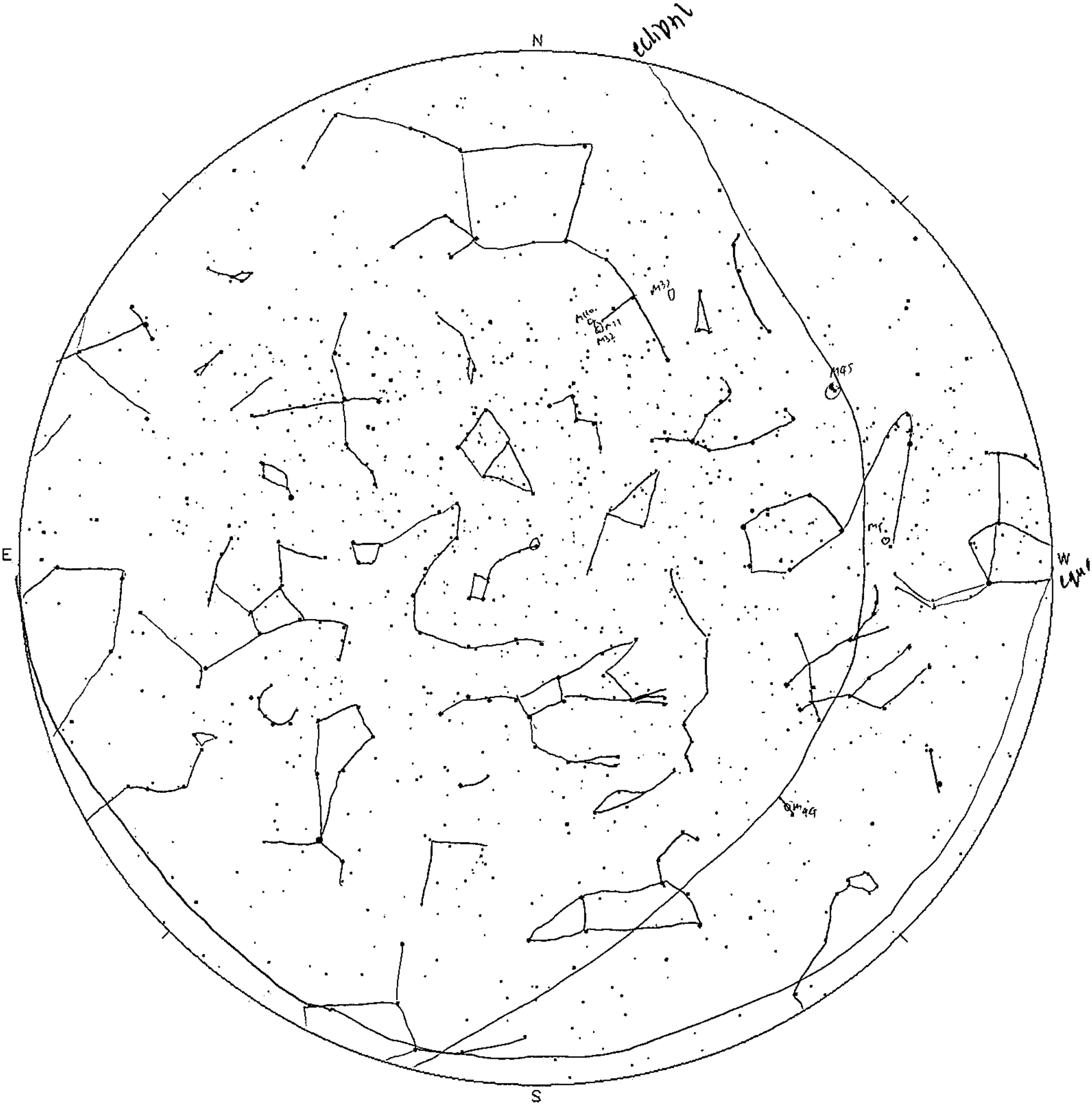
Pup
Phoenix
Eridanus
Lepus
CMa
M42, M43
M78
Taurus
Auriga
Gemini
Cancer
M45
Perseus
Pisces
Pegasus
Andro
Cassio

22


ecliptic
N
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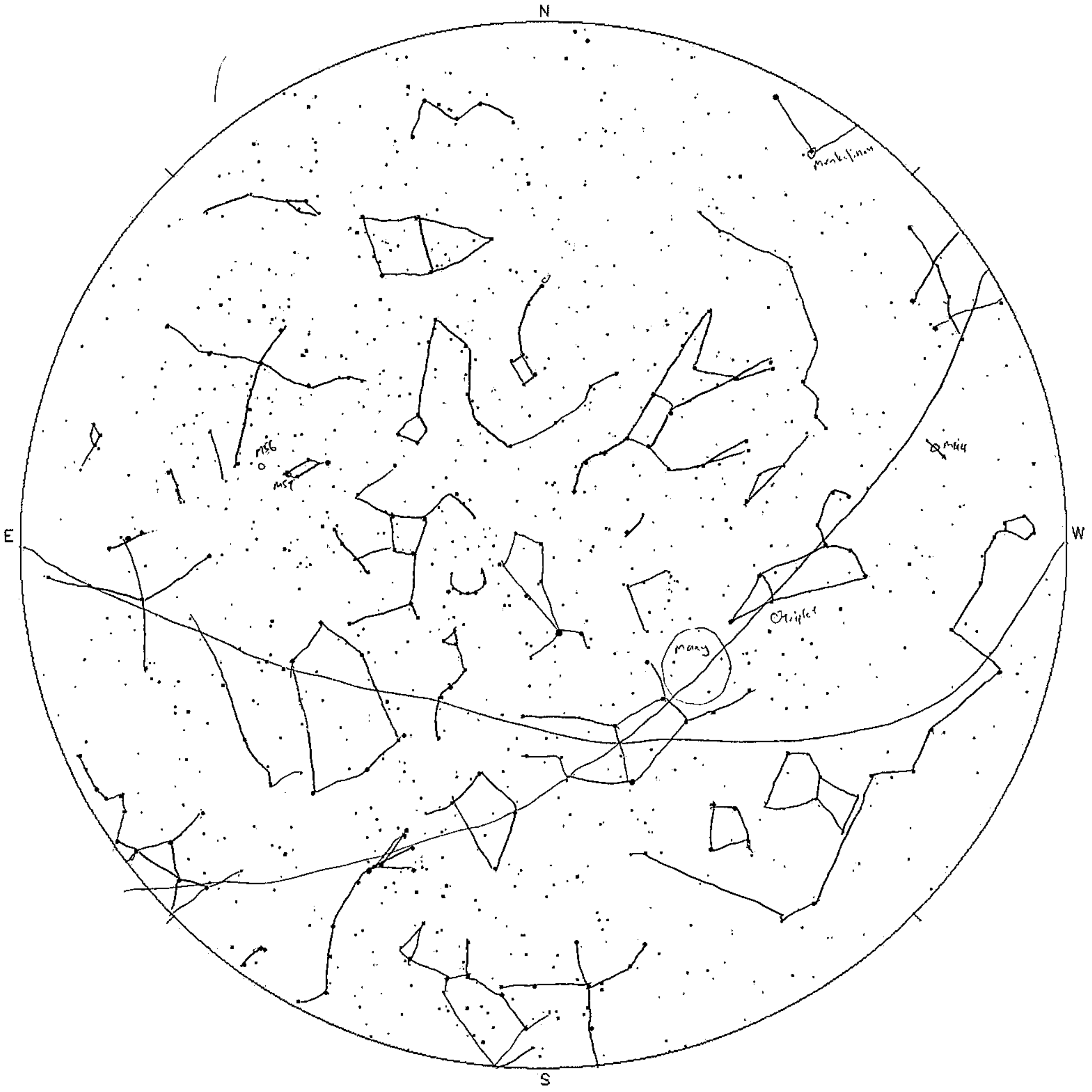
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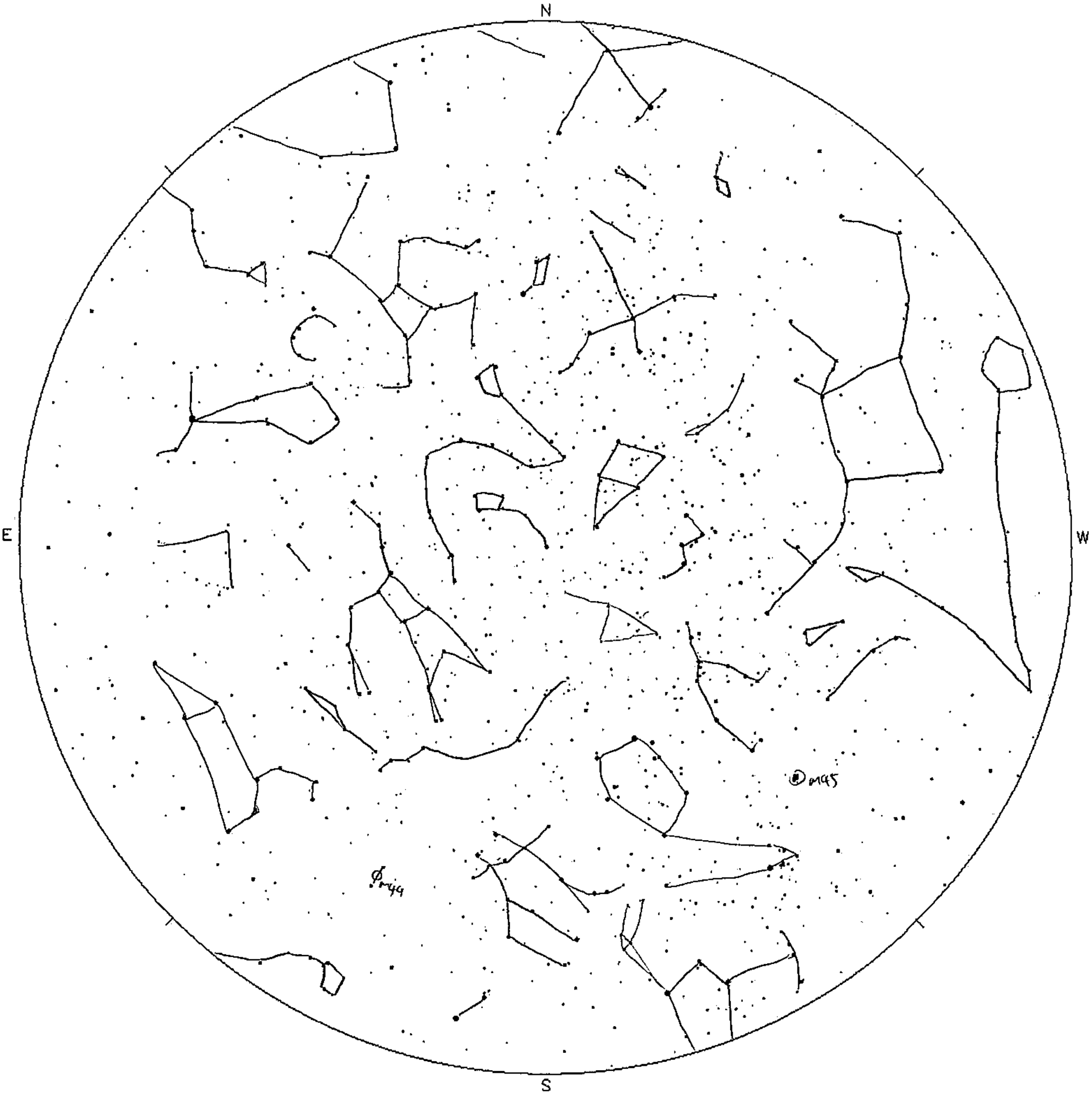
Menkalinan
M56
M57
M44
E
W
Triplet
Many
S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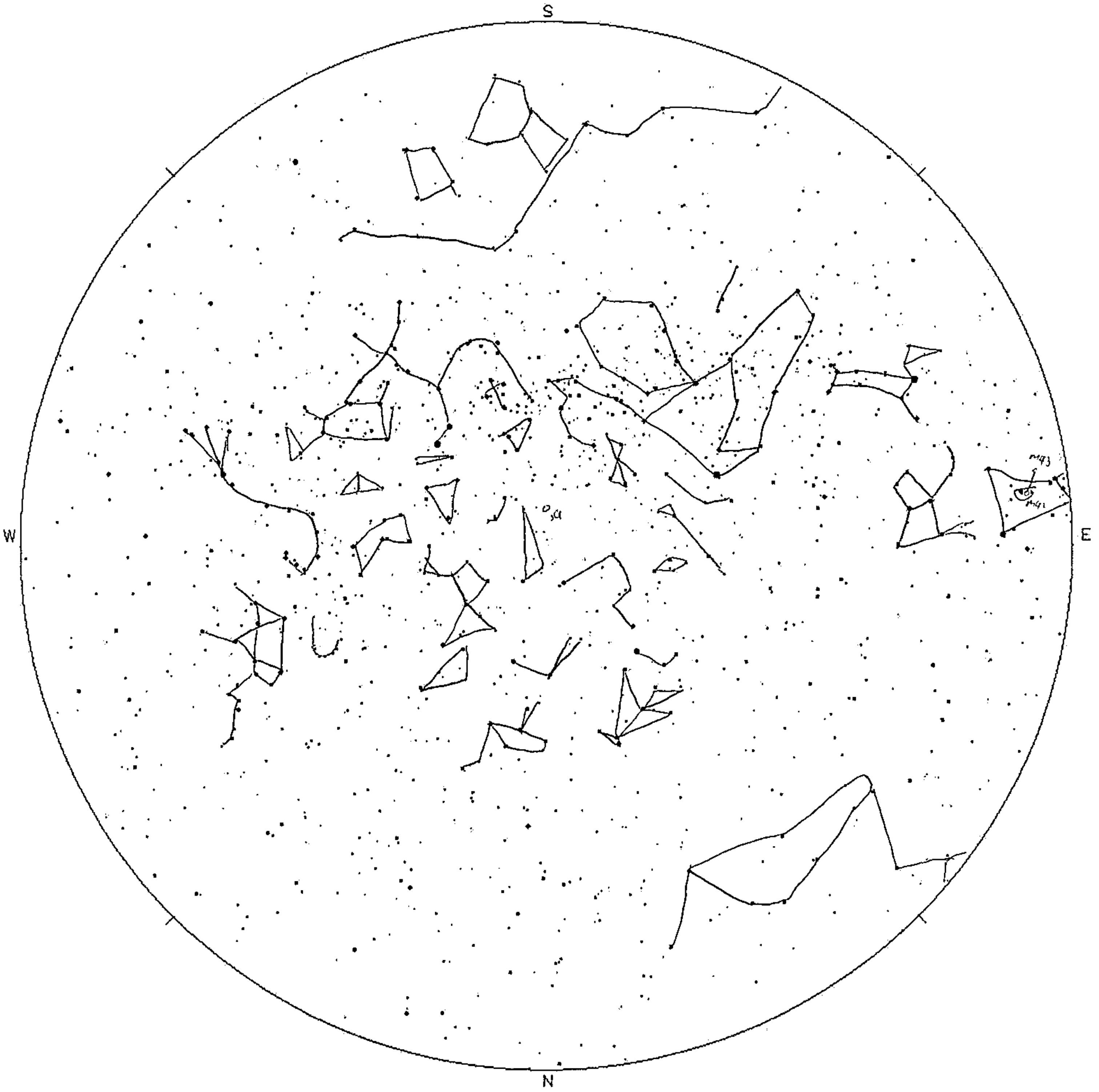
E
W
S
m95
m44


S
W
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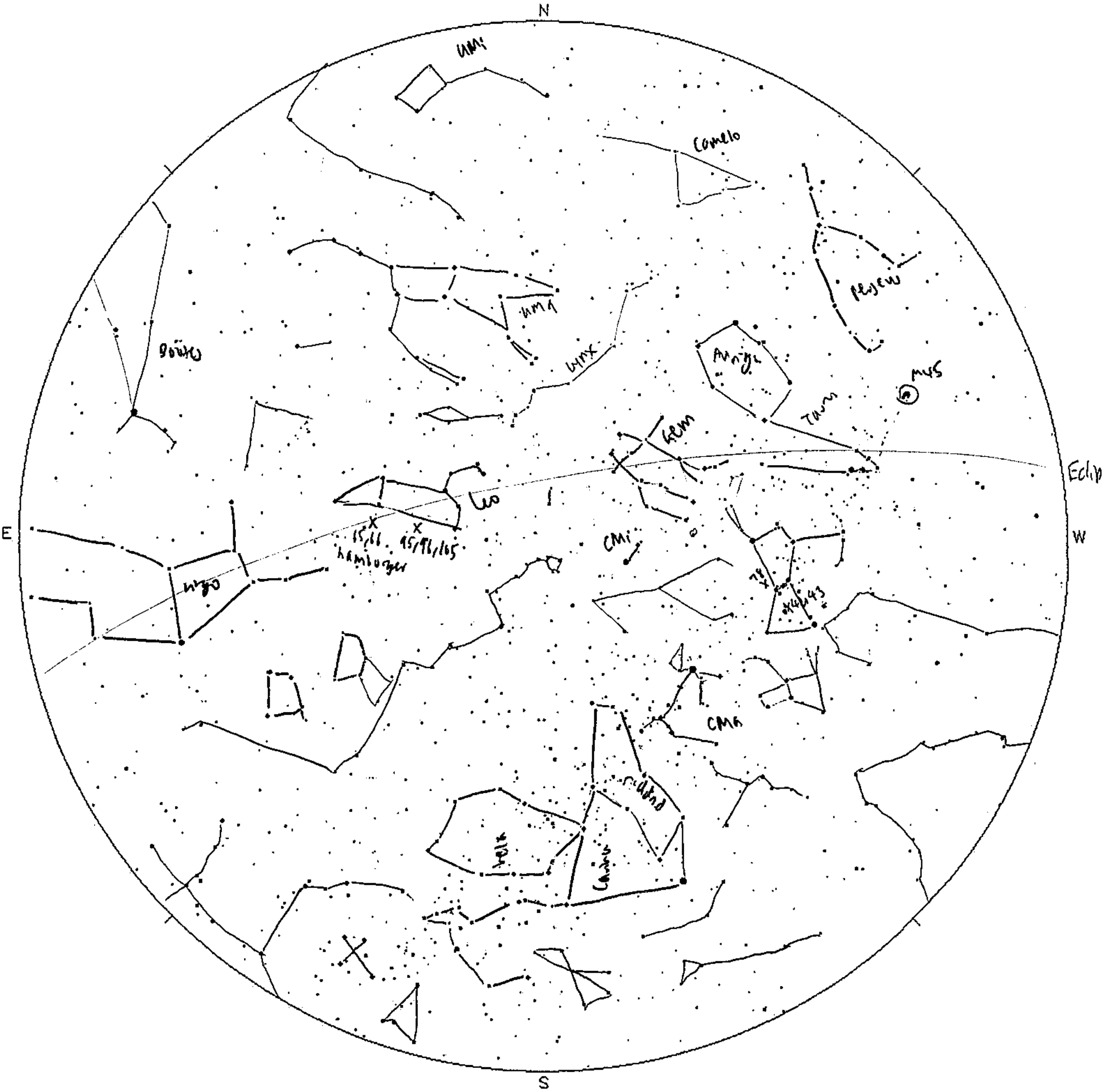
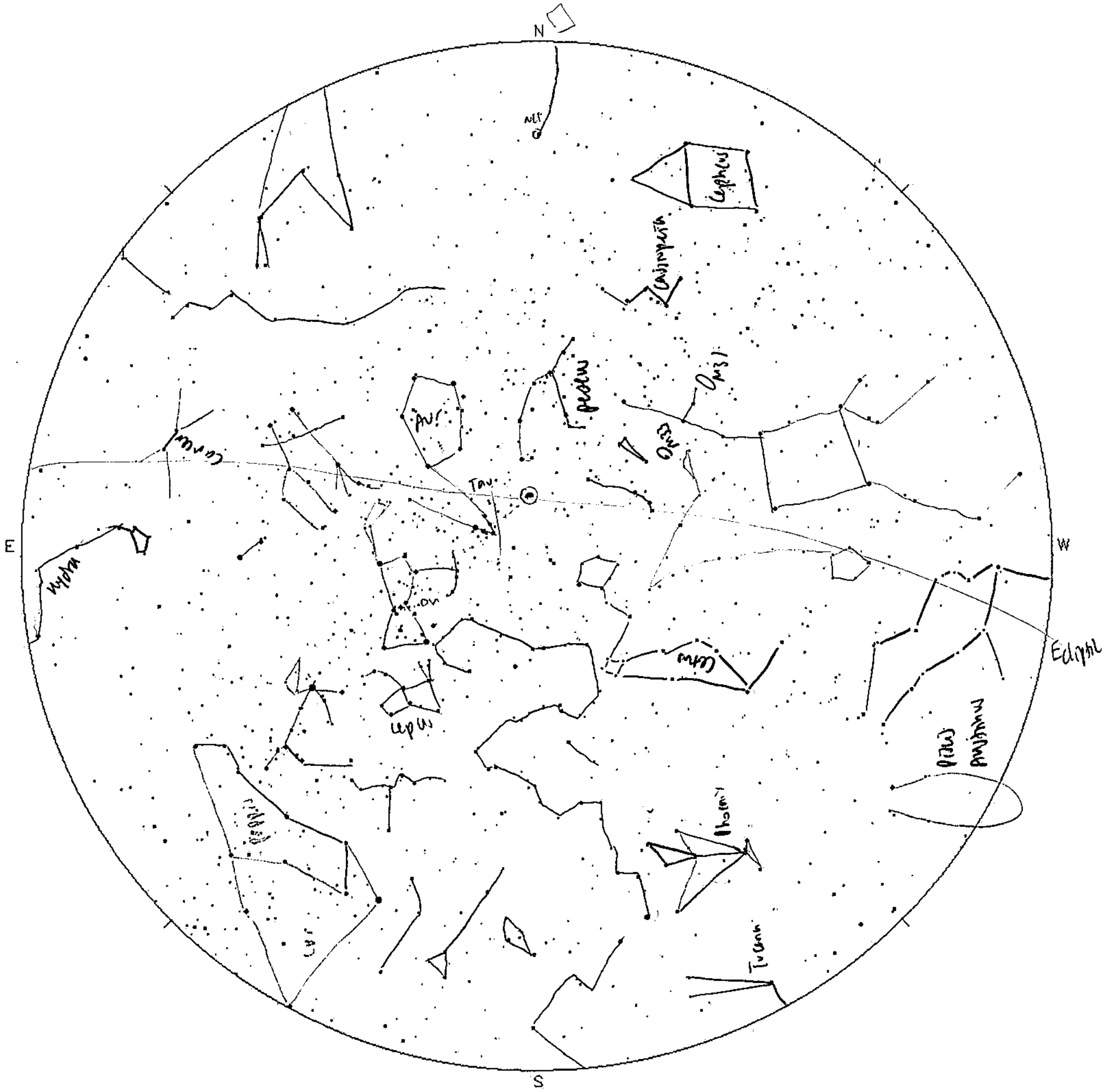
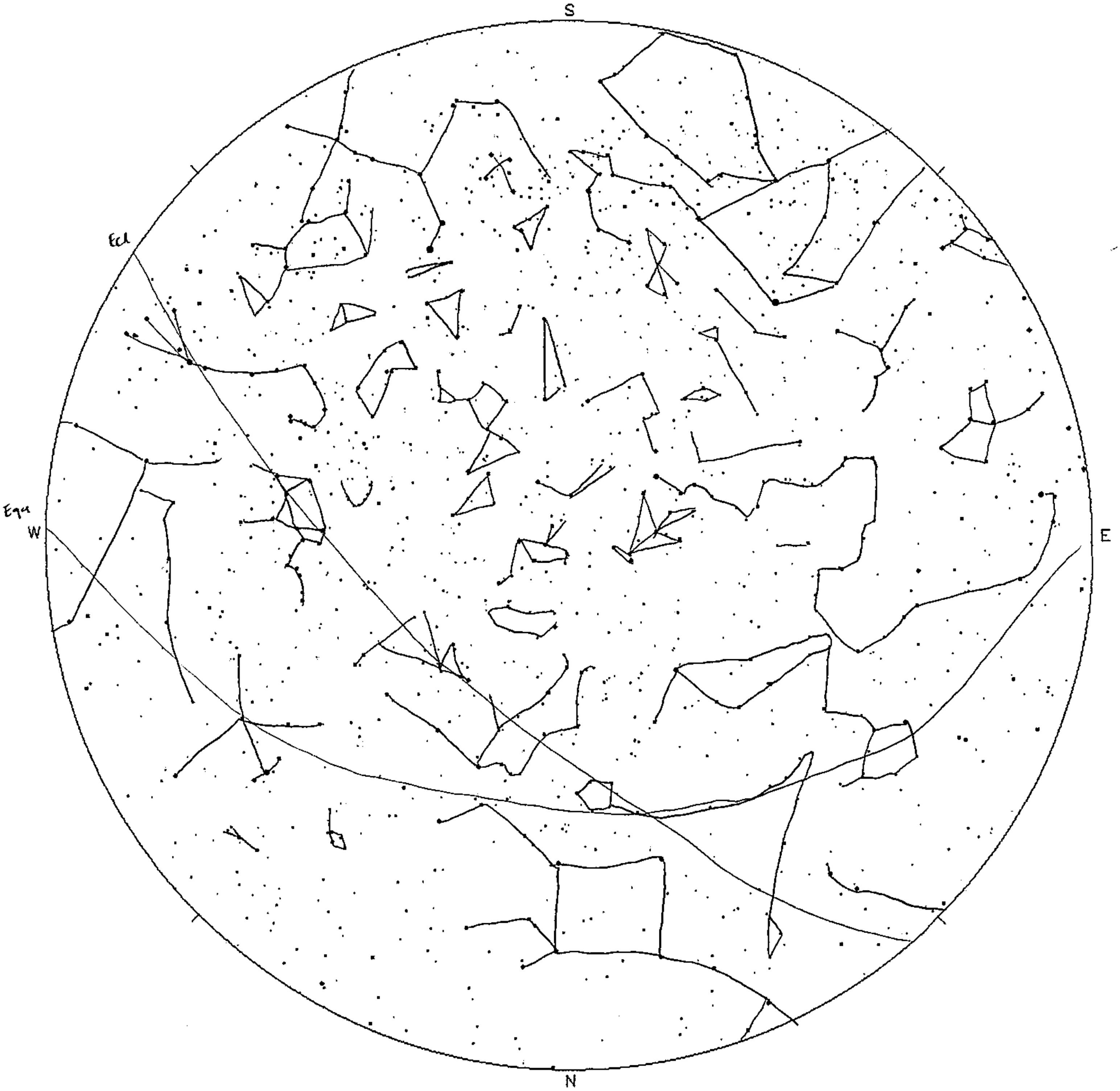
N
m43
m41
o,a


N
UMi
Camelo
Perseus
Boötes
UMa
Lynx
Auriga
M45
Taurus
Gem
Eclip
E
W
Leo
X
X
15/66
95/96/105
hamburger
CMi
Virgo
78
X
X42/43
CMa
Puppis
Vela
Carina
S


N
M31
Cepheus
Cassiopeia
Perseus
M31
M33
Aur
Tau
Canis Minor
E
Hydra
Ori
Lepus
W
Ecliptic
Cetus
Piscis
Austrinus
Puppis
Car
Phoenix
Tucana
S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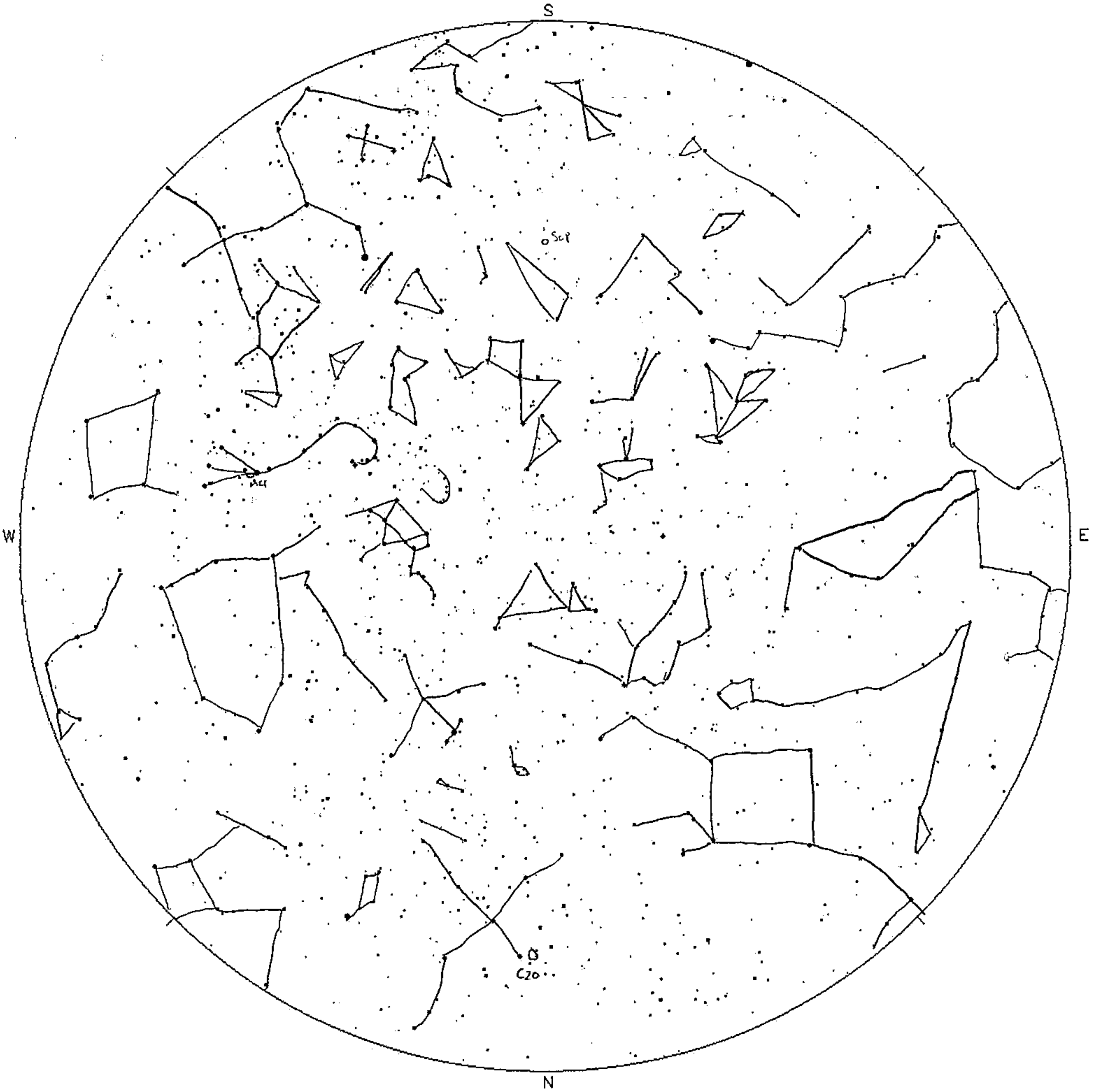
Ecl
Equ
W
E
N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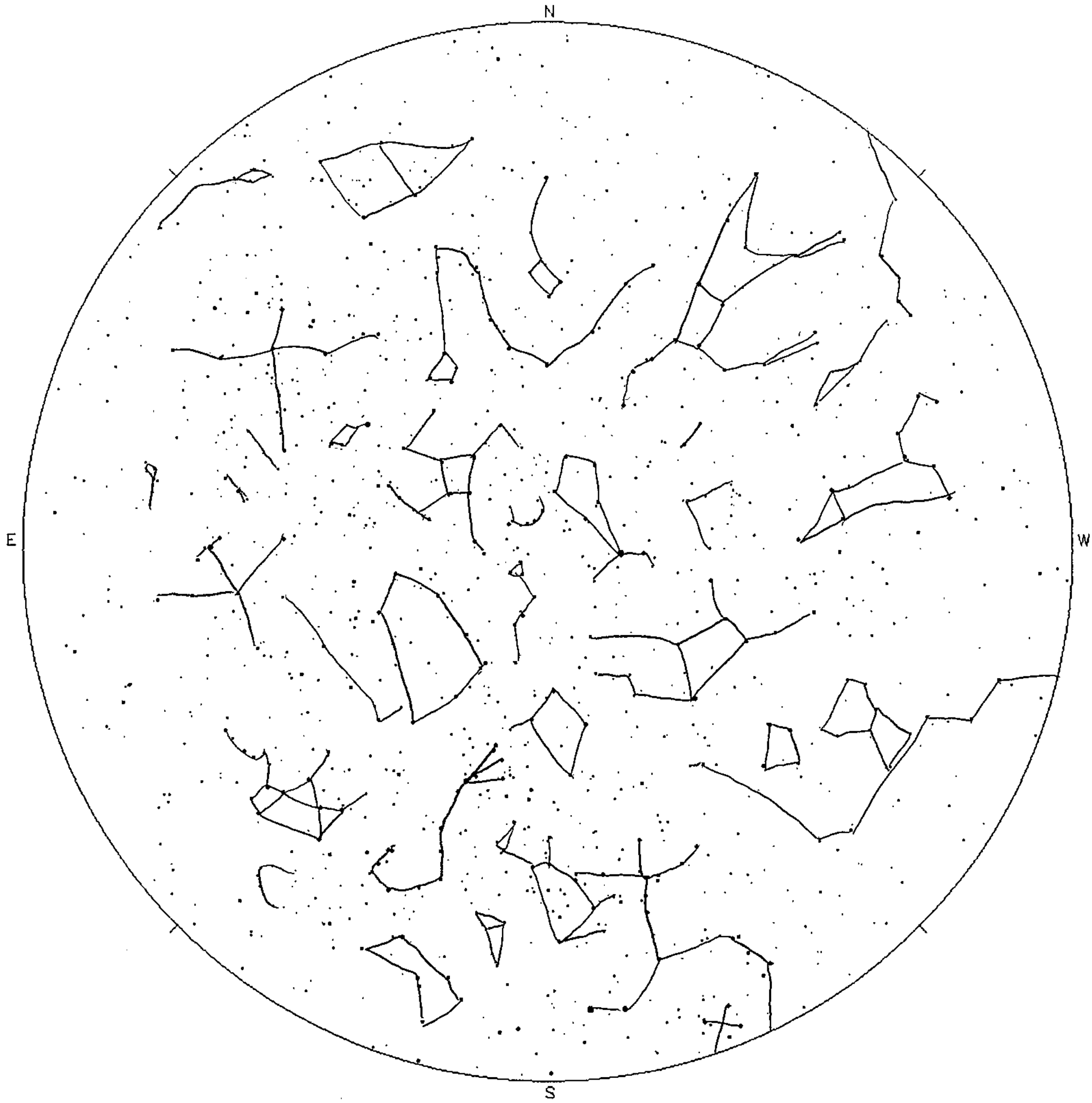
Scp
M4
W
E
C20
N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E
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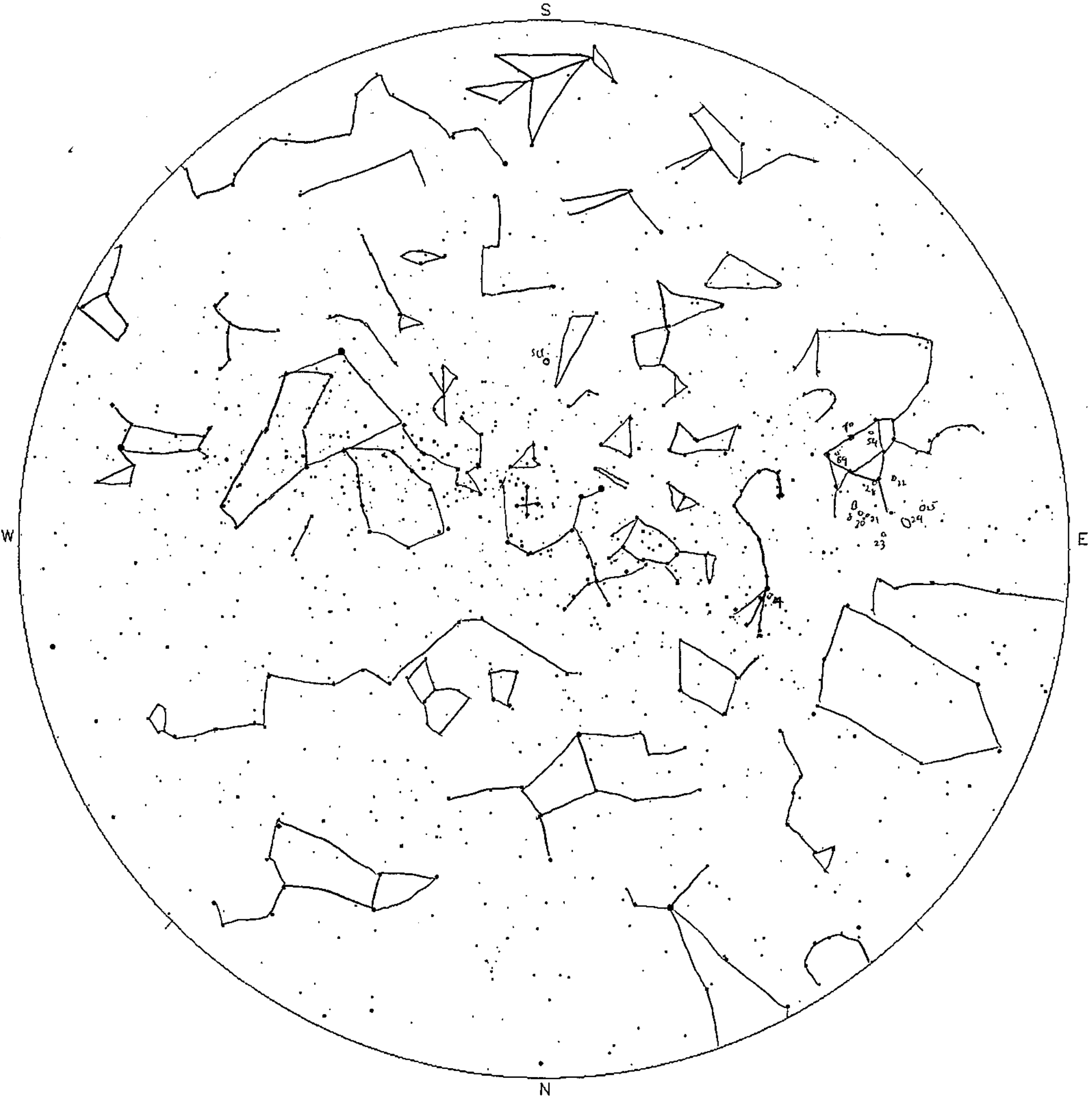
S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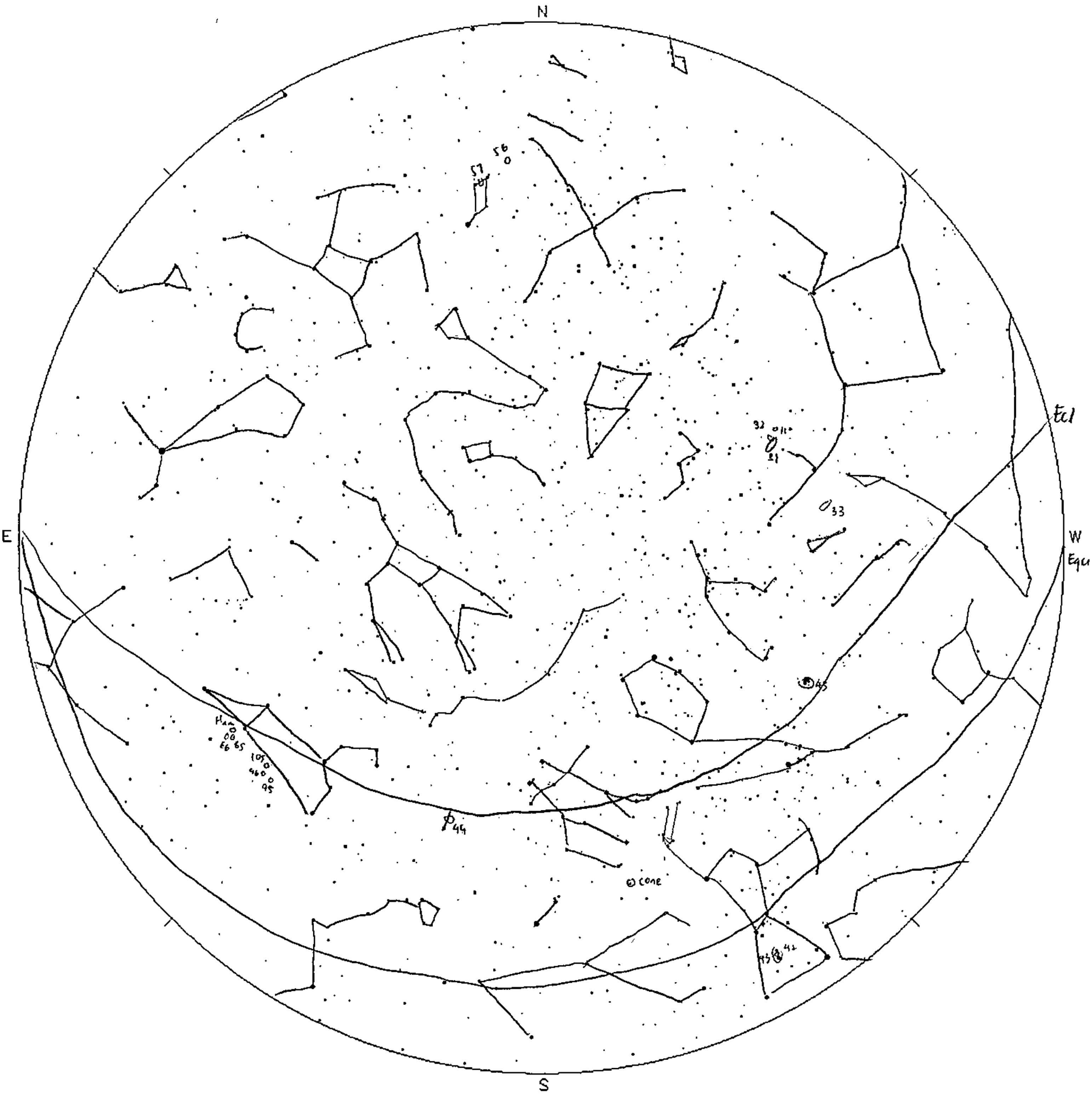
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57
56
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33
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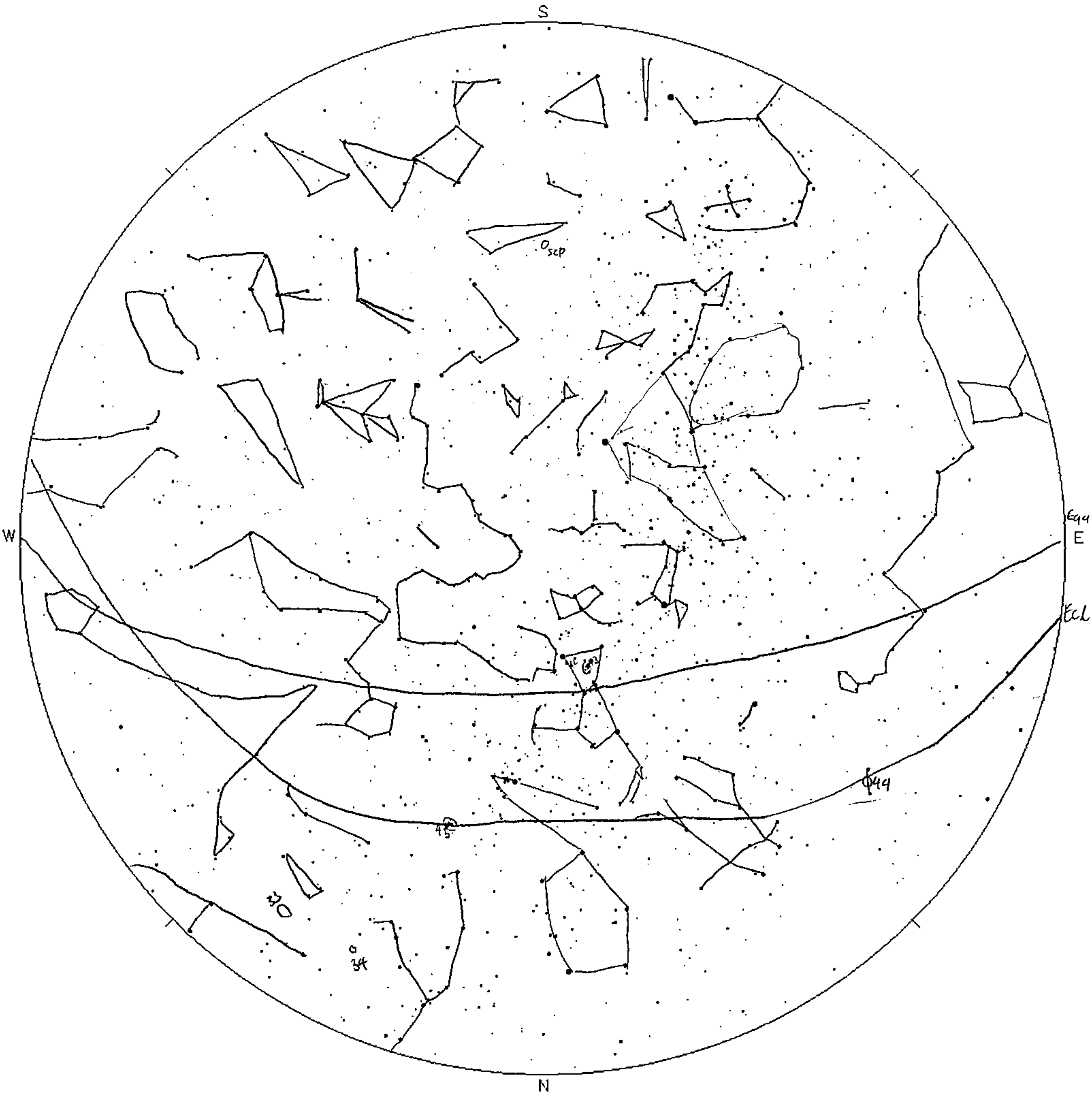
W
Ecl
Equ
45
Han
E6
65
105
46
95
44
cone
43
42
S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Oscp
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Eq4
E
Ecl
GP2
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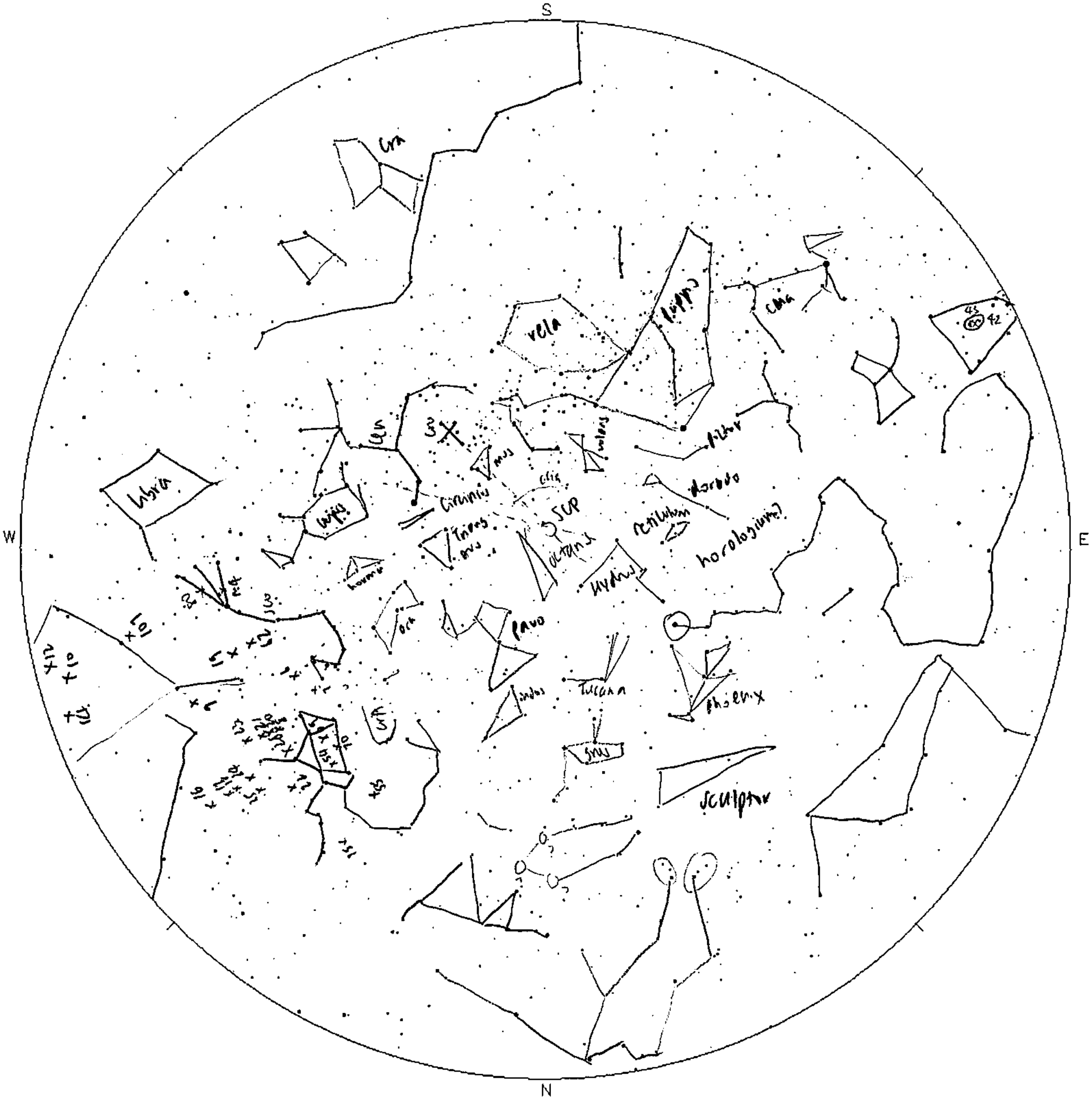
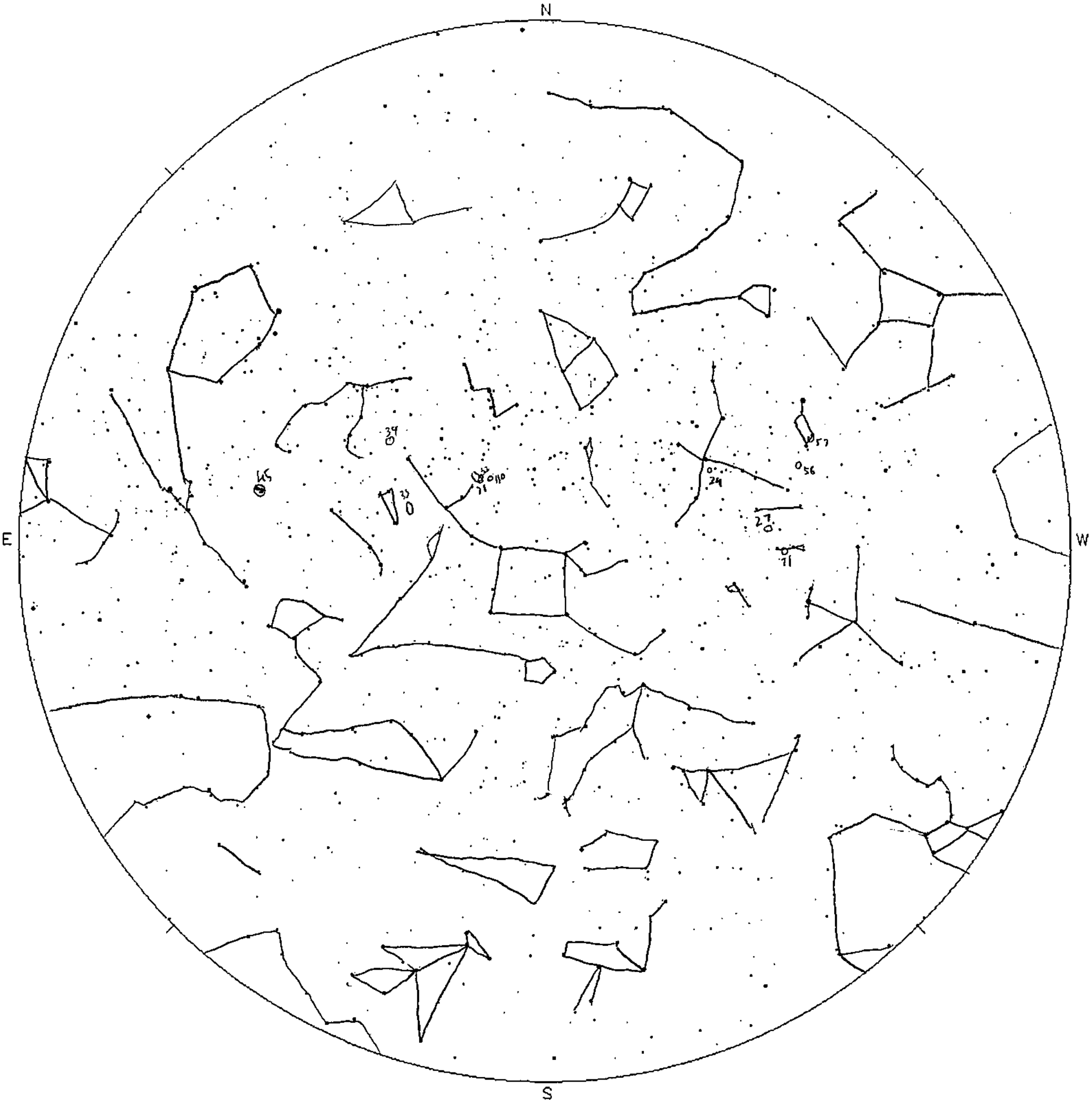
34
N


S
W
E
N
Gra
vela
puppis
Cma
45
50
42
Cen
Cru
libra
lupus
mus
volans
pictor
Circinus
Cha
SCP
Octans
Triang Aus
dorado
reticulum
horologium
Norma
Ara
Hydrus
Pavo
Indus
Tucana
Phoenix
SMC
sculptor
CrA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71


S
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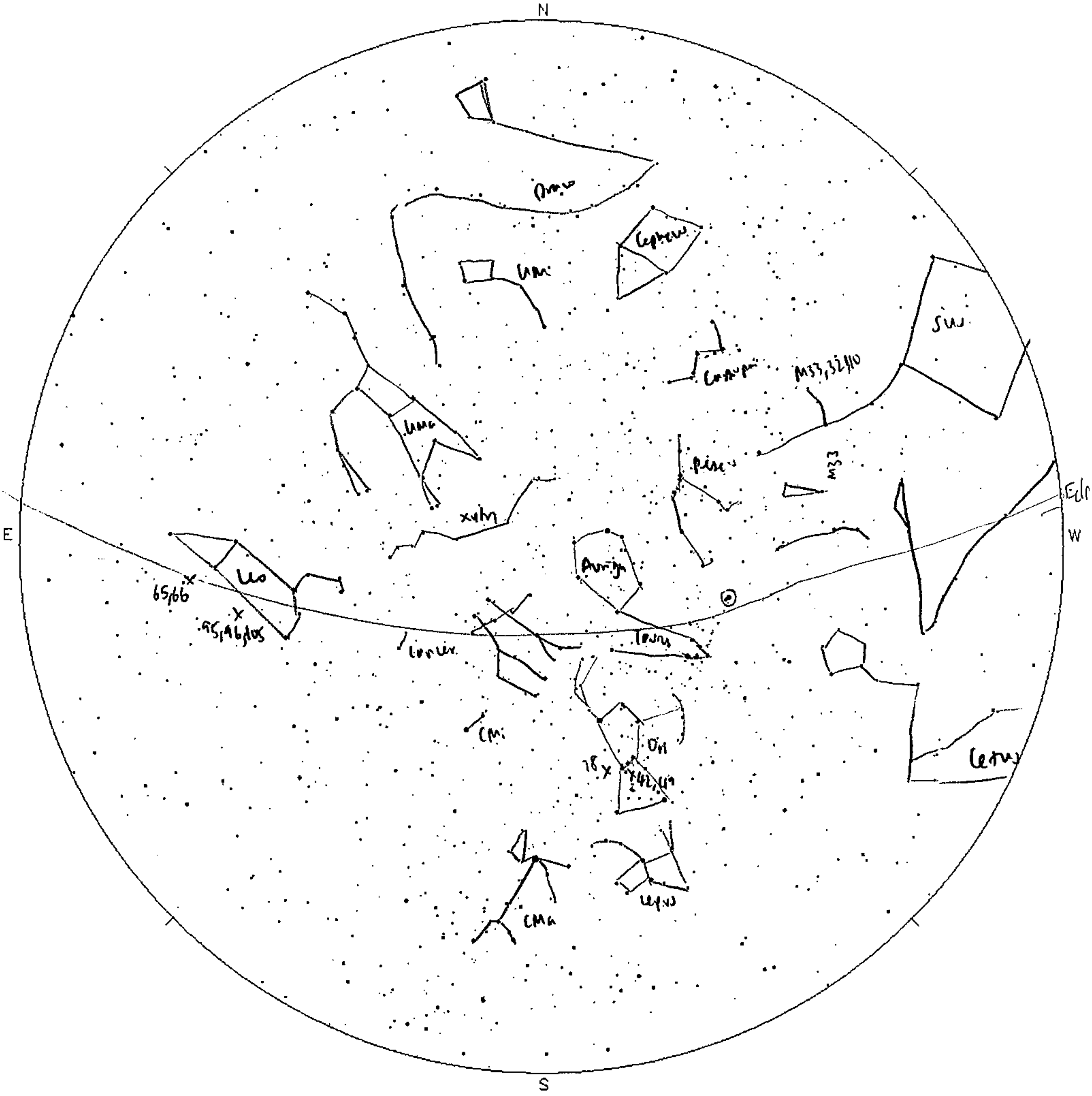
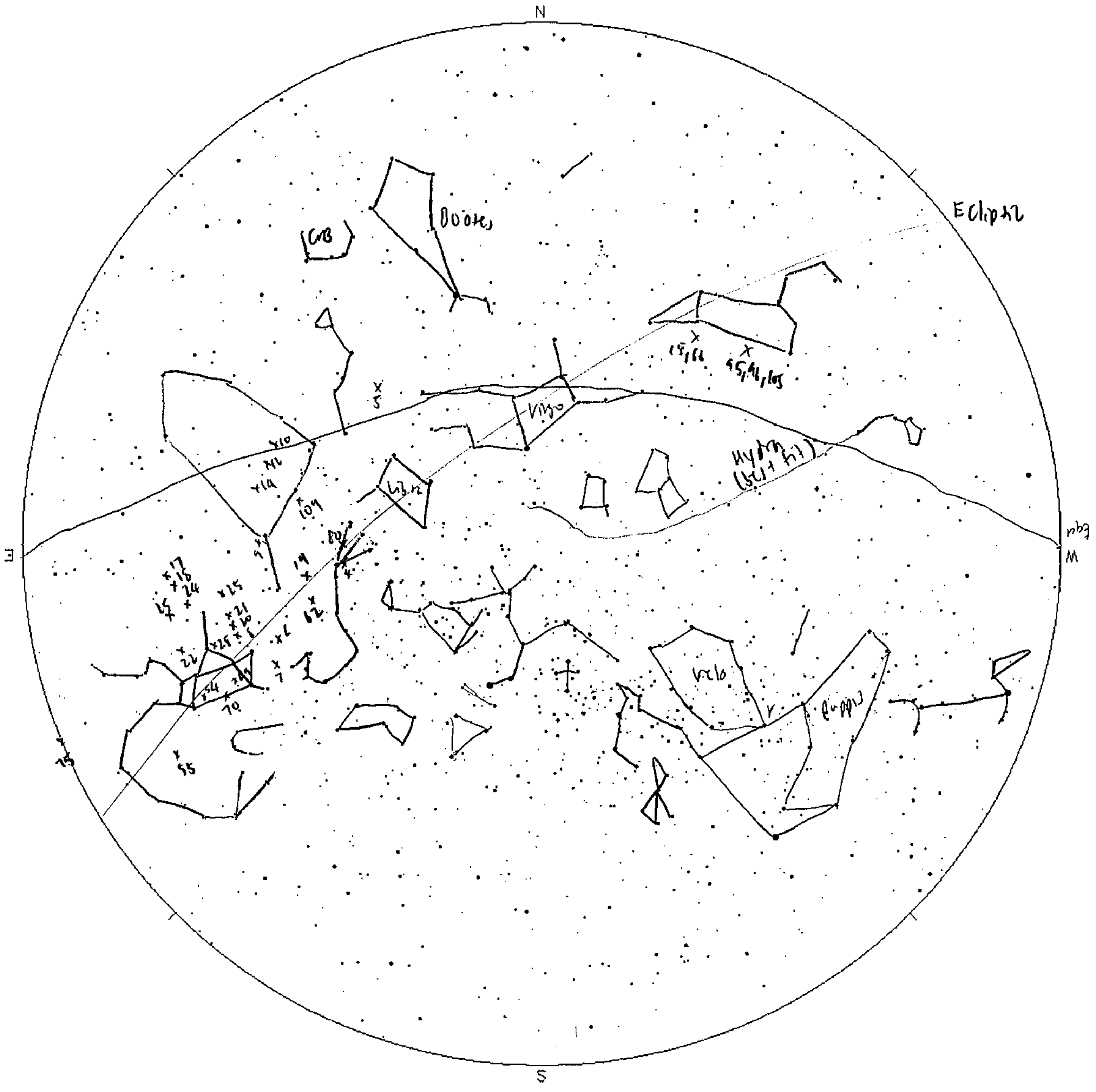
W
E
N


N
Draco
Cepheus
UMi
Cassiop
M33,32,110
Sw
UMa
Pisces
M33
Lynx
E
Leo
65,66
95,96,105
Auriga
Ecl
W
Taurus
Cancer
CMi
Ori
78
42,49
Cetus
Lepus
CMa
S


N
Bootes
CrB
Ecliptic
x
19,166
x
45,41,105
x
5
Virgo
Hydra
x10
x12
x14
109
Libra
80
9
19
x
x17
x18
x24
x25
25
x21
x20
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x22
x25
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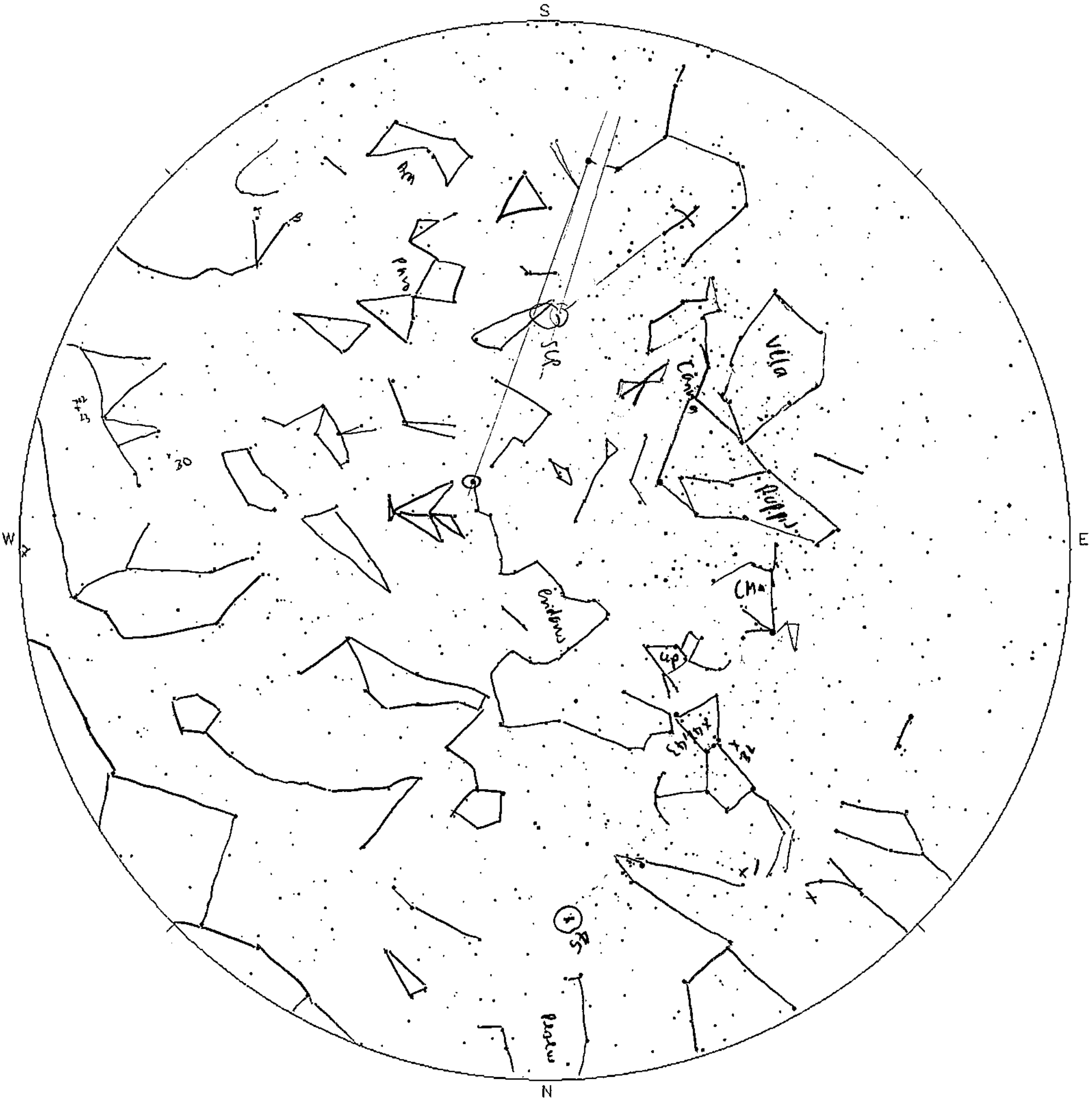
7
x
55
75
Vela
Puppis
E
W
Equ
S


S
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N
Ara
Pavo
SR
Vela
Carina
Puppis
CMa
Eridanus
Lep
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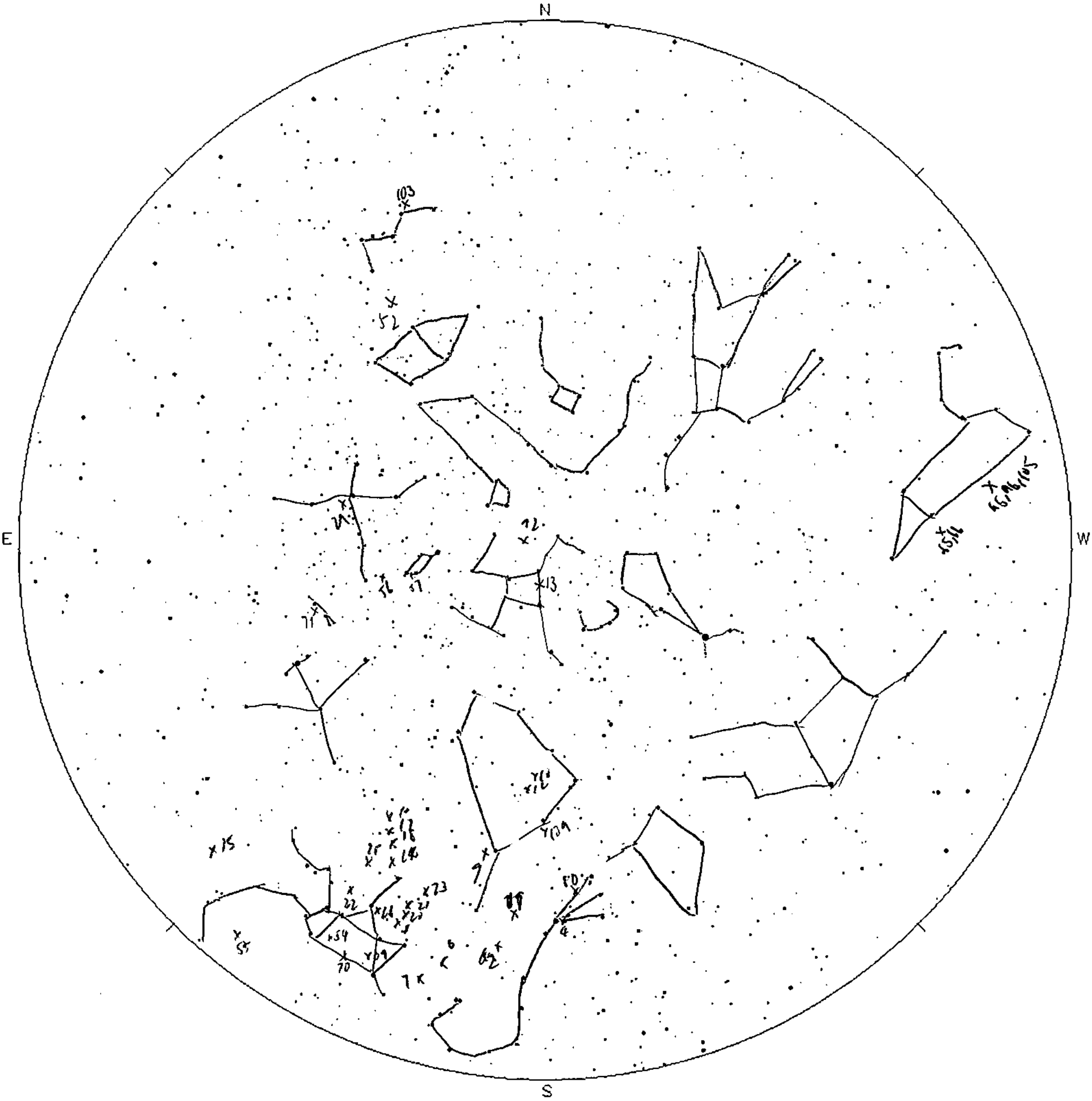
x1
45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W
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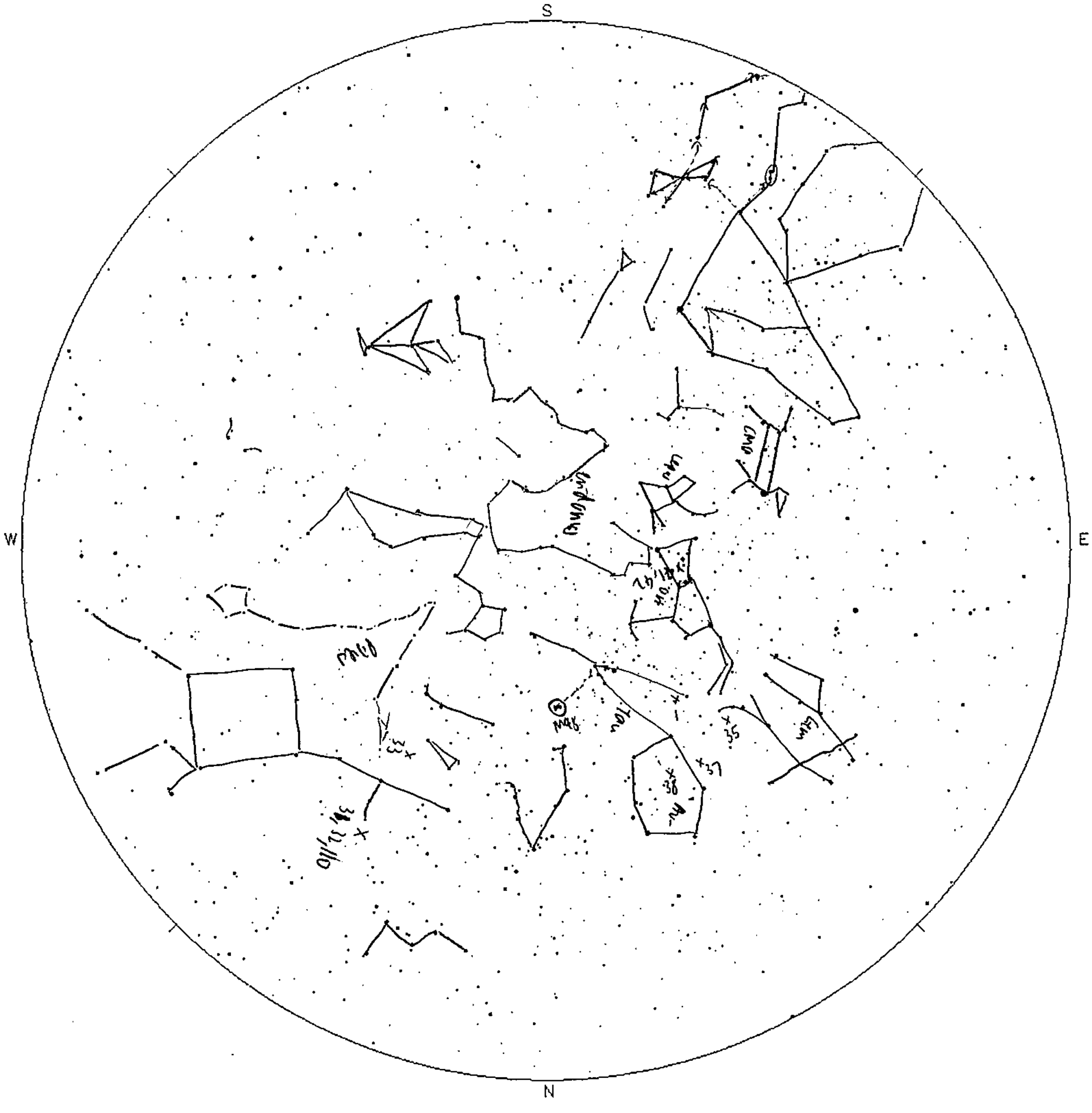
S
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E
N
CMi
Per
33
38, 32, 110
M45
Tau
37
38
Aur
35
Gem


N
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W
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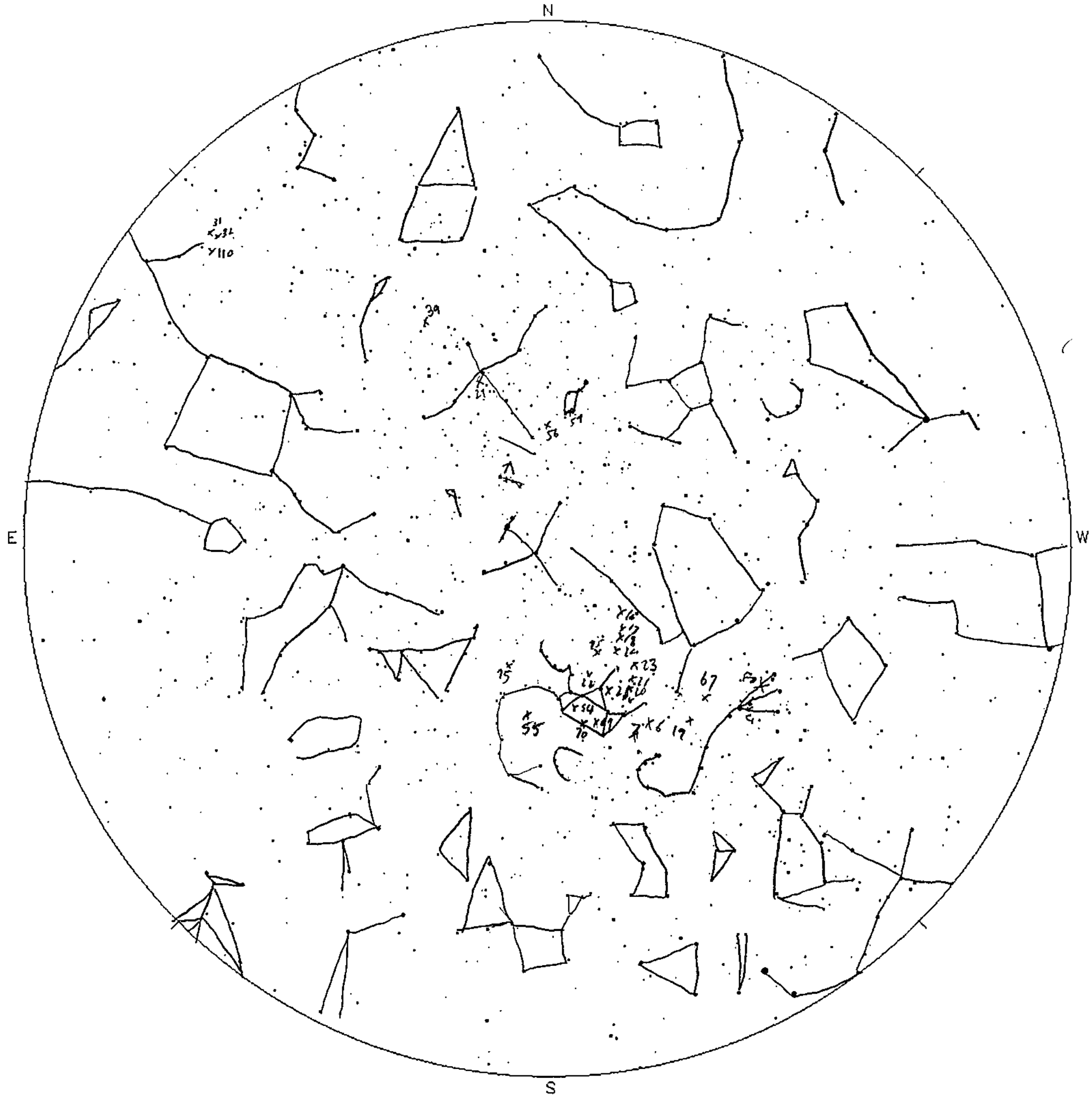
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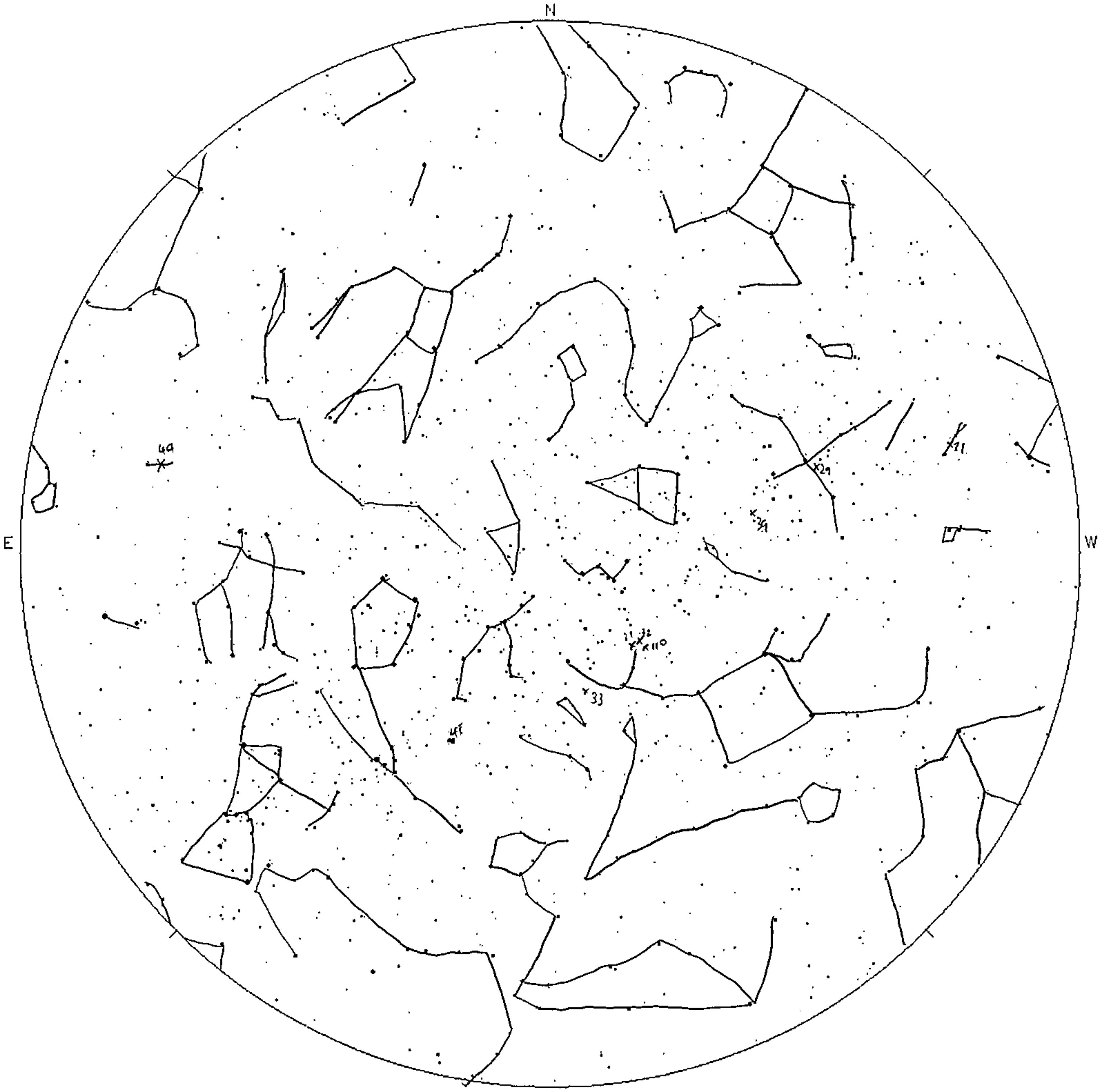
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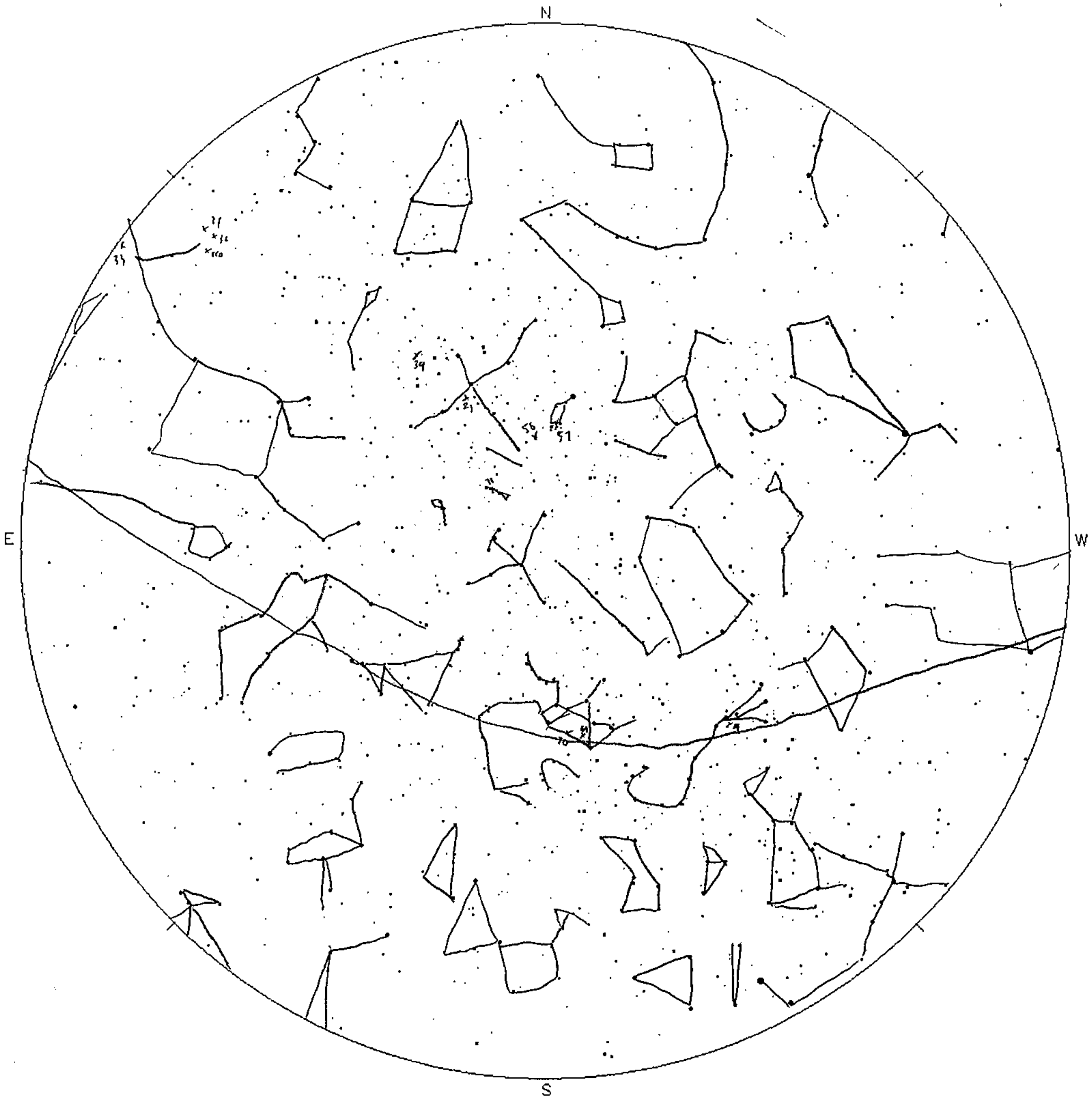
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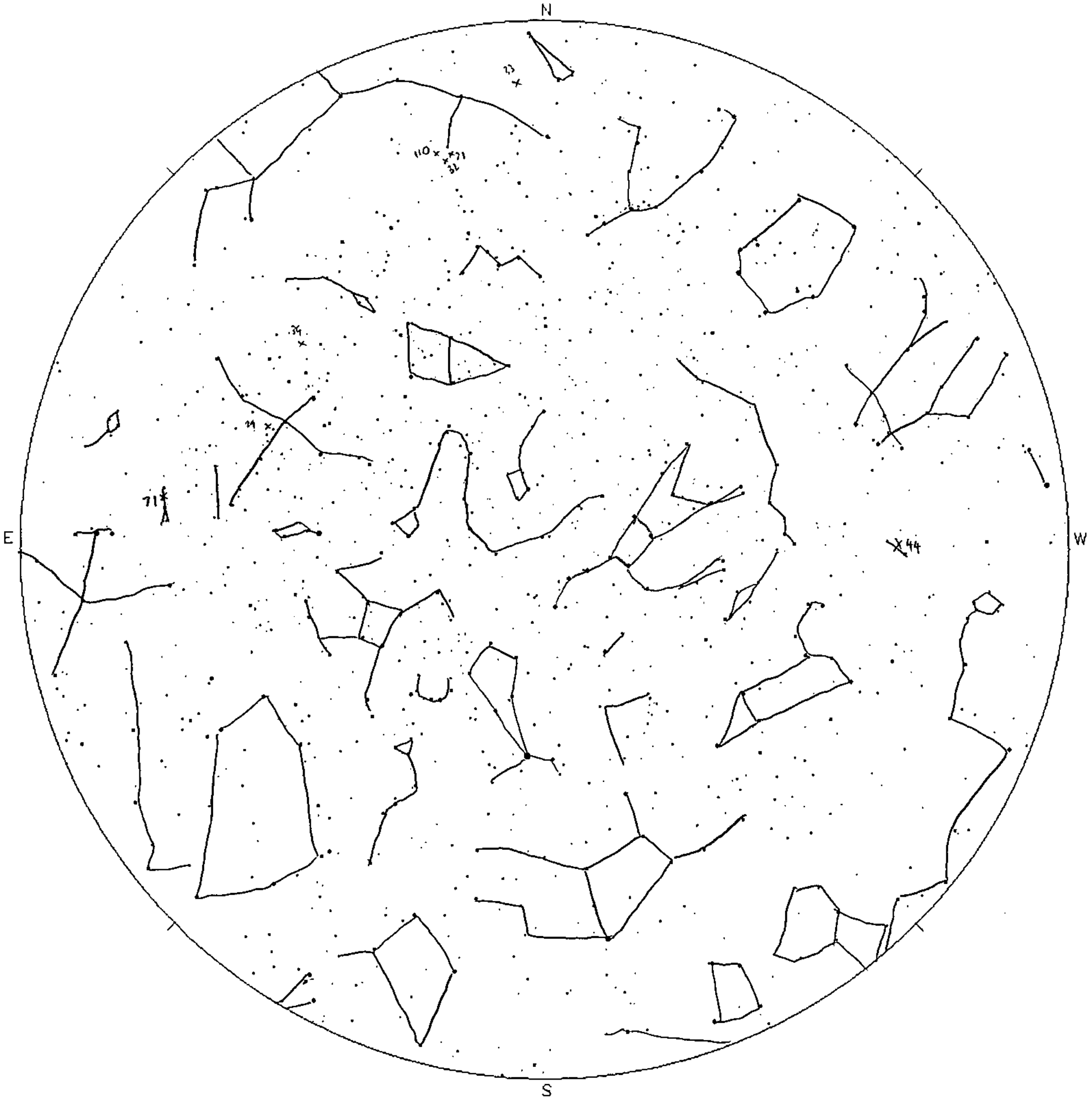
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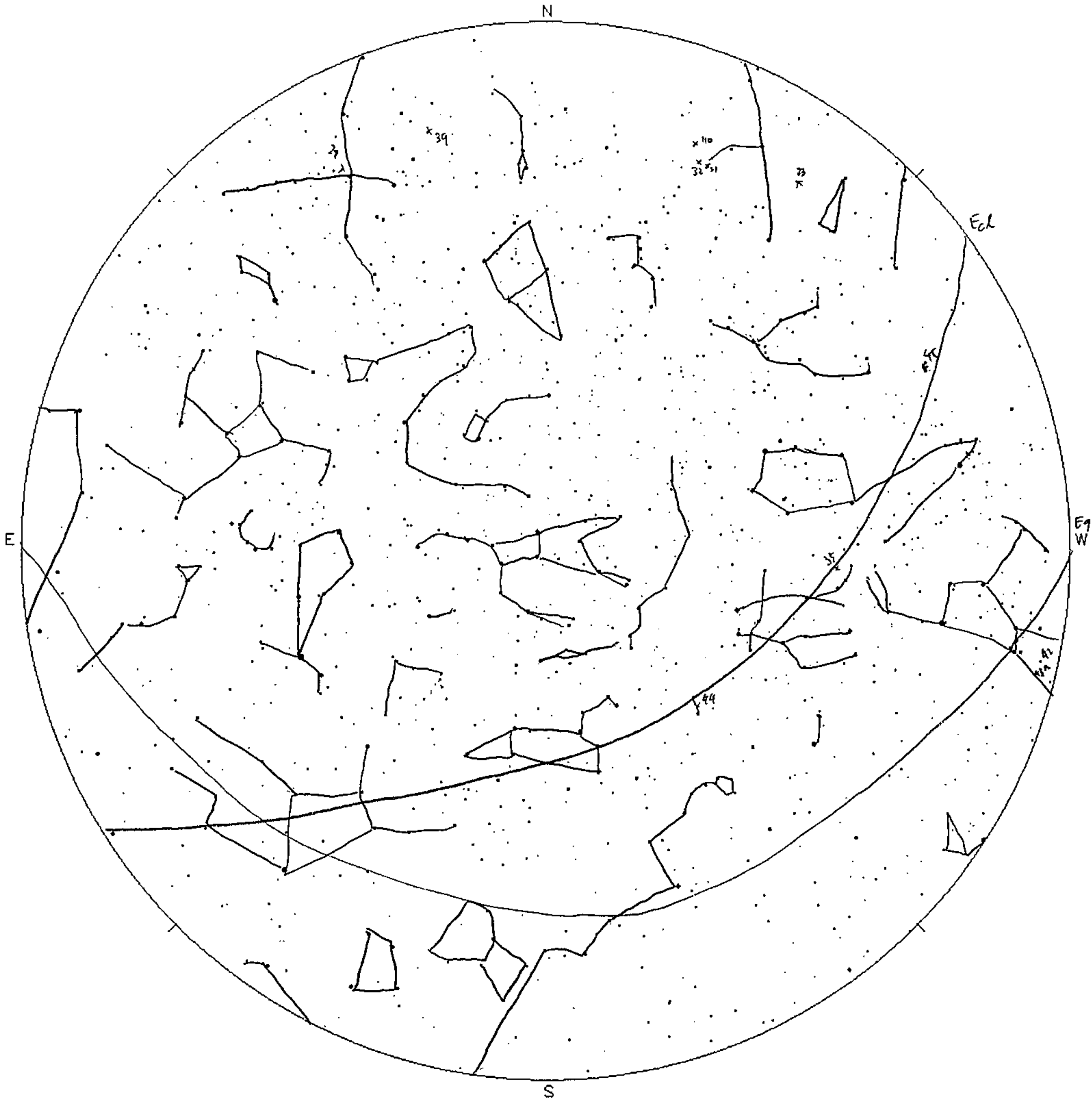
S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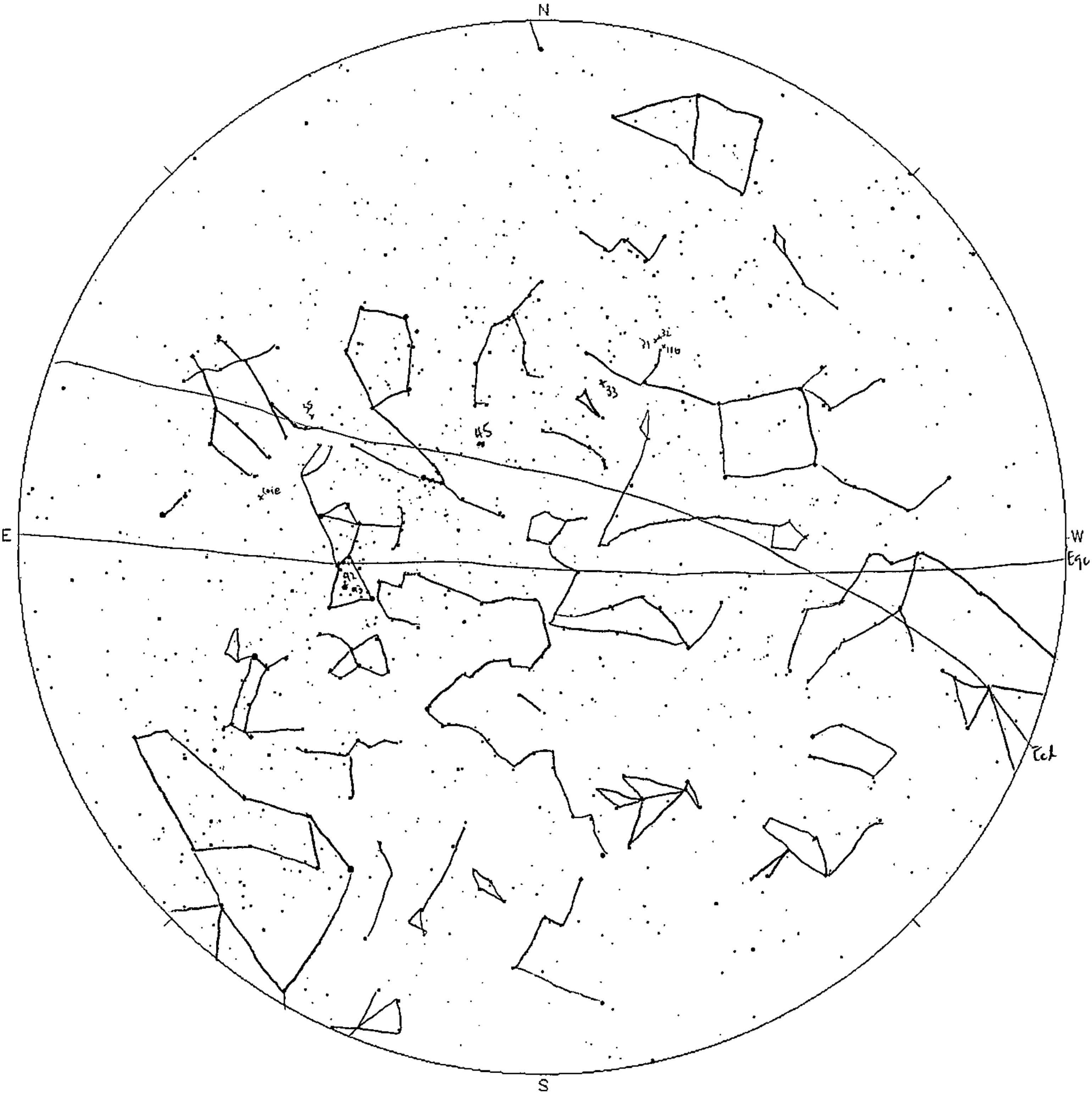
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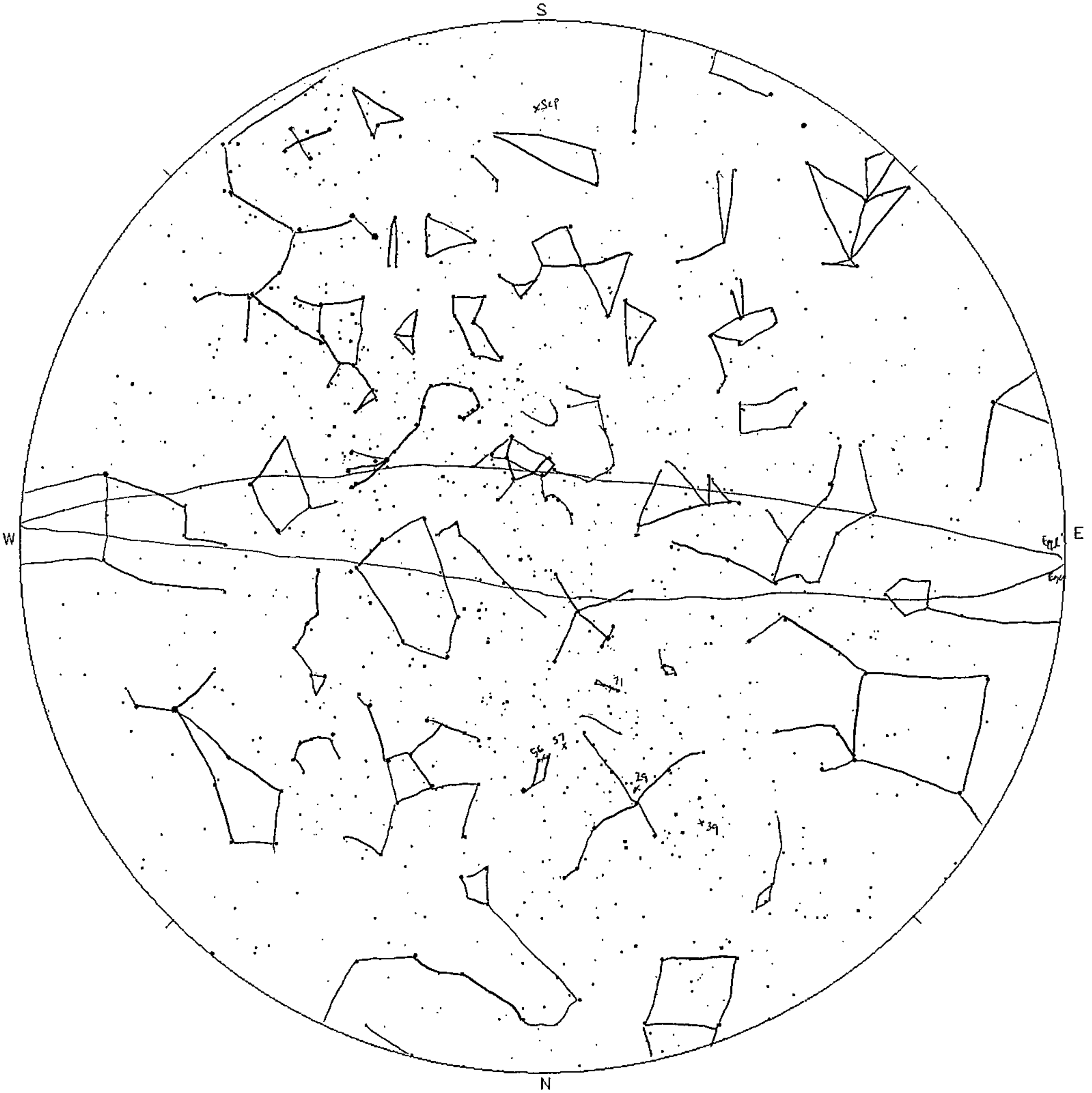
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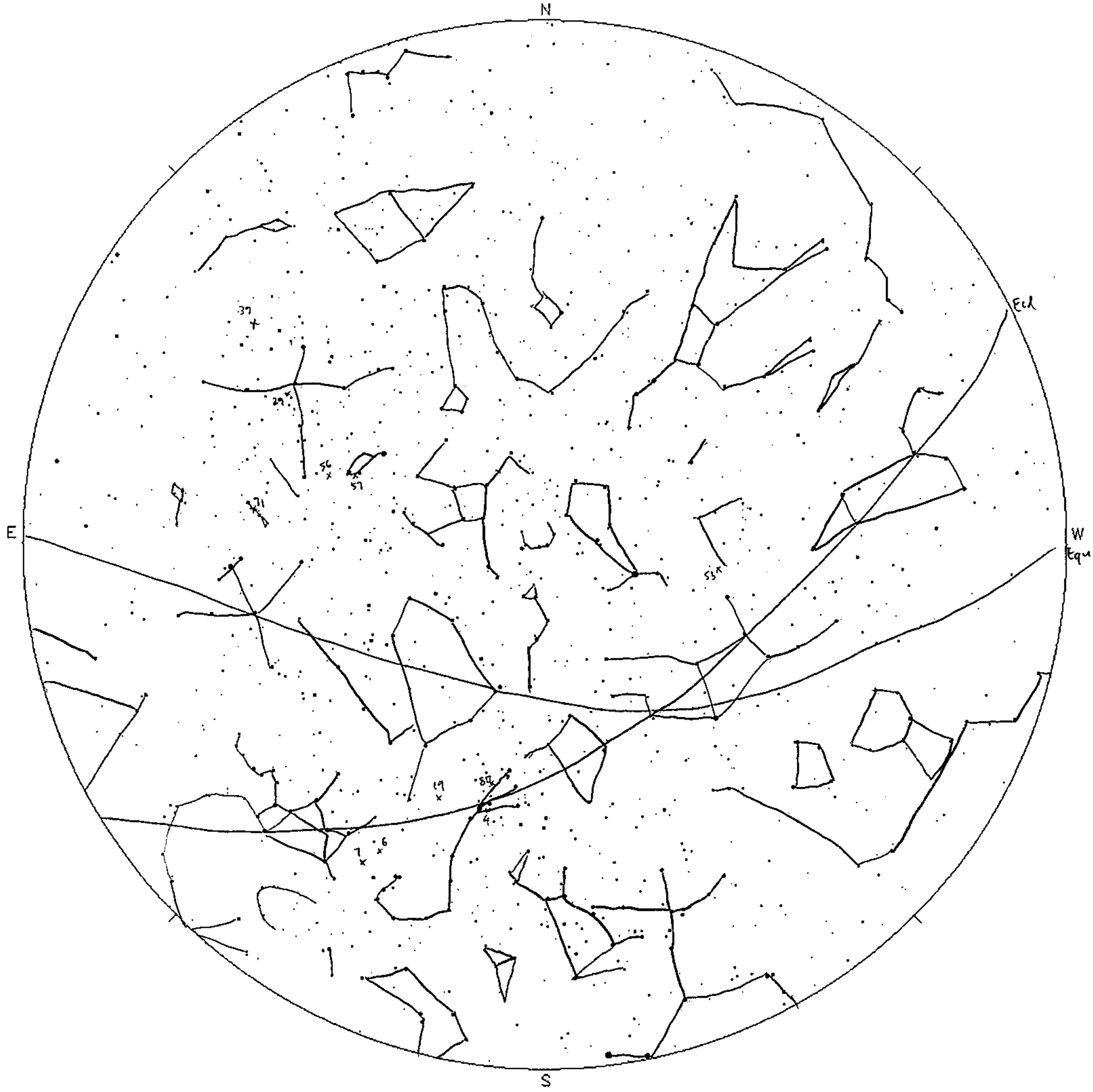
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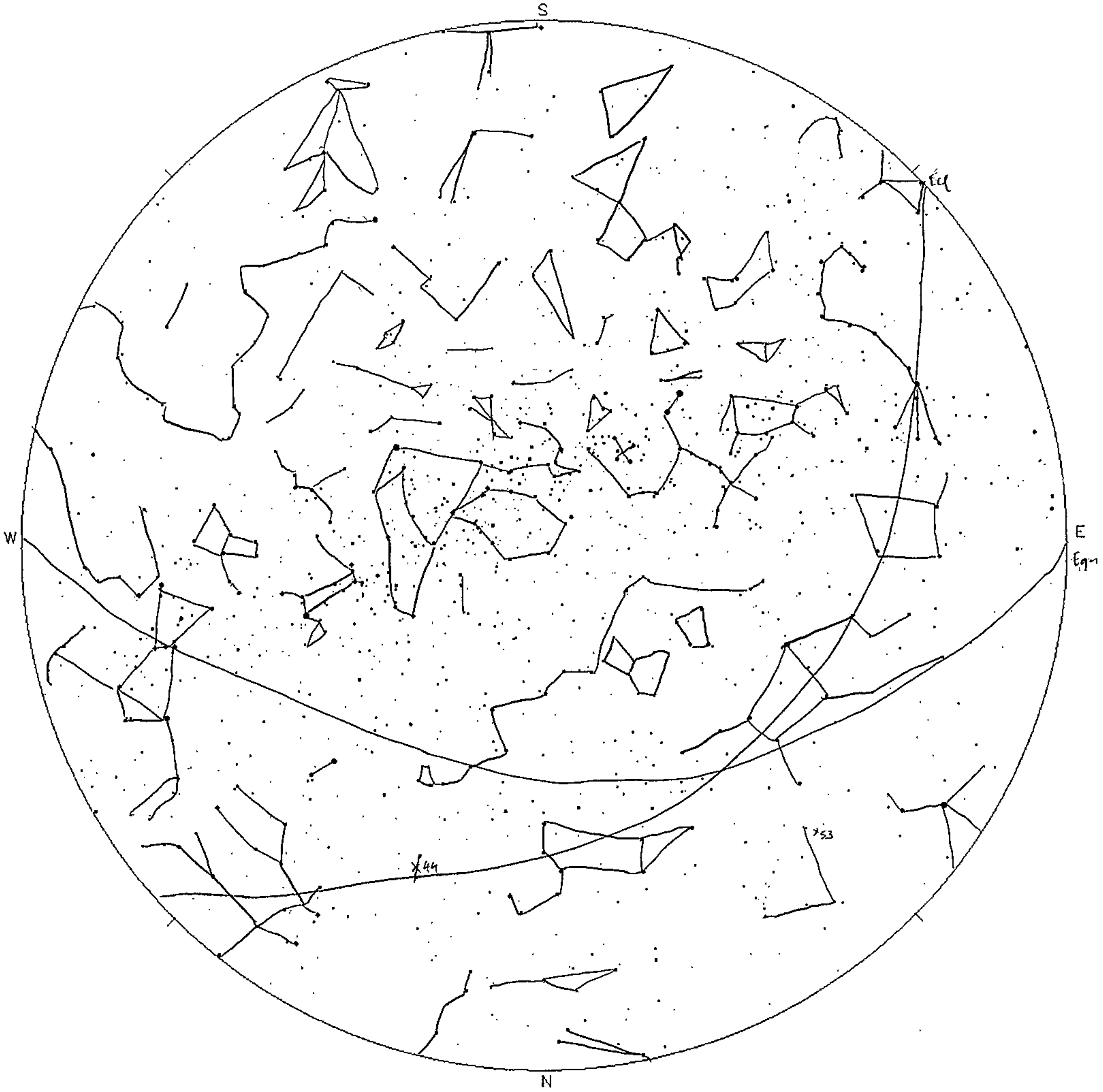
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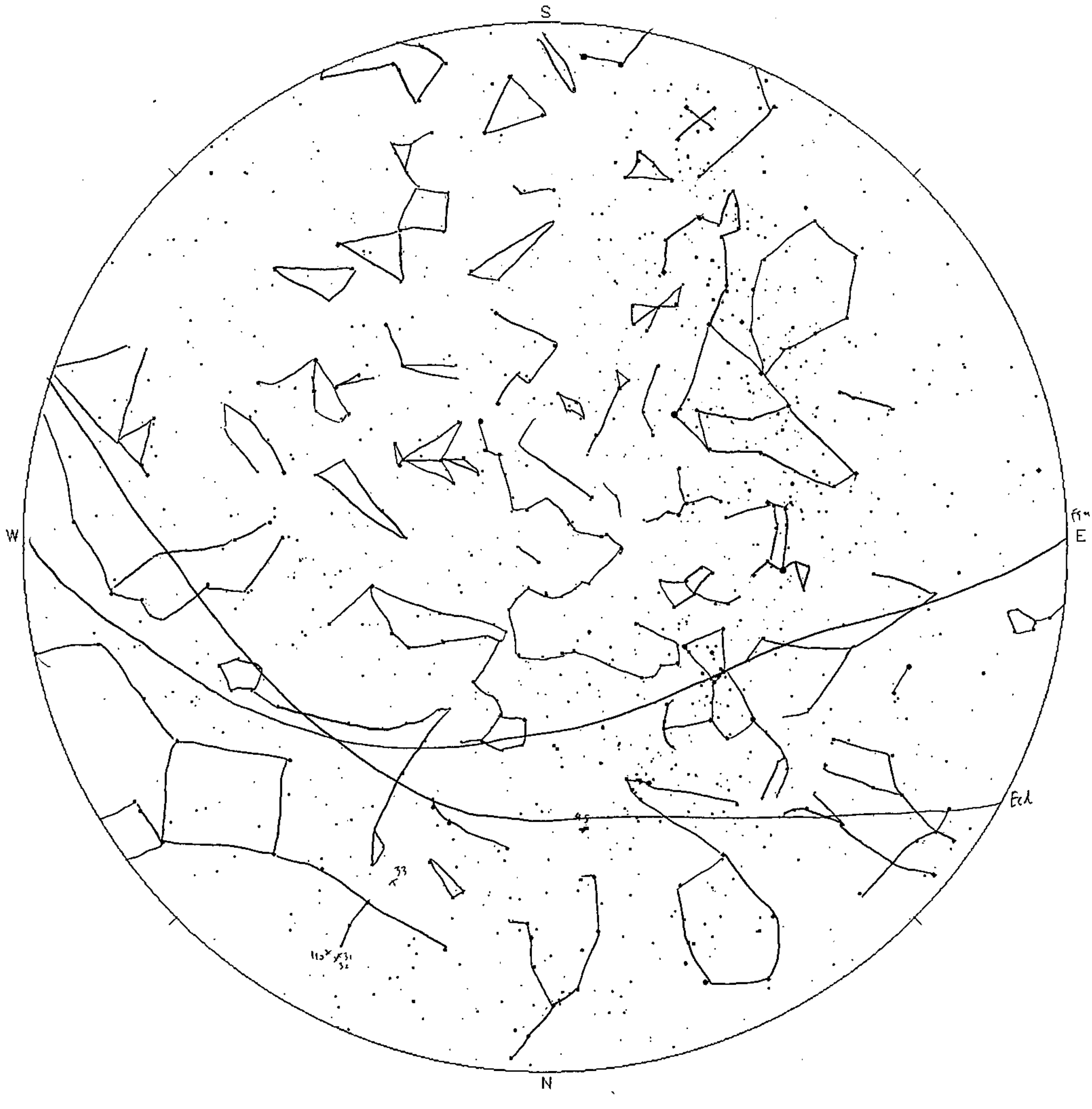
Eqn
×53
×44
N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Equ
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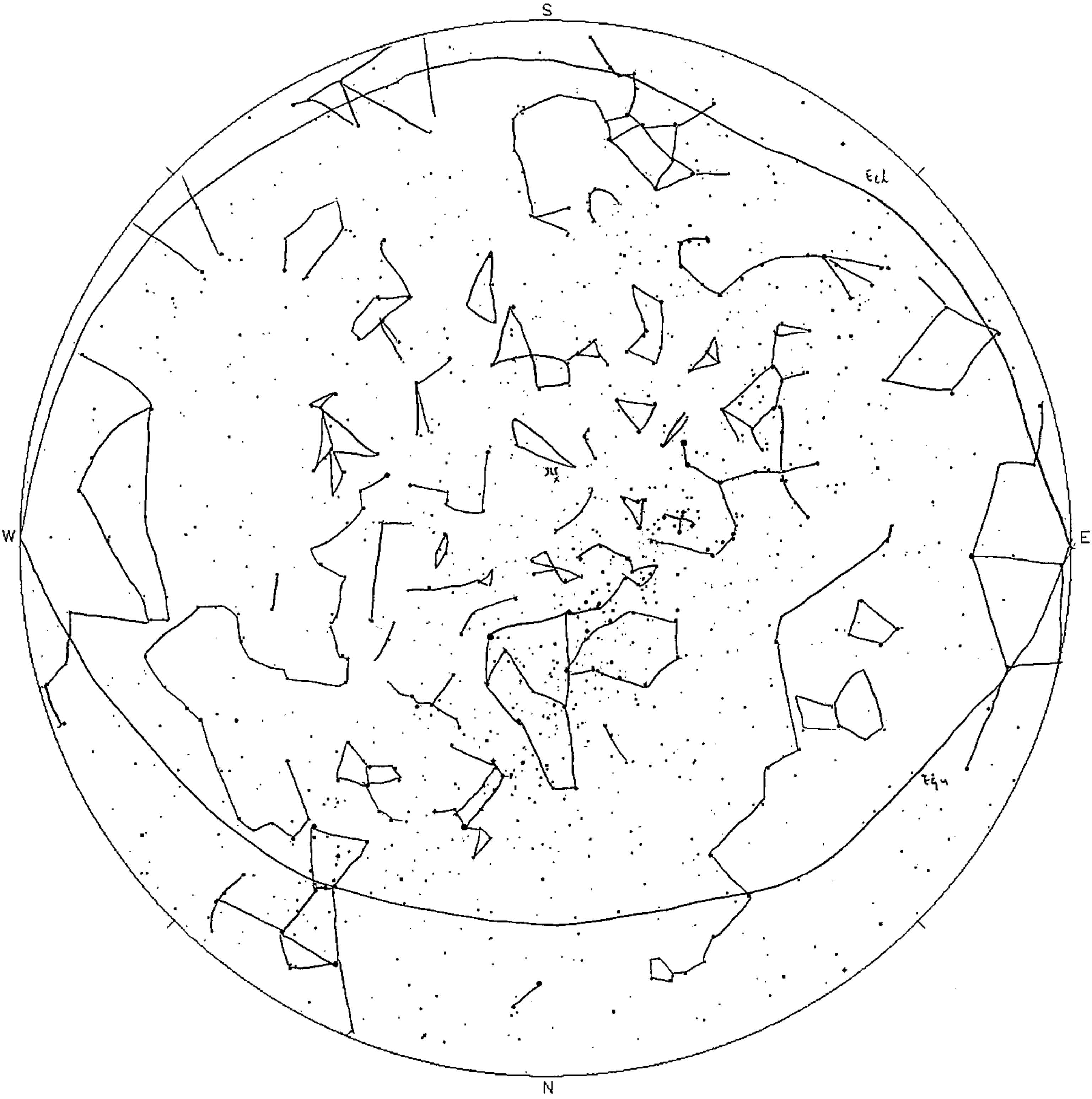
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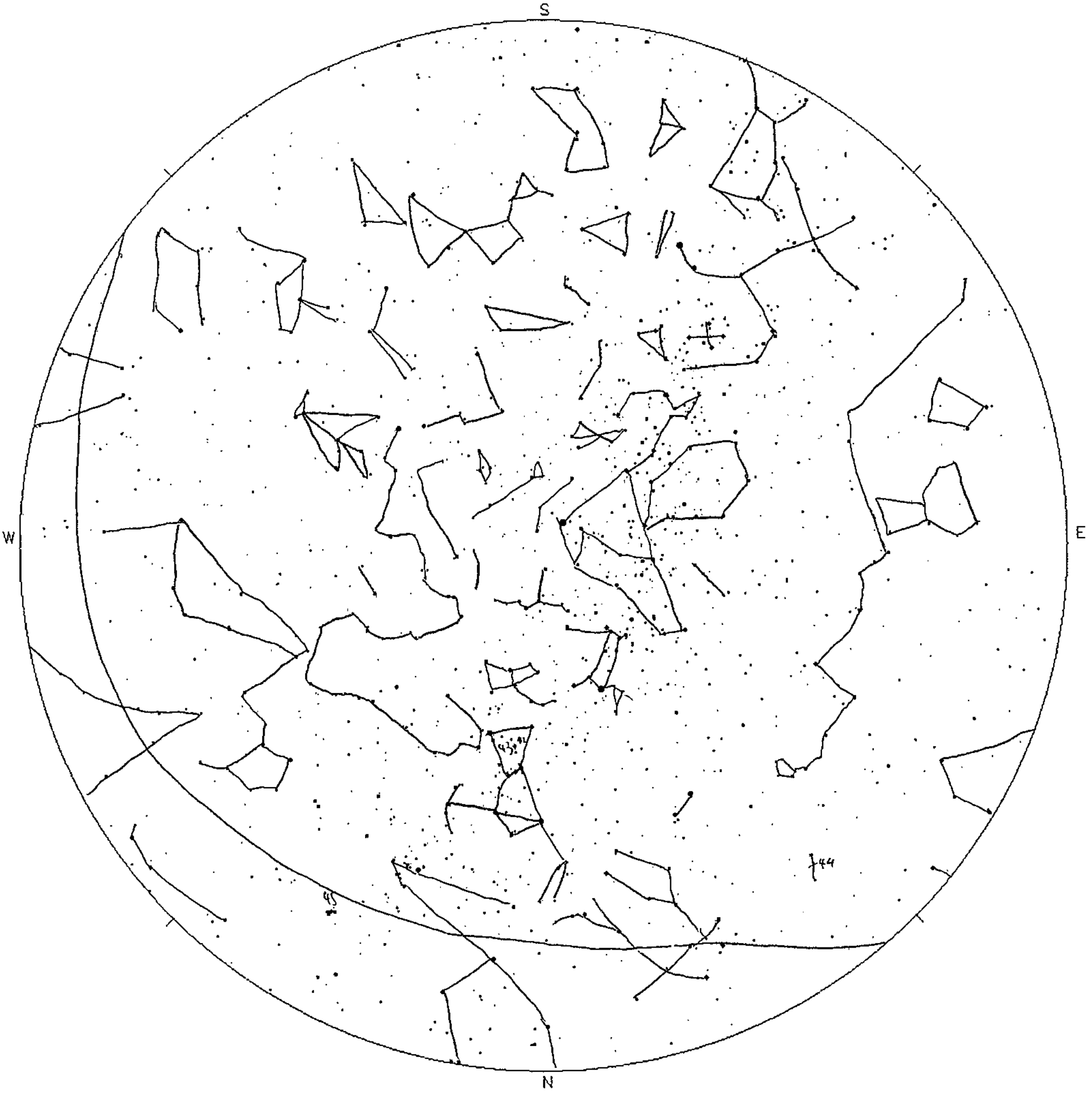
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W
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Equ
x scp
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43
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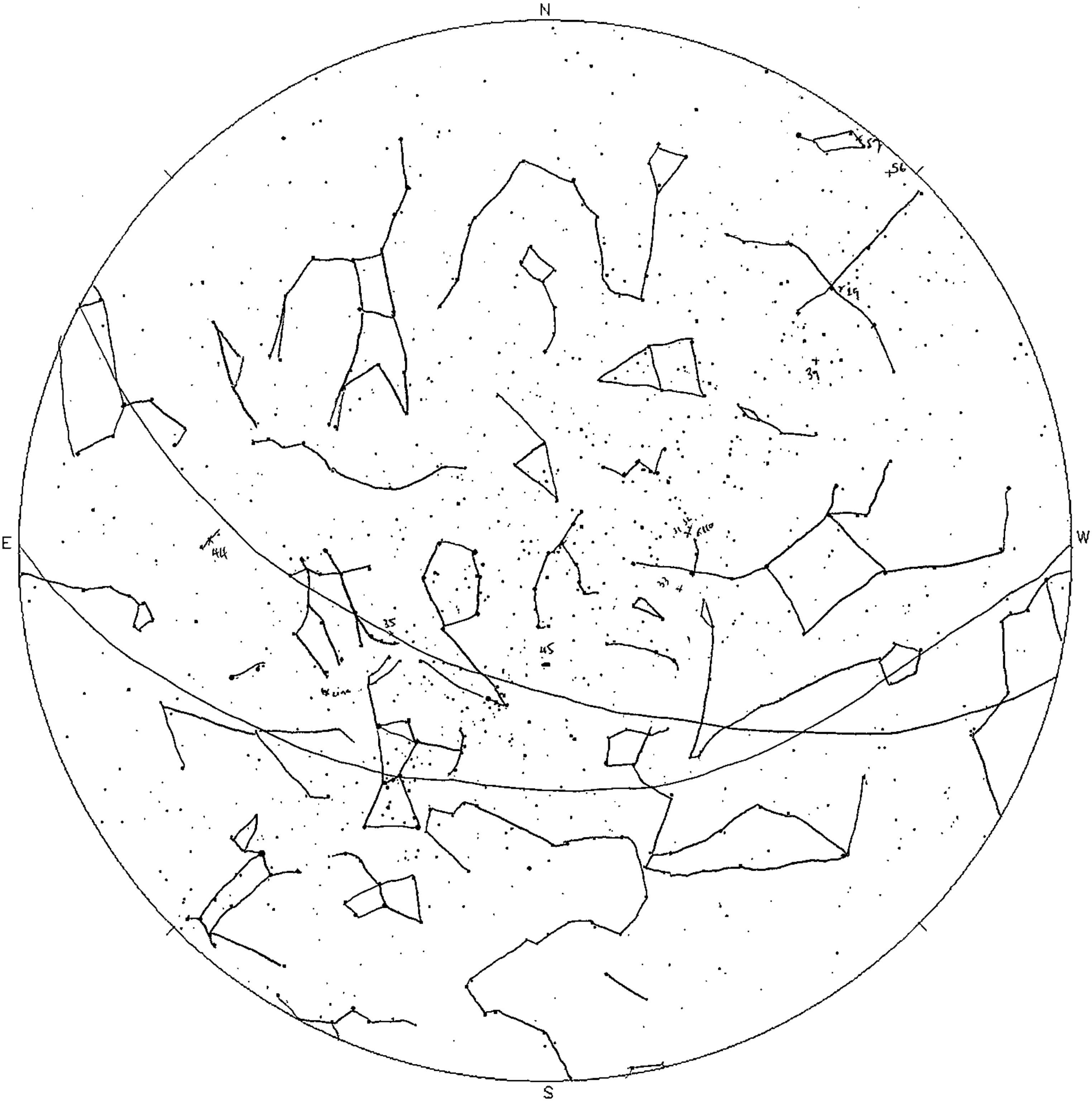
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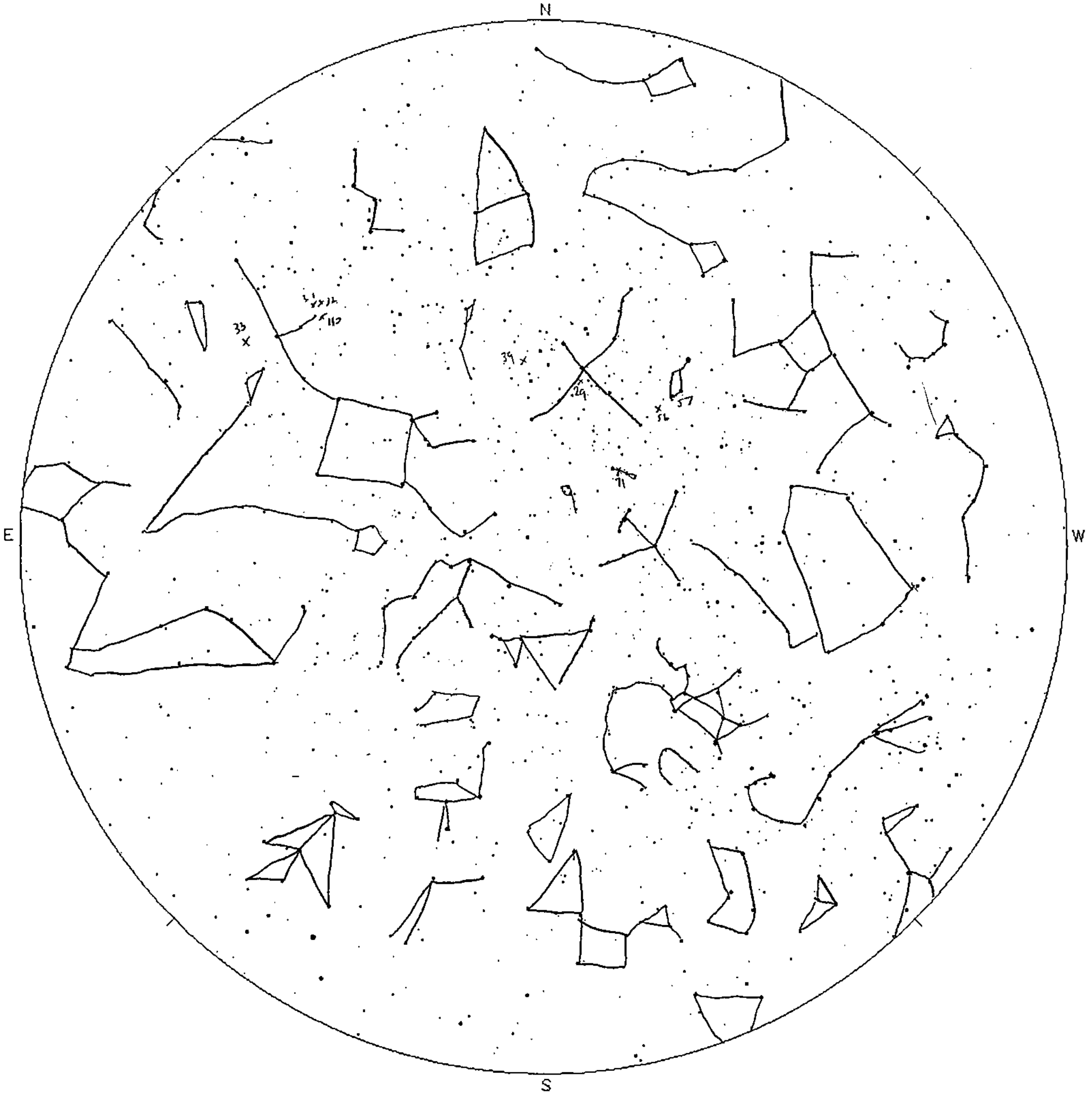
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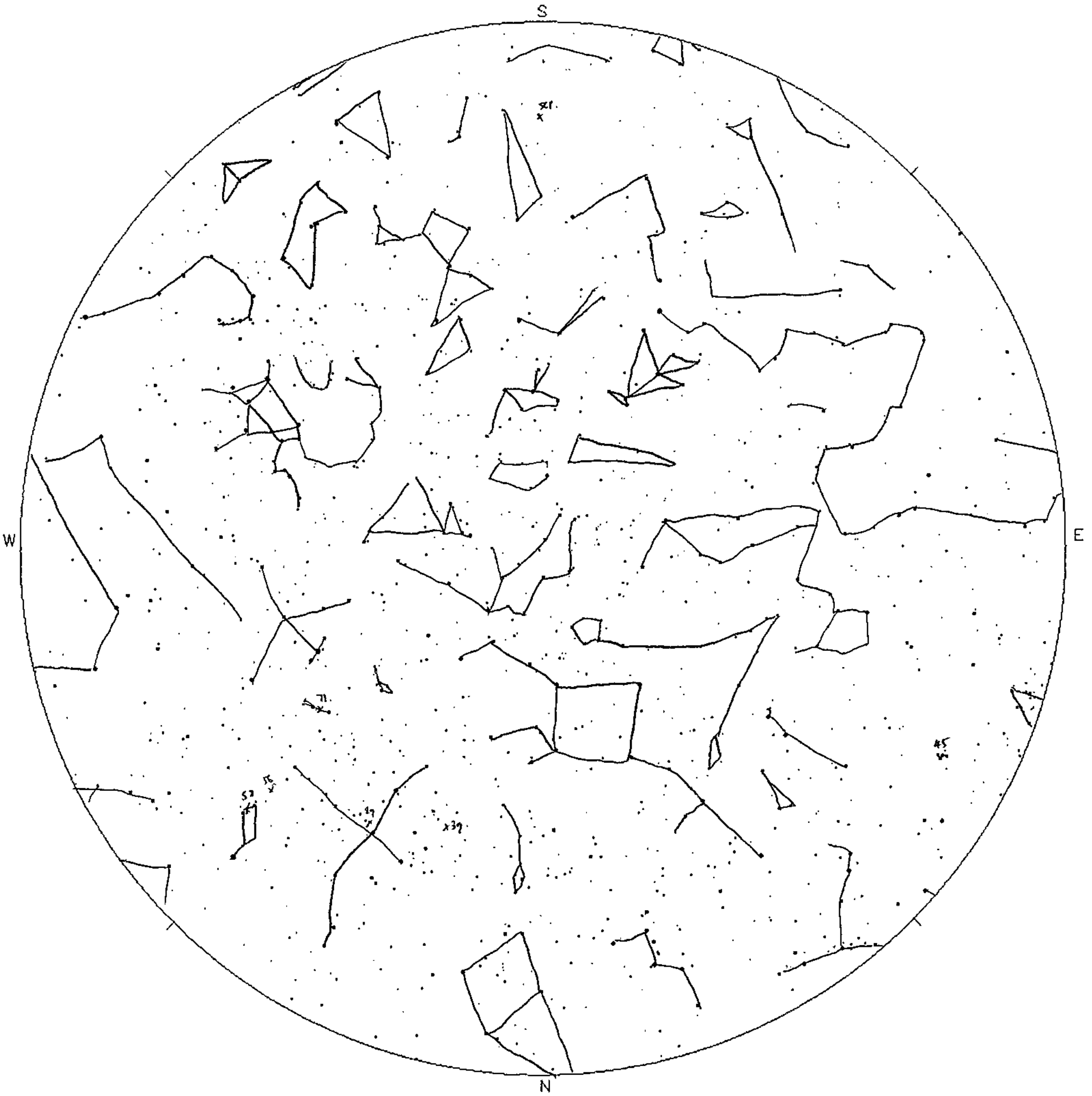
S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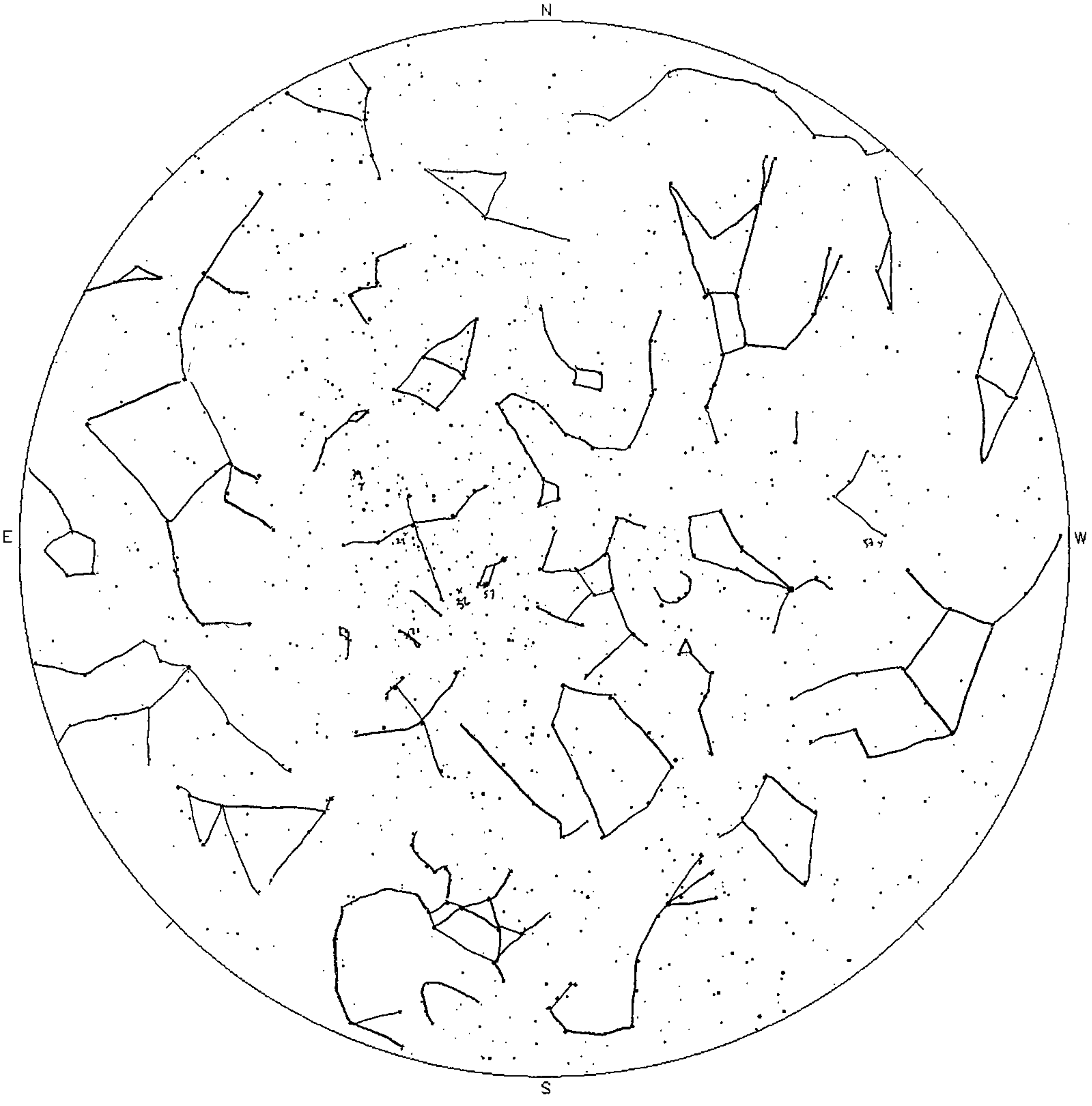
N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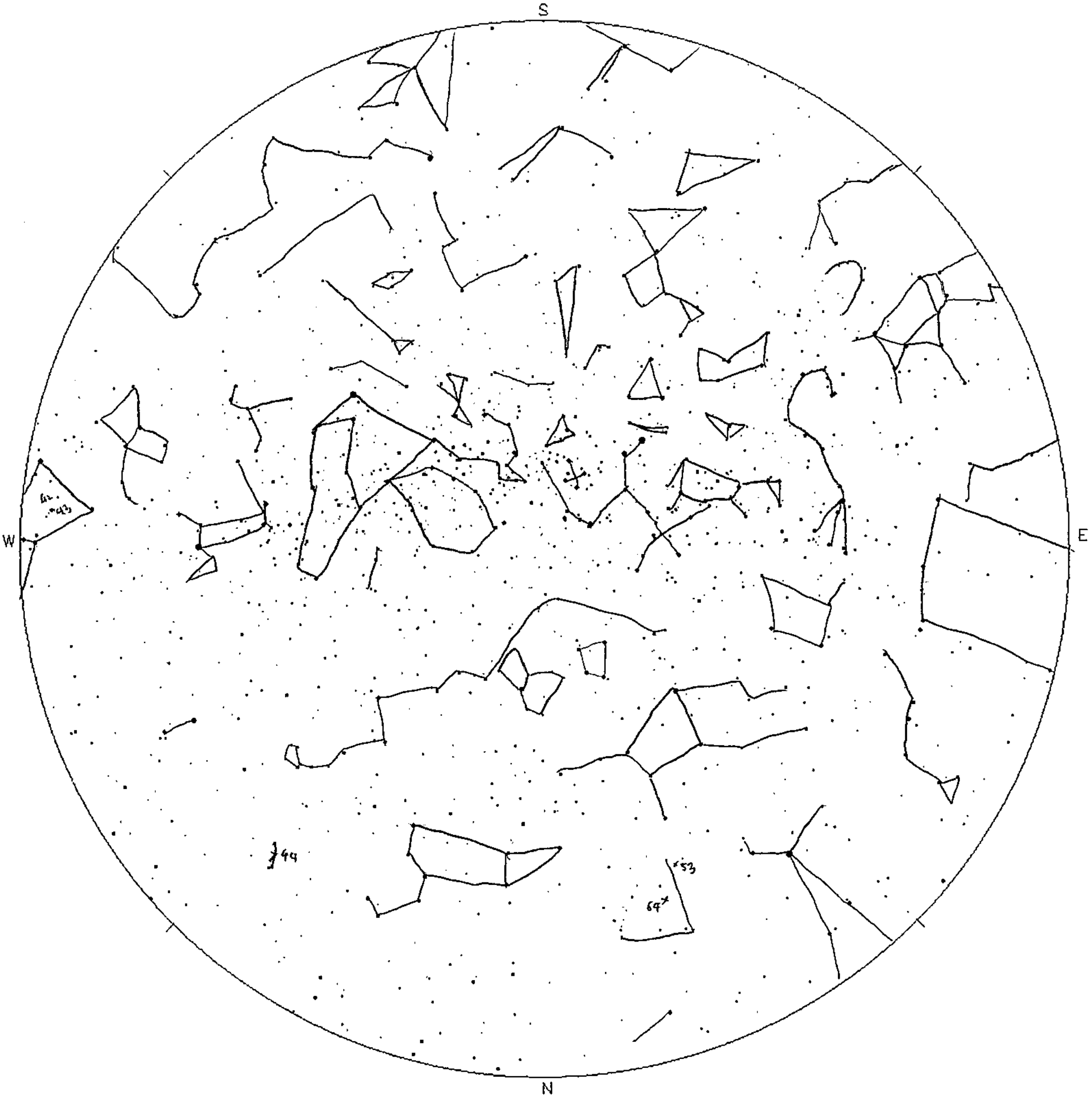
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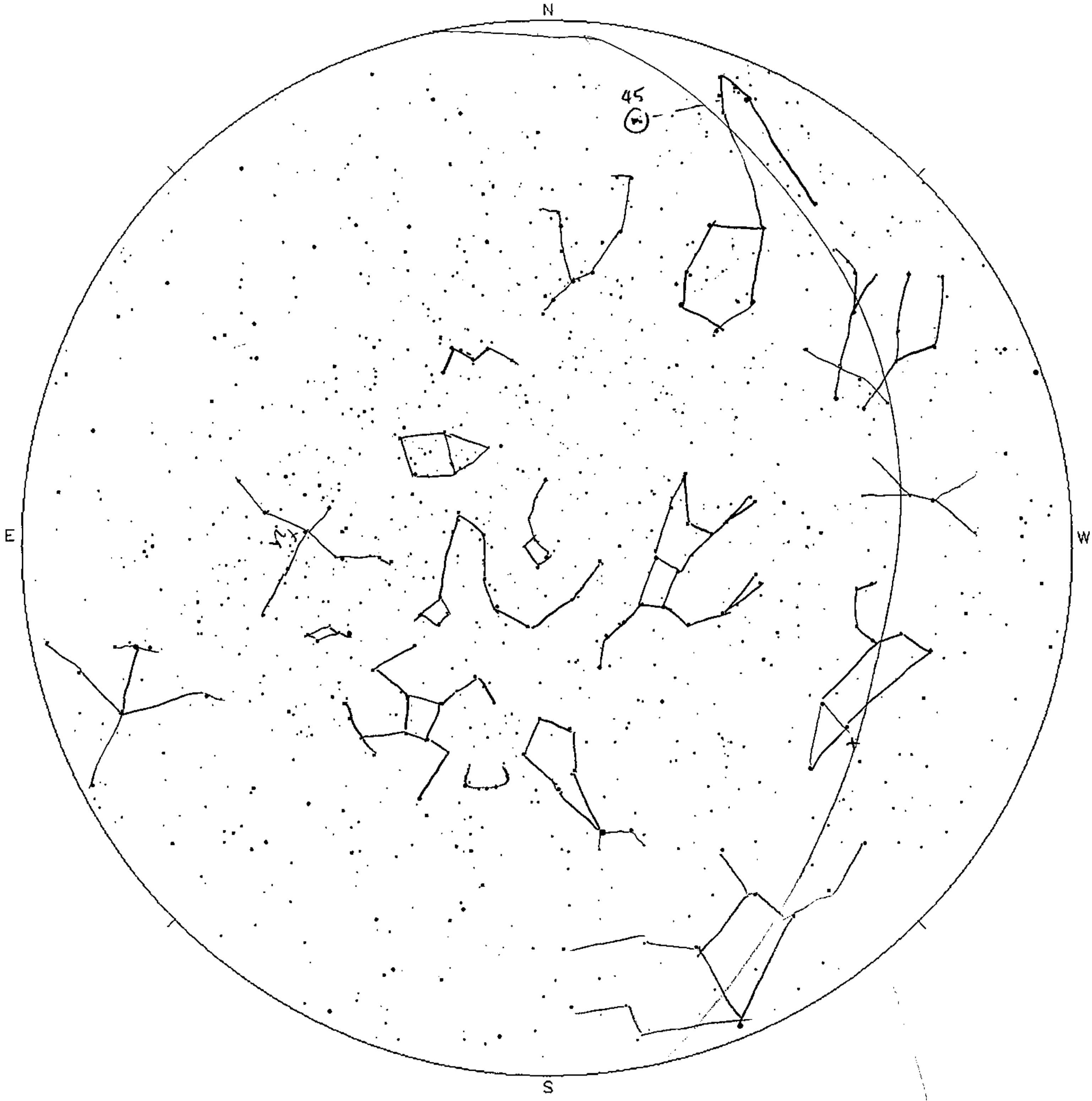
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⊙
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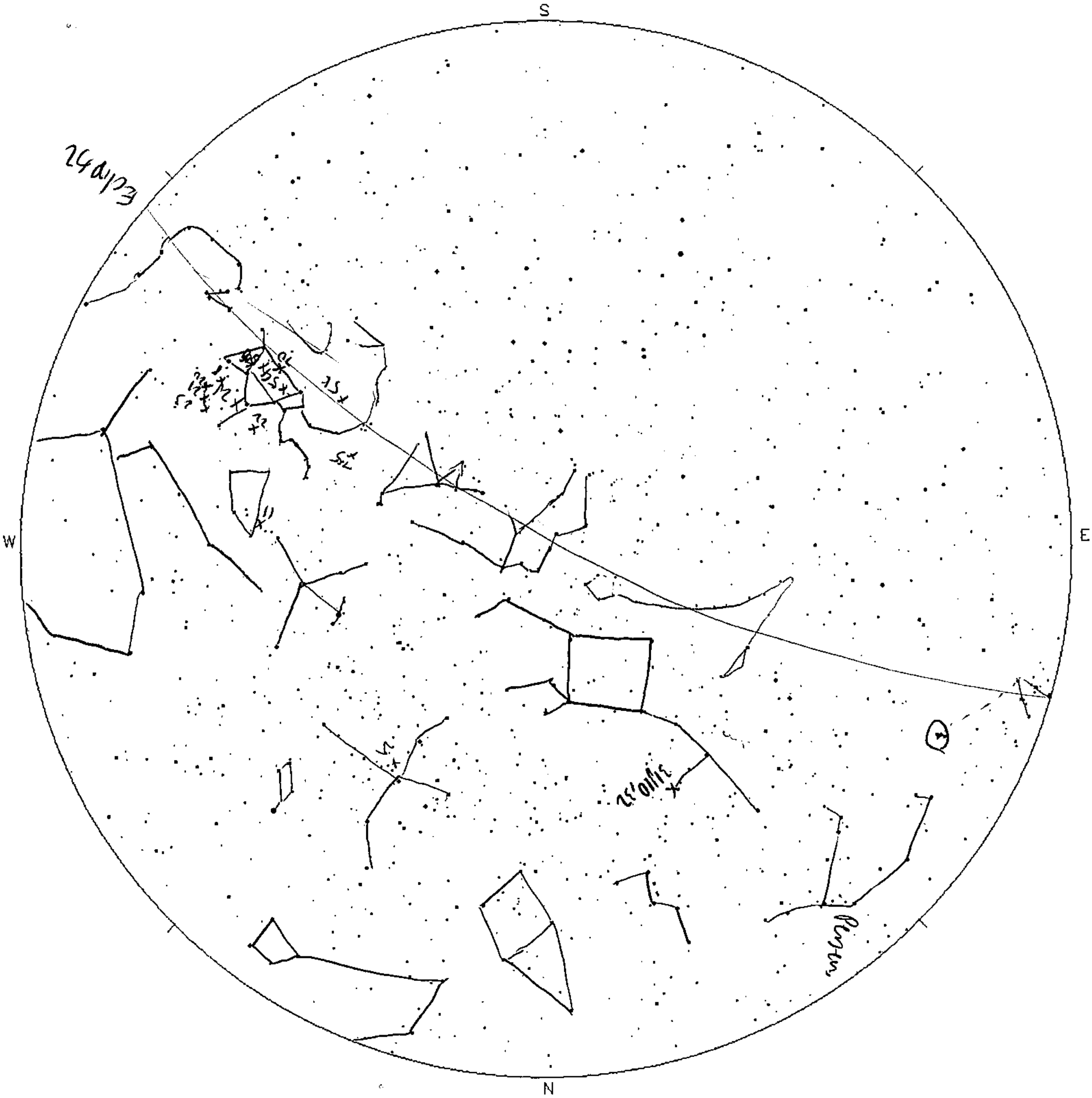
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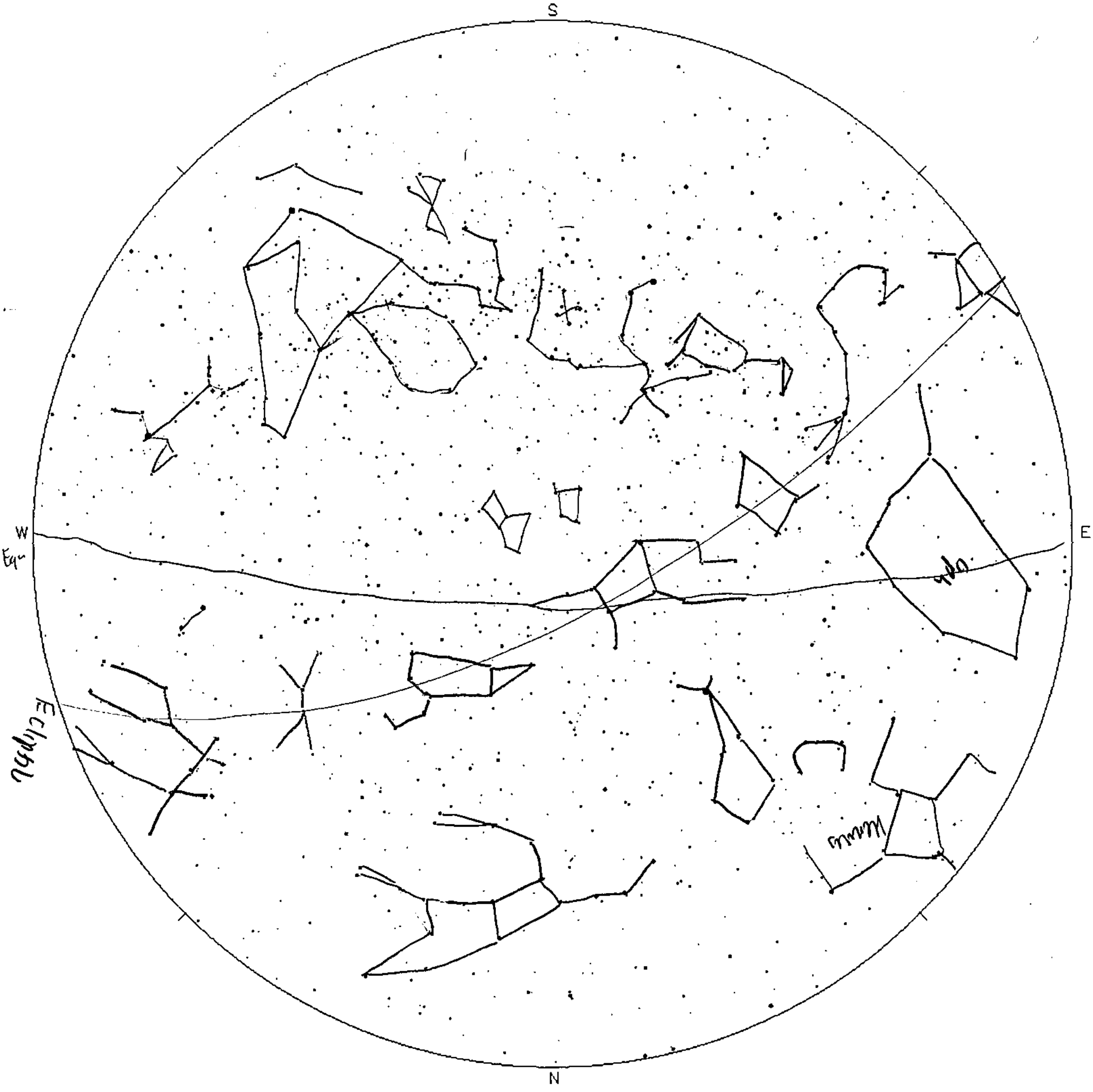
Capella
Perseus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Ecliptic
Oph
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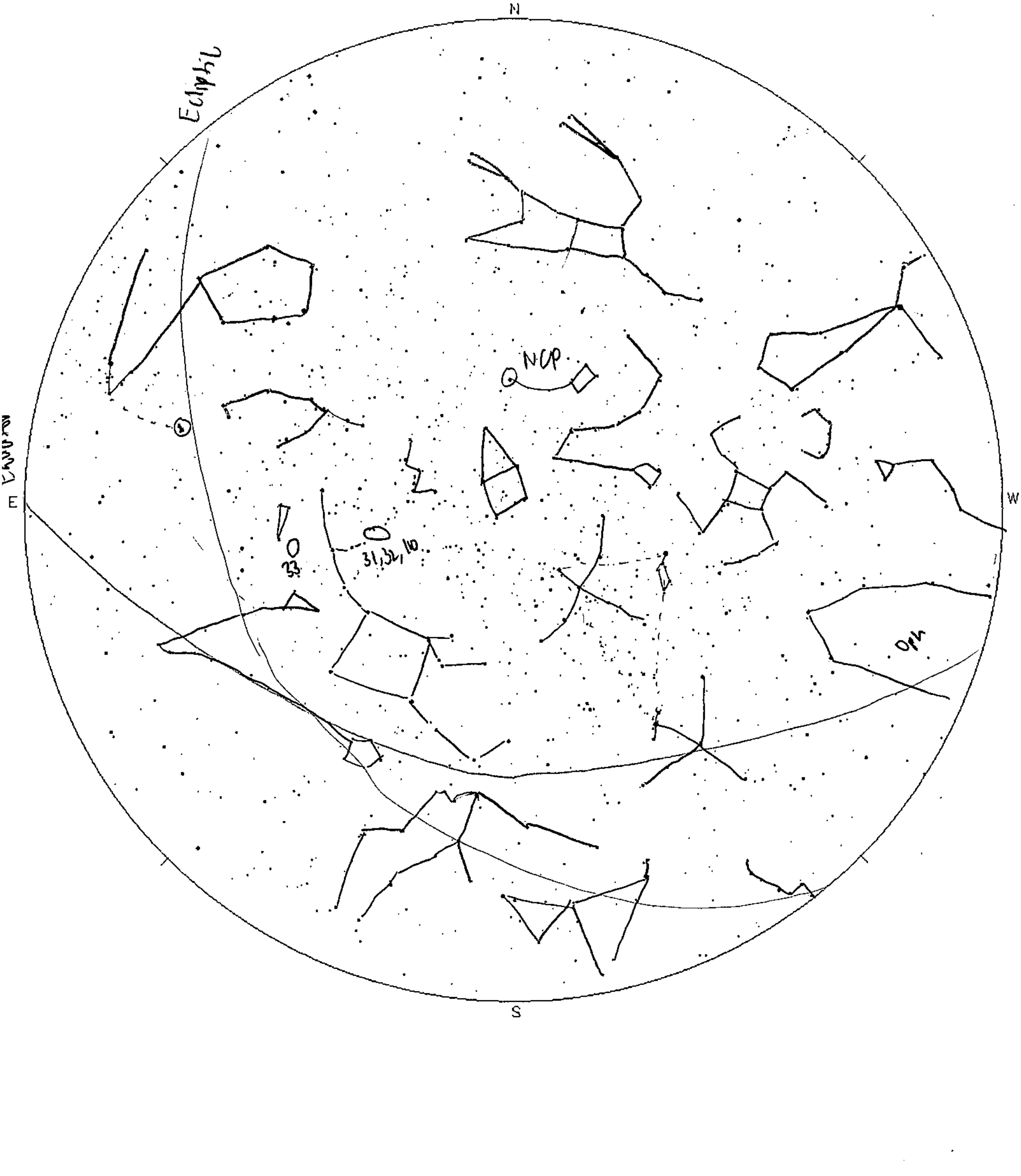
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Equator
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Oph
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SCP
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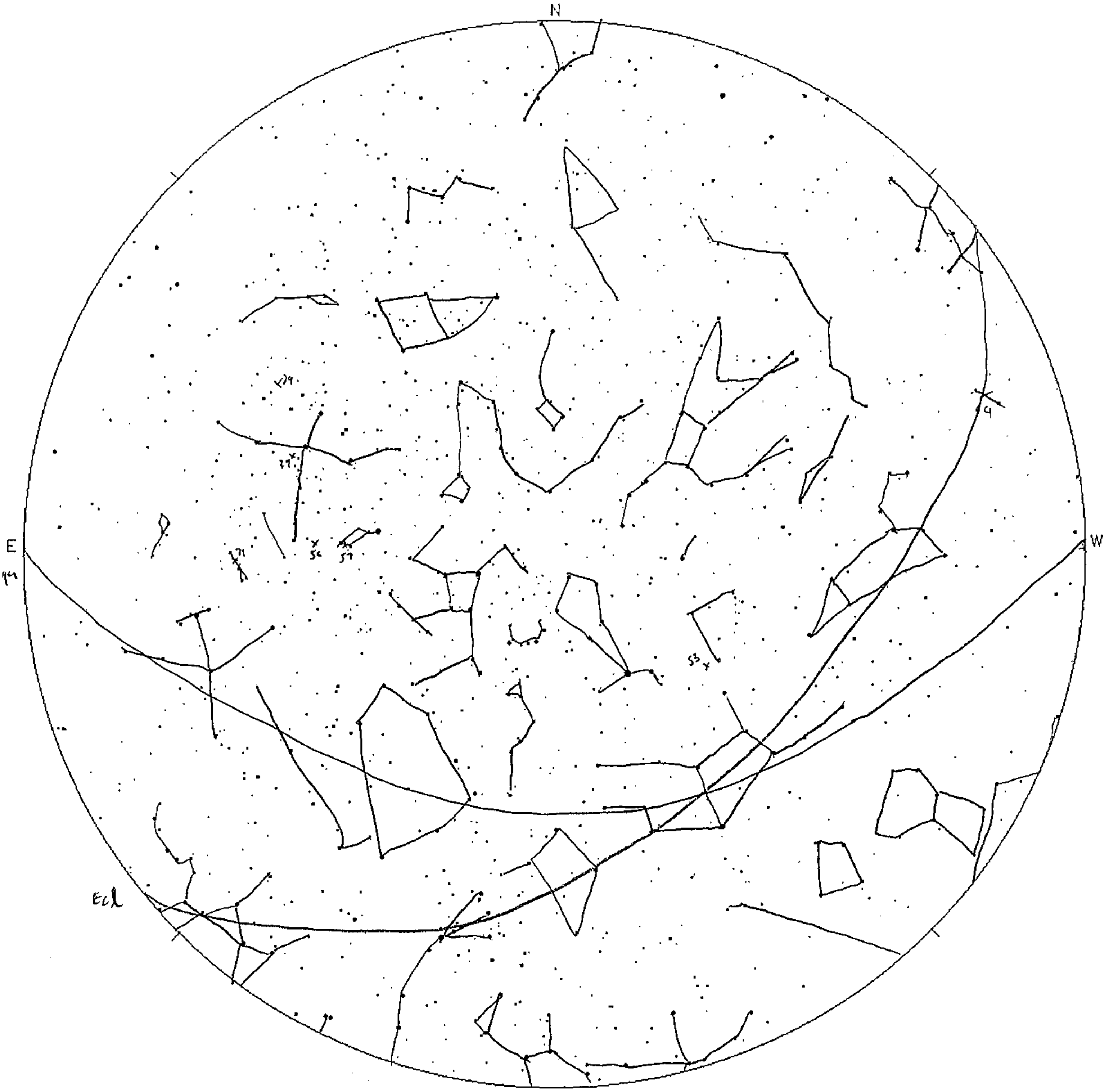
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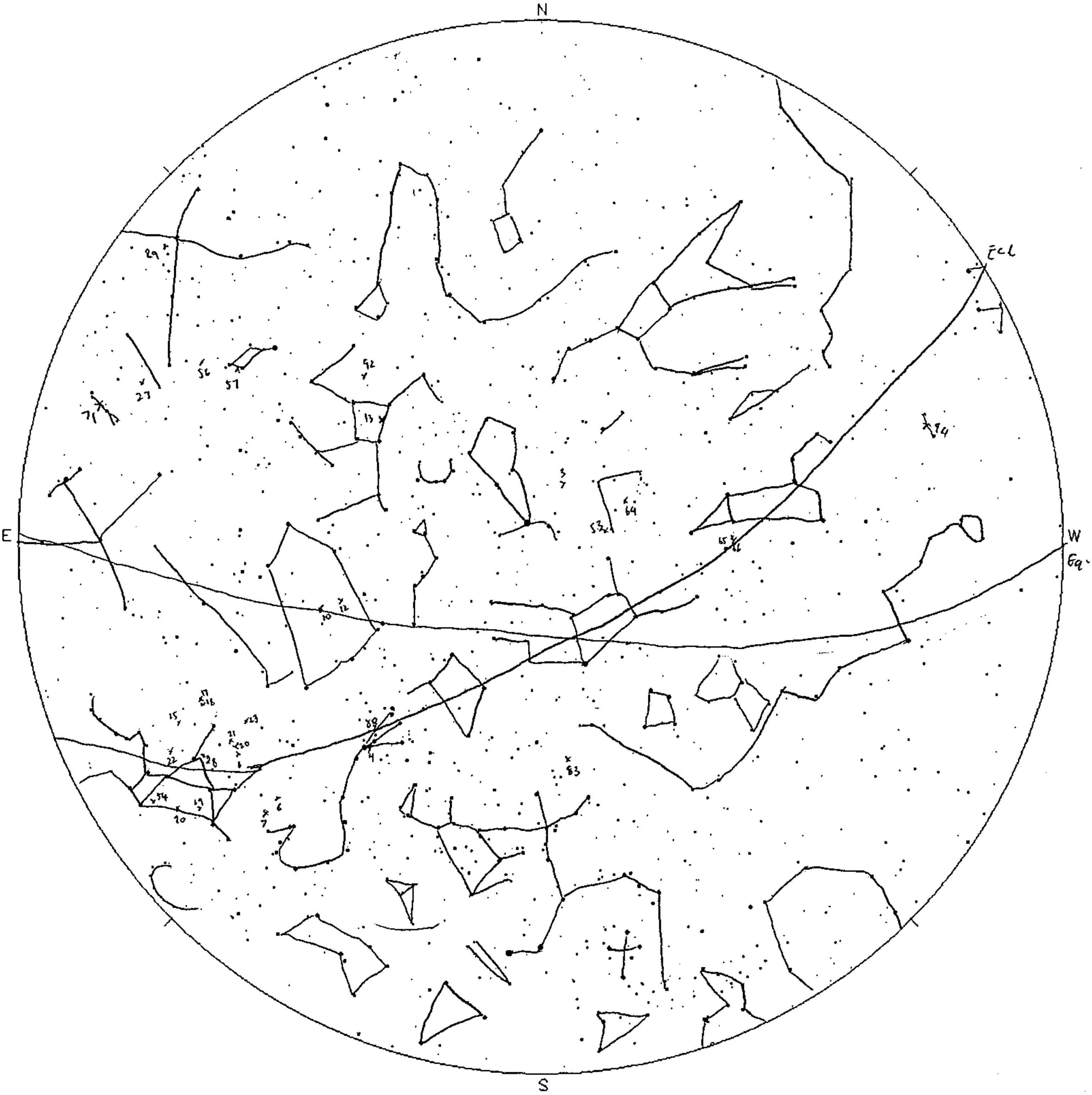
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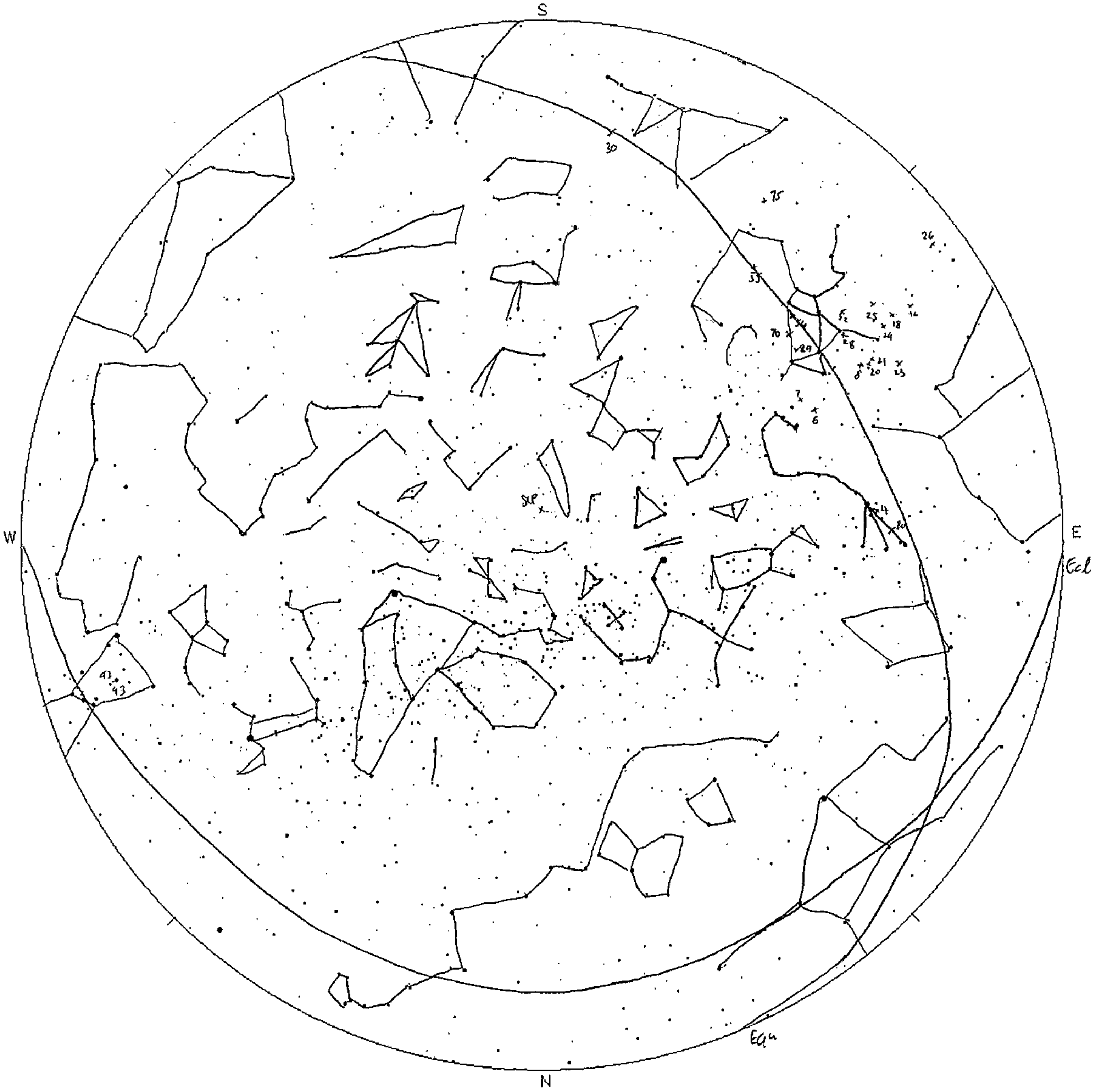
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Eqn
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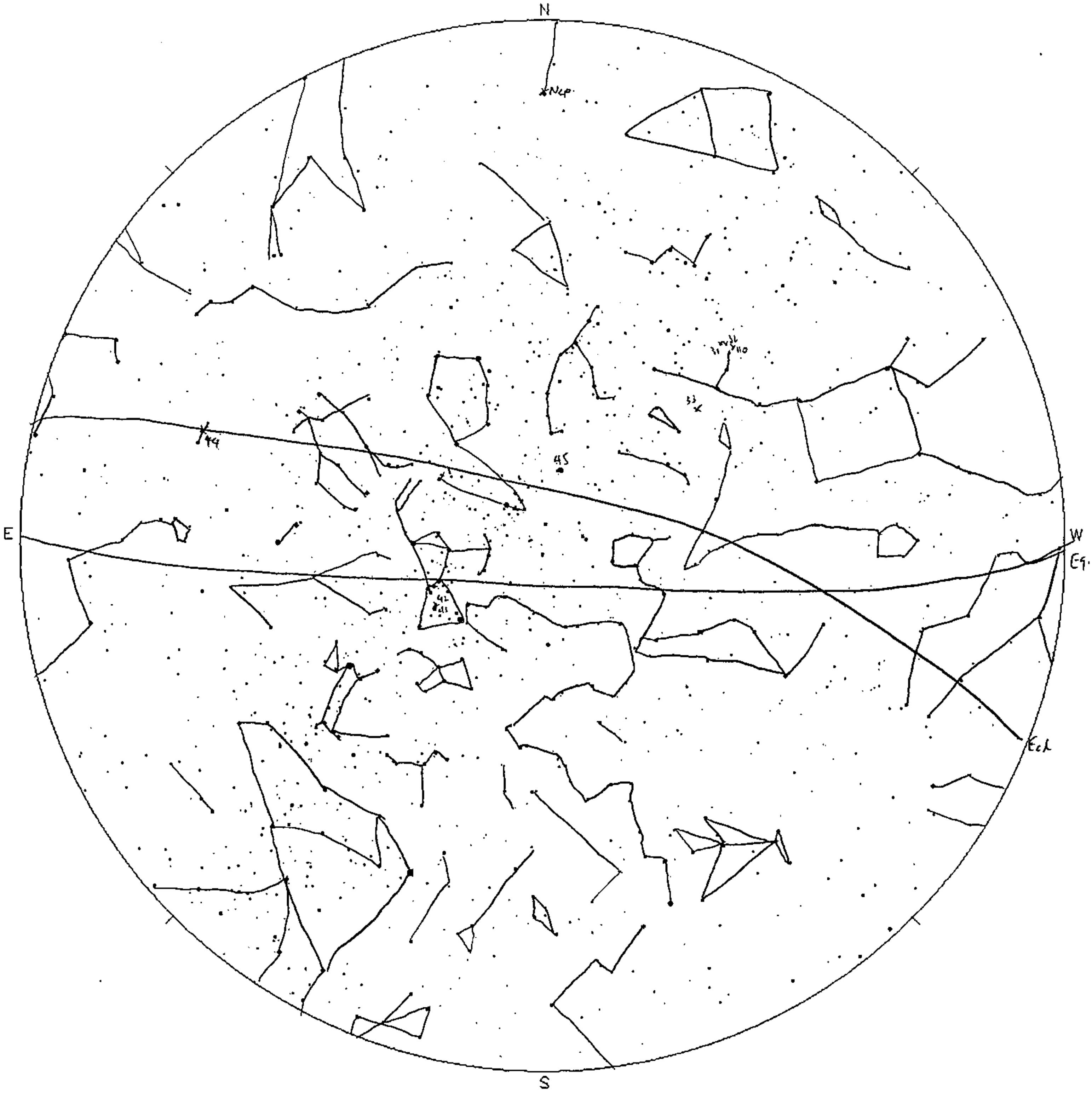
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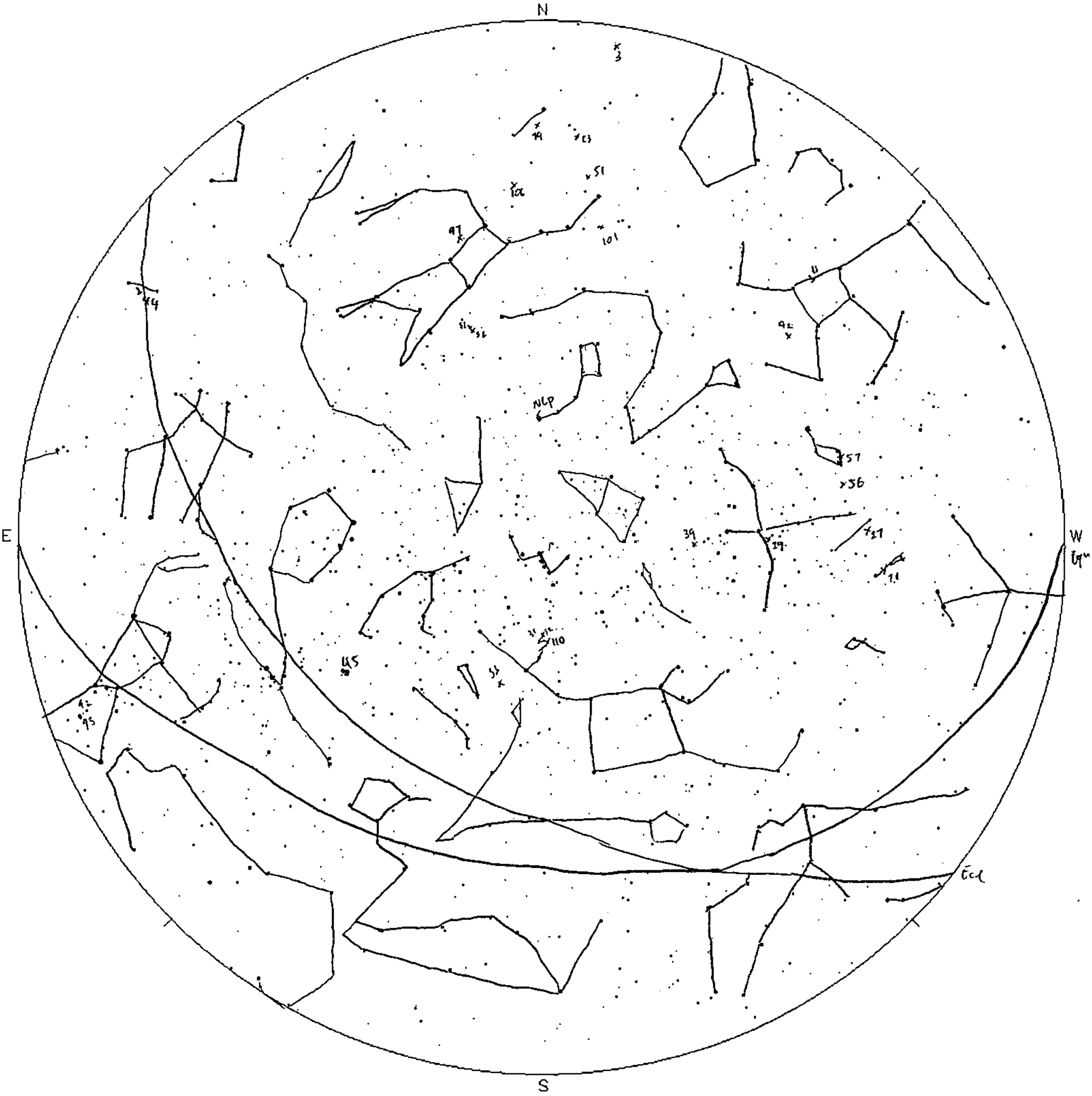
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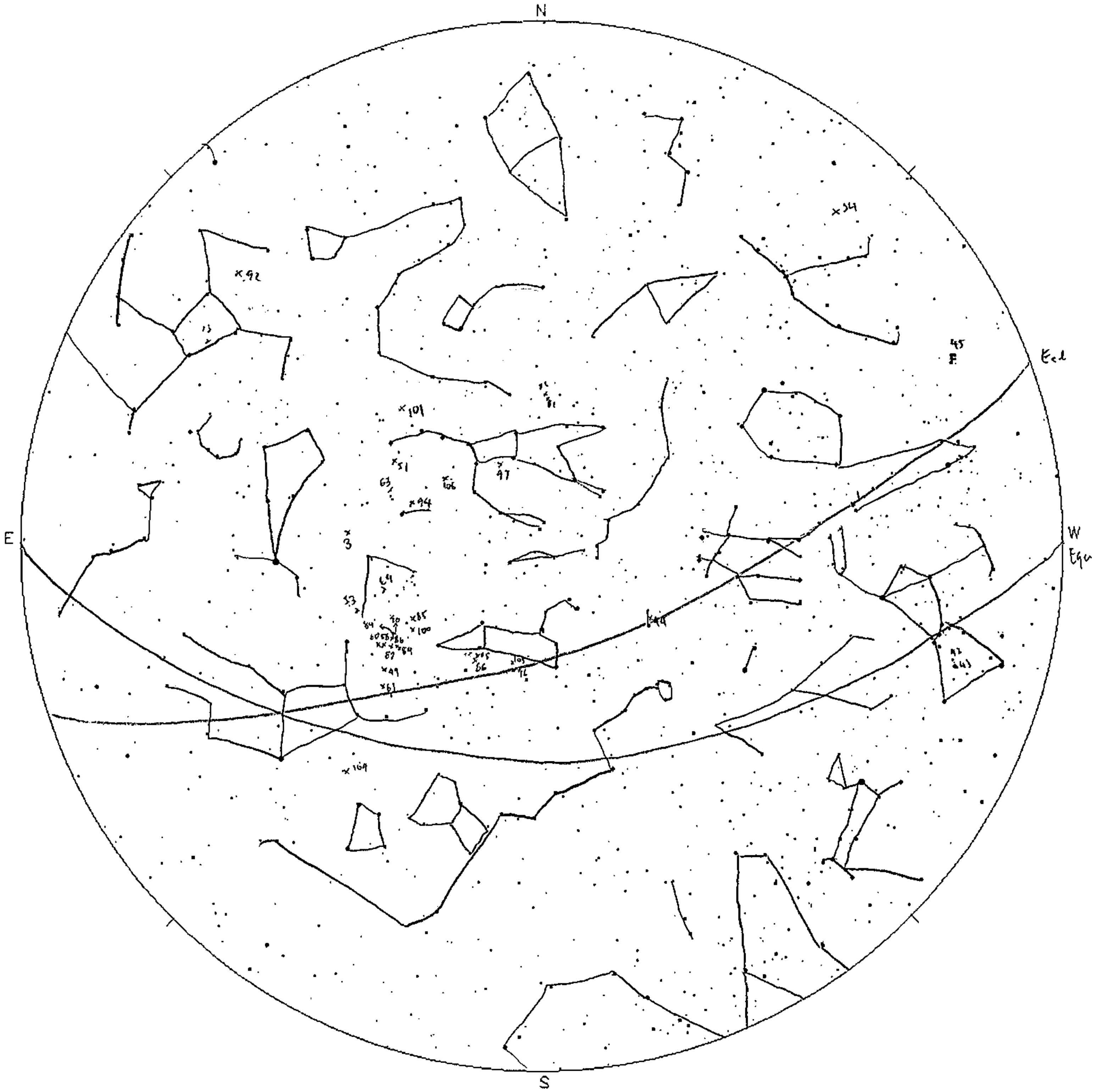
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×101
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×106
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×94
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×85
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×61
×95
66
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76
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×164


S
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Equ
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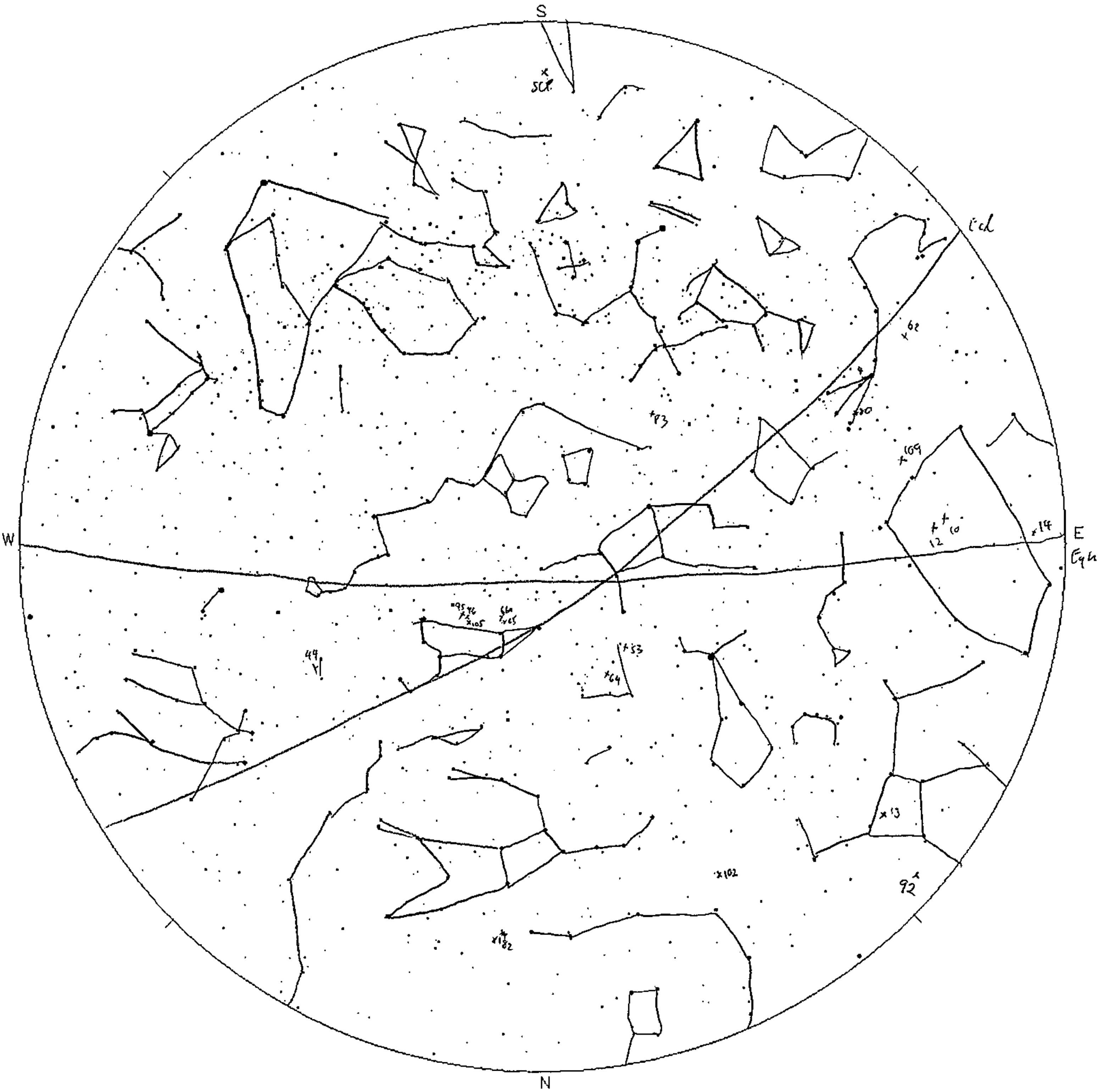
S
SCl
Ecl
62
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95 96
105
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49
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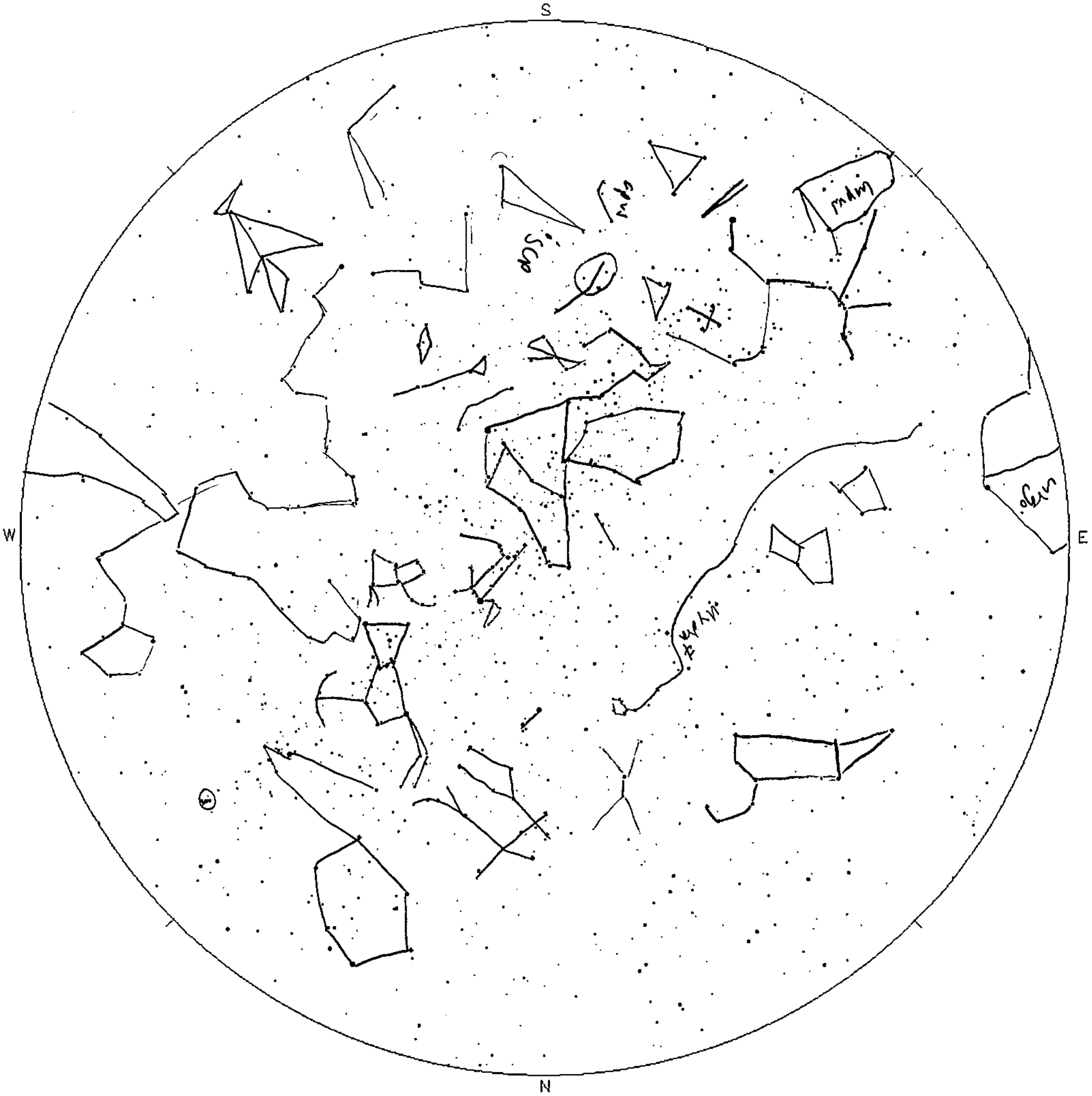
S
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Sco
Ara
Lupus
Virgo
Hydra


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C100
♃
☊
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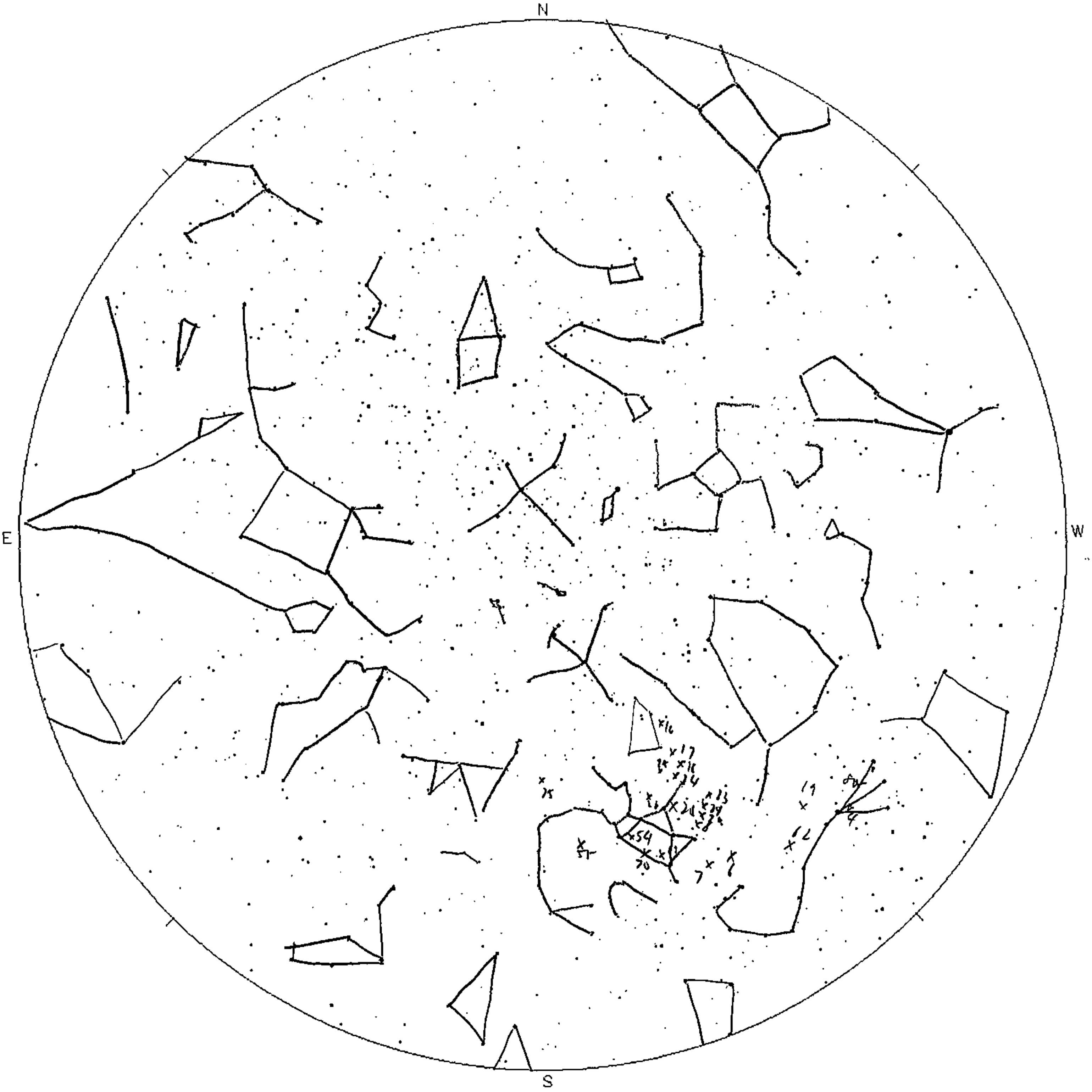
eridanus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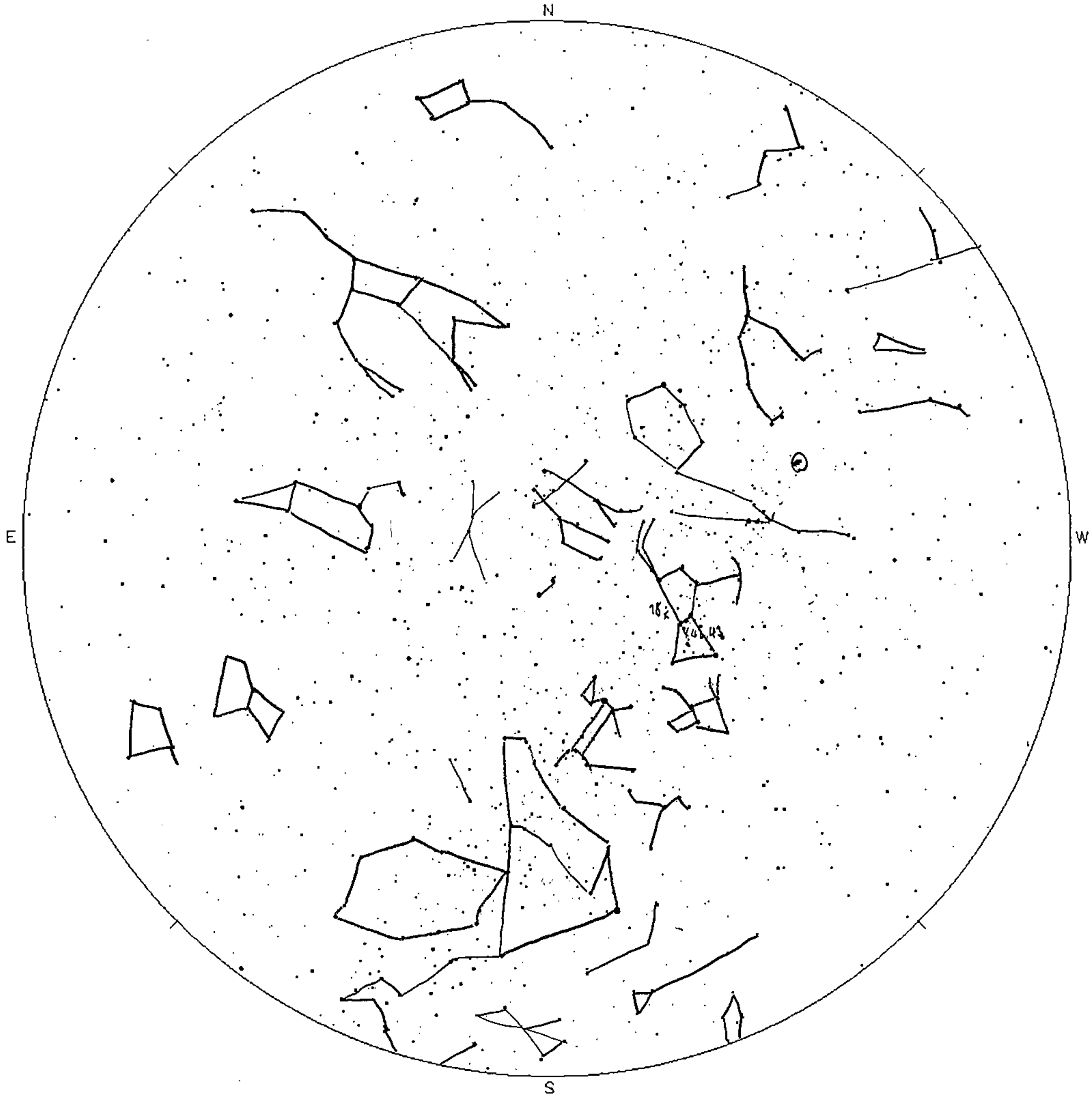
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S
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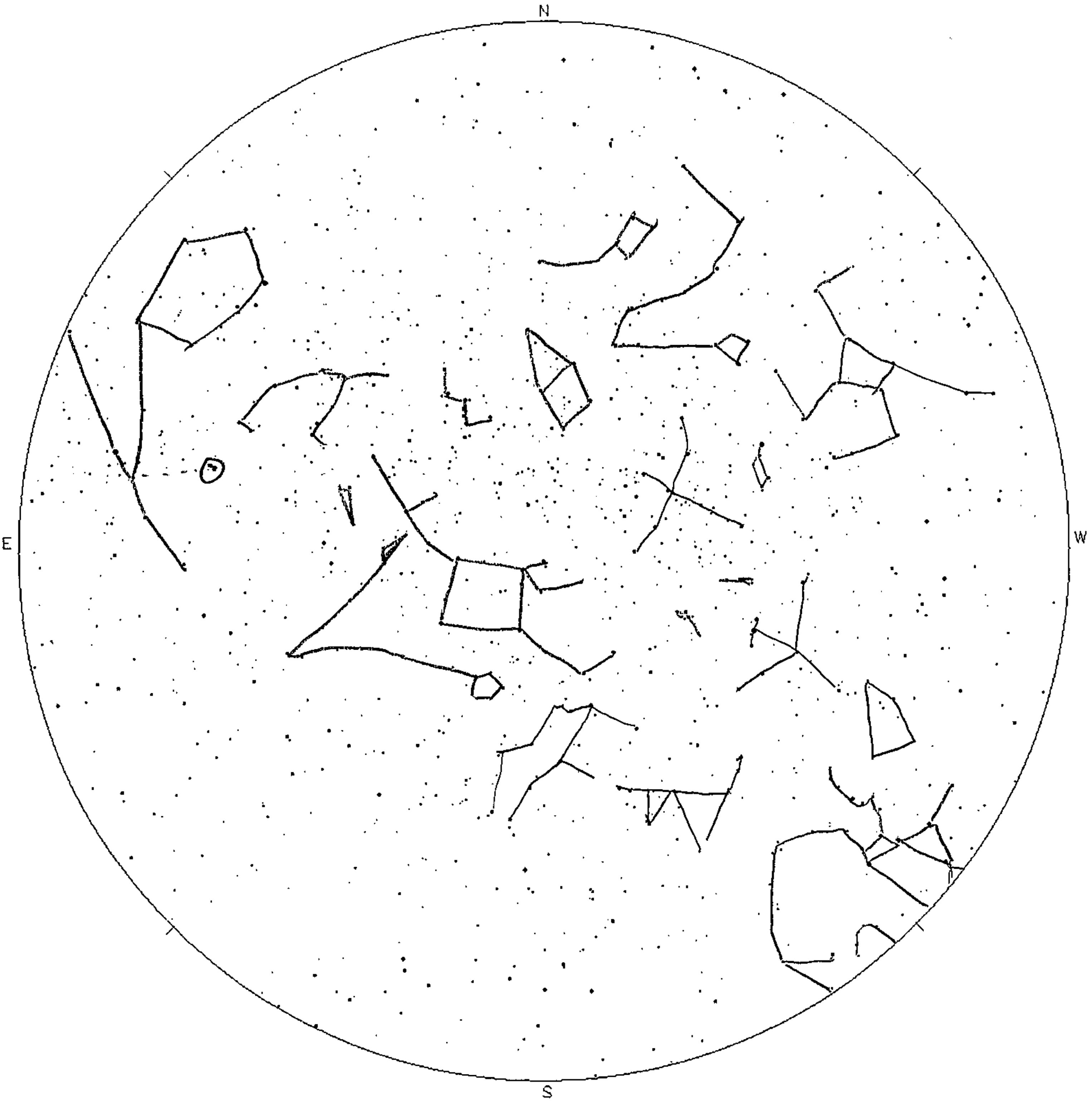

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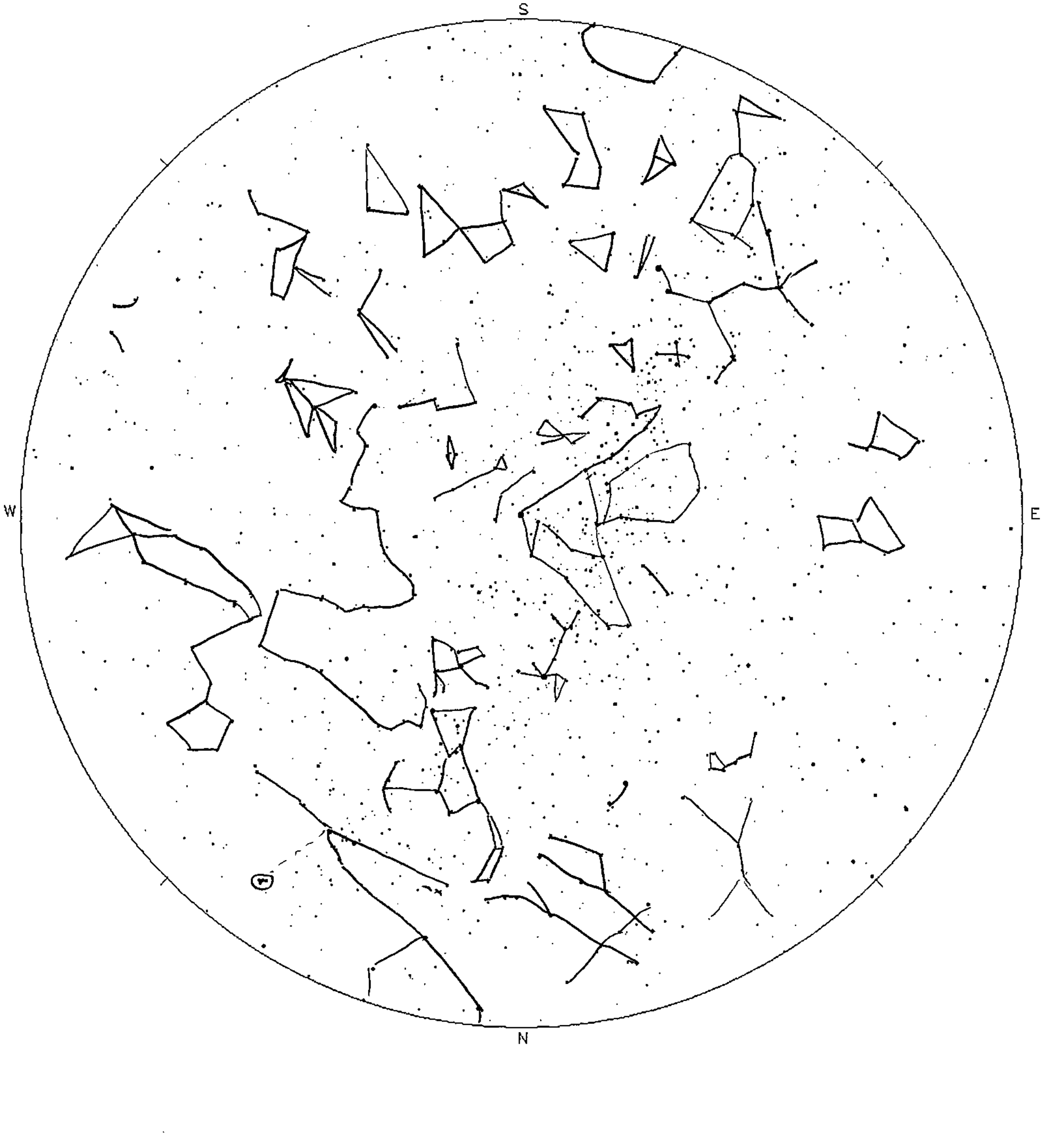
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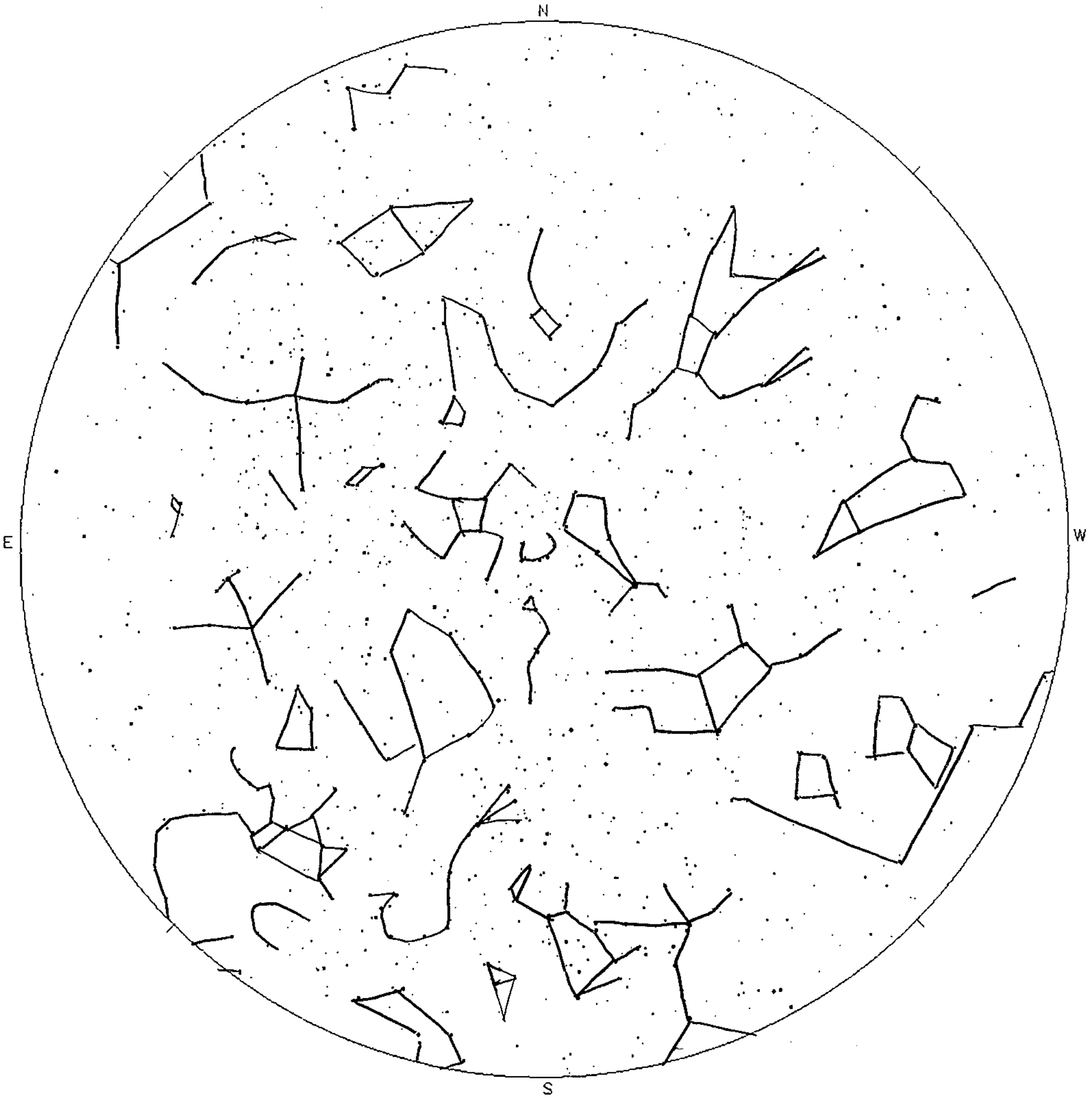
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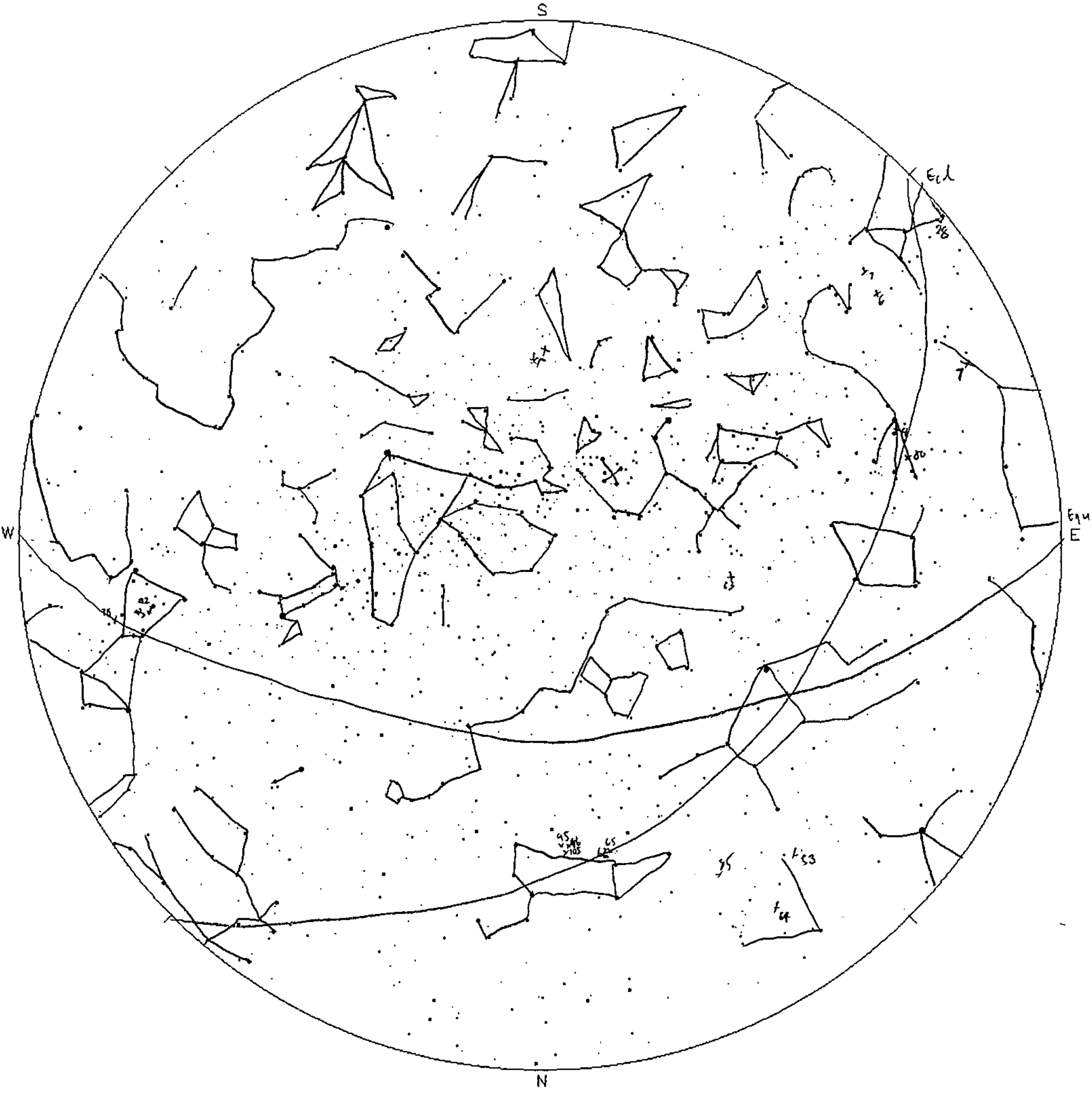
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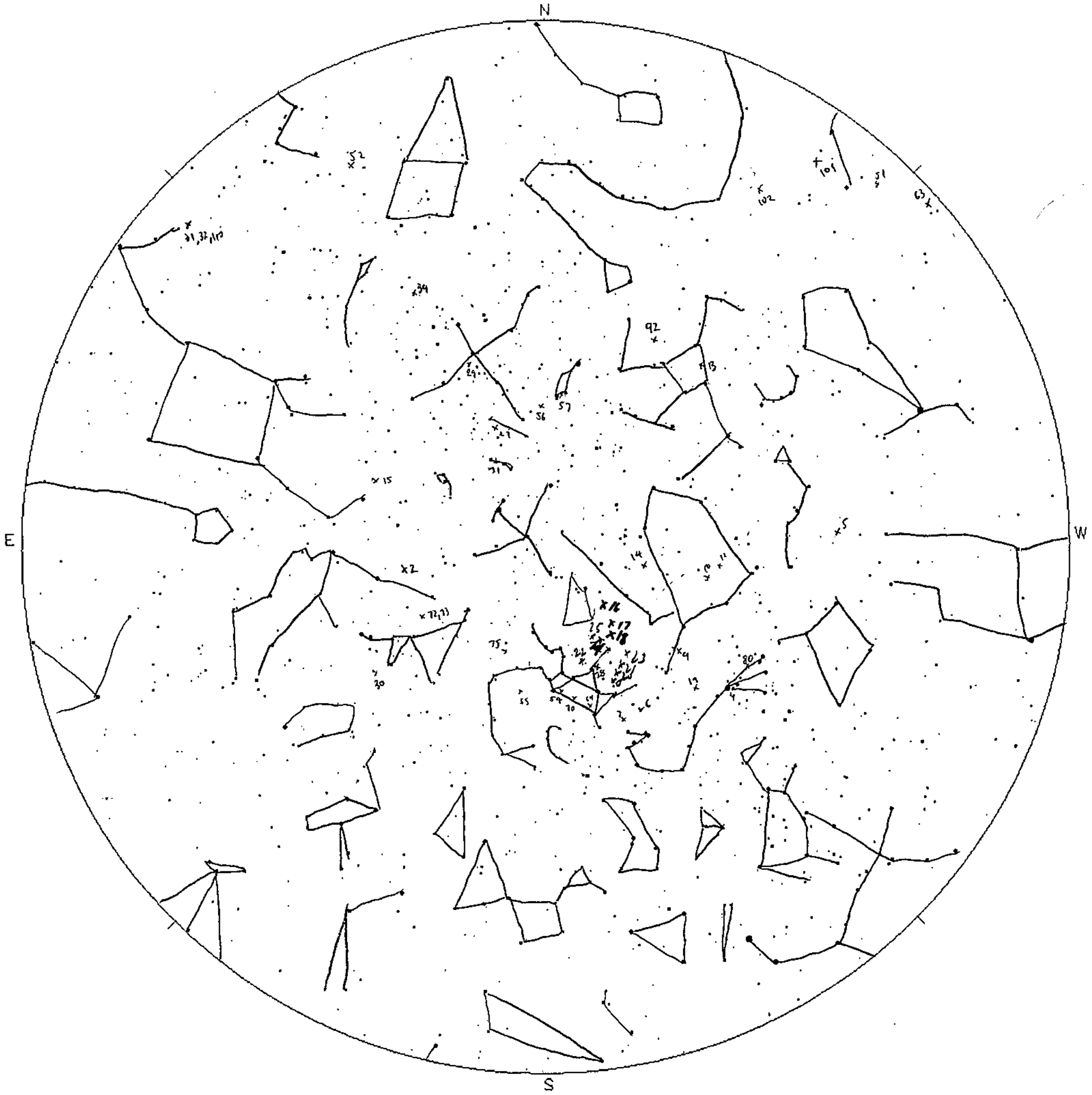
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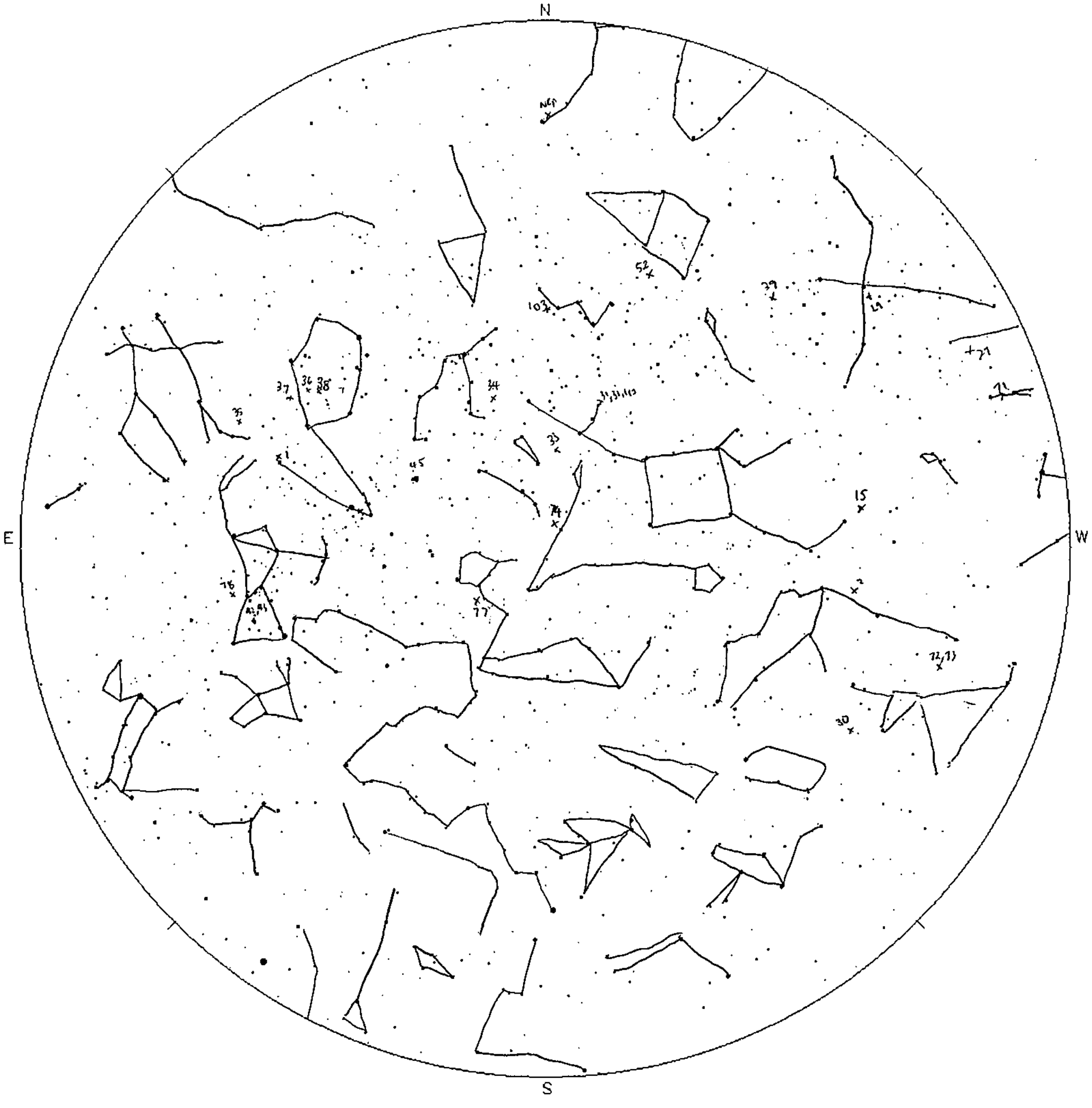
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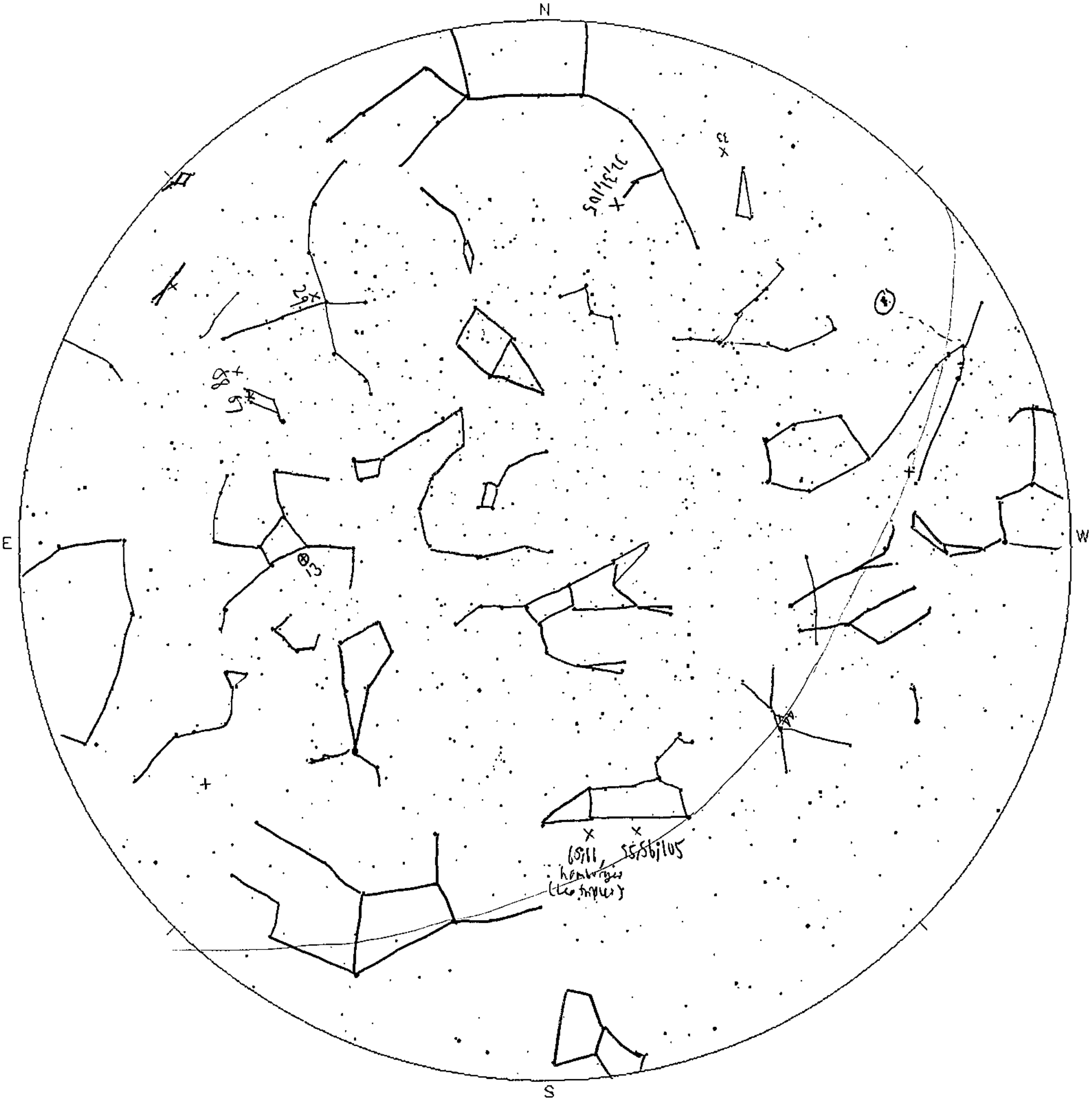
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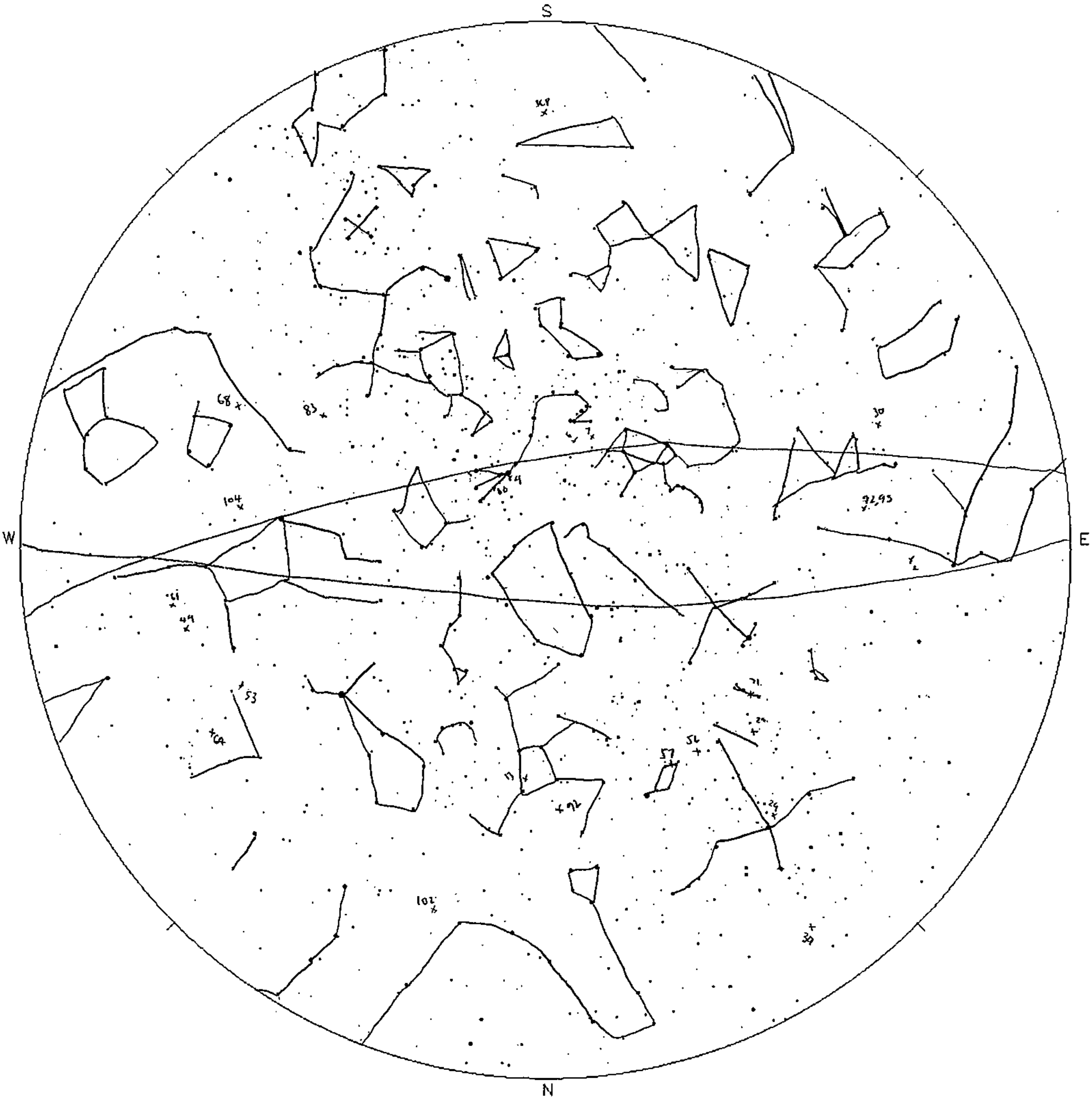
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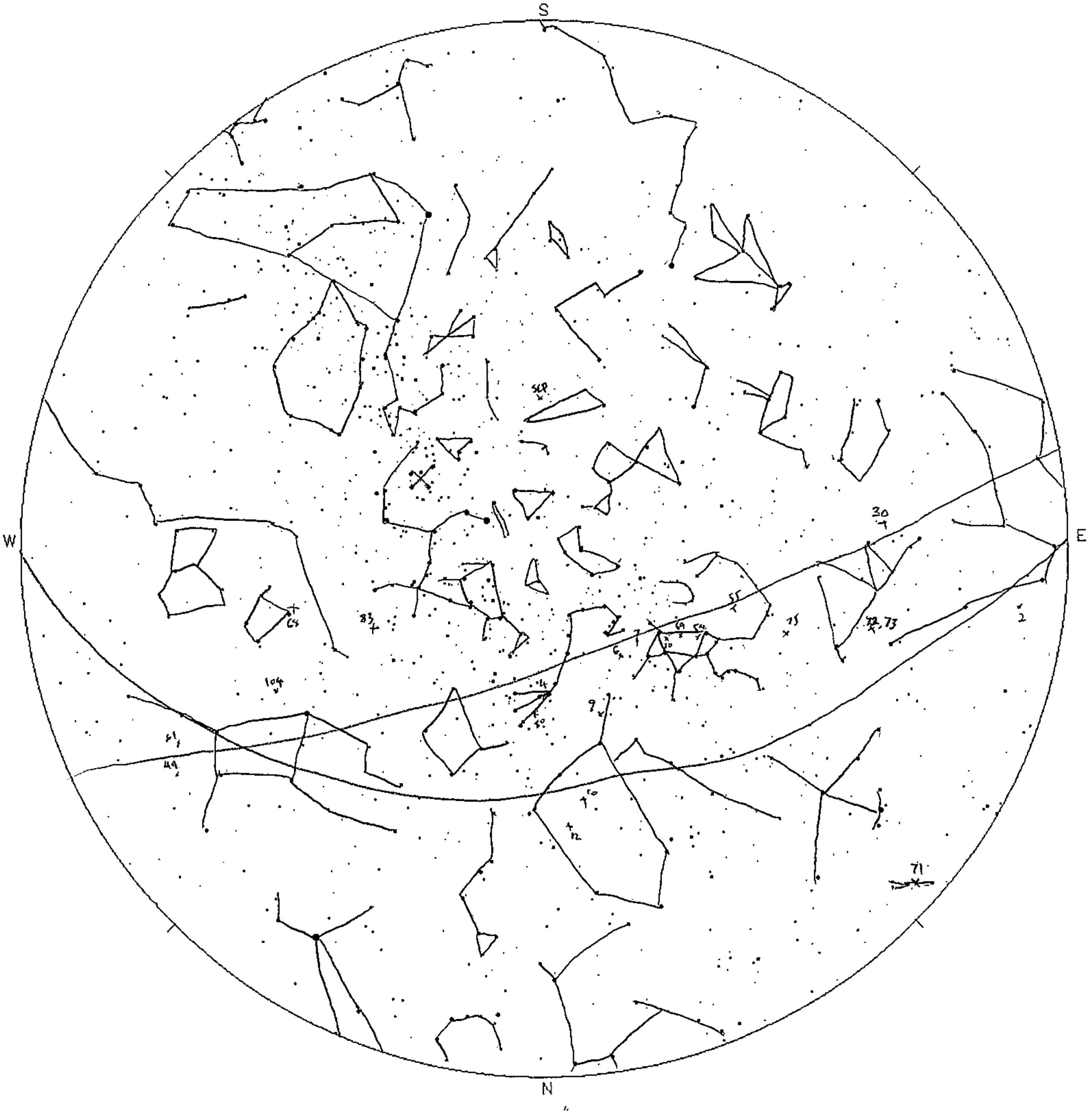
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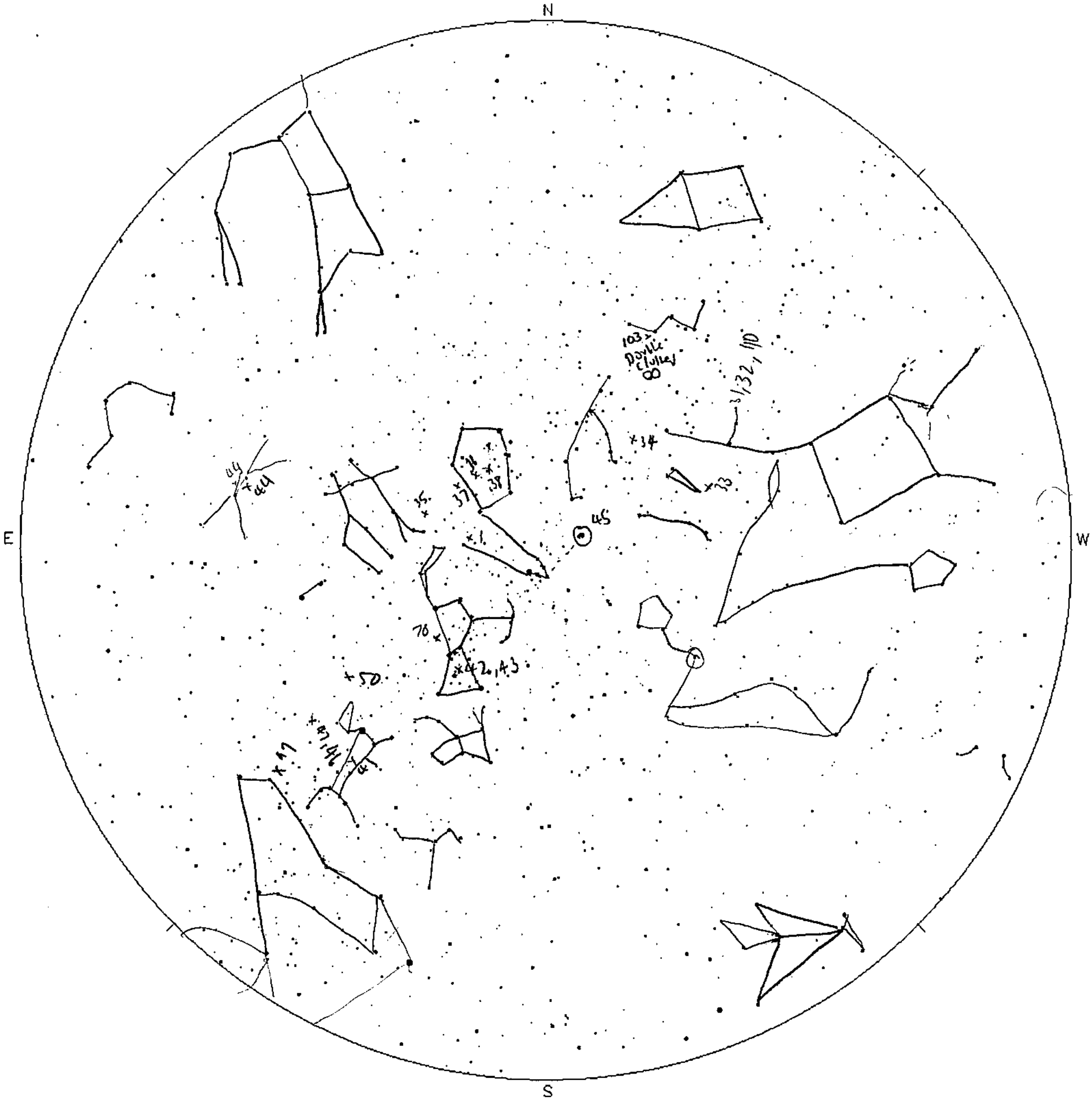
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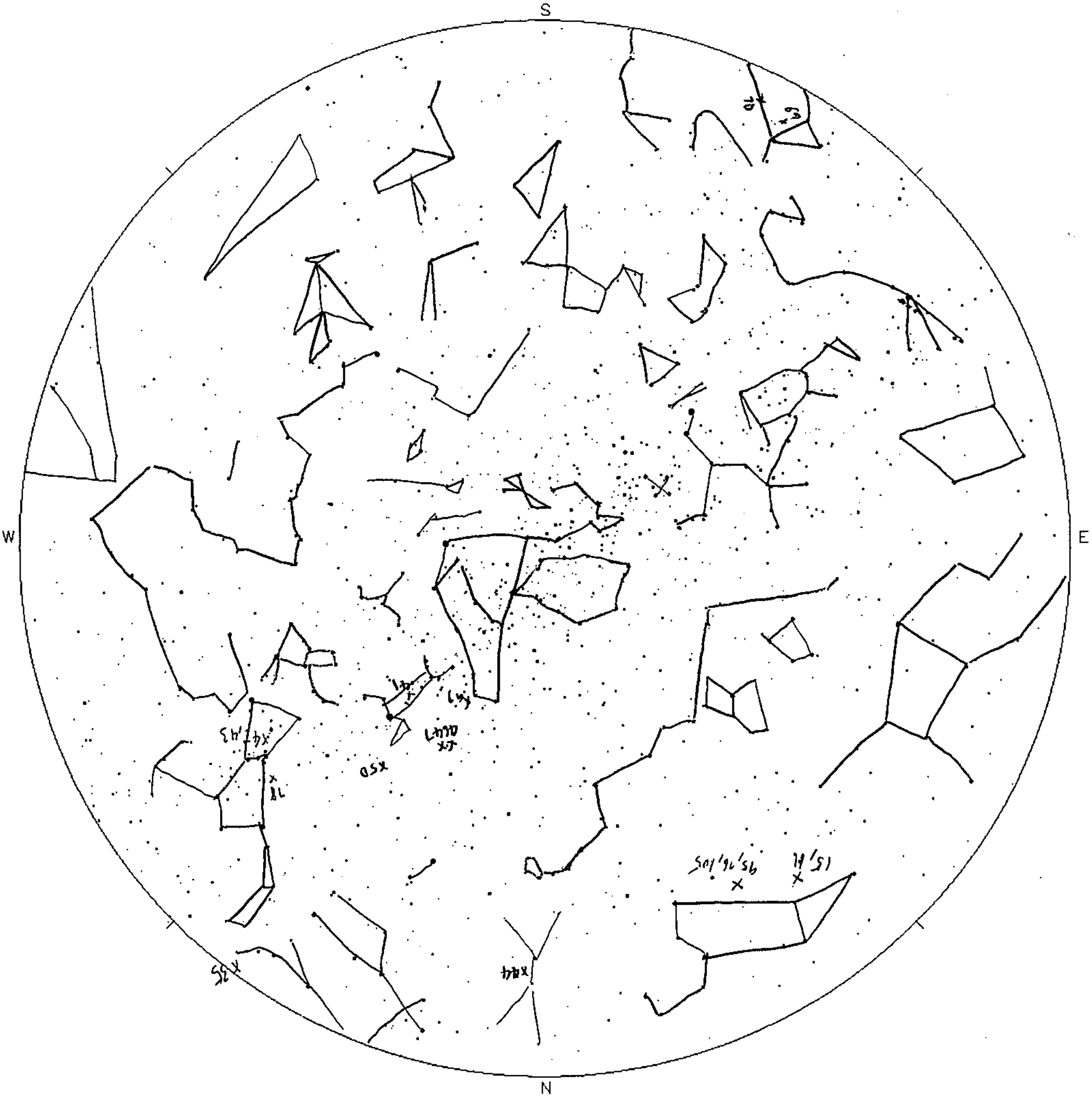
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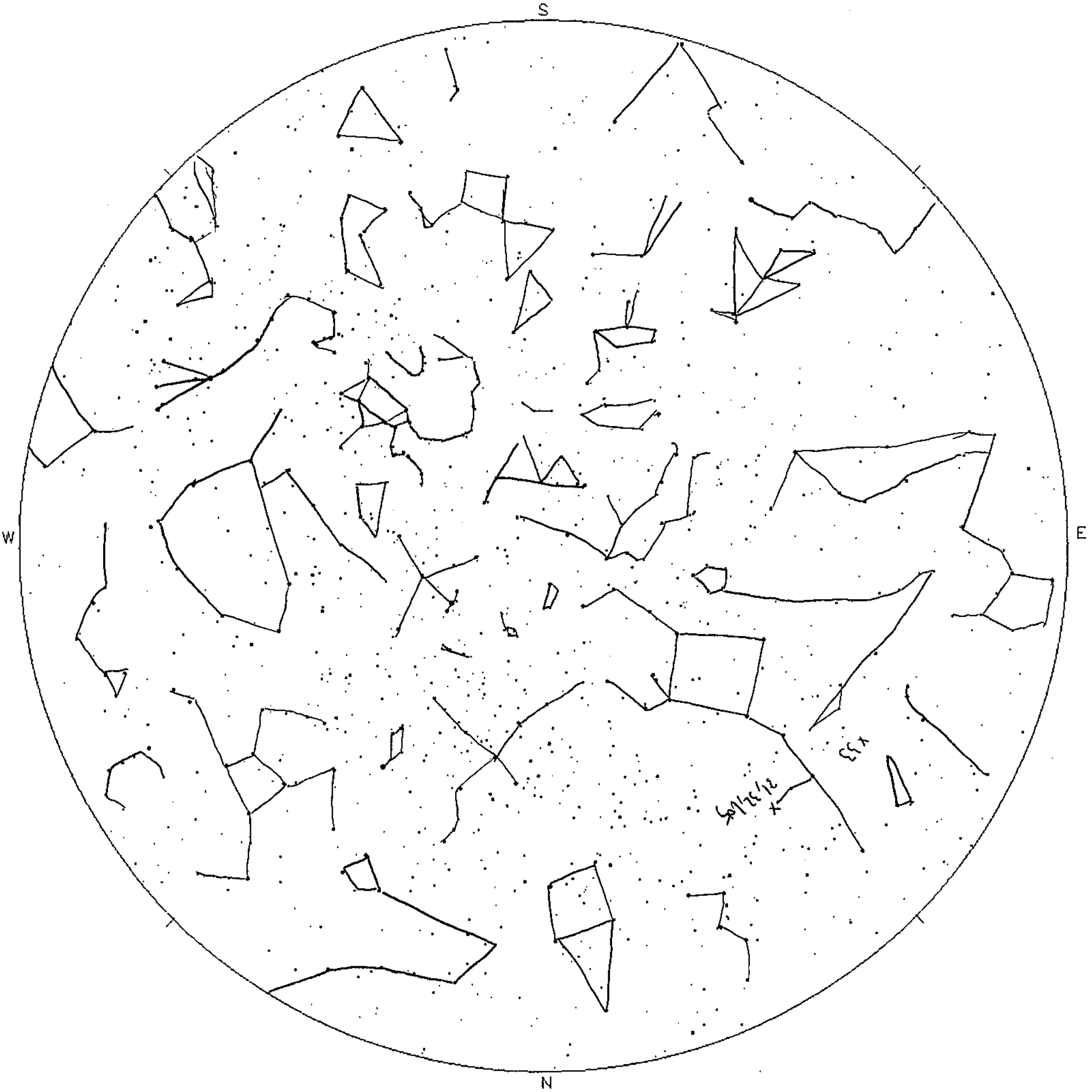
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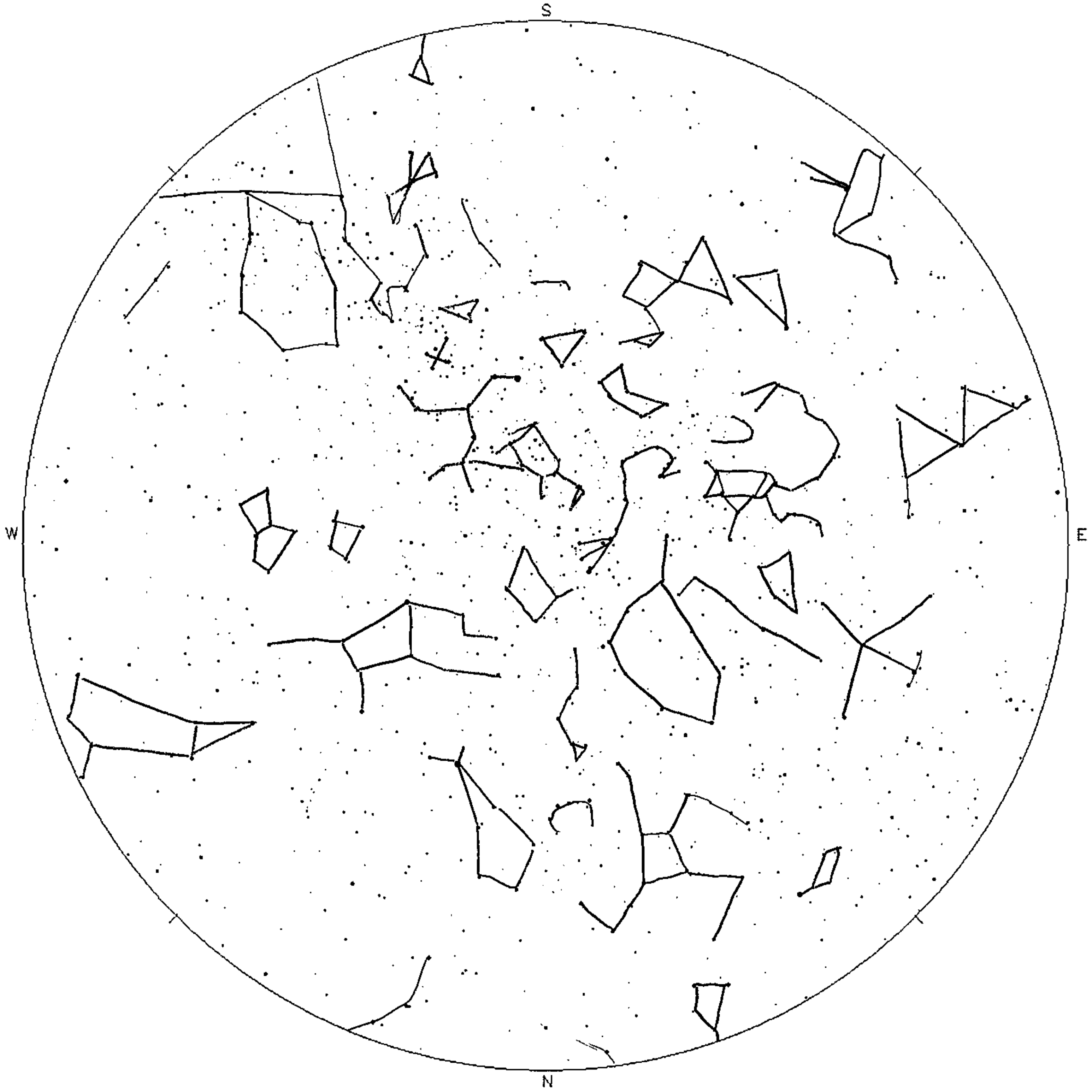
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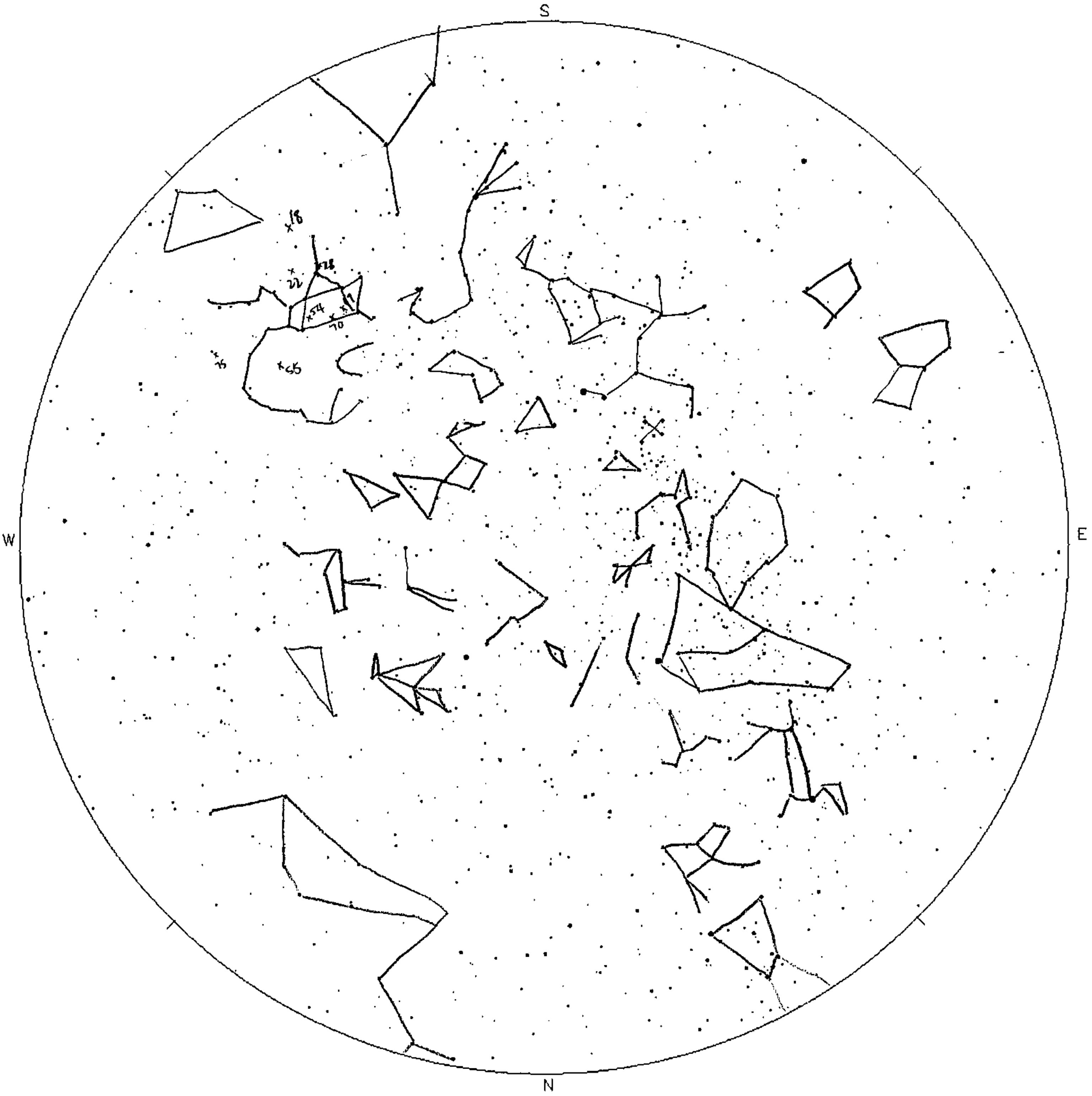
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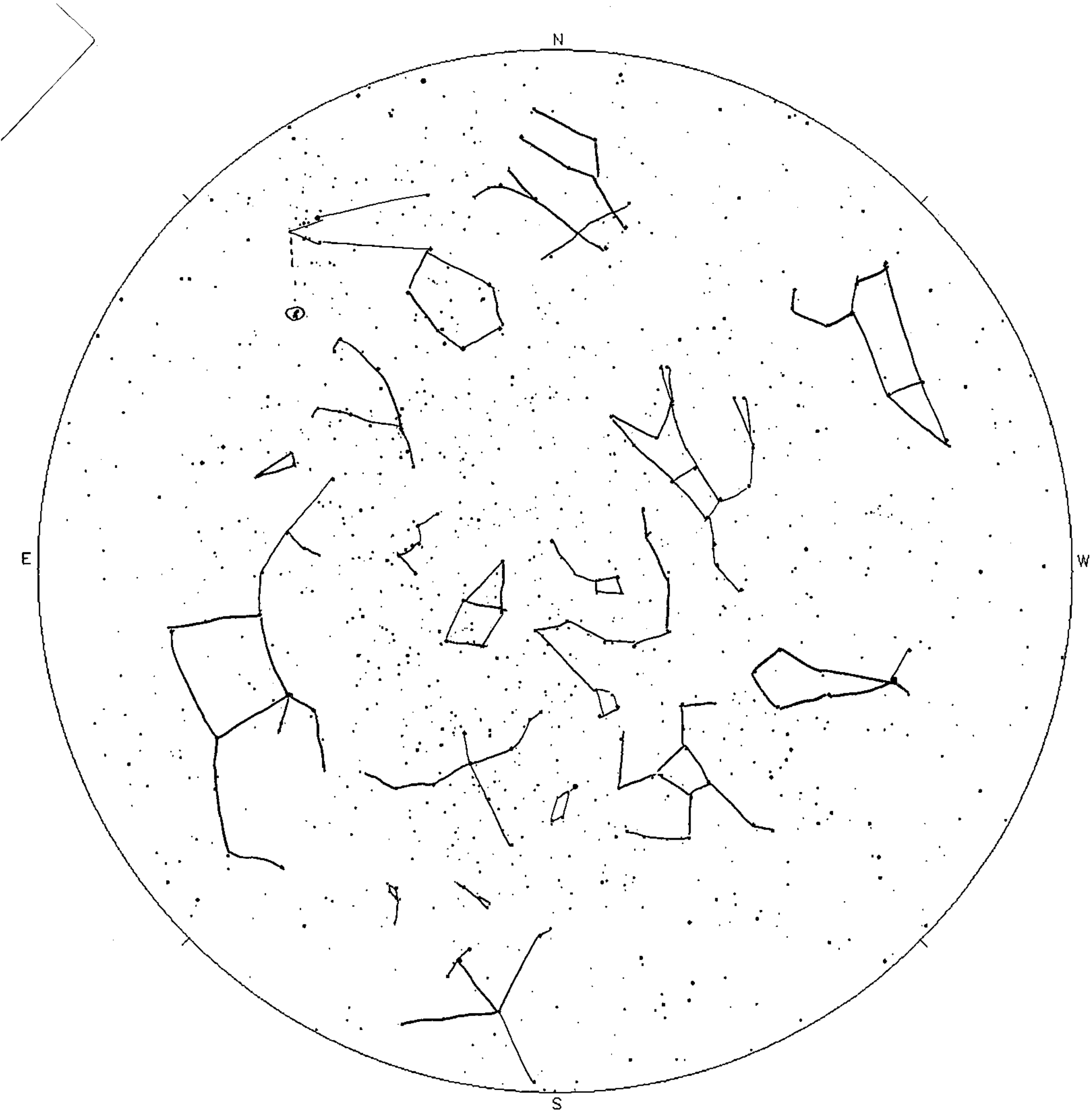
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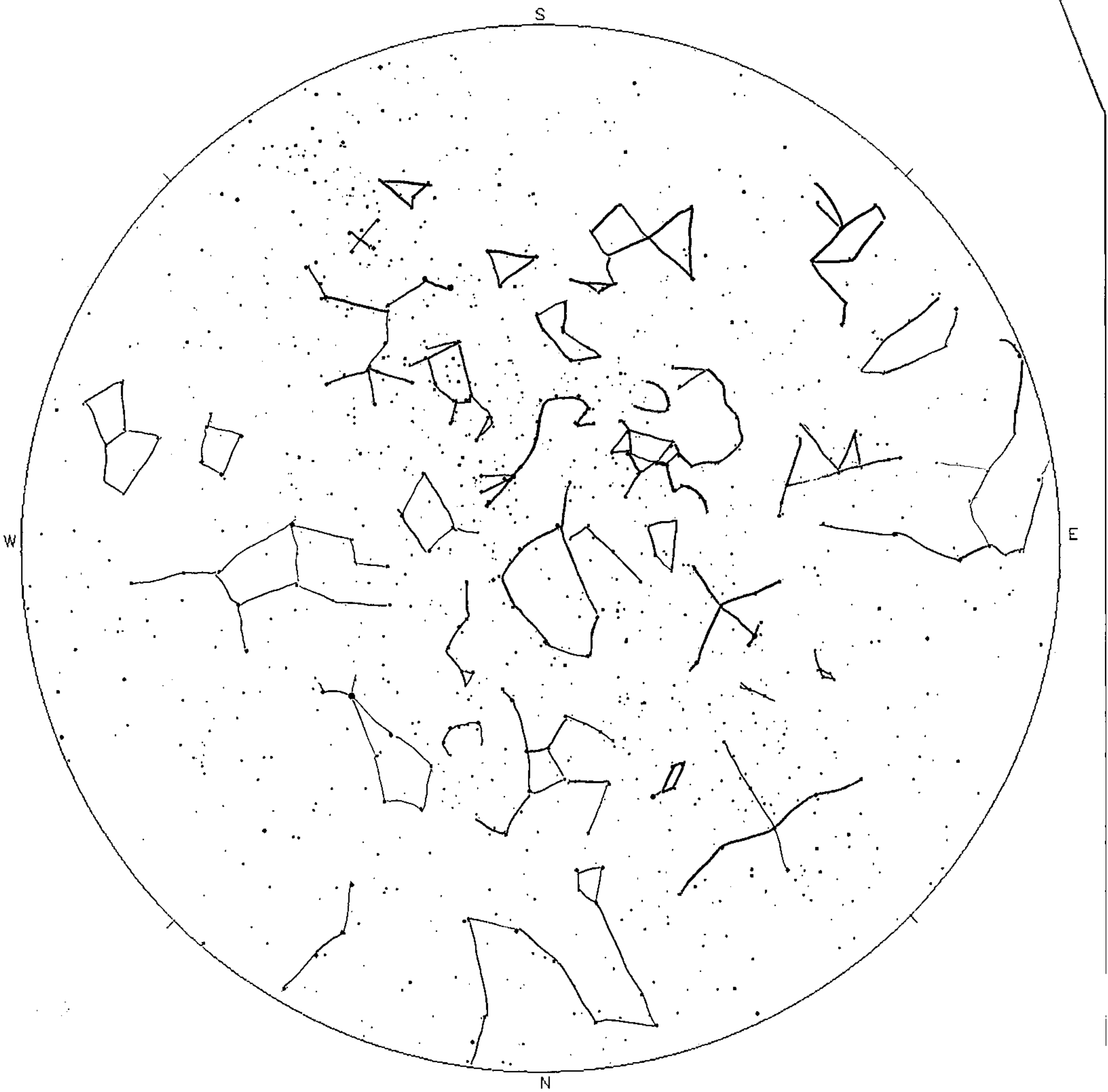
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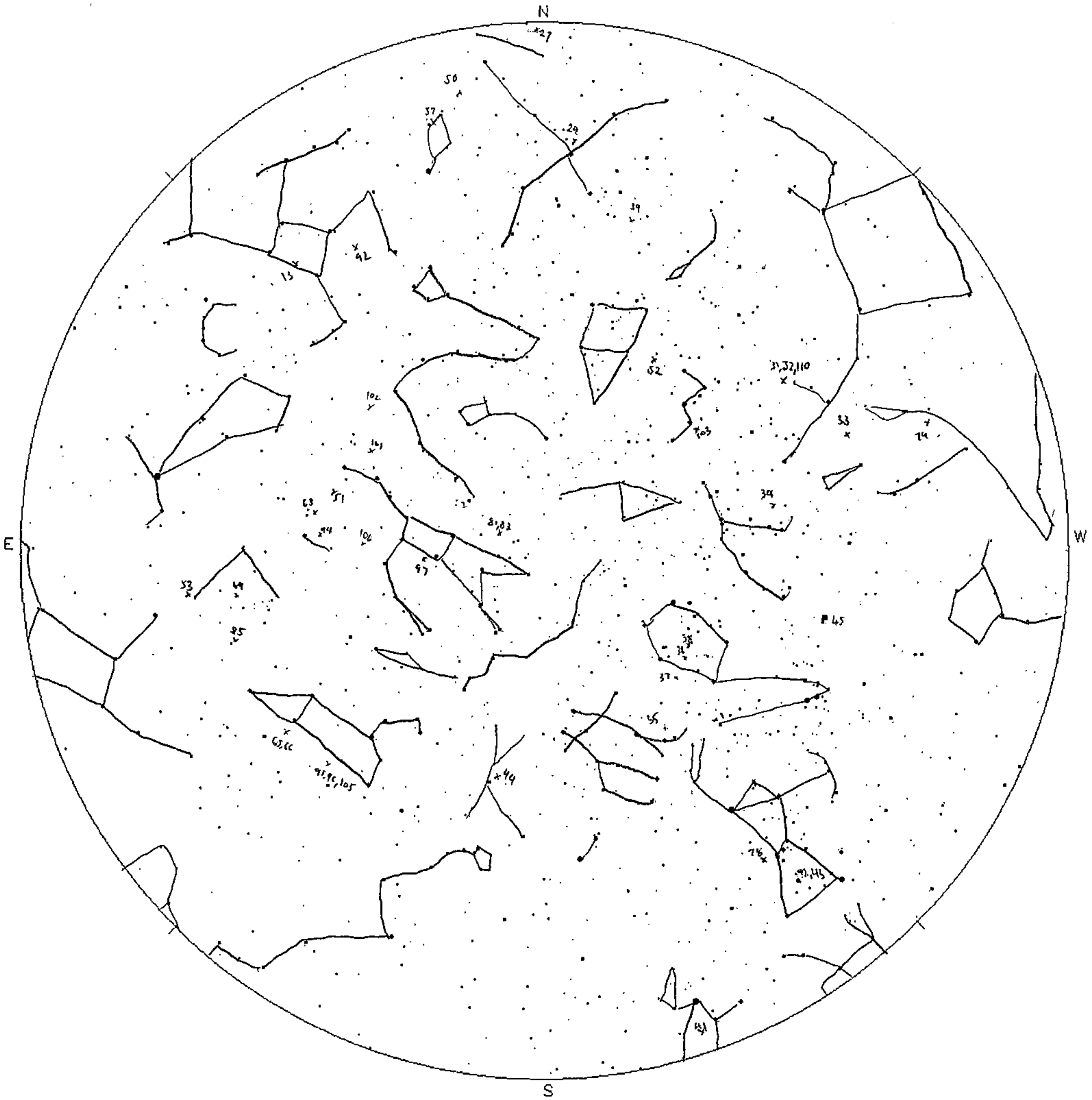
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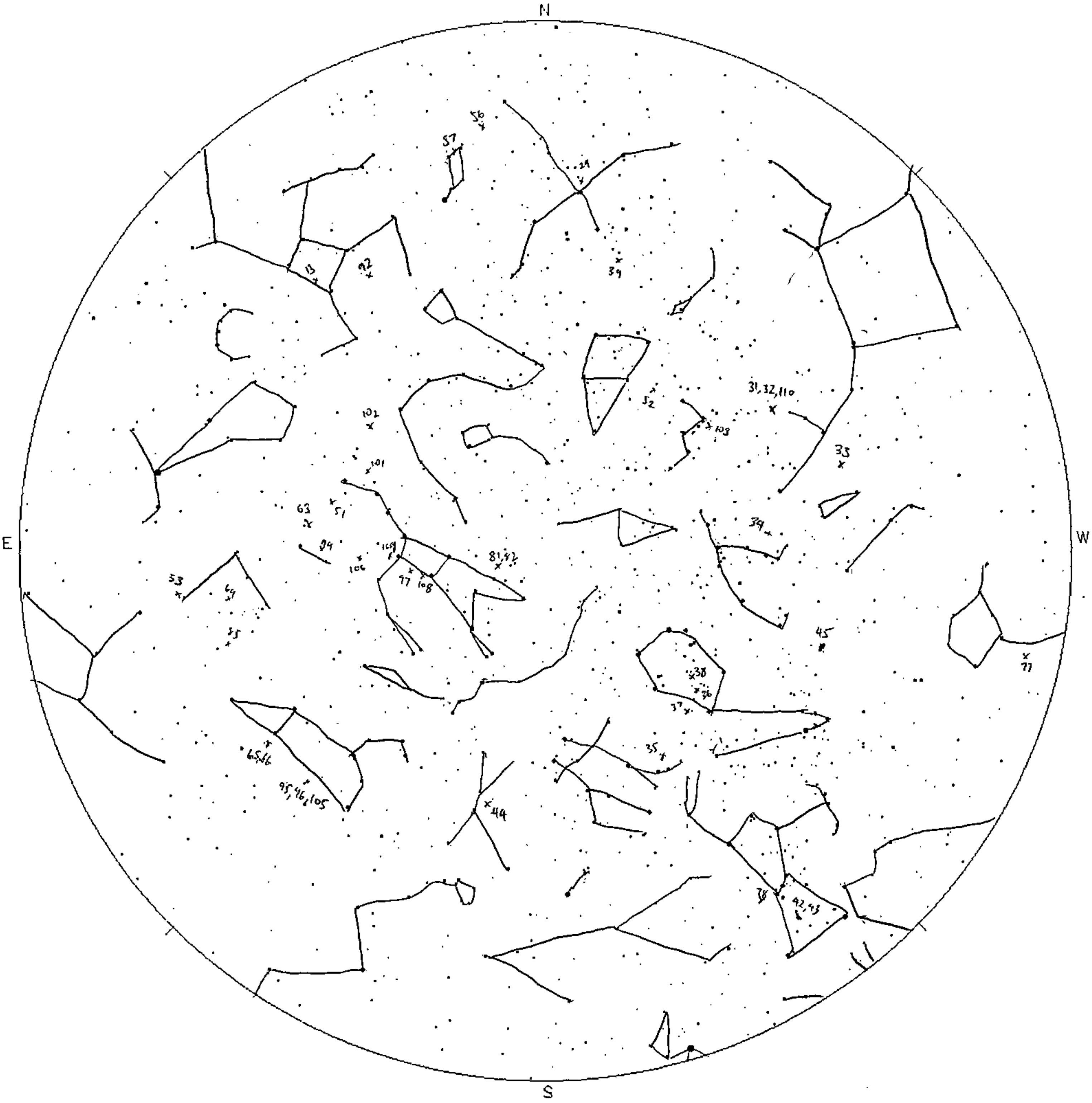
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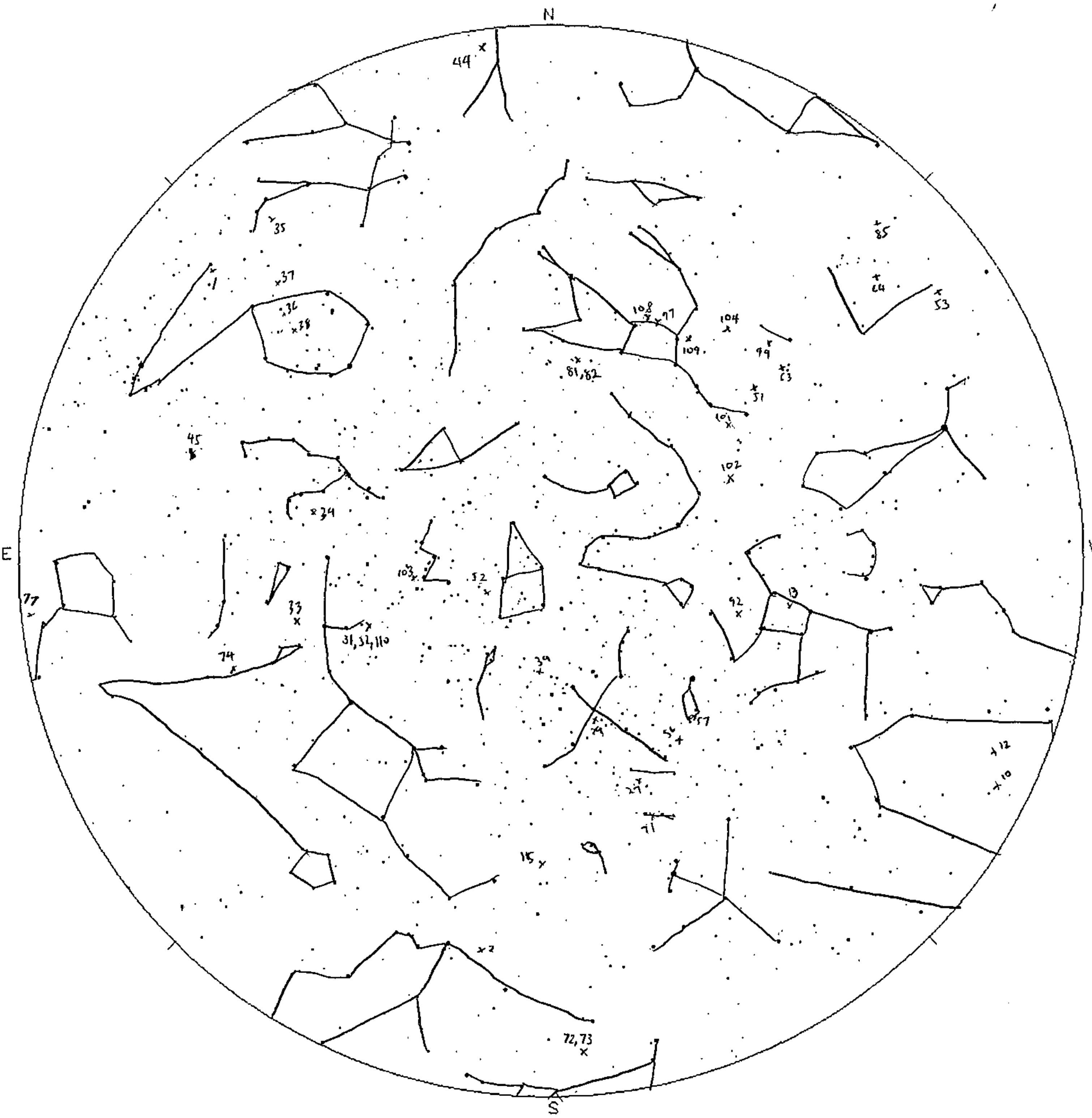
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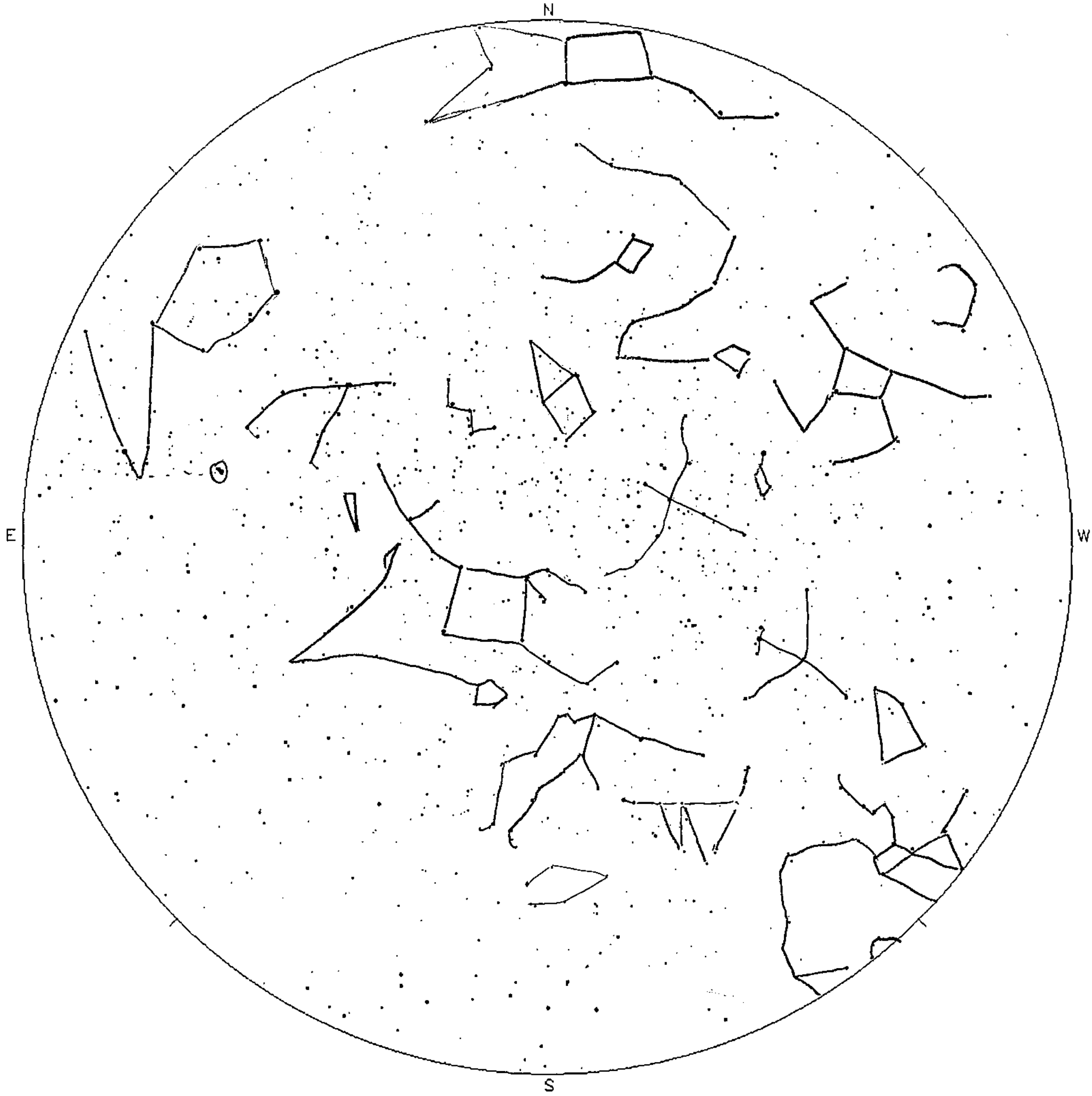
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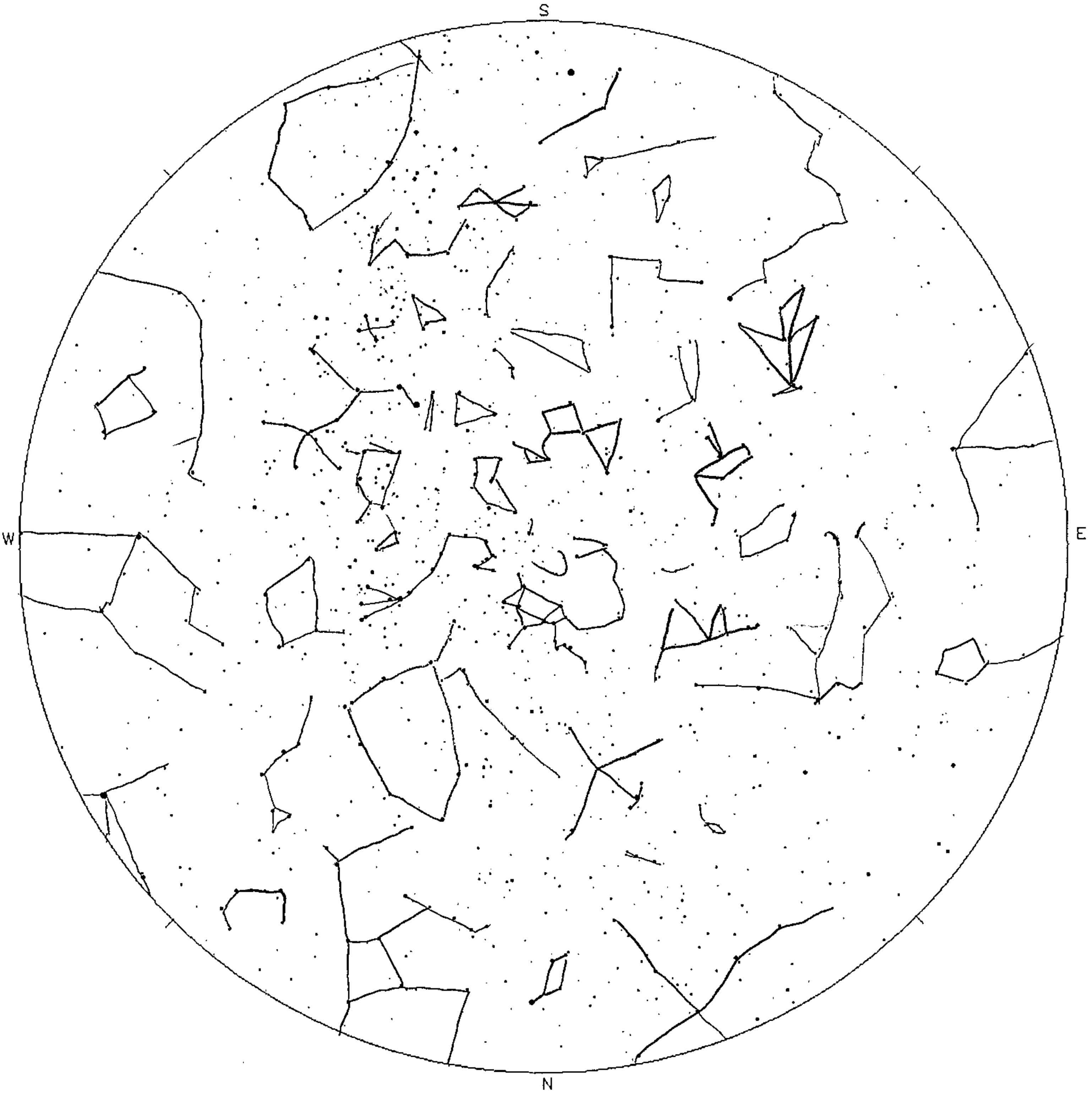
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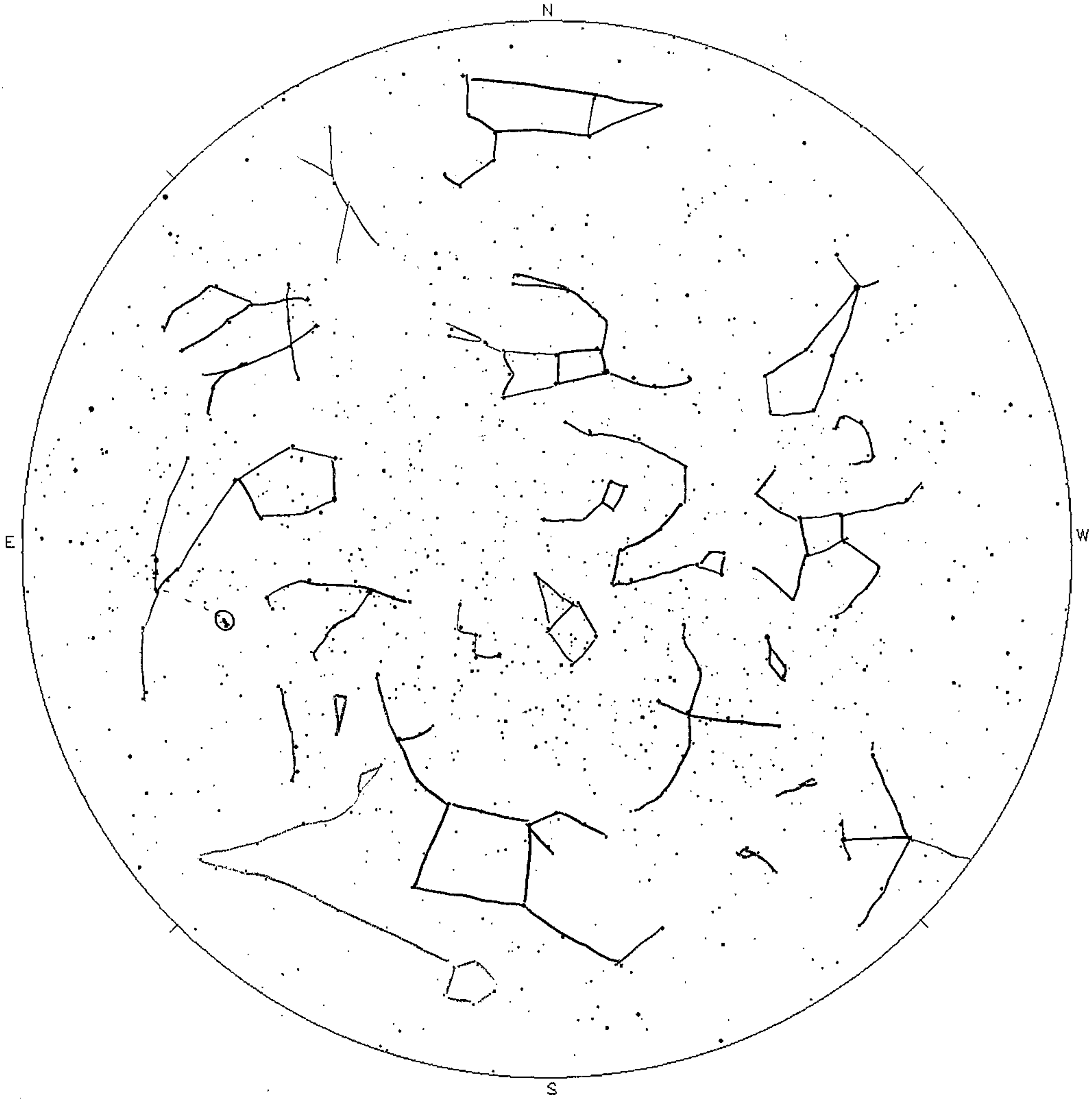
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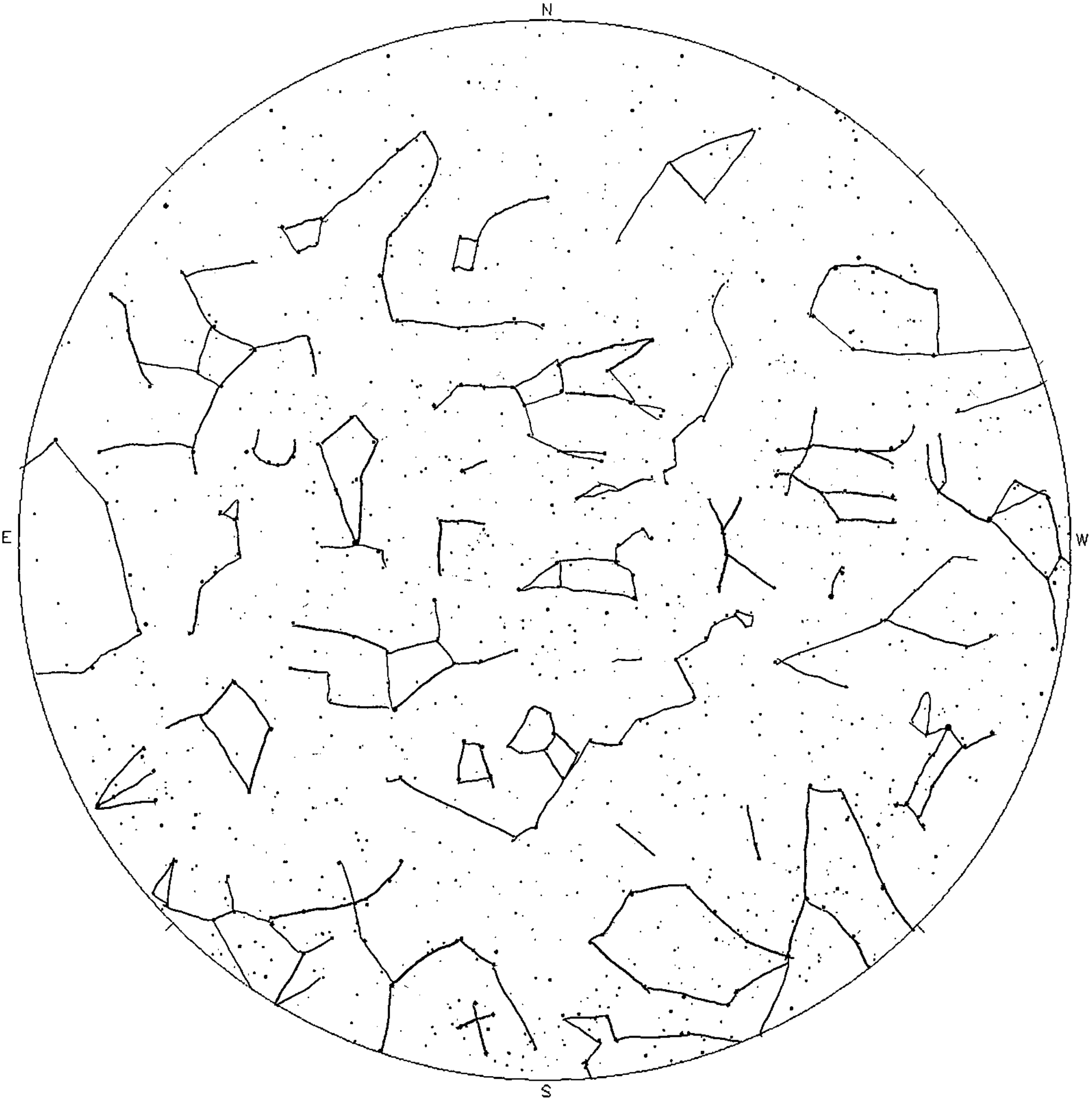
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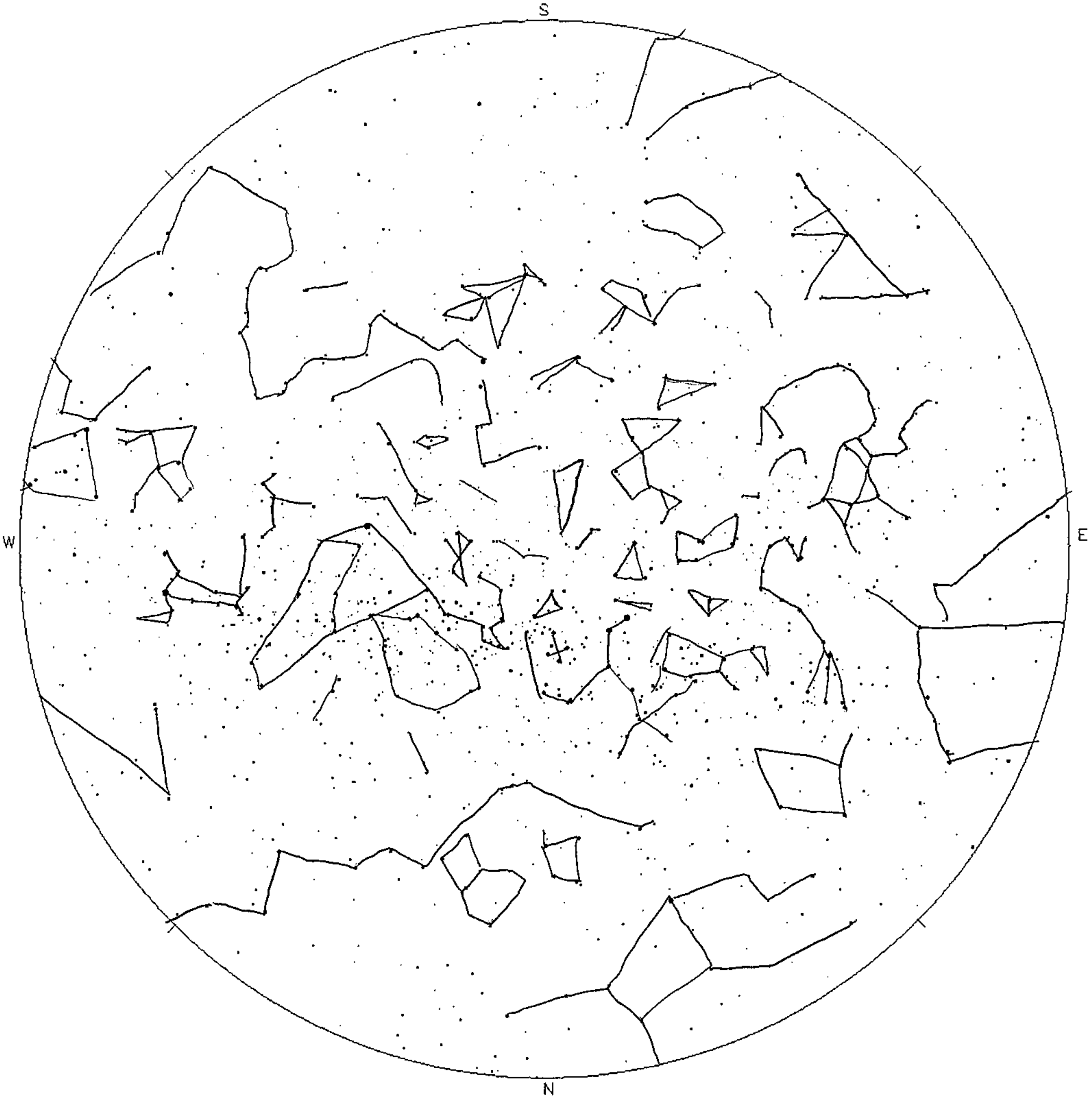
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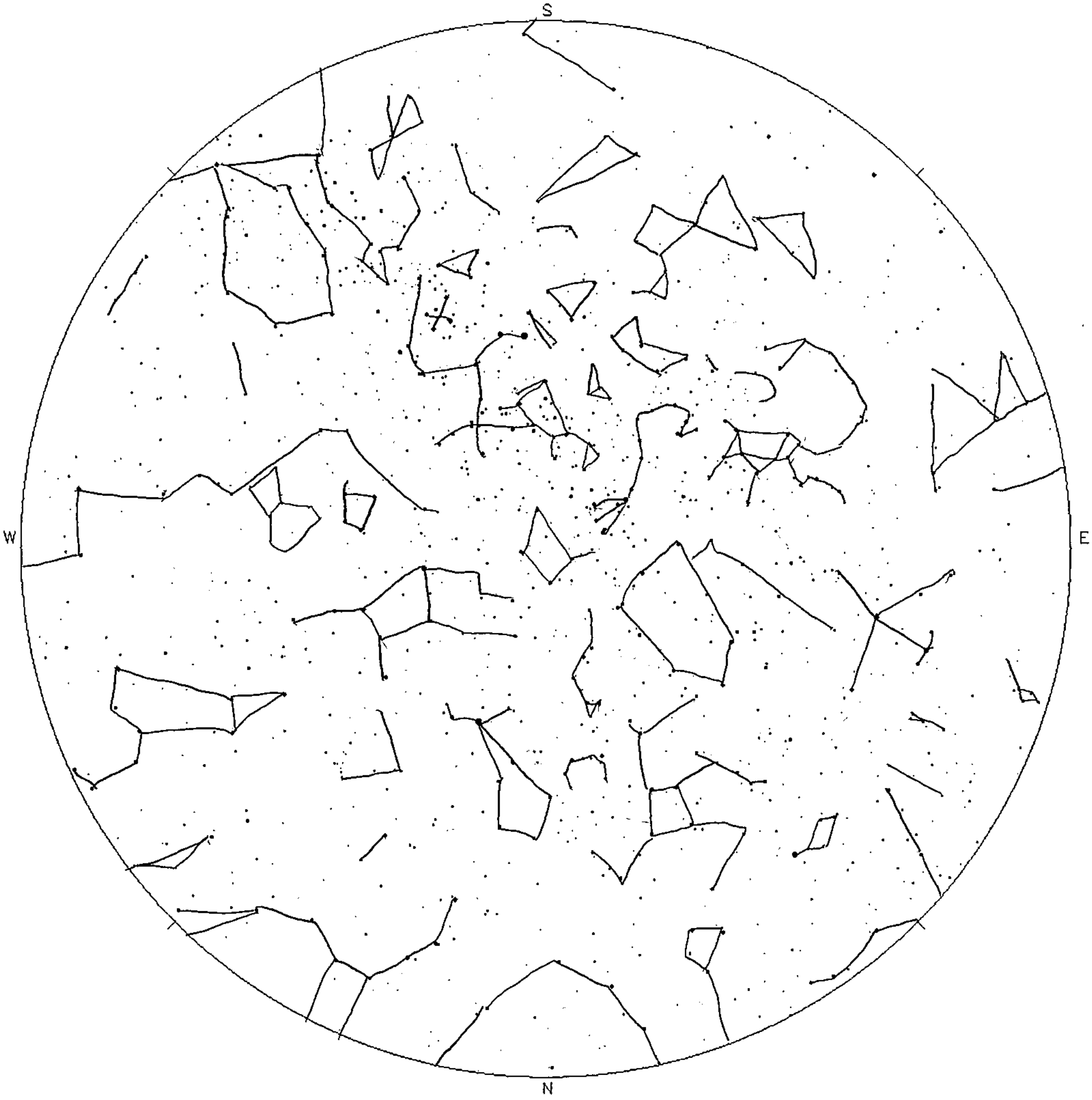
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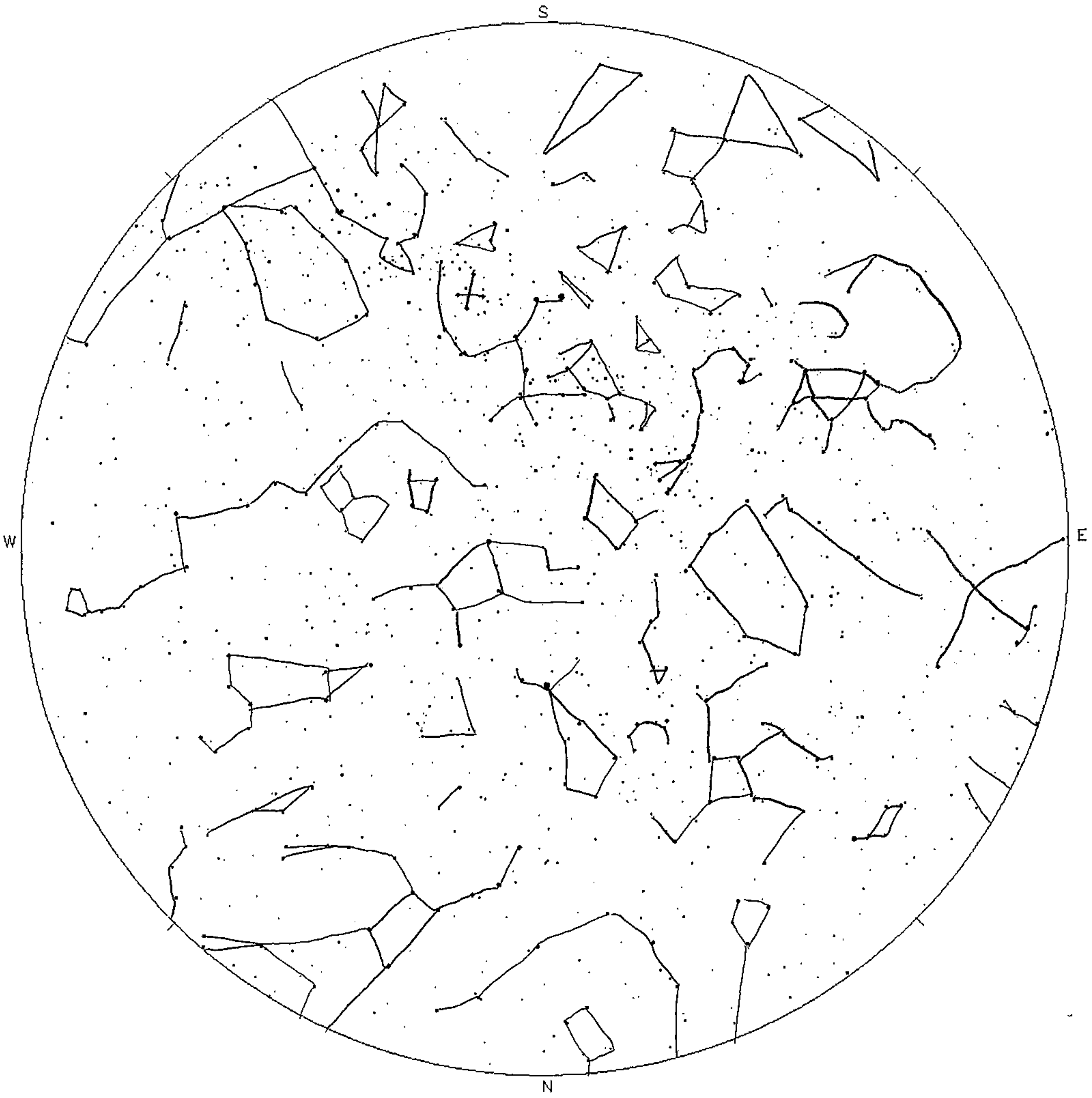
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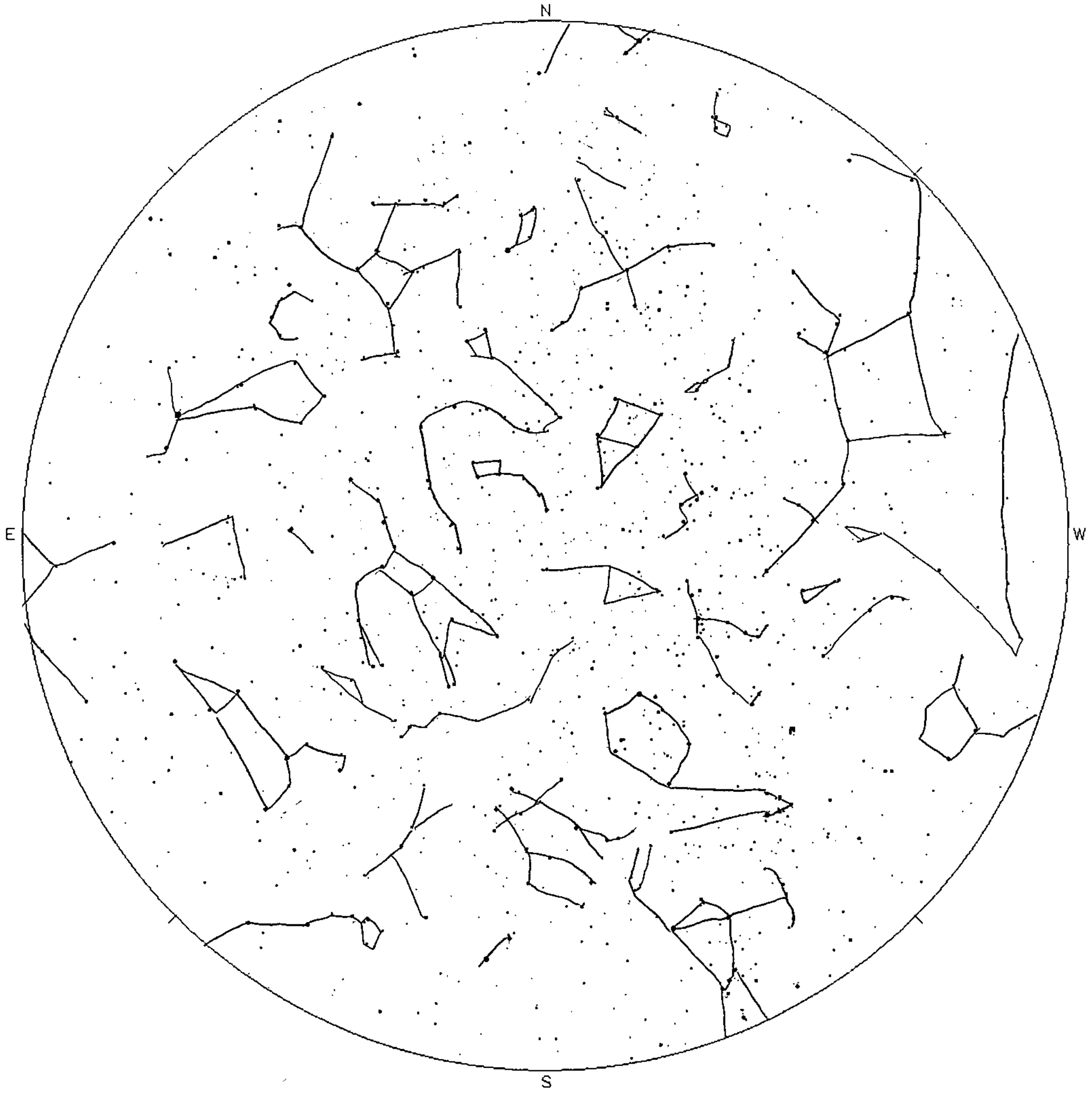
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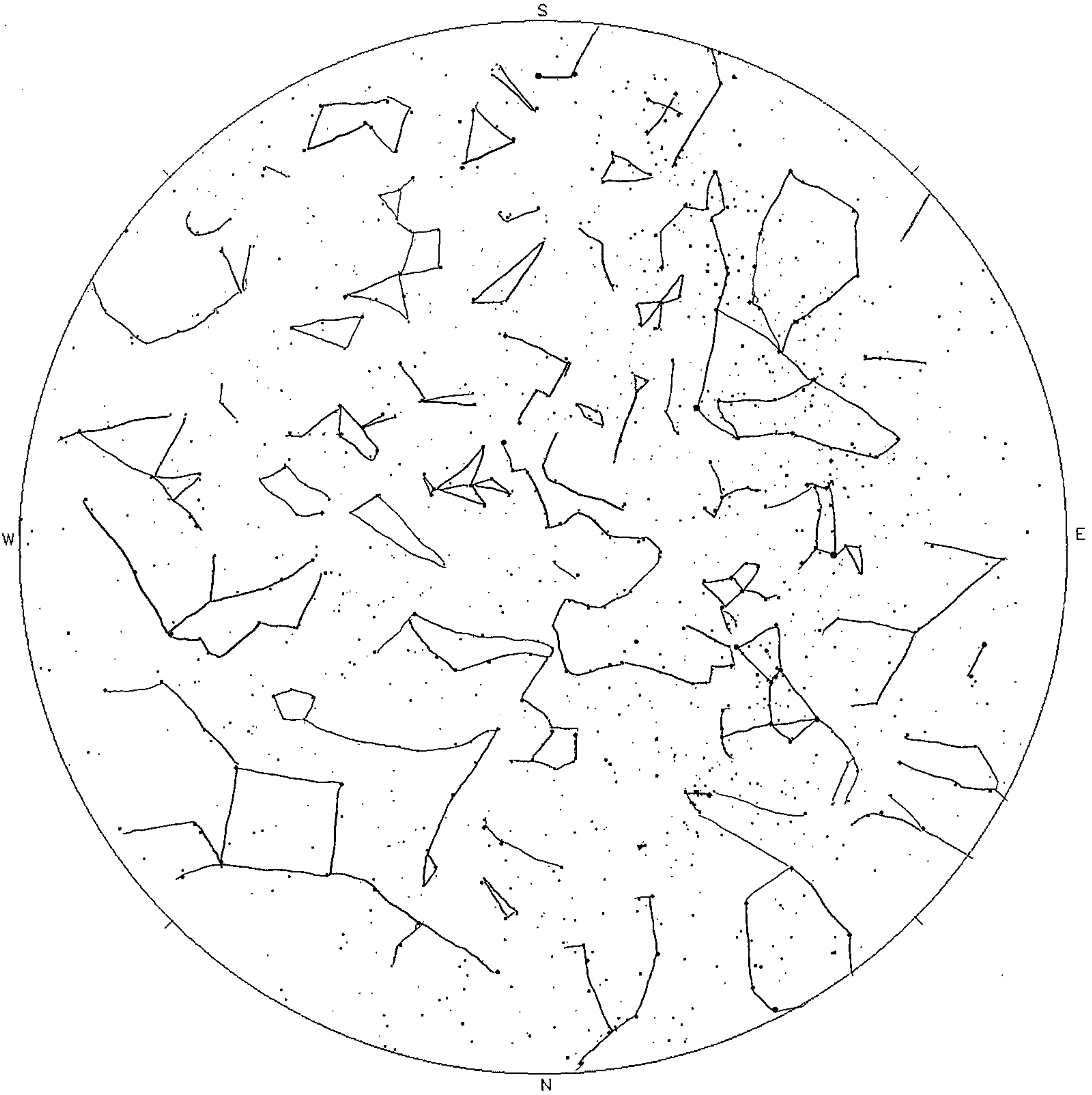
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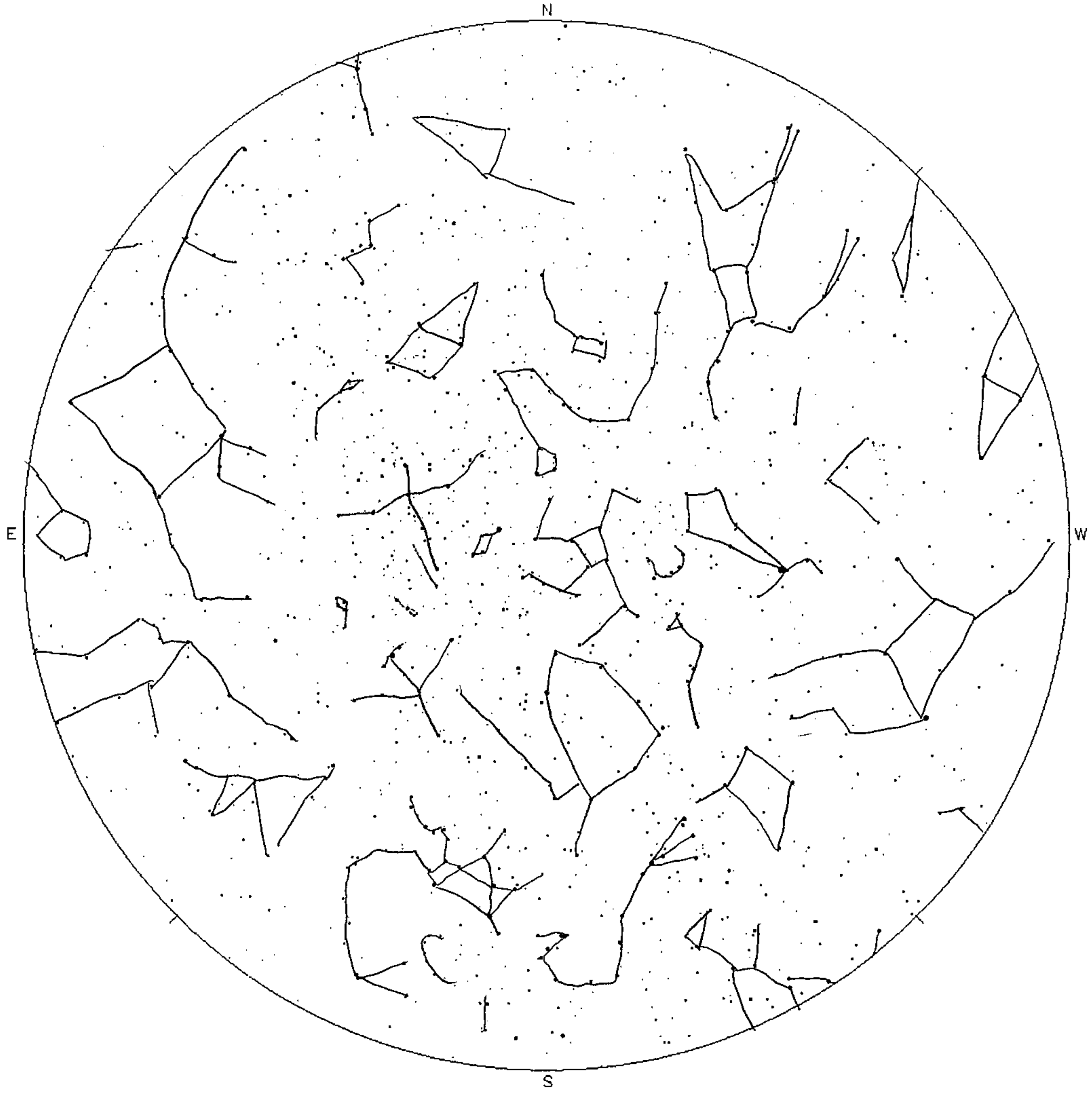
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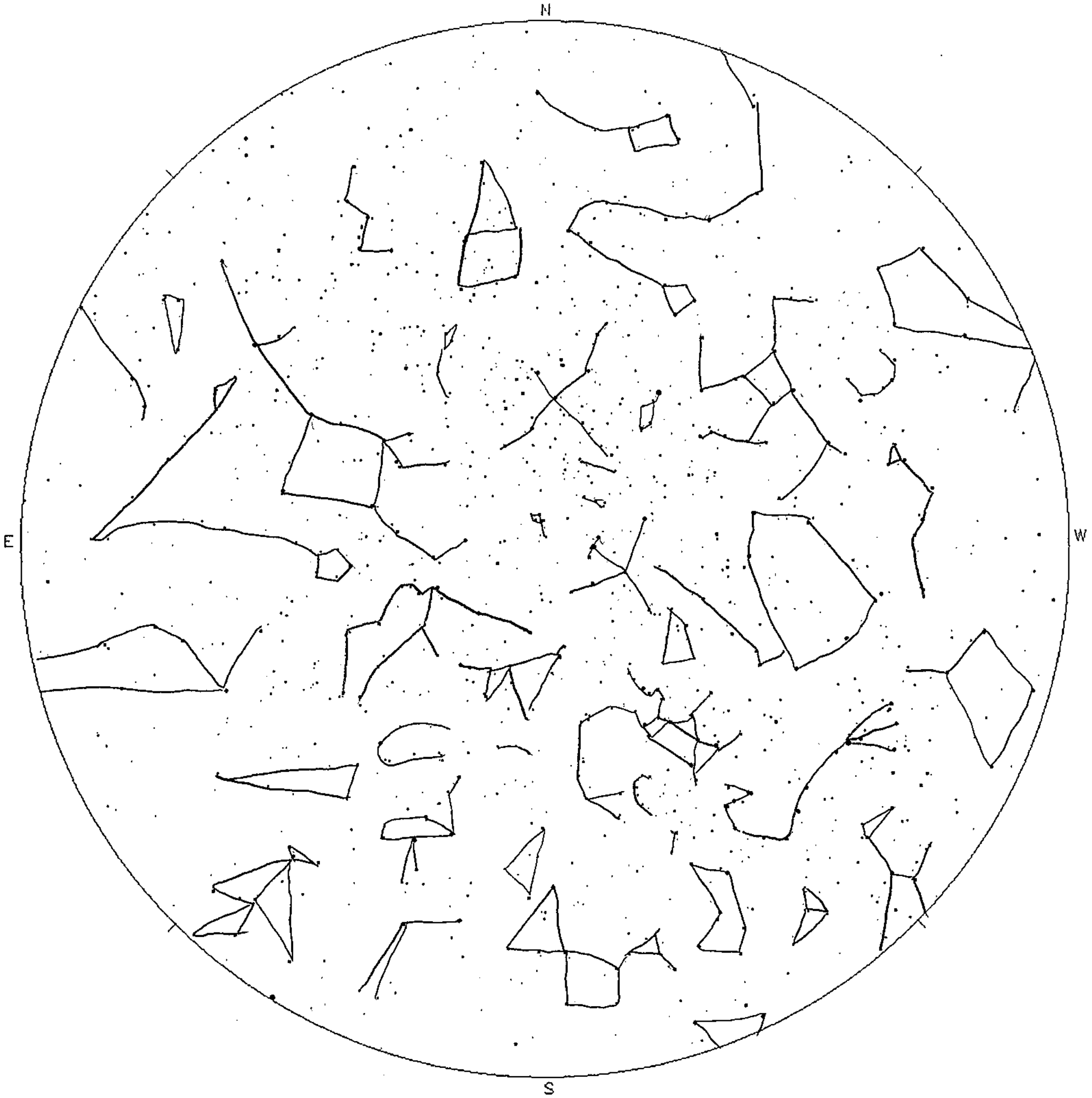
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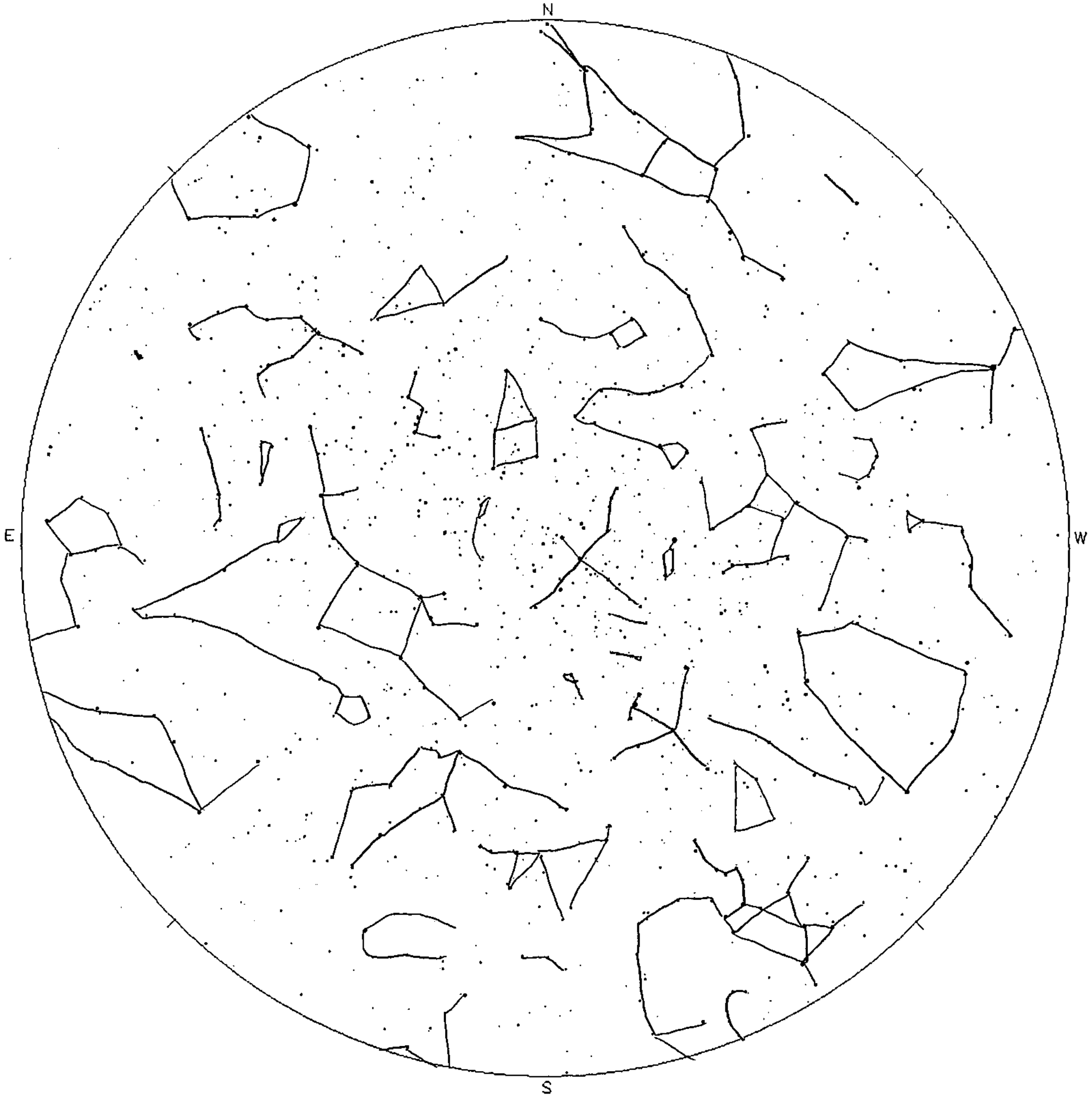
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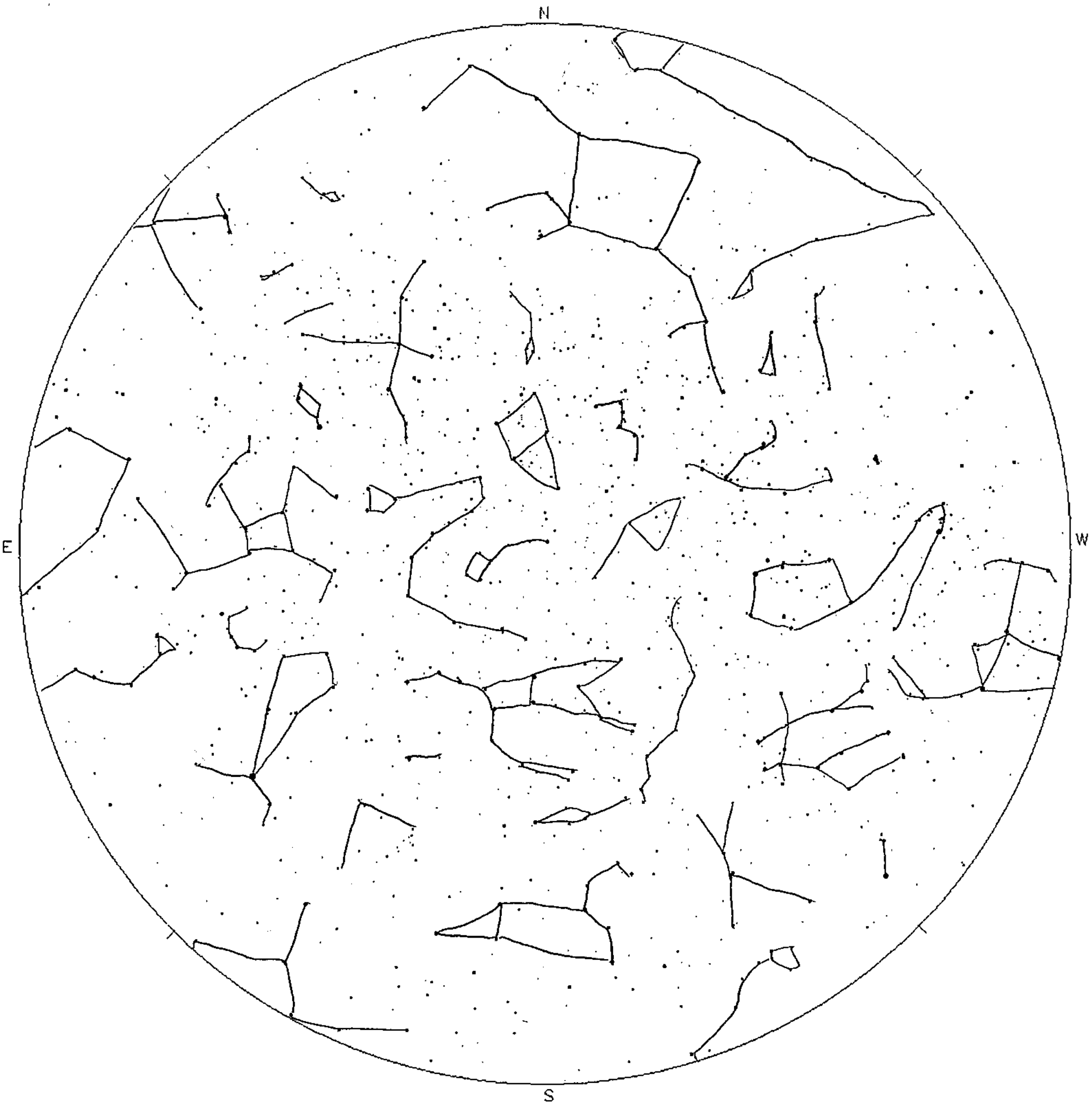
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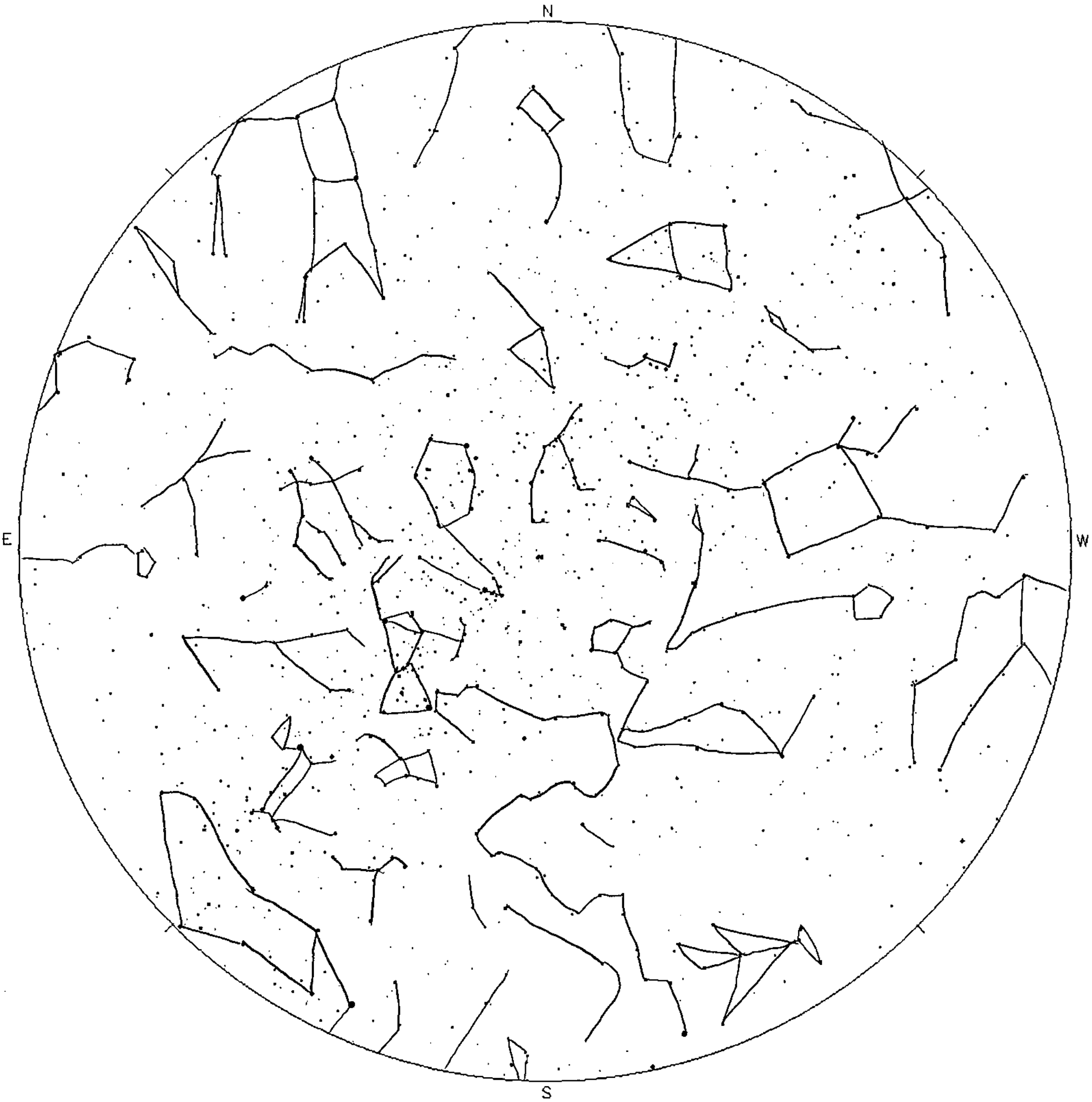
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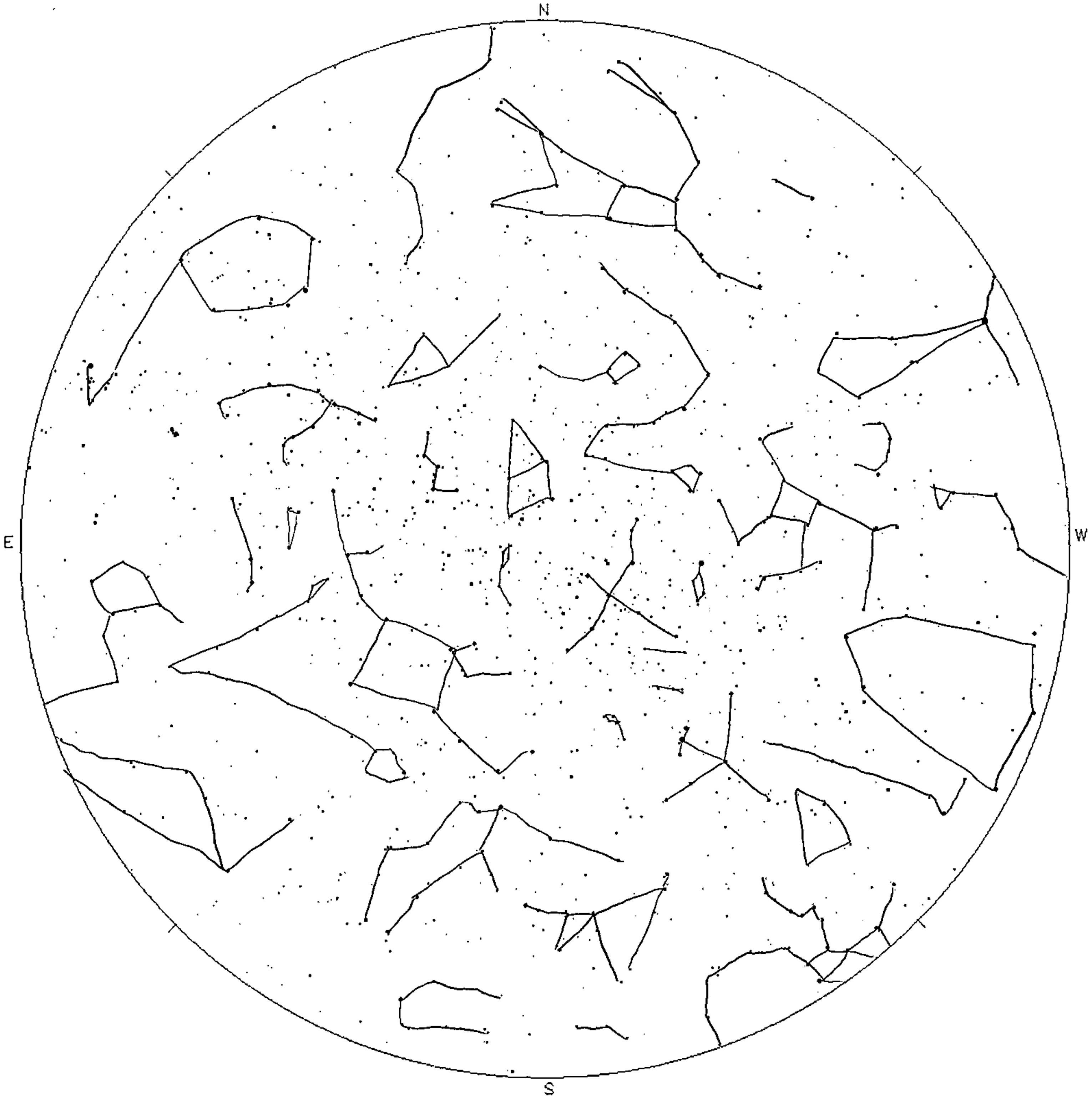
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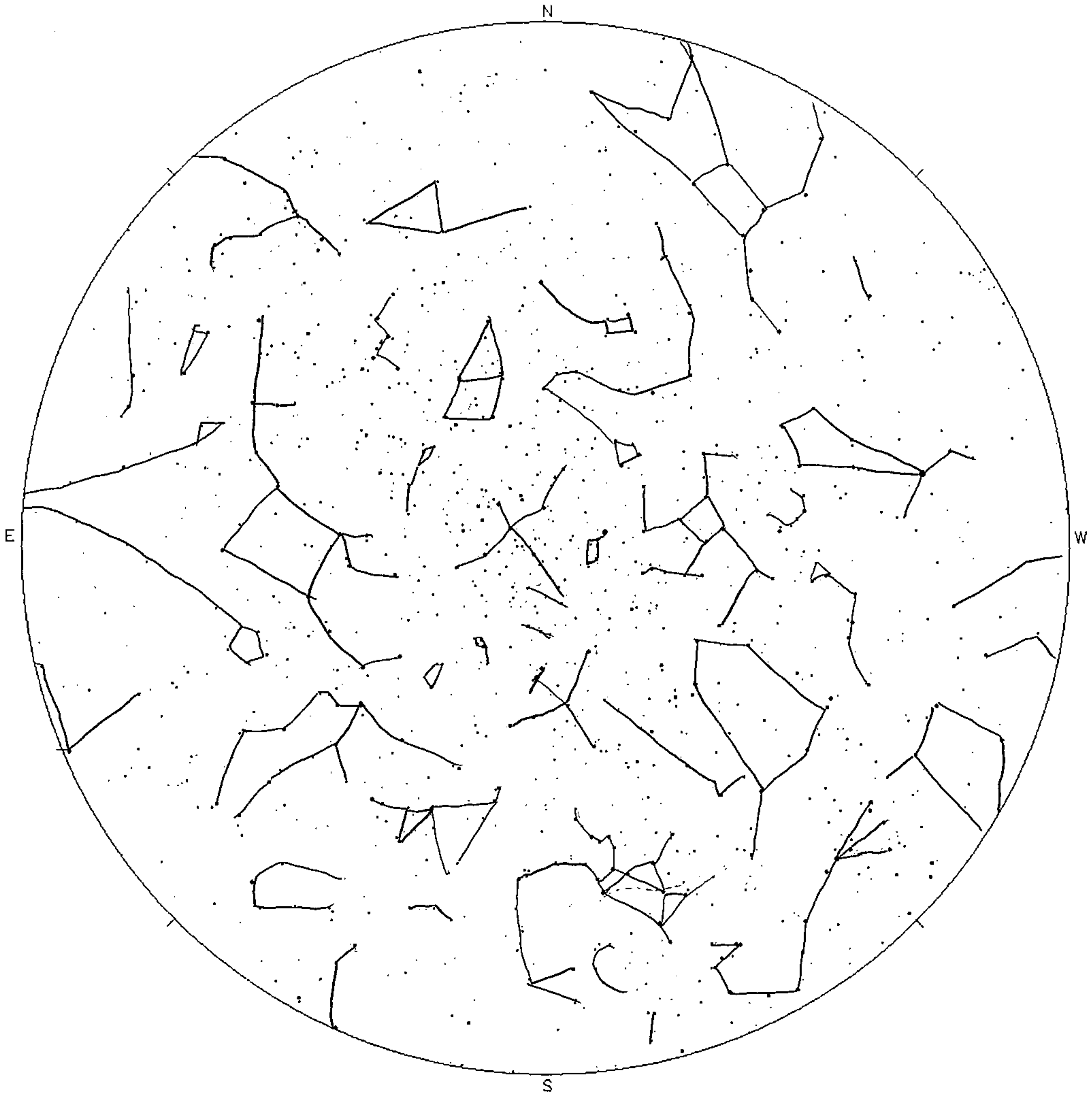
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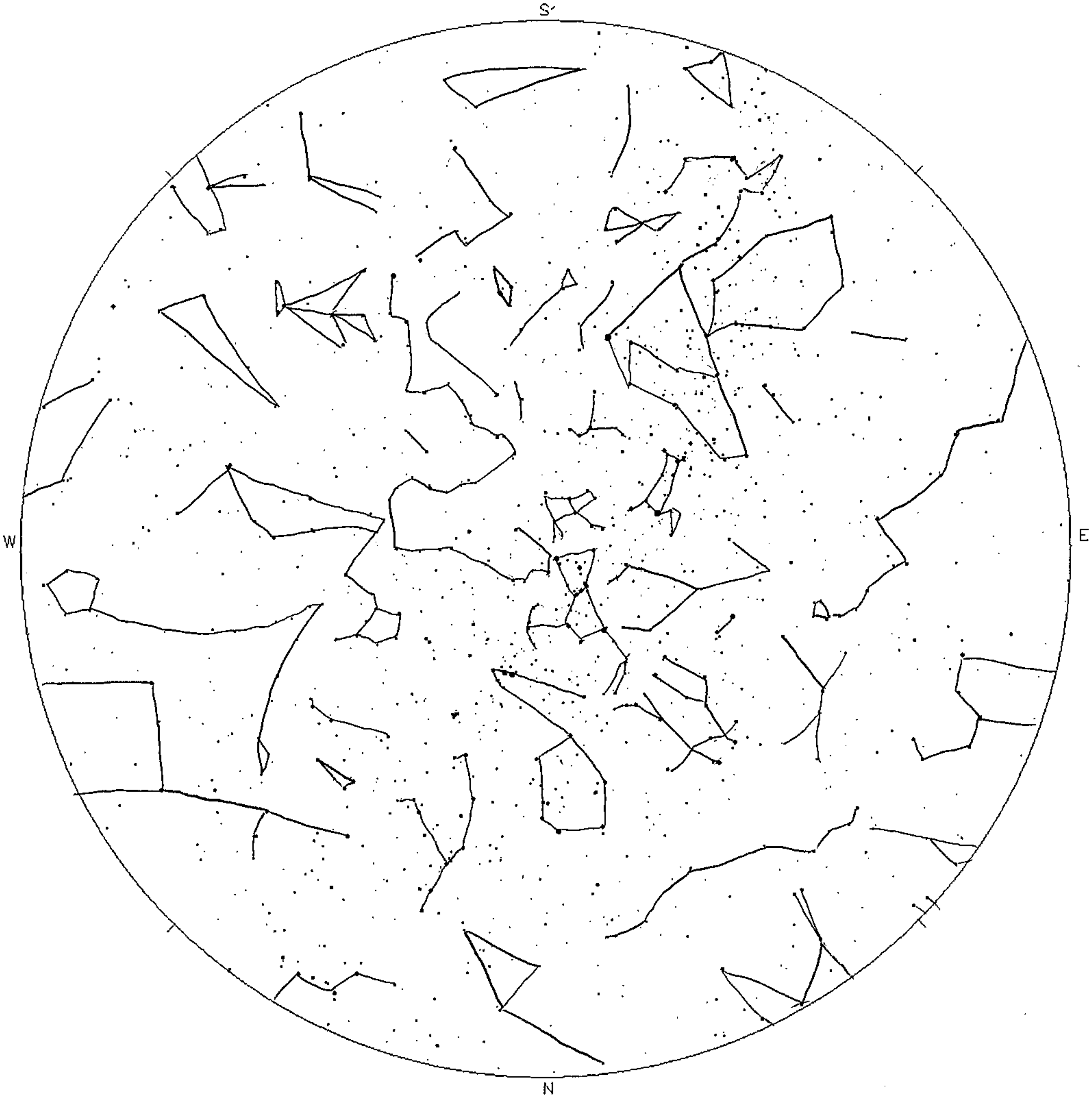

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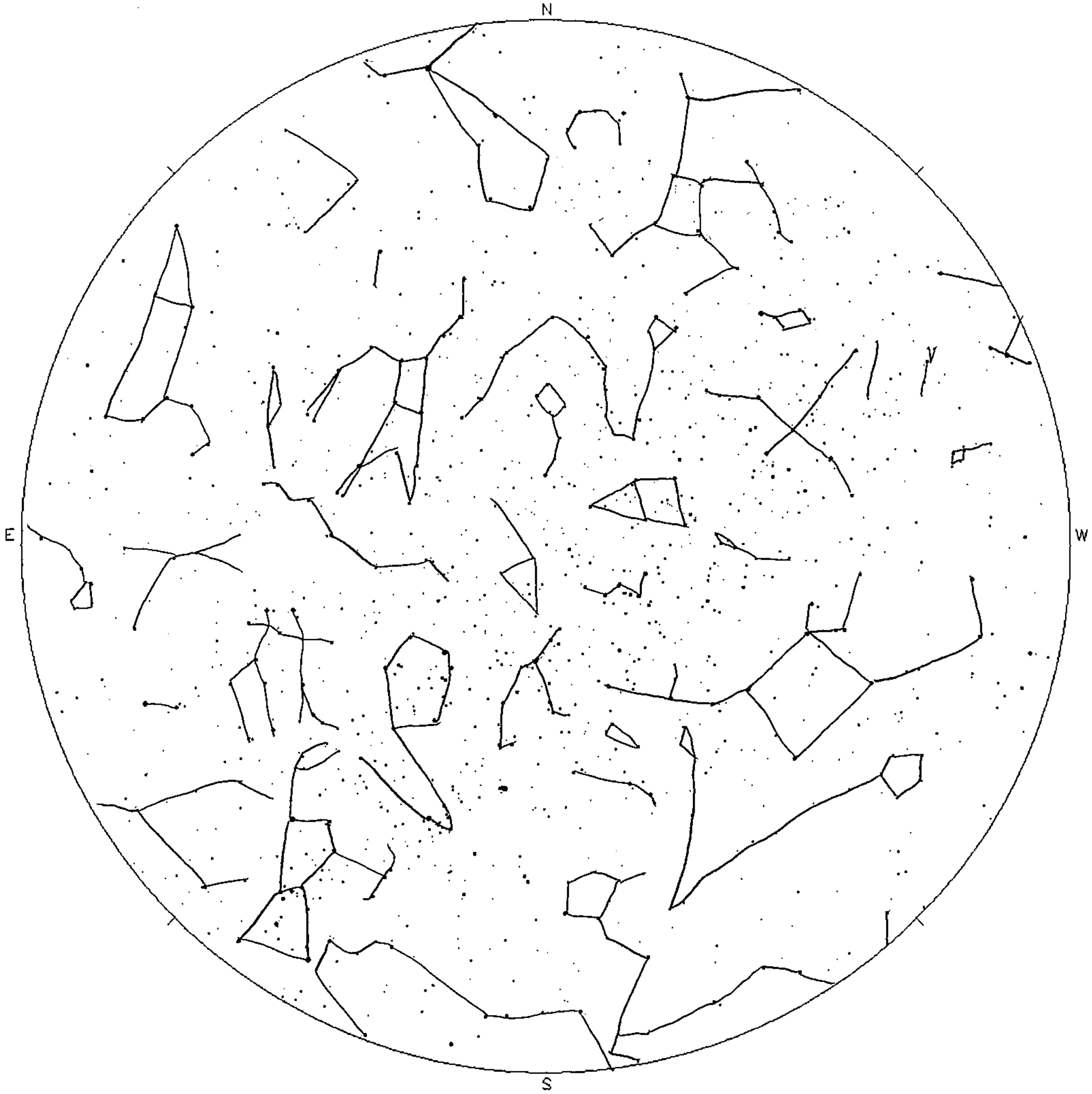
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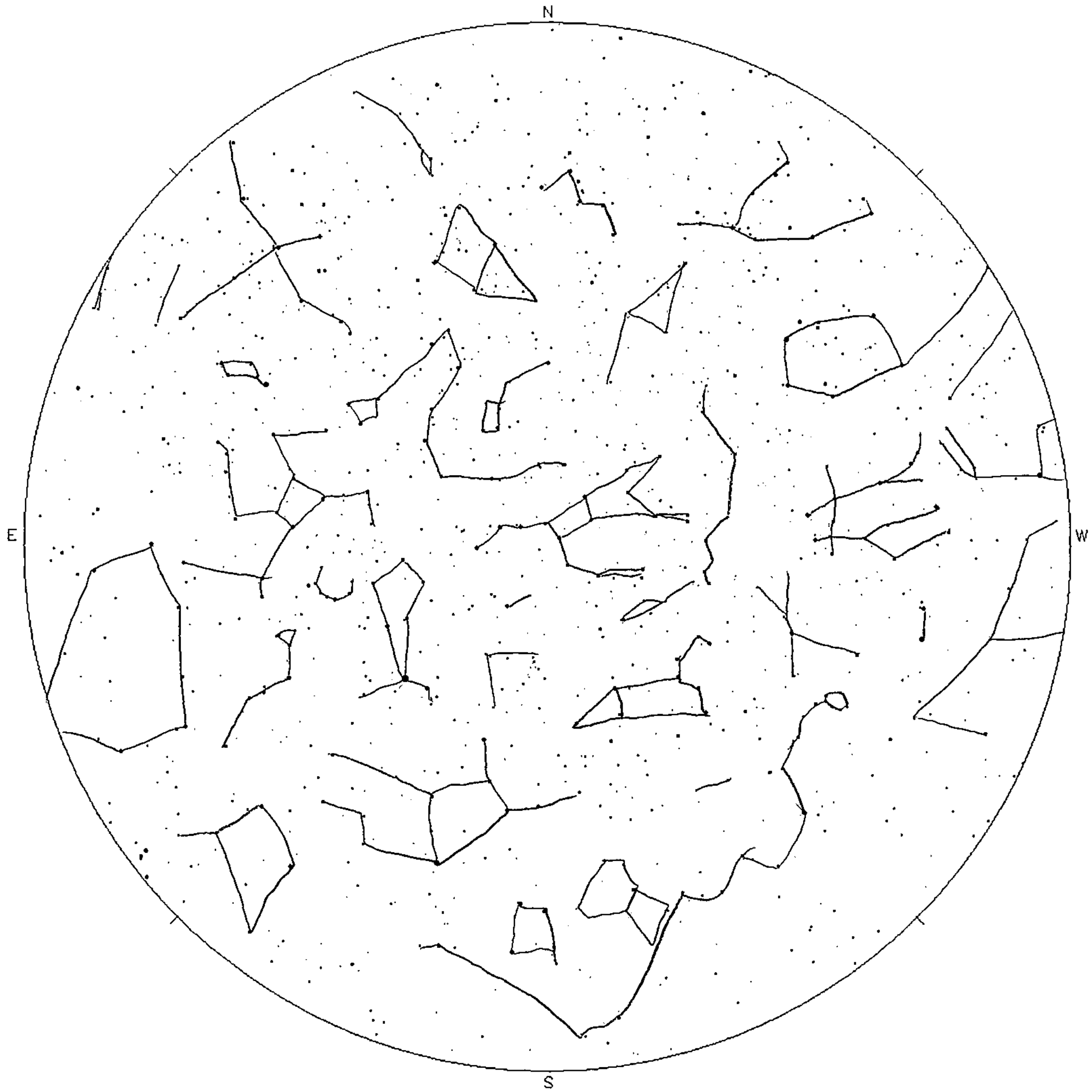
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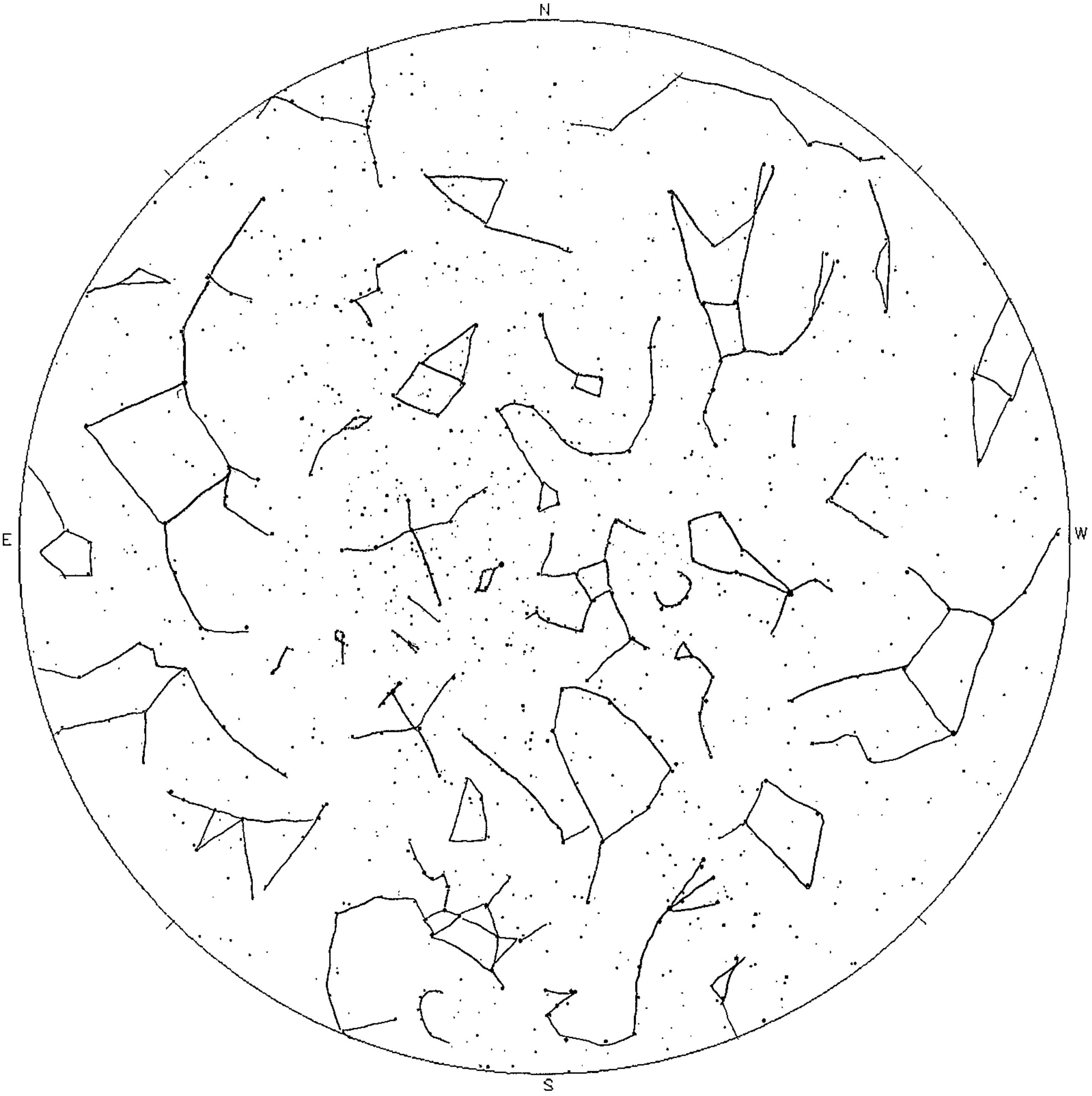
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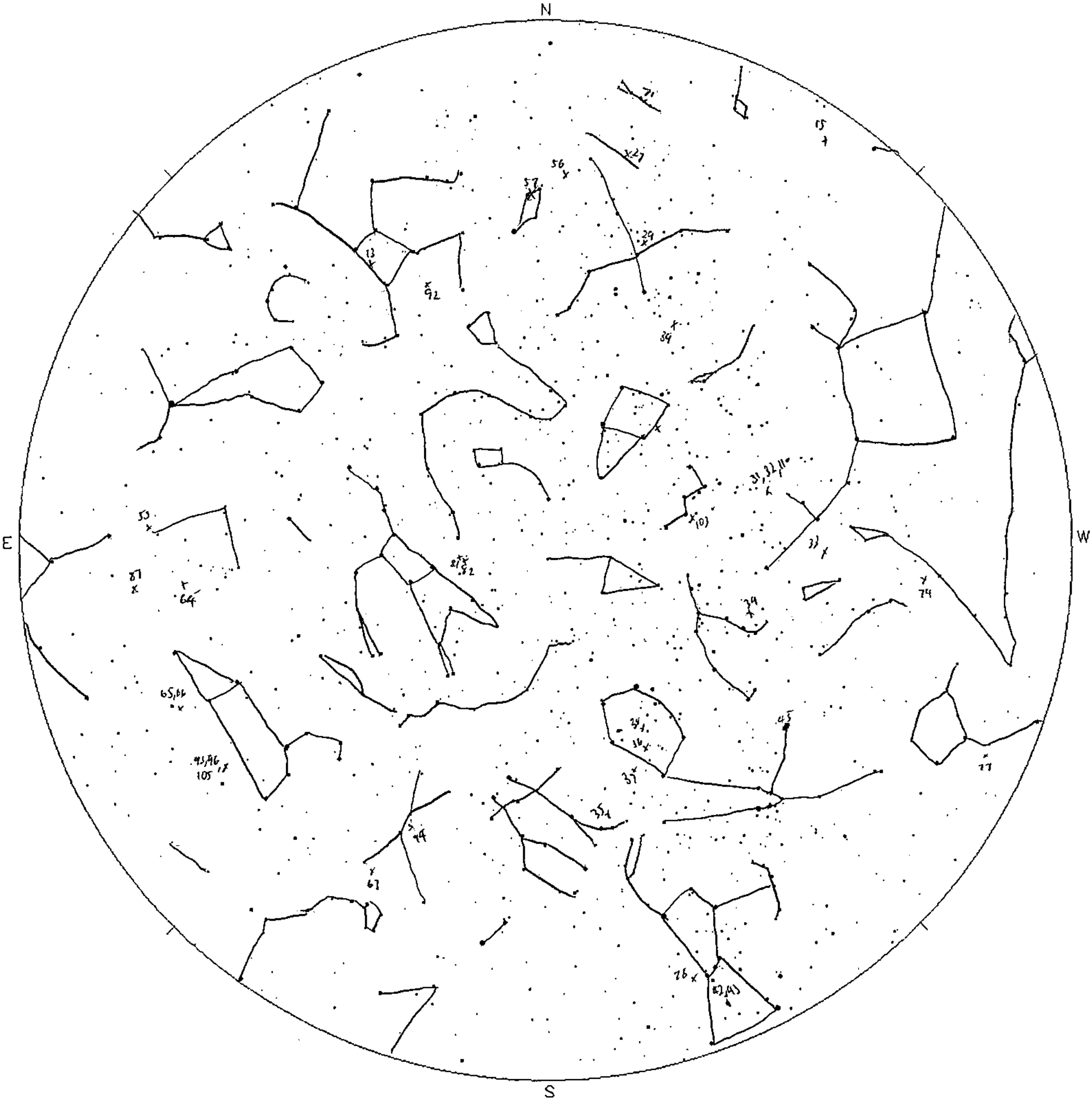
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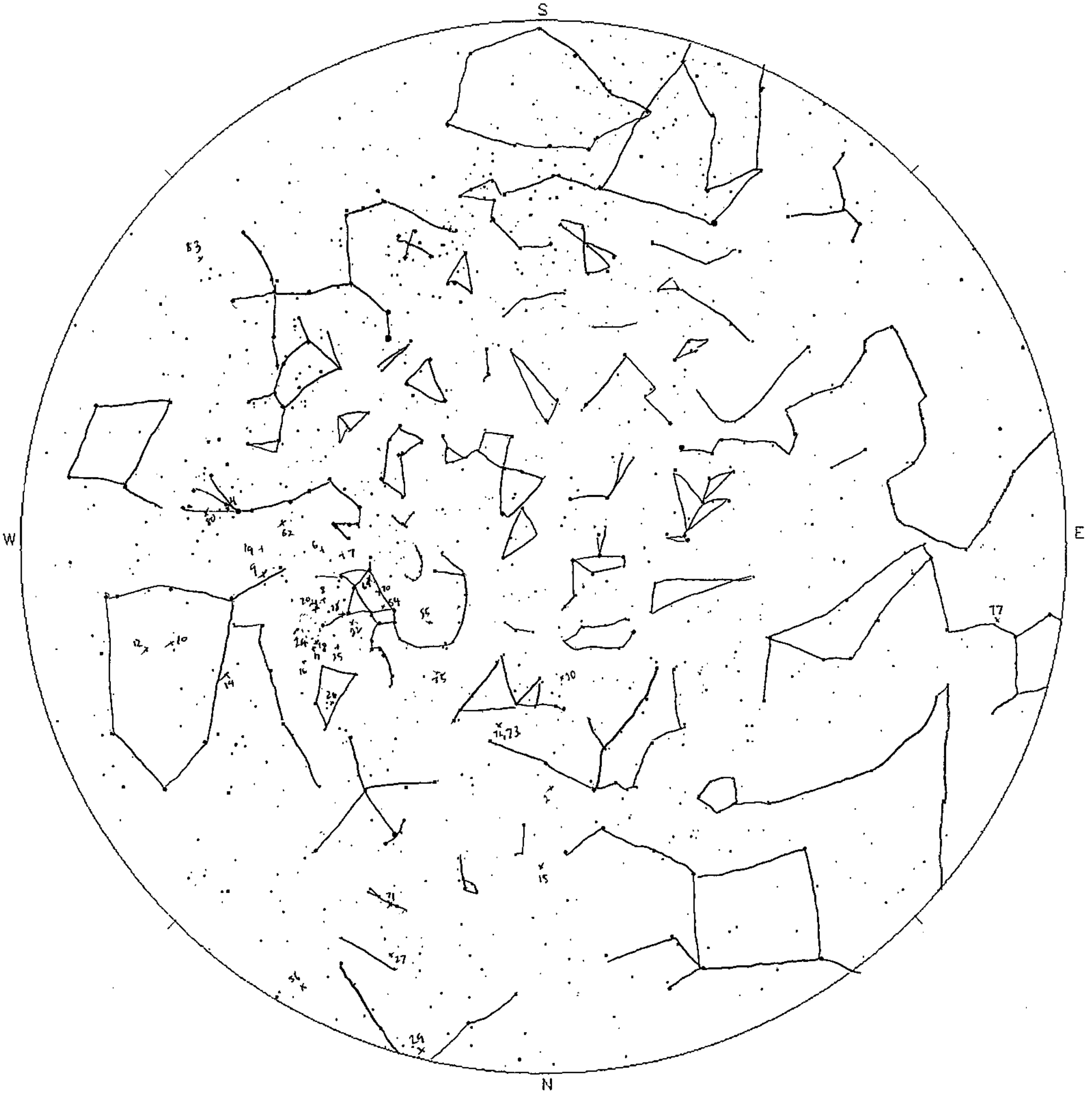
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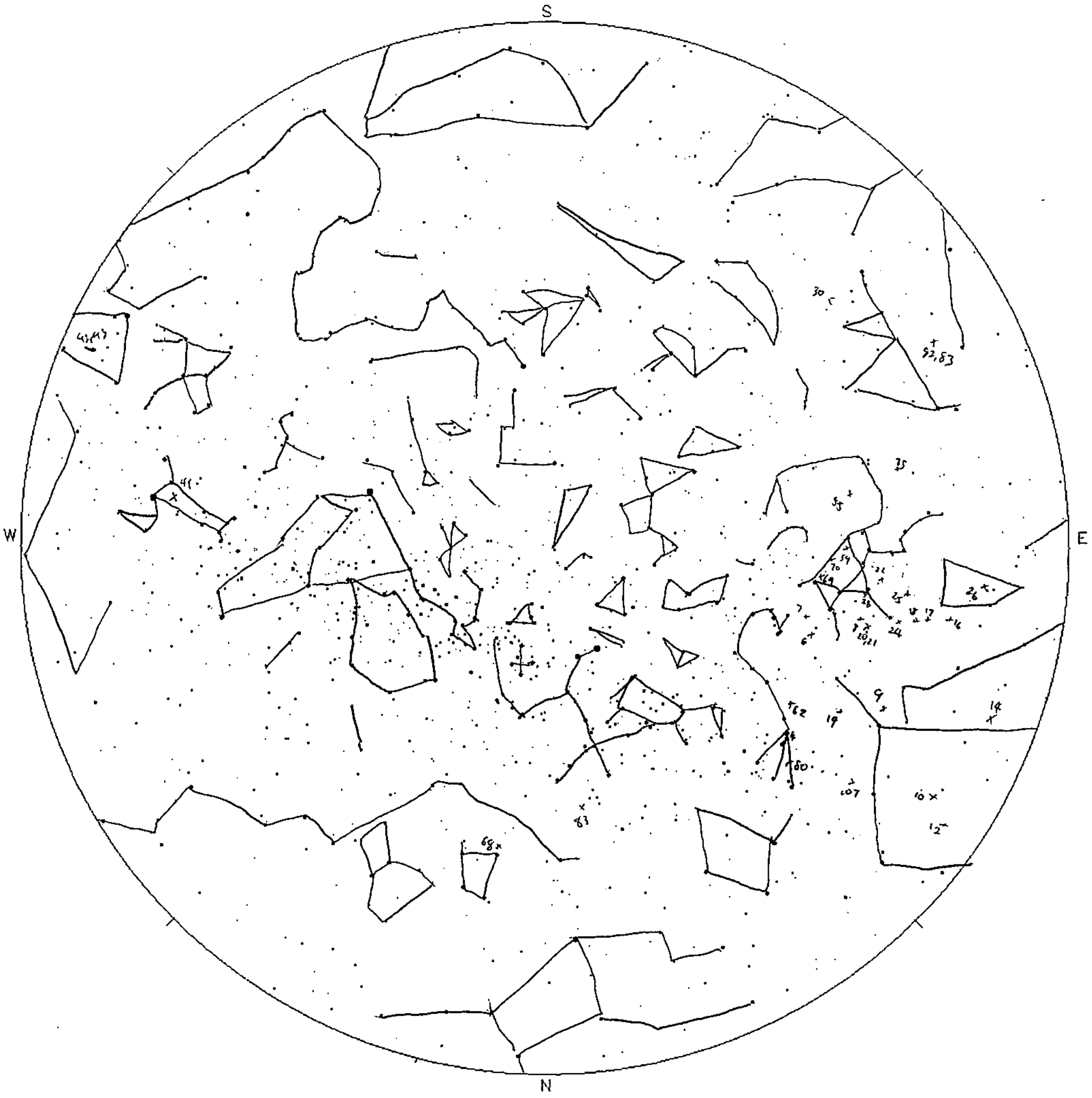
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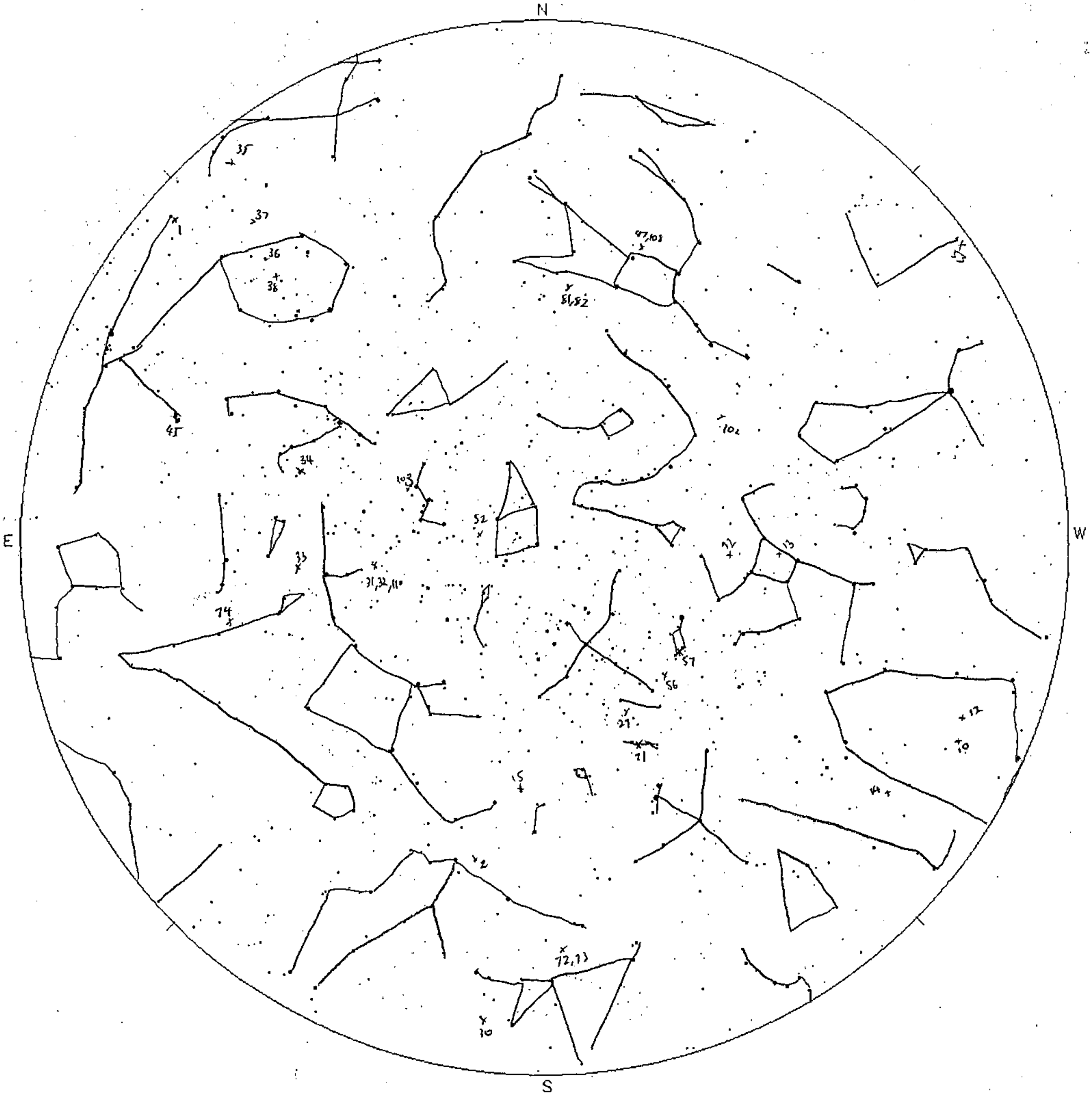

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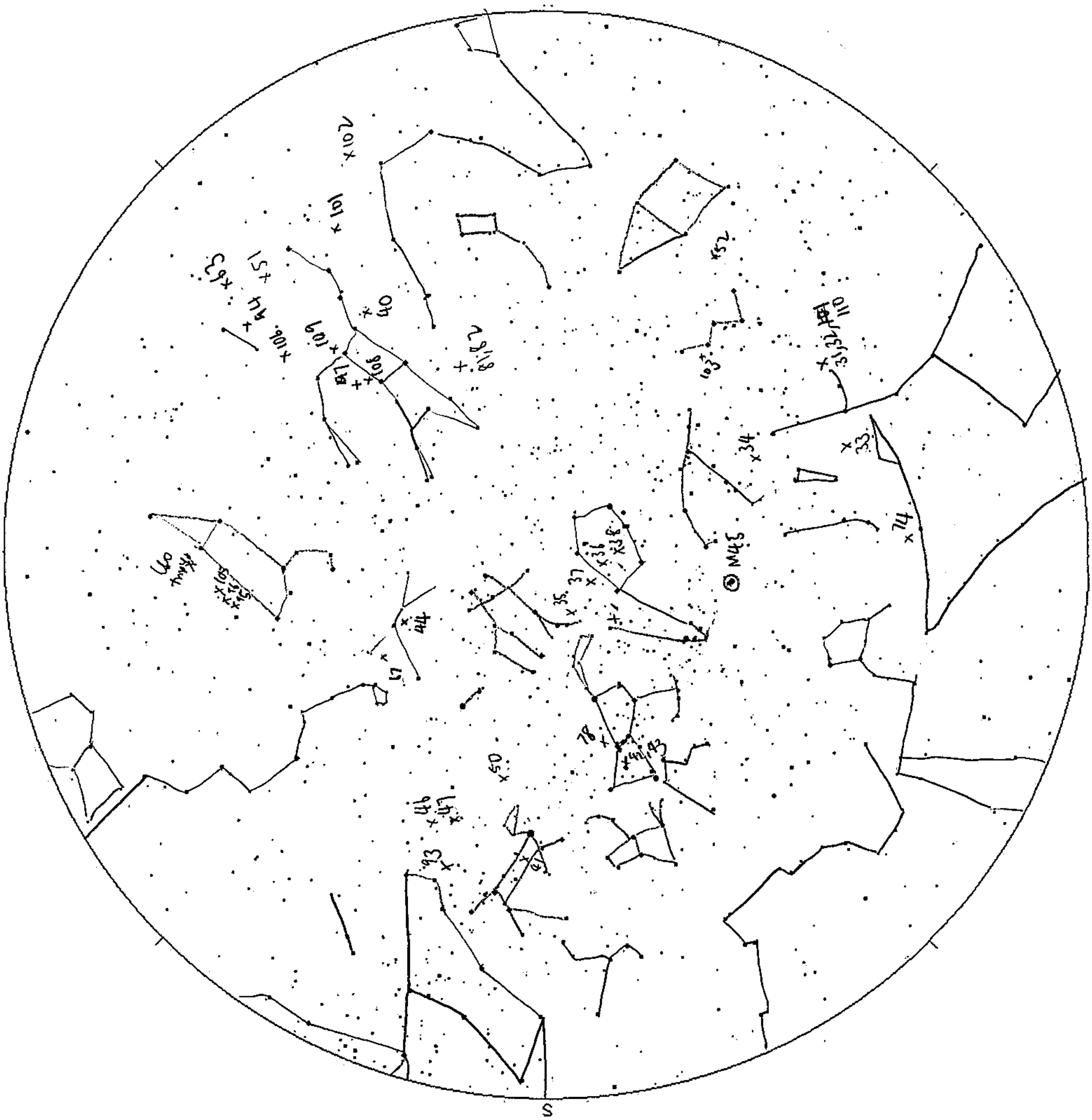

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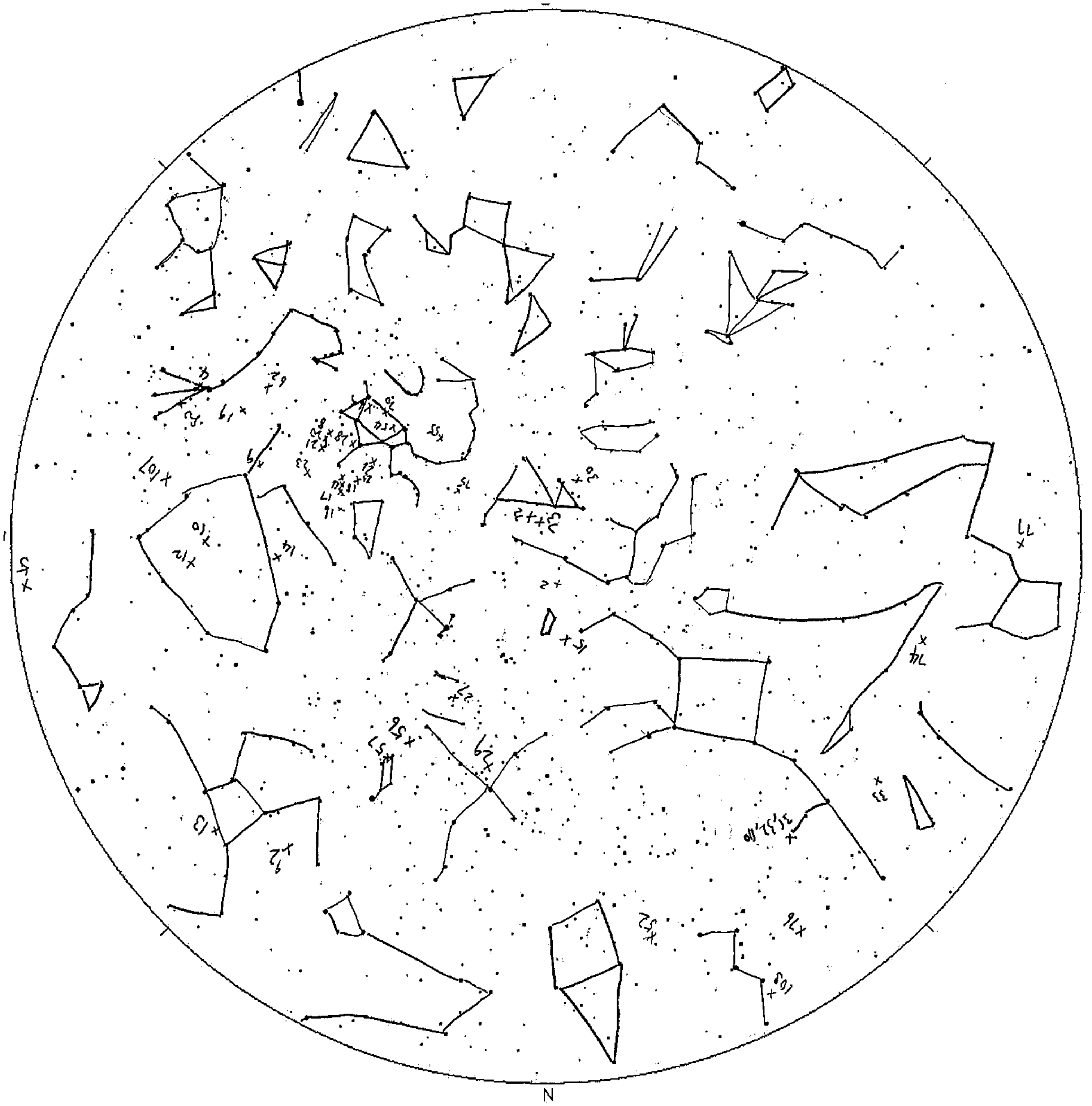
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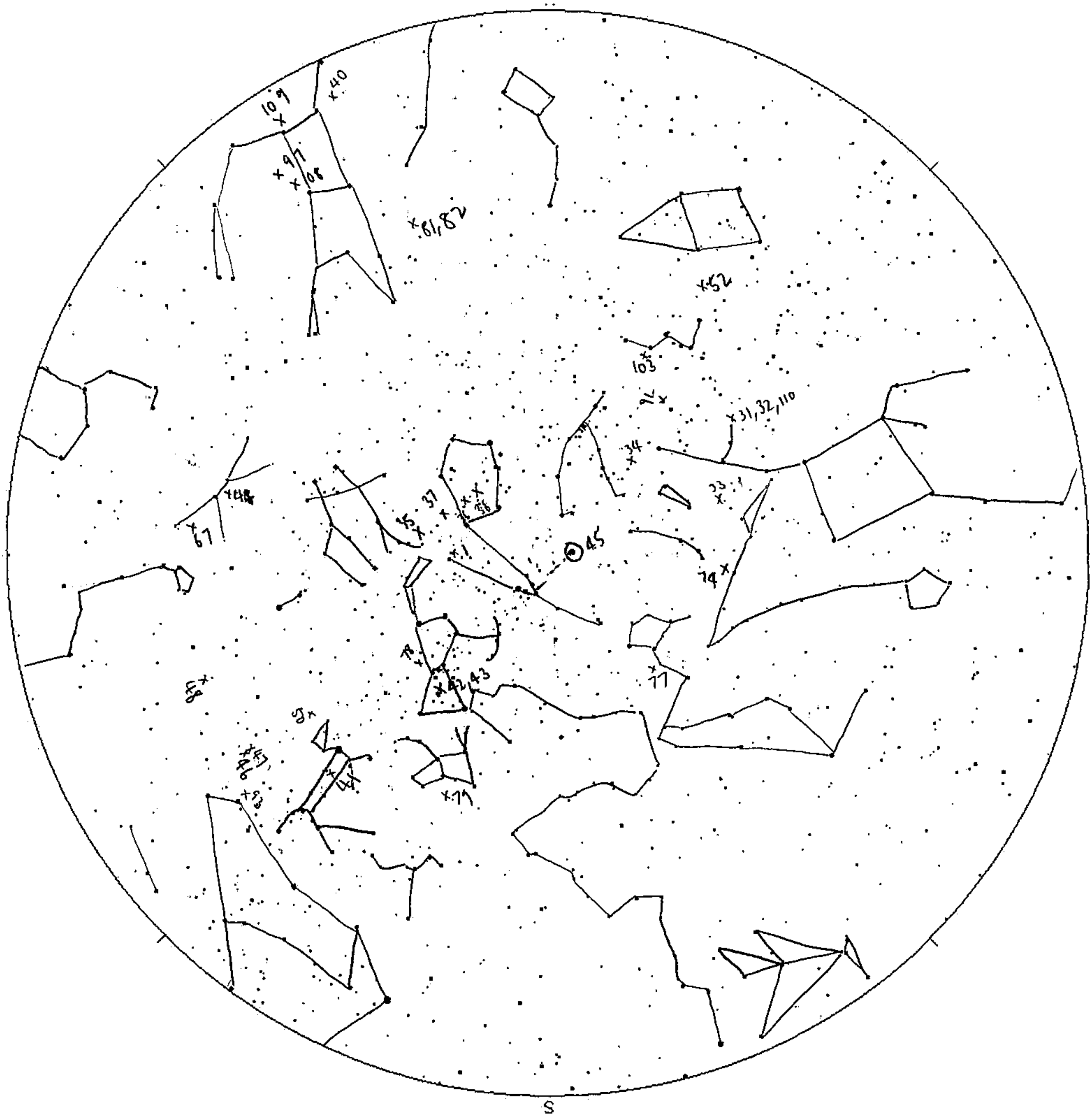
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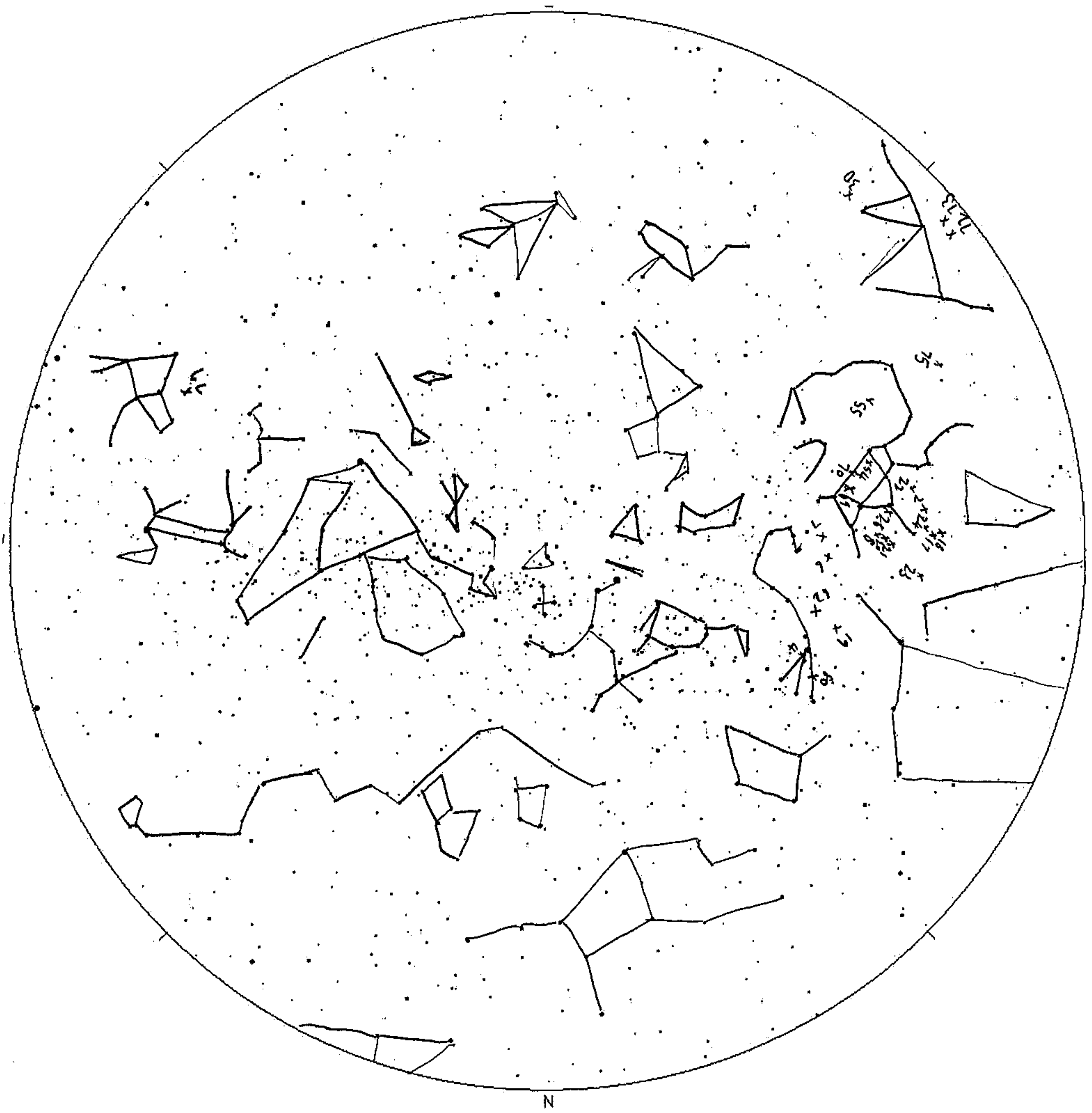
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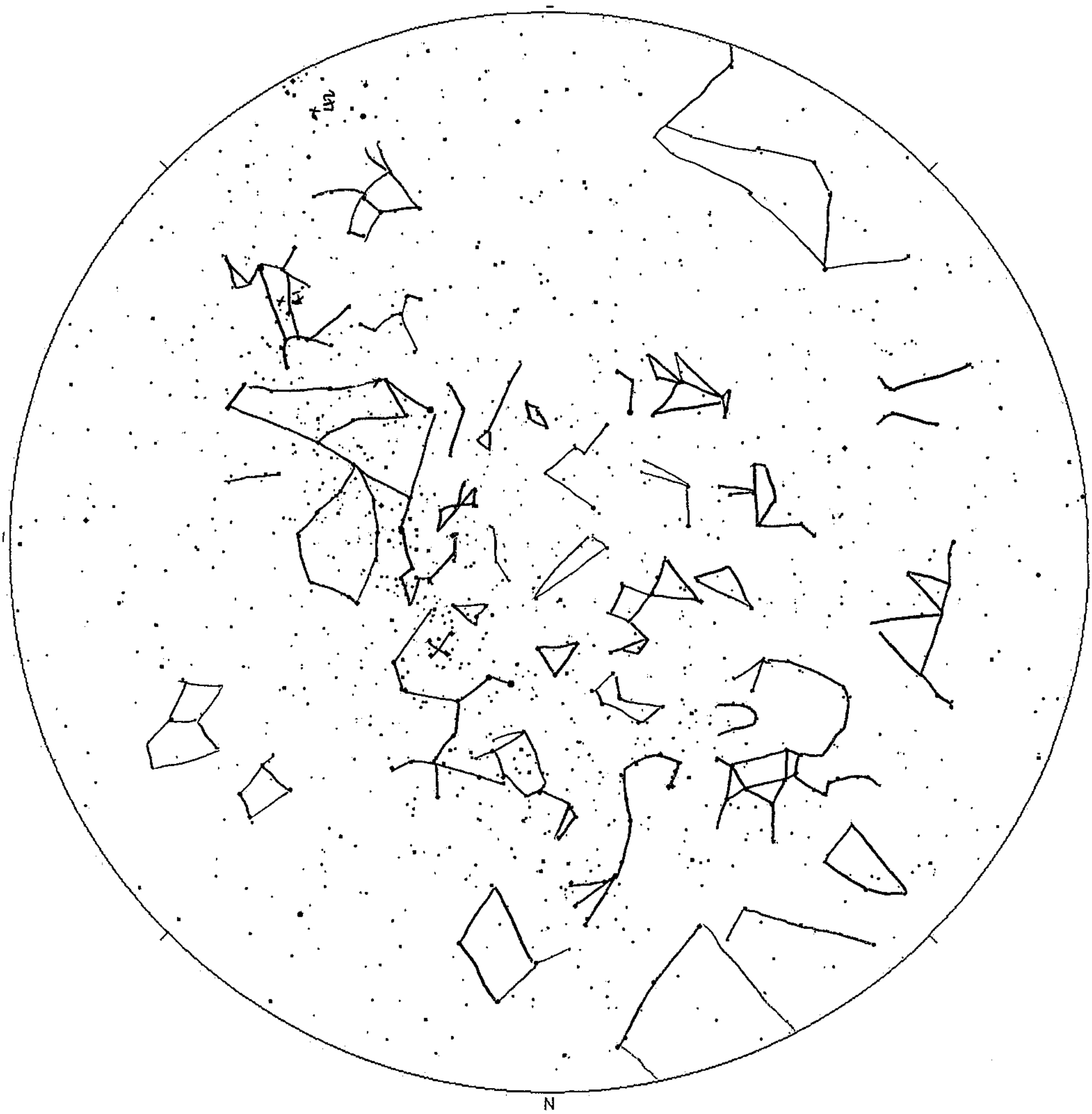
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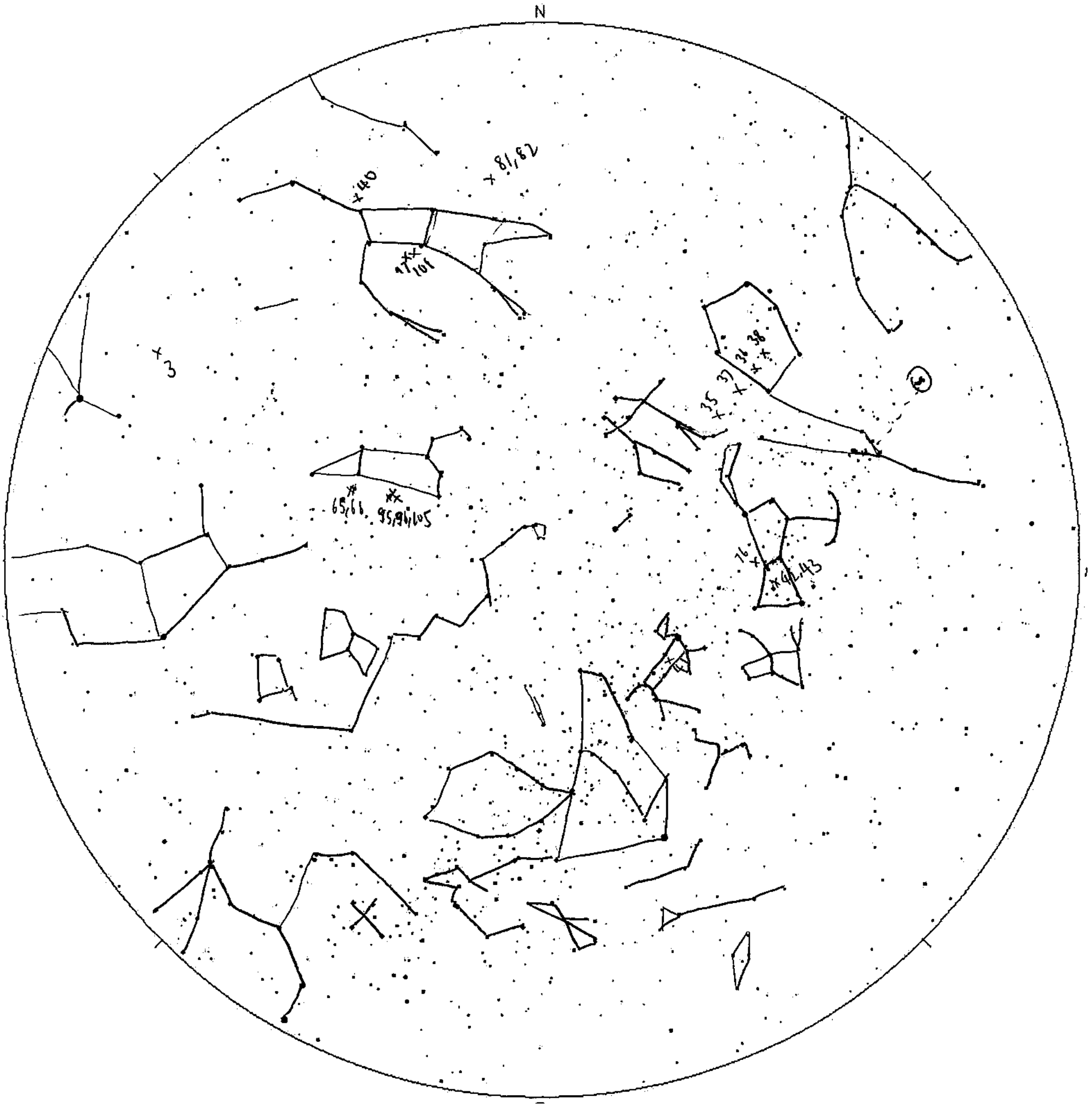
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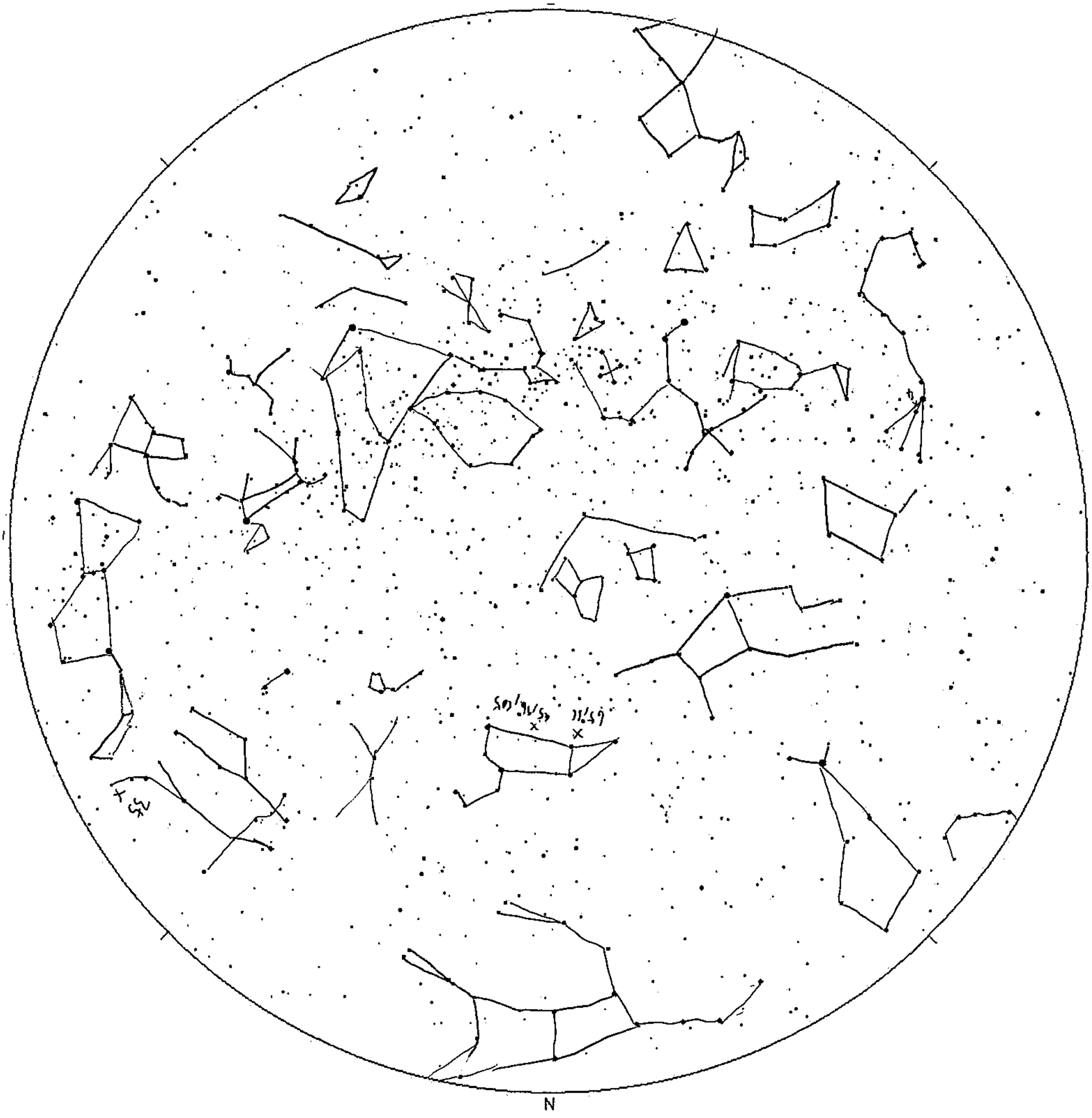
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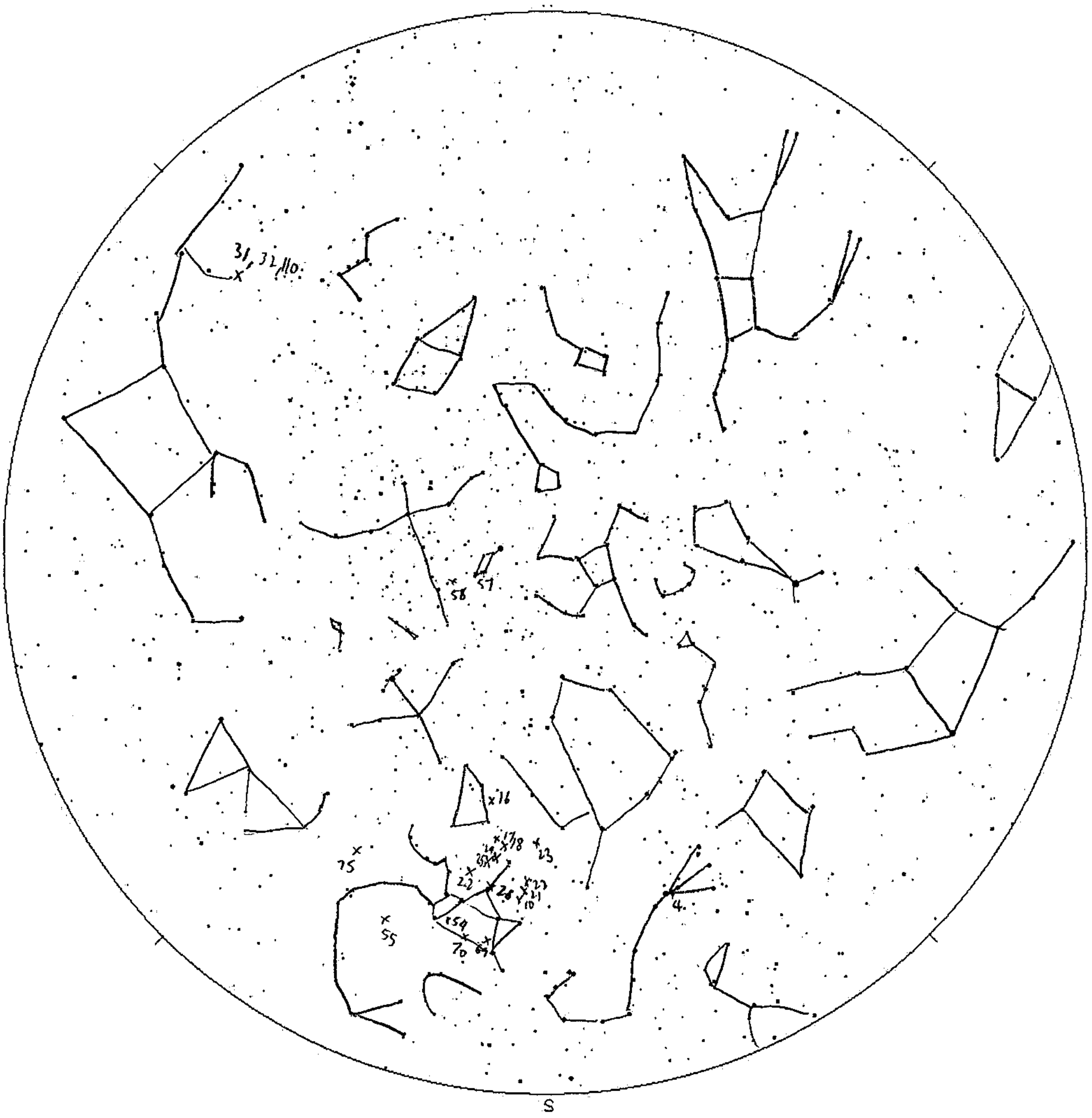
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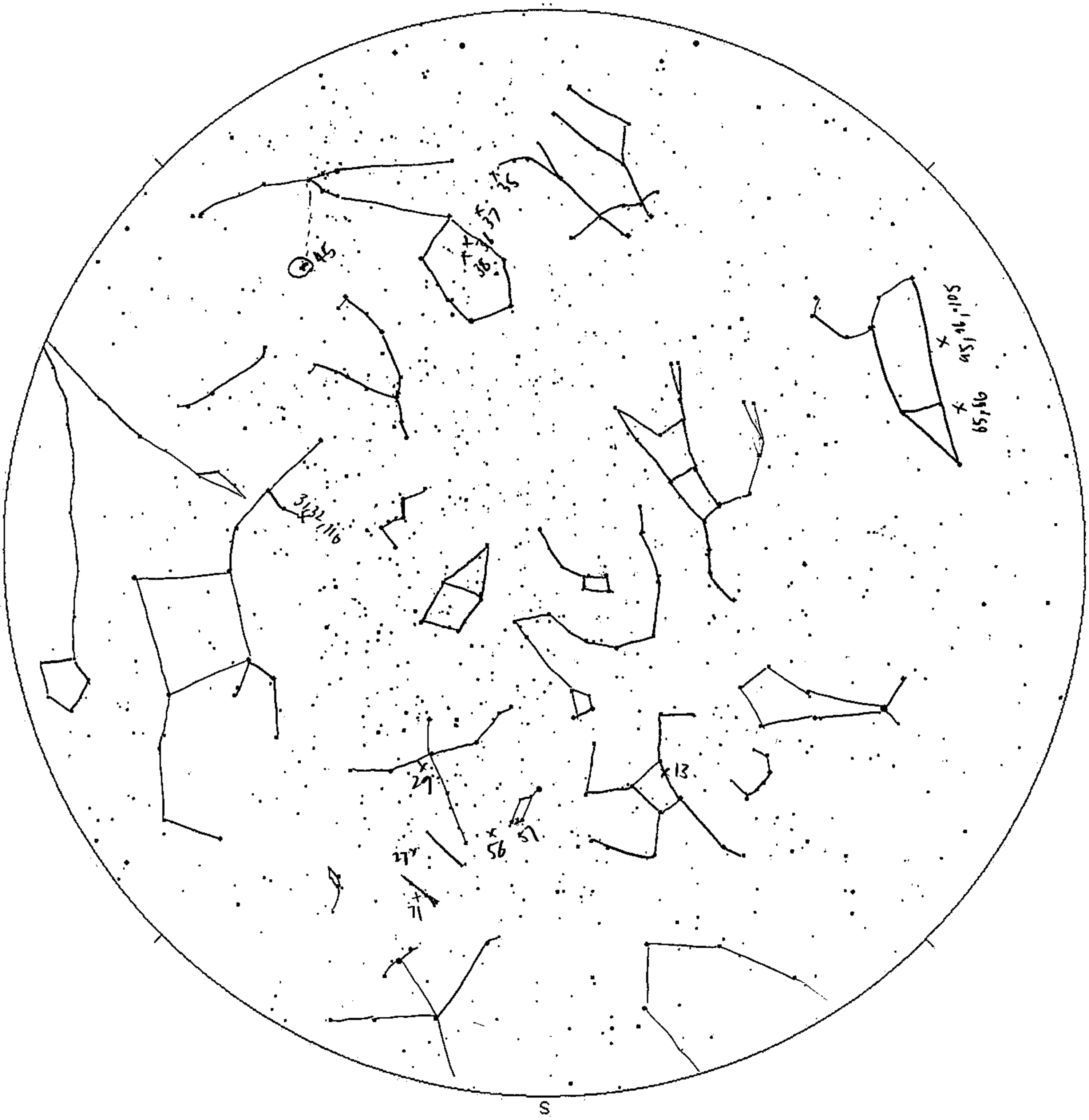
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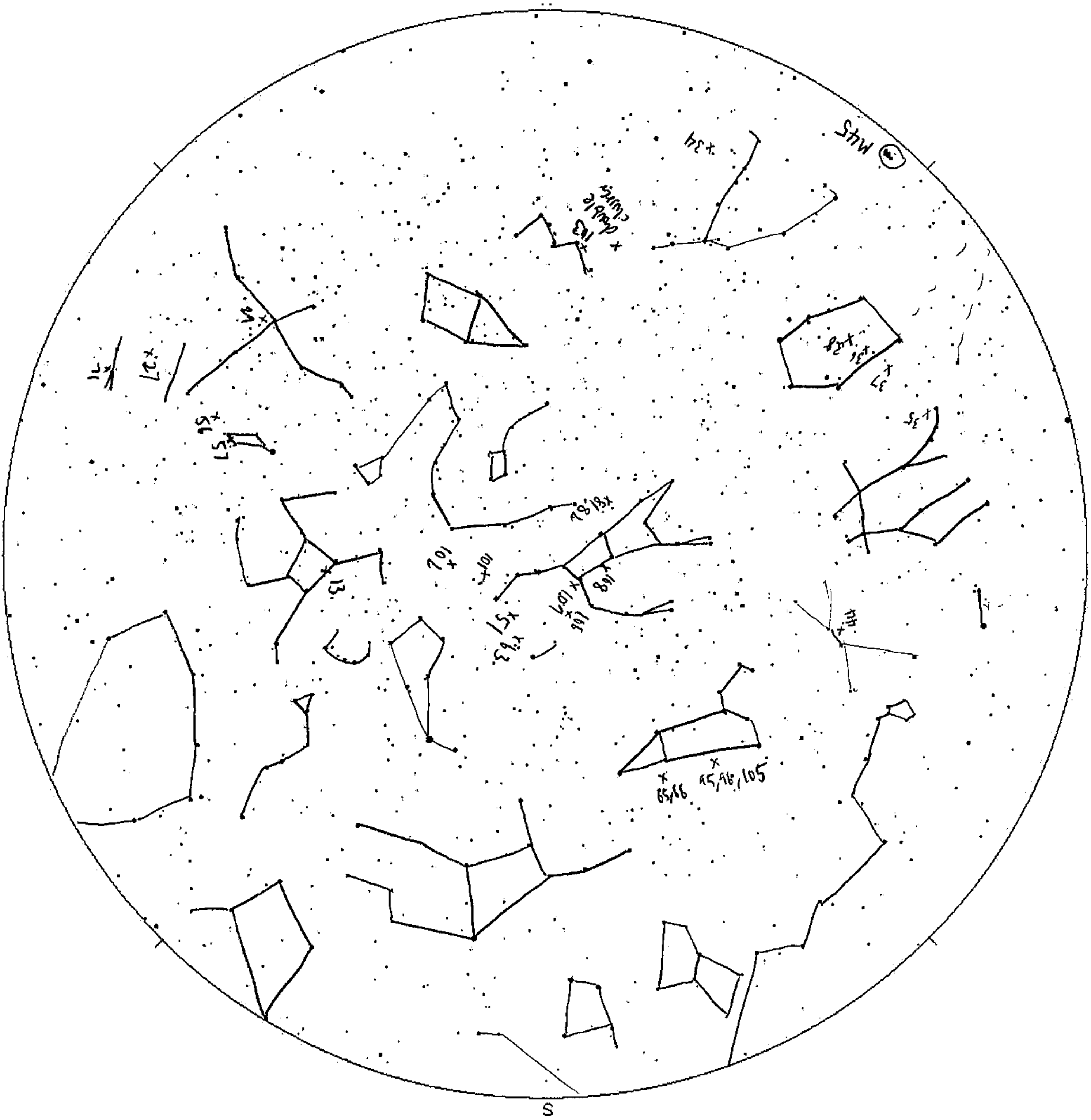
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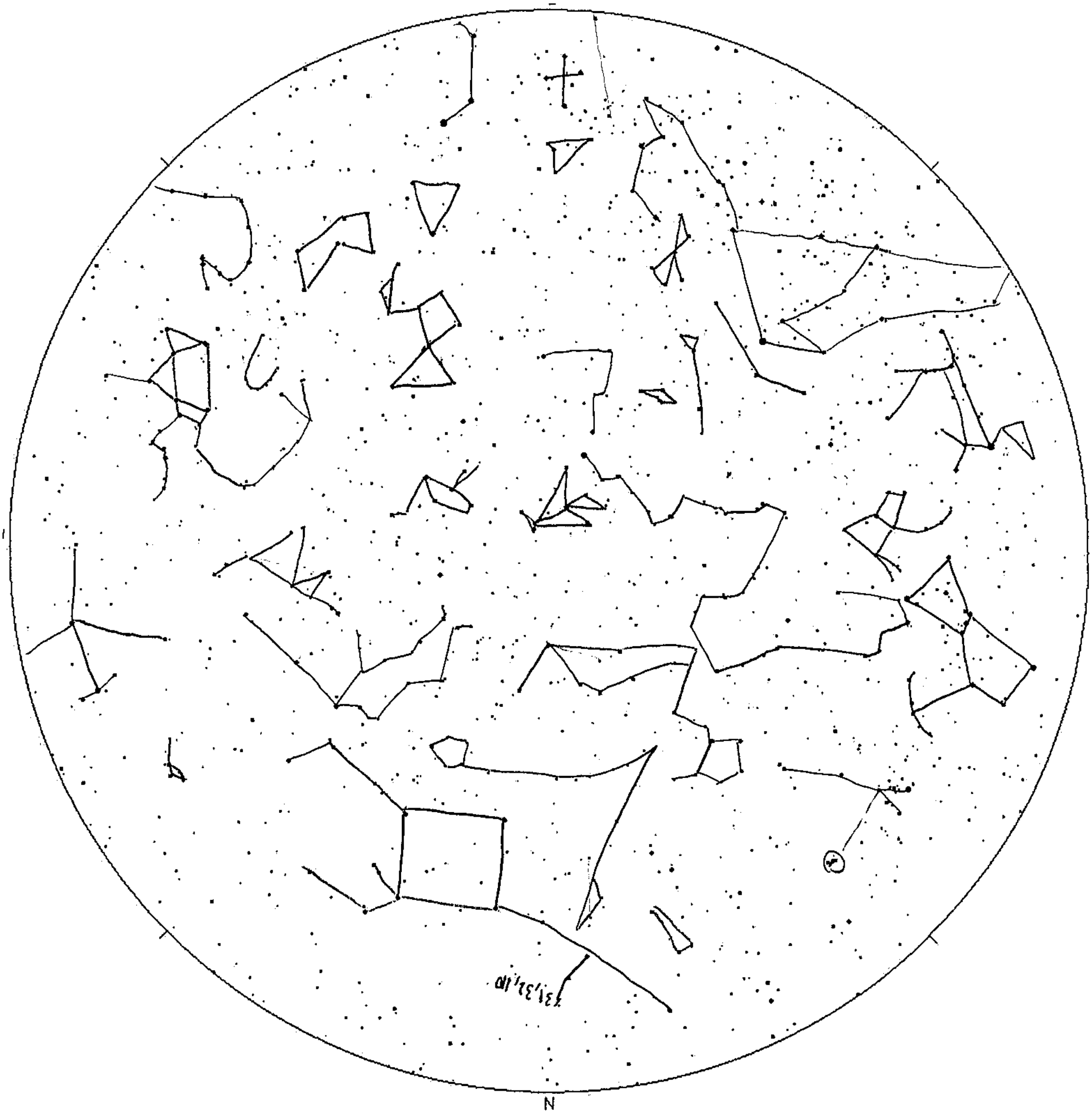
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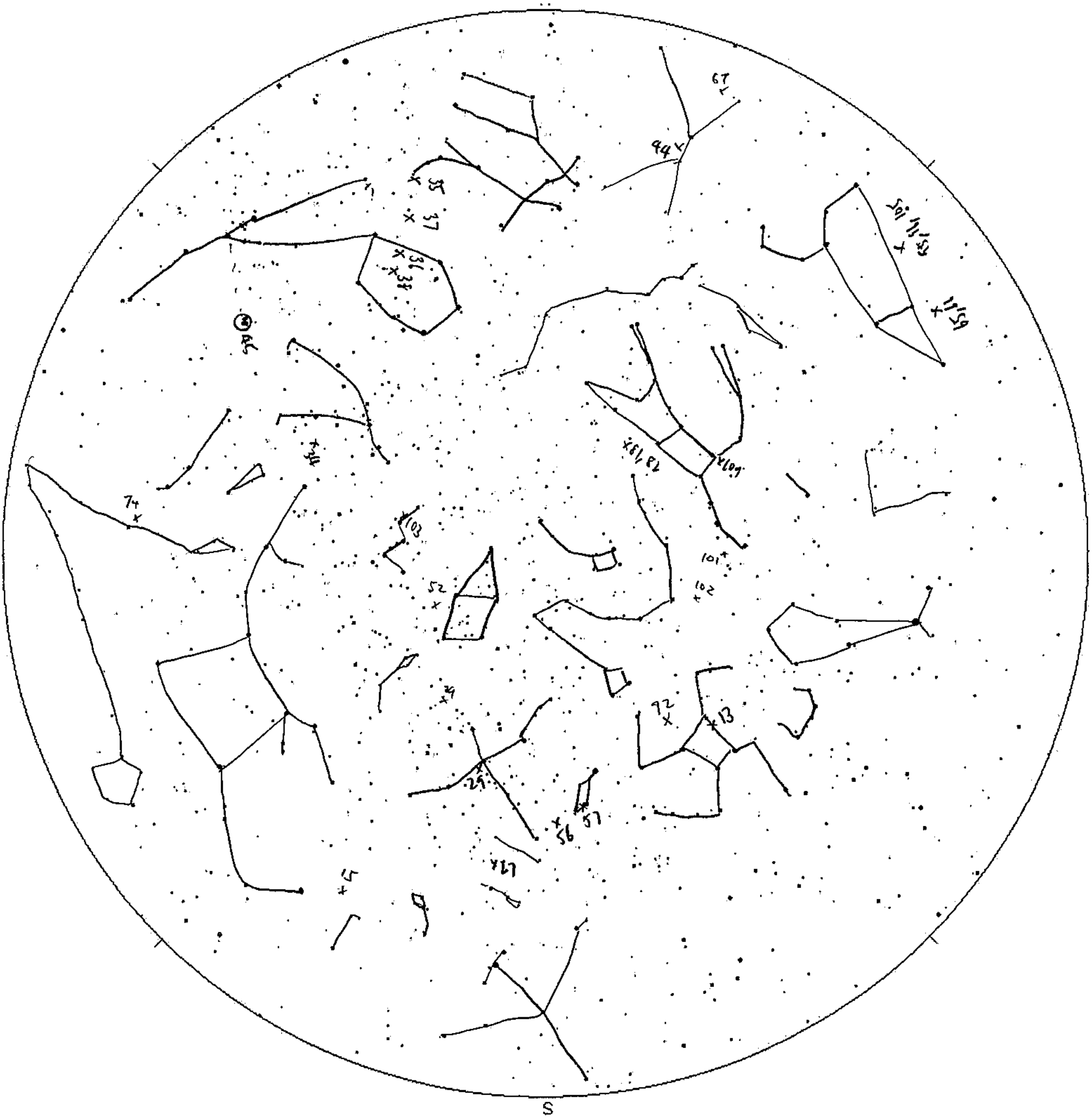
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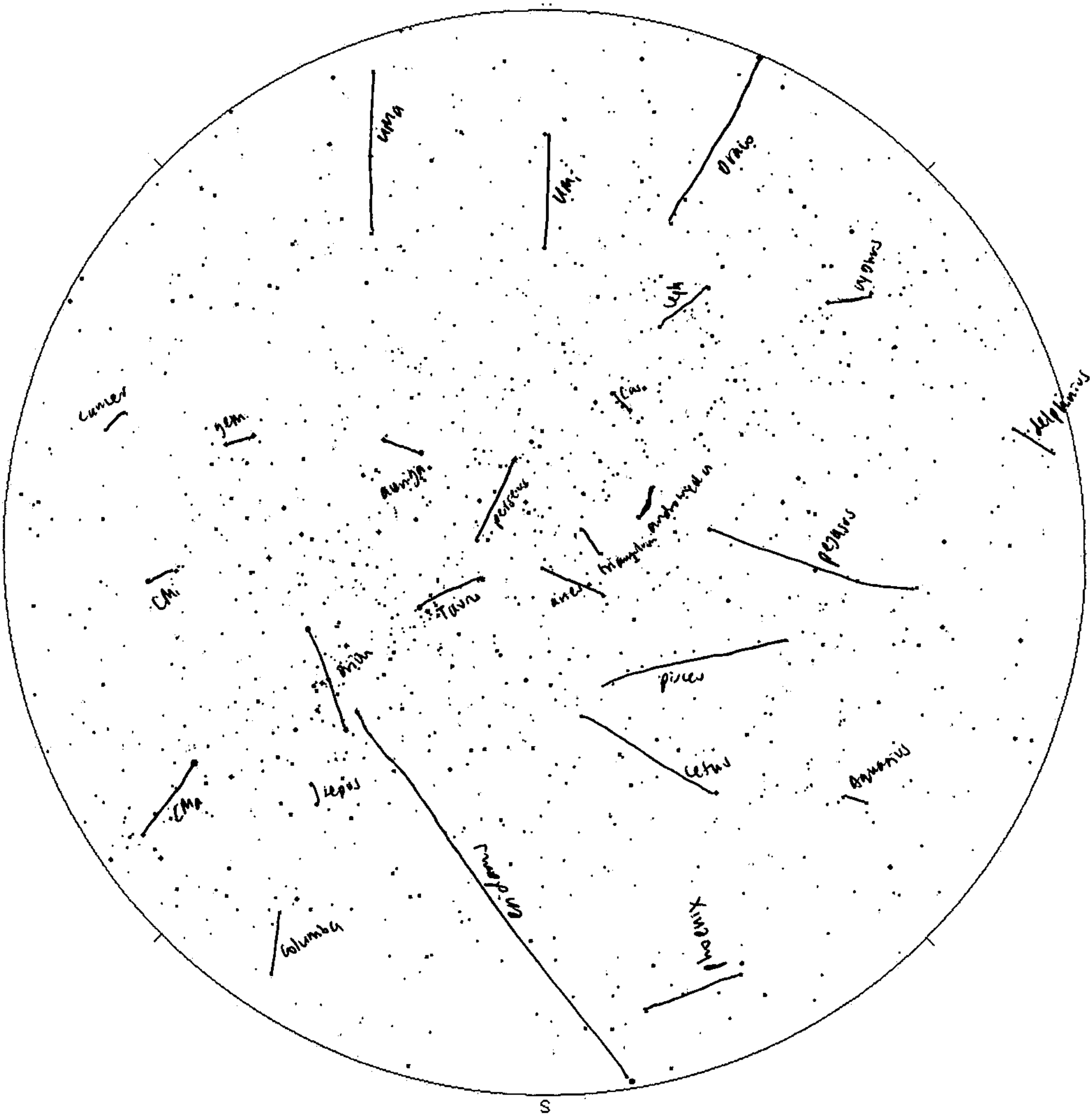
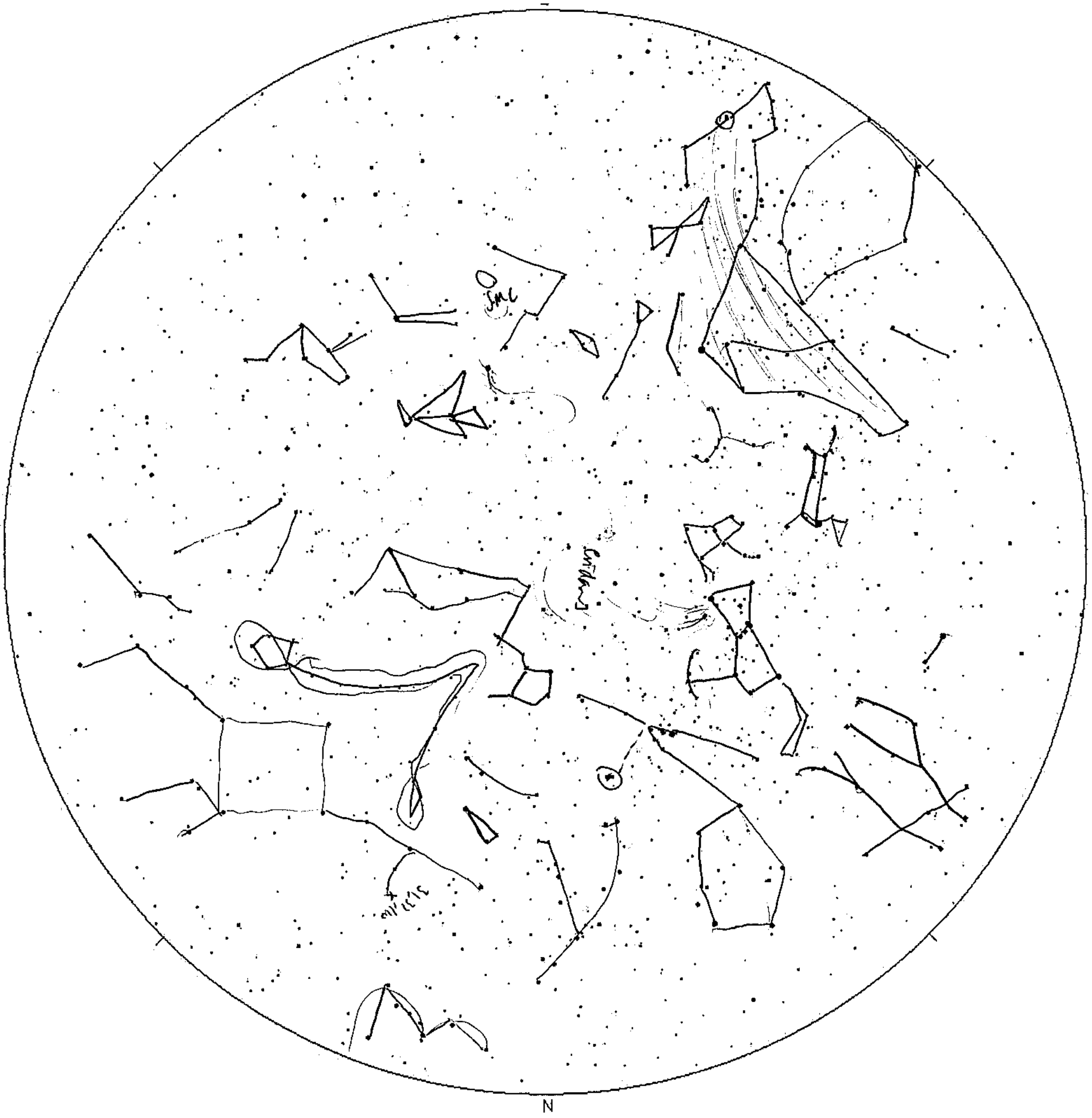


Every constellation like Canis minor + in pln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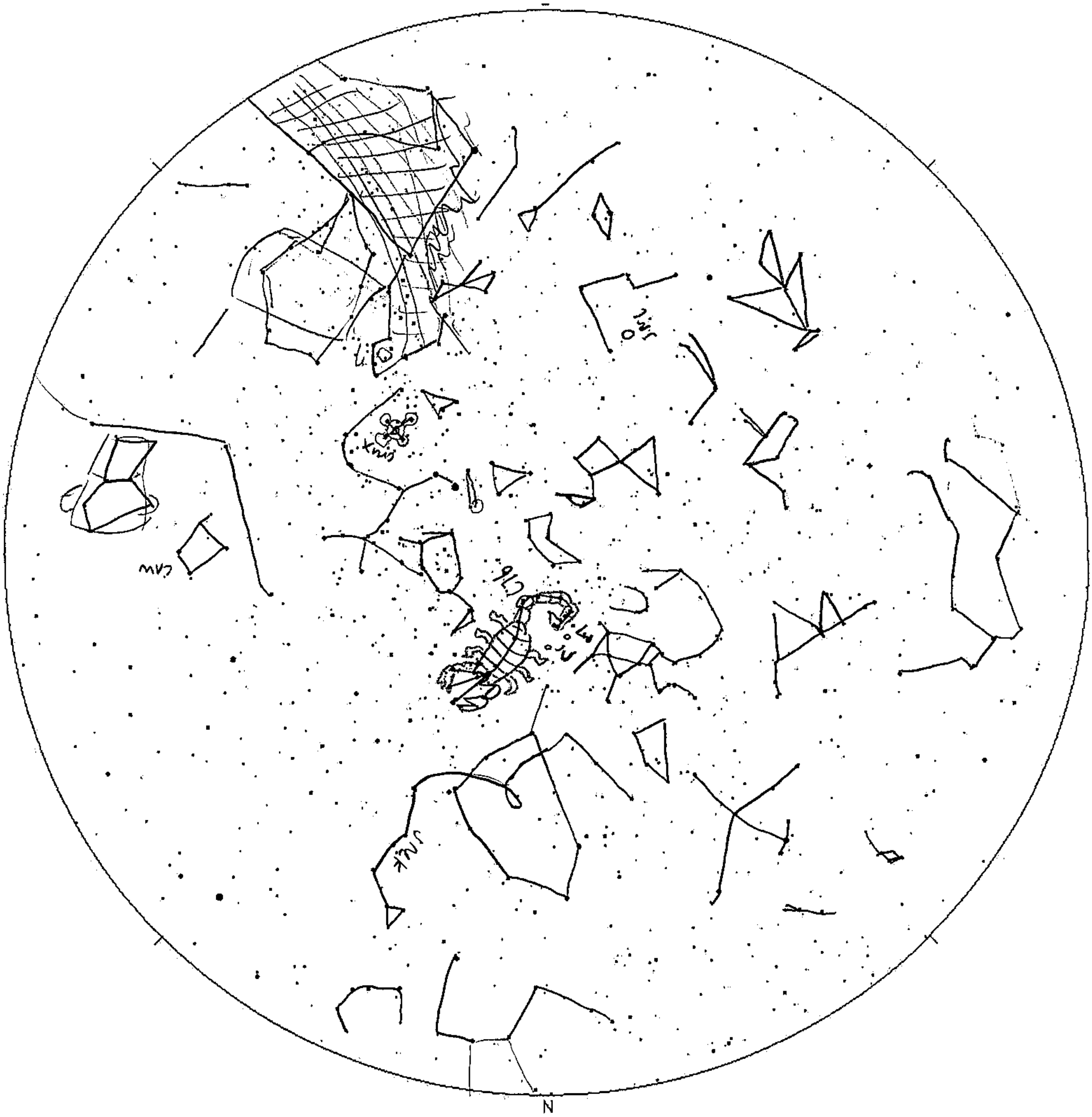
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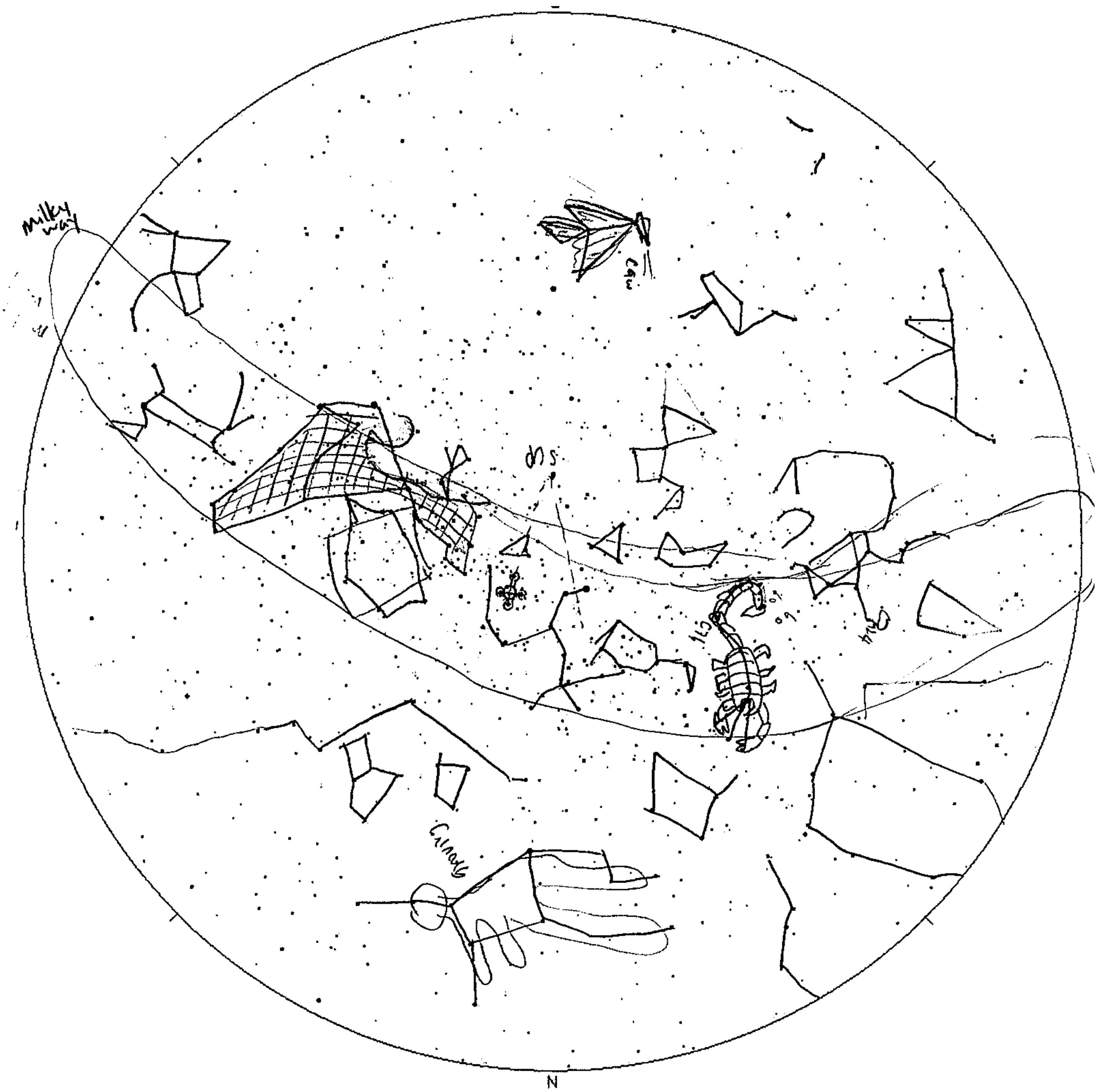
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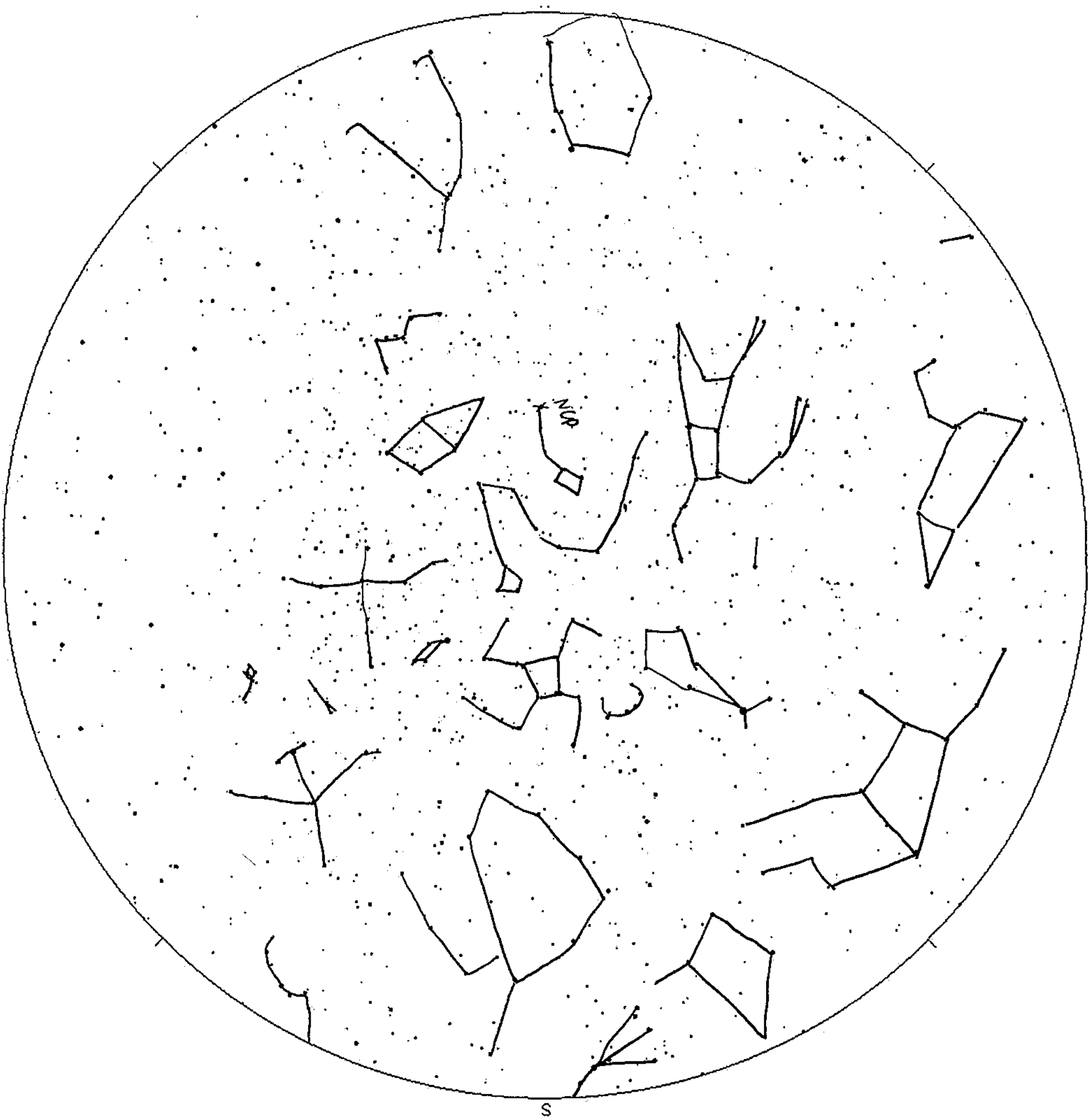
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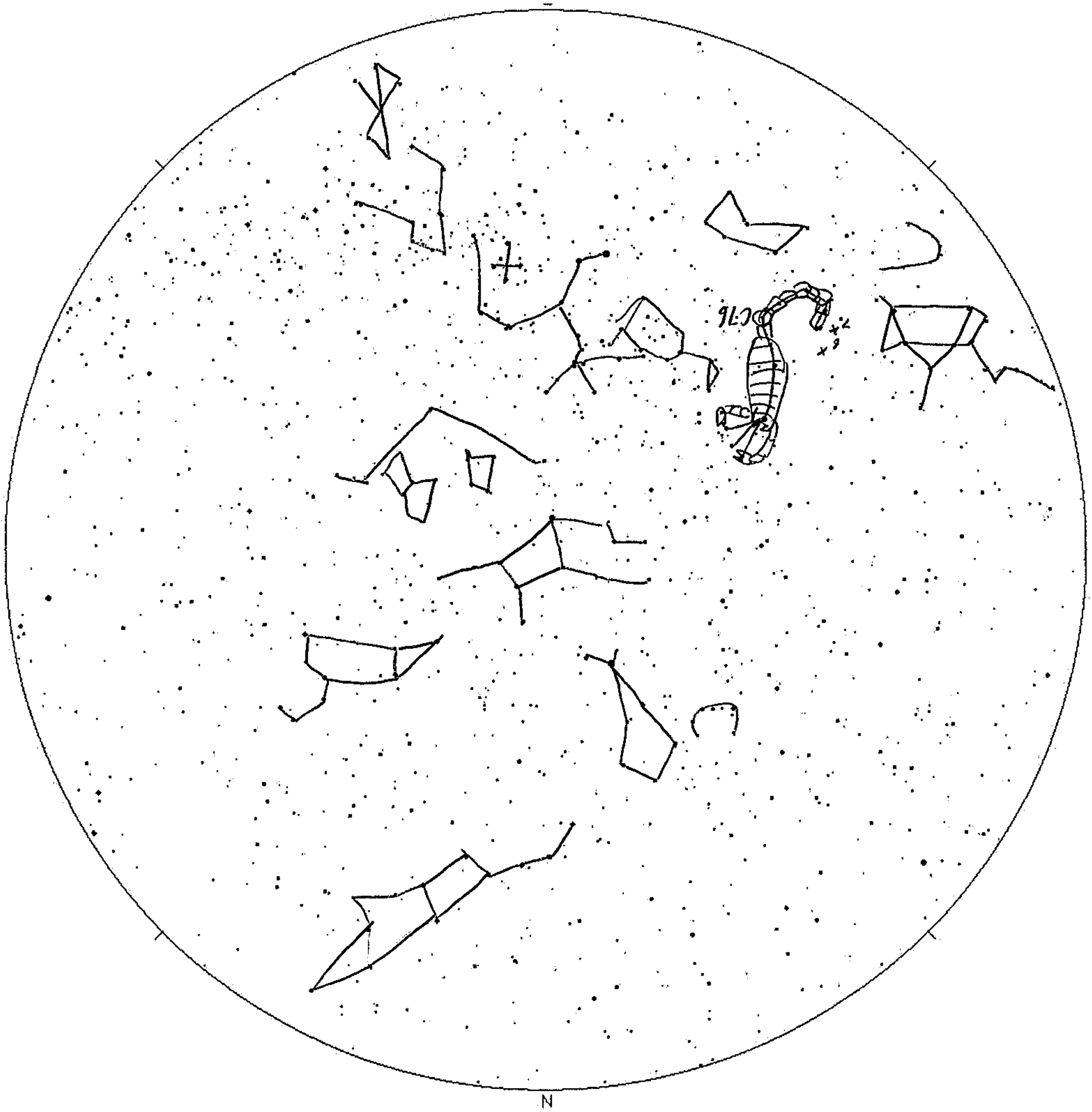
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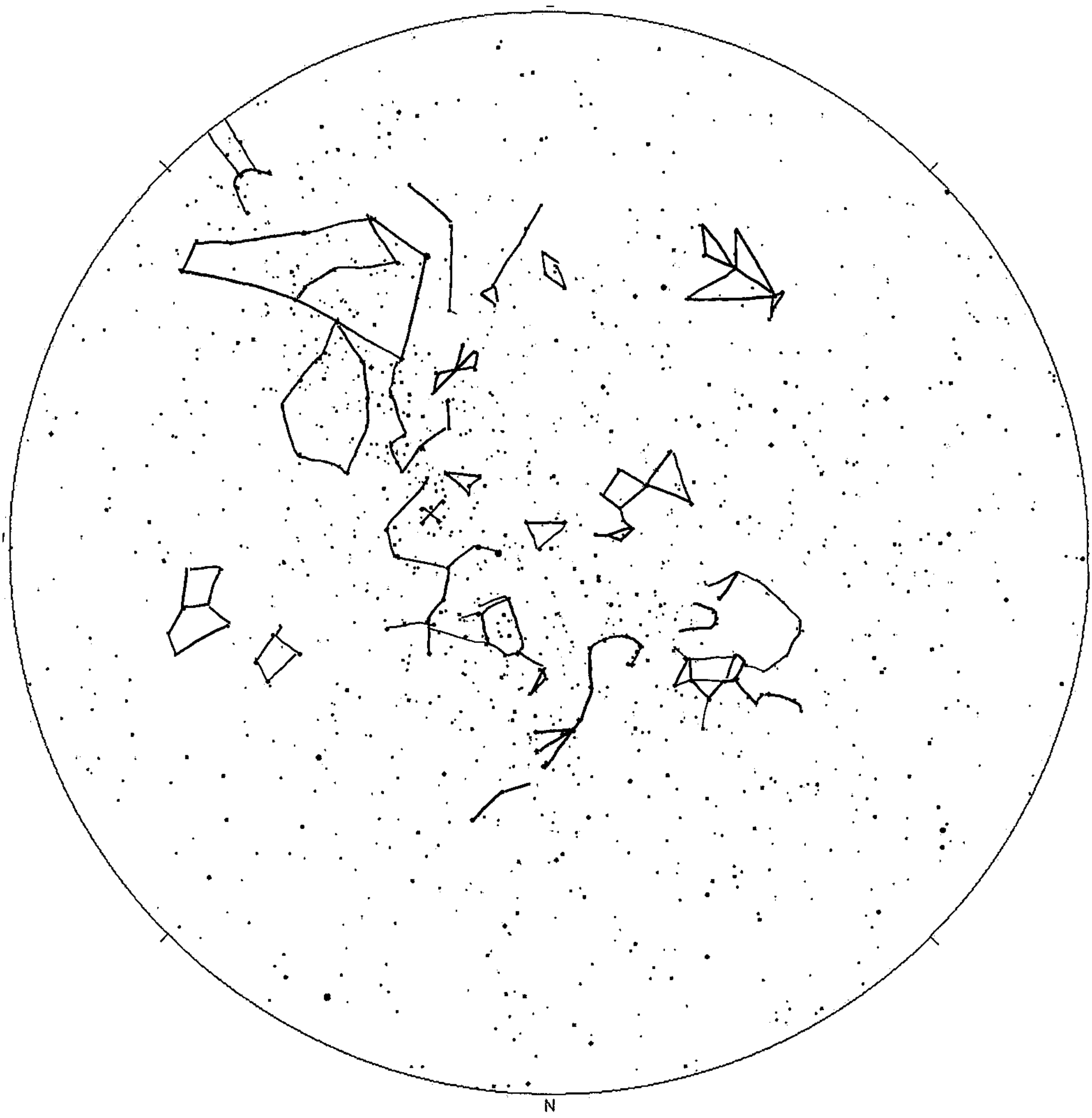
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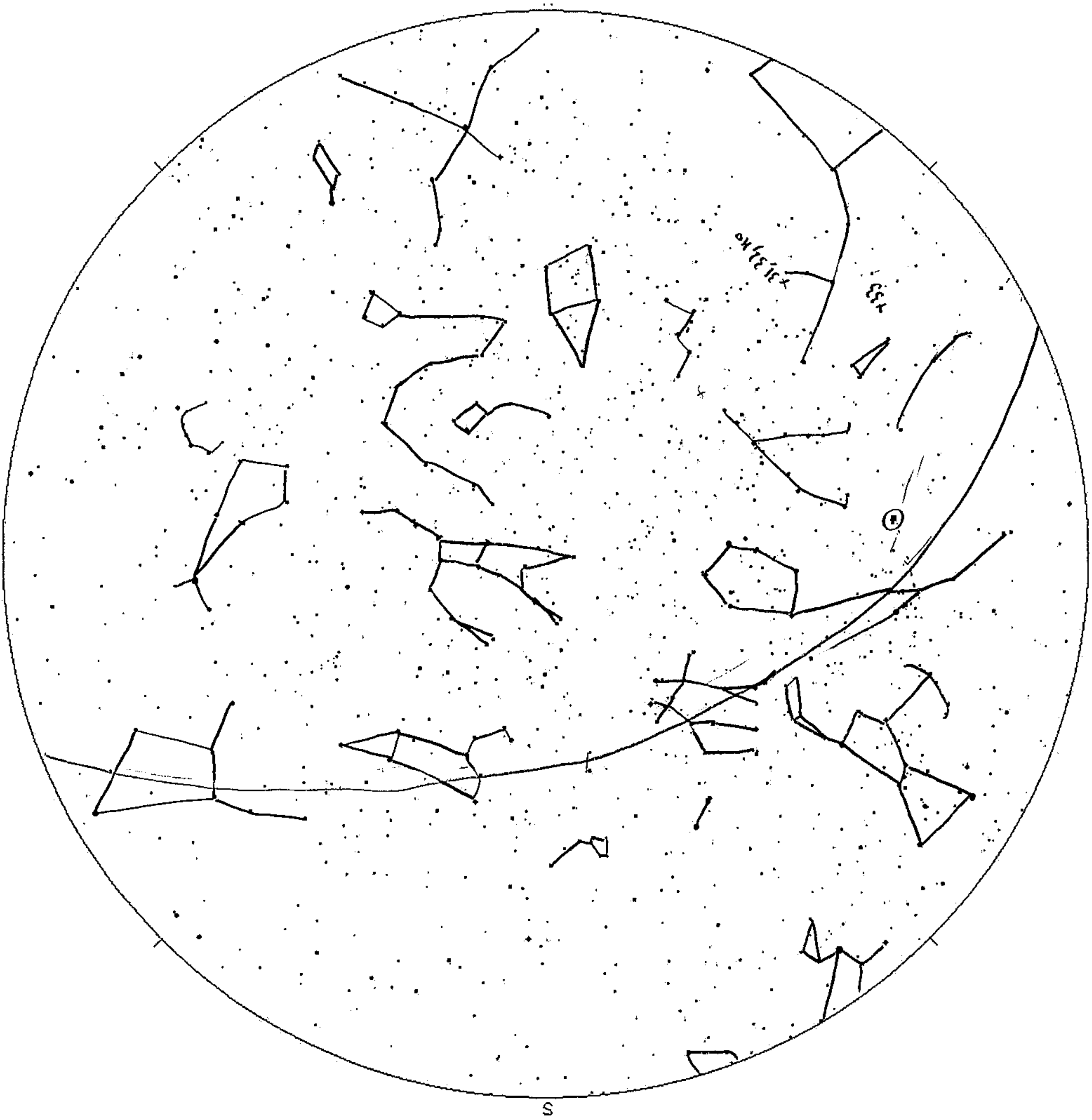
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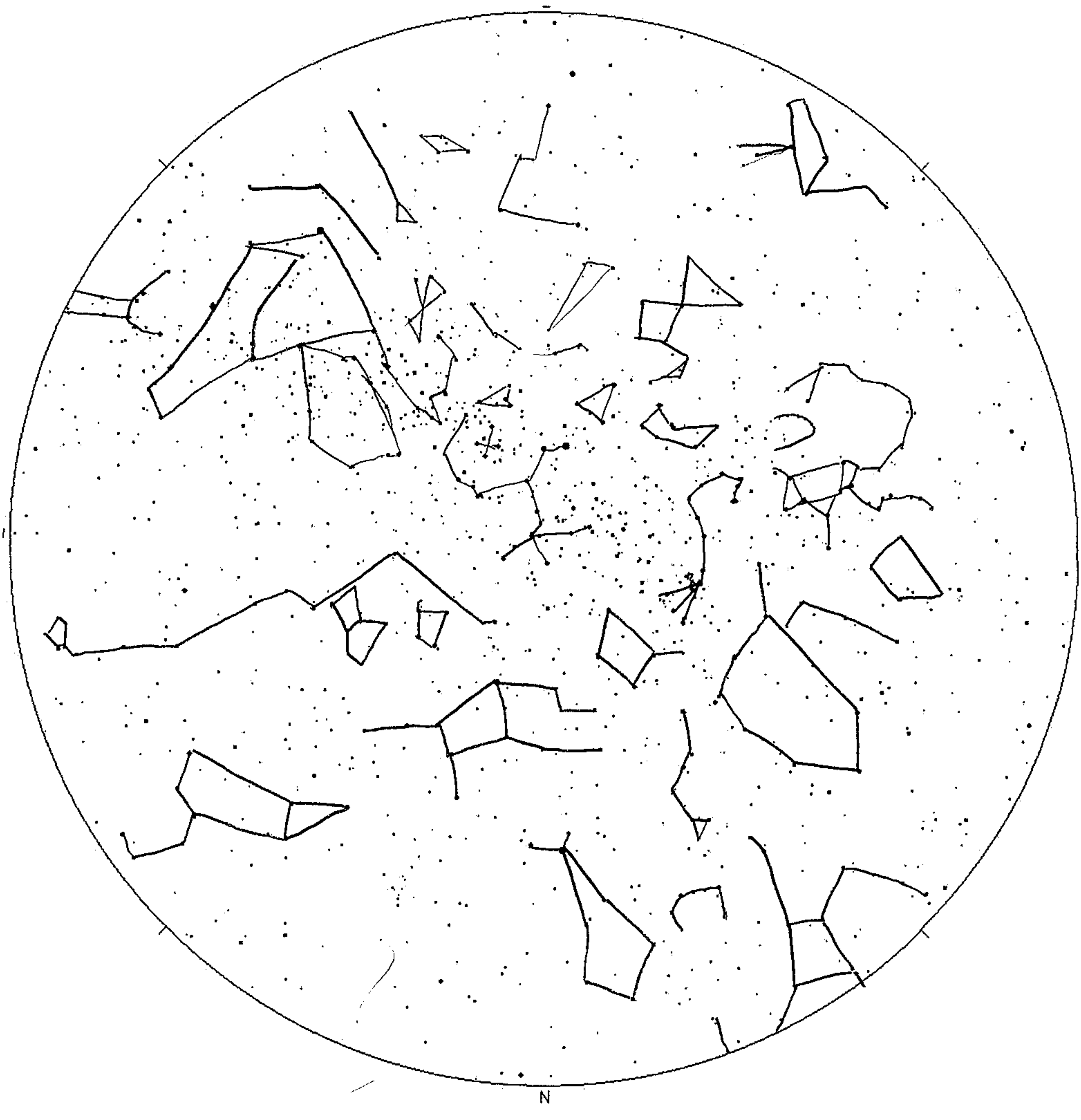
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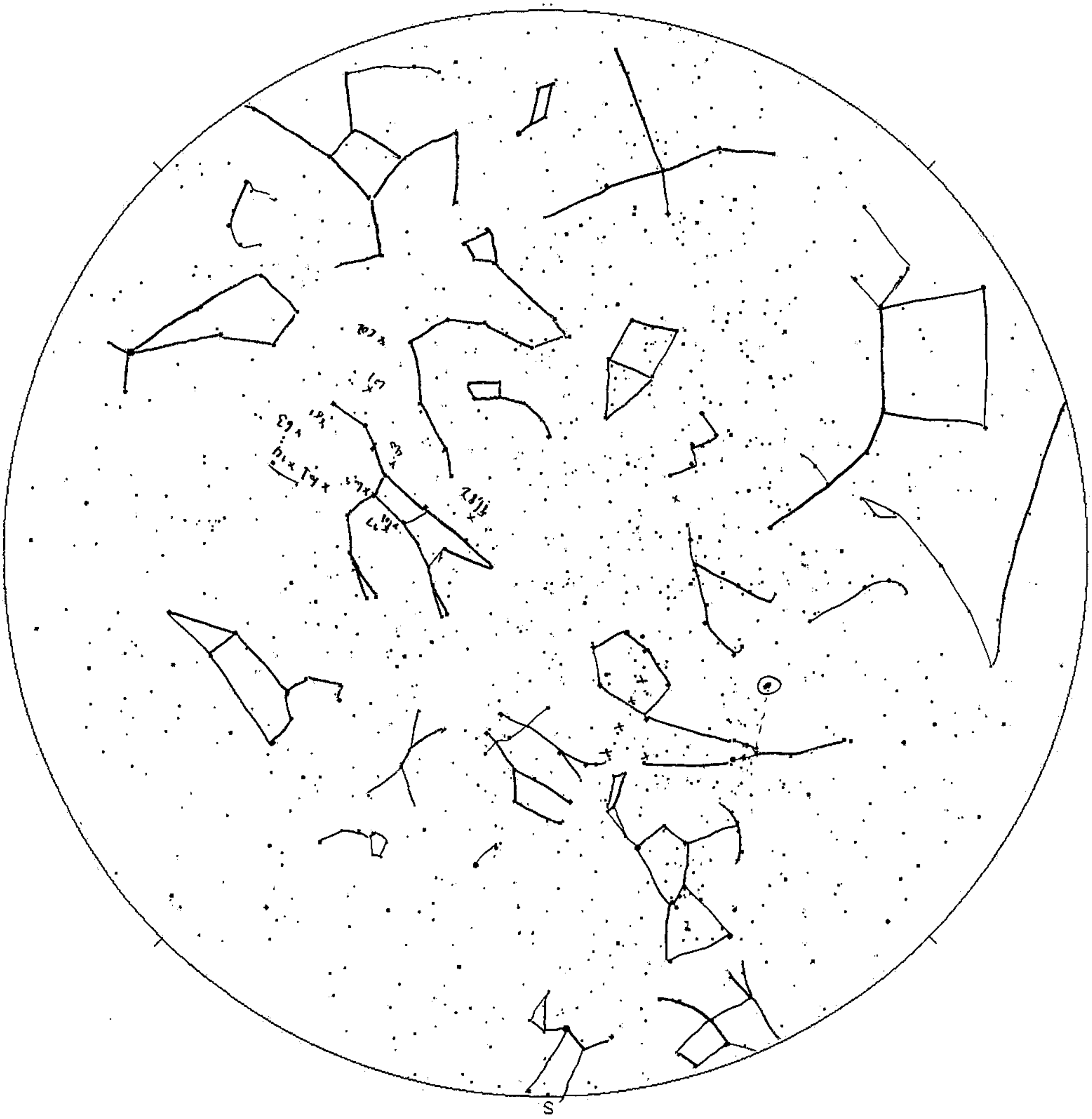
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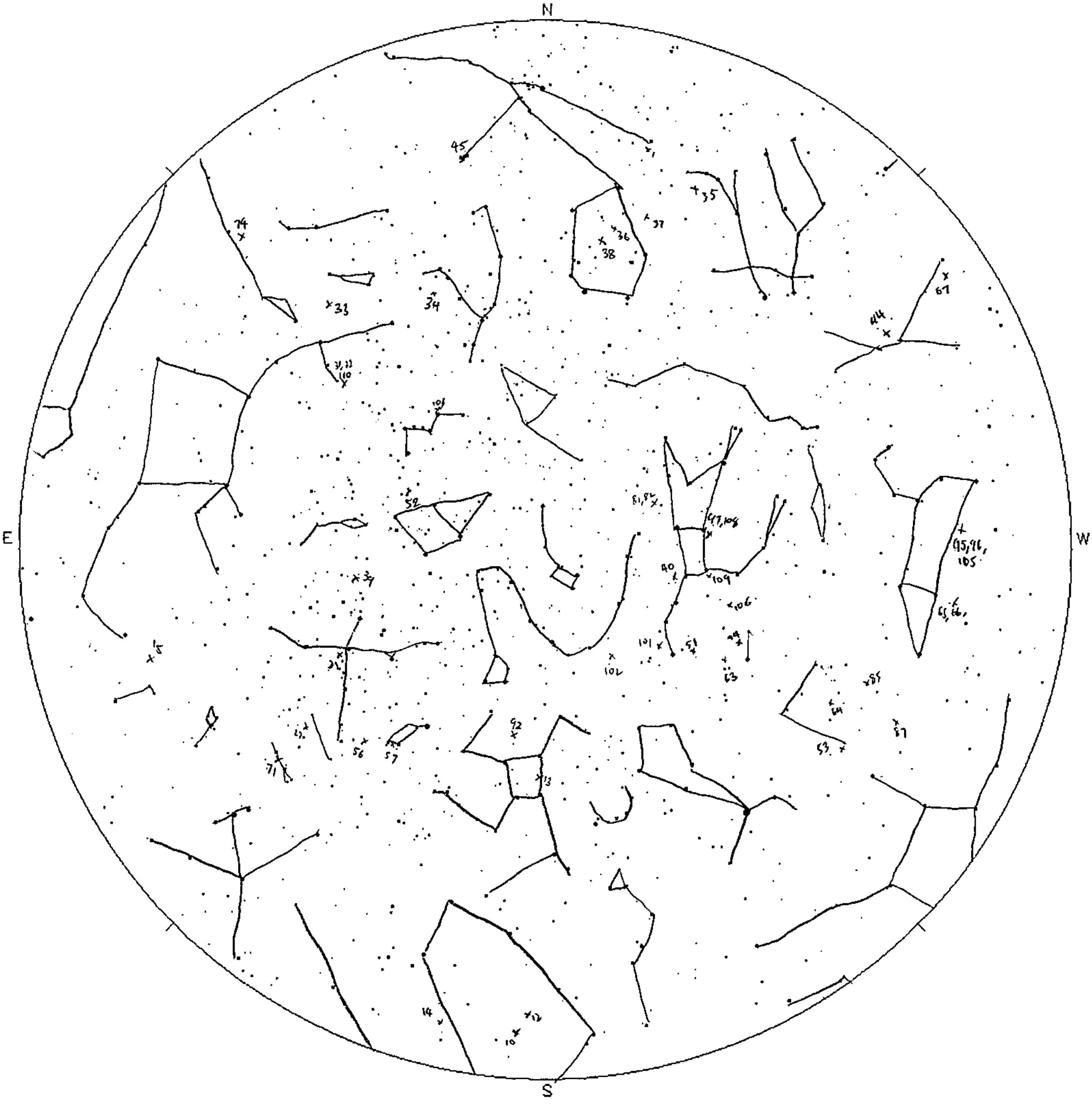
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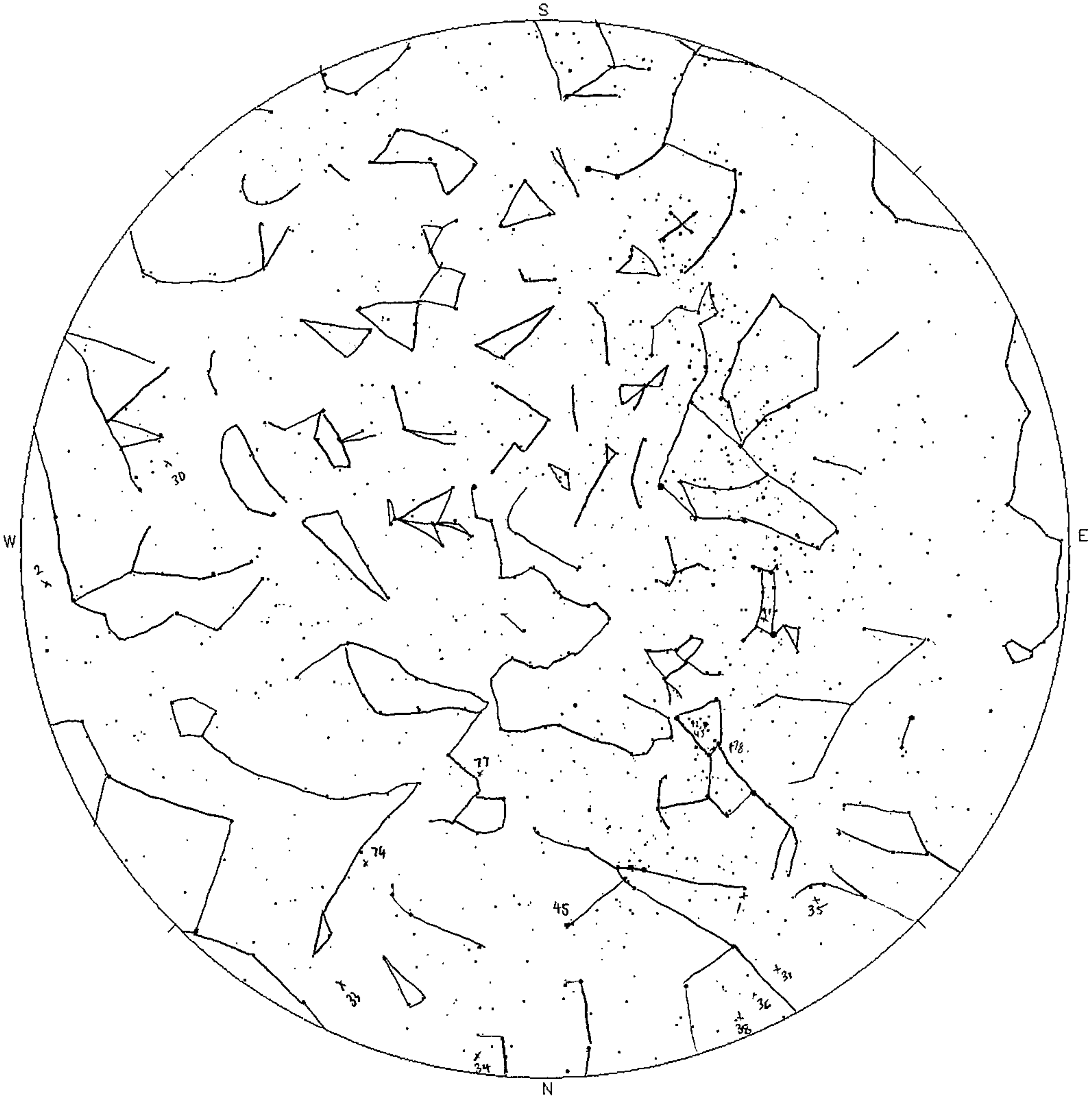
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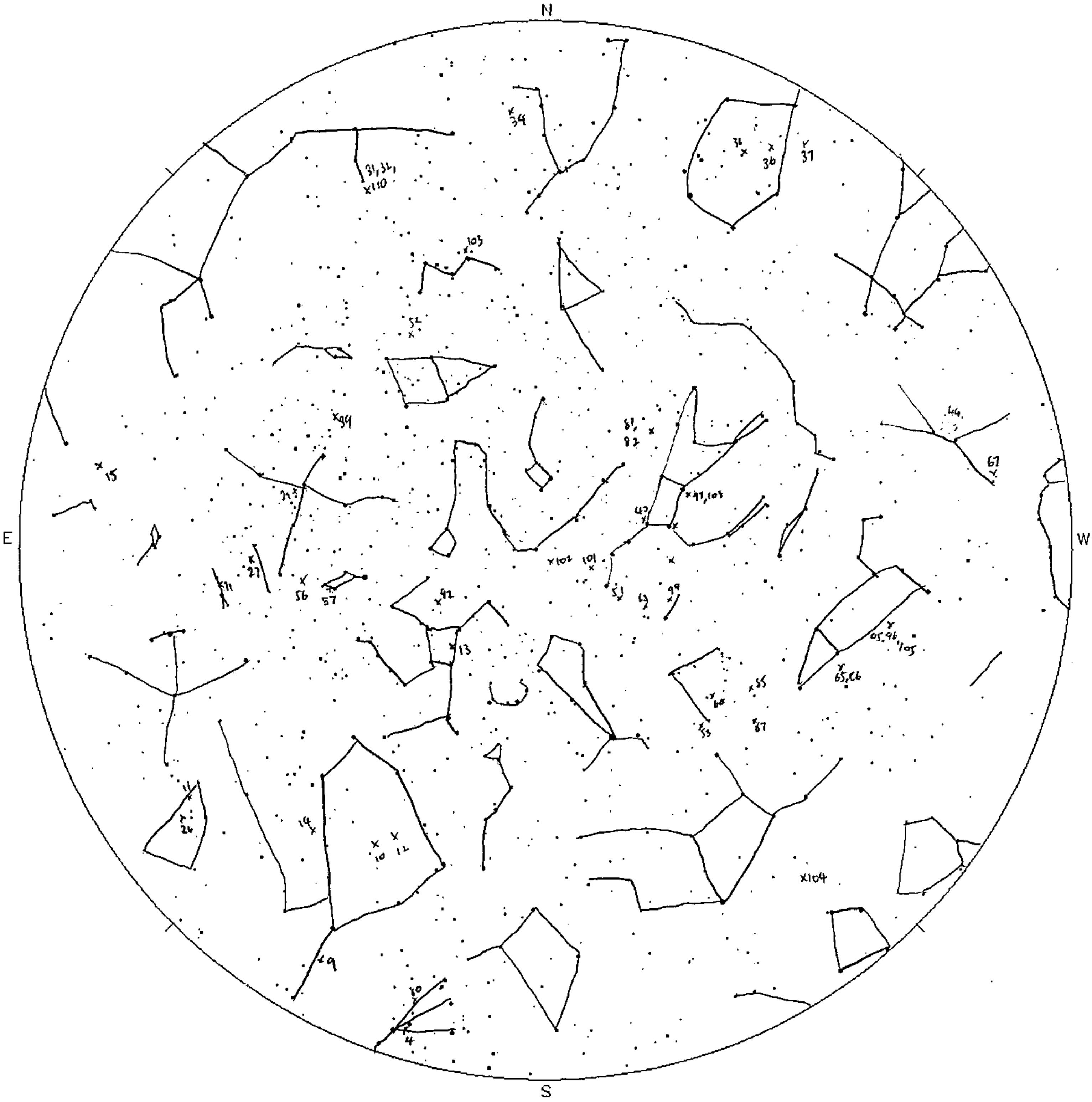
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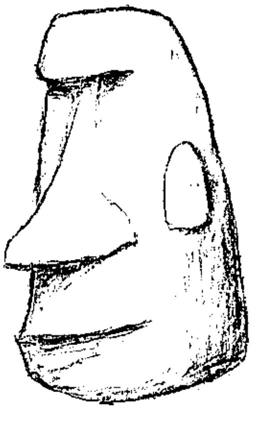

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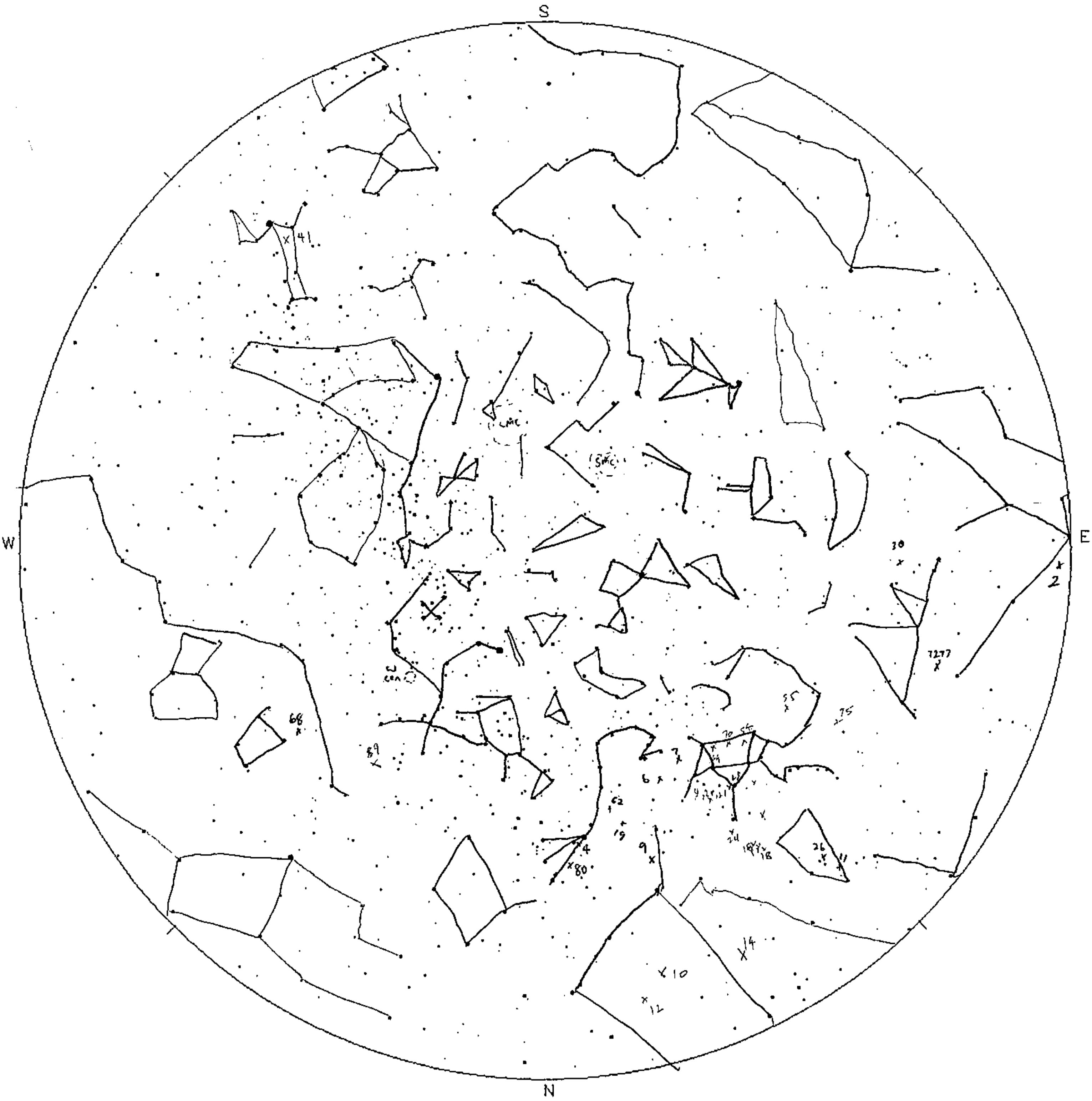
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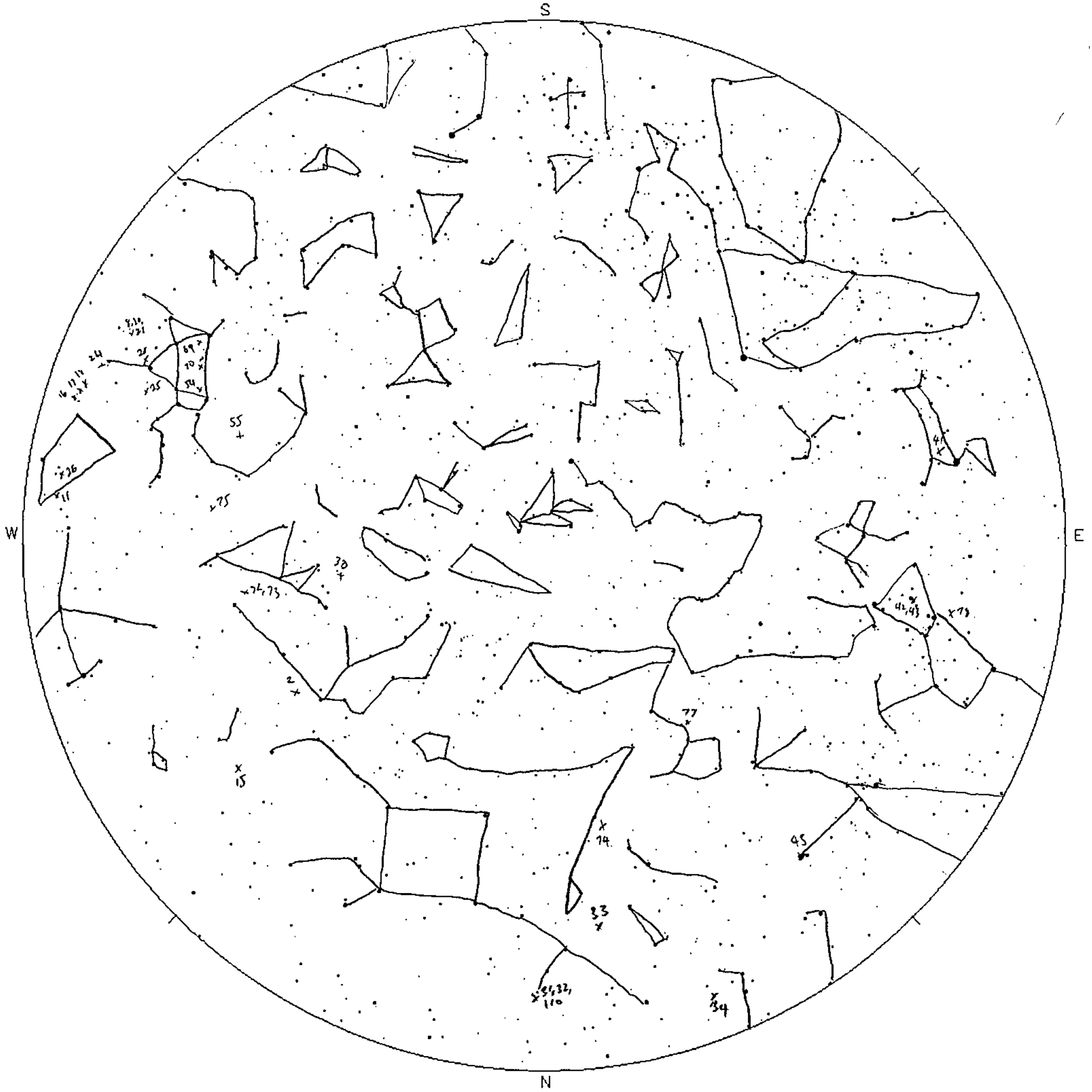
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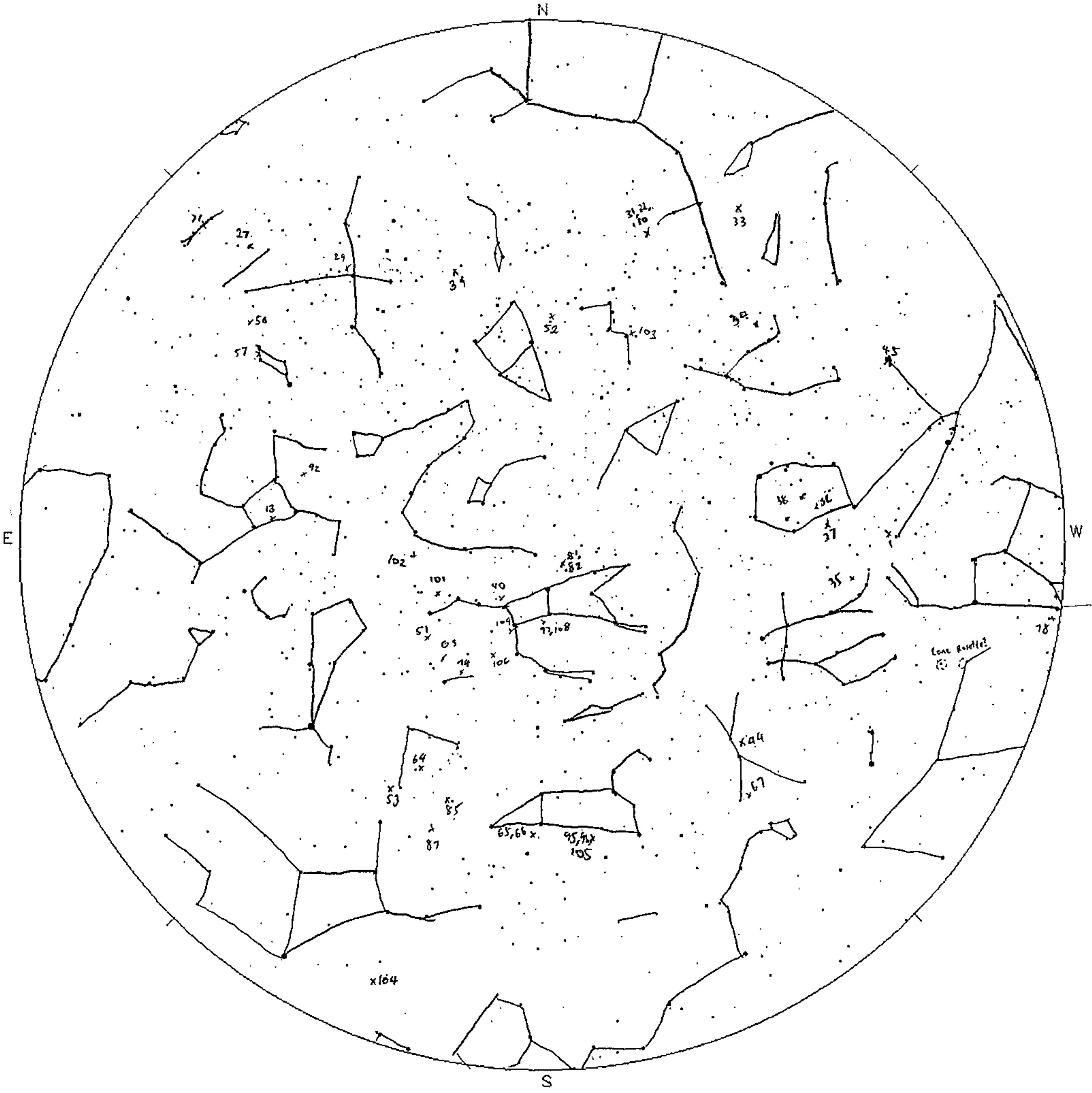
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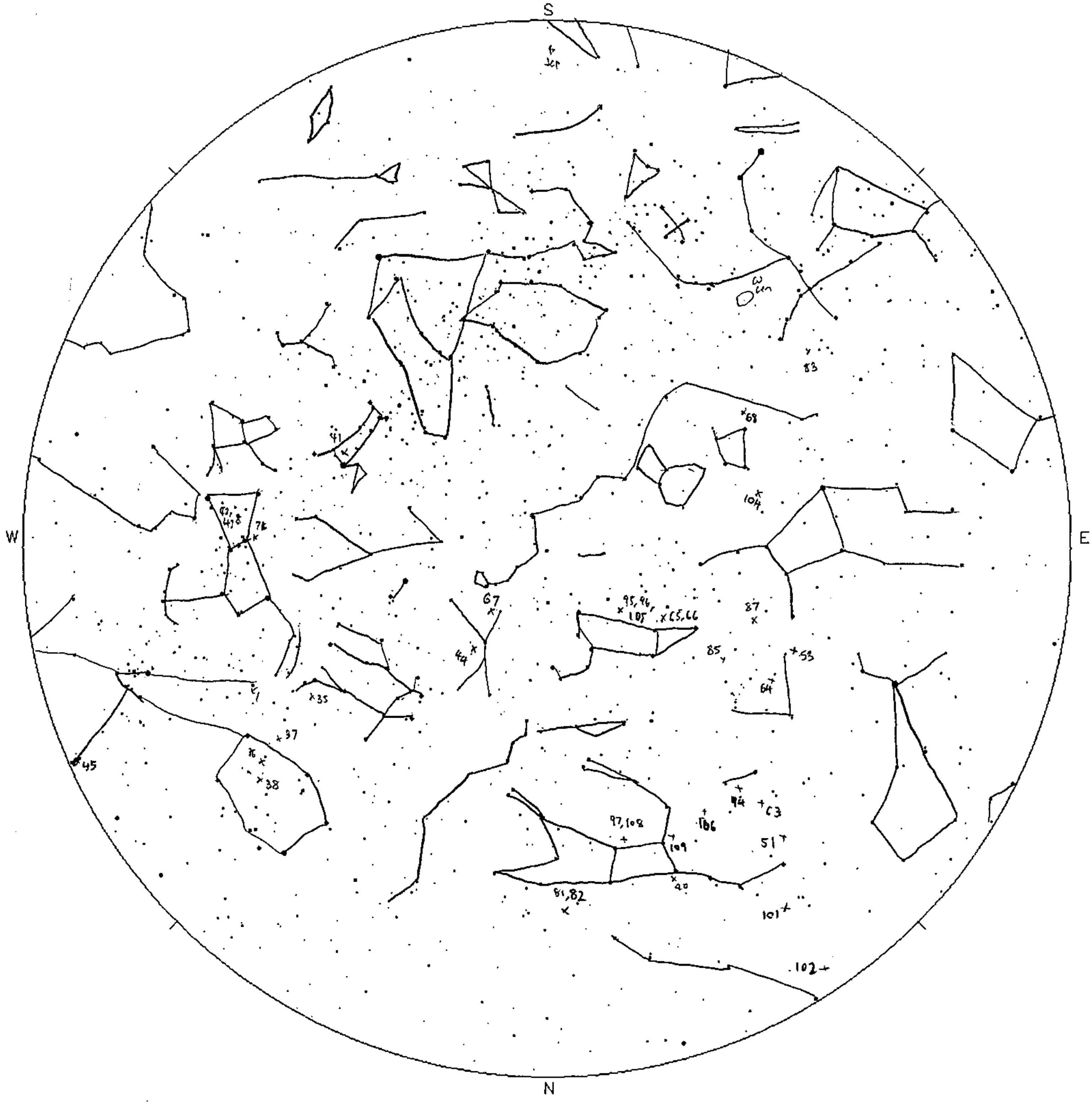
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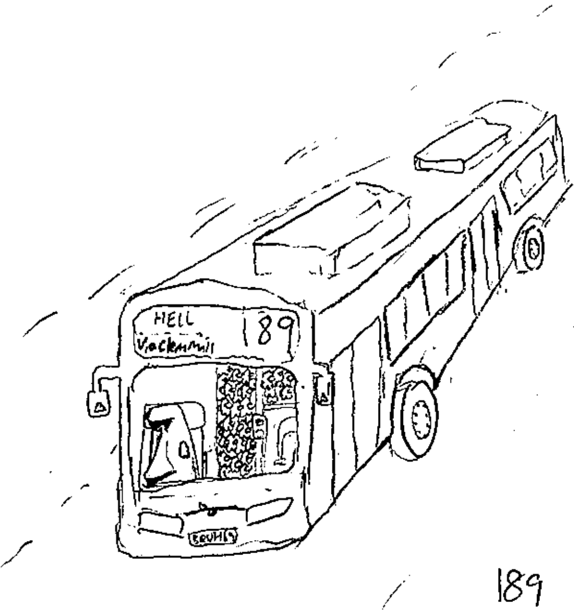
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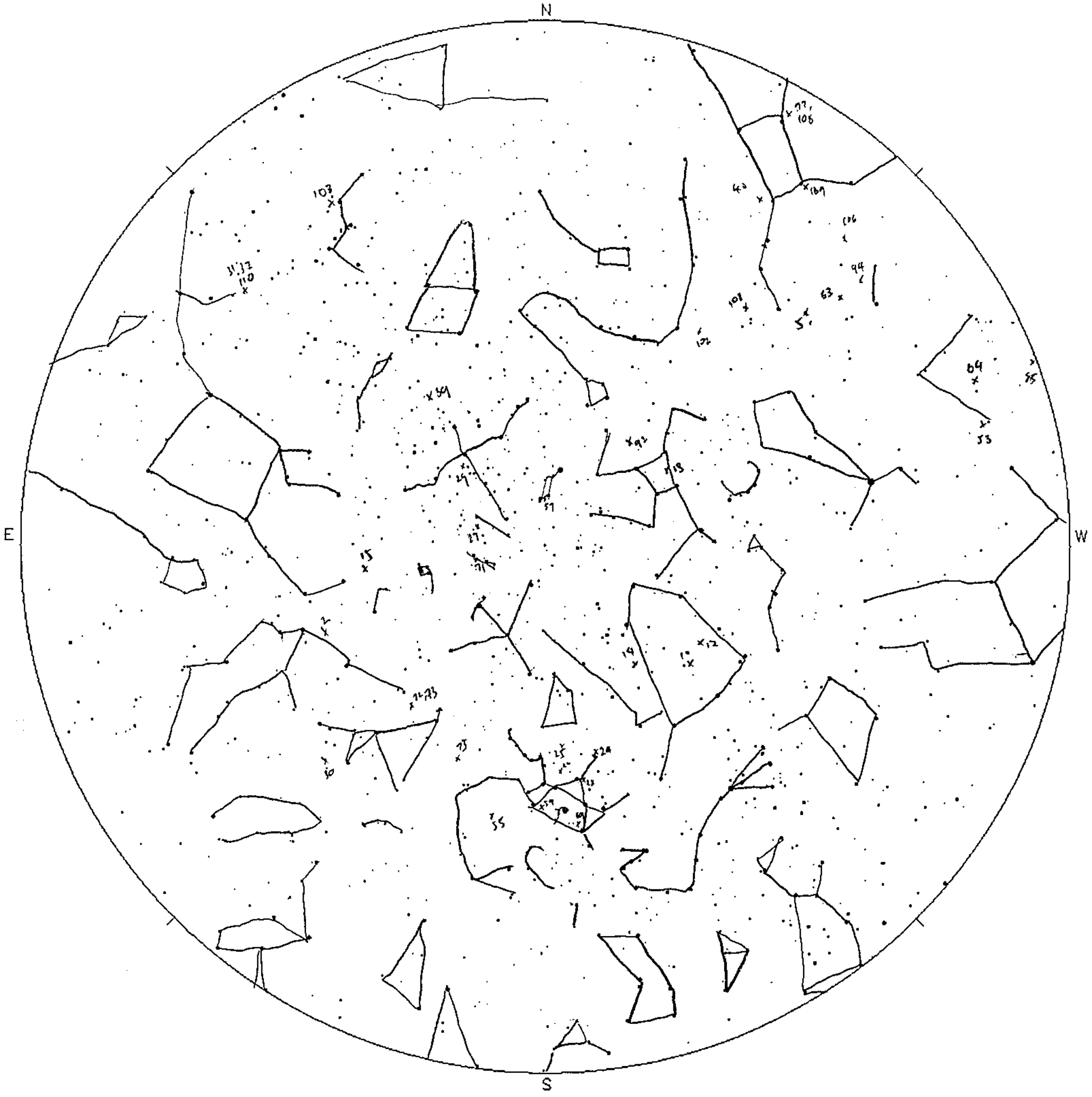
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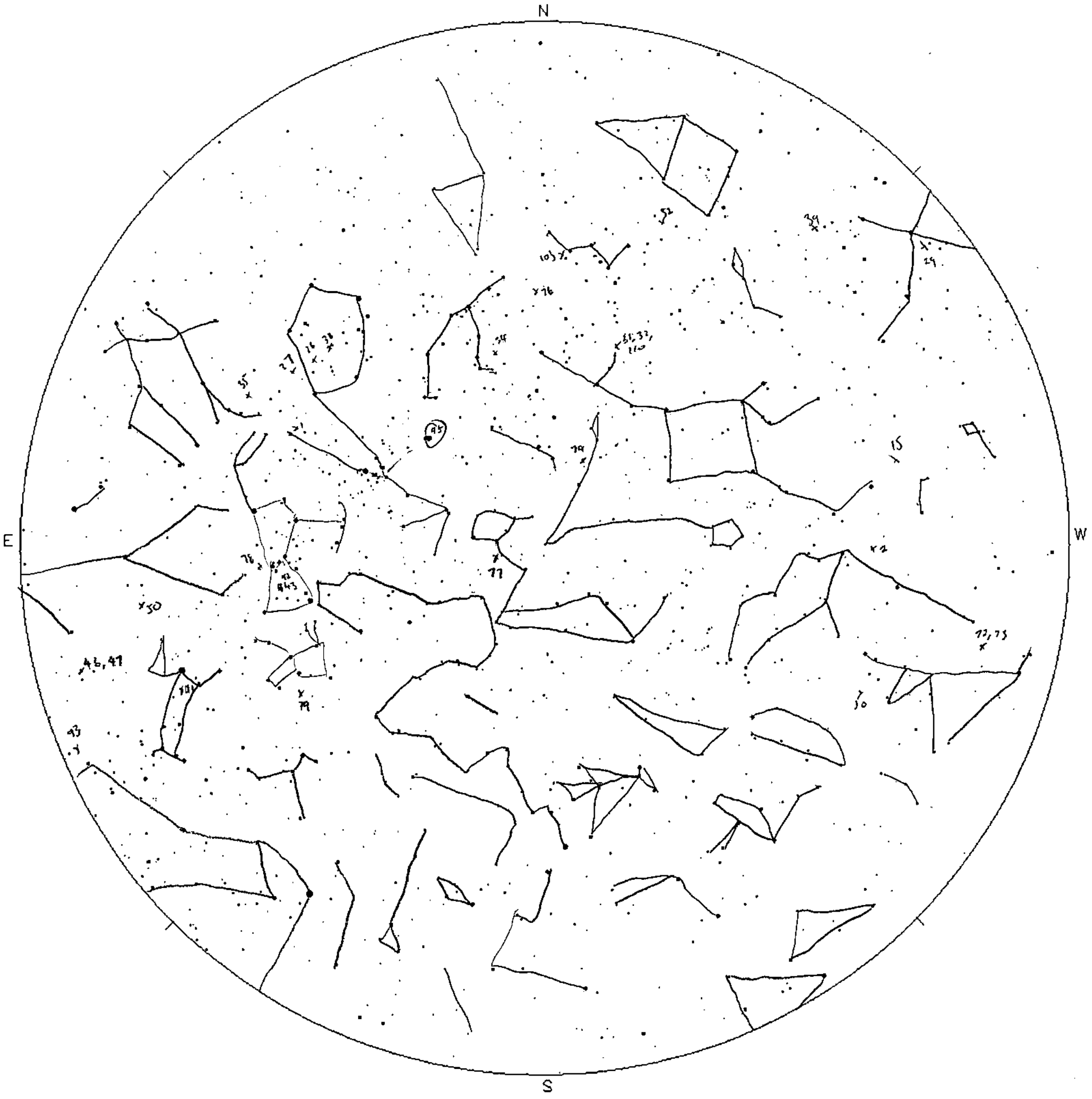
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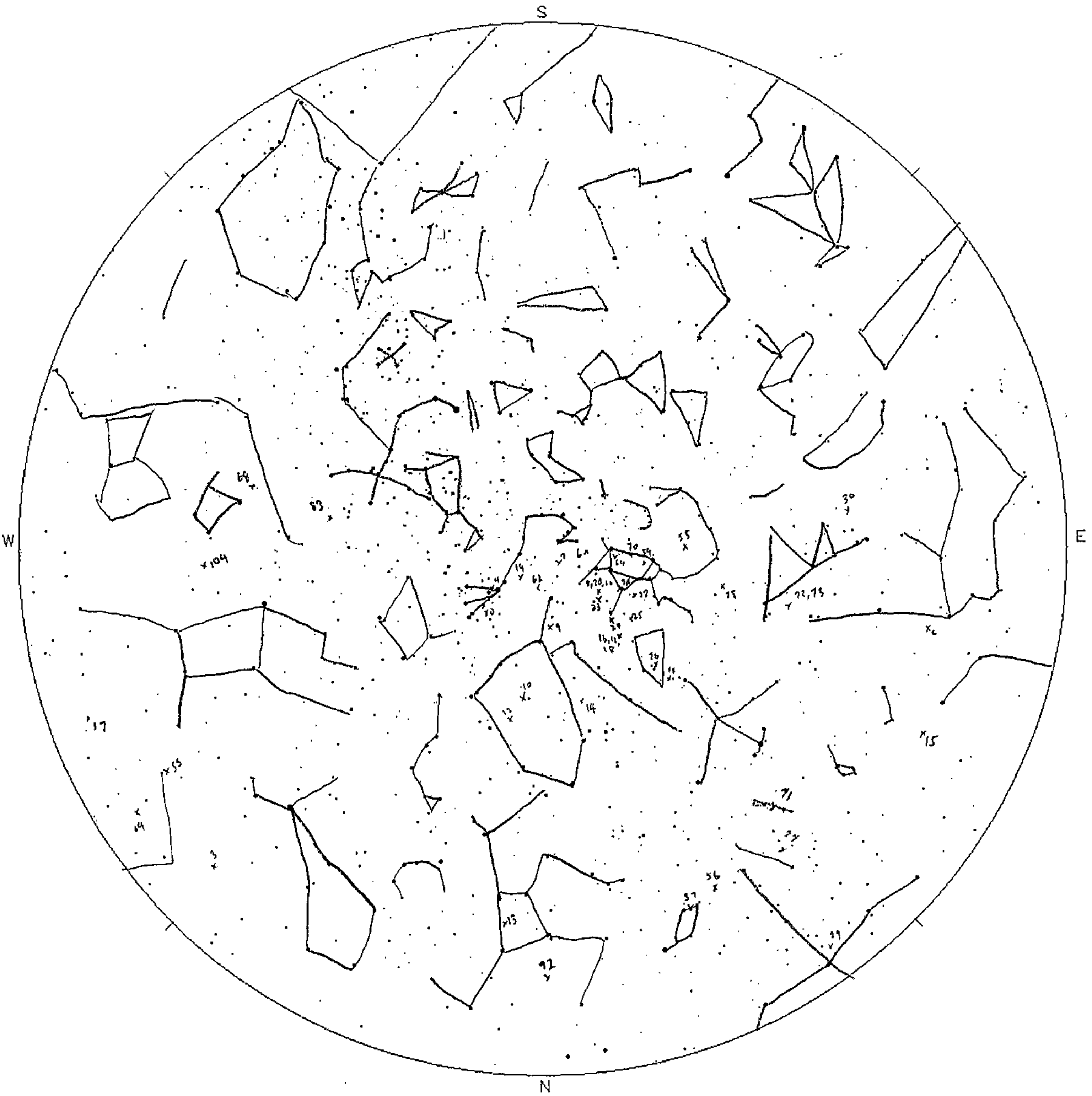
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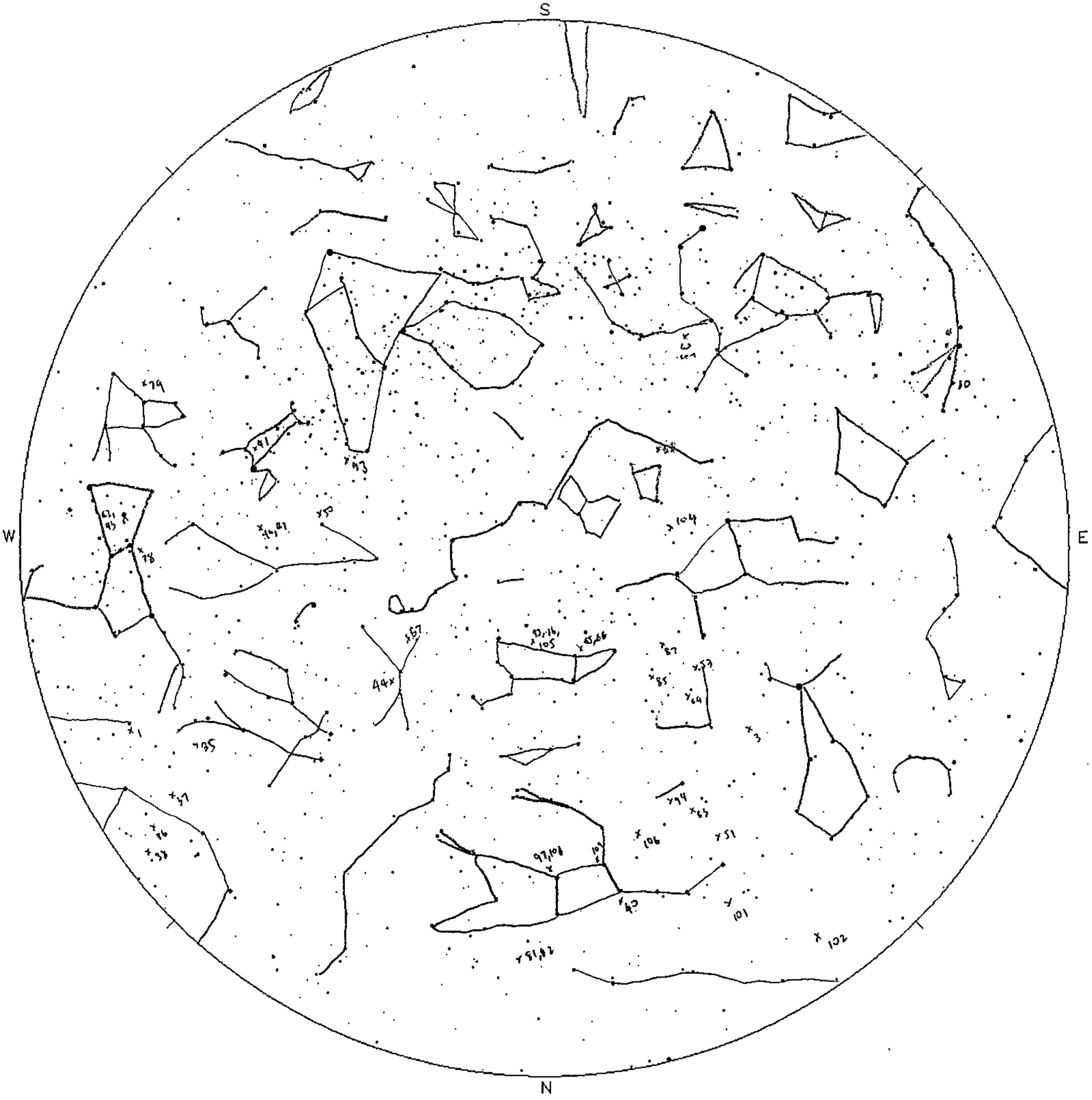
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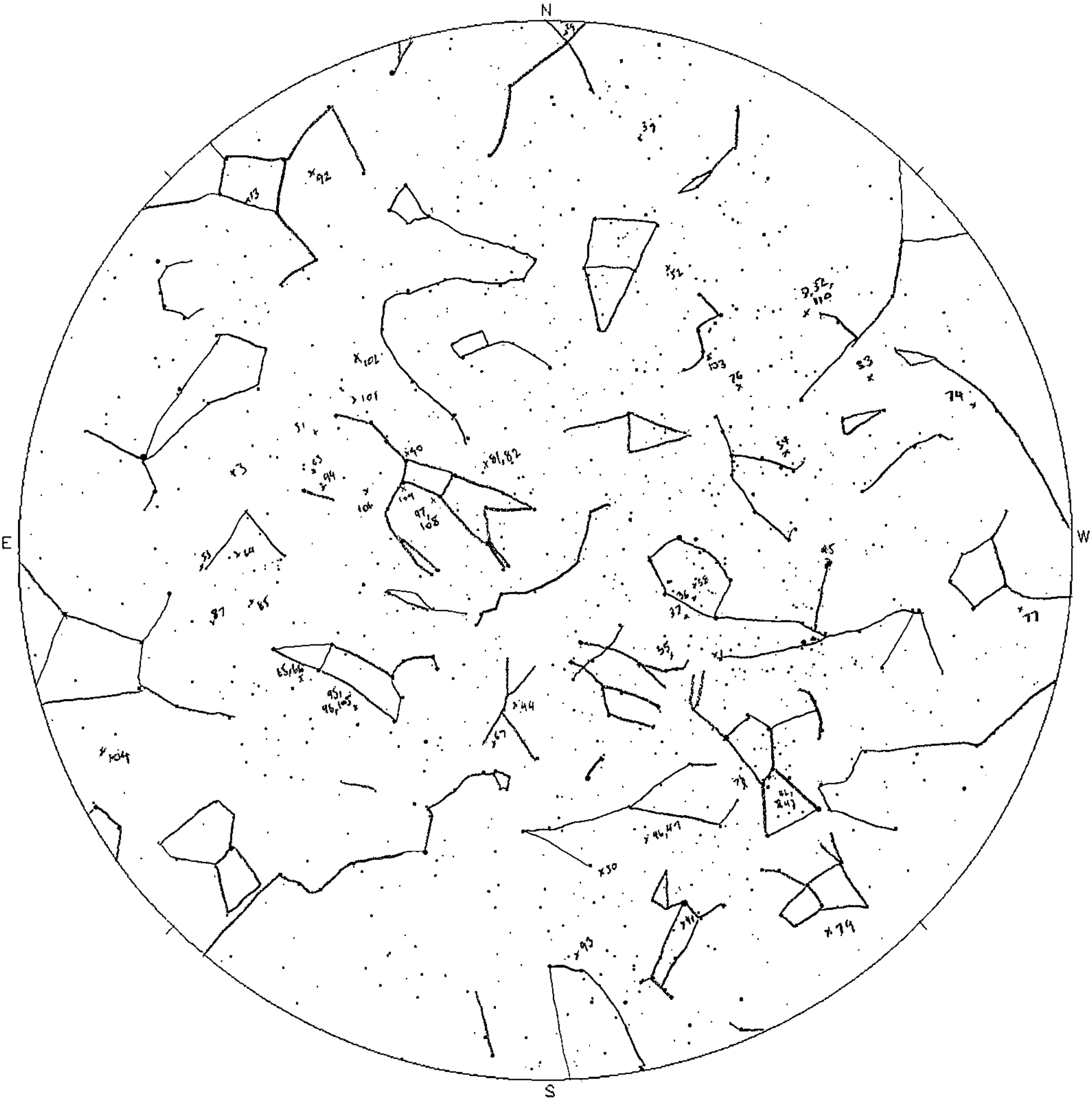
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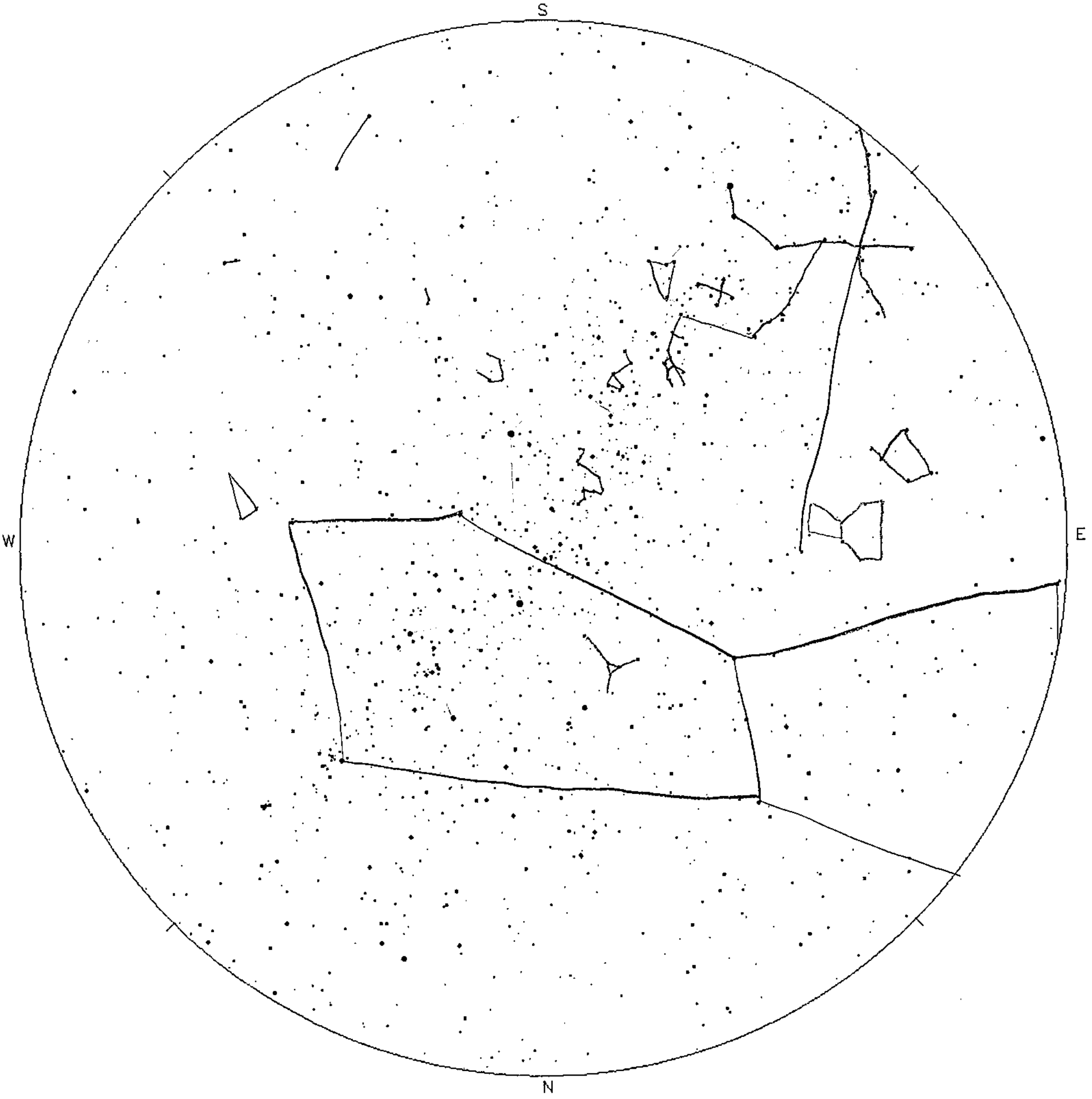
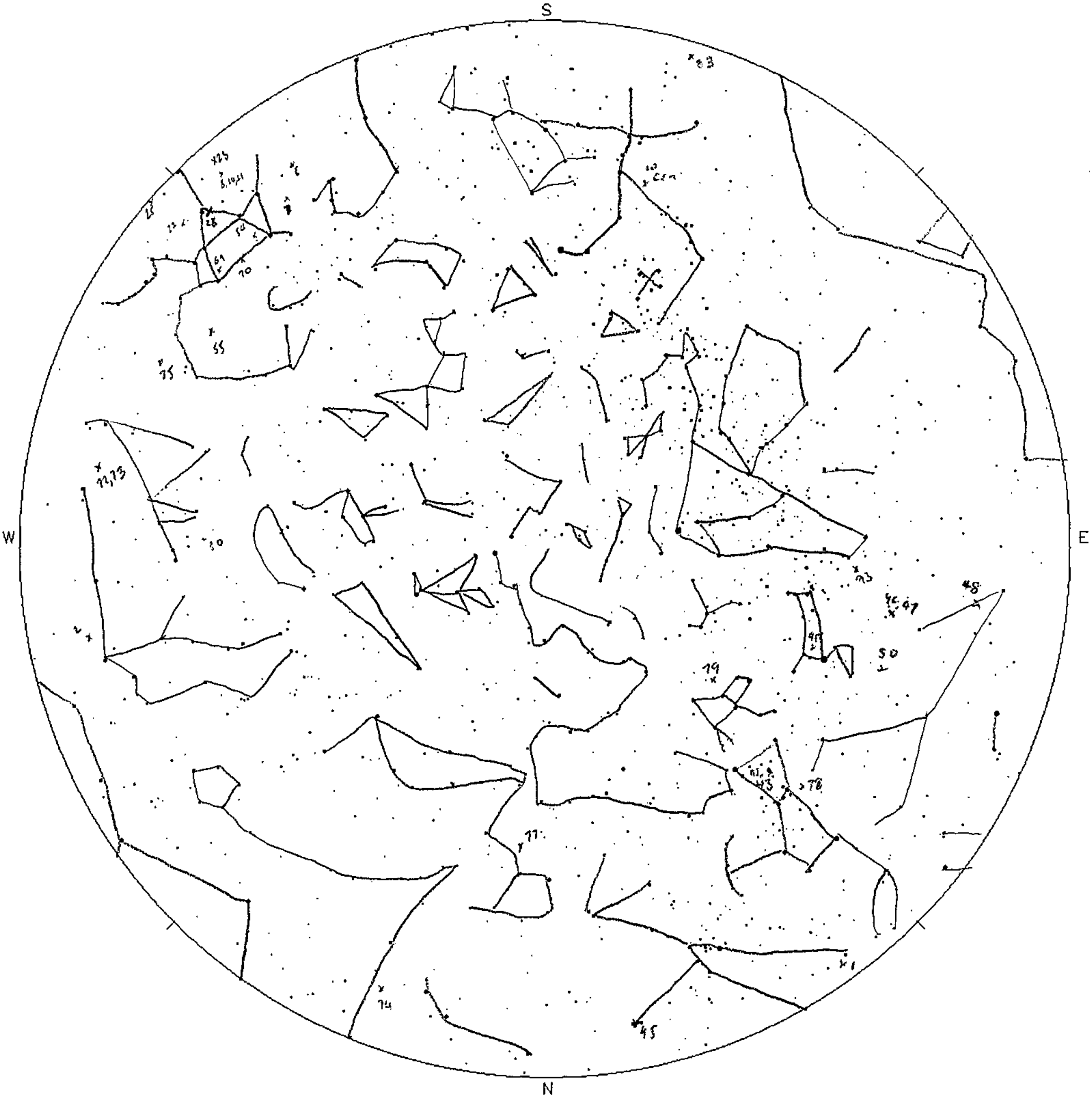
Courtesy of Andrew,
who found Orion in everything +

Also kane did some other stuff here



we let Andrew run wild again
either way we are close to 200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reached on 27/7/2022
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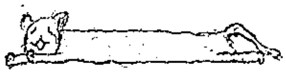

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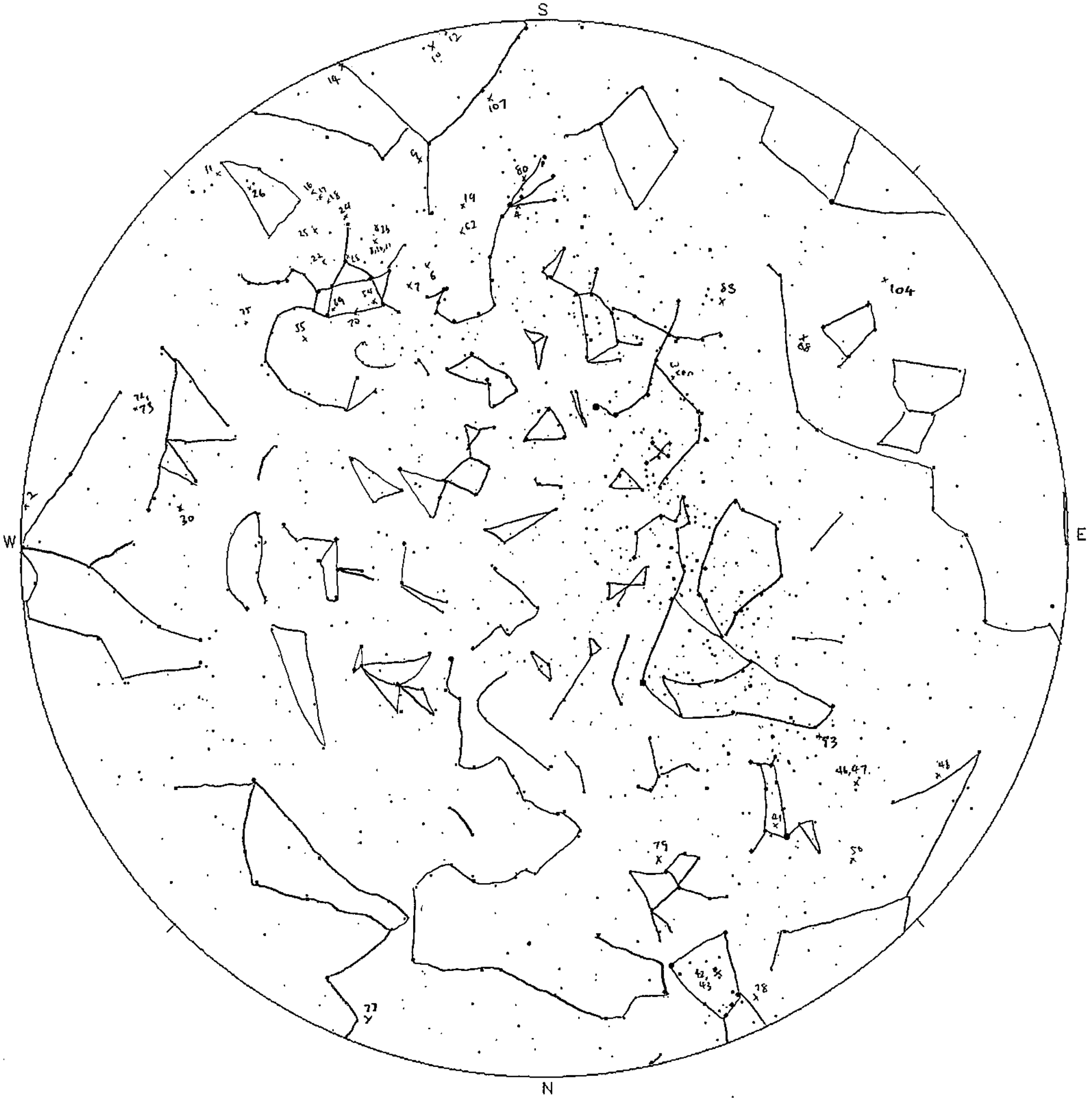
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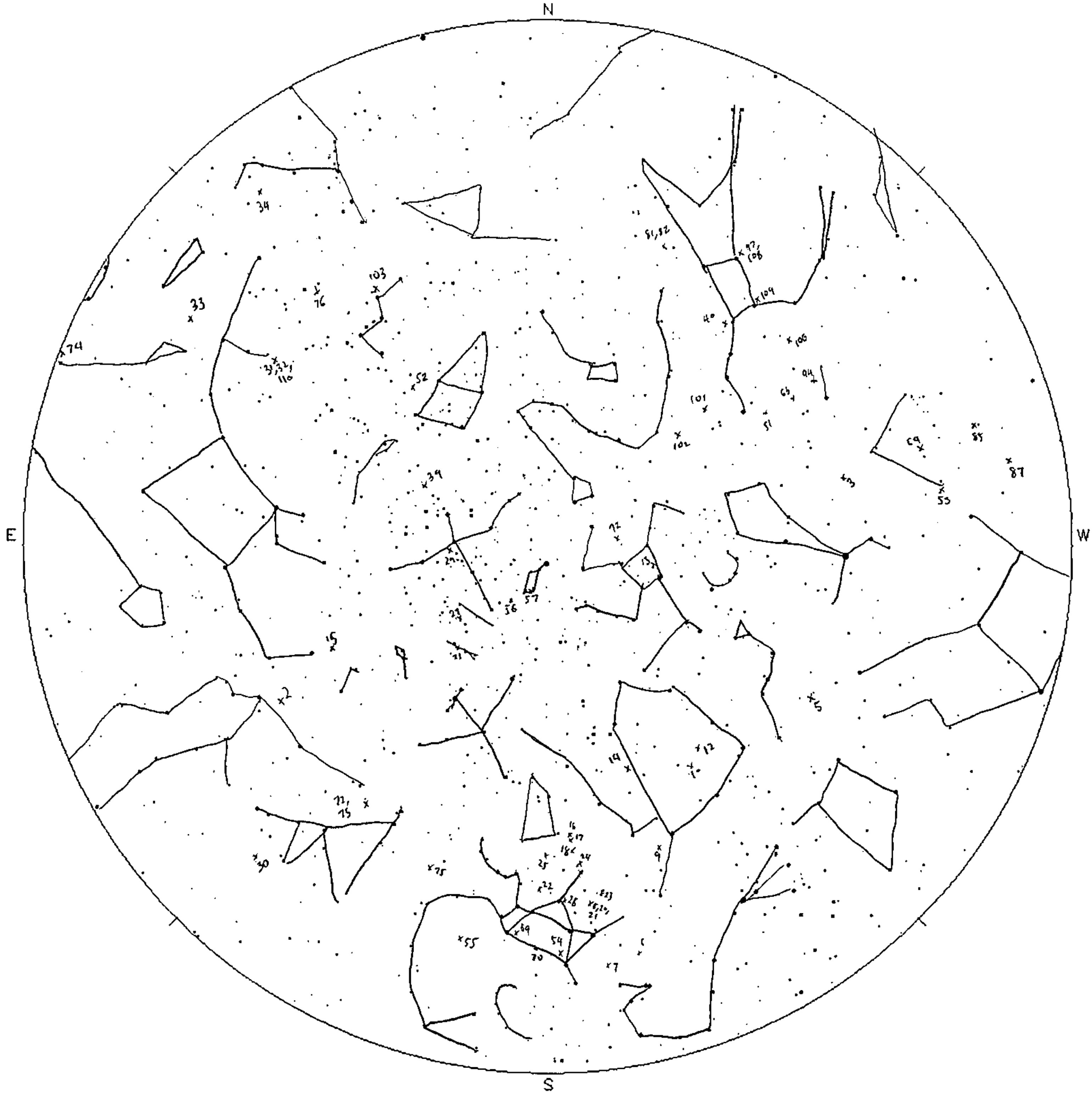
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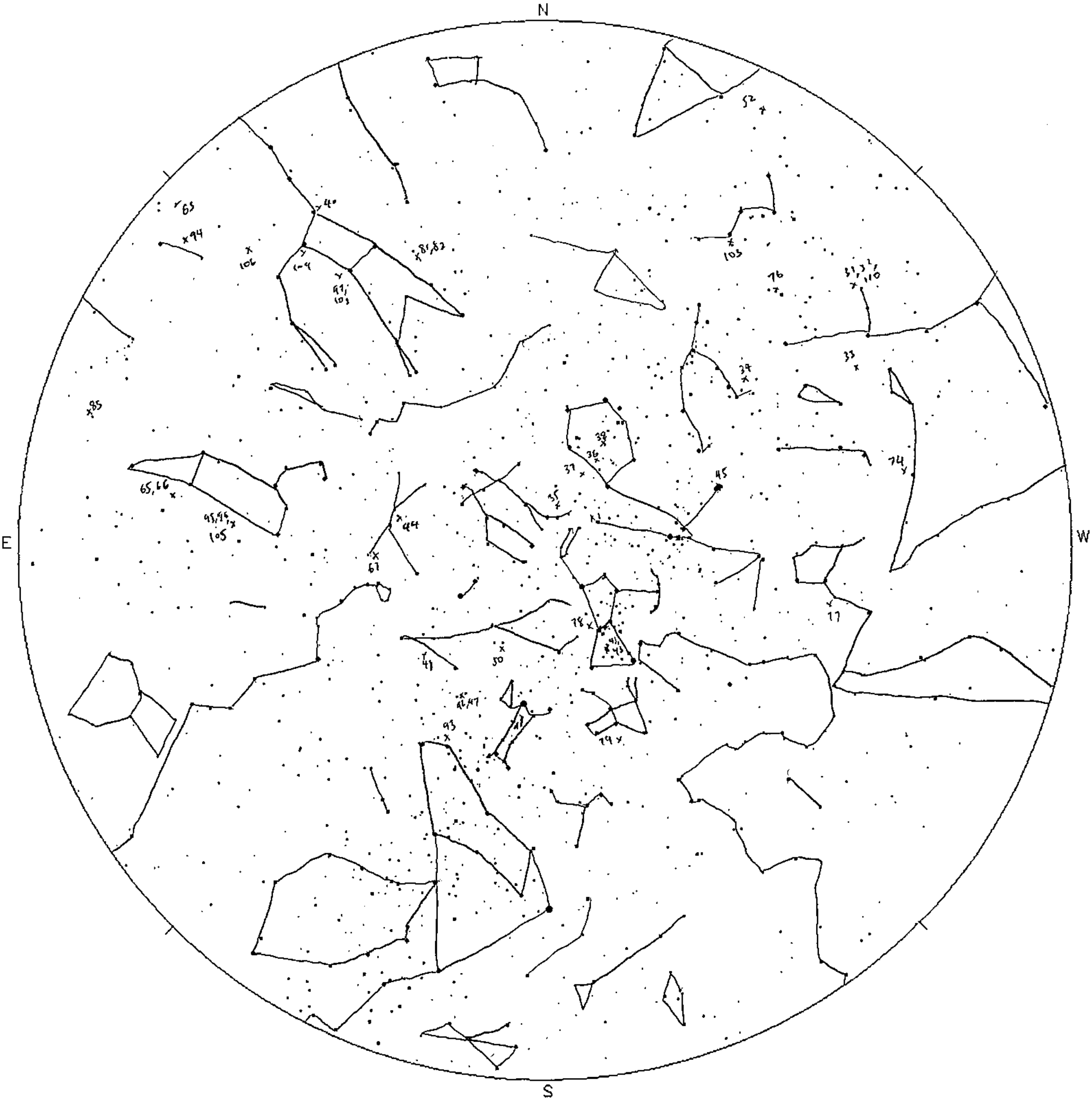
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94
x35
95,96,105
x1
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x38
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81,82
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x87
x106
x60
x53
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84
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x3
103
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101
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74
102
W
31,32,110
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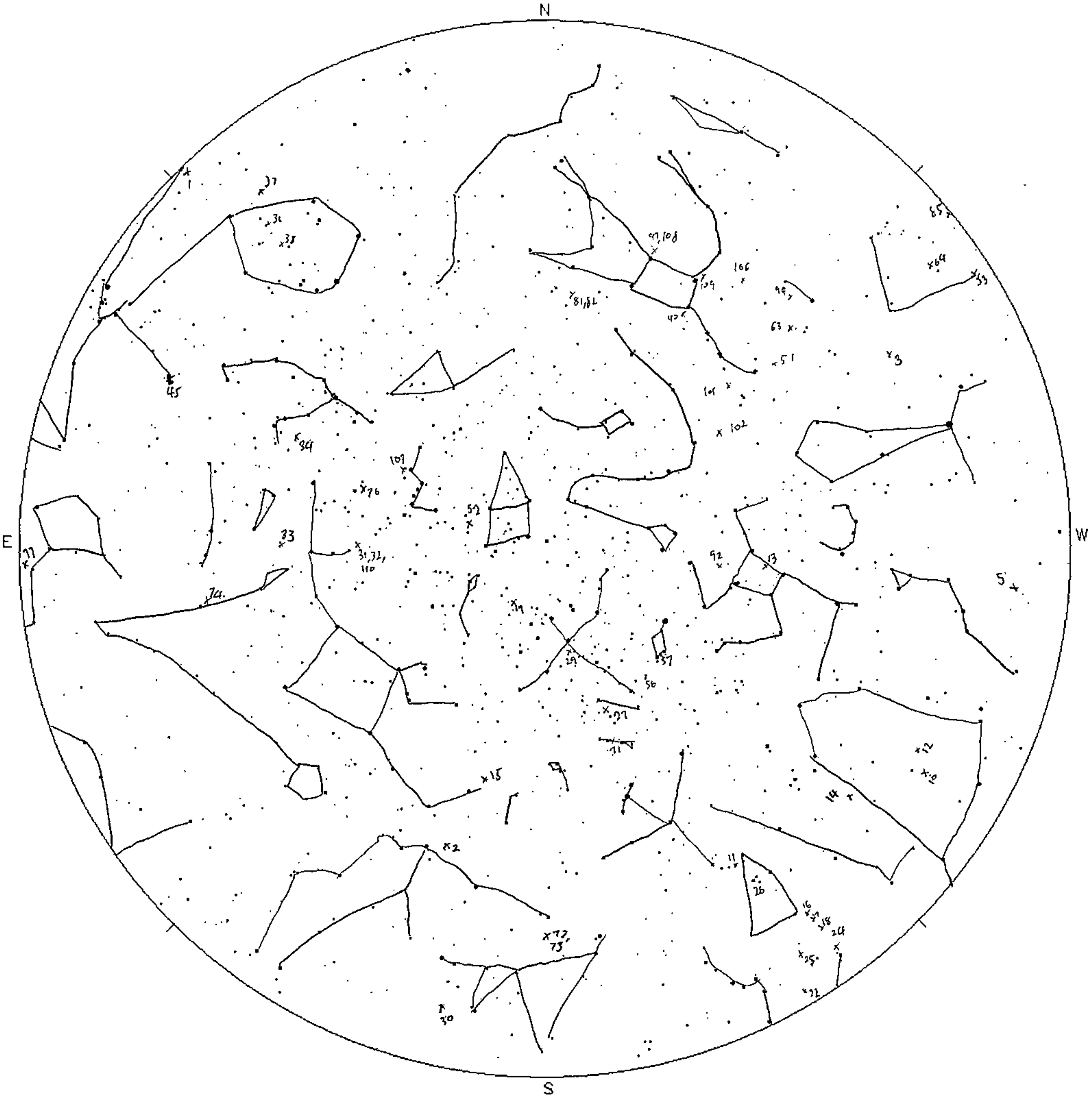
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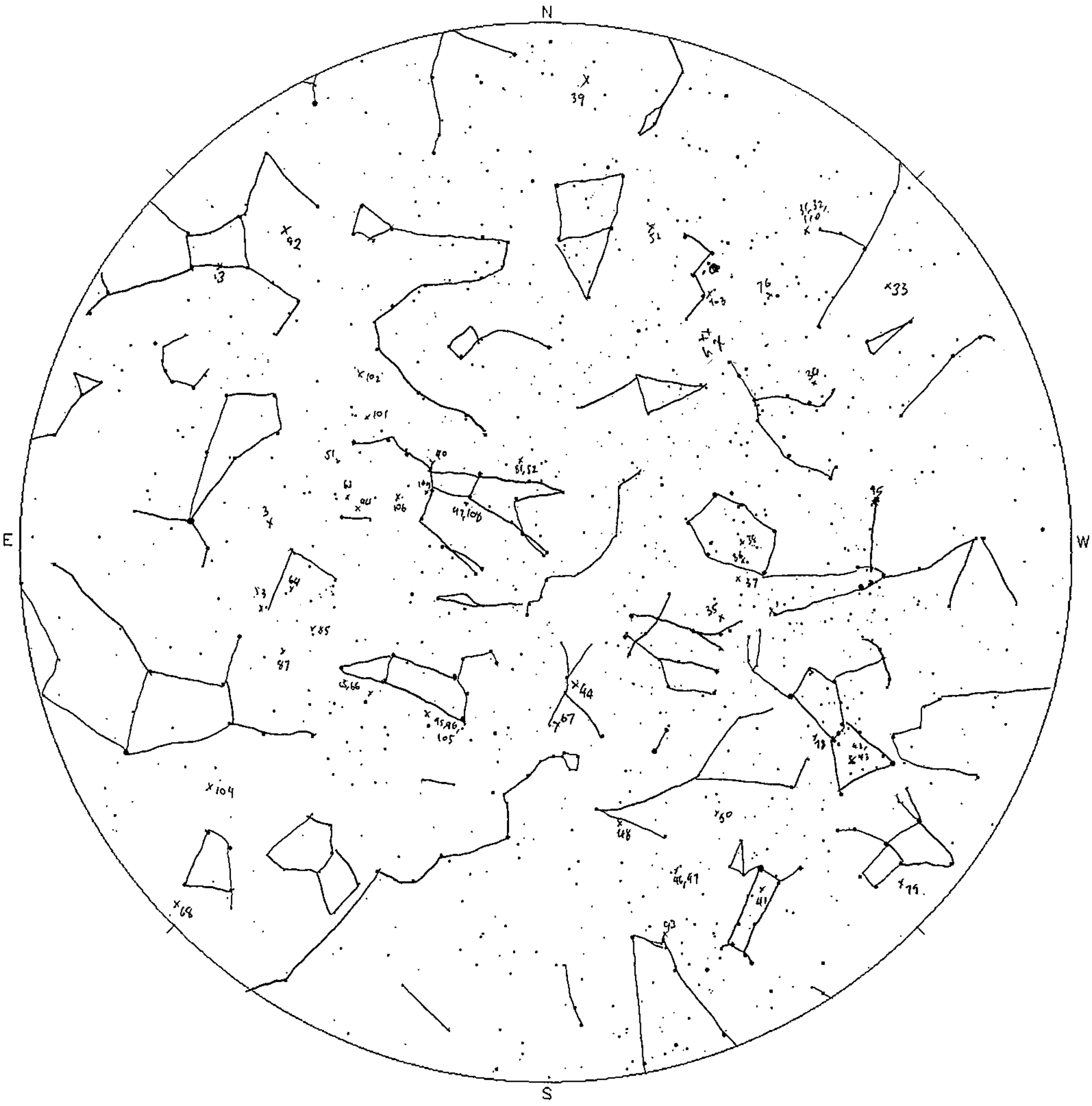
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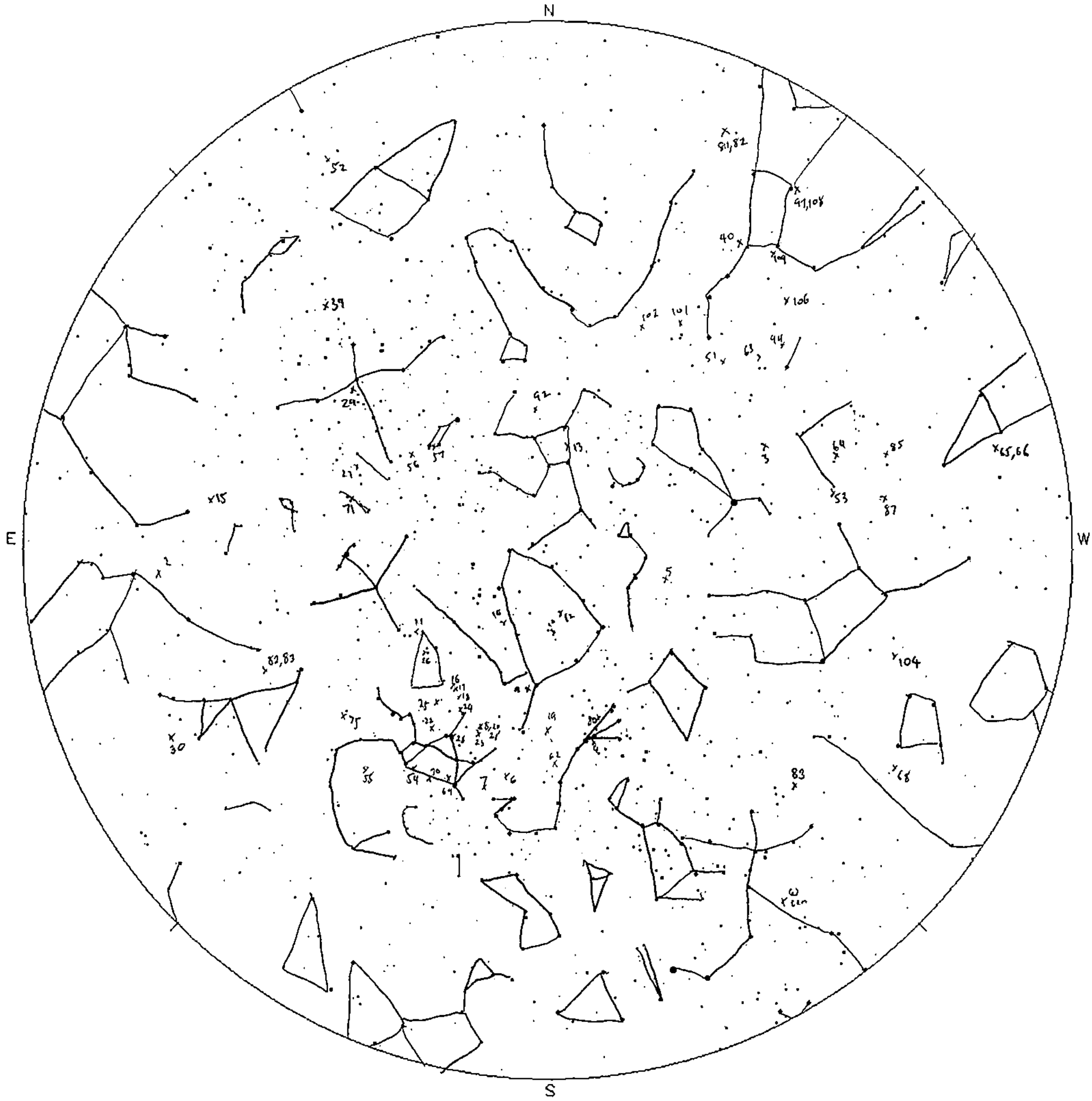
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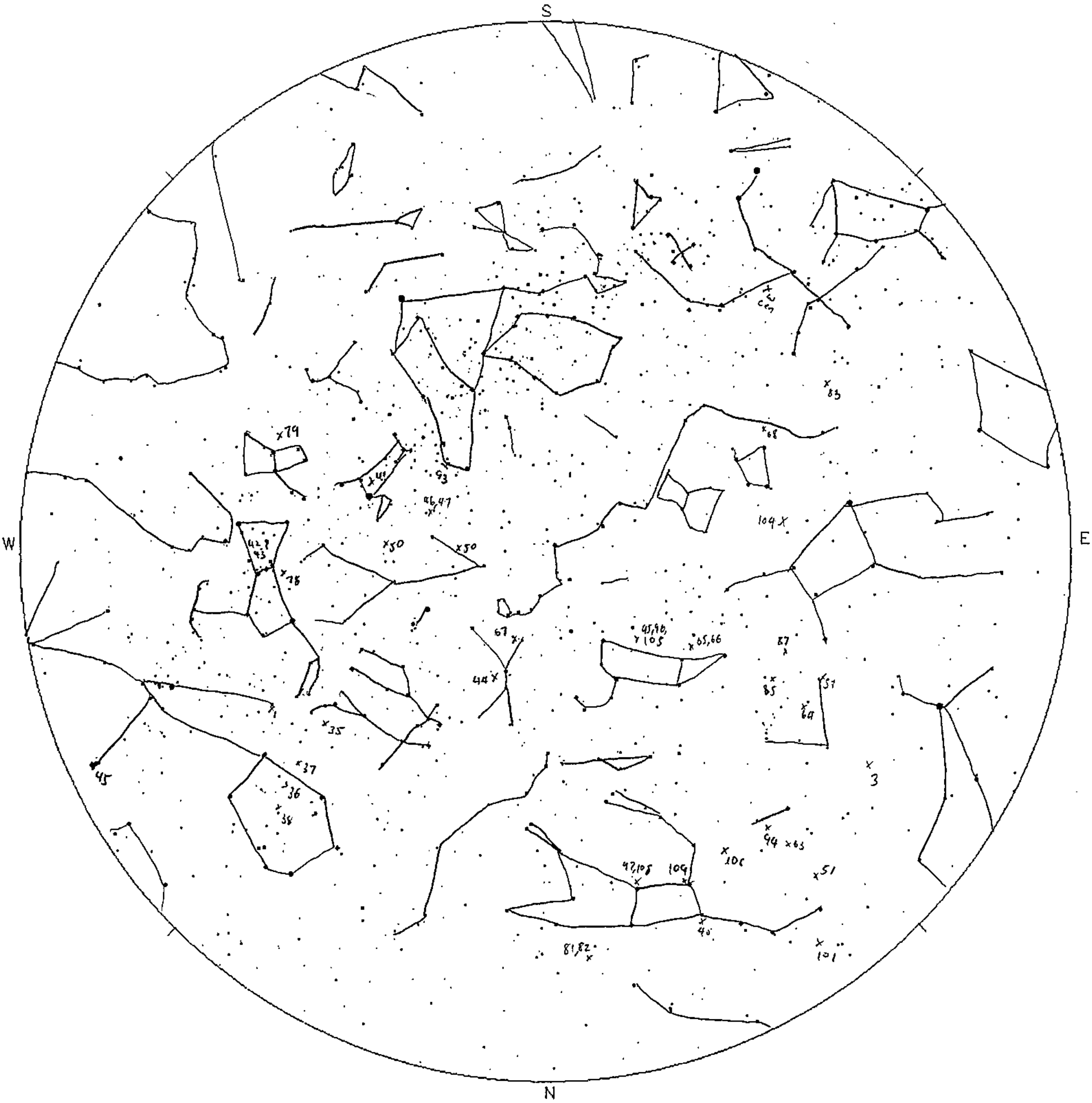
S
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x50
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x78
ω Cen
x83
x68
109x
67
44x
45,46, 105
x65,66
87
85
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x106
x51
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81,82
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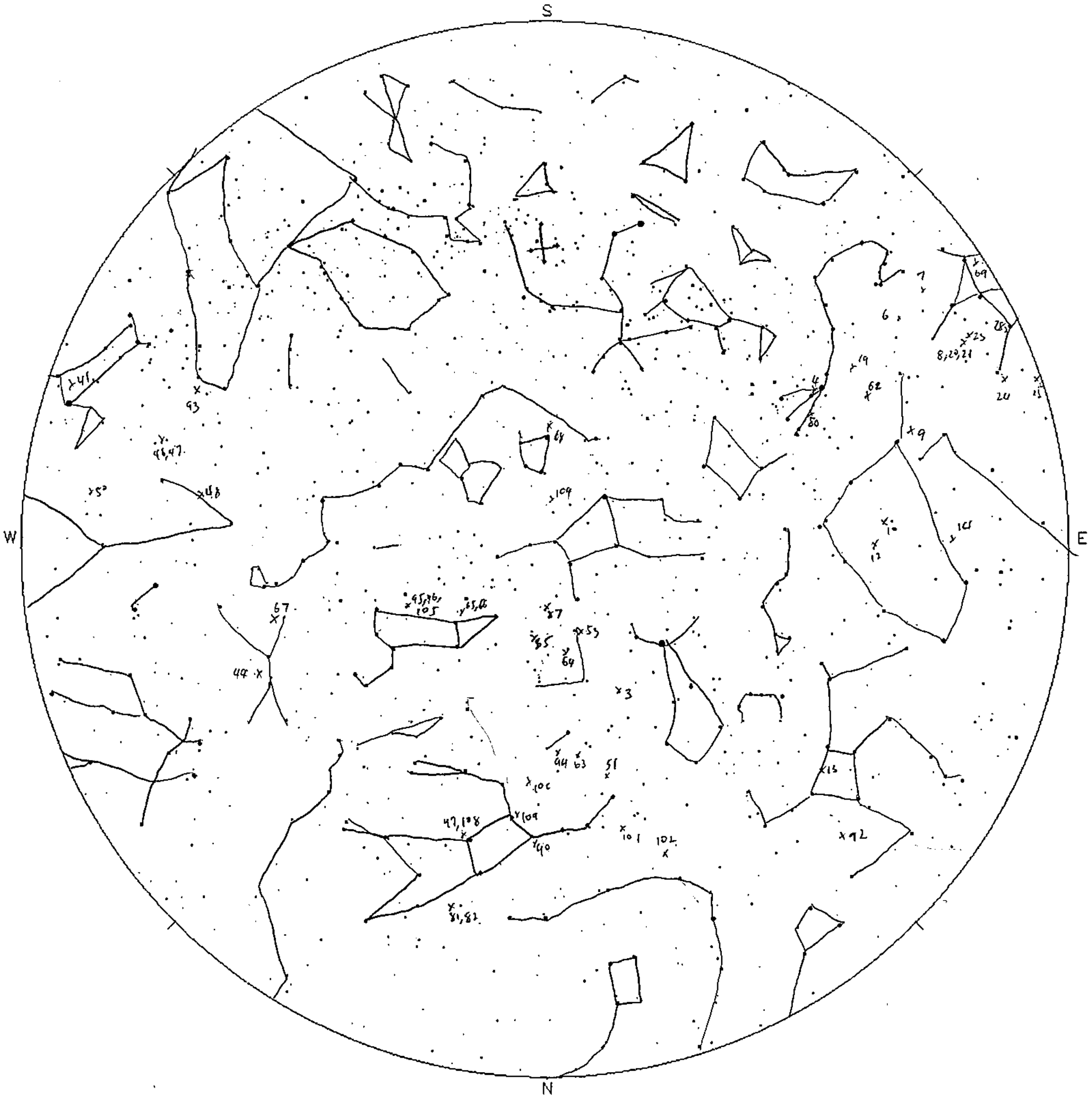
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95,96,105
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87
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94
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47,108
109
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81,82


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76
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31, 32, 110
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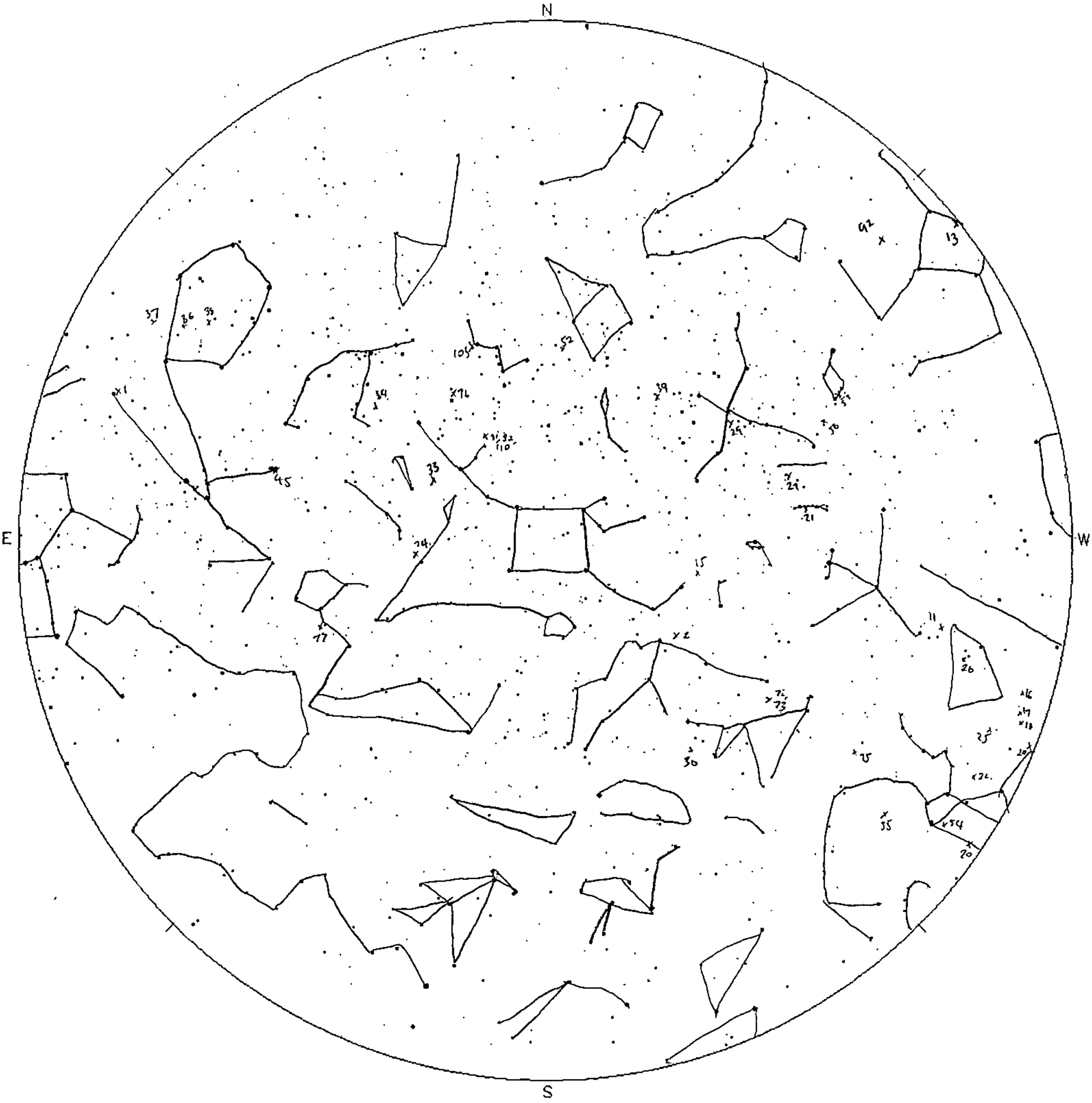

Cl	H_2O	NH_3
green	blue	orange
red	orange	blue

$$\frac{1}{\text{upper T}} - \frac{1}{\text{most T}}$$


S
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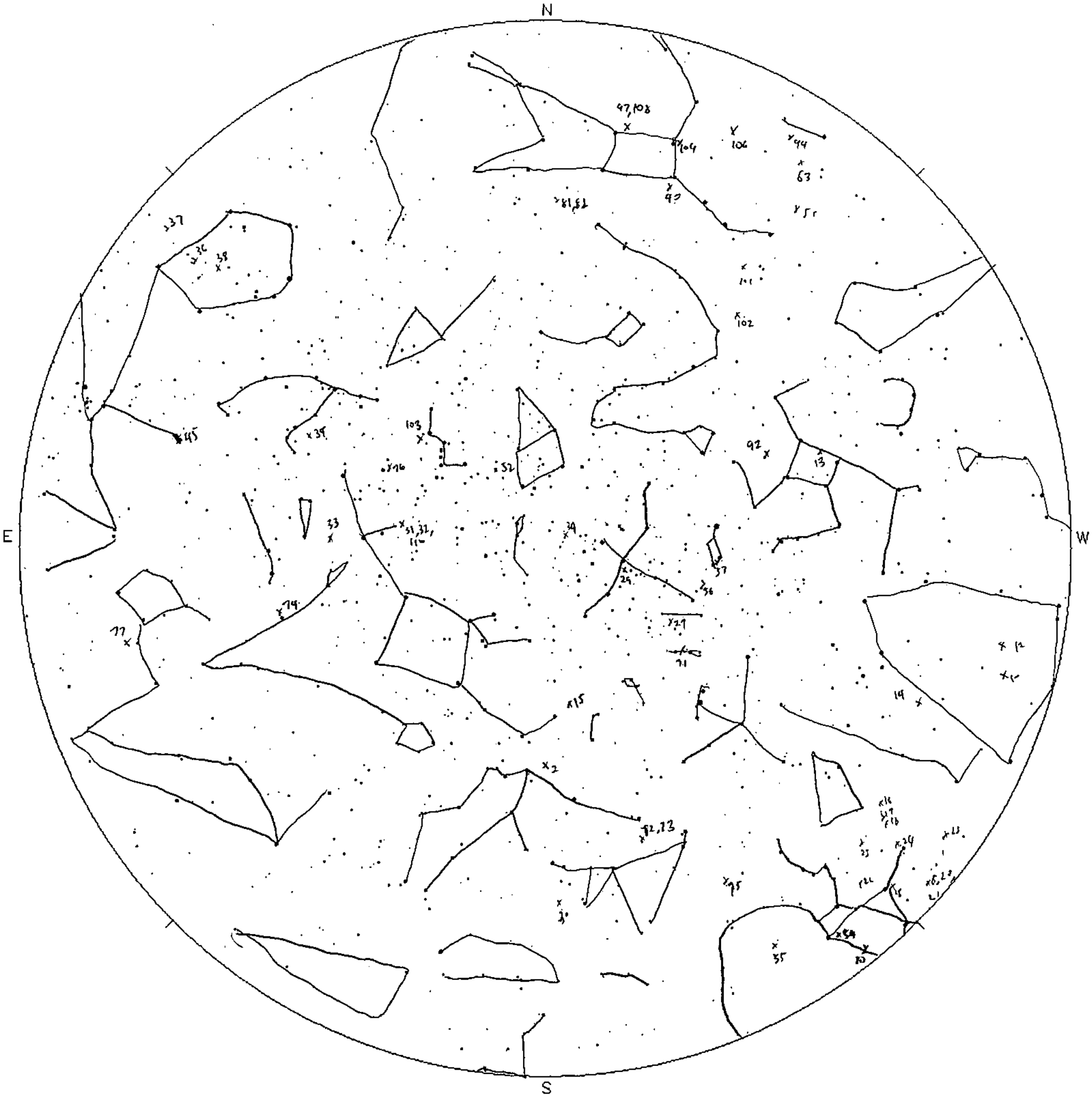
N
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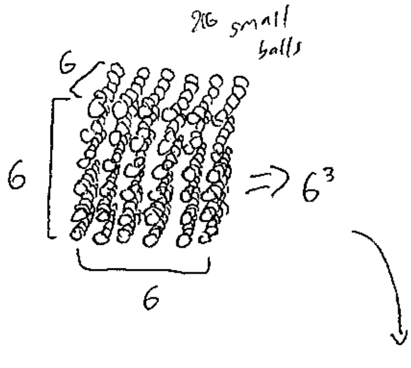
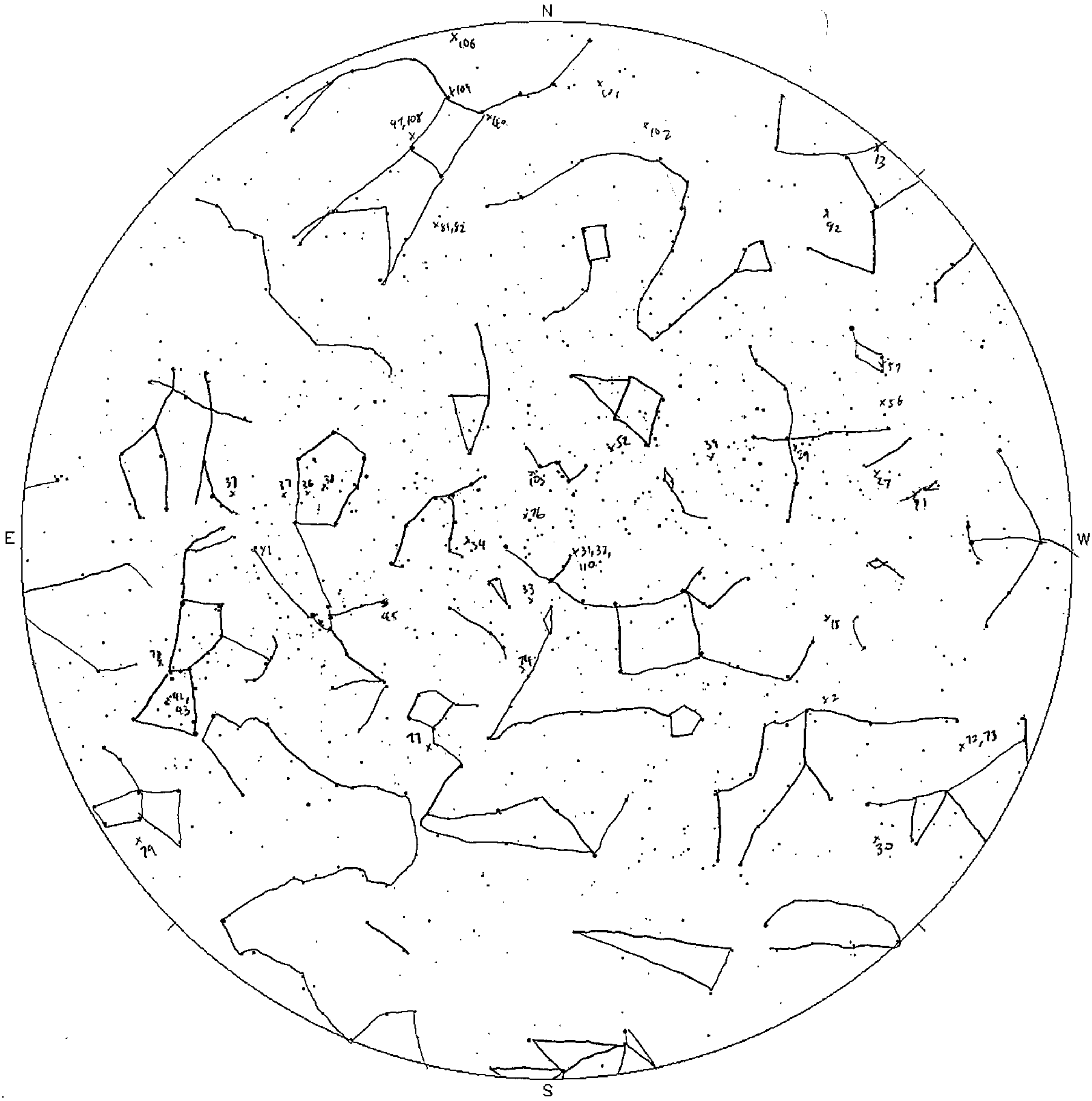

216 small balls
6
6
6
⇒ 6³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76
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110
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33
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74
78
42,
43
77
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x6
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x7
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22
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55
75
W
92
73
x30
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x93
E
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x
x50
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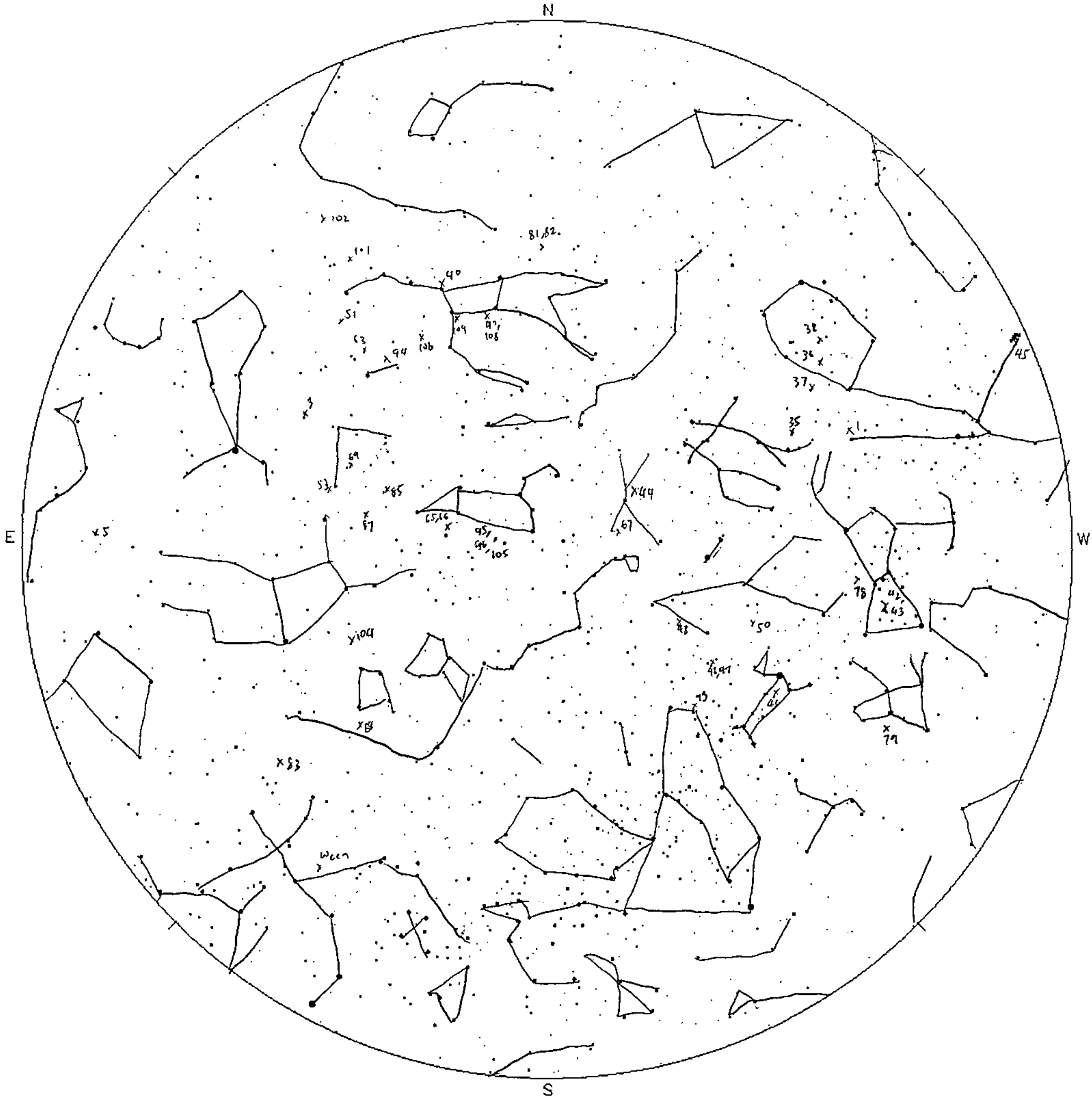
x
74
43
x77
x
14
85
N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x109
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x3
69
53
x85
x87
65,66
95,96,105
x44
x67
38
36
37
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x43
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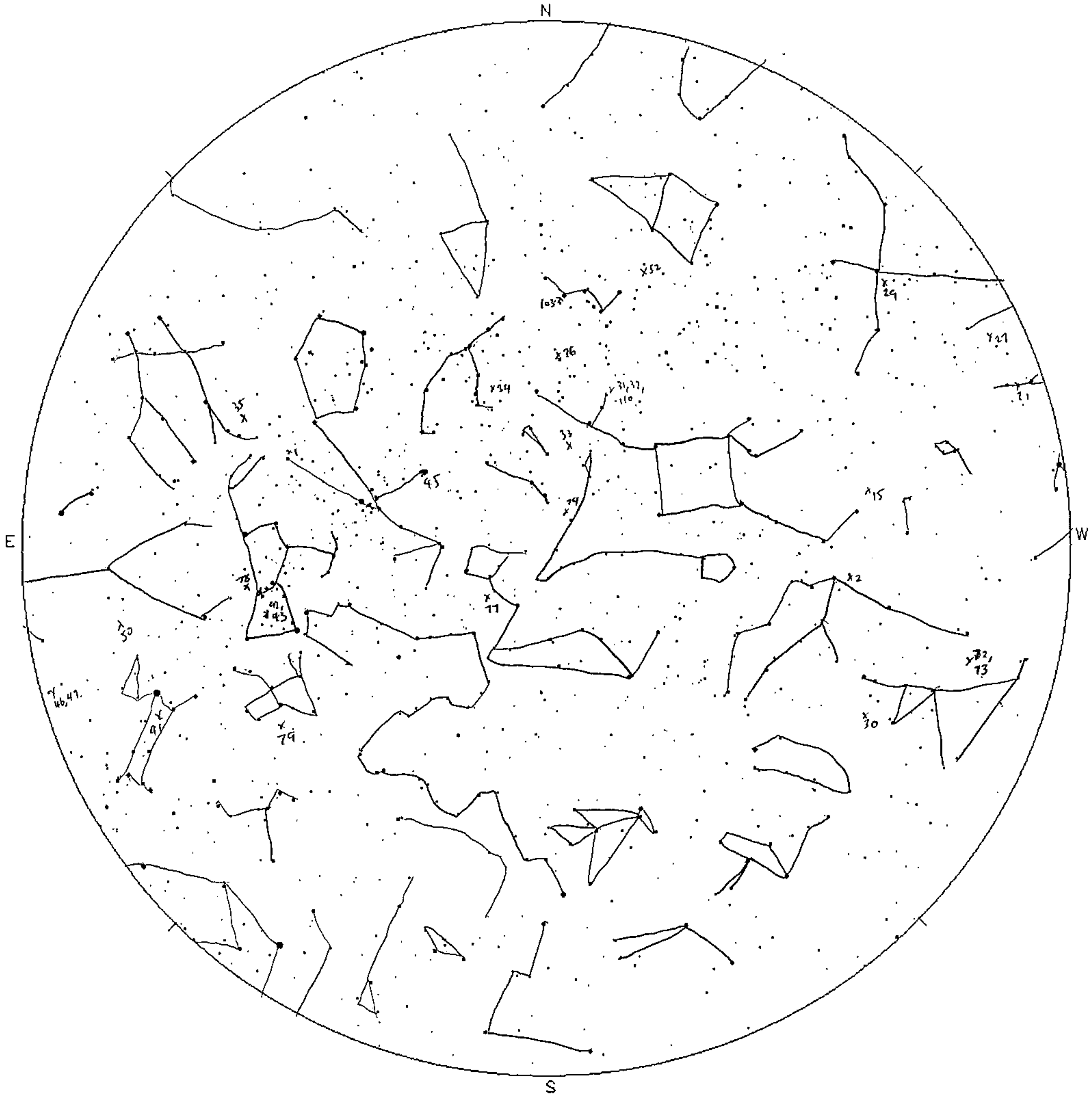
x50
41,47
73
46
x79
x104
x18
x83
x5
Moon


N
x52
1037
x26
x34
35 x
x1
45
33 x
x31,32,110
x29
Y27
x1
x15
E
W
78 x
40,43
x77
x74
x2
x32,73
x30
30
46,47
91
x79
S


S
x93
x30
W
E
55
73
72, 73
70
69
54
x22
x25
x18
16
15
x11
x14
x10
x12
62
80
9
x6
7
x104
65
83
63 66
x87
x85
64
x53
x3
x5
x13
71
N

13 x 17


N
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W
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71
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79
33
37, 72, 110
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52
18
78
103
34
45
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92
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88
86
87
102
81, 82
101
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104
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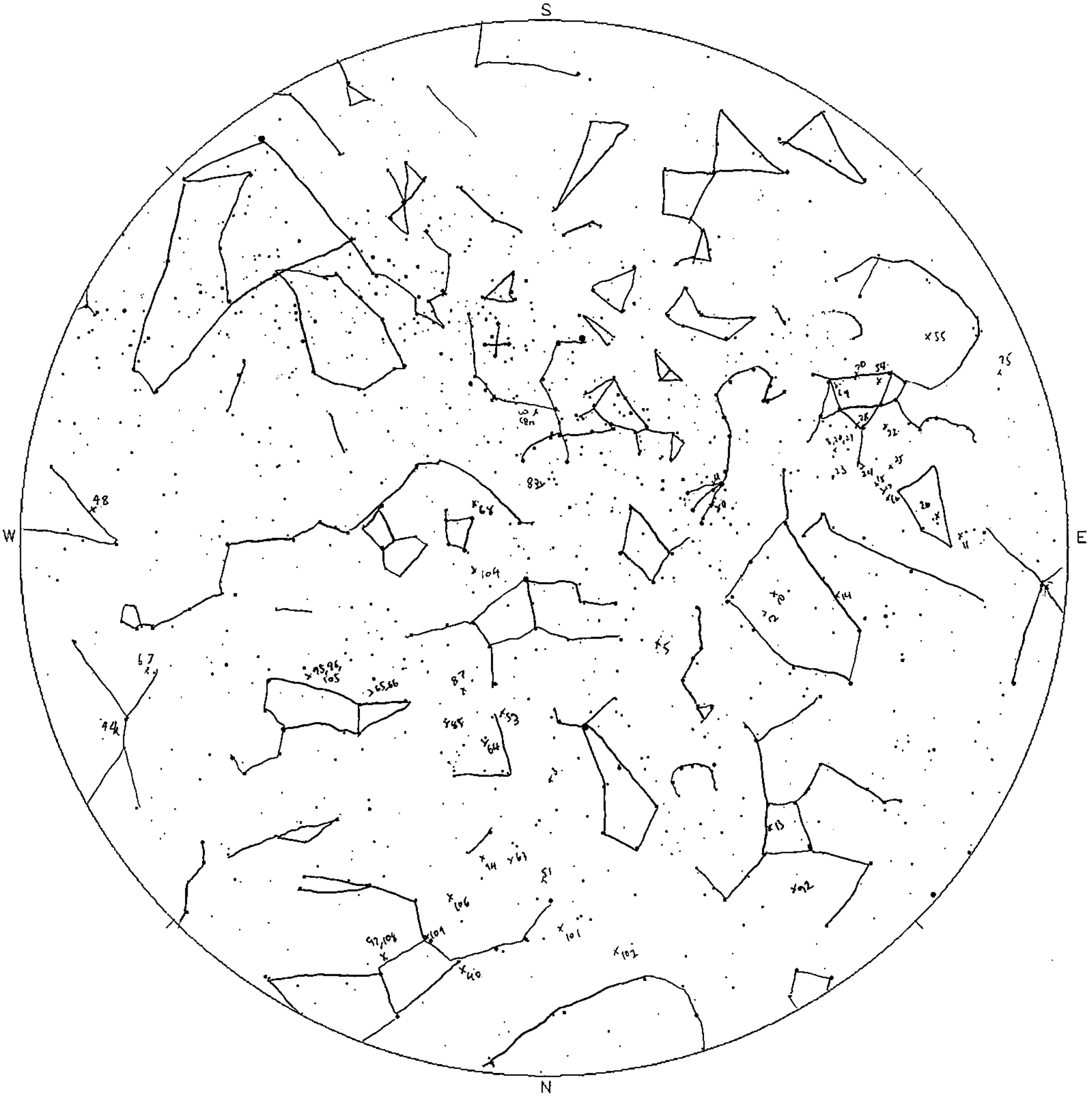
2x3x37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97,108
109
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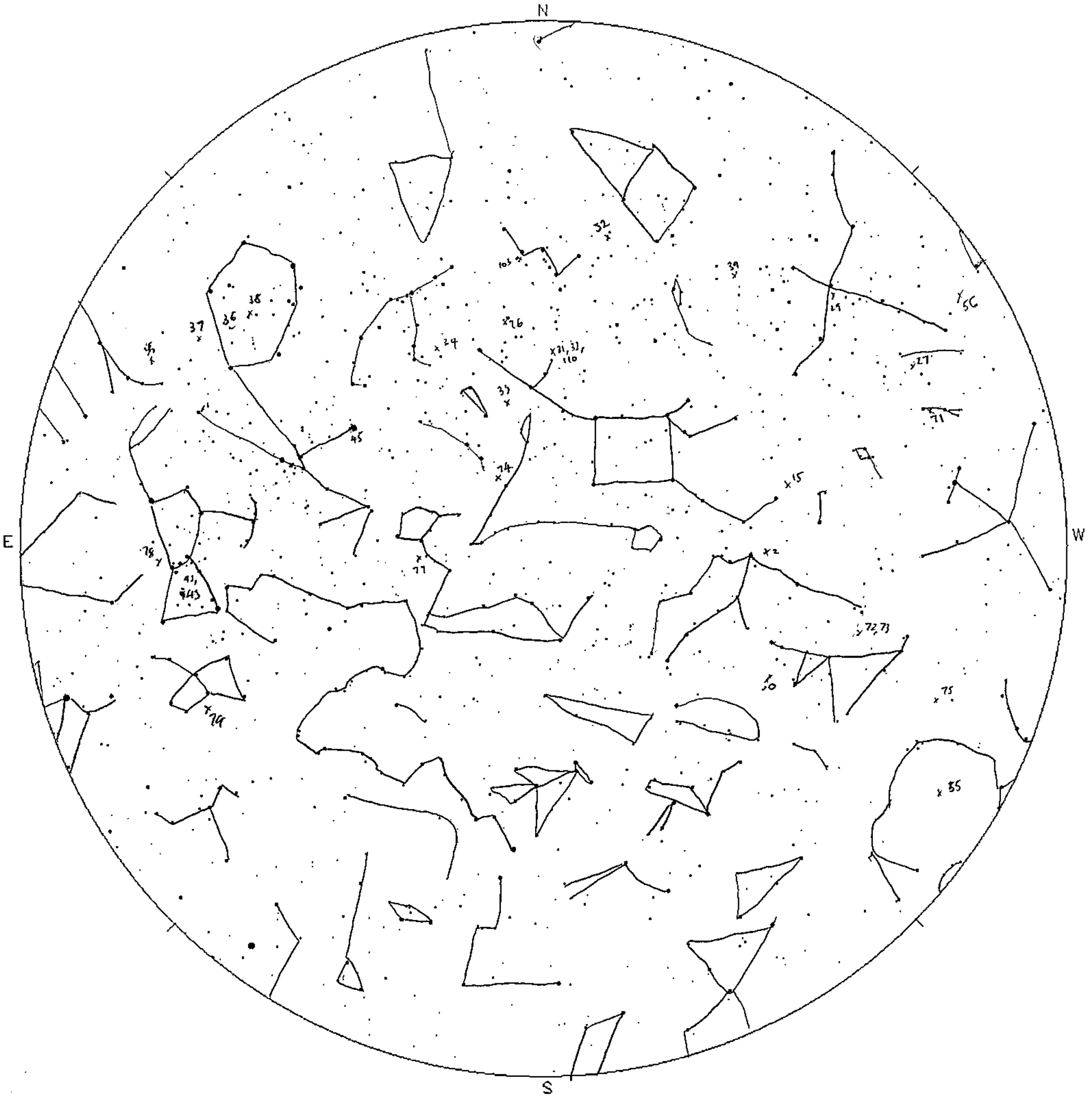
prime!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74
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78
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41, 43
77
72, 73
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S

7×2^5


N
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W
S
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103
79
31, 32, 110
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35
37
36
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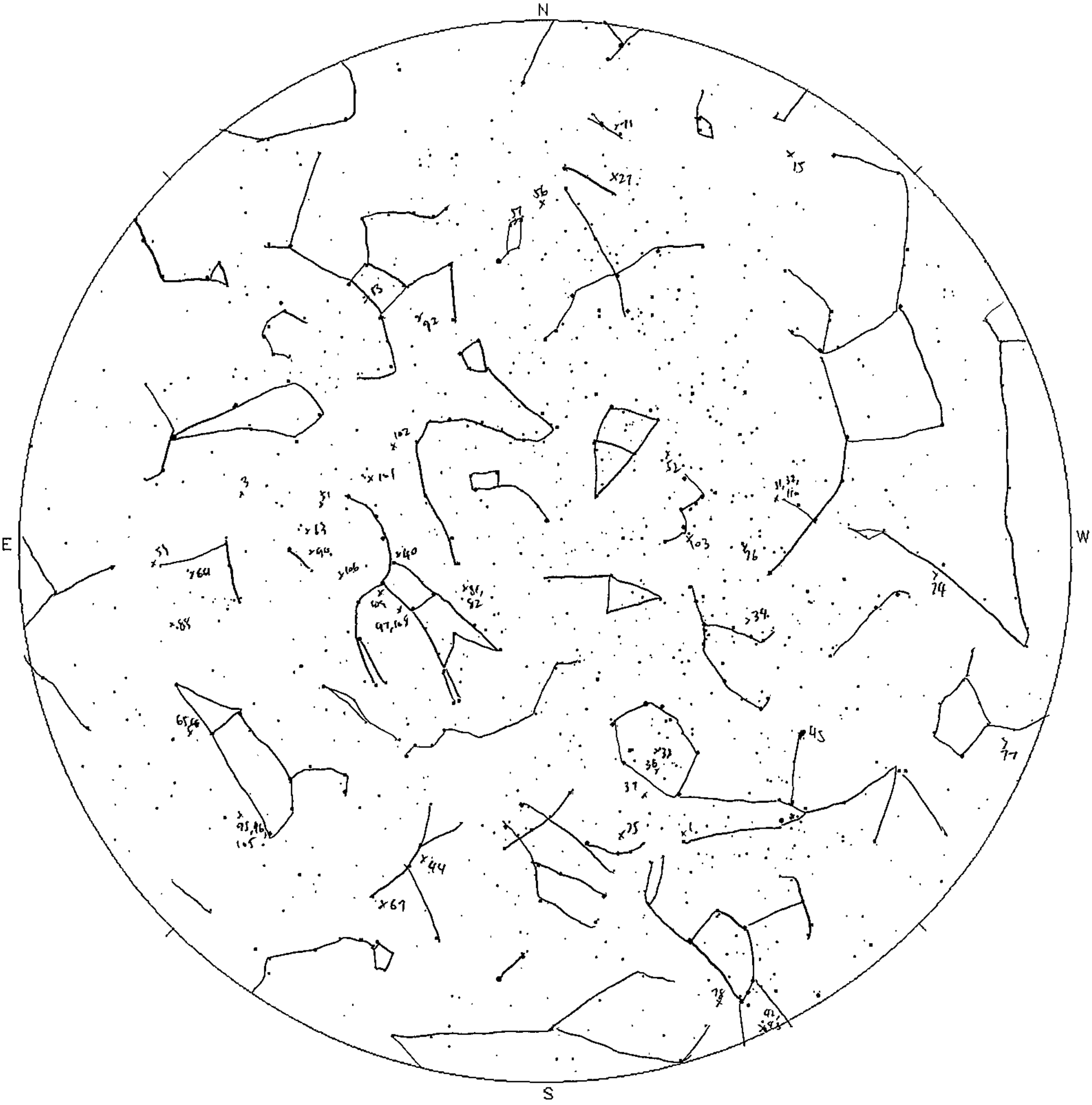
46, 47
41
79
50

$3^2 \times 5^2$


N
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63
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81, 82
97, 109
34
52
31, 32, 110
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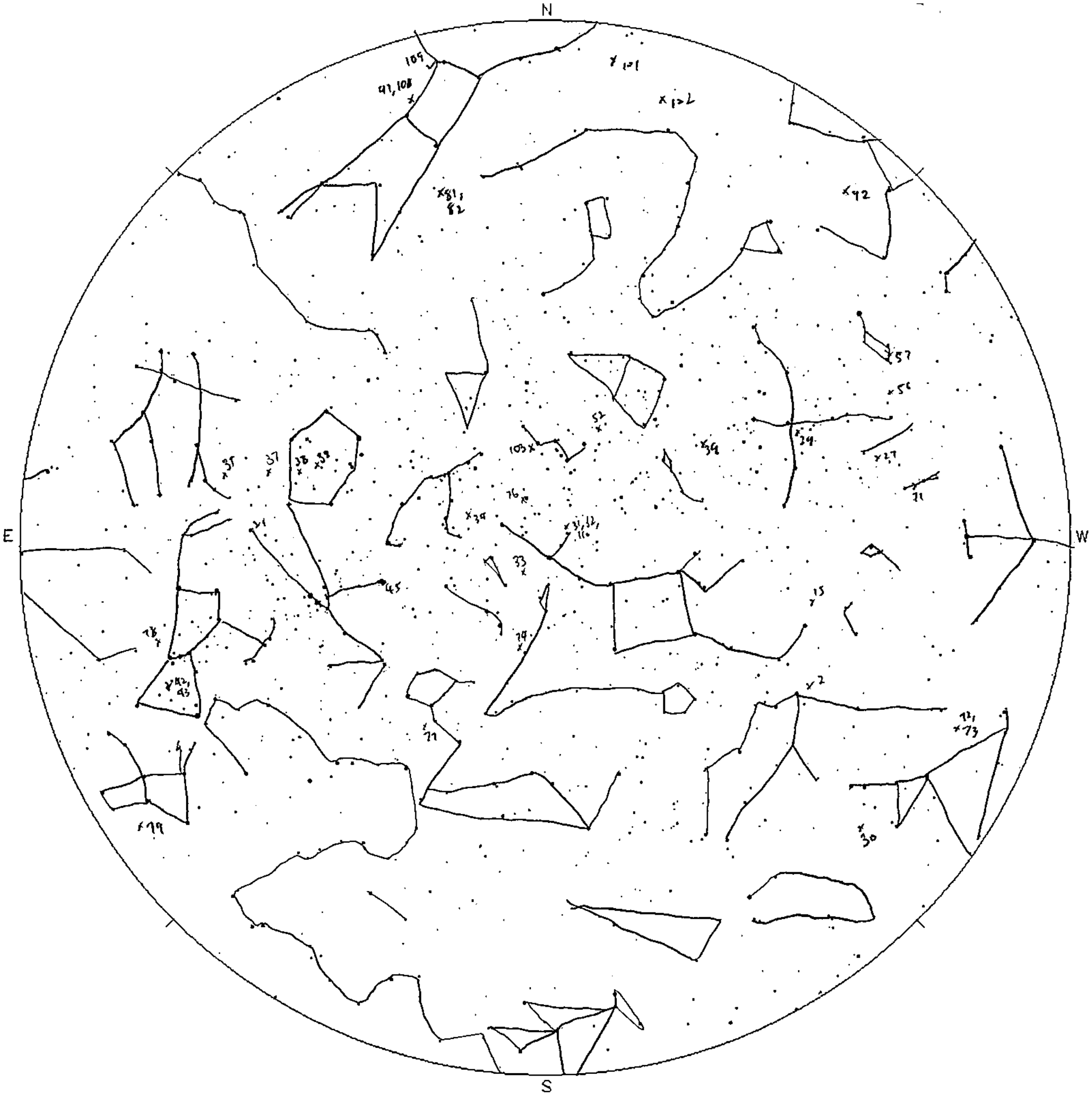
67
78
47, 83

2/17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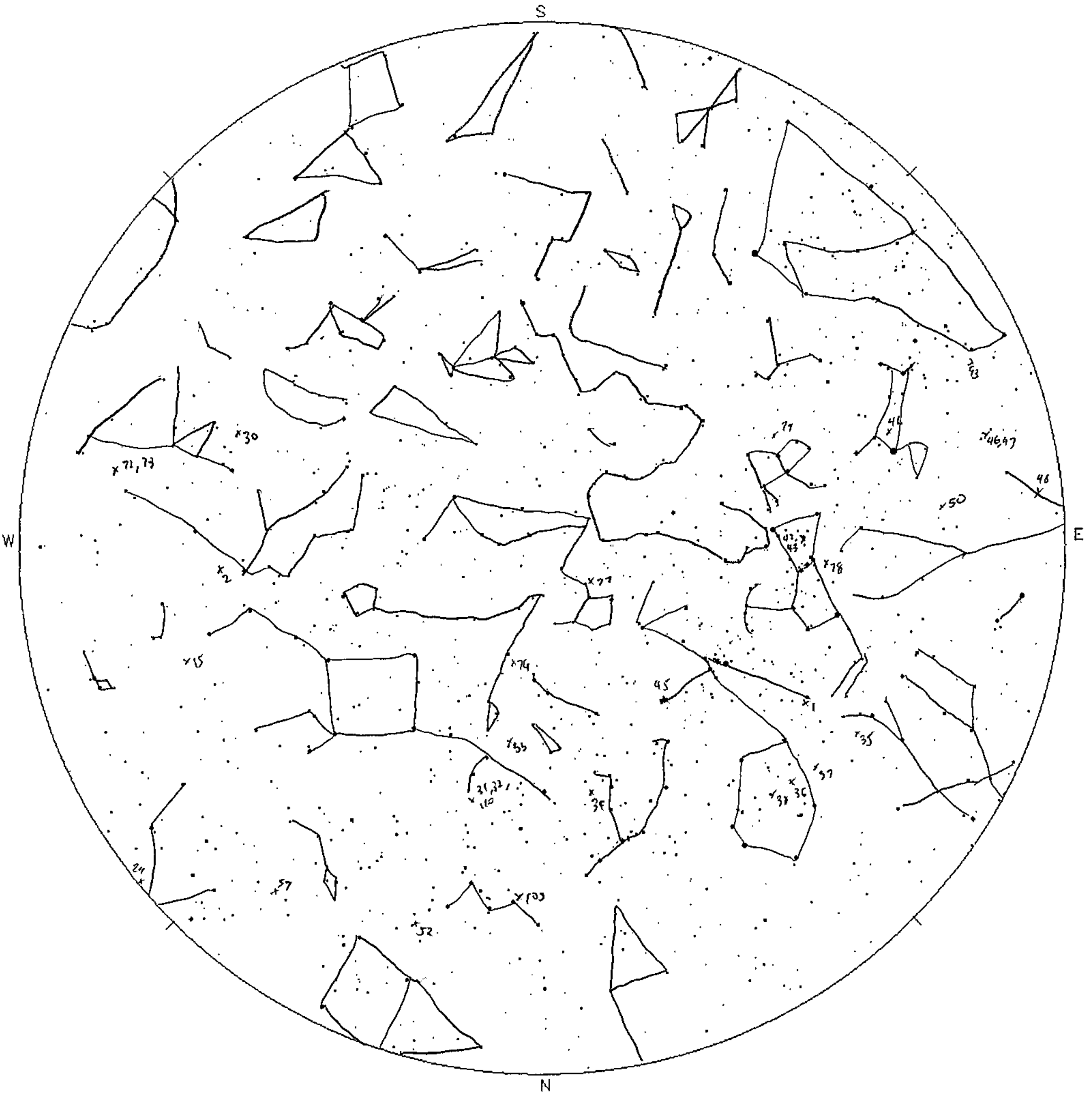
S
W
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N
x30
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x2
x15
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x52
x103
x31, 32
x110
x33
x74
x77
45
x38
x1
42, 43
x78
x71
48
x53
x46,47
46
x50
x35
x37
x38
36


N
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74
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76
103
31, 32, 40
52
81, 88
97, 108
107
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90
121
101
51
95, 98, 105
65, 66
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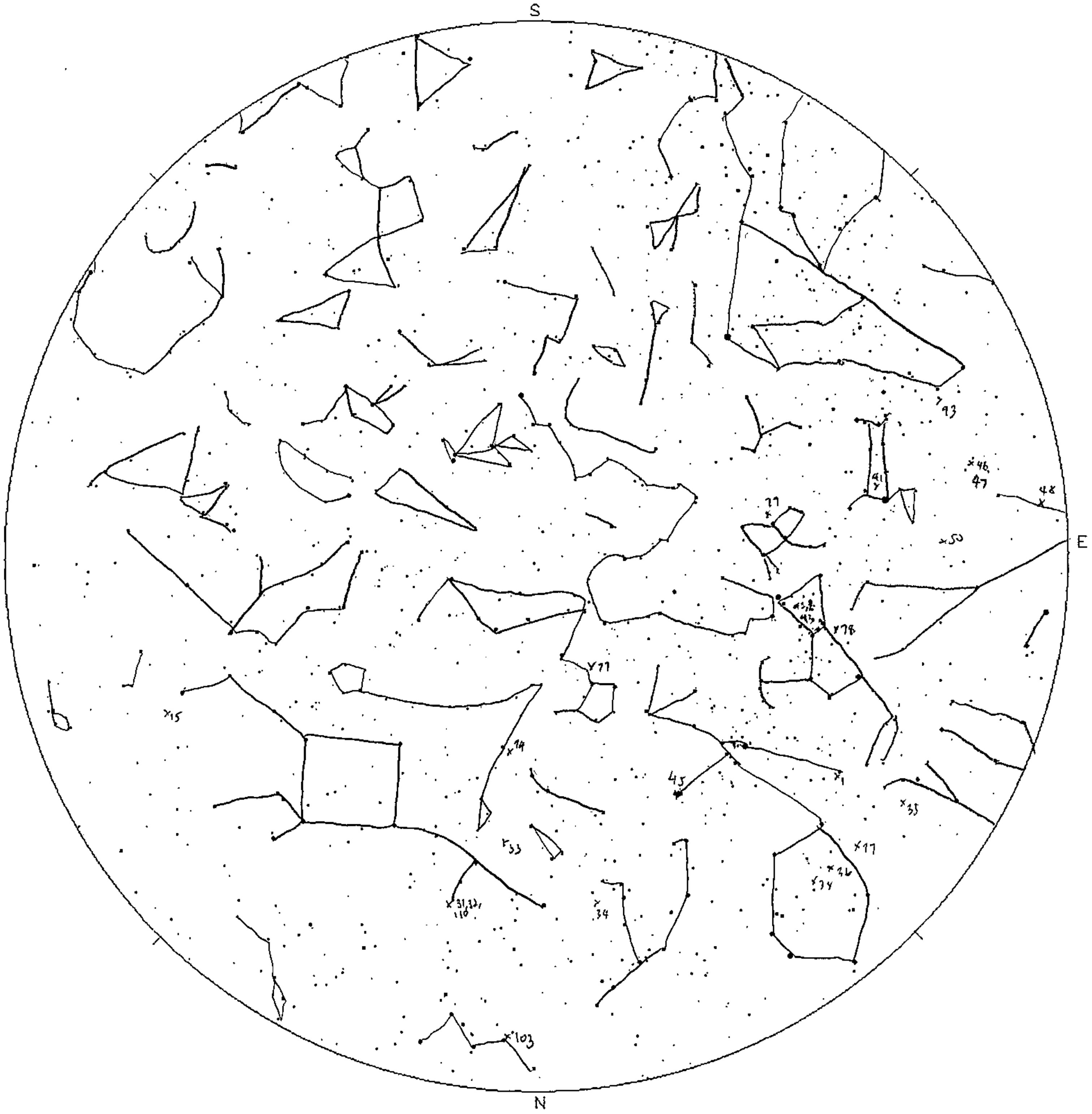
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110
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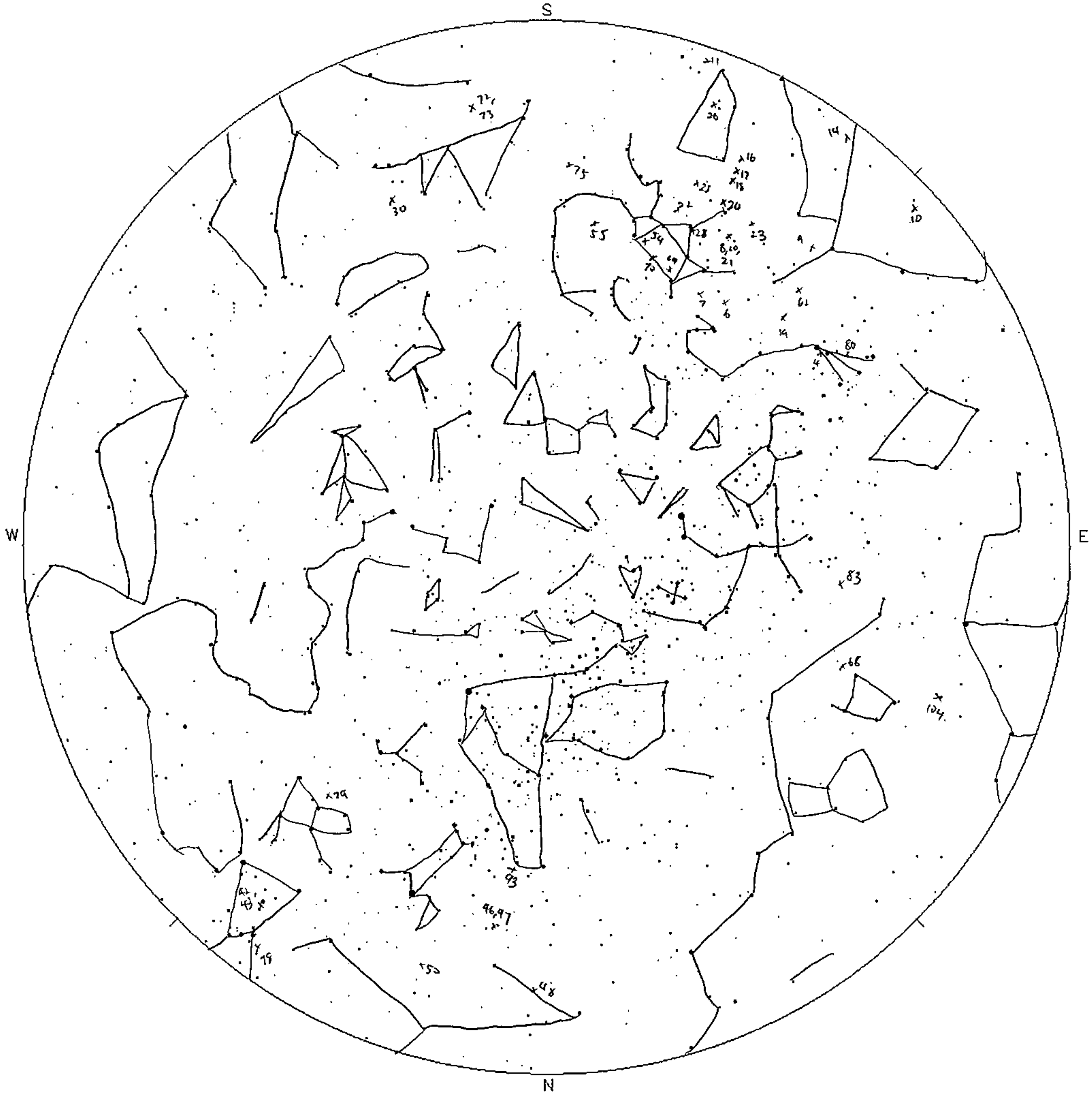
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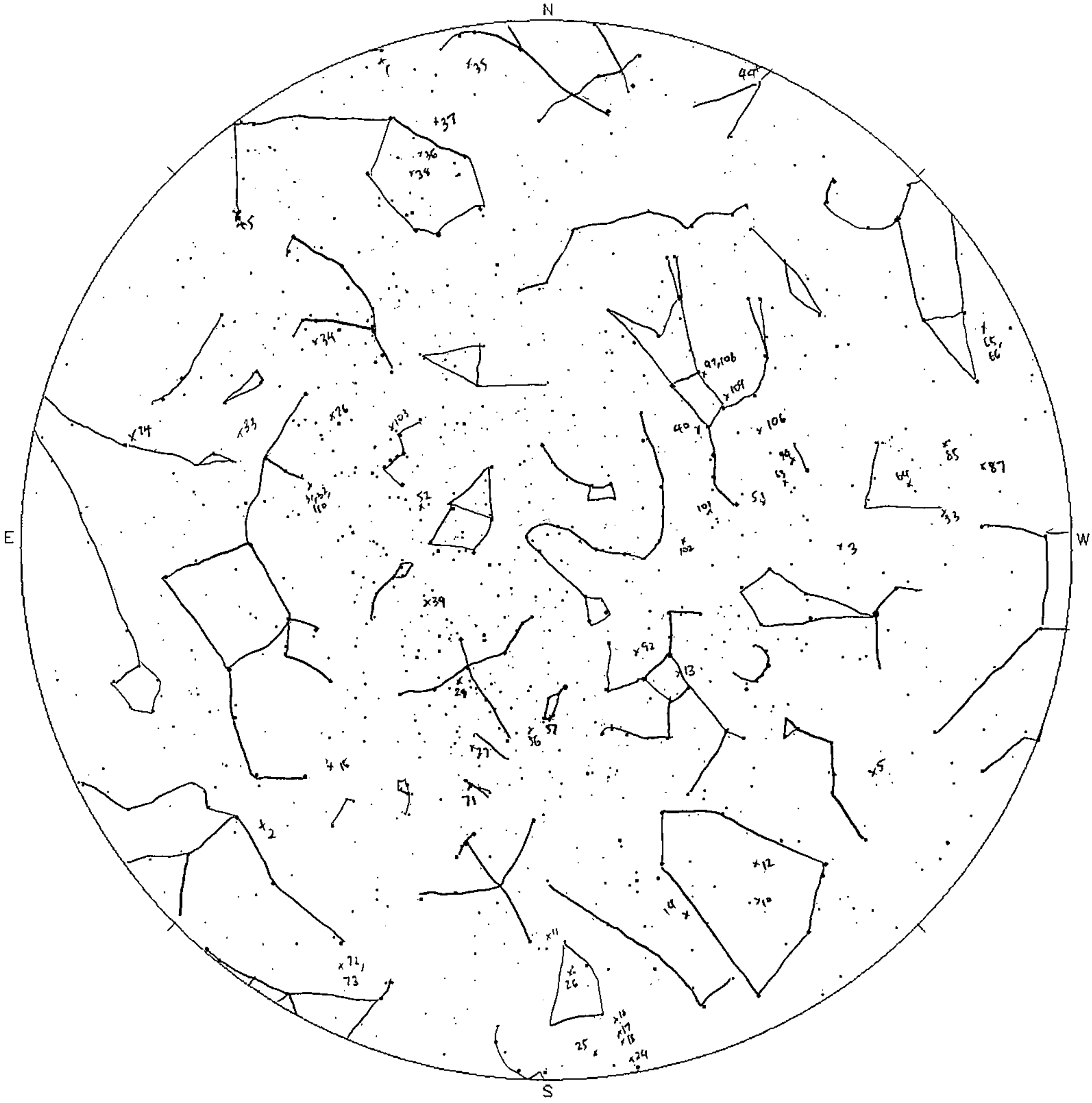
N
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103
31,32,110
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65, 66
97,108
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64
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53
101
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72, 73
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108
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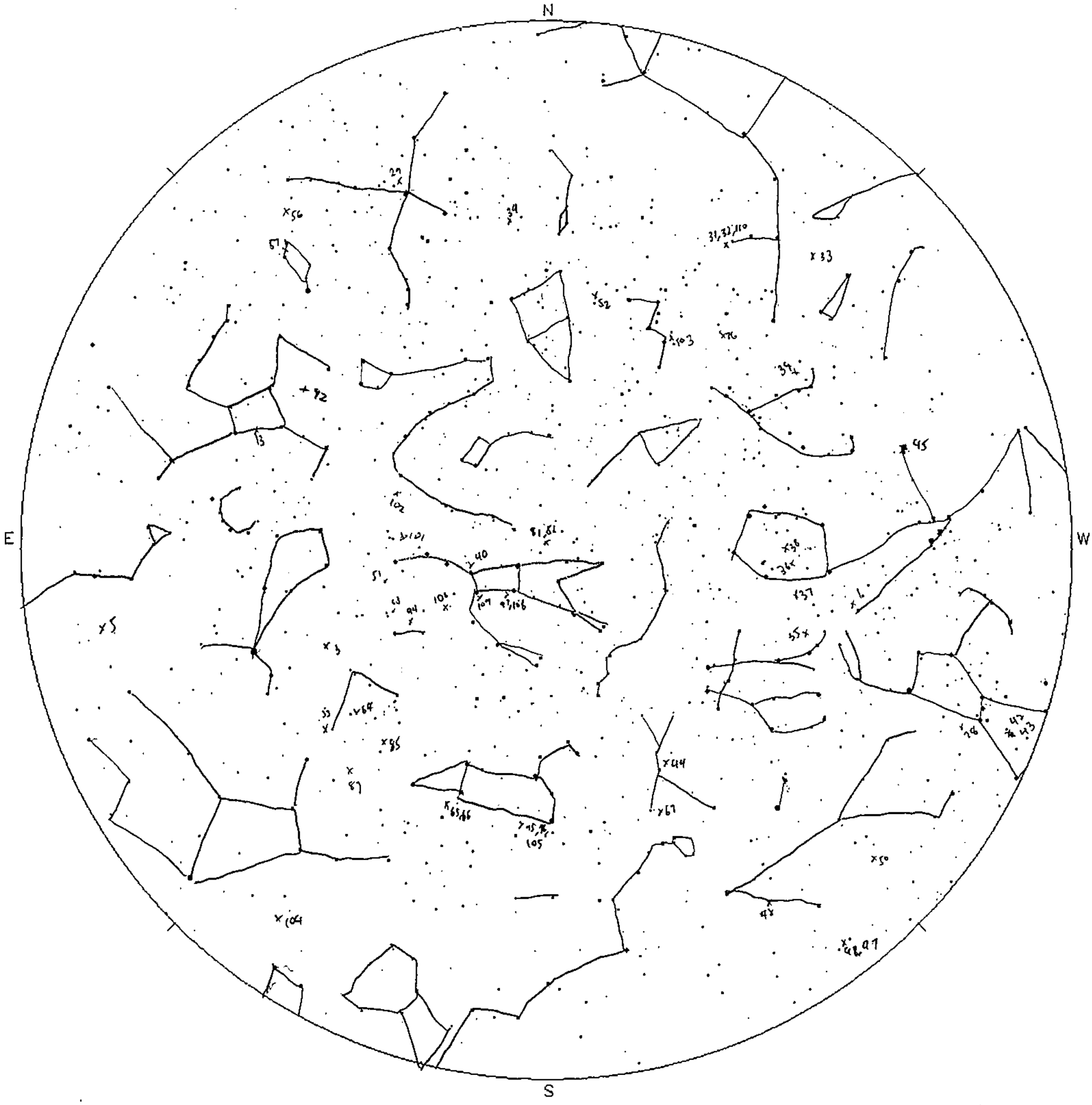
N
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29
x56
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31,32,110
x33
52
103
x76
39
x82
13
102
101
81,82
x40
51
63
94
108
109
43,106
x5
x3
38
36x
37
x1
35x
45
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64
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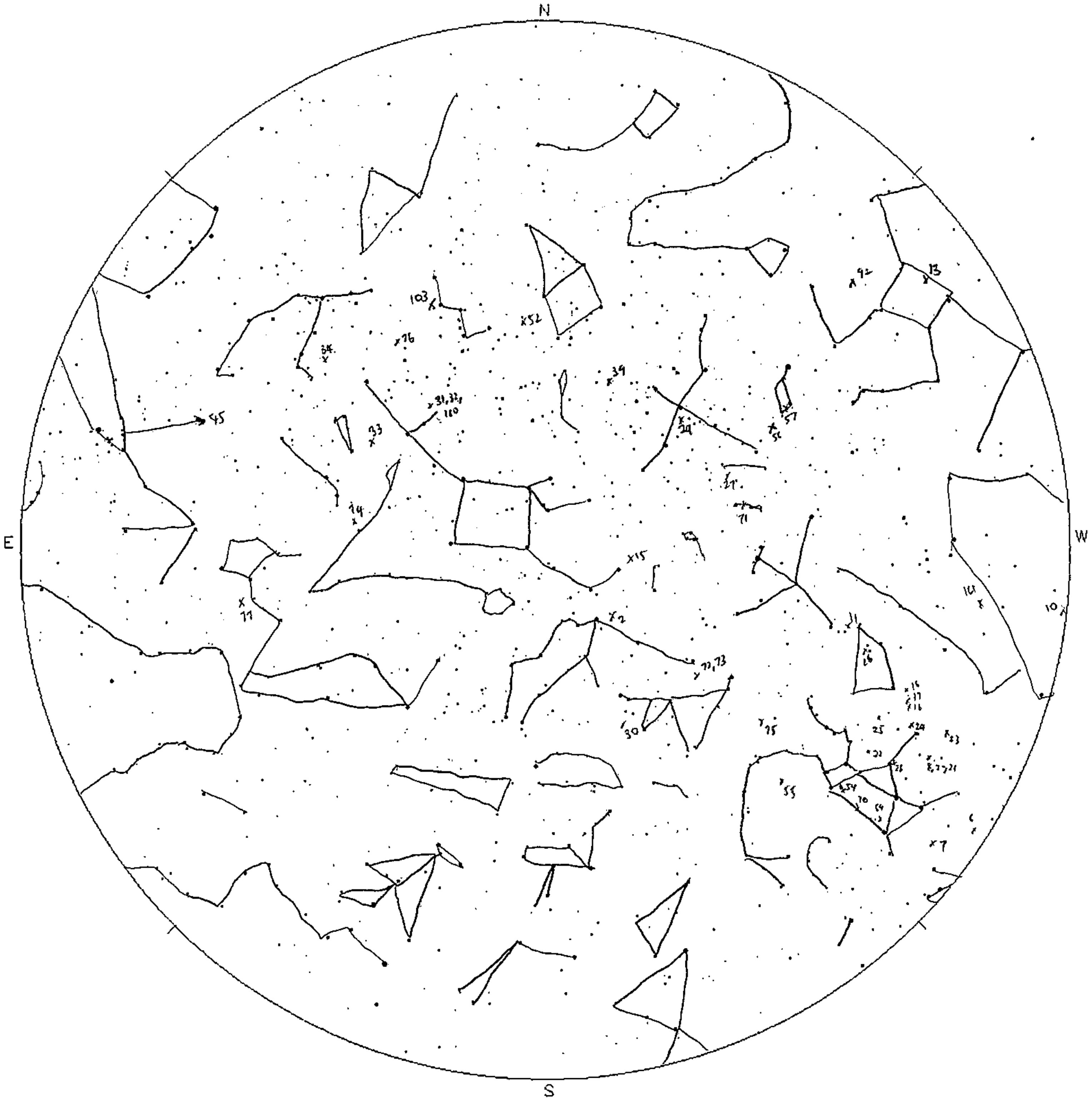
87
x44
x67
65,66
45,46
105
76
47
43
x50
48
48,97
x104


N
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x76
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x31,32,
100
x39
29
57
56
92
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21
71
x15
x2
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x72,73
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64
x7
101
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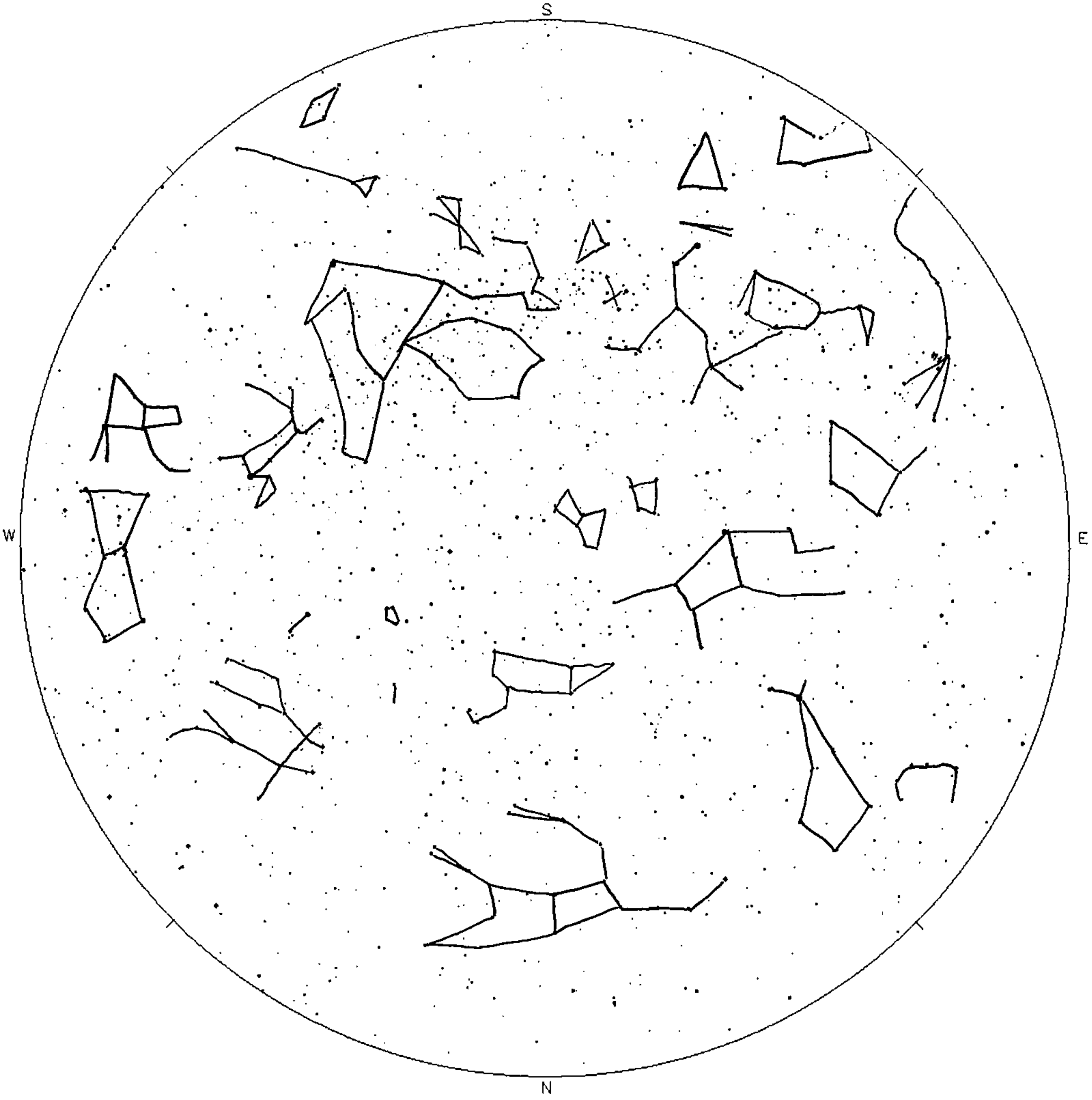
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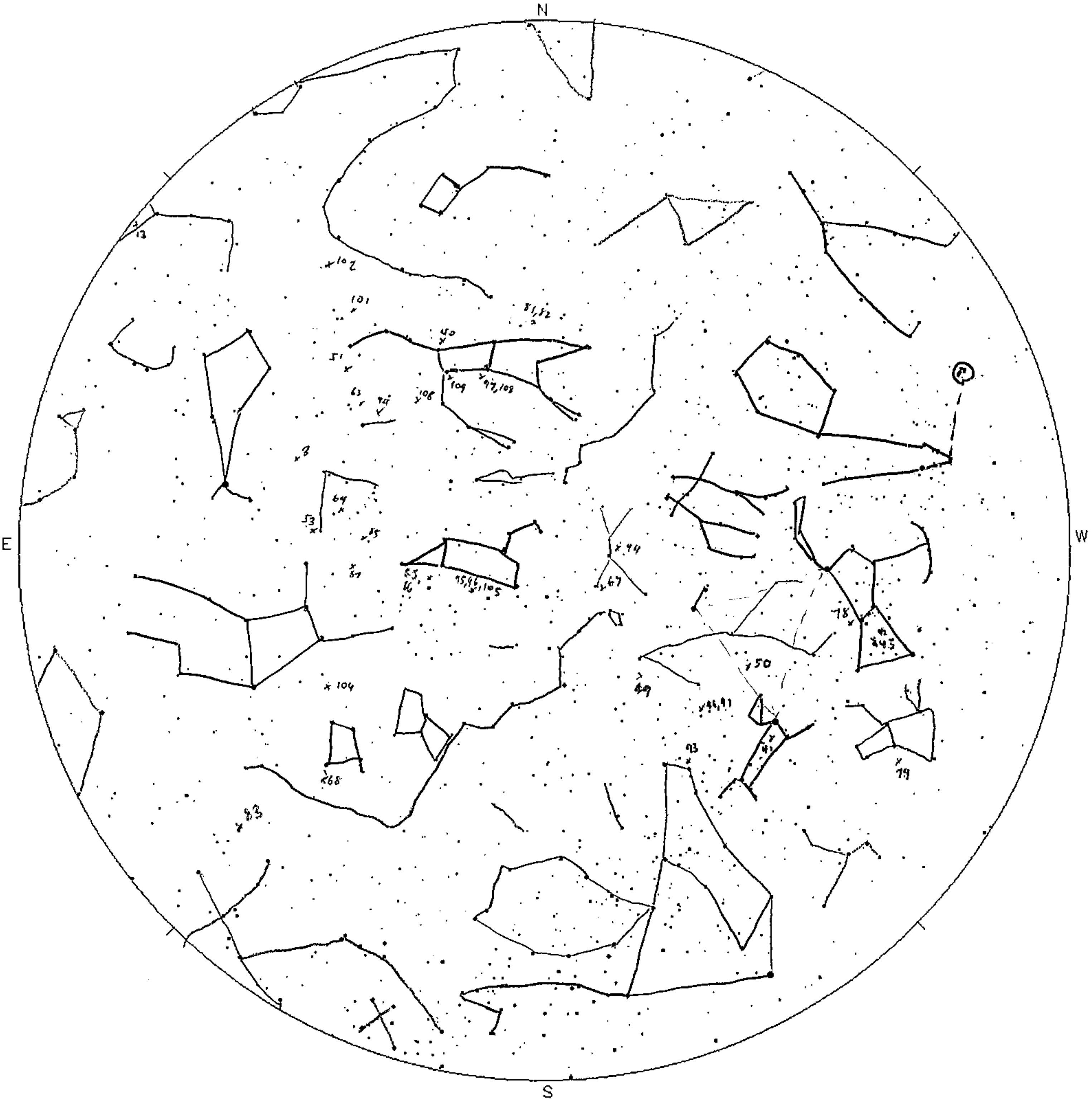
N
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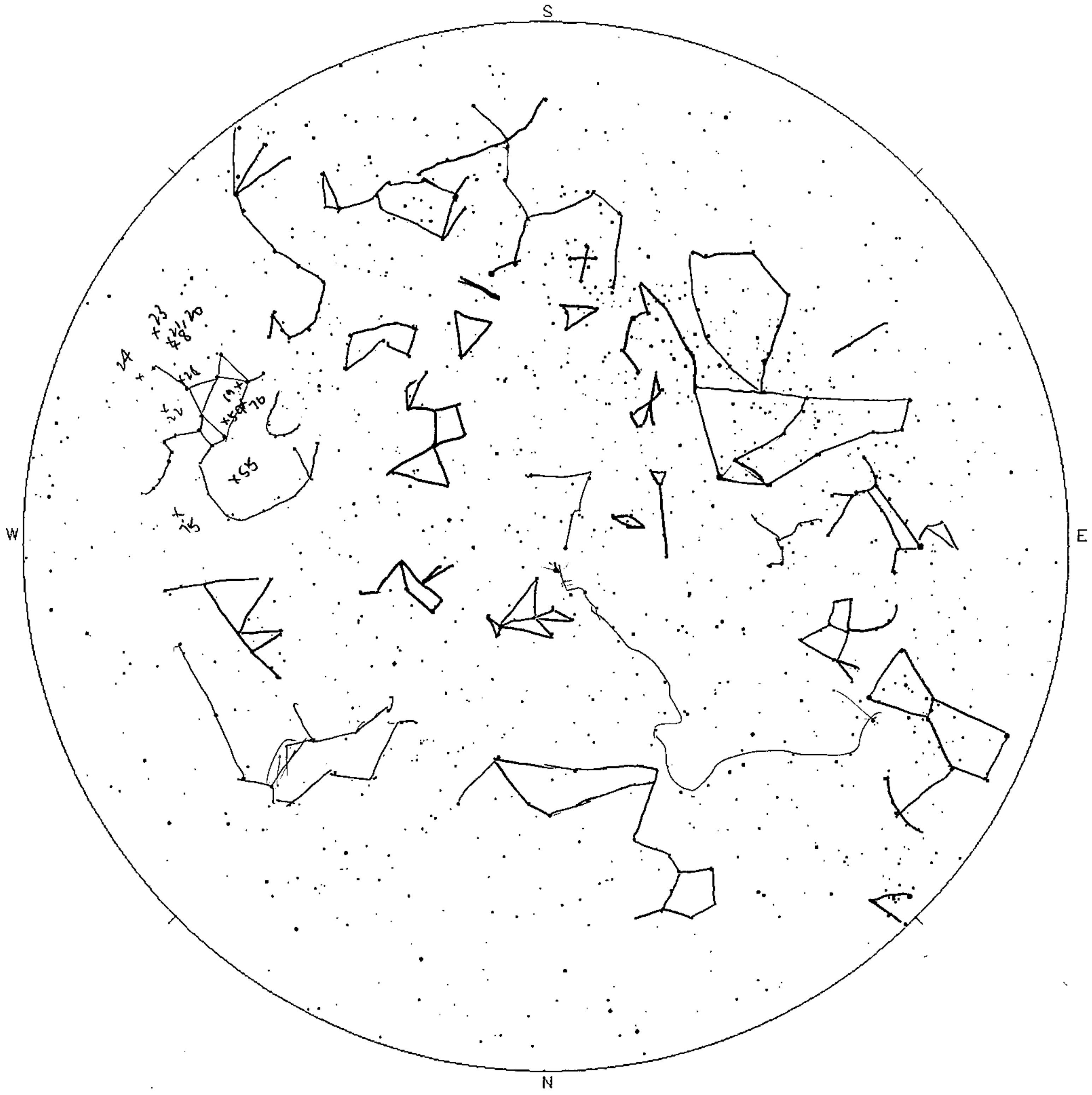
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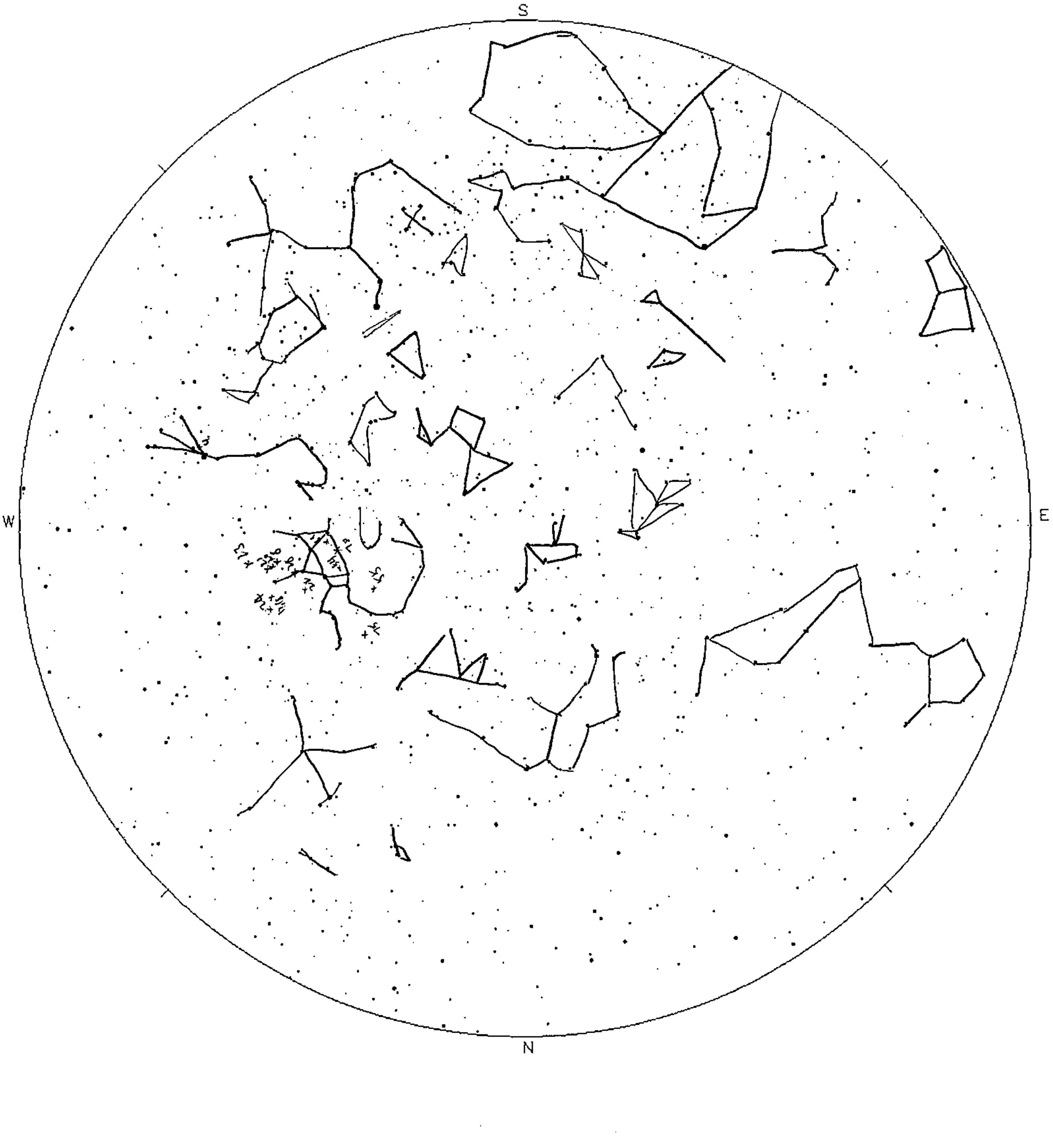
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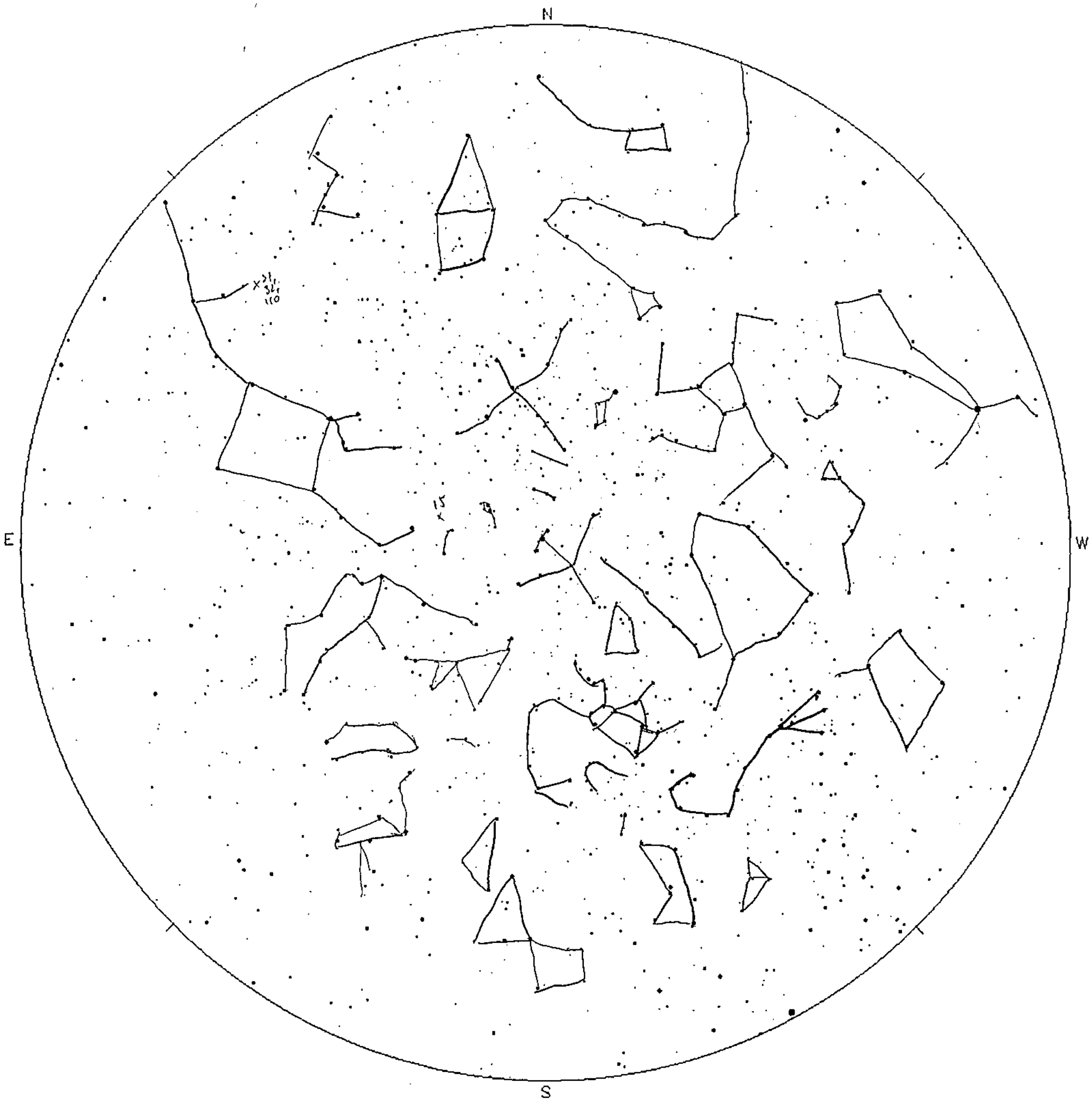
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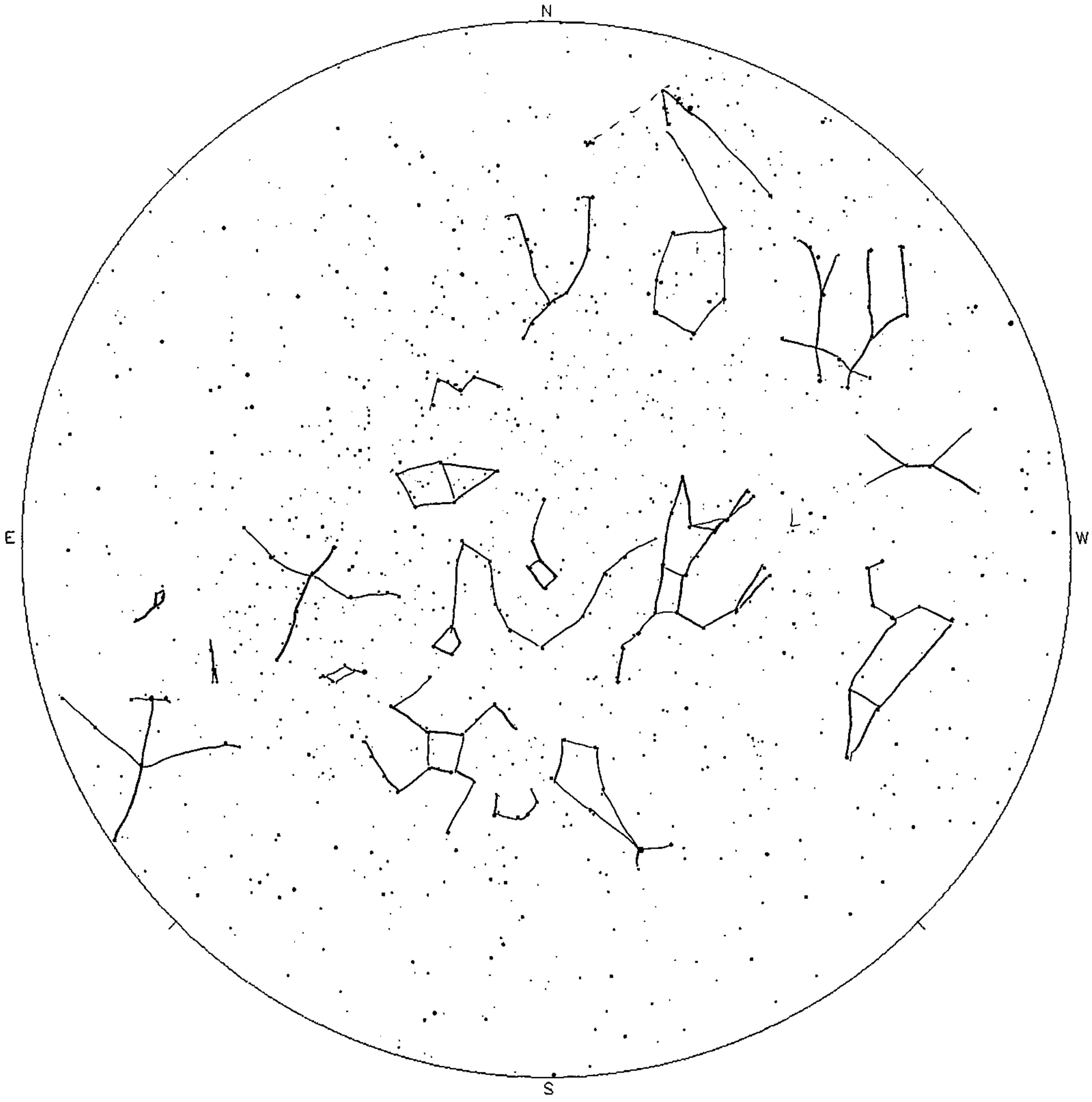
110
15
x


S
W
E
N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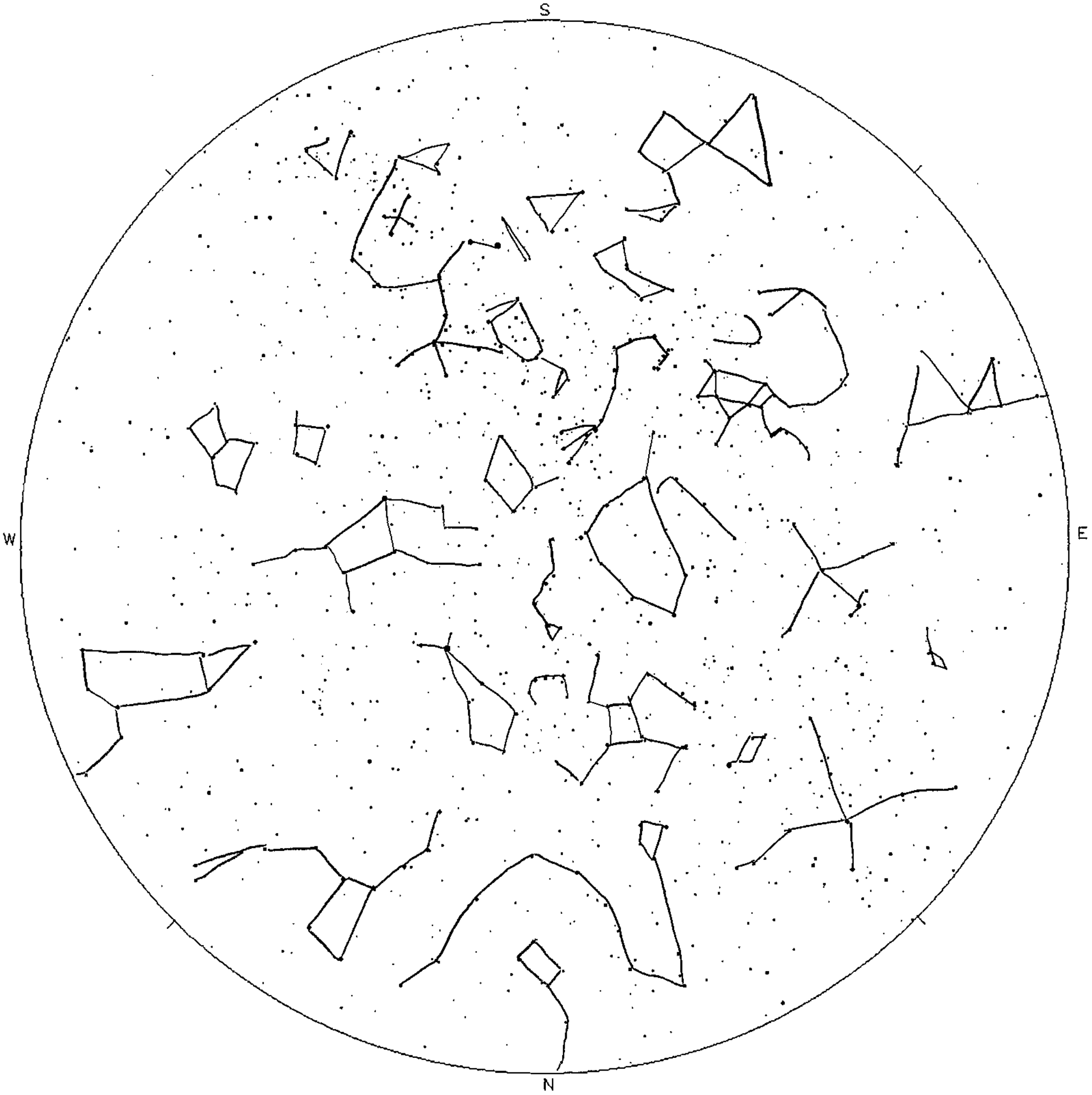
S
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N
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87,84
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88,
X109
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X83
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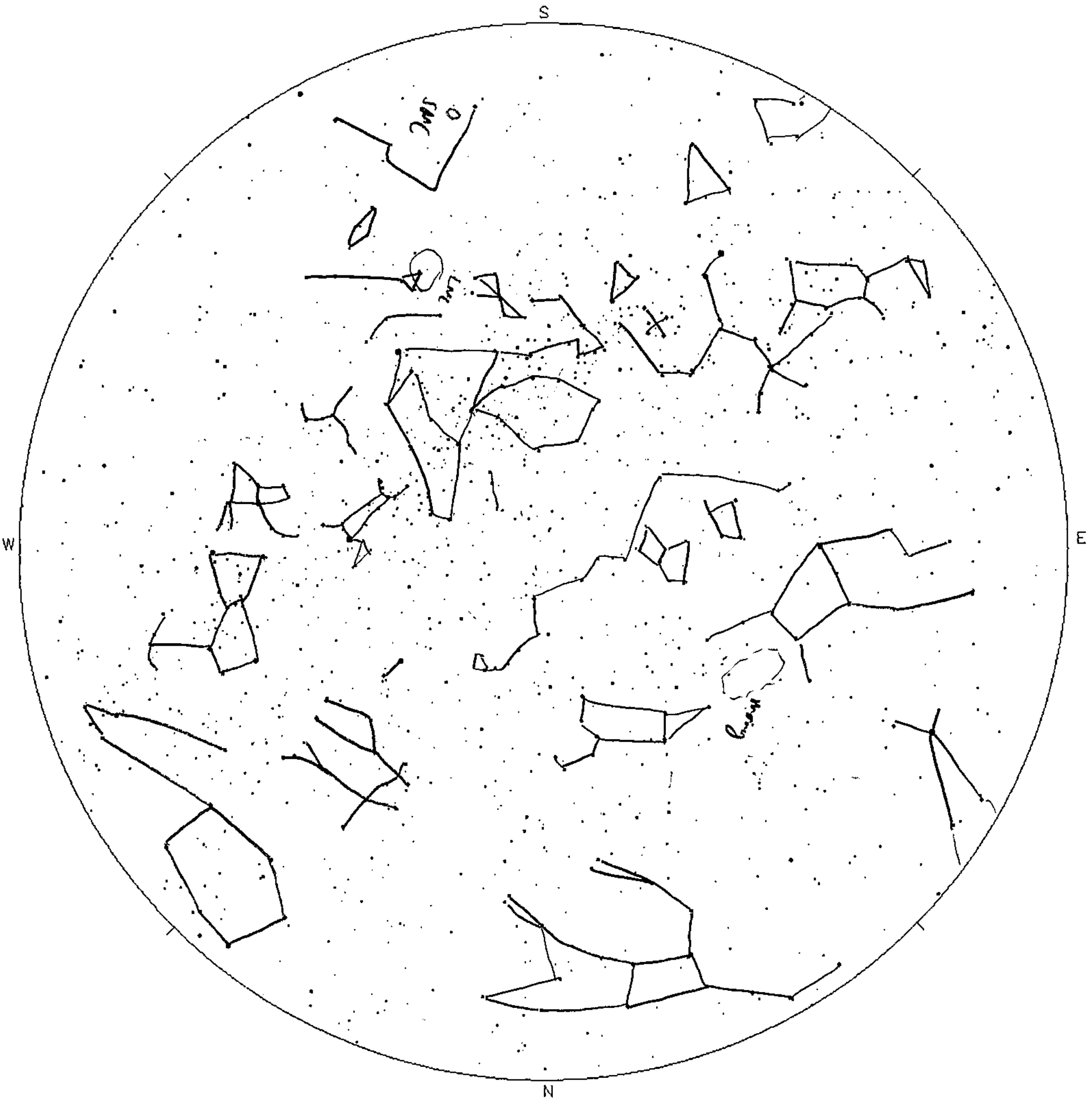
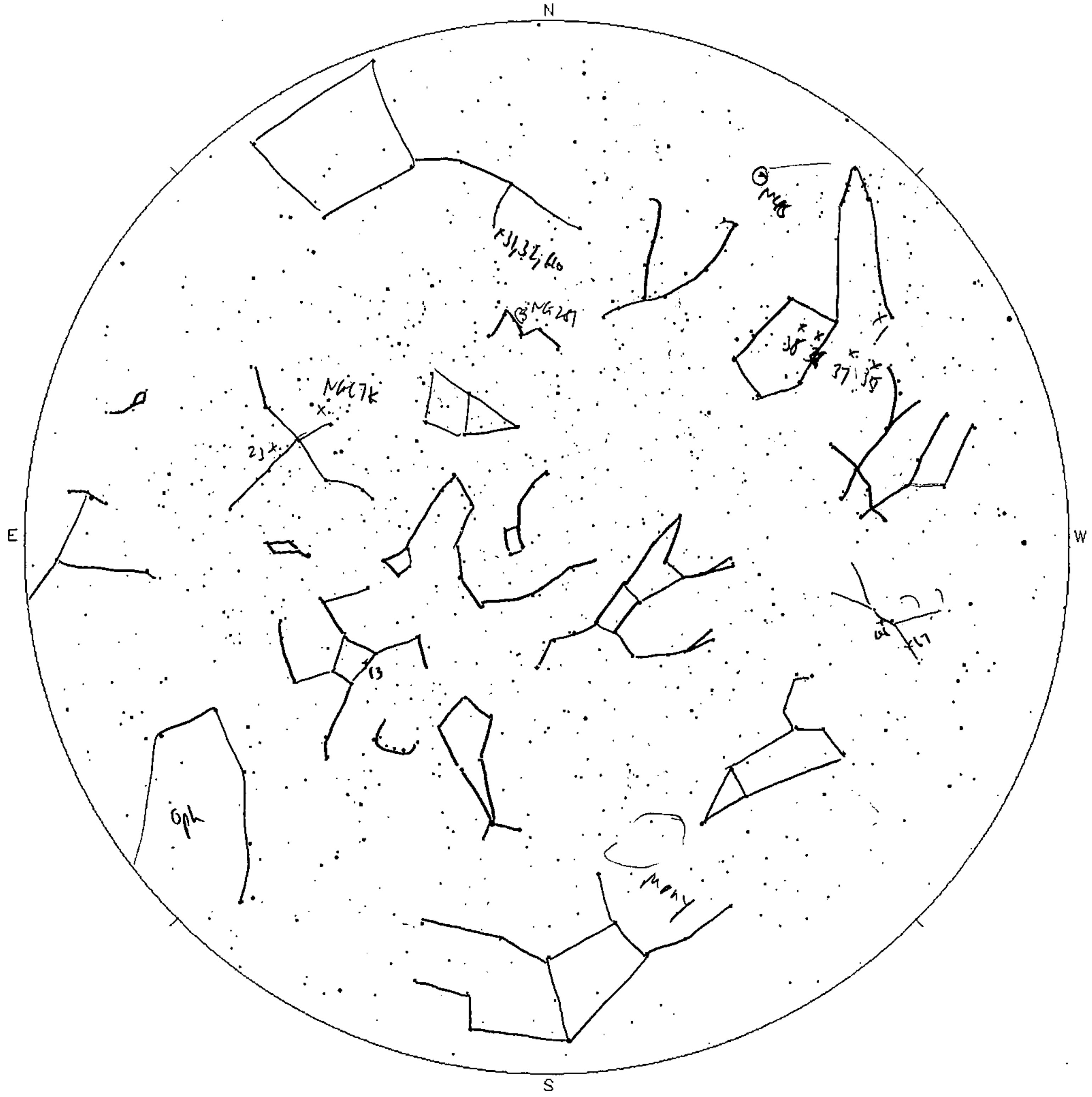
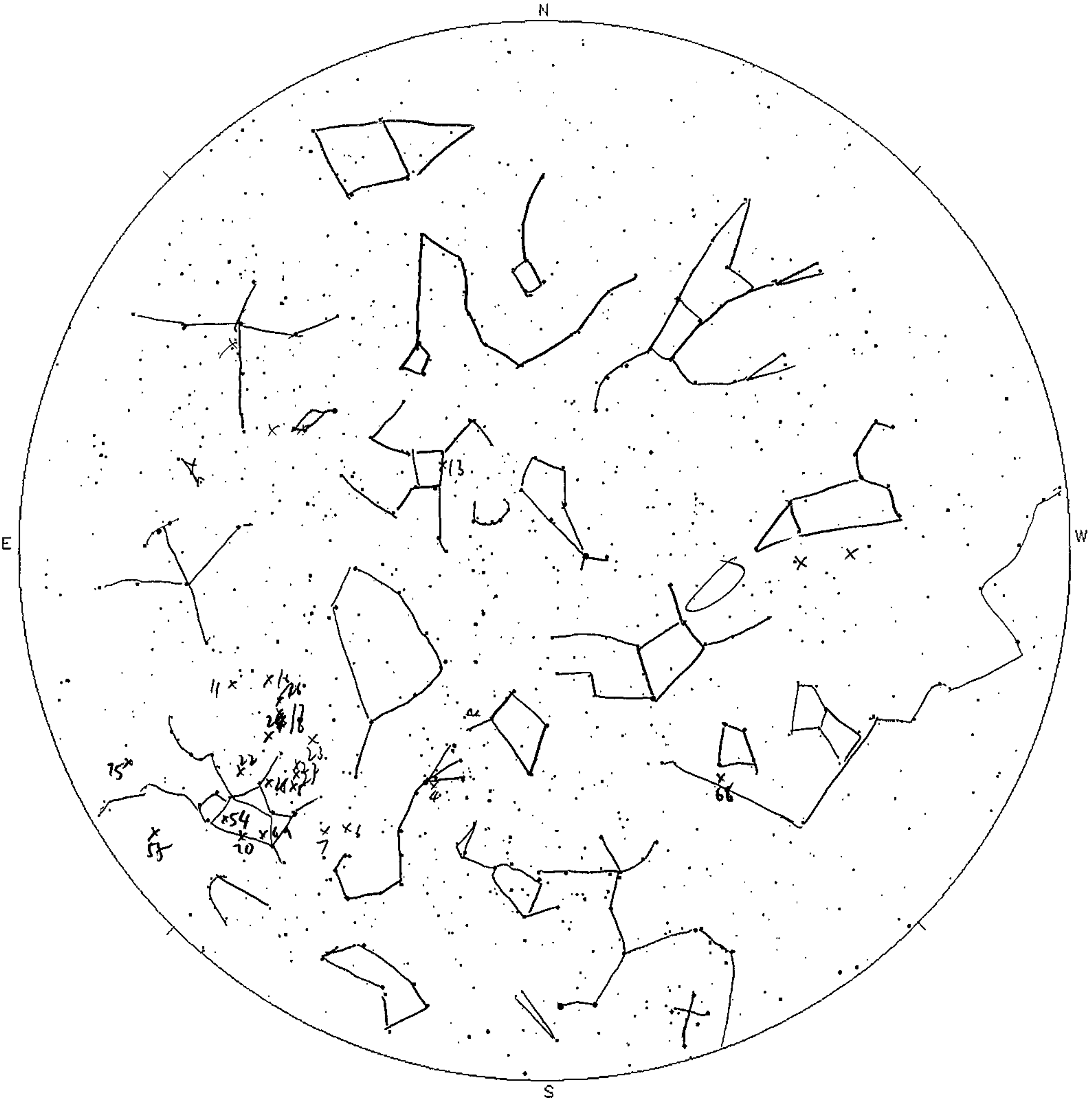
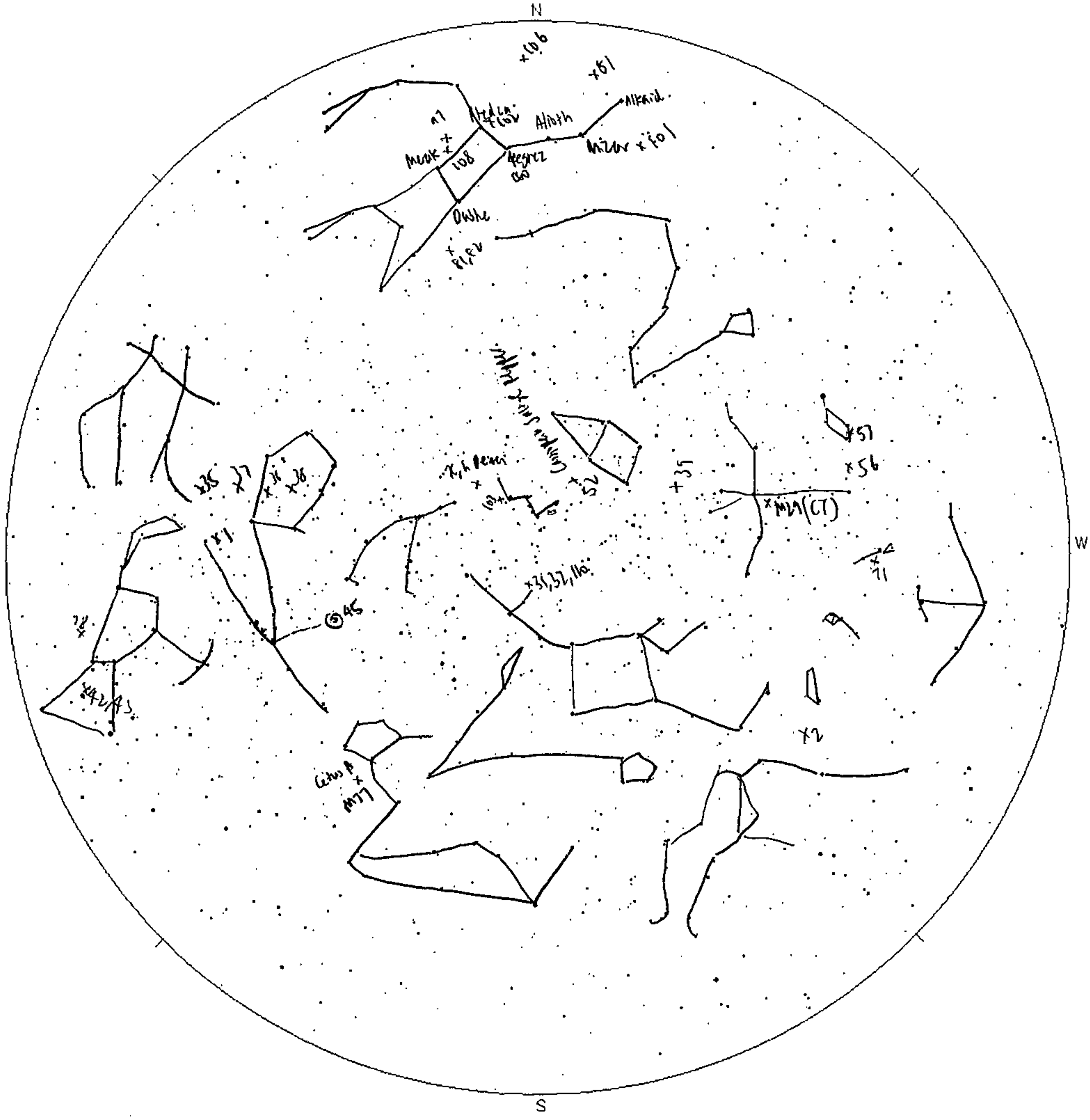
38
X
36
X
37
X
35
X

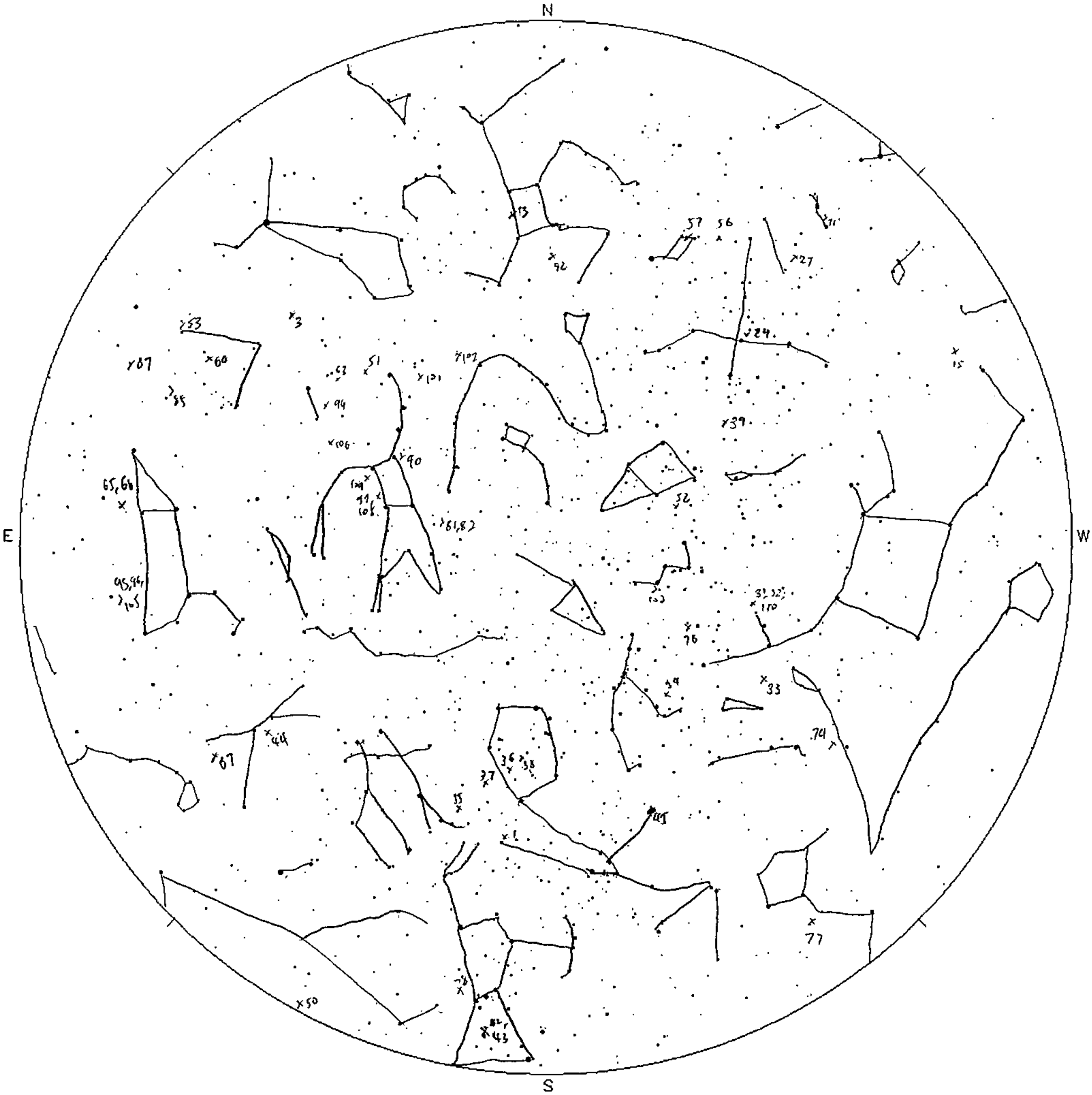

S
SMC
LMC
W
E
N

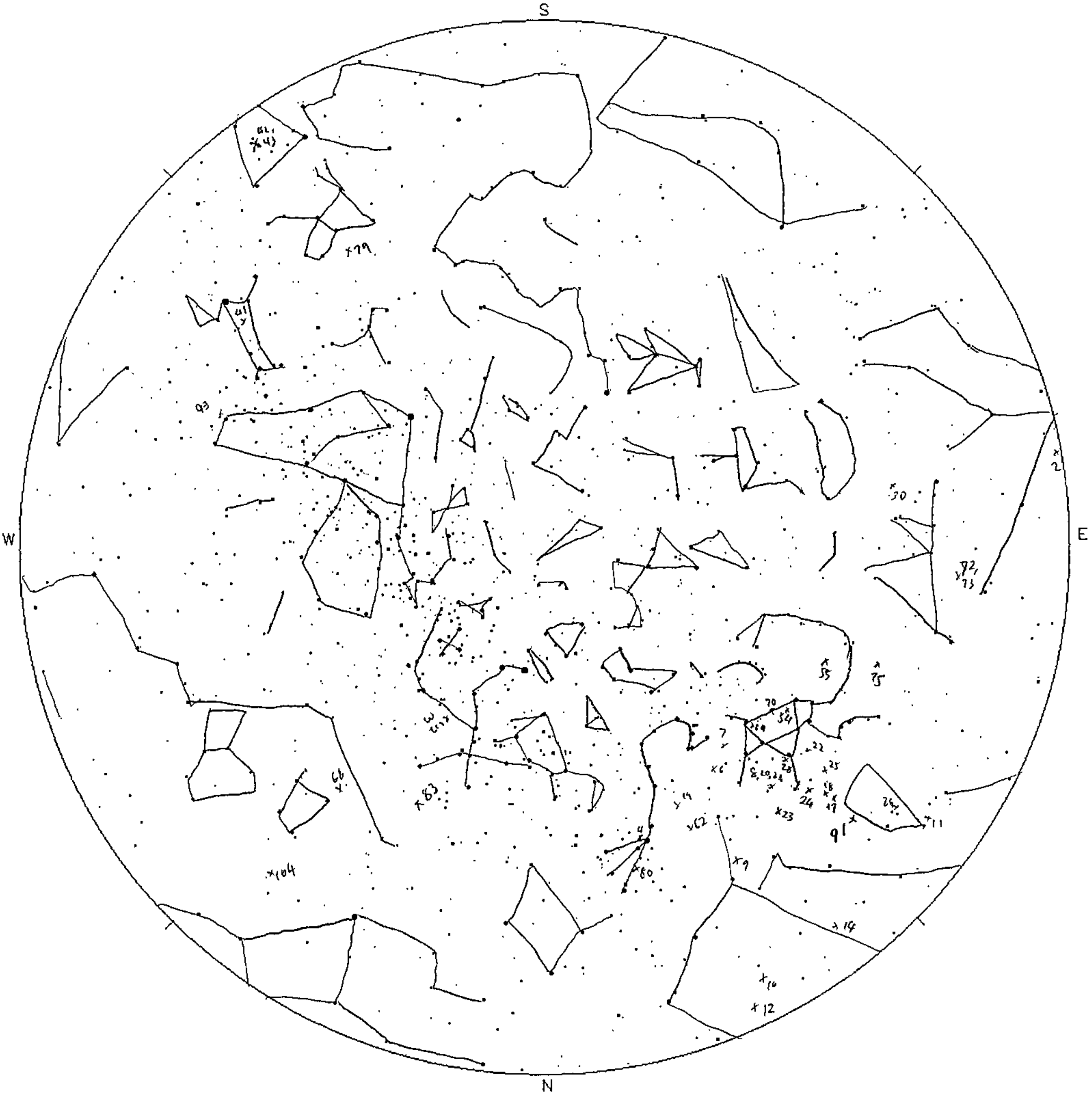

N
E
W
S
M48
M31,32,110
NG281
NGC7K
27
36
37
38
13
44
47
Oph
Many


N
E
W
S
13
11
12
26
24
17
18
23
22
15
21
16
8
54
6
20
57
7
1
4
66
a


N
E
W
S
x 94
x 63
x 51
x 102
106 x
97 x
x 40
x 101
x 81,82
x 44
x 13
x 57
x 56
x 35
x 37
x 36
x 38
x 1
x 78
x 42,43
45
χ, h persei
103 x
x 52
NGC 281
x M39
x Wolling Tuner (M29)
x M71
x 31,32,110
x 33
15 x
x 2

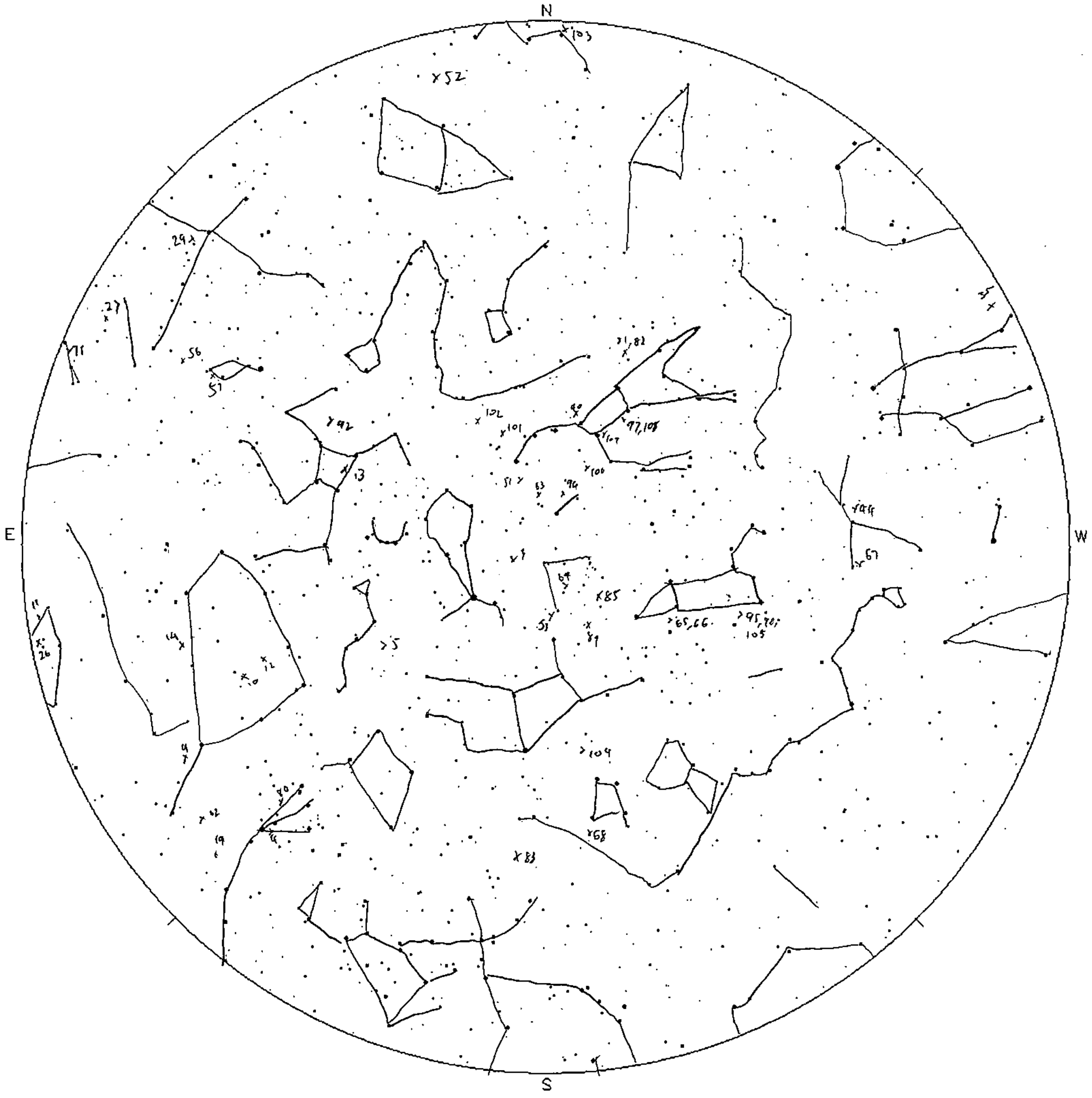

N
E
W
S
x106
x81
Alkaid
97
Alcor
Alioth
Megrez
Mizar x101
Merak
108
Dubhe
x 81,82
x35
37
x36
x38
x1
x, h Persei
103
52
+33
57
56
M29 (CT)
71
x31,32,110
45
78
x42/43
Cetus
M77
x2

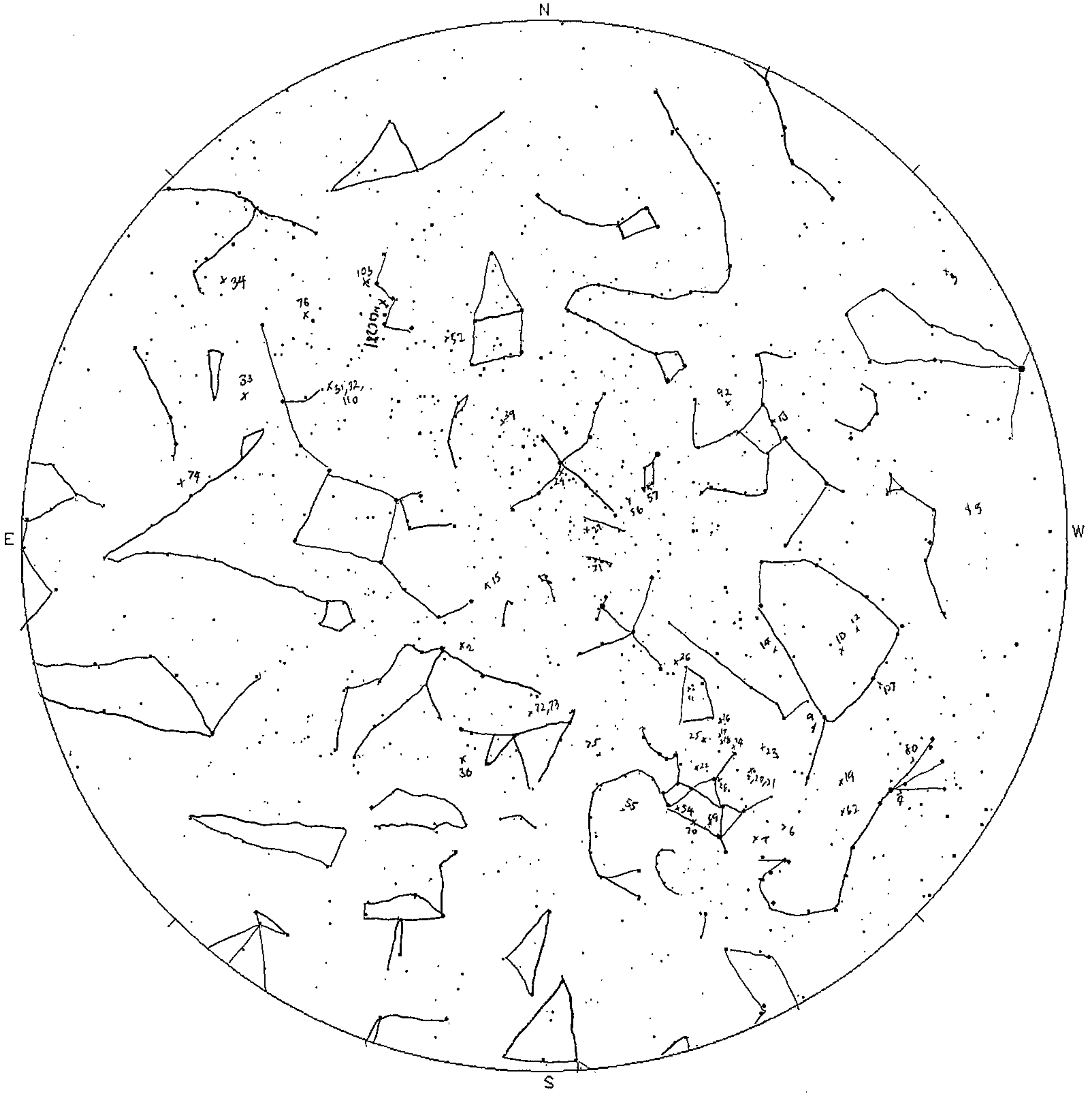

N
E
W
S
13
92
57
56
71
27
24
15
39
53
3
67
60
85
63
51
101
102
94
106
90
65, 66
109
99, 108
61, 82
52
95, 96, 105
103
31, 32, 110
76
34
33
74
44
67
37
36
38
35
1
45
77
78
82, 43
50


S
62
43
79
41
93
W
2
30
72
73
E
55
75
70
54
22
25
7
6
28
18
24
17
23
91
26
11
19
62
9
14
10
12
4
80
3
83
66
104
N


S
W
E
N
2
82,83
30
15
55
11
26
16
17
18
22
25
24
64
70
69
28
14
4
10
12
1
6
62
19
4
68
83
68
104
79
41,45
18
91
93
5
46,47
66


N
E
W
S
x92
13
y102
x101
x81,82
x40
x51
x104
97,108
x
106
x63
x94
x28
x36
y37
45
x1
x35
x3
53
x
x64
x85
x5
x87
x65,66
x98,99
105
x44
x67
76
x42
x43
x48
x50
x104
46,47
x
x68
x93
x11
x79
x83
Wun


N
103
52
29
27
71
56
57
92
13
102
101
90
91,82
97,108
107
106
51
63
96
99
67
35
E
W
7
64
85
65,66
95,98,
105
18
26
14
10
12
5
53
81
4
104
80
62
19
6
68
83
S

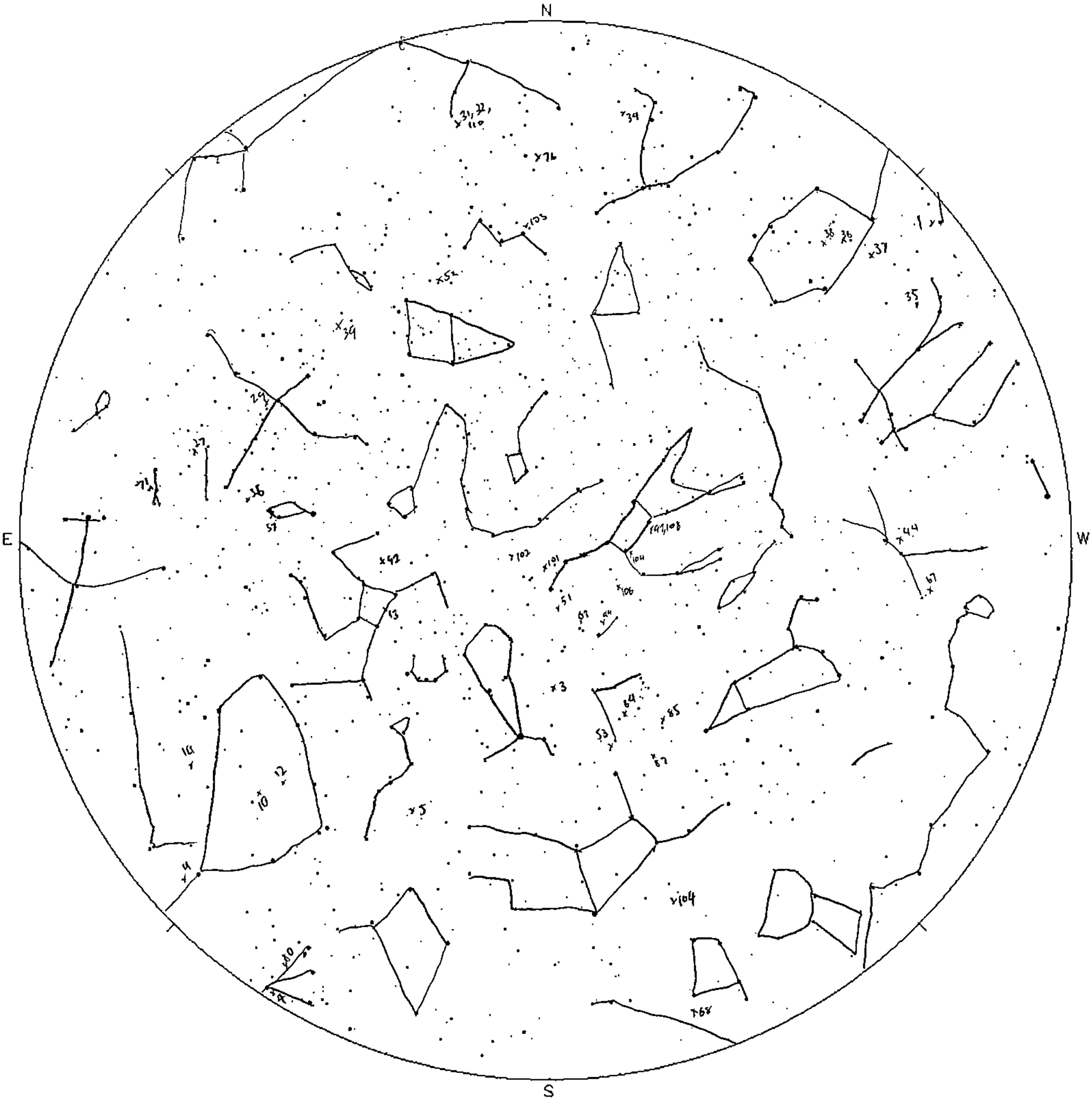

N
E
W
S
34
76
103
1820 MX
52
33
31, 32, 110
74
39
24
56
57
27
71
15
92
13
49
2
72, 73
26
36
75
25
16
17
18
24
23
21
20, 21
28
55
54
70
69
7
6
14
10
12
107
9
19
62
80
4

2^8 nice

256

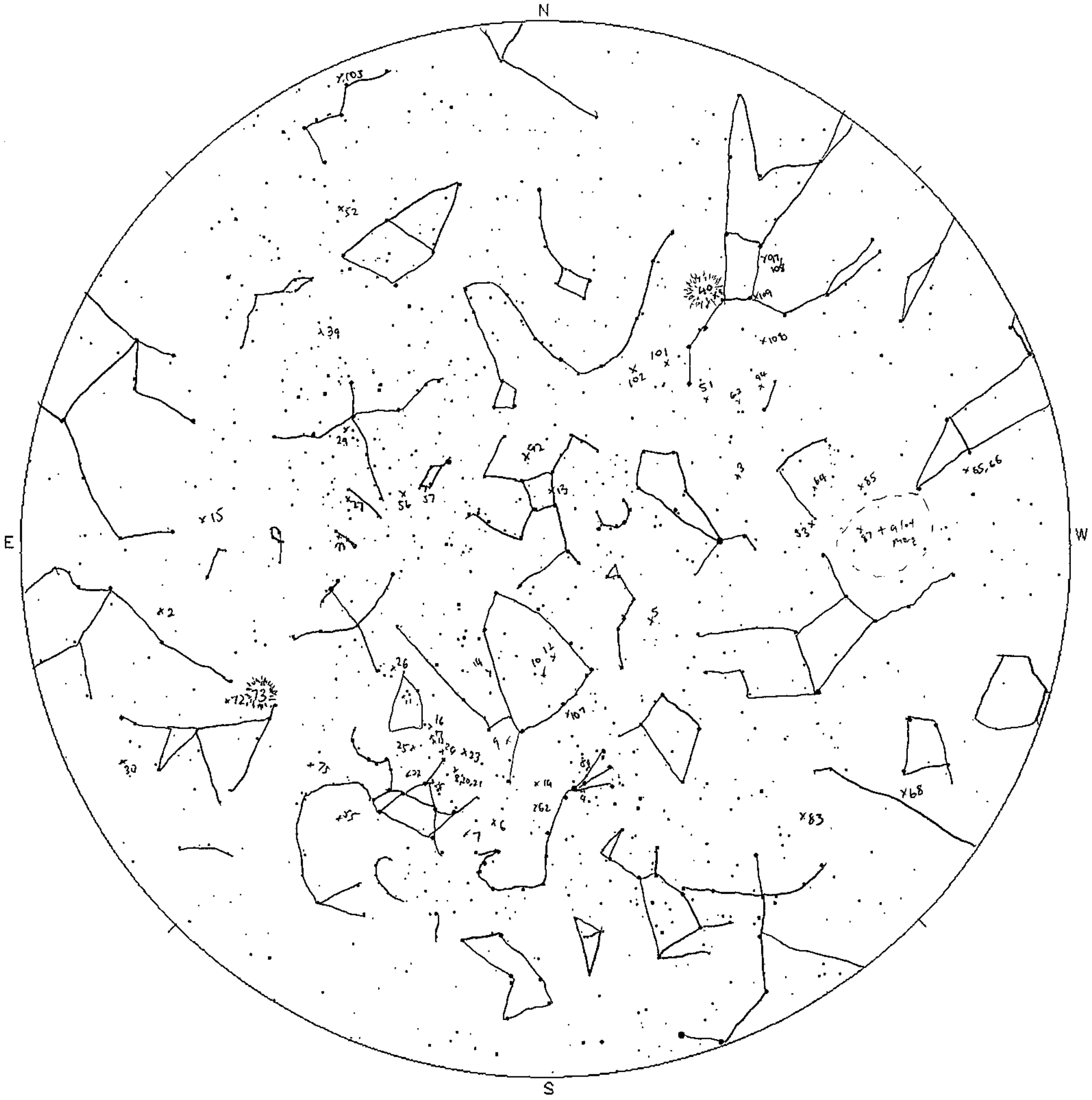

S
W
E
N
62
19
6
7
4
23
8,20,21
28
69
70
34
55
22
20,18
25
17
16
11
14
26
75
30
72,
73
2
15
21
27
56
57
29
37
52
103
31,32,
112
76
33
34
74
77
95

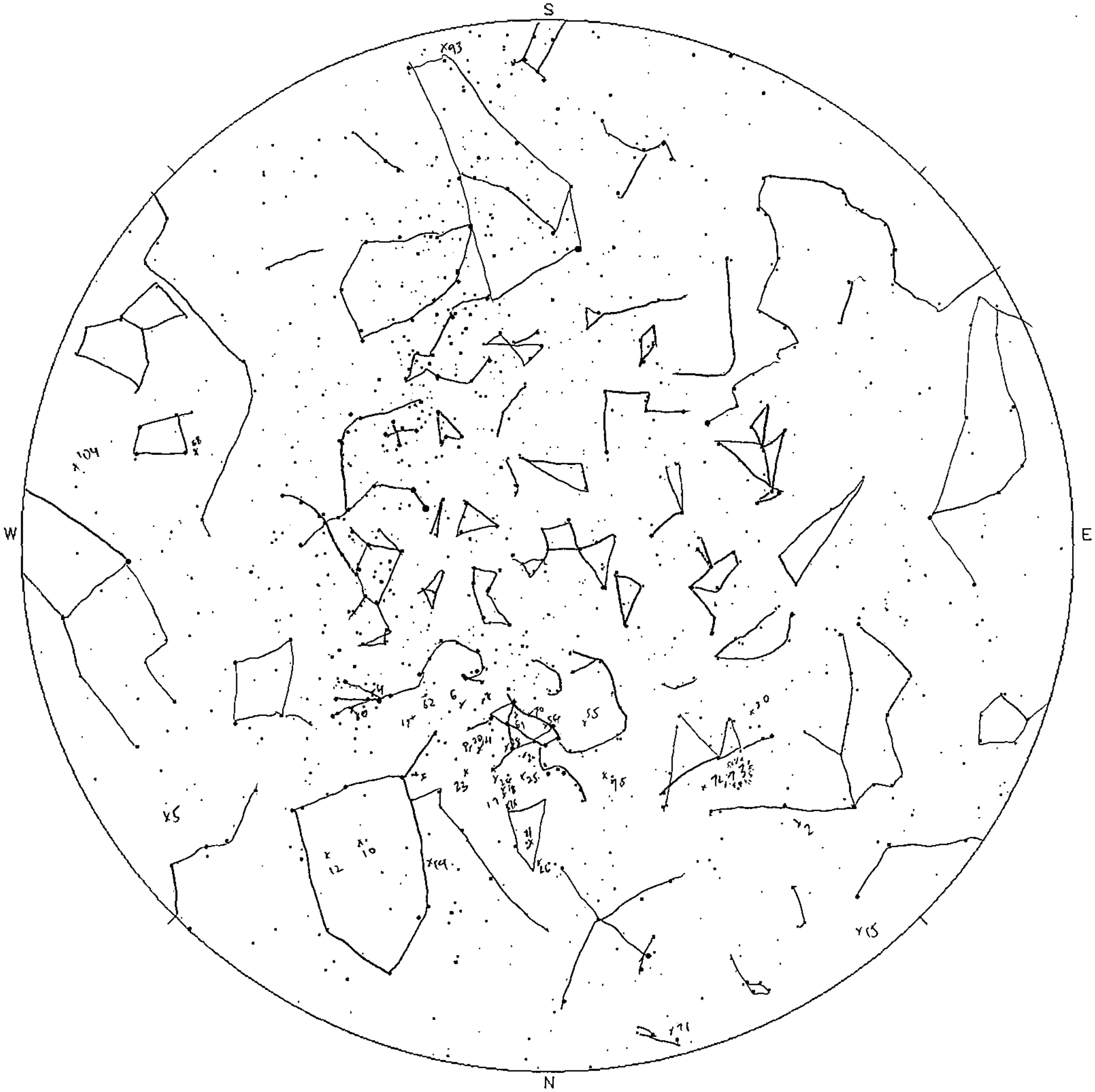

N
E
W
S
81,82
109
97,101
103
70
31,32,110
34
33
74
38
36
37
35
45
44
65,66
95,96,105
61
78
42,43
77
50
48
46,47
41
39
93


N
31, 32, 110
39
76
103
52
38
36
37
35
39
29
27
73
36
57
E
42
102
101
144, 108
104
106
51
63
54
13
44
67
W
3
84
85
53
87
14
10
12
4
5
104
80
α
68
S


N
E
W
S
35
37
36
38
1
45
103
76
52
39
57
56
29
31, 32,
33
27
71
70
15
78
112,
93
77
2
26
11
72, 73
30
25
79
55


S
W
E
N
x74
x93
x 44,47
43,8
93
x78
x50
x48
4
x80
x68
x104
x5
x67
95,96,105
65,66
44 x
x87
x85
x53
60
x1
x35
x37
x36
x3
x44
x63
x106
x51
97,108
109
x40
101
x 81,82

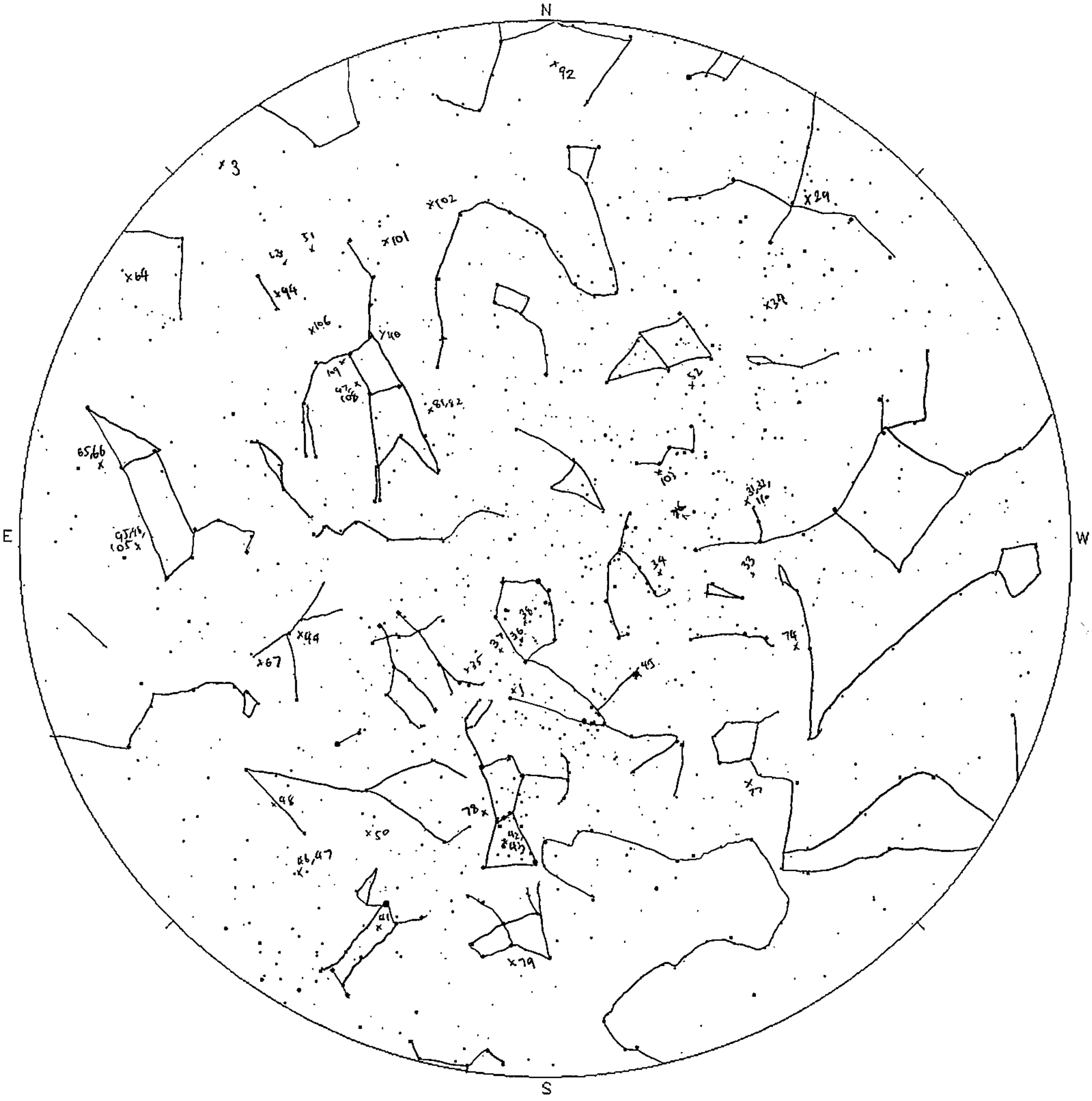

N
x103
x52
x39
29
27
56
57
31
92
13
101
102
51
63
94
40
97/108
109
108
3
64
85
65,66
53
87 + 9 1/04 more
E
x15
x2
x72
73
x30
x75
x55
26
11
16
35x
17
18
29
x23
22
8,20,21
x7
x6
14
10
12
107
9
x14
262
83
9
x5
W
x68
x83
S


S
x93
x104
68 x
W
E
x5
x12
x10
x14
23
17
55
x95
x30
x2
x15
x71
N


N
E
W
S
101
×31,32
110
×52
104
×101
×102
51
63
×94
×89
×3
×64
×53
92
×13
29
×56
87
×15
×5
×2
12
10
14
×107
93
×73
16
17
23
×20
×23
×75
22
×19
×30
×55
×7
×6
×63
×83

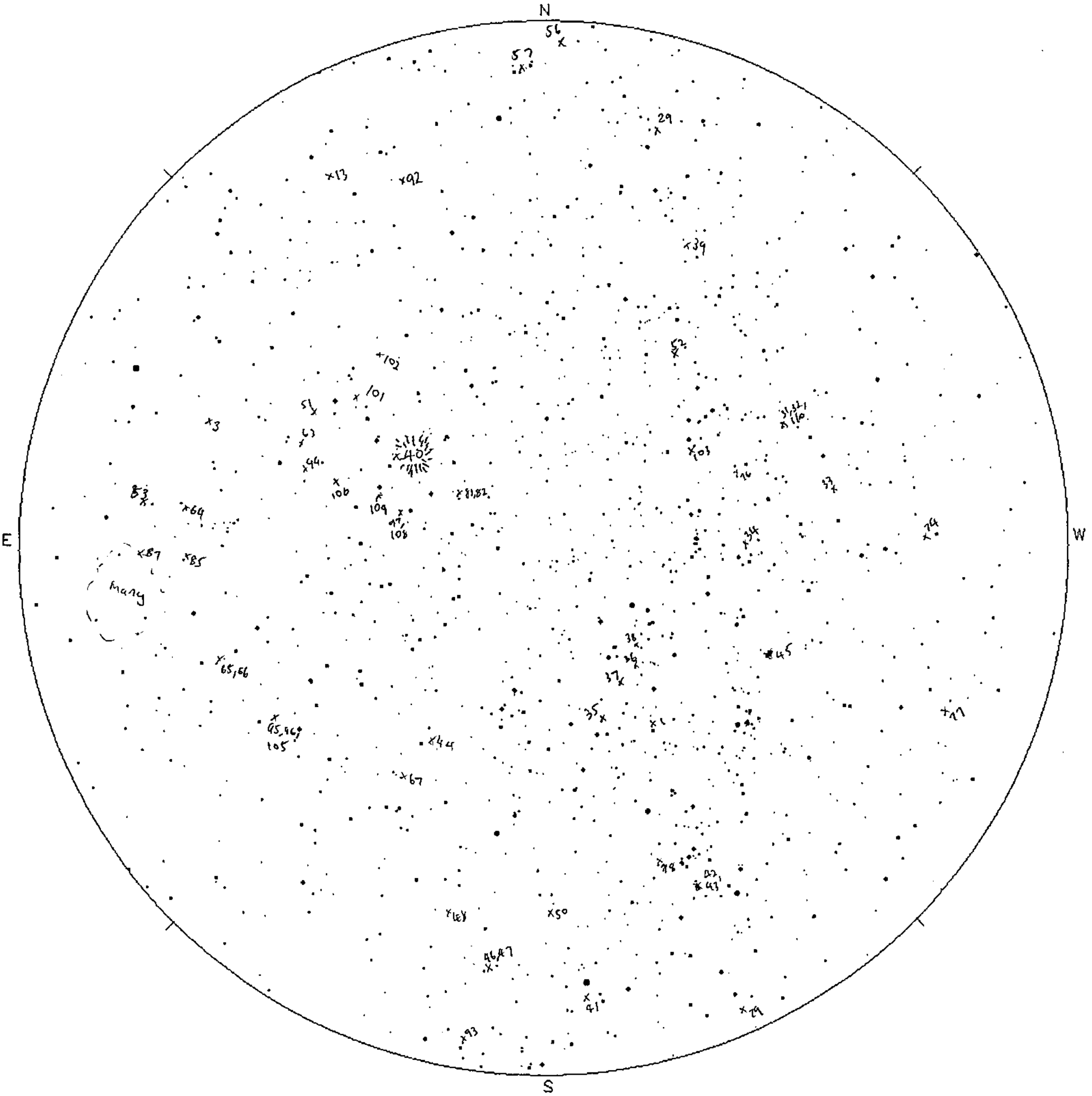

N
13
92
3
64
57
56
71
27
51
63
99
101
102
106
29
90
65,66
109
108
81,82
95,96
105
39
15
52
E
W
103
19
31,32,110
44
67
34
33
38
36
35
37
45
24
48
46,47
50
78
41
43
77
79
S


S
W
E
N
ω
Cen
83
68
104
95,46,105
65,66
87
85
57
64
3
99
63
51
108
109
97,108
40
21
102
62
6
7
19
40
11
9
8,29,11
26
69
70
54
22
28
25
23
18
17
16
24
10
12
14
5
13
92
5
7
2
73


N
x92
x3
x102
x29
31
28
x101
x64
x94
x106
x39
y40
109x
47,46 x
108
x81,82
52
65,66 x
101
31,32, 110
E
W
93,98, 105x
34
33
38
37
36
x35
74 x
x67
x44
45
x1
x77
78x
x48
x50
42 43
86,47 x
41
x79
S

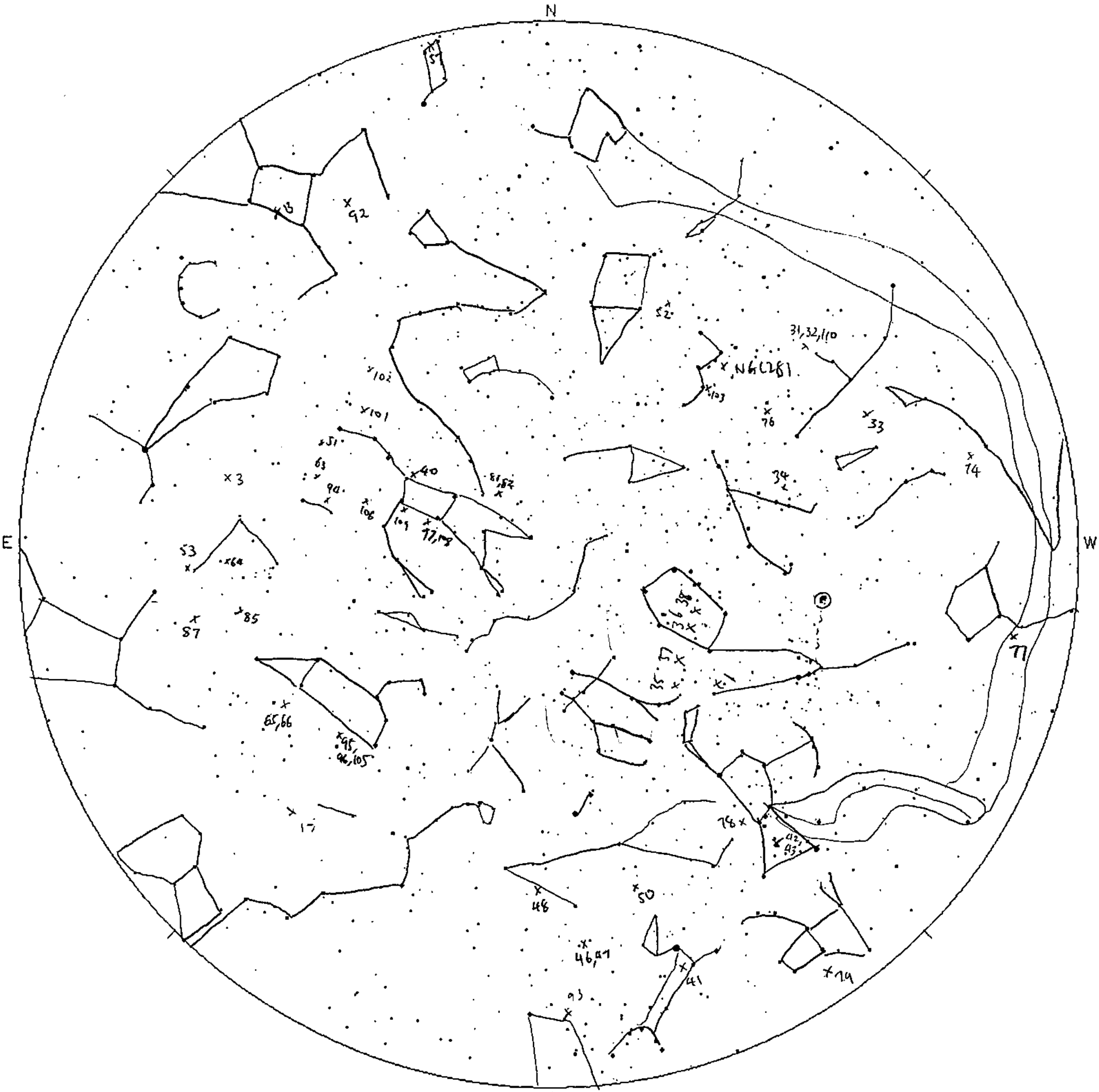

S
Near 0°N!!
SCP
W
E
N
NCP
x94
x70
x54
x28
x22
x85
x29
x18
x17
x25
x16
x75
26
x11
x70
x72,73
x2
x15
x71
x27
57
x
56
x
29
x
39
x
x33
x31,32,
110
x76
x34
x52
x103
45
x77
x79
42, x
93
x78
x1
x
37
x
38
x
36


N
E
W
S
x102
x81,82
x101
13
51
63
x44
106
109
97, 108
39
38
37
35
x1
x3
64
53
x85
x87
65,66
x95 96, 105
x98
x67
x5
78
42 43
48
x50
x109
46,47
93
41
x88
x79
80
x83

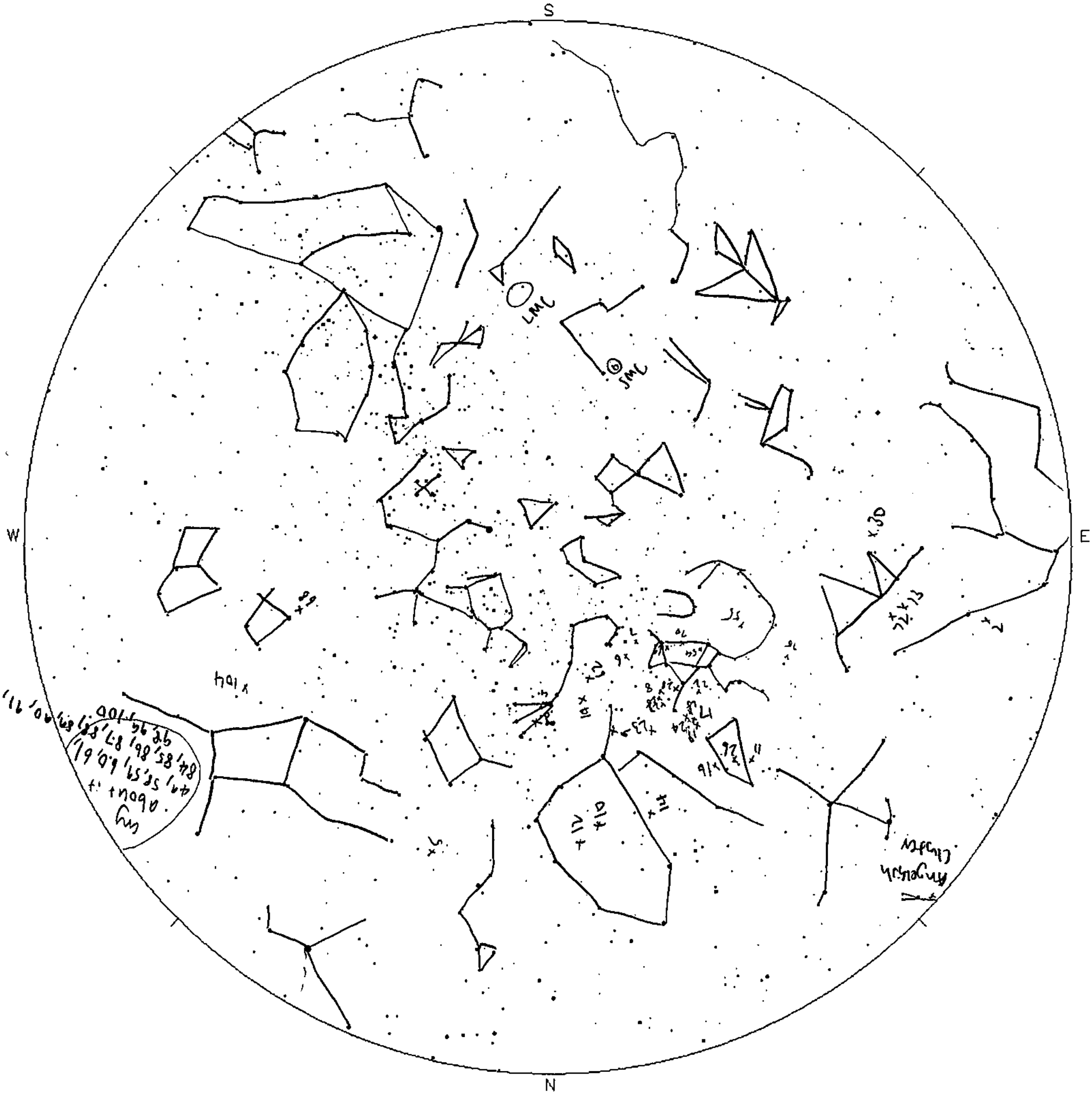


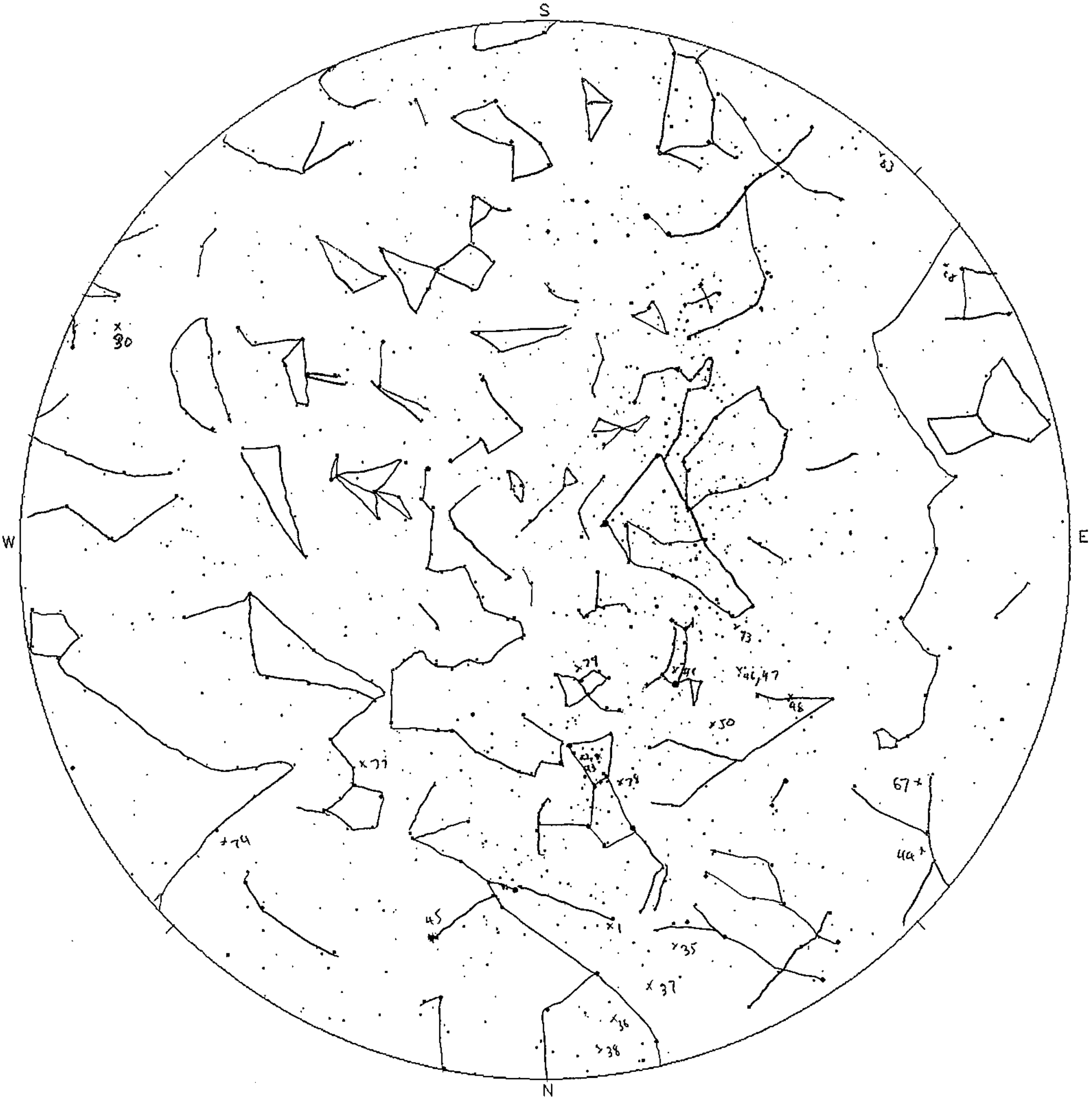
Everything but the constellation lines!

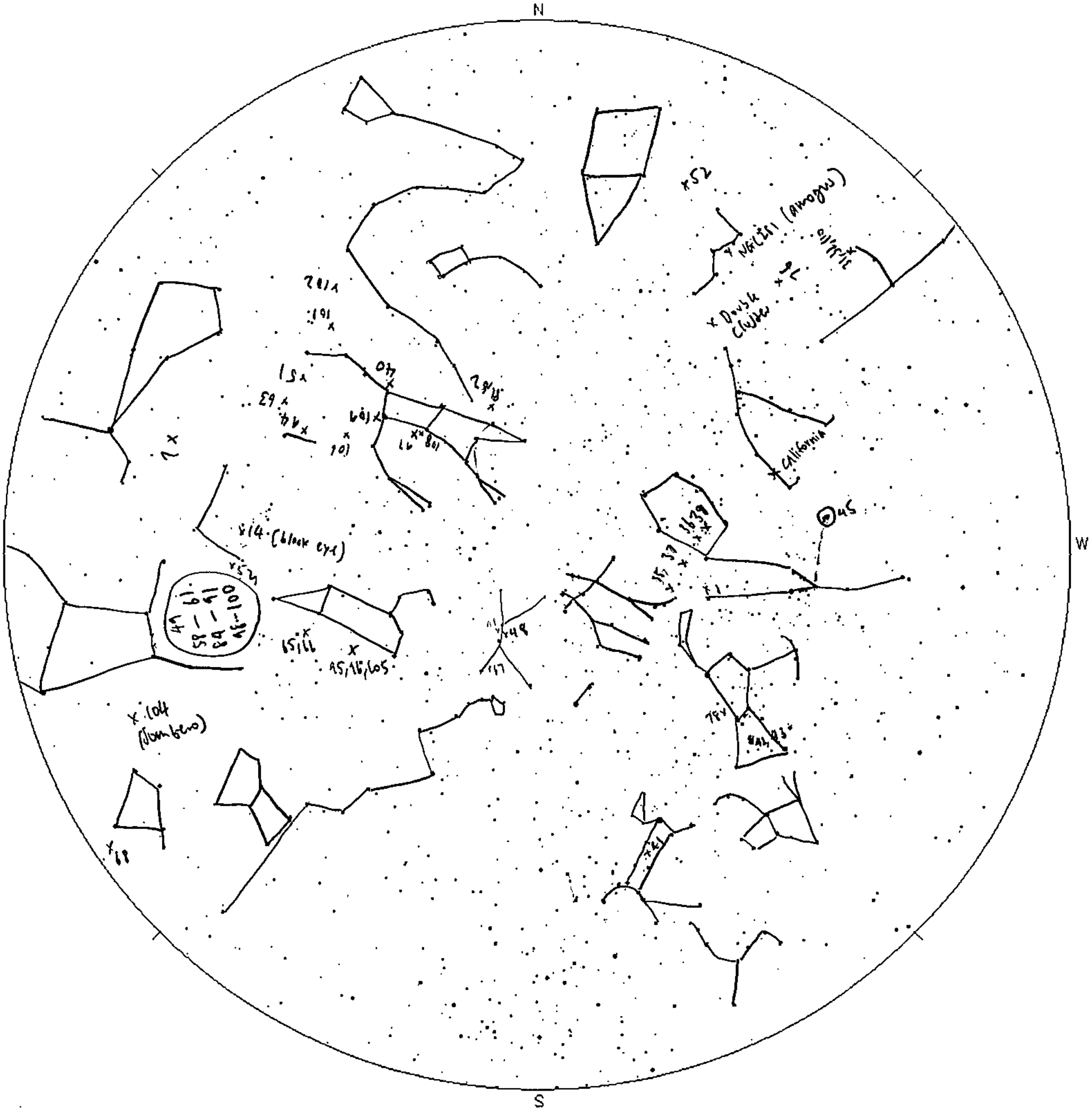
(you should be able to figure them out by now)

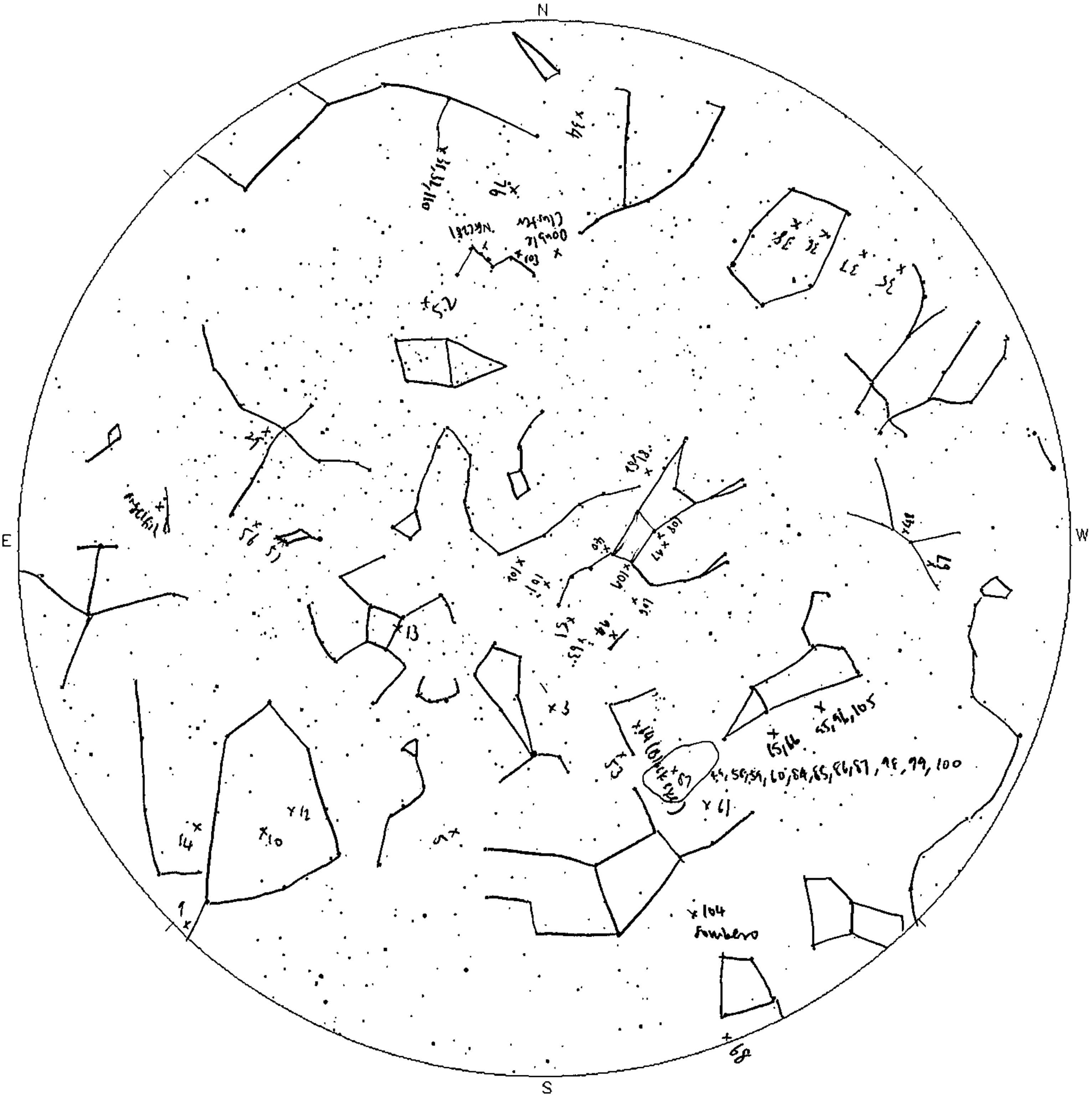

N
E
W
S
57
13
92
52
31,32,110
NGC281
103
76
33
34
74
102
101
51
63
94
3
40
81,82
106
109
97,108
53
64
87
85
38
36
37
1
65,66
95,96,105
17
77
78
42,43
48
50
46,47
41
93
79

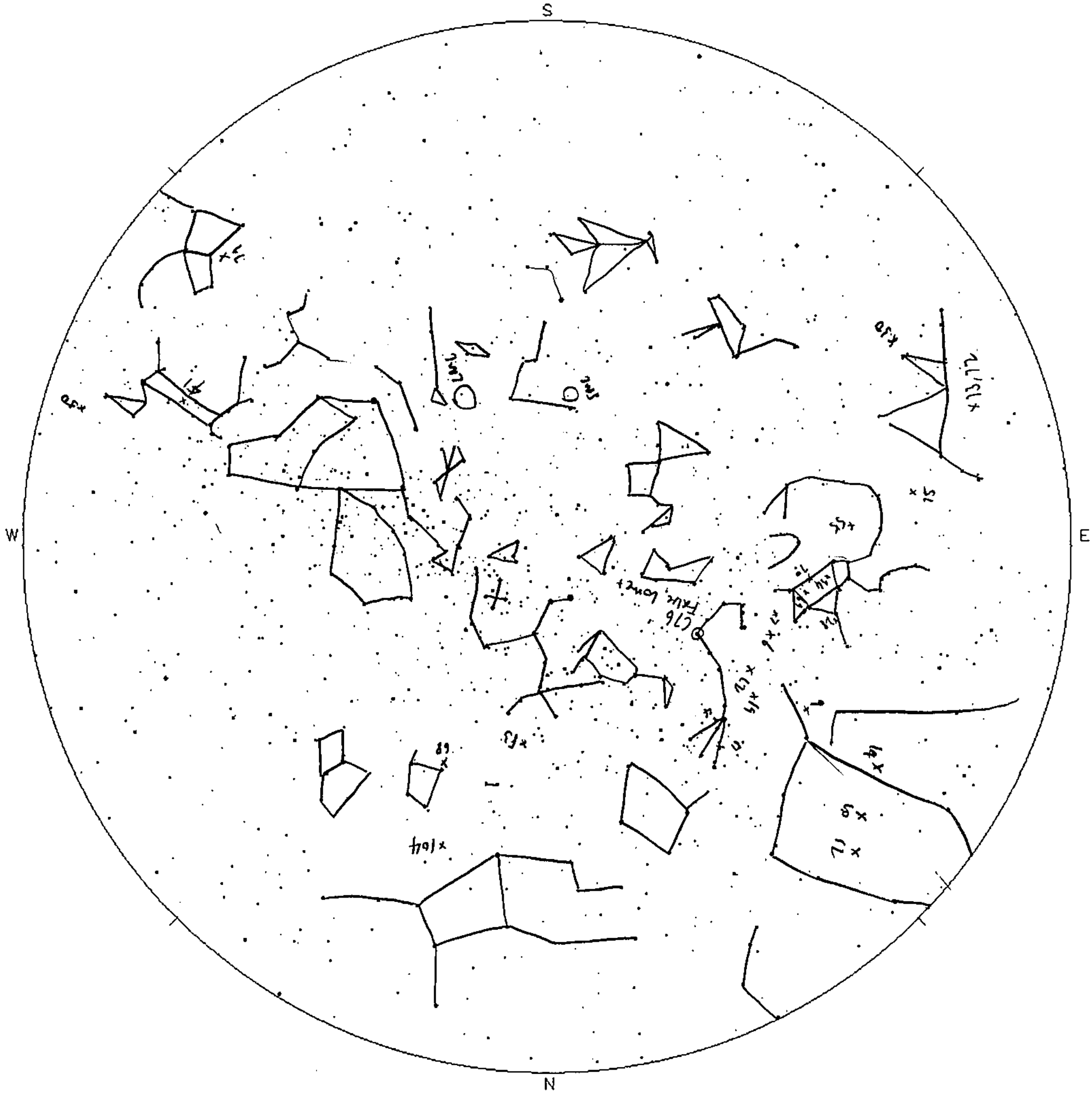
N
E
W
S
x102
x106
x109
x97, 108
x81, 82
x103
x76
x31, 32, 110
x39
33 x
38 x
36 x
37 x
x74
x35
x1
x45
x65, 66
x95, 96, 105
x44
x67
x78
x42, 43
x48
x50
x77
x46, 47
x93
x41
x79

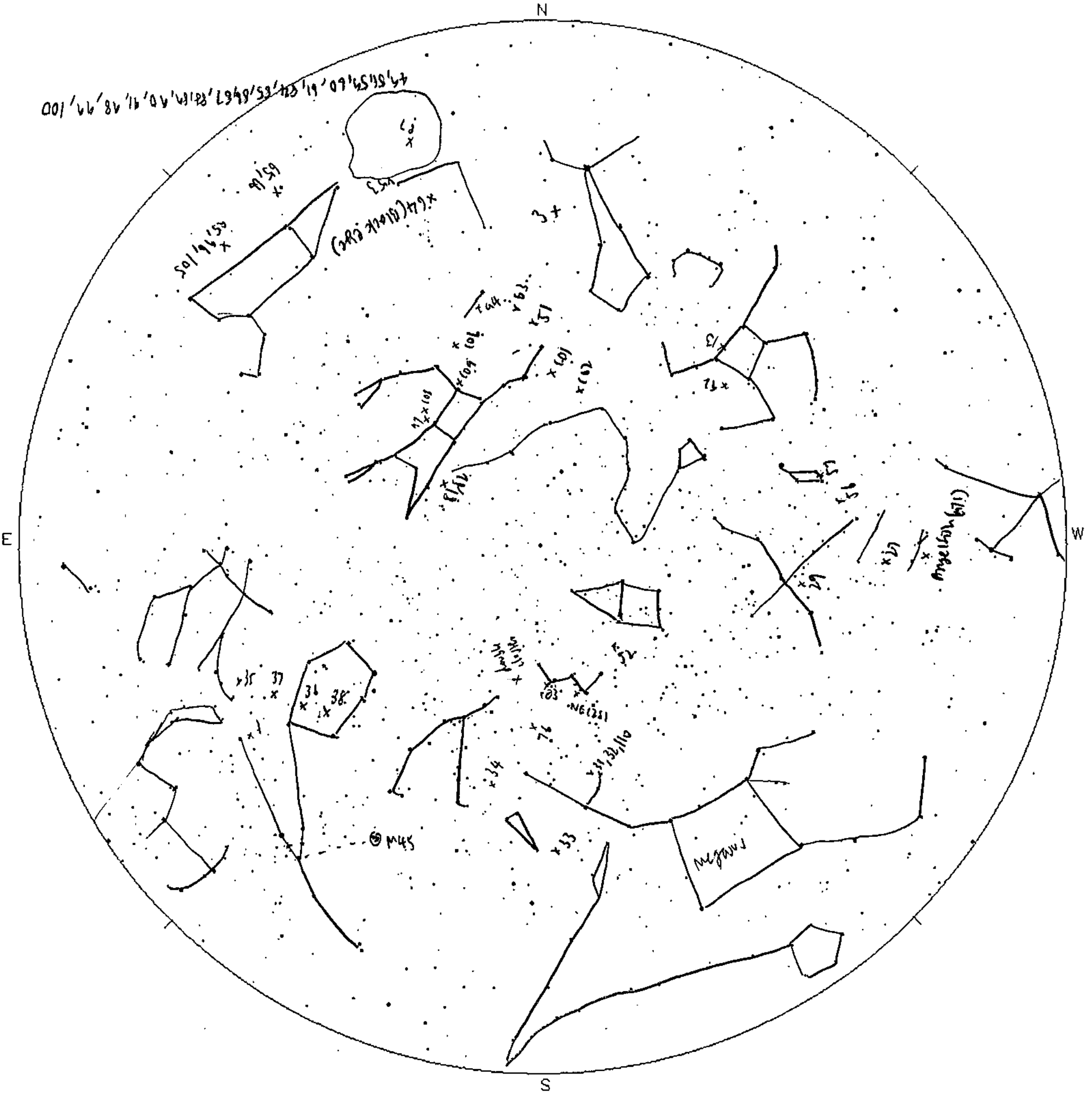

S
W
E
N
LMC
SMC
any
about it
49, 58, 59, 60, 61,
84, 85, 86, 87, 88, 89, 90, 91,
92, 96, 100
104
88
5
14
10
12
11
26
16
23
17
18
24
19
6
7
8
55
54
70
76
30
72
13
Angelish
Cluster

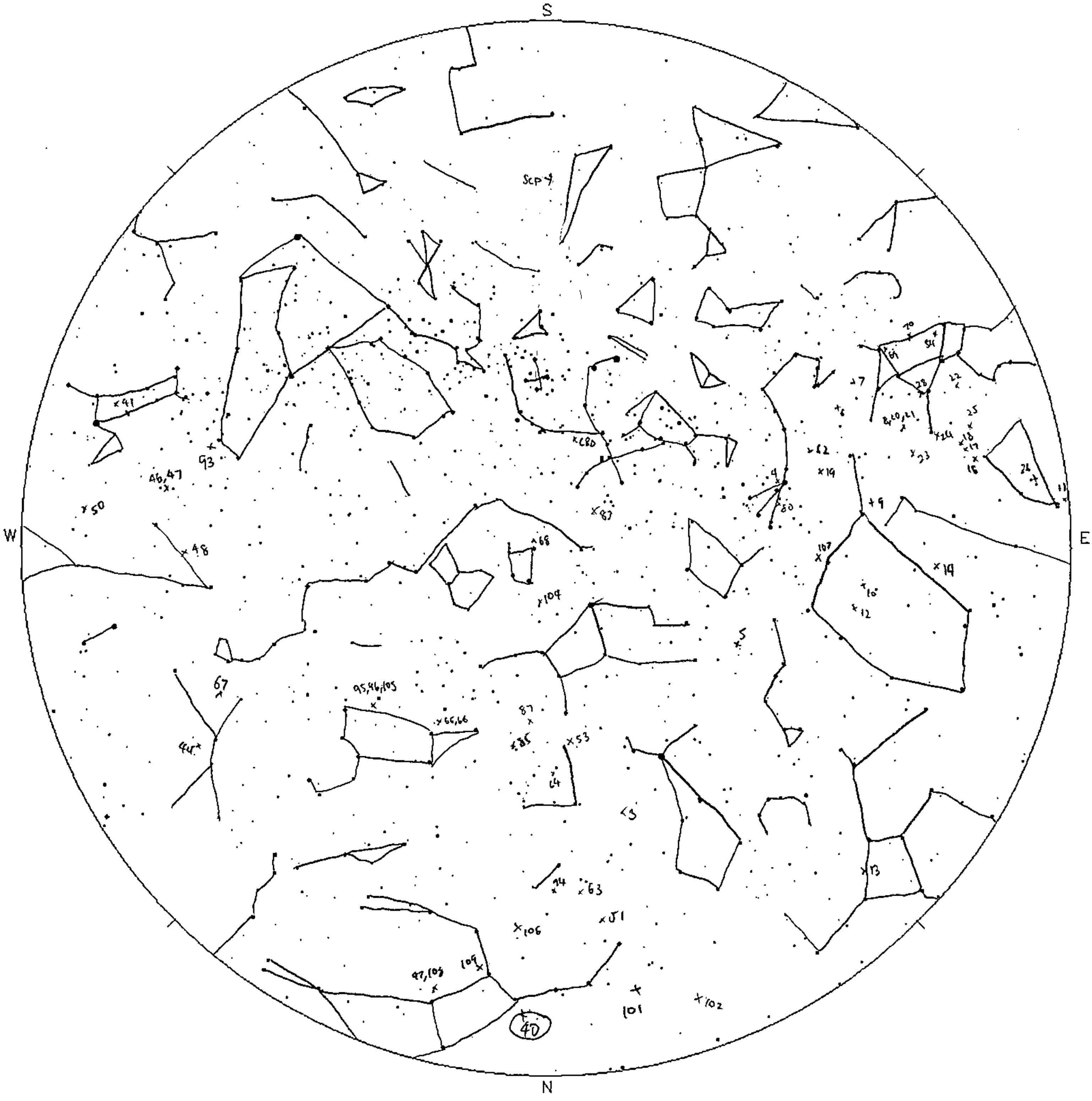

S
W
E
N
83
68
x 30
x 73
x 79
x 41
x 46, 47
48
x 50
x 78
x 77
67 x
44 x
x 74
45
x 1
x 35
x 37
x 36
x 38

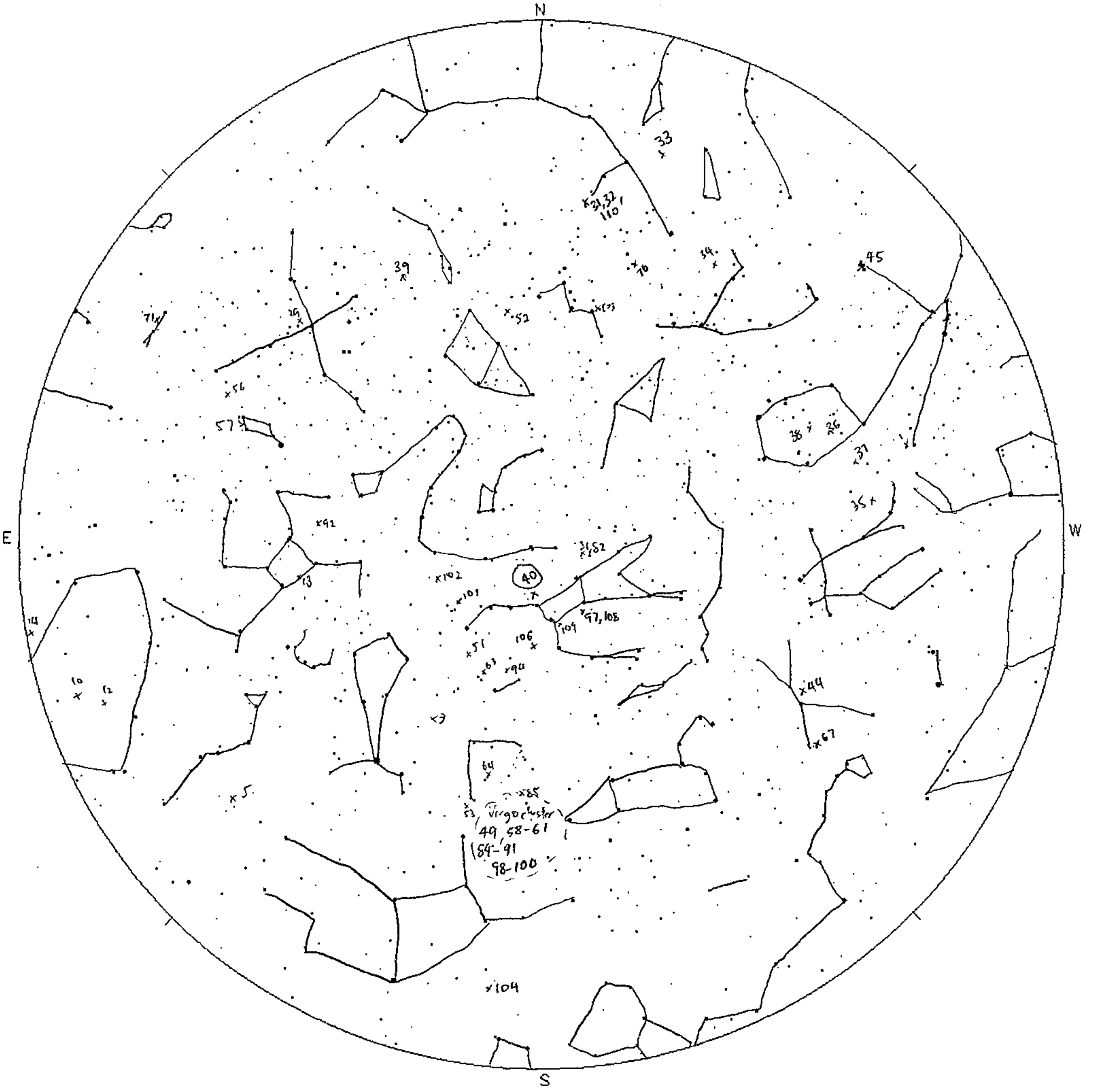

N
E
W
S
x 52
x NGC 281 (amogus)
31/32/110 x
x 76
x Double Cluster
California
x 102
x 161
x 51
x 63
x 94
40
x 109
81/82
97 x x 108
101
x 2
x 64 (black eye)
x 53
49 – 61
58 – 91
84 – 100
85 – 100
65,66
x 95,96,105
x 48
67
44
x 104 (Sombrero)
x 68
x 36 38
35 37 x
x 1
45
78
42,43
x 41

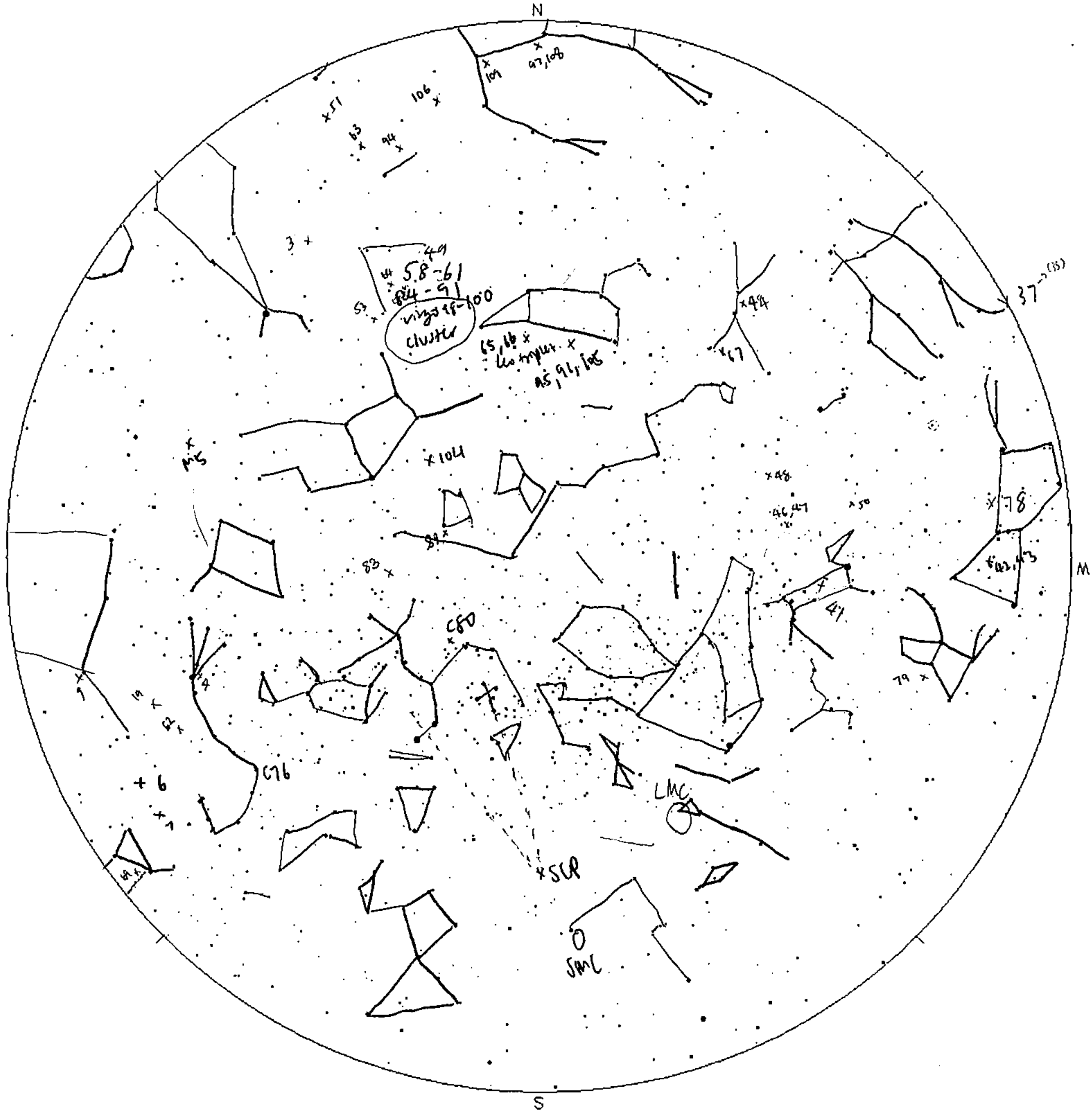

N
E
W
S
34
76
31,32,110
NGC281
Double Cluster
103
52
36
38
37
35
95
45
13
101
102
108
97
109
51
63
94
49
48
3
14
10
12
9
2
53
61
15/16
65,96,105
55,58,59,60,84,85,86,87,98,99,100
104
Sombrero
68

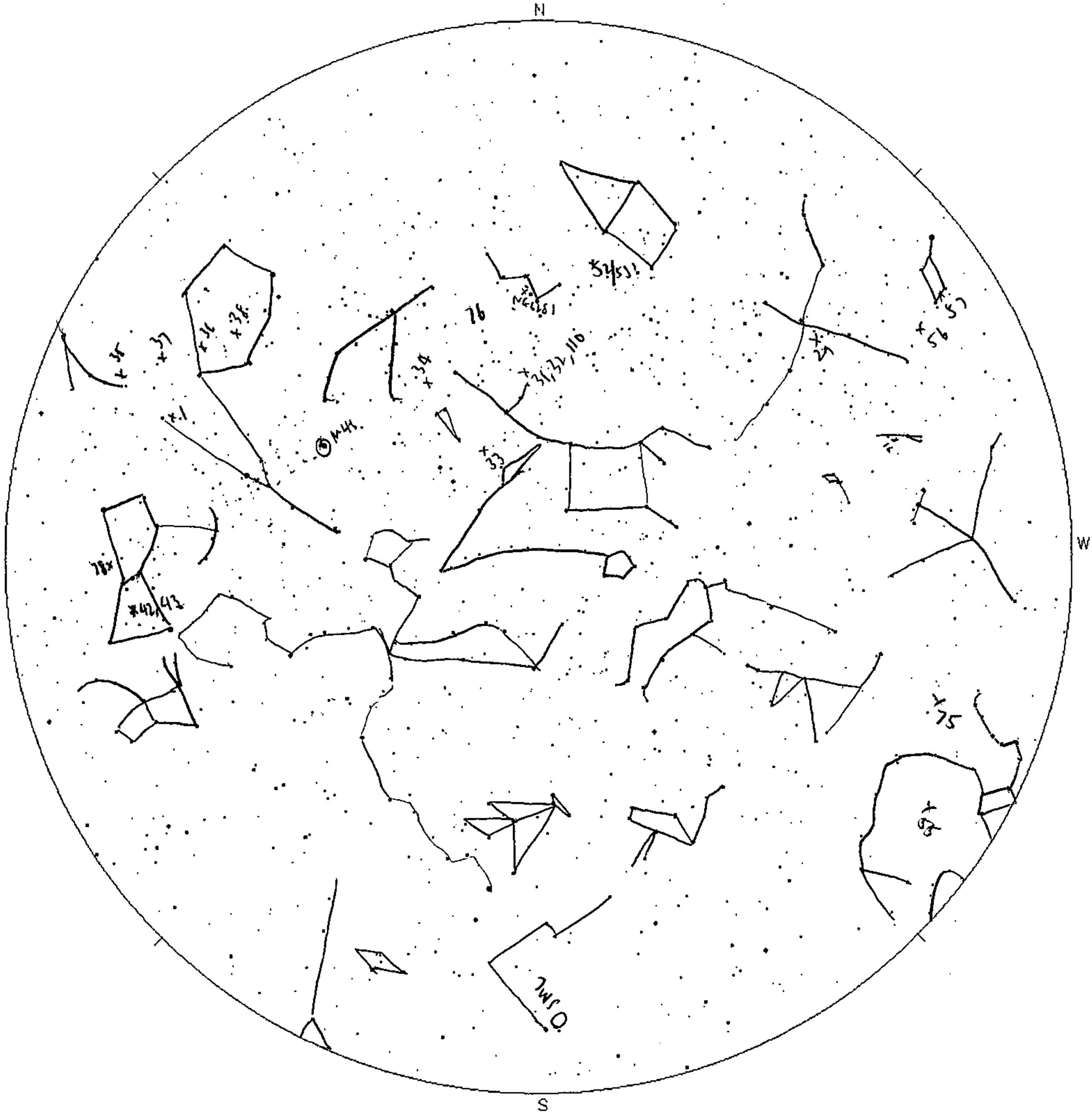

S
W
E
N

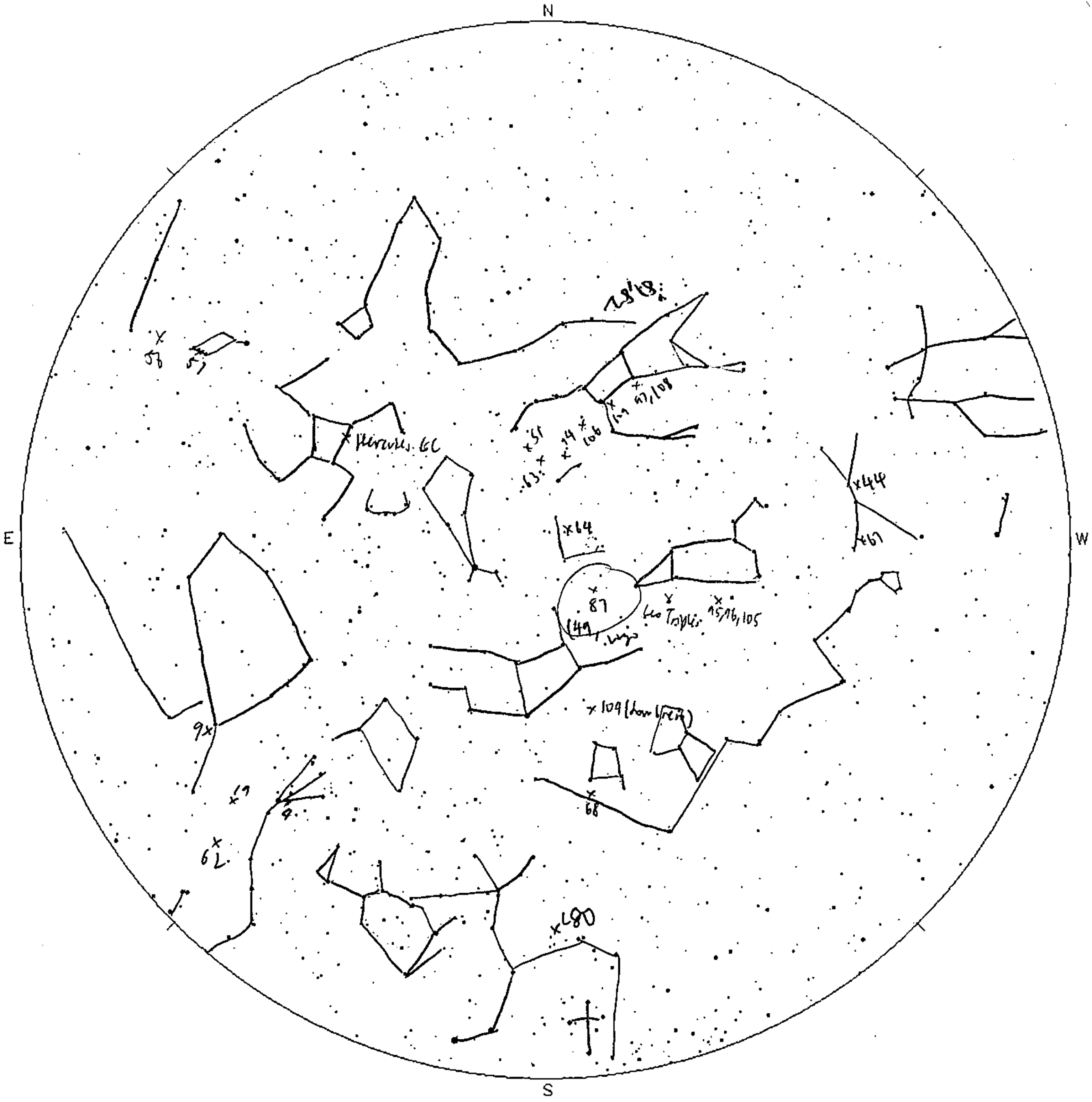

N
E
W
S
49,58,59,60,61,84,85,86,87,88,89,90,91,98,99,100
65,66
95,96,105
64 (Black Eye)
53
3
94
63
51
106
109
108
97
81,82
102
101
13
92
57
56
29
27
35
37
36
38
1
M45
34
76
103
NGC281
52
31,32,110
33
Double Cluster
Pegasus

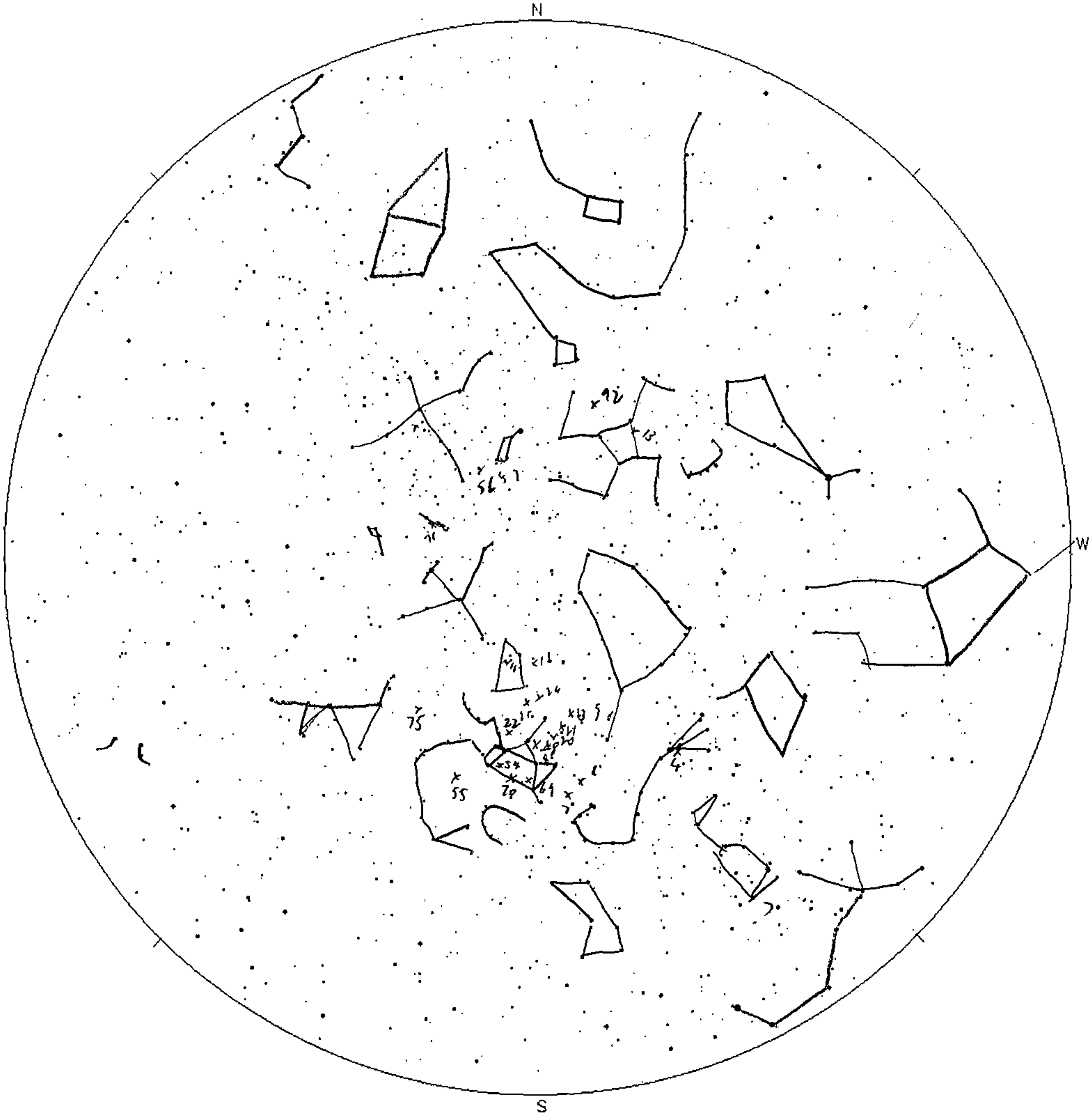

S
Scp
x41
93
46,47
x50
x48
W
x68
x104
xC80
x83
4
80
x62
x19
7
6
70
54
61
28
8,20,21
22
25
x24
x23
18
17
16
26
11
+9
107
x19
10
12
E
5
67
44
95,96,105
x66,66
87
x85
x53
64
<3
x13
94
x63
xJ1
x106
97,103
109
101
x102
40
N

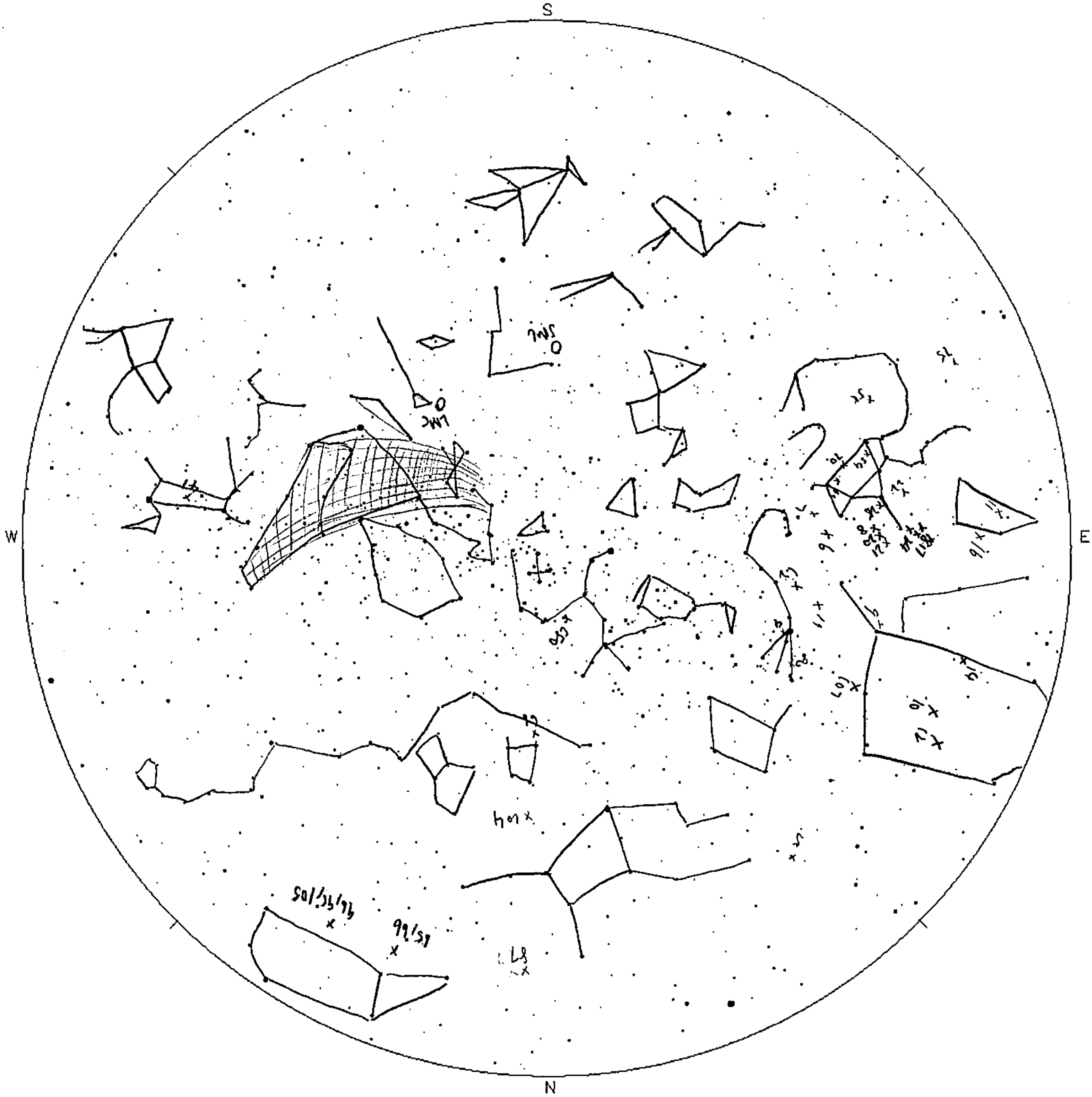

N
33
31,32, 110
34
70
45
39
29
71
52
103
56
57
92
13
38
36
37
1
35
E
W
14
10
12
102
101
40
81,82
97,108
109
106
51
63
94
3
44
67
5
64
85
53
virgo cluster
49, 58-61
84-91
98-100
104
S

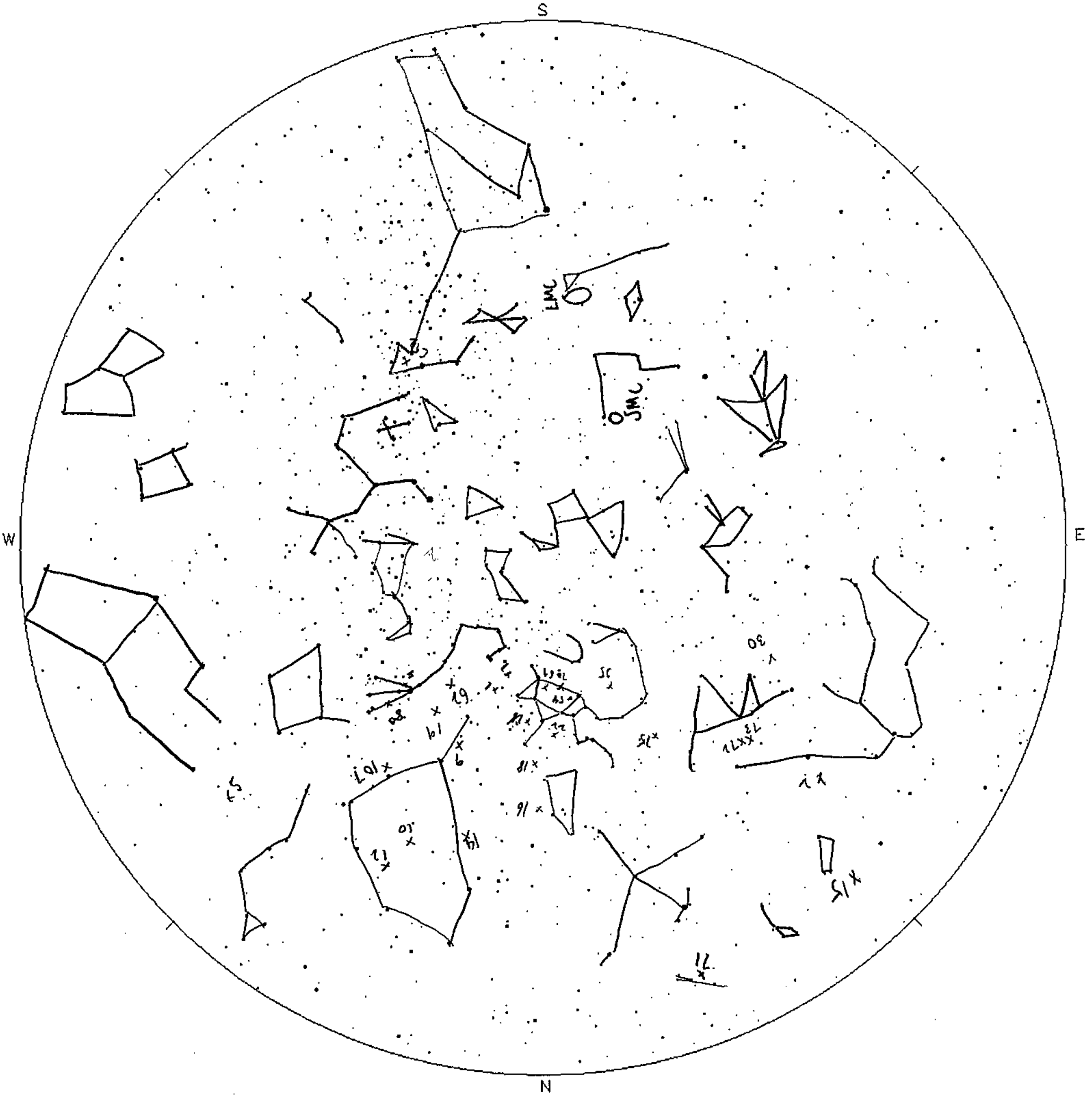

N
S
E
W
109
97,108
106
x 51
63
94
3 x
49
44
58-61
84-91
53
virgo 98-100
cluster
65,66 x
Leo triplet x
95,96,105
x 49
x 67
37 (35)
x 104
M5
x 48
46,47
x 50
x 78
42,43
41
89 x
83 x
C60
79 x
1
19
62
4
C76
+ 6
x 7
69
LMC
x SGR
SMC


N
E
W
S
35
37
36
38
x1
M41
34
76
NGC281
54/53
31,32,110
33
29
57
56
78x
42/43
75
93
OSML


N
E
W
S
28/8:
57
81
97,108
51
63
94
106
Hercules GC
44
67
64
87
49
Virgo
Leo Triplet
15,96,105
104 (Sombrero)
68
9
10
4
62
80


N
E
W
S
92
13
75
55
54
78
22
4


S
W
E
N
LMC
SMC
x 104


S
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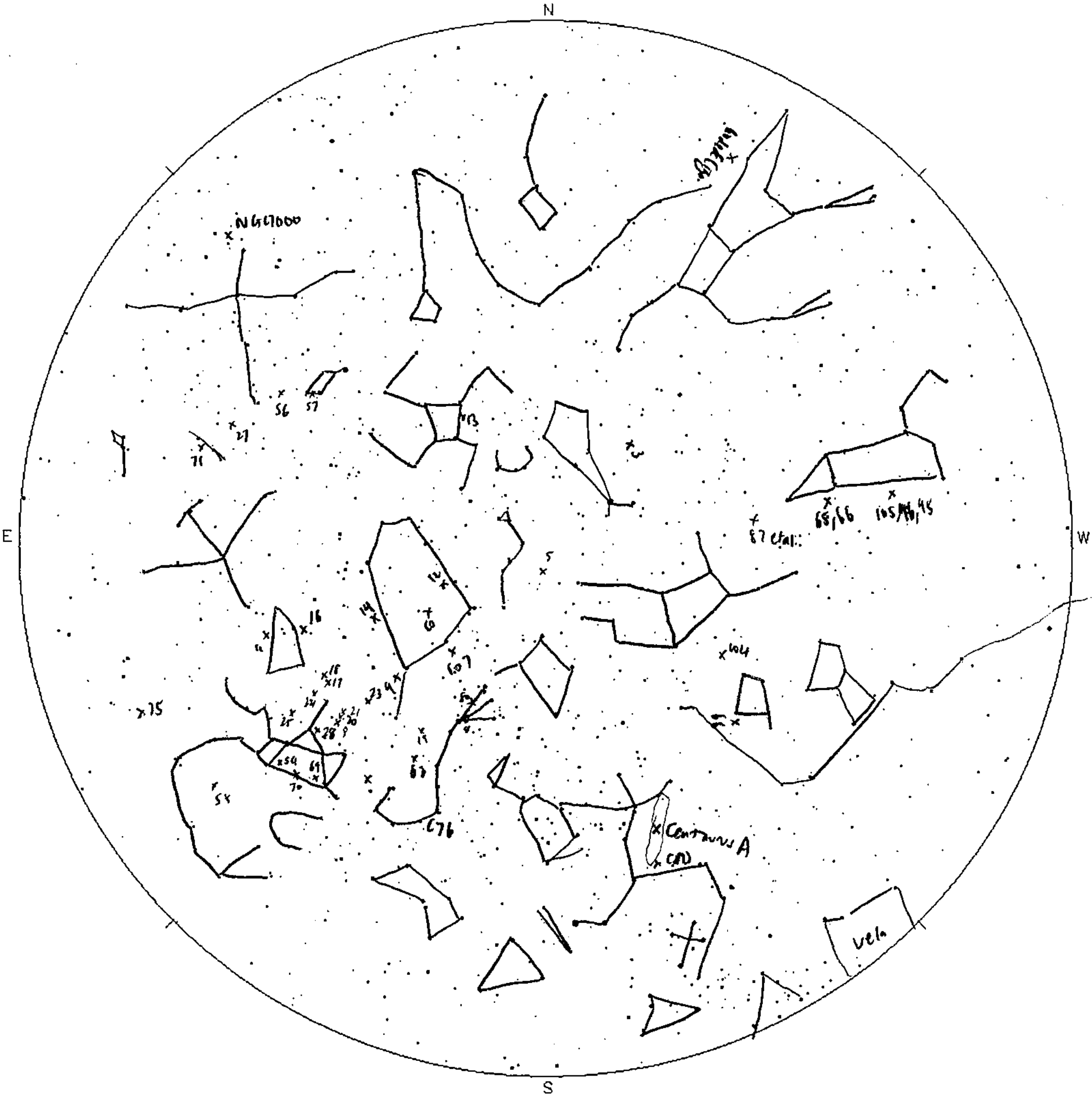
LMC
SMC


N
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NGC7000
Algieba
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57
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71
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68,66
105/96,95
87 etal.
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107
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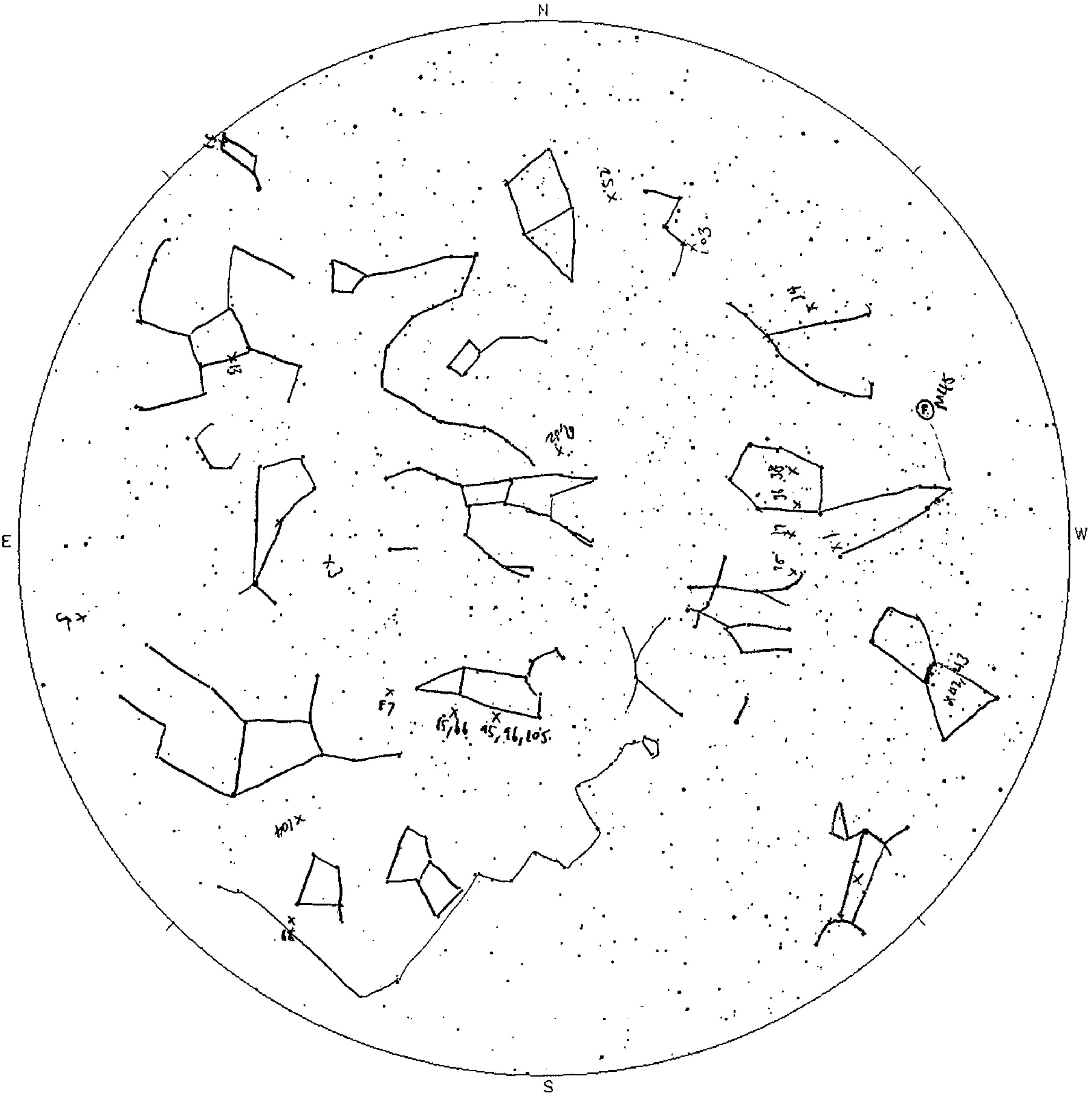
C76
75
104
83
Centaurus A
C80
Vela


N
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57
52
103
34
M45
F
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81, 82
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36, 38
37
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35
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95, 96, 105
42, 43
104
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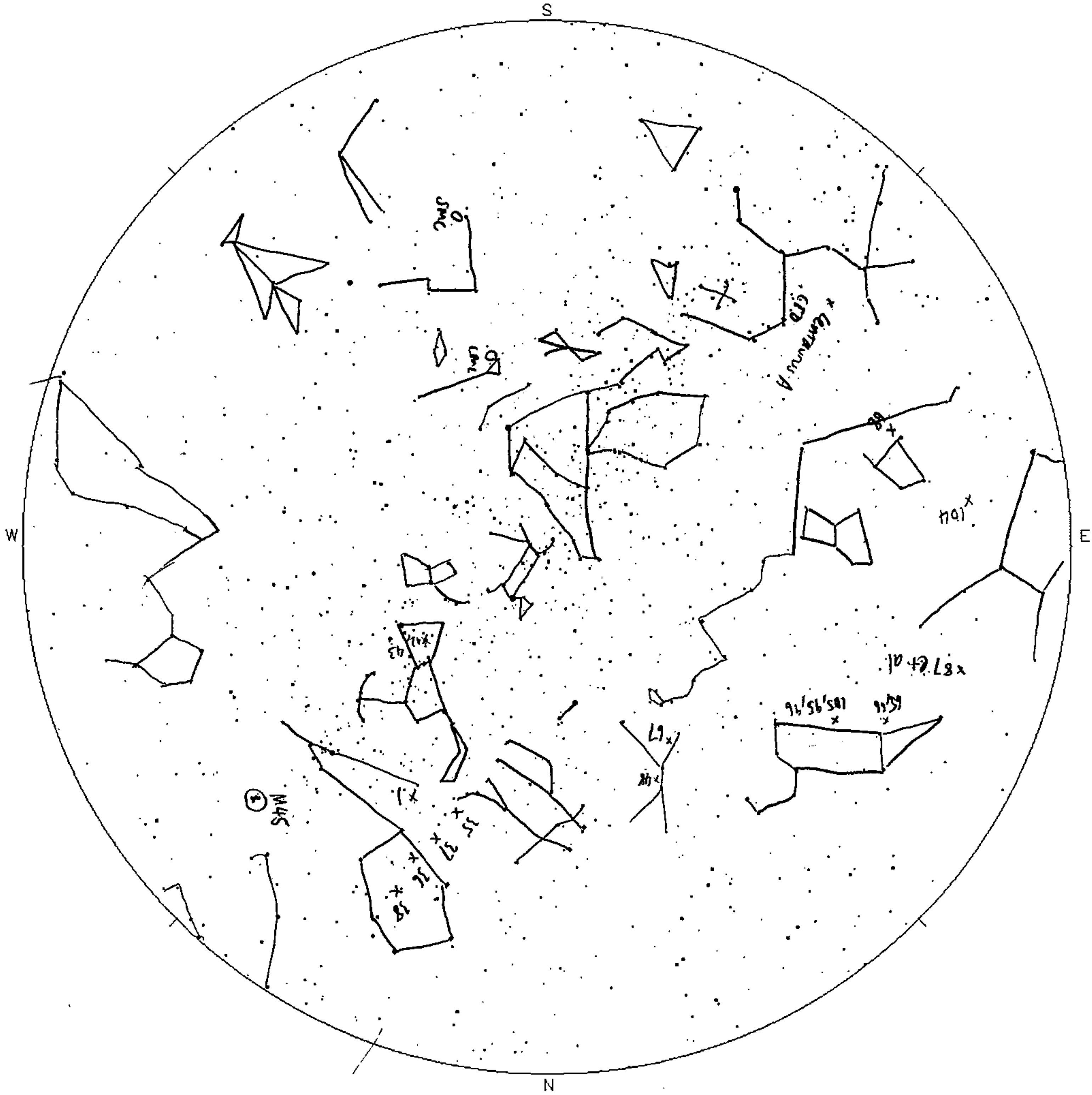
S
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SMC
LMC
ω Cen
Centaurus A
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x104
x87 et al
65,66
105,95,96
x67
x48
*42,
43
x1
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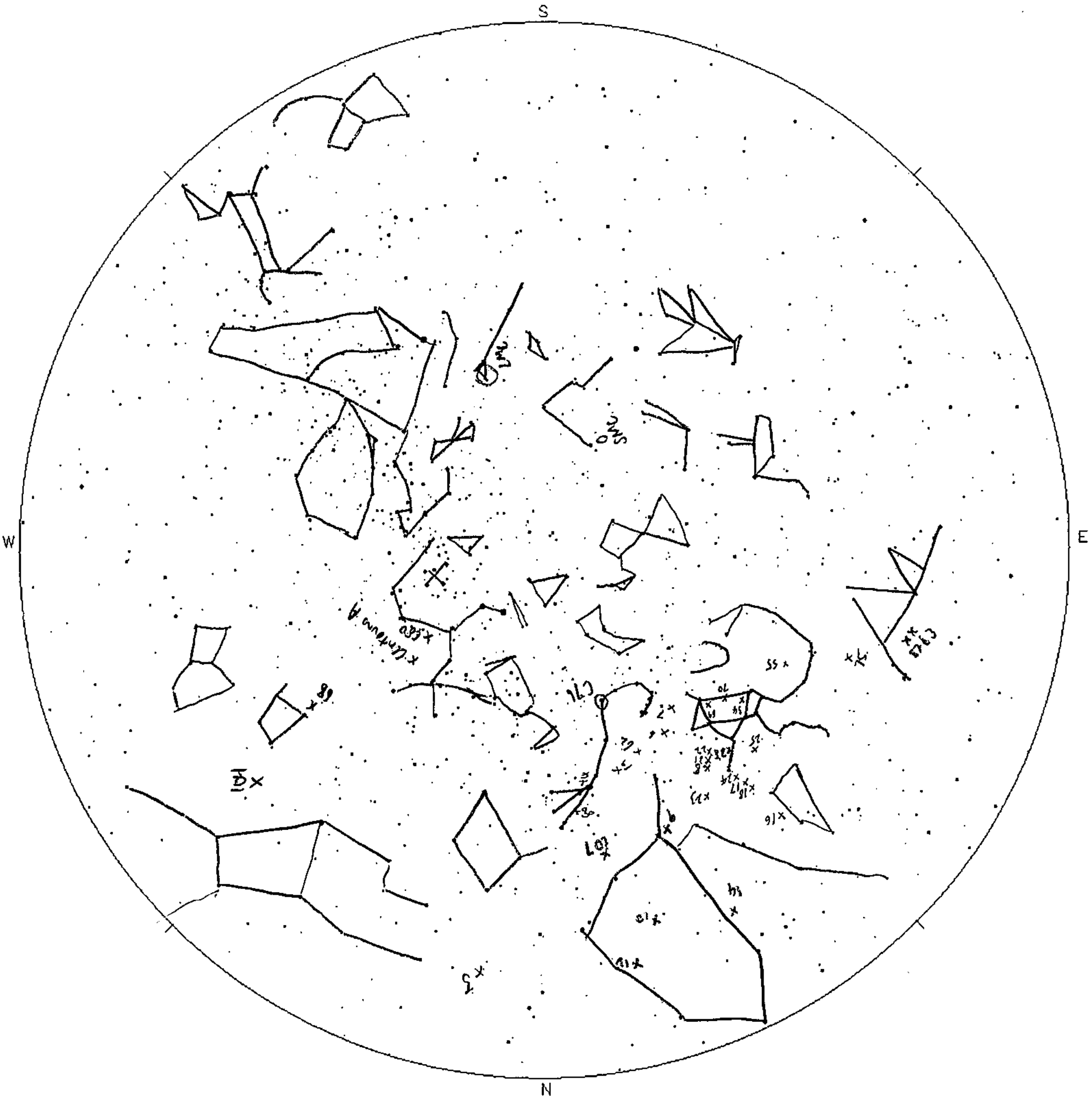
37
36
38
M45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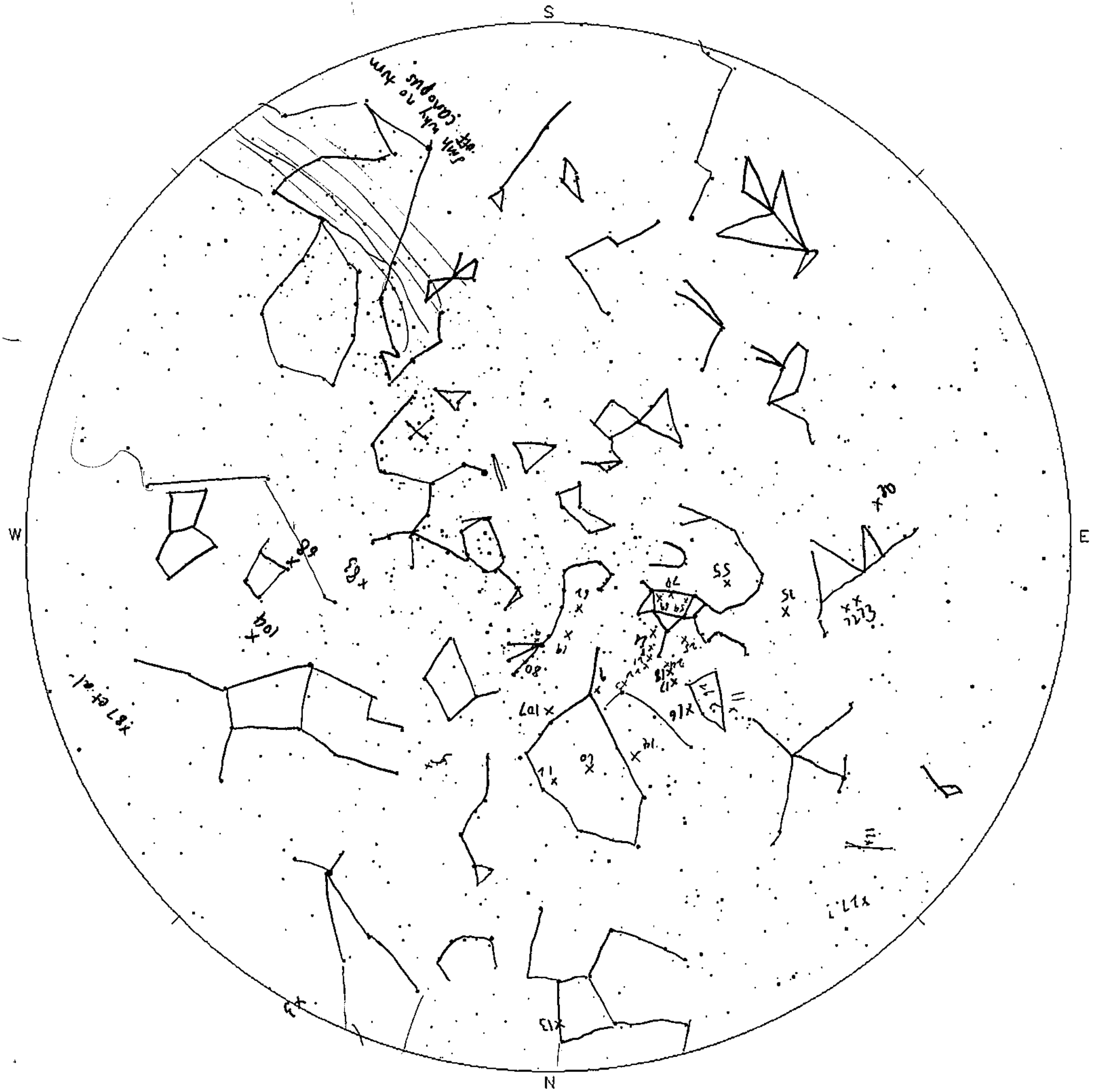
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Smh why no turn off Canopus
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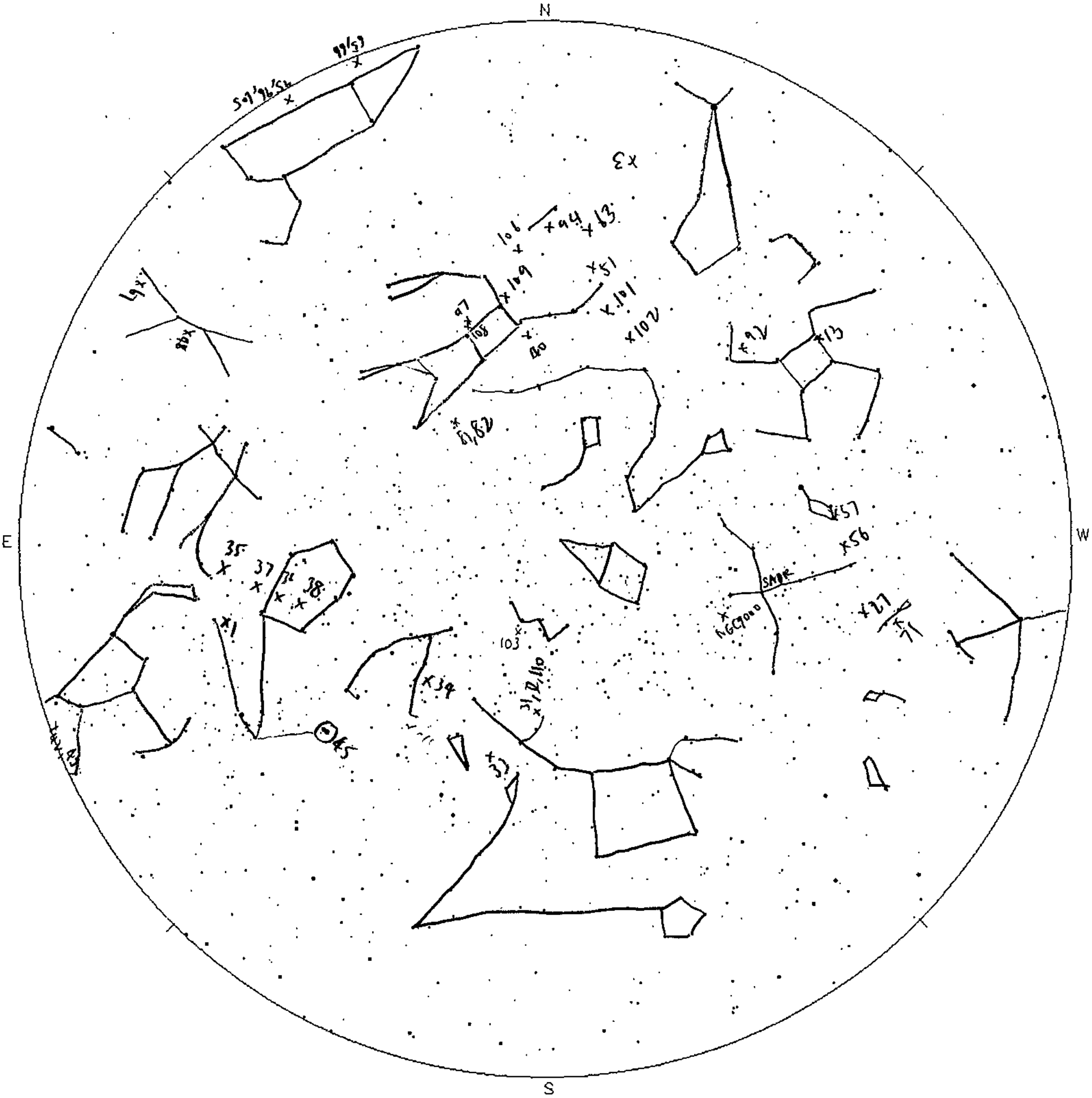
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95/96/105
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81, 82
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92
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SN1R
NGC 7000
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103
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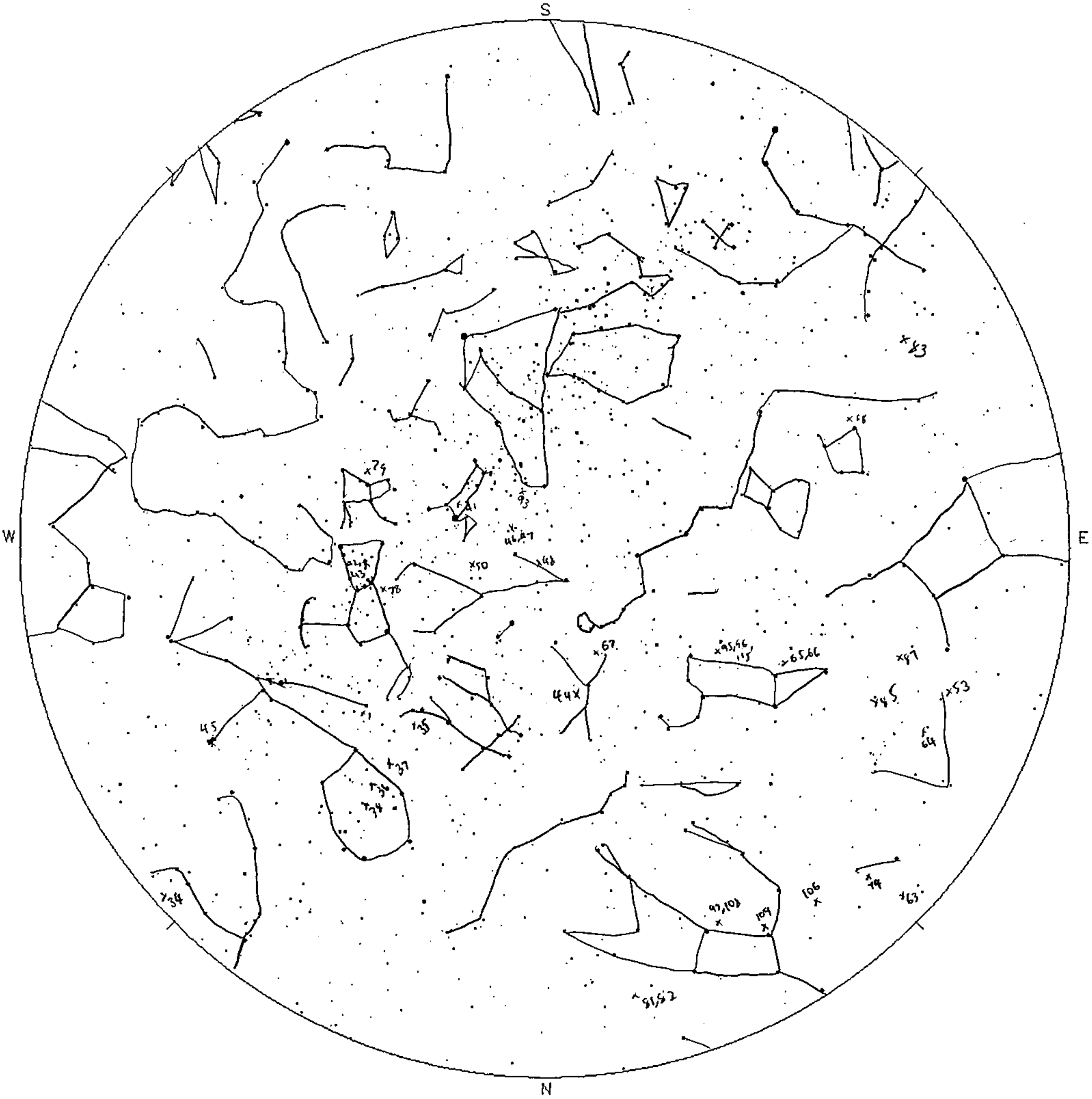
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×83
×58
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81
93
46,47
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×78
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44×
×95,96,113
×65,66
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97,108
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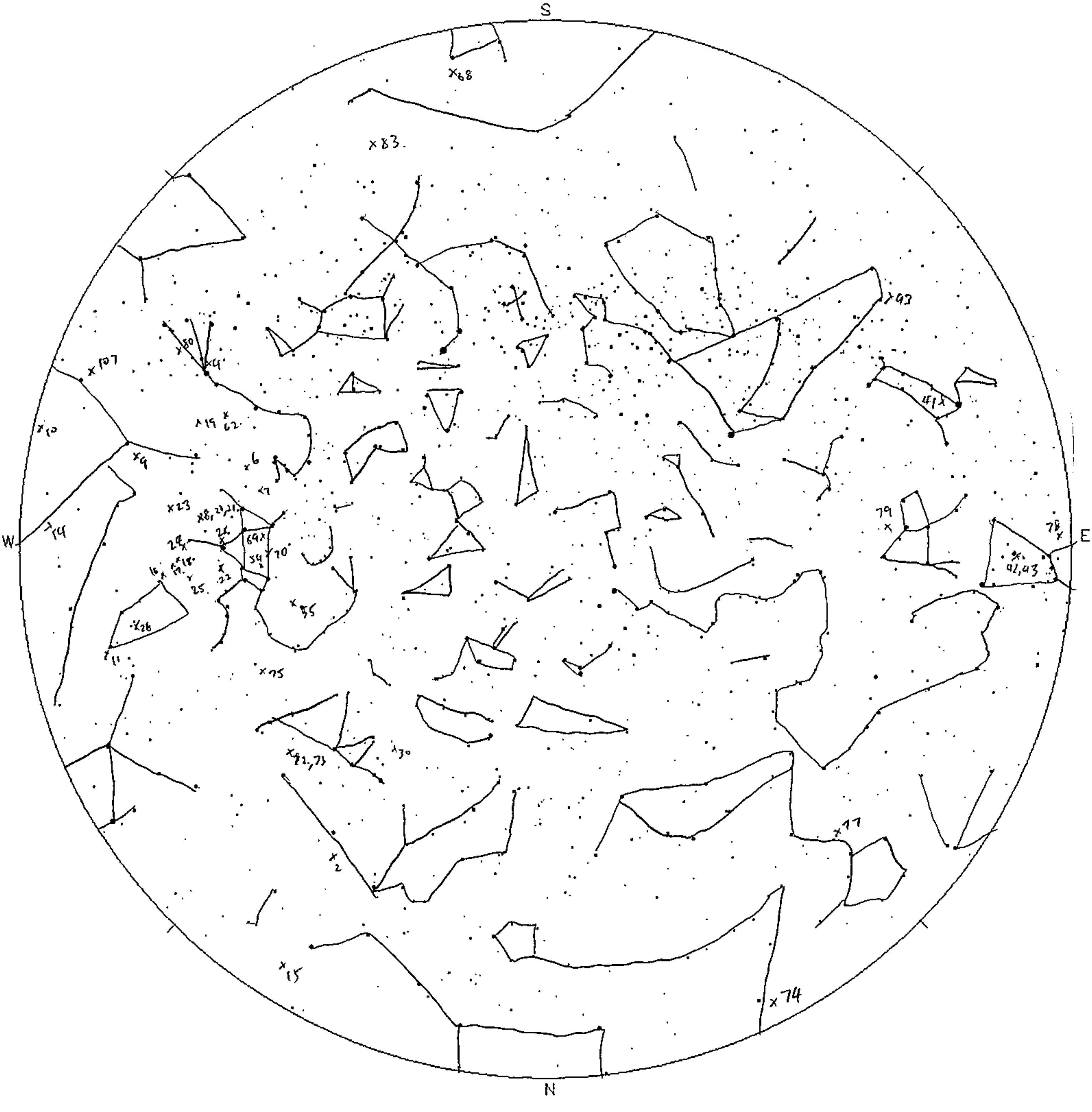
S
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x93
x107
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x10
x19
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x6
x9
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x23
x8, 20, 21
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64
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x28
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x55
x75
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78
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42, 43
x72, 73
x30
x2
x77
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81,82
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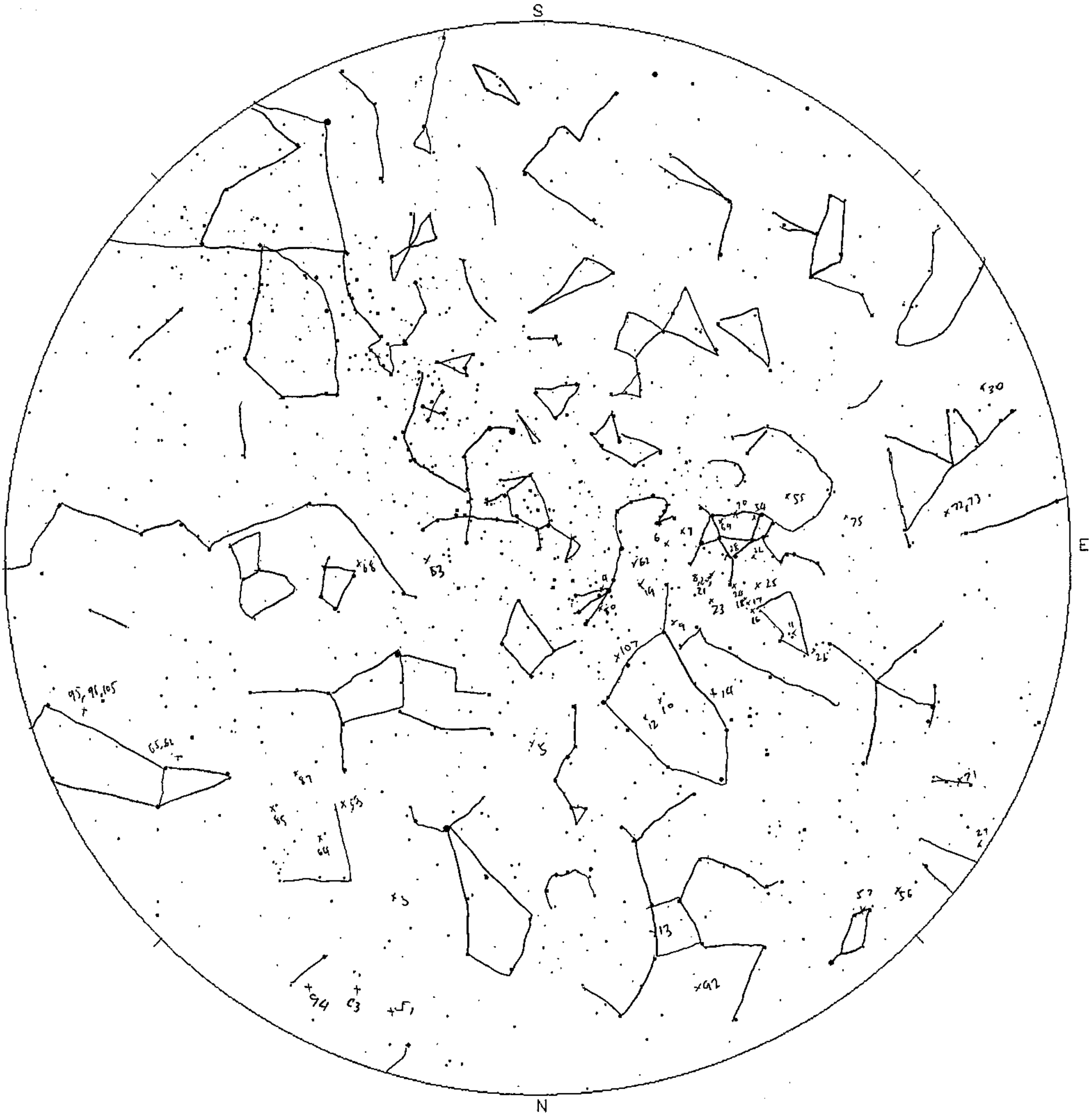
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94
C3
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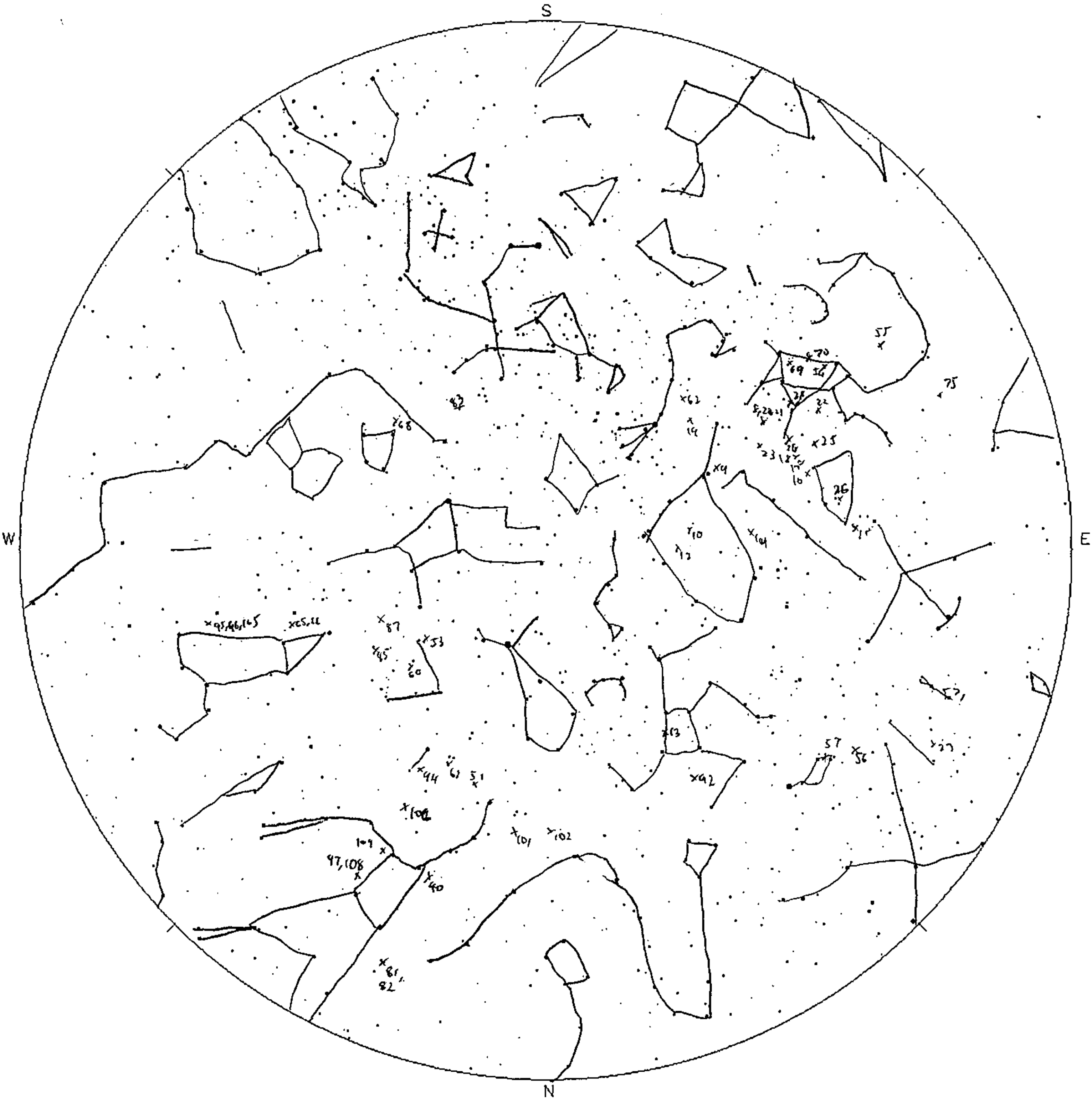
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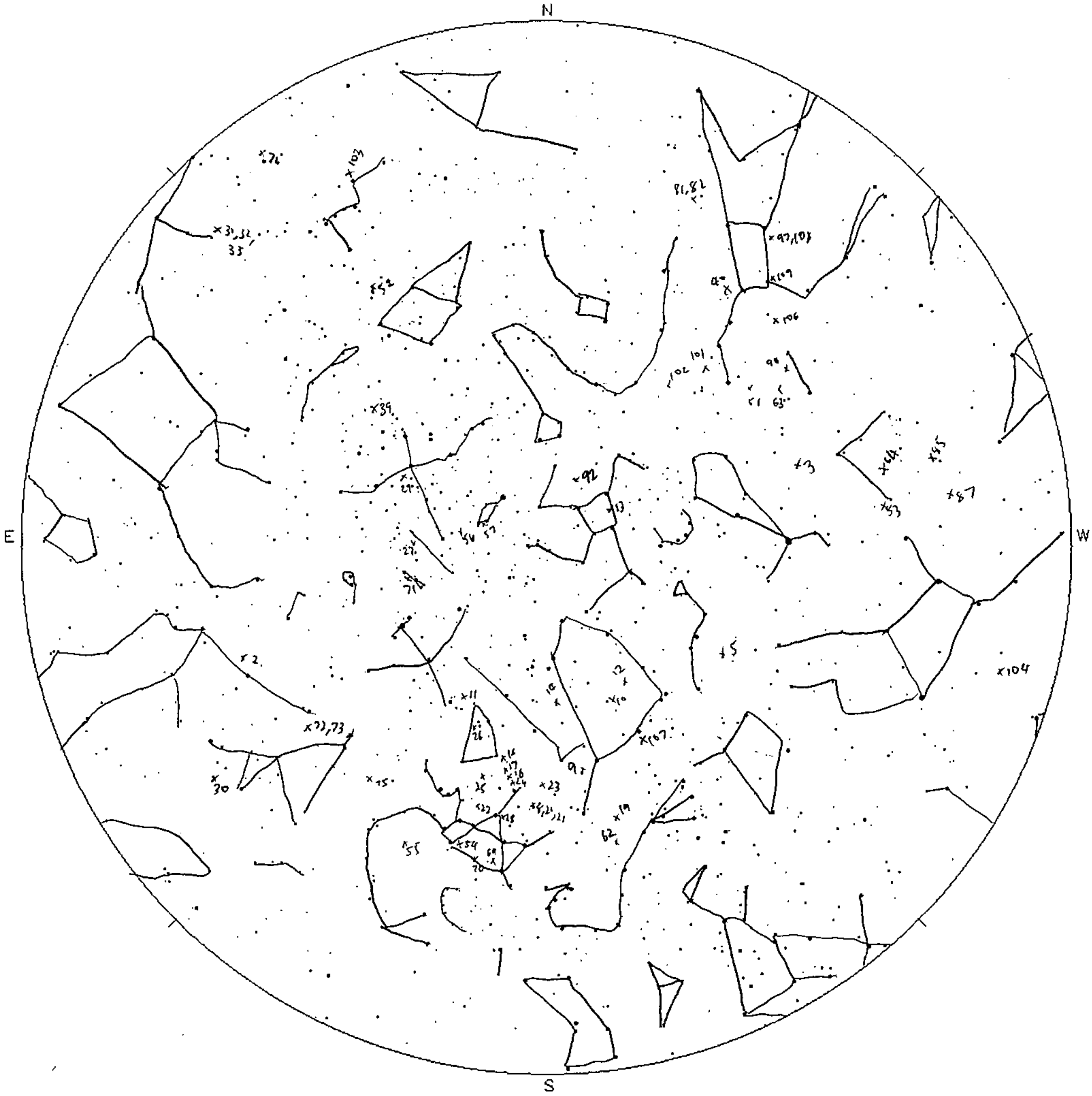
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31, 32, 33
81, 82
97, 108
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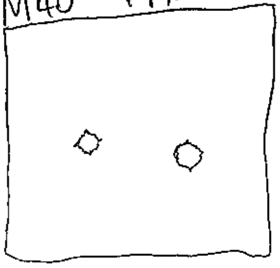
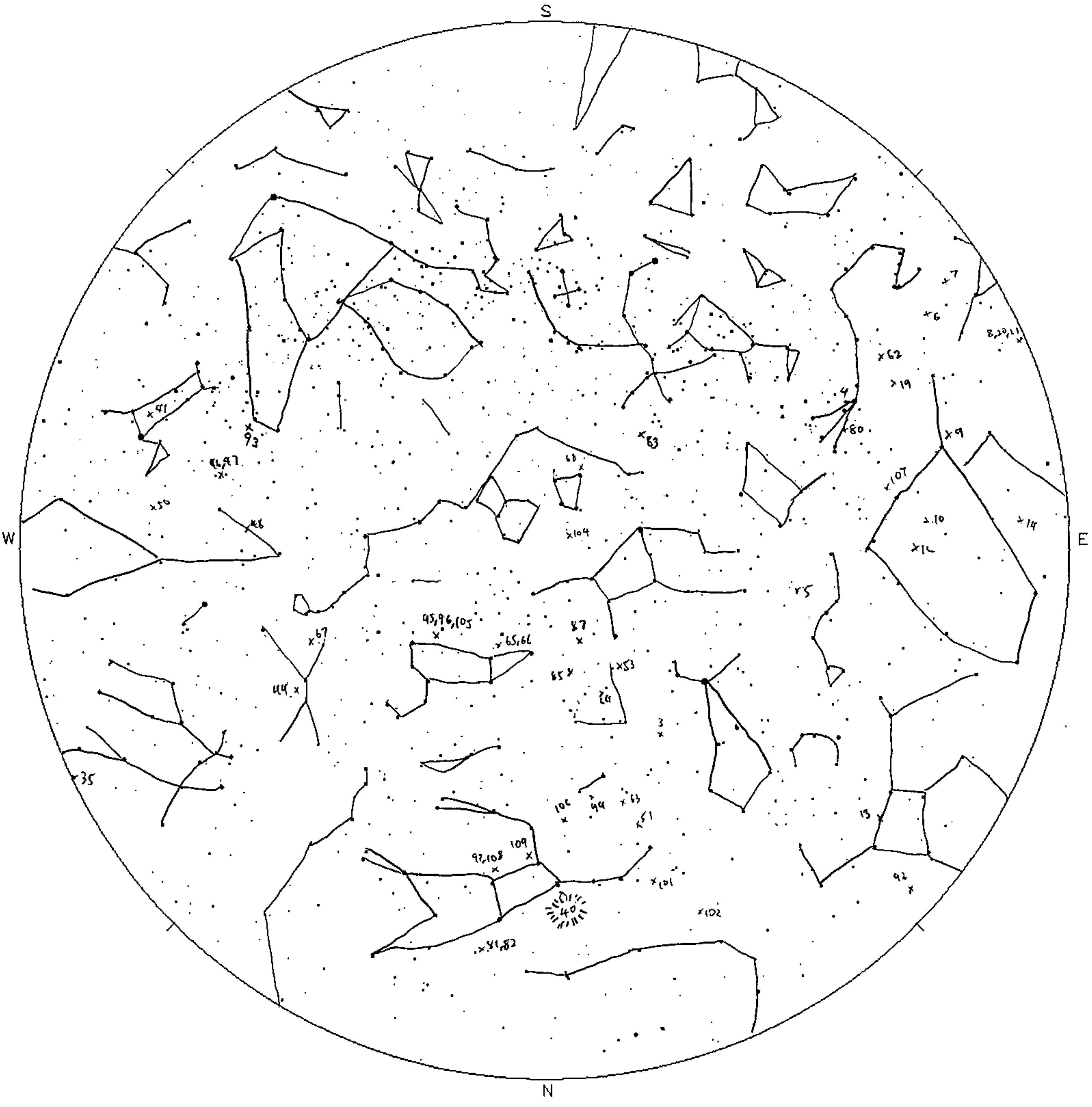
Reached on 23/9/2022 3:30

M40 FANART

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68
x104
x41
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x67
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x65,66
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x81,82
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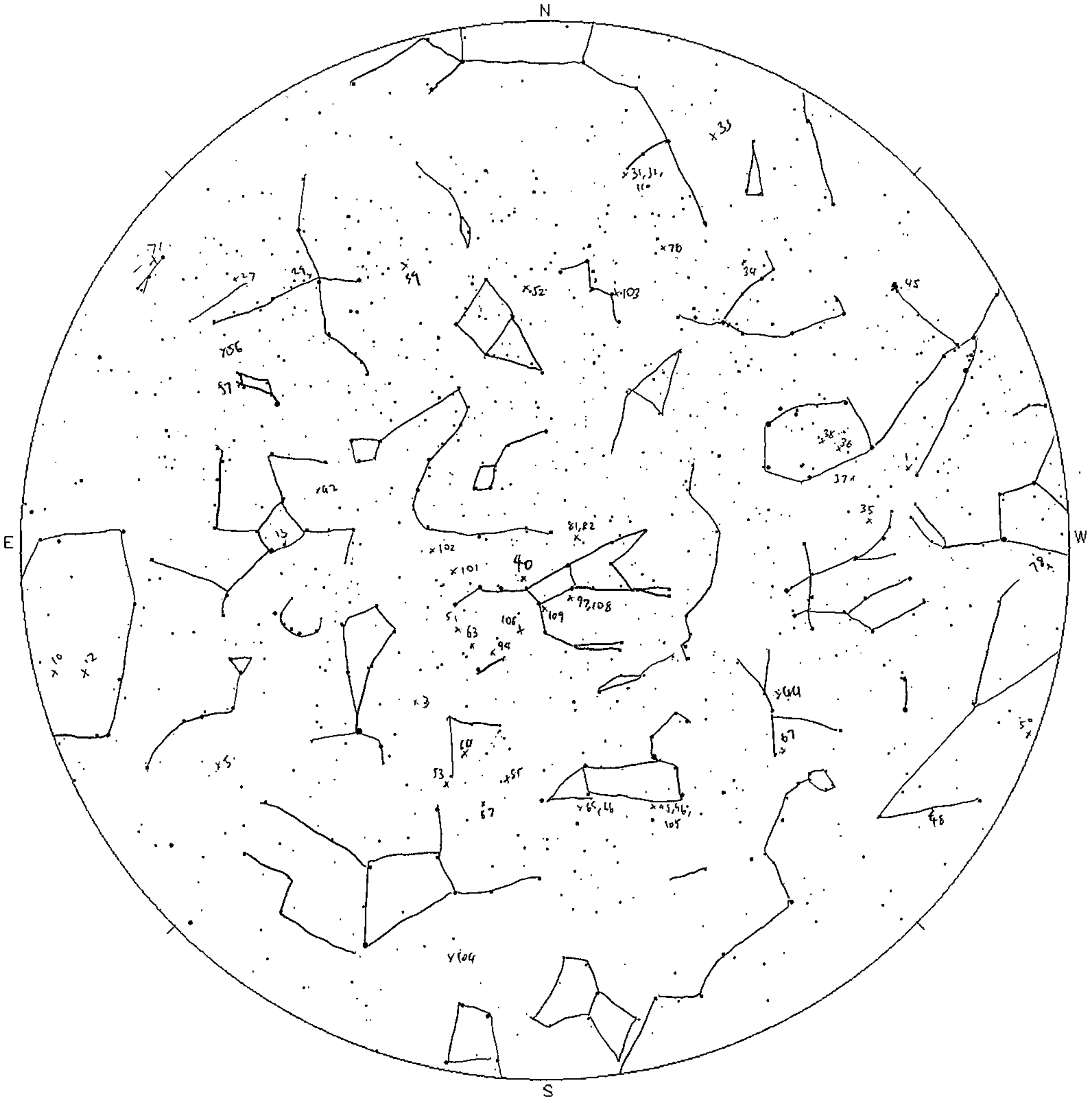
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81, 82
x102
x101
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97, 108
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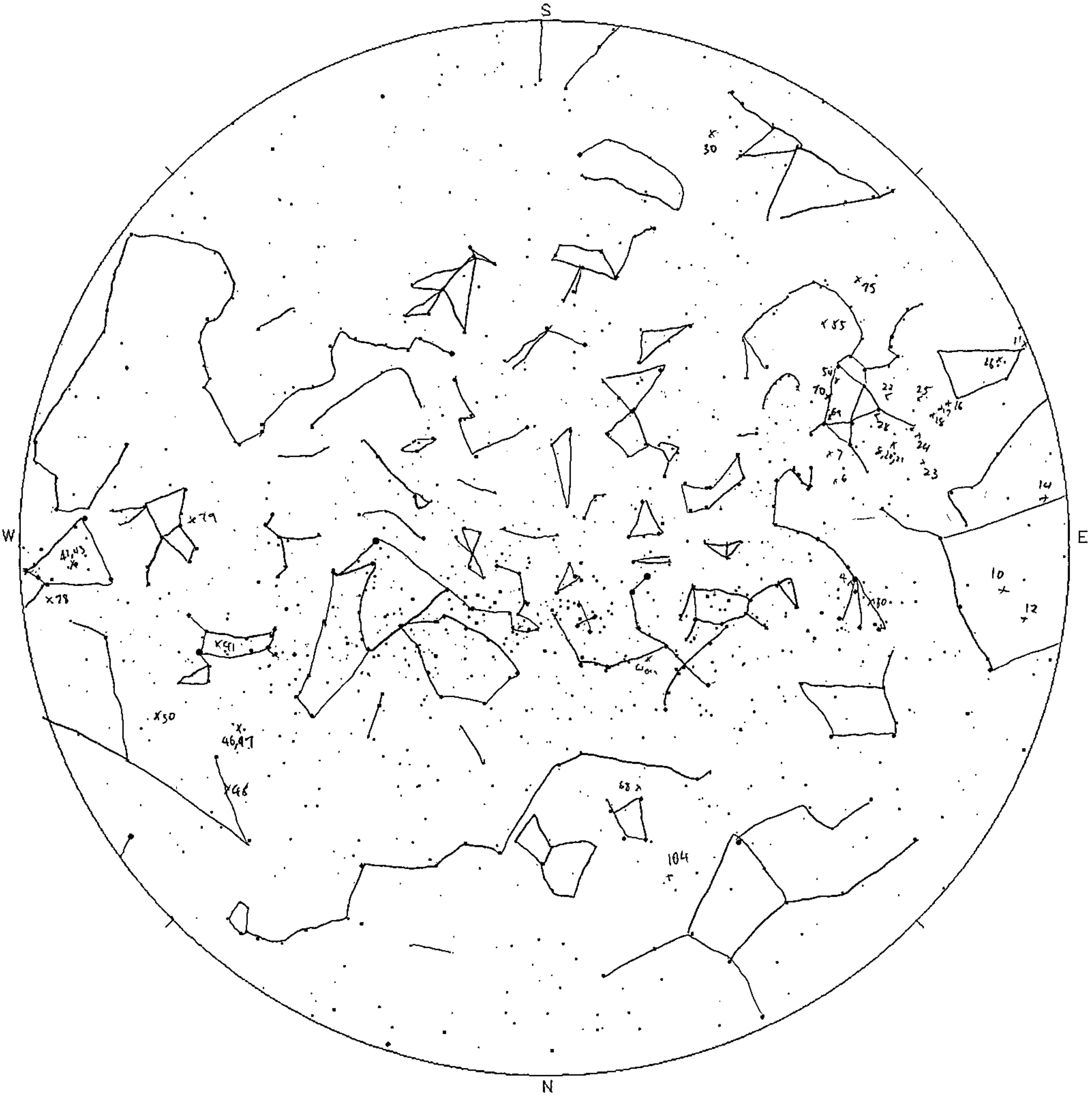
95, 96,
105
48
104


S
x 30
x 15
x 35
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x 16
x 17
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5, 20, 21
x 23
x 7
x 6
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x 79
41, 43
x 78
E
10 x
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x 51
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46, 47
x 46
68 x
104
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×93
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×107
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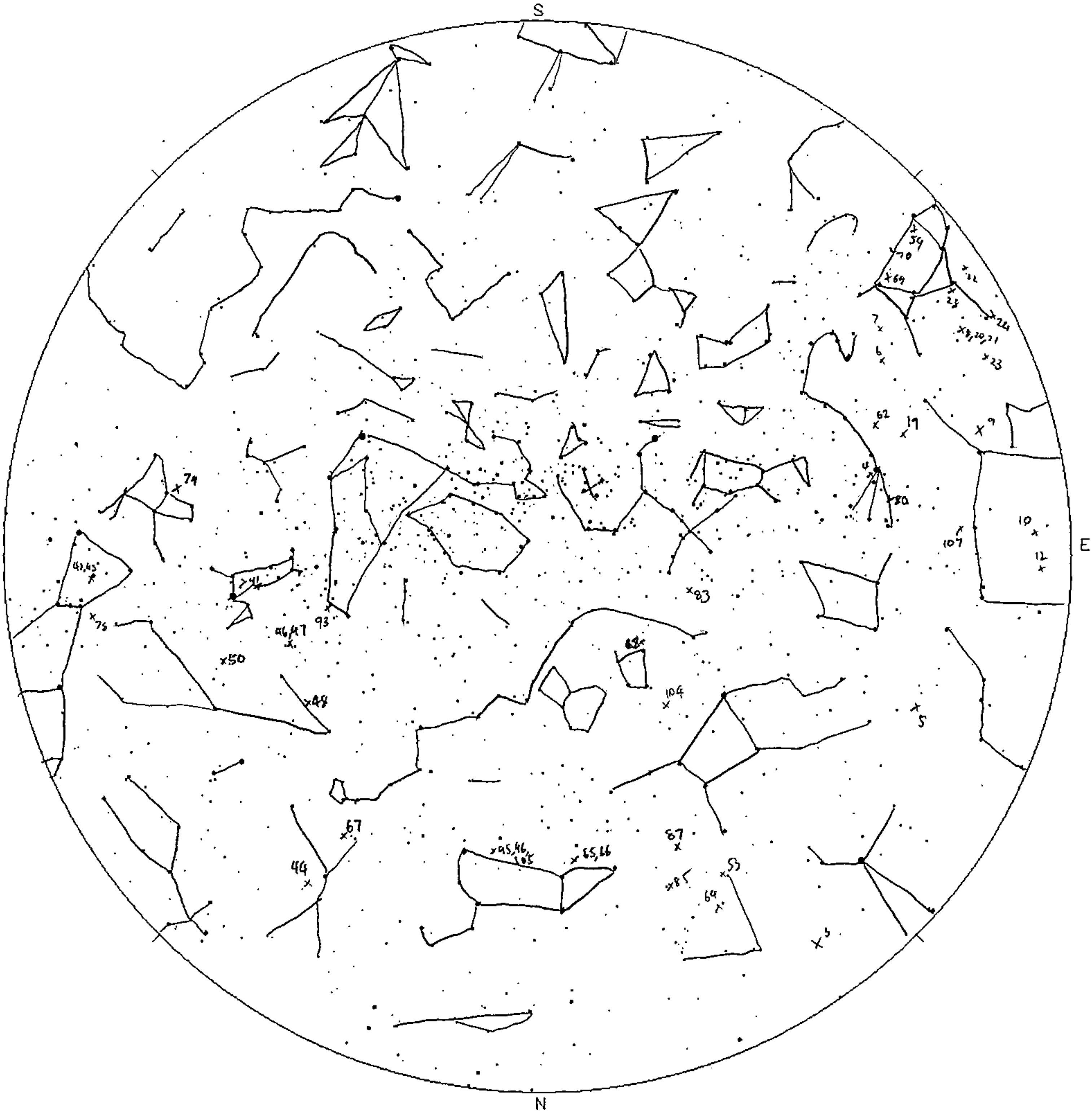
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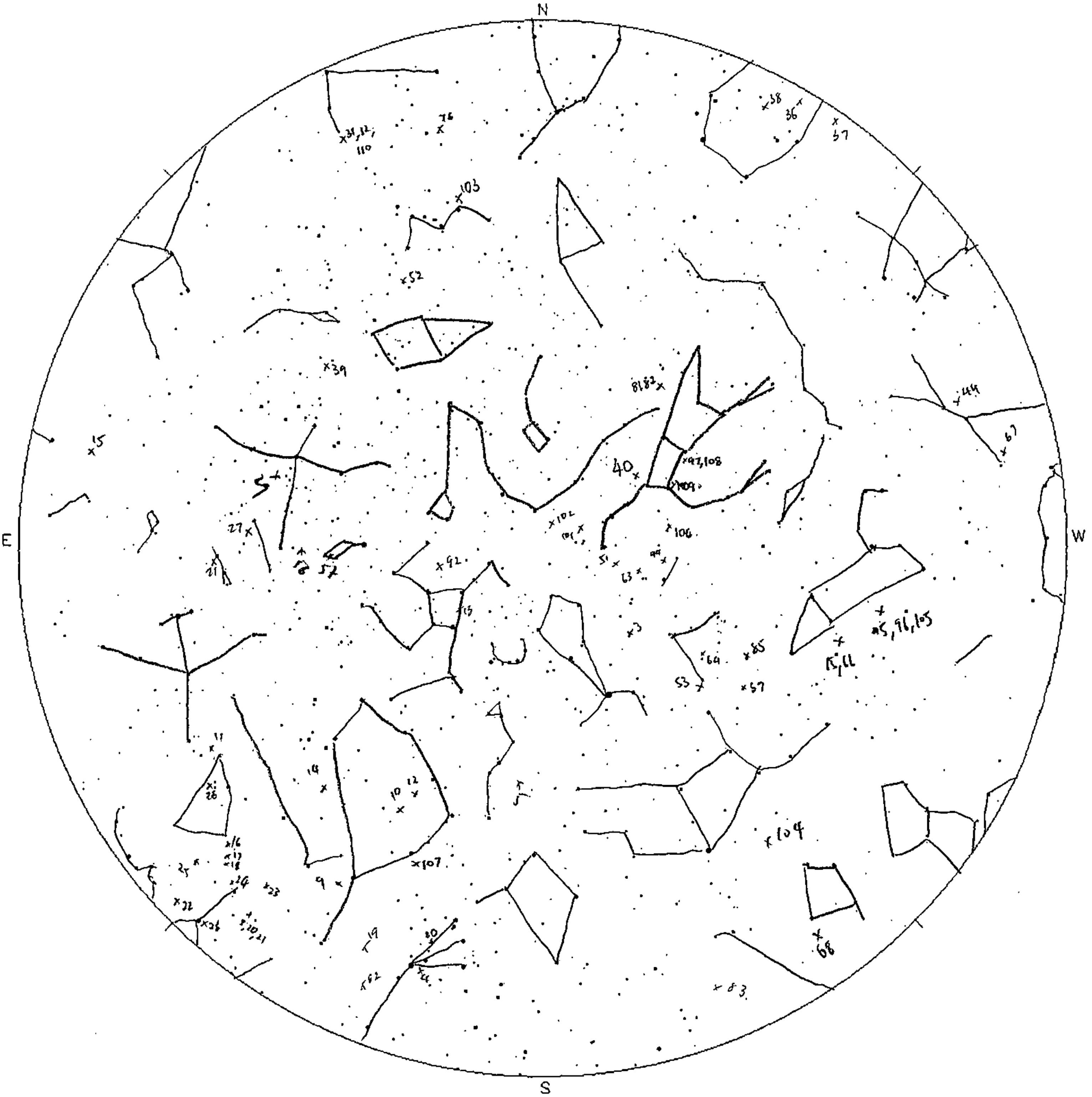
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x31,12,110
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x97,108
x109
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27x
21
18 57
x102
101x
x106
51x
63x
99x
x92
13
x3
x64
x85
53x
x57
x5,96,105
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x17
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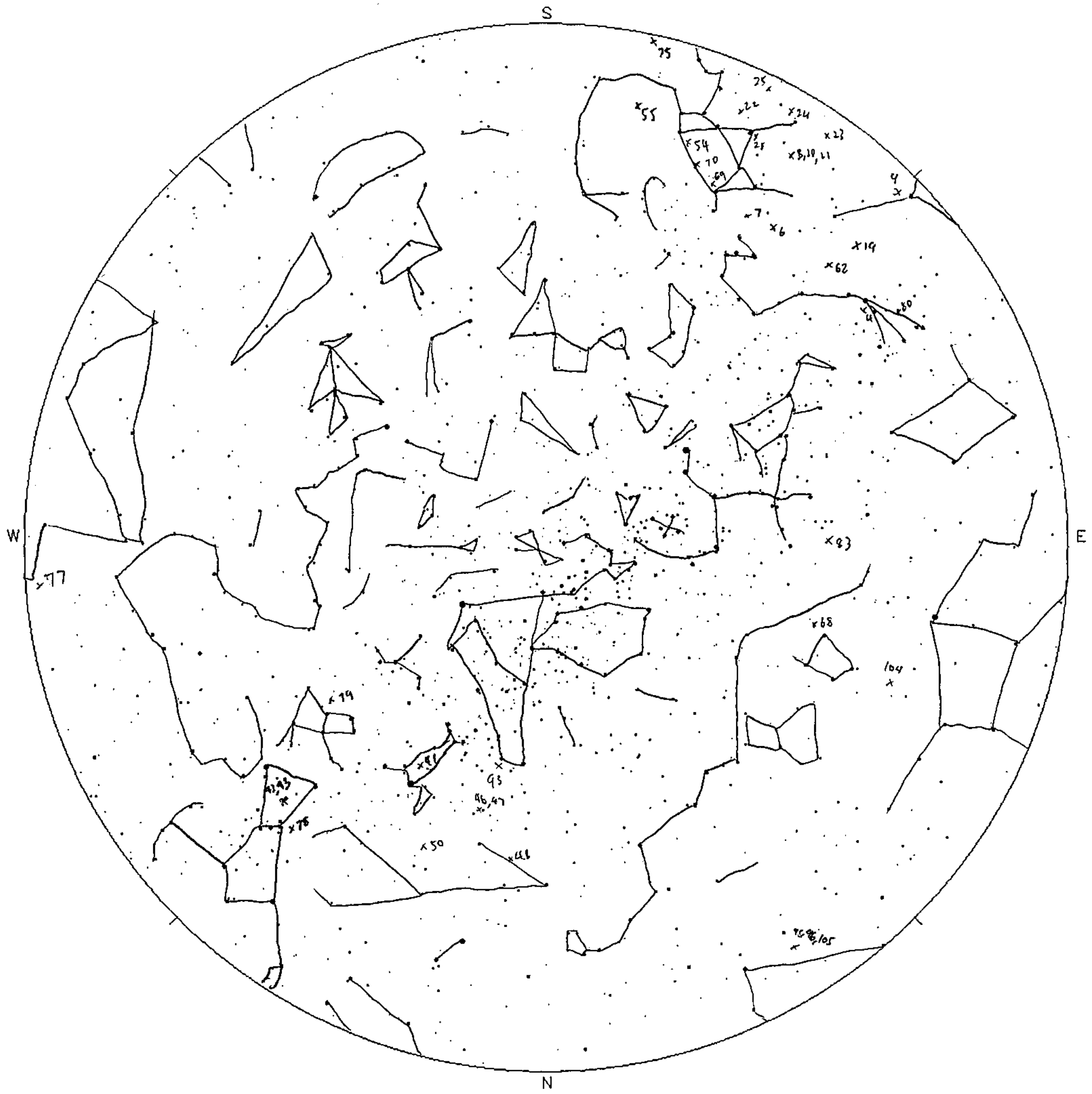
x83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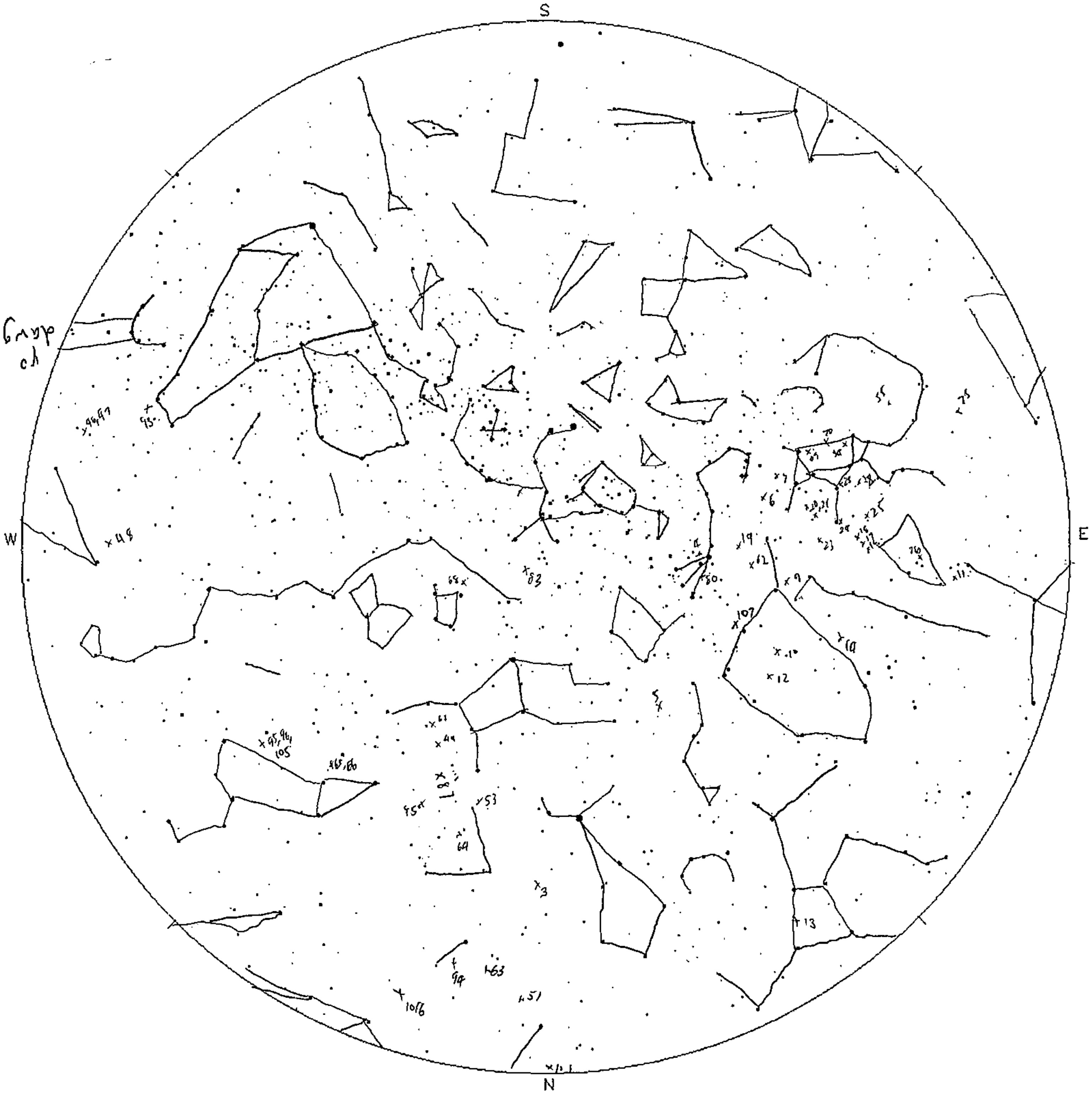
95,96,105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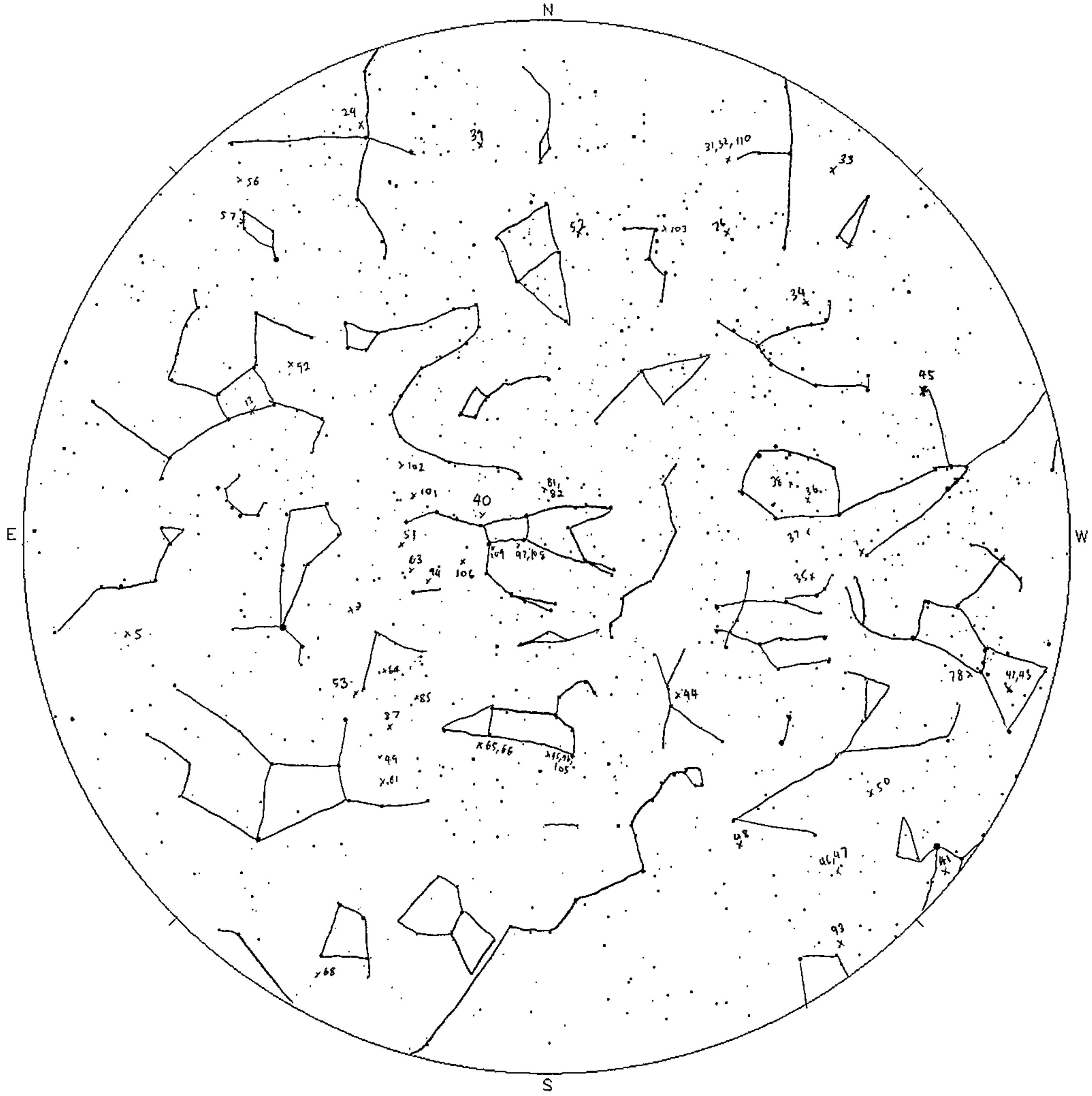
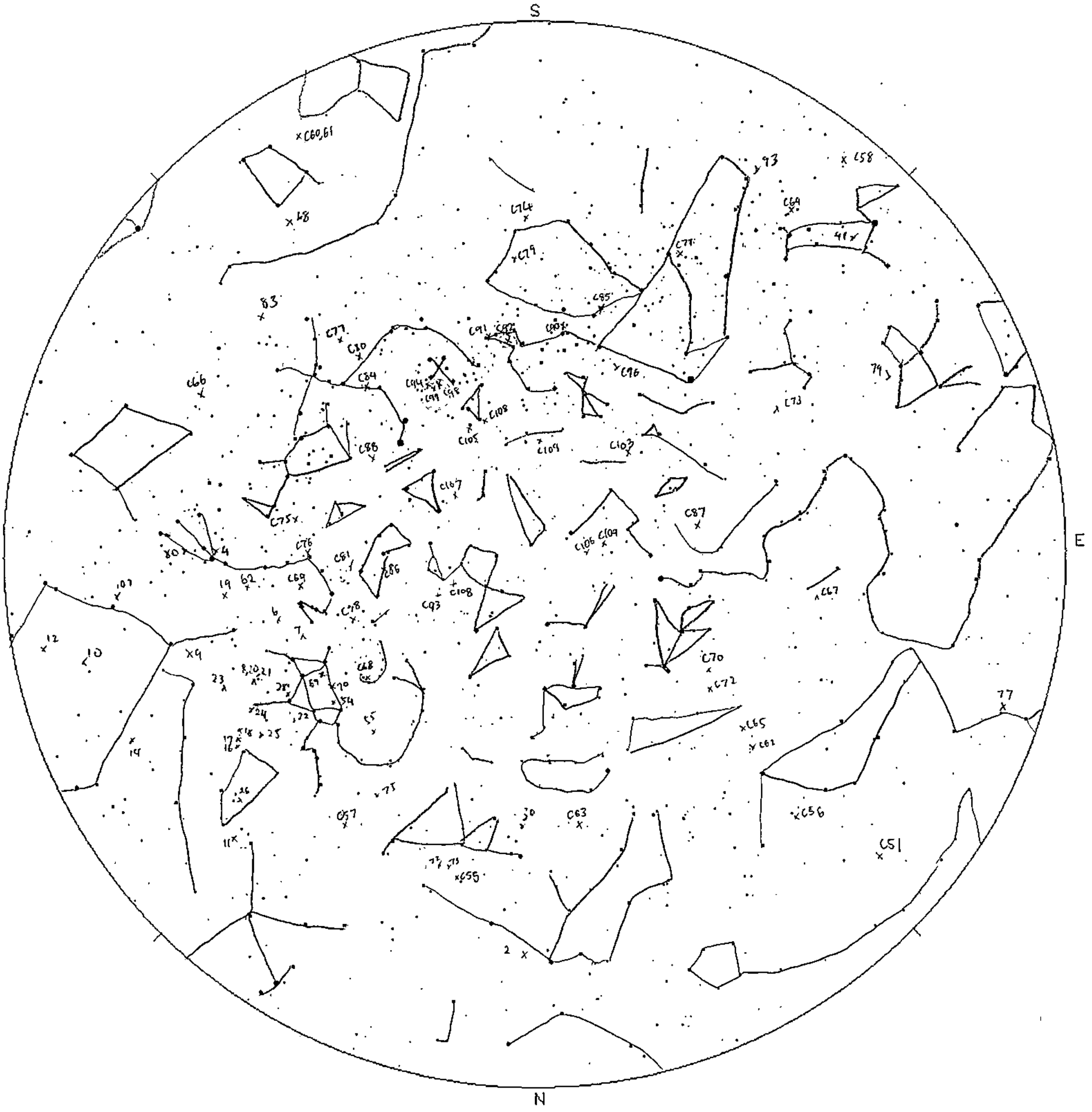
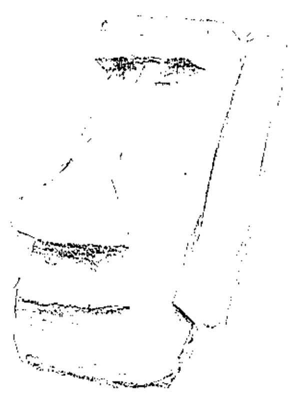


Hello from Hackathon 2022!

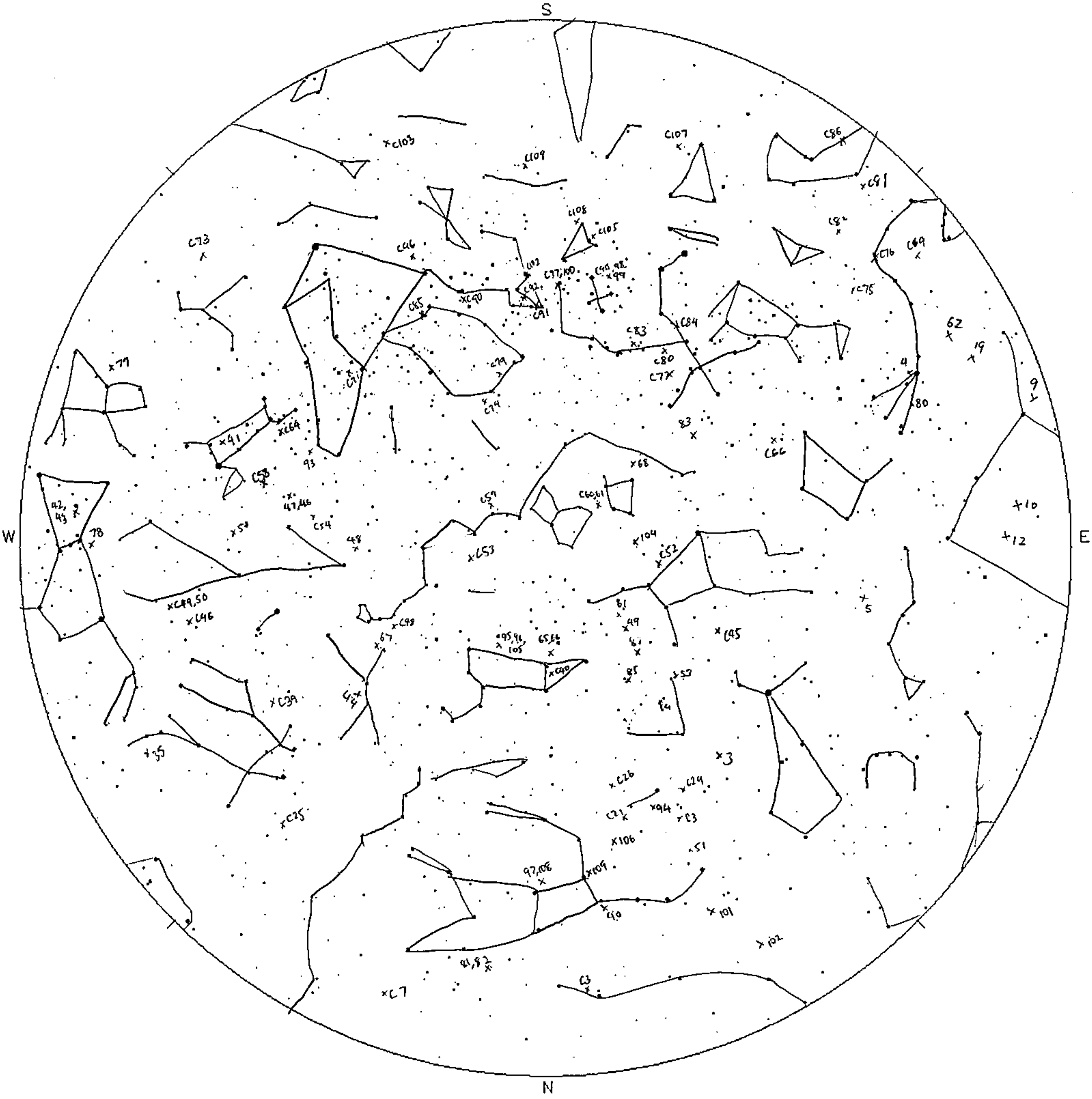
im doing this at 2am
im not even in hackathon im just
staying overnight for cubesat

also, thanks for reading this far! love u! ♡





Oh yeah, ill probably
note down some caldwell
ones...


S
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C109
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C99,98
C97,100
C102
C92
C91
C90
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C84
C80
C7
62
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C66
C64
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93
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47,46
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C60,61
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104
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C49,50
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C39
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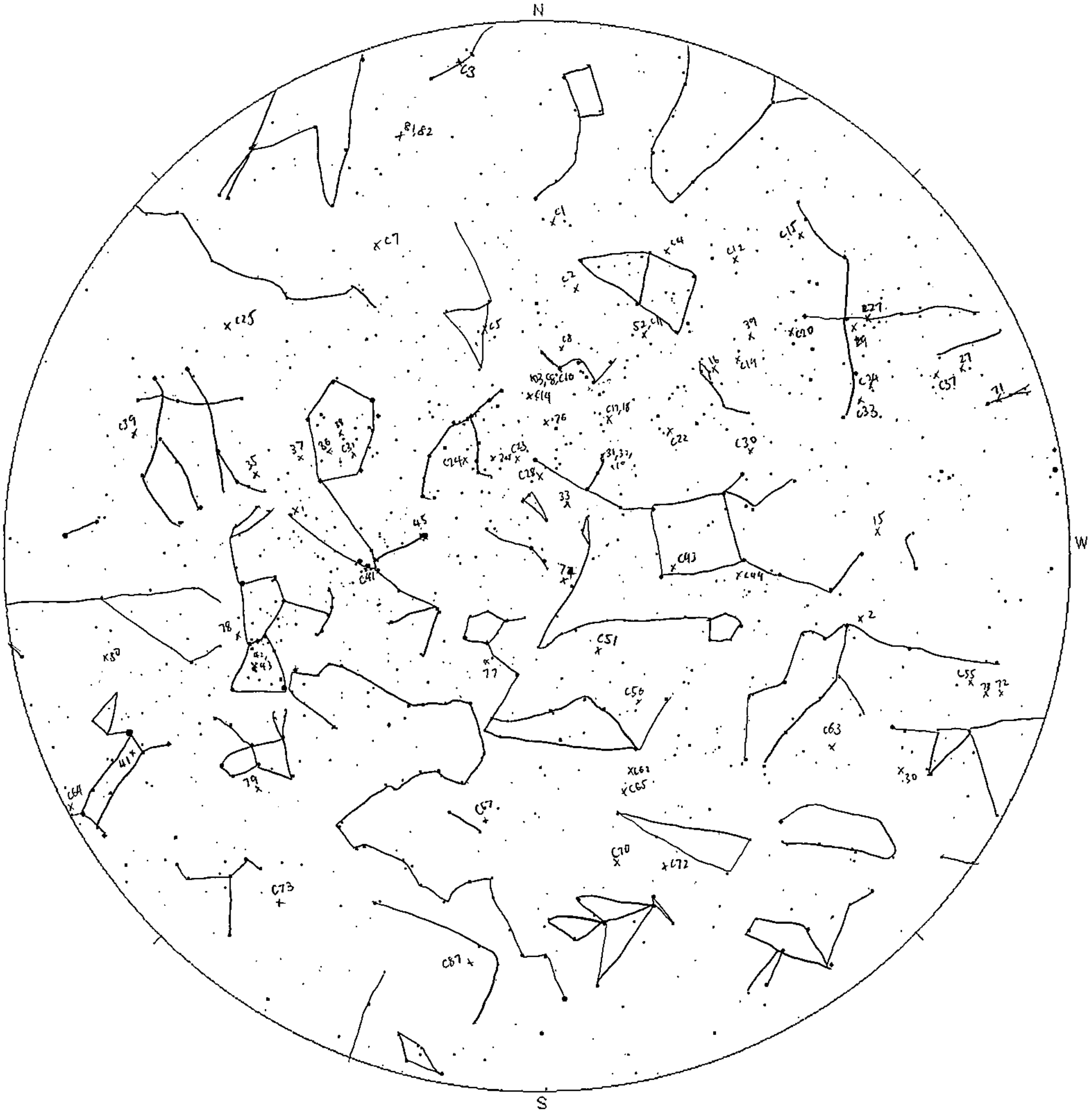
C3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103, 58, C10
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C57
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C39
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C31
76
C17, 18
C22
C30
C24
24
C23
C28
31, 32, 110
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C41
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C43
C44
74
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77
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C72
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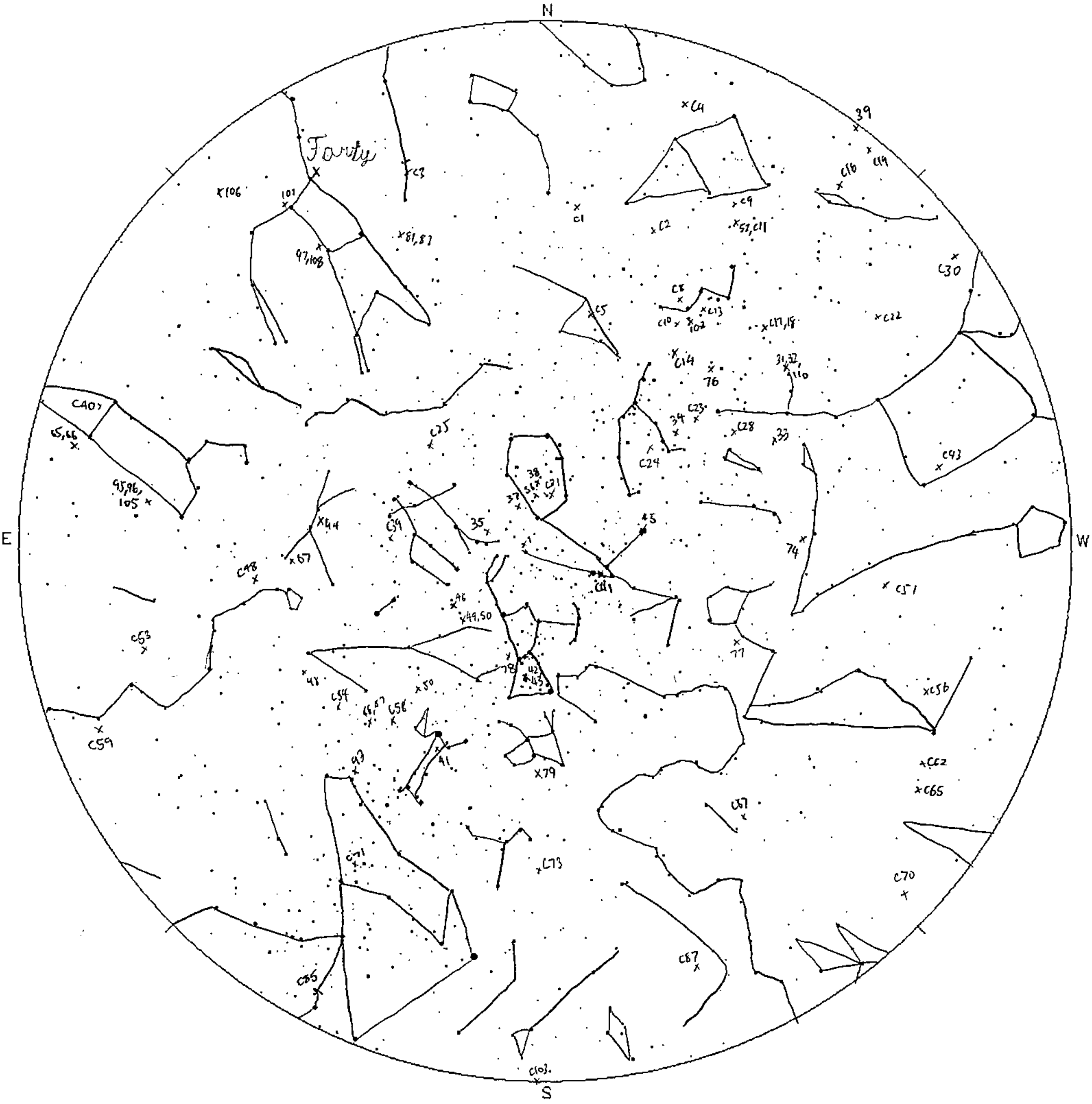
C87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x52, C11
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C8
x C13
C10
102
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x33
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X44
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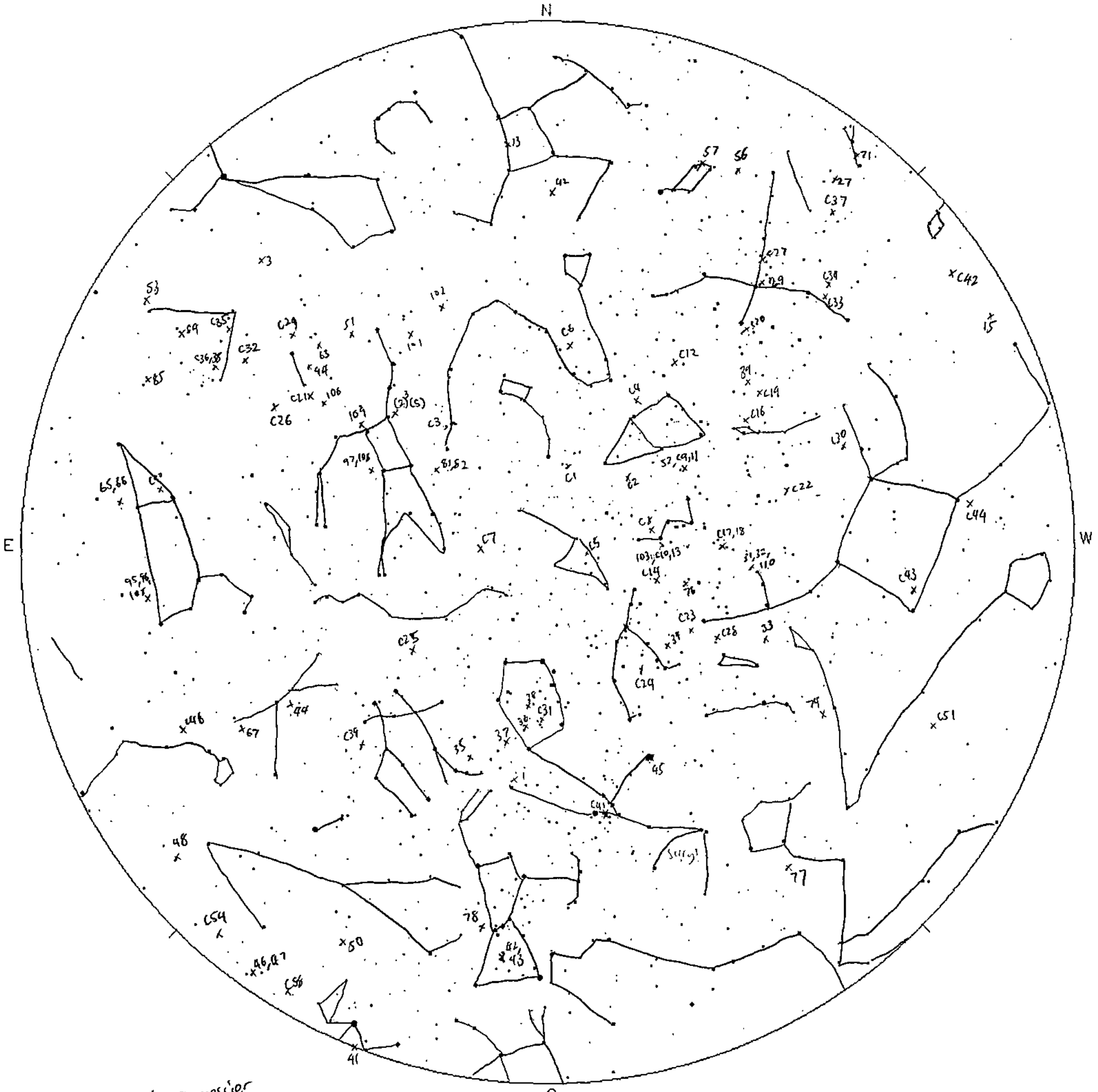
C103

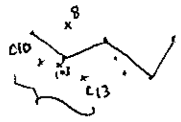


unlabeled → messier

C prefix → caldwell

if there's too many to individually write out in an area,
I'll just list it with commas.

Eg:



becomes

103, C10,13

messier caldwell

π!!

↓

314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C69
41
C71
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x C60,61
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104
x 68
C85
C90
C96
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C77
C80
C83
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C92
C97, 100
C102
C94,98,99
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72,73,C55
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C20
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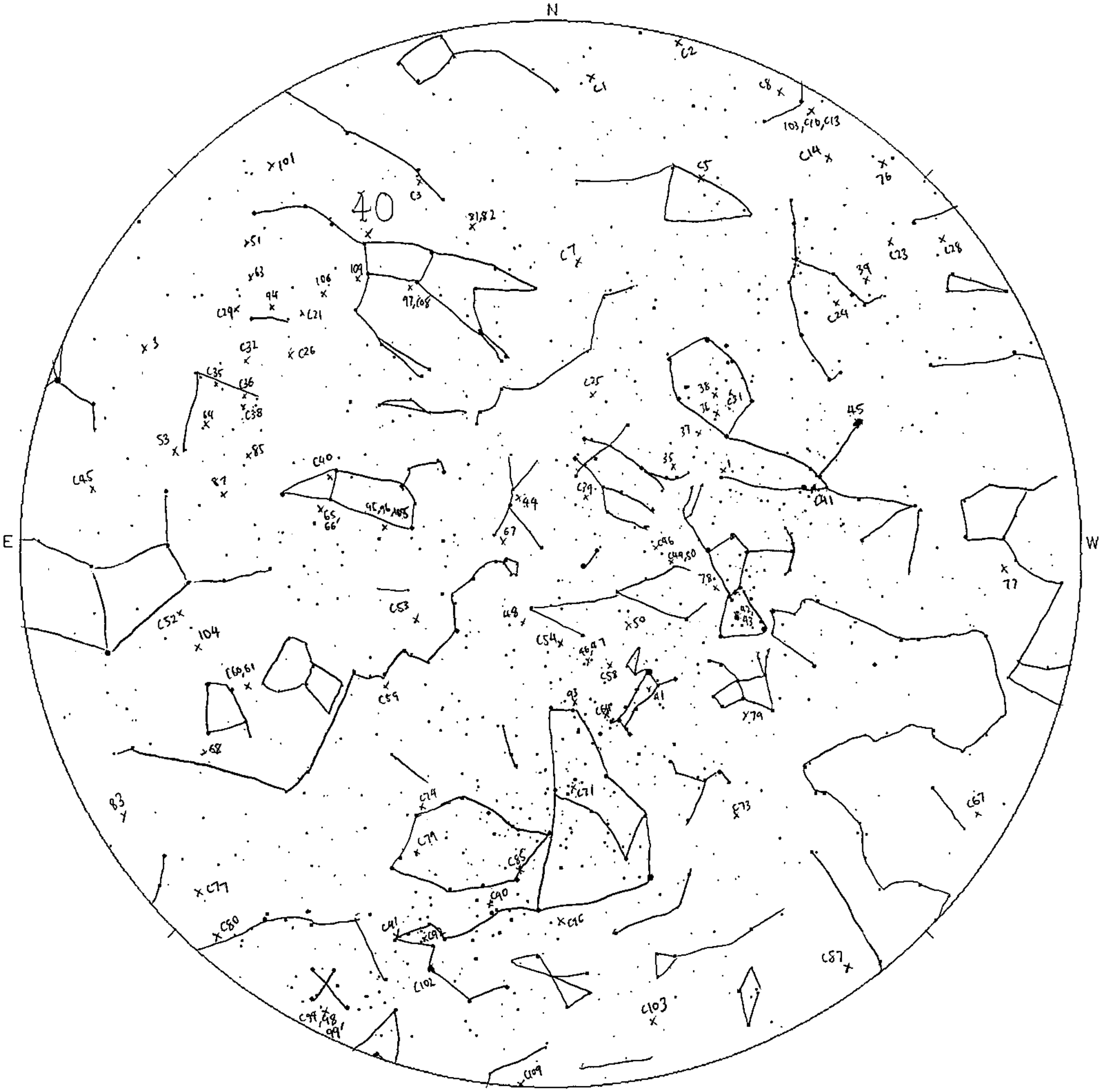
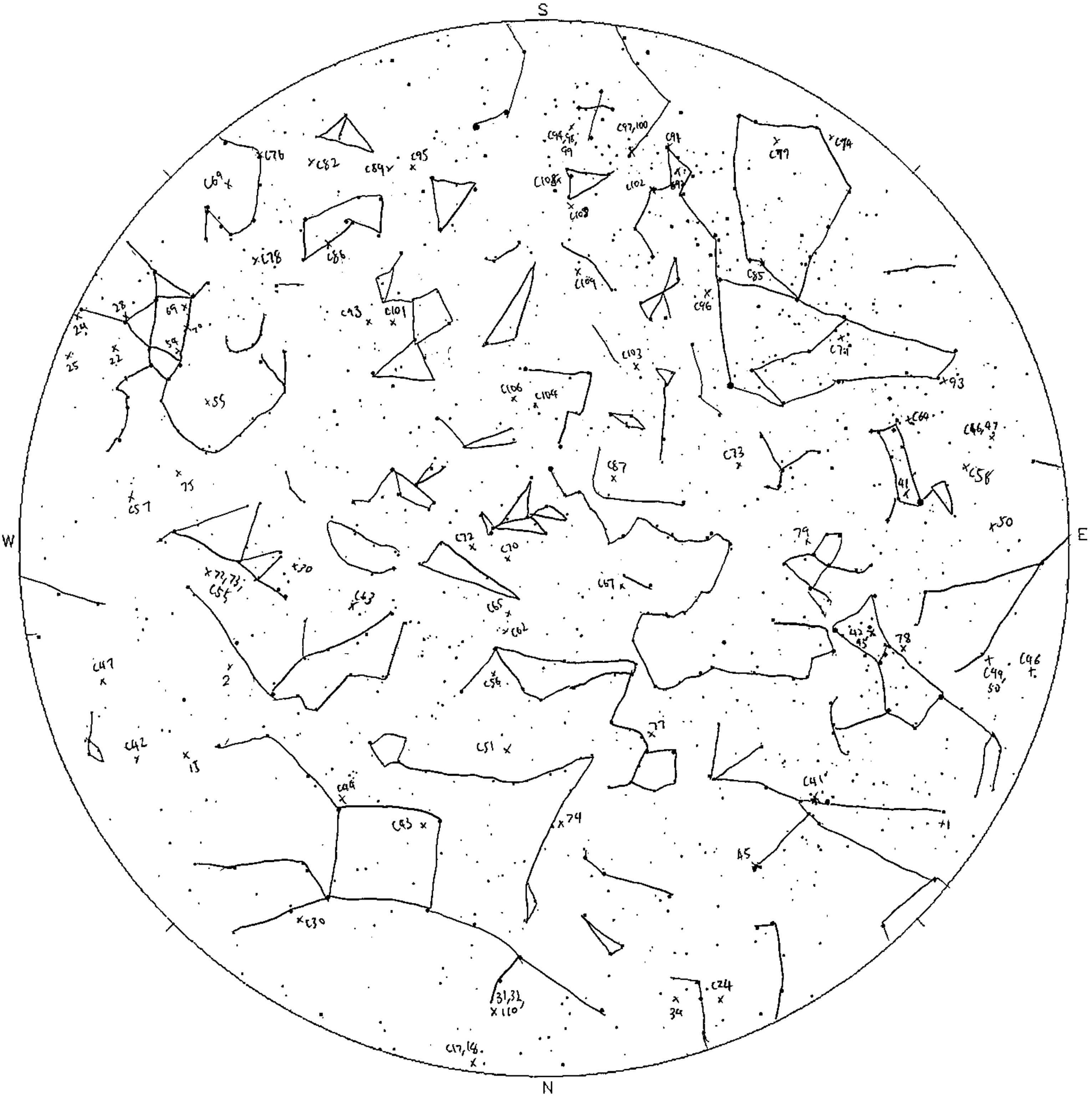


Due to the large number of objects, some may not be labeled,

sorry!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C101
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x55
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93
C87
C58
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+50
79
C72
C70
x77,73
C55
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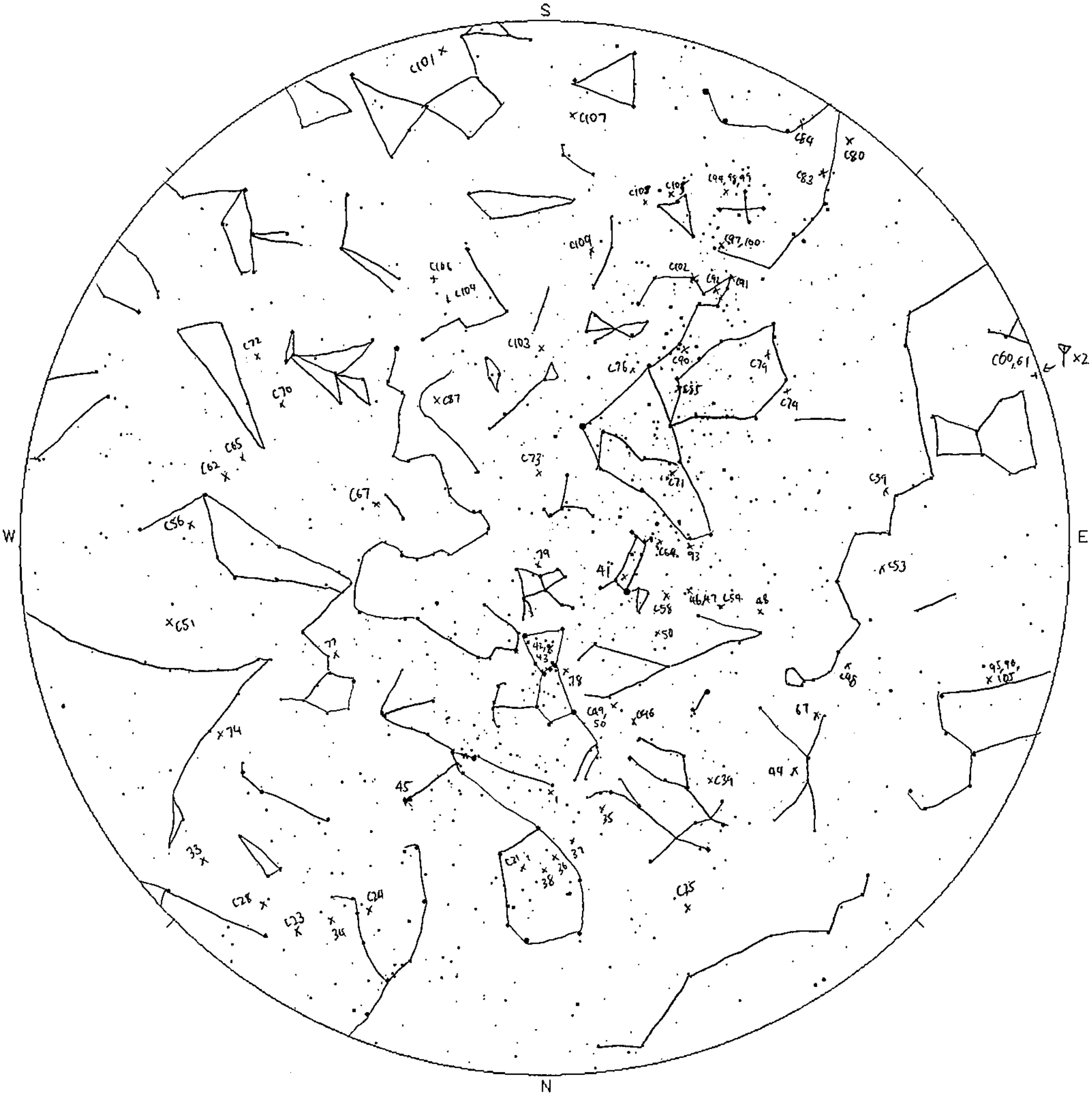
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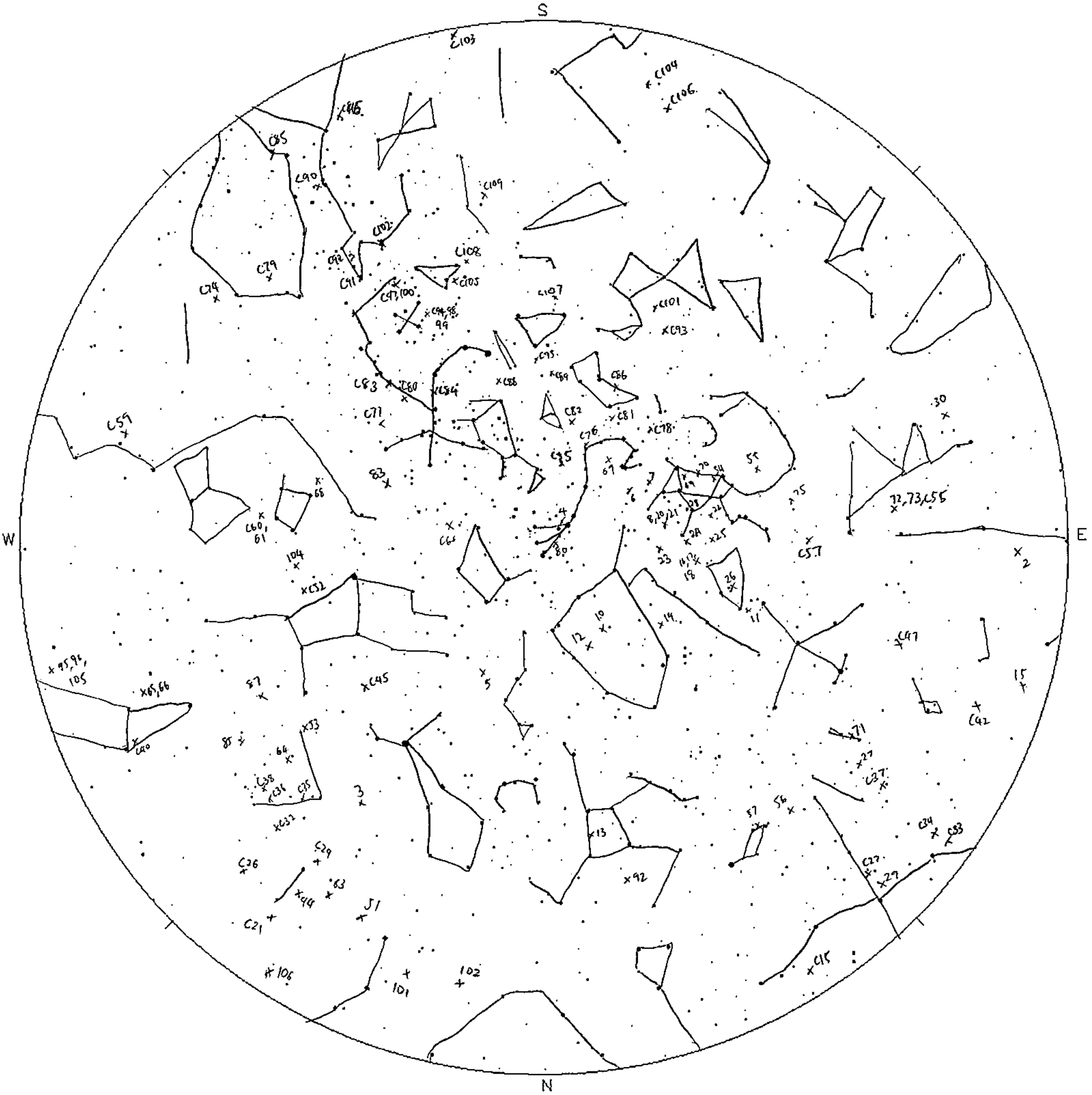
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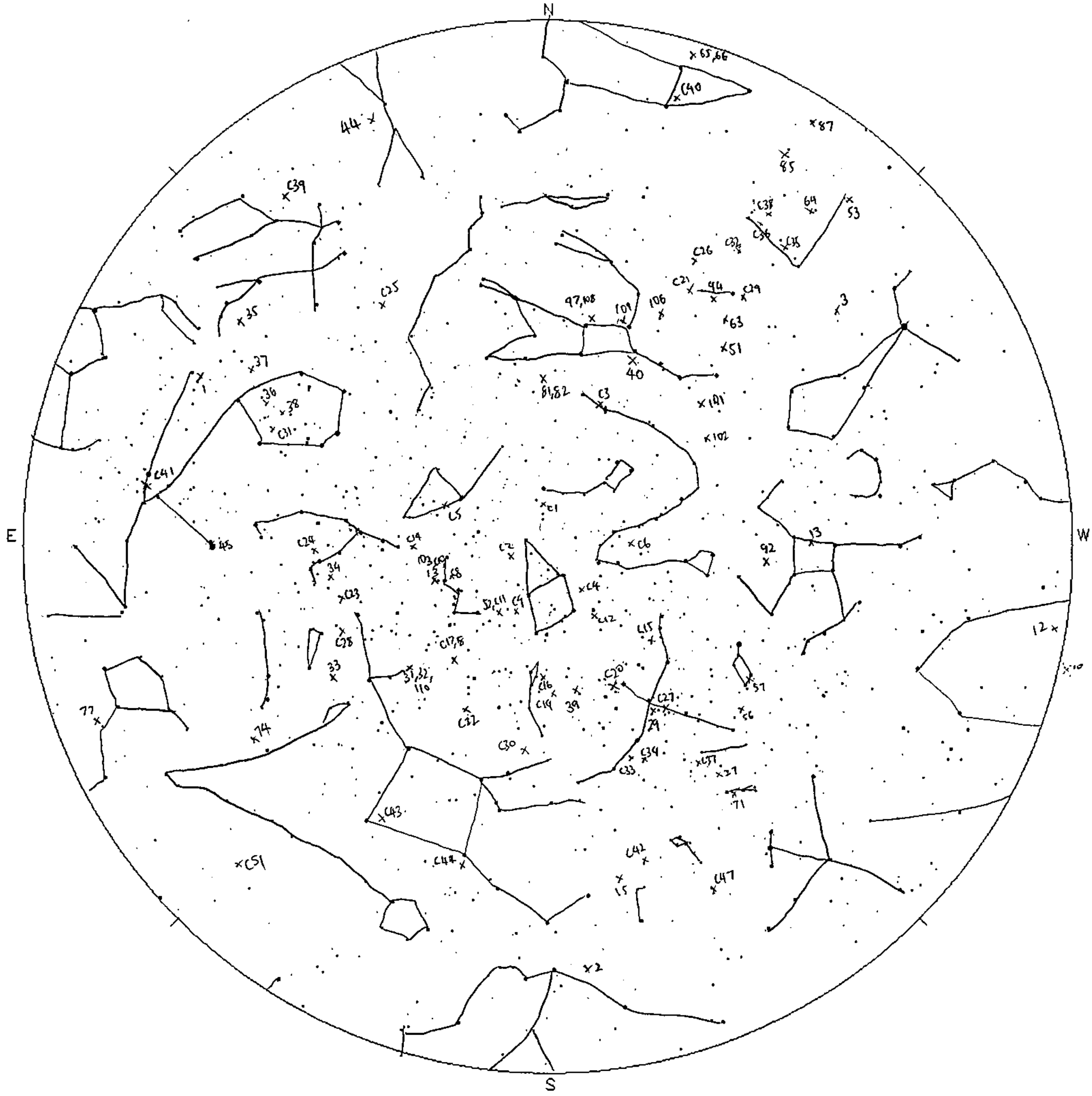
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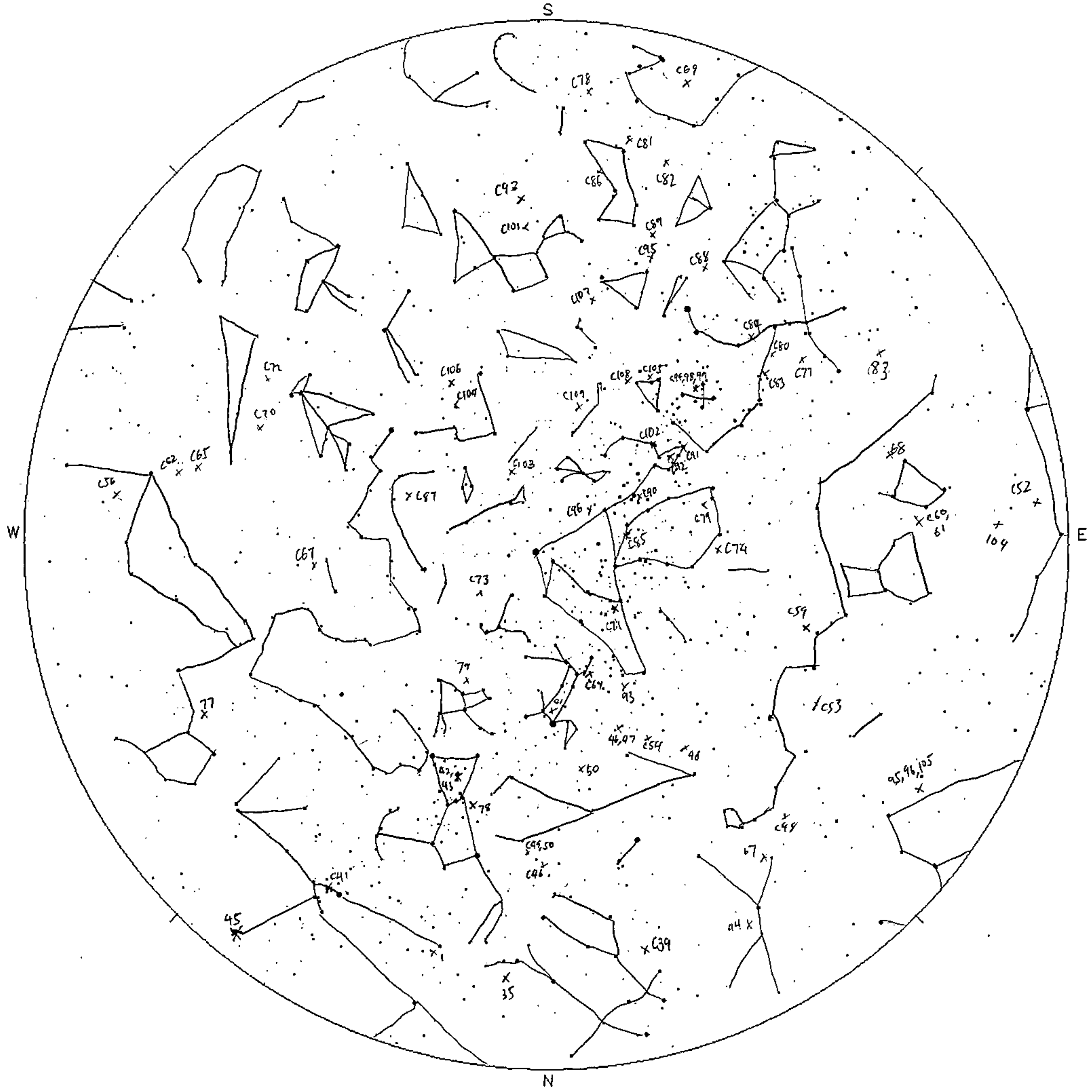
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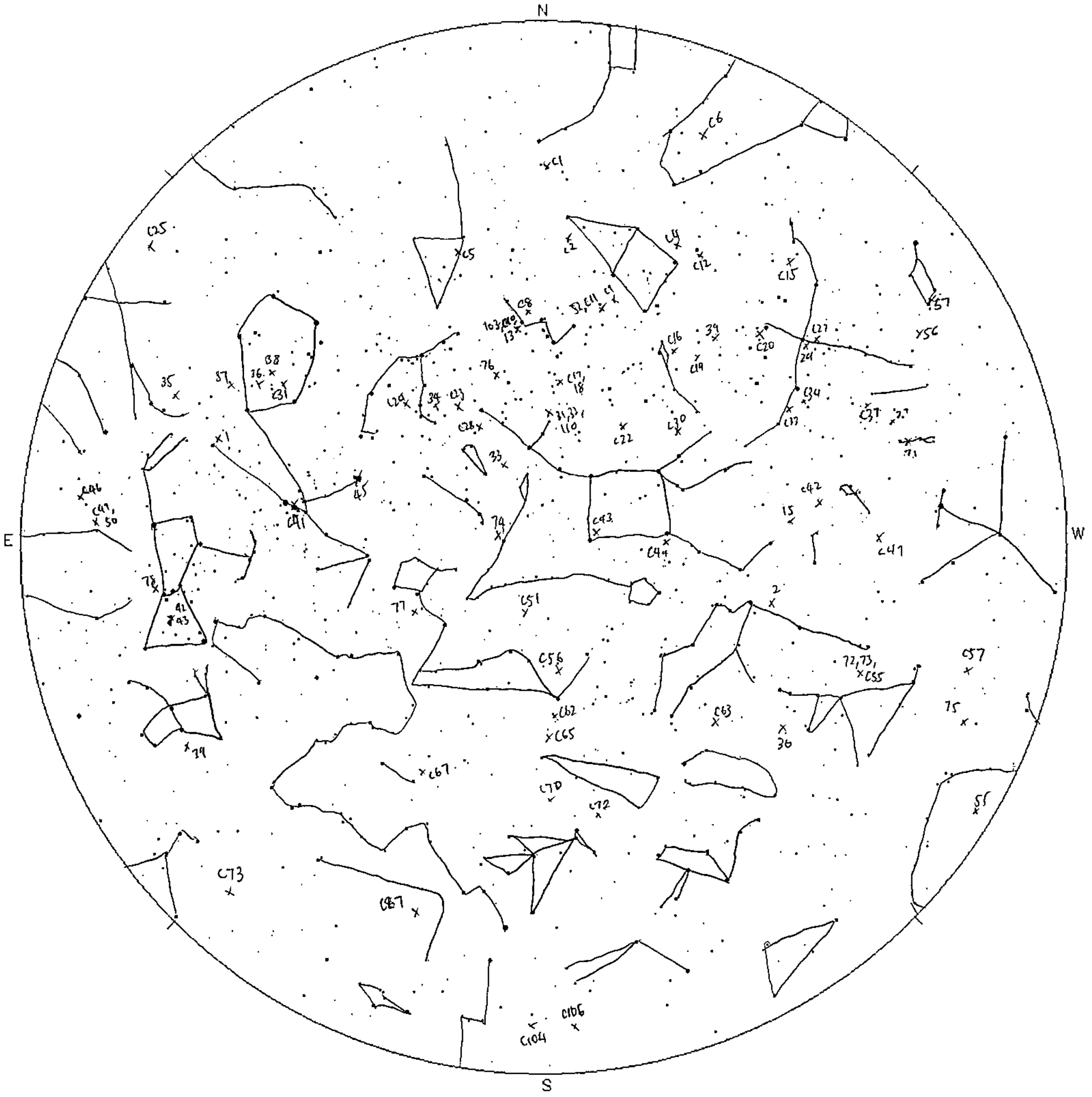
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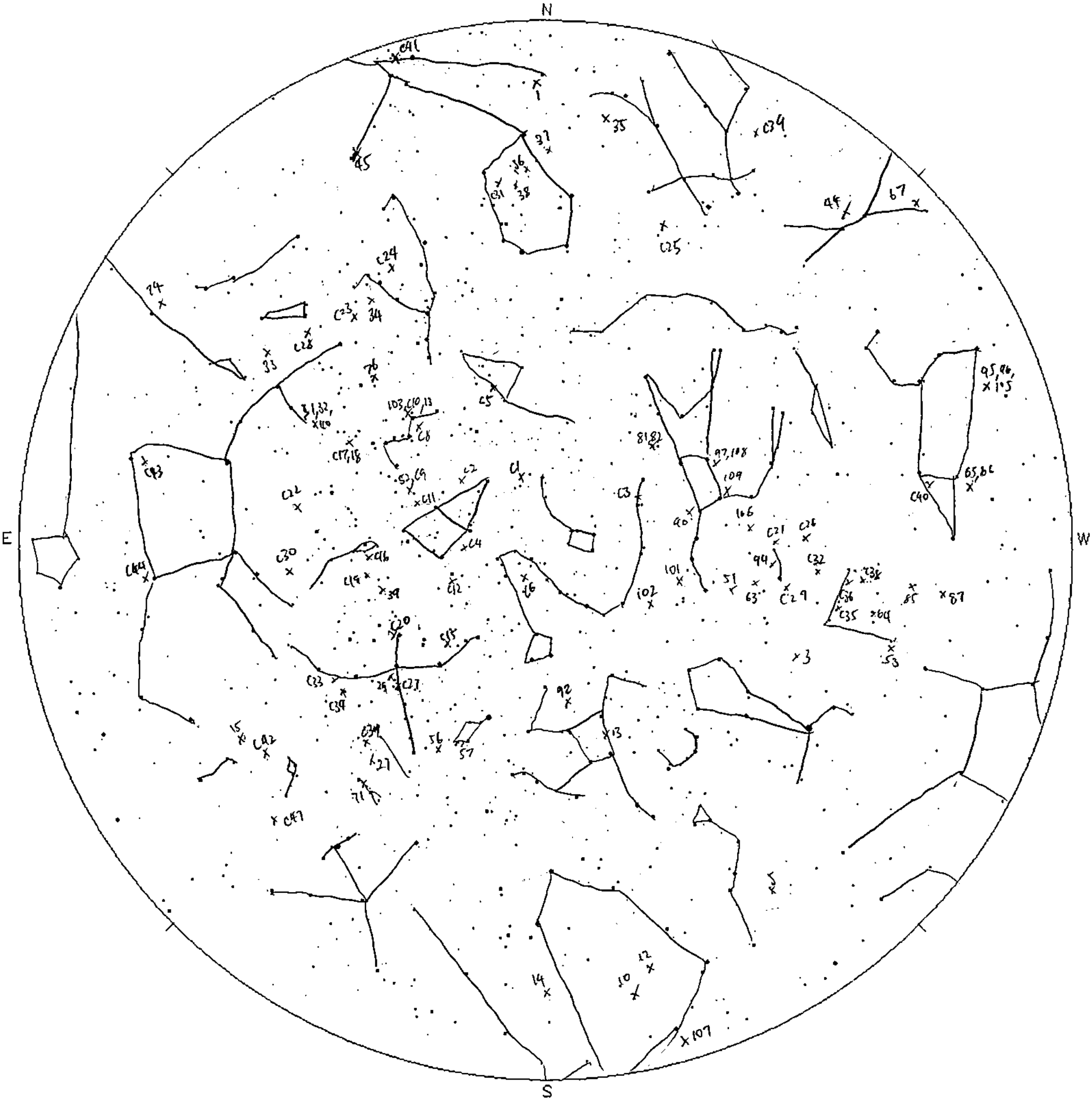
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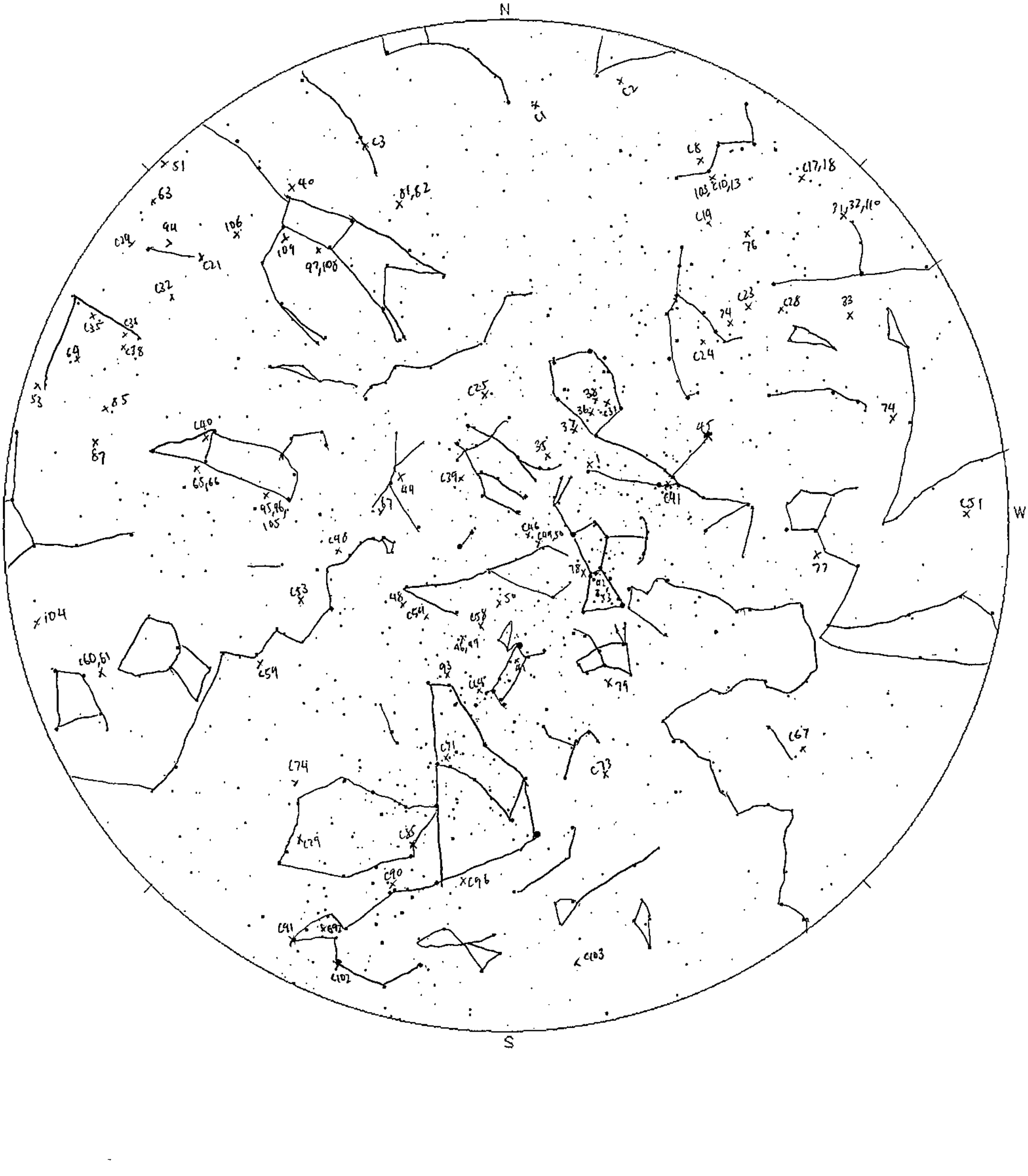
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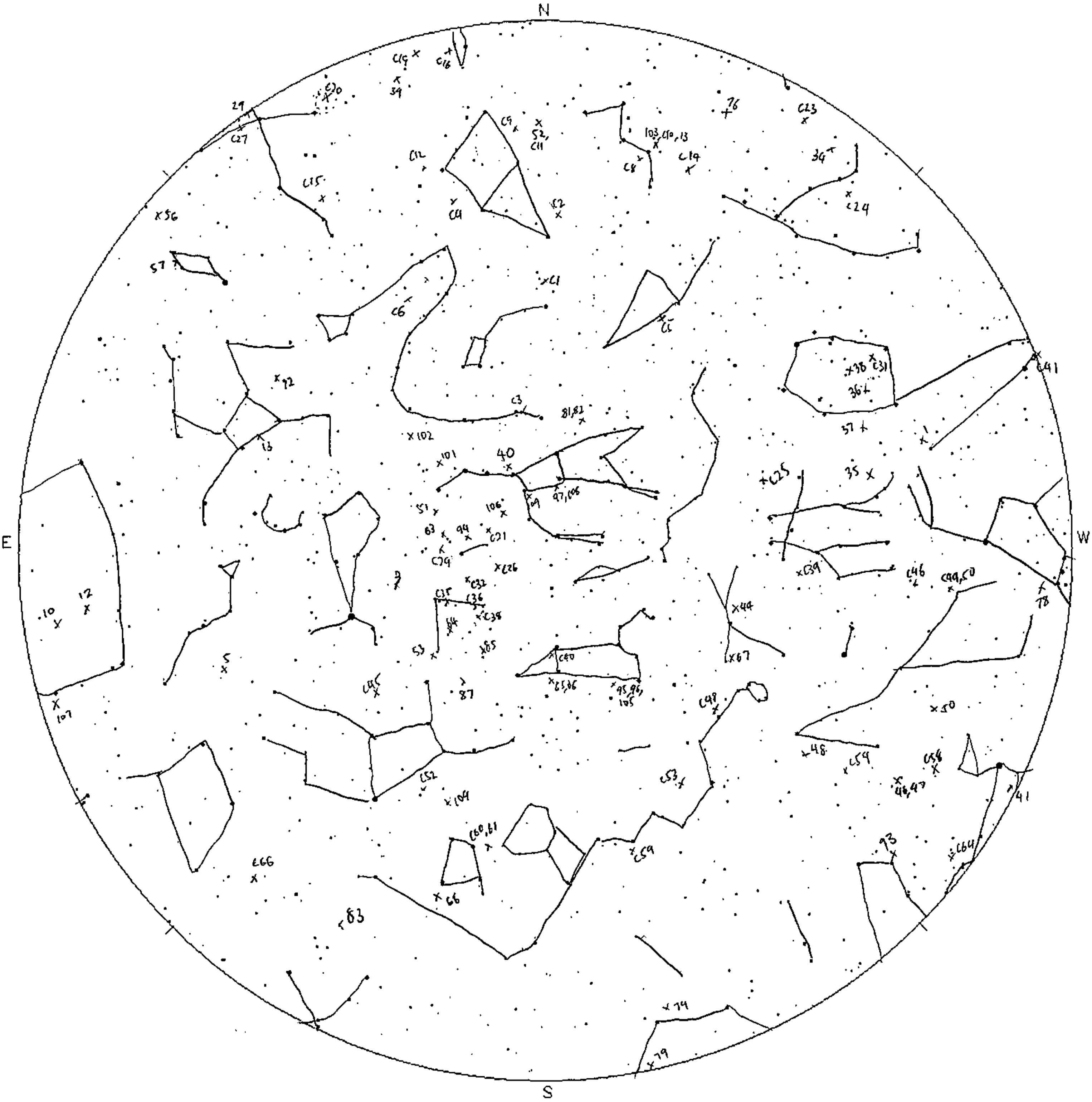
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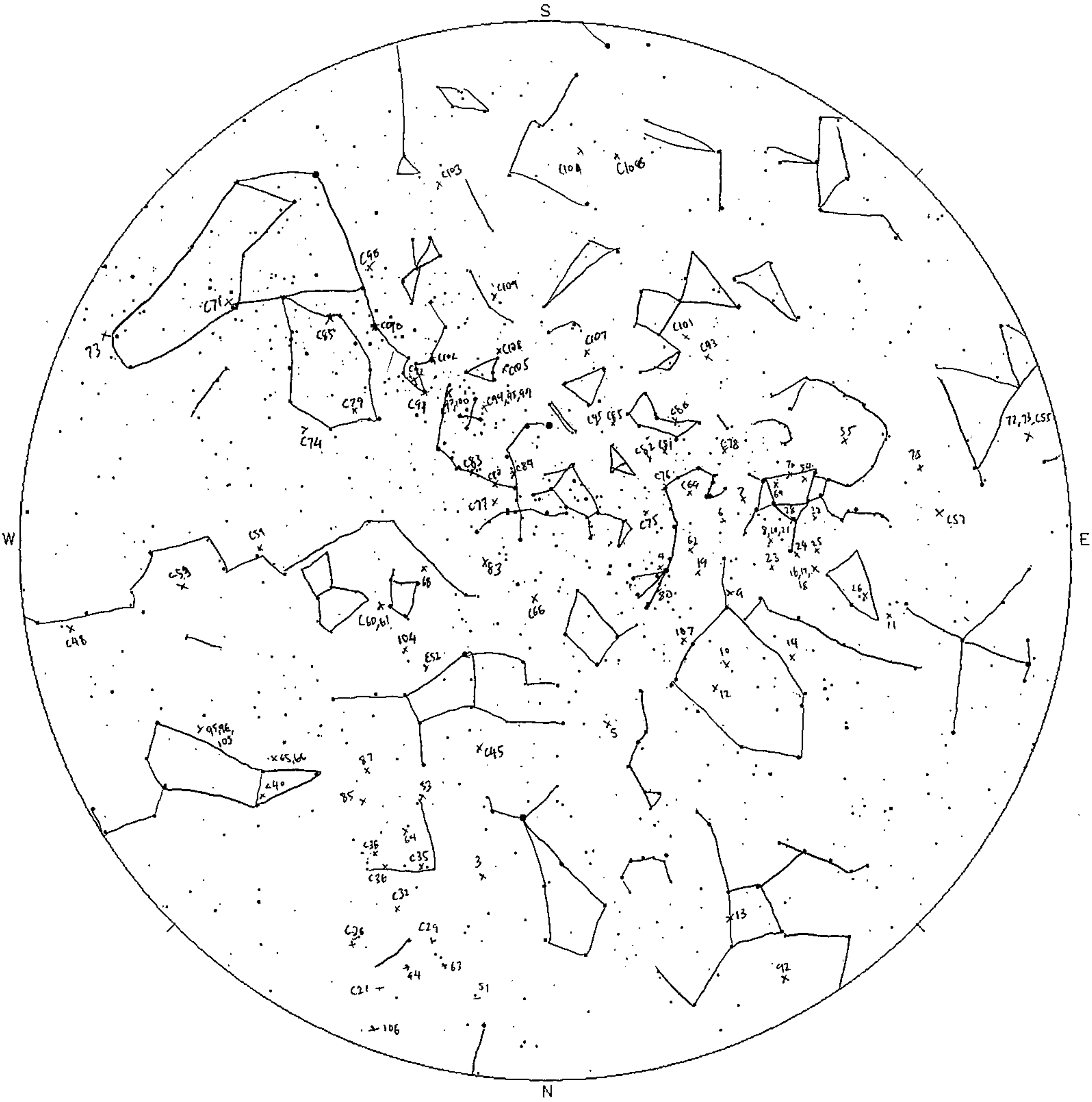
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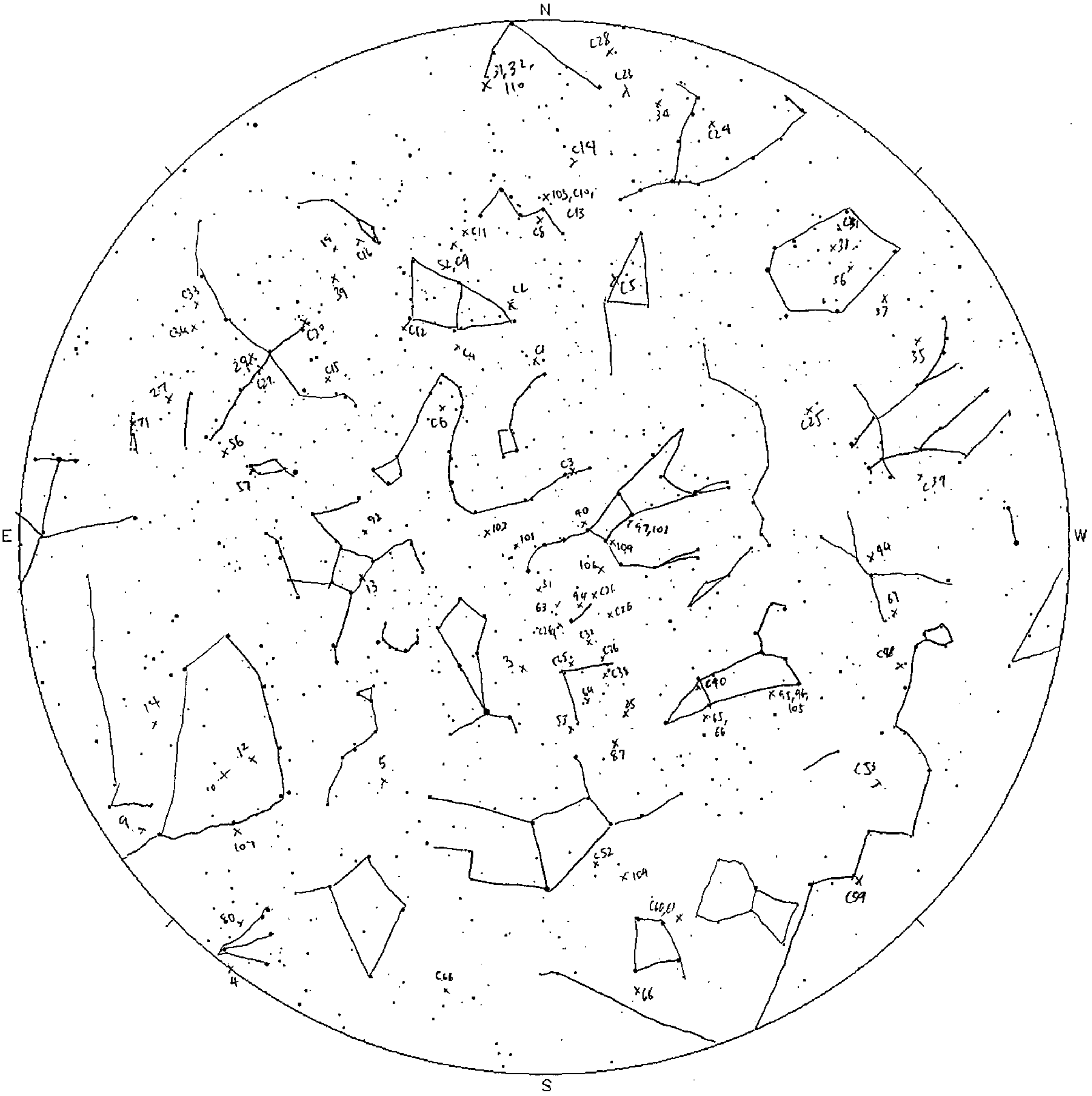
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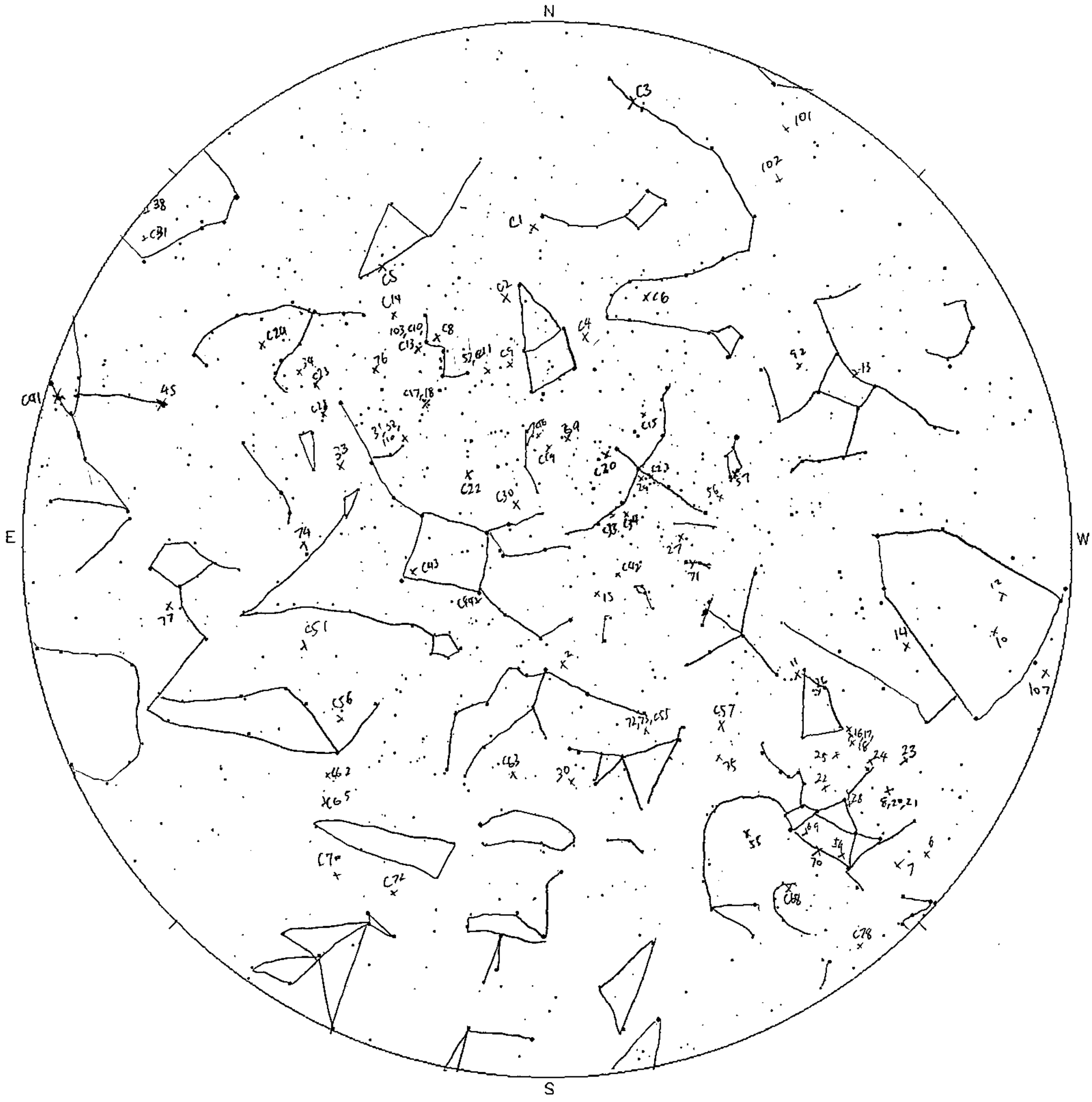
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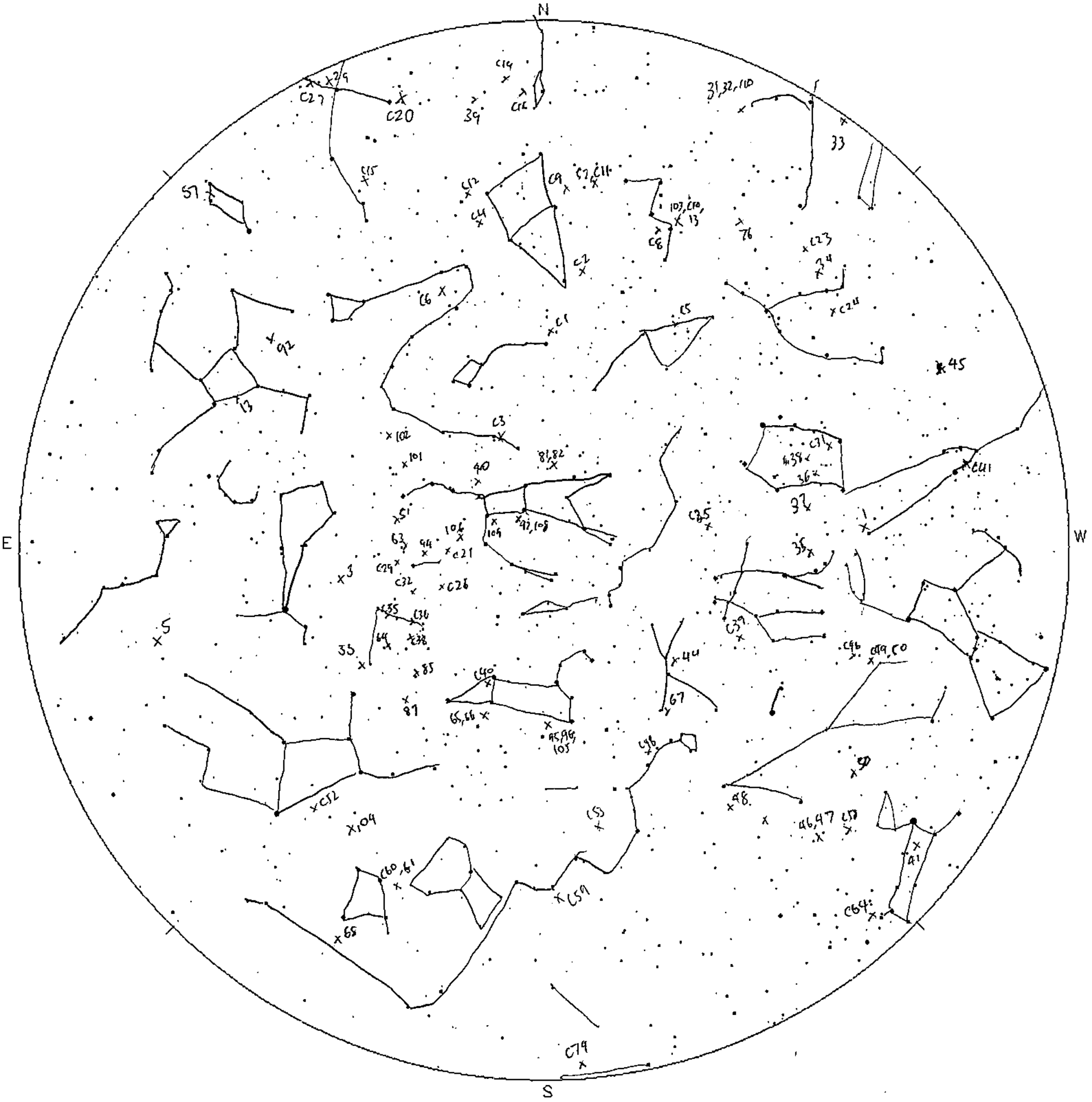
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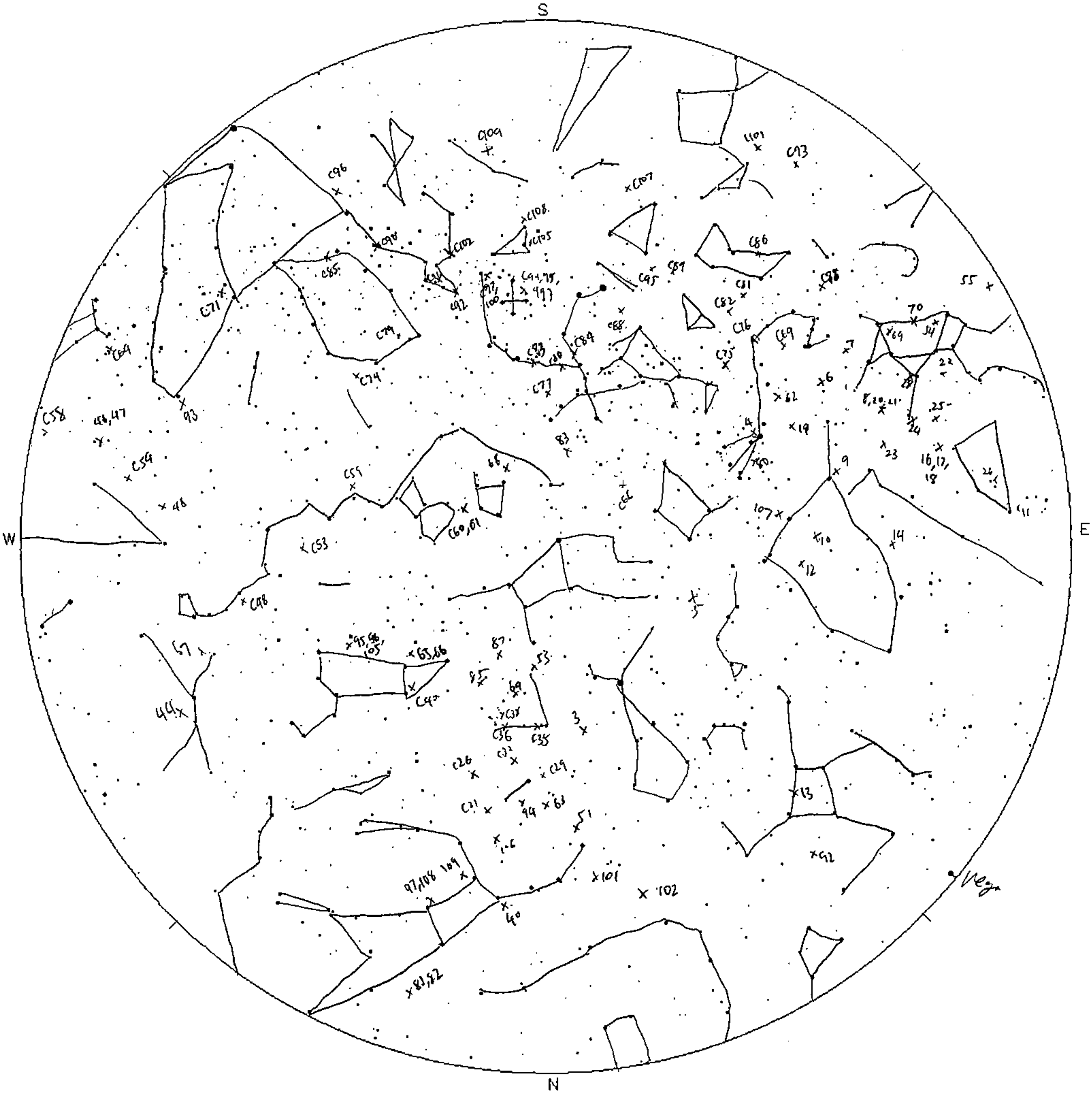
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55
C71
C85
C79
C74
C64
C58
93
46,47
C59
48
C55
66
C60,61
C53
C48
C83
C80
C89
C77
83
C66
C75
C76
C69
4
C50
62
6
7
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70
69
54
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8,20,21
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25
23
16,17,18
26
11
107
9
10
12
14
5
57
44
95,96,105
65,66
C42
87
85
53
89
C38
C36
C35
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C21
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81,82
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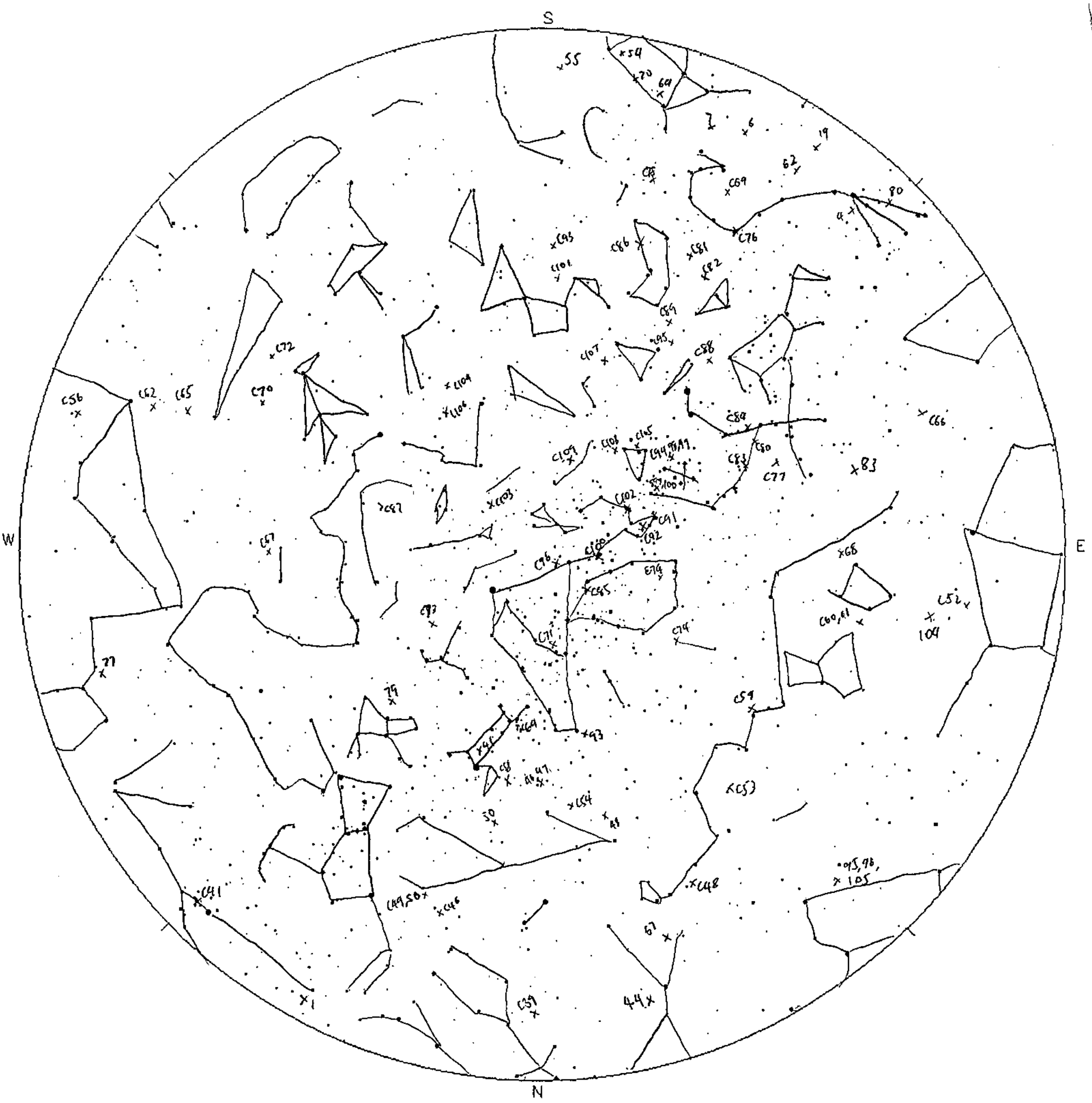
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C98
C69
80
4
C76
C93
C86
C81
C82
C101
C89
C95
C88
C107
C72
C104
C106
C56
C62
C65
C70
C66
C84
C109
C108
C105
C94,97,99
C80
C83
C77
83
C99,100
C87
C103
C102
C91
C92
W
C67
C96
C100
C85
C79
x68
E
C52
C93
C60,61
104
C71
C74
77
79
C59
C64
x43
x45
C8
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C39
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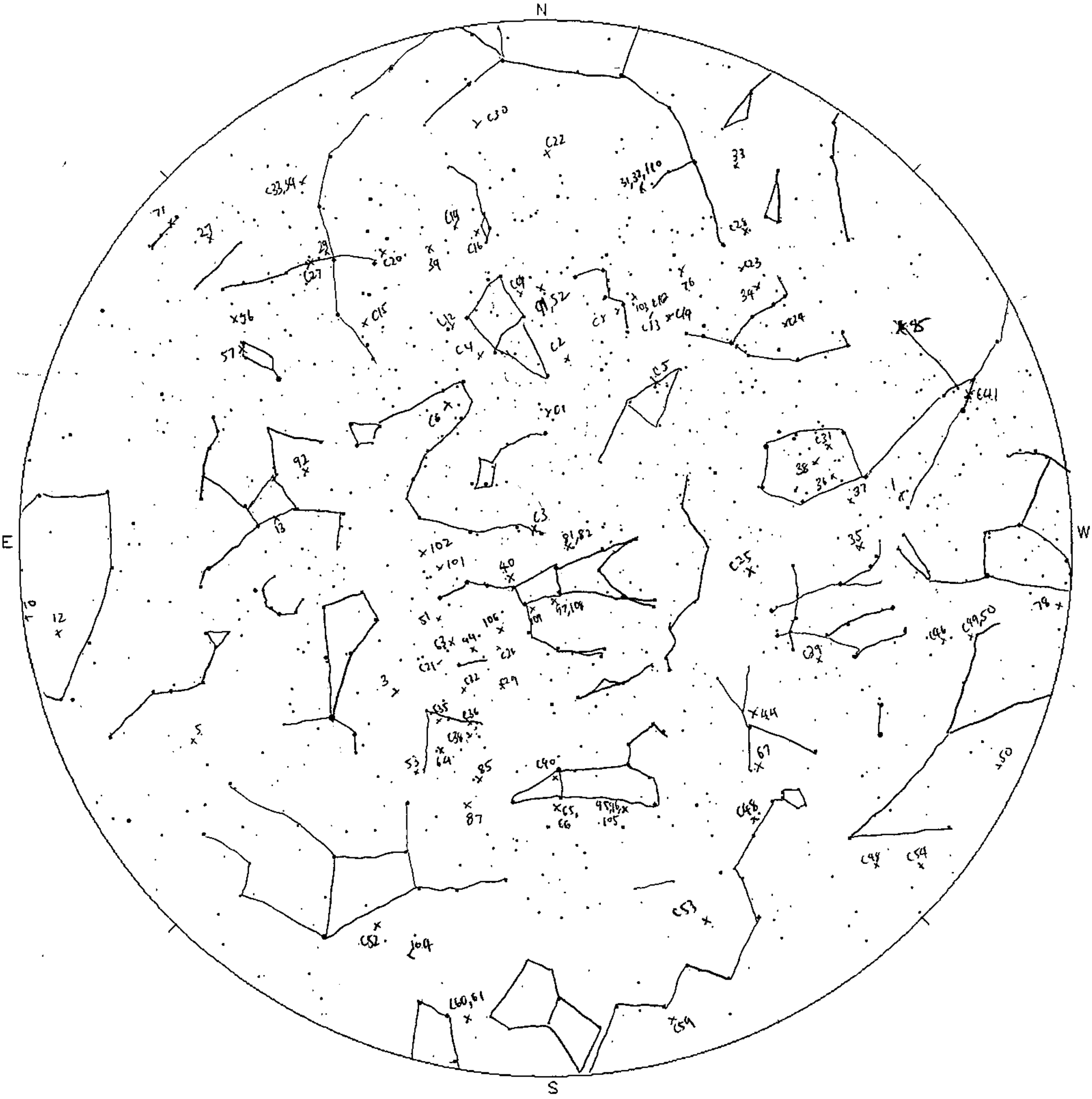
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C22
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C27
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39
C19
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31,32,110
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C28
C23
76
34
C24
85
C41
X56
57
C15
C12
C4
C9
91,52
C2
C7
103,C10
C13
C14
C5
C6
C1
92
13
C31
38
36
37
E
10
12
102
101
C3
81,82
40
C25
35
W
79
51
106
C11
97,108
C26
C21
C29
C39
C46
C49,50
3
C32
C29
44
5
C35
C36
C38
53
64
85
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C53
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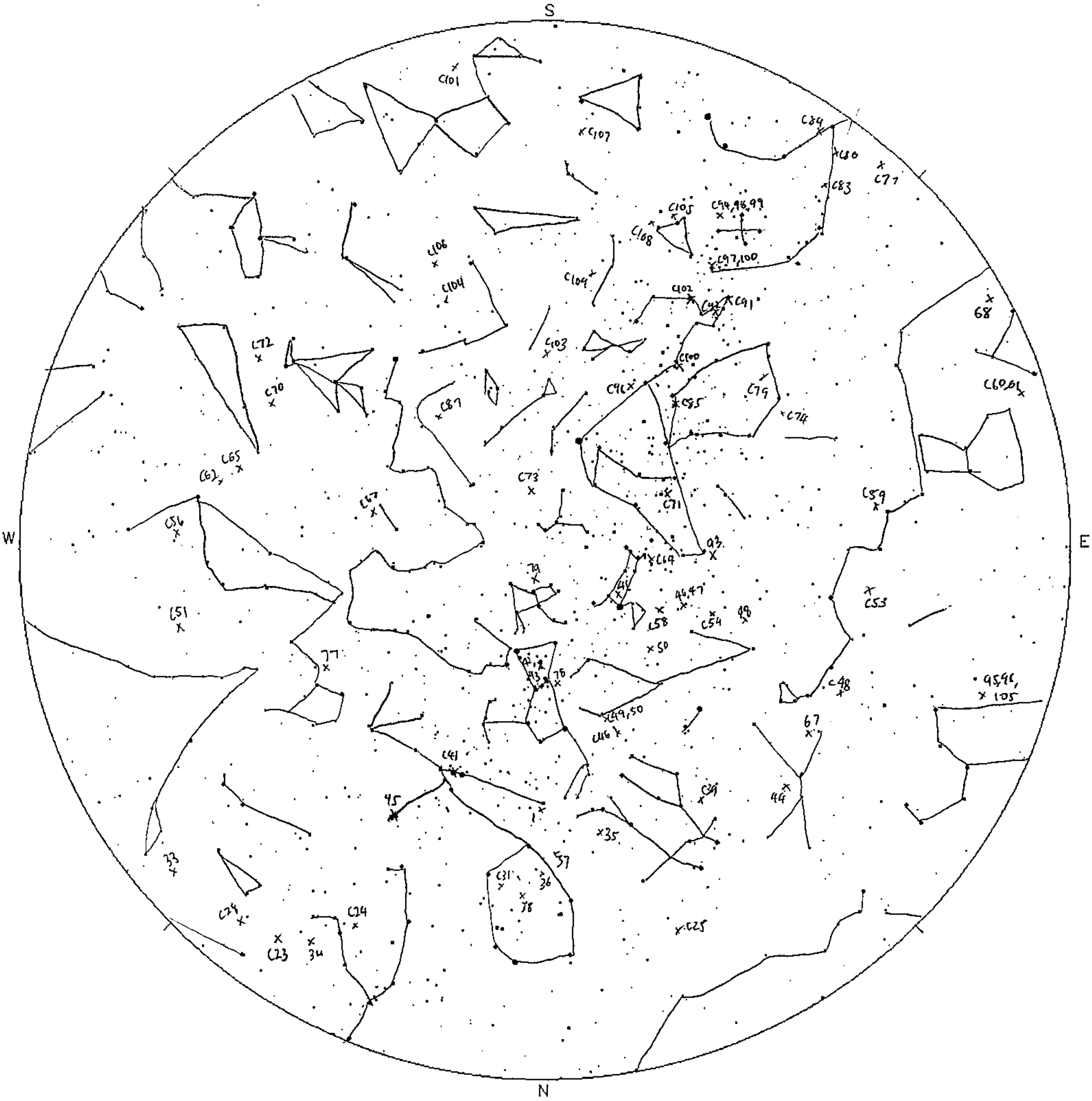
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C77
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C105
C94,98,99
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C102
C42
C91
68
C72
C103
C100
C70
C87
C96
C85
C79
C74
C60,61
C62
C65
C67
C73
C71
C59
C56
W
93
E
79
C69
41
46,47
C58
C54
48
C53
C51
50
77
42
43
78
C48
95,96,
105
C49,50
C46
67
C41
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1
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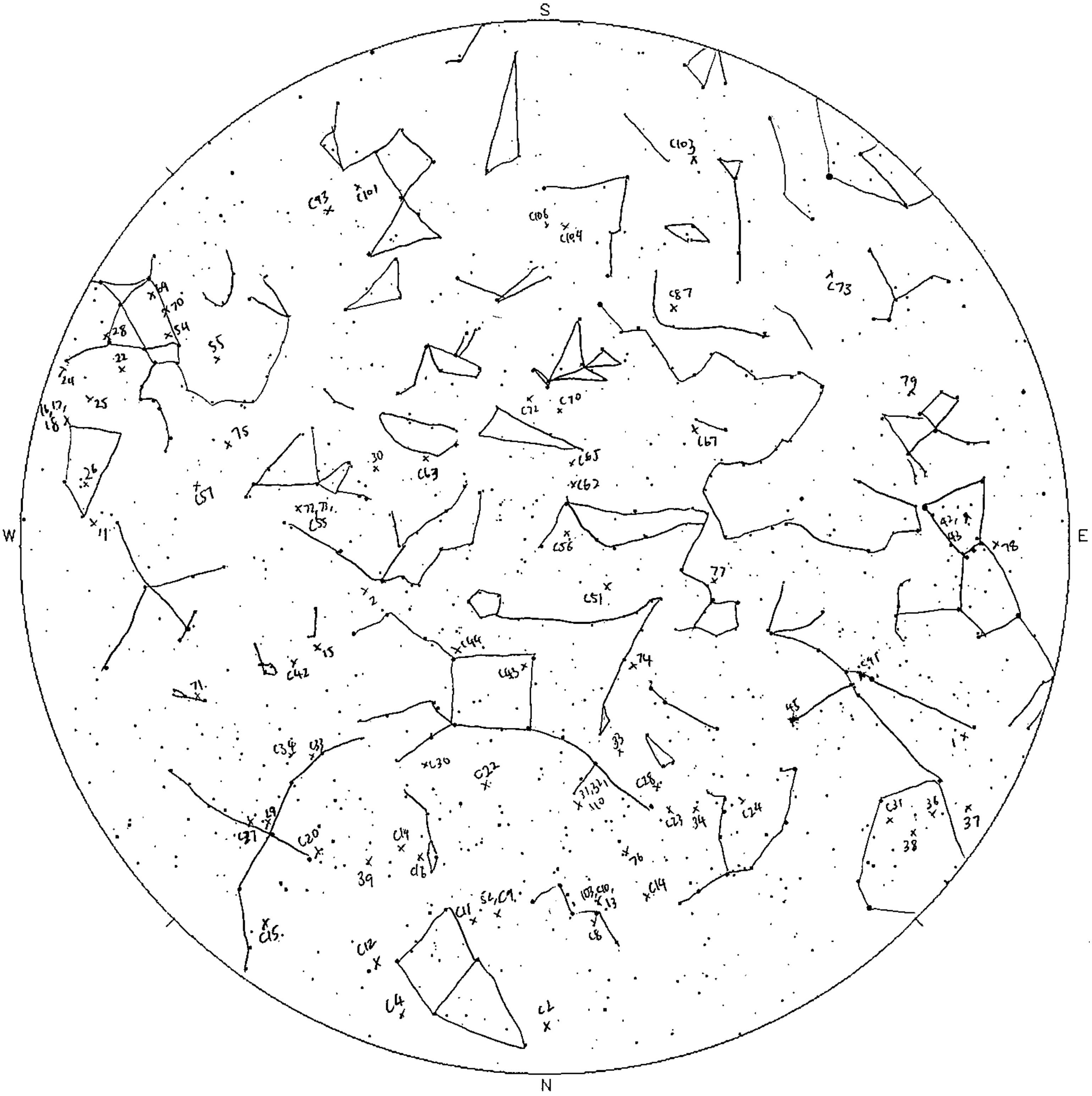
57
C31
36
38
C27
C24
C23
34
C25
N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C103
C93
C101
C106
C104
C87
C73
69
70
28
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55
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24
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16,17,
18
79
C72
C70
C67
75
C65
30
C63
C62
26
C57
72,73,
C55
47,
43
78
W
E
C56
11
77
2
C51
74
C44
C43
C42
15
C45
71
45
1
33
34
33
C30
C22
C18
31,32,
110
C23
34
C24
29
27
C20
C19
C16
39
76
C31
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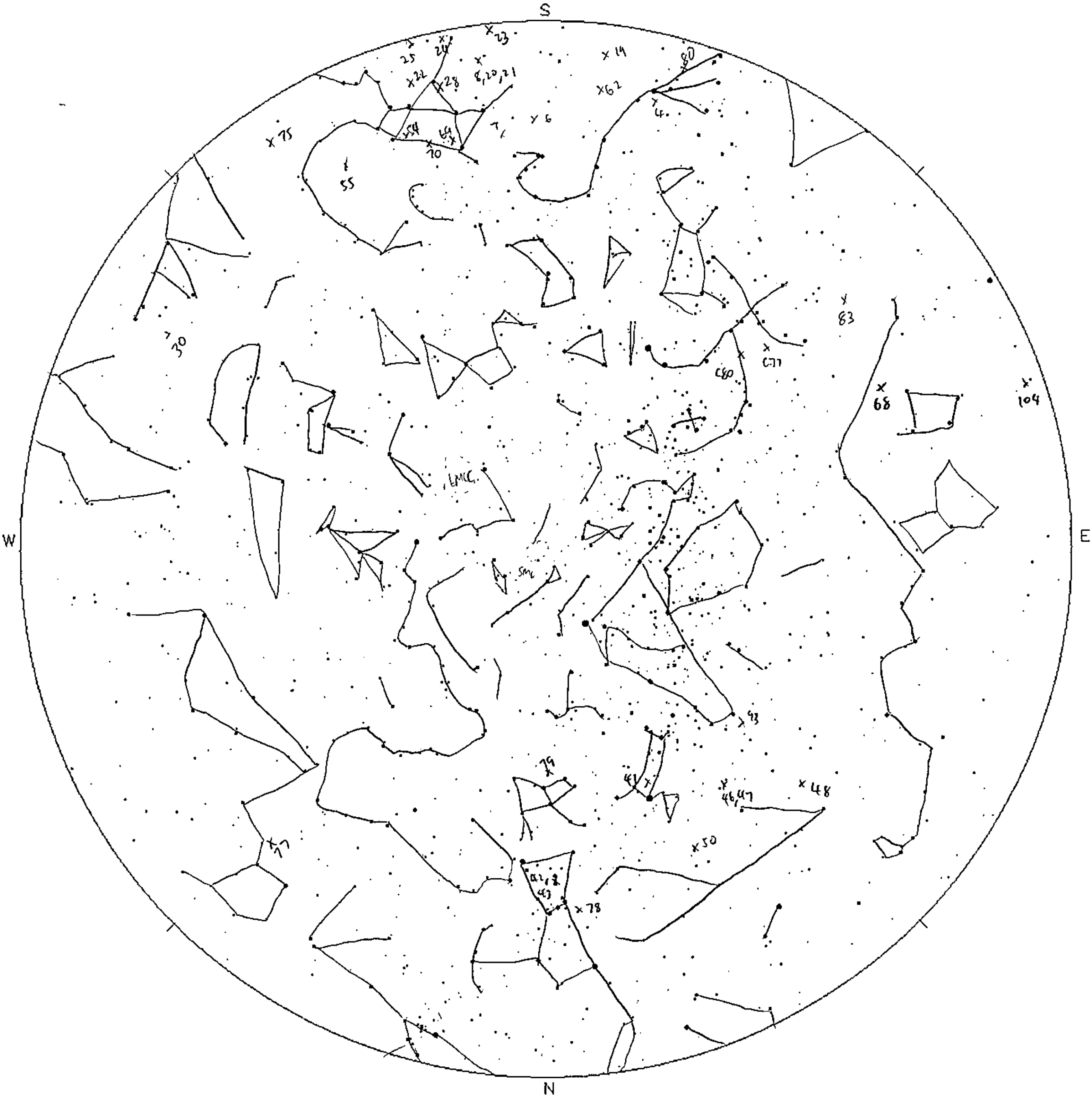
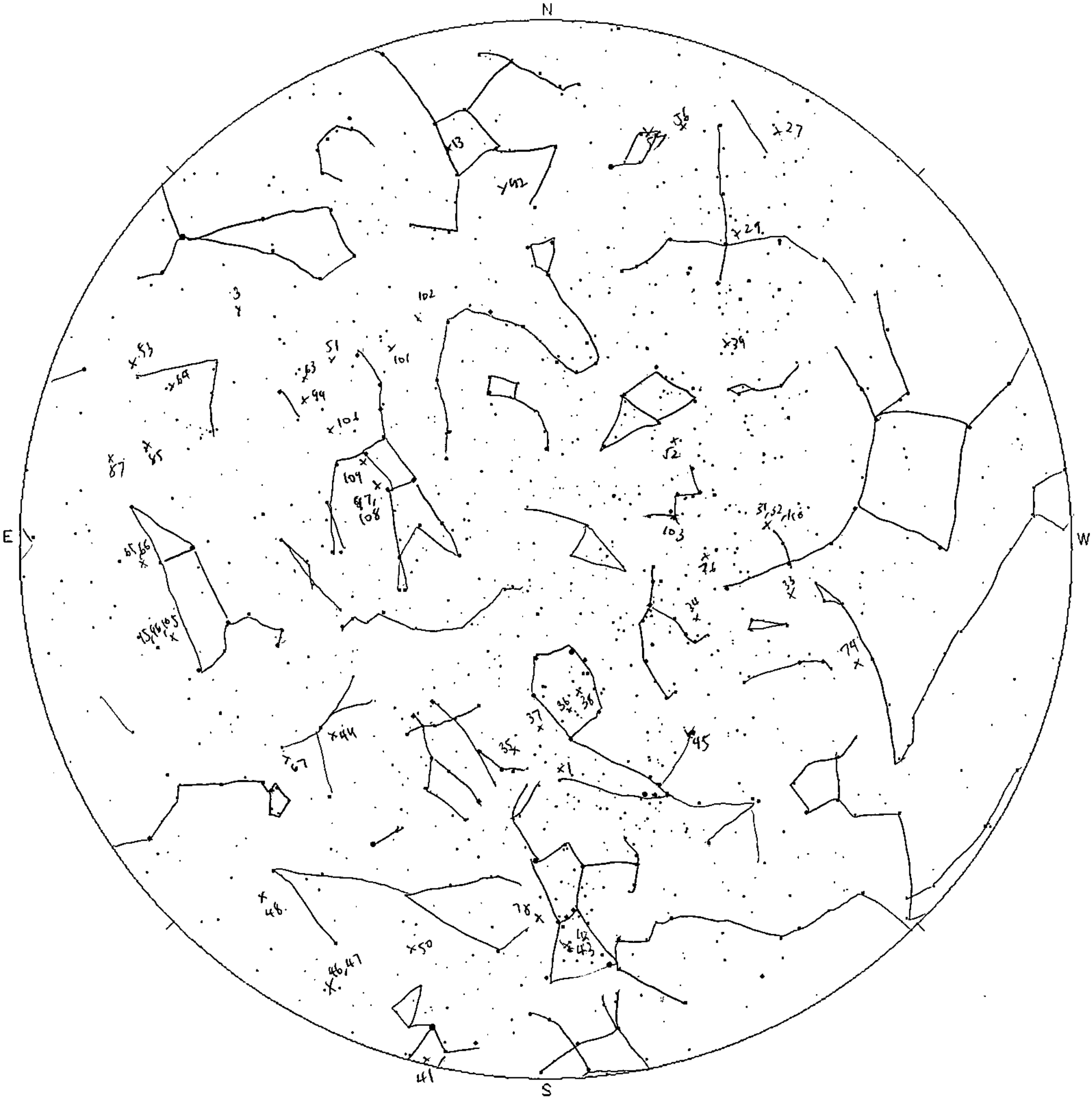
13
C15
C11
52,C9
C8
C12
C4
C2
N

(triple 7!)



no more caldwell ☹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69
94
104
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87
109
87,
108
52
39
103
31,32,110
76
33
34
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36
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44
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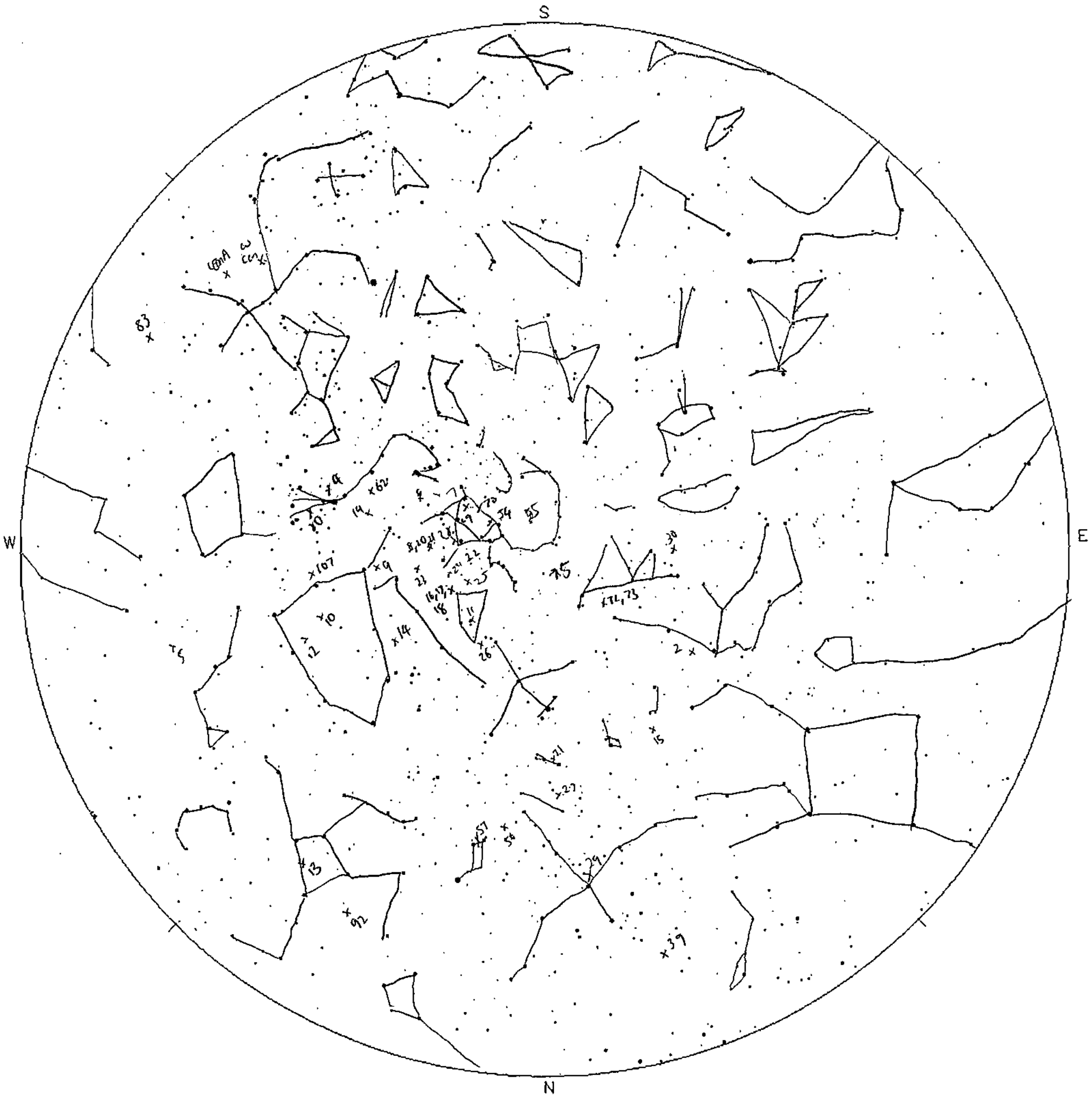
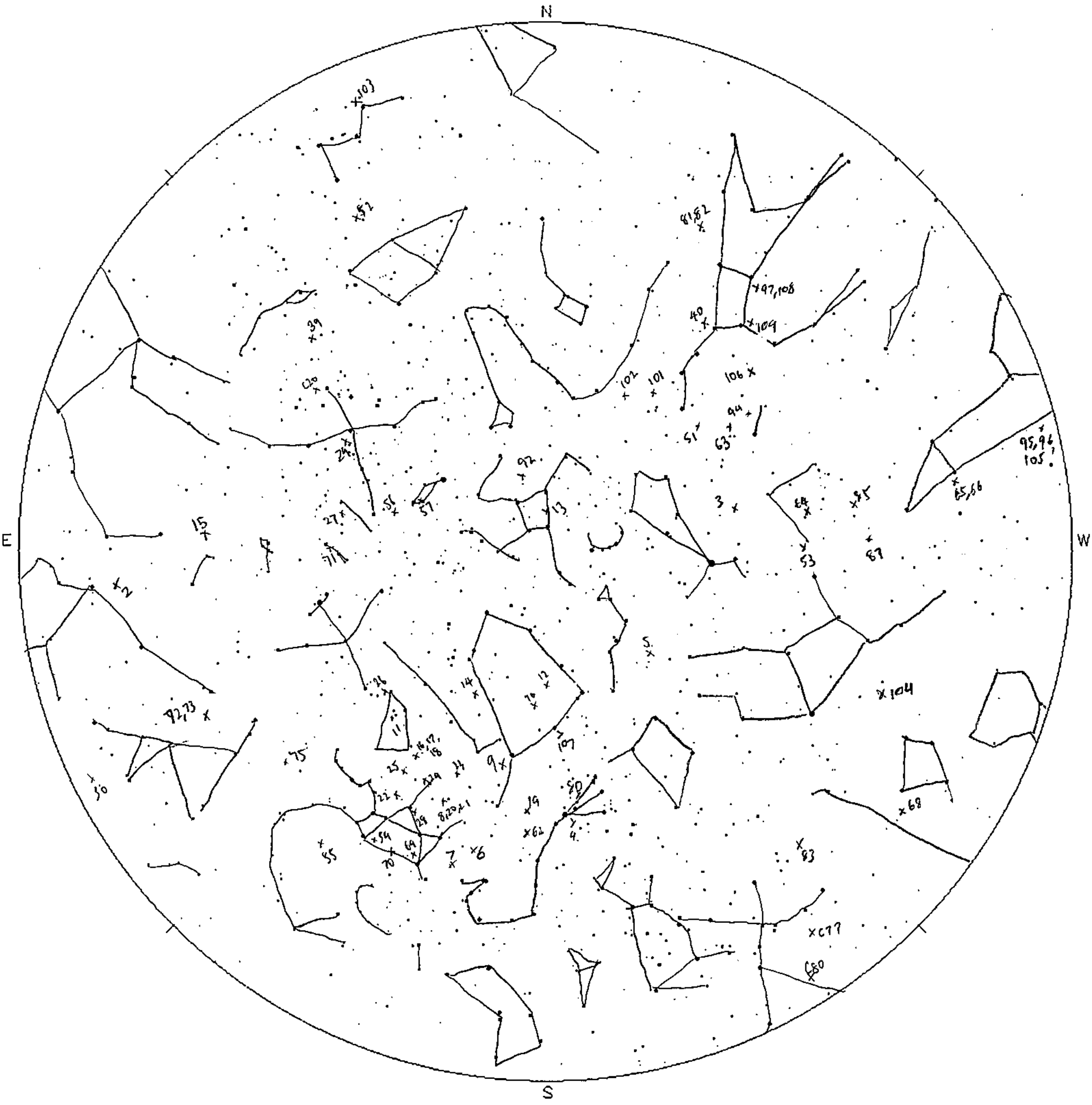
78
42
43
48
50
46,47
41


S
W
E
N
ω Cen x
83 x
x α
x 62
14 x
30
x 107
x 9
x 10
x 12
x 14
8,10,11
x 22
16,17, x
18
x 25
11
26
x 7
20
54
55
75
30 x
x 72,73
2 x
x 15
21
x 27
57
x 56
29
x 39
13
x 92


N
x103
x32
81,82 x
x97,108
40 x
x109
39 x
106 x
102 x
101 x
120 x
51
94
63
95,96 105
24
92
65,66
3 x
84 x
x85
27 x
56 x
57
x13
E
15 x
71,18
W
53
87
x2
S. x
14 x
12 x
76 x
26
11
x104
92,73 x
107
x75
25 x
x16,17,18
x29
24
9 x
30
22 x
19
50
x68
28
8,20,21
x59
64
55
x62
4
7 x6
70
83
x C77
C80
S


N
109
97,108
40
101
102
81,82
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57
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103
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76
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C2
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110
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43
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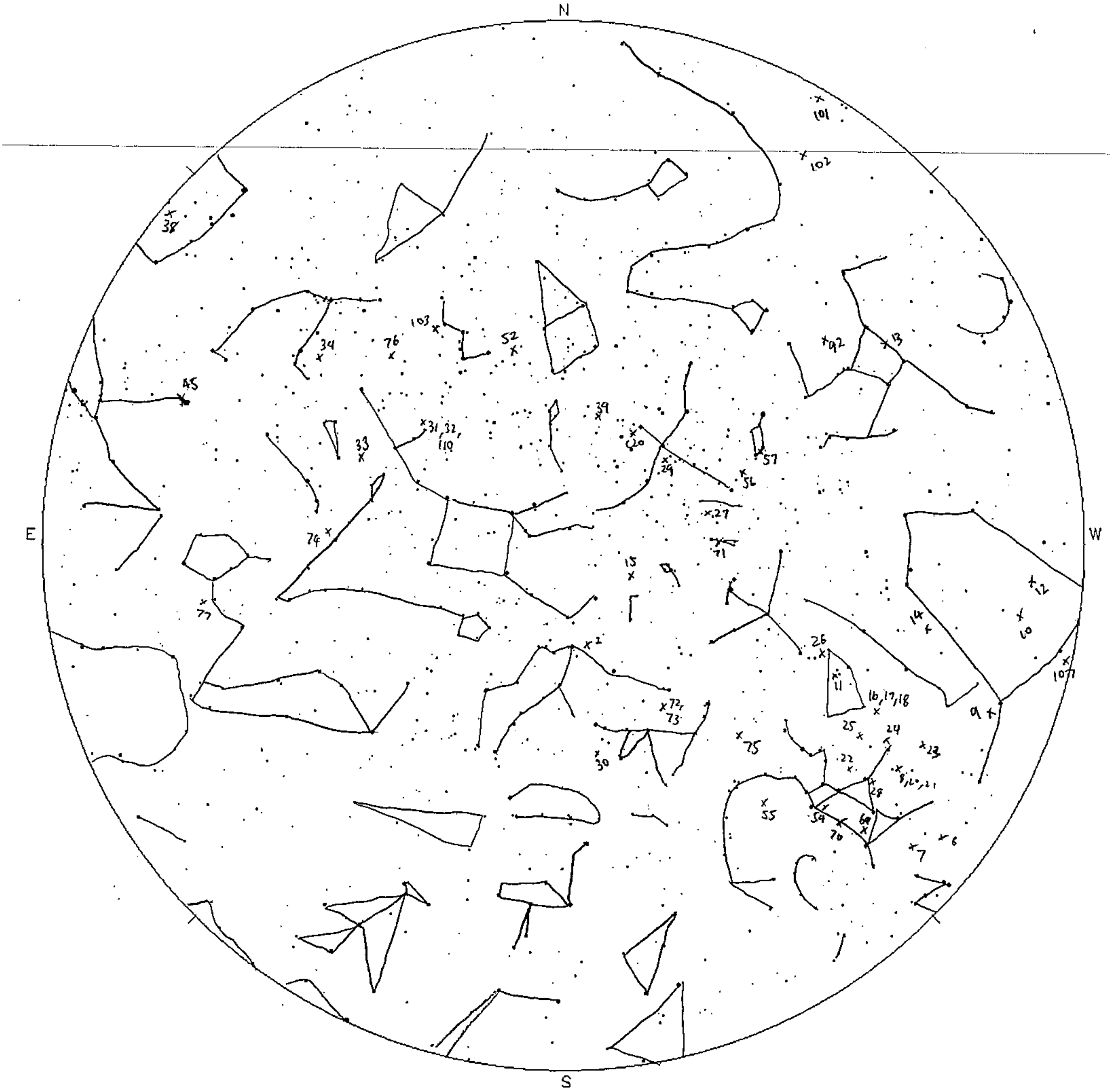
72,
73
30
S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101
102
38
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16, 17, 18
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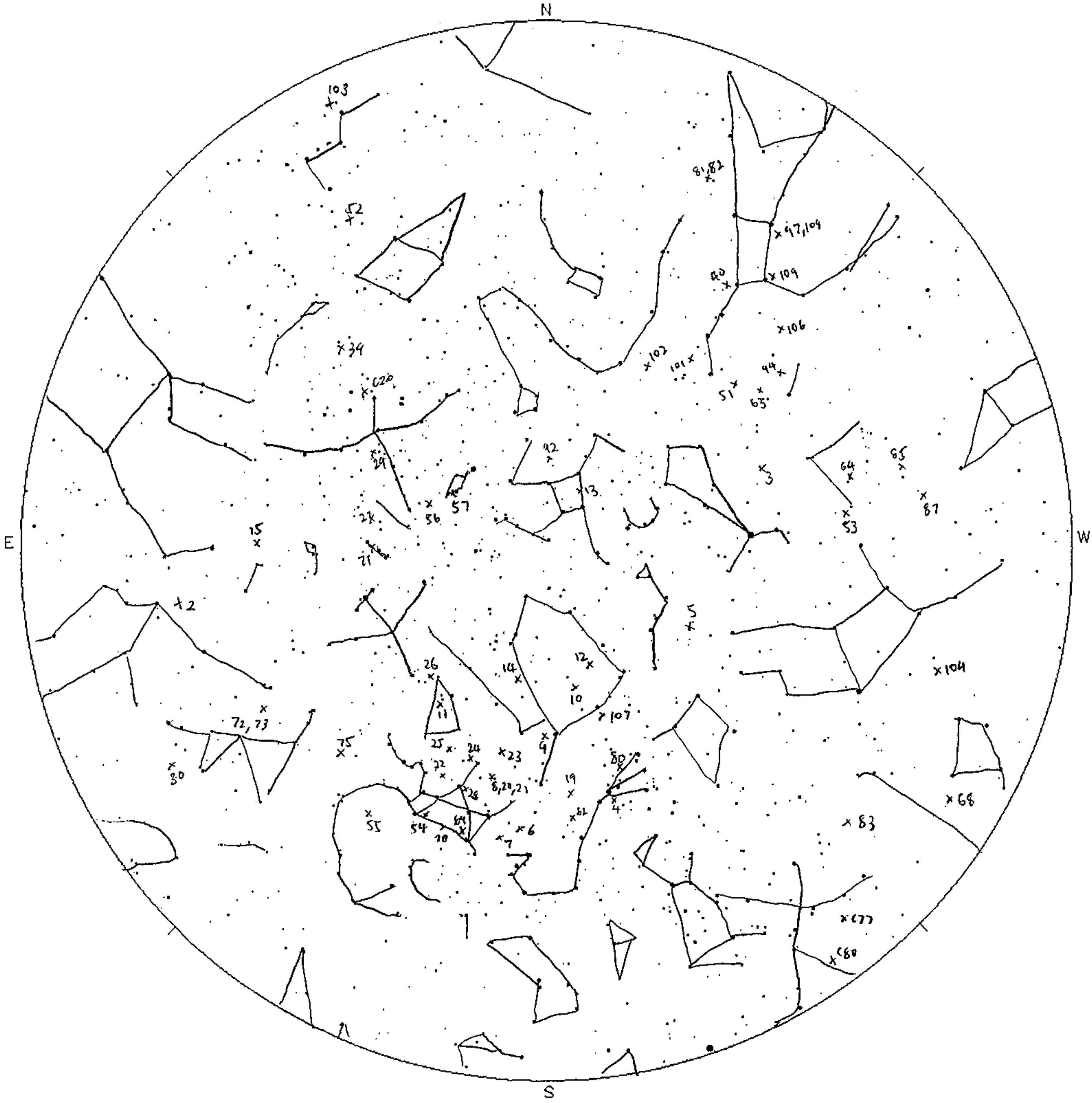
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103
81,82
52
×97,104
80
×109
×106
×34
×102
101×
94
×C20
51
63
92
29
×13
64
85
×3
56
57
27
87
53
E
15
W
21
×2
5
12
26
14
×104
10
11
×107
72, 73
75
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24
×23
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80
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32
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×68
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54
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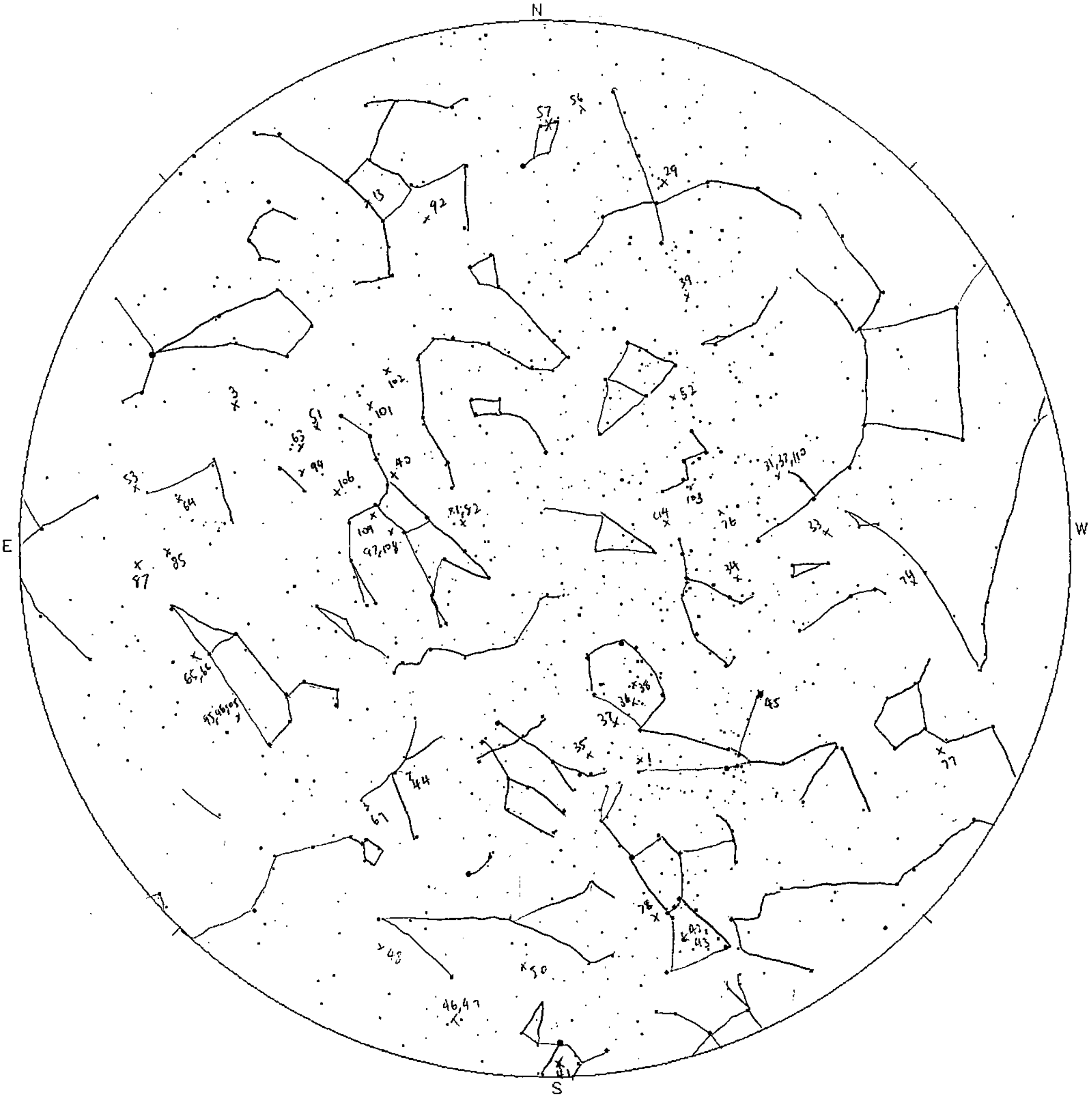
×62
×6
×7
×83
×C77
×C80
S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101
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106
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31,37,110
103
104
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81,82
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97,108
87
85
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74
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65,66
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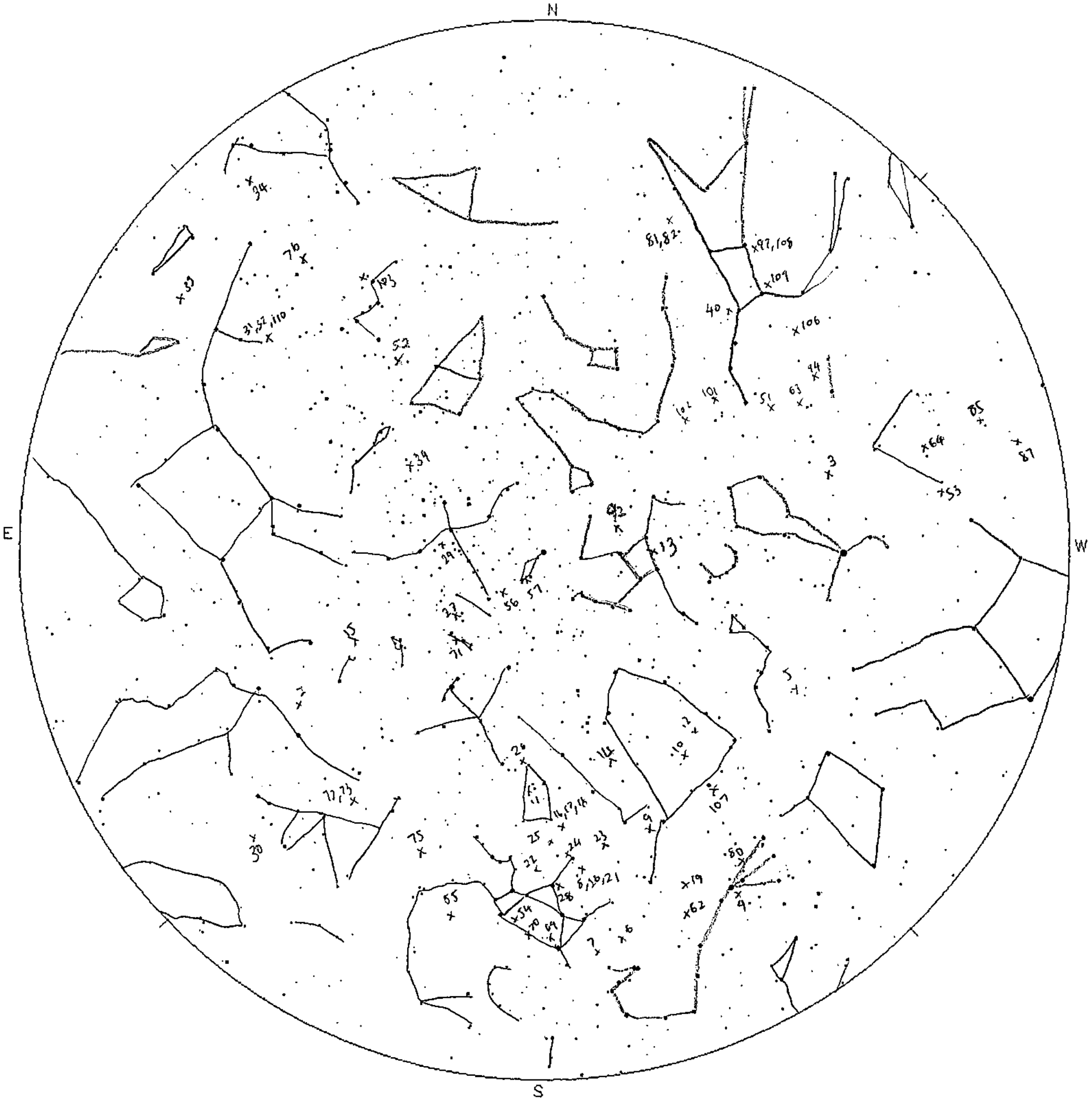
S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31,52,110
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81,82
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102
101
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107
77,73
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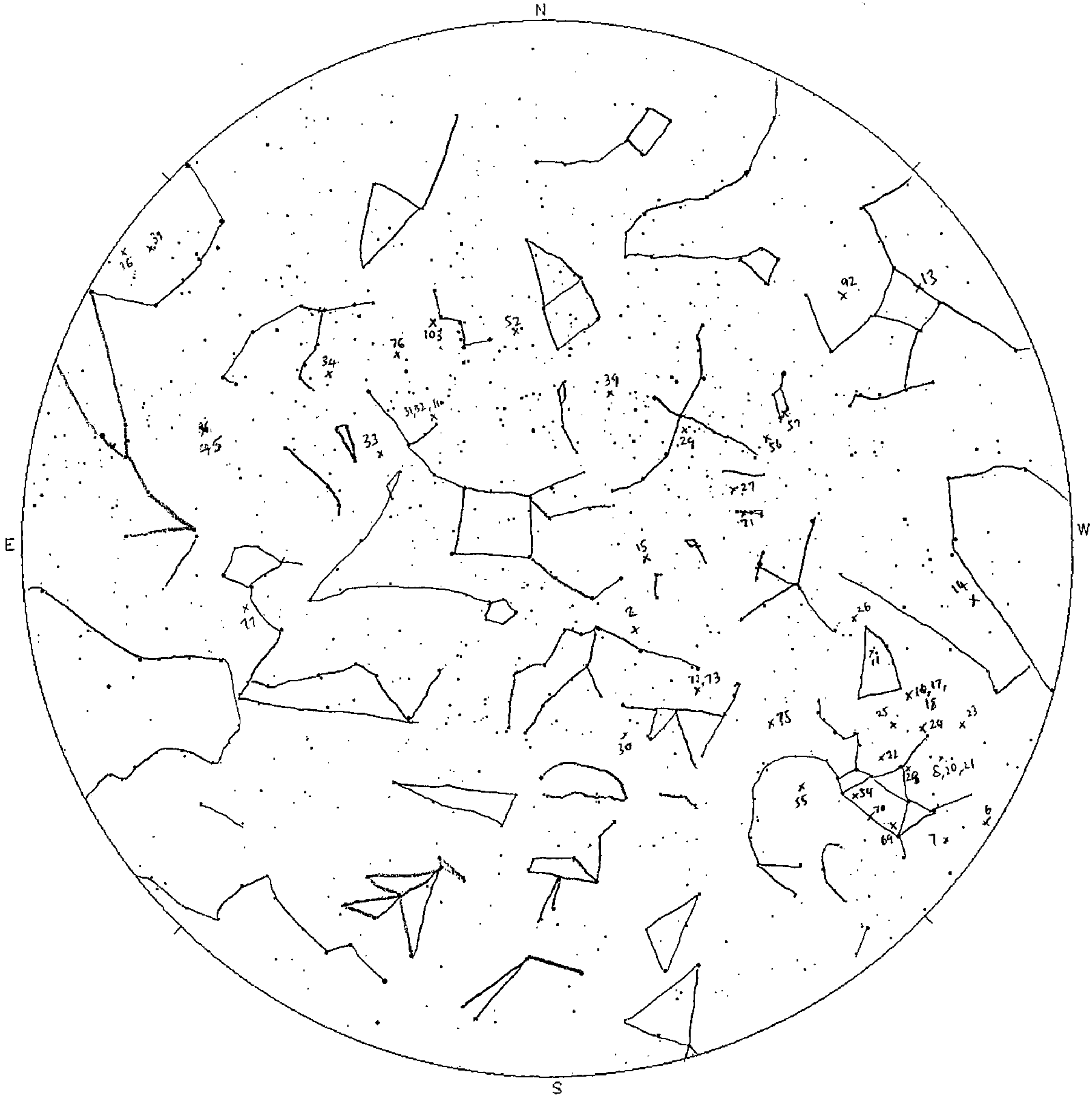
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8,10,21
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C77
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16,17,18
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107
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102
101
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72,
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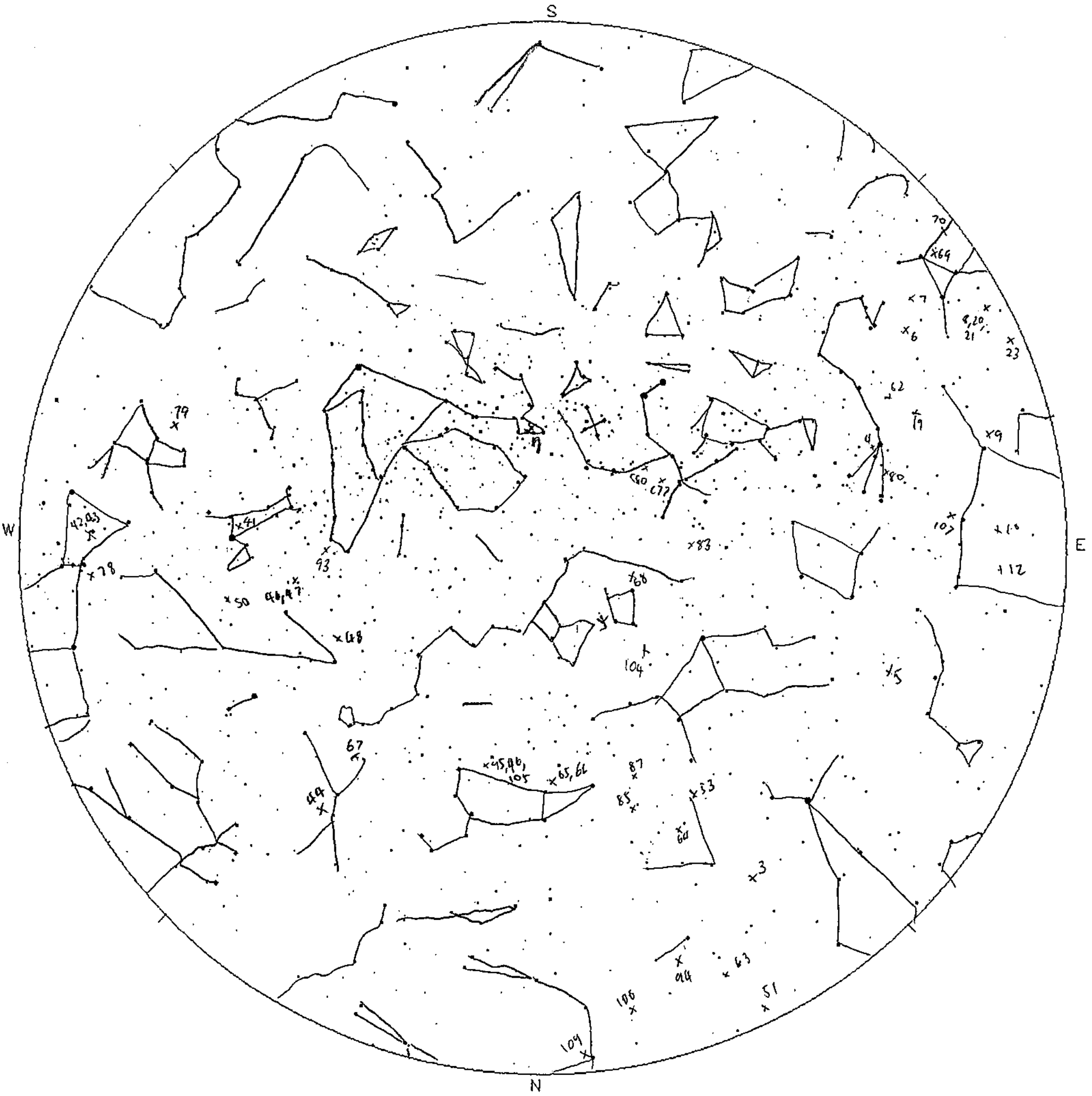
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x69
x7
8,20,
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x6
62
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x9
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x80
107
x10
+12
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79
W
42,43
x78
x41
93
x50
46,47
x48
580
C77
x83
x68
104
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x33
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x3
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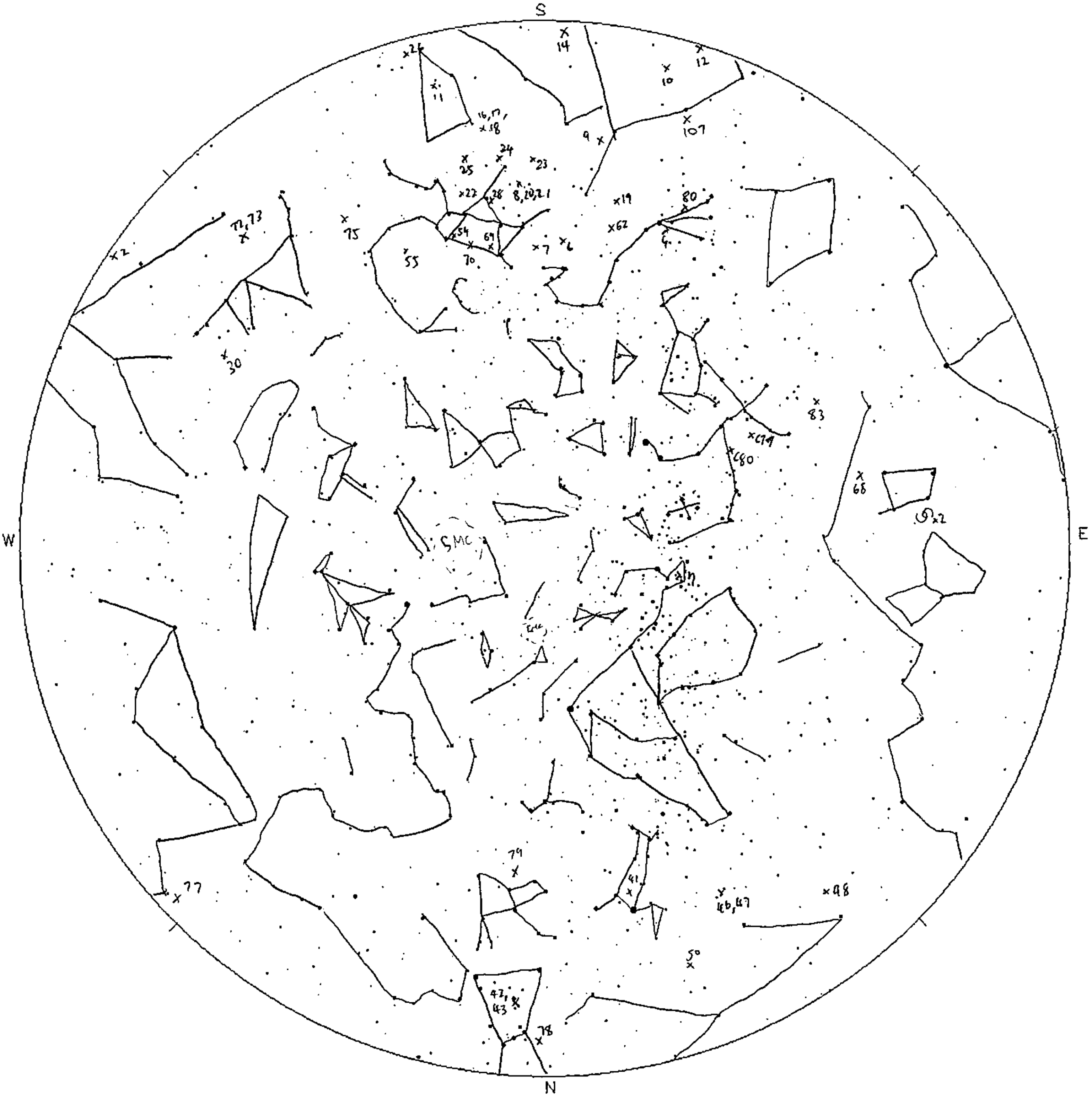
x63
51
106
109
N


S
W
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14
12
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107
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26
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16, 17, 18
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8, 20, 21
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80
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680
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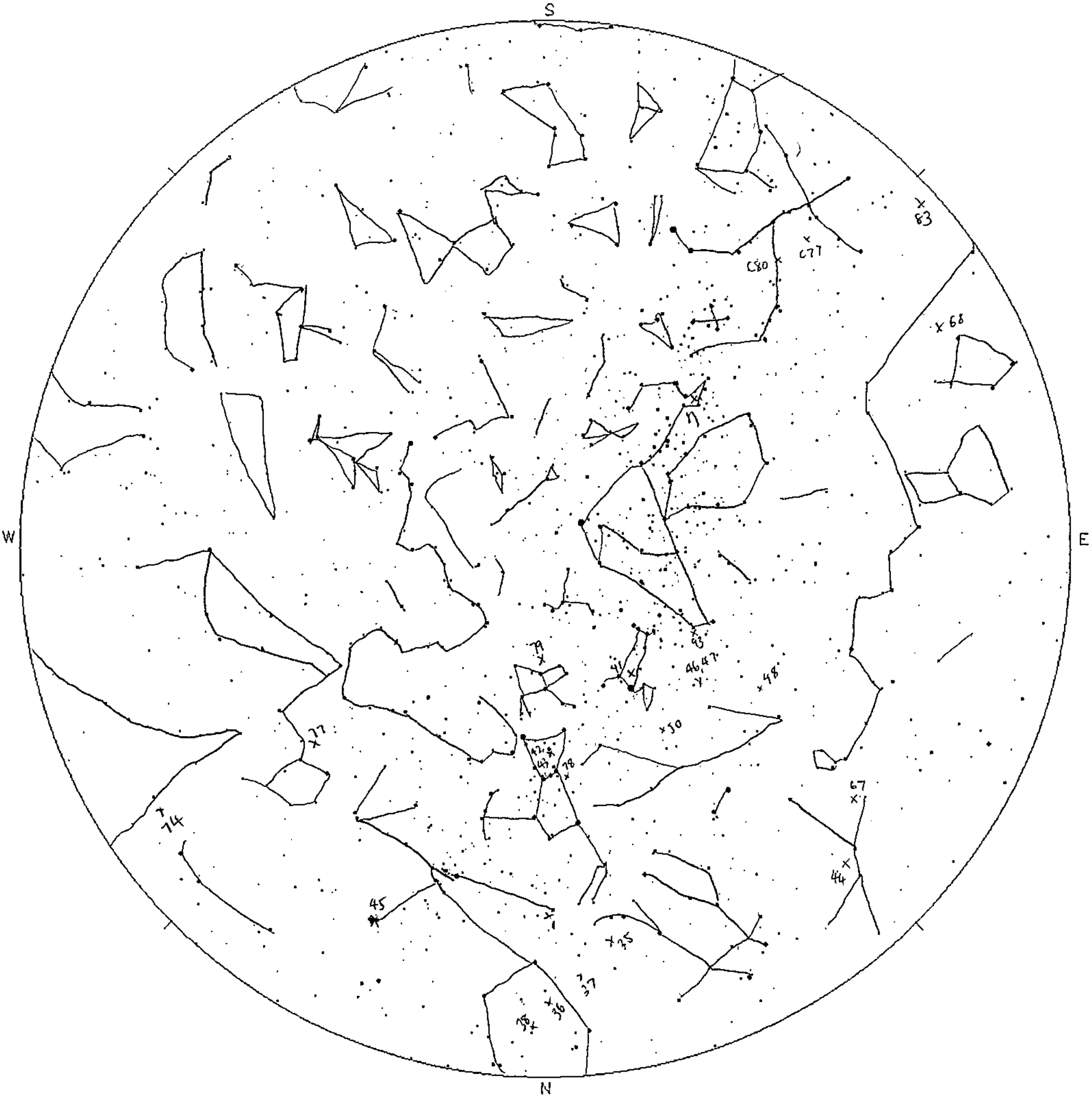
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83
C80
C77
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95,96,105
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110
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81,82

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C80
C72
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83
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69
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8,10,21
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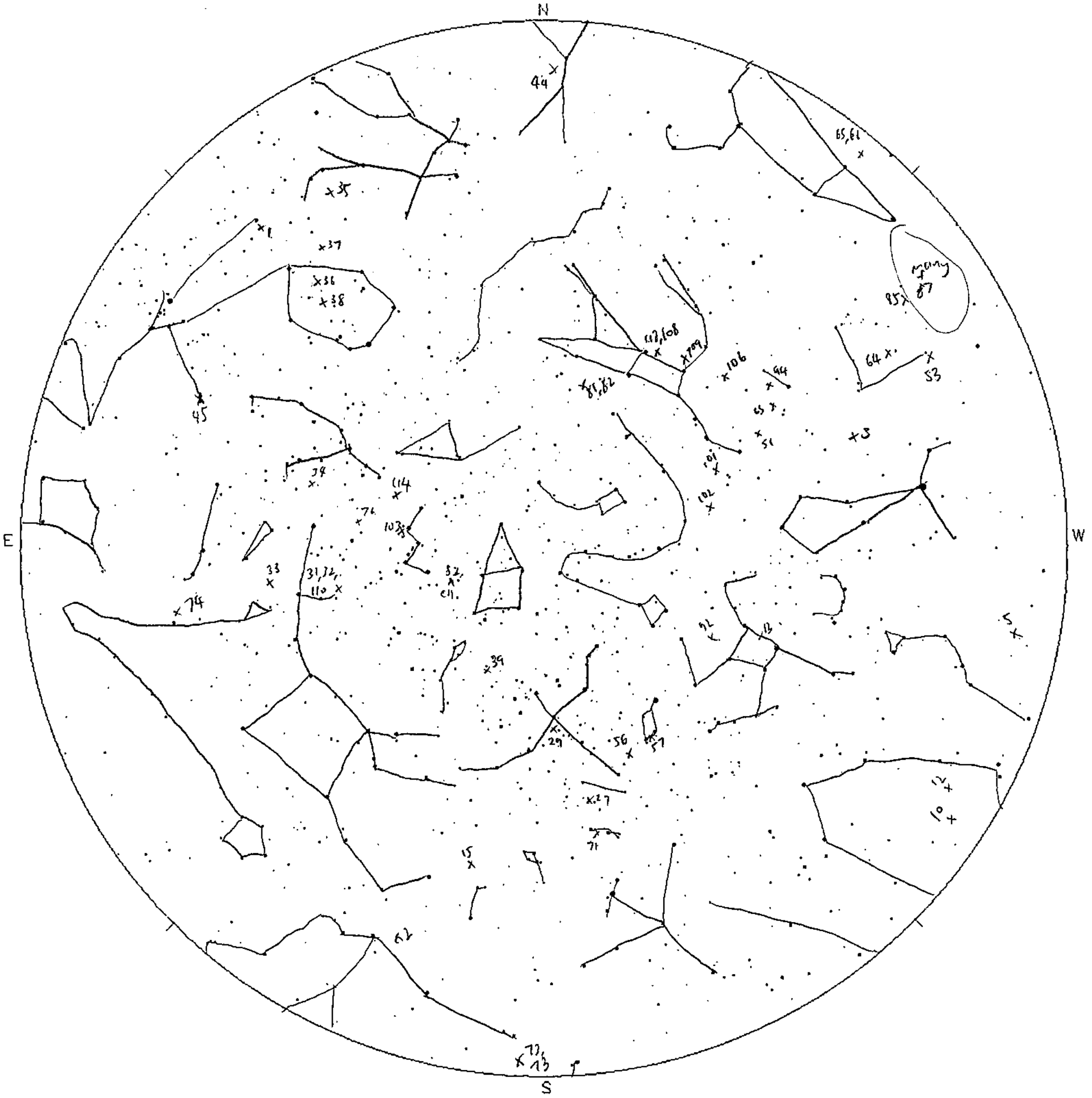
71
N


N
44
65,66
×35
×1
×37
×36
×38
many
87
85×
112,108
×109
×106
94
64×
53
81,82
45
65×
51
+3
34
114
101
102
76
103
E
W
33
31,72,
110
32
C11
×74
92
13
5
×39
29
56
57
12
10
×27
71
15
62
77,
13
S


N
94
63
106
51
109
97,108
40
101
102
81,82
13
92
57
56
35
37
31
38
1
103
52,111
39
29
27
71
78
34
33,32,110
45
15
78
44,42,43
74
2
77
72,73
30
E
W
S


S
x68
C85
79
x83
C77
C80
C102
C99
47 Tuc
W
x4
80
62
19
6
x7
E
107
77
8,23,121
69
x70
x54
74
23
12
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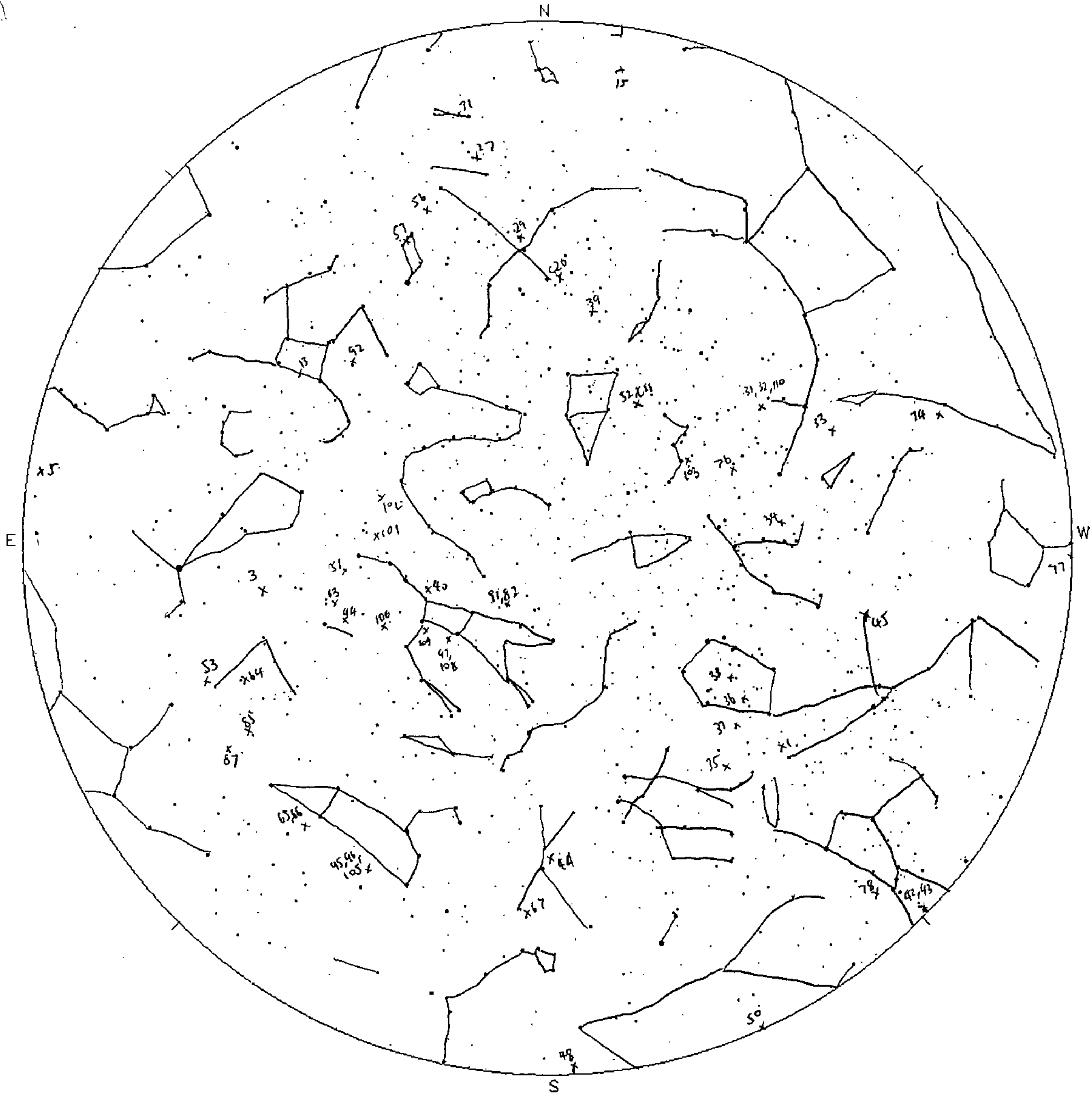
x11
x26
x72,73
x2
x15
x71
27
N


N
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W
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71
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31, 32, 110
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5
103
76
102
101
34
3
51
40
83
94
106
81, 82
69
47, 108
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77
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95, 96, 105
44
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42, 43
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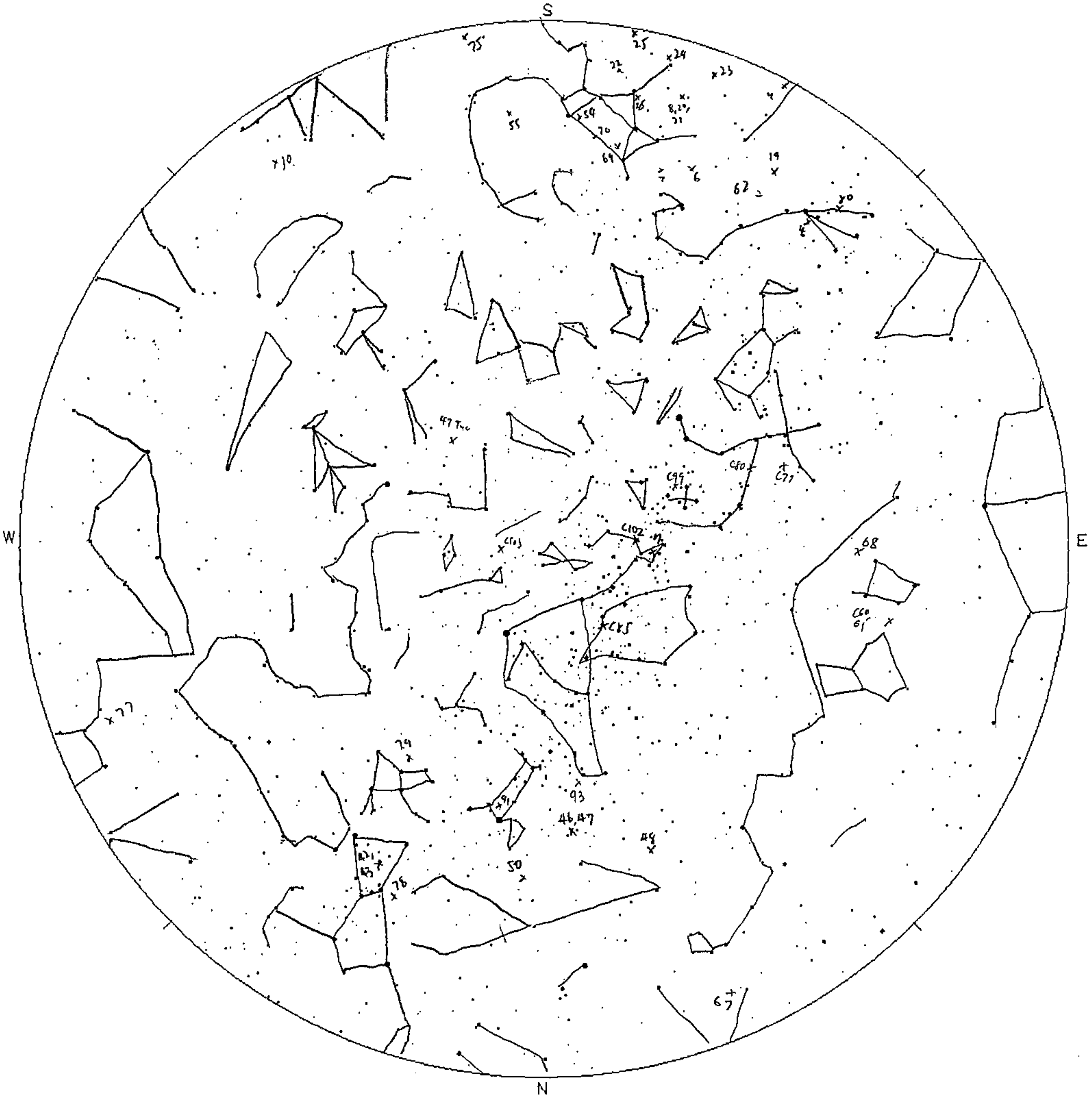
48

year


S
75
25
22
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x23
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54
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8,29,
31
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70
69
x10
7
6
19
62
20
8
47 Tuc
C99
C80
C77
C102
C103
68
C60
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C85
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E
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46,47
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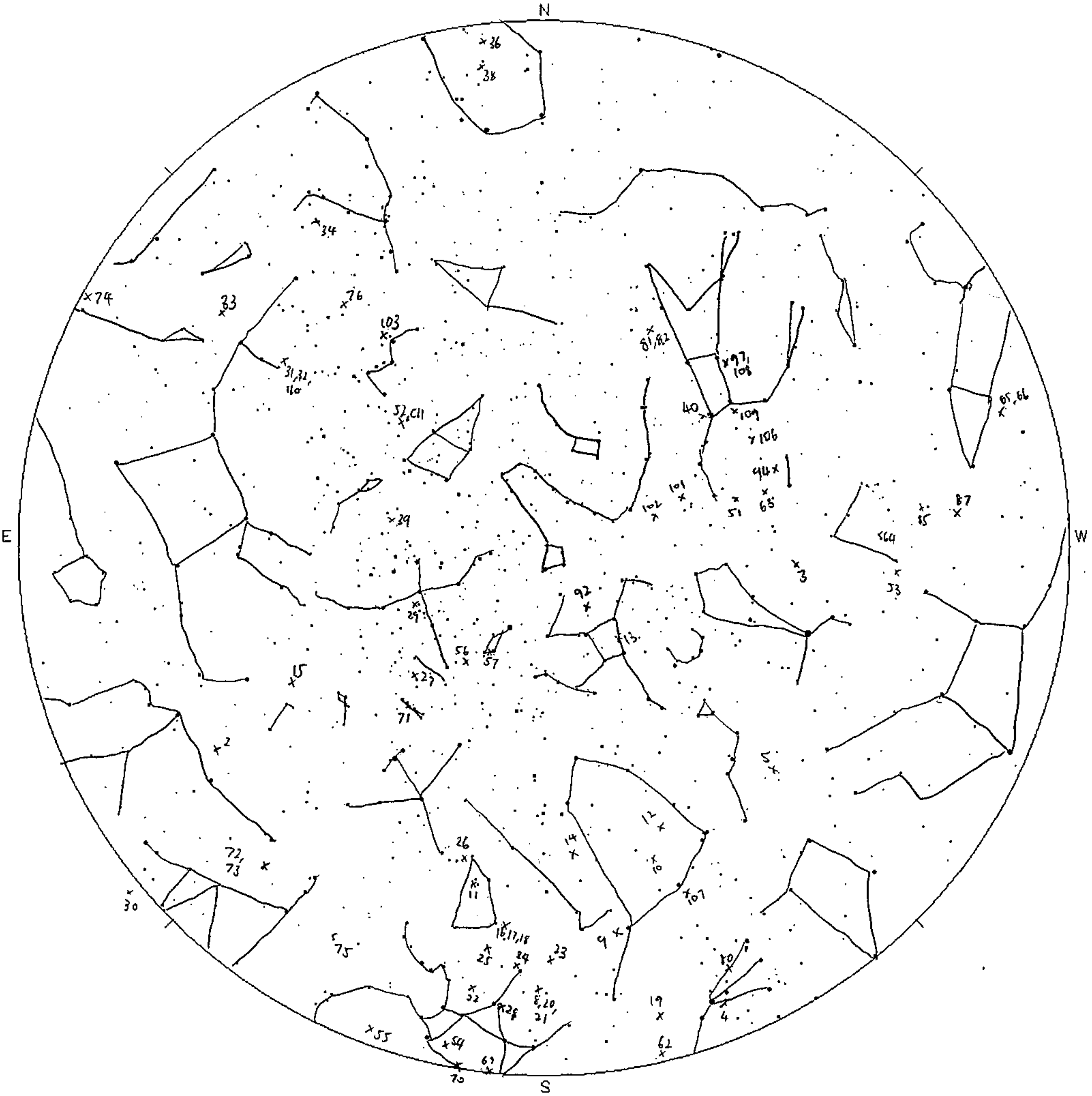
67
N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108
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94
101
102
51
65
87
85
564
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53
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W
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92
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71
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4
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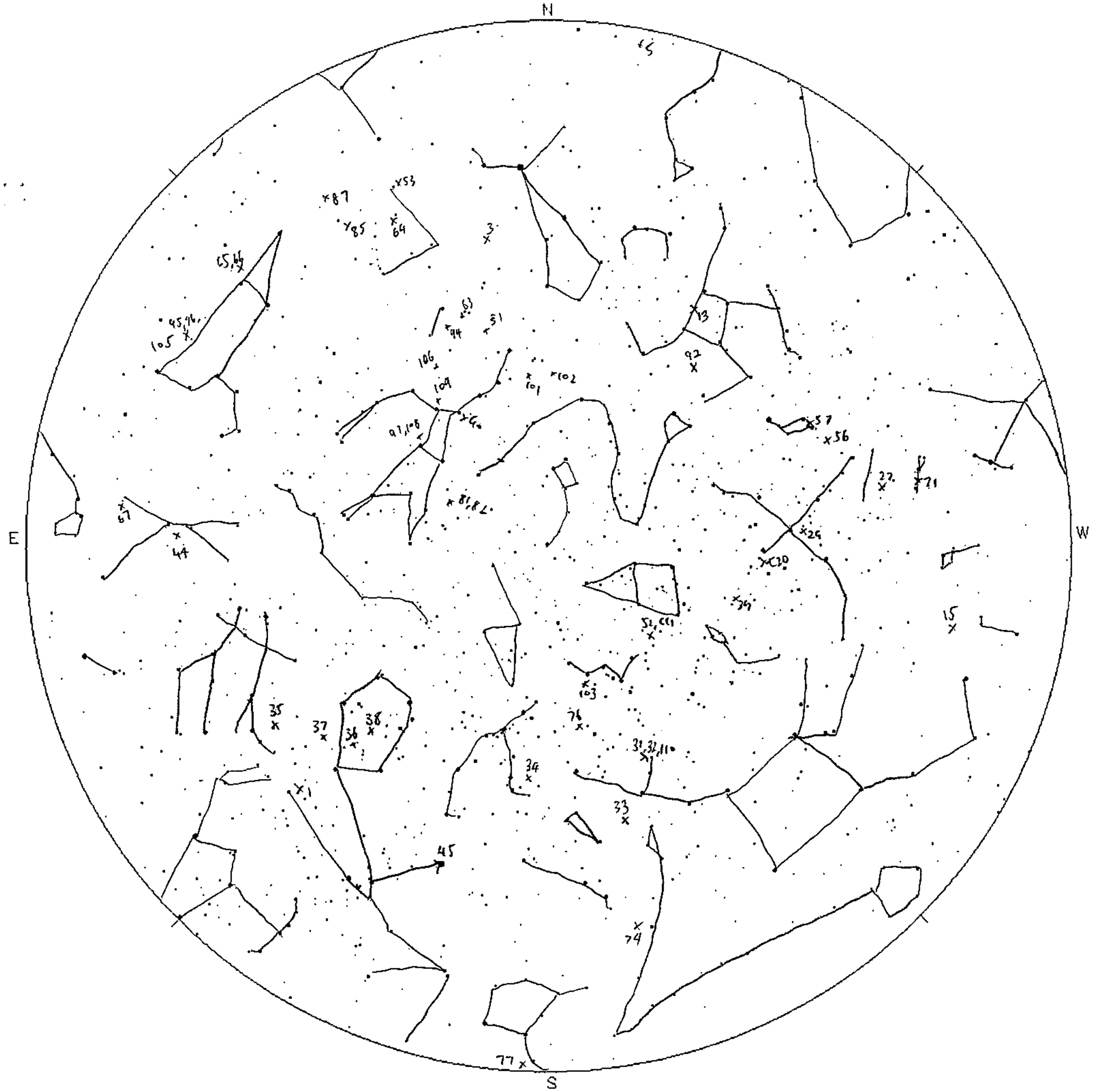
70
S



This guy is at north pole


S
W
E
N
C85
C102
x9
C99
C80
C77
83 x
68
62
6
7
4
10
x19
x9
107
70
69
59
55
8,20,21
26
x22
23
24
x25
16,17,18
11
26
x10
12
14
x5
67
44 x
x95,96,105
x65,66
87
85
x53
64
3
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63
51
x106
x109
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101
x102
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x92
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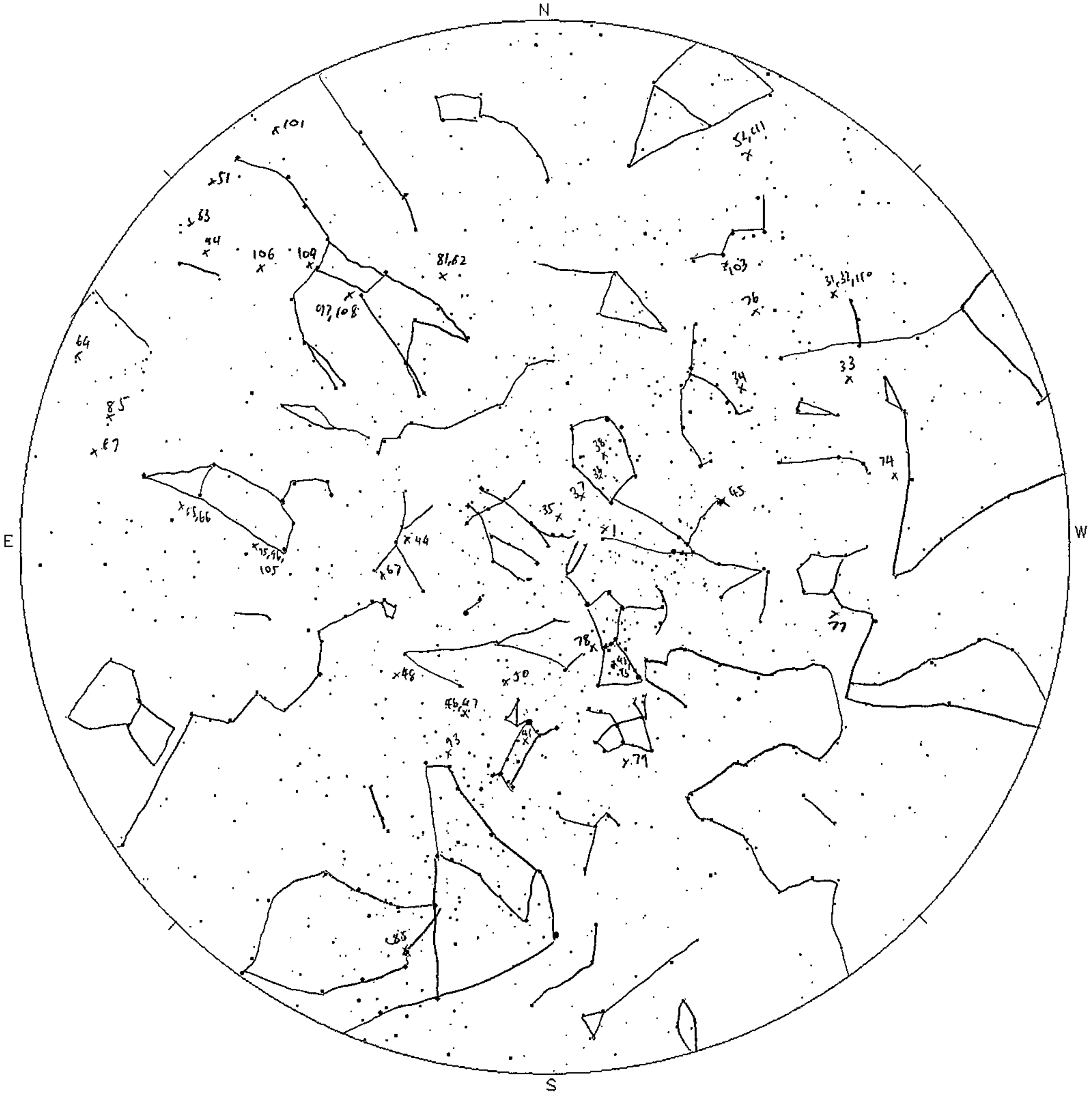
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76
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34
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87
74
38
39
37
65,66
35
45
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W
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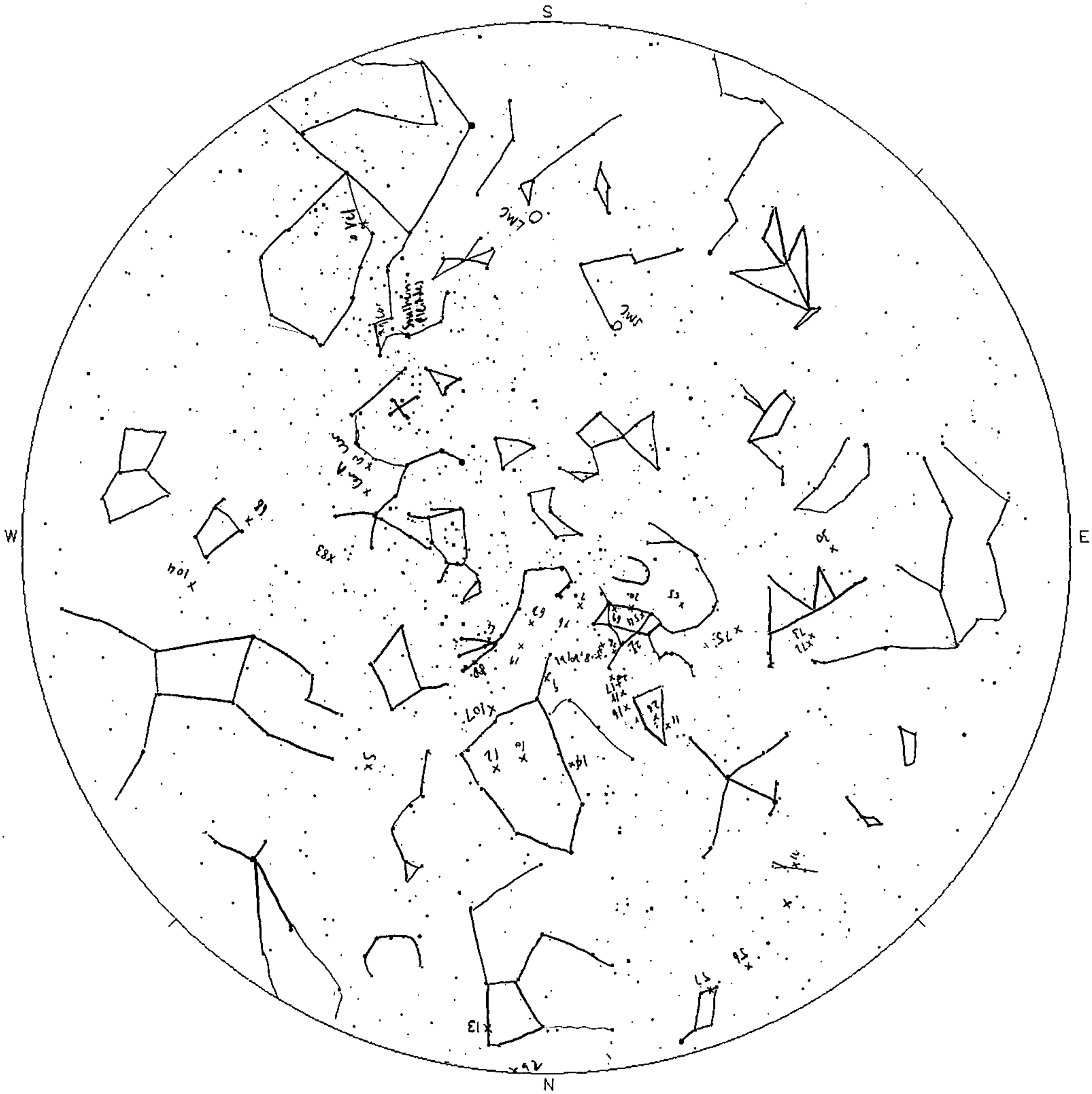
67
77
78
43,73
48
50
46,47
41
79
93
88
S


S
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E
N
LMC
SMC
Vel
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104
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107
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12
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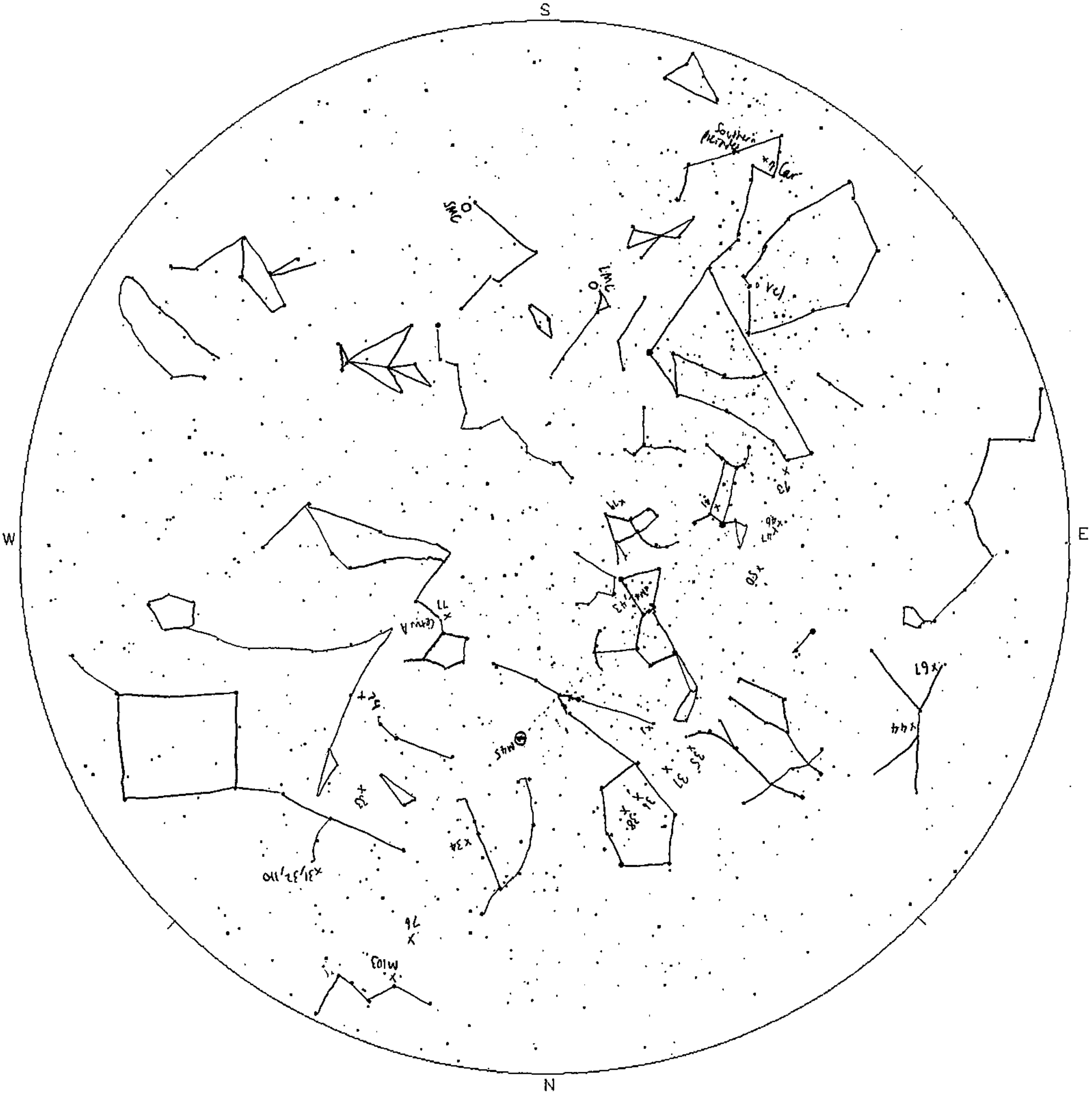
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Southern Pointers
η Car
SMC
LMC
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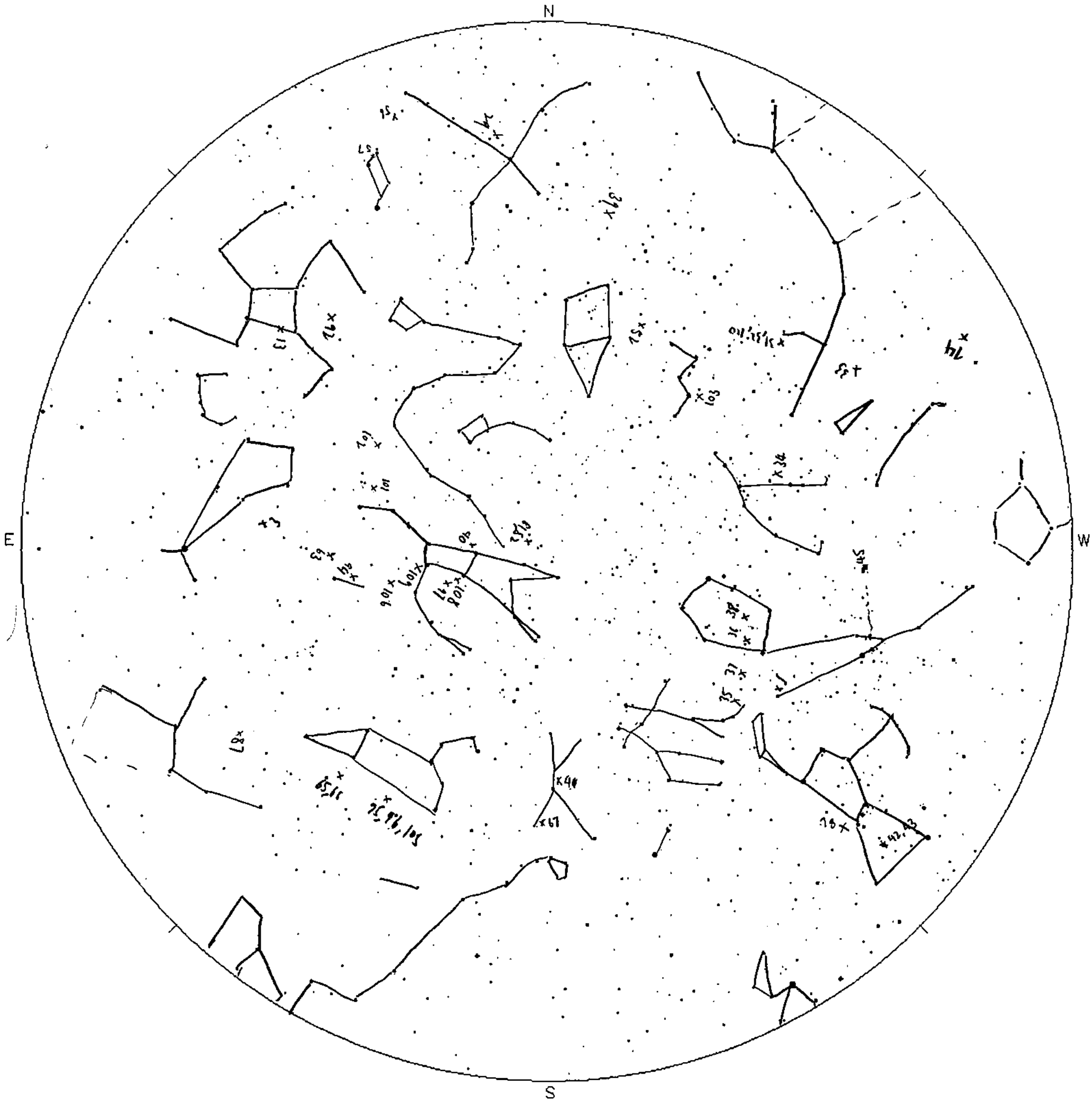
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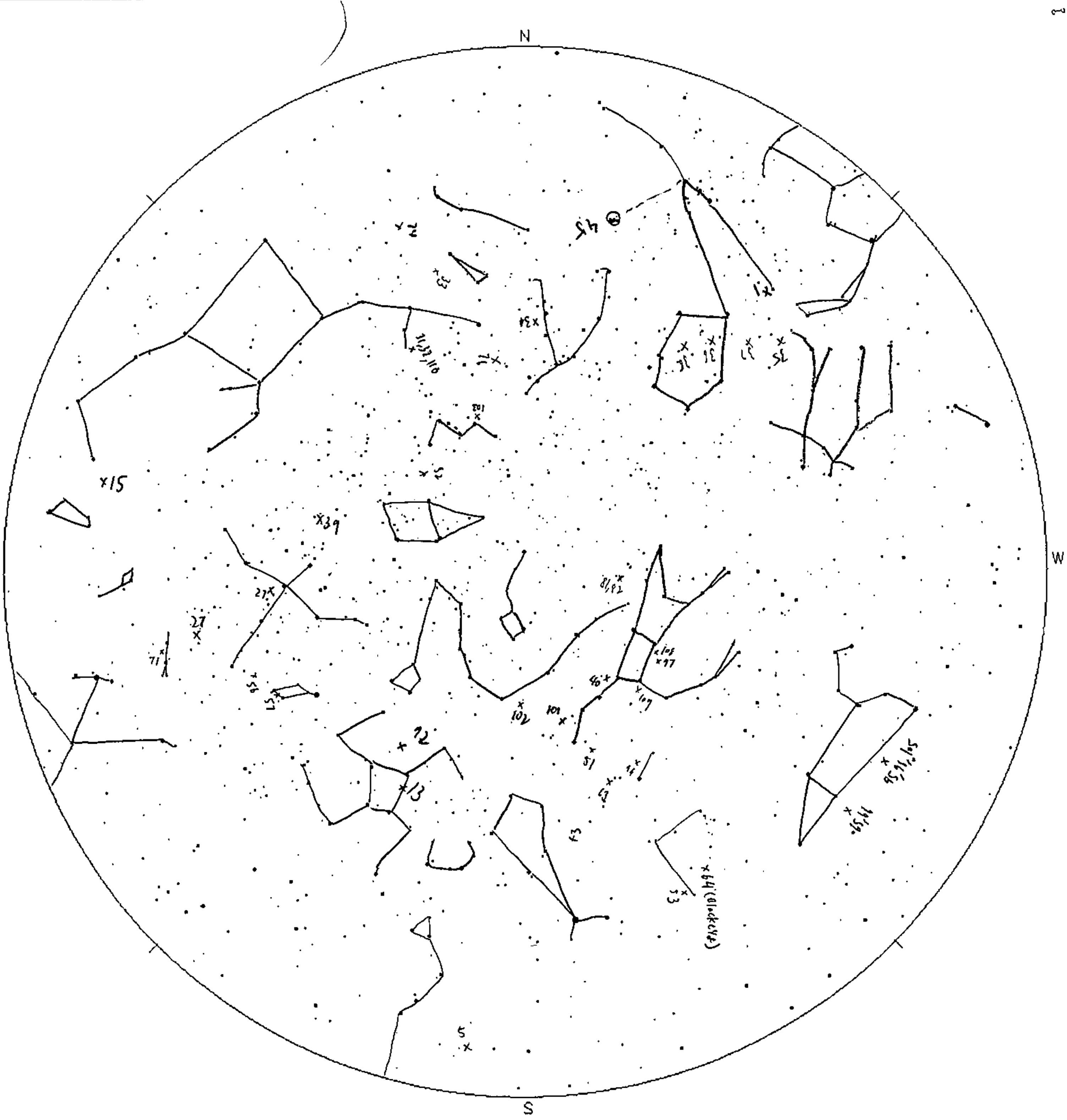
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57
x12
x13
102
101
81,82
108
97
94
109
51
63
3
53
x64 (Blackeye)
95,96,105
65,66
5


N
E
S
W
x13
92
57
56
x29
NGC7000
81/82
x94
+63(Sunflower galaxy)
x51(Whirlpool)
x101(Pinwheel)
x102
x109
x40
97
108
65/66
95/96/105
x52
x103
x31,32,110
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x41
x44
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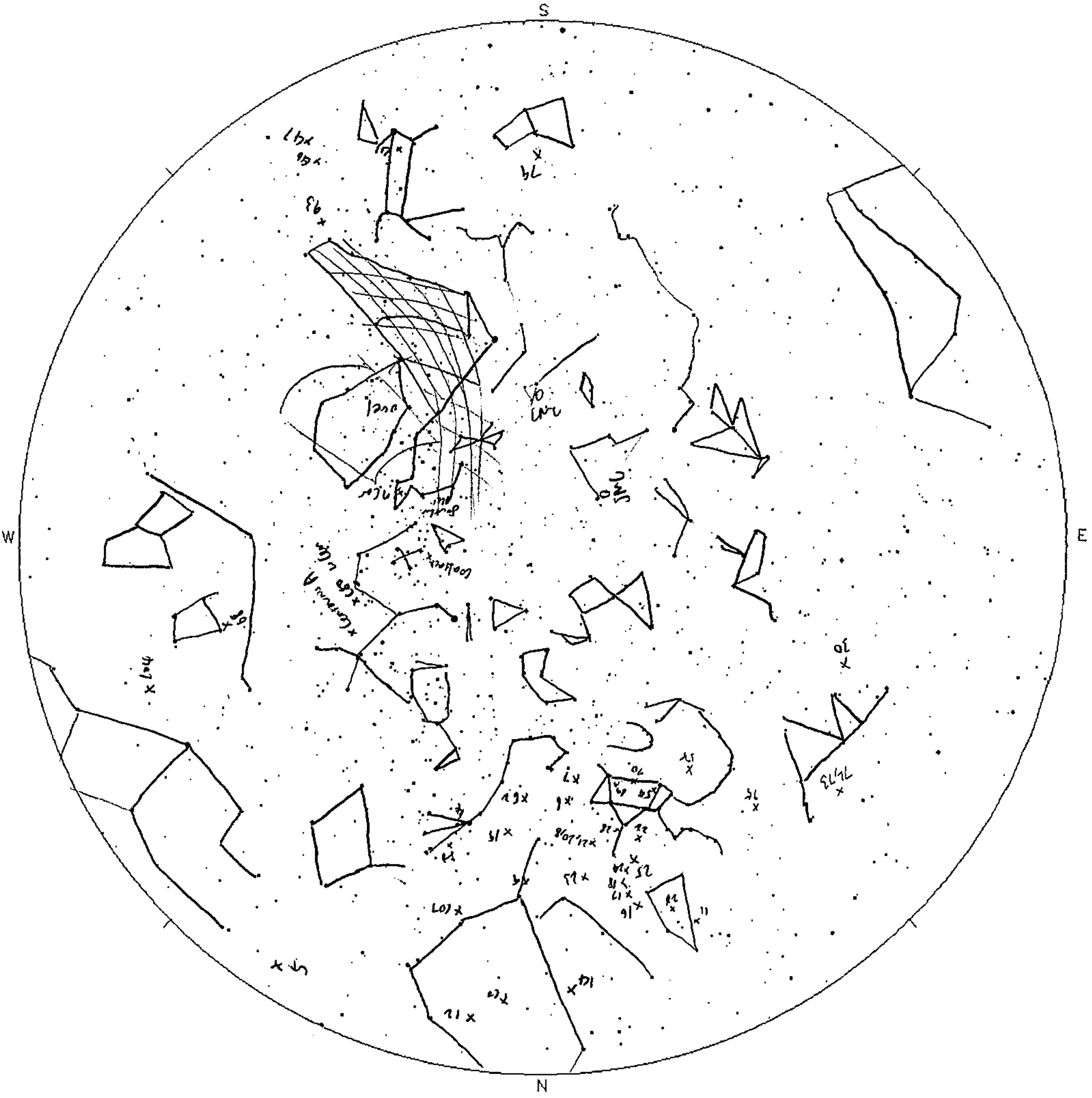
Lhw A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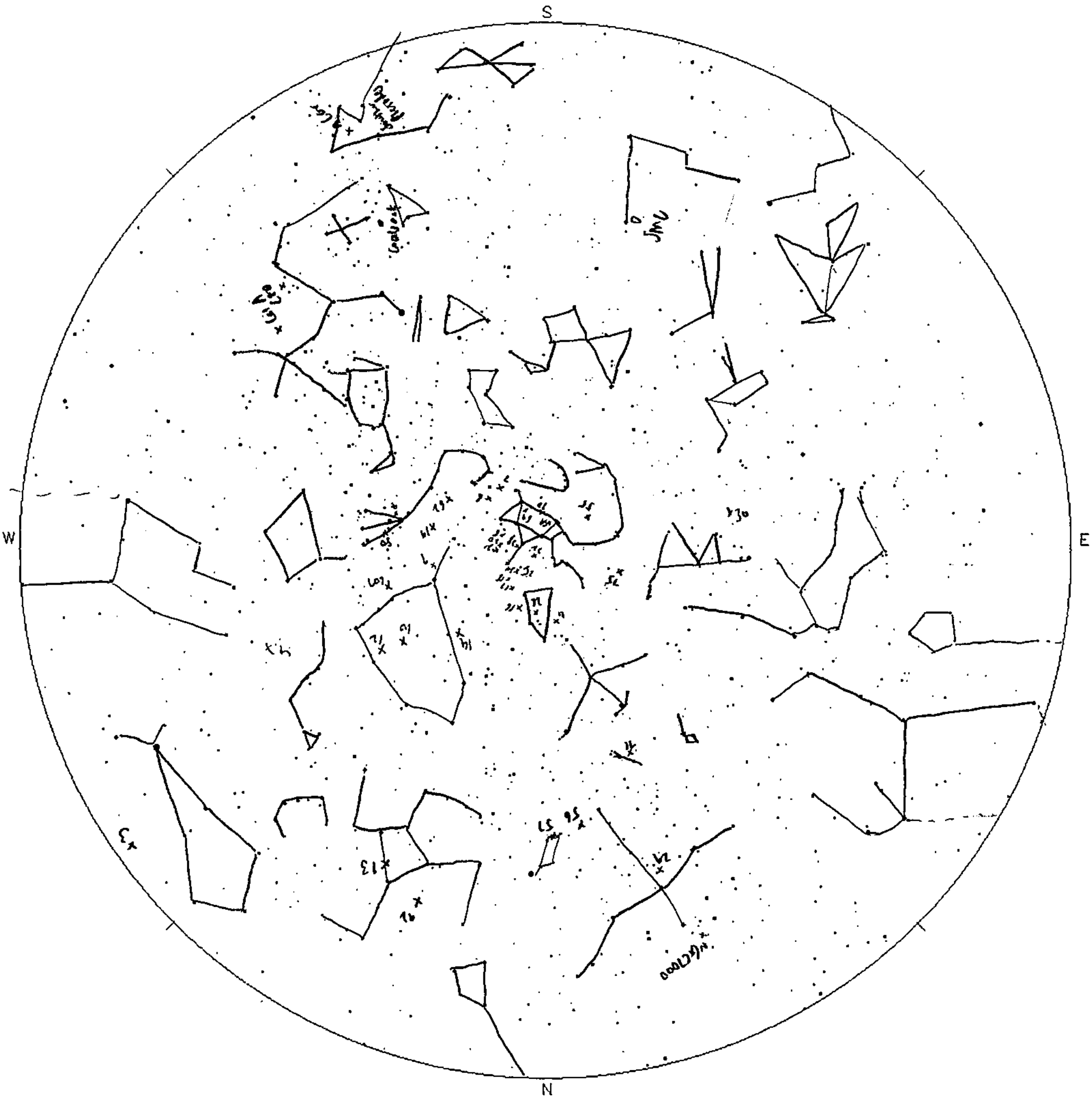
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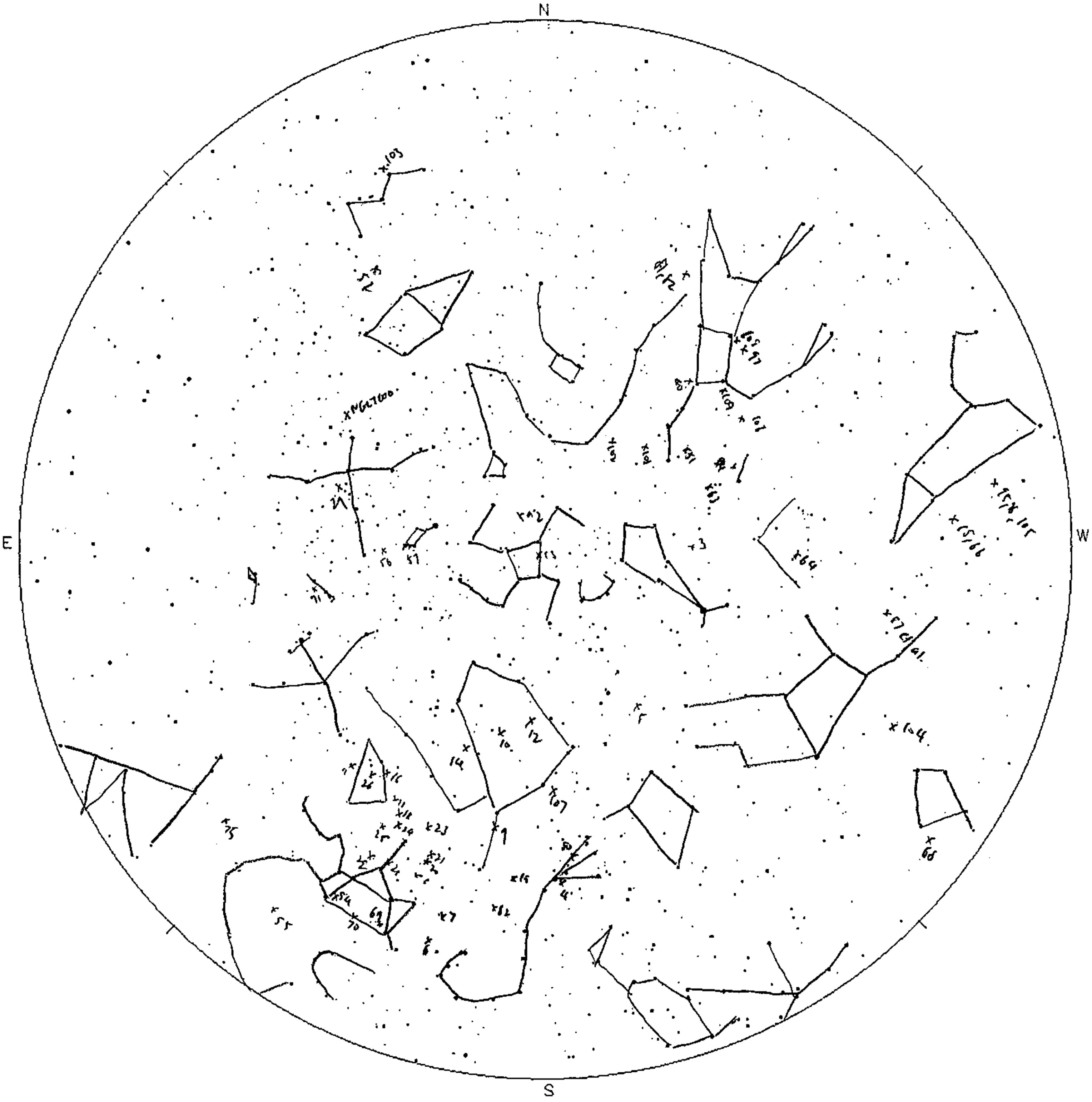
Coalsack
Juno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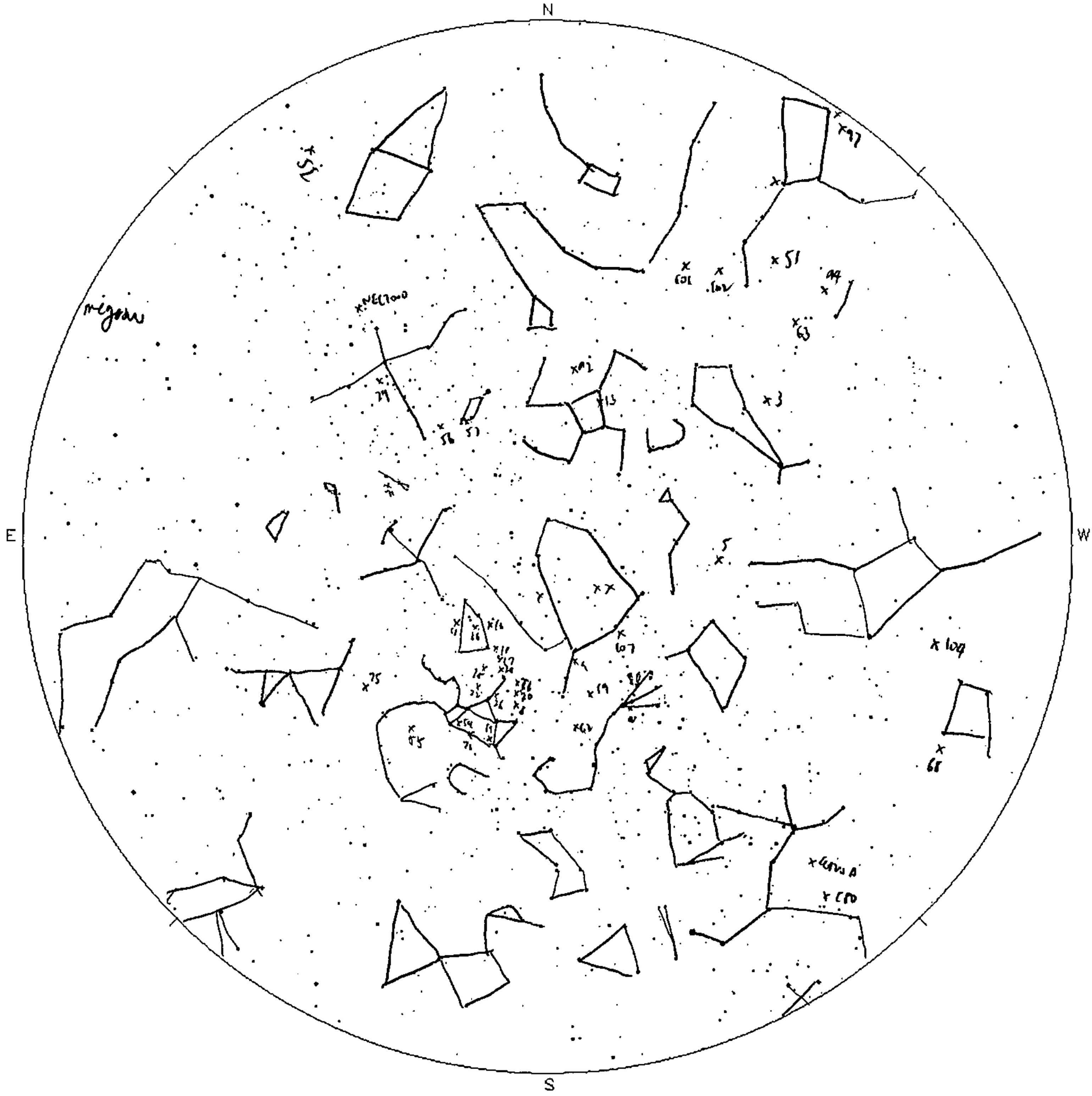
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NGC7000
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75
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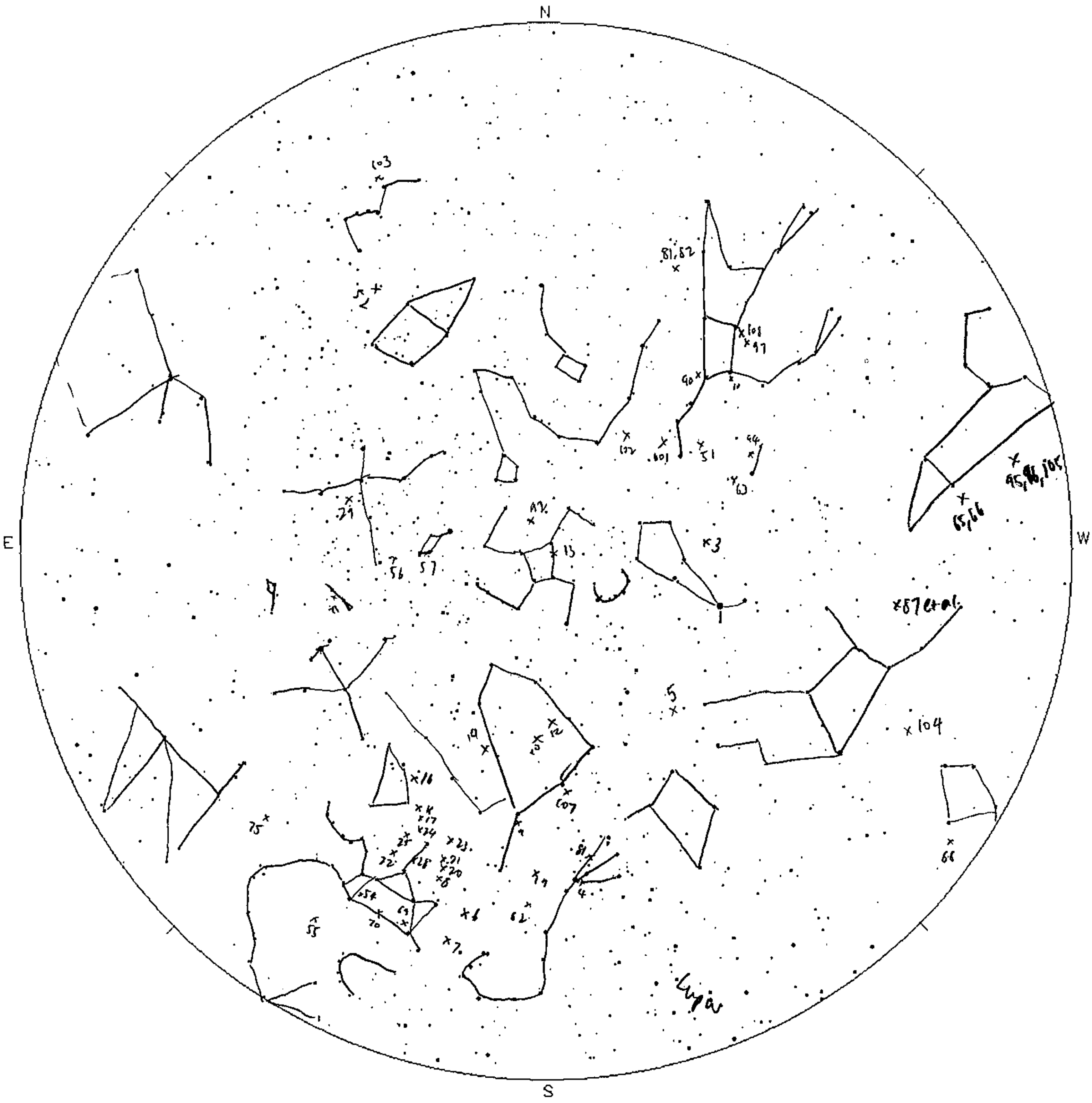
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92
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87 et al.
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12
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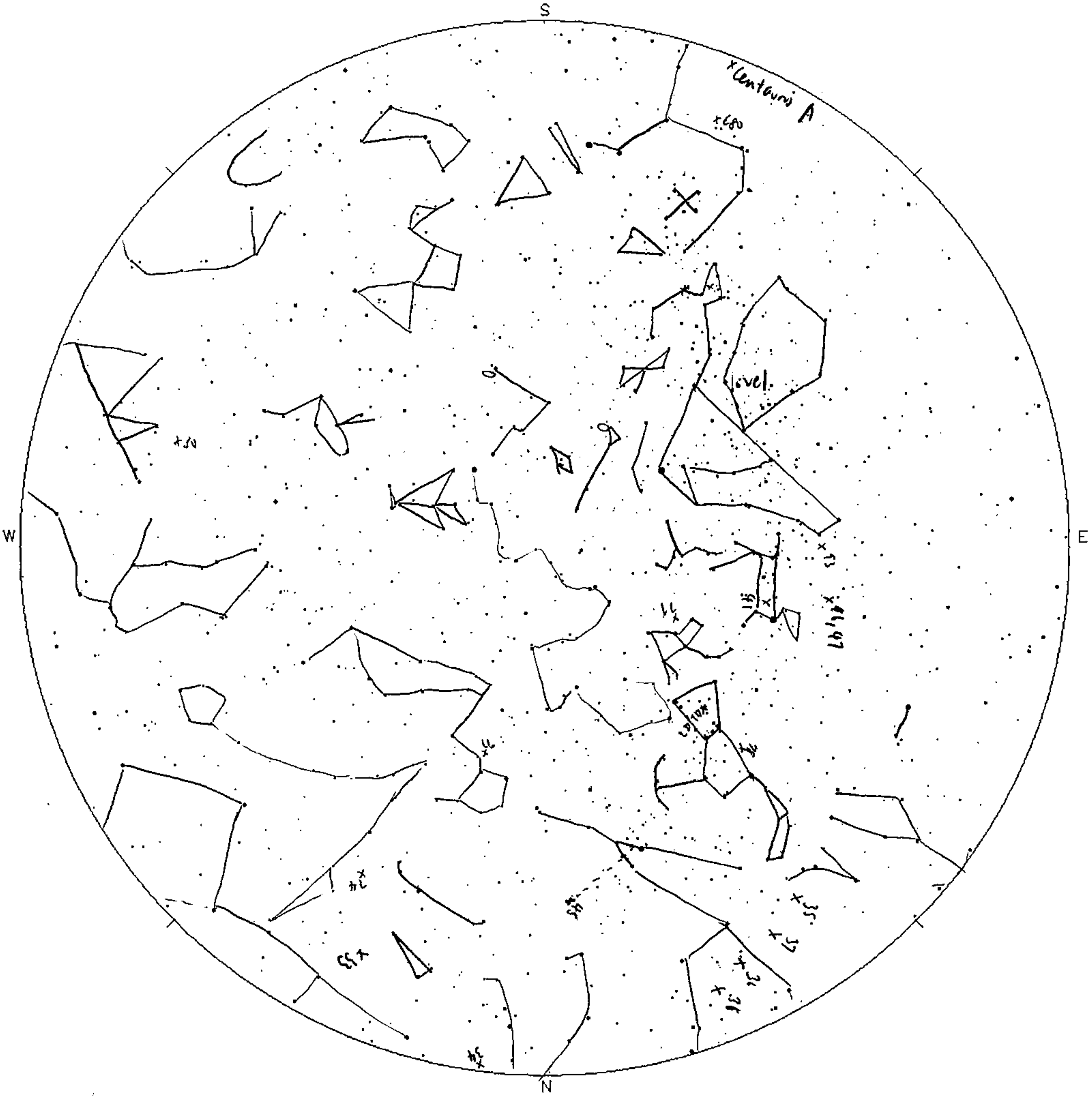
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×680
Vel.
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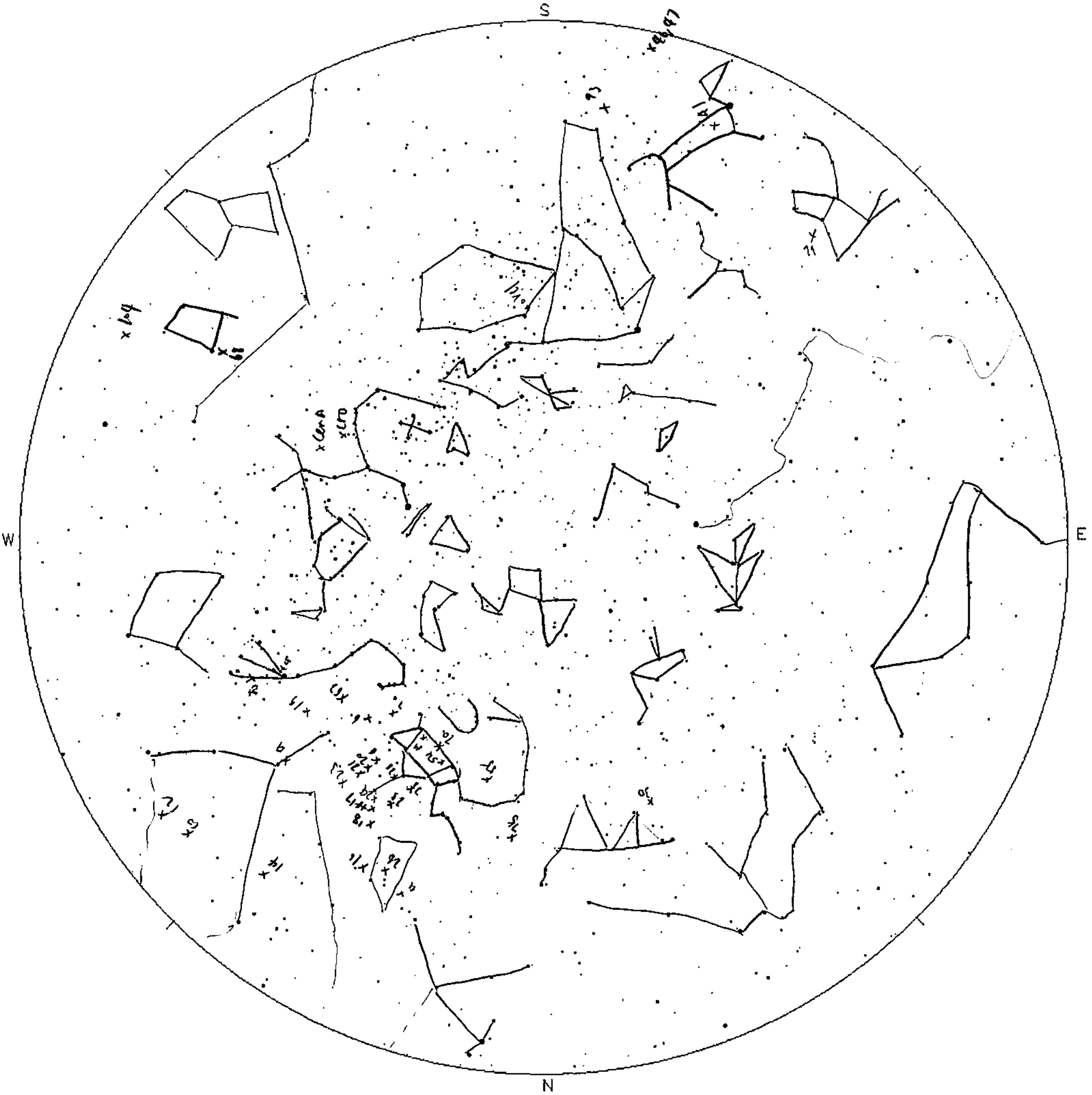
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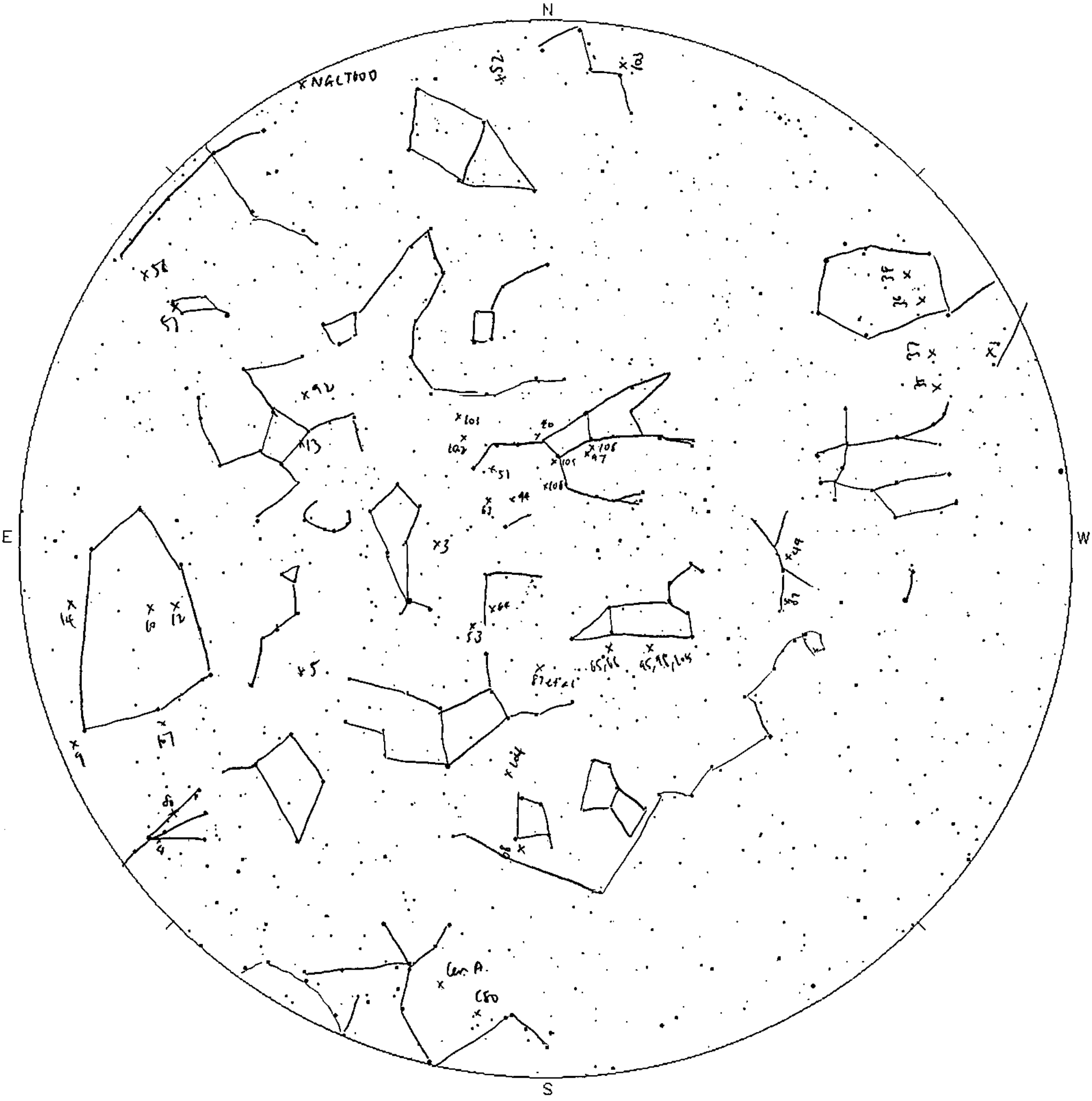
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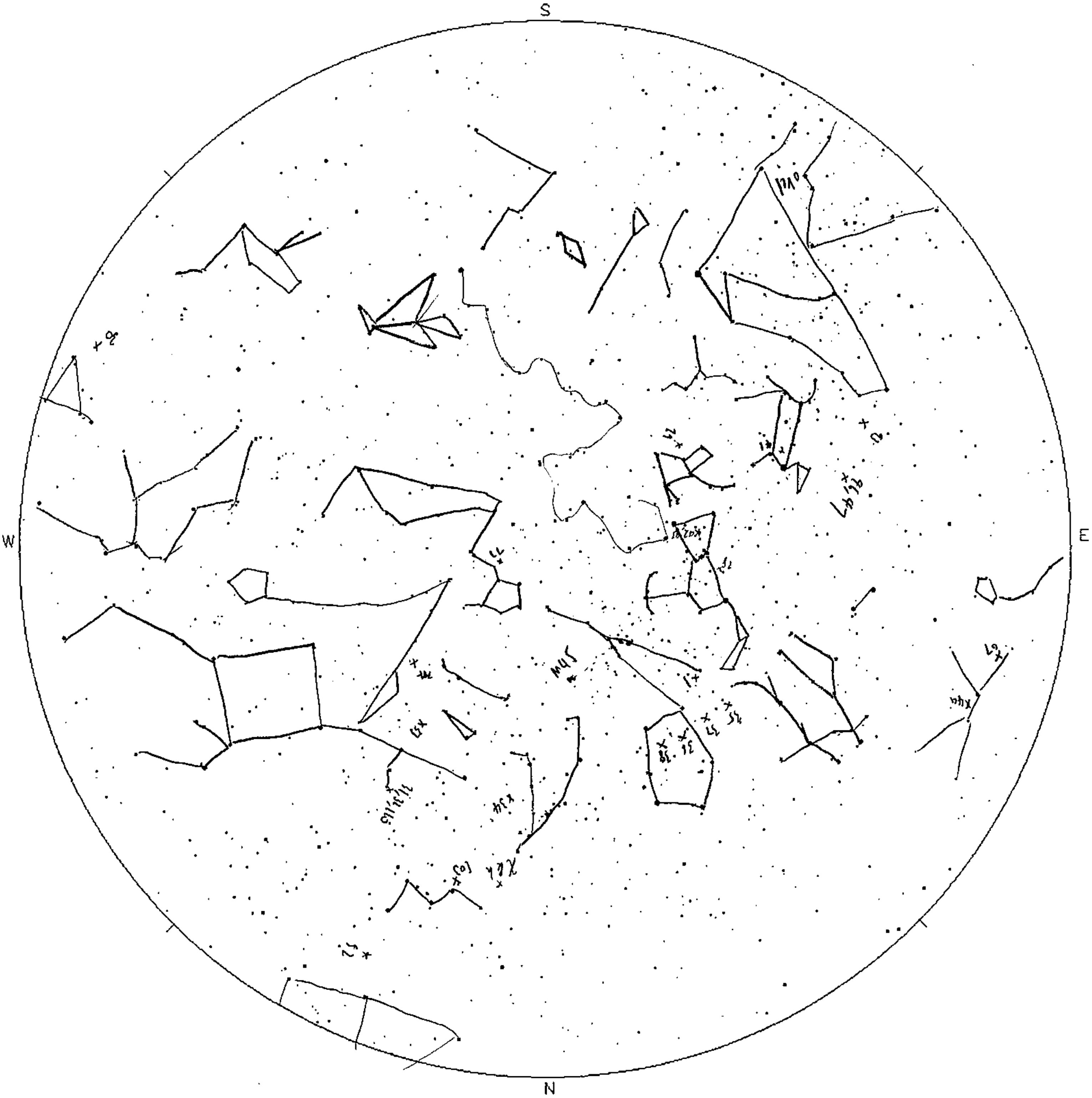
C80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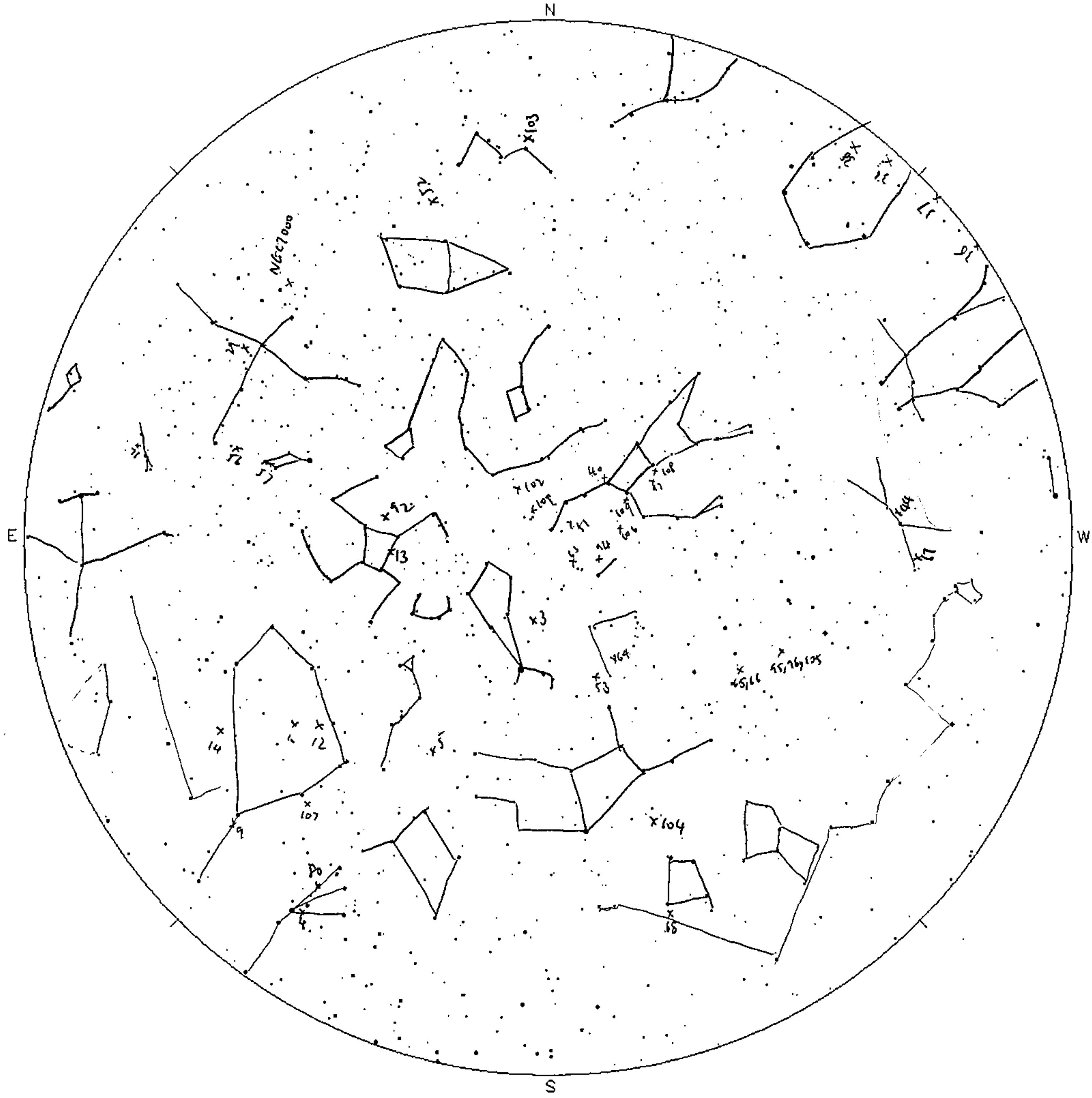
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NGC7000
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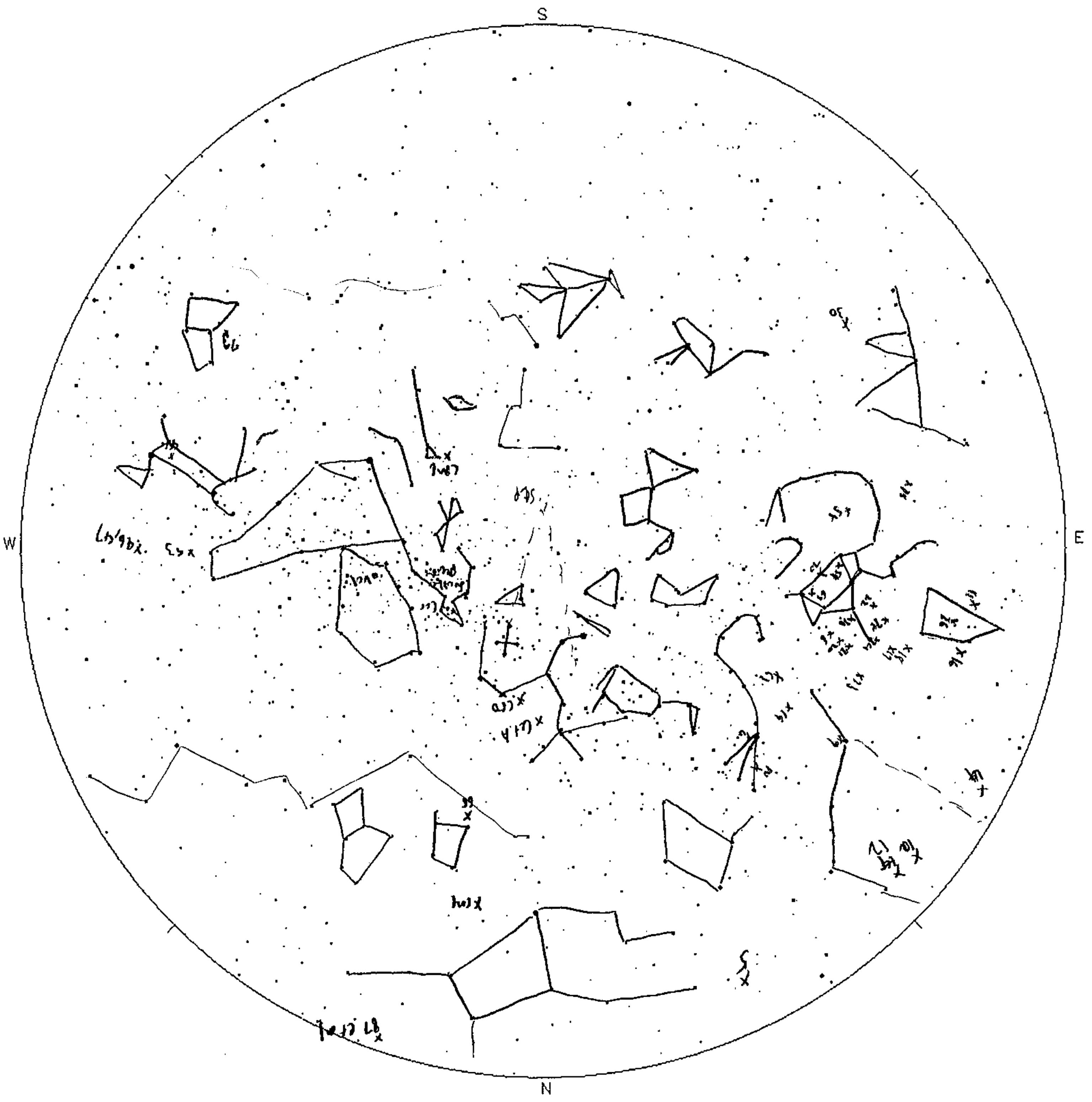
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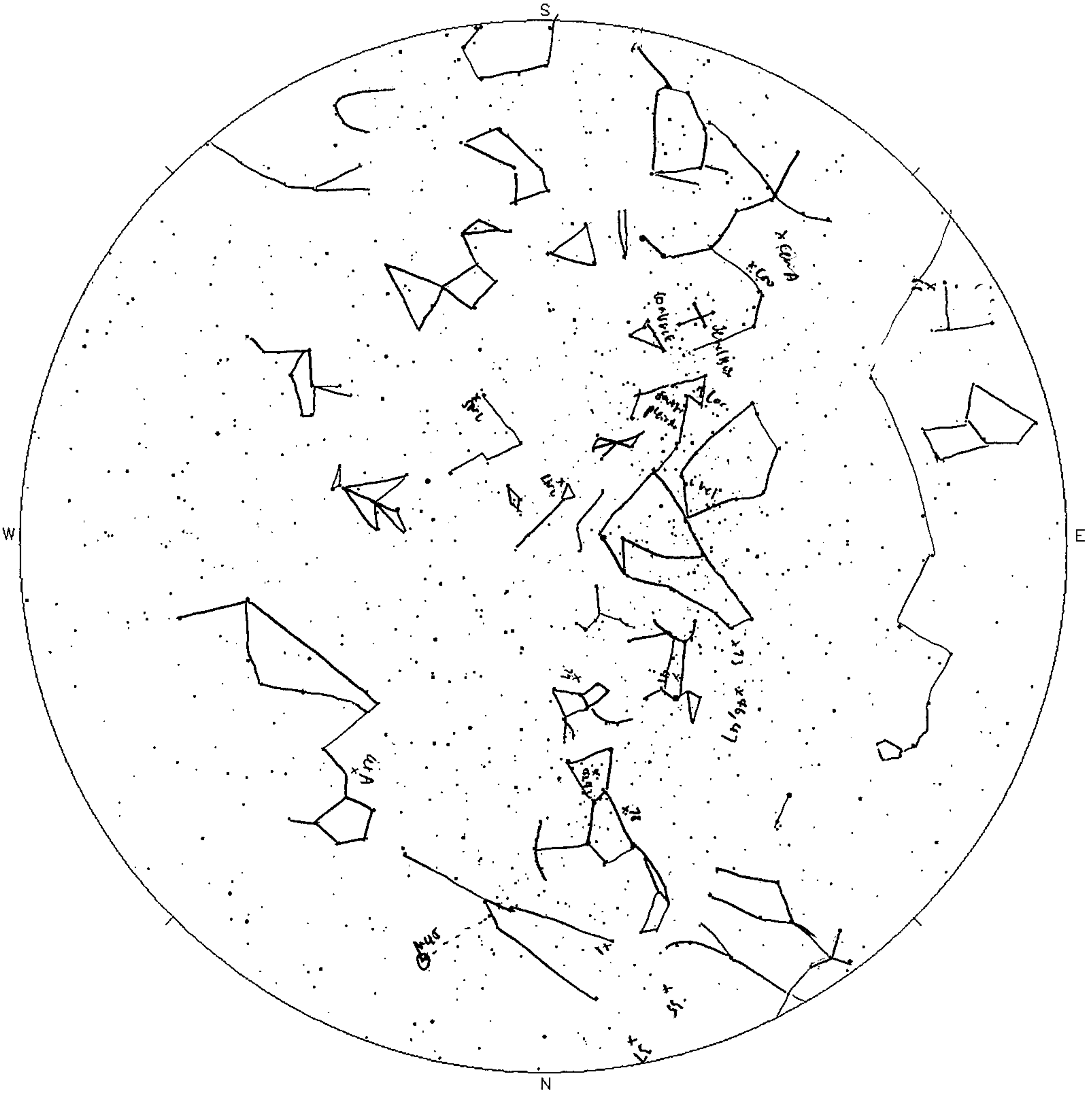
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E
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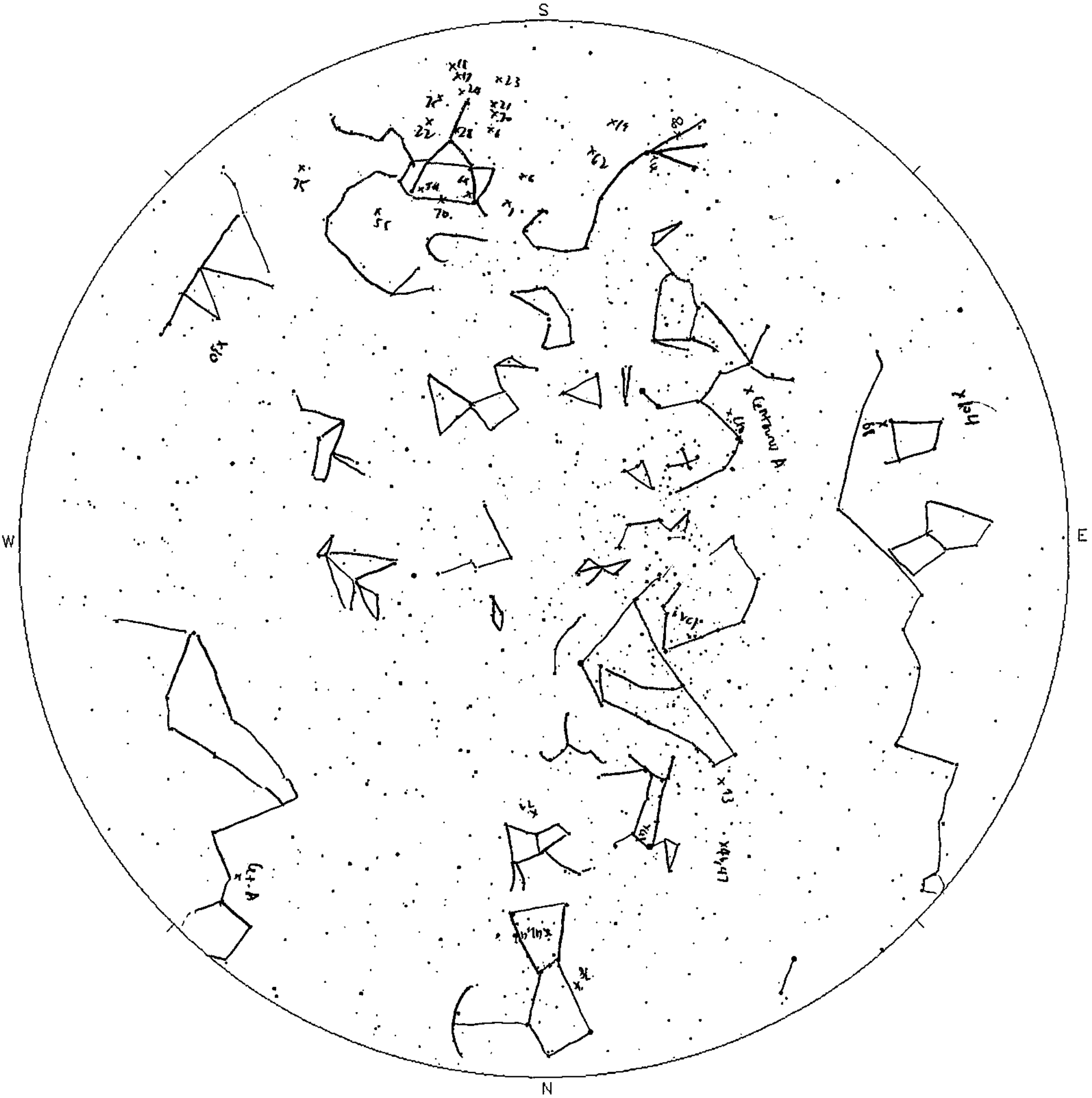
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Centaurus A
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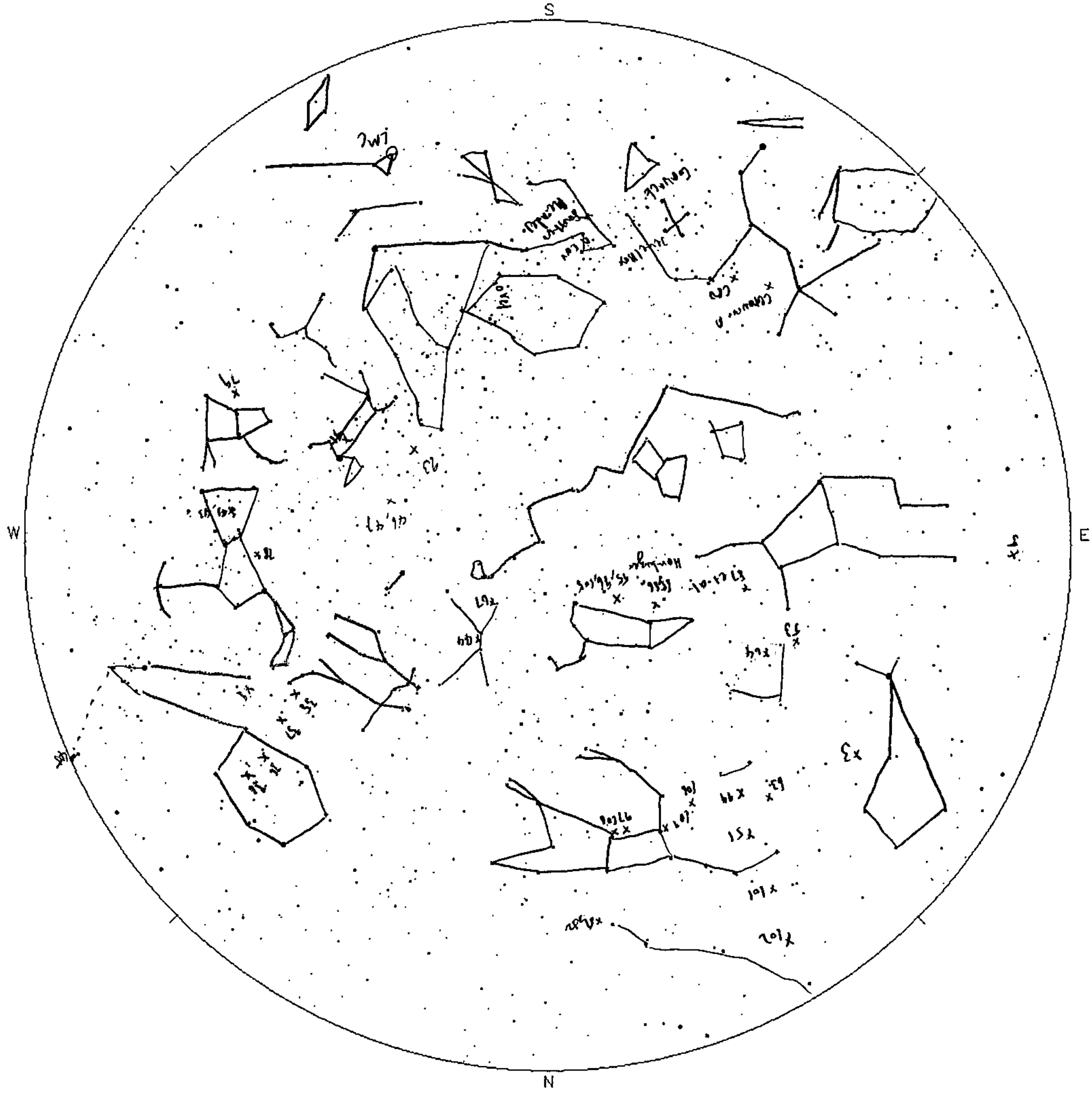
S
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N
LMC
Jewel Box
Southern Pleiades
Centaurus A
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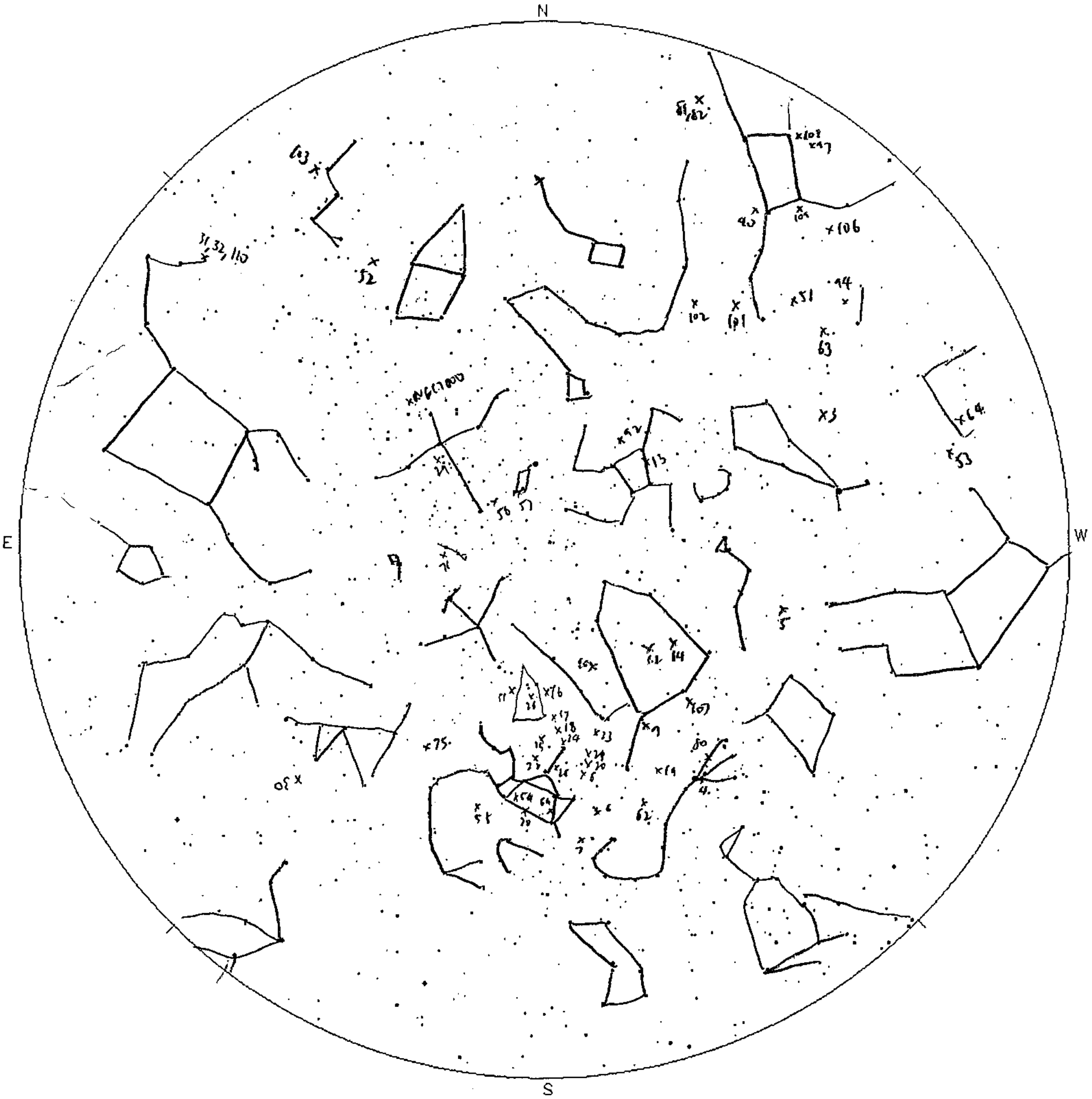
Horologium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x NGC7000
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x107
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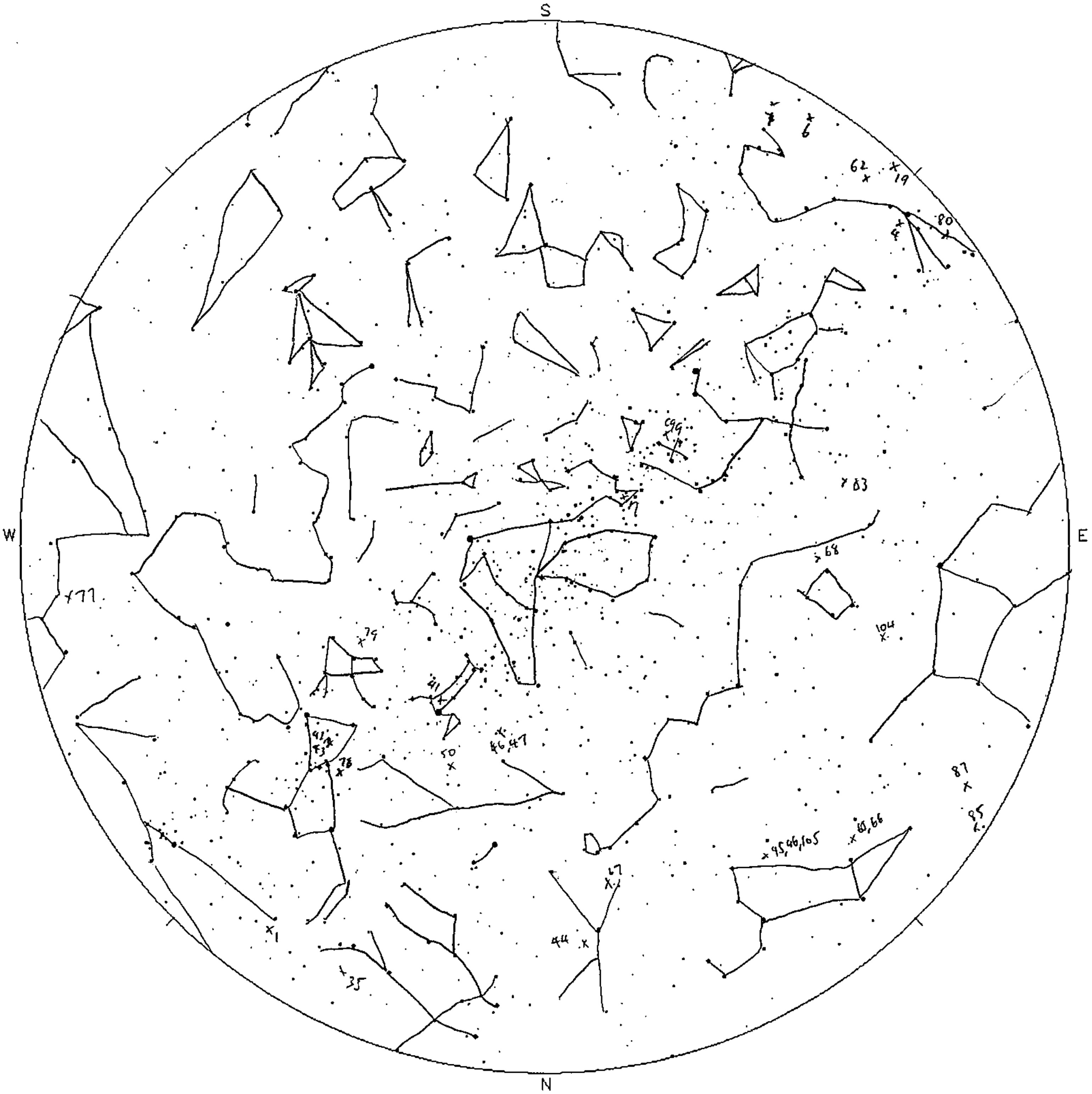
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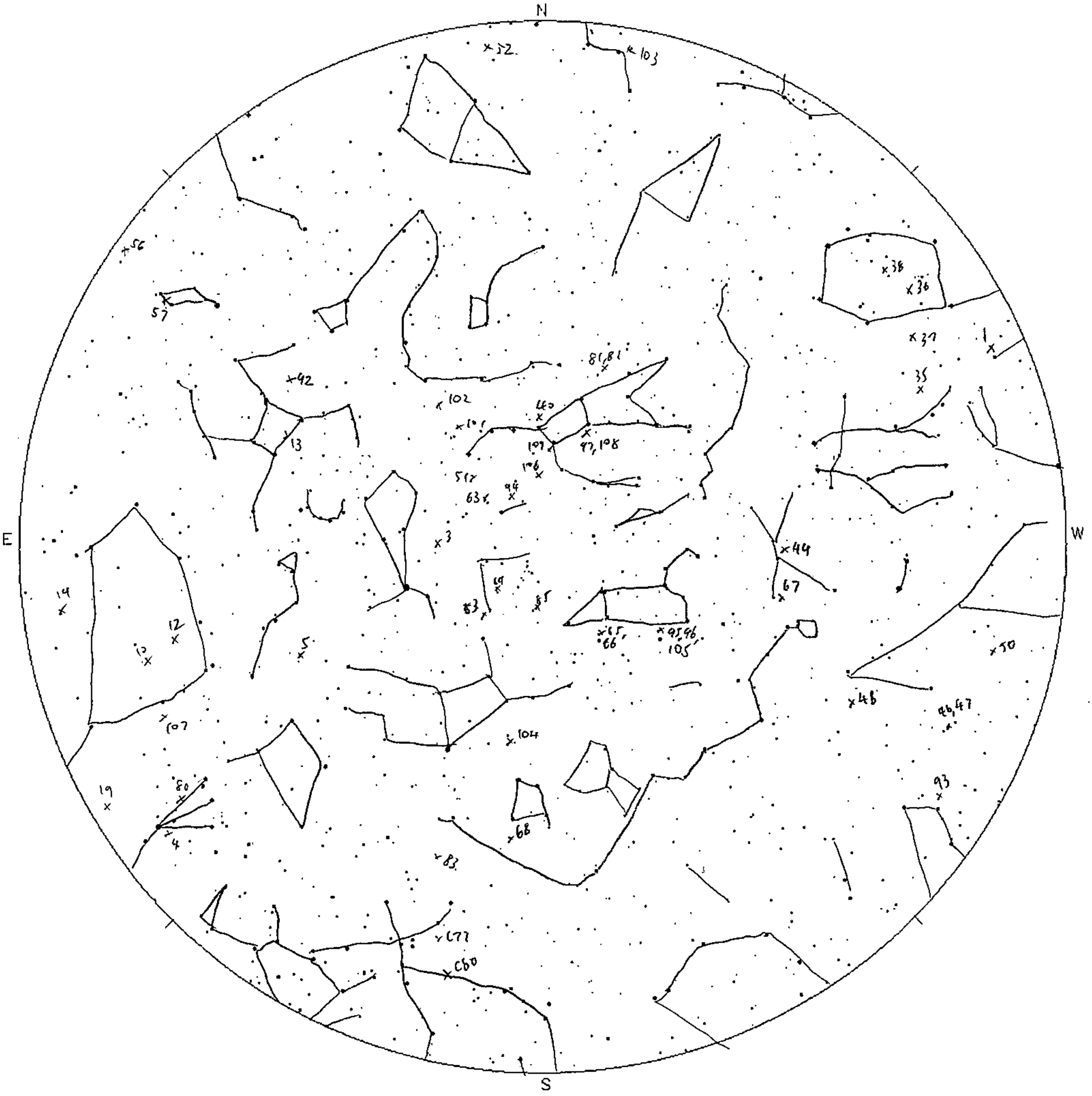
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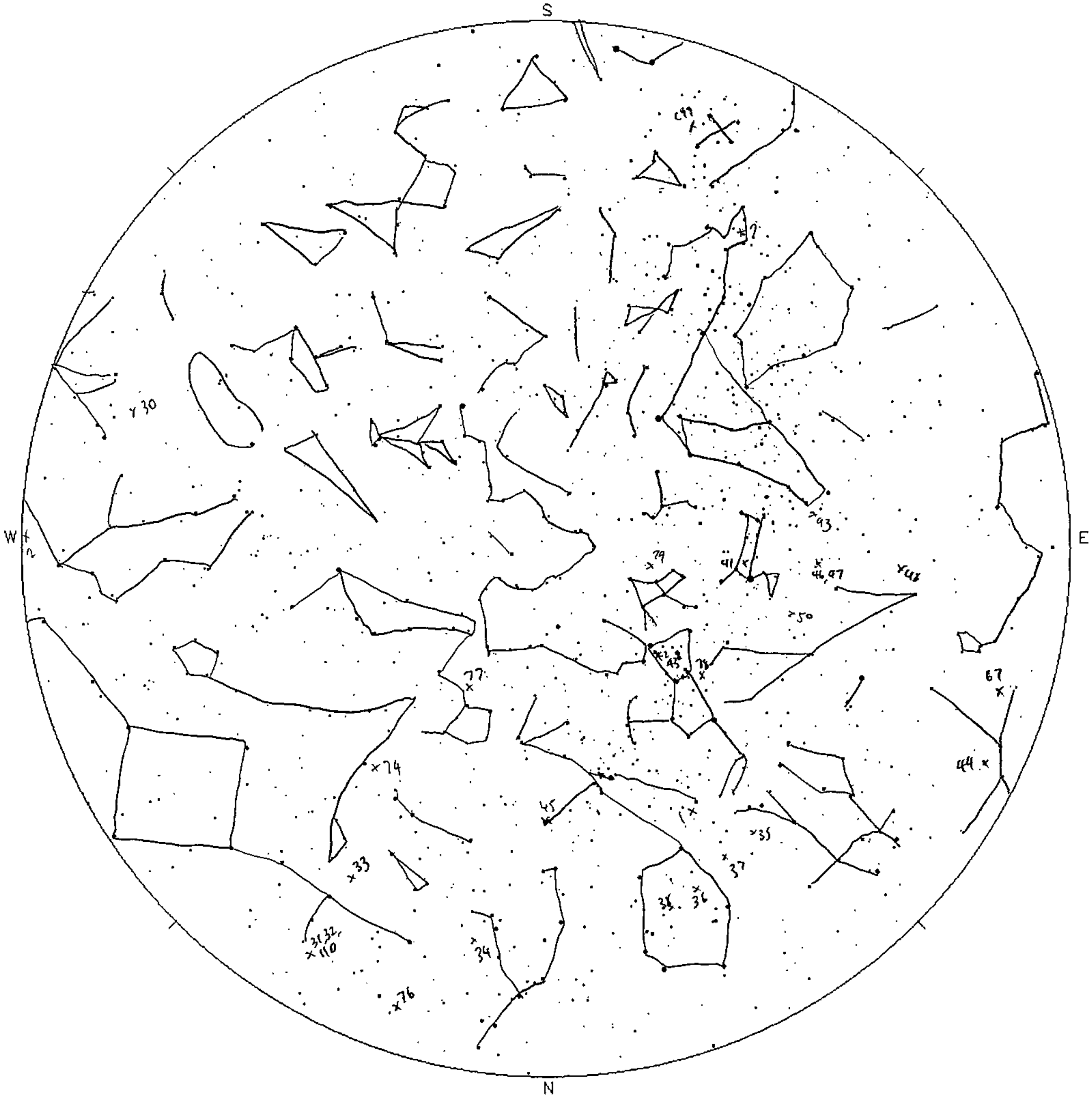
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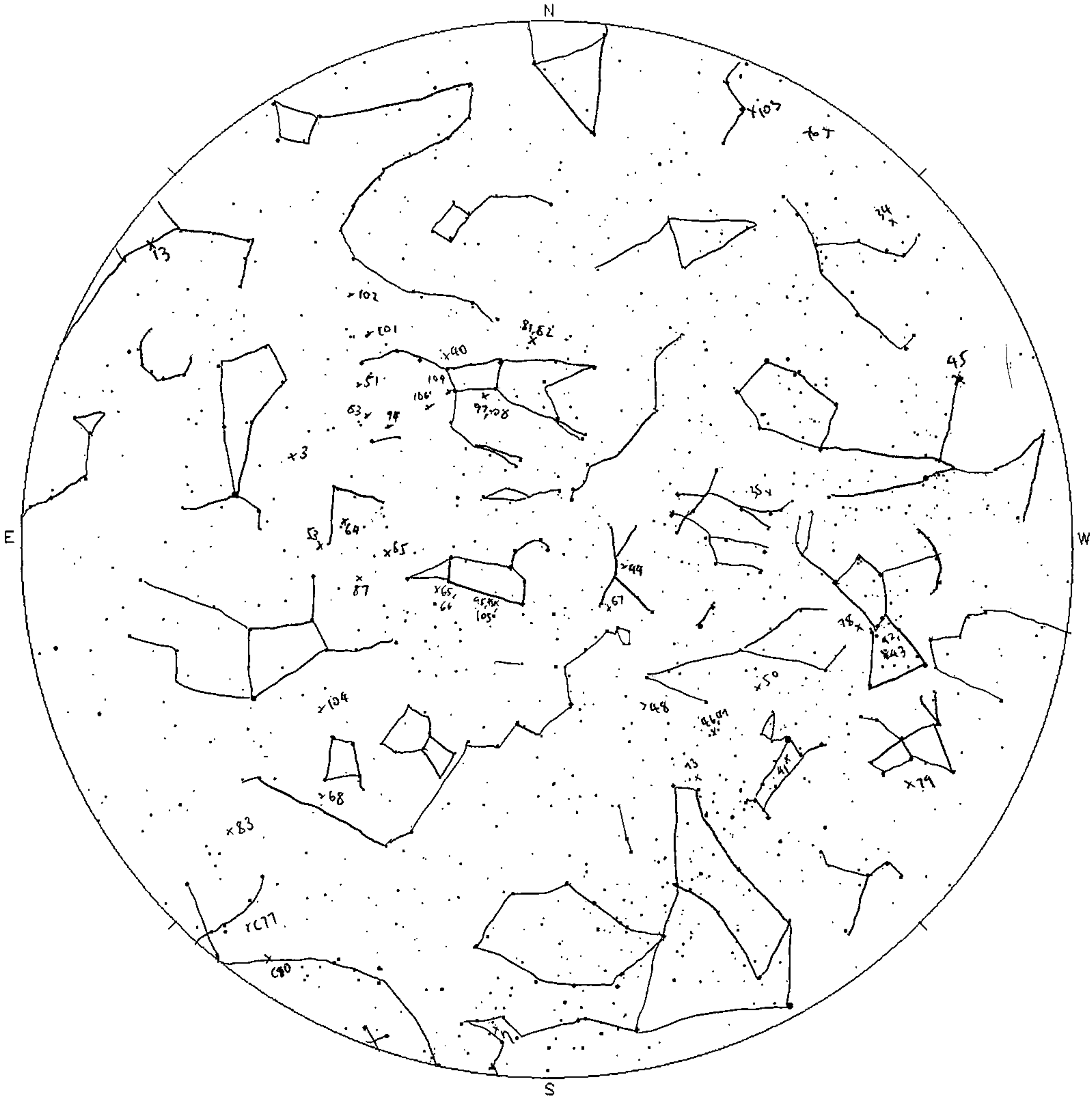
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C80
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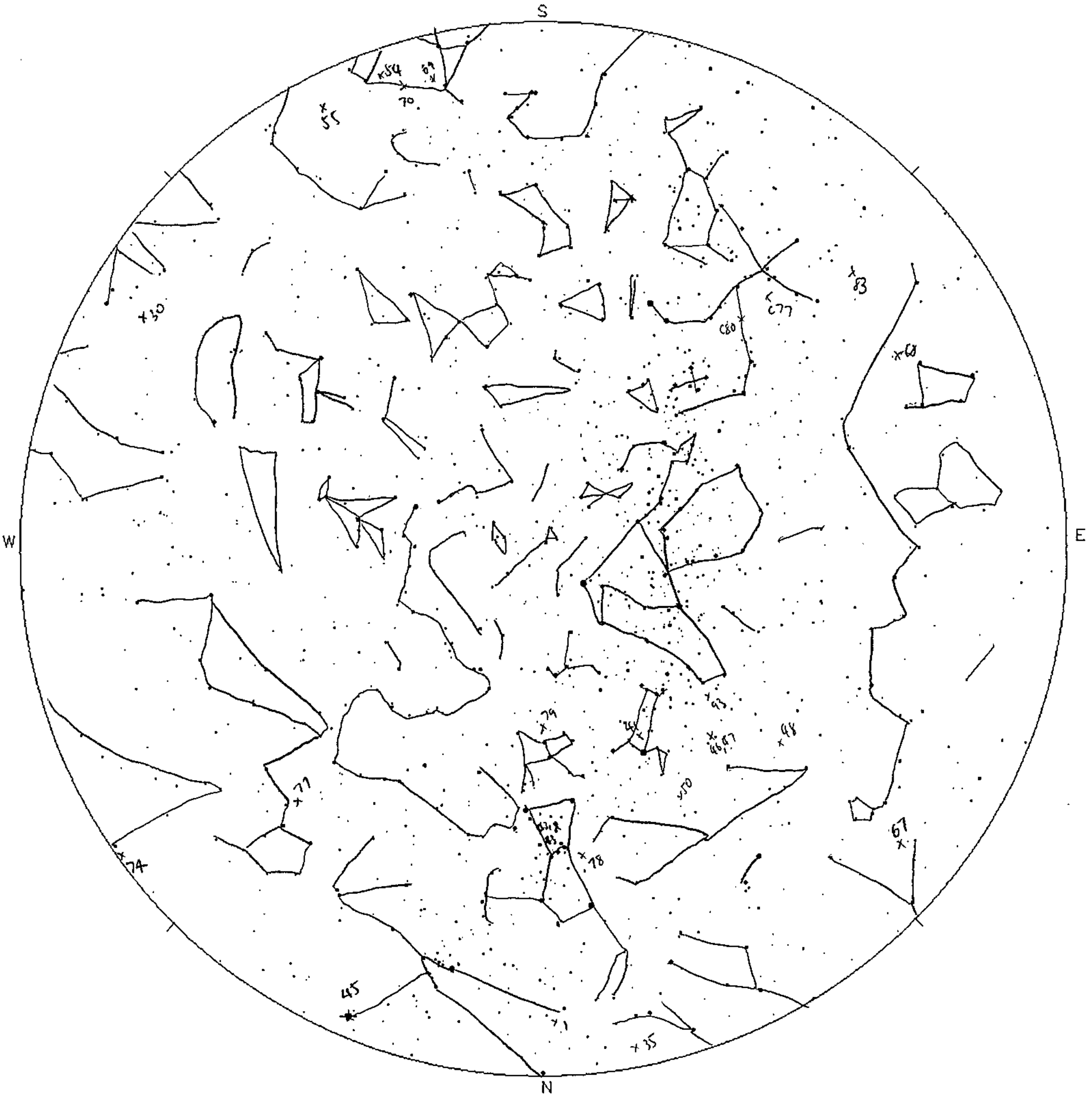

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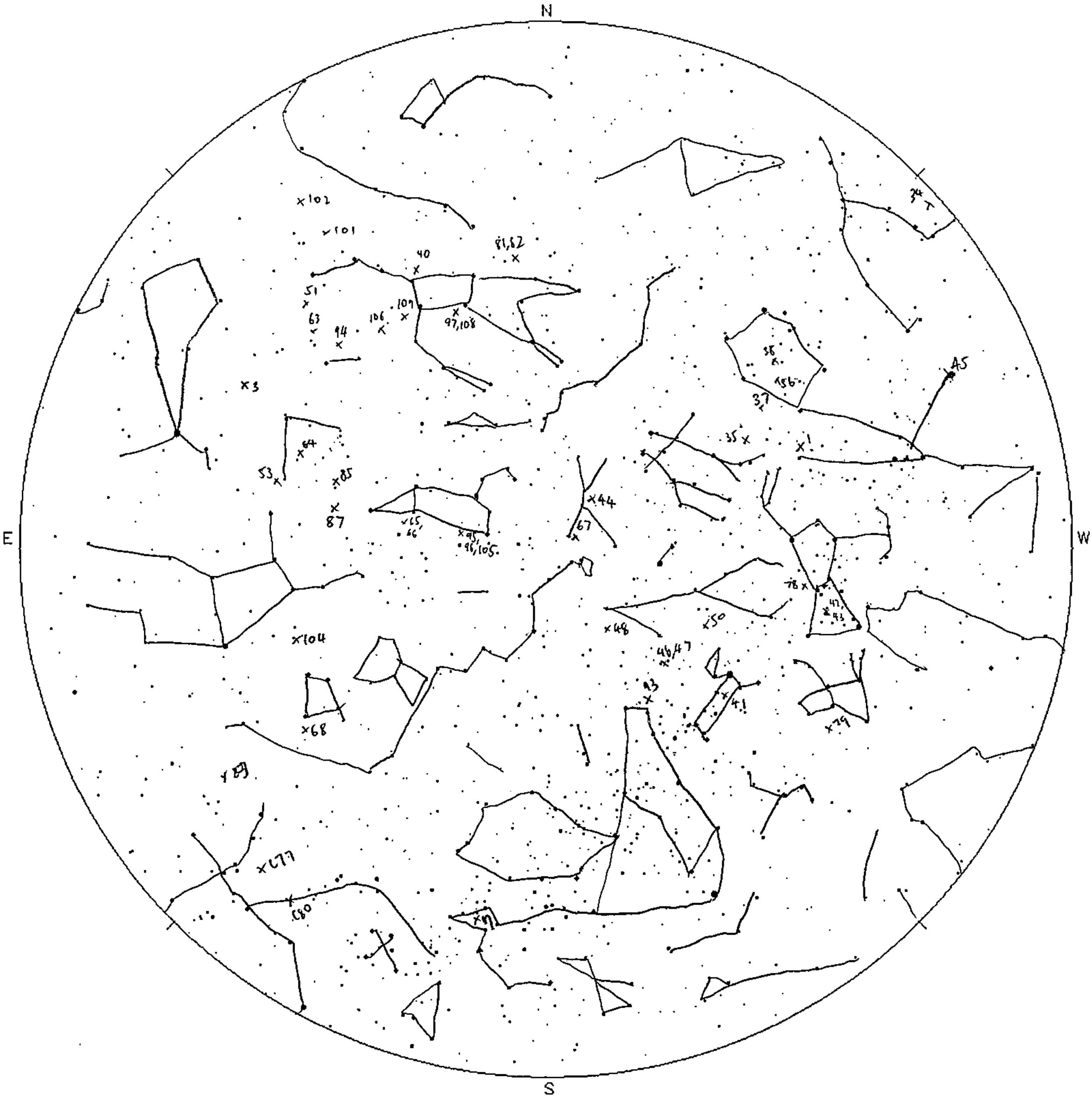
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x95
96,105
x44
67
35 x
x1
34
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156
37
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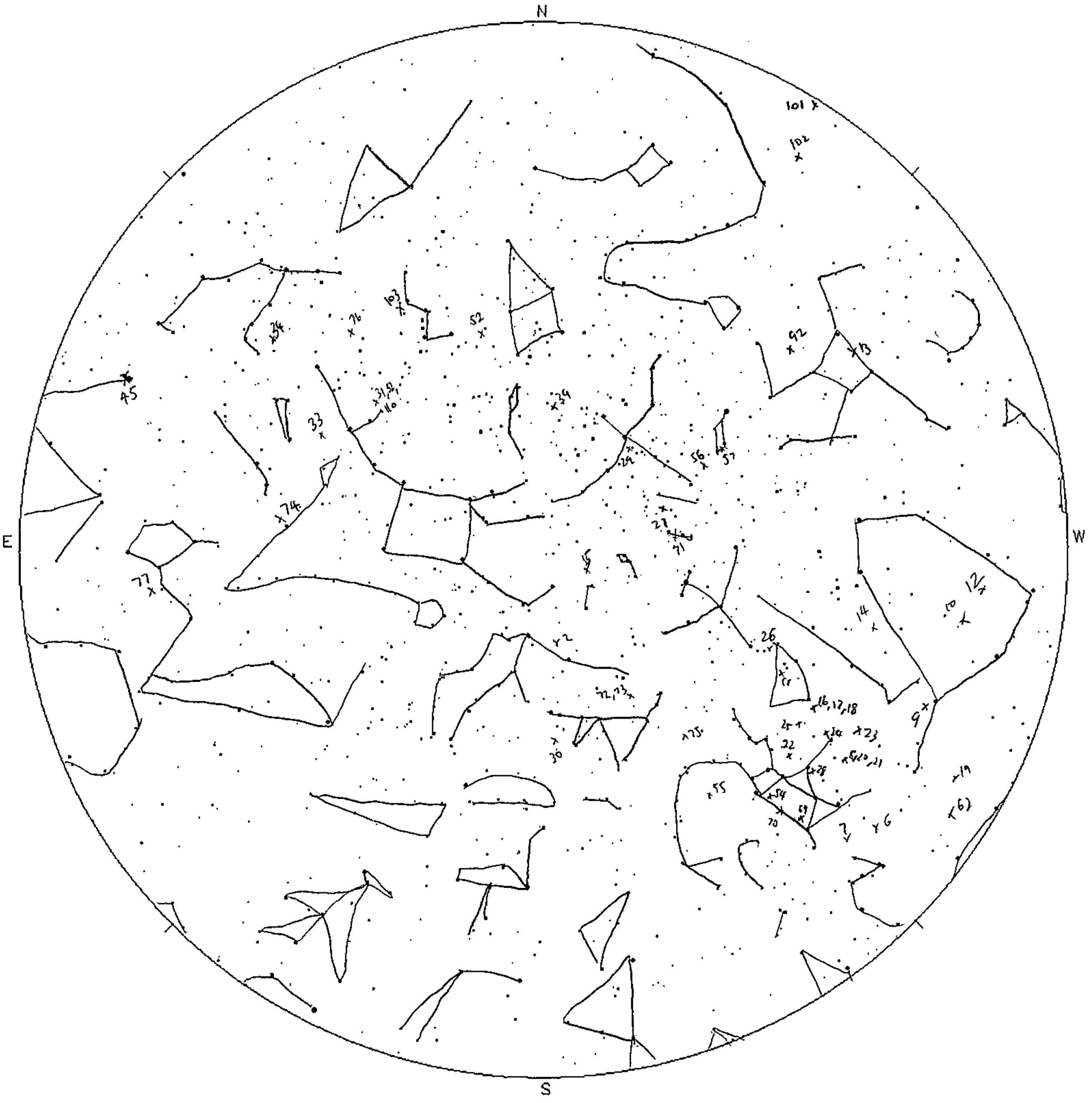
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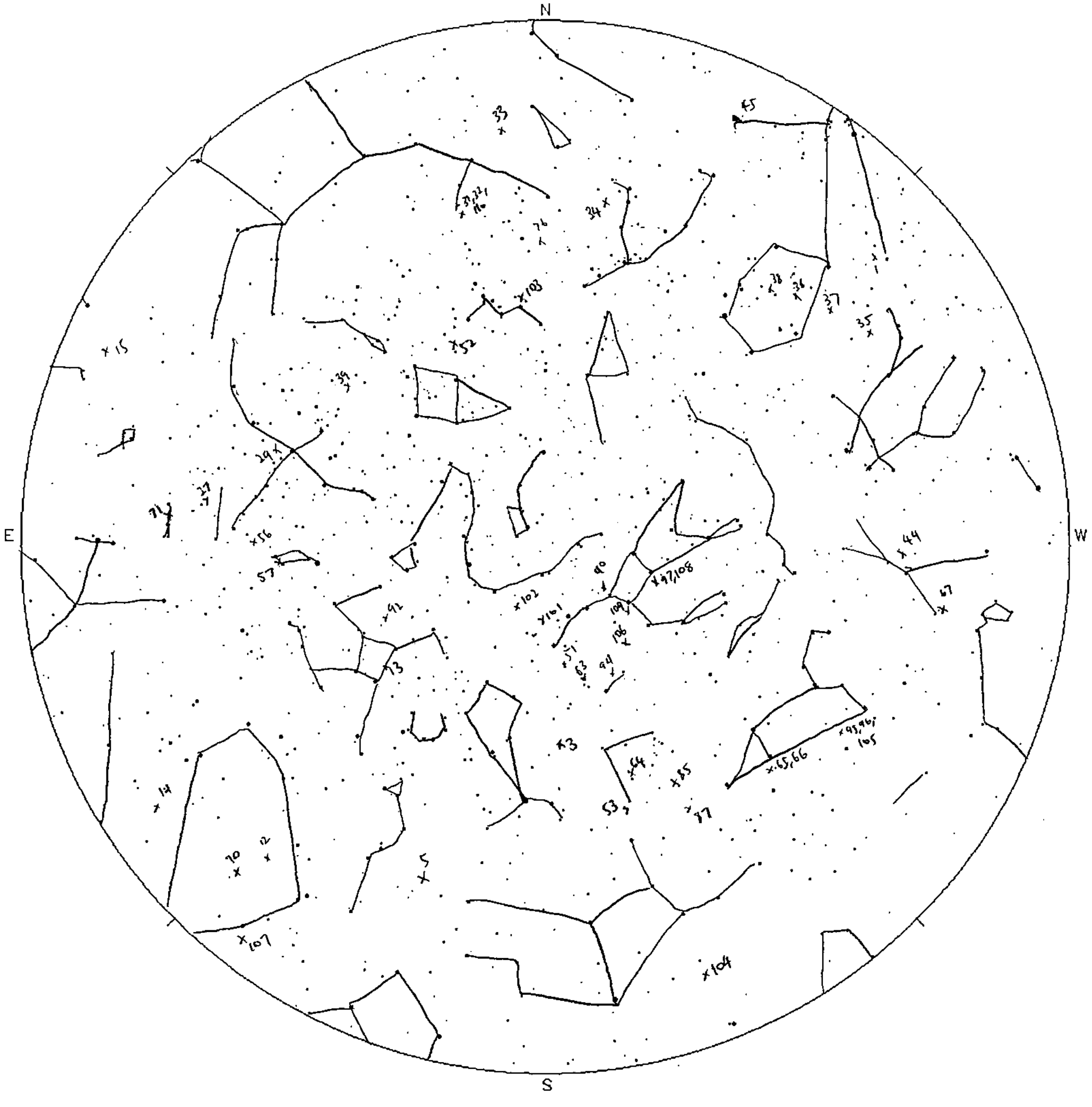
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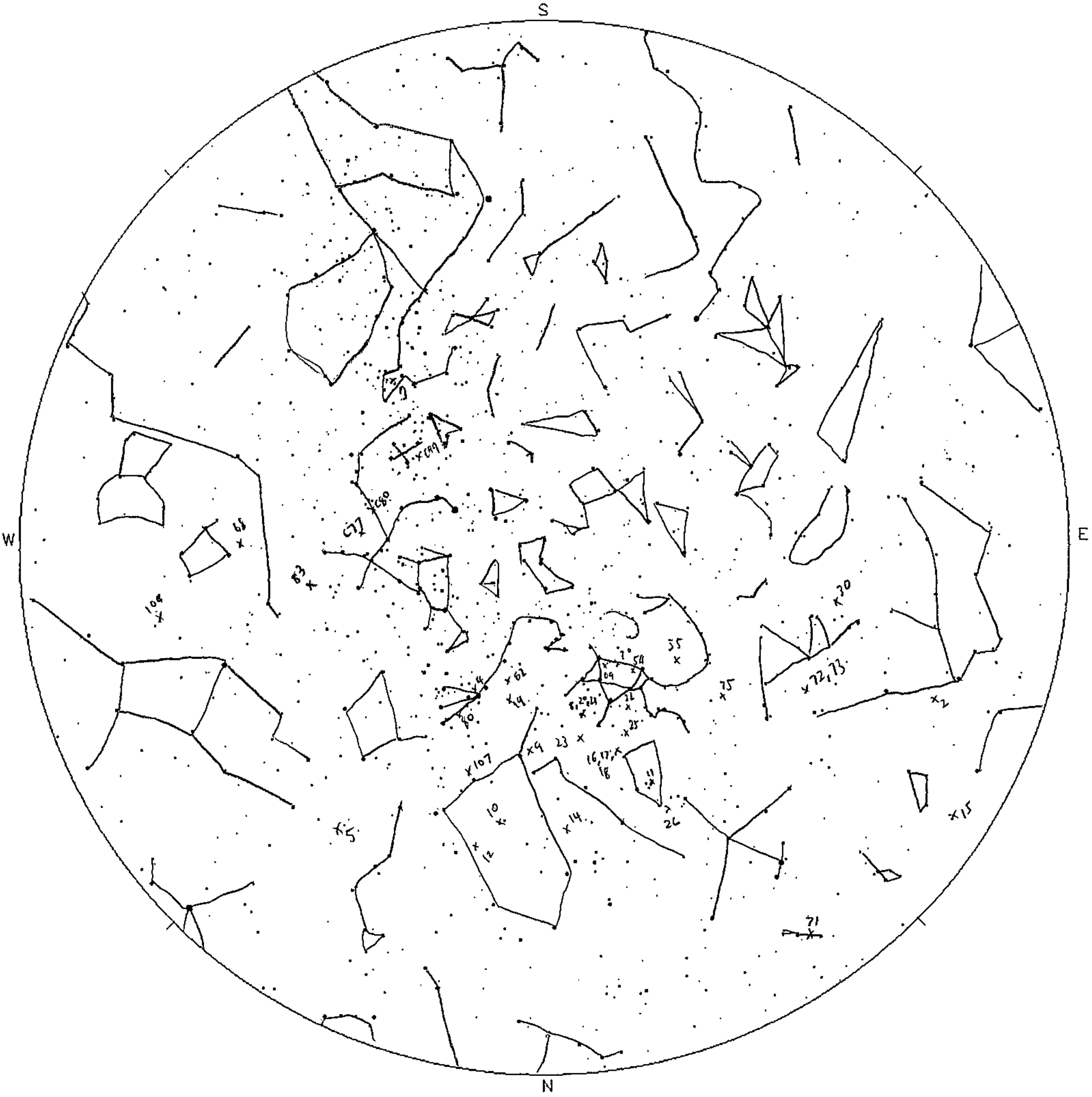
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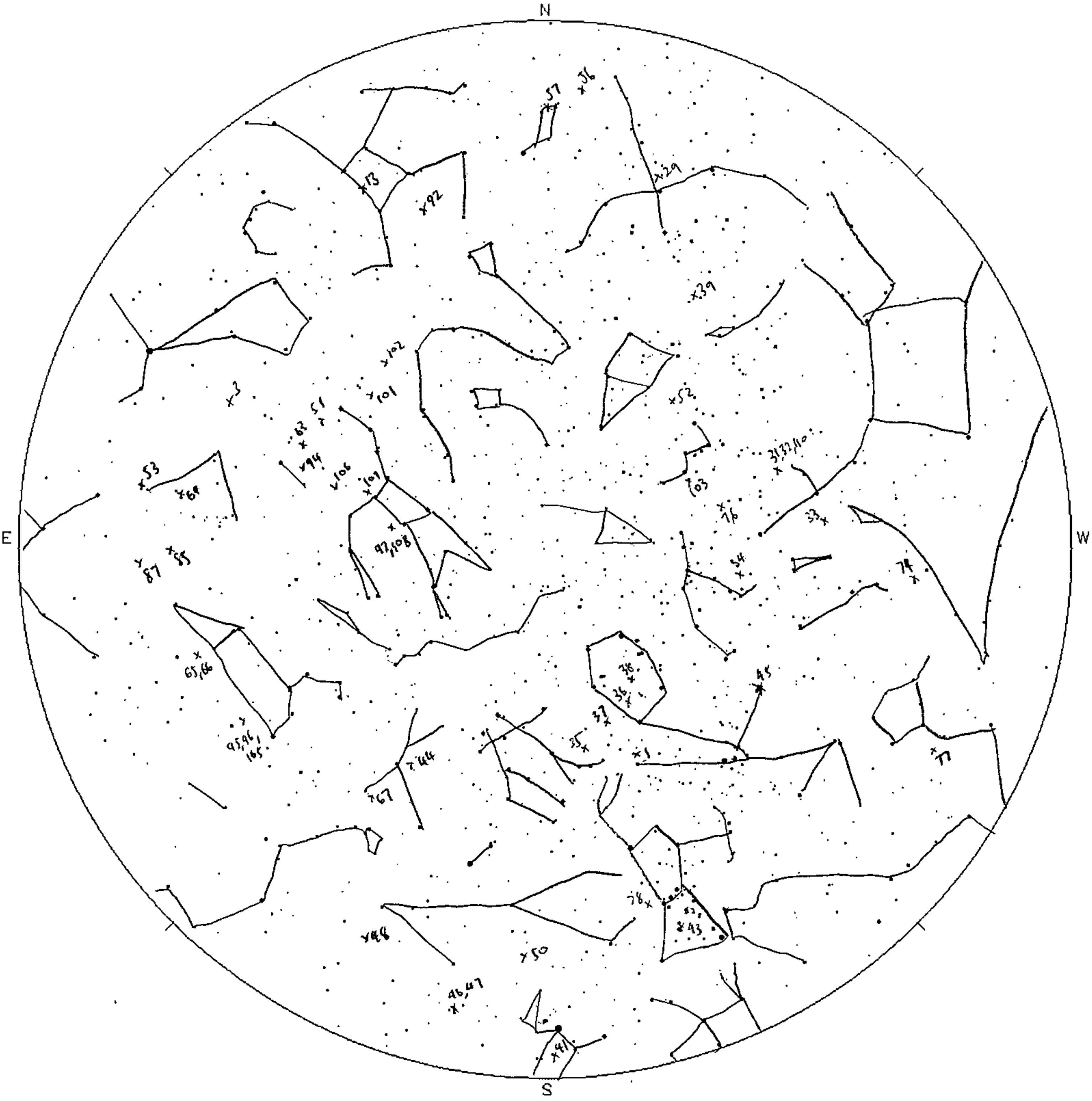
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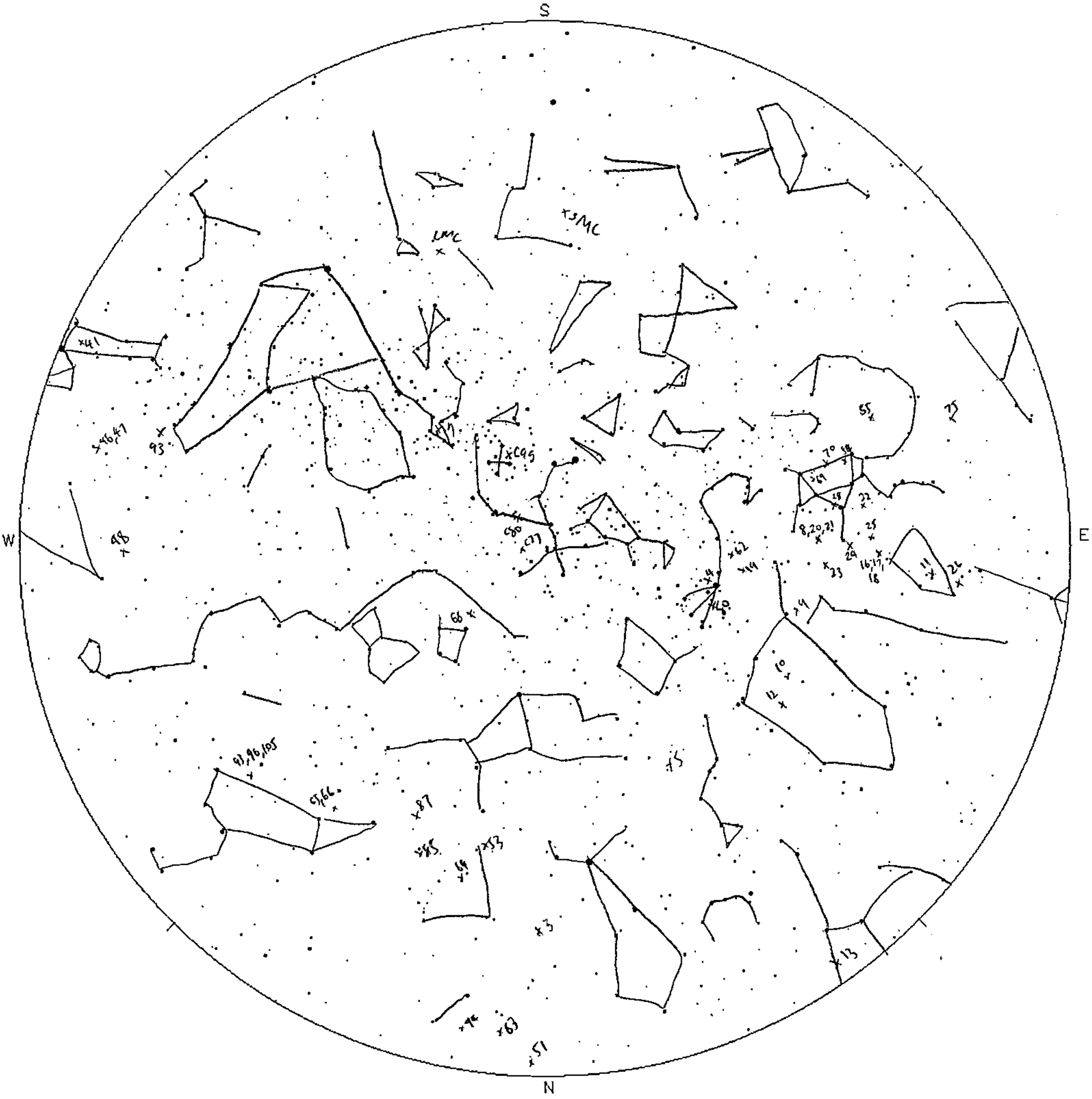
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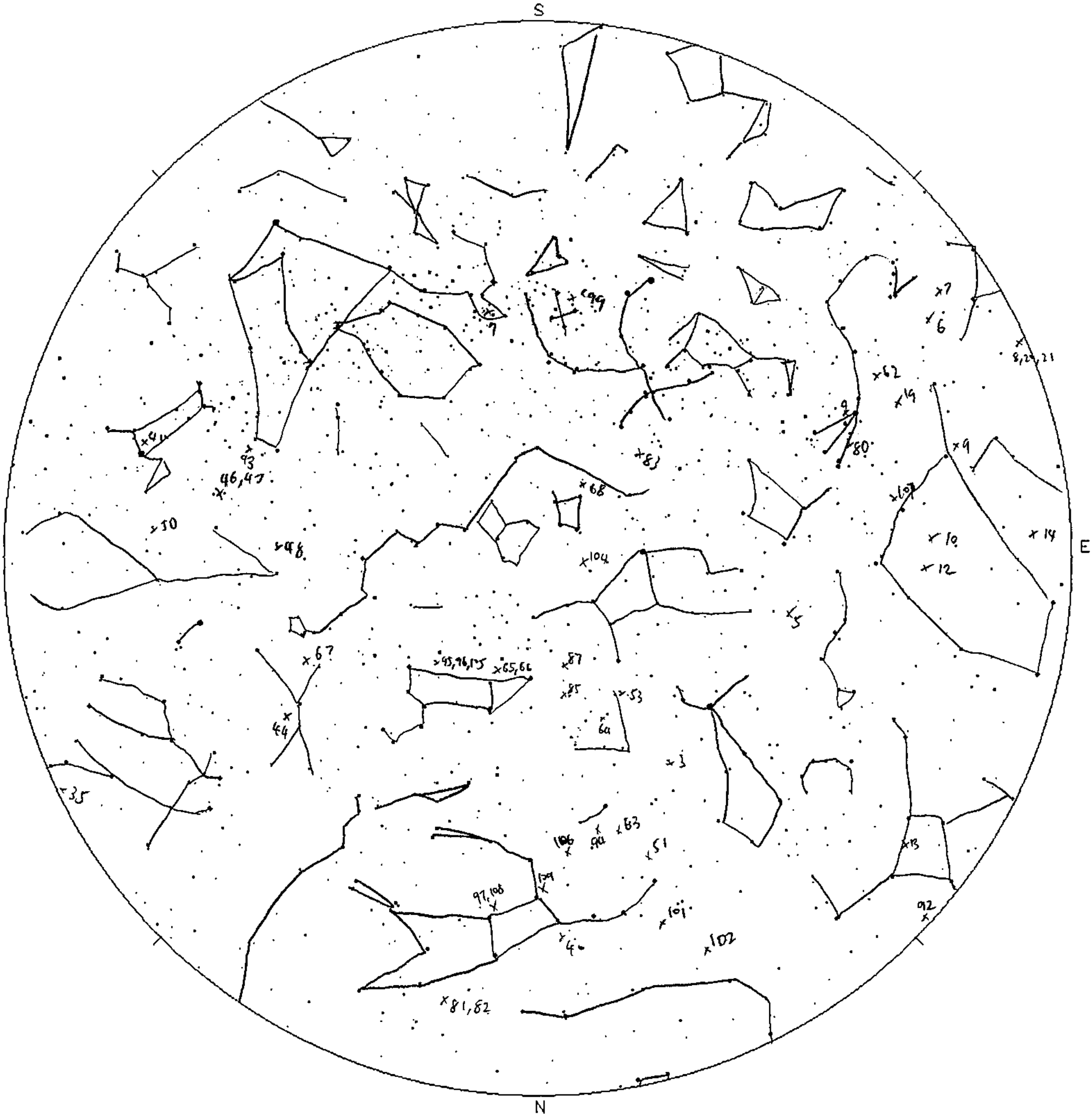
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S
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SMC
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C80
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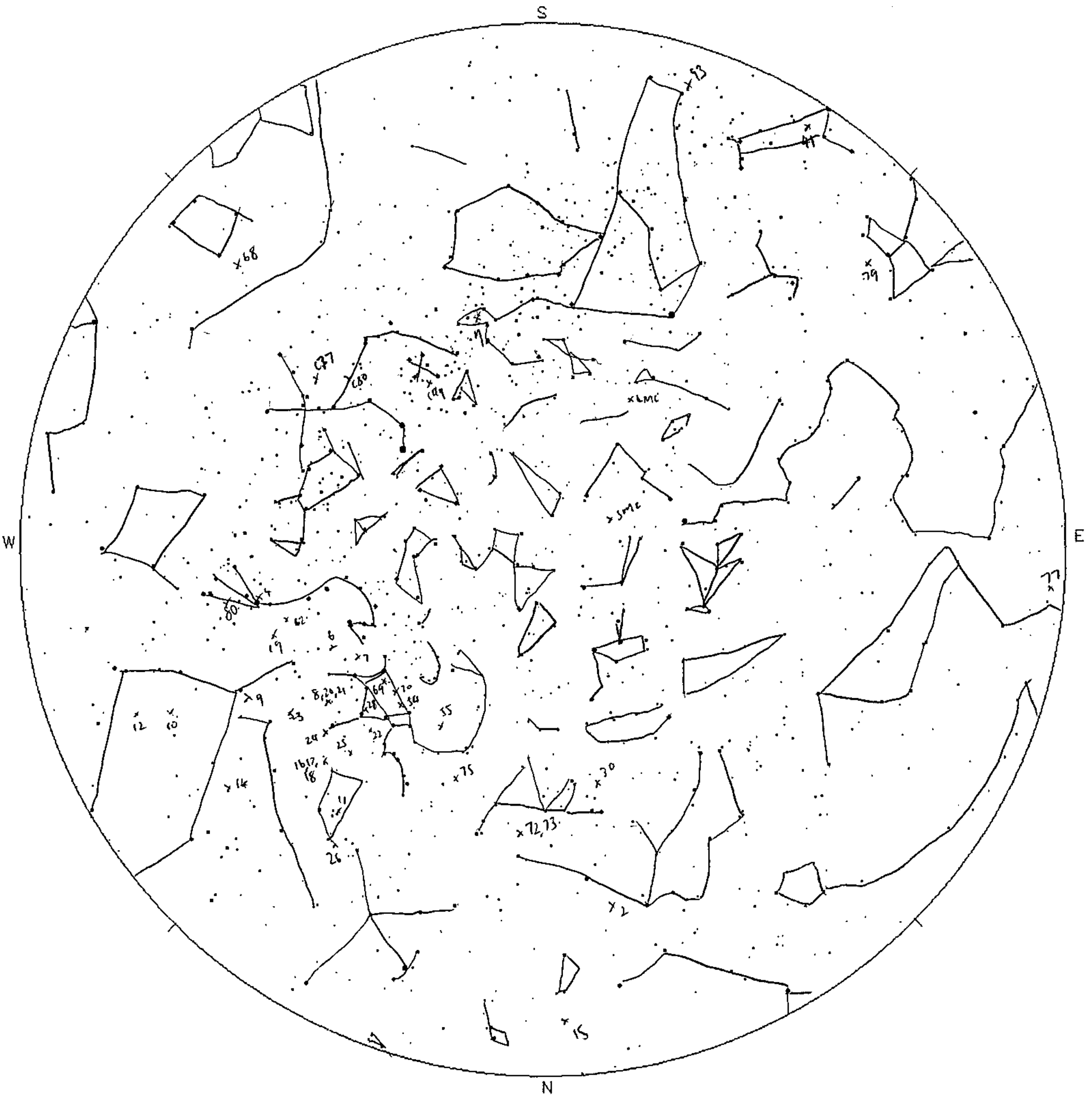
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x79
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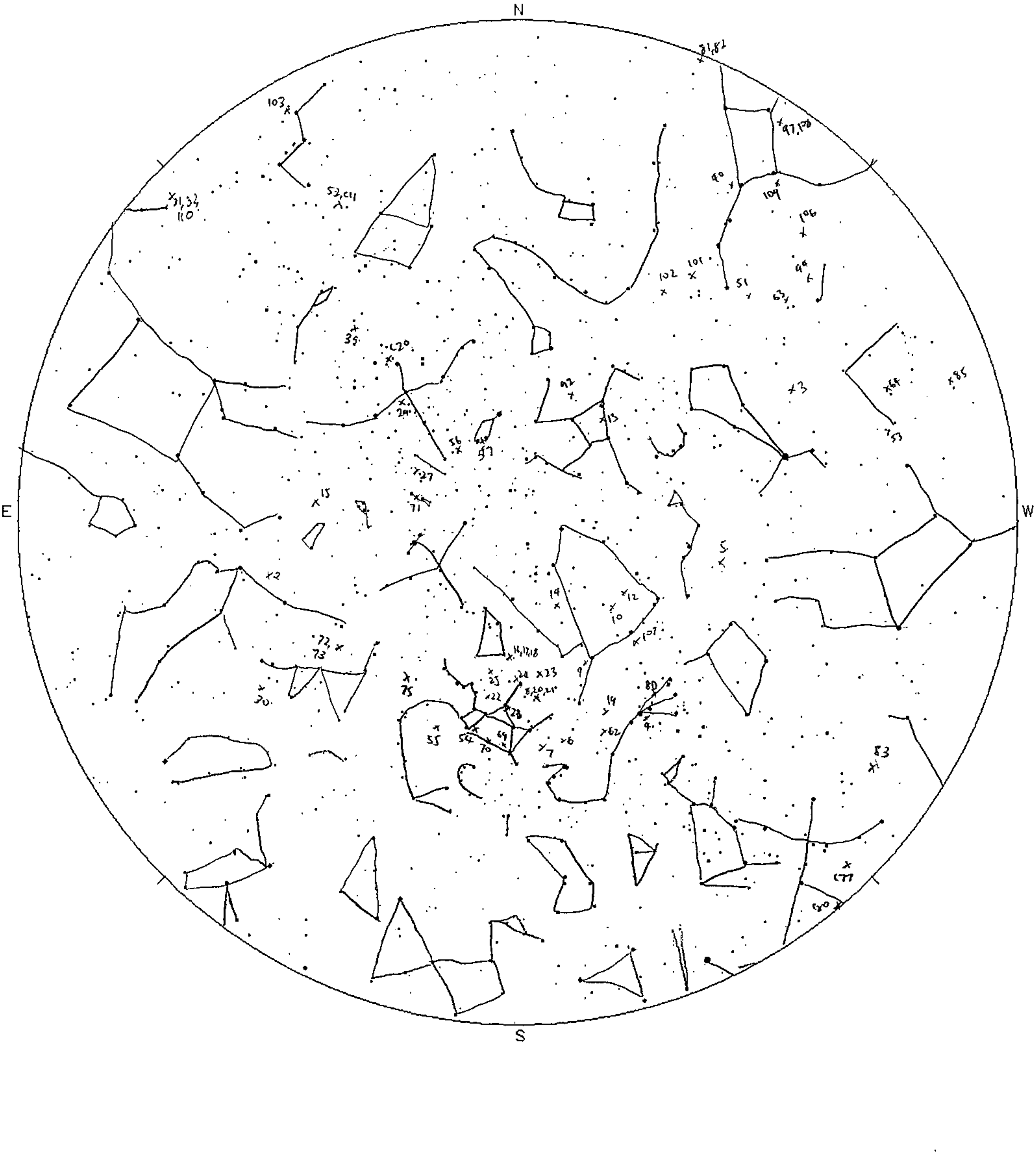
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C77
C80
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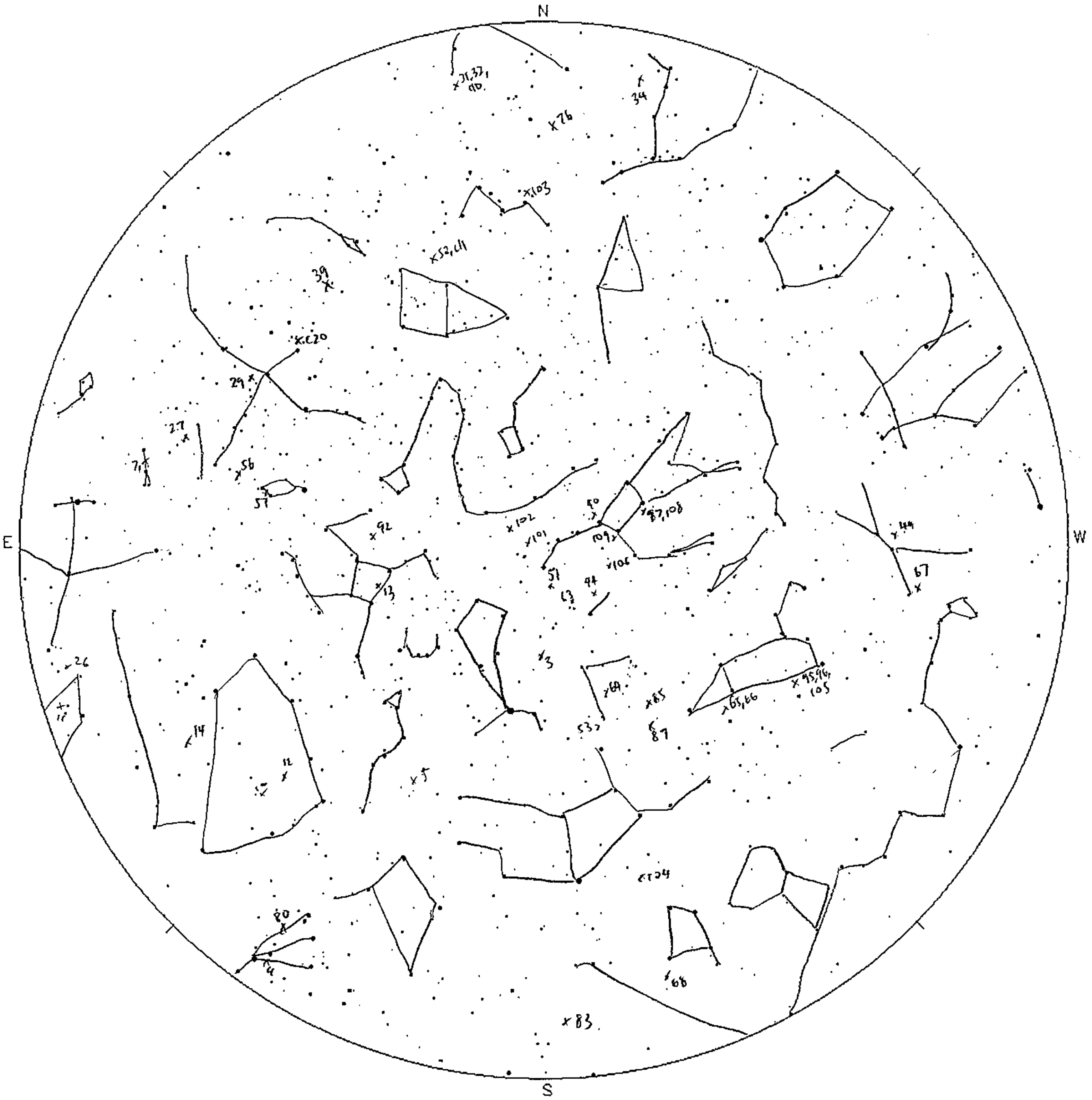
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C20
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102
101
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87, 108
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94
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67
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85
53
87
65, 66
95, 96, 105
5
C124
80
4
68
83


N
x103
x34
x102
x101
x81,82
x40
51x
63x
94
106
104
97,108
45
x38
x36
37
35x
x1
x9
5x
53x
x64
x85
x87
x65,66
x95,96
105
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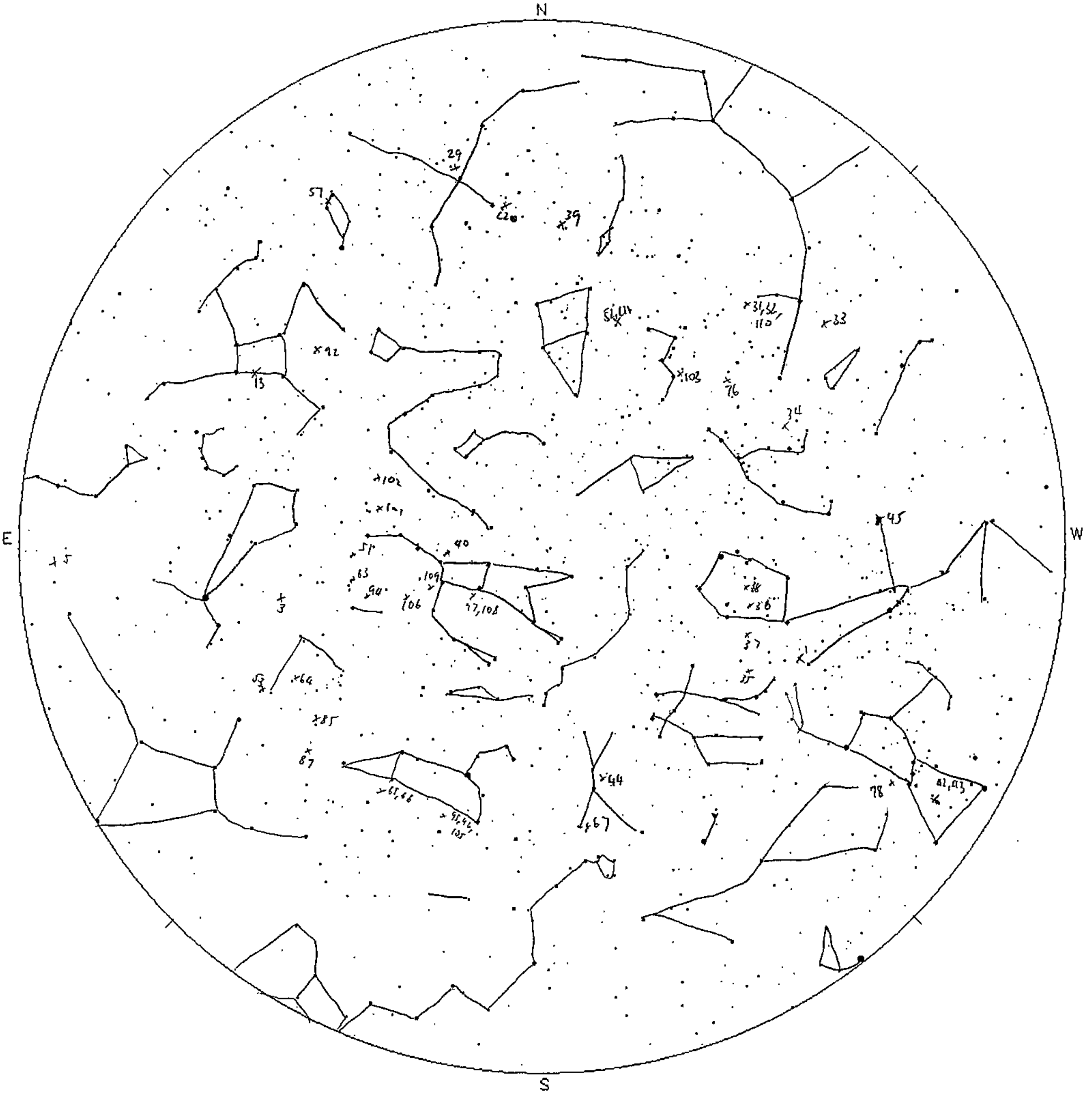
W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97,108
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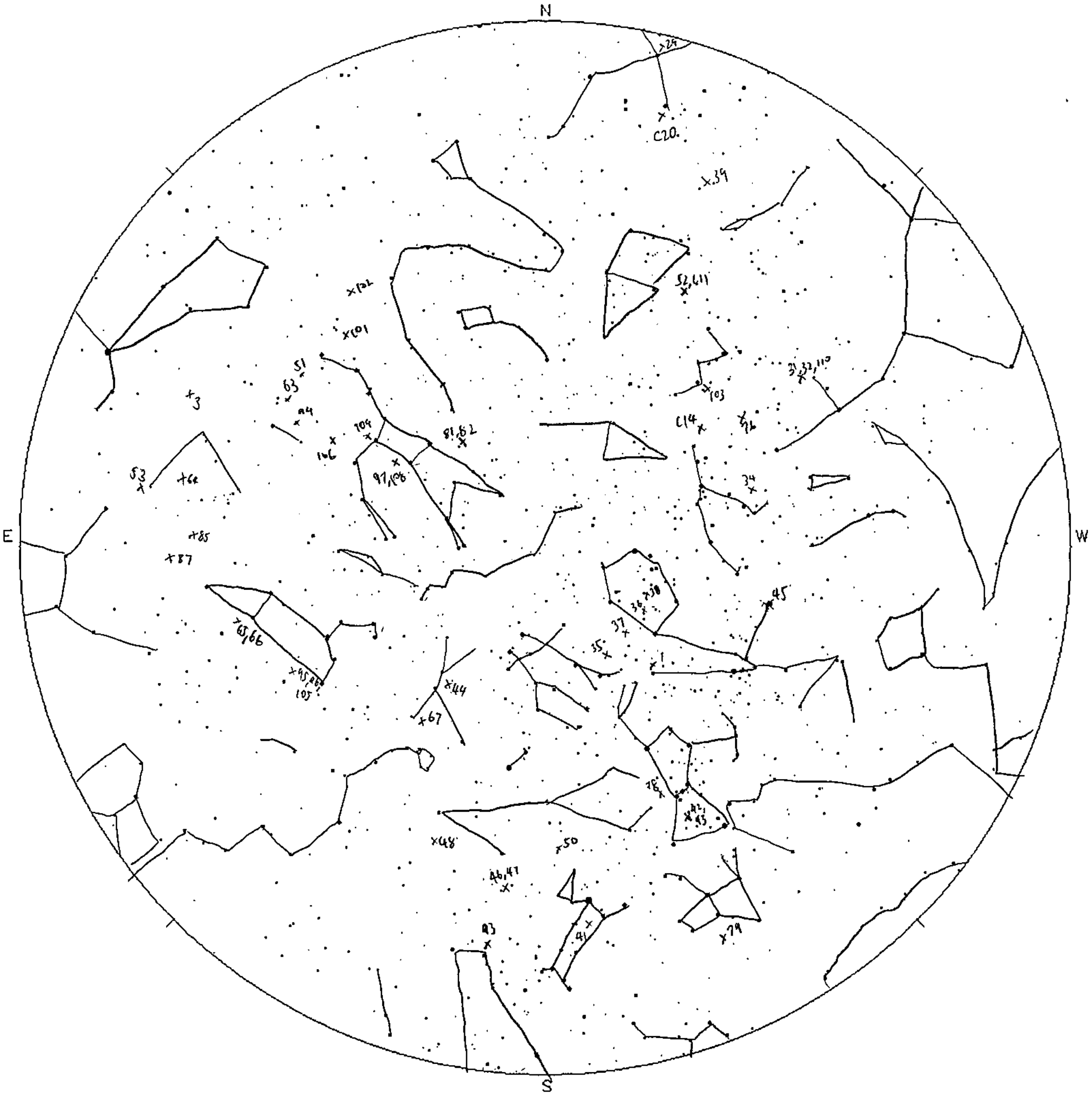
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97,108
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87
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36,38
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65,66
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95,96,105
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67
78
42,43
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79
S


N
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x33
x31,32,110
x76
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39 X
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29
52,111
x103
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x56
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x36
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x81,82
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x101
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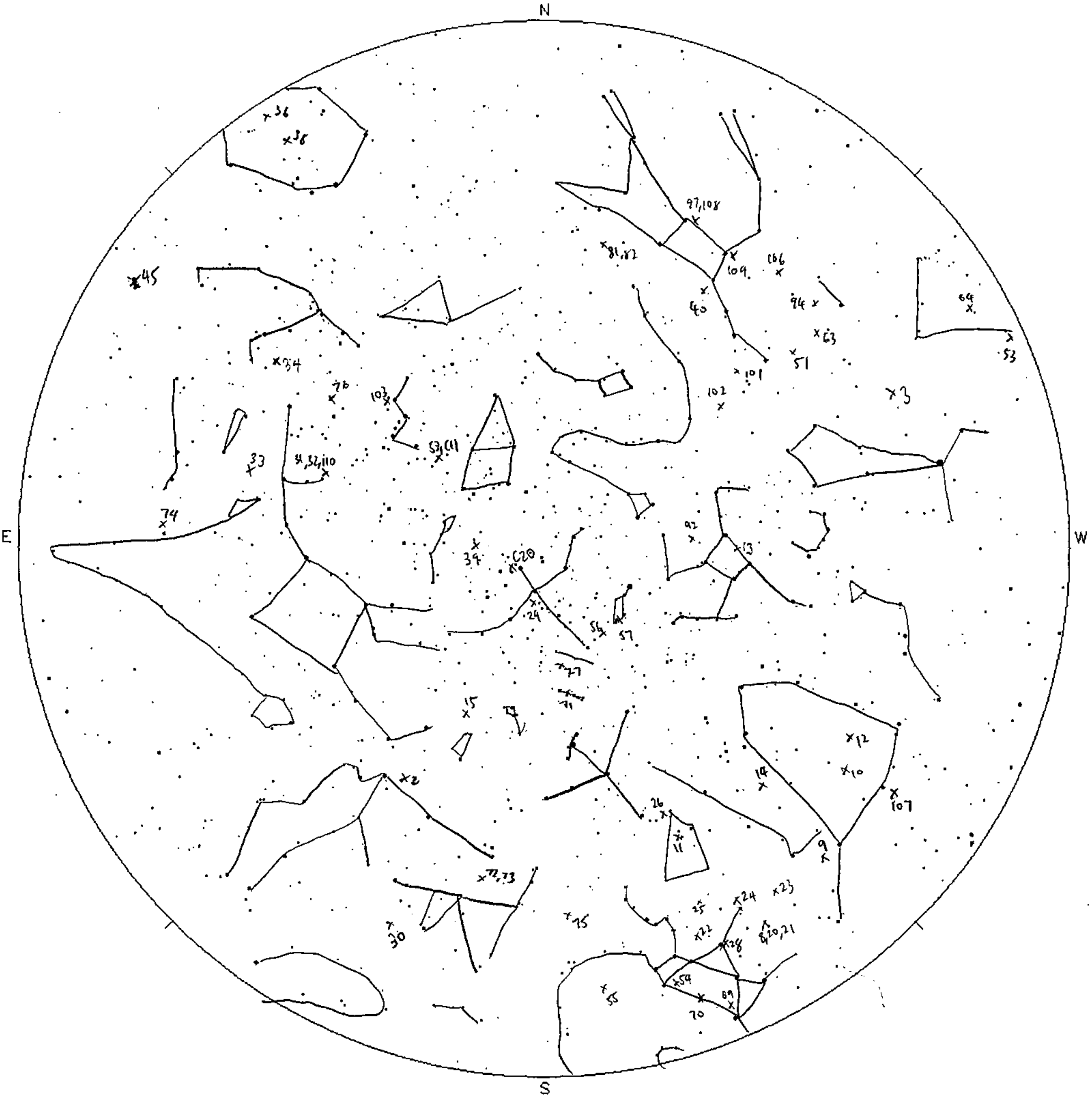
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101
102
3
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92
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C20
24
56
57
27
71
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2
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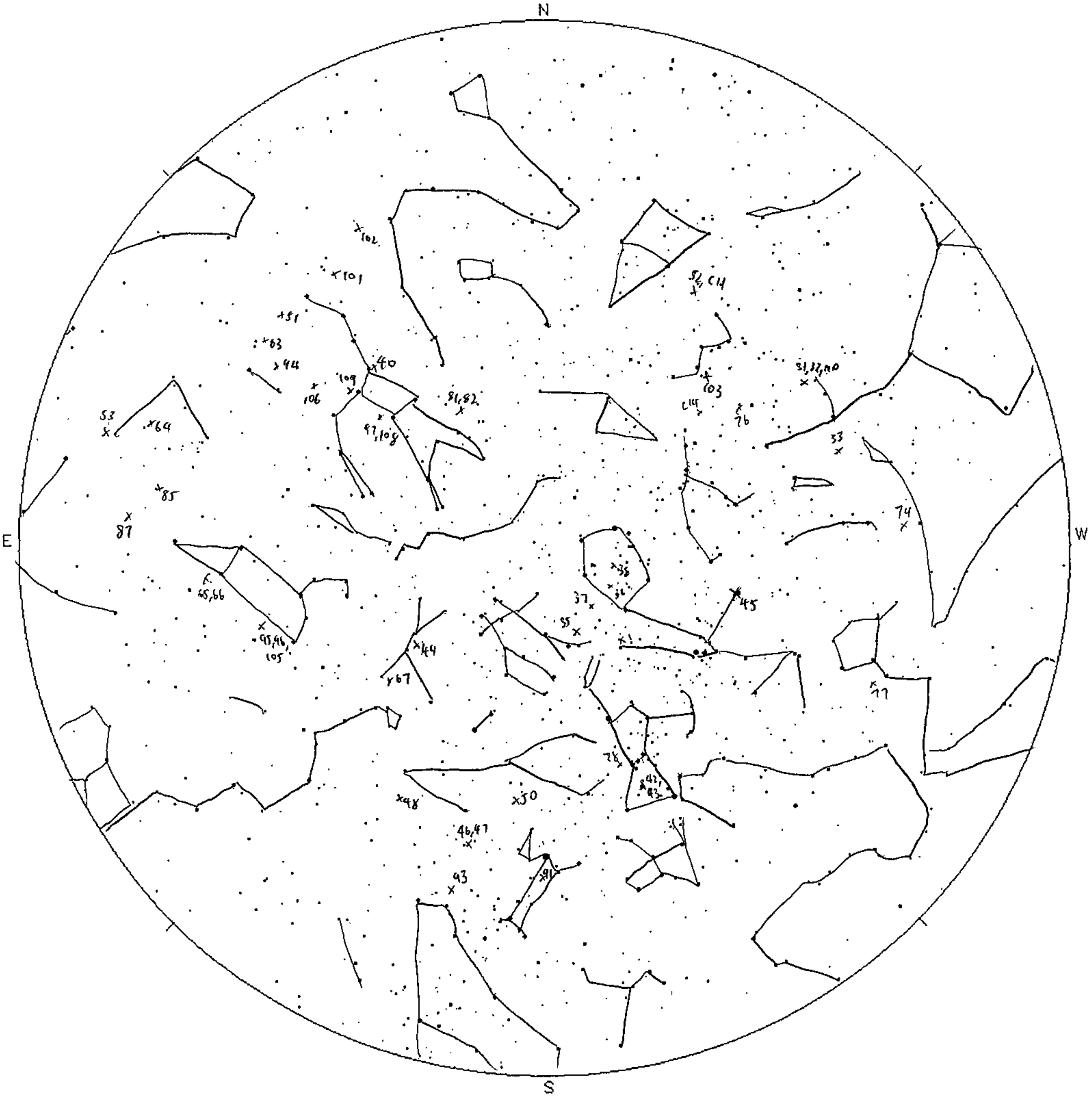
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x106
109 x
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81,82 x
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87
65,66
95,96,105
x44
x67
37x
35 x
x38
x36
x1
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42,43
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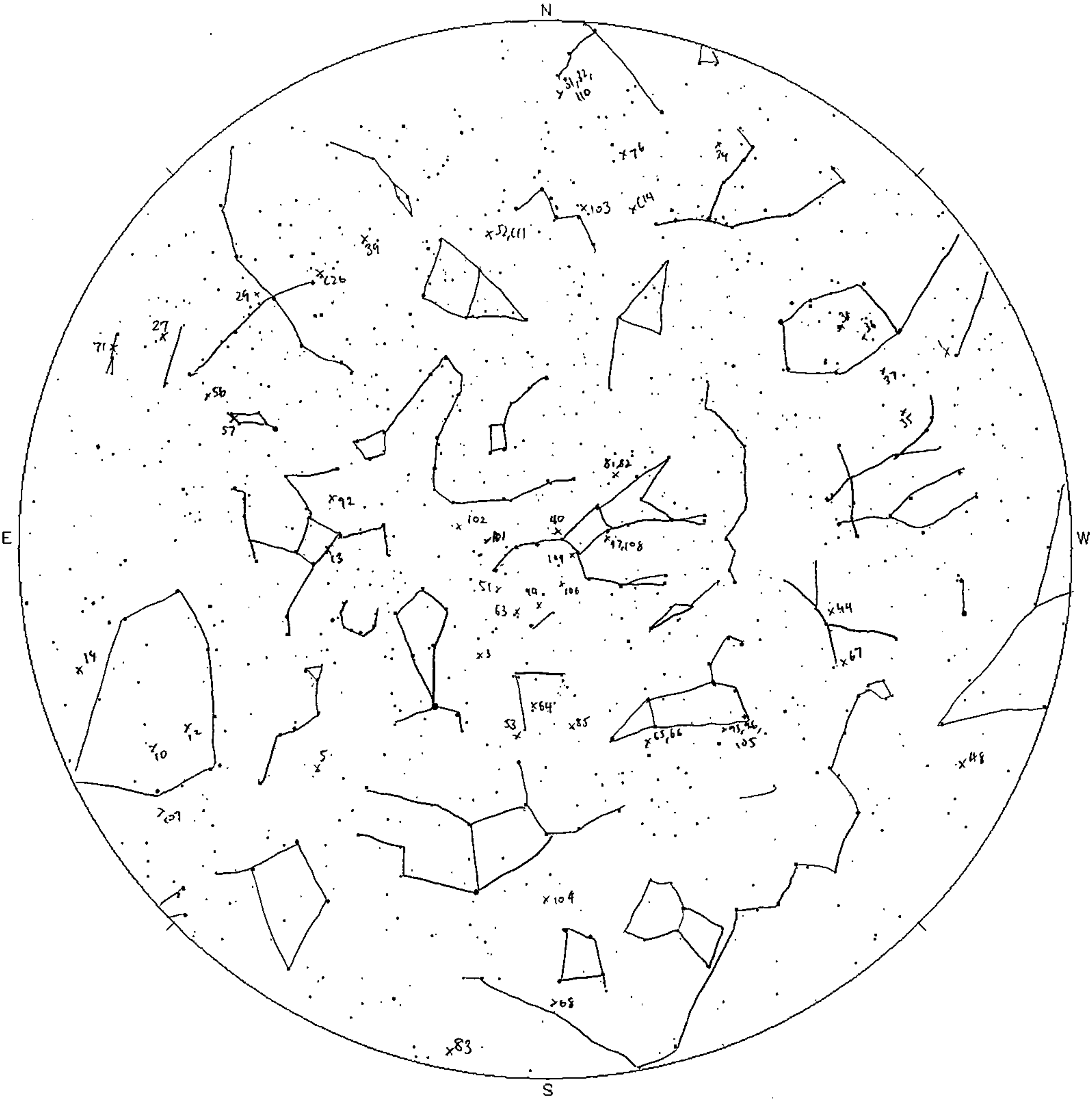
93
x91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81,82
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7,C9
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95,96,105
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104
68
83


S
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E
C99,99
C80
C77
68
83
104
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8,10,21
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16,17
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72,73
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71
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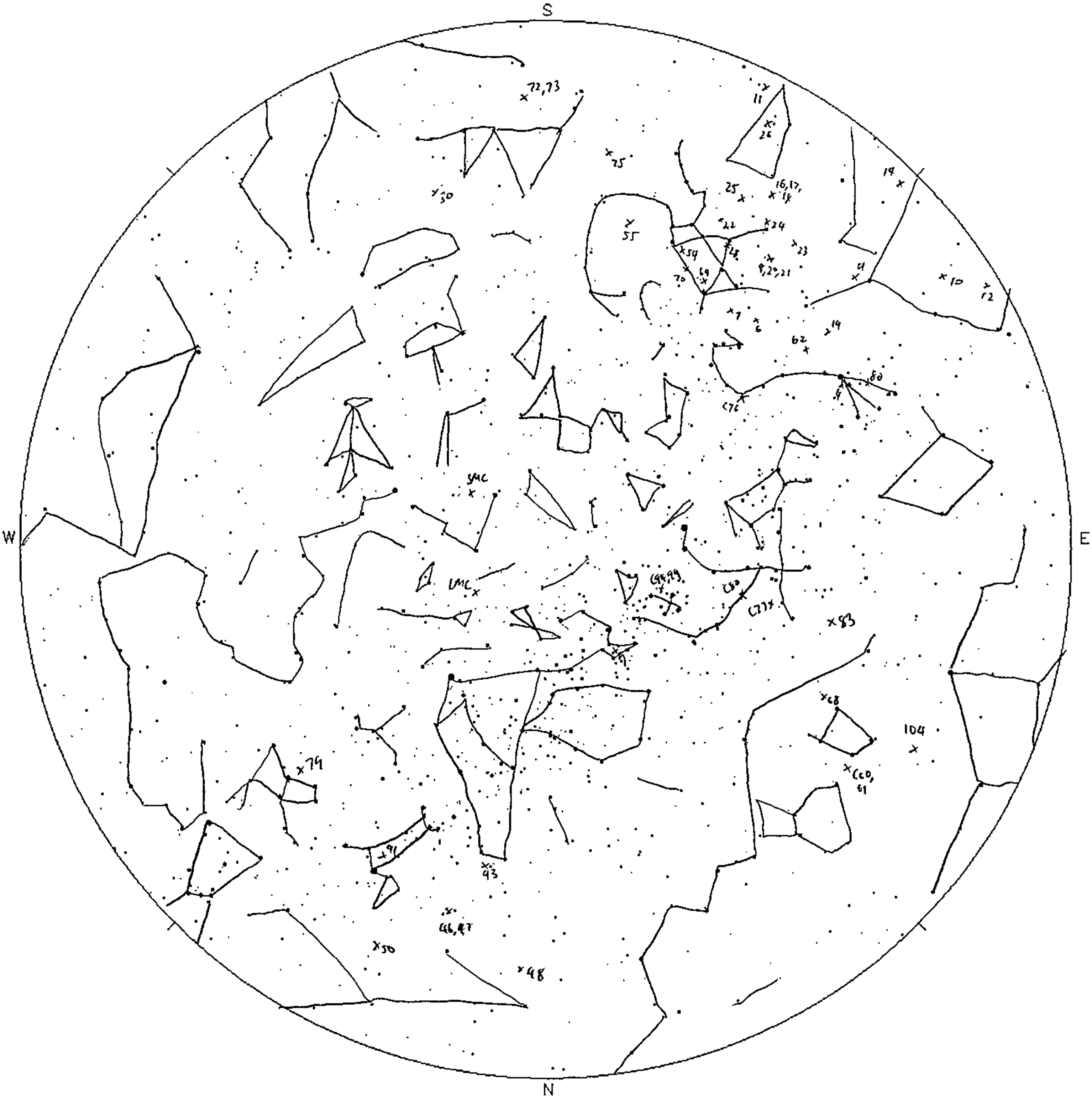
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12
7
6
62
19
80
C76
W
E
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LMC
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C77
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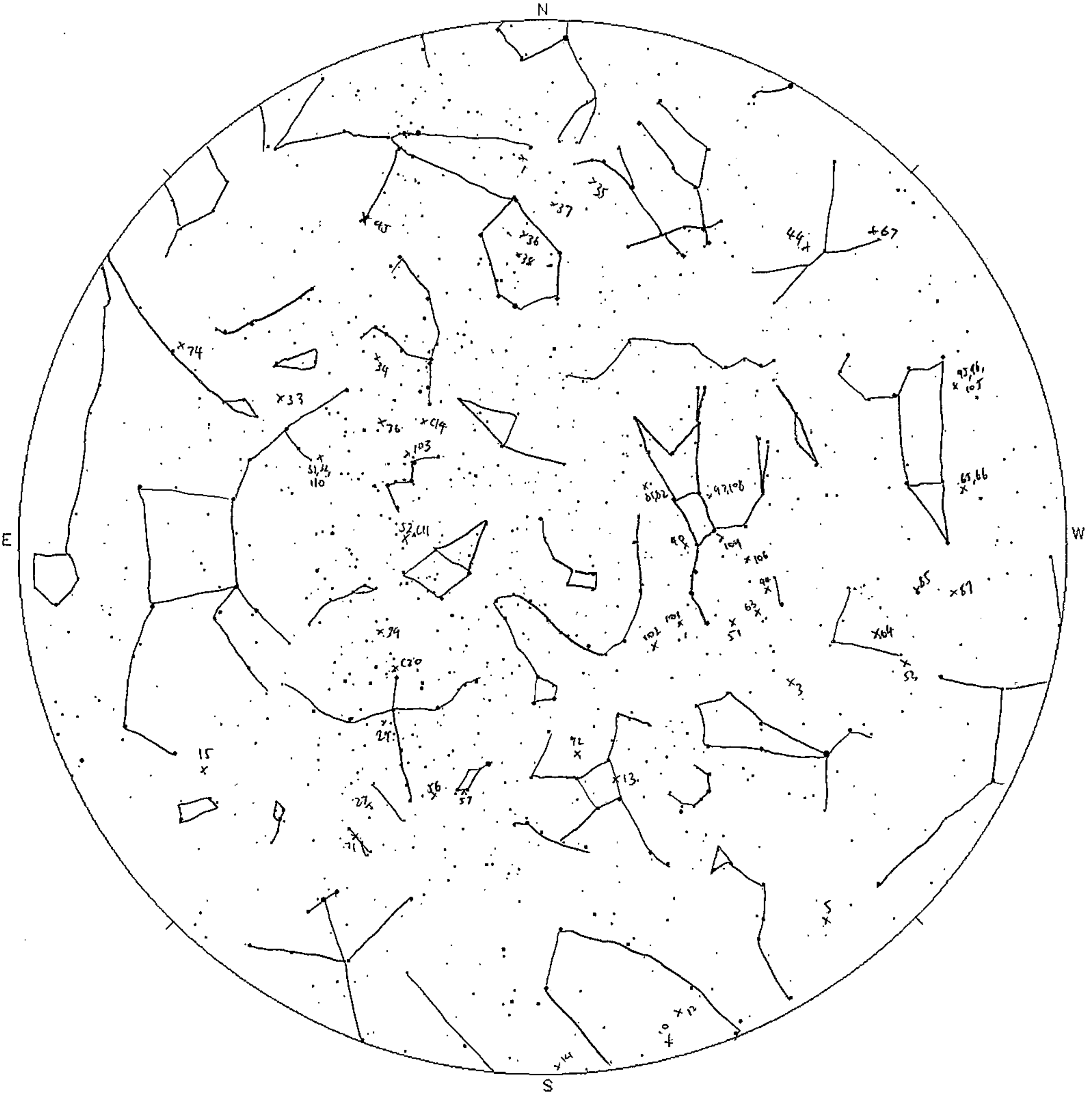
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81, 82
97, 108
52, C11
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109
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94
C20
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C14
103
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31,32,110
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43
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SMC


S
83
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C77
C80
C76
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SMC
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46,47
72,73
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77
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N
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W
S
65, 66
95, 93, 135
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53
64
3
63
94
51
106
159
91, 108
101
102
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92
67
49
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56
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71
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C20
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114
54, 111
105
76
31, 32, 112
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92, 93
45
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74
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2
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62 ×
×83
×68
16,17,18
×24
×23
× 8,10,21
×25
×22
×28
×6
×7
C26
65 ×
×54
×70
×75
×55
C44, 45
×11
77,73 ×
×30
×2
×93
×48
46, 47
×41
×50
×79
42, 43
×78
×77
+ 74


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×33
×34
×31,32,
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×103
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×15
×52,C11
×39
×C20
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×102
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×92
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×3
×64
×85
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×49
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105
×65,66
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c80
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c49,
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72,73
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41,47
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42,43
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74


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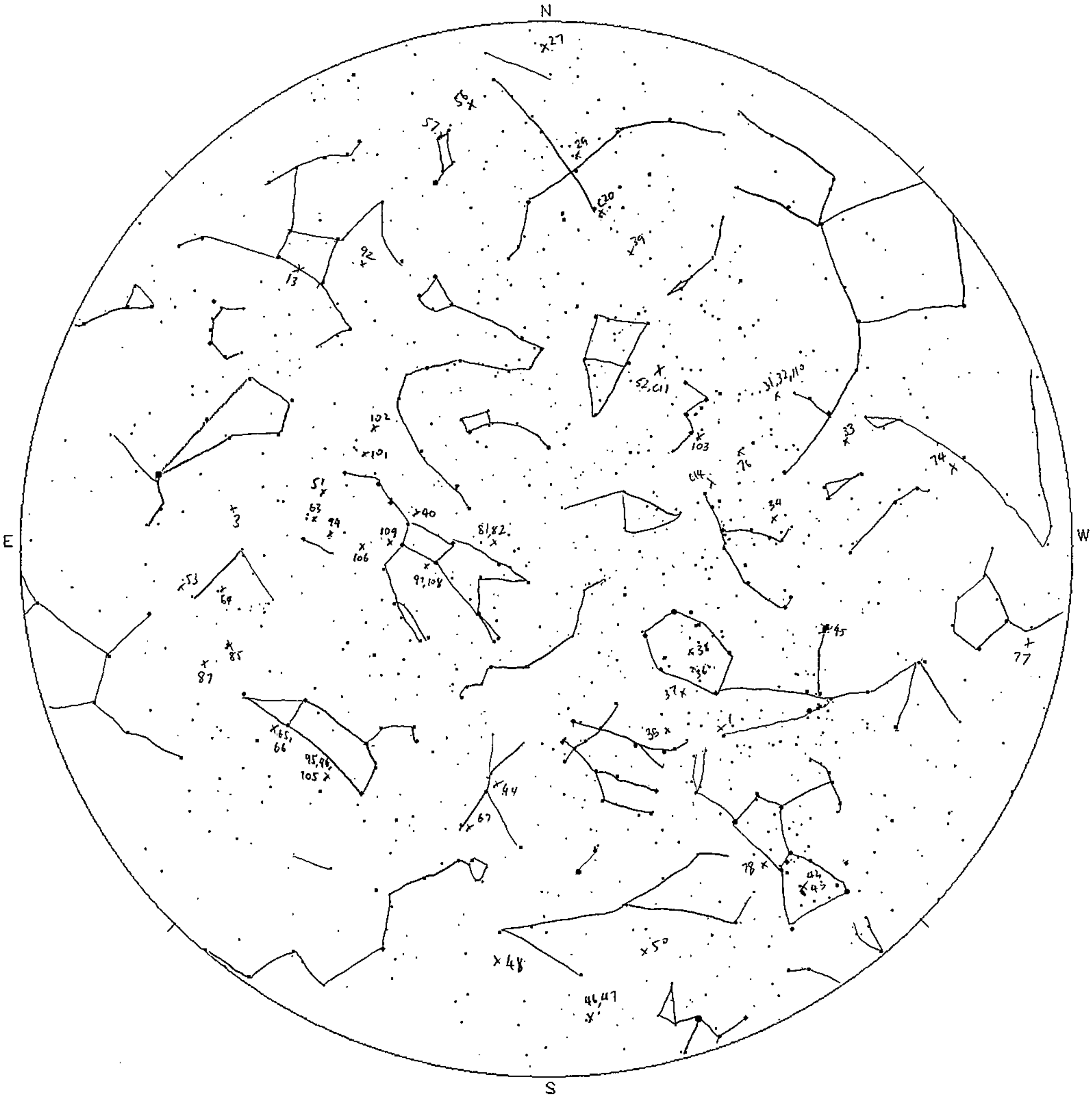
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97,108
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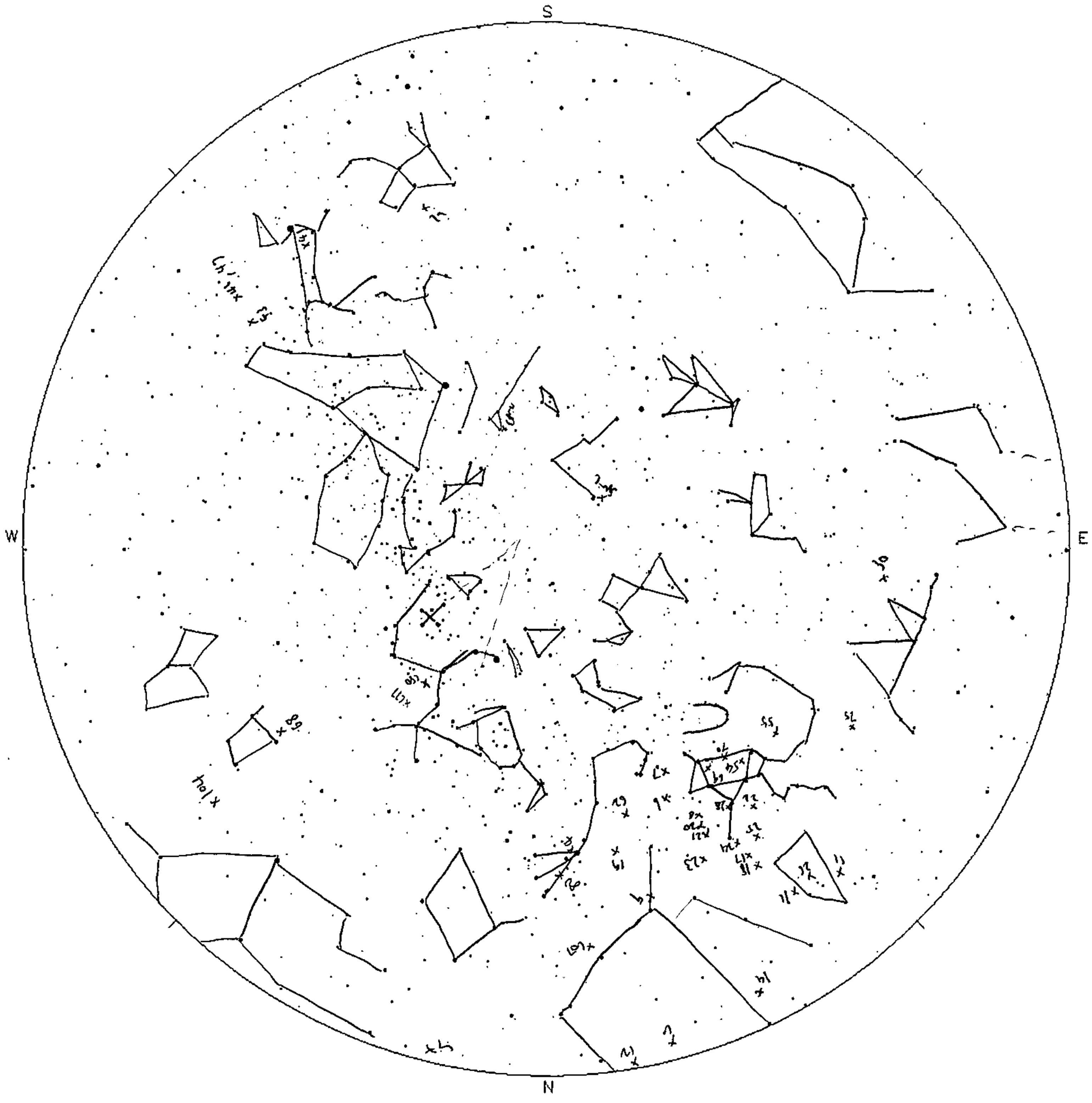
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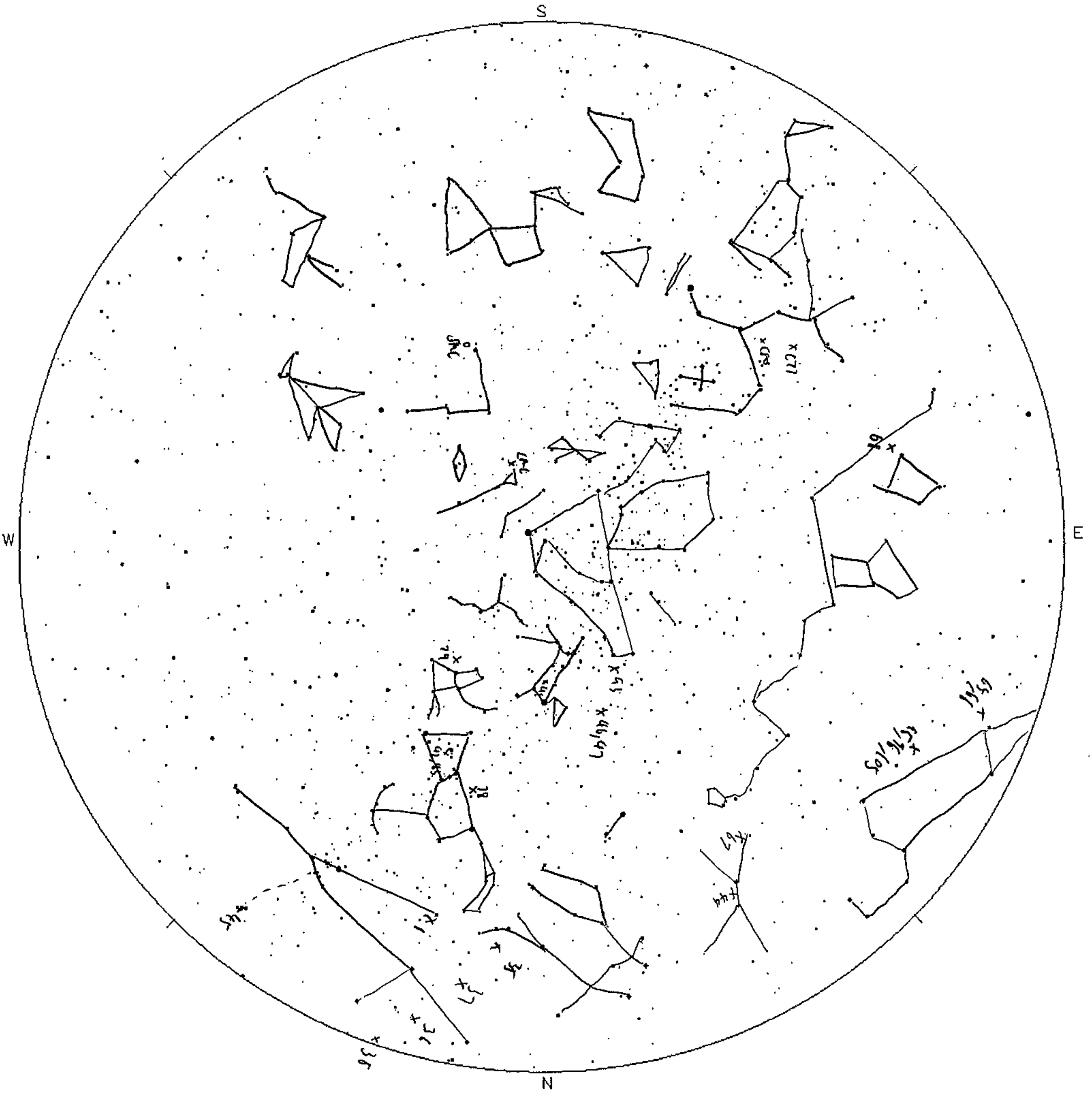
N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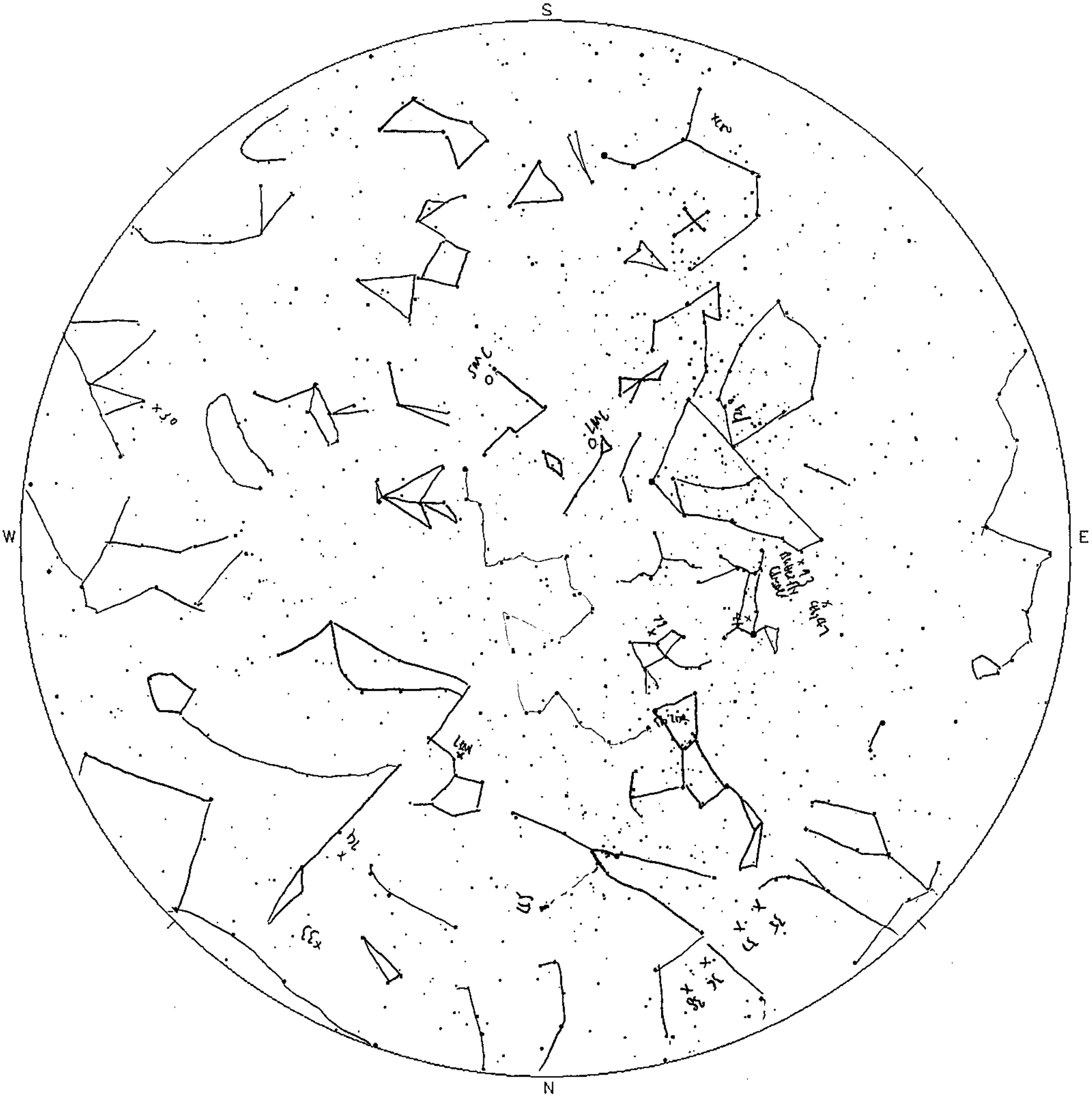
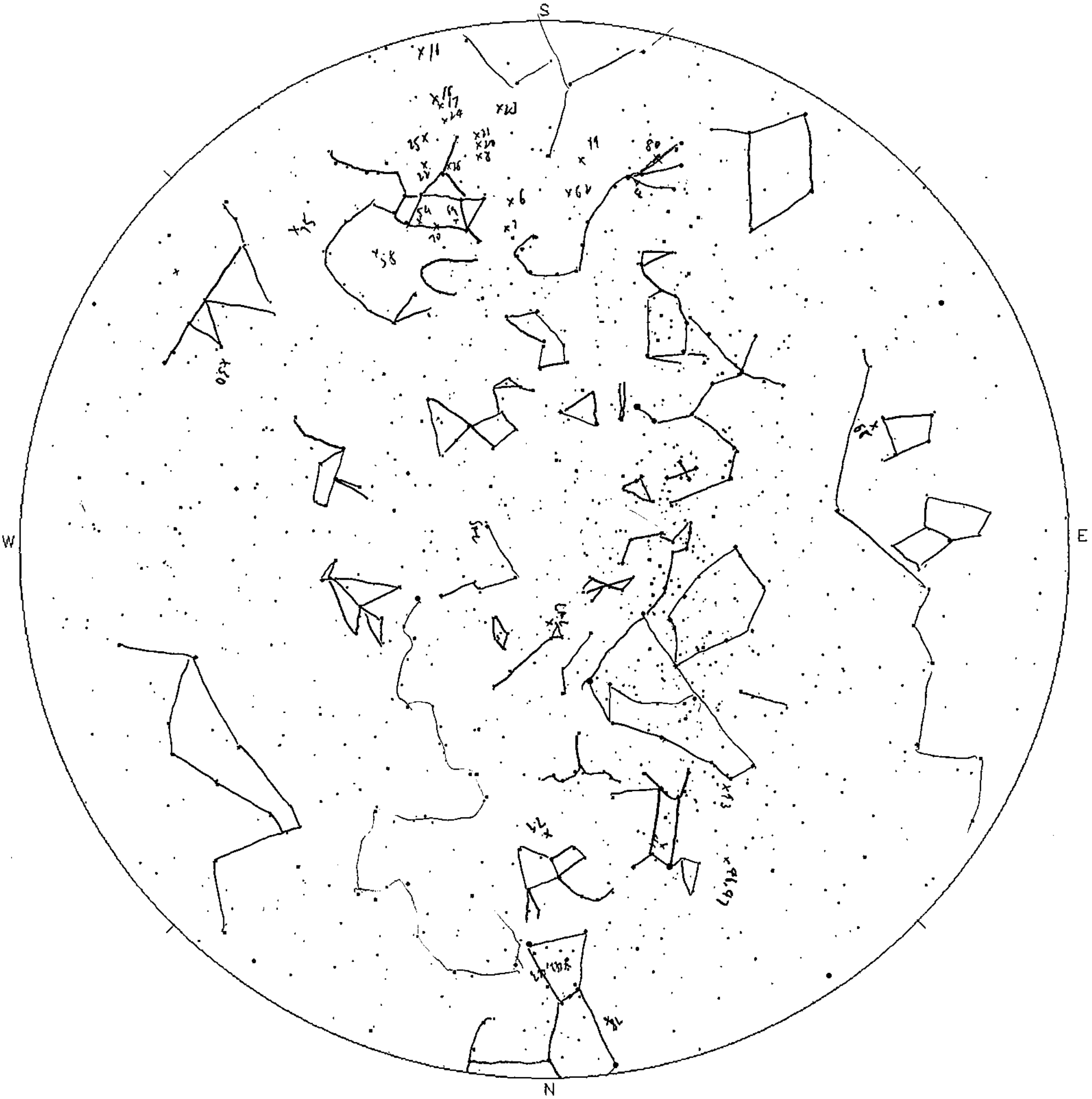
N


S
W
E
N
SMC
LMC
x 30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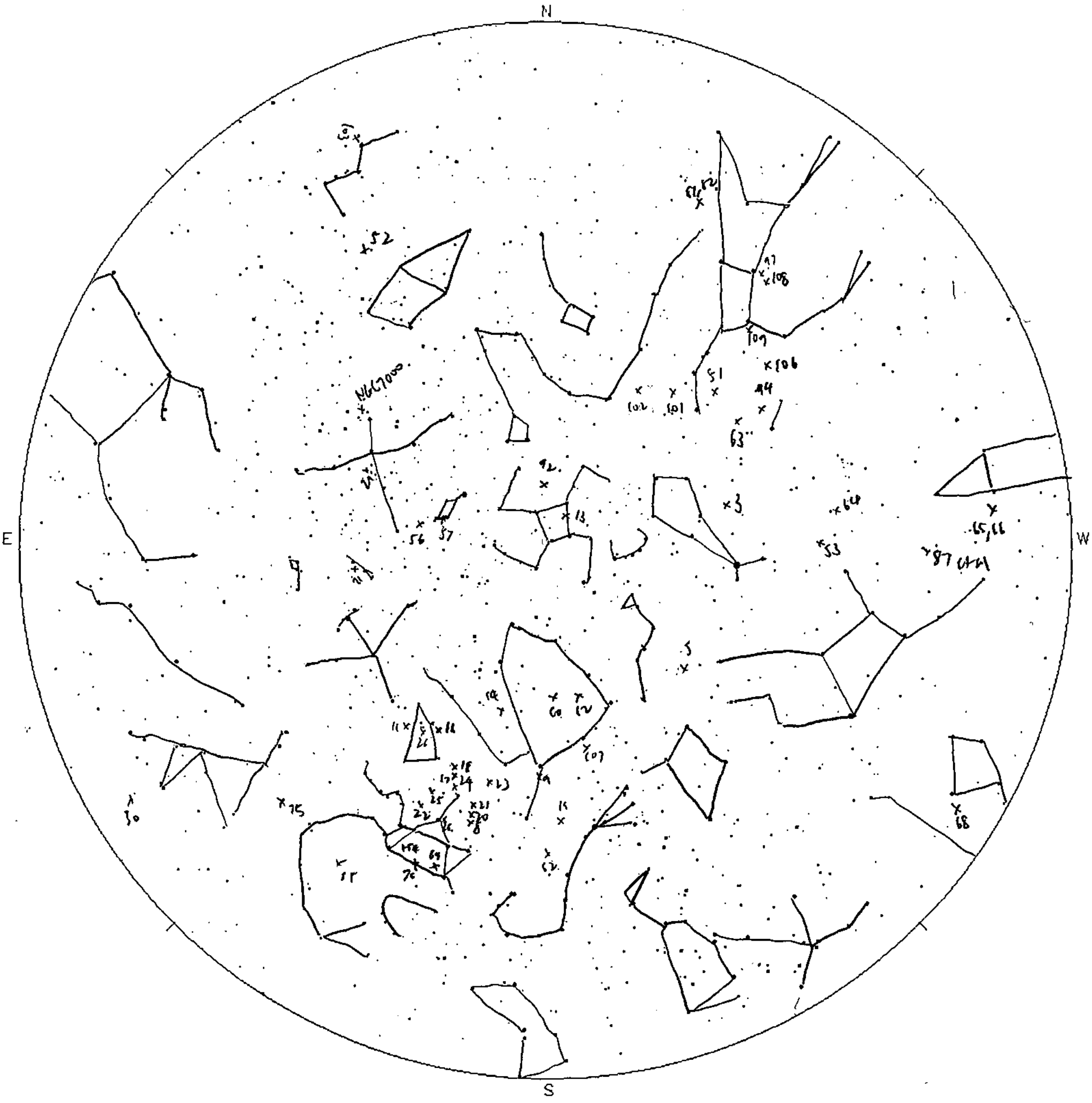
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NGC7000
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81, 82
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94
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101
63
92
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87 M
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19
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72
107
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52
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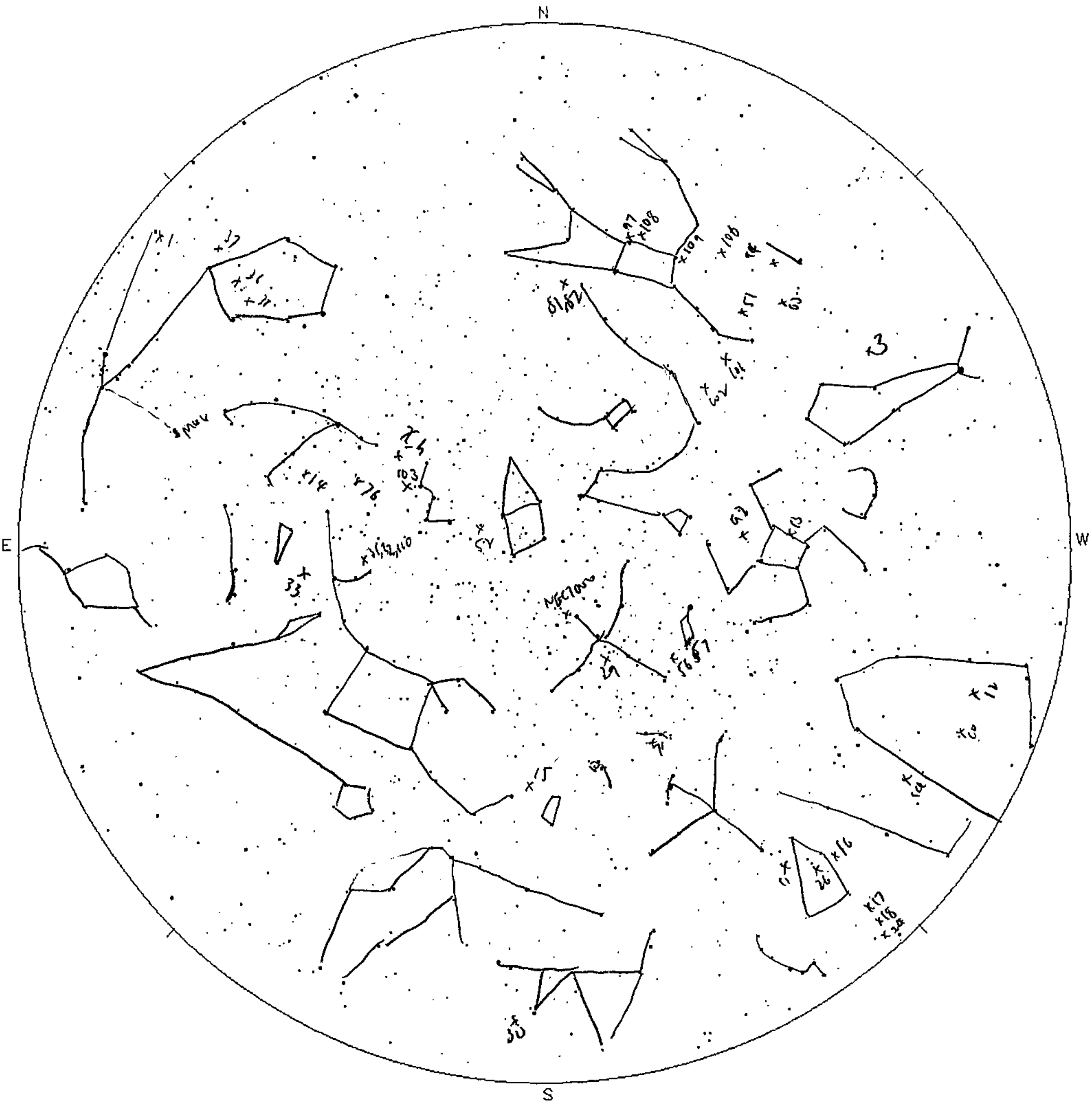
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E
W
S
x1
x97
x108
x109
x106
x51
x101
x13
x92
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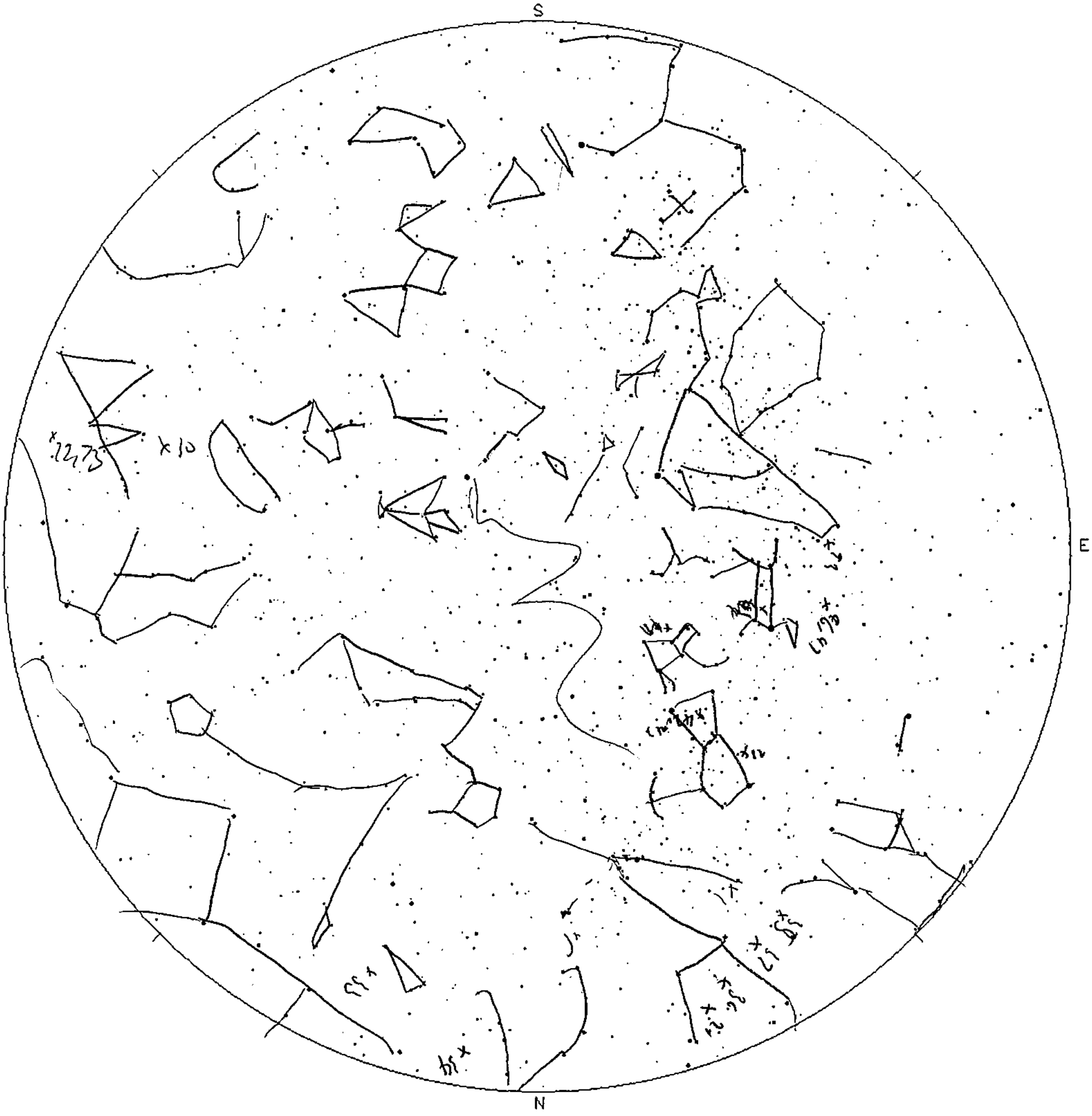
x76
103
NGC7000
33
x15
x16
x17
x18
x20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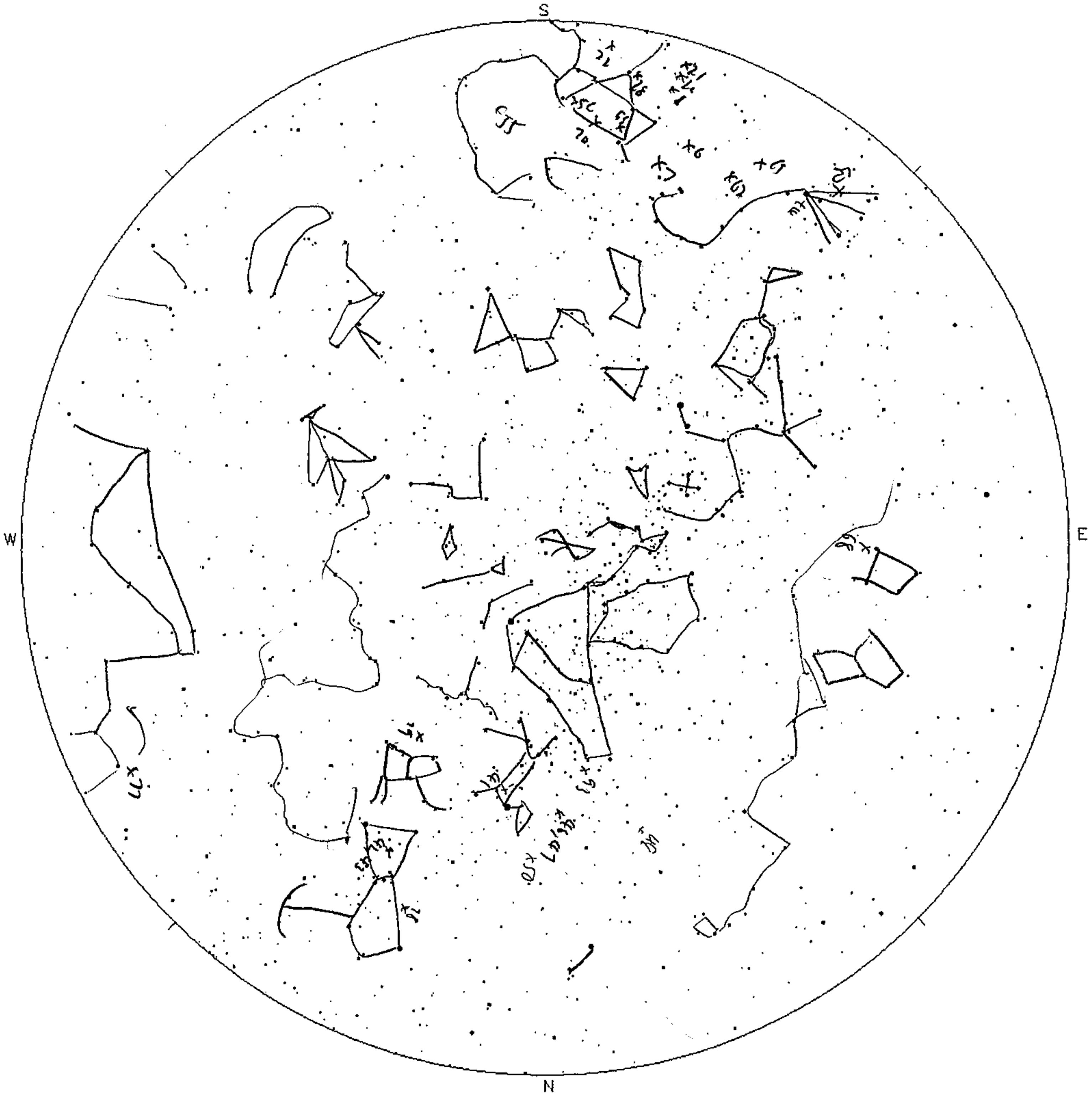
x10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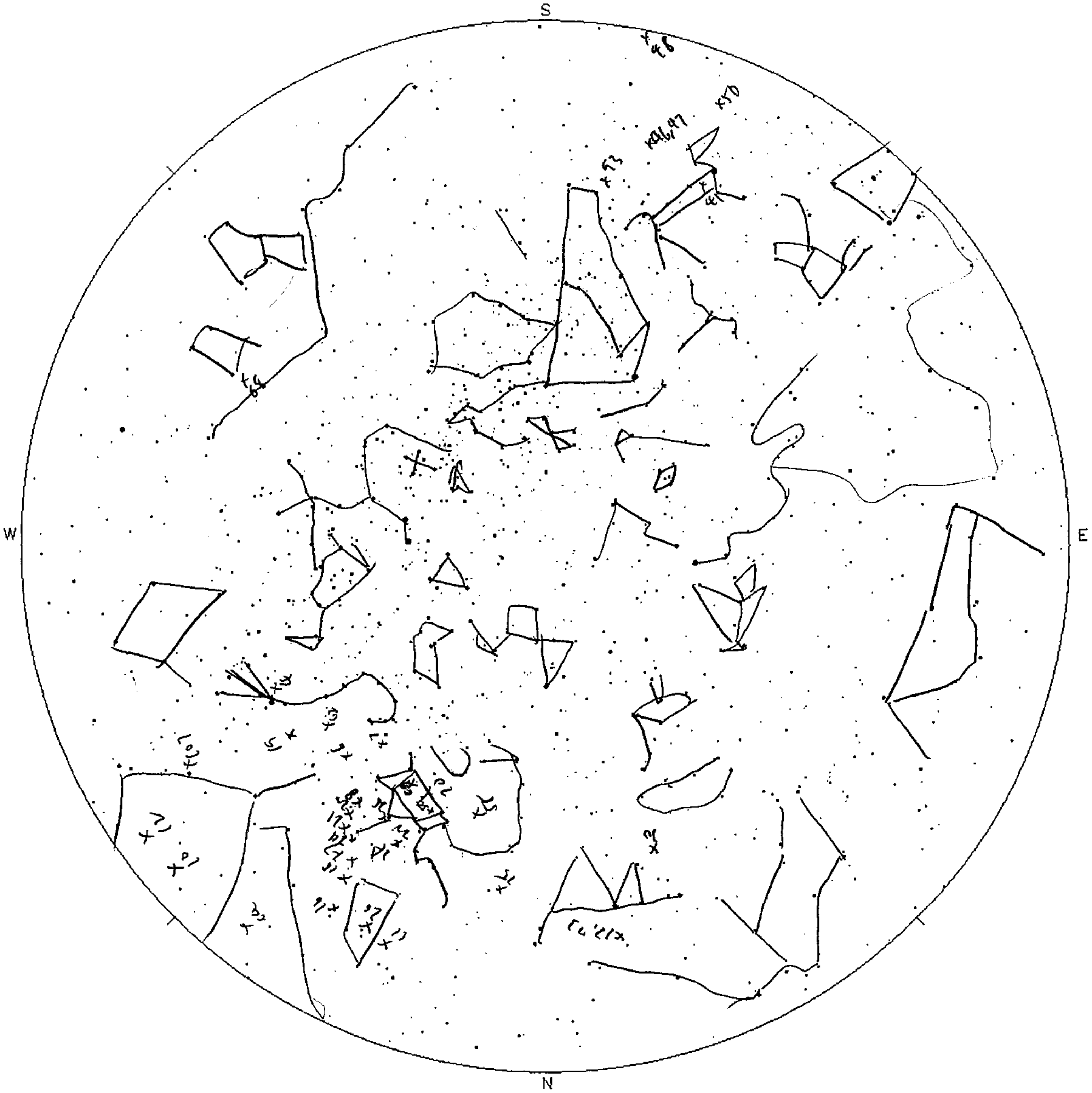
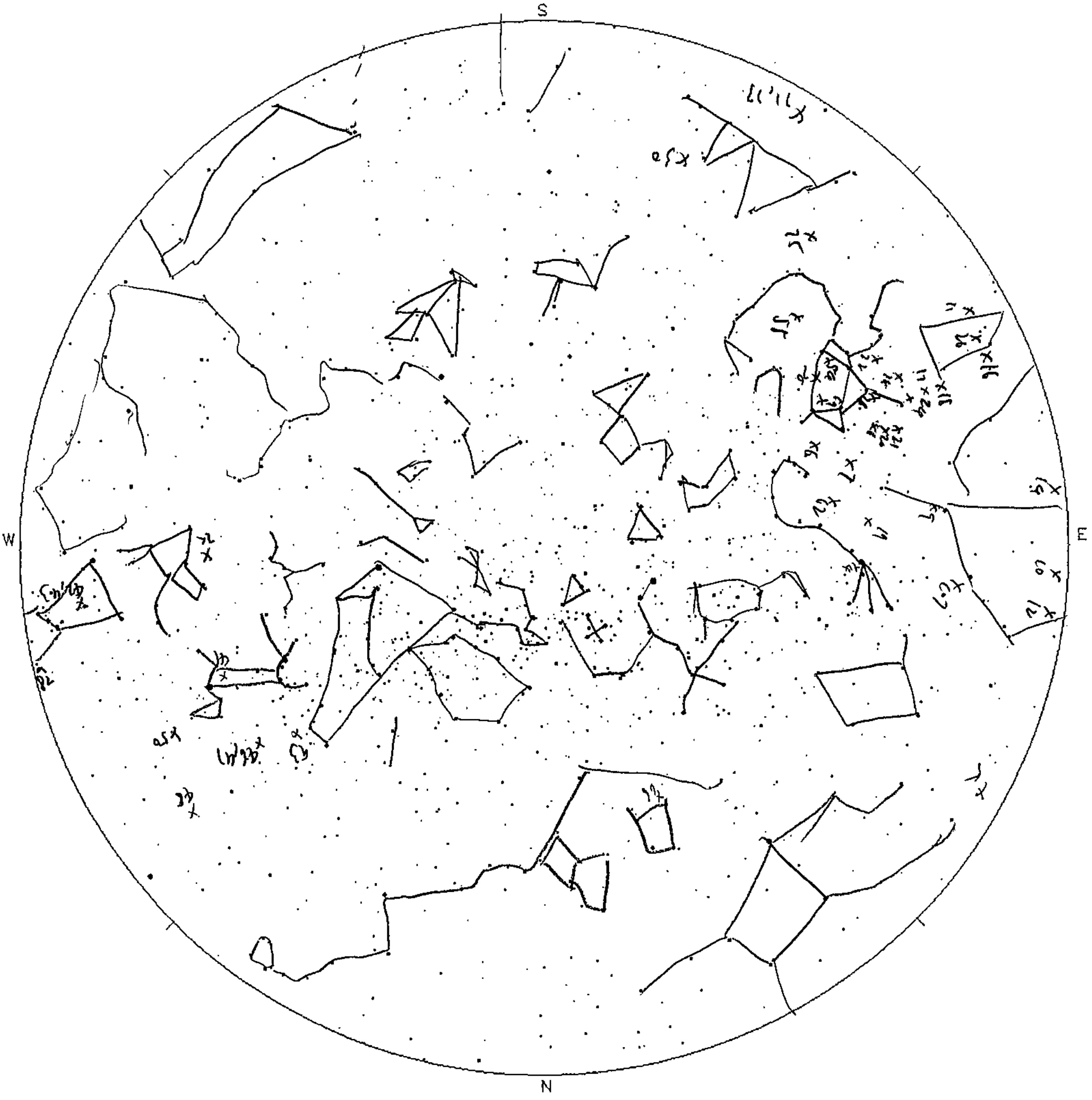

S
x 48
x 50
x46,47
x 53
W
E
N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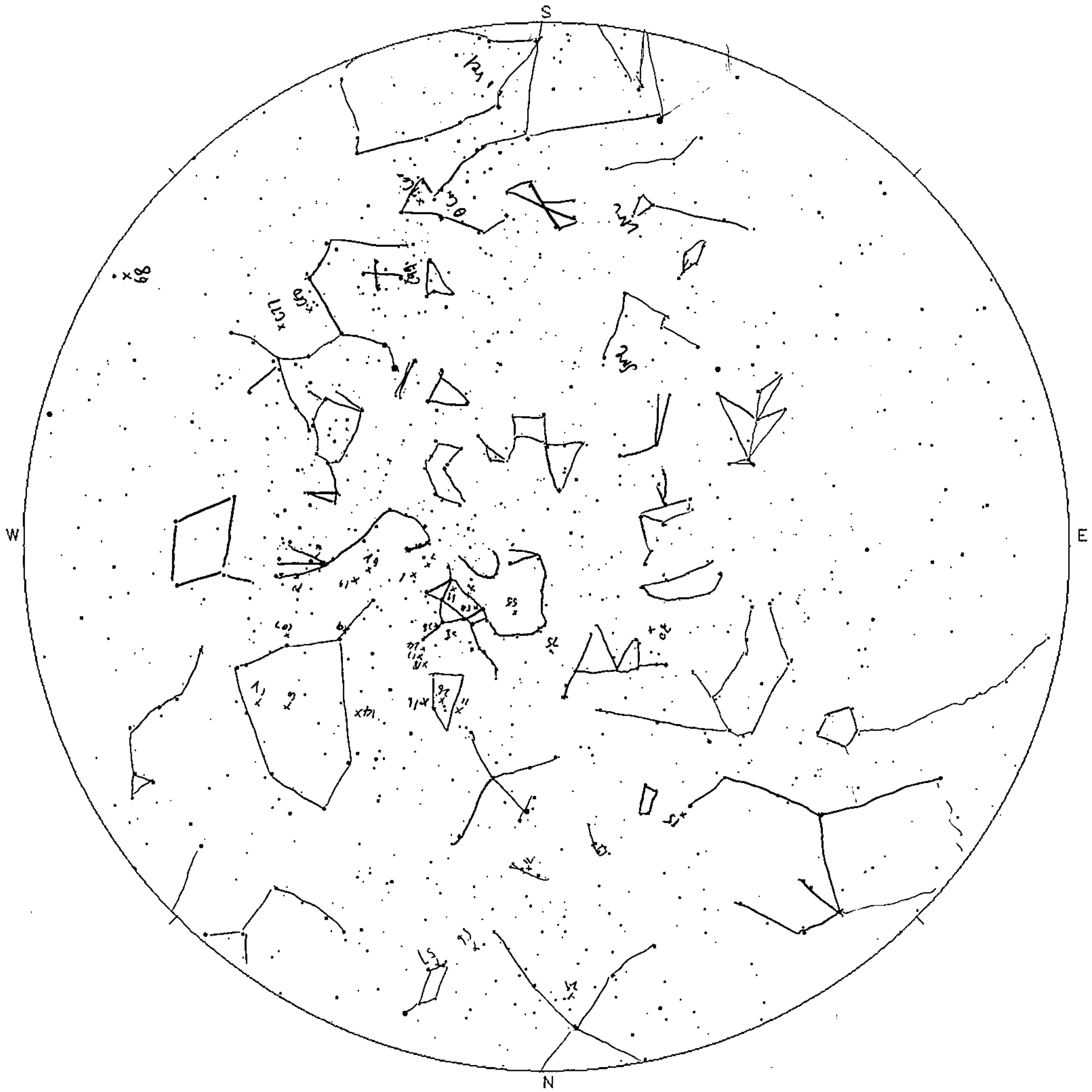
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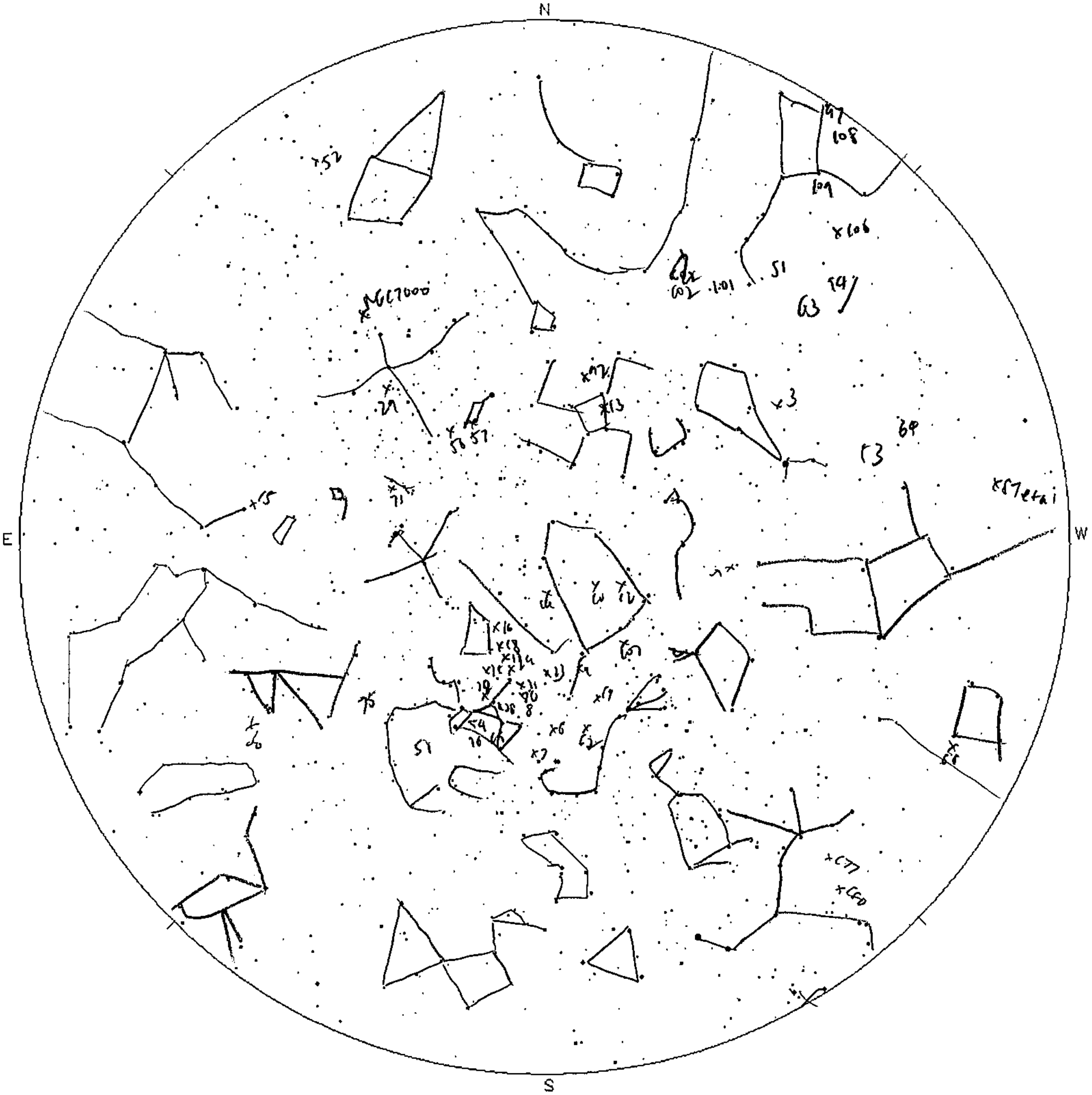
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NGC7000
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×15
×92
×13
×3
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×106
102
101
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×57 eta i
×16
×18
×19
×11
×13
×10
×9
×17
×6
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×7
×24
20
28
8
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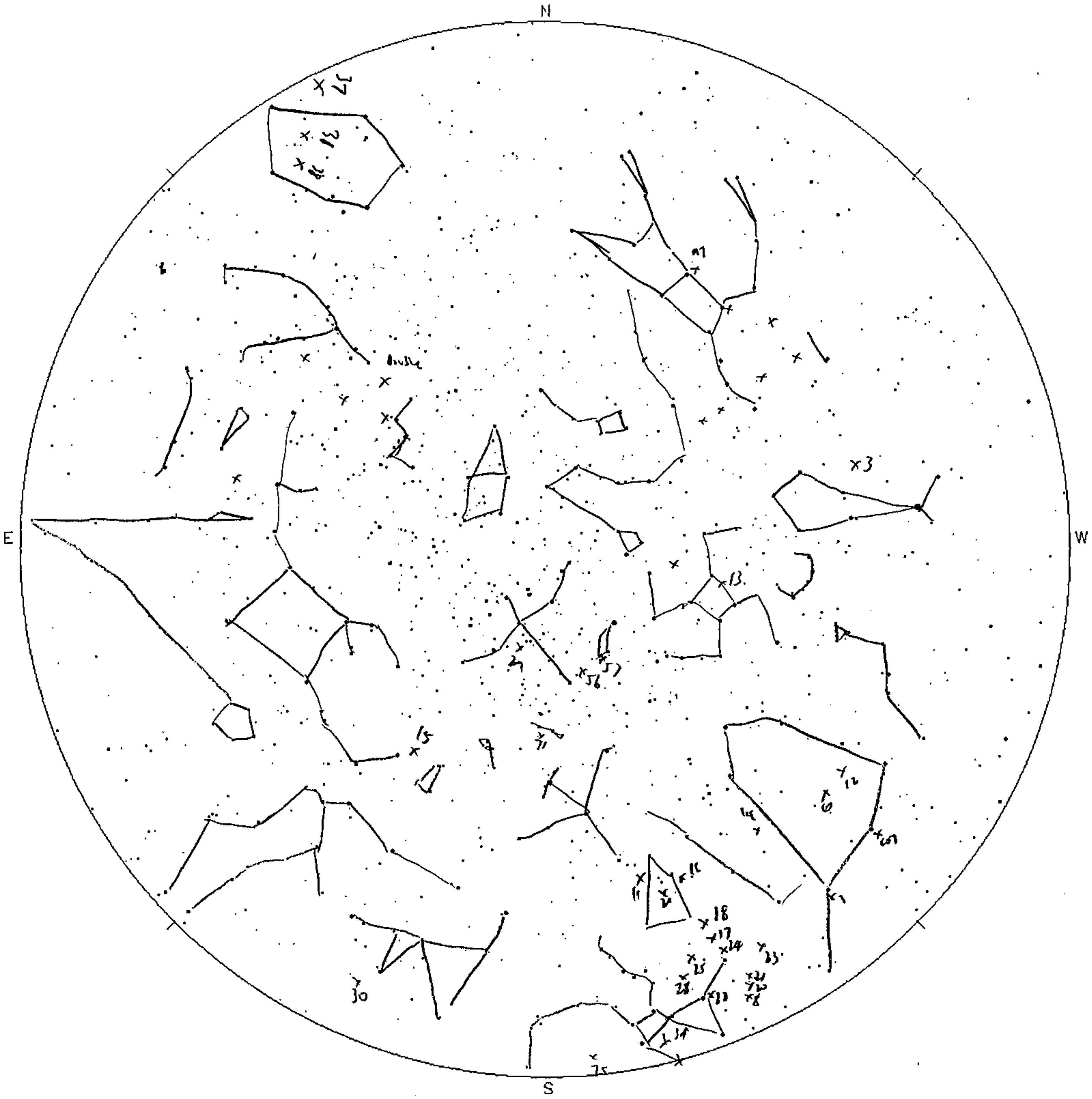
×C77
×C60


N
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60
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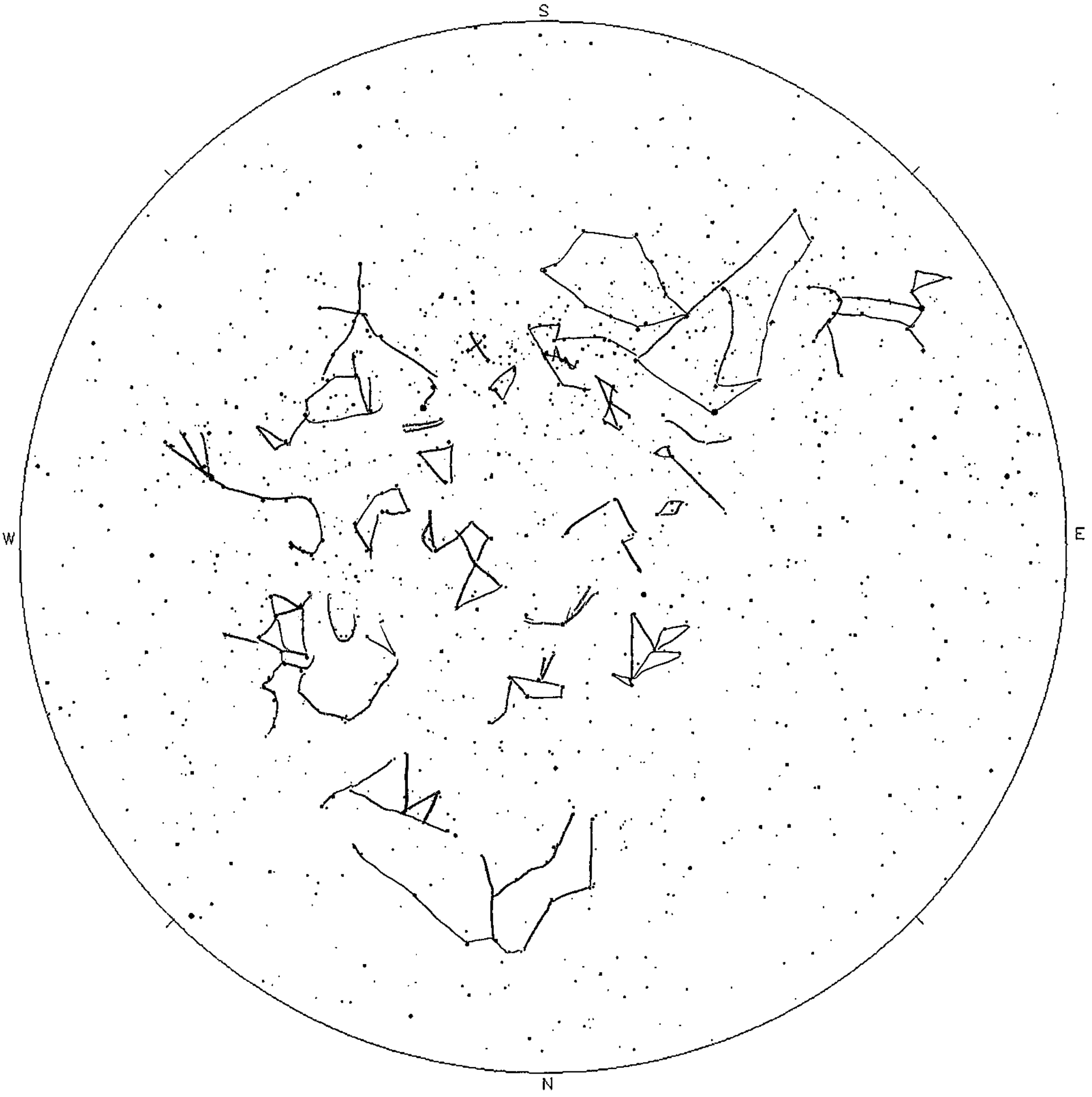
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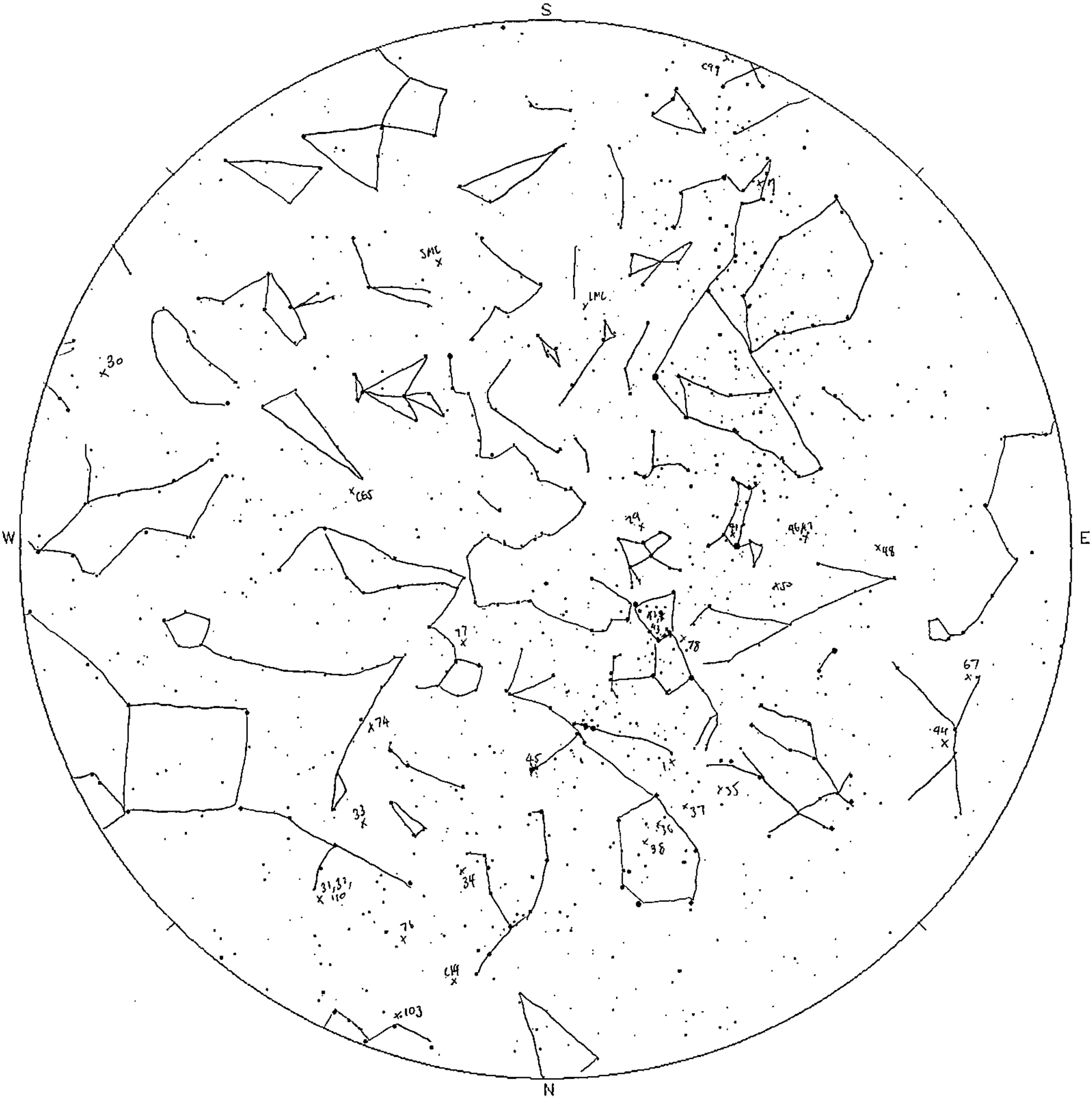
S
C99
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SMC
LMC
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C65
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103
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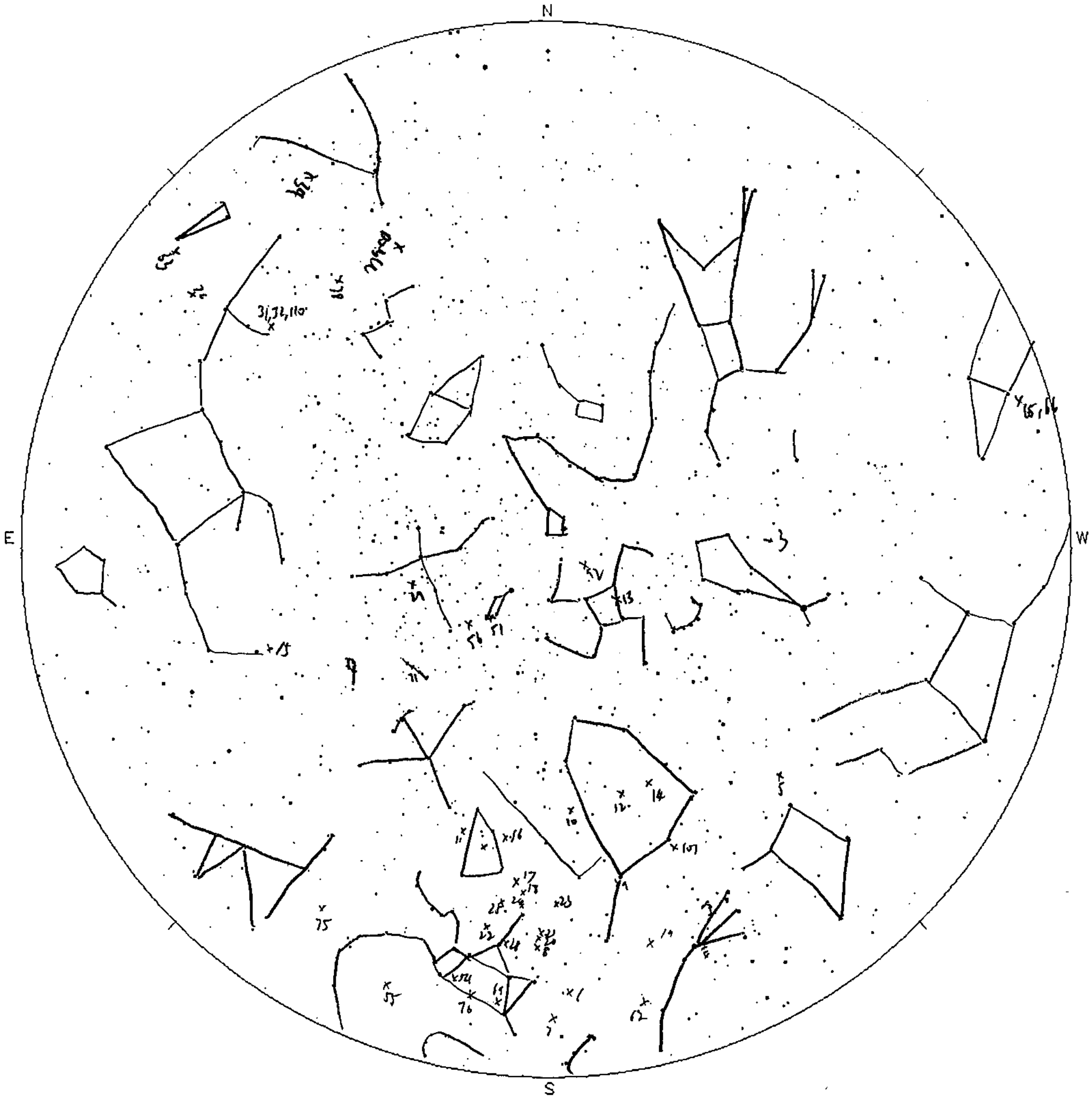
North Pole
map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75
51
56

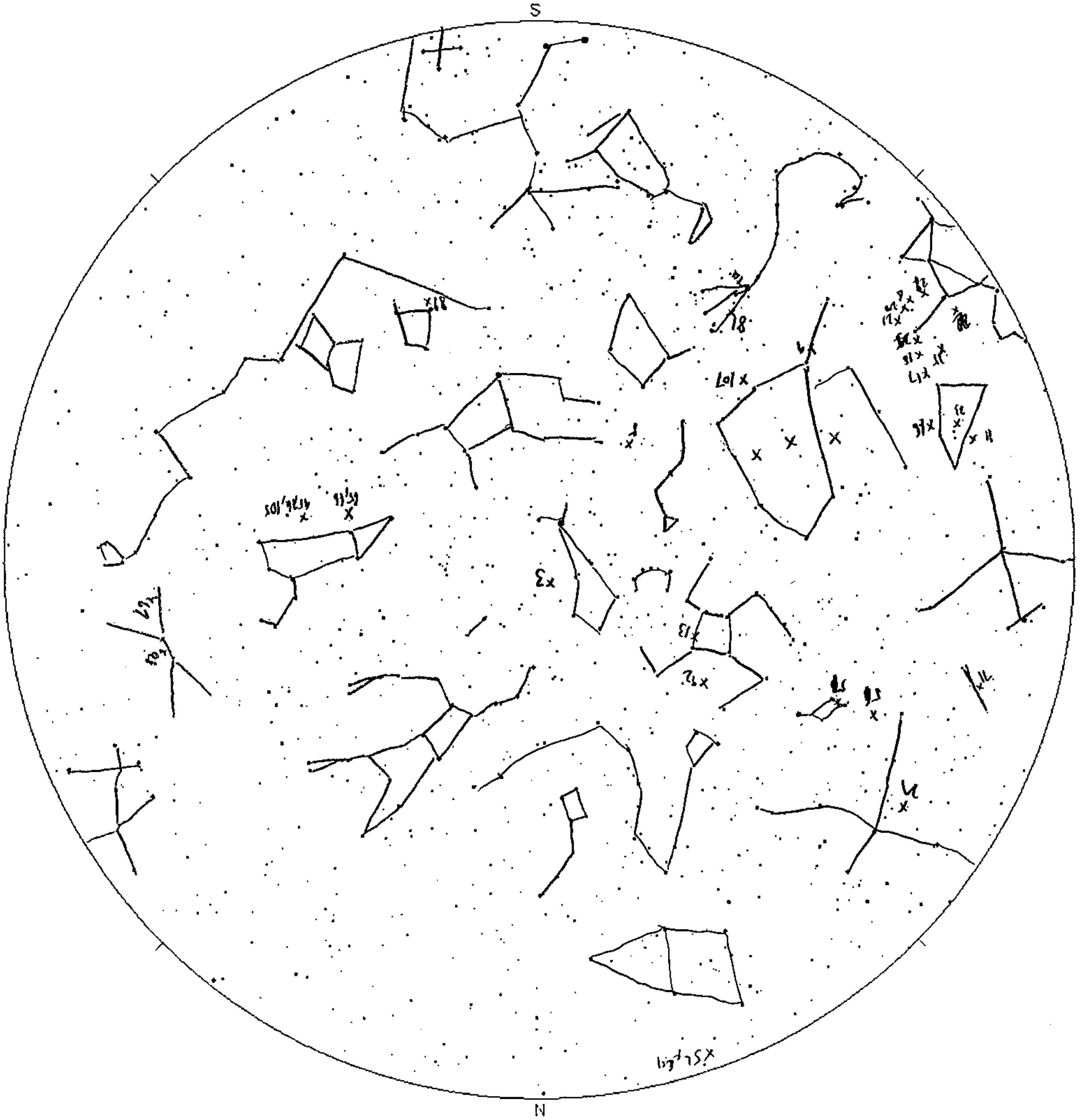
$$\sqrt{40^2+\left(30+\frac{d}{2}\right)^2}-\sqrt{40^2+\left(30-\frac{d}{2}\right)^2}=4$$

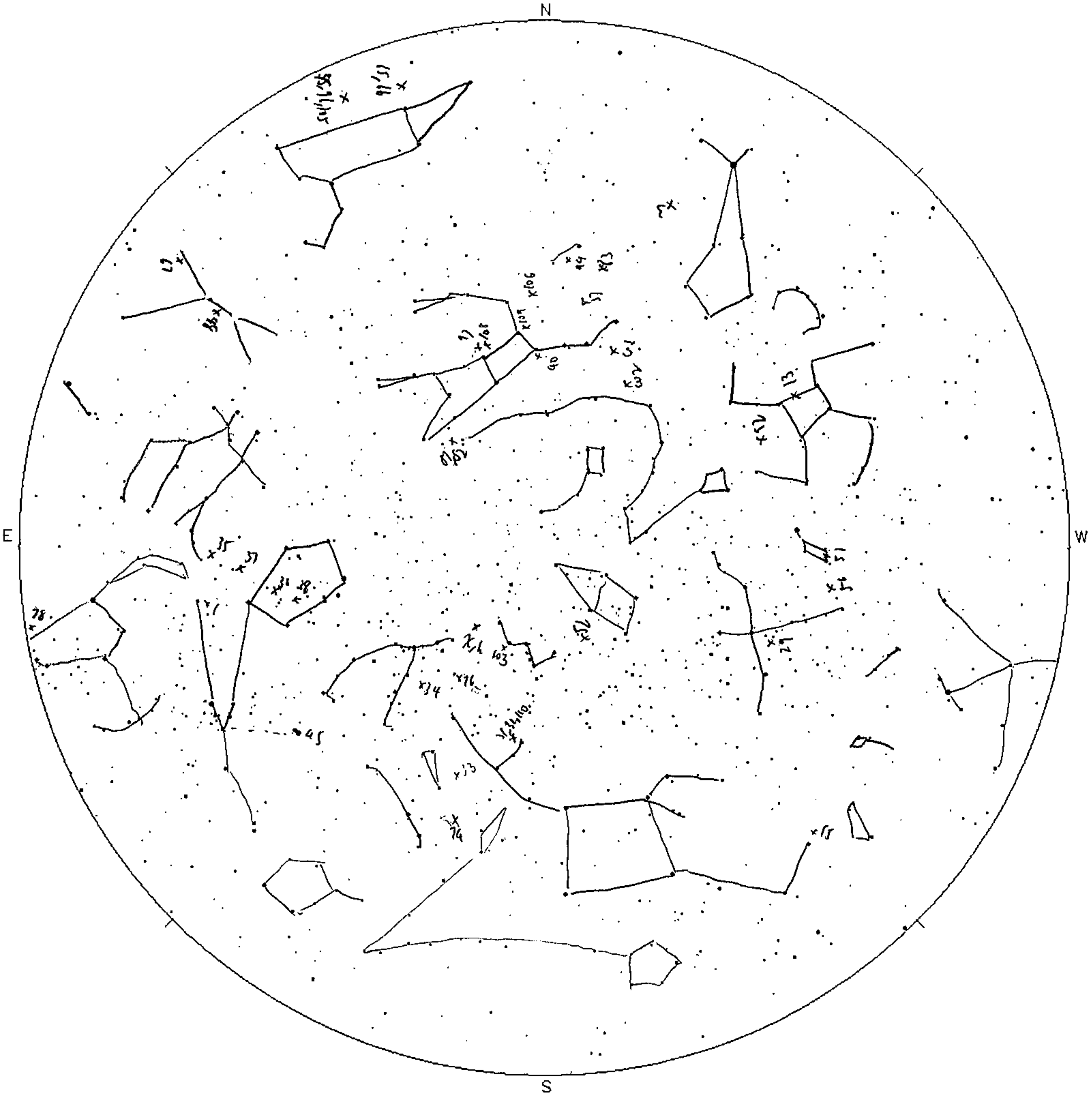
$$\left(30+\frac{d}{2}\right)^2=\left(4+\sqrt{40^2+\left(30-\frac{d}{2}\right)^2}\right)^2-40^2$$

$$30+\frac{d}{2}=\sqrt{\left(4+\sqrt{40^2+\left(30-\frac{d}{2}\right)^2}\right)^2-40^2}$$

$$d=2\sqrt{\left(4+\sqrt{40^2+\left(30-\frac{d}{2}\right)^2}\right)^2-40^2}-2(30)$$

$$d=6.676183683\ldots$$

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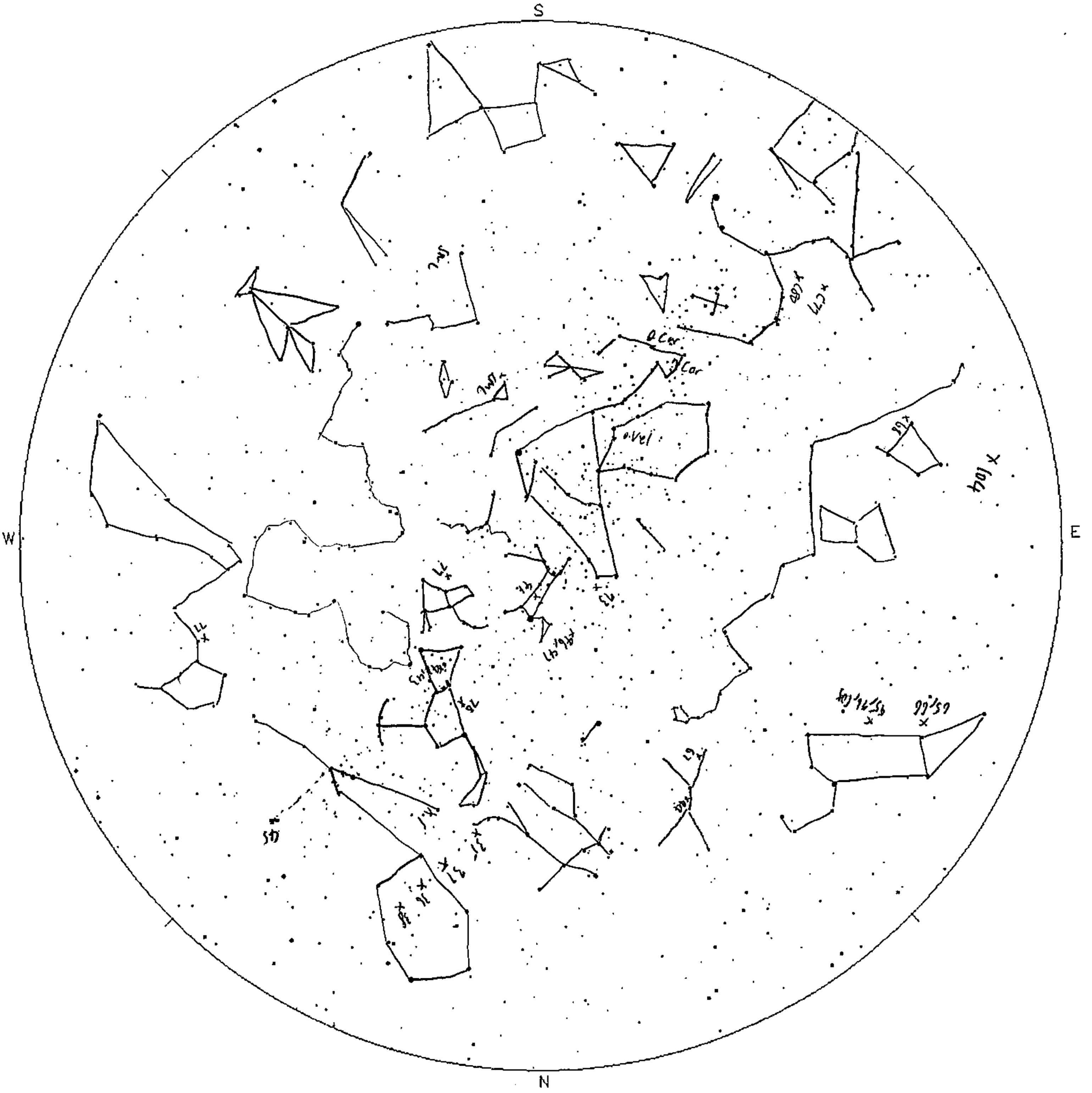
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24x
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26 x
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x14
x5
x93,96,105
65,66 x
87 x
85 x
64 x
x53
3 x
x71
57 x
56 x
x13
x92
x84
x63
x106
x51
x107
x101
x102


S
x48
x50
46,47
43
41
42,43
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83
77
80
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76
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80
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62
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107
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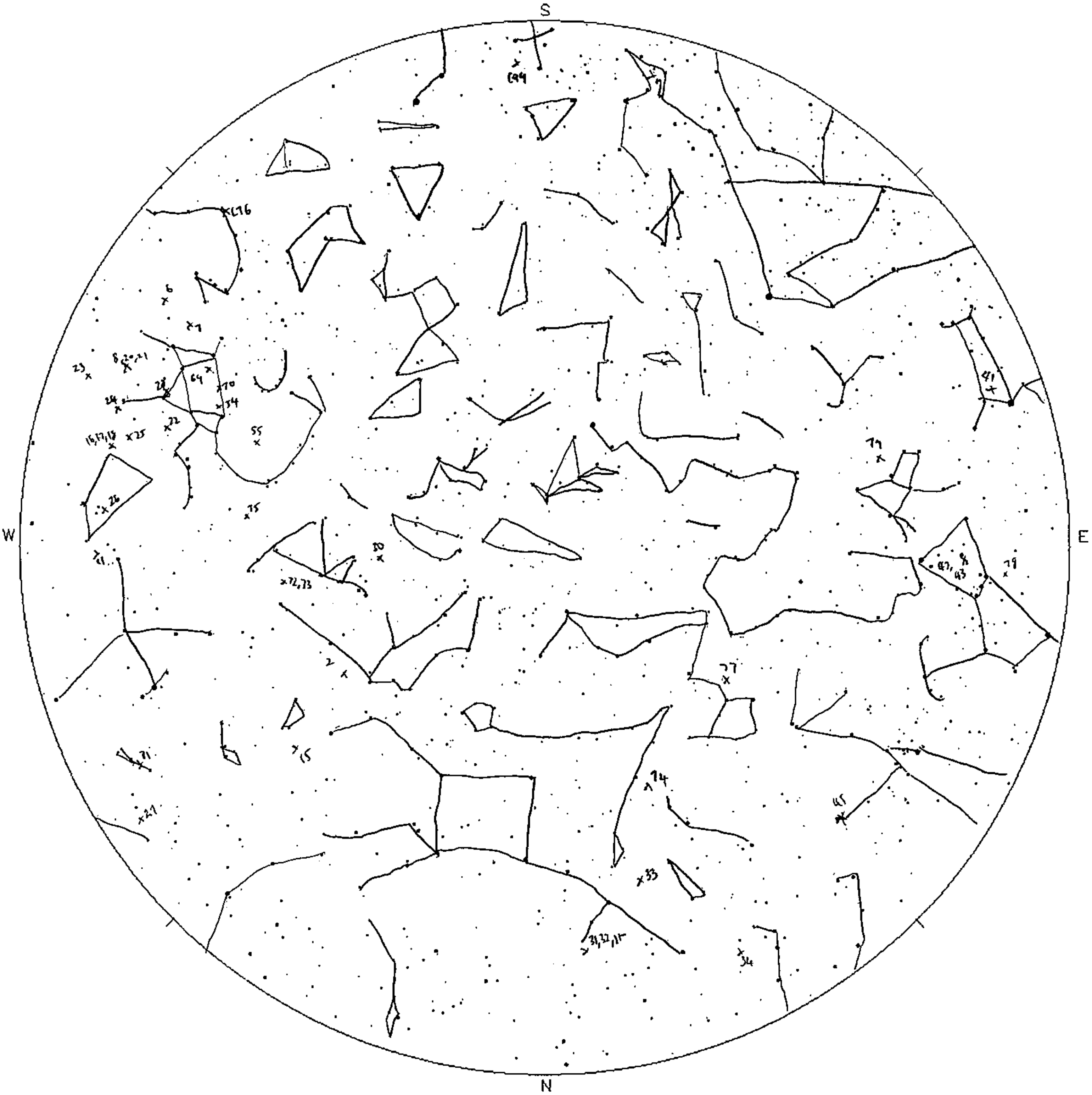
S
194
176
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48
78
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N
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97,108
95,96,105
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112
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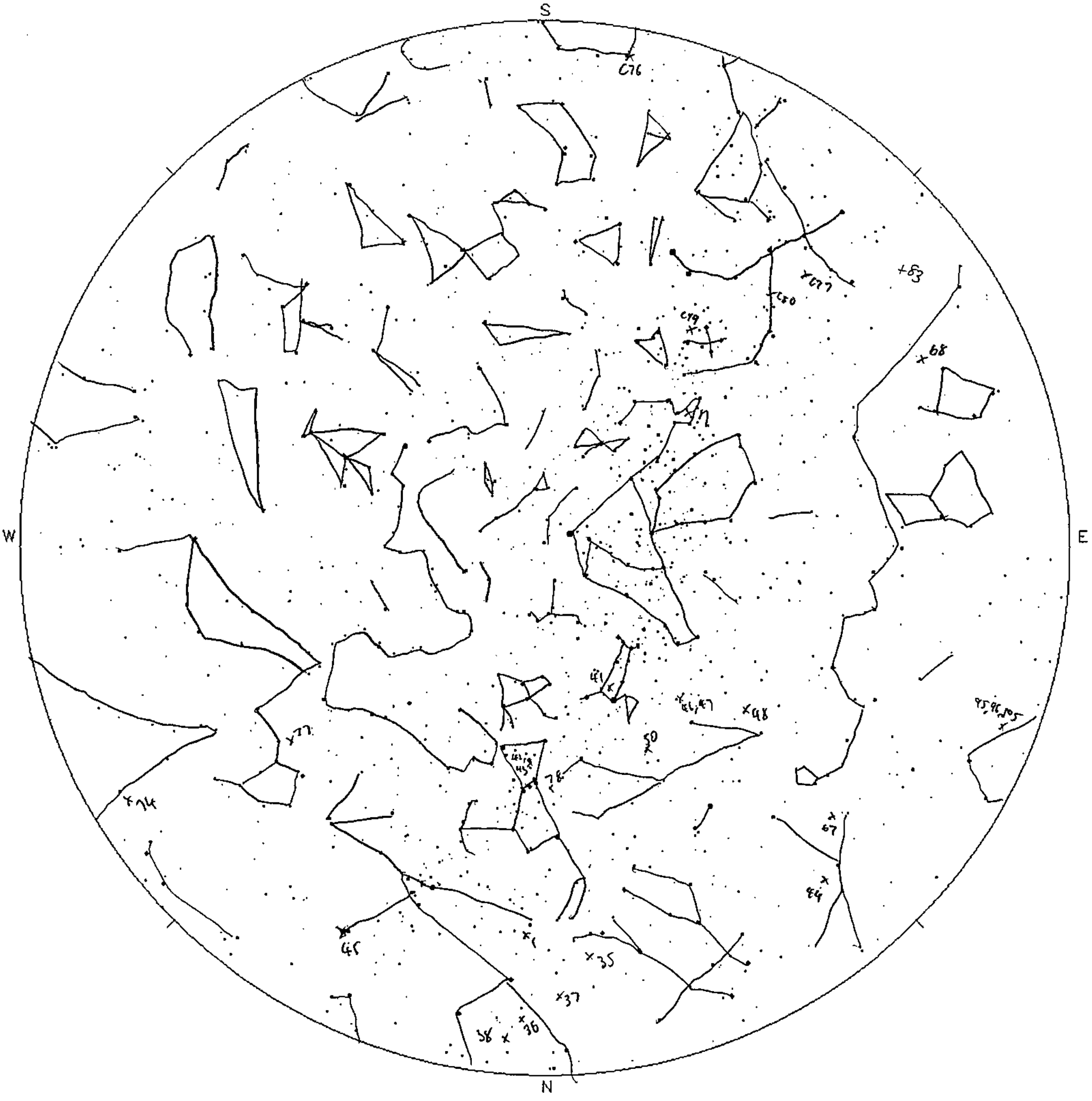
7
5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77
74
67
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N


N
44
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37
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38
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114
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113
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74
31,32,110
32,111
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81,82
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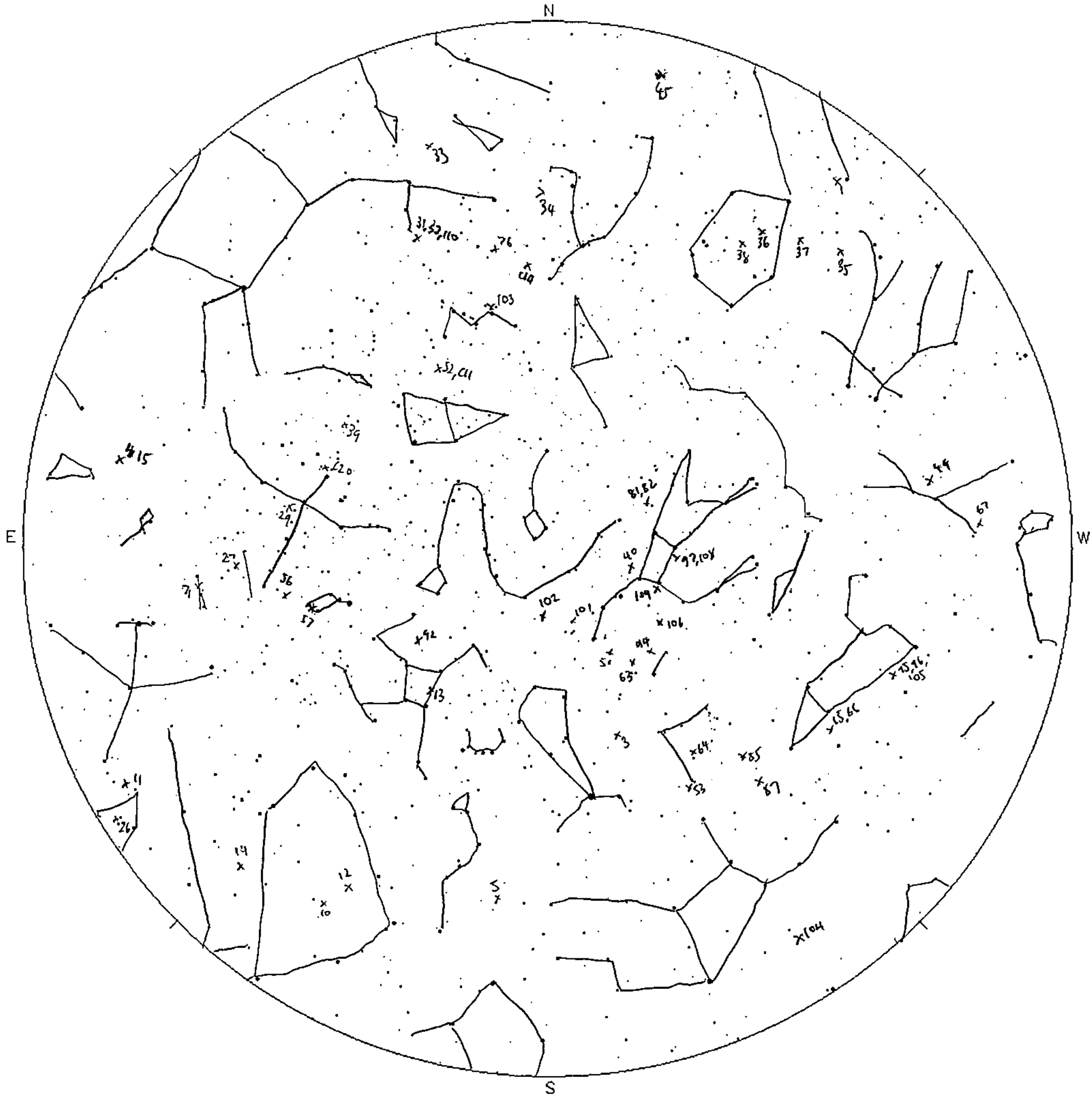
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56
57
81,82
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97,108
102
101
109
106
92
13
50
119
63
3
64
85
53
87
49
67
E
W
75,96,105
58,66
11
26
14
12
10
5
104
S


S
C77
C80
C99
4
C76
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80
62
6
7
19
107
9
W
10
C2
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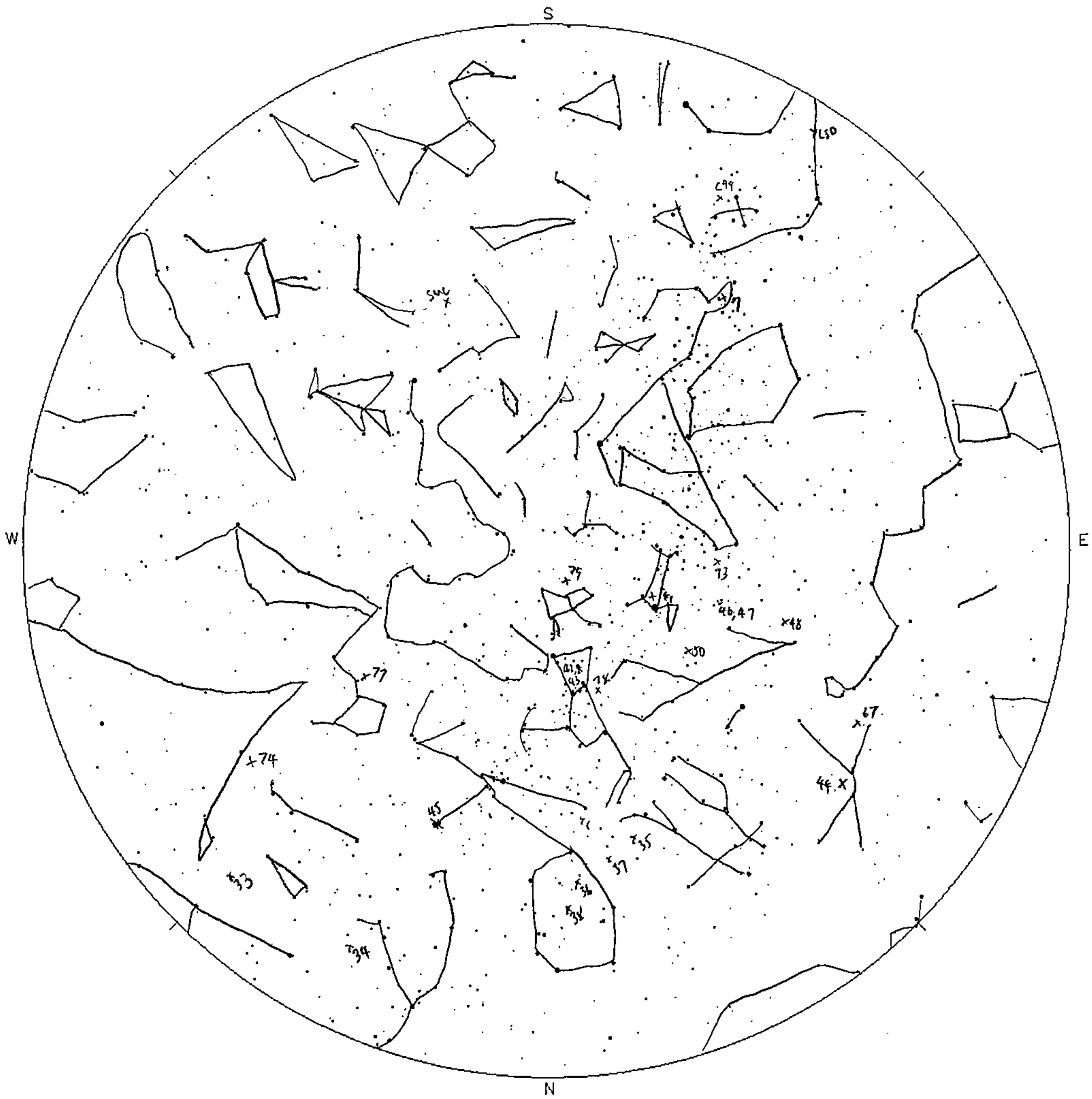
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N
E
W
S
140
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47,108
81,82
57,c11
103
114
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31,32,110
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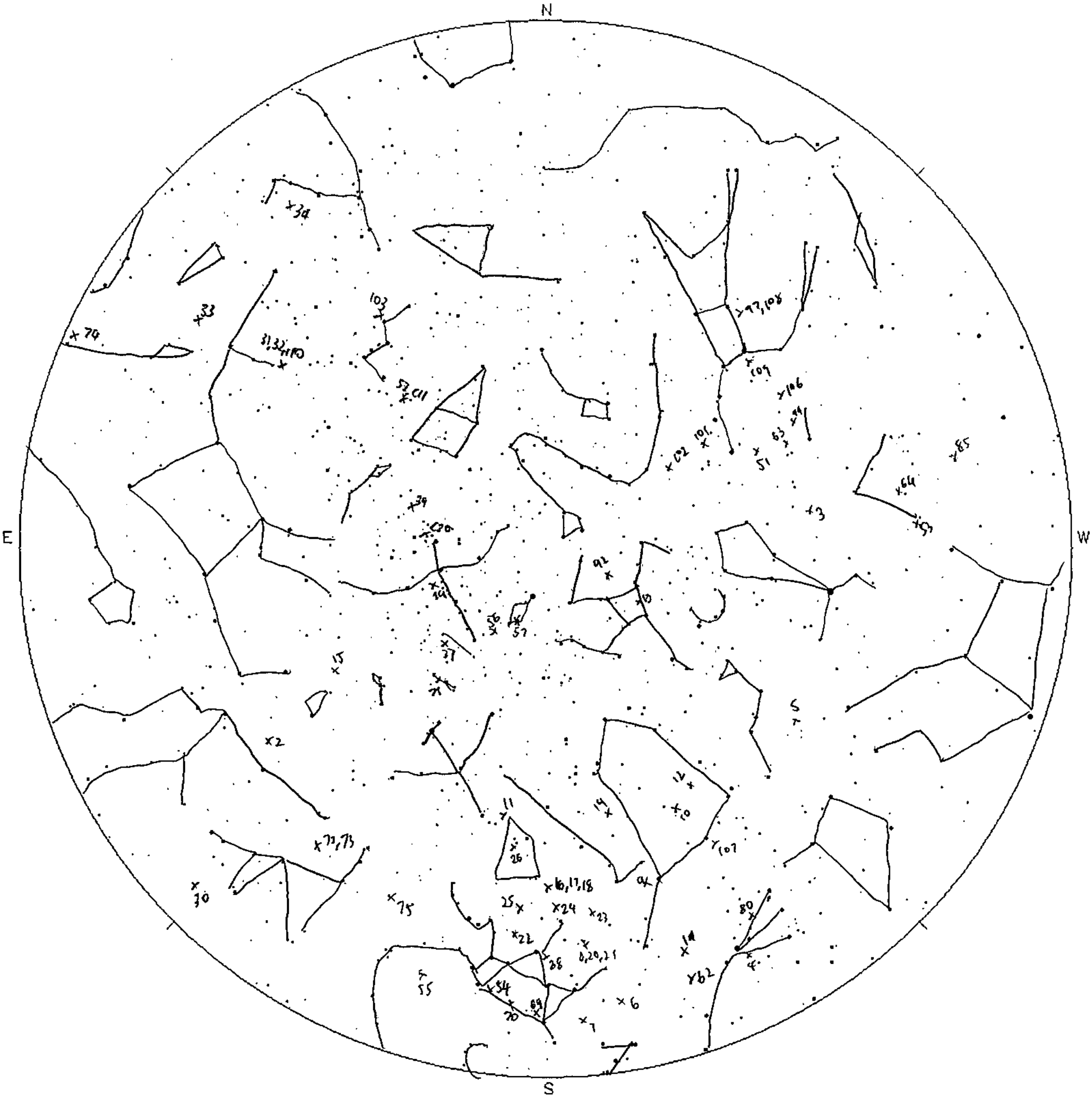
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101
x102
x85
x64
93
3
79
100
92
13
56
57
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x2
5
12
10
14
11
26
107
x71,73
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75
x16,17,18
25
x24
x23
x22
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8,20,21
19
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55
54
70
69
x6
x7
9


S
W
E
N
55
59
70
60
21
25
24
16,17,18
7
8,10,21
23
6
C76
62
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47
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107
2
LMC
C95
C80
C81
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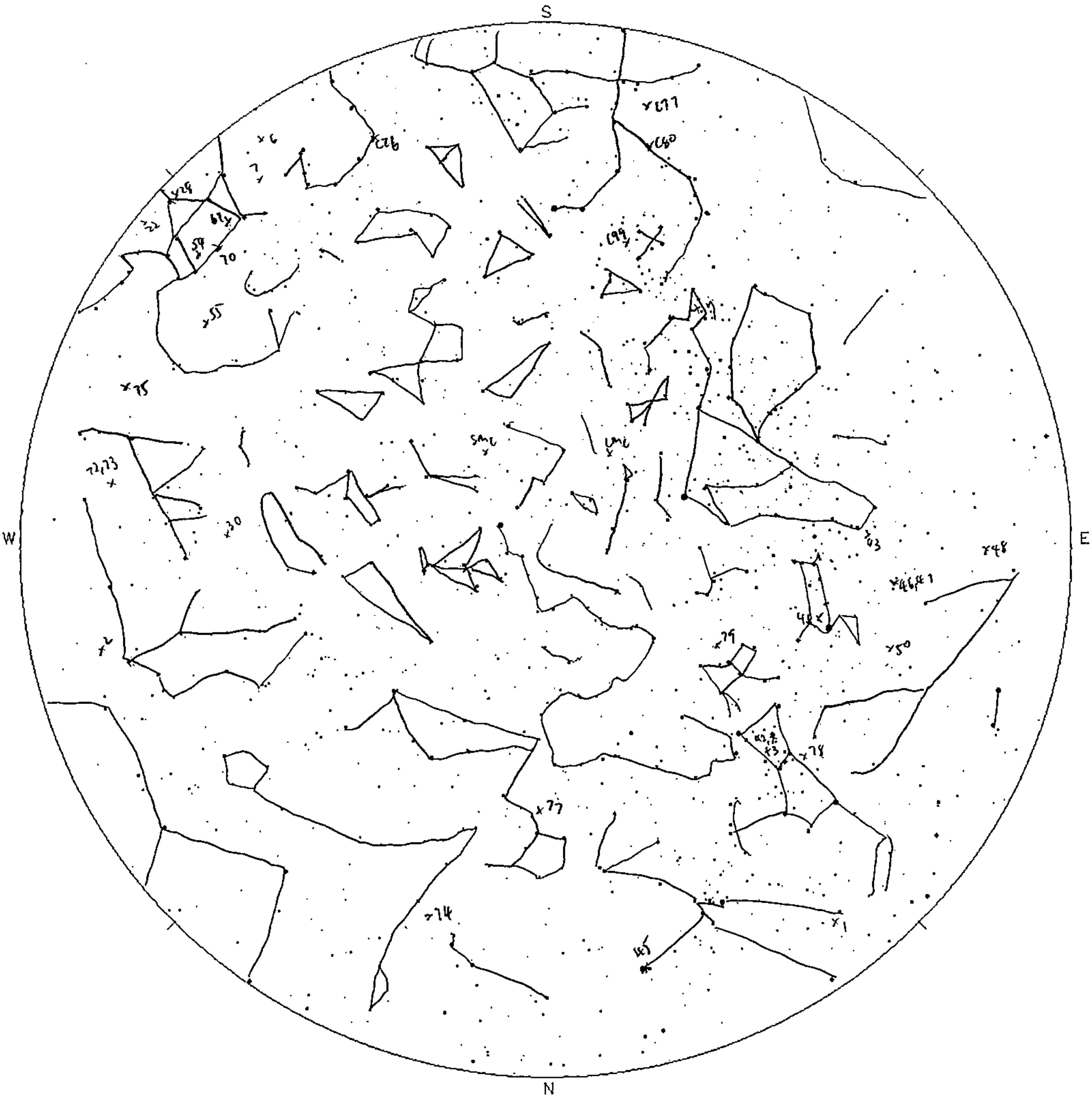
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x55
x75
22,23 x
SMC x
LMC x
x30
W
63
E
x48
x46,47
49x
x2
x79
x50
42,8 x3
x78
x77
x74
x1
165
N


N
E
W
S
39
120
29
56
57
27
71
15
42
13
3
64
85
65
87
40
104
106
102
101
51
63
94
2
11
18
12
10
107
5
26
108
77
73
75
70
25
24
23
22
35
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80
82
4
9
55
64
70
63
7
6
C16
83
68
C77
C80
C99


N
E
W
S
x102
x101
x3
51
x90
83
x94
109
x
106
x
97,108
81,82
53,111
x103
x119
31,33,110
x
x
76
54
x
x33
33
x
x64
x
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x
87
65,66
95,96
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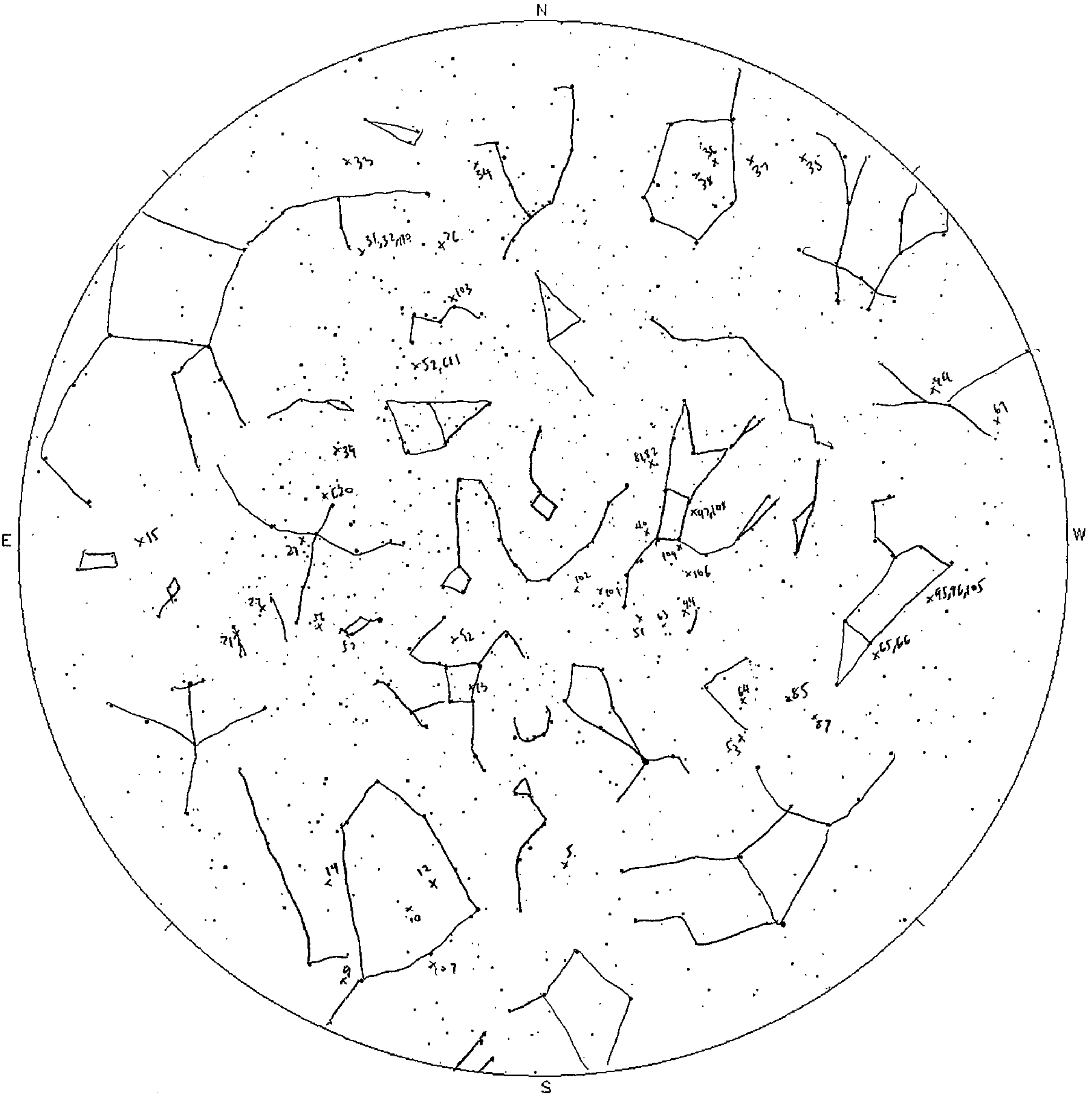
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x120
x15
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x44
x67
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x
x97,108
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x106
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x101
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x94
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x
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x
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x
57
x92
x95,96,105
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x
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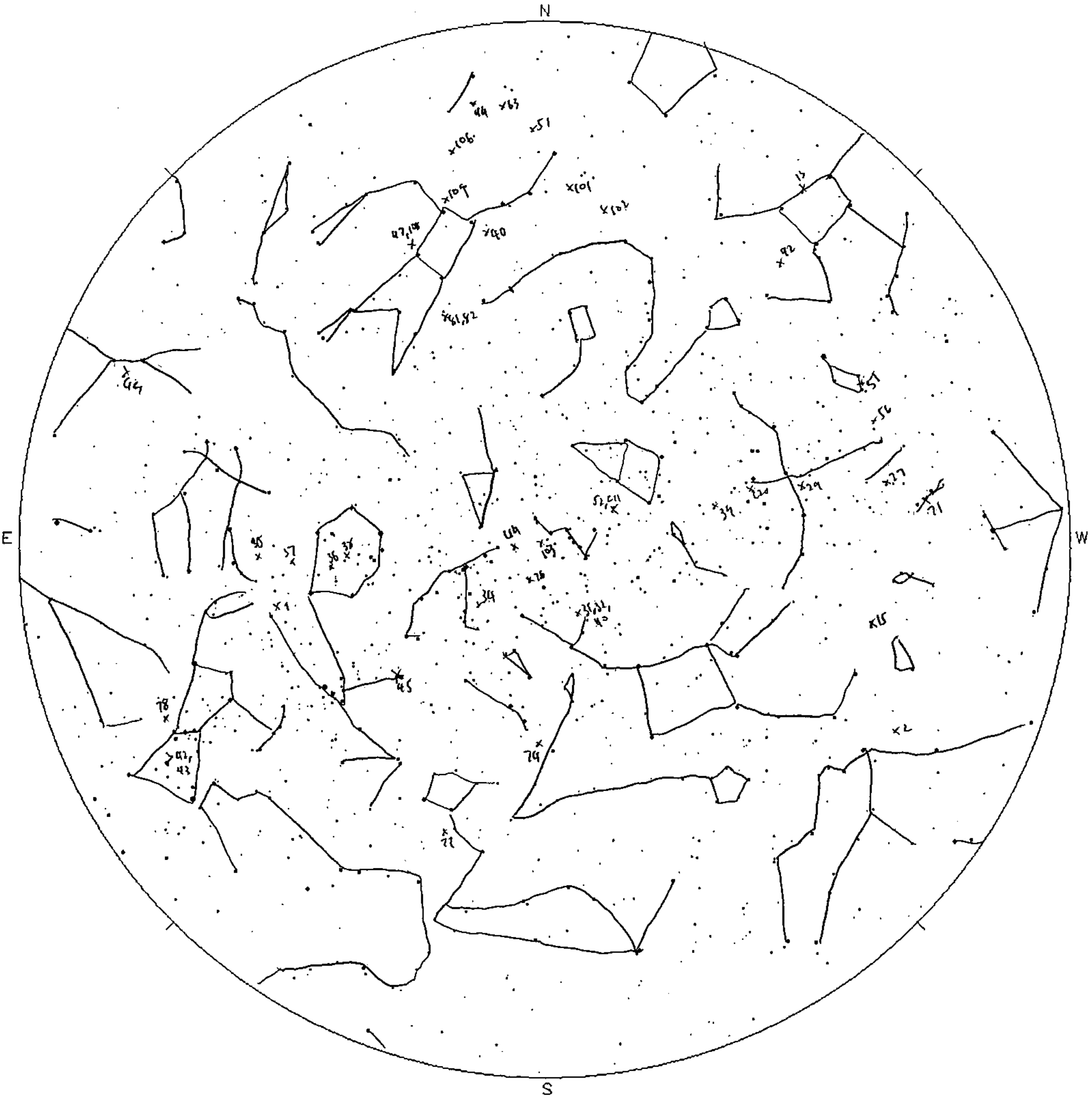
x9
x107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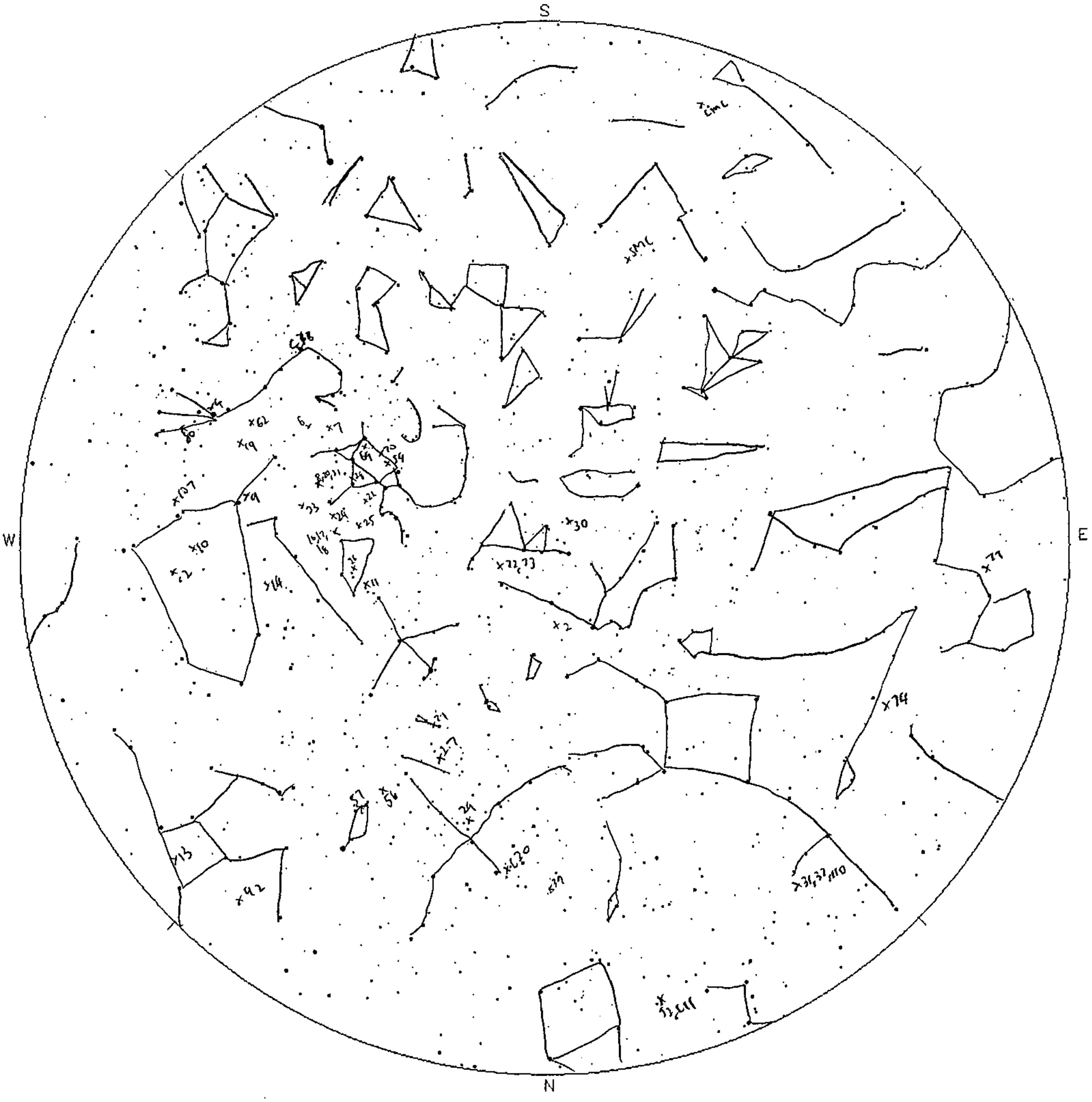
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x SMC
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x10
x62
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x14
x64
x70
x54
x22
x23
x24
x25
16,17,
18
x36
x11
x30
x22,73
x2
x77
x74
x21
x27
57
x56
x24
x120
x39
x13
x92
x31,32,110
x52,511
W
E
N


S
W
E
N
LMC
SMC
C99
C77
C6
68
83
x104
x87
x5
C76
x62
x9
x19
80
x107
x10
x12
x14
15
20
58
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x2
8,10,21
x22
x23
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28
x11
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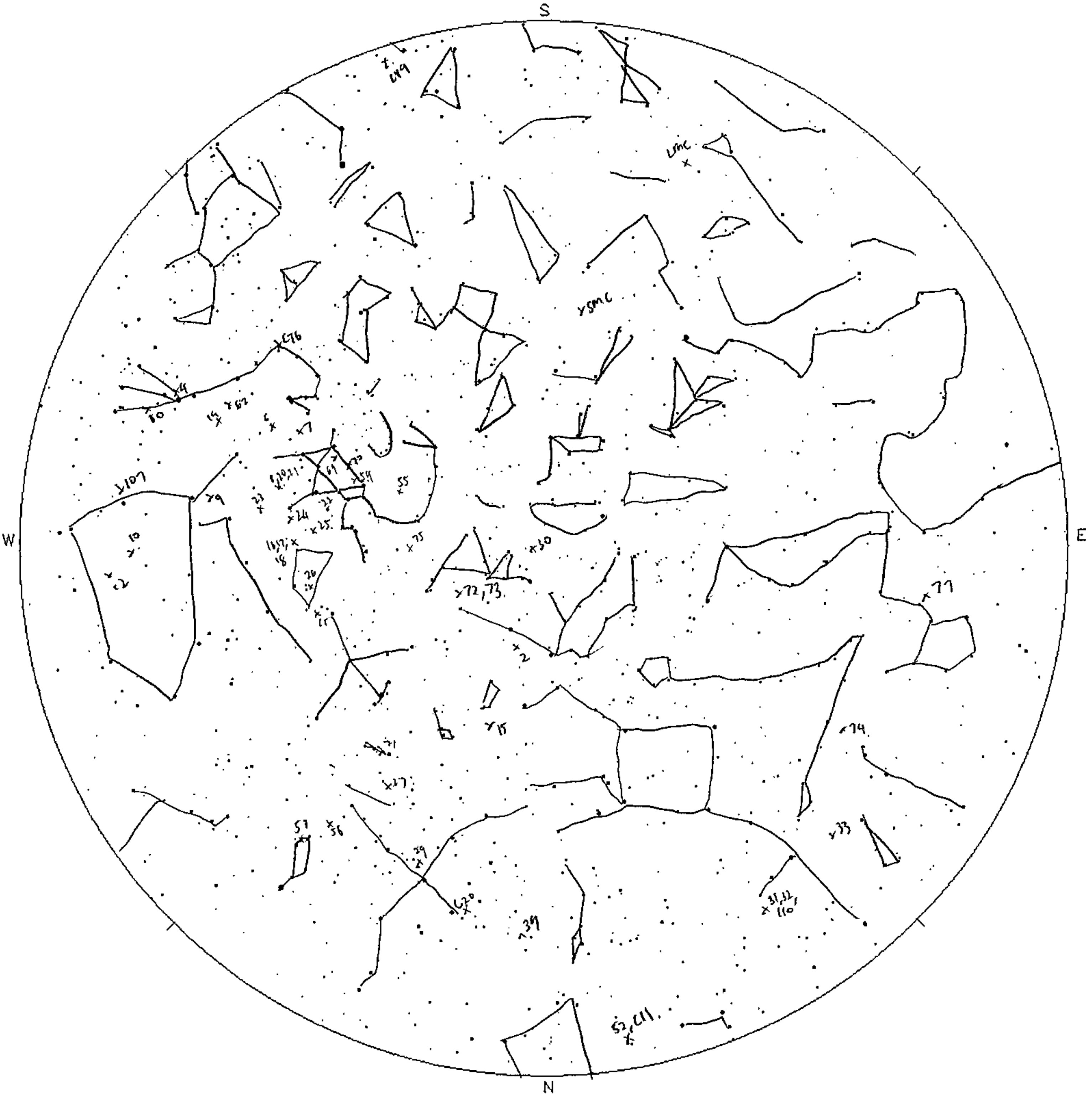
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SMC
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C76
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15
62
6
7
107
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23
8,20,21
69
70
59
55
24
22
25
10
C2
16,17,18
26
C11
75
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74
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27
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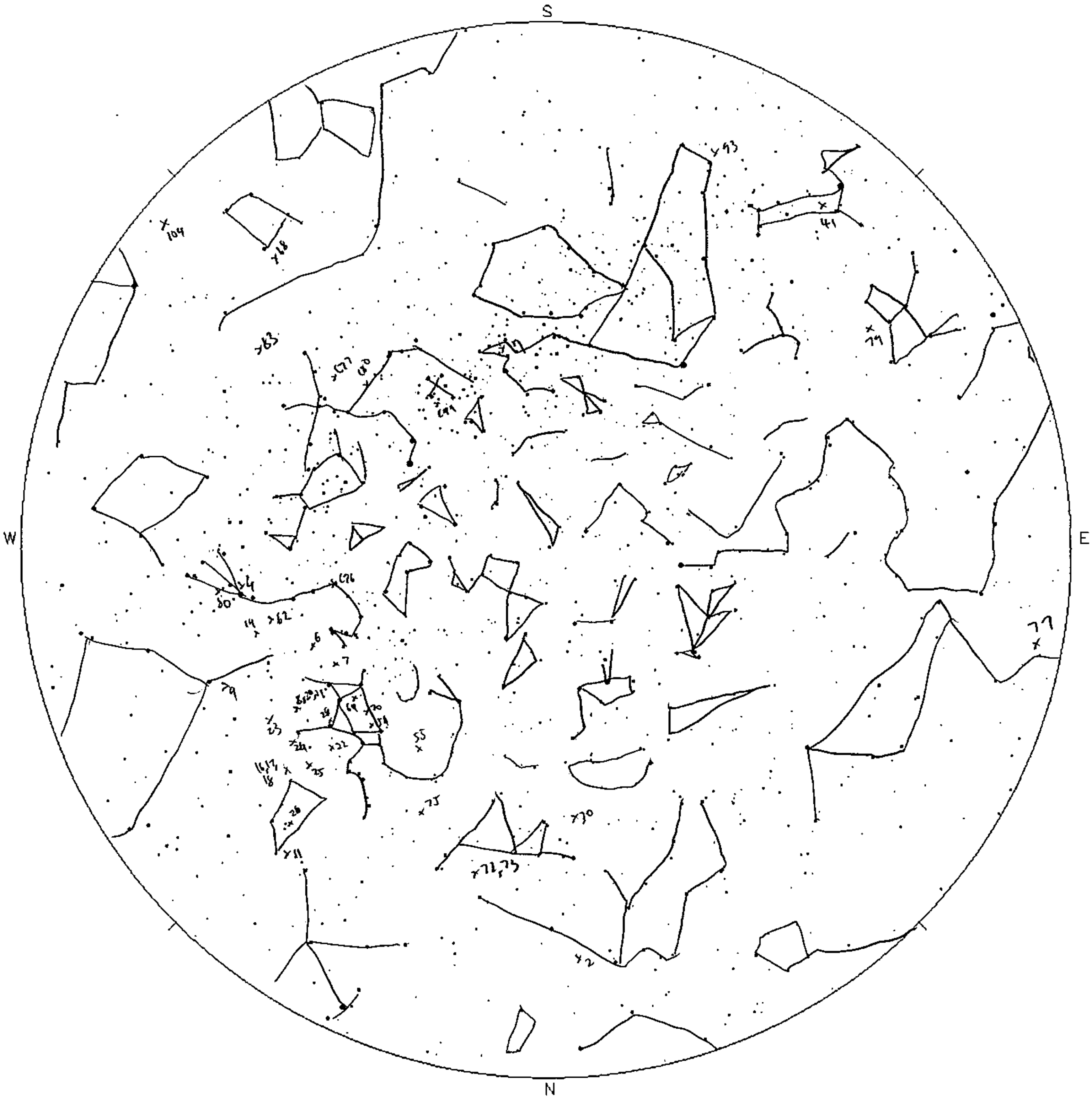
31,32,110
52,C11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E
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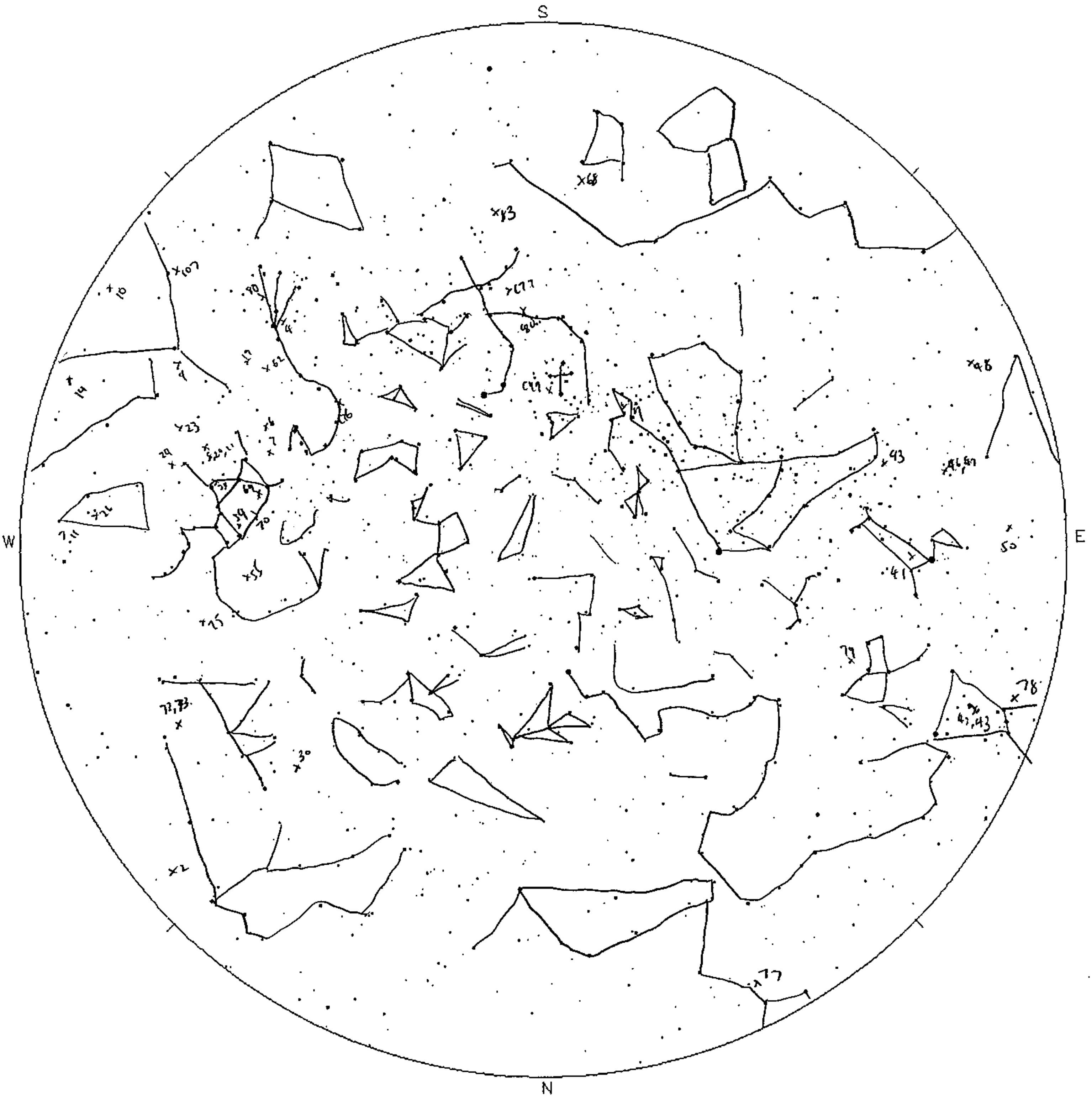
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x107
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x23
x43
x48
W
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x25
x30
x2
x77
x78
41
50
E
N


S
W
E
N
SMC
LMC
7
6
C76
4
80
C77
C80
λ
η
79
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83
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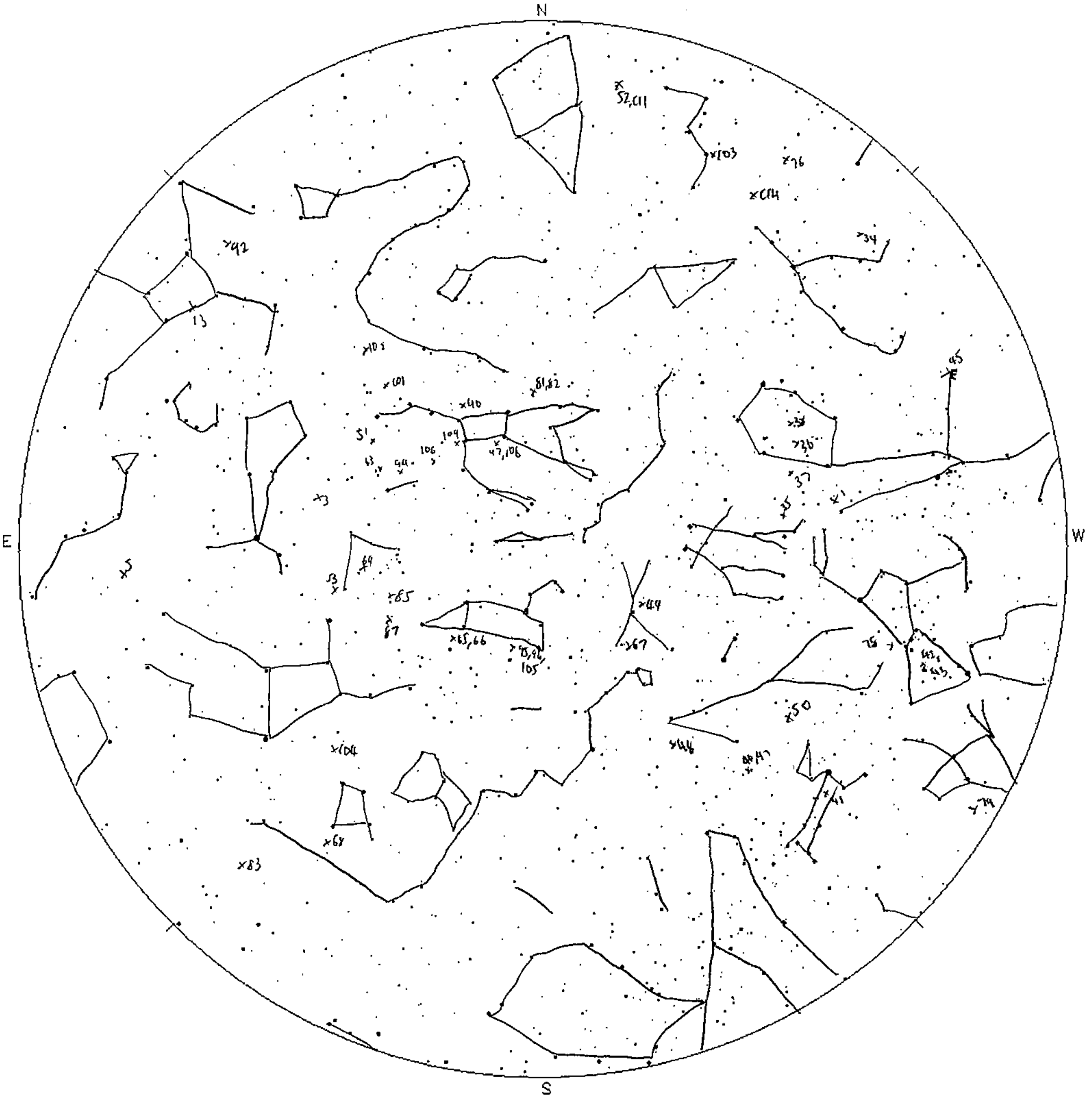
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95,96,105
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267
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75
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50
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48,49
41
79
104
68
83


S
x44
x83
x127
150
x 149
x126
x4
80
19 x
x62
6 x
x107
x7
8,13,21 x
69
70
x54
79
x23
x24
x22
11,17,x
18
x25
x10
12
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x30
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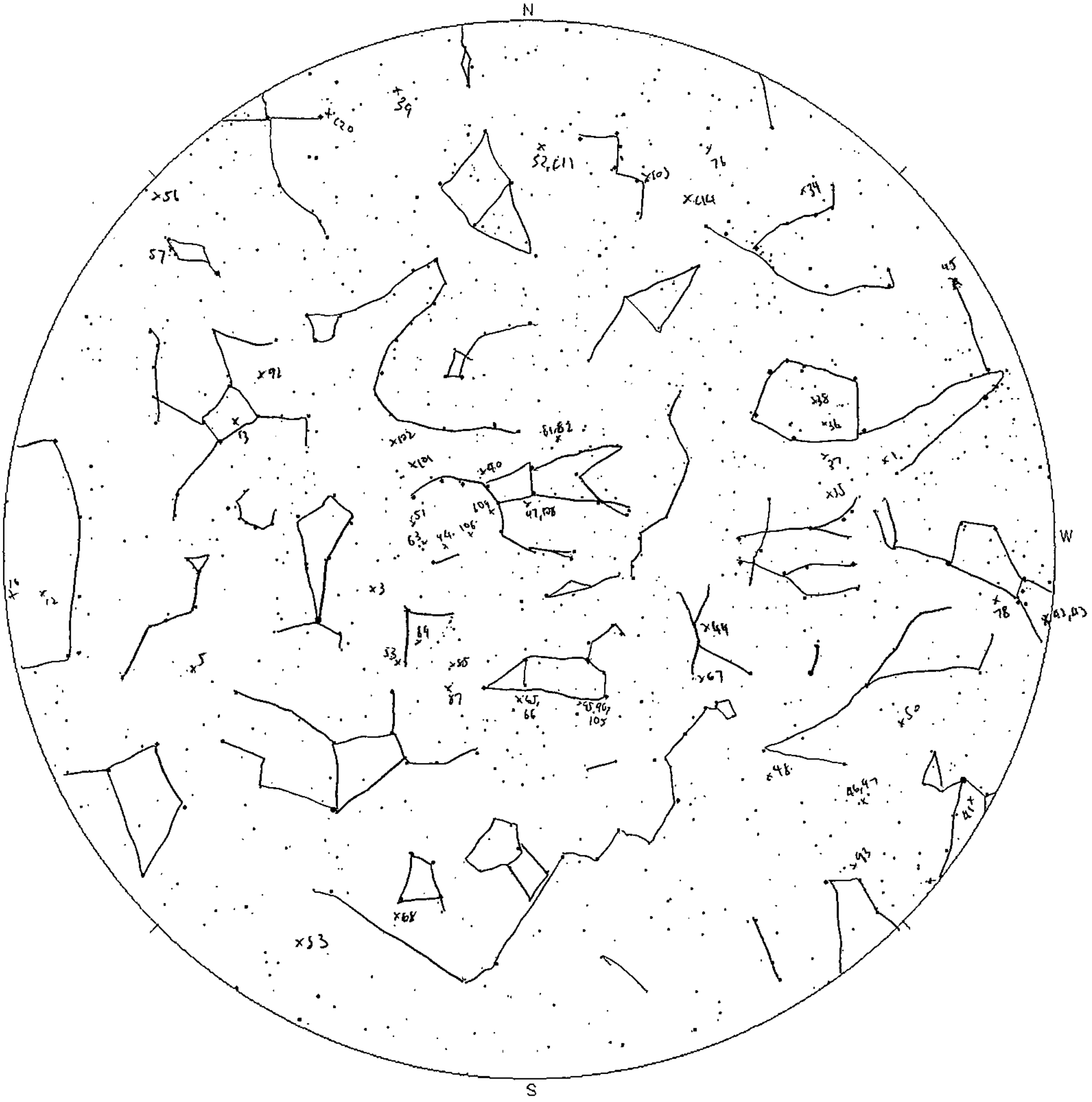
E
N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x38
x36
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x101
x90
x37
x1
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47,108
x35
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63
44
108
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W
16
x12
x3
84
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x55
x44
x5
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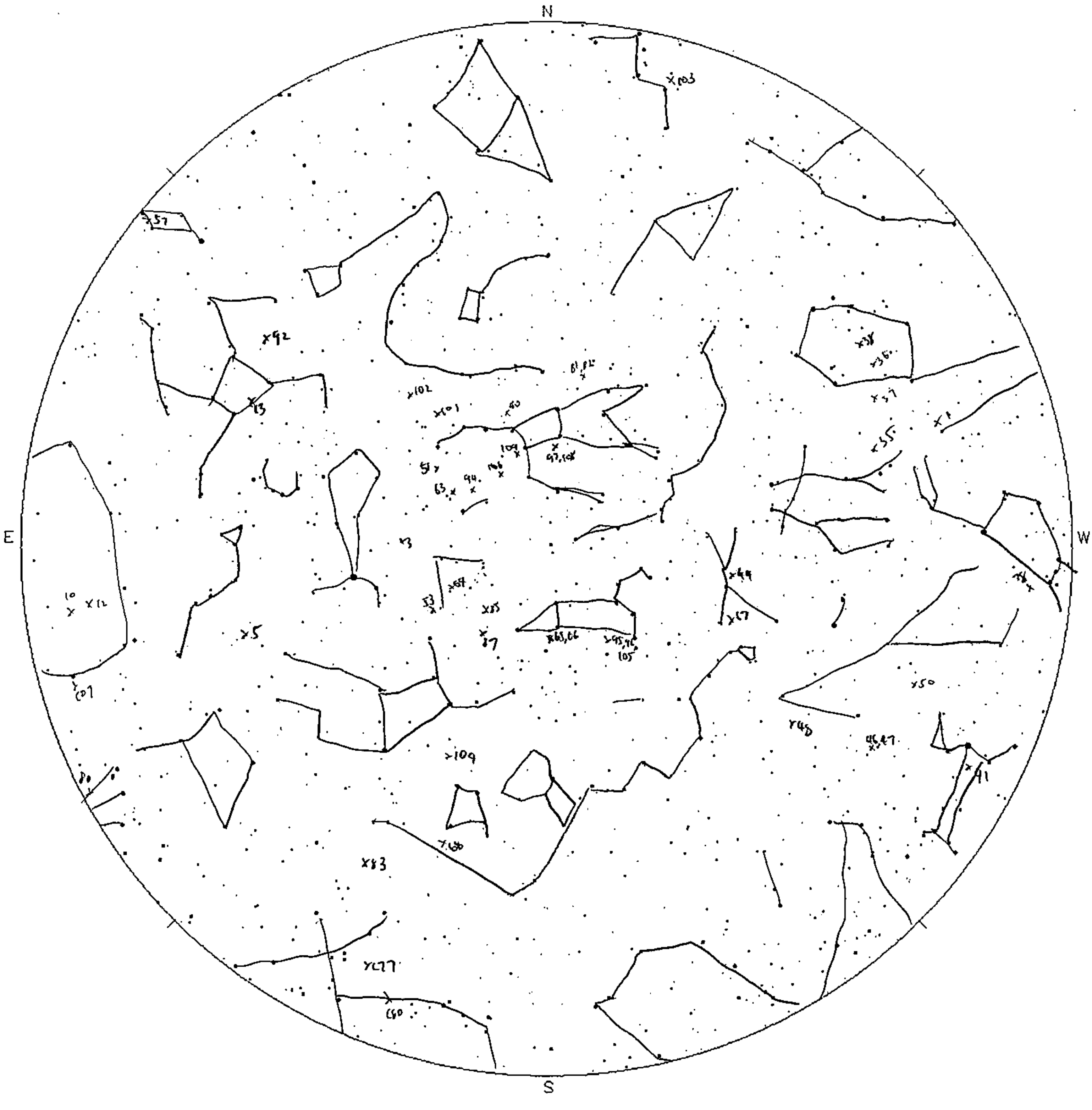
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94
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3
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x85
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x95,96
105
x44
x67
E
W
10
x12
x5
39
107
x50
x48
45,47
x41
x109
80
x86
x83
x77
150
S


S
W
E
N
x83
xC77
C80
x
C49
x71
LMC
x
x71
SMC
x8
x
80
C76
x107
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x62
6
x7
x9
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x23
x64
x73
x54
x55
x12
x10
x24
x22
10,17,
18
x25
x14
x26
x
11
x75
x30
x72,73
x2
x77
x21
x15


N
E
W
S
94
63
51
106
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111
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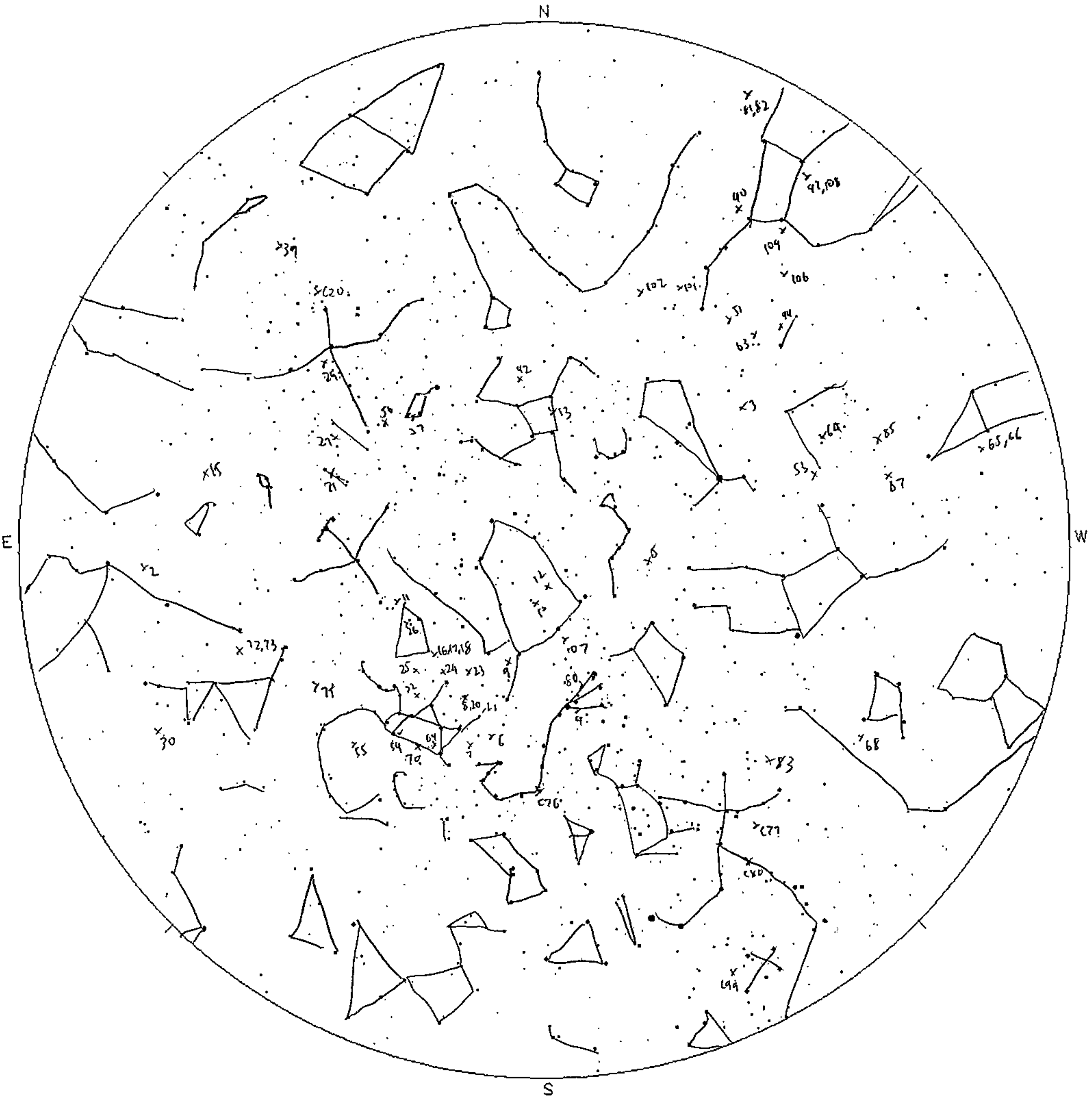
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C20
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13
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37
27
21
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69
85
65,66
53
67
8
12
13
11
36
16,17,18
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72,73
74
107
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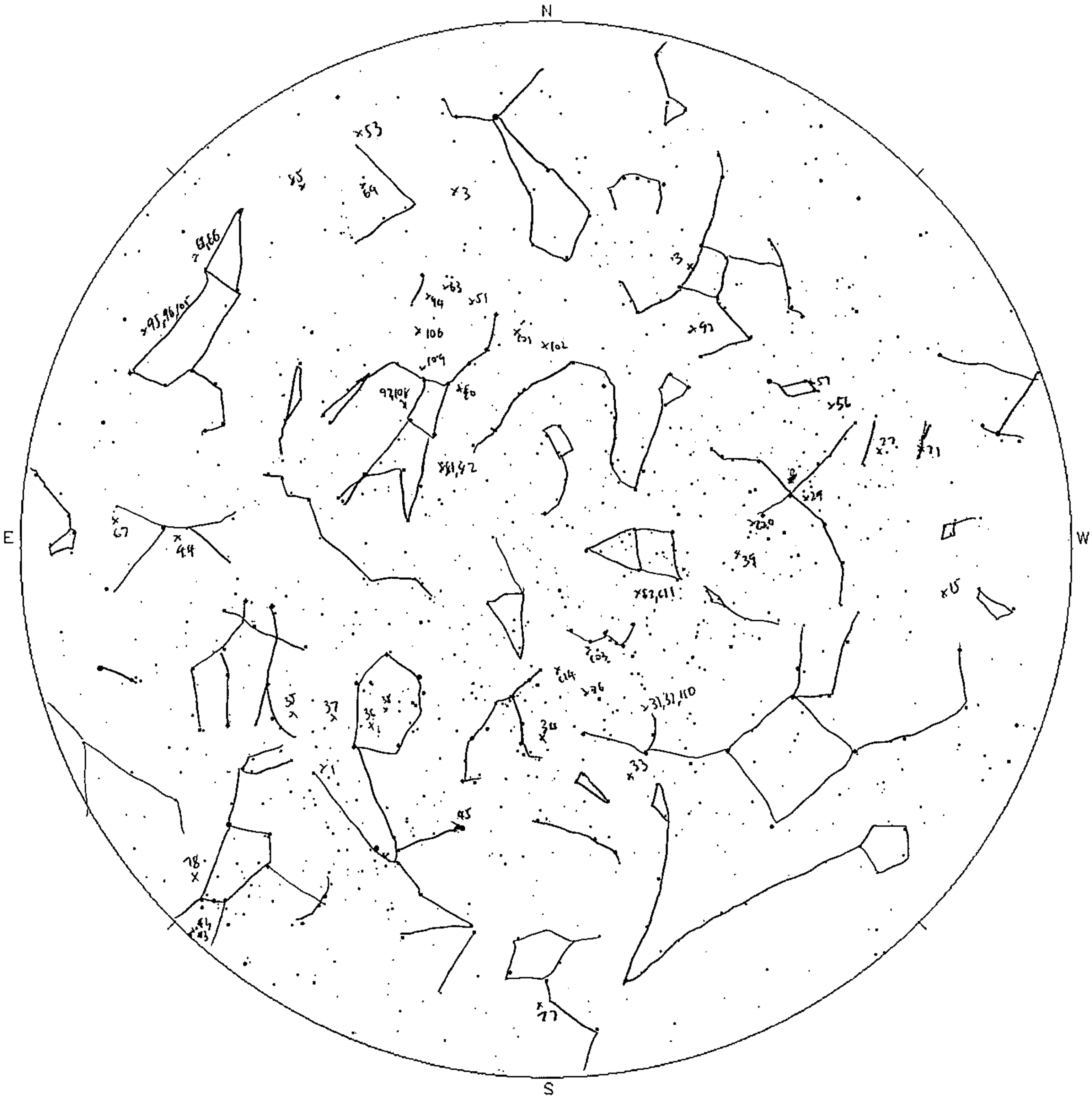
83
C77
C80
C99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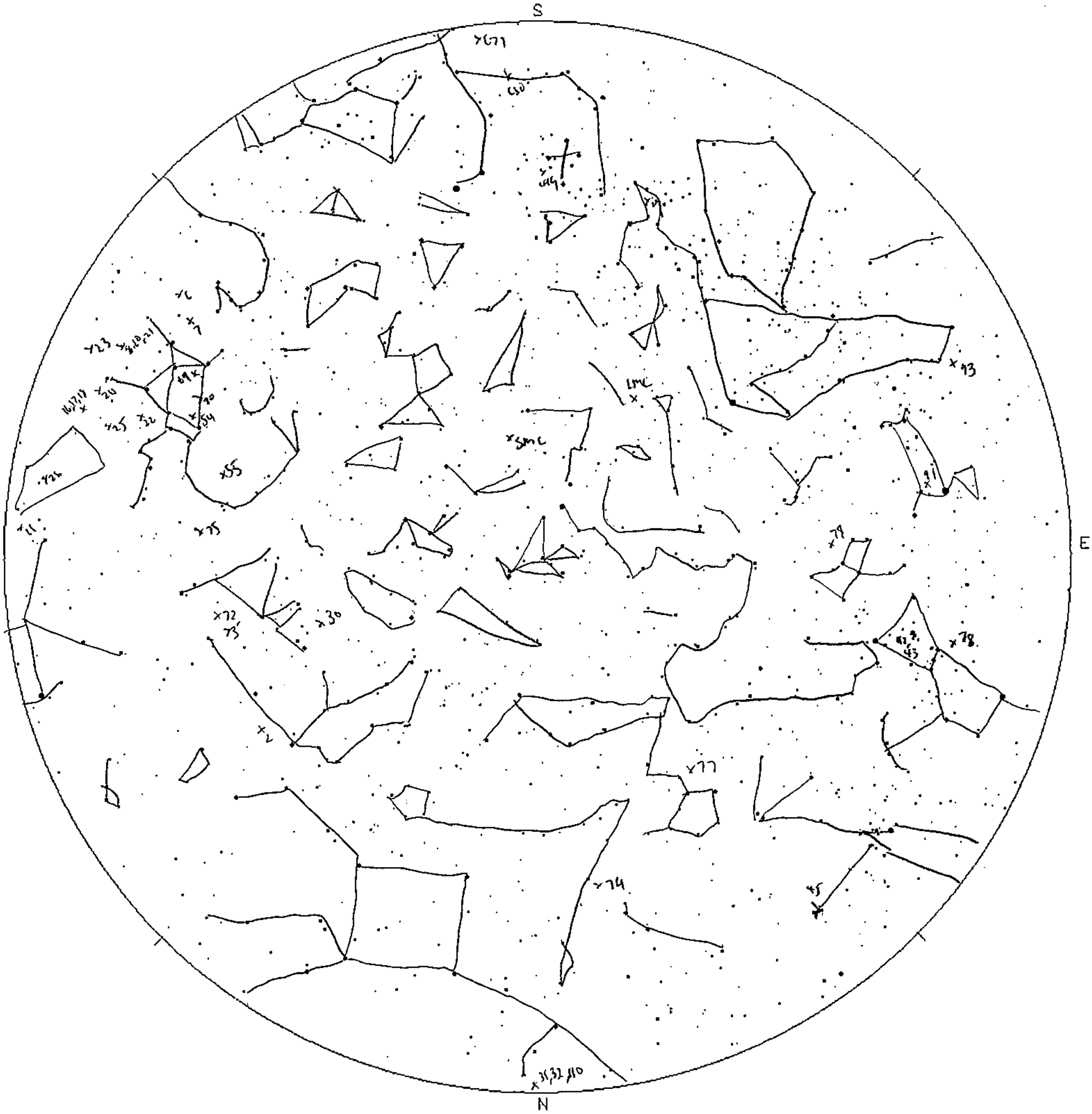
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x7
x23
x8,10,21
x20
16,17,19 x
x25
x22
x89
x90
x54
x26
x55
x11
x35
W
LMC x
x SMC
x93
x91
x79
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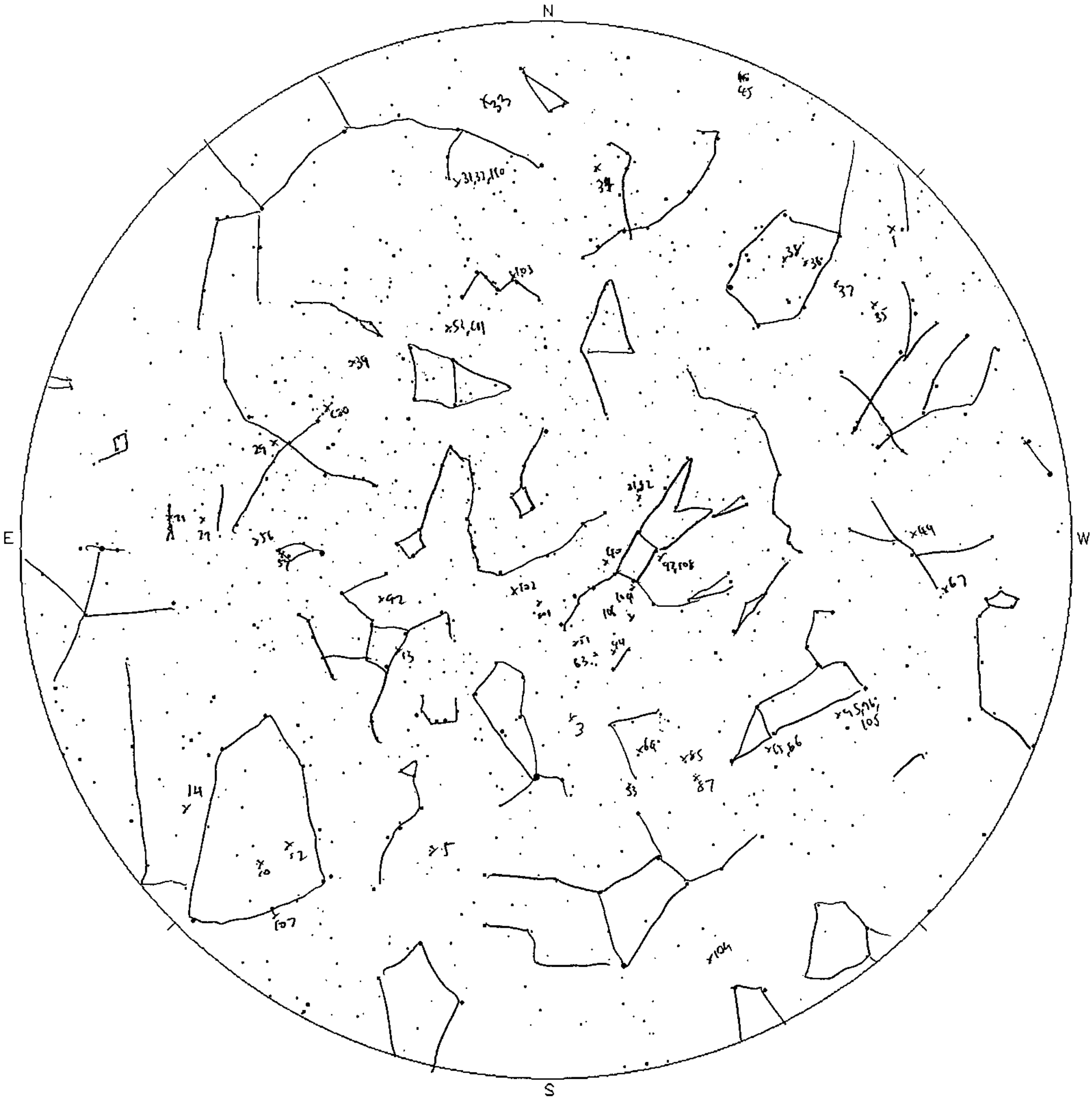
x74
x5
x 31,32,110
N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E
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51,101
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C20
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101
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51
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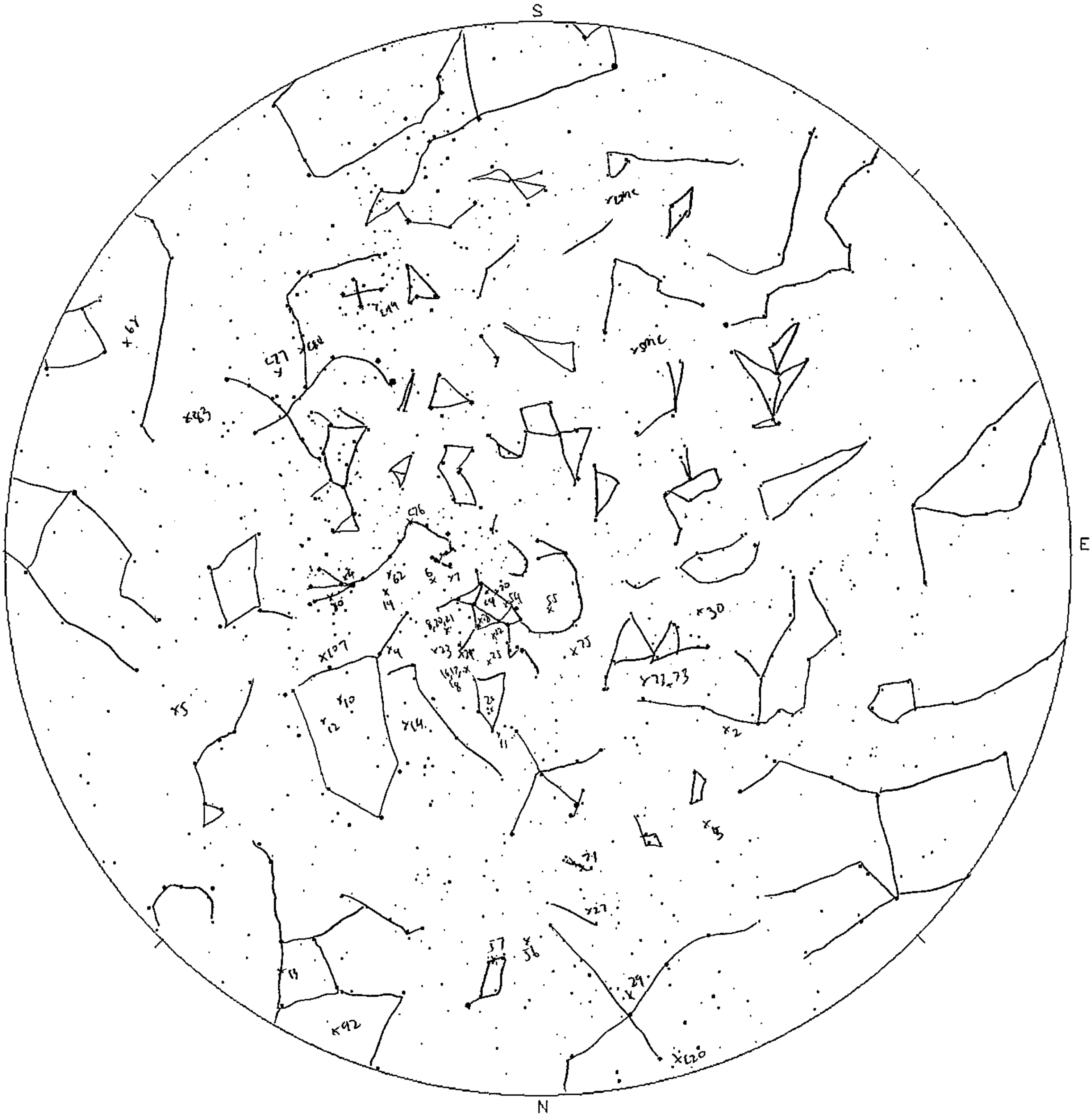
104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W
E
N
x 6Y
C77 x
x C88
x83
C249
x5
x NGC
x NGC
C76
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x 62
x 14
6 x
x 7
70
54
C4
55 x
x 50
8, 20, 21 x
x 12
x 23
x 24
x 25
x 75
x 107
x 9
16, 17, x 18
23
x 11
x 10
x 12
x 14
x 30
x 72, 73
x 2
x 15
31
x 27
57
x 56
x 29
x 120
x 13
x 92


N
x103
x52,61
x39
x120
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x71
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57
x81,82
x92
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x101
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x10
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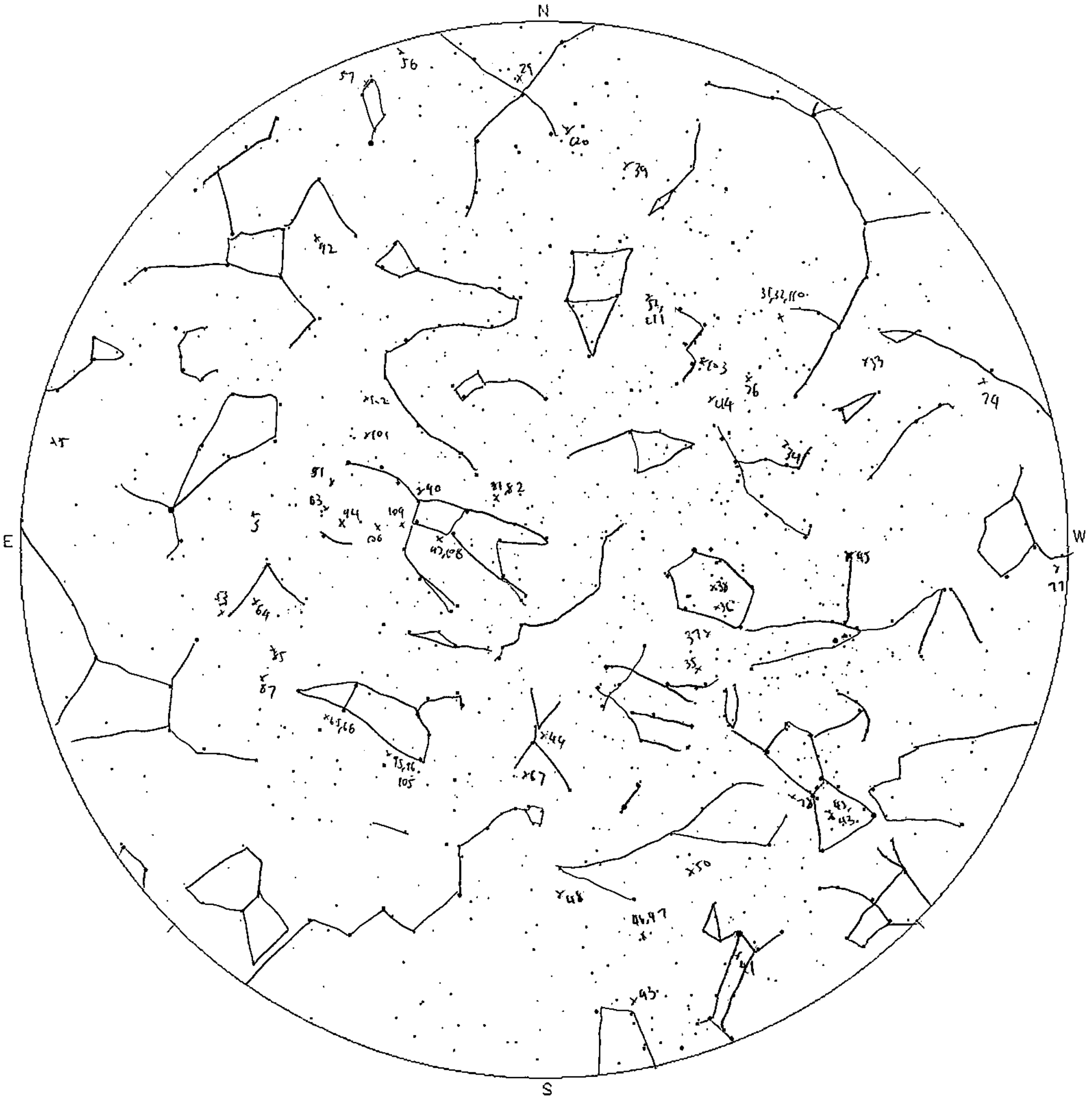
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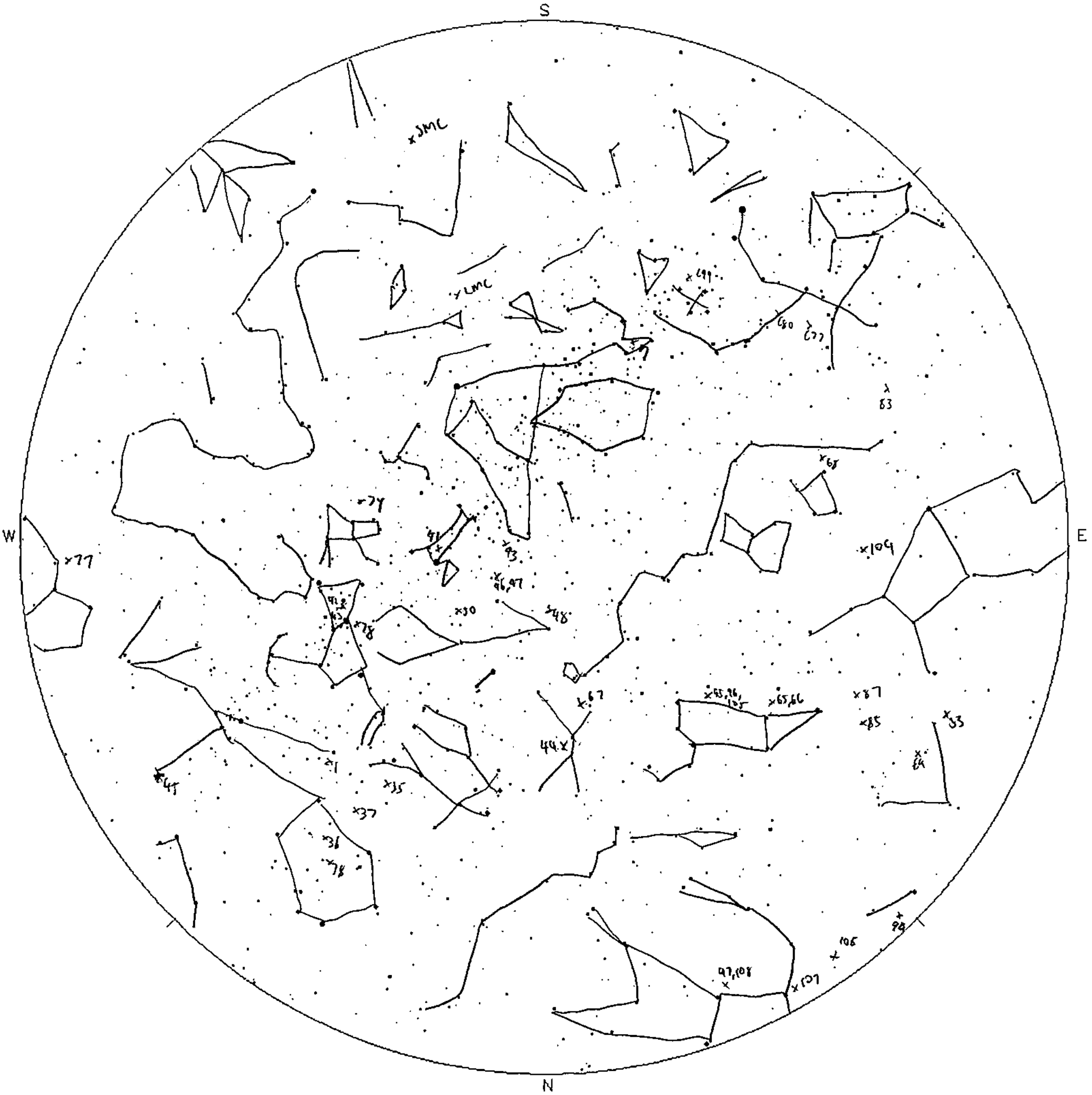
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LMC
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107
97,108


S
W
E
N
42, 43
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SMC
C99
C80
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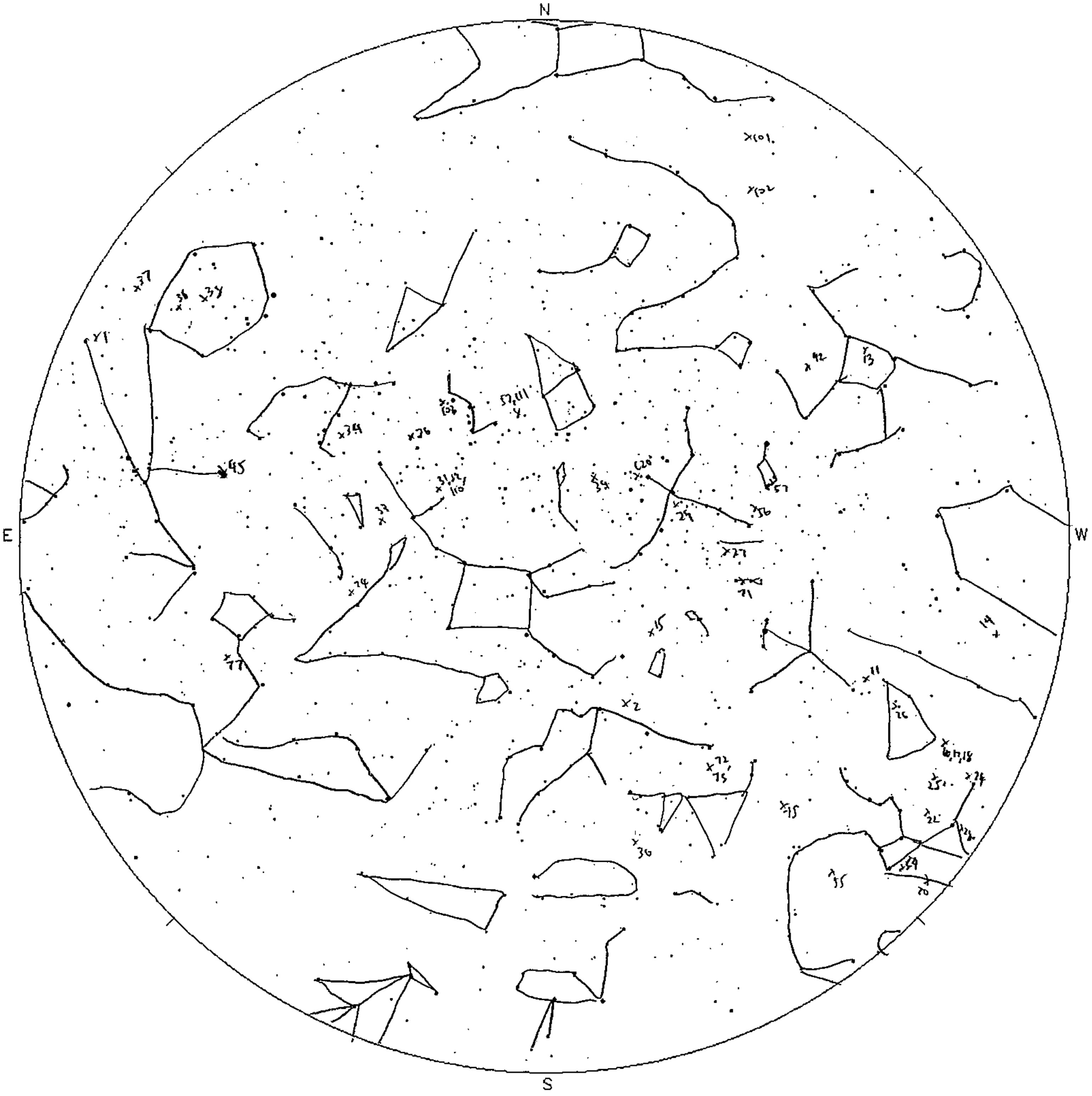
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x34
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x26
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x74
x77
x15
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x15
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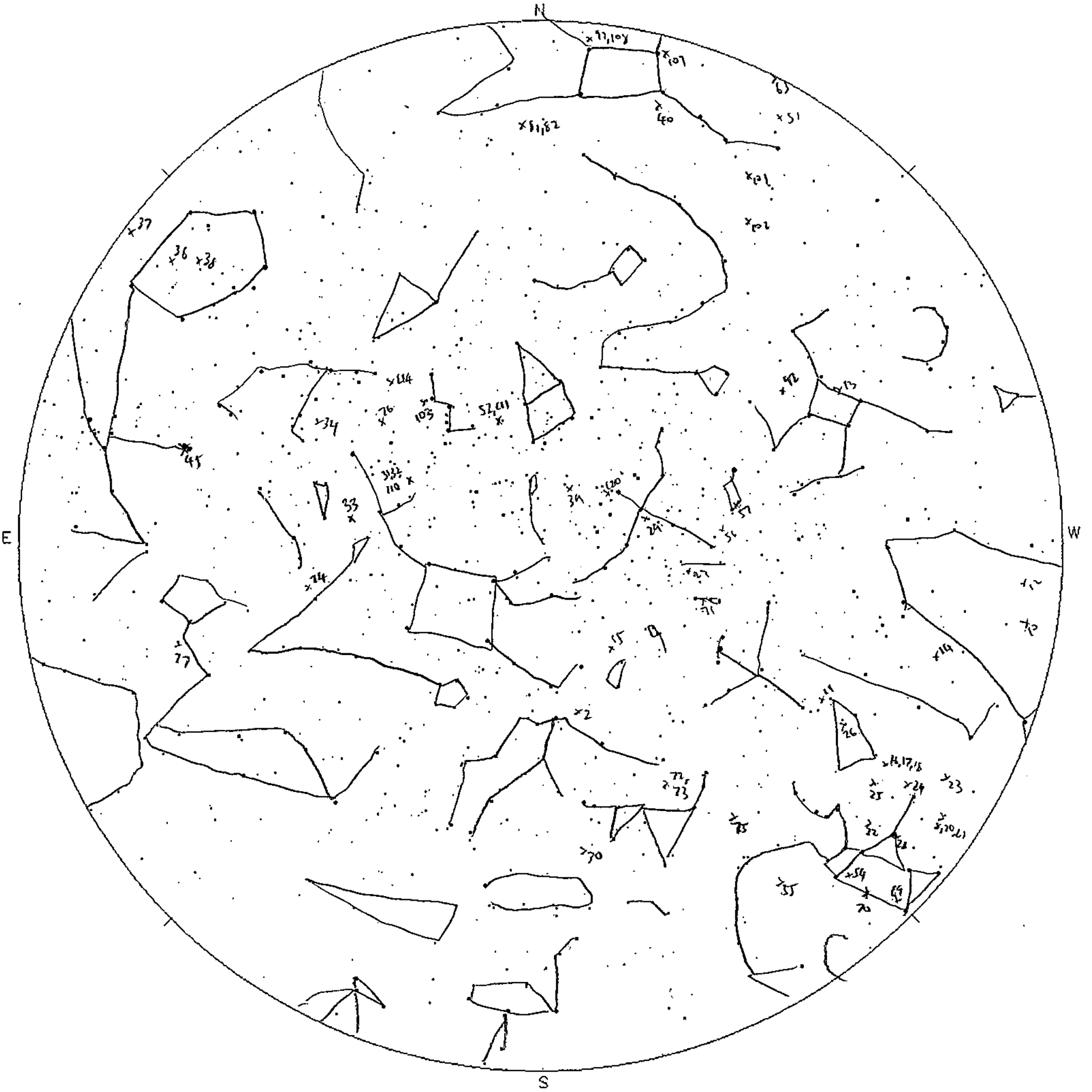
59
70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E
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72,73
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3,20,21
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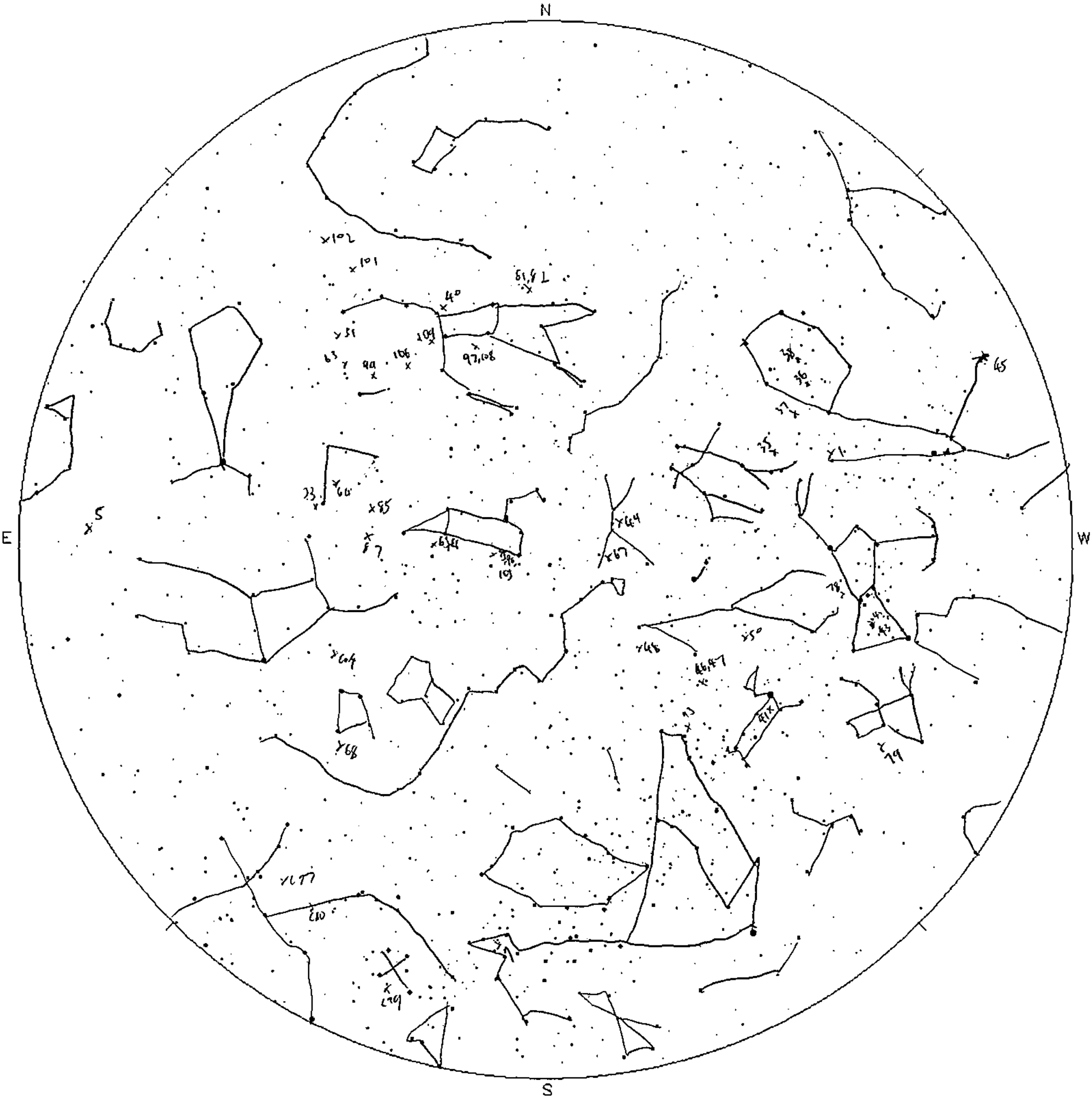
35
70
69
S


N
E
W
S
x102
x101
61,81 T
x40
x51
63 x
99 x
106 x
109 x
x 97,108
33 x
x66
x85
x 87
x63,88
x98,103
x64
x67
x5
x64
x68
x48
x50
x46,47
x43
41x
x38
x36
37x
35x
x1
65
78x
44x
43
x79
x177
x110
x179


N
E
W
S
37
36
38
1
45
44
10
32, 11
76
34
31, 32, 110
33
74
39
120
29
57
56
27
21
42
13
15
2
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26
16, 17, 18
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64
70
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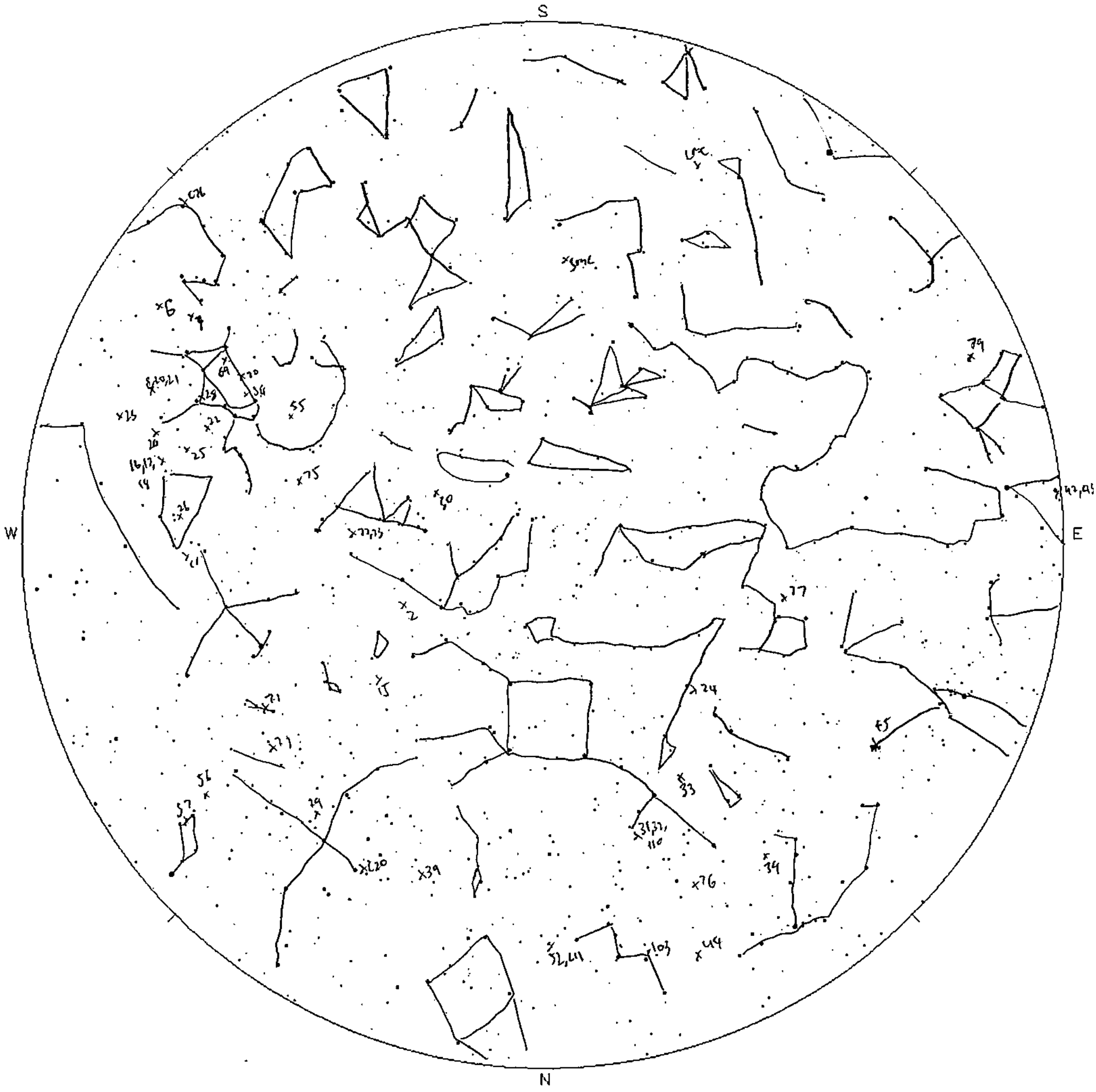
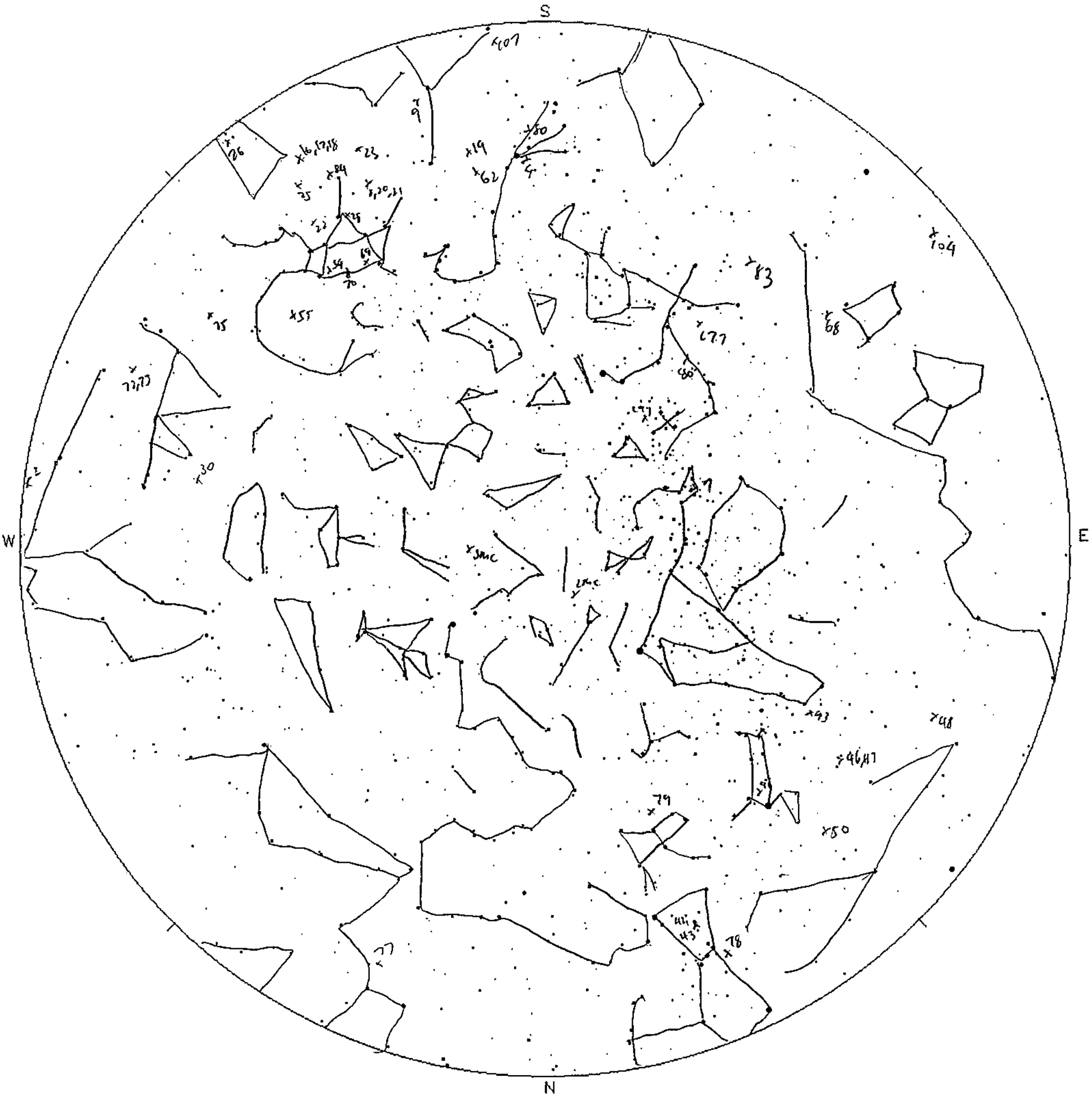
72, 73
75
30
77


S
W
E
N
C76
x6
x9
x20,21
x69
x70
x36
x28
x35
x22
x26
x25
16,17,
14
x55
x75
x36
x11
LMC
SMC
x80
x77,73
x2
x15
x71
x71
56
57
29
x120
x39
x24
x77
x79
x42,45
x33
x31,32,
110
x76
x34
x65
x52,41
x103
x44


S
107
9
80
19
62
4
26
16,17,18
23
84
25
3,20,21
22
25
34
69
70
55
75
83
104
68
177
80
47
7
72,73
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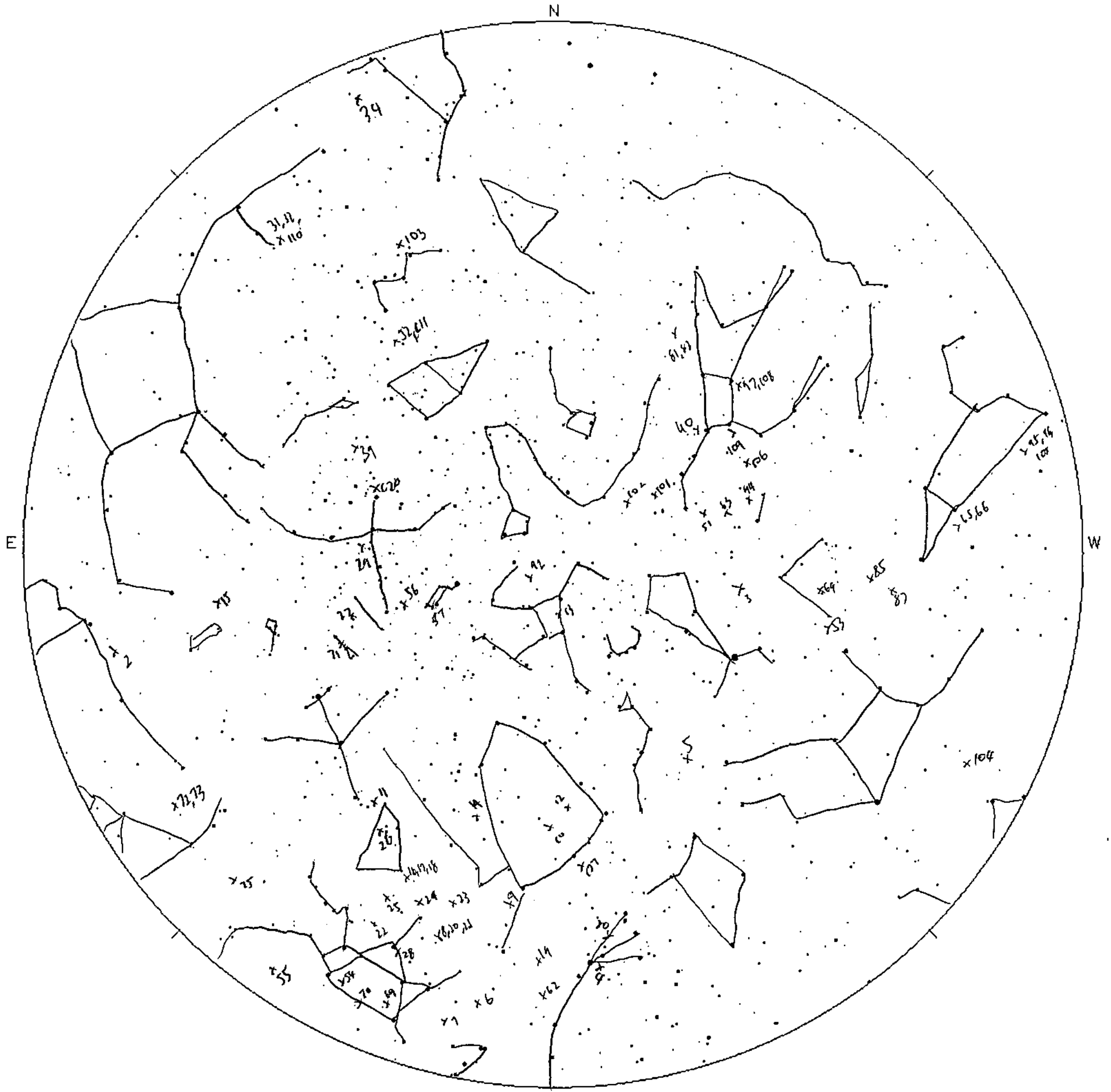
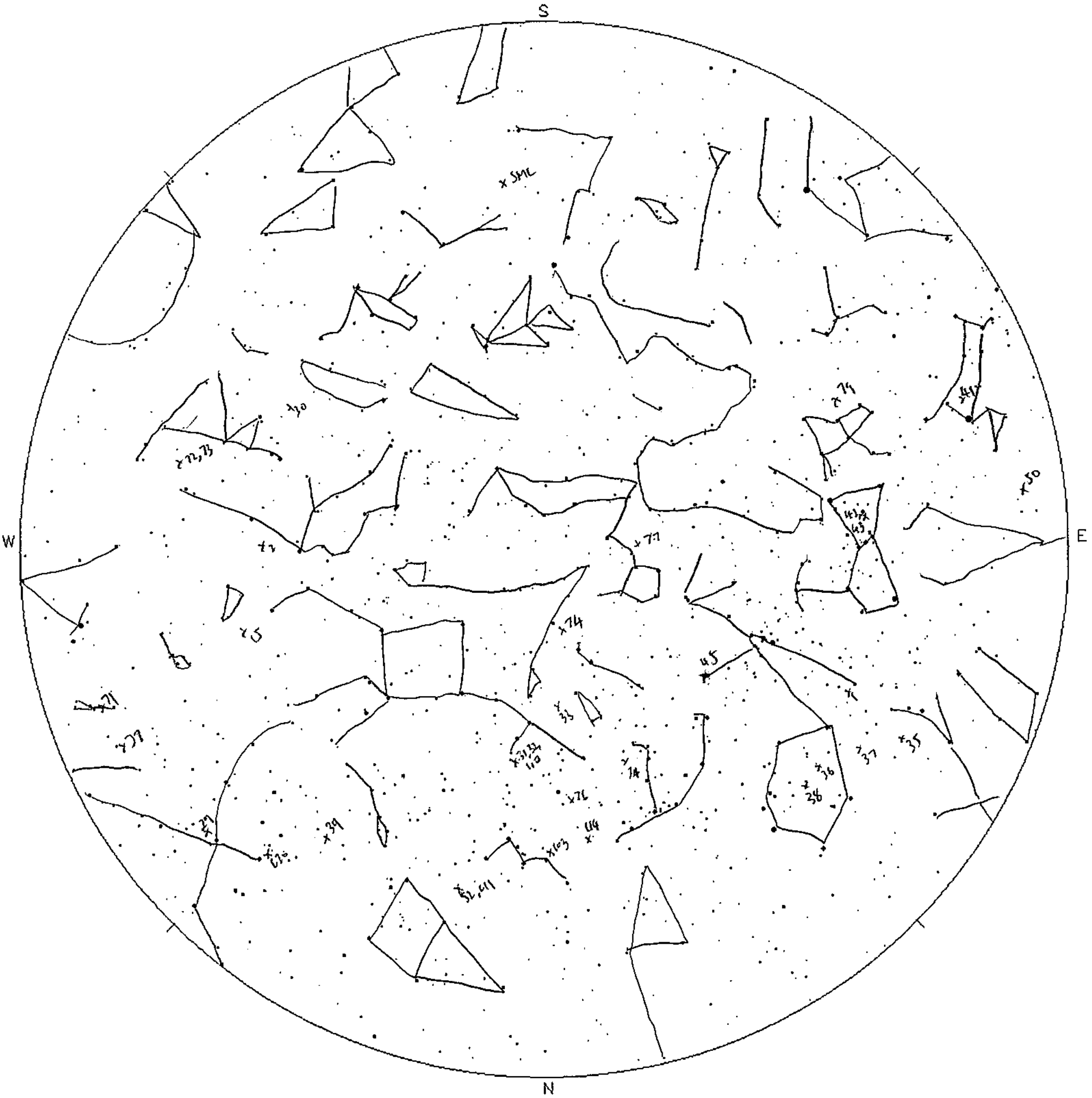
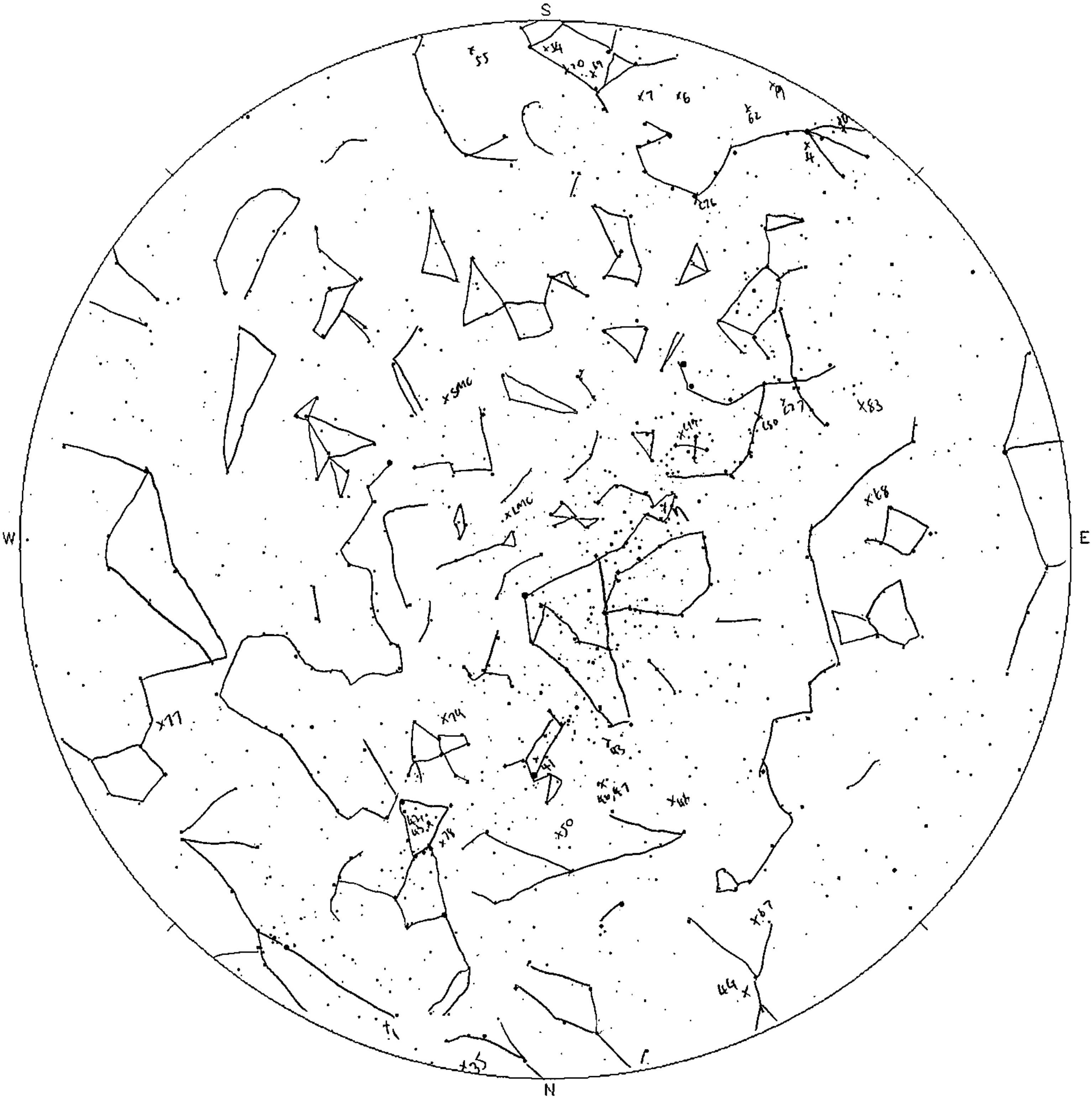
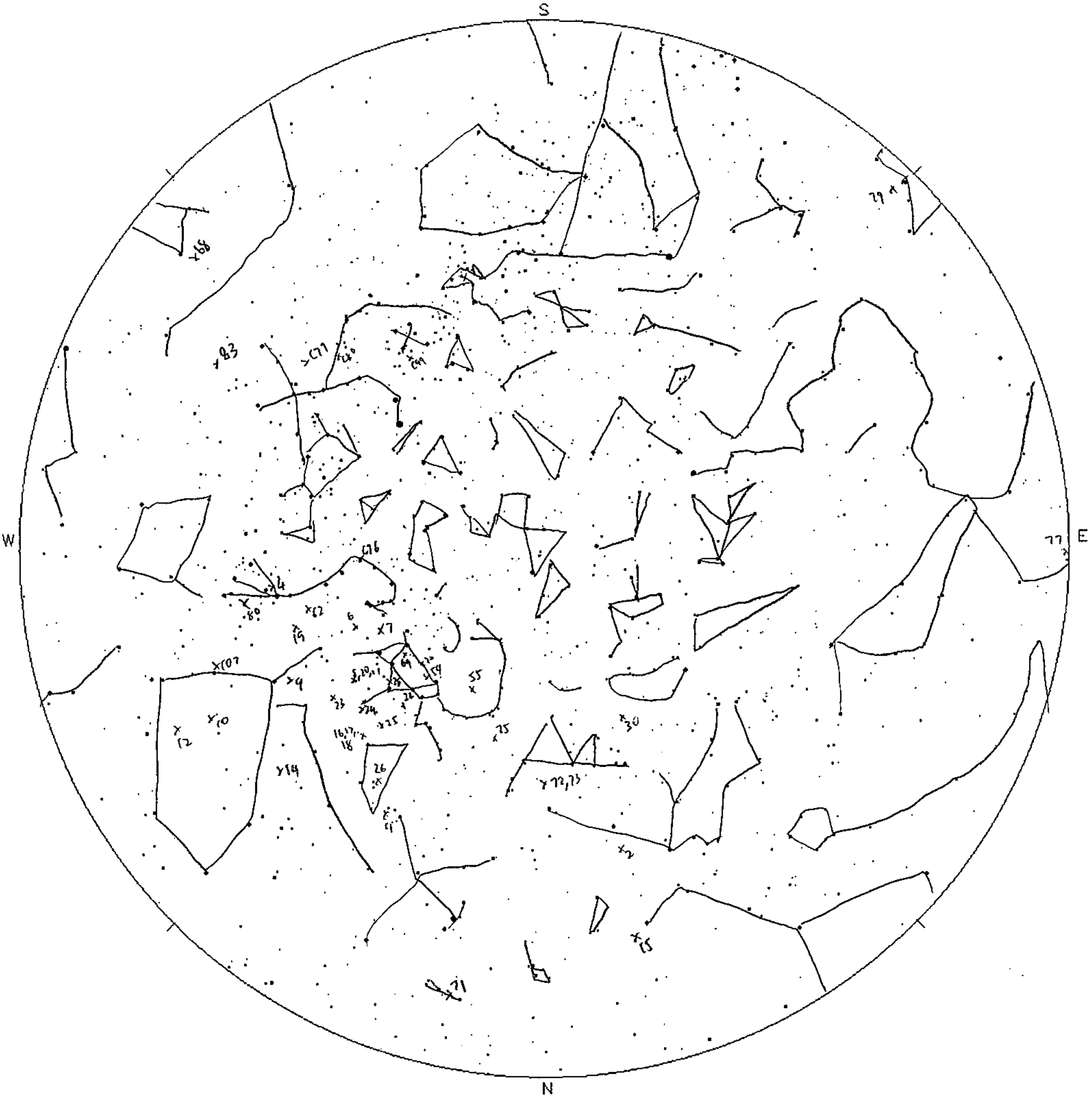
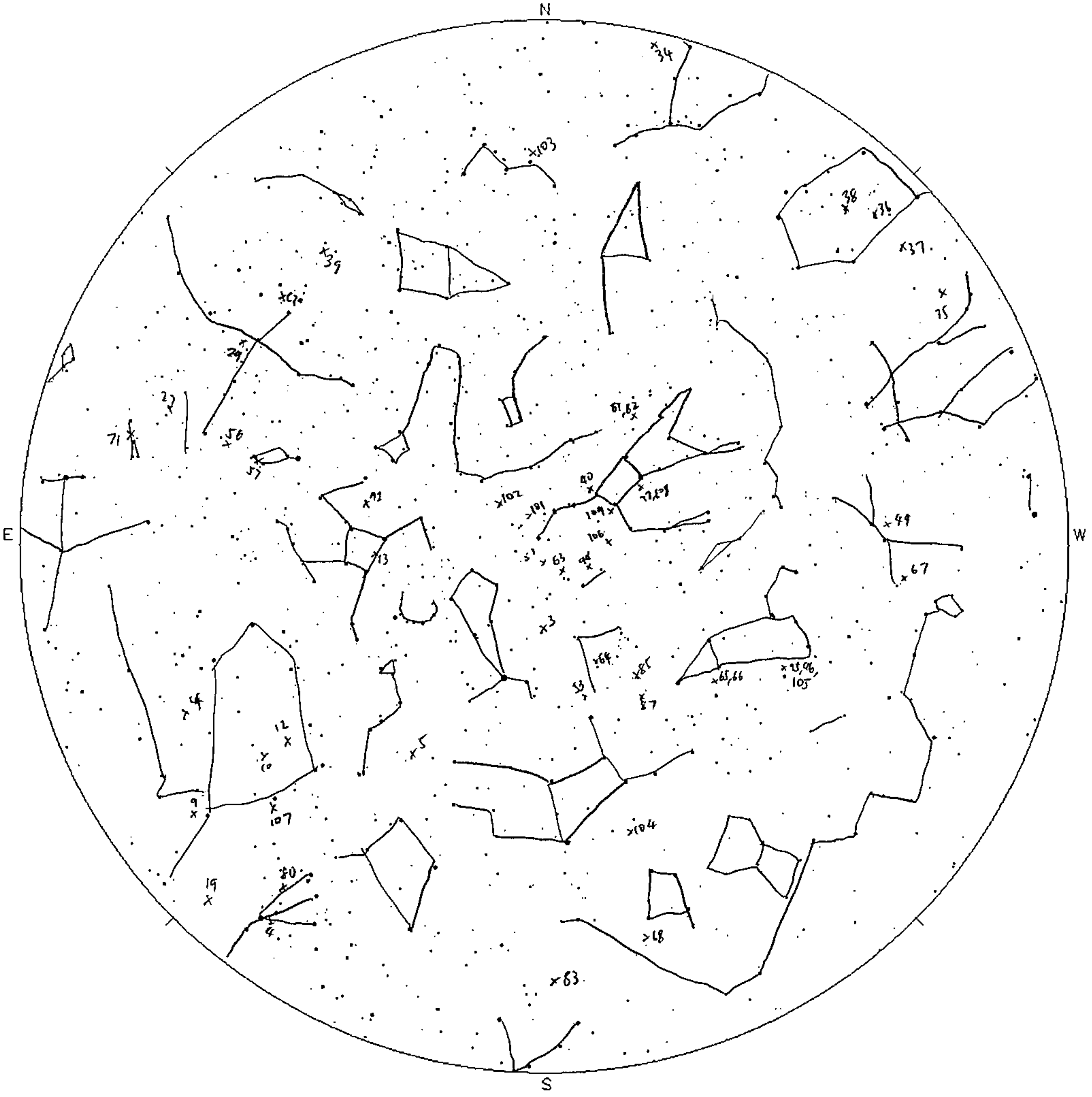
K2
W
E
SMC
LMC
43
48
46,47
79
50
41
43
78
77
N

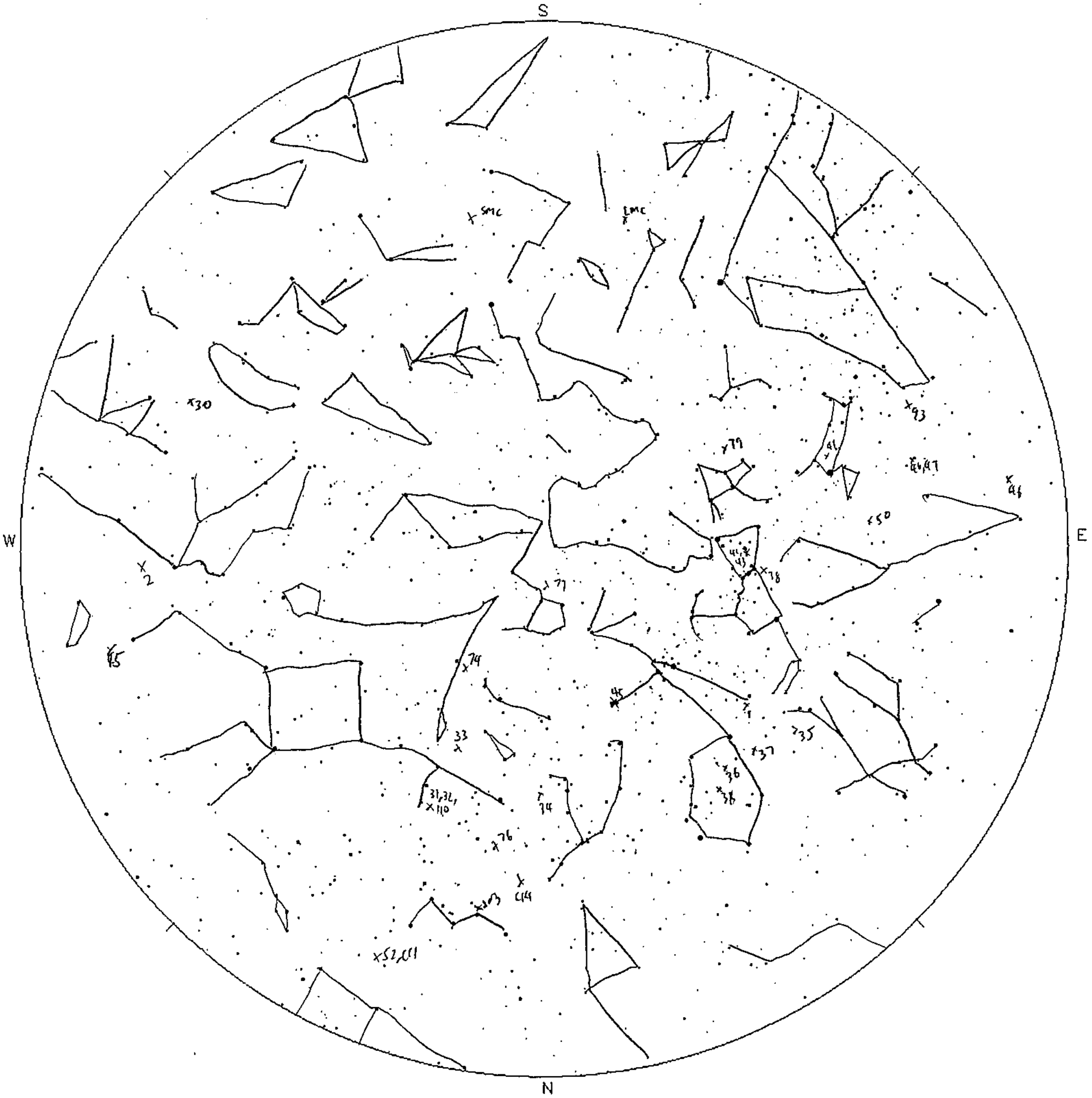

N
E
W
S
34
31,32,
x110
x103
x32,&11
61,41
x97,108
40
109
x106
x39
x62,70
x102
x101
51
63
44
x95,96,
100
x65,66
29
x92
x56
57
13
x3
x69
x85
87
x53
x15
27
71
x2
5
x104
x72,73
x11
26
x16,17,18
14
12
60
x107
x35
25
x24
x23
x9
22
x8,10,21
28
x55
x54
70
x69
x7
x6
x19
x62
20
4


S
x SMC
x 30
x 72,73
x 2
x 79
x 41
x 50
W
E
x 77
x 5
x 74
45
x 4
x 71
x 77
x 33
x 31,32,110
x 14
x 76
x 36
x 34
x 37
x 35
27
x 39
x E20
114
x 103
x 52,111
N


S
x55
x34
x20
x19
x7
x6
x79
x62
x10
x4
C76
W
E
xSMC
xLMC
x49
C50
C77
x83
x68
x77
x74
x41
x103
x46,47
x44
x50
x78
x67
44x
x35
N


S
W
E
N
x68
79 x
77
x83
x177
x180
x149
176
4
x 80
x82
19
6 x
x7
x107
x9
x10
x 12
64
x 59
55 x
x23
x24
x25
x75
x30
16,17, 18
26 x
x84
x 72,73
x 11
x2
x15
x 71

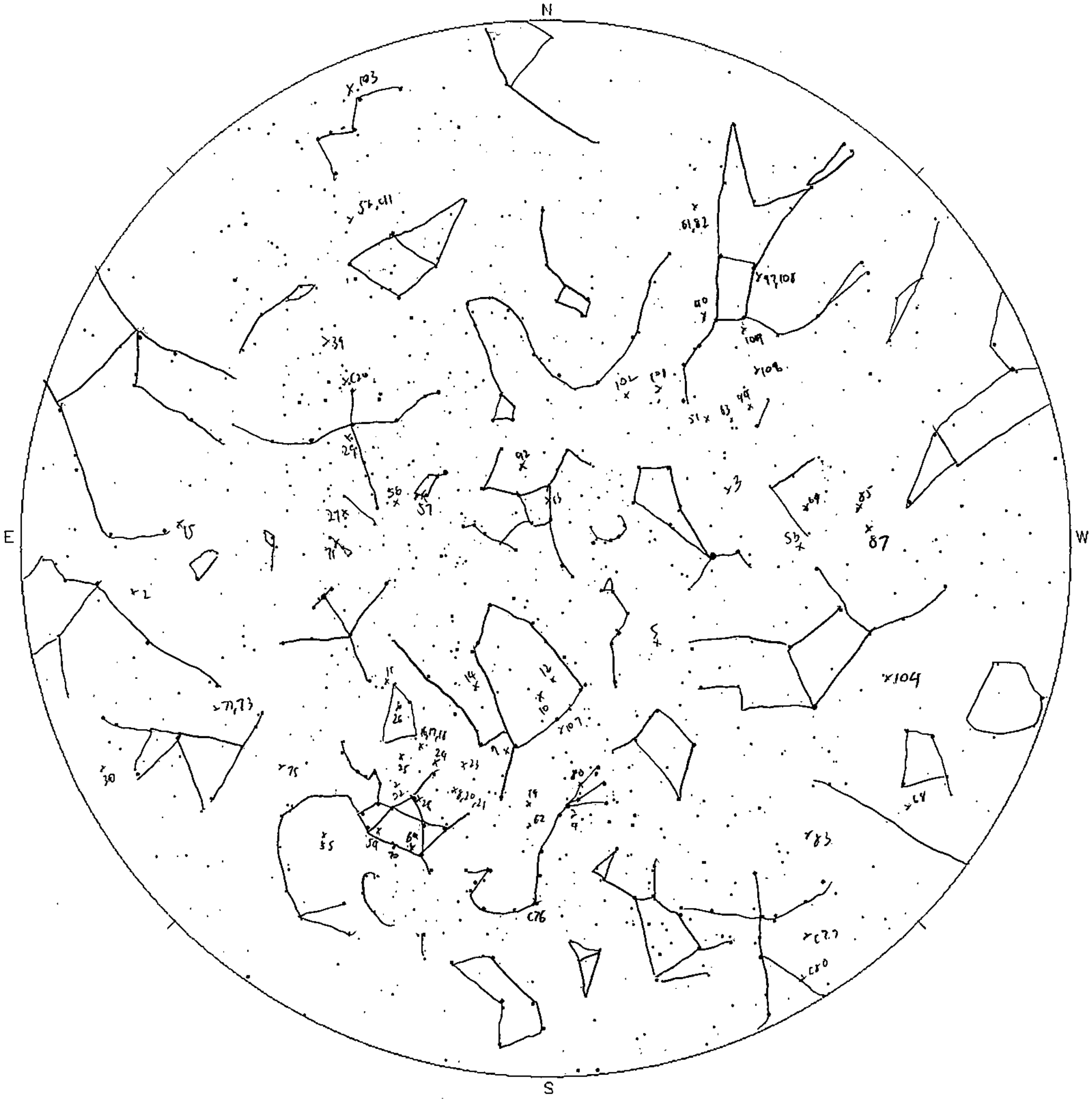

N
34
103
38
36
37
39
70
75
29
27
71
58
57
61, 62
40
72, 78
102
101
109
106
92
E
W
13
49
51
63
98
67
3
64
85
65, 66
25, 96, 105
53
87
14
12
10
5
9
107
104
19
80
4
68
83
S

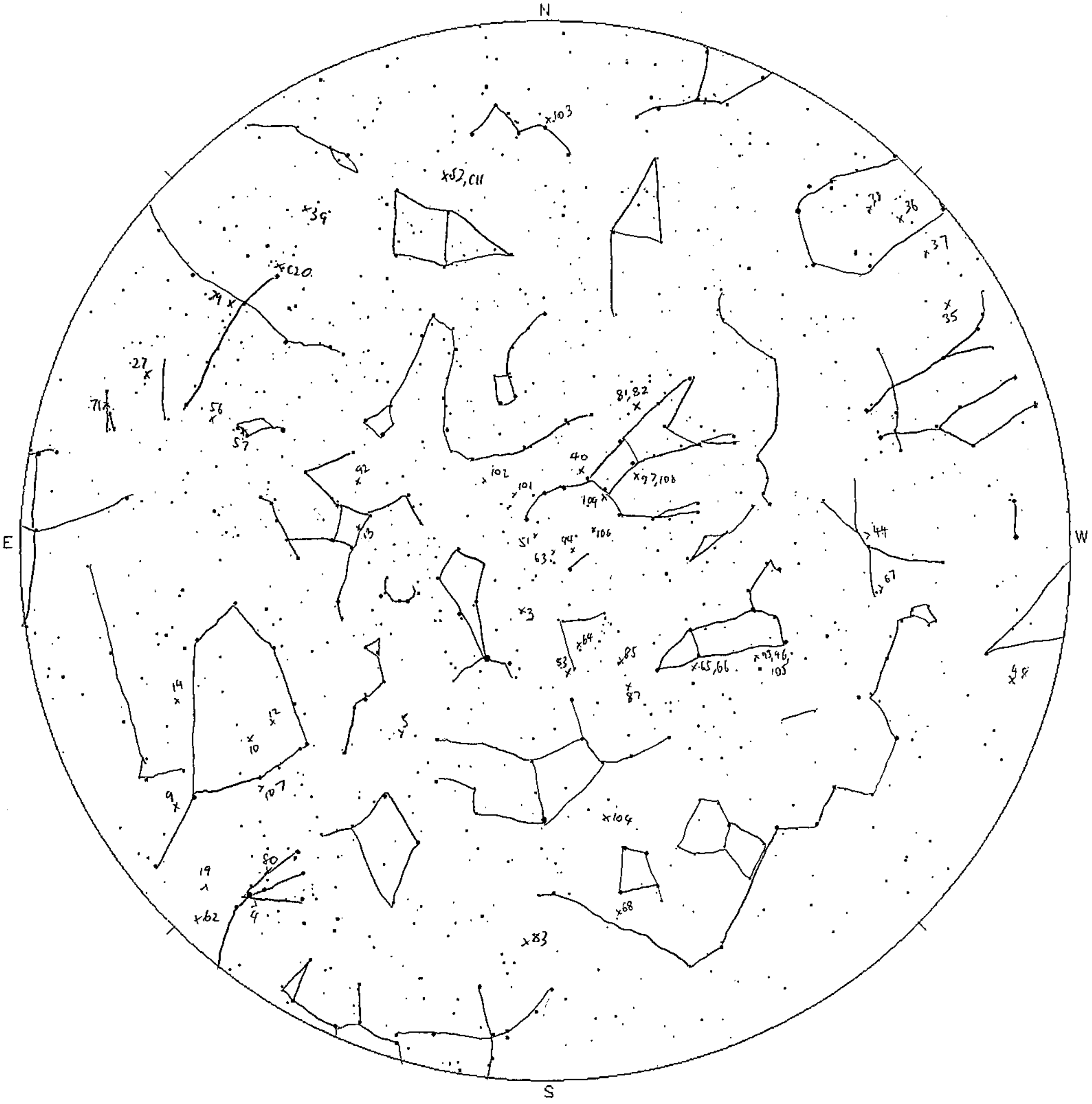


Reached on

11:23,
10/3/2023

One day
before
SAO


N
E
W
S
103
58, C11
61, 82
97, 108
40
39
C20
109
106
102
101
51
83
49
29
92
13
3
69
85
56
57
27
71
53
87
2
104
71, 73
30
75
15
14
12
10
107
4
26
16, 17, 18
25
24
23
22
28
8, 20, 21
9
19
62
80
7
55
59
64
70
C76
64
83
C22
C80


N
E
W
S
x103
x52, C11
x39
xC20
79x
27x
71
56
57
92
13
102
101
81, 82
40
x97, 108
109x
51
94
106
63
x3
64
53
85
87
x65, 66
x95, 96, 105
14
12
10
5
9
107
x104
19
80
4
x62
x68
x83
38
36
x37
35
44
67
48


S
SMC
LMC
W
E
93
C80
C77
63
68
104
4
50
107
7
6
10
59
55
35
69
28
22
3,20,21
27
29
25
16,17,19
18
41
10
12
14
5
95,96,
105
65,66
87
85
53
64
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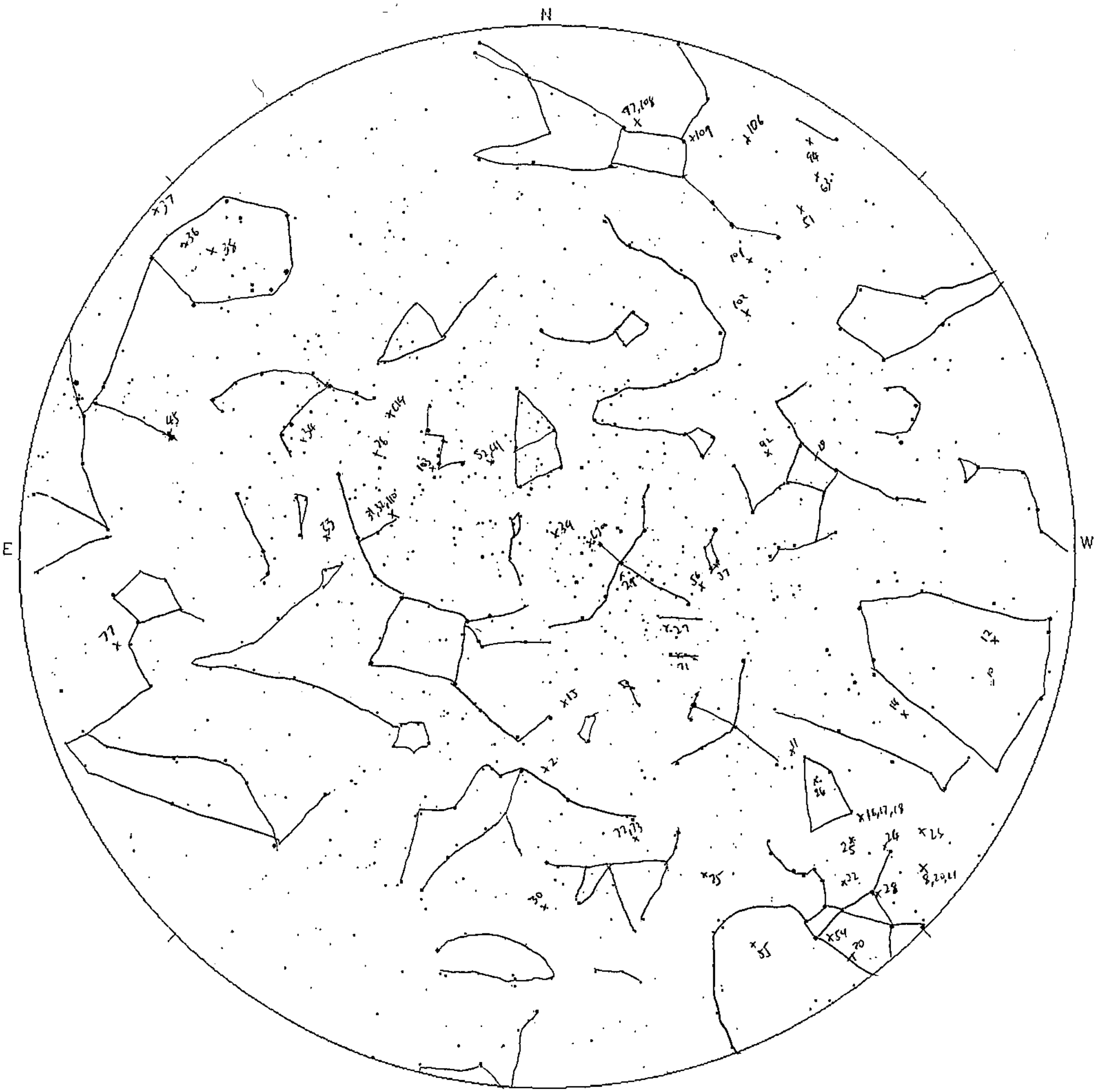
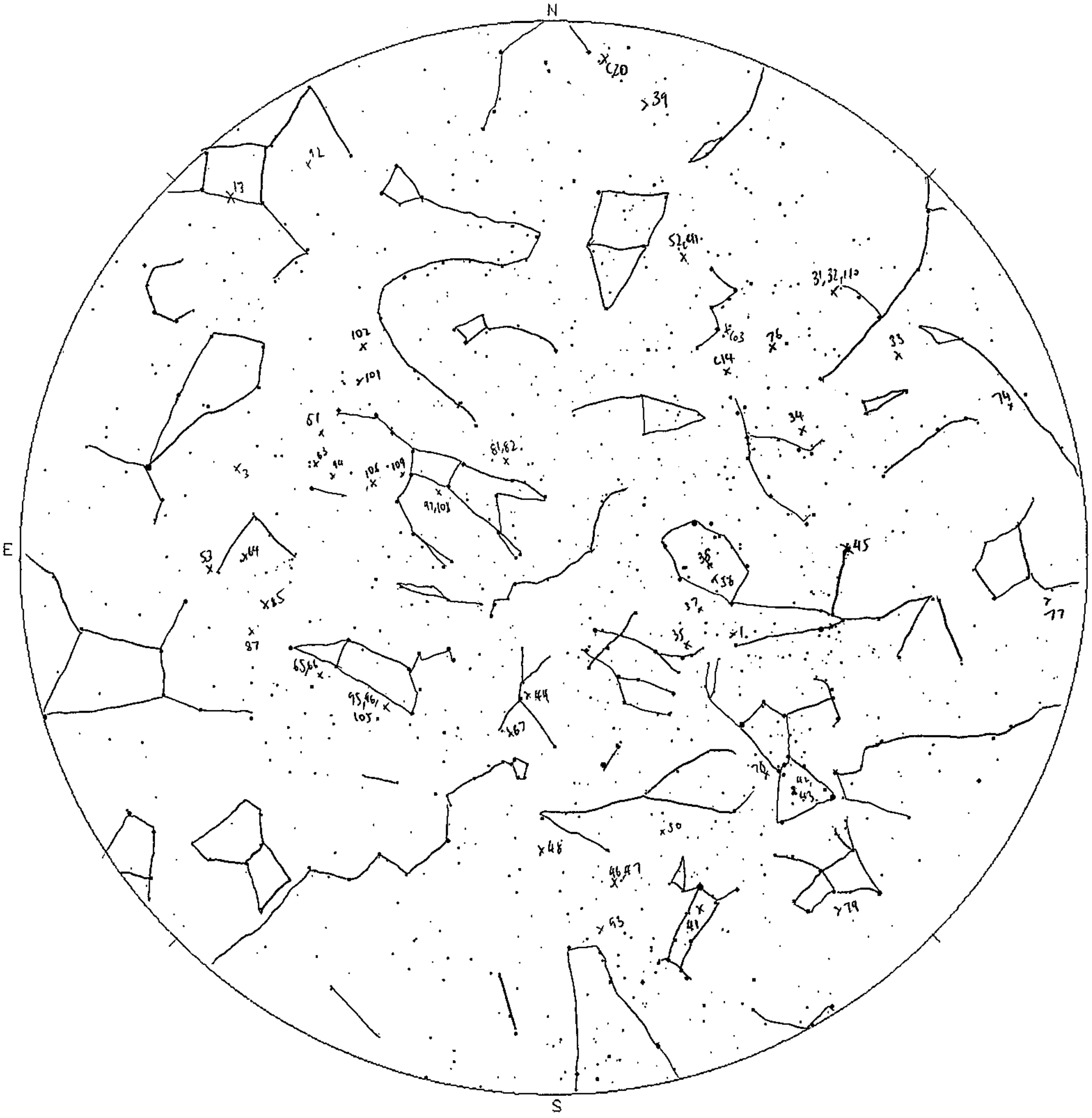
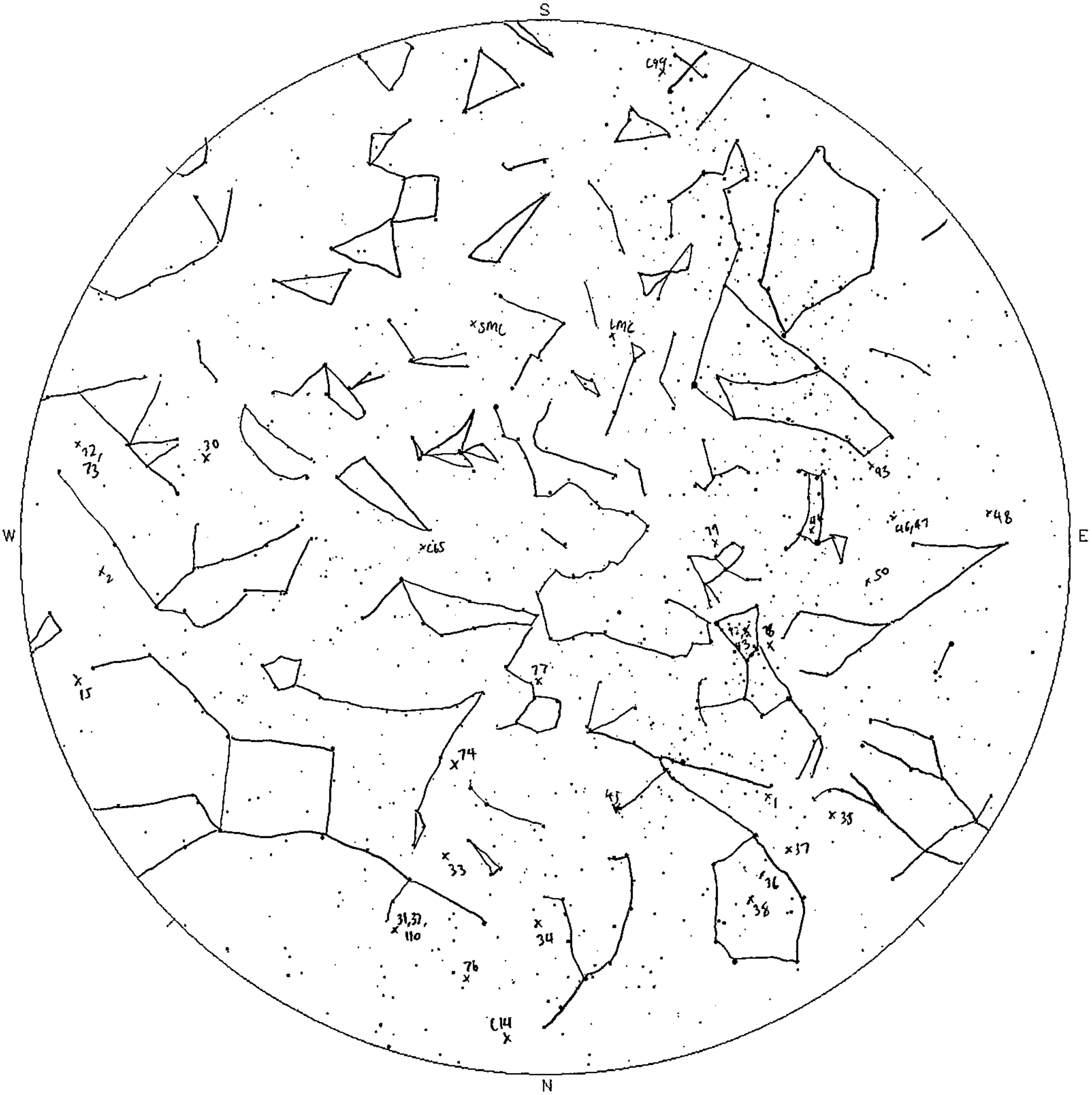
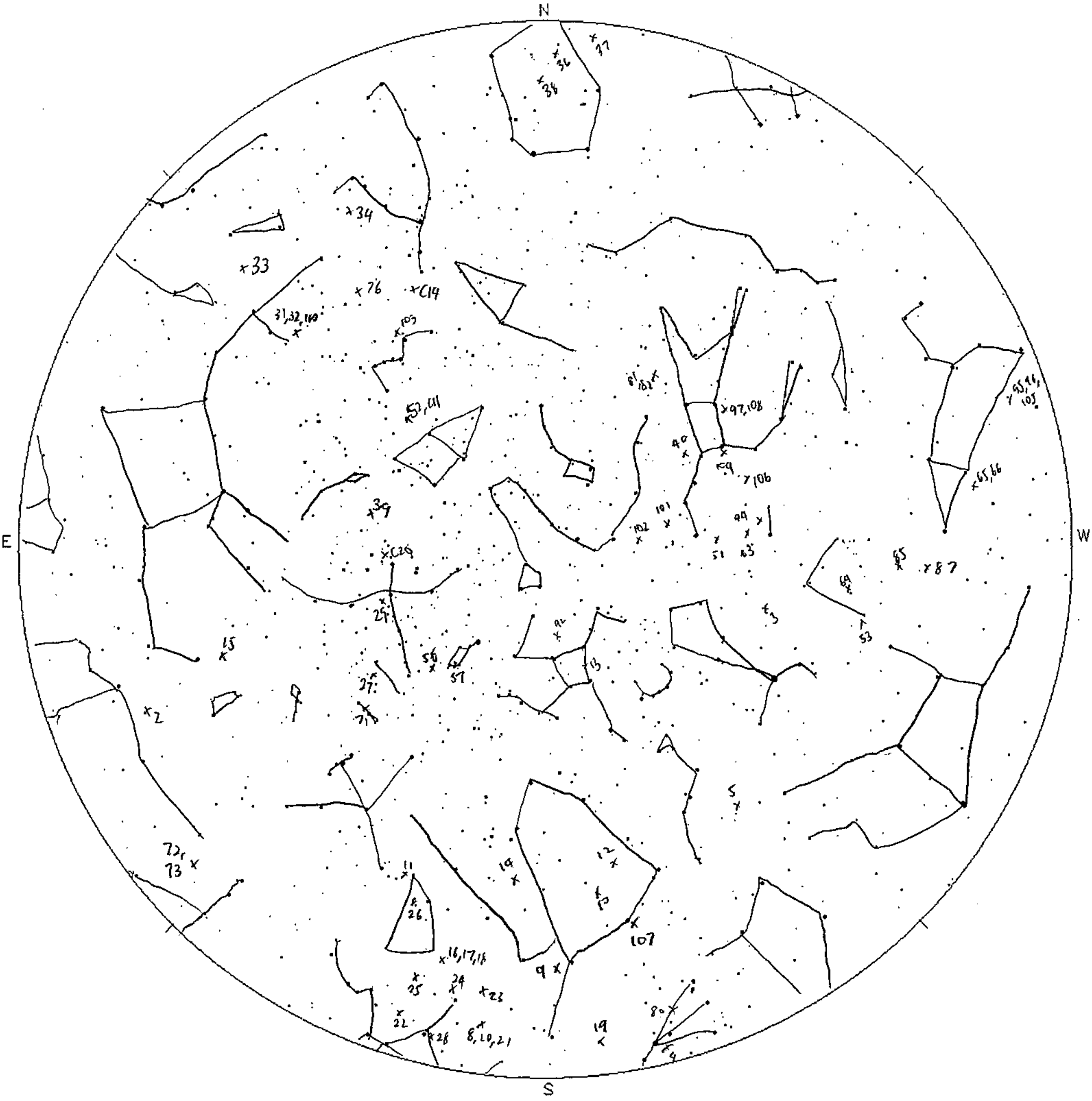
42
57
99
63
51
106
109
101
102
N


N
E
W
S
97,108
109
106
94
63
51
101
102
37
36
38
45
34
104
76
103
52,61
3,37,110
75
39
67
29
56
37
27
71
92
18
77
13
2
11
86
16,17,18
25
26
24
22
28
8,20,21
35
55
54
70
30
72,73
14
12
10


N
E
W
S
x109
97,108 x
52,81 x
x103
x C19
x76
71,3?,110 x
34 x
33 x
95,98,105 x
x44
x67
37 x
36 x 38
35 x
x1
45
79 x
x77
x78
42,43
x48
x50
46,47 x
93 x
x
41
79x
x LMC

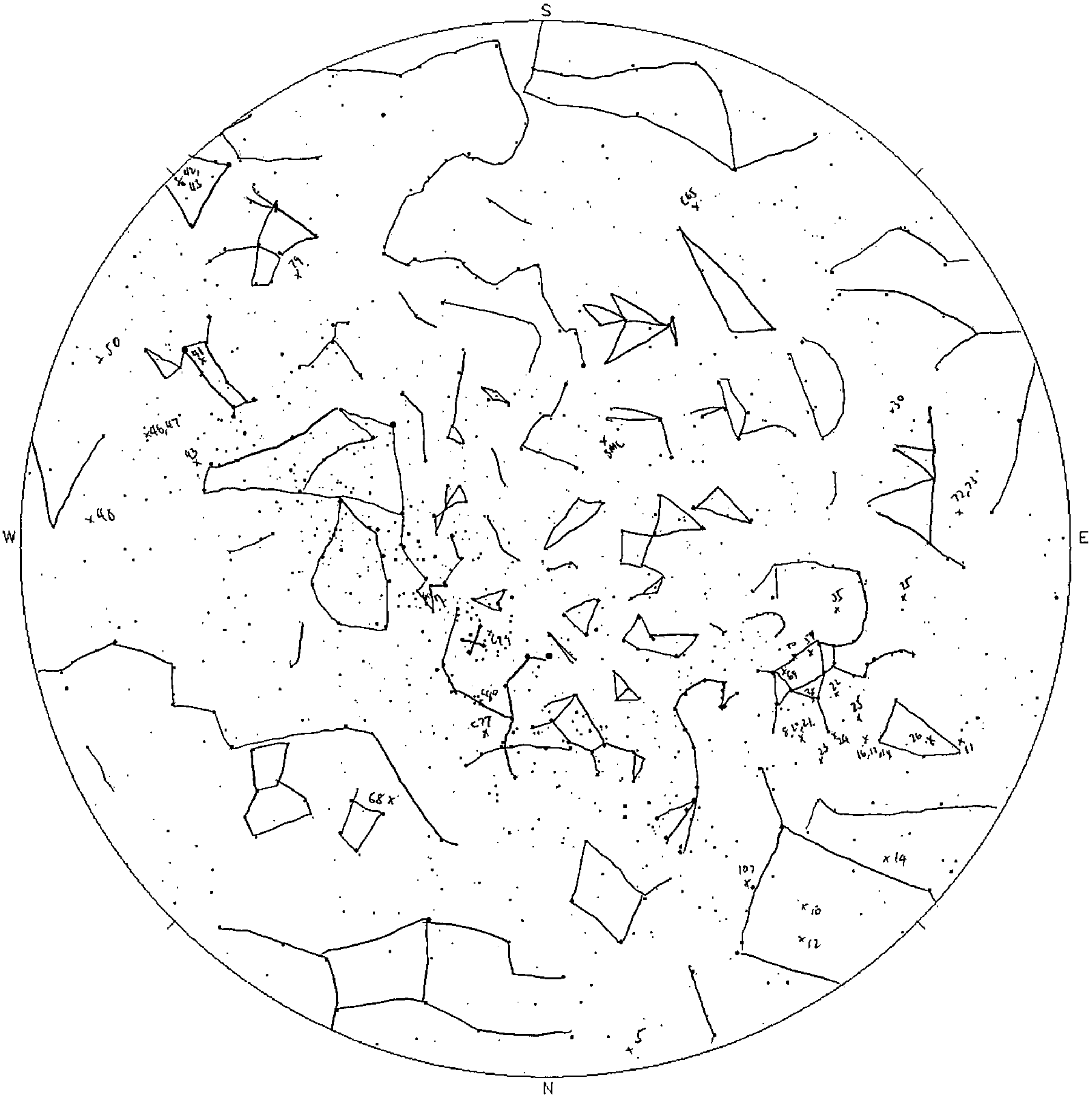

N
C20
39
12
13
52, C41
31, 32, 110
103
76
33
102
101
C14
61
74
34
81, 82
63
94
3
106
109
97, 108
53
64
45
W
E
38
58
37
85
77
87
35
1
65, 66
95, 96, 105
44
67
70
42, 43
50
48
46, 47
79
41
93
S


S
C99
SMC
LMC
W
E
N
72, 73
30
C65
2
15
74
77
79
41
42
43
78
93
46,47
48
50
45
1
35
37
36
38
33
31,32, 110
34
76
C14


N
37
36
38
34
33
76
C14
31,32,140
103
52,C11
39
C20
E
29
15
2
27
56
57
71
81
102
97,108
40
59
106
101
102
51
99
63
65,96,105
65,66
W
85
87
69
53
3
92
13
5
72,
73
11
26
14
12
10
107
9
16,17,18
25
24
23
22
28
8,10,21
19
80
4
S


S
83
6
7
54
69
70
55
75
C77
C80
68
C99
72,73
30
SMC
LMC
W
E
2
C65
93
98
46,47
41
79
80
61,62
42
78
77
74
45
1
35
N


S
W
E
N
80
4
19
62
16,17,18
23
26
29
25
8,20,21
22
28
6
7
64
3
70
54
C76
55
75
72,73
30
2
83
68
C77
C80
C49
SMC
LMC
48
46,
47
44
50
79
42,8
43
78
37

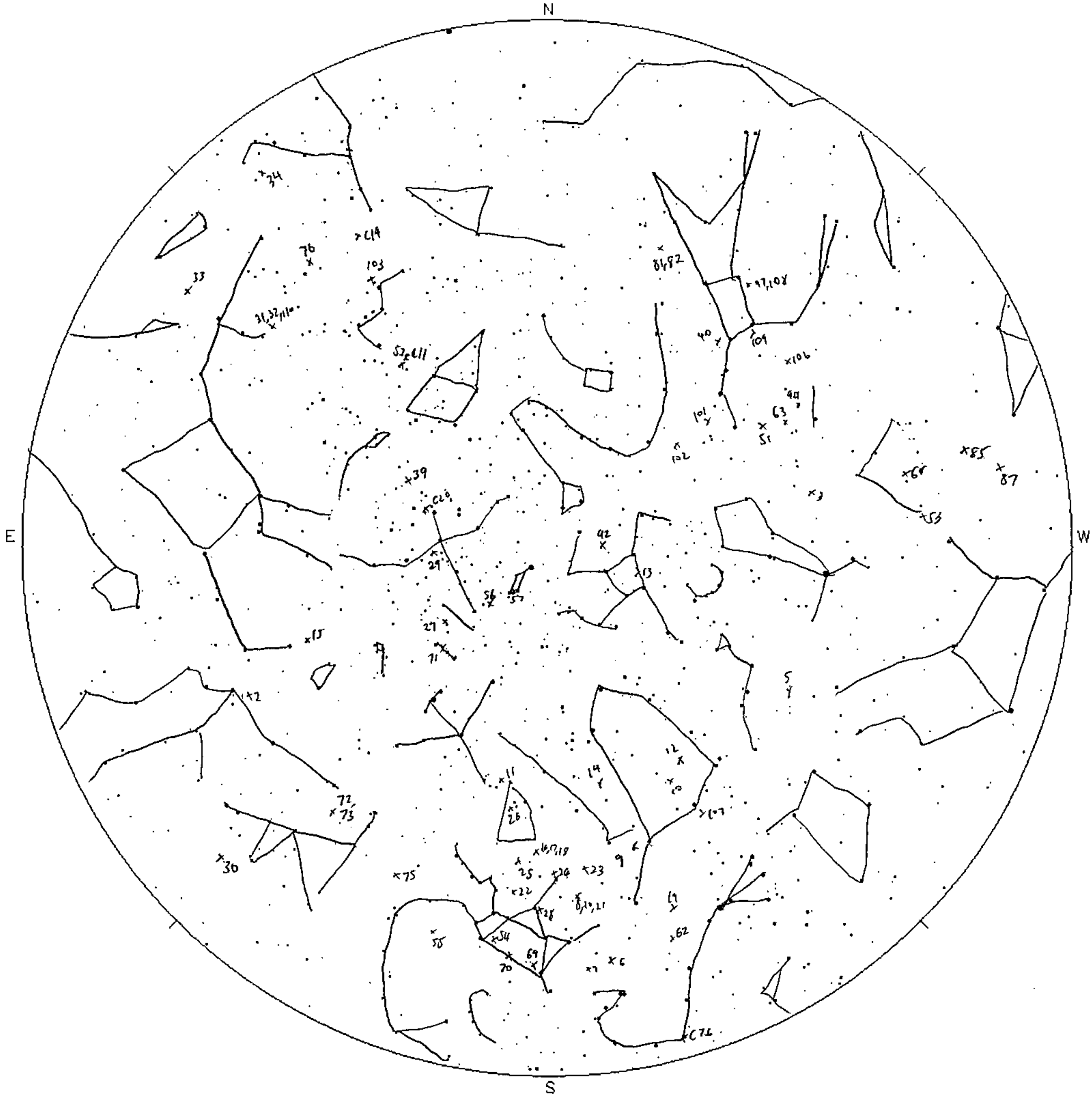

S
W
E
N
x42, 115
79 x
c65 x
x50
91 x
x46,47
43 x
x40
SMC
x30
72,73 x
94
40
c77 x
35 x
25 x
70
54 x
69
22 x
38
25 x
8,20,21 x
23 x
24
16,17,14
26 x
x 11
68 x
x14
107 x
x10
x12
x5

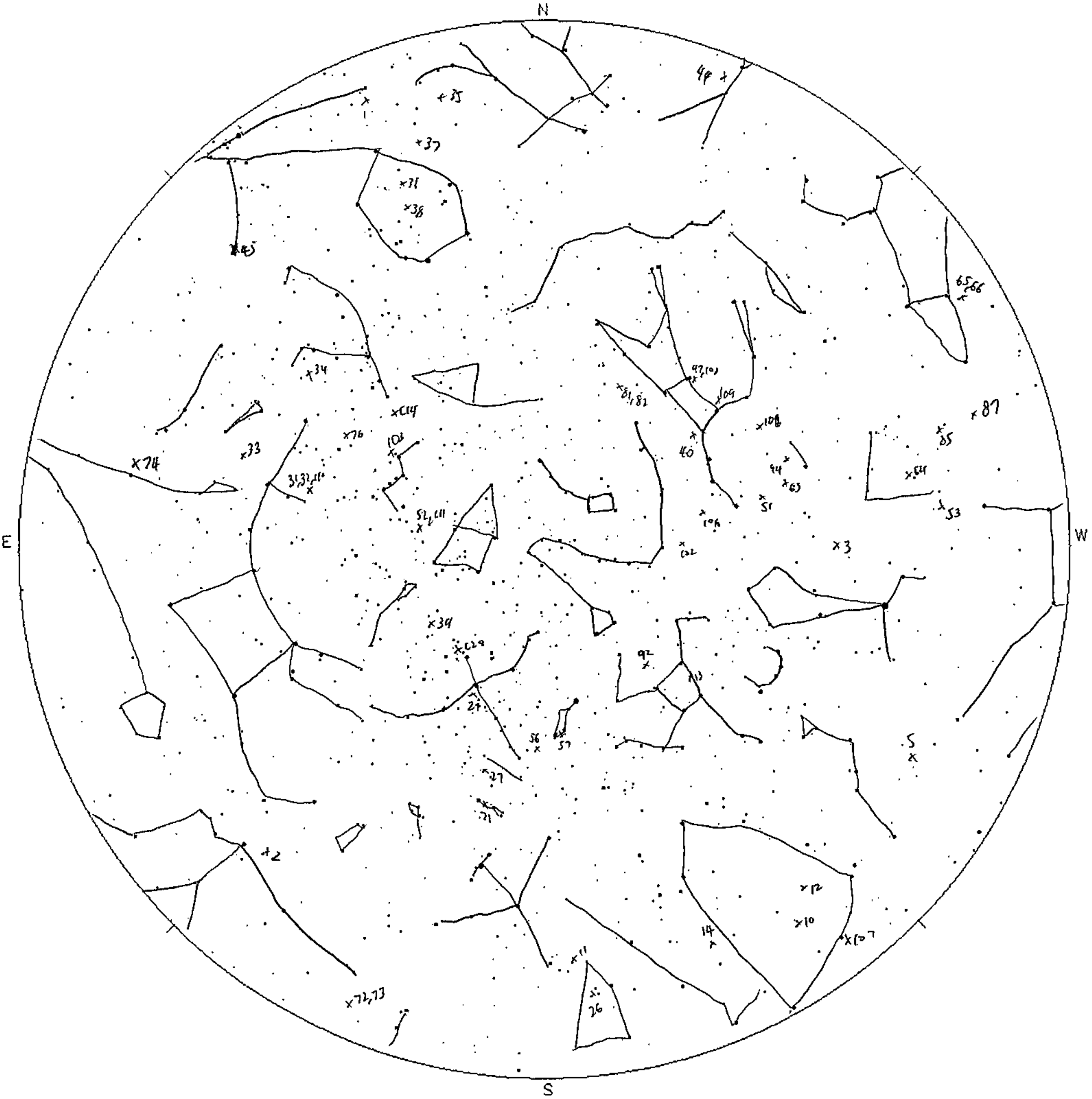
highest 2^n such that

$2^n < 1000$ and $n \in \mathbb{Z}$

2^9!

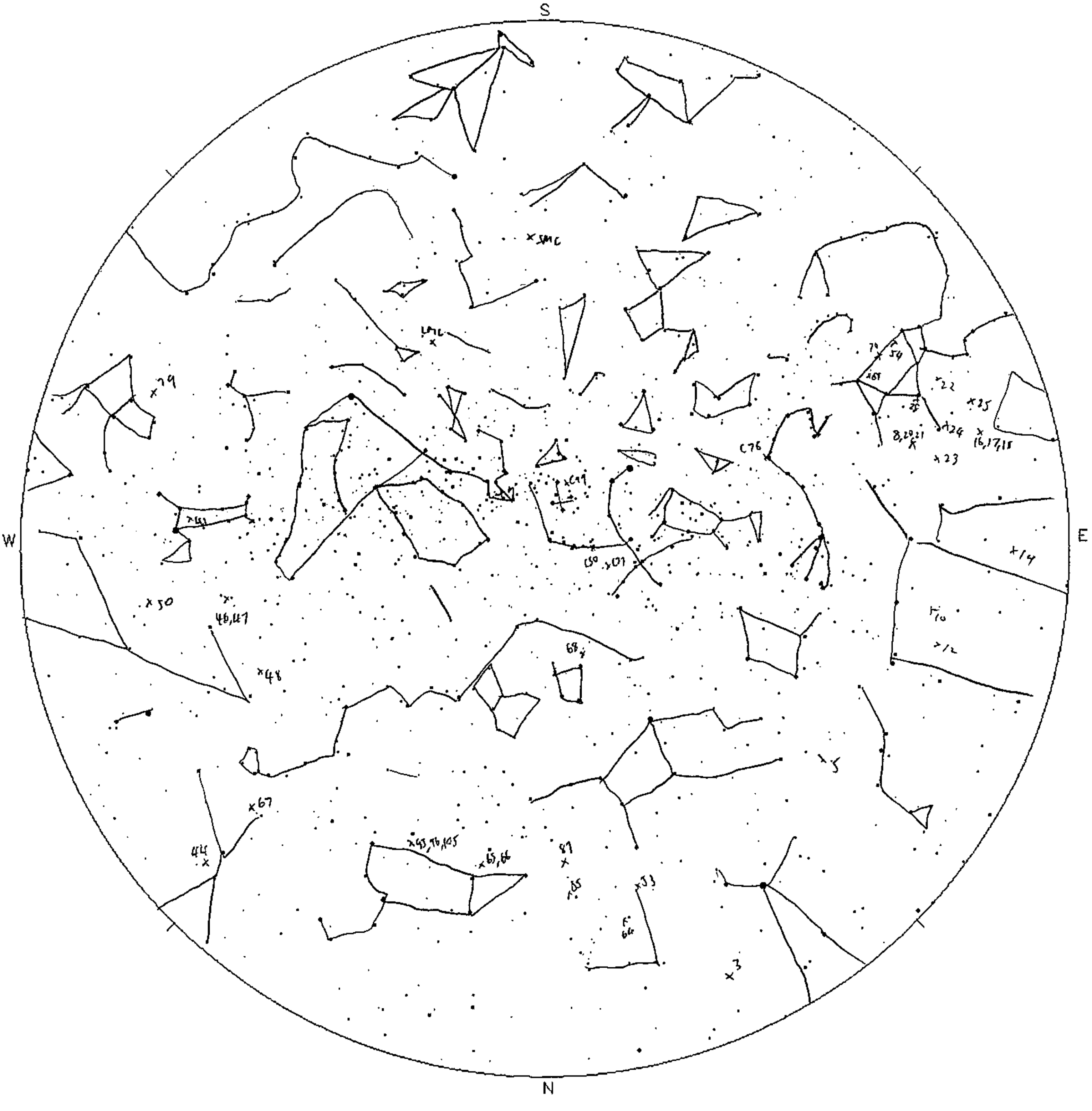
512

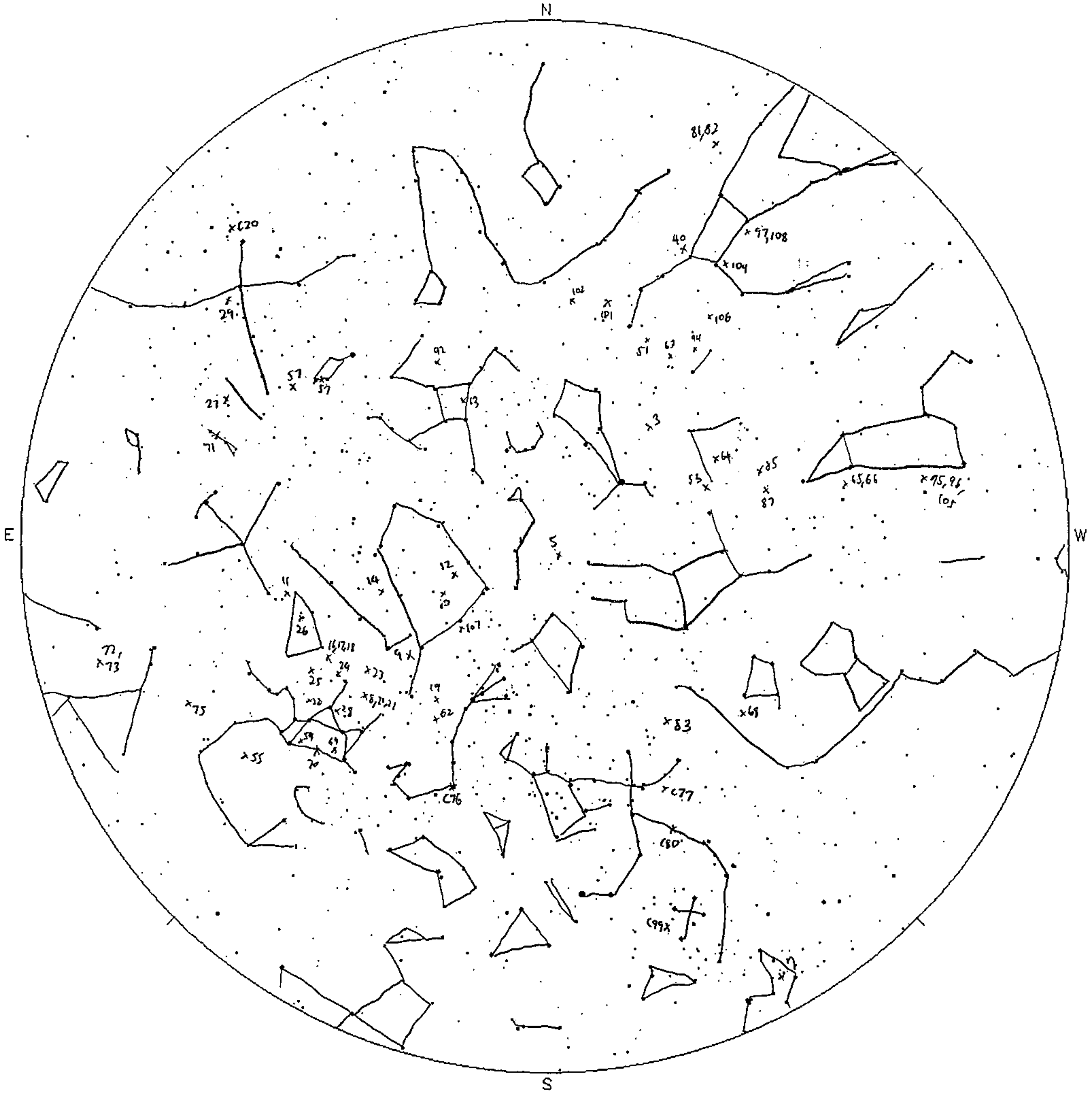

N
E
W
S
34
33
76
C14
103
31,32,110
53, C11
81,82
47,108
40
109
106
101
98
63
51
102
39
C20
29
56
57
27
71
92
13
85
68
87
53
3
15
2
5
12
10
107
14
11
26
72,
73
30
75
16,17,19
25
24
23
9
8
22
28
8,10,21
19
62
54
55
69
70
7
6
C72


N
44
×1
×35
×37
×71
×38
×45
65,66
×34
×C14
×87
×81,82
47,101
109
×108
×76
103
×33
×74
31,32,110
40
×85
×54
94
×63
51
53
52,C11
×106
132
×3
W
E
×39
×C20
92
113
24
56
57
×27
×71
5
×2
×12
×10
14
×107
×11
×72,73
26
S

S14


S
N
W
E
x85
xC77
C50
80
x4
xC76
x9
x23
x20,21
29
16,17,18
x25
x22
28
648
59
70
x26
x11
x35
75
x37
LMC
SMC
46,47
81
50
79
x78
42,43
72,73
30
xC65
7
x15
x77
x79


S
W
E
N
x SMC
LMC x
x79
x41
x50
x 46,47
x48
x67
44 x
x43,96,105
x65,66
87 x
x85
x33
64
x3
x5
68 x
x C99
130 x107
C76
70 x 54
x68
x22
x25
35
8,20,21 x
x24
x 16,17,18
x23
x14
10
x12


N
E
W
S
C20
29
57
37
27
71
81,82
40
97,108
104
102
101
106
51
67
94
92
13
3
64
85
53
87
65,66
95,96,105
5
12
10
14
11
26
107
9
16,17,18
24
25
23
22
28
8,20,21
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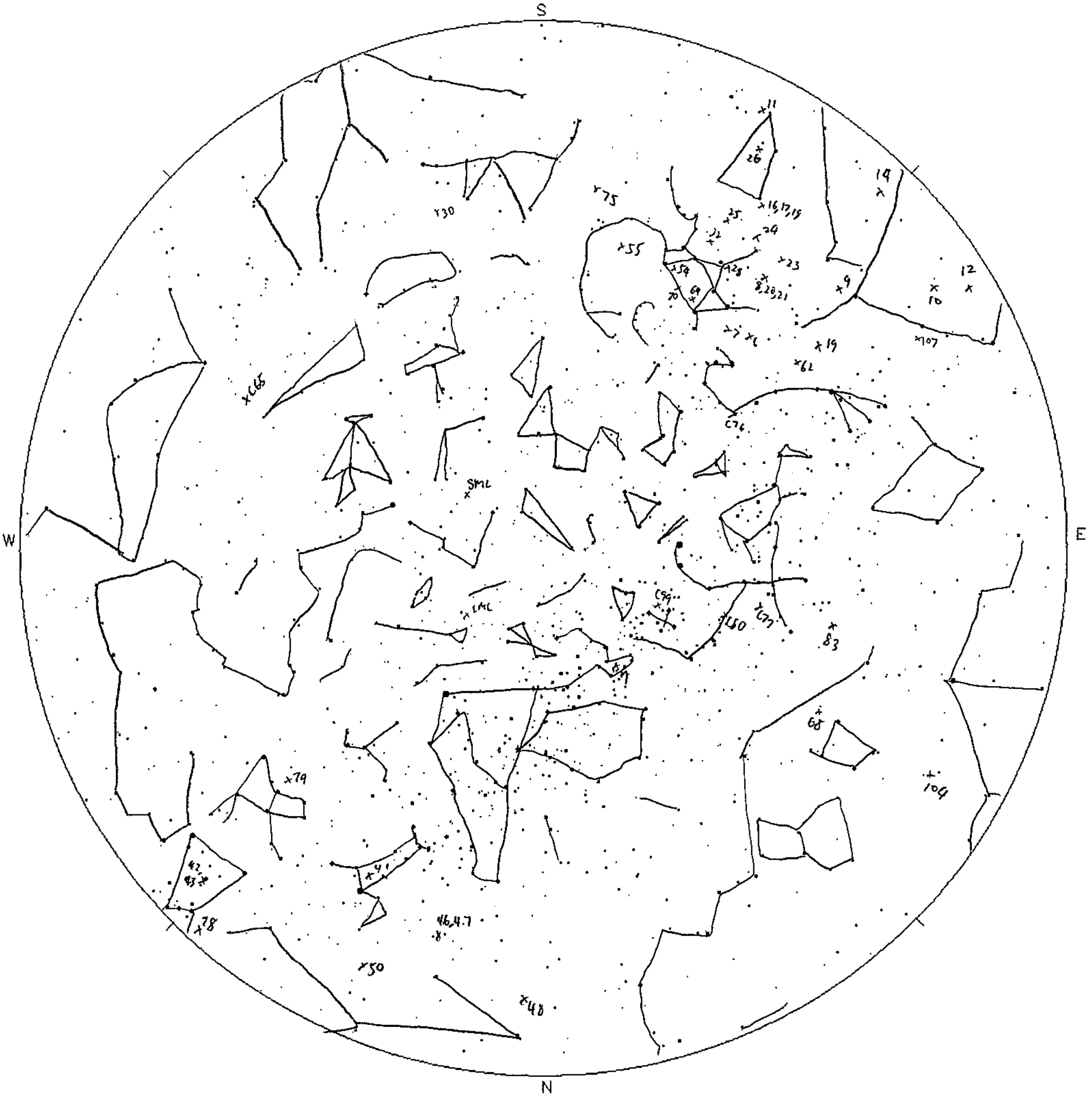
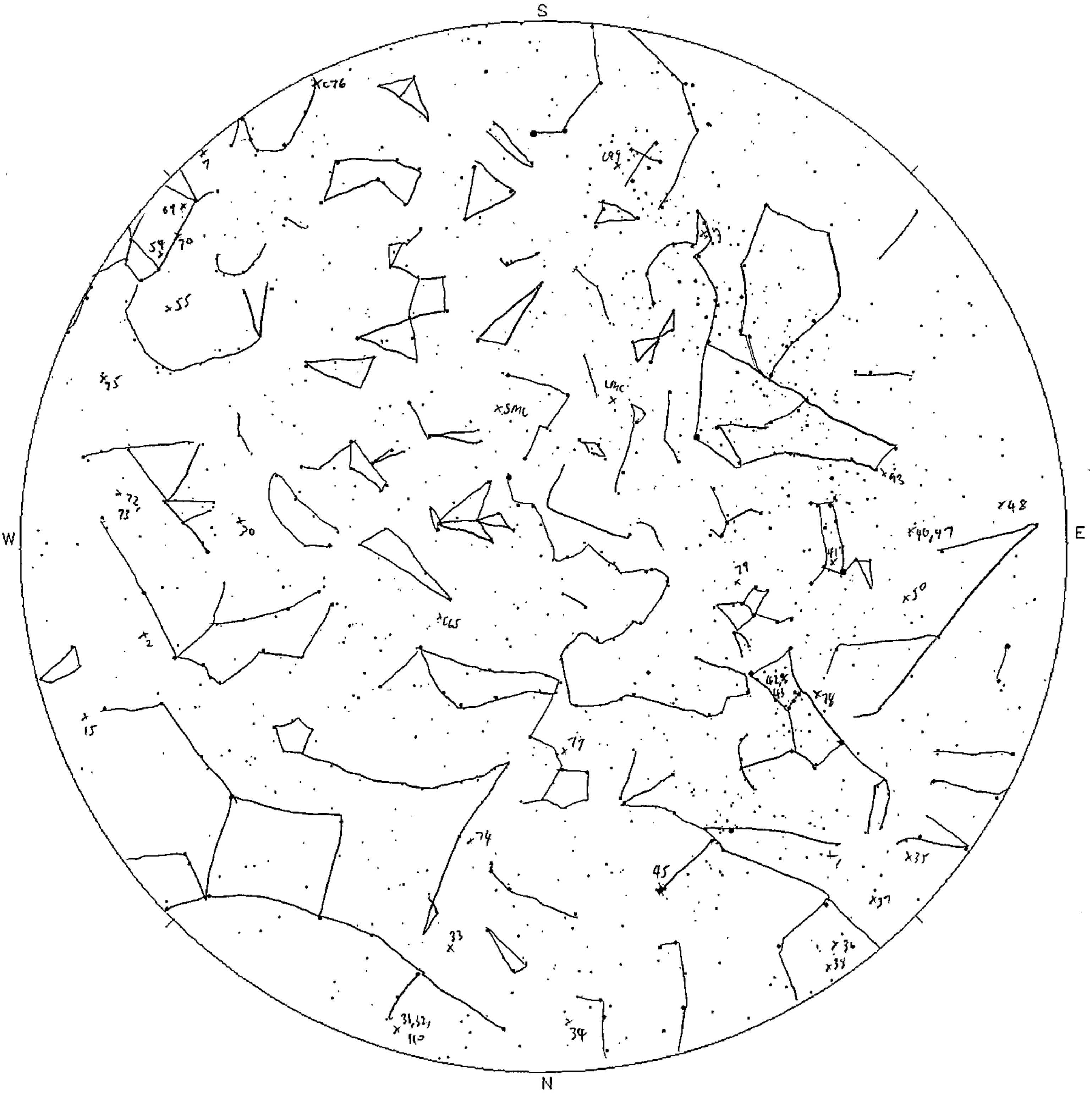
62
72,
73
75
55
59
69
70
83
68
C76
C77
C80
C99
7


S
11
26
30
75
14
16,17,19
25
32
24
55
23
54
28
8,20,21
9
12
10
70
69
7
6
19
107
62
W
E
C65
C76
SMC
LMC
C99
C77
160
83
44
68
104
79
42,
43
41
78
46,47
50
48
N


S
x68
x83
x40
Milky Way
xC77
80
x93
x46,47
x50
x12
x107
x10
x4
C99
41
19
x62
xC76
1
9
W
7
14
x6
x7
x23
20,21
28
16,17,18
25
22
58
x26
x11
x55
LMC
SMC
78
79
E
x15
x72,73
30
xC65
2
N


S
c76
7
69
70
54
55
75
C69
7
LMC
SMC
72
73
30
W
E
93
48
46,47
41
79
50
2
C65
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42,
43
78
77
74
45
1
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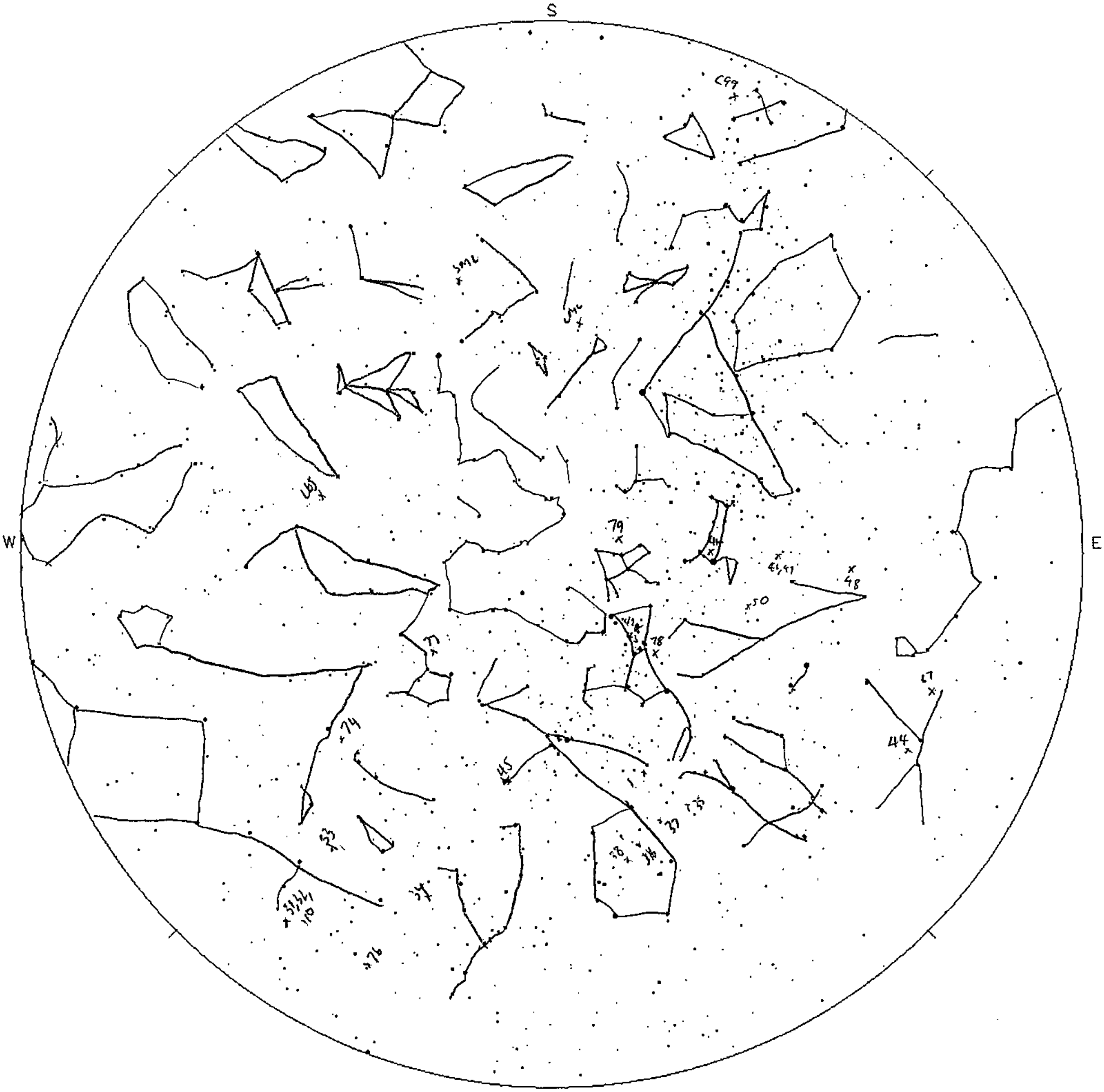
37
36
38
33
31,32,
110
34
N


S
W
E
N
C99
SMC
LMC
103
79
73
78
48
50
74
45
44
27
53
37
35
38
34
76


N
E
W
S
13
42
51
63
94
102
101
109
57
56
27
71
29
30
39
105
15
103
49
76
34
33
74
67
44
35
32
38
36
81
45
48
50
78
79
77


S
W
E
N
199
180
177
83
68
4
80
62
6
7
19
70
69
54
55
30
75
12,73
107
9
23
24
25
26
28
11
10
12
14
5
2
87
85
53
64
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94
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41
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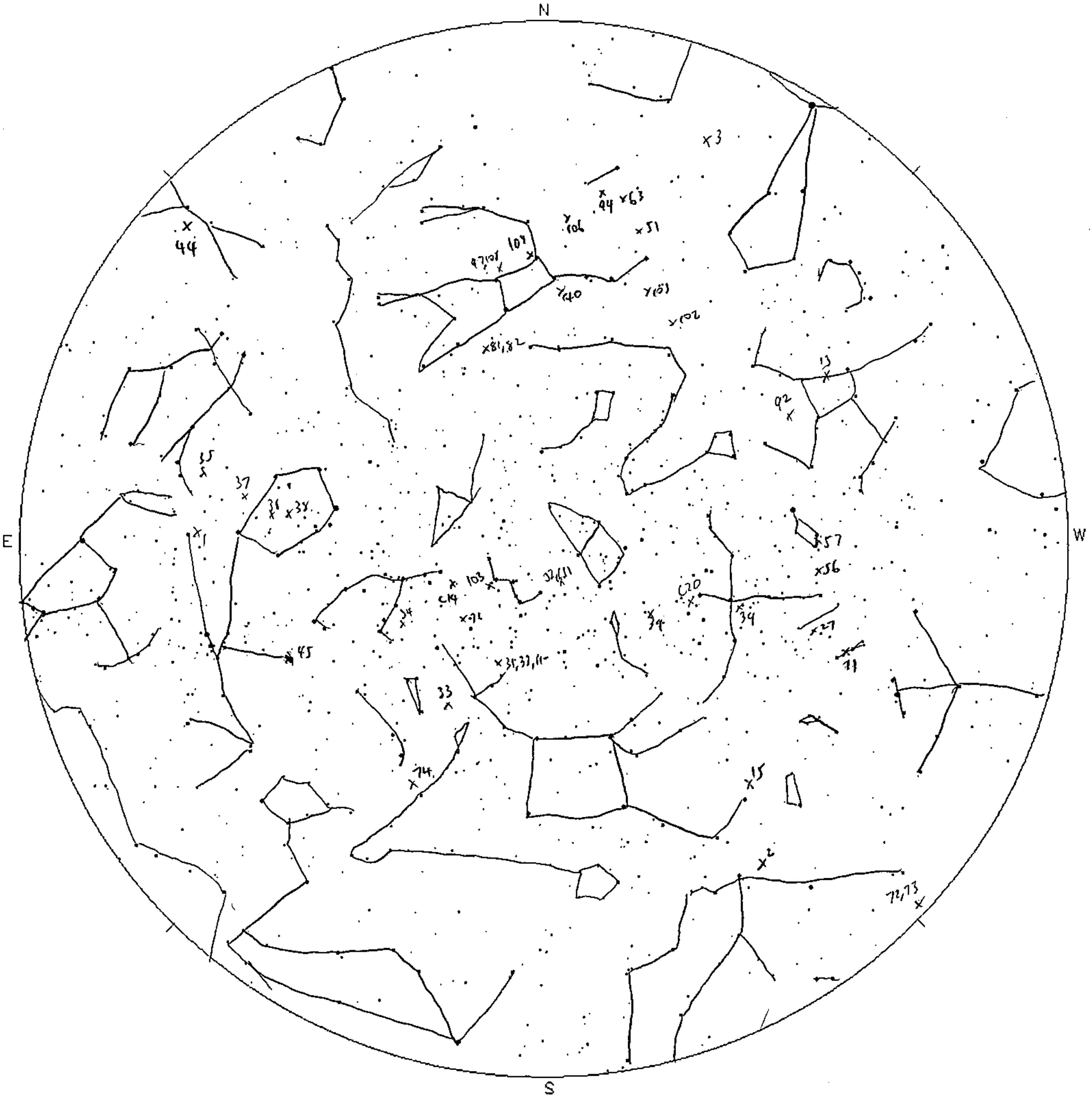
106
109
110
97,108
39


N
E
W
S
x3
44
94
x63
106
x51
97,101
109
140
103
102
81,82
13
92
35
37
36
x38
1
57
x56
C20
34
39
x27
71
103
C14
32,C11
x92
24
x45
x31,32,110
33
74
15
2
72,73


S
W
E
N
47,43
79
41
46,47
46
93
LMC
SMC
47
C99
C80
C77
C60,61
68
83
C96
30
2
72,73
75
55
70
54
69
7
6
62
19
4
80
28
22
8,20,21
24
25
23
16,17,
18
26
61
9
10
2
15


S
W
E
N
SMC
LMC
C65
79
41
93
46,47
48
50
42,43
77
74
45
1
35
37
36
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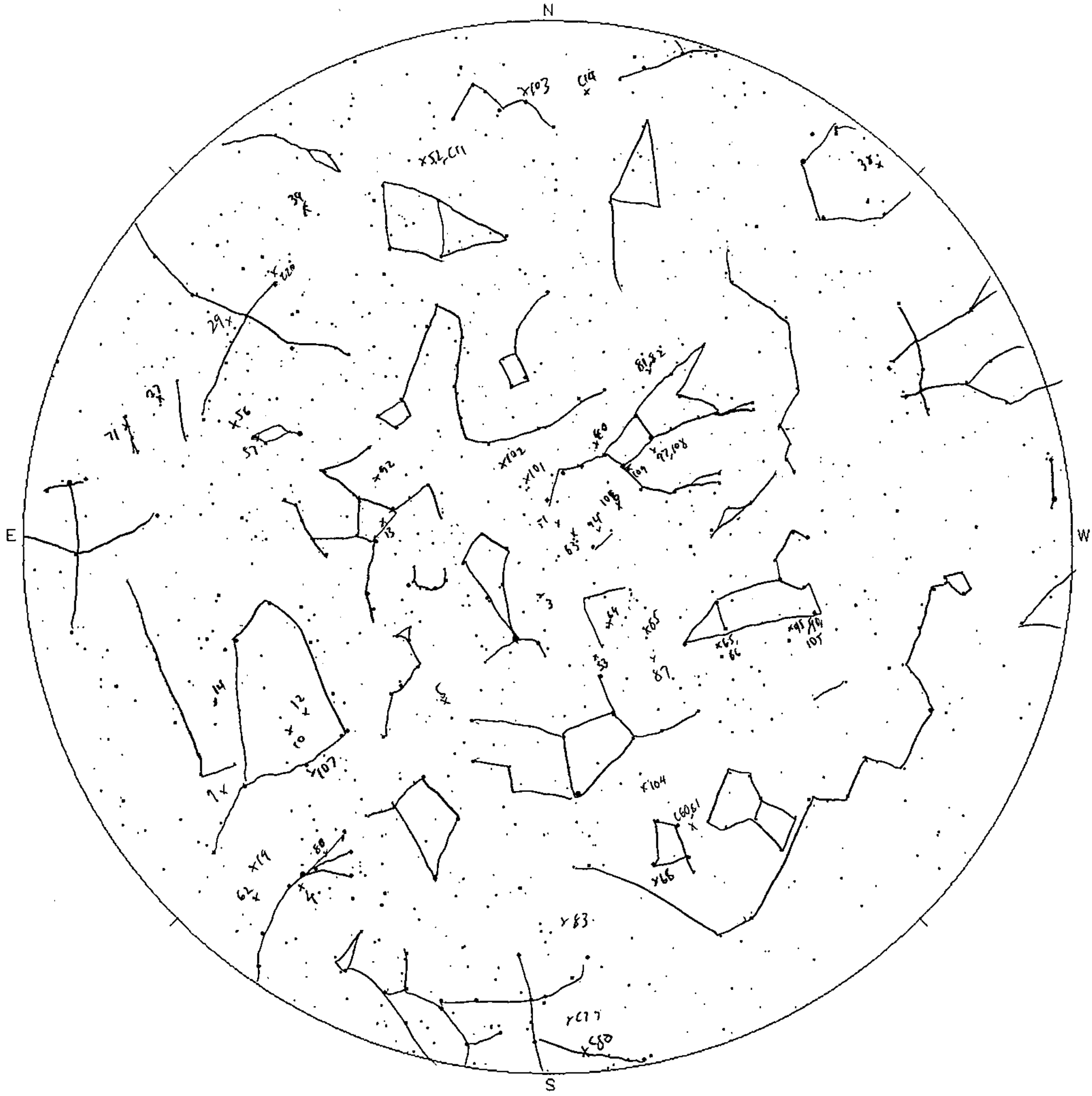
31,32,110
76
C14
103
67
44
95,96,105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x56
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x92
x102
x101
x80
97,108
109
13
51
63
94
106
3
64
x65
53
87
65
66
x95
98
105
14
12
10
x107
9x
x104
C60,61
x66
x19
80
62
4
x83
C77
x58


S
W
E
N
SMC
LMC
70
54
69
8,20,21
23
C76
62
19
9
9
80
107
10
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C99
C80
C77
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12,63
78
46,47
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C49,
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C60,61
104
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67
44
93,98,
105
65,66
87
85
53
64
3


N
x101
x102
C14
103
x76
39
45
52,C11
92
x13
31,37,110
33
35
C20
57
29
56
E
W
74
27
71
77
x15
x12
14
10
11
26
x2
107
72,
73
16,17,
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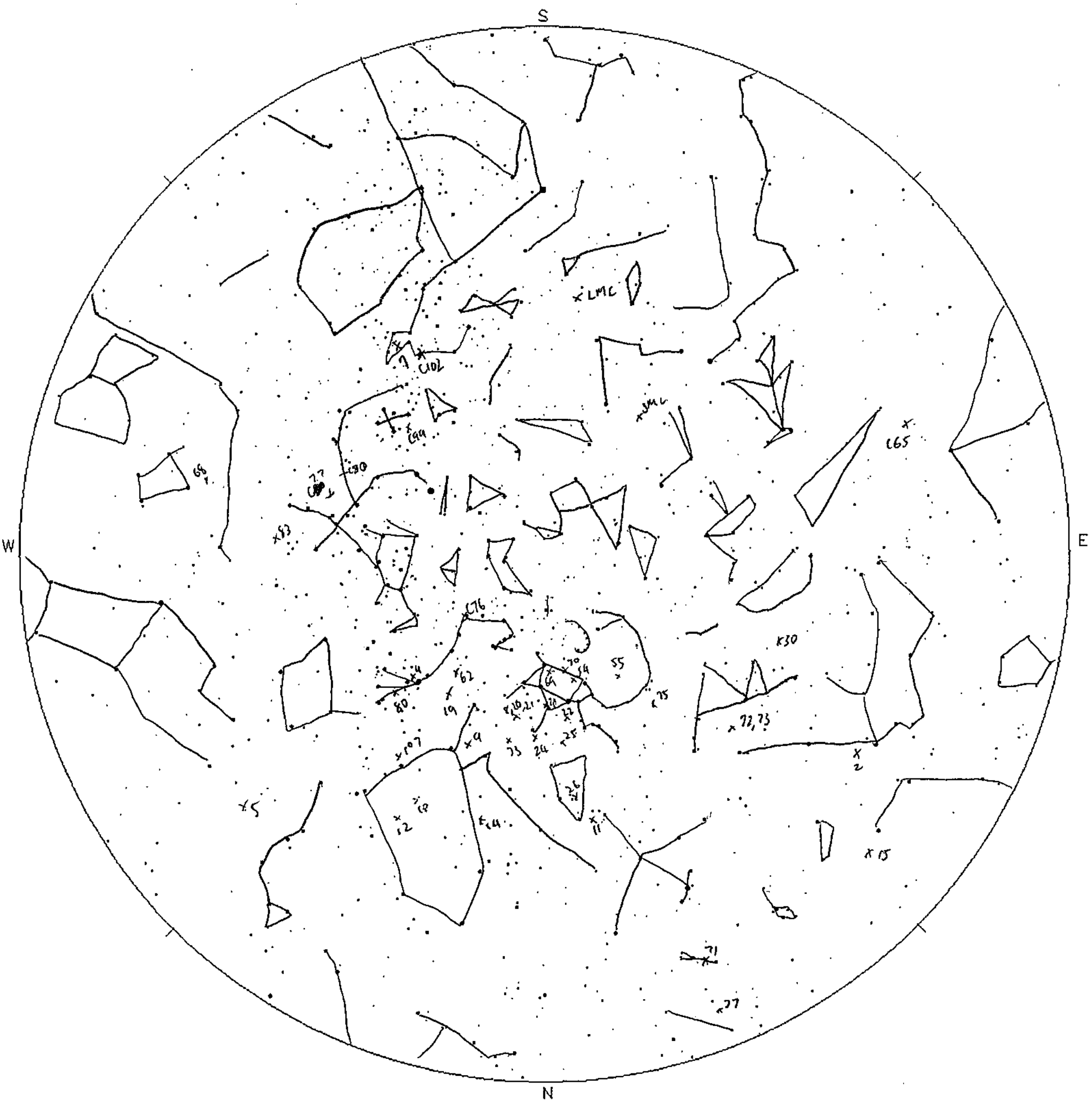
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8,10,21
20
22
C75
72,73
107
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18
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71
77


S
W
E
N
x93
xLMC
SMC x
C65 x
C98
C80
C77 x
68 x
83
C76
x30
x72,73
x2
35 x
x75
70
34
67
22
8,10,11
x23
24
(61)x
18
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x11
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x62
x19
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x9
x107
12 x
x 13
x14
x5
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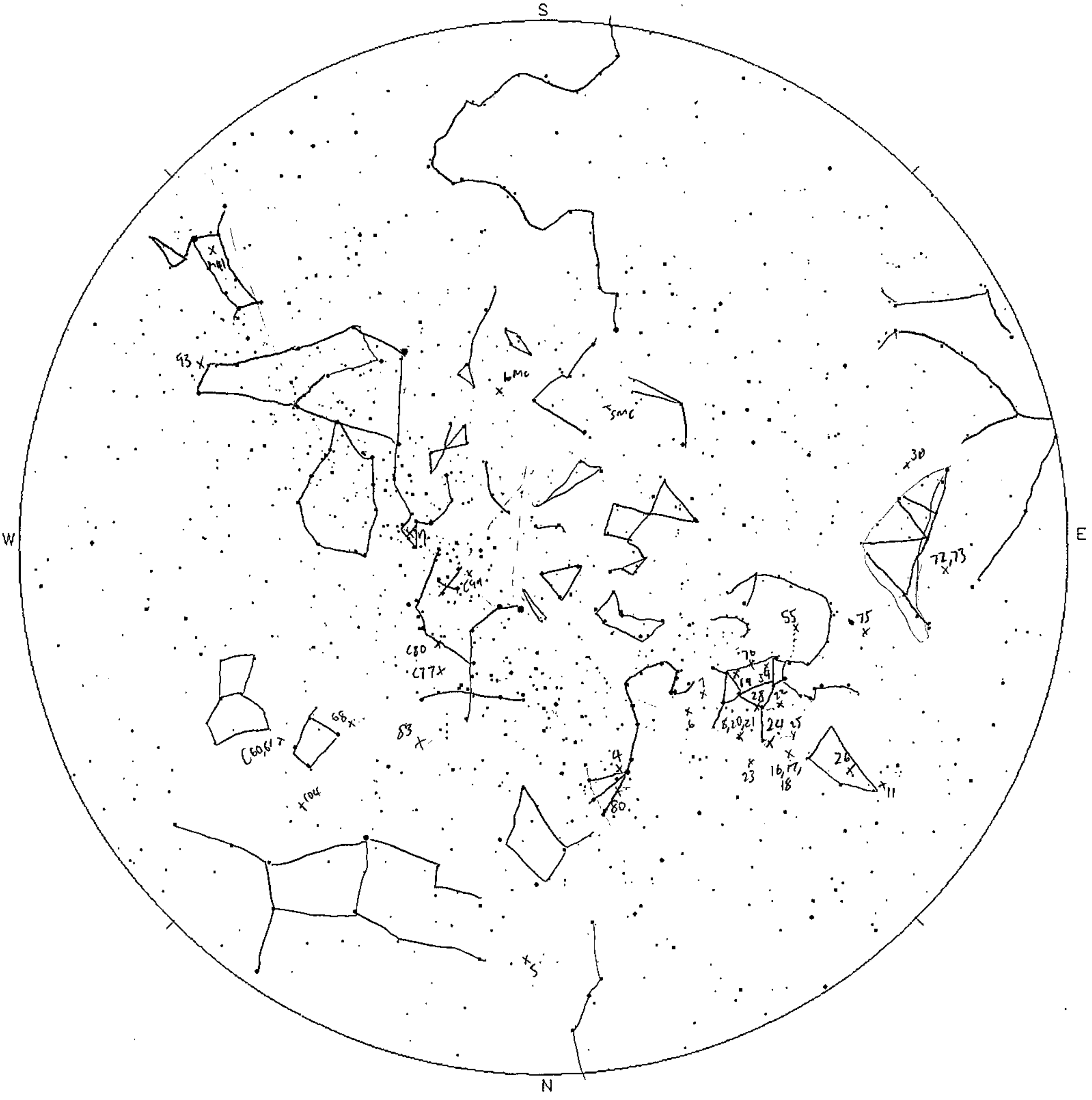
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C60,61
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5
7
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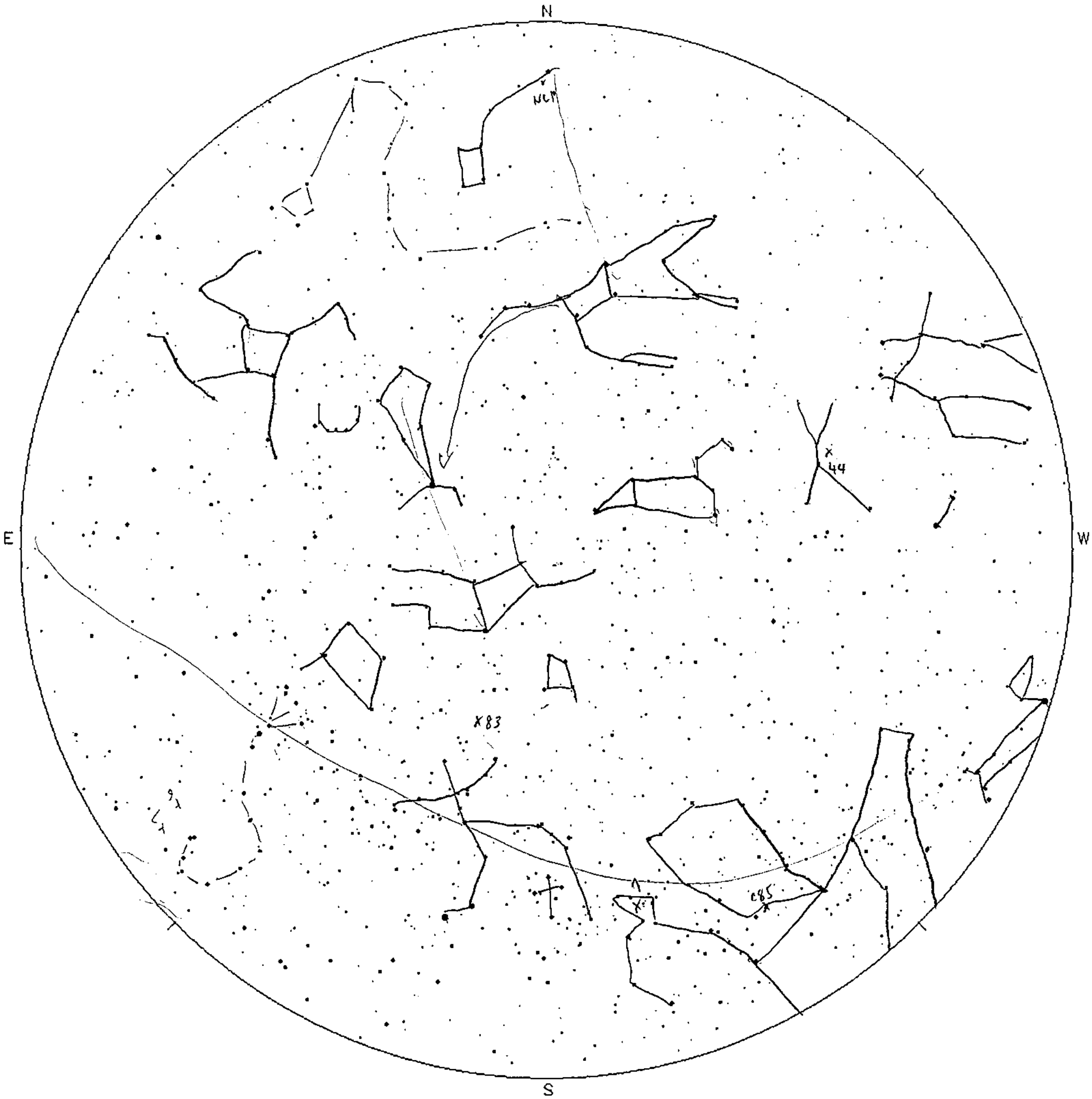
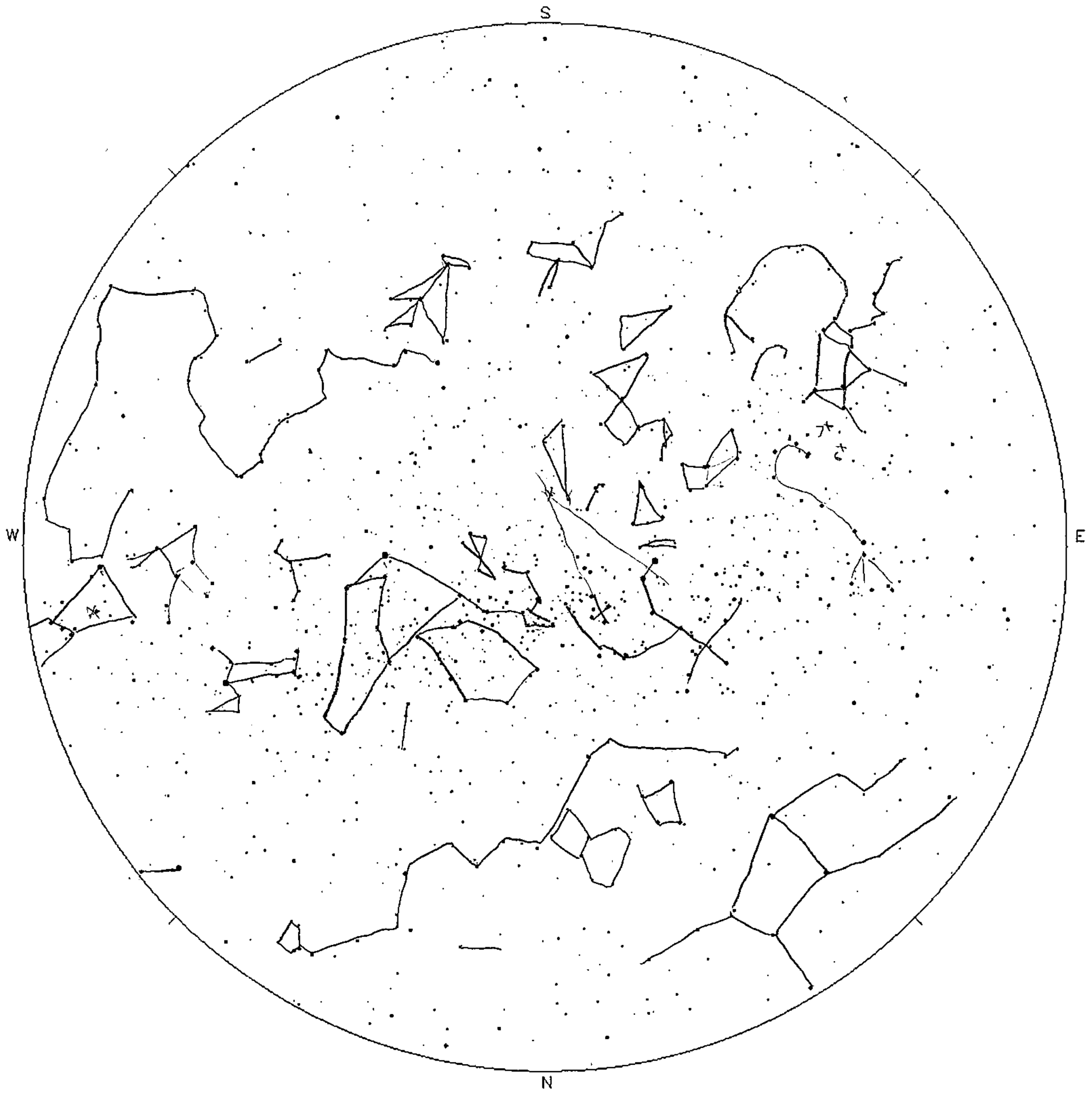


$2\tan^{-1}\left(\frac{R}{R_0}\right)$

ATGC LVLSS CAP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65, 66
NGC
169
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97, 108
81, 82
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C20
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C14
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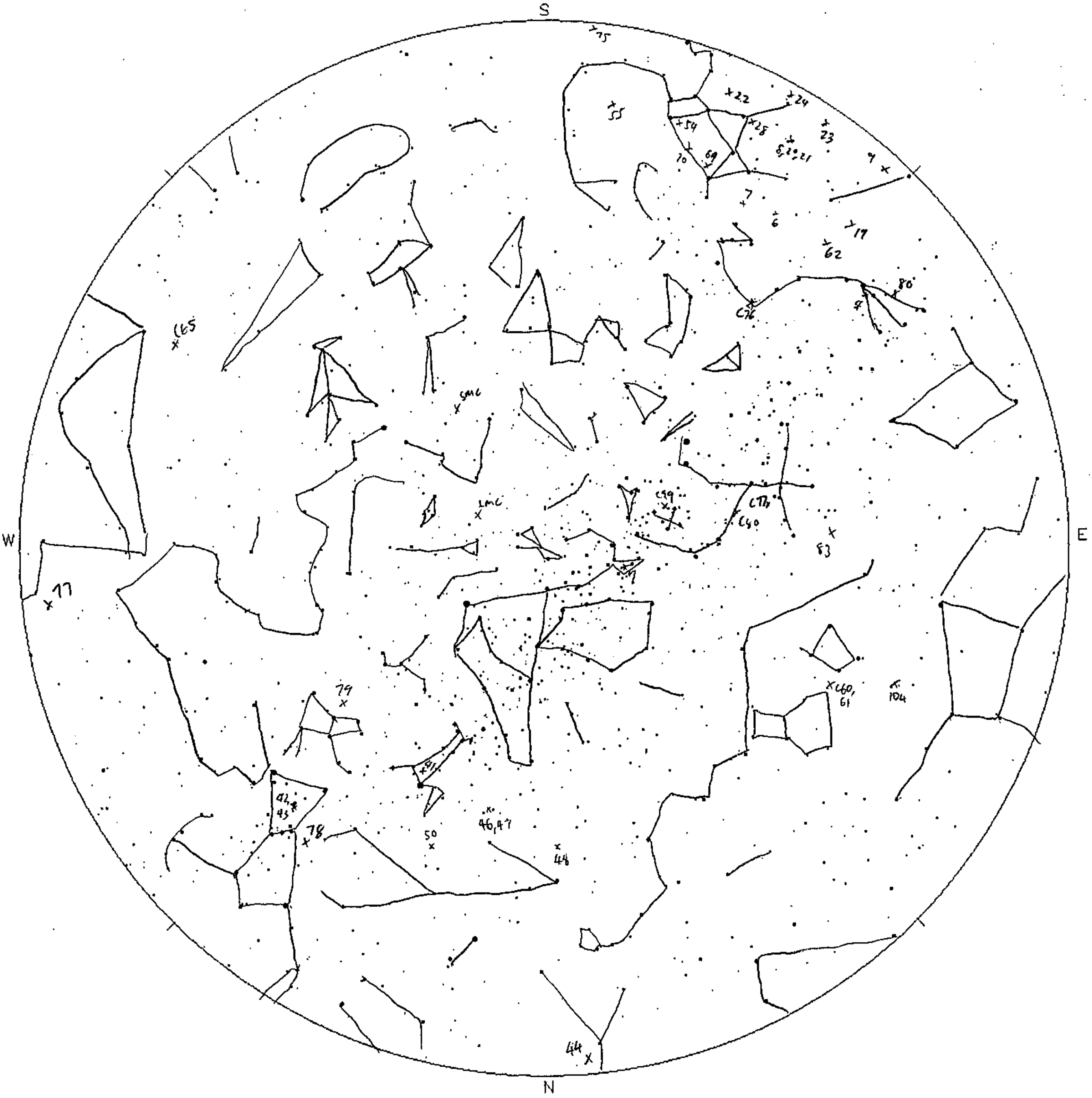
42, 43
71

Started again on 11/5/2023
for IOAA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C65
SMC
LMC
C99
C77
C40
83
W
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77
79
C60, 61
104
41
42,4 43
78
50
46,47
48
44
N


N
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W
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x97,108
x109
x
81,82
x106
x
40
94
x
34
51
63
103
101
x3
102
33
31,32,110
52,111
x39
92
13
x
29
56
57
5
27
15
71
x12
x2
14
10
26
x
11
x107
x10,17
18
77,
x73
x25
x29
x23
9 x
80
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x75
30
x
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8,20,21
19
x
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69
20
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x6
C76


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31,32, 110
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81,82
87,108
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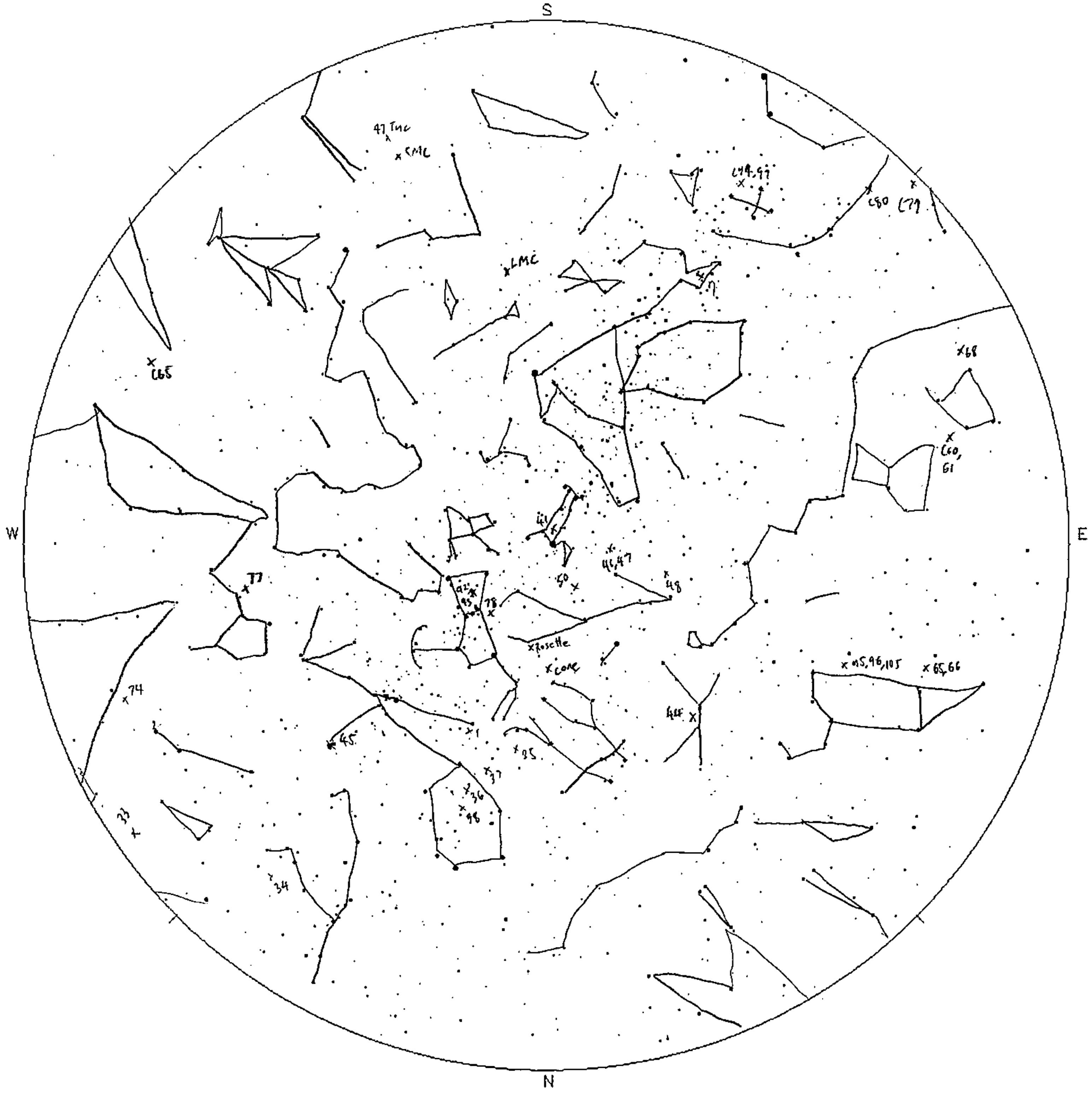
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47 Tuc
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C94, 97
C80
C79
LMC
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68
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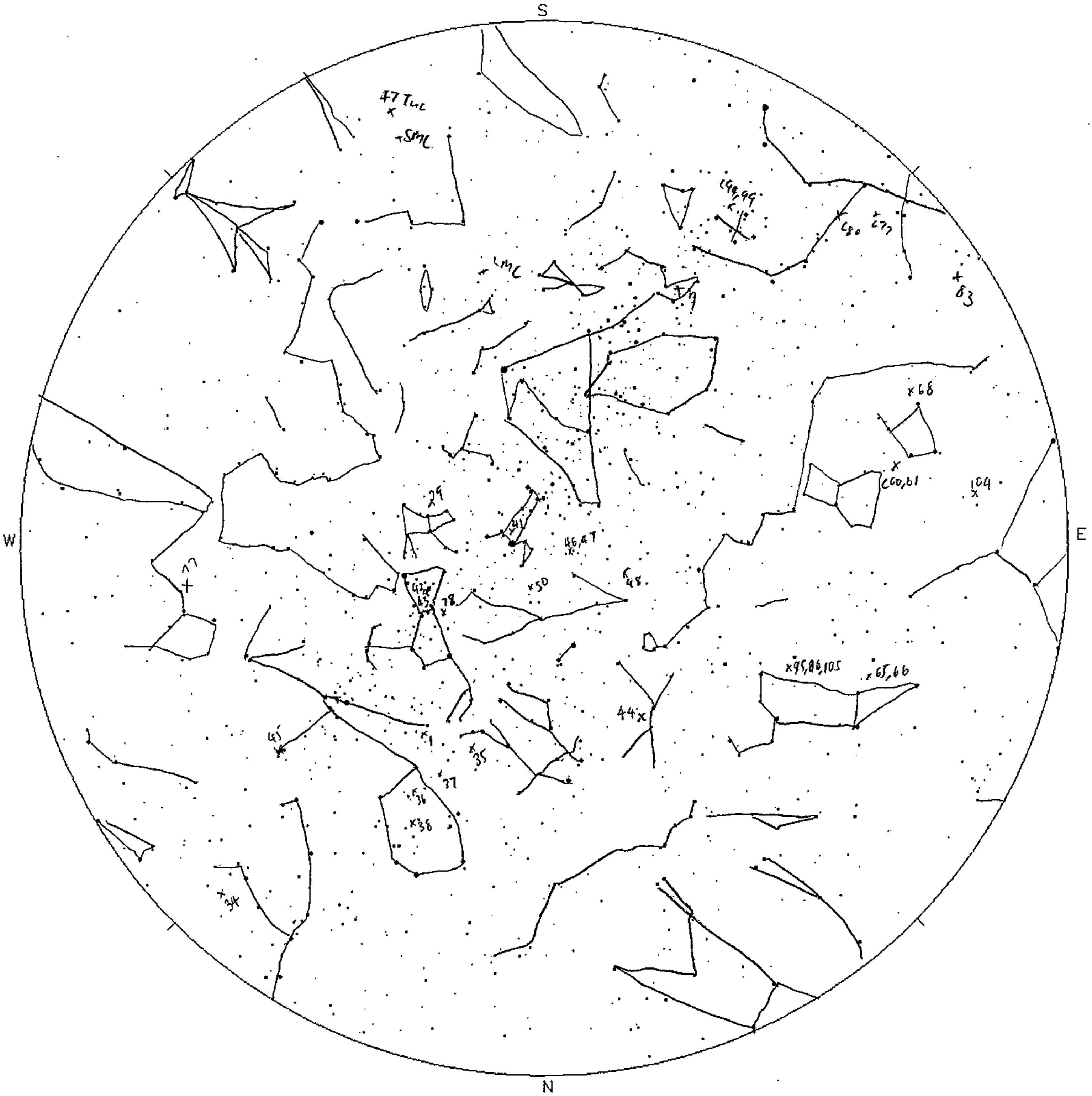
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C80
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LMC
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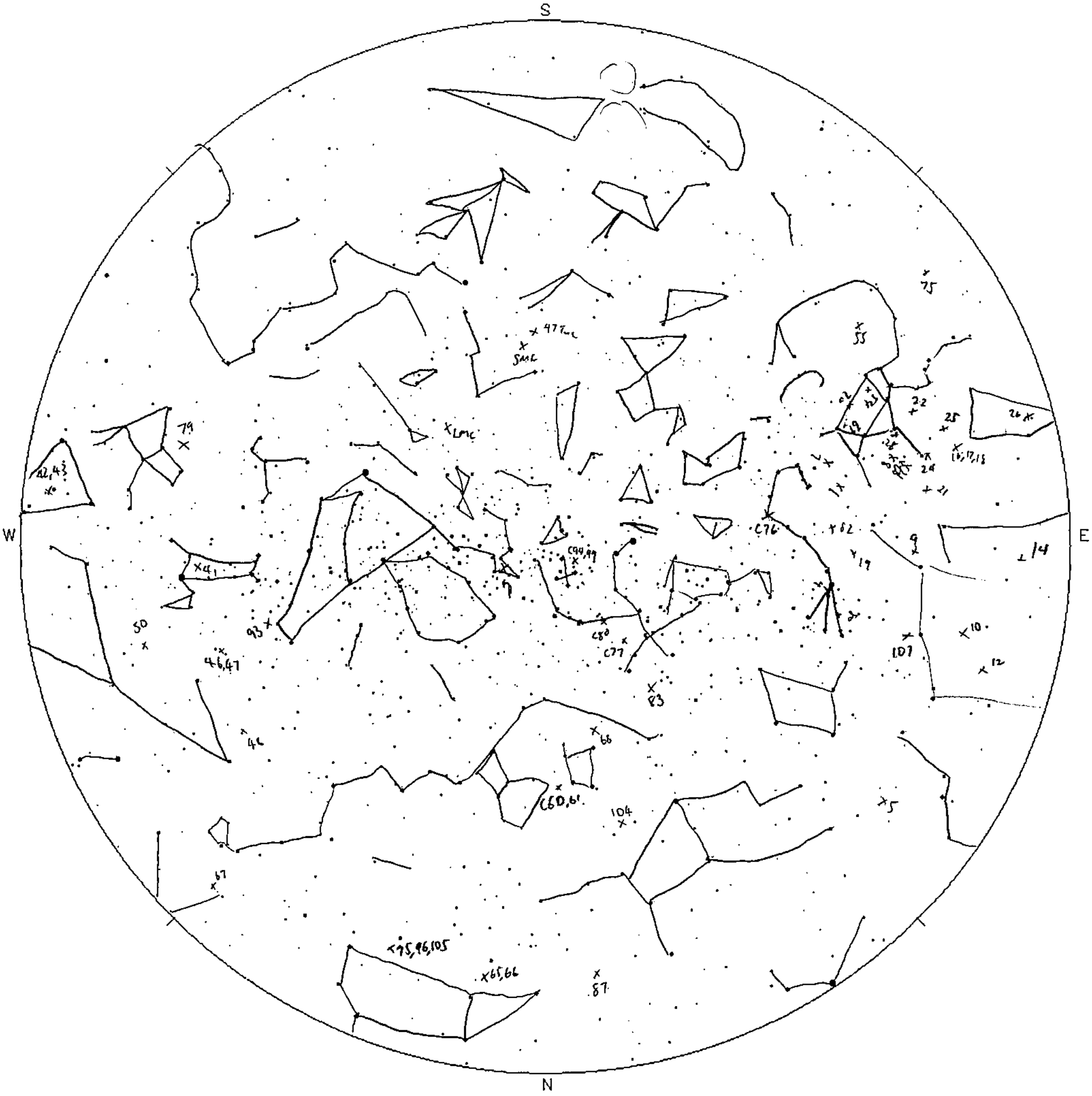
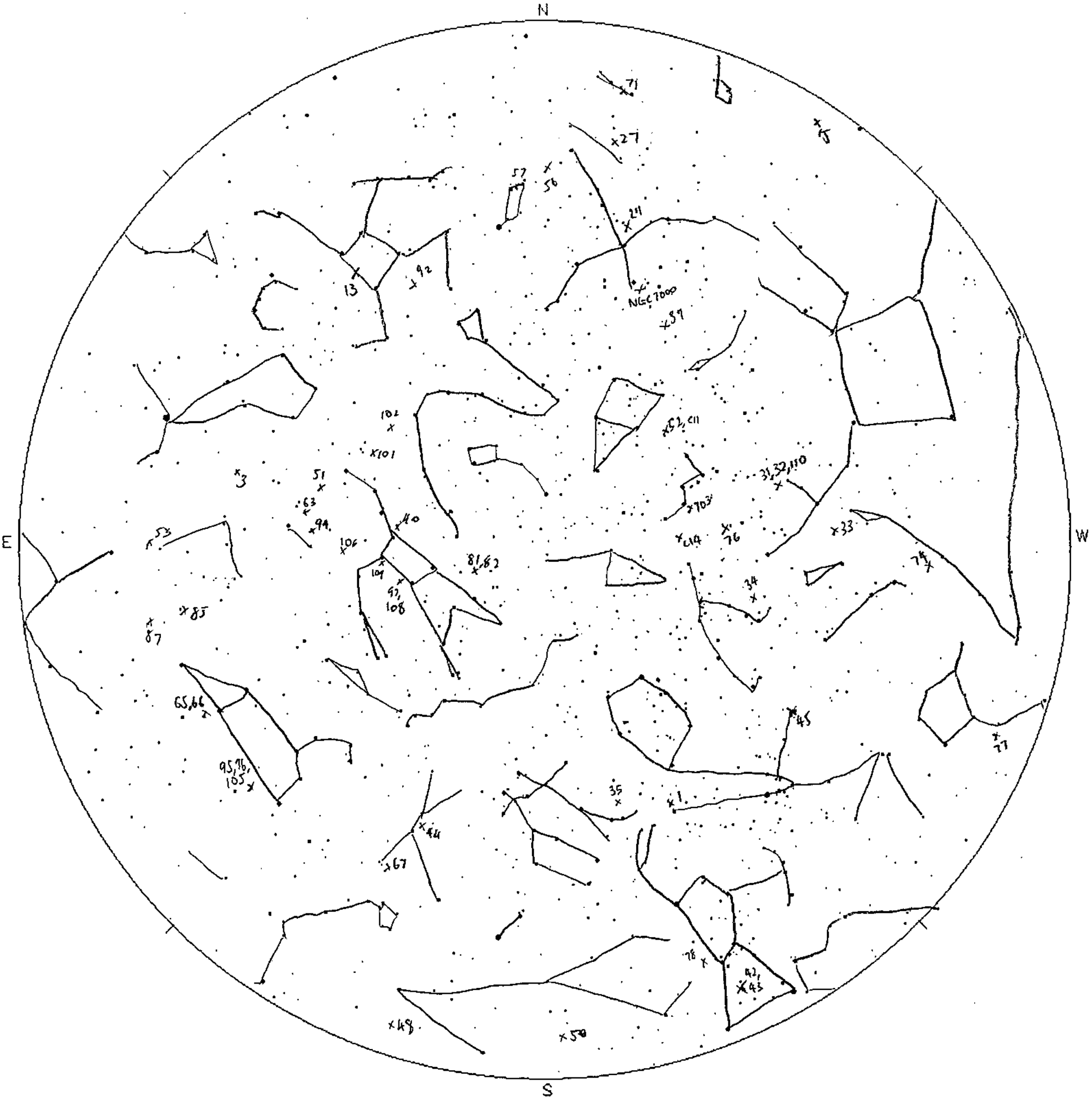


Switzerland star map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NGC7000
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101
52, C11
31, 32, 110
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94
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106
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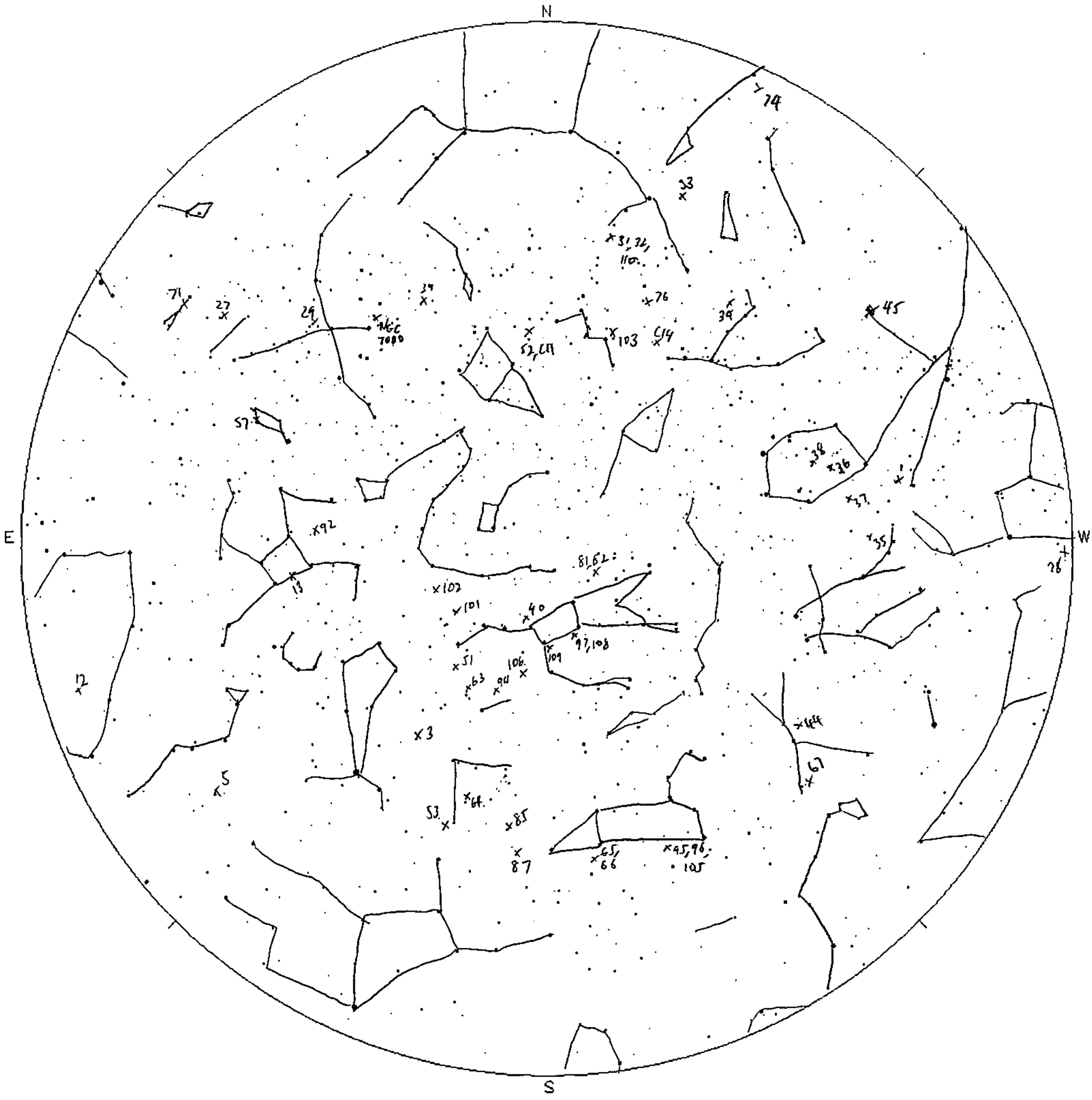
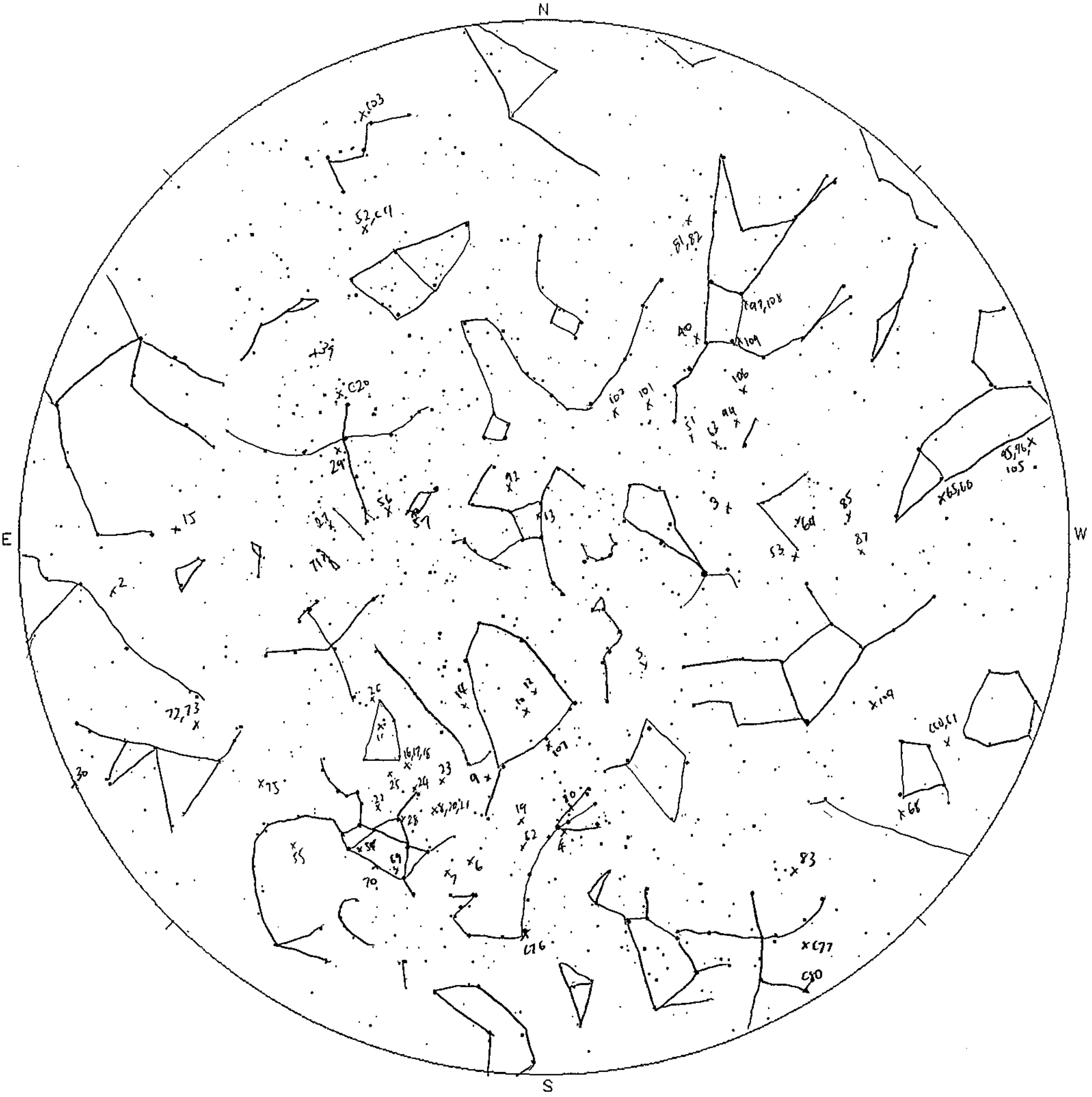


Back in Singapore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C20
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97, 108
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109
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65, 66
95, 96, 105
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8, 10, 21
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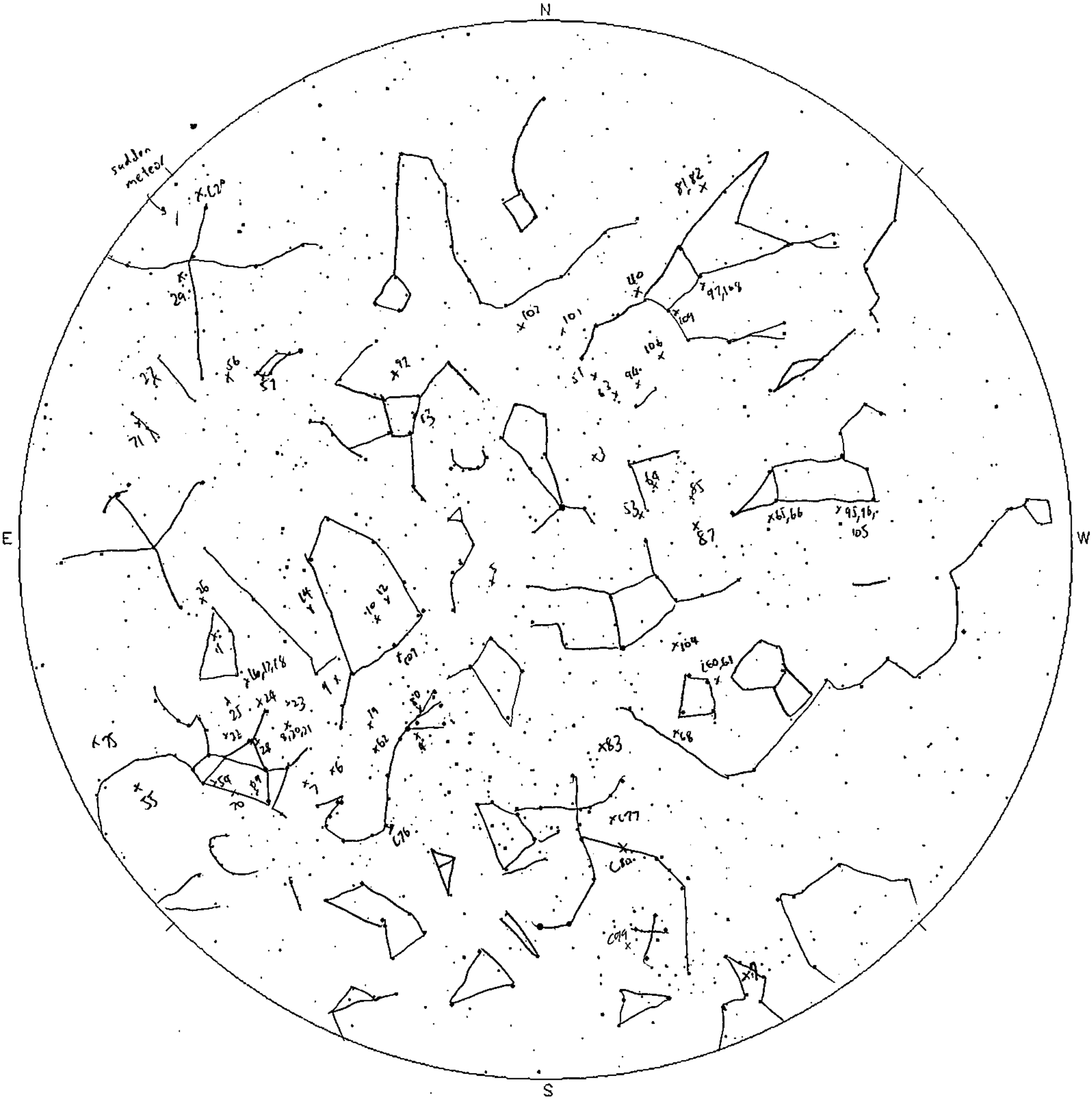
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81,82
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x 65,66
95,96, 105
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x 104
60,61
x 16,17,18
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x 24
25
x 23
x 32
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x 75
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x 6
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x 83
x 68
C76
x C77
C80
C99
x 9


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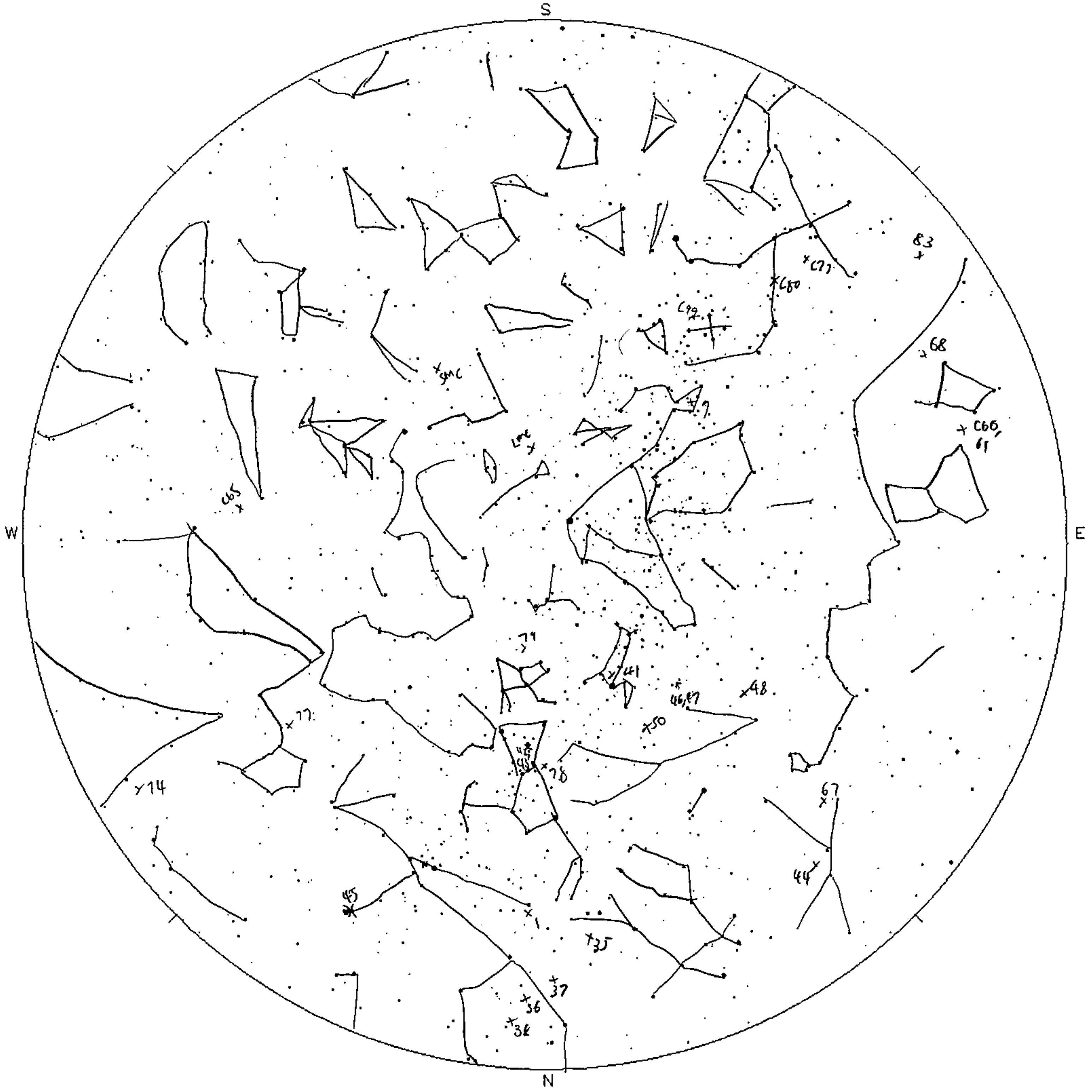
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SMC
LMC
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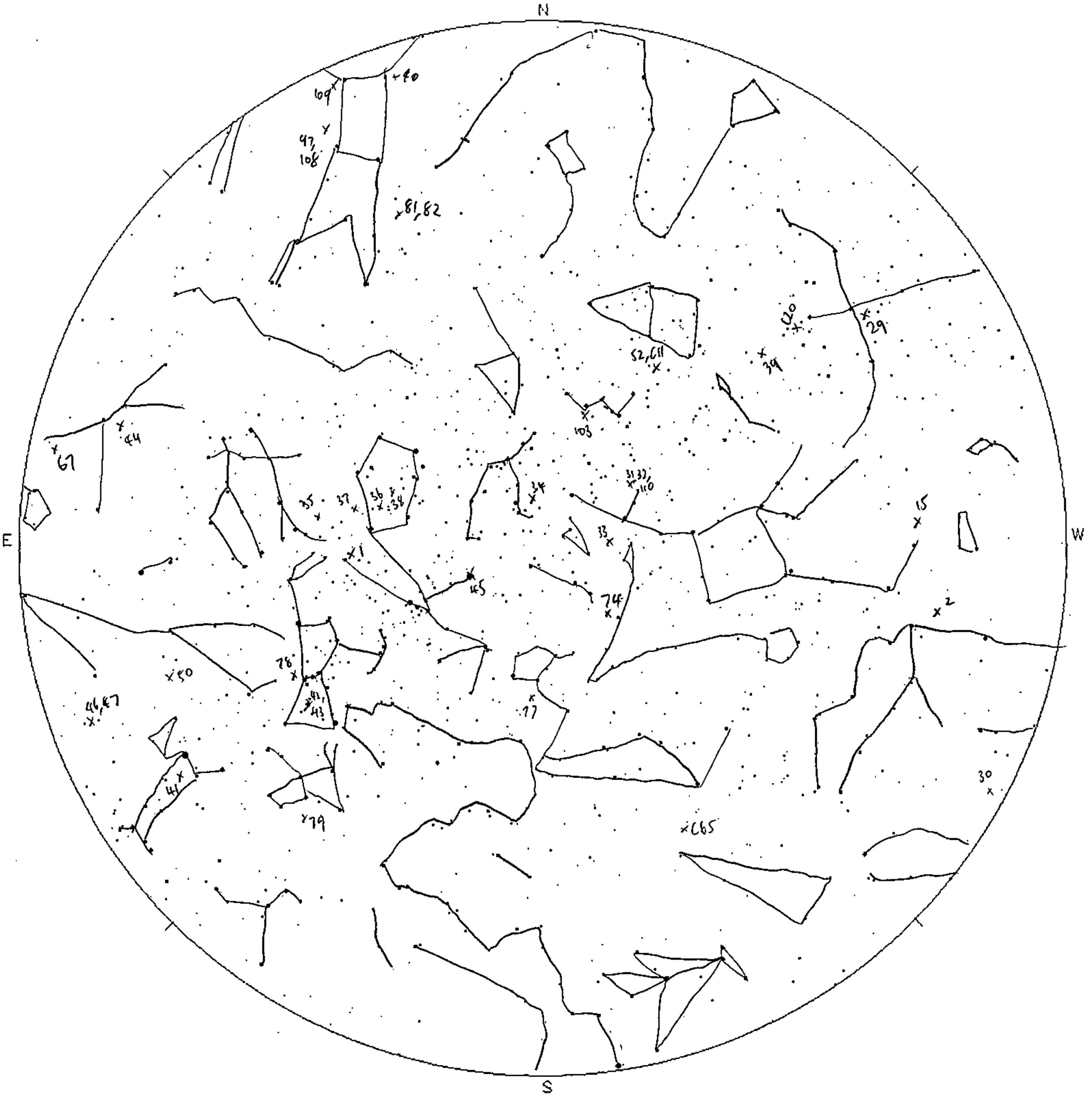
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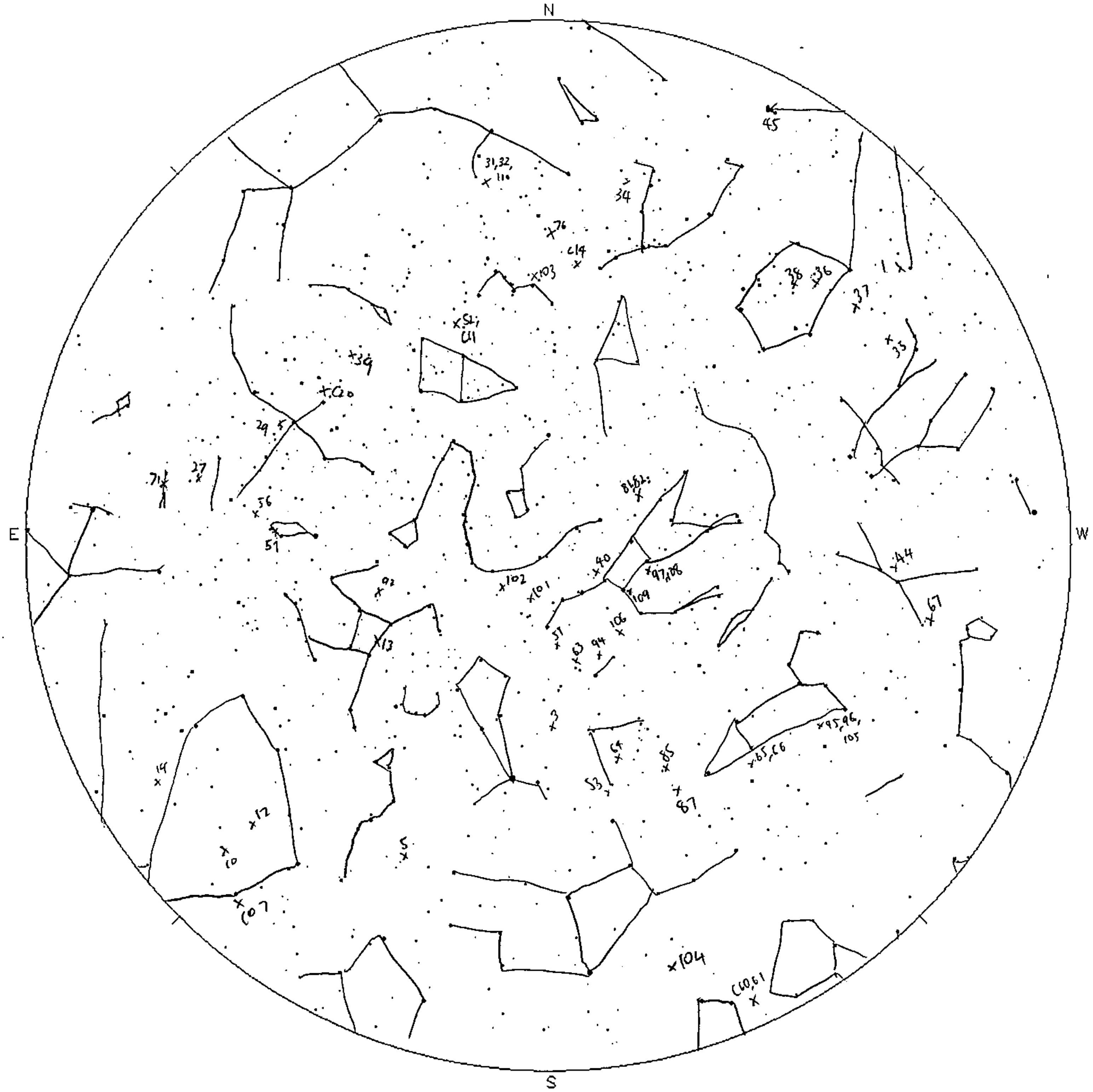
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C20
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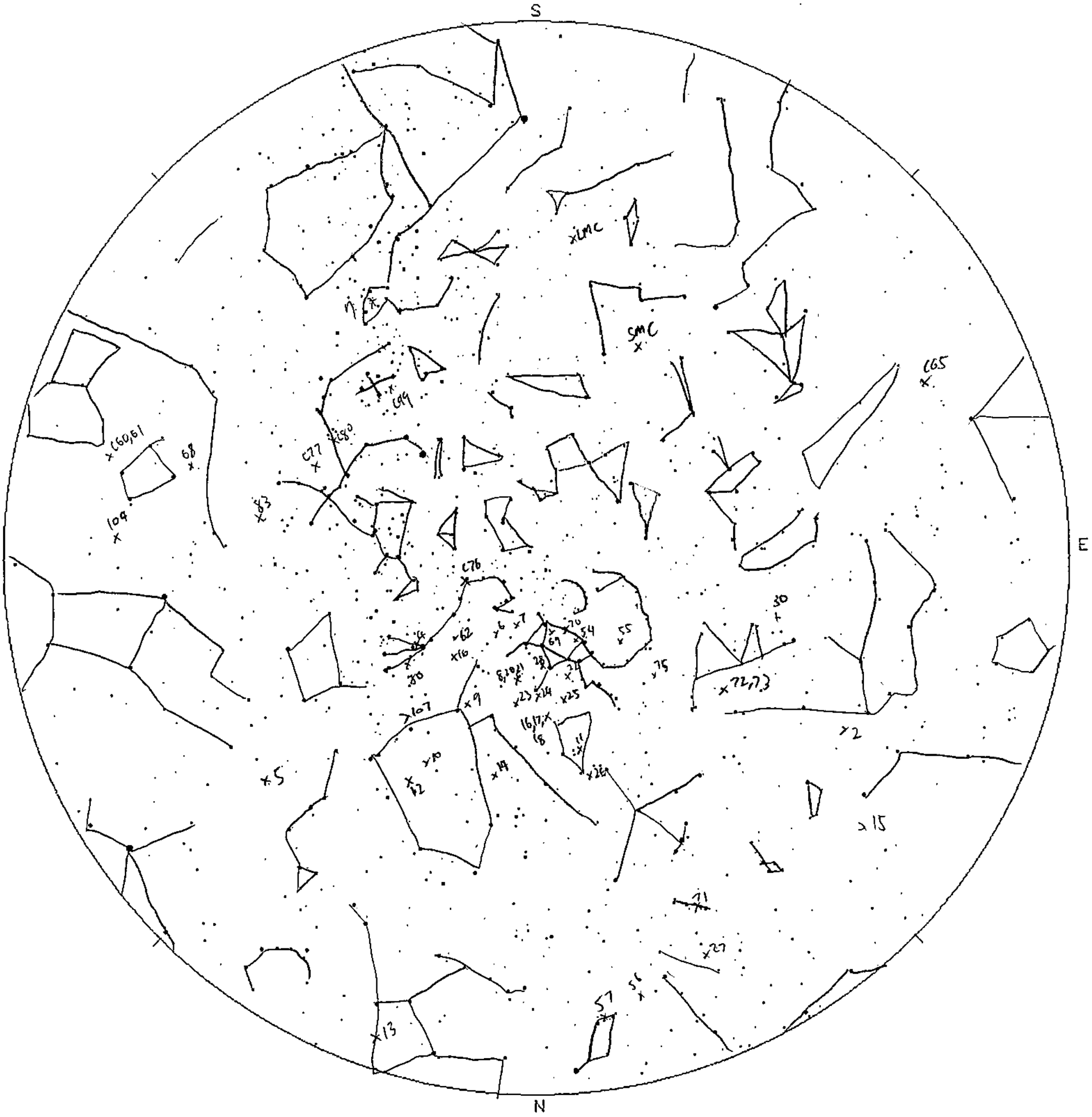
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CH4
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M1
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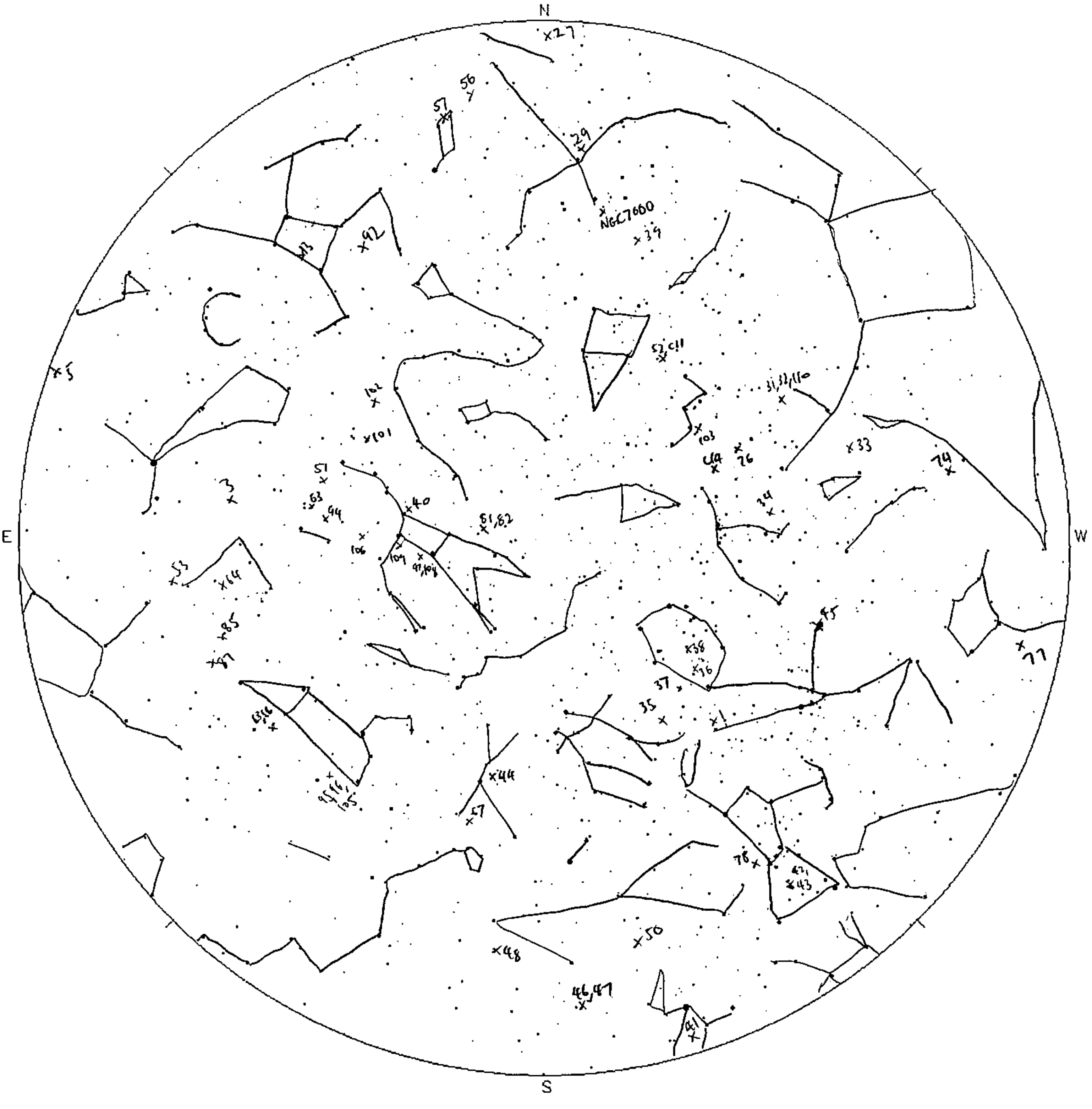
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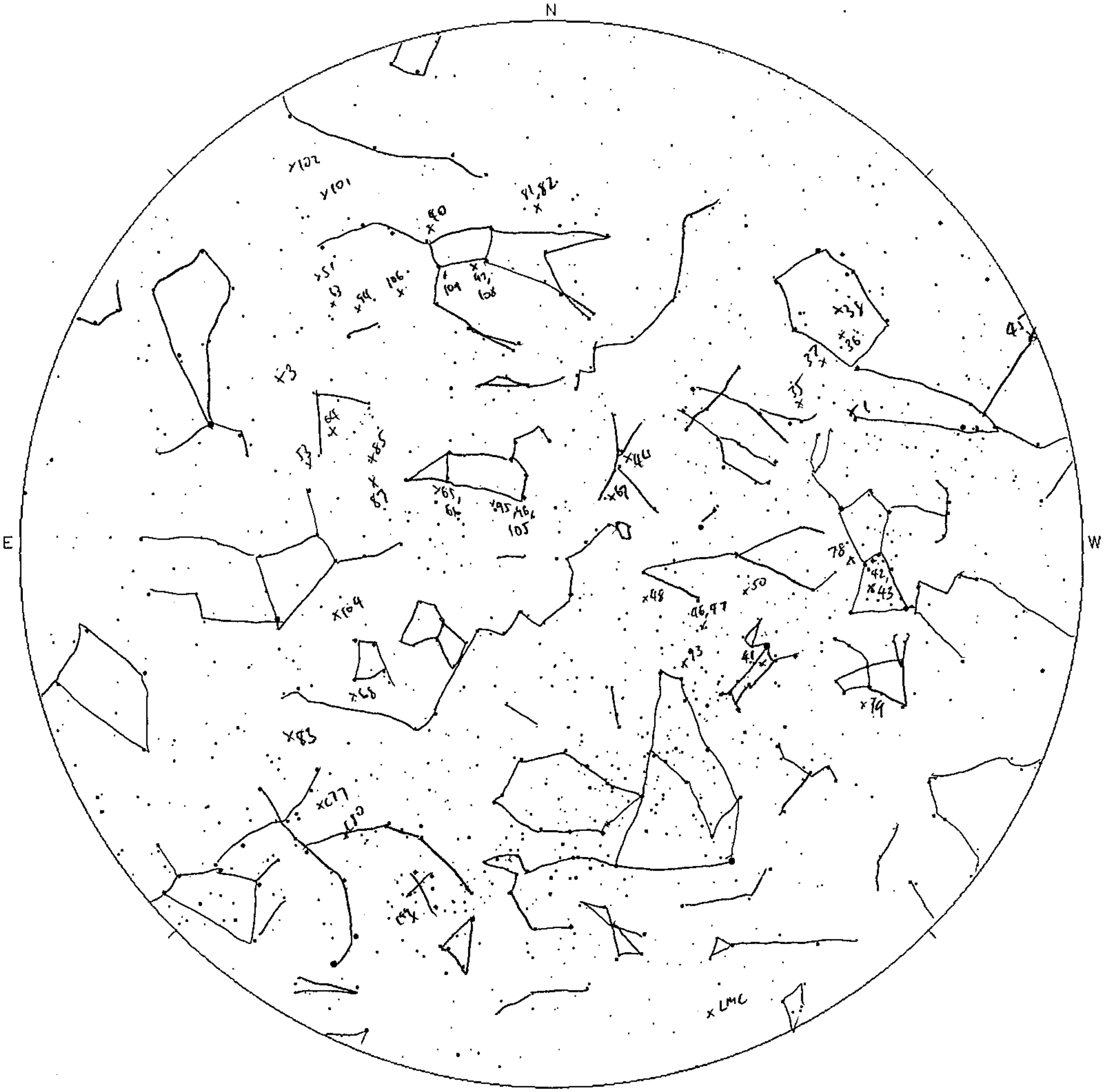
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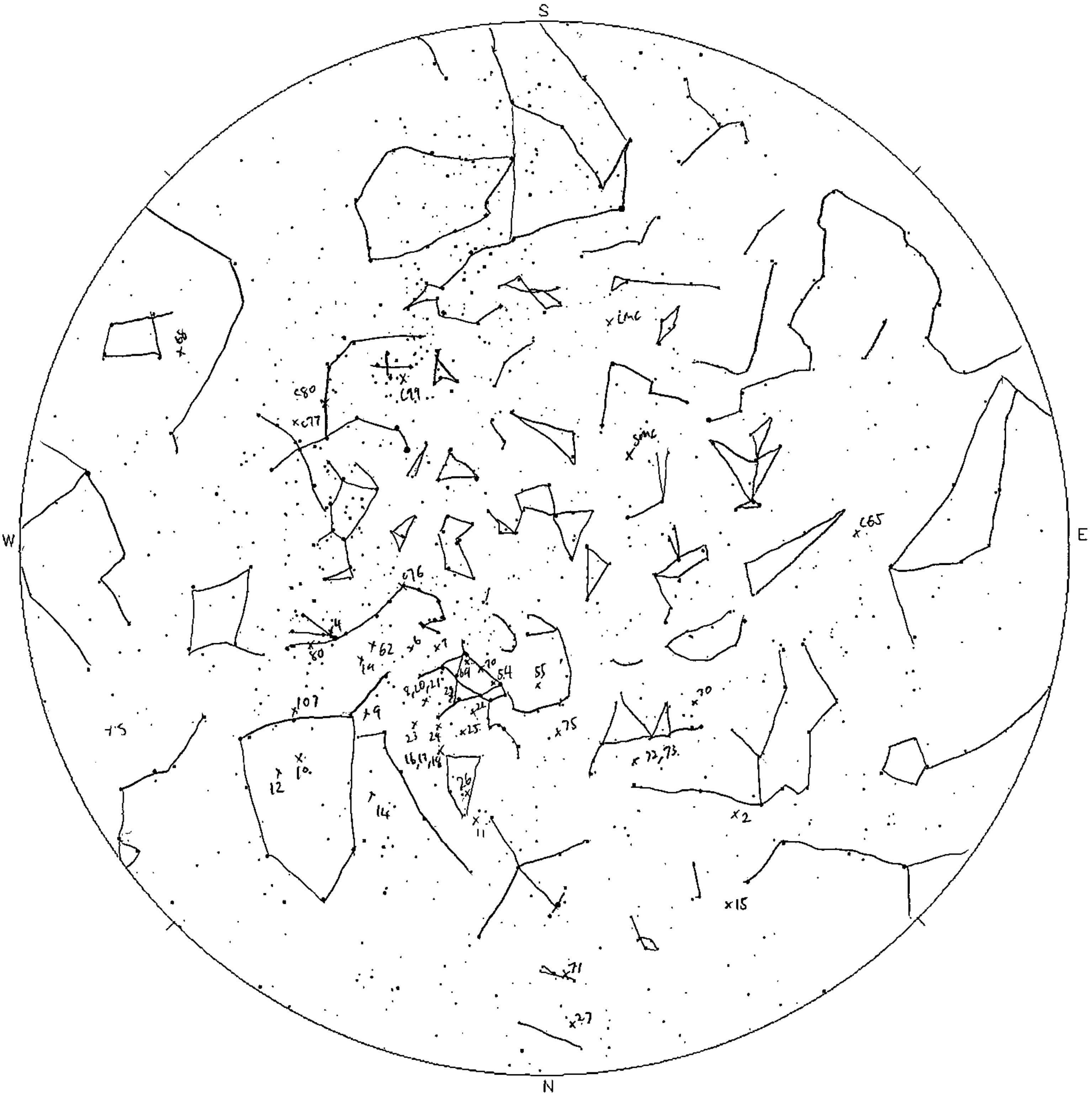
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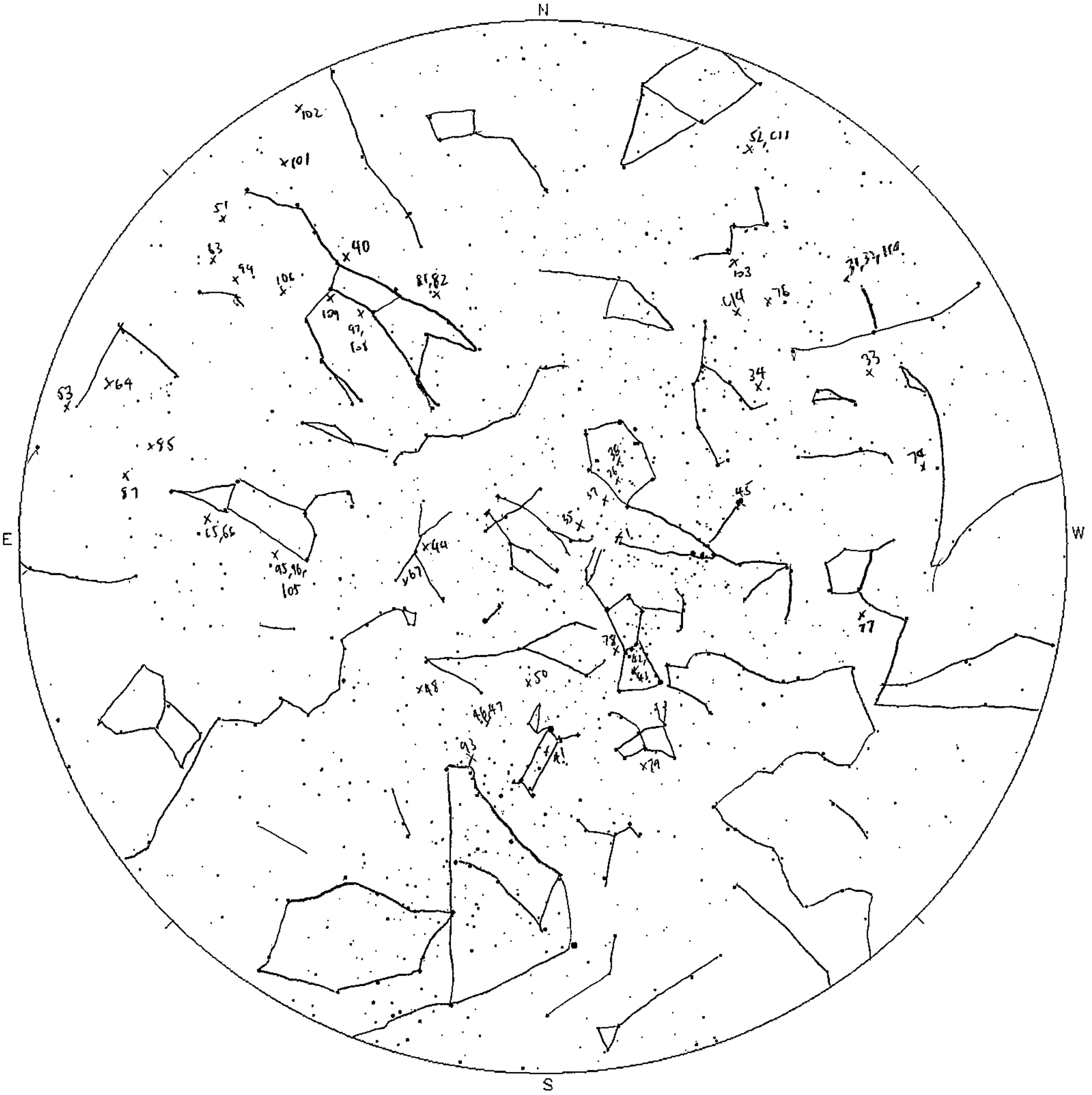
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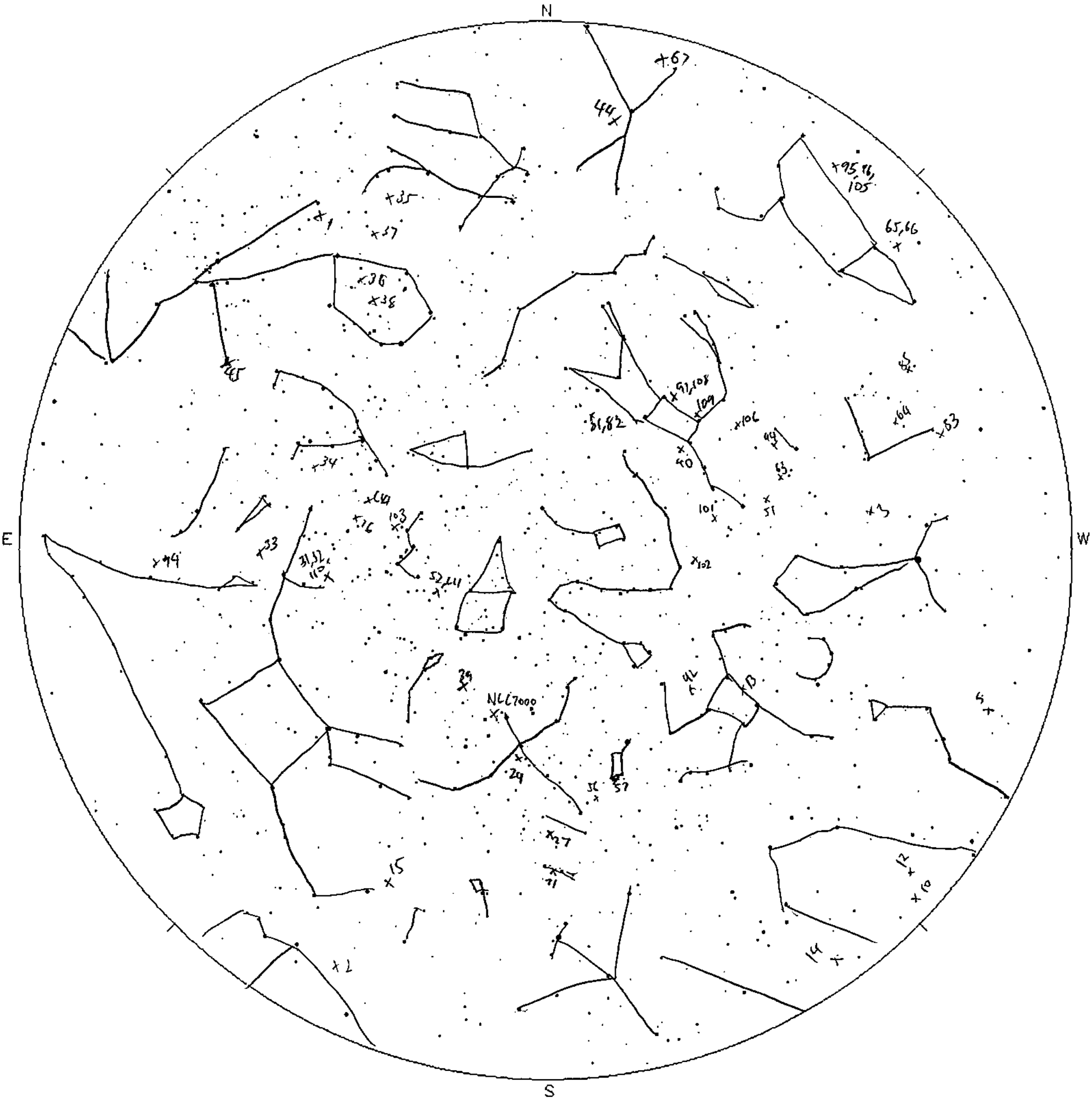
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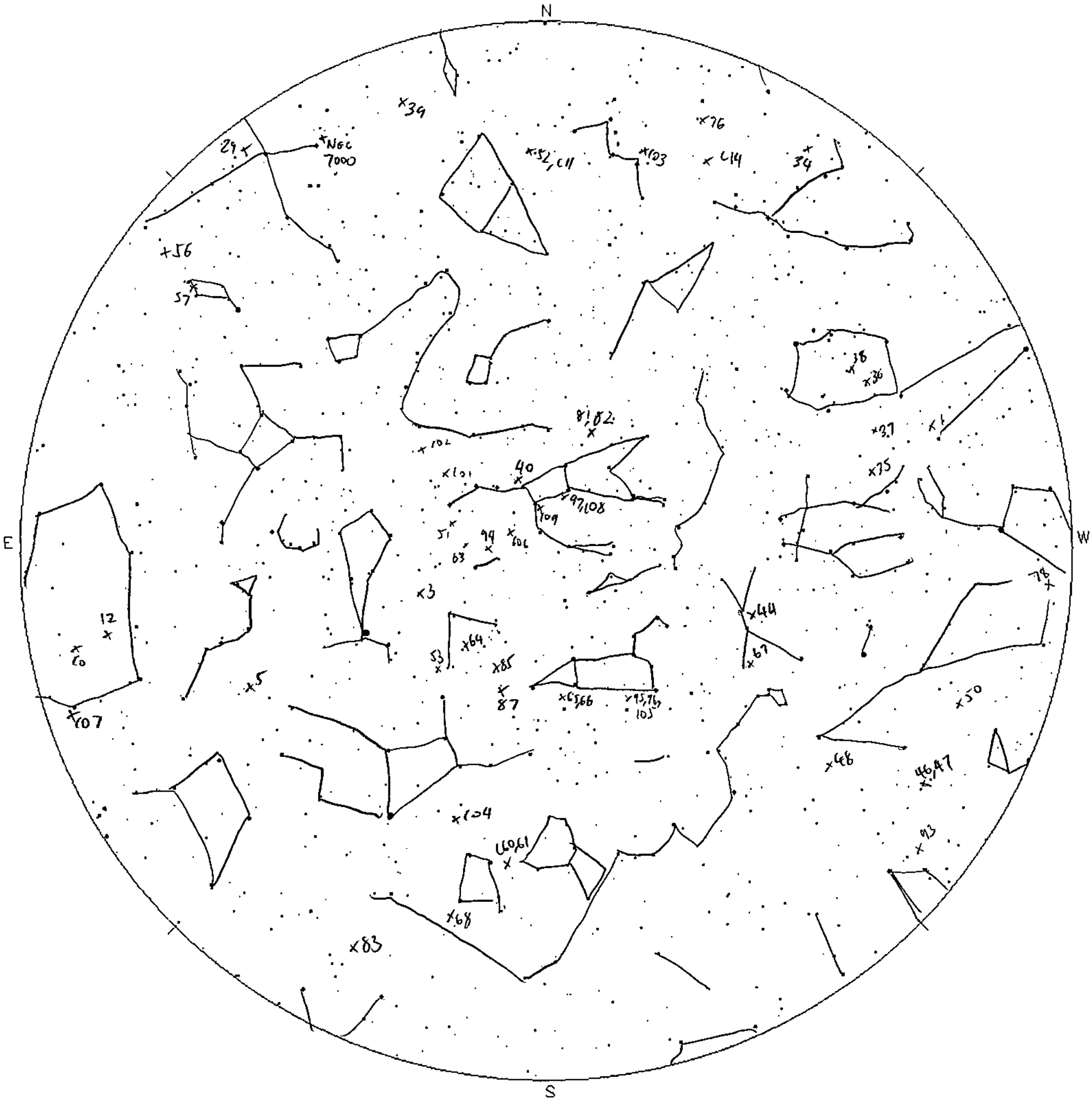
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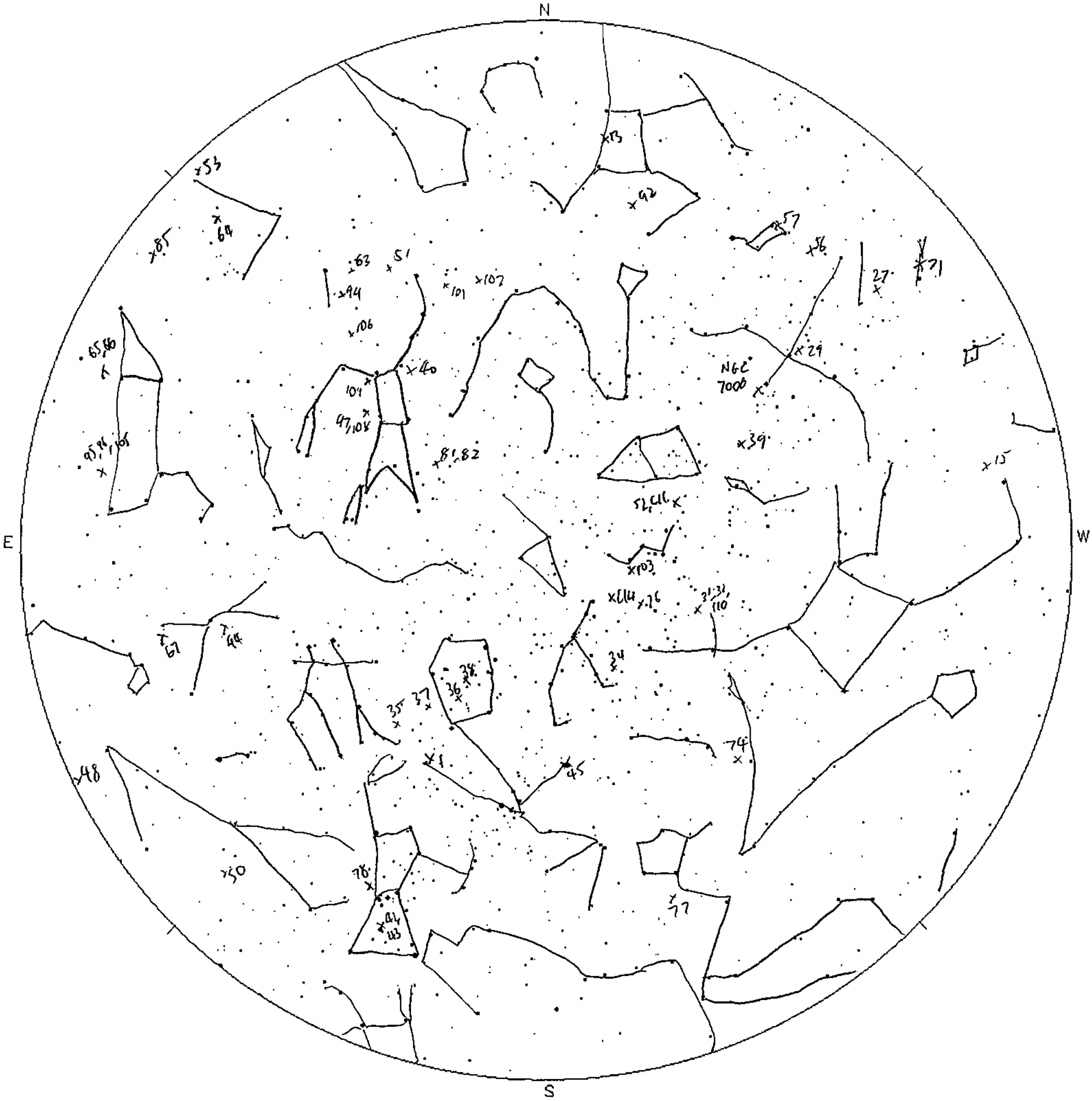
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114
76
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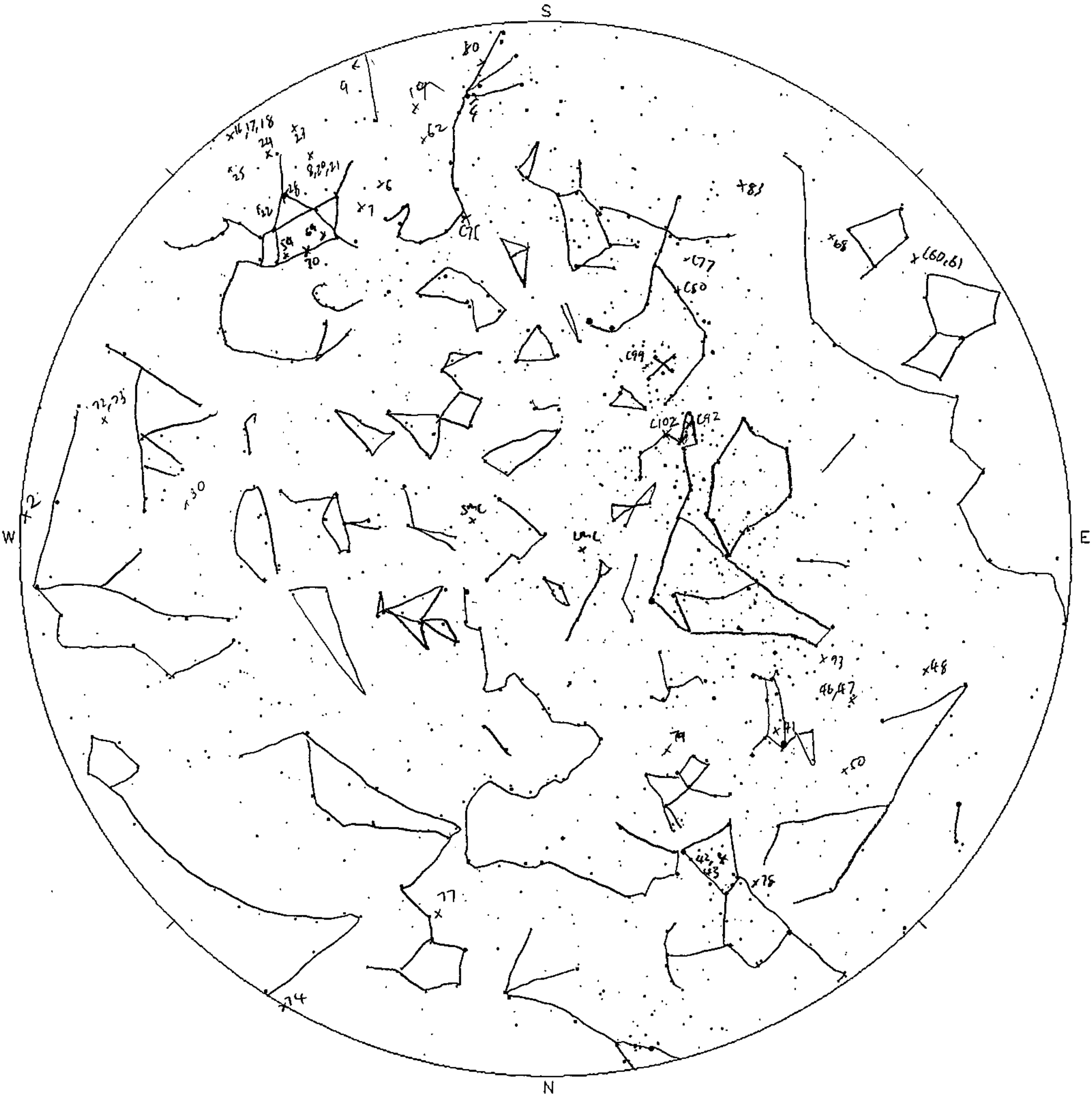
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C71
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C77
C50
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C99
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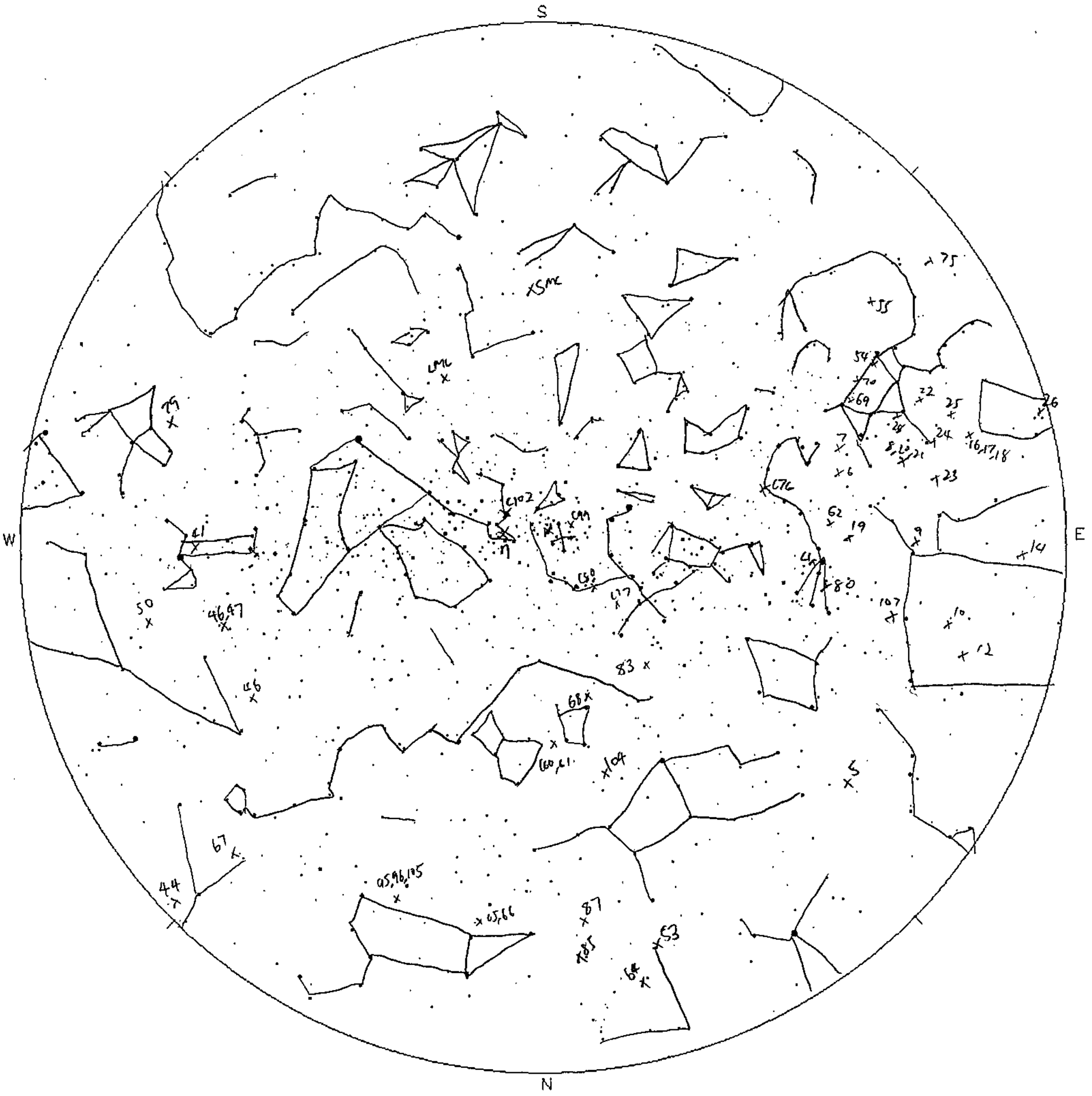
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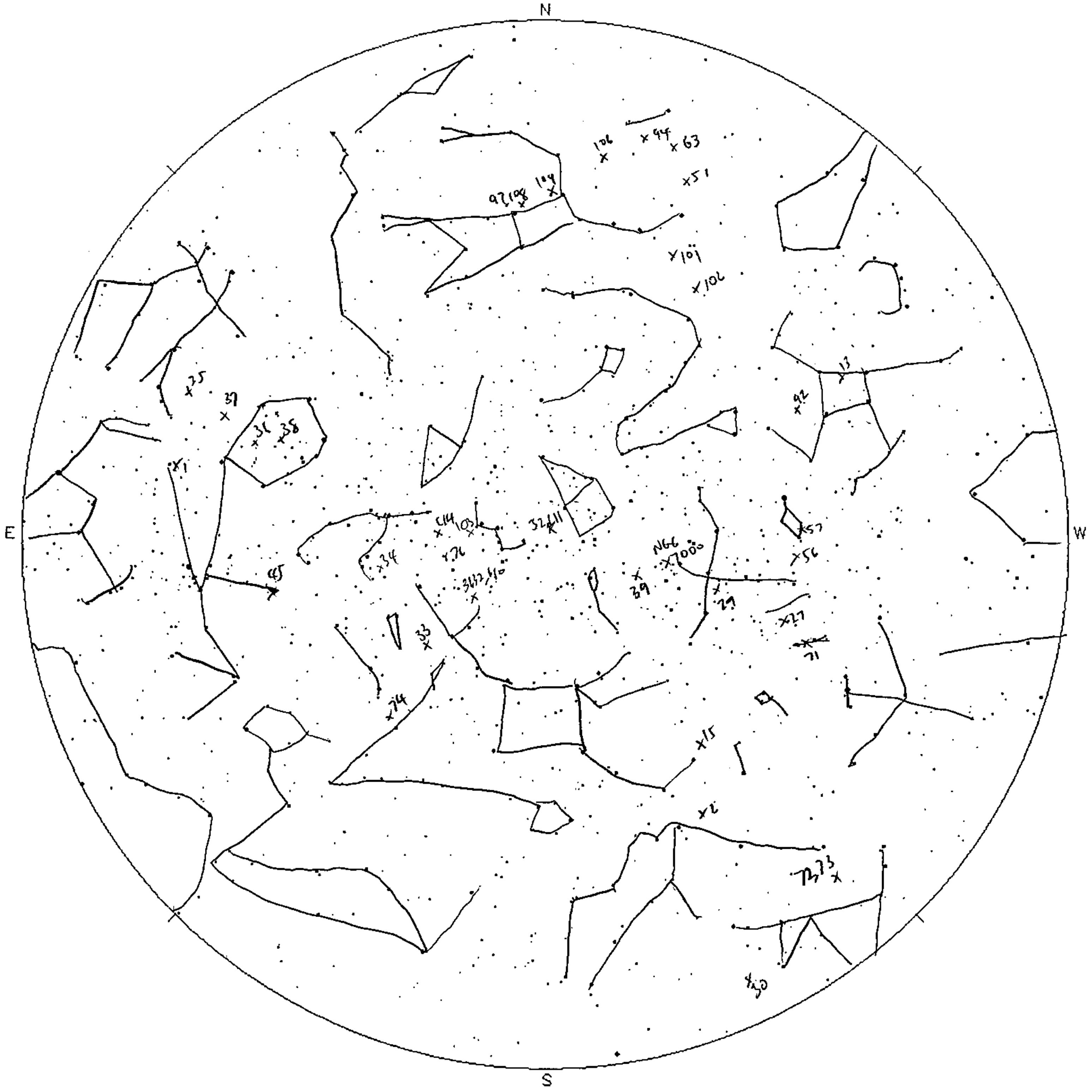
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C14
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32 & 11
76
34
36 37 38
33
74
NGC 7000
39
29
57
56
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71
92
13
15
2
72 73
30


S
W
E
N
C63
C77
C80
C99
η
C102
41
+LMC
79
SMC
80
64
19
62
107
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8,20
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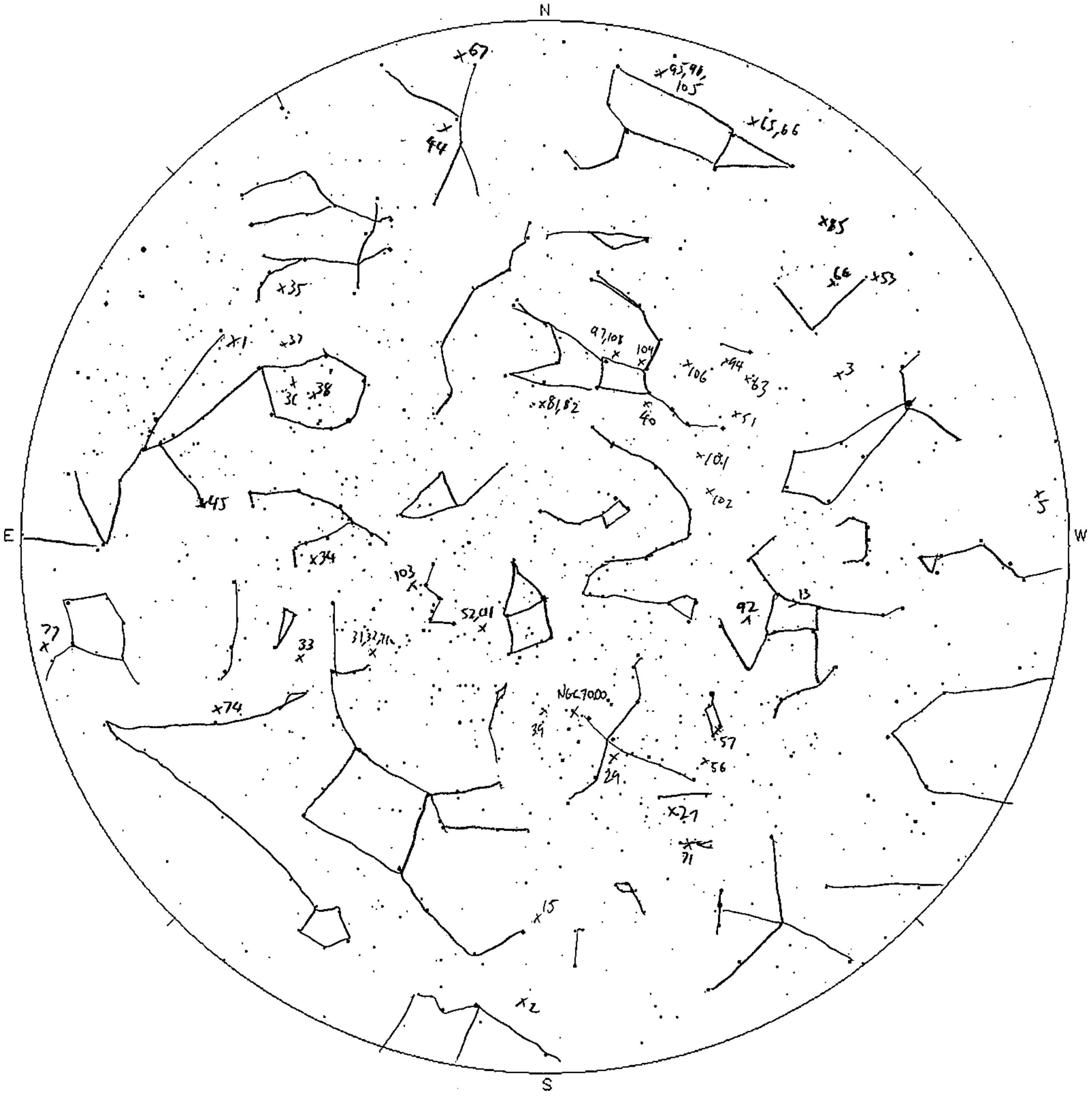
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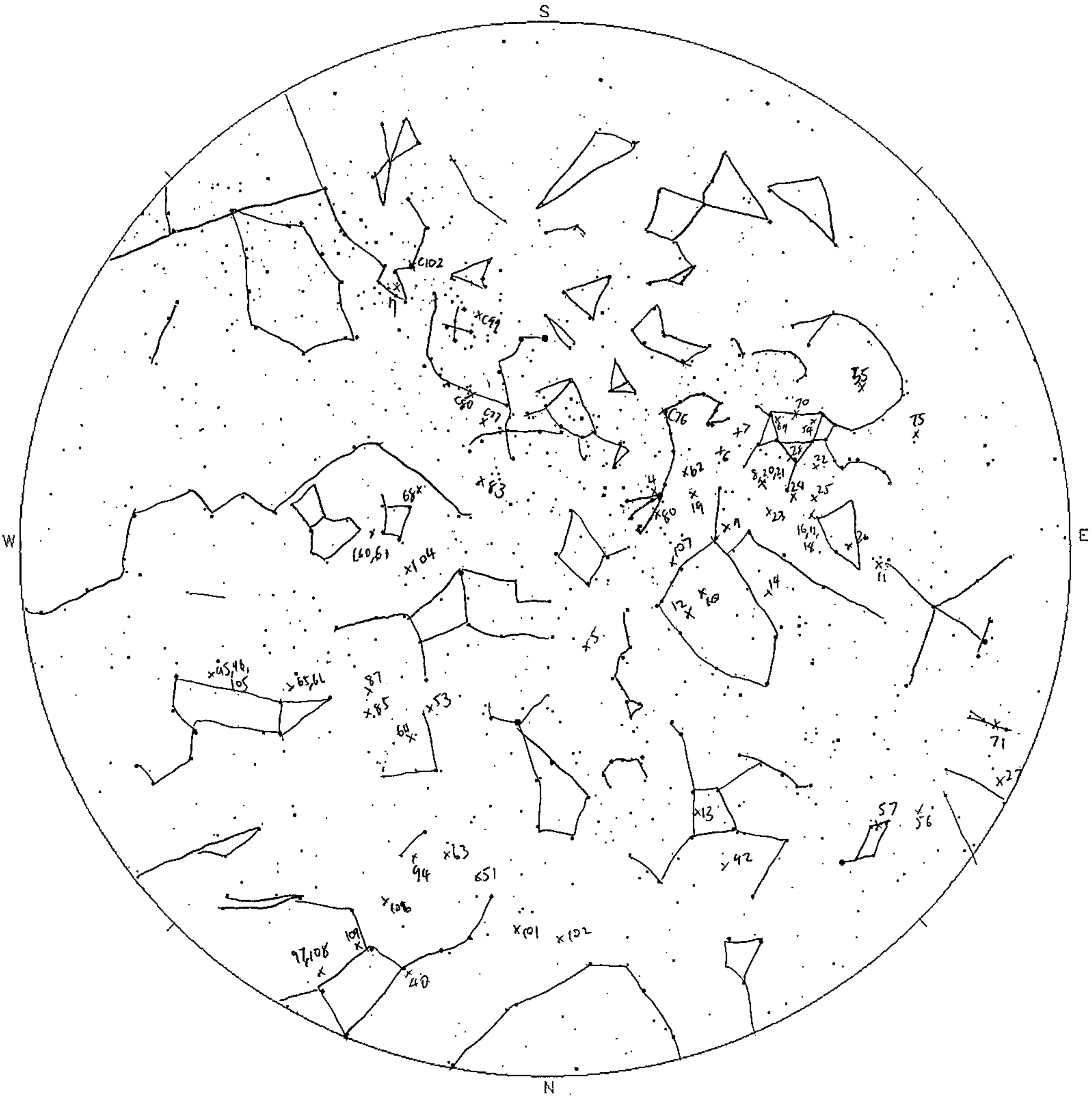
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16,17,18
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107
14
12
10
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45,46,105
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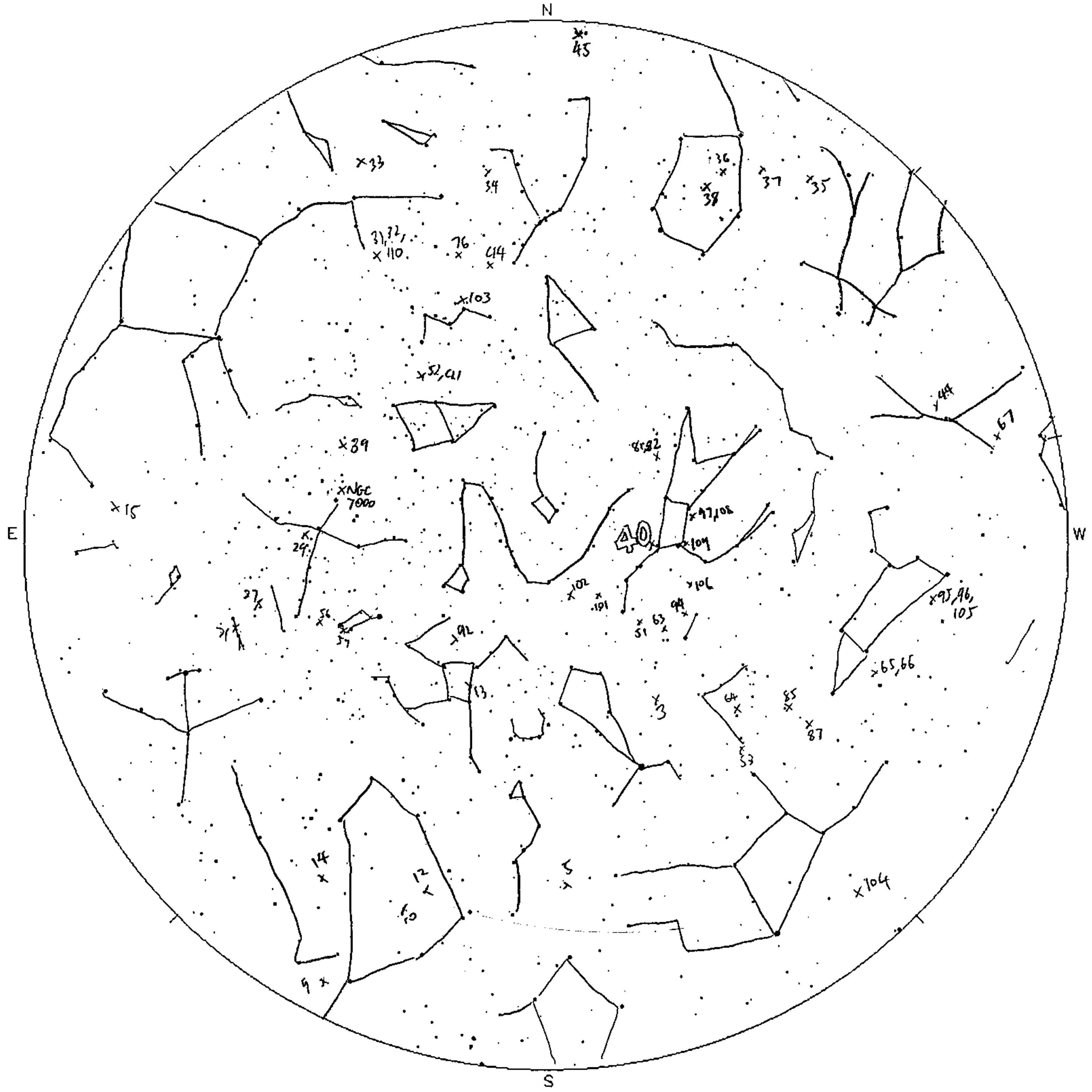
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E
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NGC 7000
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97,108
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W
102
101
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105
65,66
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3
64
85
87
53
14
12
10
5
104
9
S


S
12
10
14
107
9
11
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16,17,18
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22
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19,20,21
70
54
69
55
75
19
63
80
4
C78
83
104
C77
68
C60,61
C80
72,
73
2
30
C89
C102
SMC
LMC
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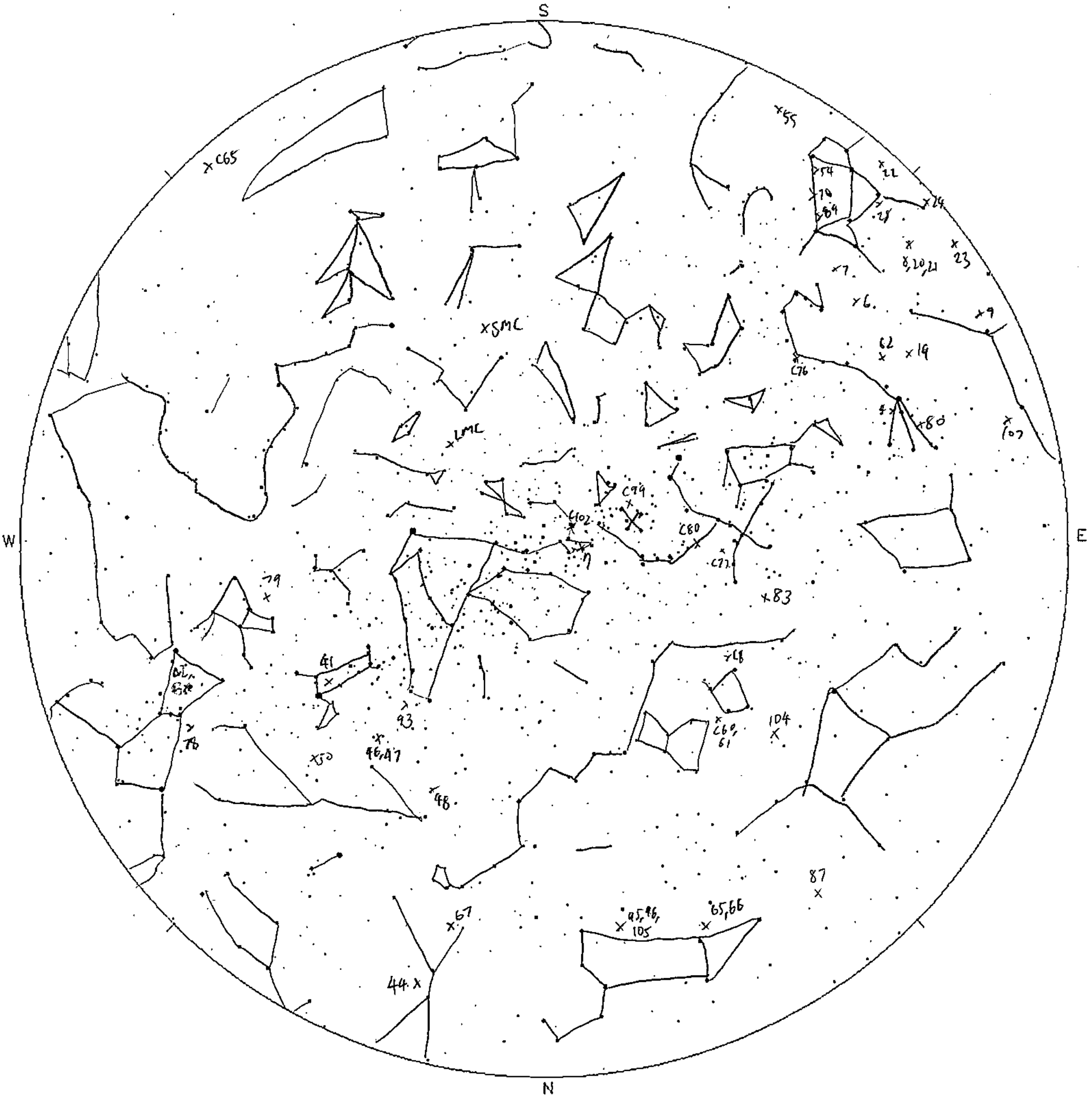
77
N

South pole

Slightly south equator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C102
C80
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C60,
61
87
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95,96,
105
65,66
44
N


S
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C77
S80
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22
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69
70
C97
C102
55
75
SMC
LMC
W
72, 73
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E
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93
46,47
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C65
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74
N


N
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57
NGC 7000
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31, 32, 110
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74
103
76
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61
102
101
81, 82
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51
63
94
106
109
97, 108
E
5
3
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W
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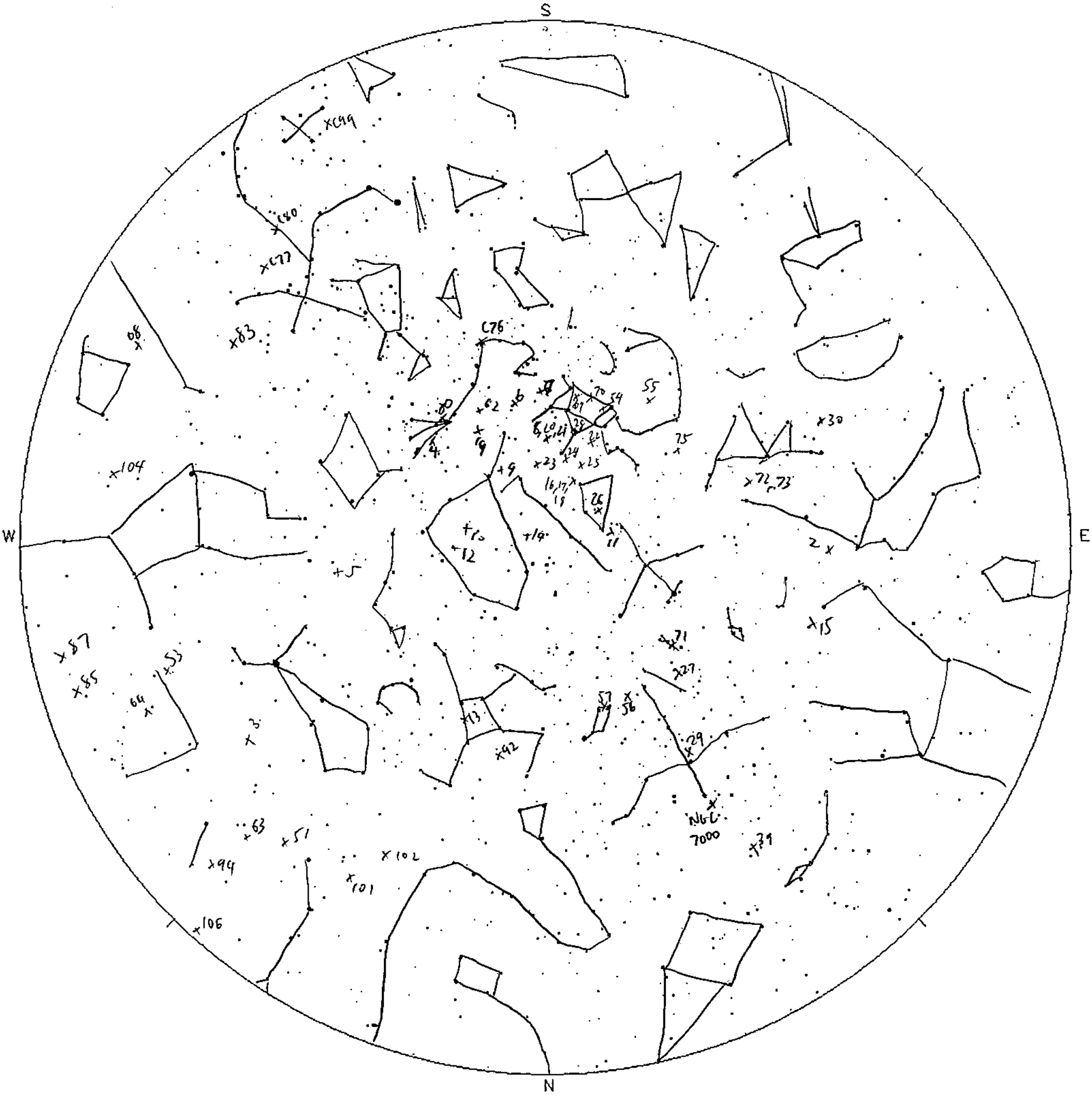
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C80
C77
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C76
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14
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81
70
54
55
60
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24
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16,17,
18
26
11
75
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72, 73
2
E
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71
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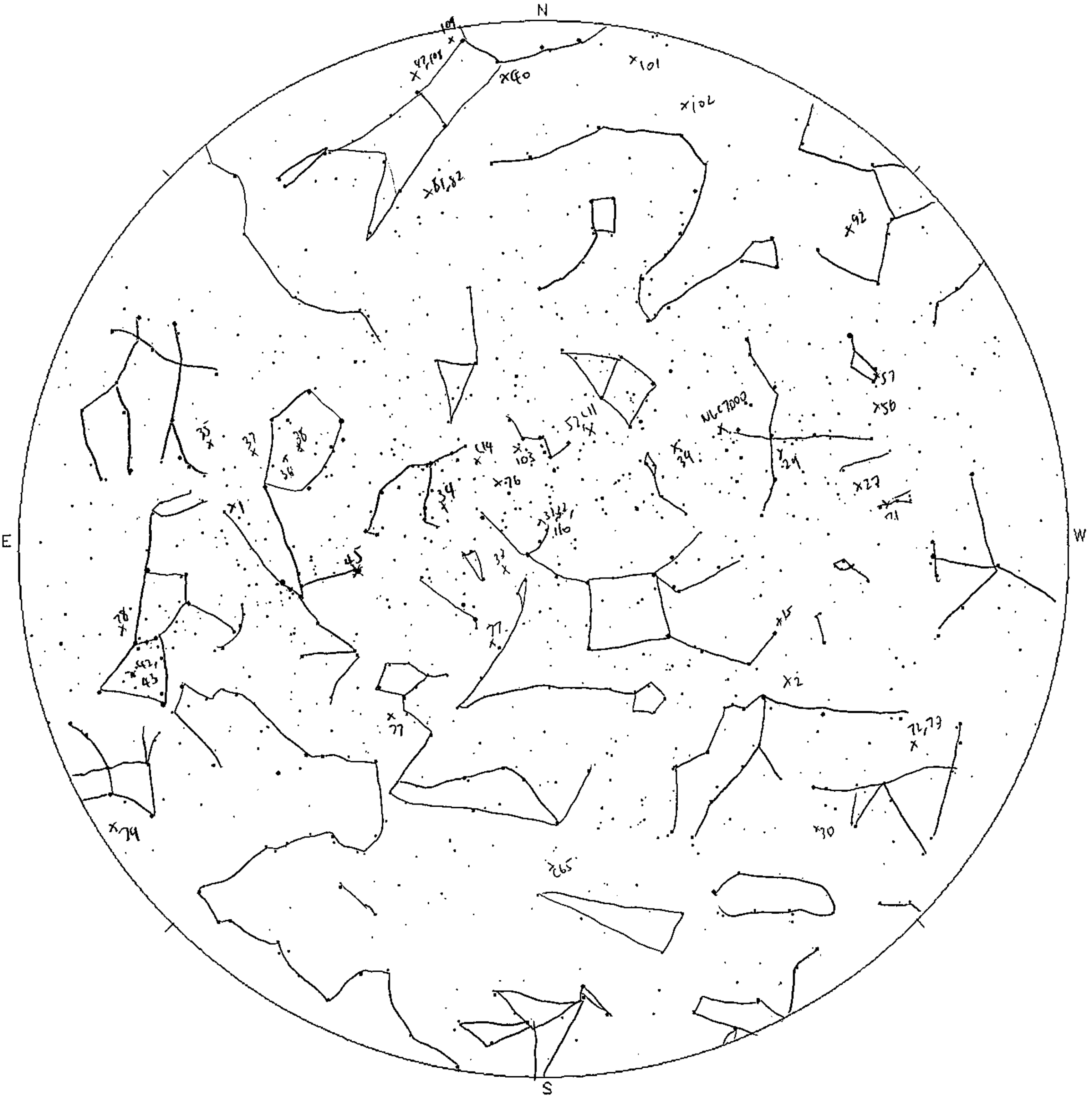
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C14
103
57,C11
76
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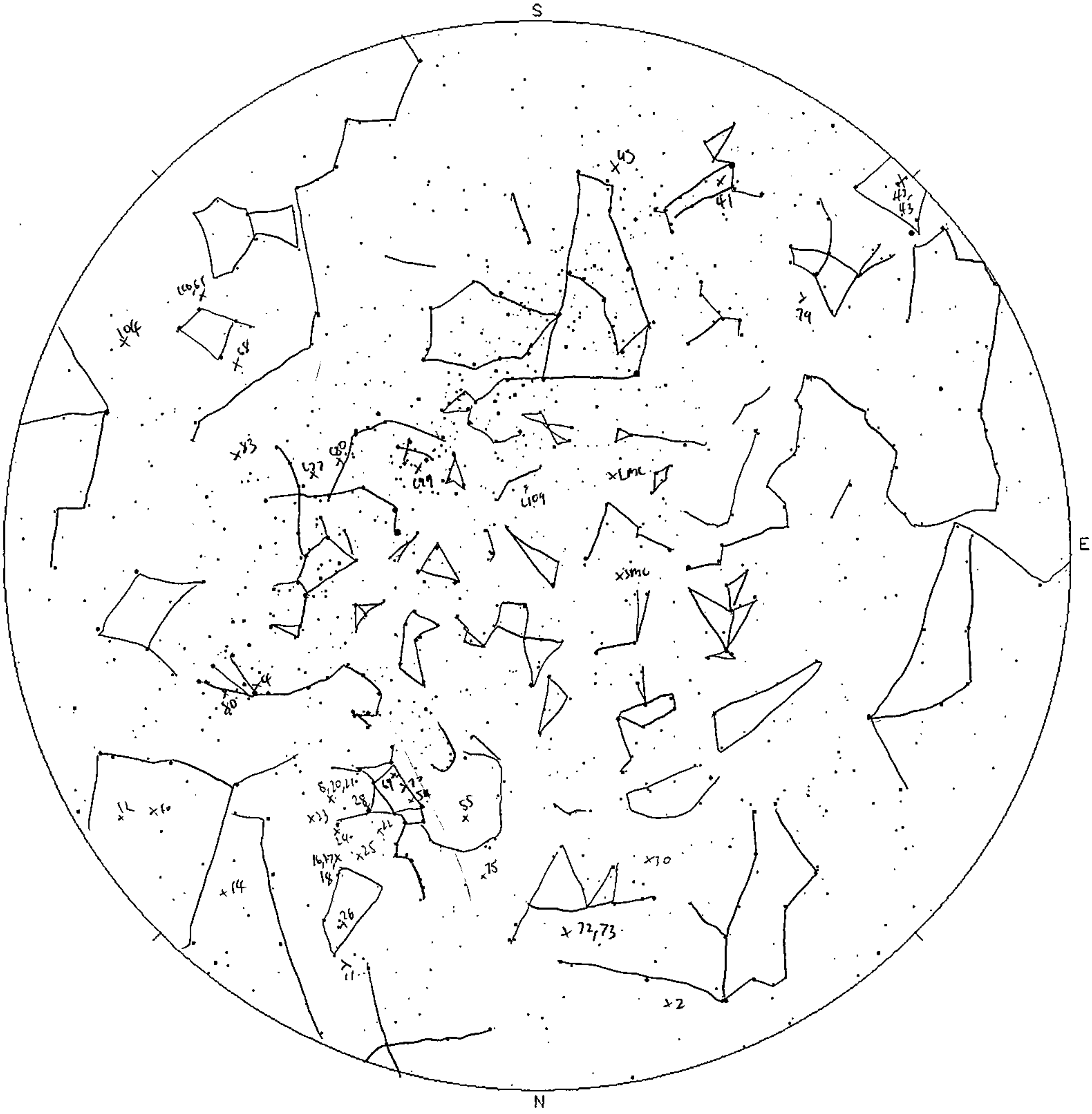
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W
E
N
x93
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43
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C60,61
x104
x68
x83
C77
C80
C99
C109
xLMC
xSMC
x4
80
12
x10
8,20,21
x23
28
69
x70
x54
55
x24
x22
16,17x
18
x25
x26
x75
x11
x14
x30
x72,73
x2


S
35
54
70
69
58
9,120,121
71
6
9
SMC
62
19
C76
LMC
80
107
C62
C80
C77
W
E
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41,93
68
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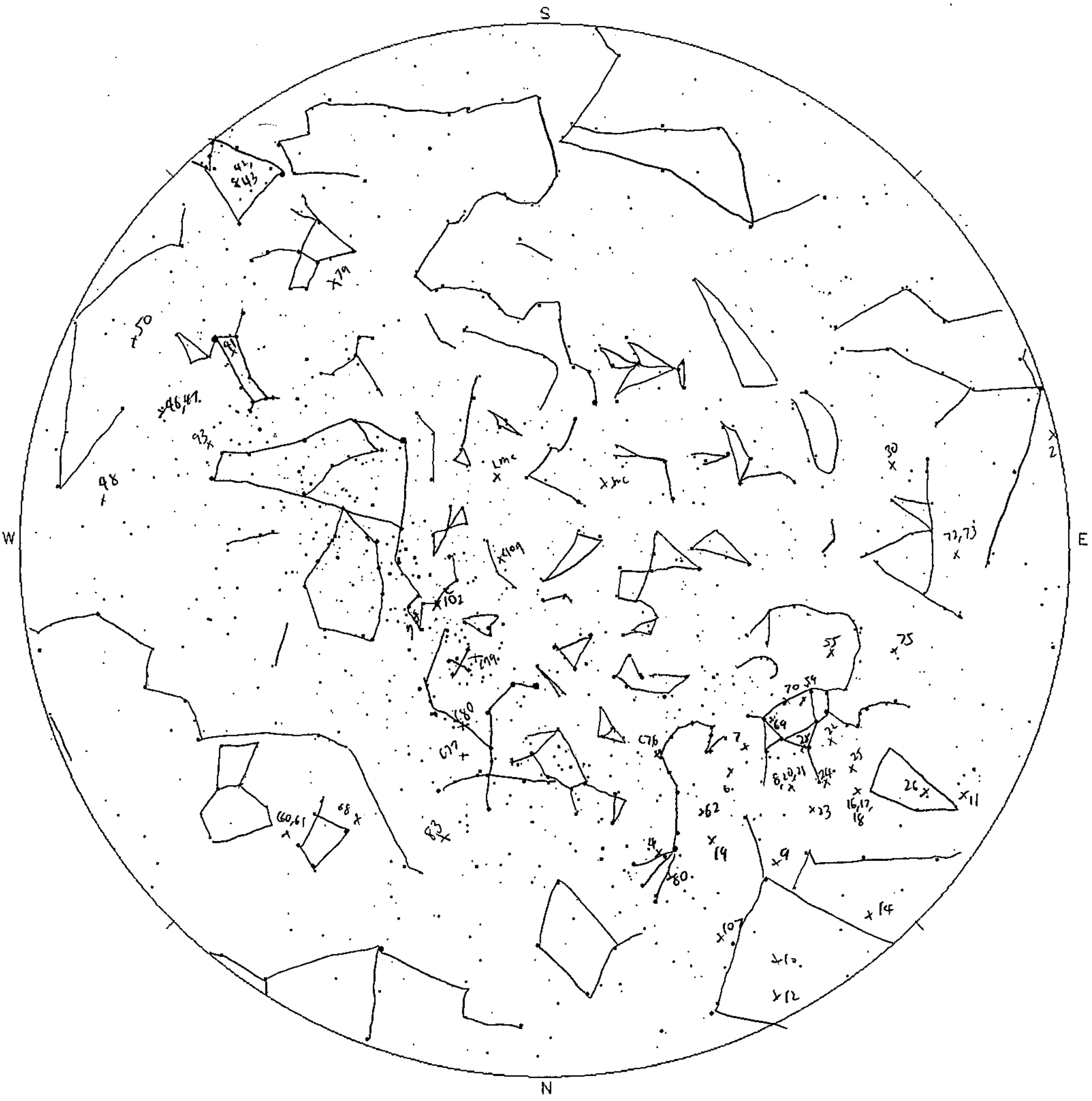
N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E
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LMC
SMC
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102
9
279
180
C77
C76
83
60,61
68
55
75
70
54
69
28
22
7
6
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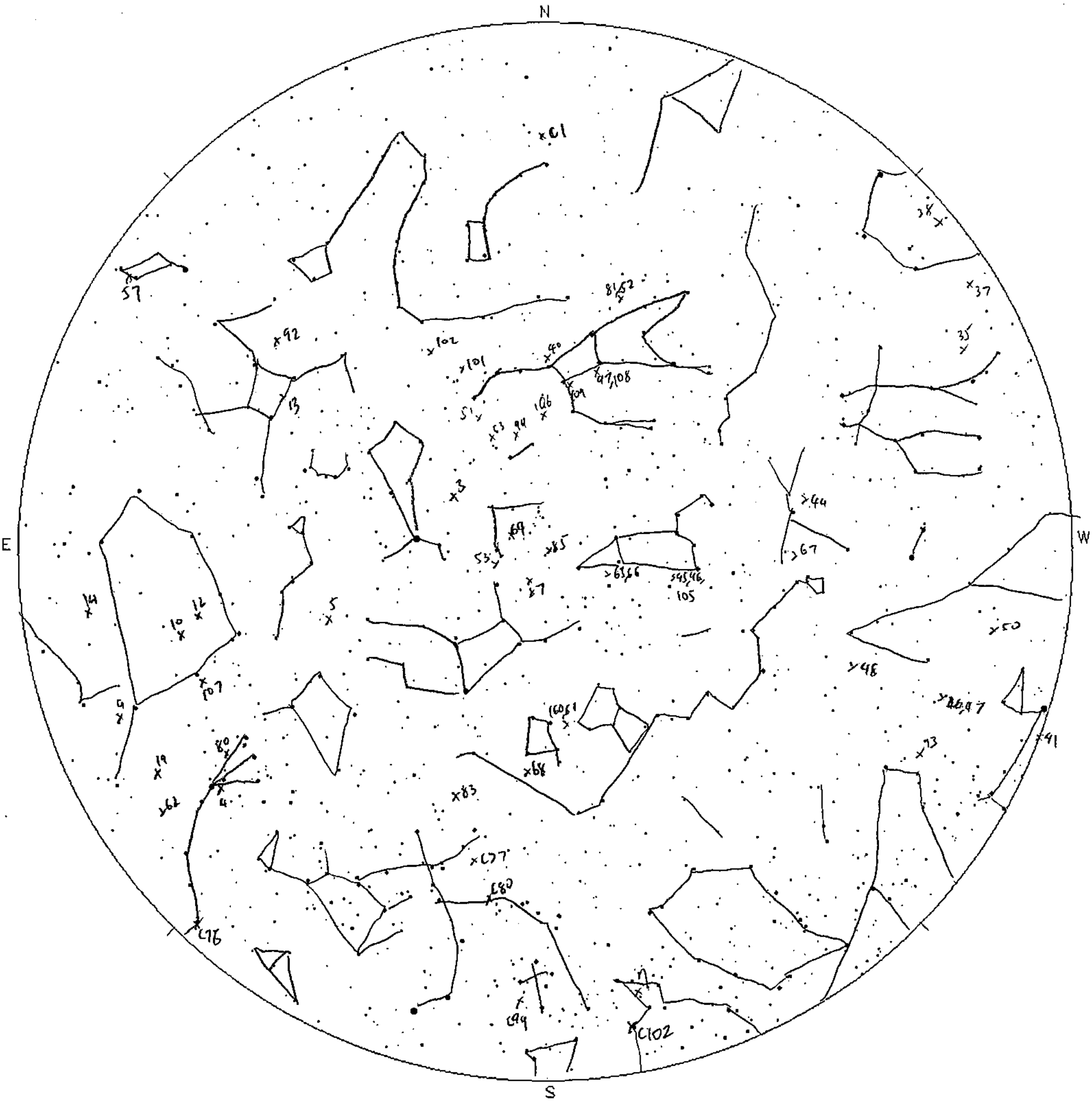
107
12
12

South pole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W
S
x61
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x92
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x102
x101
x40
81,52
47,108
109
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106
x3
x44
x67
69
x85
53
x87
x63,66
54,45,46,
105
38
x37
35
14
10
12
5
107
9
19
80
4
x62
x50
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x26,97
x41
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x68
x83
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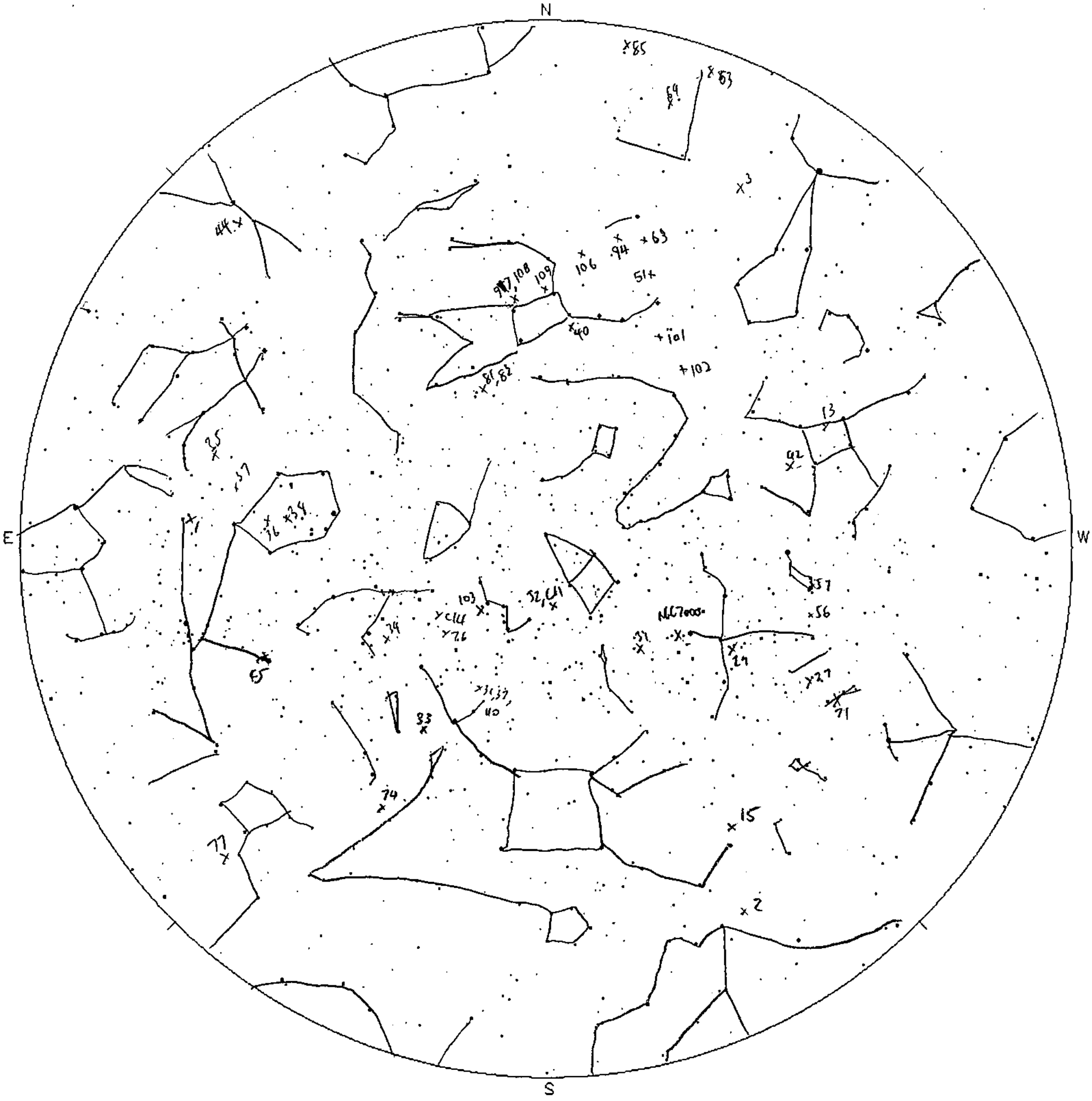
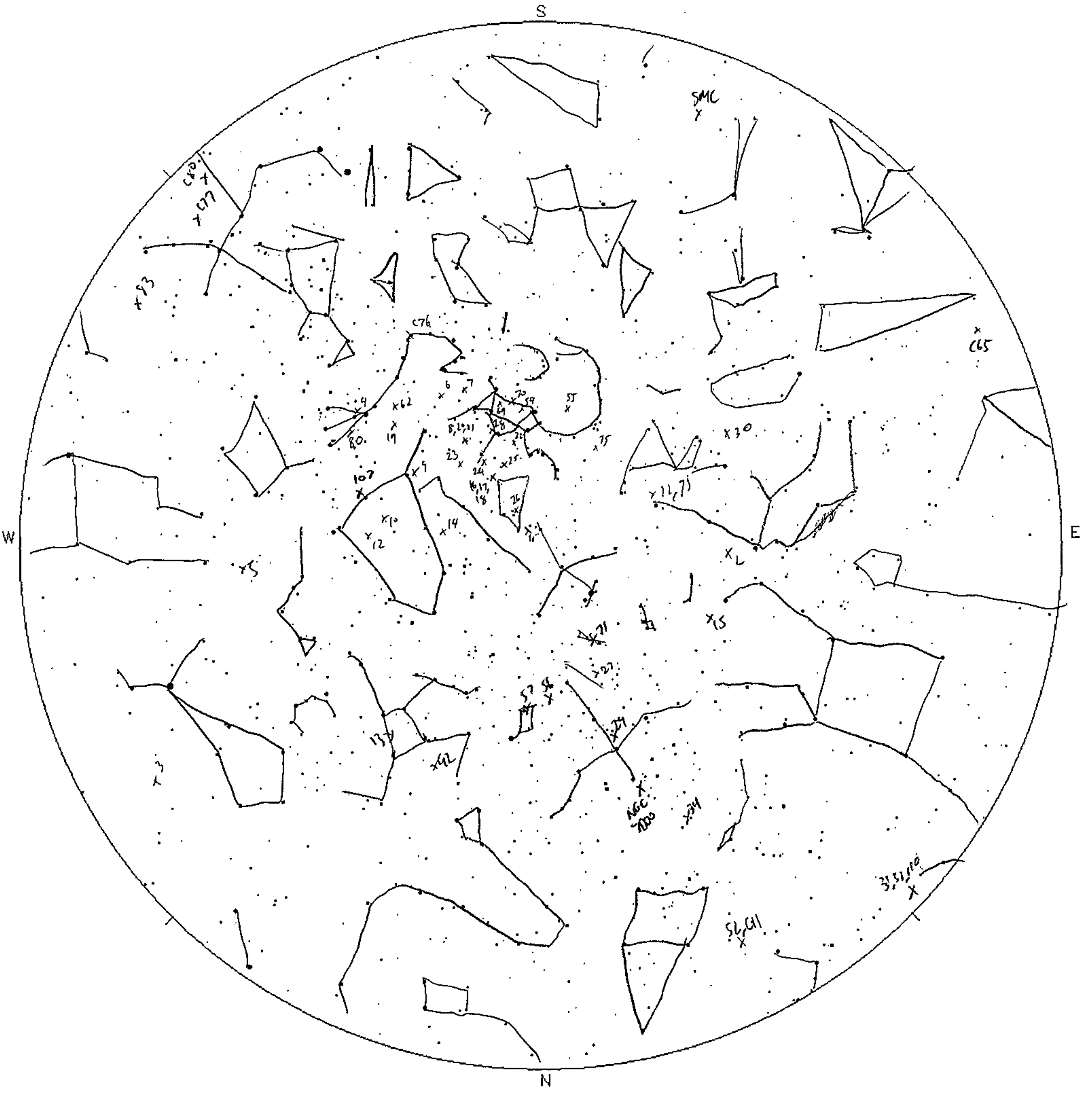
C80
C76
C99
C102
7


N
E
W
S
x85
x83
69 x
x3
x 94
x 63
x 106
51x
97,108 x
109 x
x40
+101
+102
x81,82
44 x
25 x
x57
x1
x 76
x34
15
x39
xC14
x76
103 x
52,C11 x
x31,32, 110
33 x
74 x
77 x
37 x
NGC7000 x
x 29
357
x56
x27
x 71
13
92 x
x15
x2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SMC
C80
C77
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C76
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80
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28
75
30
107
9
23
22
24
25
16,17,18
26
10
12
14
11
11,73
W
E
5
L
15
71
27
57
56
29
13
42
3
NGC 7000
39
31,32,110
52,C41
N


S
N
E
W
C65
SMC
LMC
C99
C102
C50
C77
83
68
C60/61
77
79
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62/63
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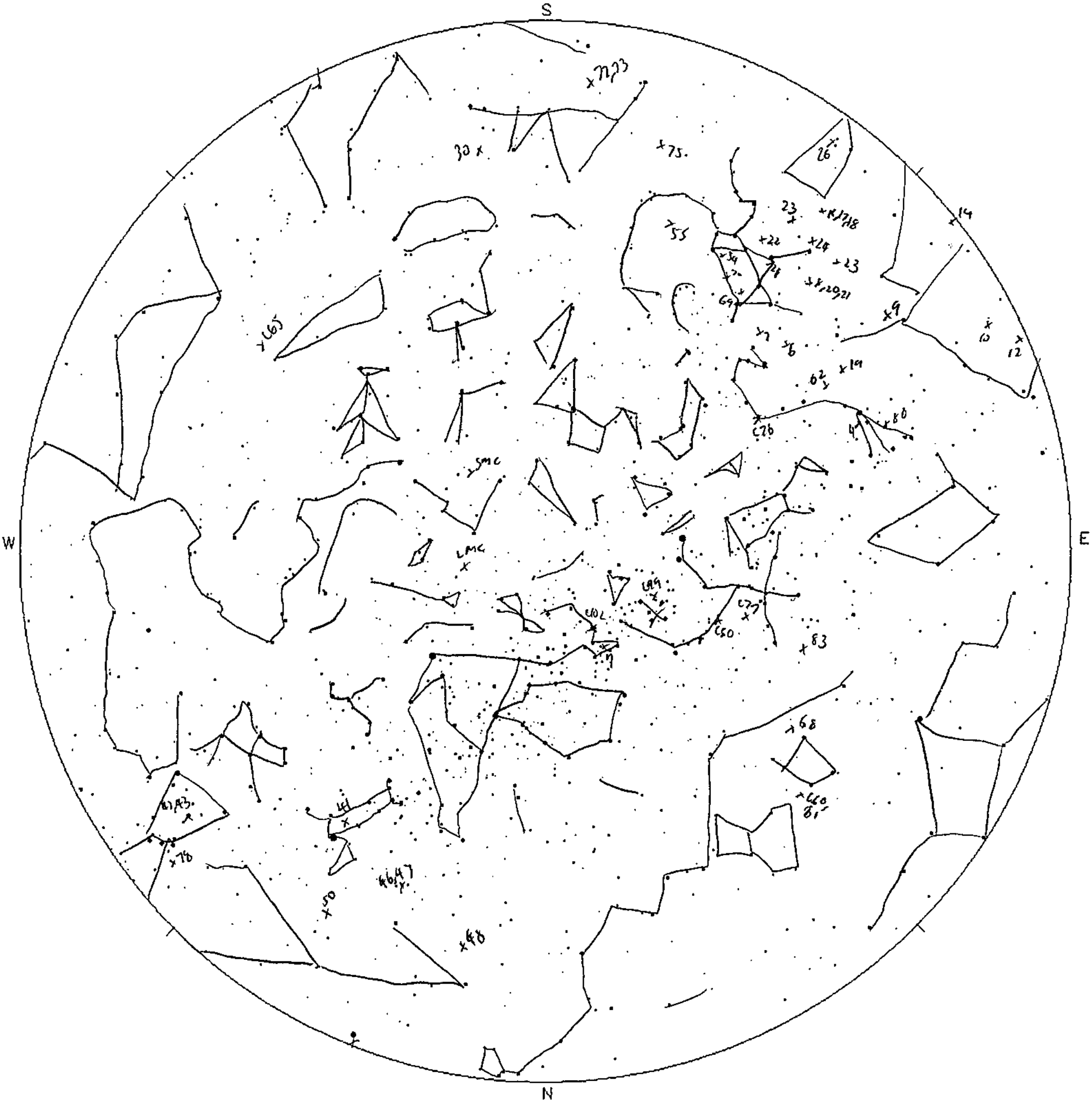
44
67
45/96/105
65/66
87
85


S
x 72,73
30 x
x 75.
26
x 65
23
x 16,17,18
x 55
x 22
x 24
34
24
x 23
x 19,20,21
69
14
x 9
10
12
7
6
62
x 19
C76
4
x 80
SMC
LMC
W
E
C99
C102
η
C50
C77
x 83
x 68
x 60
61
81,83.
41
x 78
46,47
50
x 48
N


S
N
E
W
C65
70
72,73
75.
55
SMC
LMC
11
26
22
25
20
16,17,18
63
8,20,21
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14
9
C76
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4
50
210
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C77
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93
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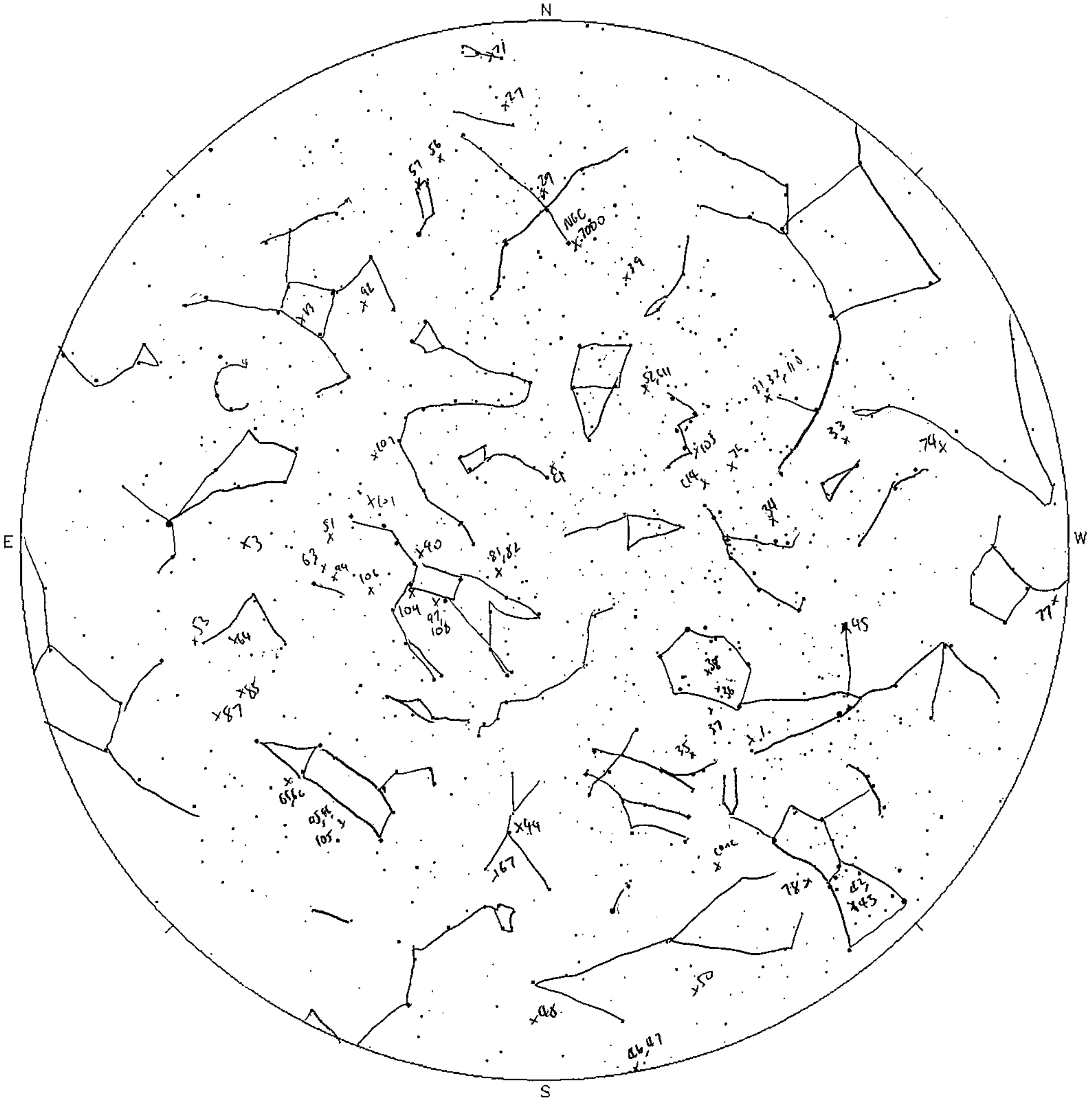
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56
29
NGC
7000
39
13
92
52,111
31,32,110
33
74
103
76
c14
34
107
101
51
E
3
63
94
106
40
81,82
104
97,
108
W
77
53
64
38
36
45
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65,66
95,96,
105
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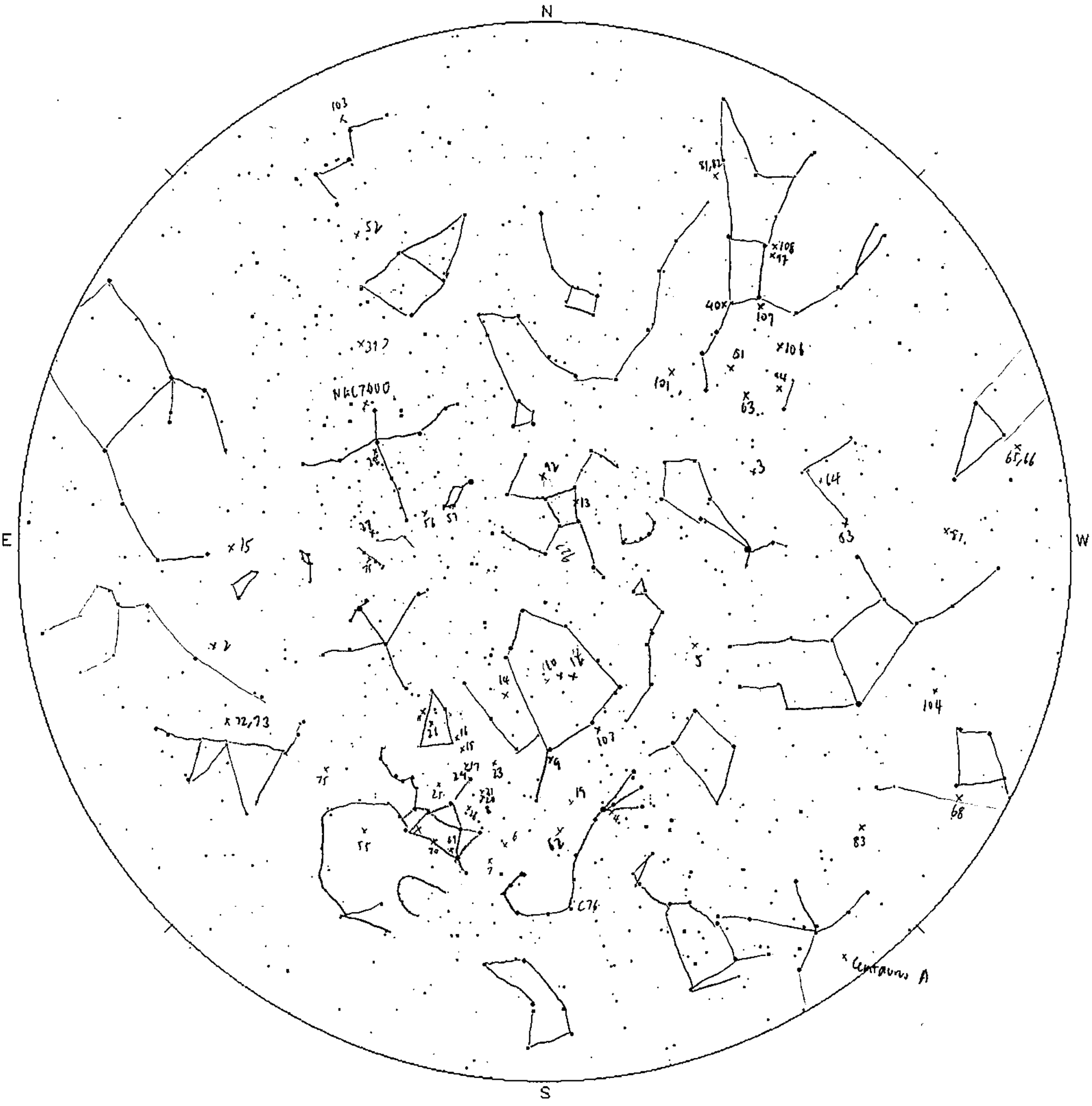
78
42,
43
50
48
46,47
S


N
E
W
S
103
x52
x317
NGC7000
28
27
71
56
57
x15
x2
x72,73
81,82
x108
x97
40x
107
x106
101
51
94
63
x3
x14
63
x57
65,66
92
x13
C26
x5
104
14
110
17
16
x16
x15
21
11
107
49
24
27
23
25
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x30
x28
8
75
55
70
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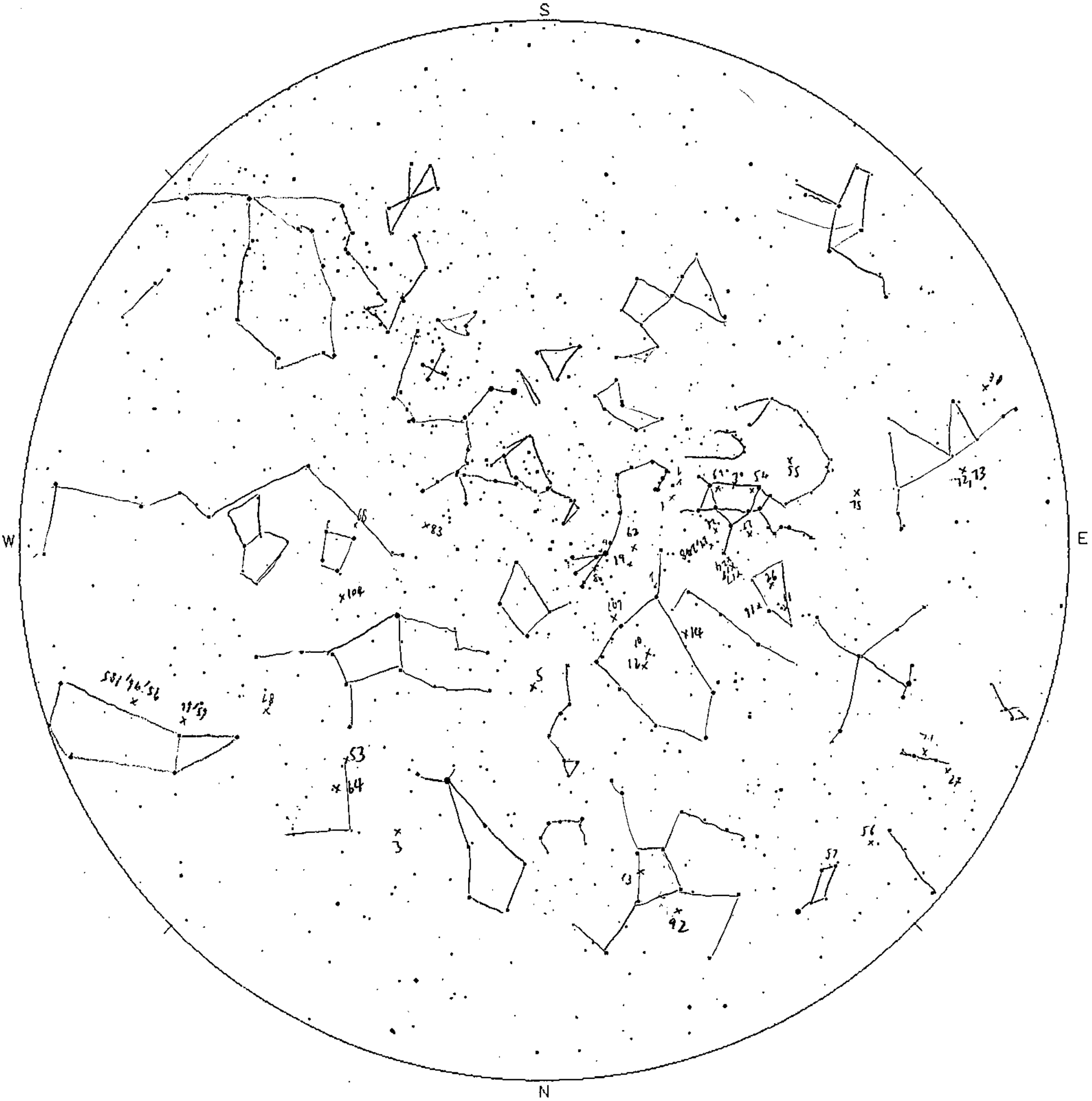
x6
7
62
19
4
C76
68
83
Centaurus A


S
W
E
N
66
x83
x104
62
19
107
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x14
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18
53
x64
3
13
92
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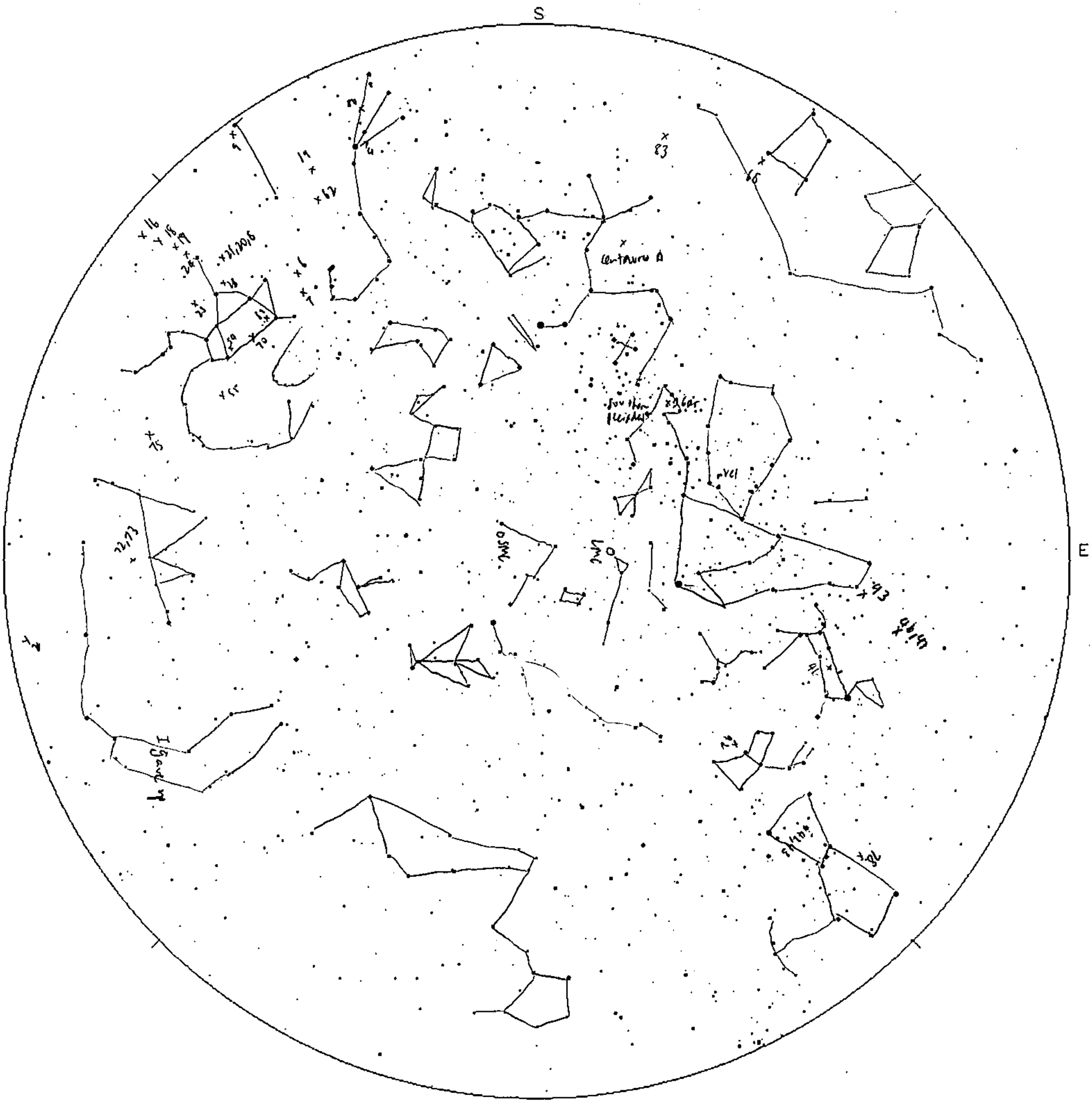
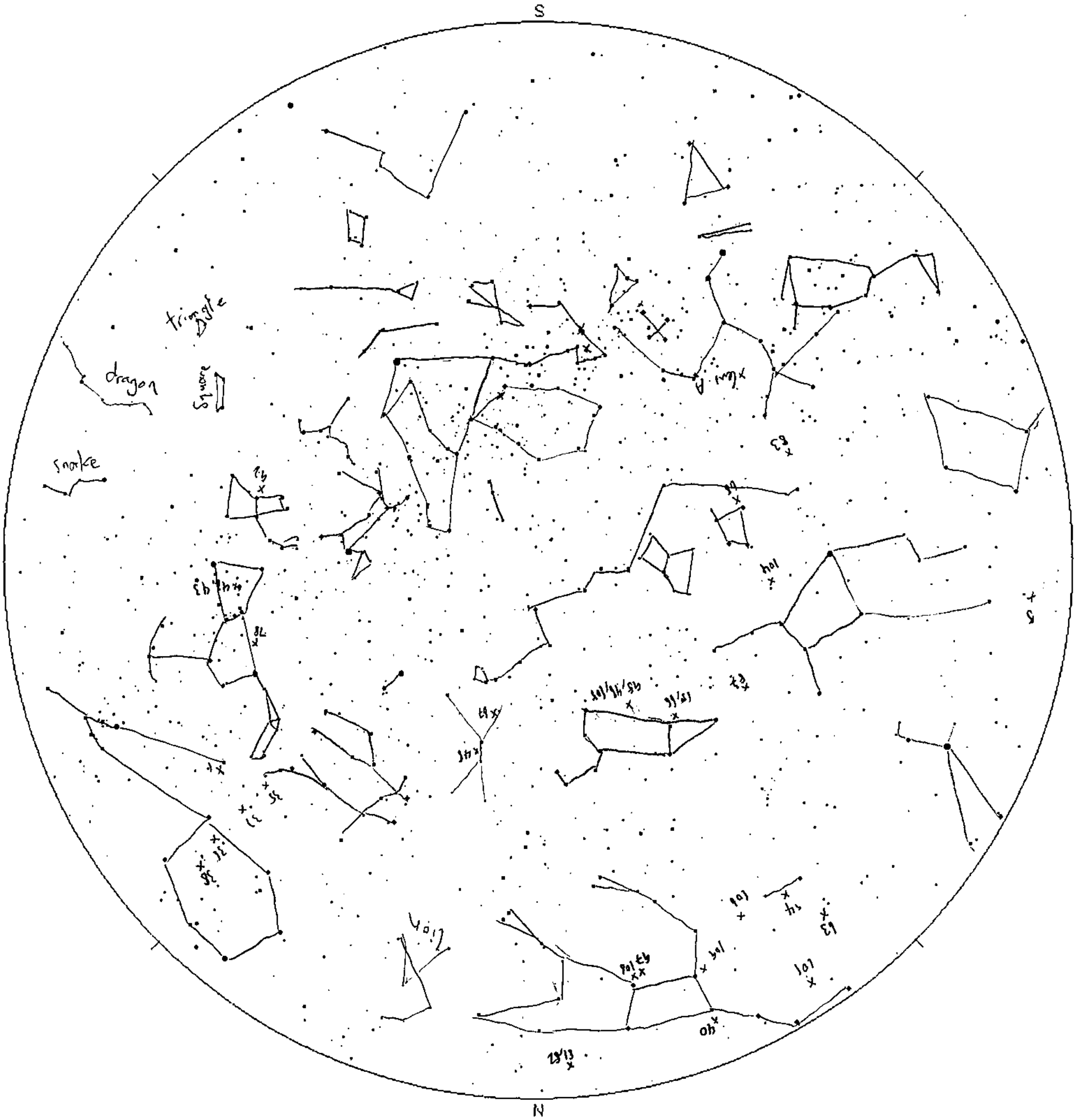
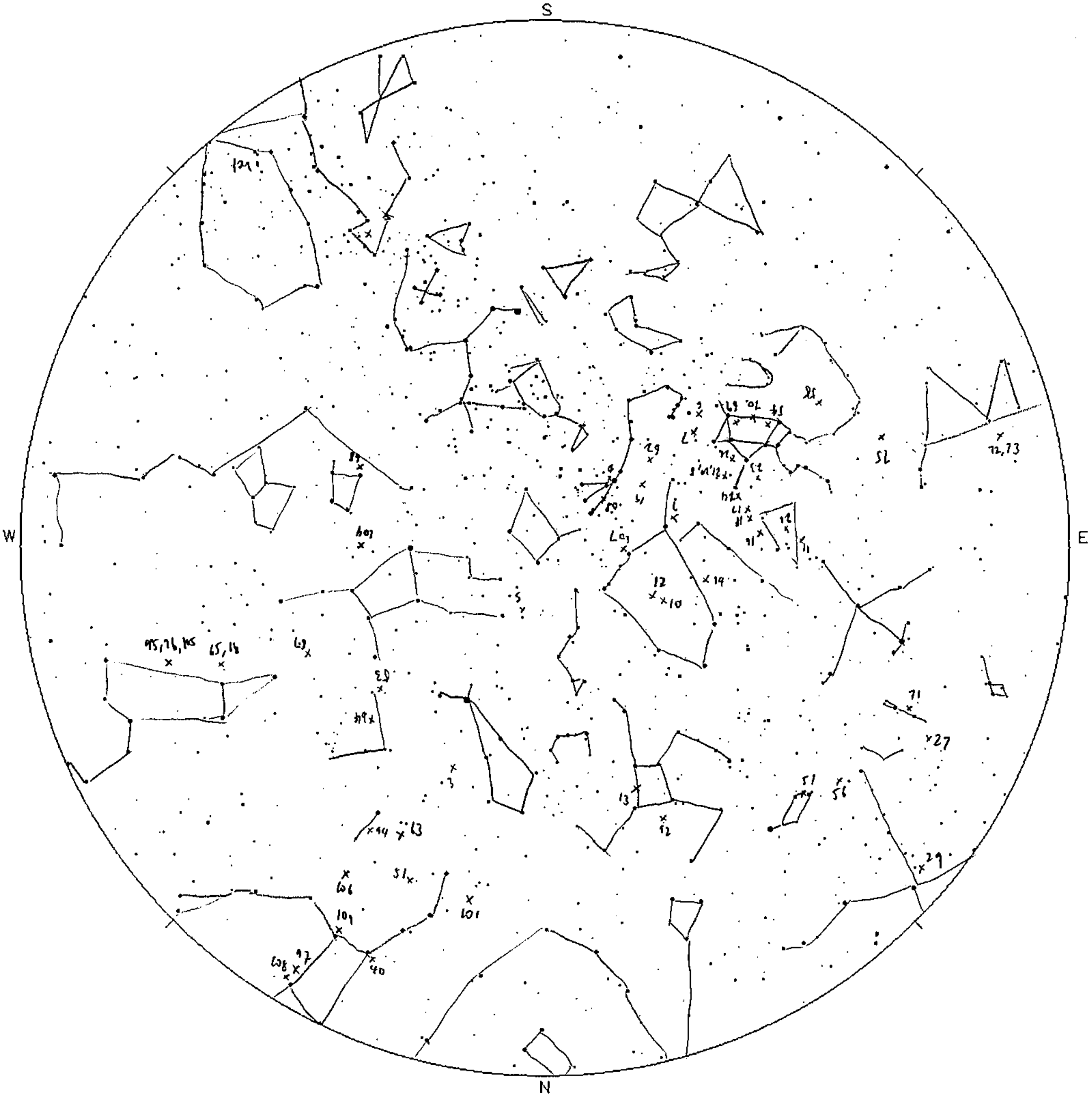
55
75
72,73
30
27
26
54


S
W
E
N
Centaurus A
Southern Pleiades
LMC
SMC
x 83
x 16
x 18
x 19
x 24
x 21/2016
x 6
x 7
19 x
x 62
x 55
x 75
x 93
x 32
x 24
72/73
x 26
x 70


S
W
E
N
triangle
dragon
square
snake
83
104
40


S
W
E
N
95, 76, 105
65, 16
69
83
104
80
49
3
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13
51
106
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108
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2
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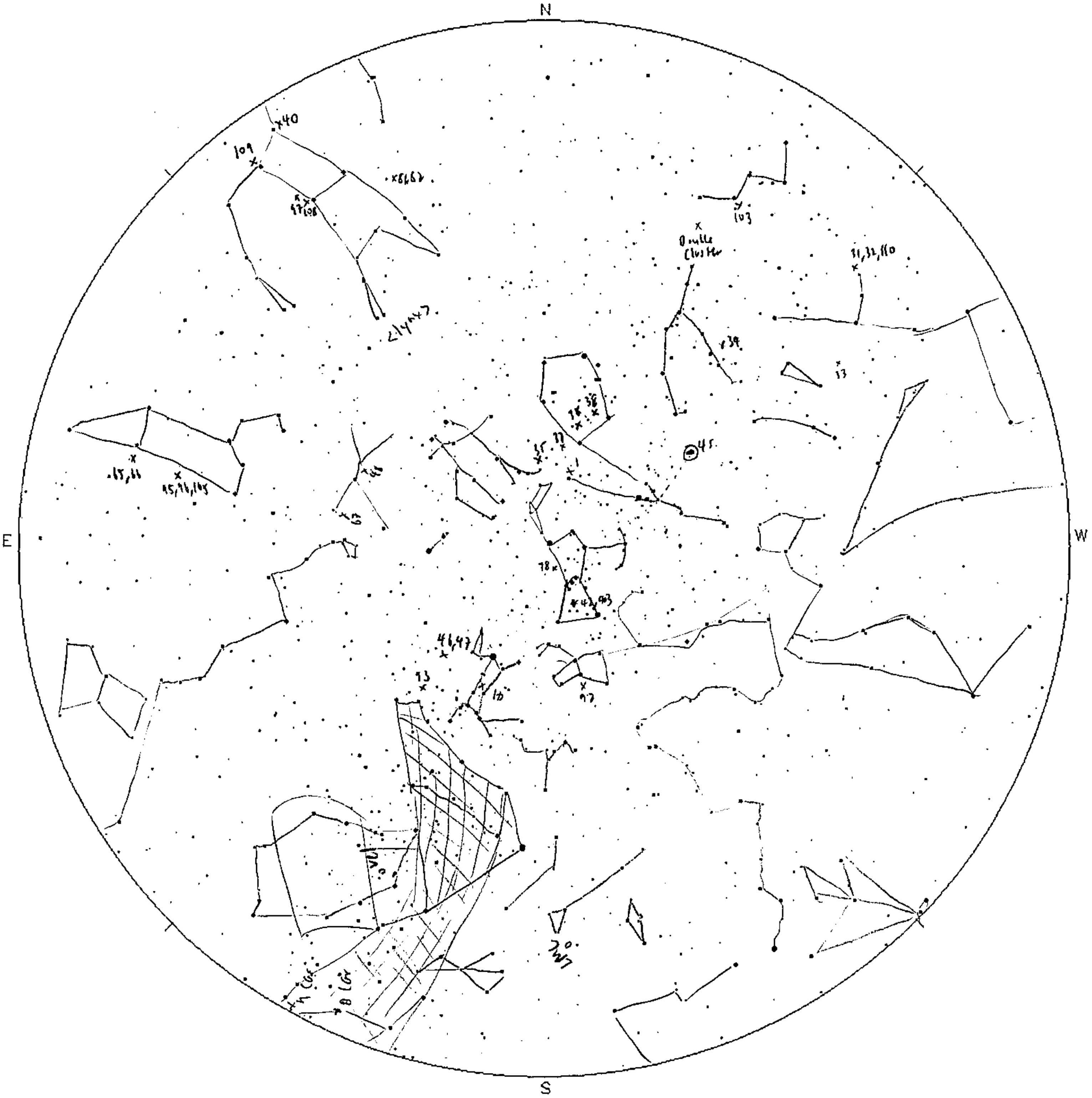
72, 73
71
27
51
56
29
13
42


N
x40
109
x6662
97,108
41/447
103
Double Cluster
31,32,110
x39
33
38
36
35
77
1
45
65,66
95,96,105
48
68
E
W
78
42,43
46,47
93
16
97
LMC
η Car
θ Car
S


N
E
W
S
108
97
81,82
Double Cluster
52
103
76
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31,32,110
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42,43
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92
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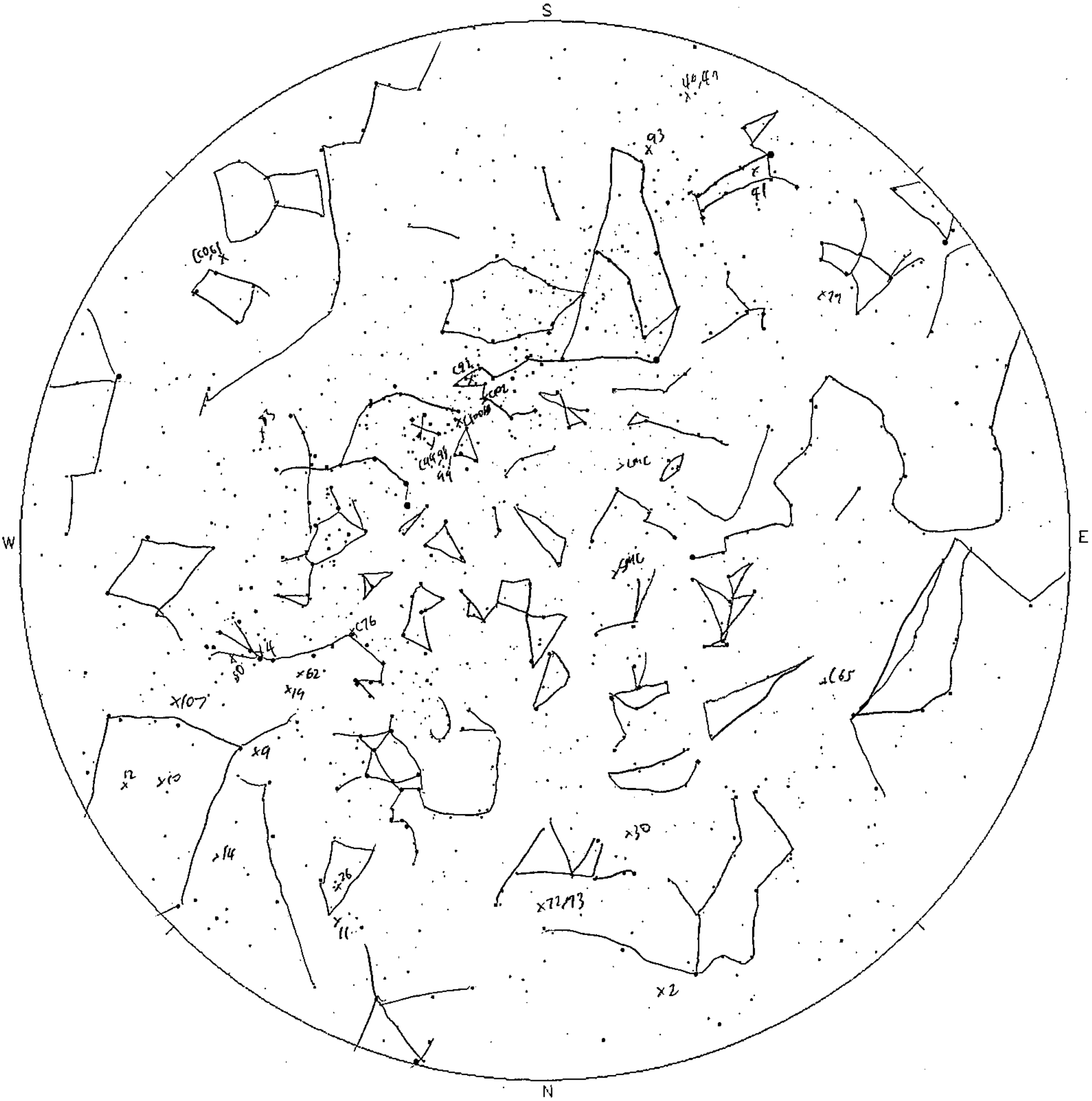
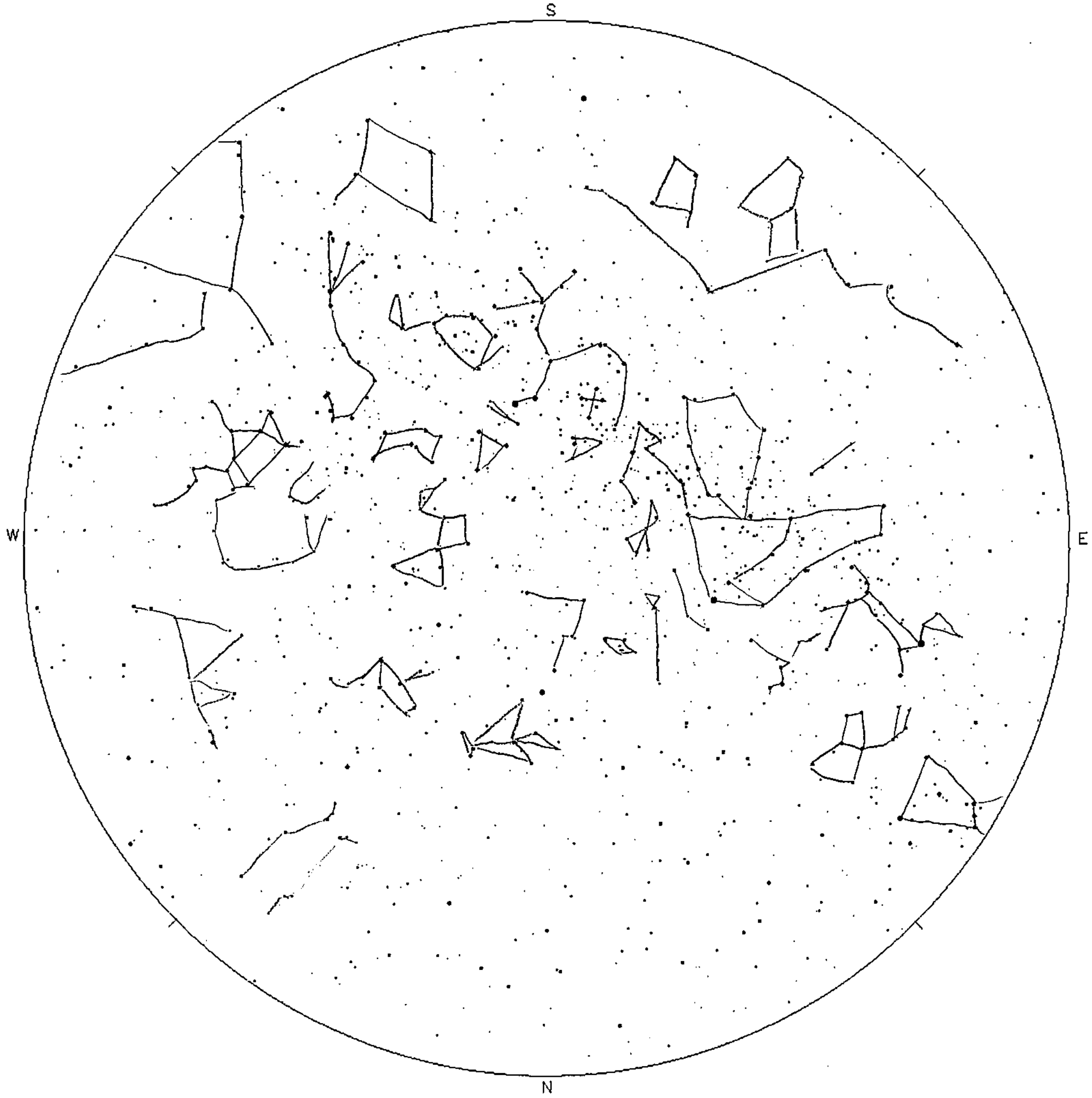
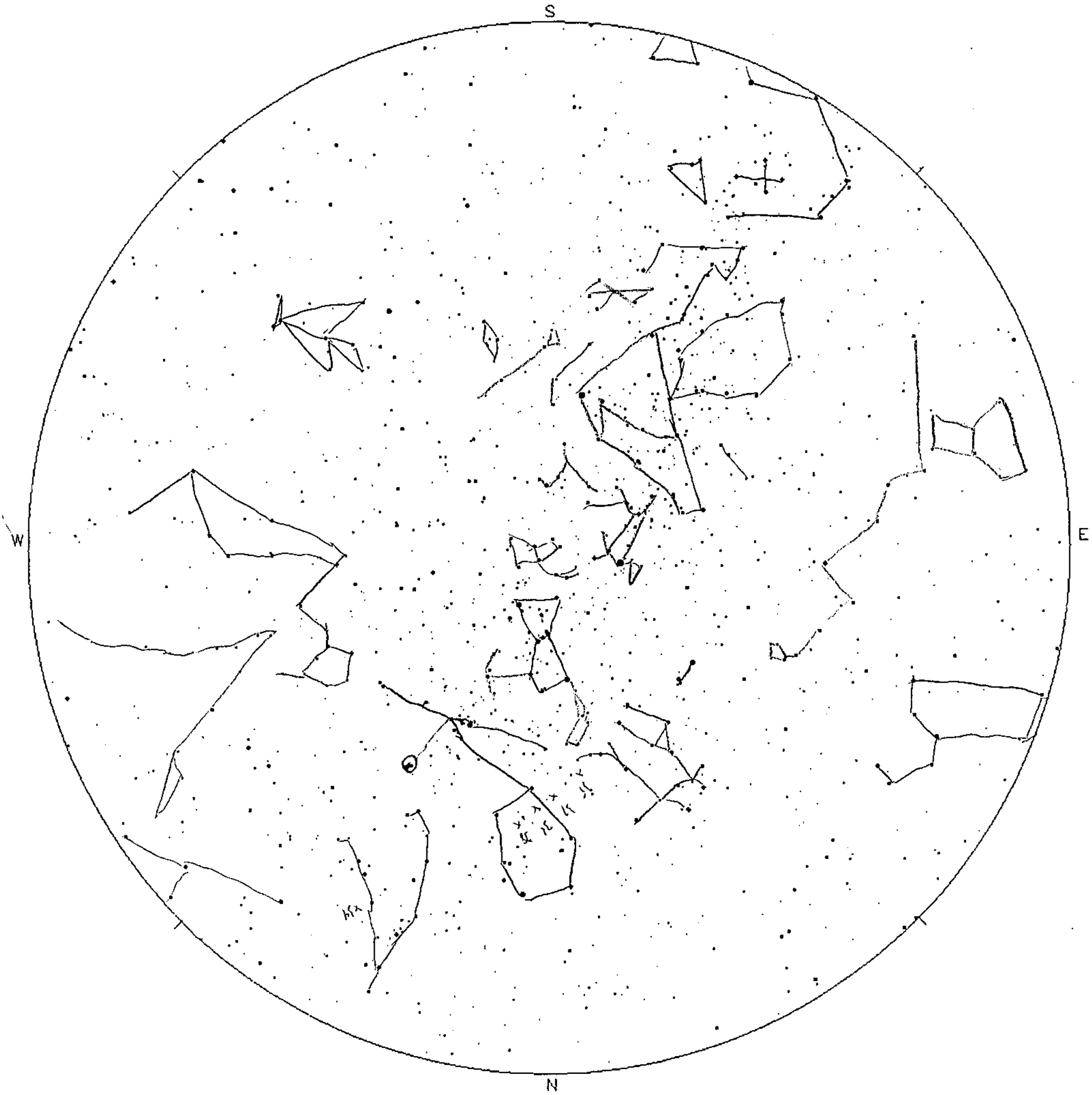
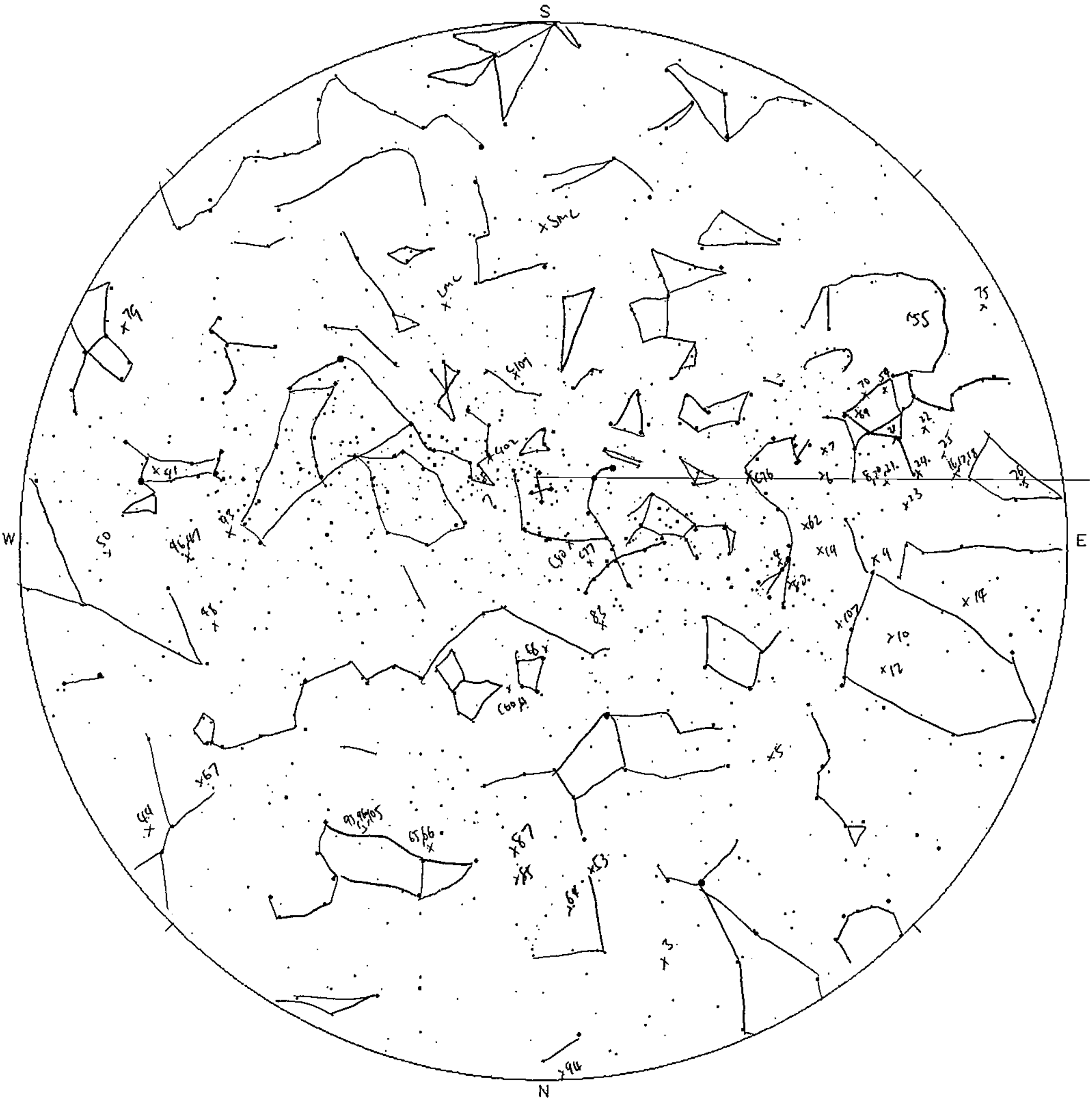
71
15


S
W
E
N
40,47
x
93
x
41
x79
C106
x
93
C92
C102
x C1008
C44 99
99
>LMC
SMC
C76
14
80
x62
x19
x107
x9
12
x
y10
>14
26
x
11
C65
x30
x72/73
x2

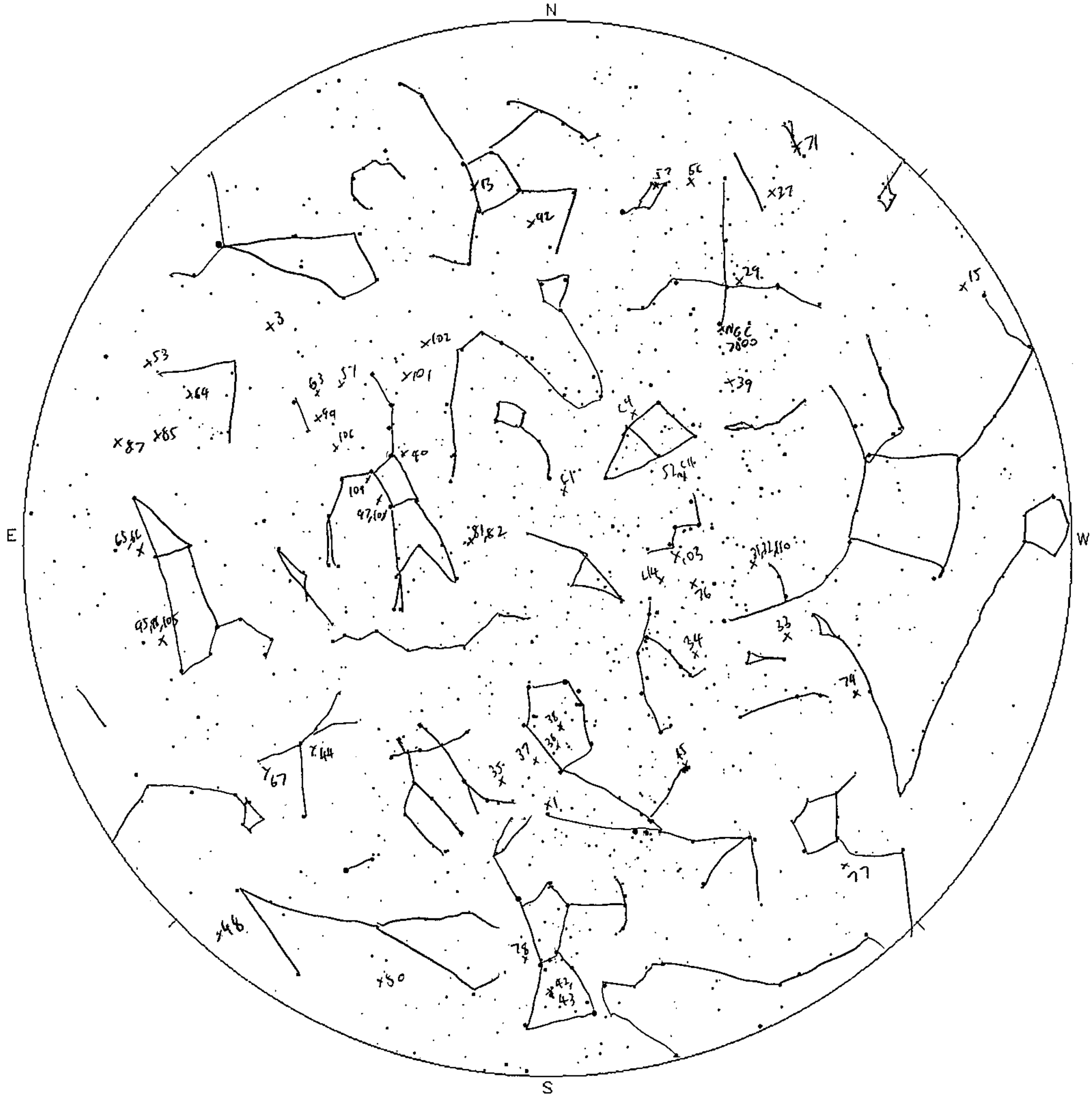

S
W
E
N



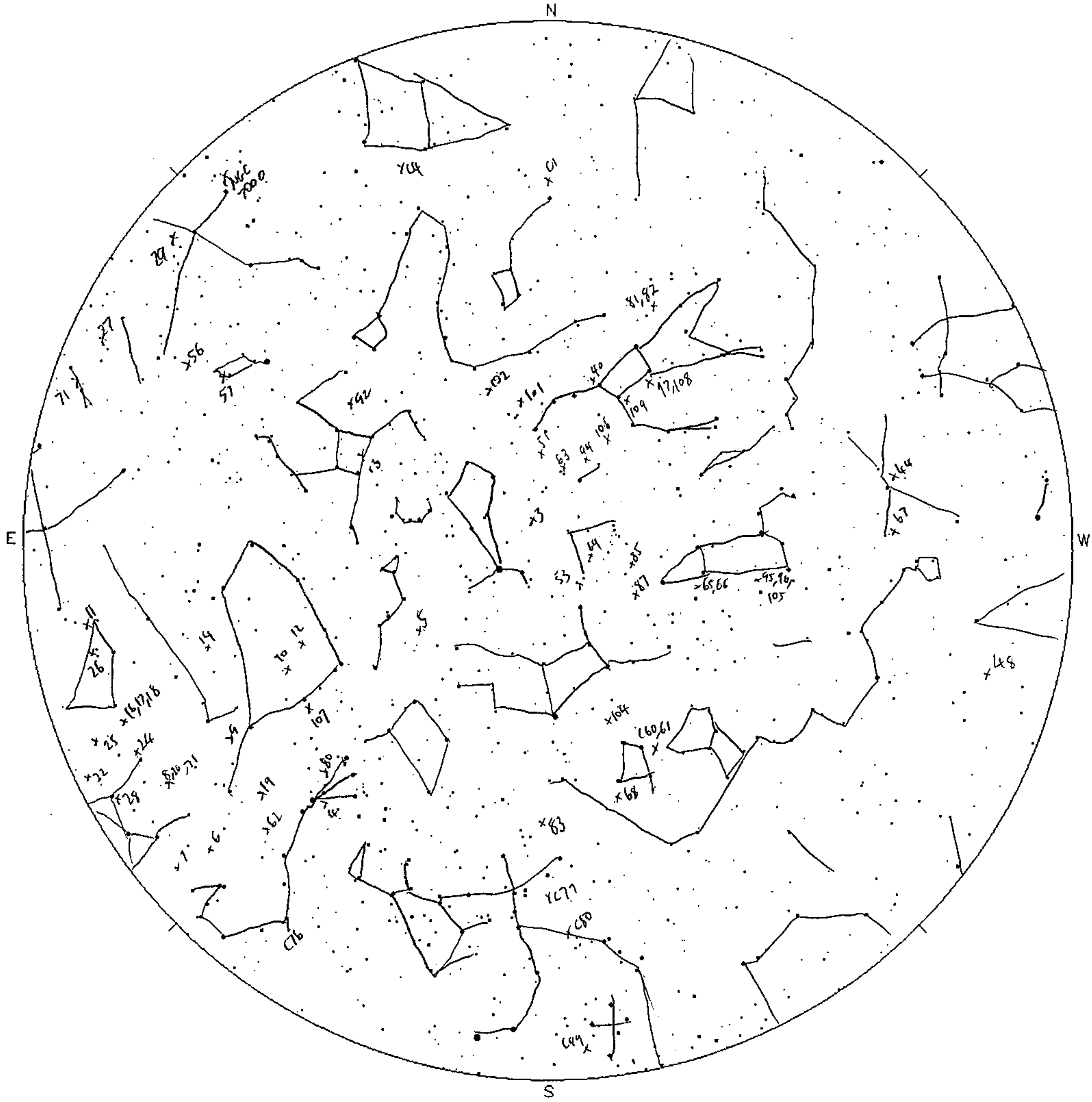
Done on ~10/7 ?

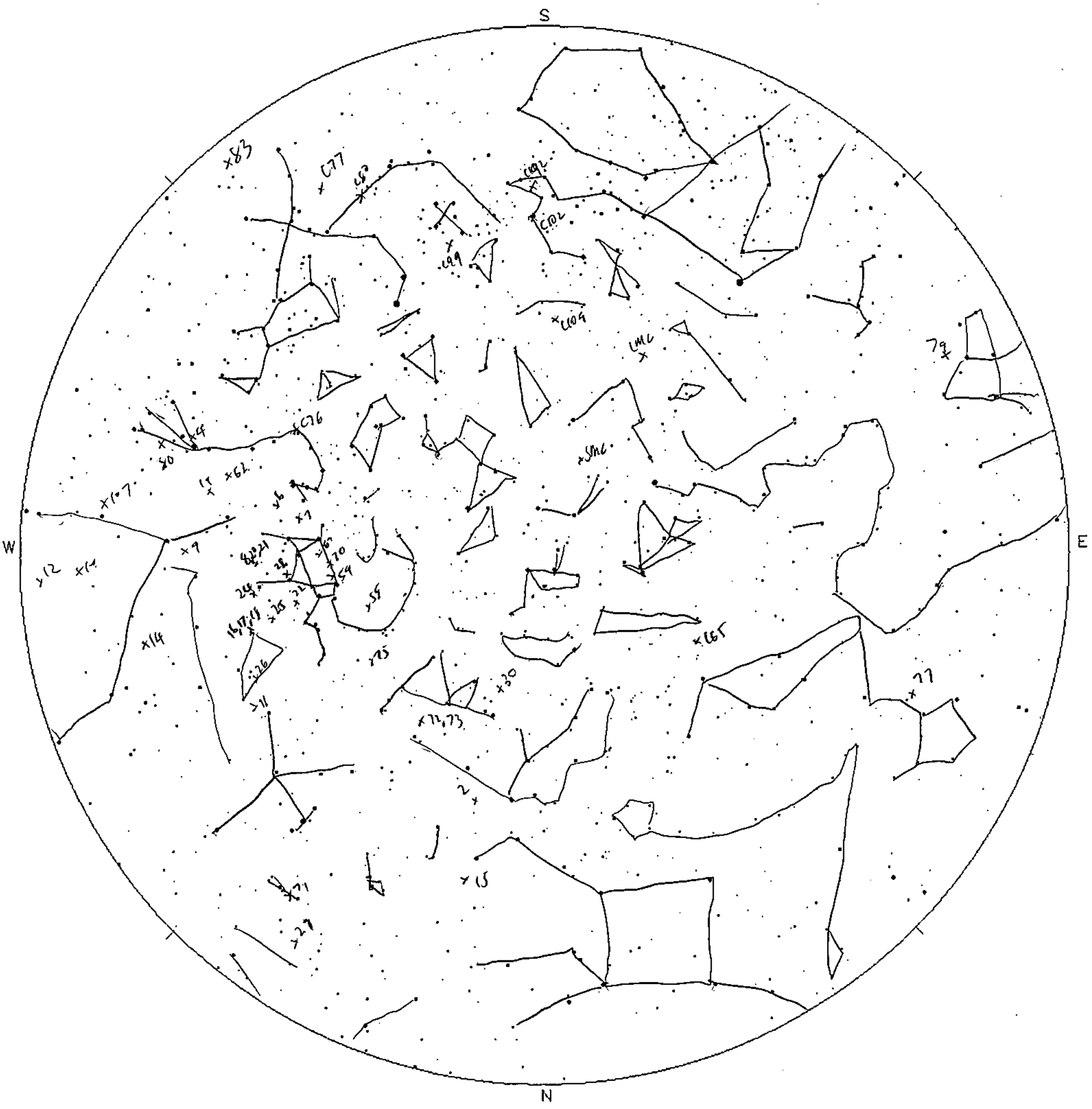

S
SMC
LMC
x79
75
x
55
C109
C102
70
59
x69
22
x7
25
24
16,17,18
x C76
x6
8,20,21
x23
26
x41
W
50
46,47
93
C50
C47
x62
x19
4
x82
x9
E
x14
48
83
x102
x10
x12
C68
C60
x5
x67
44
x
91,94,105
65,66
x87
x85
84
x53
x3
x94
N


S
9
16,17,18
23
24
25
22
28
8,20,21
19
62
80
4
6
7
34
70
69
C76
75
55
83
C77
C50
68
72,73
30
C94
900
C91
C102
C109
SMC
LMC
W
E
65
93
48
46,47
41
52
79
42,43
78
77
N

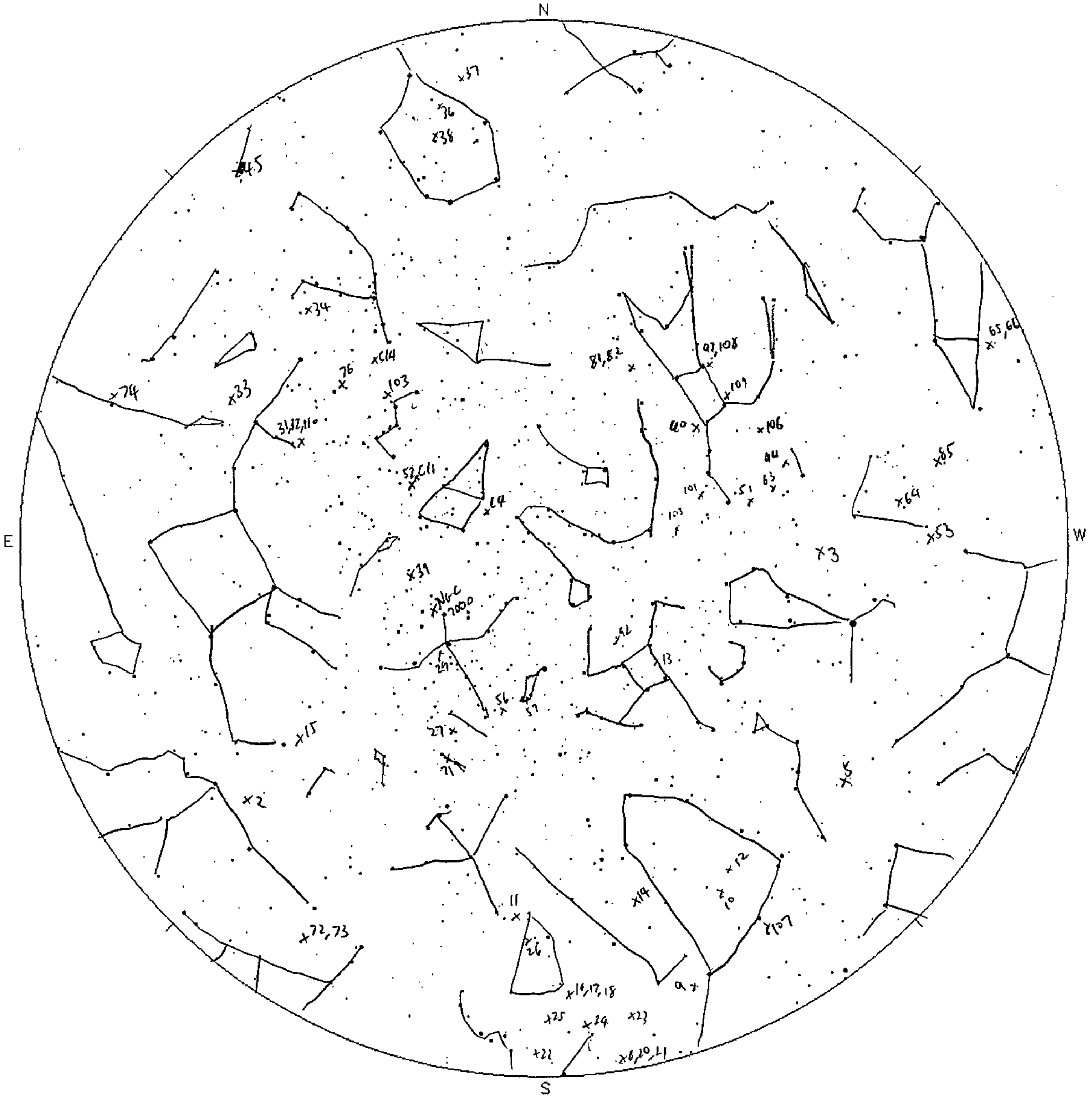

N
S
E
W
13
92
57
56
71
27
29
15
NGC 7000
39
3
53
64
102
101
63
57
49
106
40
87
85
C4
52
C11
C1
109
97,101
81,82
65,66
95,18,105
103
31,32,110
C14
76
34
33
79
36
37
38
35
1
45
44
67
77
48
30
78
42,43


S
×C109
×LMC
×C76
×SMC
79 ×
×6
×7
×9
8,20,21 ×
×44
×20
×54
28
×23
×55
24 ×
×22
×25
×75
16,17, 18 ×
×26
×30
×C65
W
E
×14
×11
177,73
×77
×2
×15
×74
71
×33
45
56 ×
57 ×
27 ×
×31,32,110
× NGC 7000
×39
×76
52 ×C11
×103
×C14
N


N
C14
C1
NGC 7000
29
27
71
56
57
42
102
101
40
81,82
97,108
109
51
63
94
106
13
3
64
85
87
53
65,66
95,96,105
44
67
E
W
48
11
26
14
10
12
107
4
5
104
C60,61
68
16,17,18
25
24
32
28
8,20,21
19
80
7
62
6
1
83
C77
C80
C76
C49
S

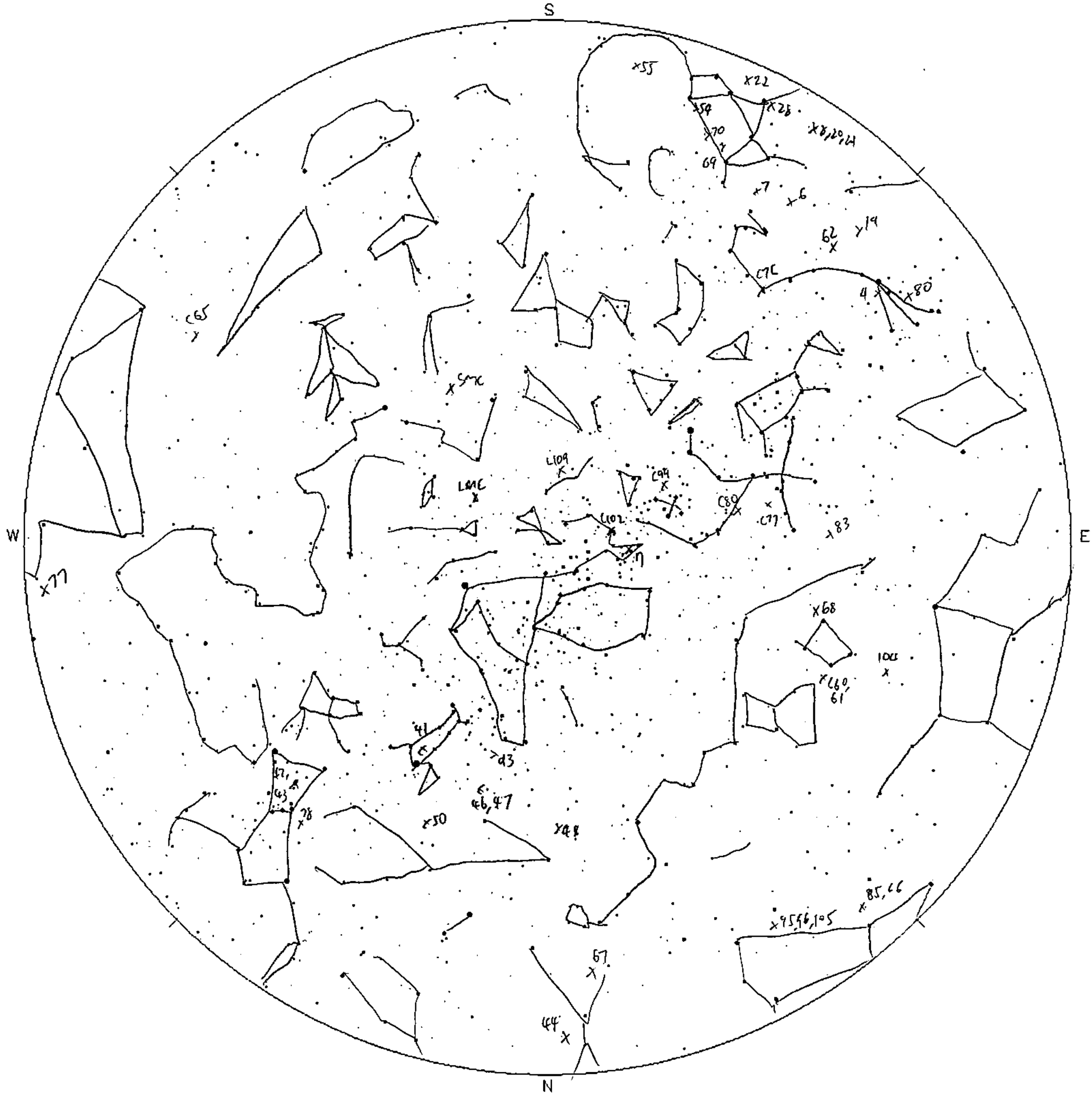

S
W
E
N
x83
x C77
C80
C92
C102
x C99
x C109
LMC x
79
x C76
x4
x 80
x107
15 x
x62
x6
x1
x SMC
x12
x14
x9
18 20 21
28
x65
x70
x54
24
x25
x22
16,17,19
x56
x14
x26
x75
x C65
x30
x11
x72,73
x77
2 x
x15
x71
x27


S
W
E
N
x79
41
x93
x CHC
865
x C109
C092
C002
x C99
SMC
x C60, 61
68
C77
x C80
83
C76
x30
55
x6
x7
x69
x70
x75
x72, 73
x2
x80
6, 70, 71
x107
x9
x10
x12
x19
76
711
5


N
x37
36
x38
45
x34
xC14
76
x103
x74
x33
31,32,110
52,C11
xC4
81,82
97,108
x109
40 x
x106
x65,66
x85
x64
x53
94
63
101
51
103
E
W
x3
x39
xNGC 7000
29
92
13
56
57
27
71
x15
x2
x5
11
26
x14
x12
10
107
x72,73
x16,17,18
x25
x24
x23
x22
x6,20,21
a
S

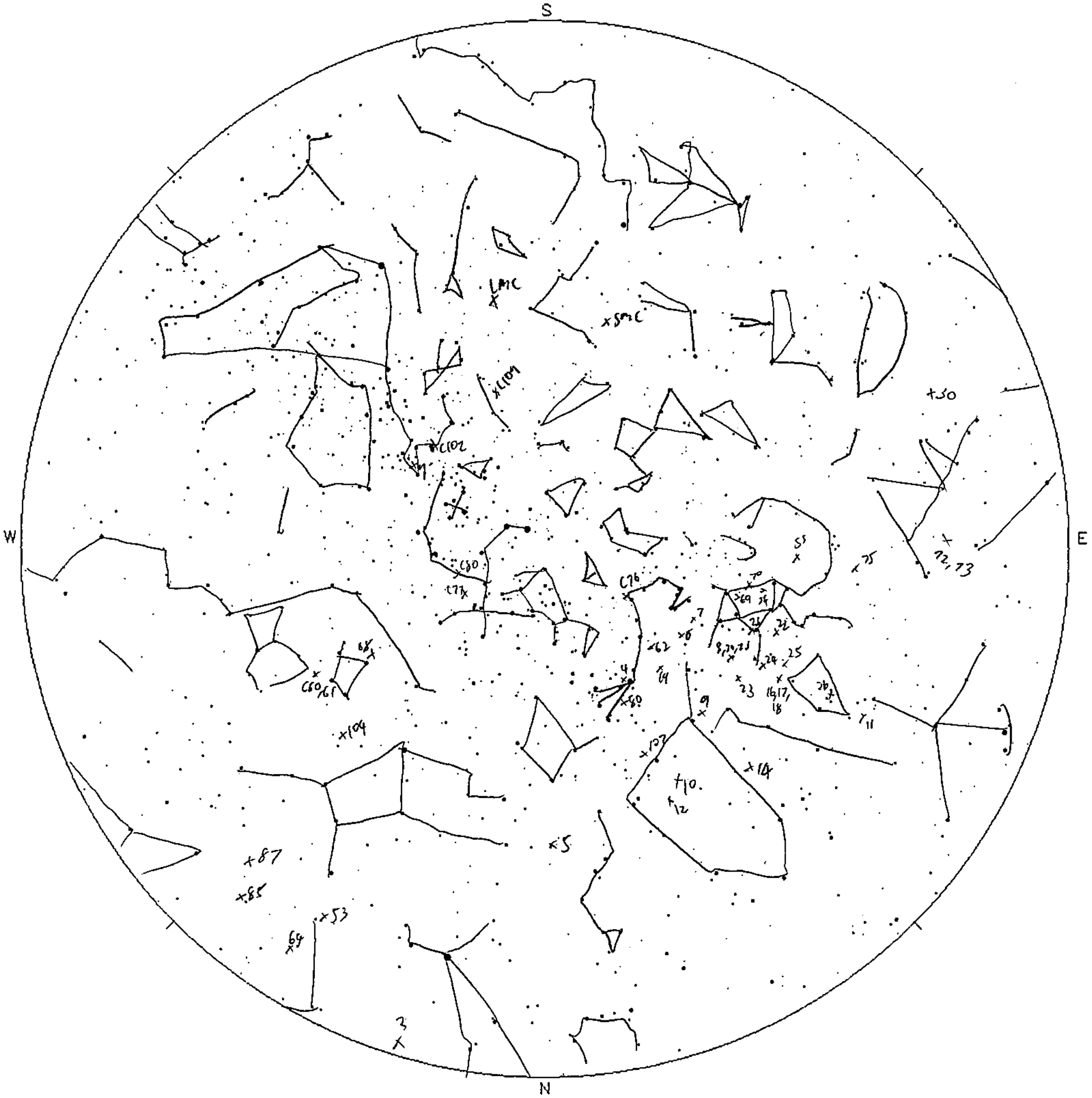

N
E
W
S
45
x1
33
x34
36
x
38
x37
x35
x103
x52,C11
xC4
xC1
81,82
x39
xNGC 7000
29
27
71
x56
57
x15
40
x97,108
x109
x102
x101
x106
51
63
94
x44
x67
x95,96,105
x65,66
x92
13
x3
x64
x85
x87
x53
12
5


N
E
W
S
x92
x102
x101
x40
x81,82
x38
x36
x37
x1
x35
13
x51
x53
44
106
104
x47,108
x3
x69
52
x85
87
x5
12
x
x
10
x107
9
x
x65,66
x45,46,105
x49
x67
x104
C60,61
x68
x48
x50
46,47
41
80
4
x83
xC77
xC80
x
C99
71
C102

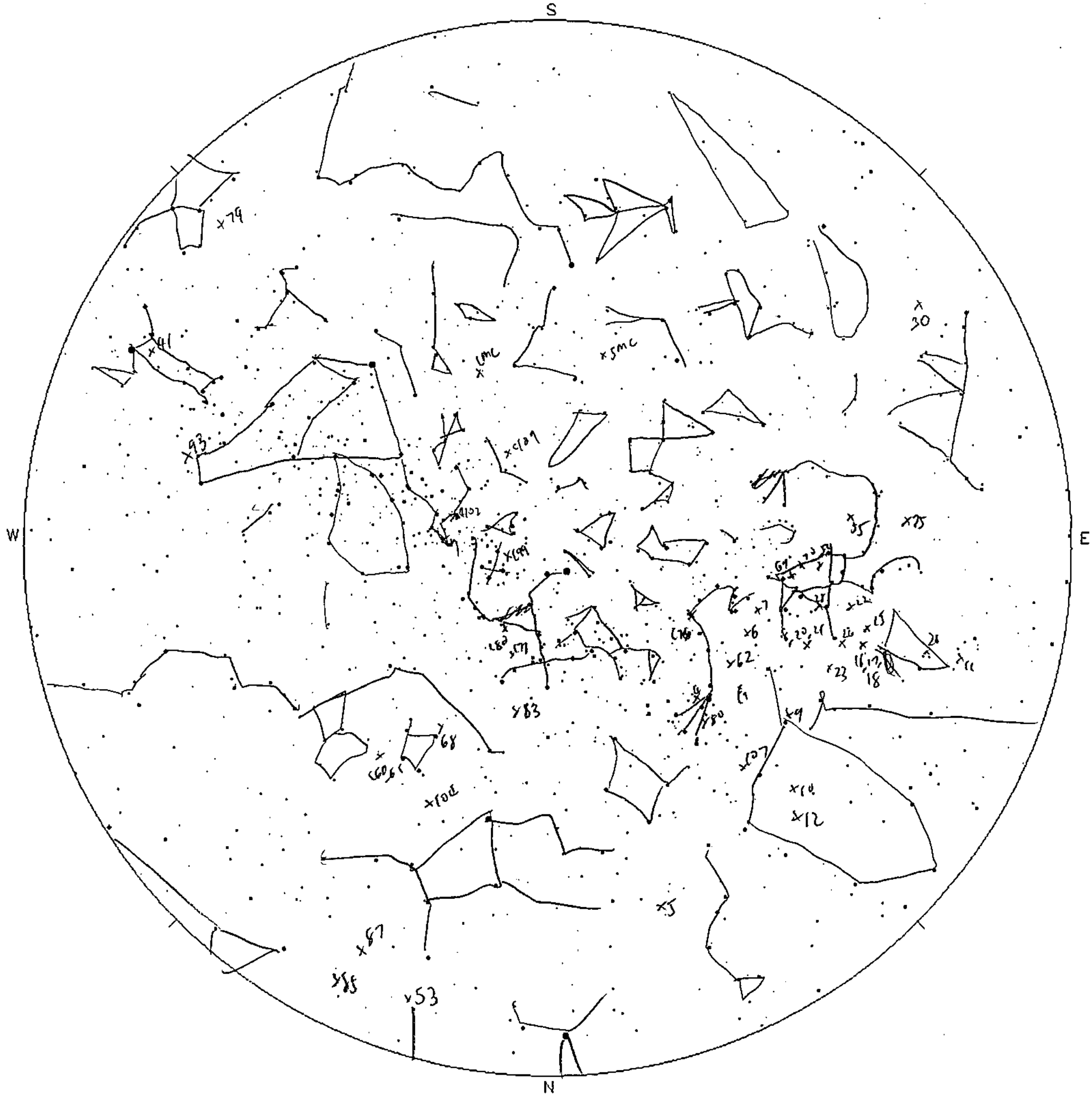

S
x55
x22
54
x28
x70
x8,20,21
69
x7
x6
62 x
x19
C65 x
C70
4 x
x80
x SMC
L109 x
LMC x
C94 x
C89 x
x C77
x83
C102
η
W
x77
E
x68
100 x
x60, 61
41
x83
47, 48
43
x78
46,47
x50
x48
x95,96,105
x85,66
67 x
44 x
N


S
121
93
41,47
X48
41
X79
93
LMC
SMC
17
C102
C94
C80
C78
83
68
W
E
C76
4
80
62
19
6
87
70
54
55
69
28
22
9,20,21
23
24
25
16,17
18
26
11
107
9
12
10
14
75
72,73
2
30
N

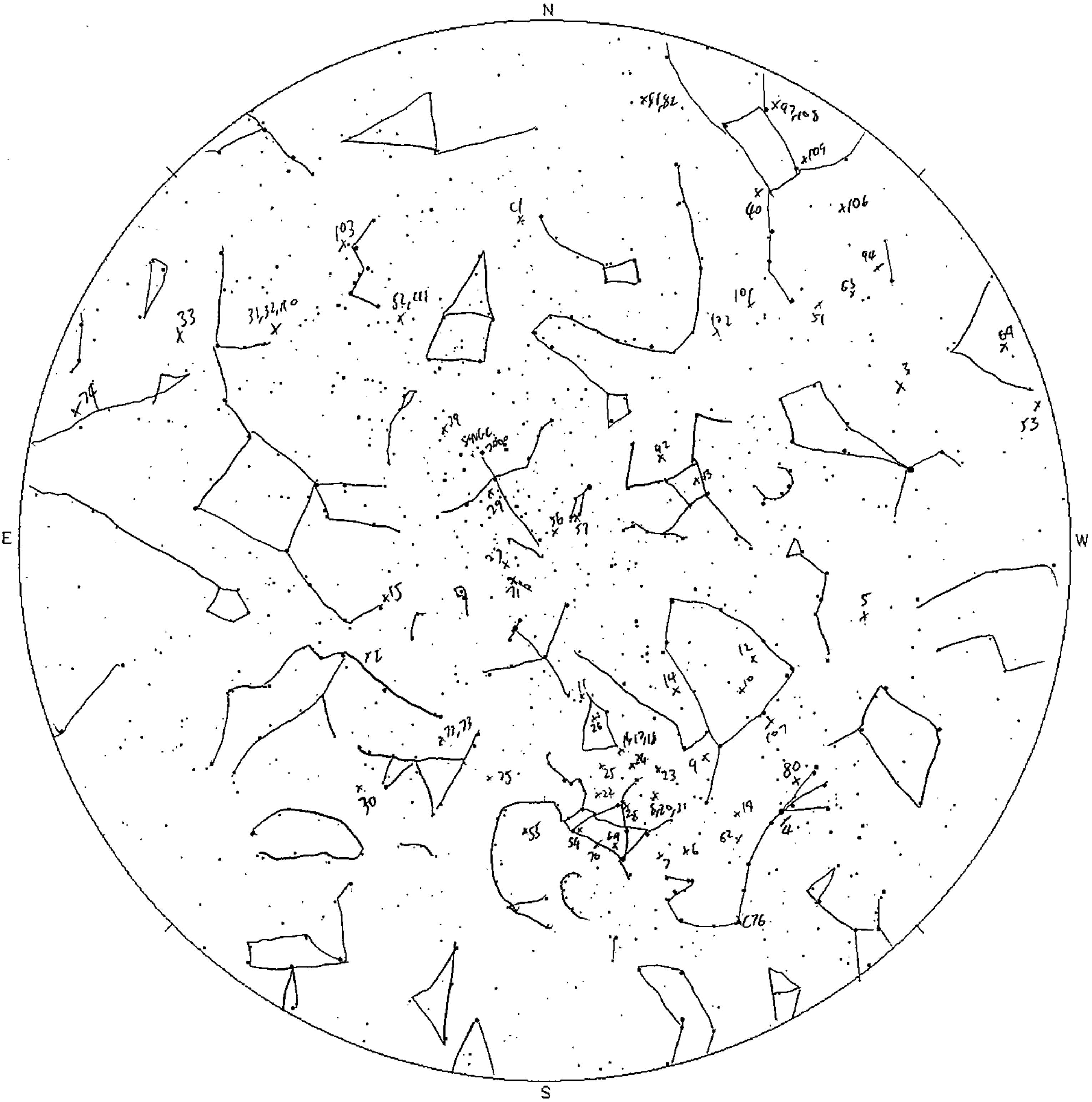
South
pole


S
W
E
N
LMC
SMC
C109
C102
C80
C77
C76
30
55
75
72, 73
70
69
34
21
22
8, 20, 21
24
25
23
16, 17, 18
26
11
7
6
62
64
4
80
9
102
14
10
12
5
68
C60, 61
104
87
85
53
69
3


N
97,108
109
106
44
63
31,62
90
51
101
3
102
145
39
119
76
105
52,111
31,32,113
33
92
13
39
NGC2000
5
W
E
74
77
79
58
57
27
71
15
12
14
10
107
2
11
26
16,17,18
9
72,73
25
24
23
95
22
28
8,20,21
30
165
53
59
69
70
S


S
W
E
N
x79
x41
x93
LMC x
x SMC
x30
x c109
x102
x c99
c80
c77
x83
x60,61
68
x104
x87
x85
x53
x5
x35
x75
69
x73
x7
c76
x6
20, 21
16
x15
x22
26
x23
11,17,
18
11
x62
81
9
x80
x9
x107
x10
x12


N
E
W
S
x52, C1
31,32,110 x
x103
76 x
33 x
xC14
xC1
x102
x101
x40
x81,82
x34
x51
x3
x63
x94
106 x
x 109
x 97,108
x38
x36
x 37
35 x
x1
x45
x53
x64
x85
x87
x65,66
x95,96, 105
x44
x67
78 x
x42, 43
x104
x48
x50
46,47 x
x93
41
x79
60,61 x
x68


N
E
W
S
x81,82
x97,108
x109
x106
40
94
63
51
101
102
C1
103
52,111
31,32,110
33
x74
69
3
53
92
x13
x79
5NGC 2000
29
56
57
27
71
x15
9
5
12
x10
14
107
11
26
16,17,18
x2
72,73
x75
30
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23
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28
8,20,21
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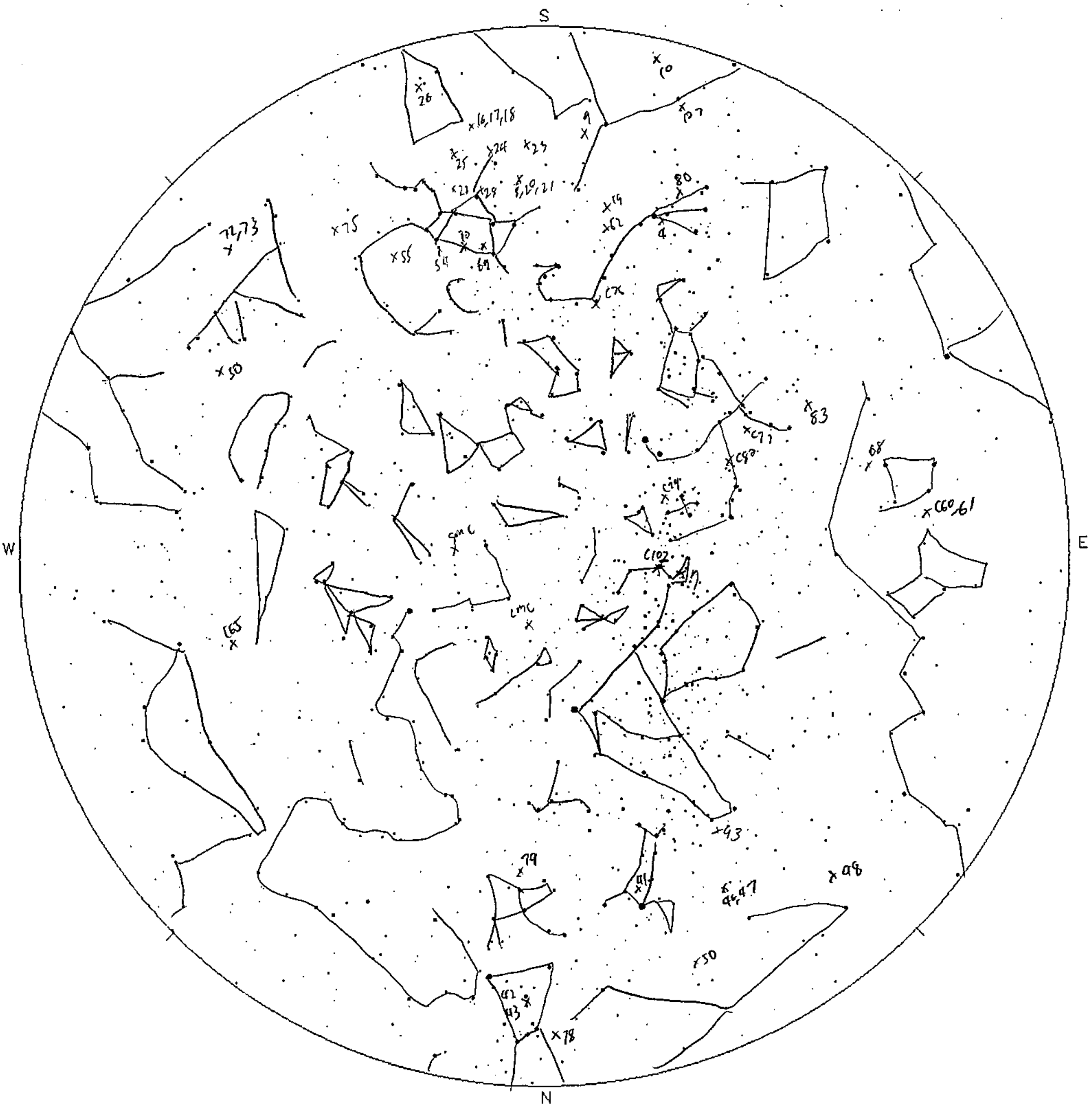
69
7
x6
62
x19
80
4
C76


S
26
16,17,18
10
107
9
25
24
23
27
28
8,20,21
80
19
62
4
72,73
75
55
70
54
69
CX
50
83
C77
C80
C99
68
C60,61
W
E
SMC
C102
LMC
C65
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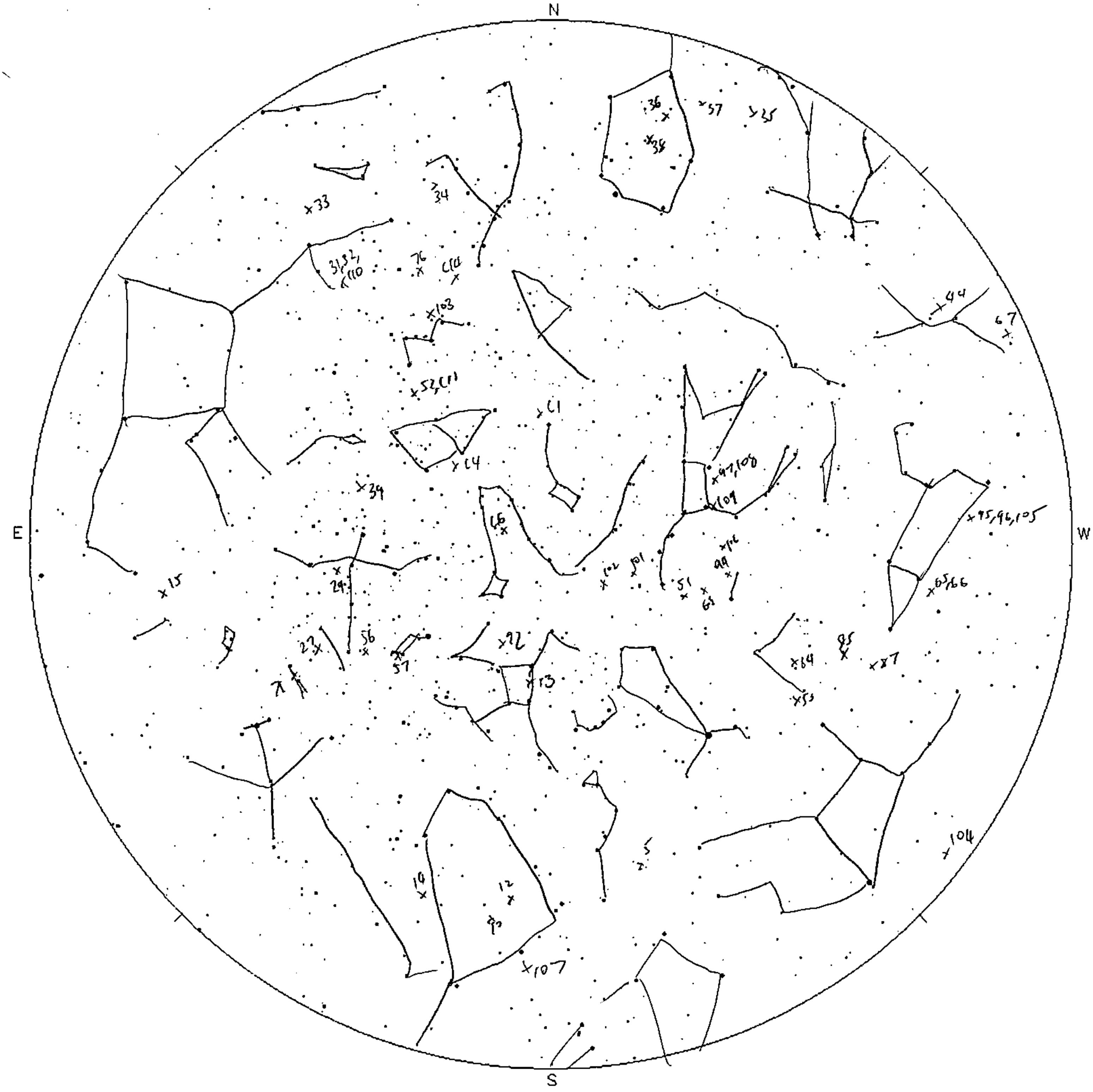
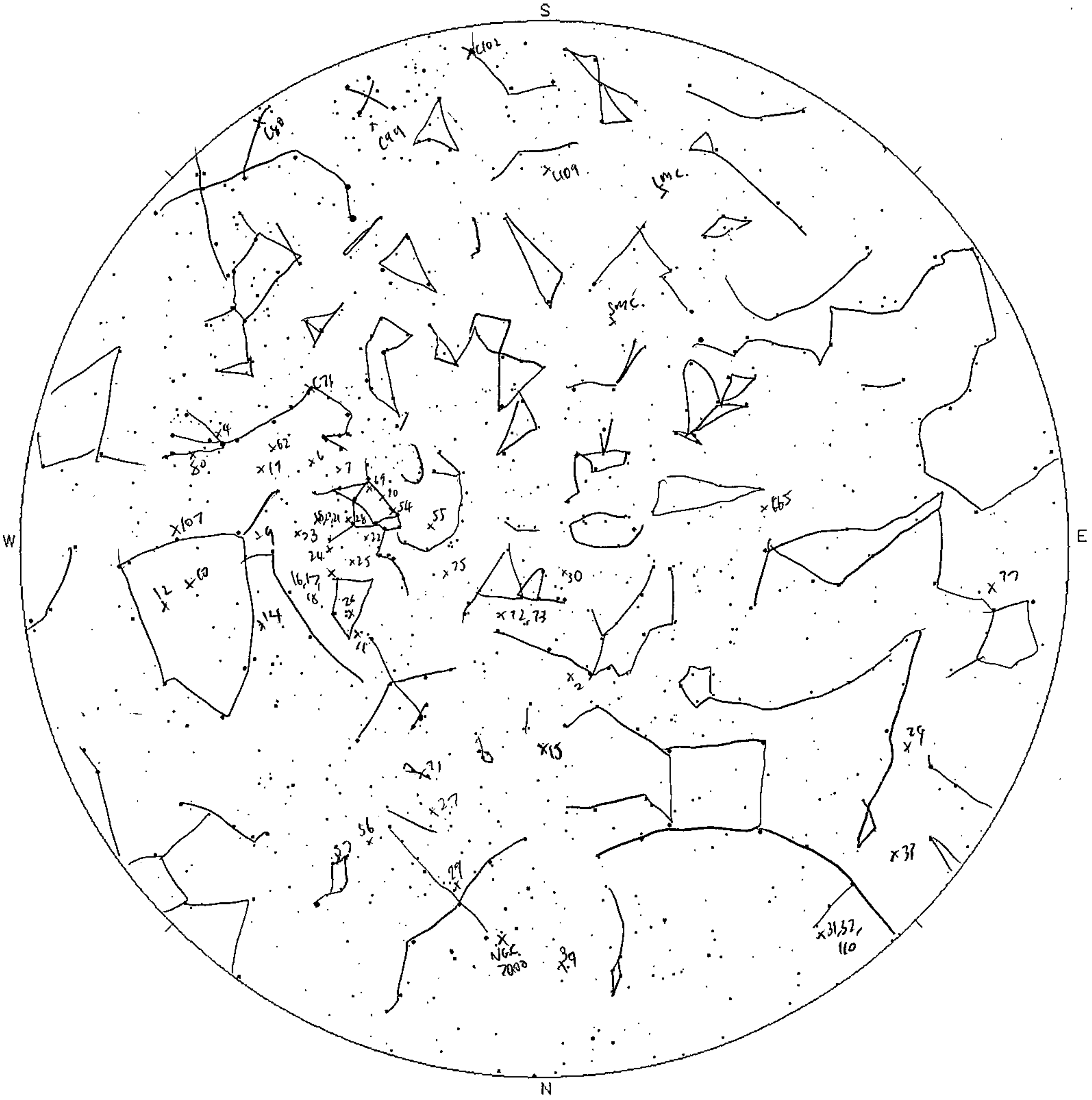
79
98
46,47
91
50
82
93
78
N

South pole


N
E
W
S
36
x57
x35
x38
x33
34
31,32,
x110
76
x
x104
x103
x53,111
x61
x64
x39
66
x
x44
67
x97,108
x109
x95,96,105
x102
101
51
x
x
63
99
x106
x65,66
x15
x
24
23x
56
x
x
57
x92
x73
x84
85
x87
x53
x104
5
10
x
12
x
x107


S
C102
C80
C99
C109
LMC
SMC
C71
4
80
62
17
6
7
69
10
54
55
18,19,21
28
23
22
24
25
75
W
107
9
12
10
14
16,17,
18
26
11
E
65
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72,73
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15
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56
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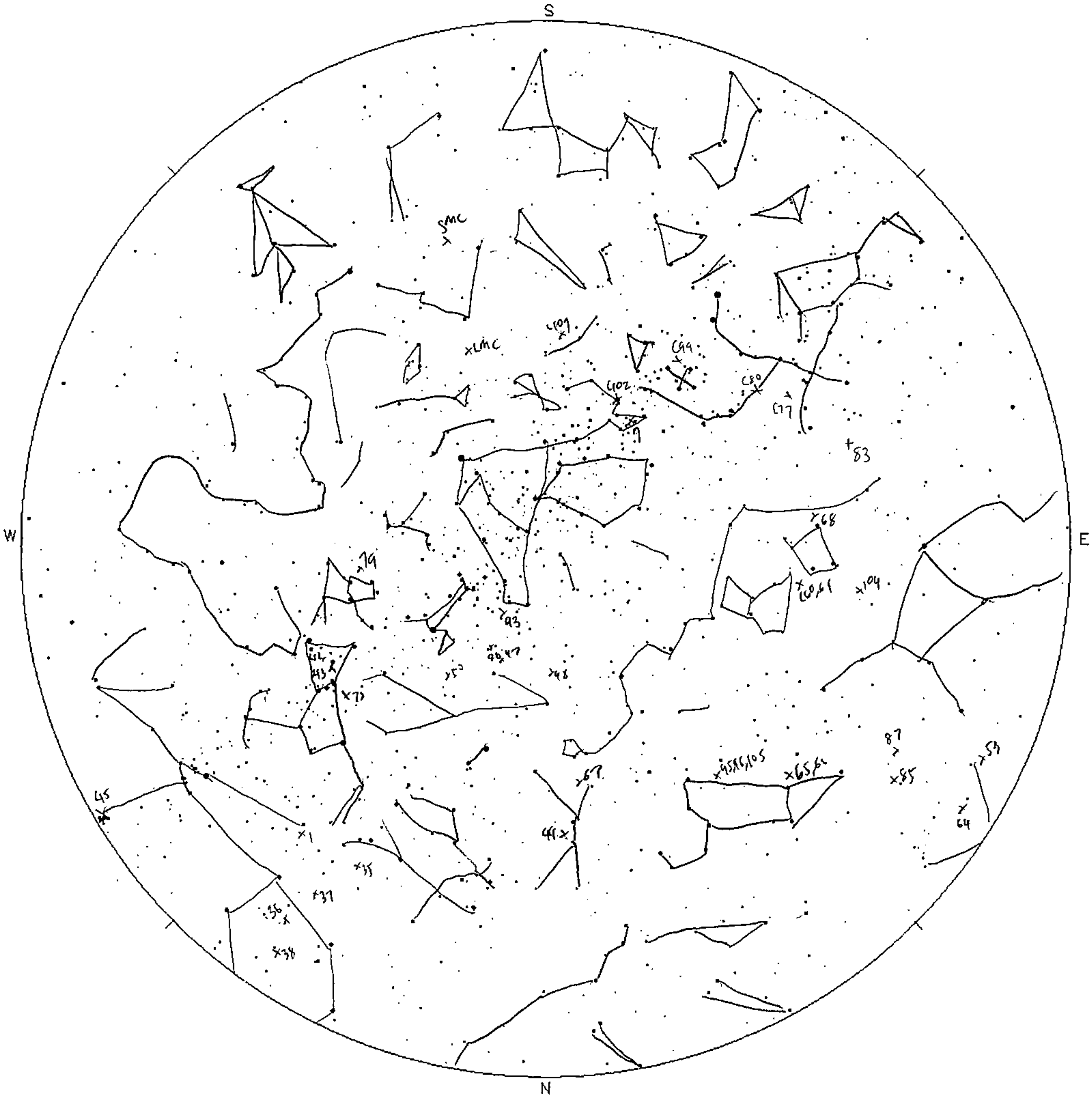
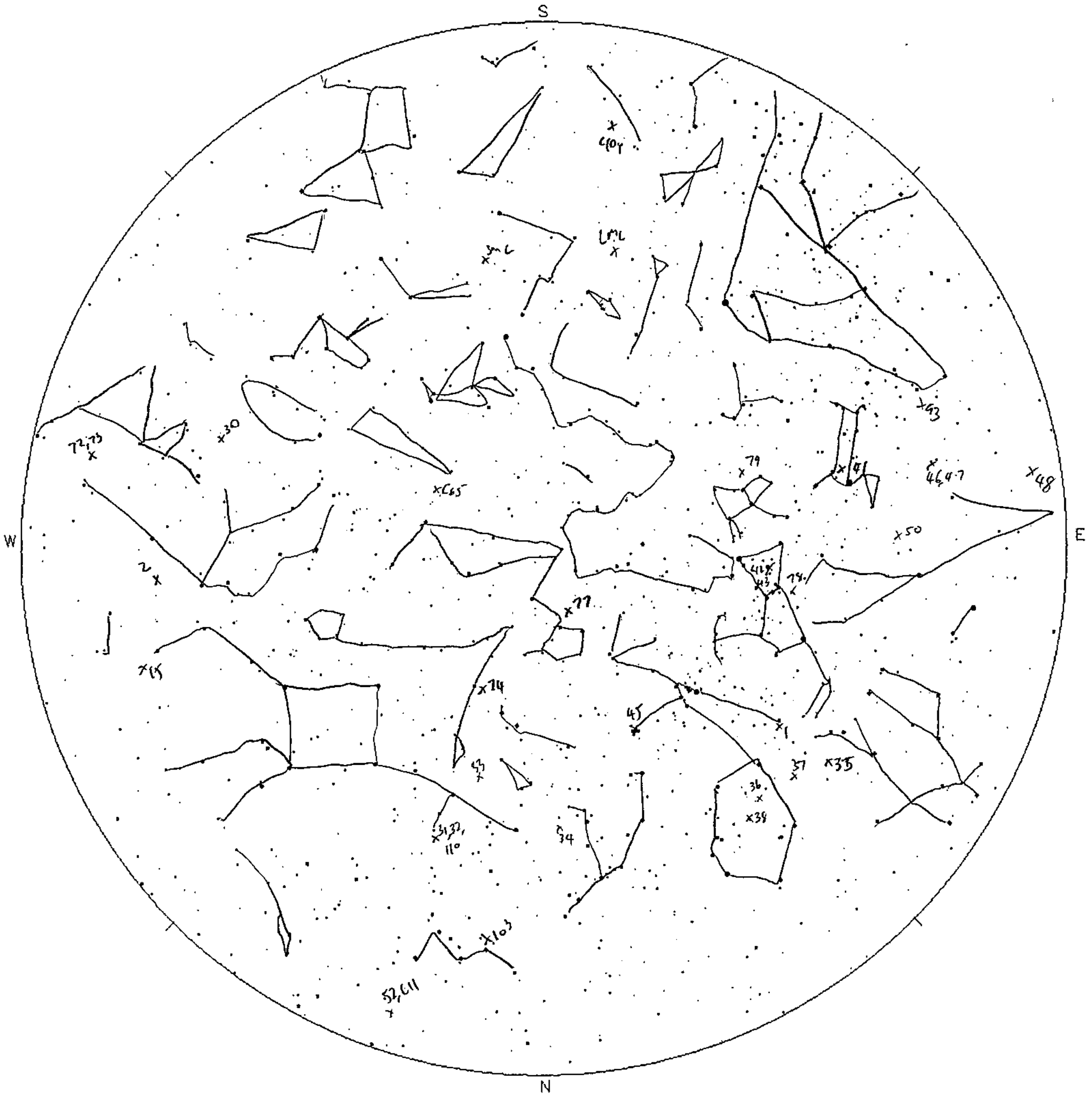
NGC
7000
X9
29
37
31,32,
110
N


S
W
E
N
SMC
LMC
C109
C99
C102
C80
C77
9
83
68
100,61
104
79
93
90,47
50
48
44
43
2
73
87
85
57
64
95,96,105
65,66
67
41
1
45
35
37
36
38


S
40?
SMC
LMC
93
79
47
46,47
48
72,73
30
C65
50
E
W
2
41
43
78
77
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24
45
1
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35
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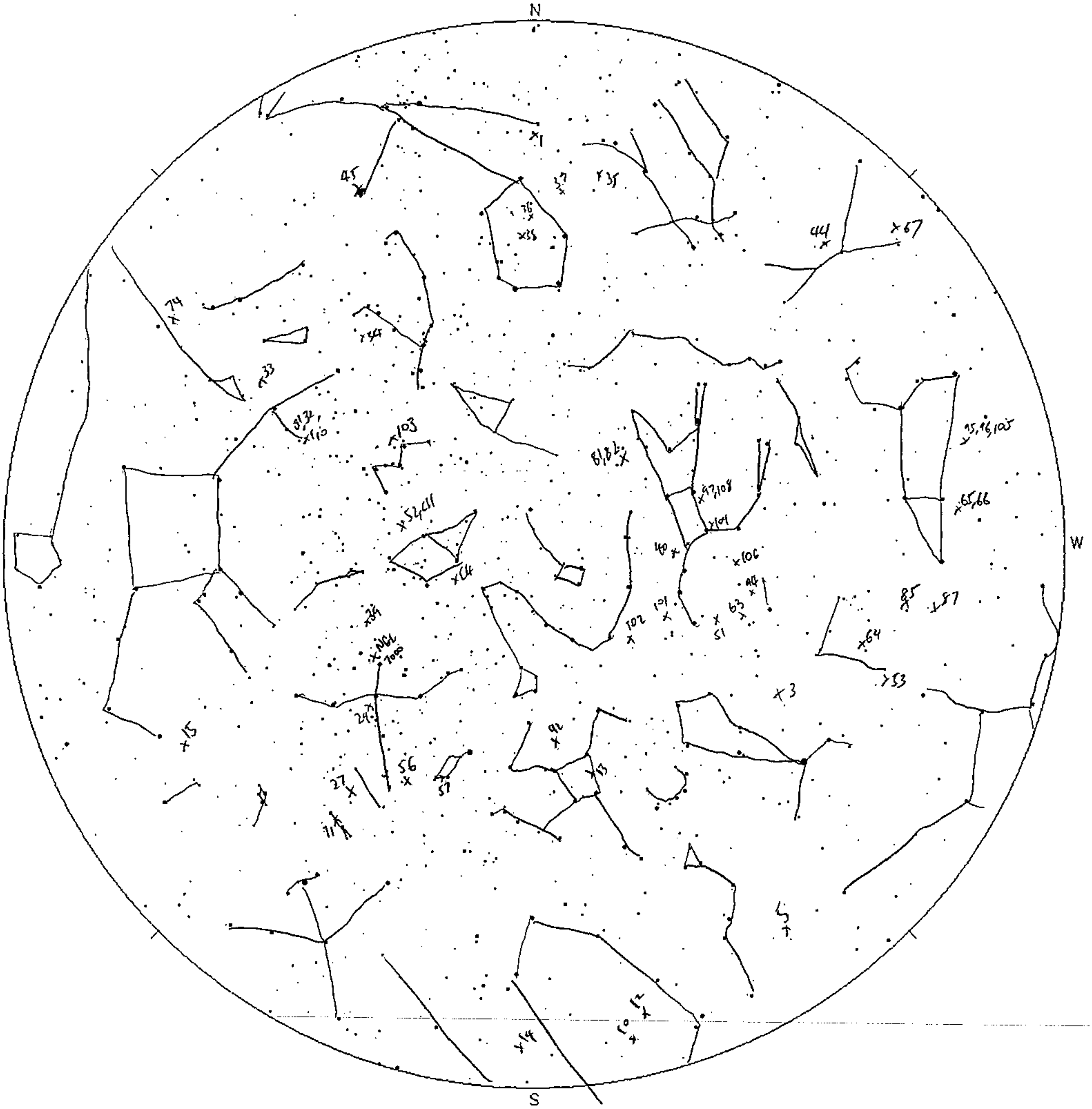
31,32,
110
34
103
52,611
N


N
E
W
S
1
45
37
35
36
38
44
67
74
34
33
31,32, 110
103
81,82
95,96,105
97,108
109
52, C11
C14
65,66
40
106
94
39
NGC 7000
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101
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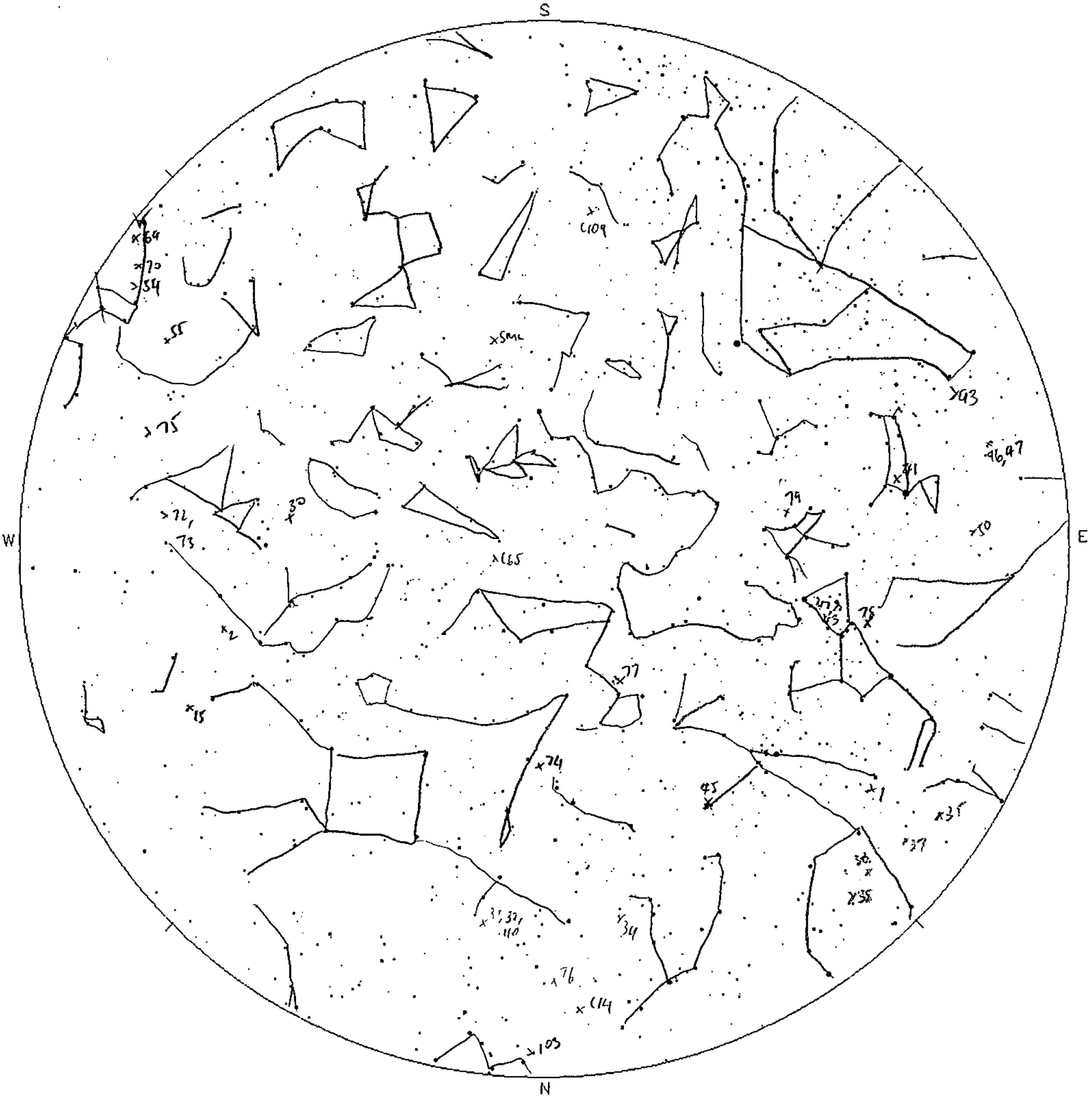
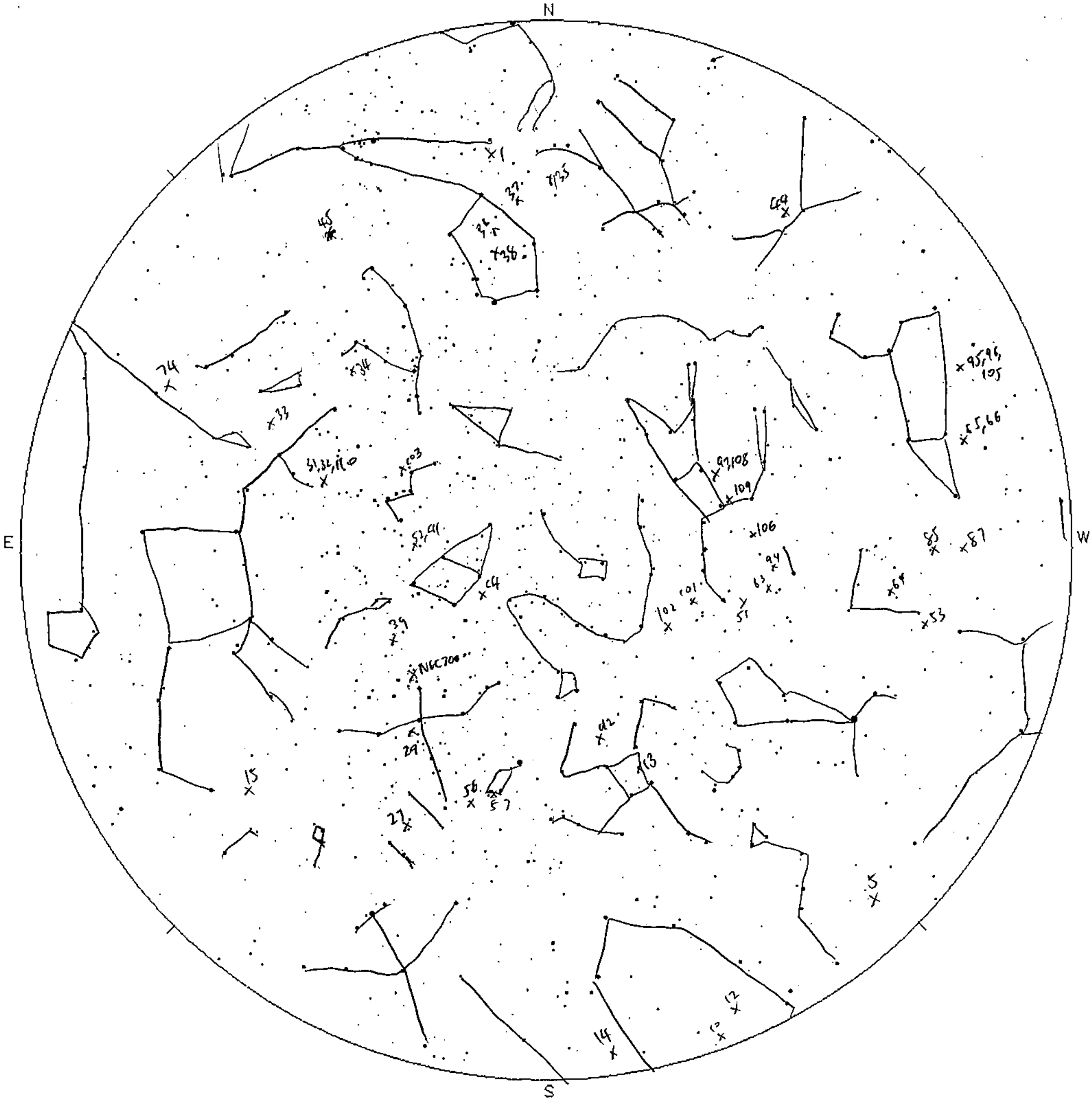
56
57
27
71
14
10
12

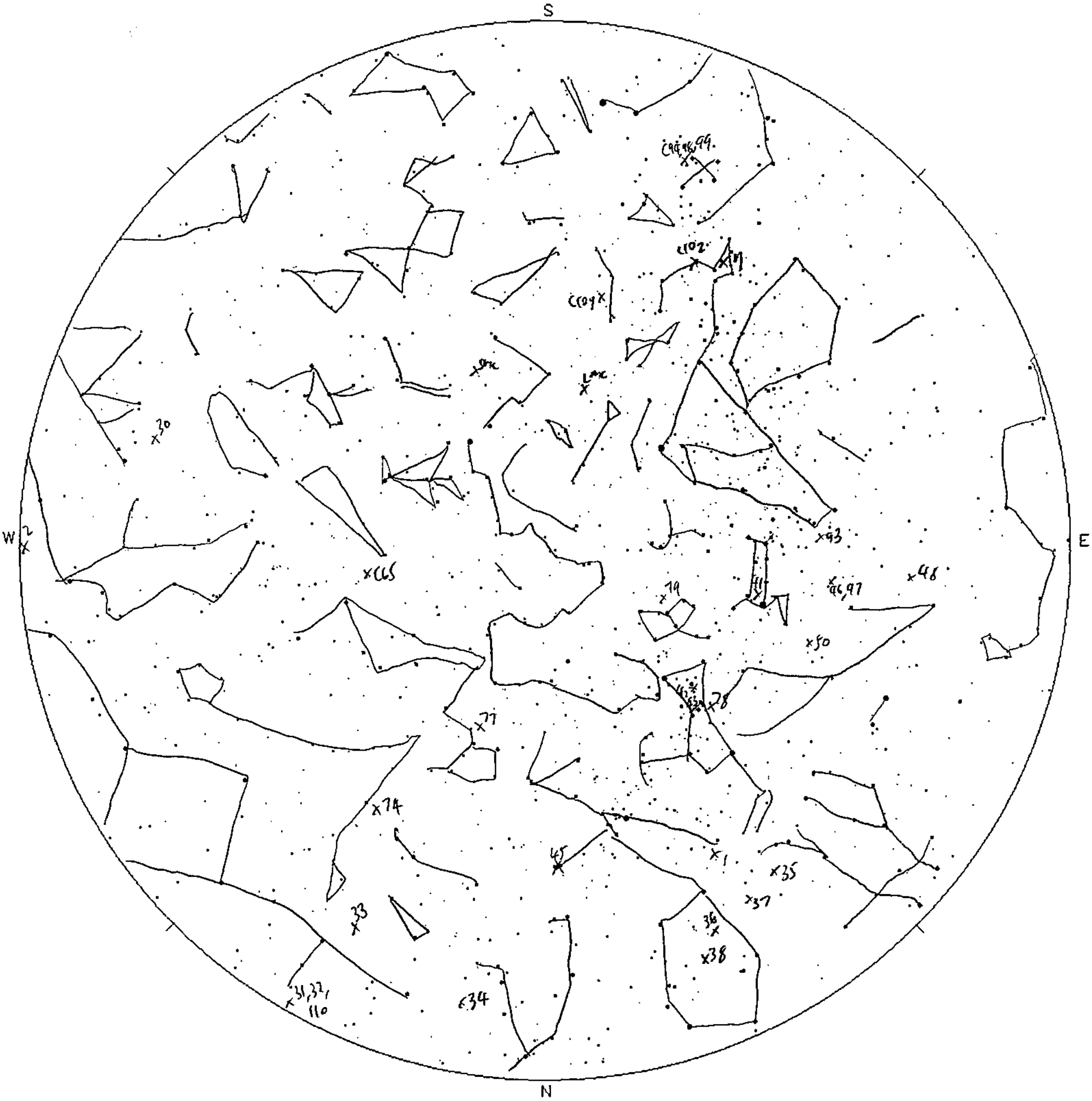

S
W
E
N
x64
x70
x54
x55
x75
x72,
73
x30
x2
x15
xSMC
C109
xC65
x93
96,97
x41
x50
79
27,3
43
75
x77
x74
45
x1
x35
x37
36
x38
x31,32,
110
34
x76
x114
x103


N
E
W
S
x36
x38
x97,108
x109
x81,82
40
x106
99
64
45
63
51
101
x3
102
x34
x C14
103
76 x
52,C11
C4
31,32,110
33
x74
39
NGC 7000
29
56
57
x92
13
x5
27
x71
15
x12
10
14
107
x2
21
26
x16,17,18
9
72,73
x75
25
x24
x23
x22
x28
8,20,21
x55
54
70
69
30

5⁴


N
1
37
35
36
38
45
49
74
33
34
31,32,110
103
52,91
64
39
NGC7000
29
27
56
57
42
13
15
97,108
109
106
101
102
94
63
51
95,96,105
65,66
85
87
68
53
5
12
10
14
E
W
S

North pole


S
W
E
N
C96,98,99.
C102
C109
SMC
LMC
30
2
C65
93
46,47
48
79
41
50
42
43
78
77
74
45
1
35
37
36
38
33
31,32,
110
C34

653-654

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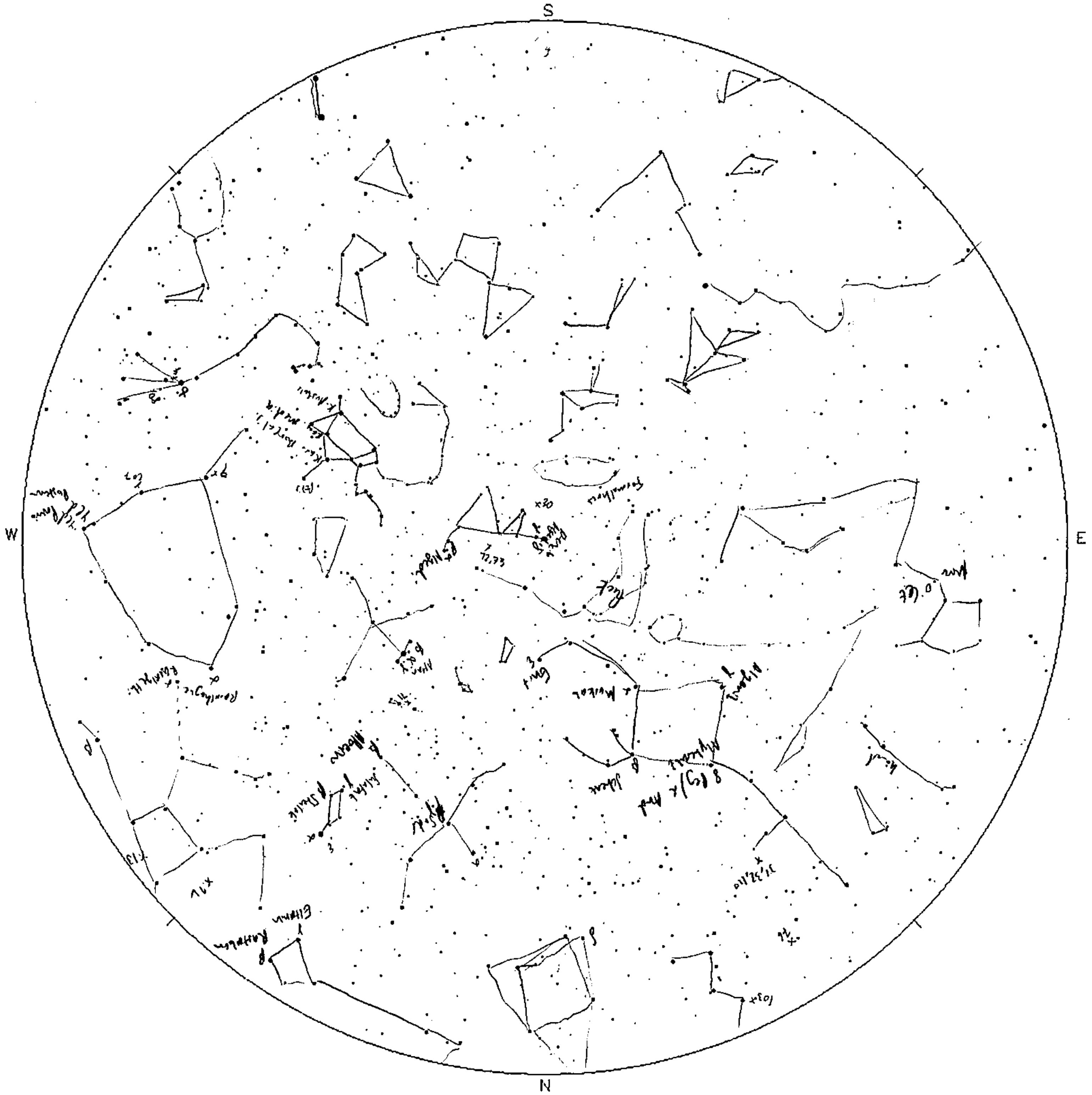
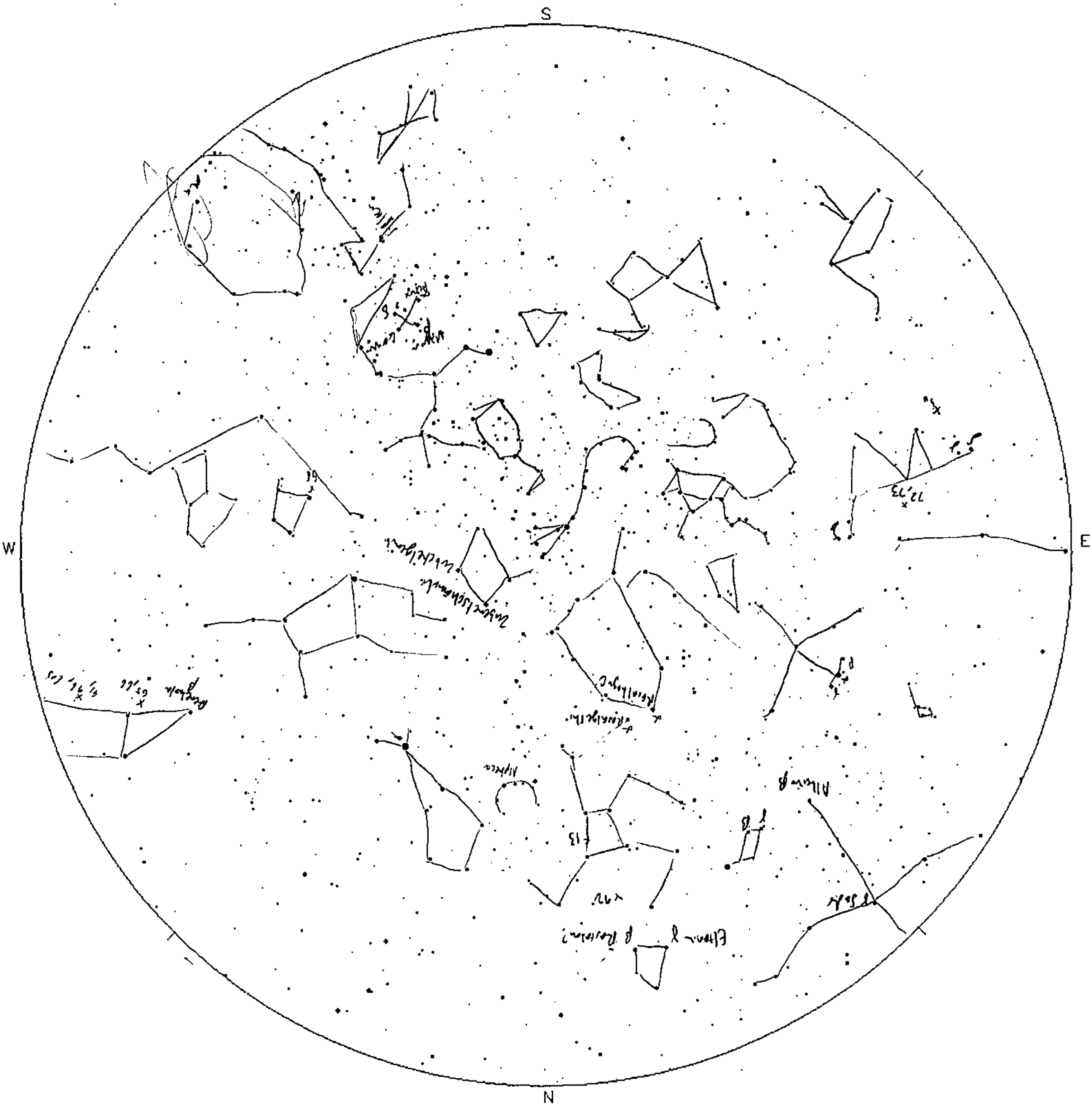
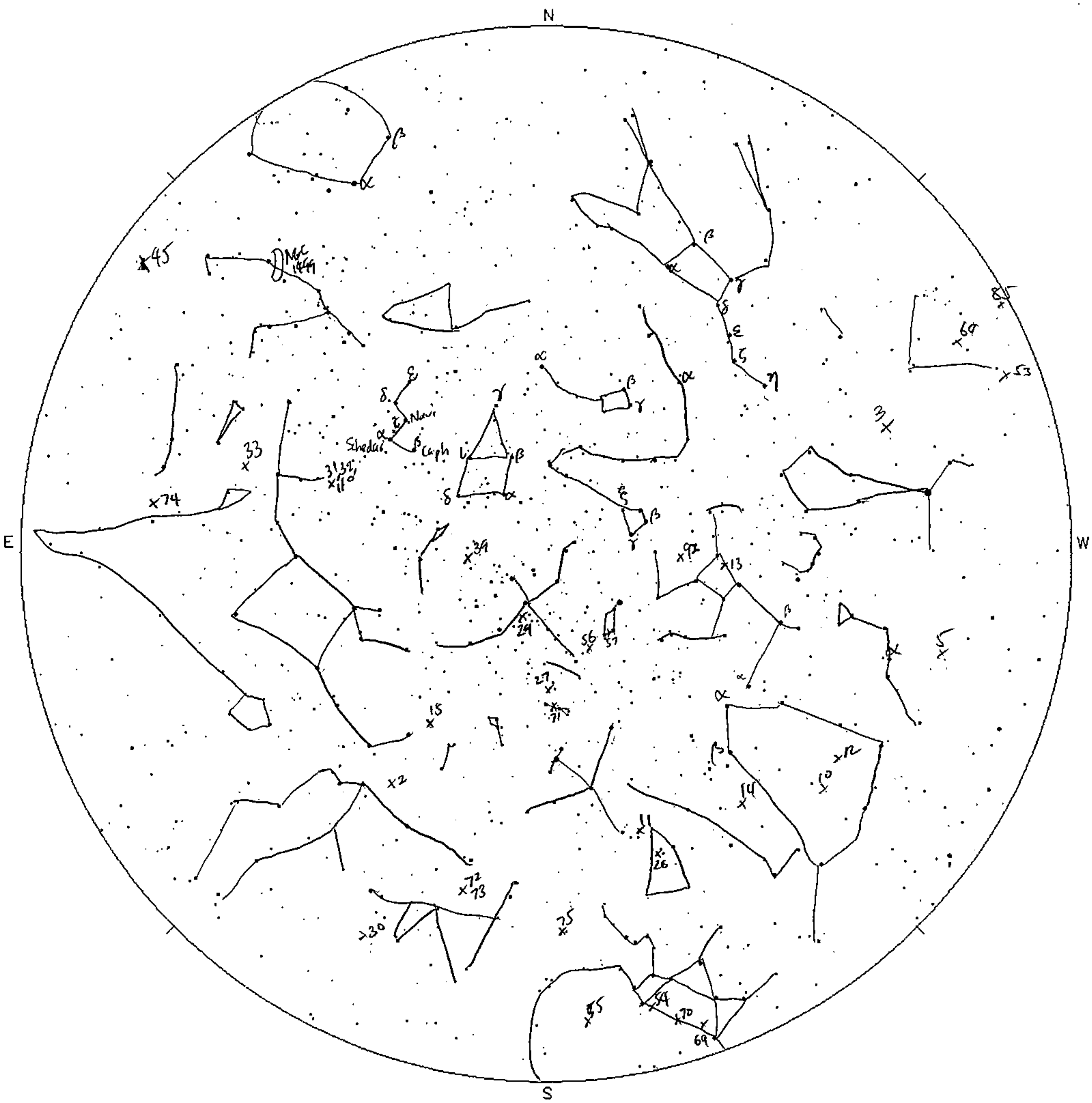
some one in IOAA

Tau!


S
W
E
N

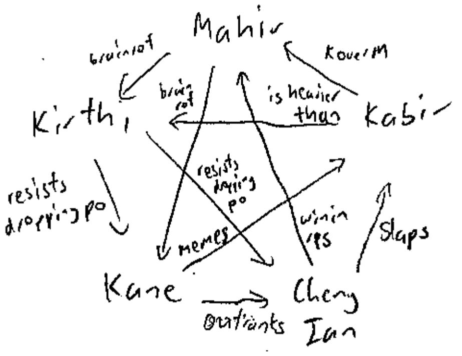

S
W
E
N
72,73
1.5
13

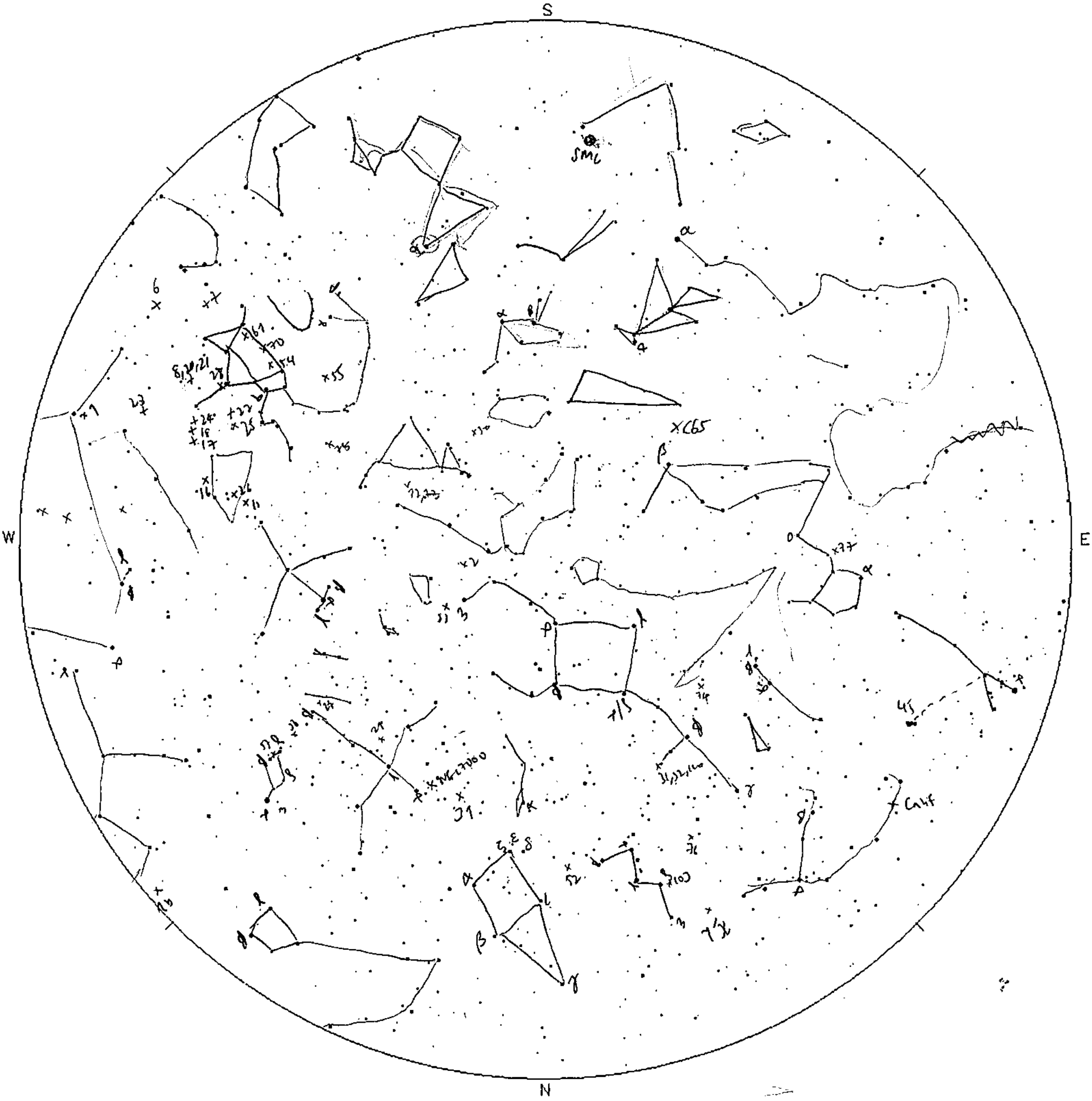


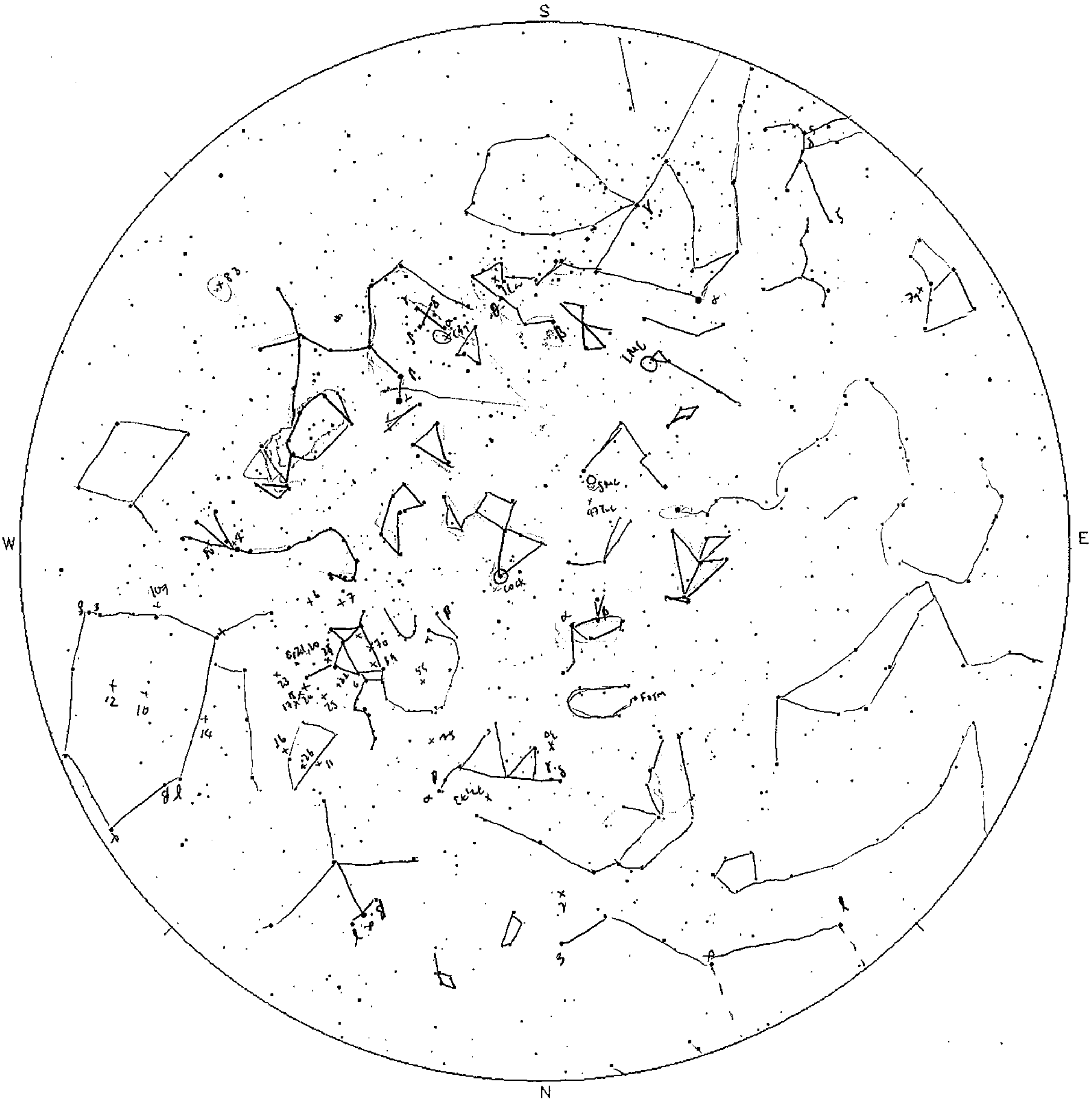
637-638
also
lent

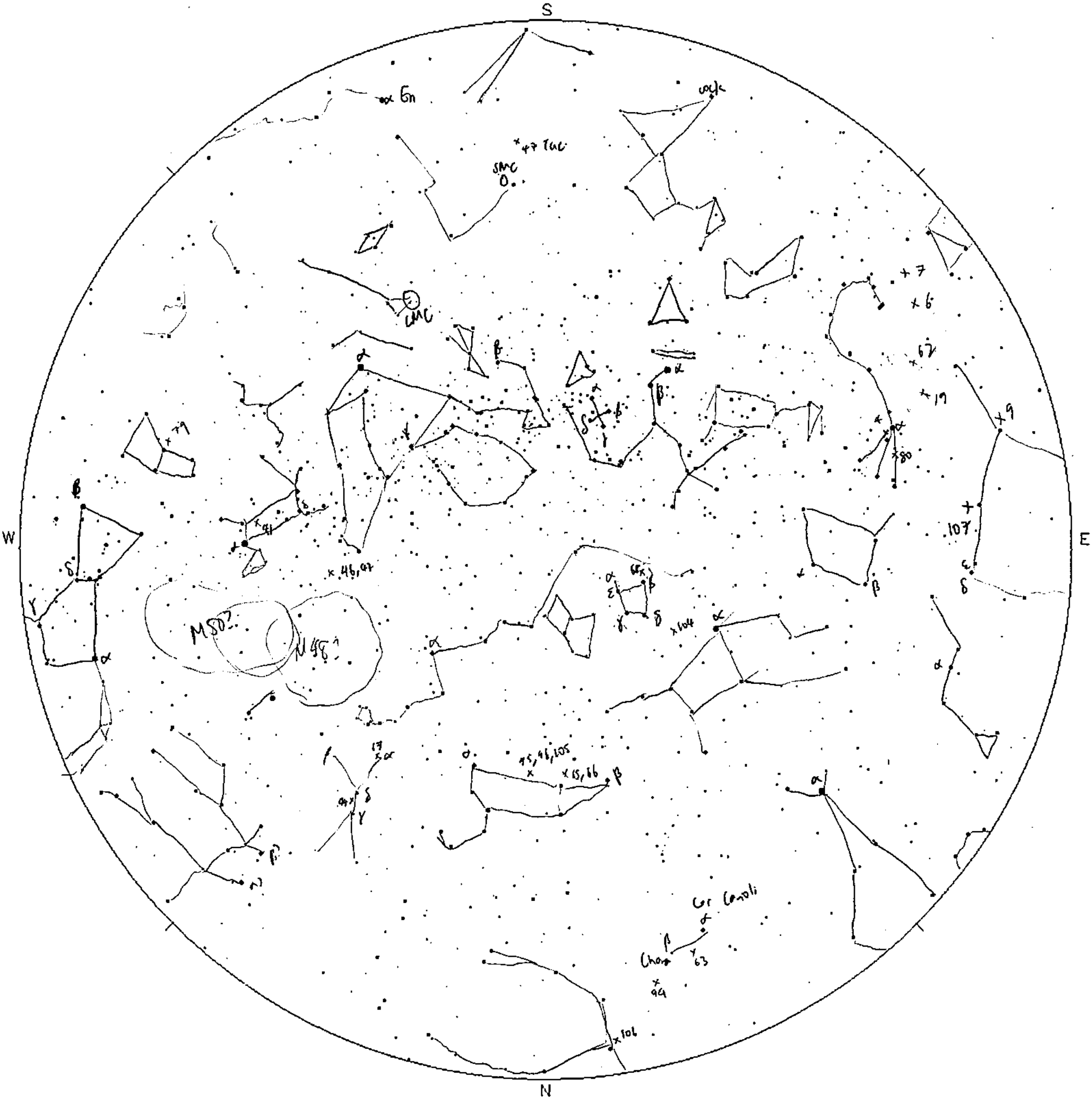

N
x102
x101
α
β
ζ
ε
δ
γ
ι
γ
β
α
x52,C11
+51
63
x94
106
x40
x109
x97, 108
81, 82
x103
31,32, x110
53
x64
x85
x87
39
β
α
38
36
35
37
β
x1
45
α
β
η
E
W
β
δ
x65,66
93,96, 105
γ
ε
α
β
α
x44
x67
α
76
α
78
λ
γ
δ
42
x43
β
κ
ε
γ
x48
50
46,47
γ
α
β
41
δ
ε
ζ
x93
x79
α
x77
ι
For
S

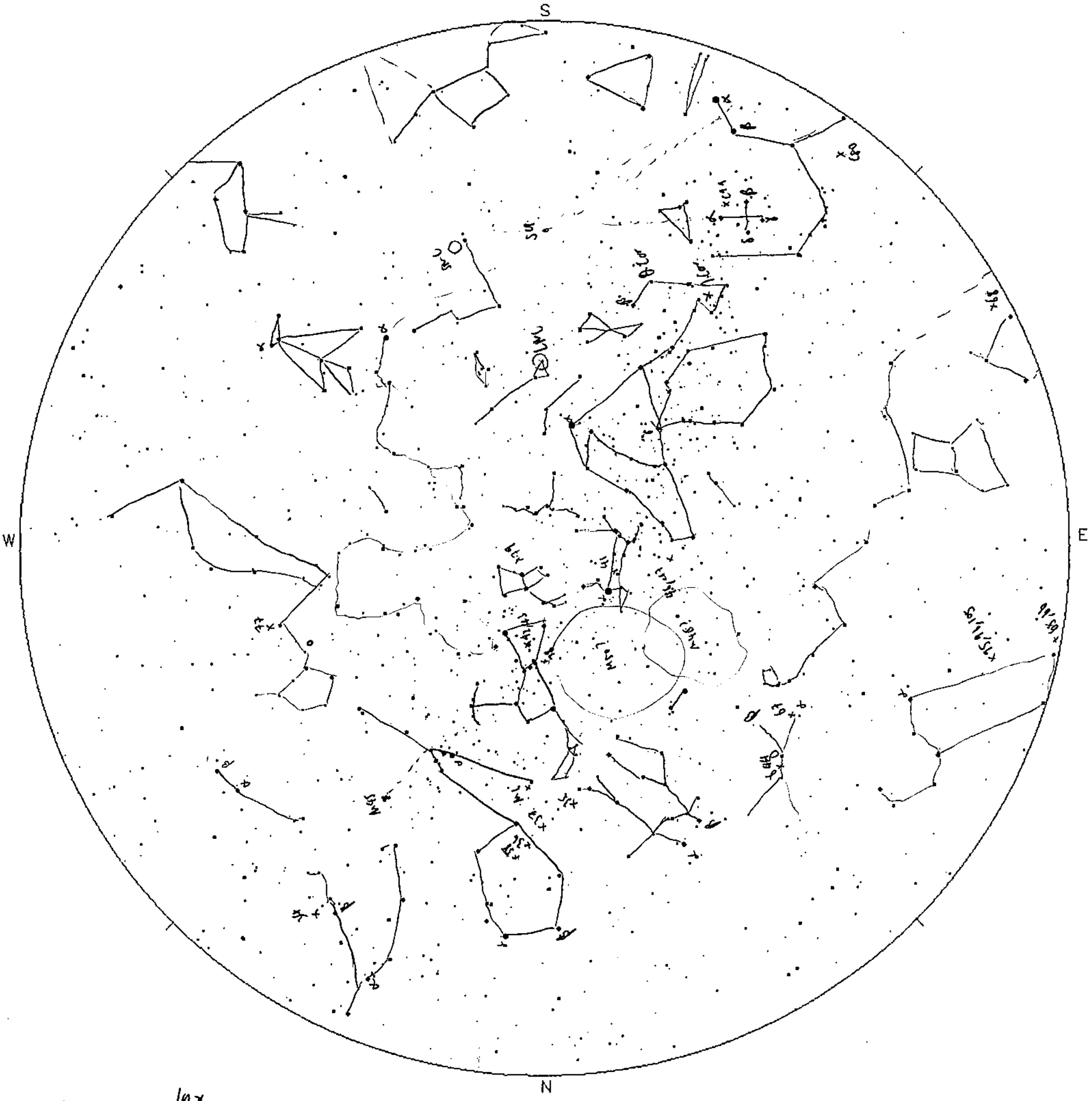

δ
γ
ε
β
α


Mahir
Kirthi
Kabir
Kane
Cheng Ian
brainrot
brain rot
Kover/M
is heavier than
resists dropping po
resists dropping po
memes
winin PS
Slaps
outranks


S
W
E
N
SMC
α
β
XC65
x77
x55
x61
x70
x54
x2
45
Ca4f
γ
δ
λ
ρ
X103
x52
x36
x14
31,32,100
x91

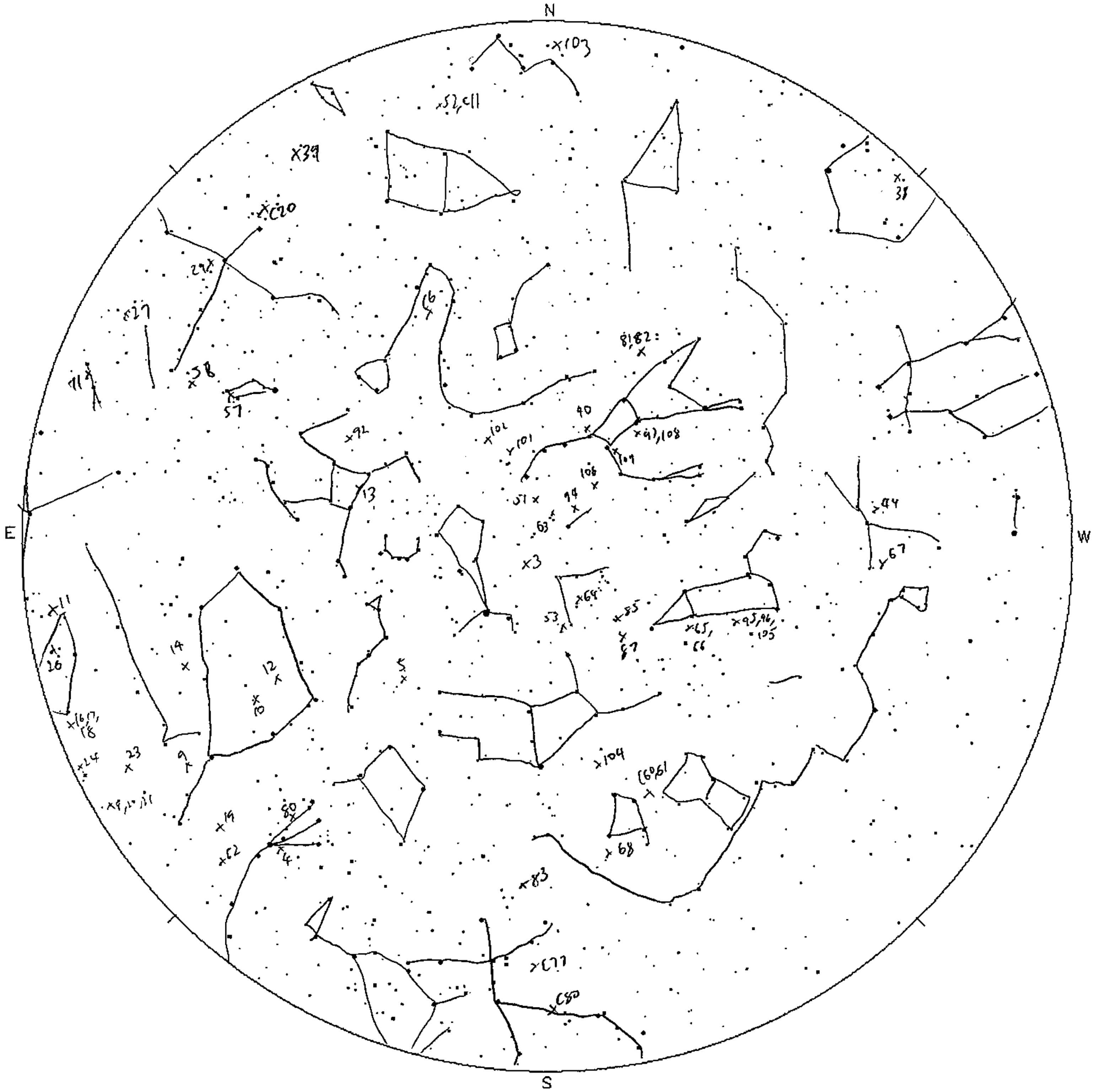

S
W
E
N
LMC
SMC
47 Tuc
Fosm


S
N
E
W
x 6n
ω Cen
x 47 Tuc
SMC
LMC
α
β
x 7
x 6
x 62
x 19
x 9
x 80
107
ε
δ
x 79
x 91
x 46, 47
M 50?
M 48?
α
ε
68 x
γ
δ
x 104
17
α
δ
44 x
γ
45, 46, 105
x
x 15, 66
β
Cor Caroli
α
Chara
β
γ 63
x 94
x 106

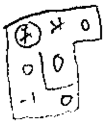


$$y = \log_{10} x = \frac{\ln x}{\ln 10}$$

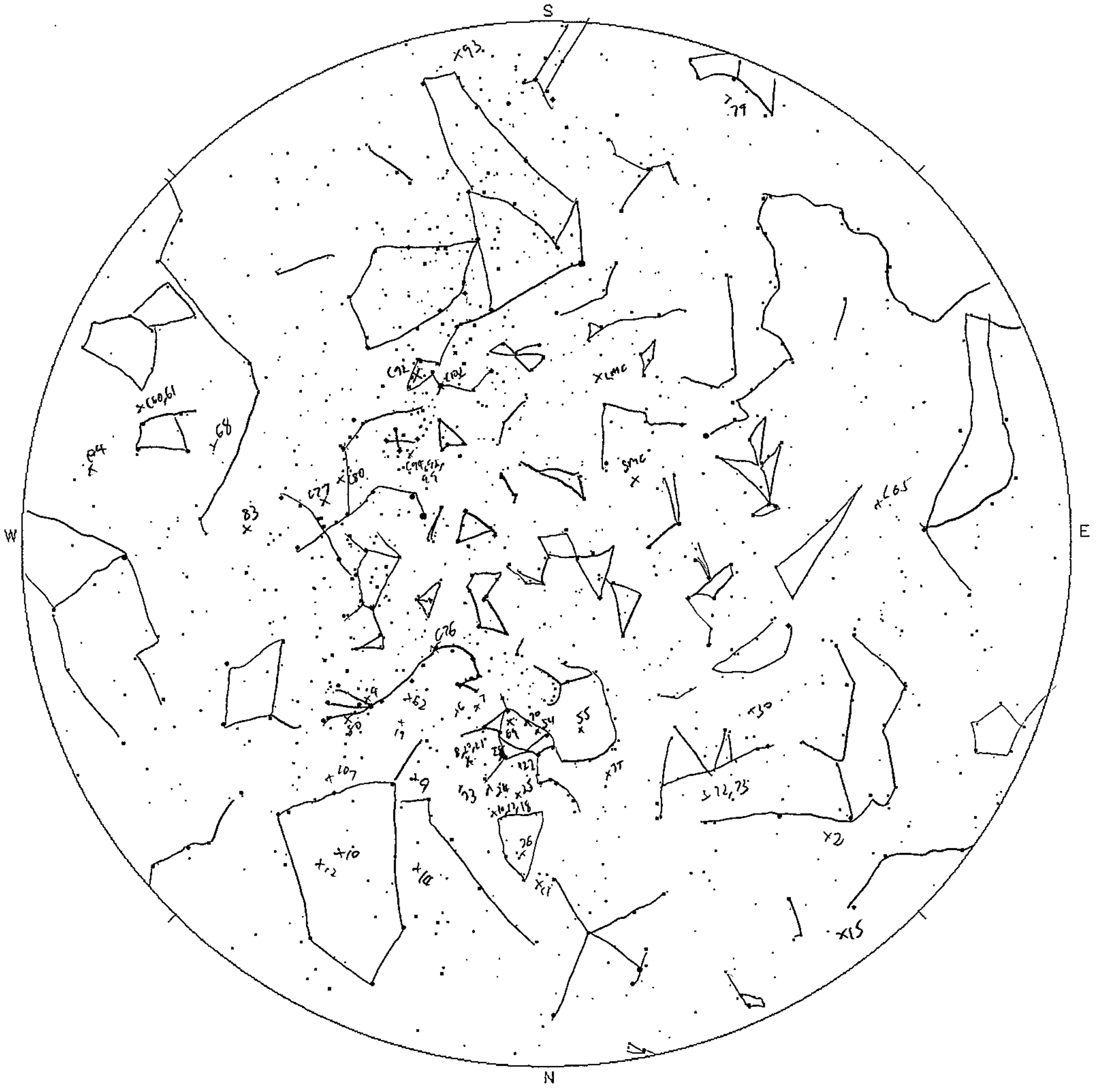
$$\Delta y = \frac{dy}{dx}\cdot\Delta x = \frac{1}{\ln 10}\cdot\frac{1}{x}\cdot\Delta x = \frac{\Delta x}{x\ln 10} \ \#$$

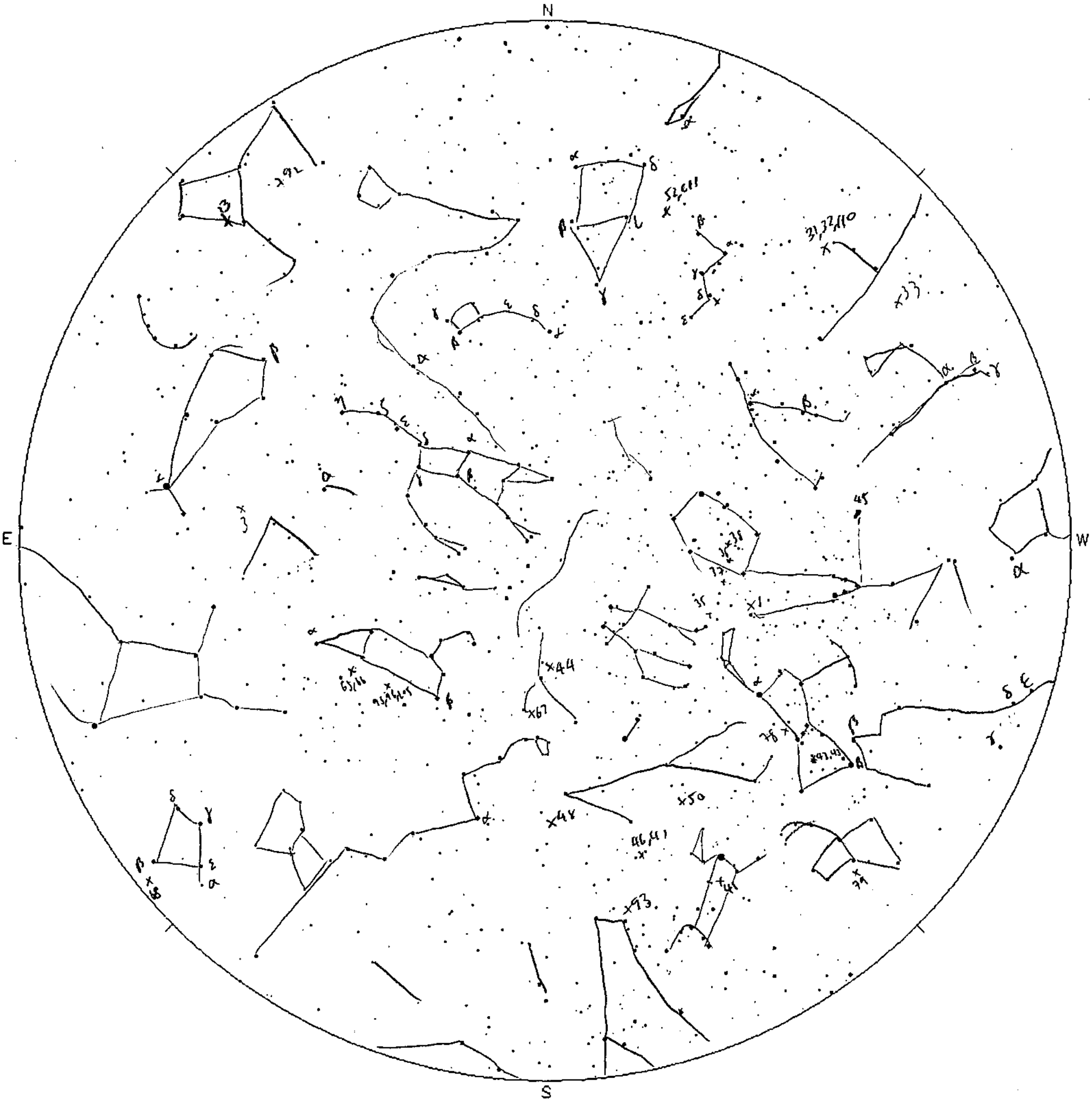


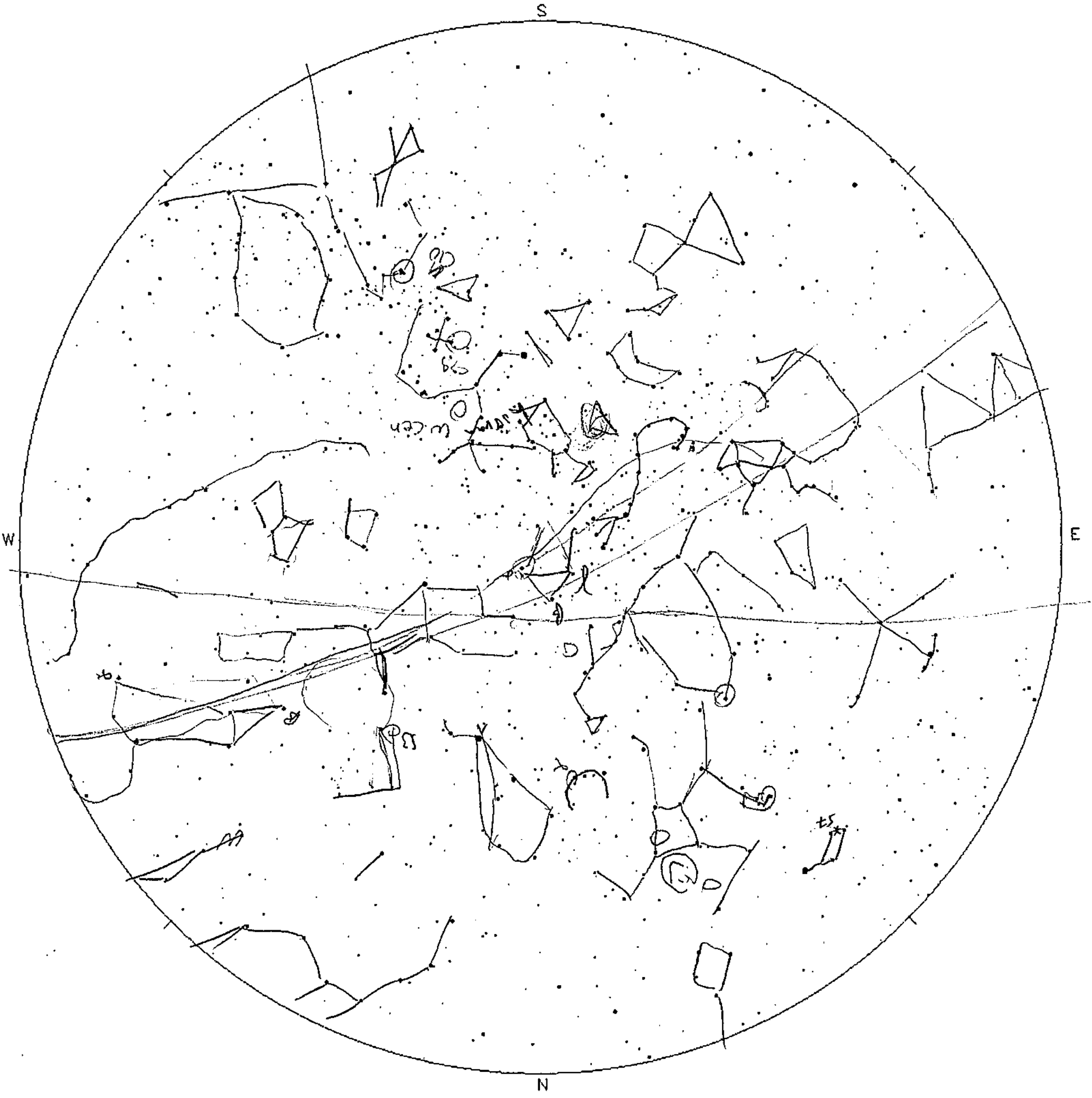
printed again
Since it was
given to other people in ZOAA

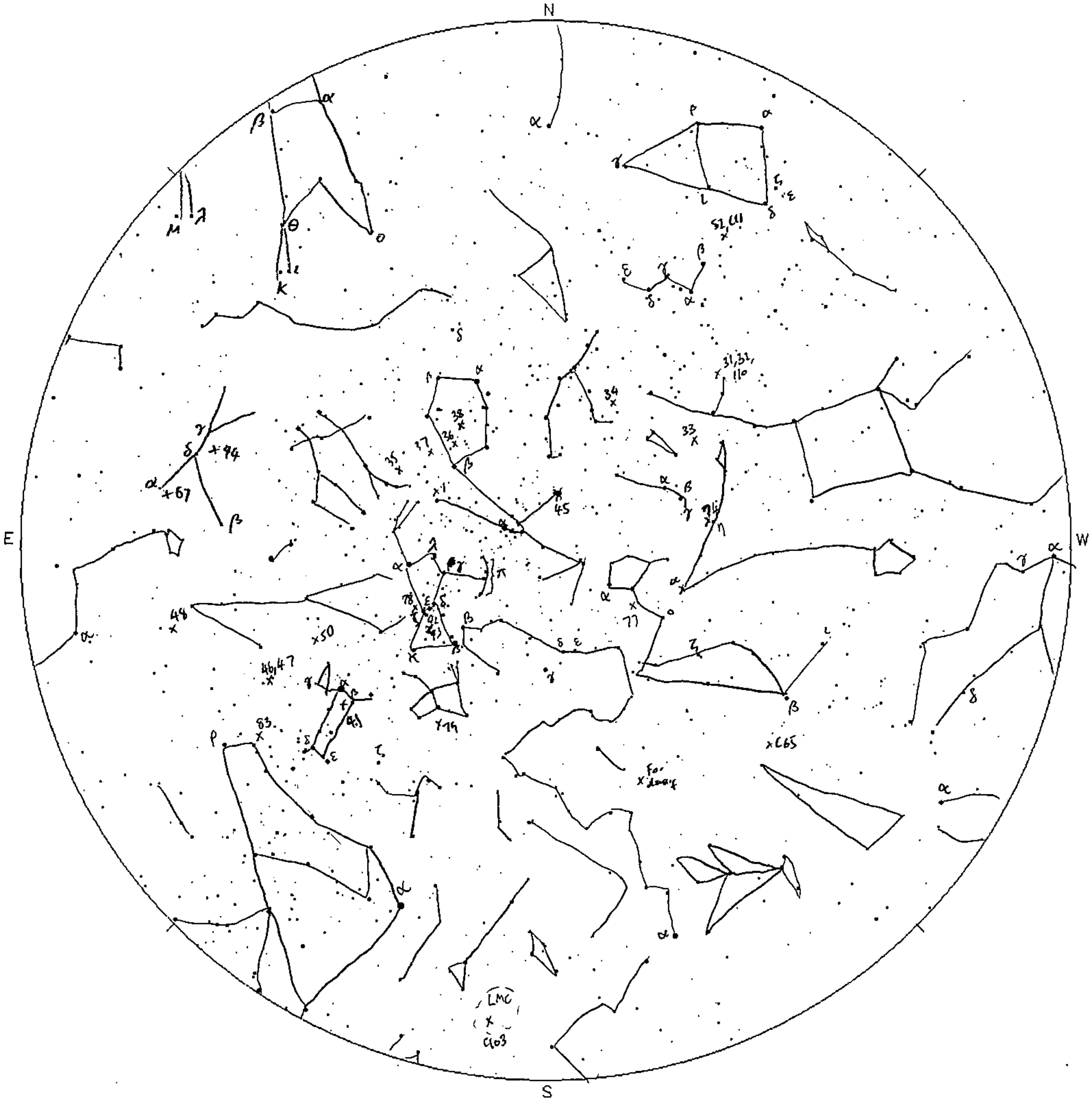


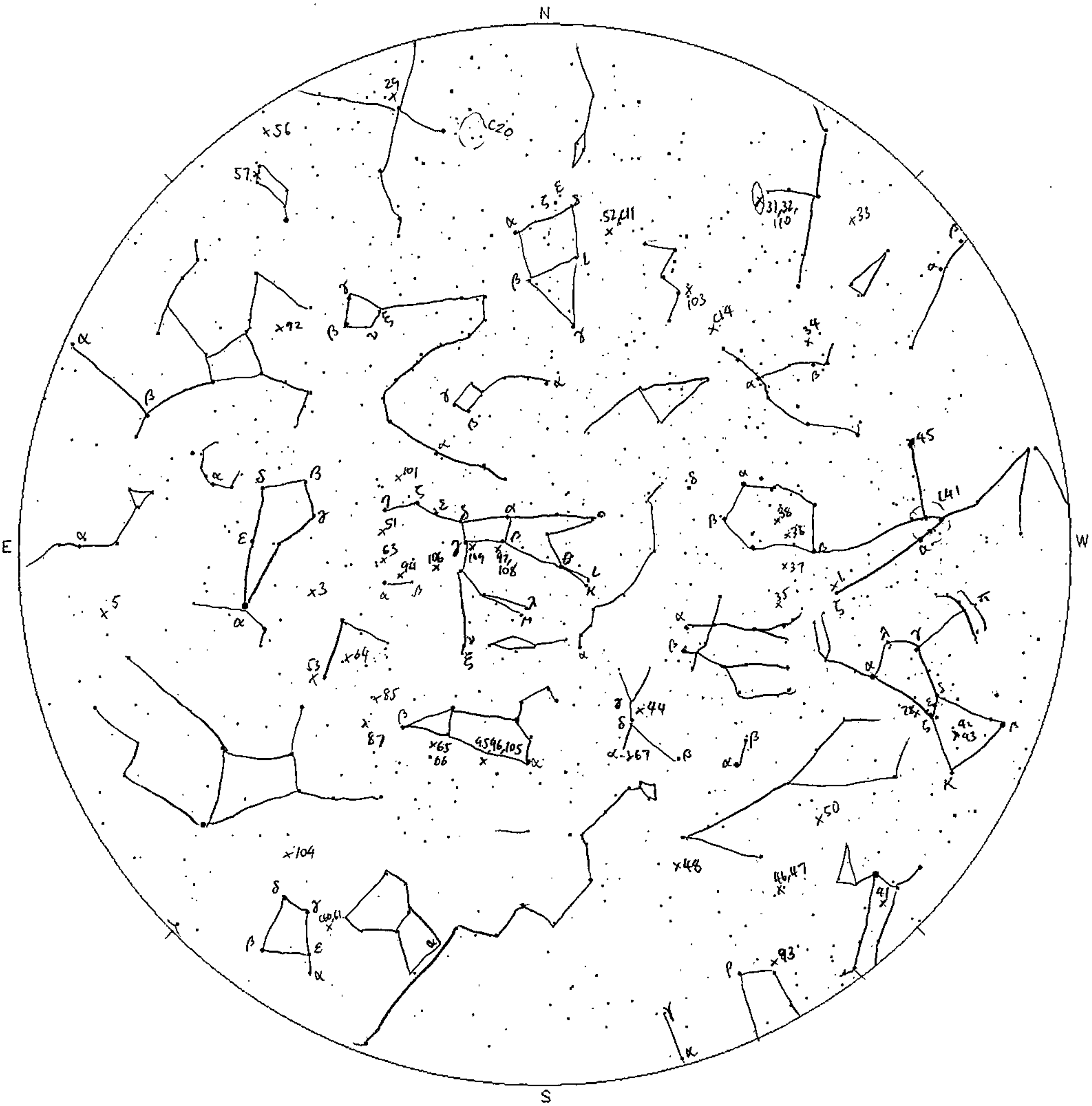
{0|0,4}


S
x93
79
C92
x102
xLMC
x(60,61
68
84
83
C77
x80
C98,C91,
99
SMC
x C65
W
E
C76
9
80
x62
19
x6
x7
70
54
69
55
8,20,21
28
x22
x37
x30
12,23
x107
9
33
34
x25
x16,17,18
26
x10
x12
x14
x11
x2
x15
N


N
E
W
S
x92
β
52,81
31,32,110
x33
α
δ
β
γ
ι
ε
η
ζ
x3
45
37/38
x1
35
x44
x67
65/66
95,96,105
x48
46,47
x50
78
x97,43
x41
x93
x79
68
ε
γ
δ


S
W
E
N

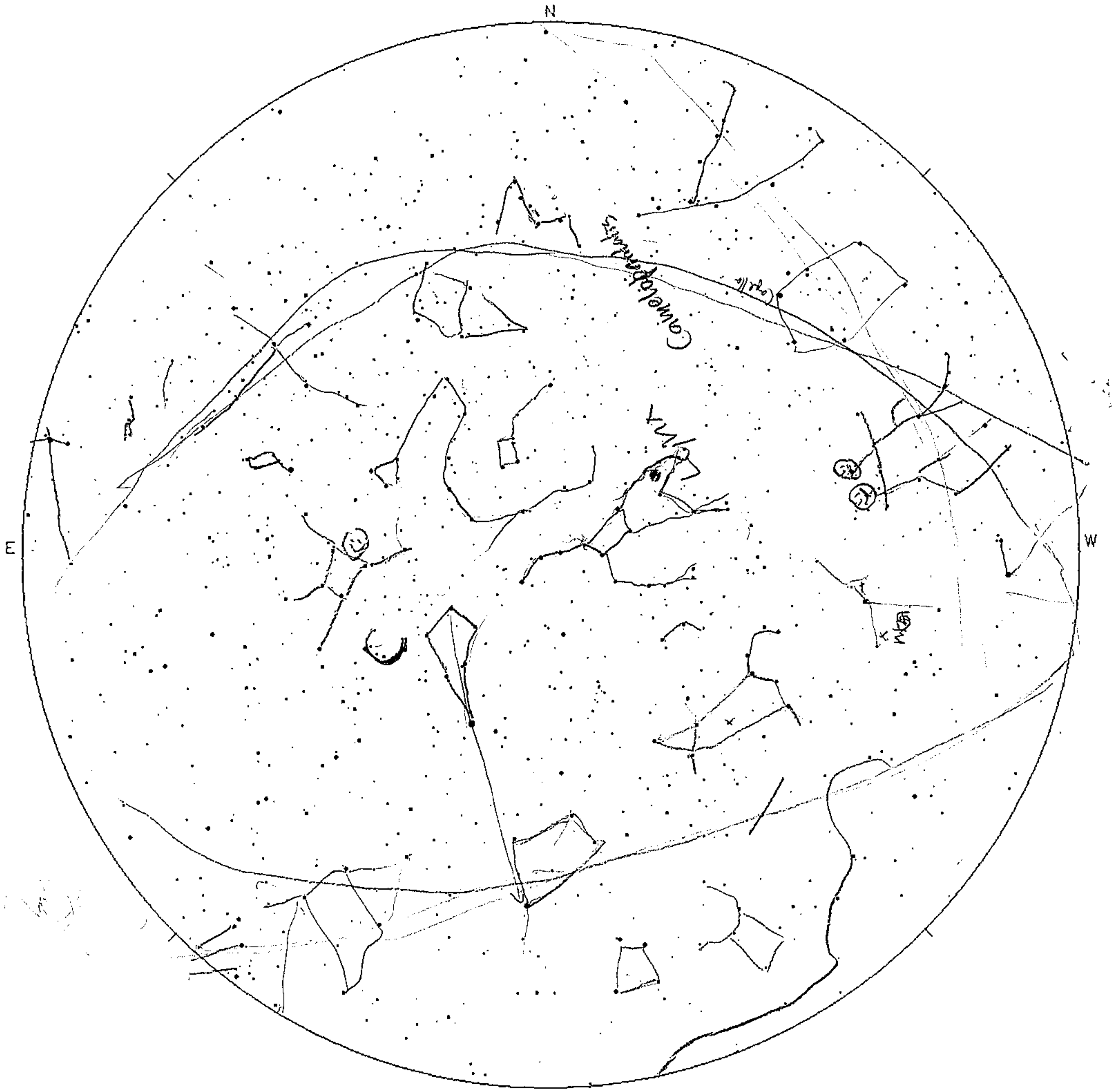

N
E
W
S
α
β
α
μ
λ
θ
o
ι
κ
ρ
α
γ
ι
δ
ζ
ε
51,101
ε
γ
β
δ
α
δ
31,32,110
34
33
ρ
α
38
37
36
35
β
γ
δ
+94
α
+67
β
1
45
α
β
γ
η
α
λ
γ
π
α
78
ε
δ
42
43
κ
β
α
77
48
α
50
β
δ
ε
γ
ζ
ι
46,47
γ
α
ζ
δ
ε
79
83
ρ
ζ
β
C65
For. dwarf
α
δ
α
γ
α
α
LMC
C103


N
E
W
S
×56
57×
29×
C20
52,111×
31,32,110
×33
×103
×114
34×
×92
×45
141
×38
×36
×37
×35
×101
×51
×63
×94
106×
109
97,108
×3
×5
53×
×64
×85
×87
×65
66
45,96,105×
×44
×267
×50
×48
46,47×
41×
42
×43
28×
×104
60,61×
×93
α
β
γ
δ
ε
ζ
η
θ
ι
κ
λ
μ
ν
ξ
π
ρ

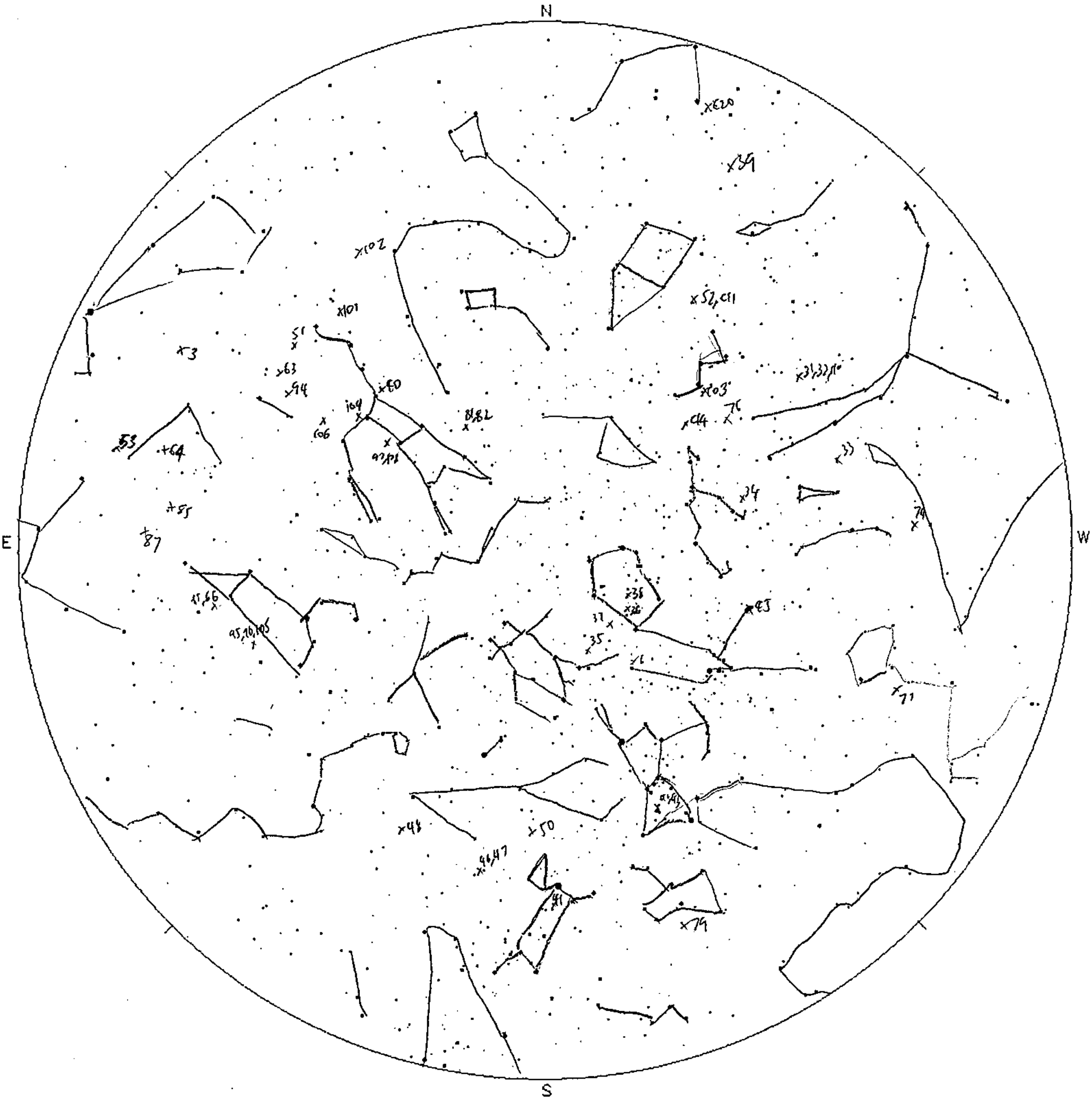

S
W
E
N
C106
M8
42
45
78
68
104
57
44
M33

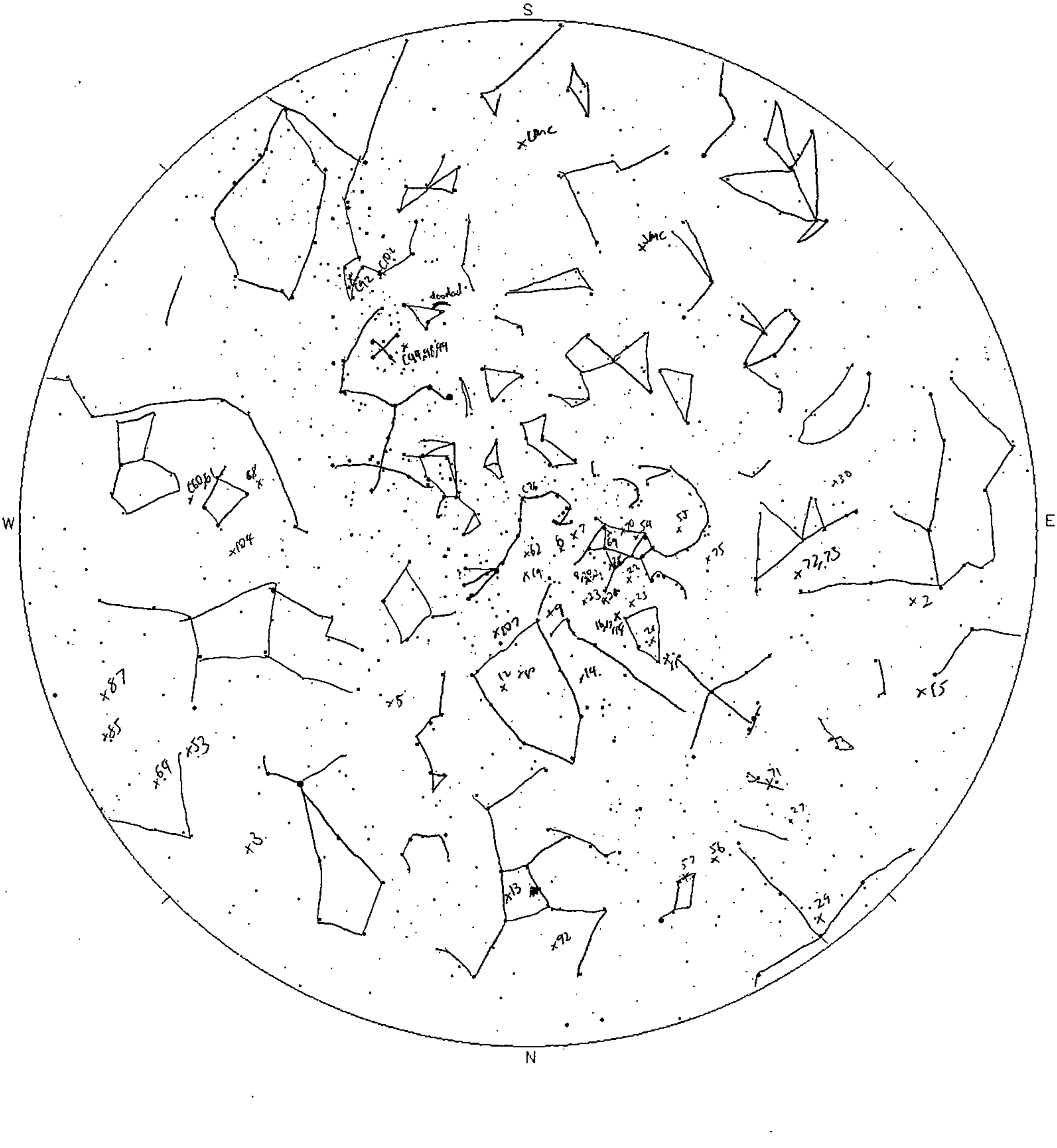

S
N
E
W
x68
3
M107
M9
M19
M44
M6
M30
M16
M12
M15
M10
M14
M11
M15
x103
C68
173
x
x

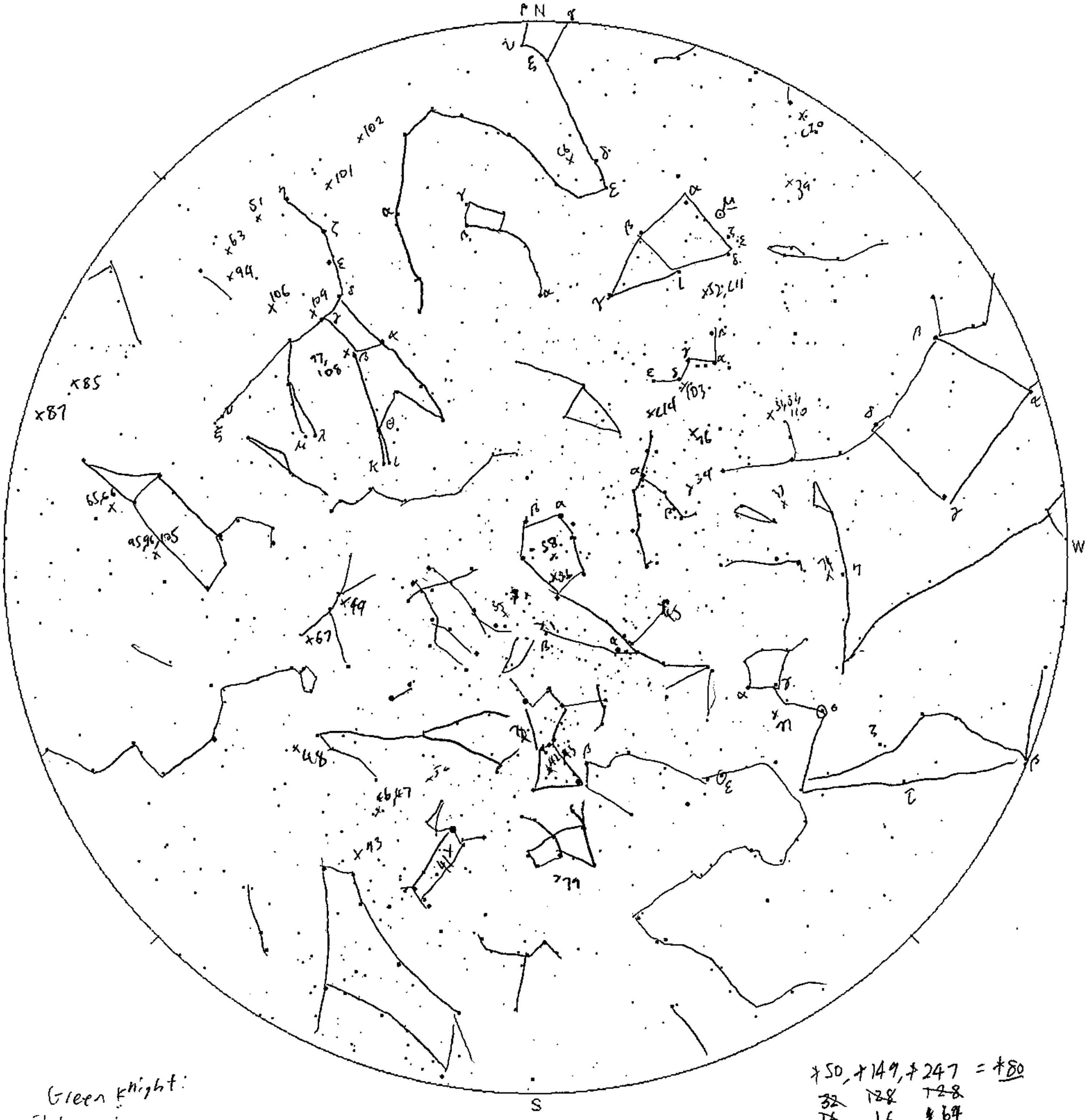

N
47,108
81,82
109
106
94
63
40
51
101
102
38
45
74
49
76
103
52,111
31,32,110
33
79
E
77
39
29
56
57
27
71
15
13
2
5
W
12
10
107
14
1
56
16,17,18
9
25
24
23
32
28
8,20,21
17
72,73
30
75
55
54
69
70
S


N
E
W
S
Camelopardalis
(Giraffe)
Lynx

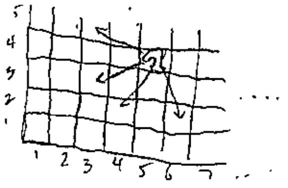

S
W
E
N
x30
x7273
x2
x15
x71
x27
x56
x29
x13
x42


N
x520
x39
x102
x101
51
x3
x63
x94
x80
104
106
x53
+64
81,82
97,98
x52,c11
x103
x44
76
x31,32,110
x33
x34
x85
87
W
E
15,66
95,10,105
x38
x36
37
35
1
45
79
71
x48
x50
46,47
41
43
x74
S


S
W
E
N
x LMC
x SMC
C92
C102
doodad
x C49,98,99
C60,61
68 x
x104
C76
x62
x7
x19
9,20,21
x23
x28
x22
x23
x9
x107
16,17 x
114
24 x
x11
x12
x80
x14
x5
69
x70
54
53 x
x75
x30
x72,73
x2
x15
x87
x85
x69
x53
x3
x13
x92
57 x
56 x
x71
x27
25 x



Green Knight:



All values nimbers since impartial game (S-G thm)

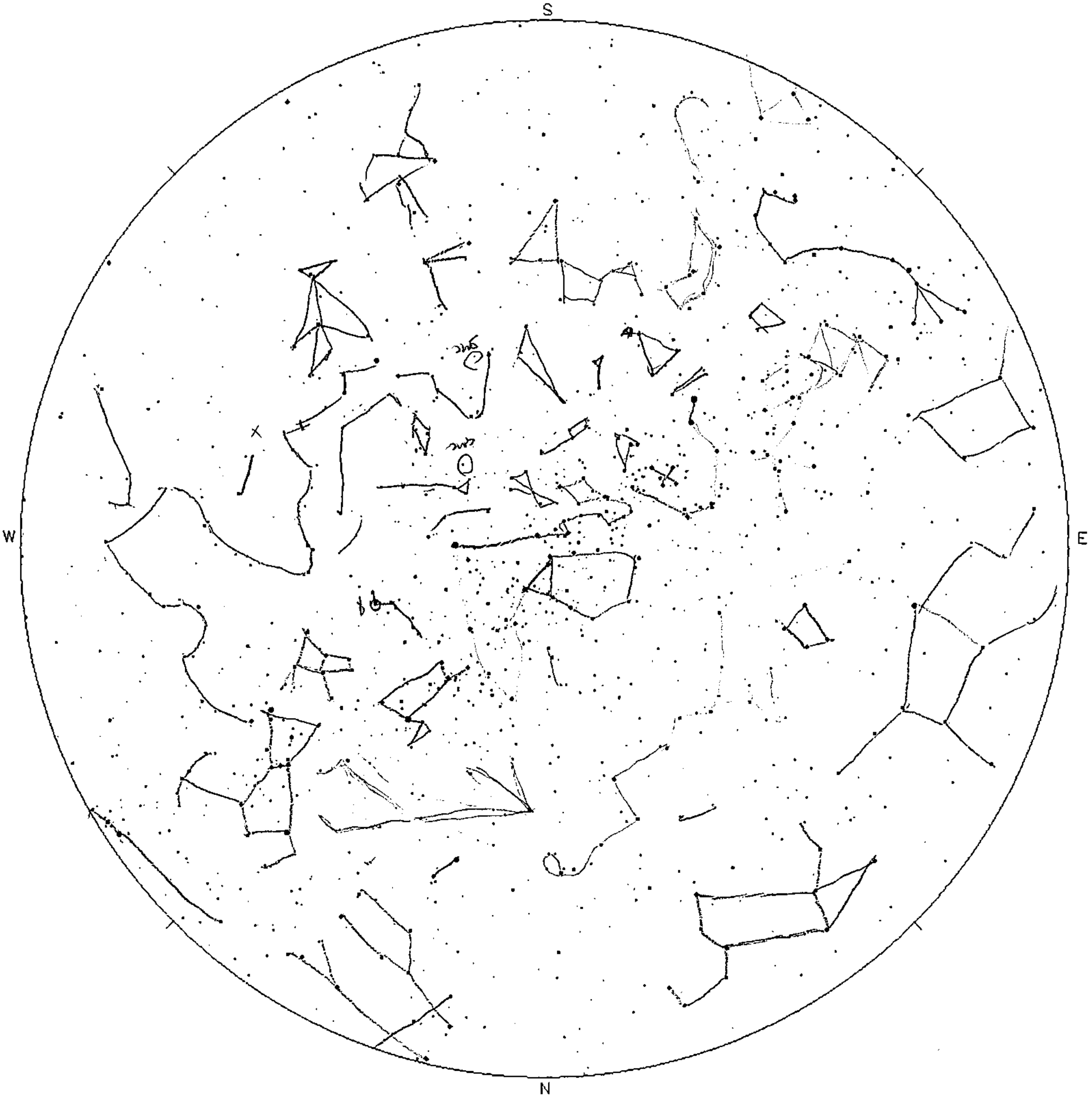
also mex rule

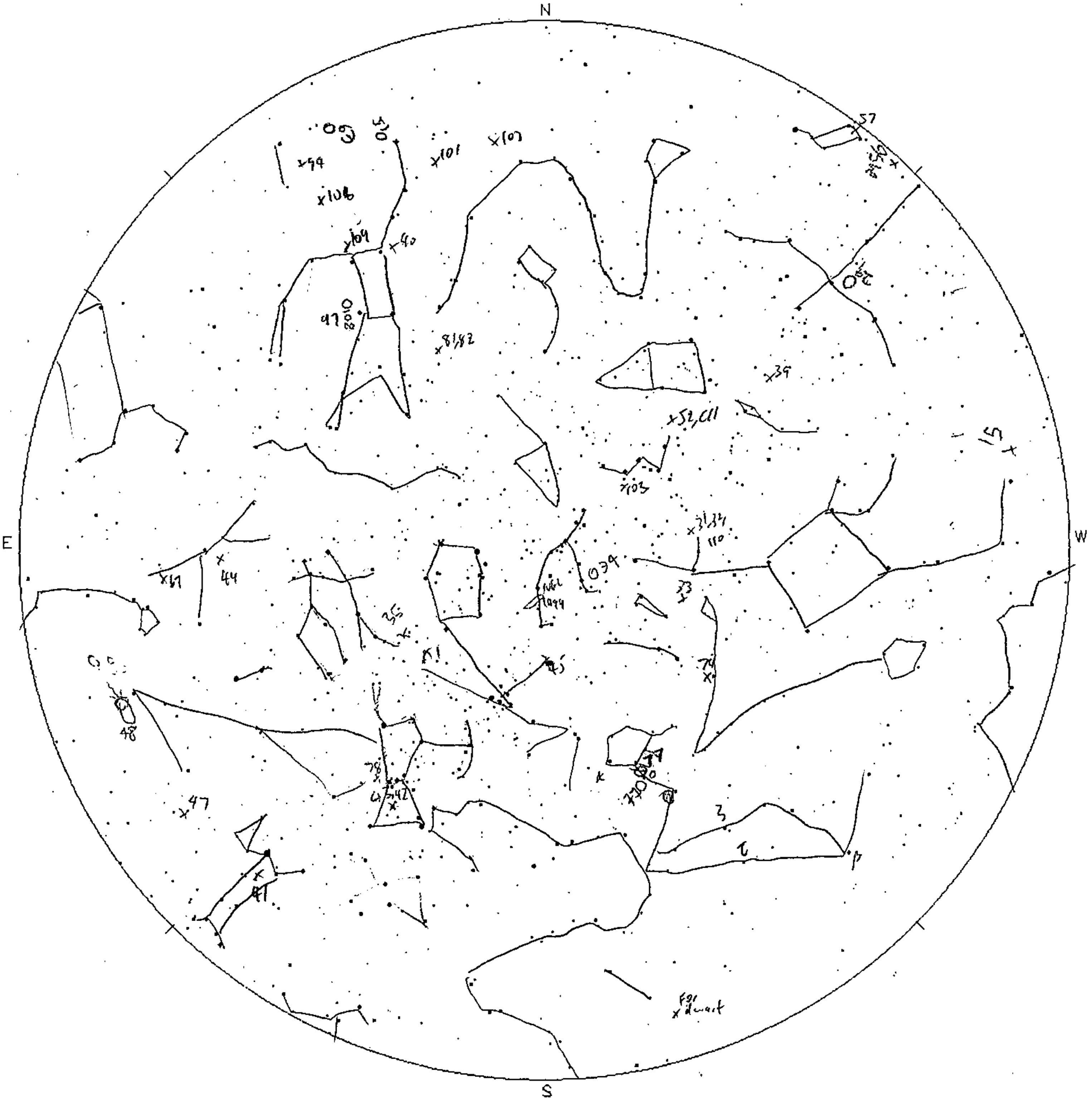
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0	0	1	1	0	0	1	1	0	0	1	1	0	0
2	0	0	2	1	0	0	1	1	0	0	1	1	0	0
3	1	2	2	2	3	2	2	2	3	2	2	2	3	2
4	1	1	2	1	4	3	2	3	3	3	2	3	3	3
5	0	0	3	4	0	0	1	1	0	0	1	1	0	0
6	0	0	2	3	0	0	2	1	0	0	1	1	0	0
7	1	1	2	2	1	2	2	2	3	2	2	2	3	2
8	1	1	2	3	1	1	2	1	4	3	2	3	3	3
9	0	0	3	3	0	0	3	4	0	0	1	1	0	0
10	0	0	2	3	0	0	2	3	0	0	2	1	0	0
11	1	1	2	2	1	1	2	2	1	2	2	2	3	2
12	1	1	2	3	0	0	2	3	1	1	2	1	4	3
13	0	0	3	3	0	0	3	3	0	0	3	4	0	0
14	0	0	2	2	0	0	2	[illegible]	0	0	2	3	0	0

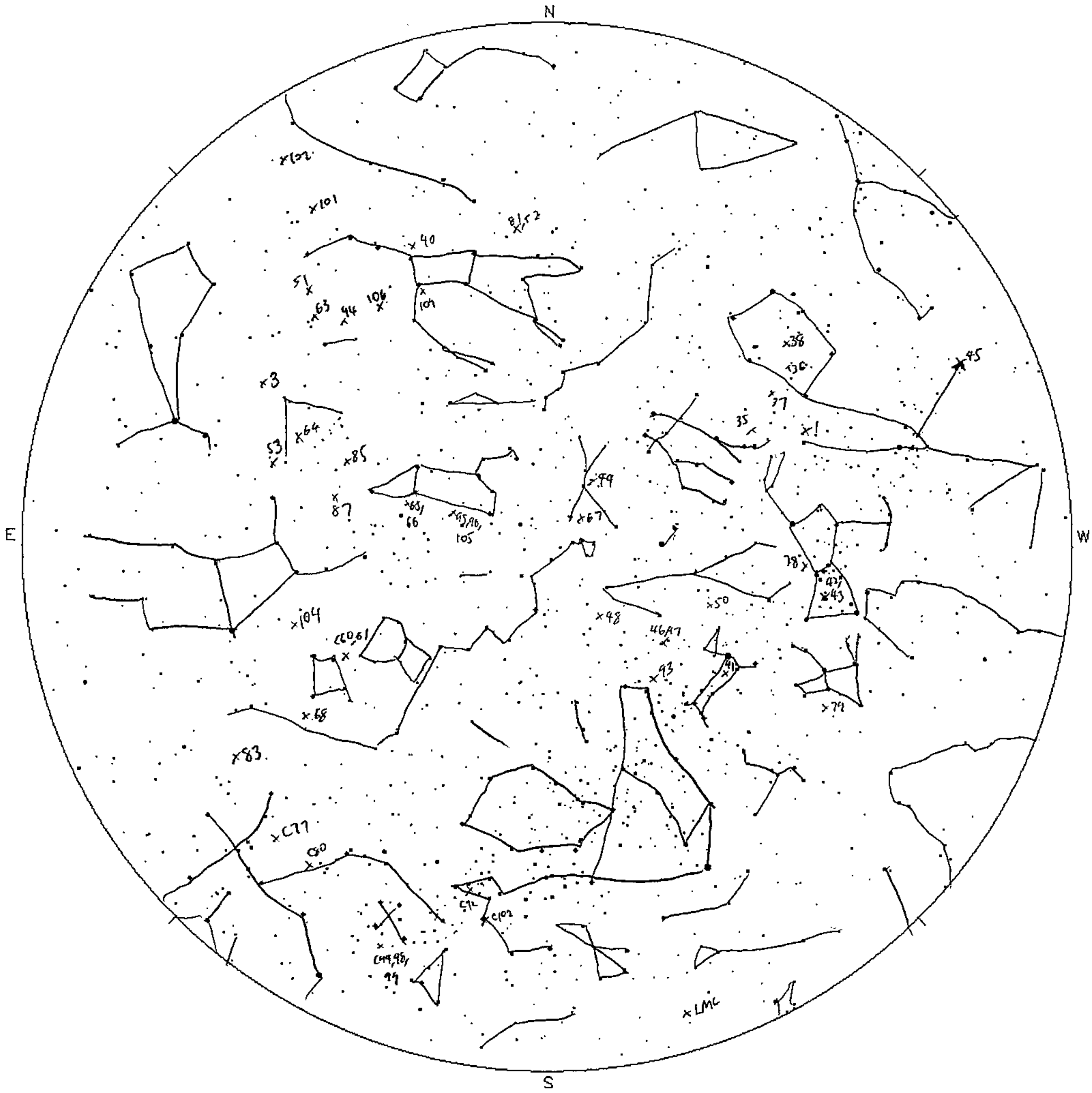
*50, *149, *247 = *80

~~32~~	~~128~~	~~128~~
~~16~~	16	64
~~2~~	~~4~~	~~32~~
	1	~~16~~
		~~4~~
		~~2~~
		~~1~~

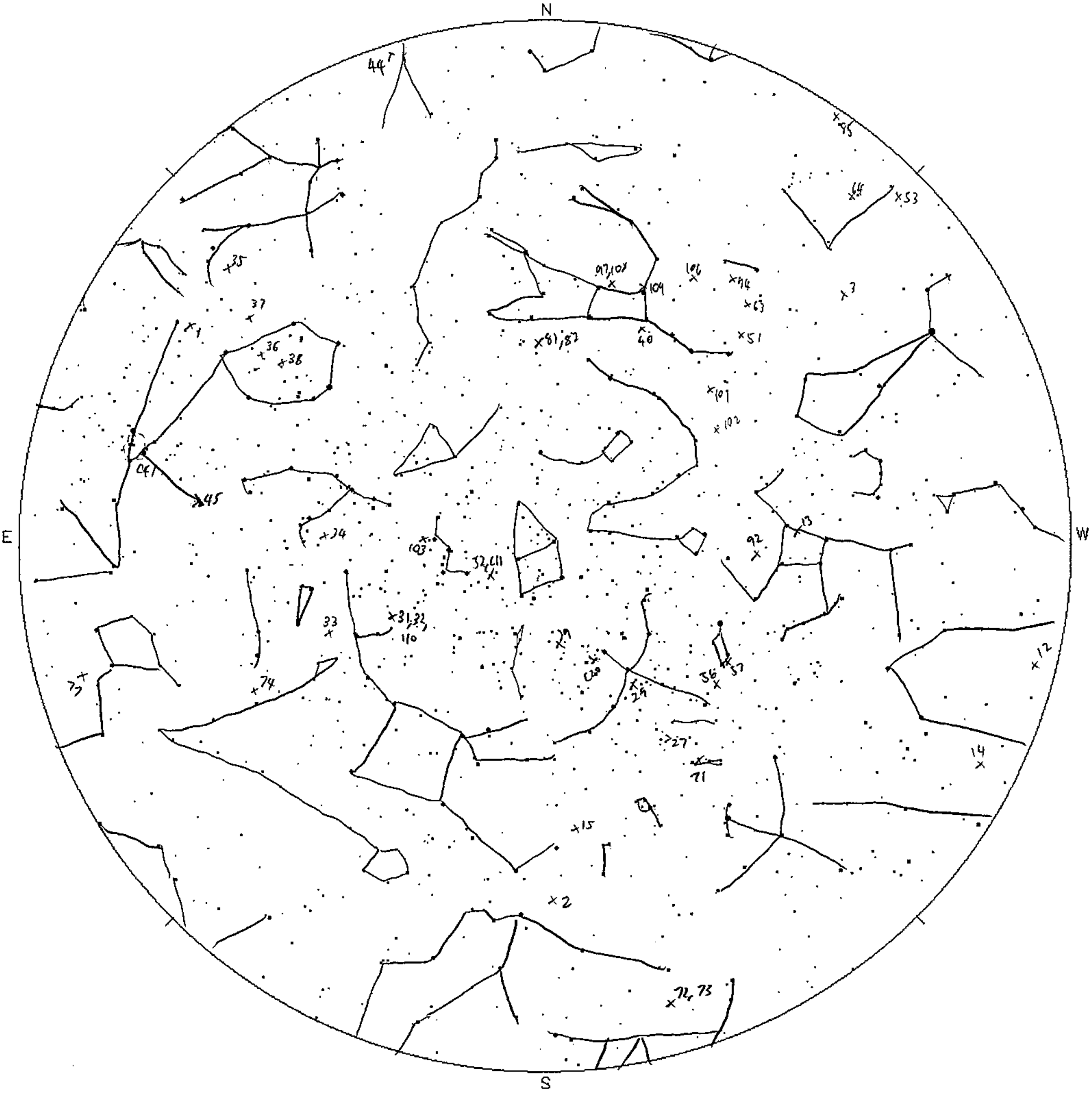
13/20!


S
W
E
N


N
E
W
S
x94
x108
x101
x107
x109
x40
97
x81,82
57
x39
x52,C11
x103
x31,34
110
039
73
x35
x1
45
74
78
x47
48
x41
x44
x44
15
3
τ
p
F91
x dwarf



same issue as #637


N
44
85
64
53
35
37
1
97,108
109
106
94
63
3
36
38
81,82
40
51
101
102
41
45
E
34
103
32,111
13
92
W
33
31,32
110
29
30
56
57
12
73
74
28
27
71
14
15
2
72,73
S

	opc	rs	rt	rd	shamt	funct
R	6	5	5	5	5	6
I	6	5	5	16 imm		
J	6	26 addr				

loop = ~~0000~~ 0000 0100 0000 0000 0000 0010 1000

17 10001

~~[illegible]~~

000010 1111 1111 1111 1111 1111 0100 00

0 B F F F F D 1

addi | $s1 | $zero | 0

001000 | 10001 | 00000 | 0000 ....

2 2 2 0 0000

j loop

000010 0000 0100 0000 0000 0000 0010 10

0 8 1 0 0 0 0 A

0001 0001 0000 0000 | 0000 0000 0000 0010

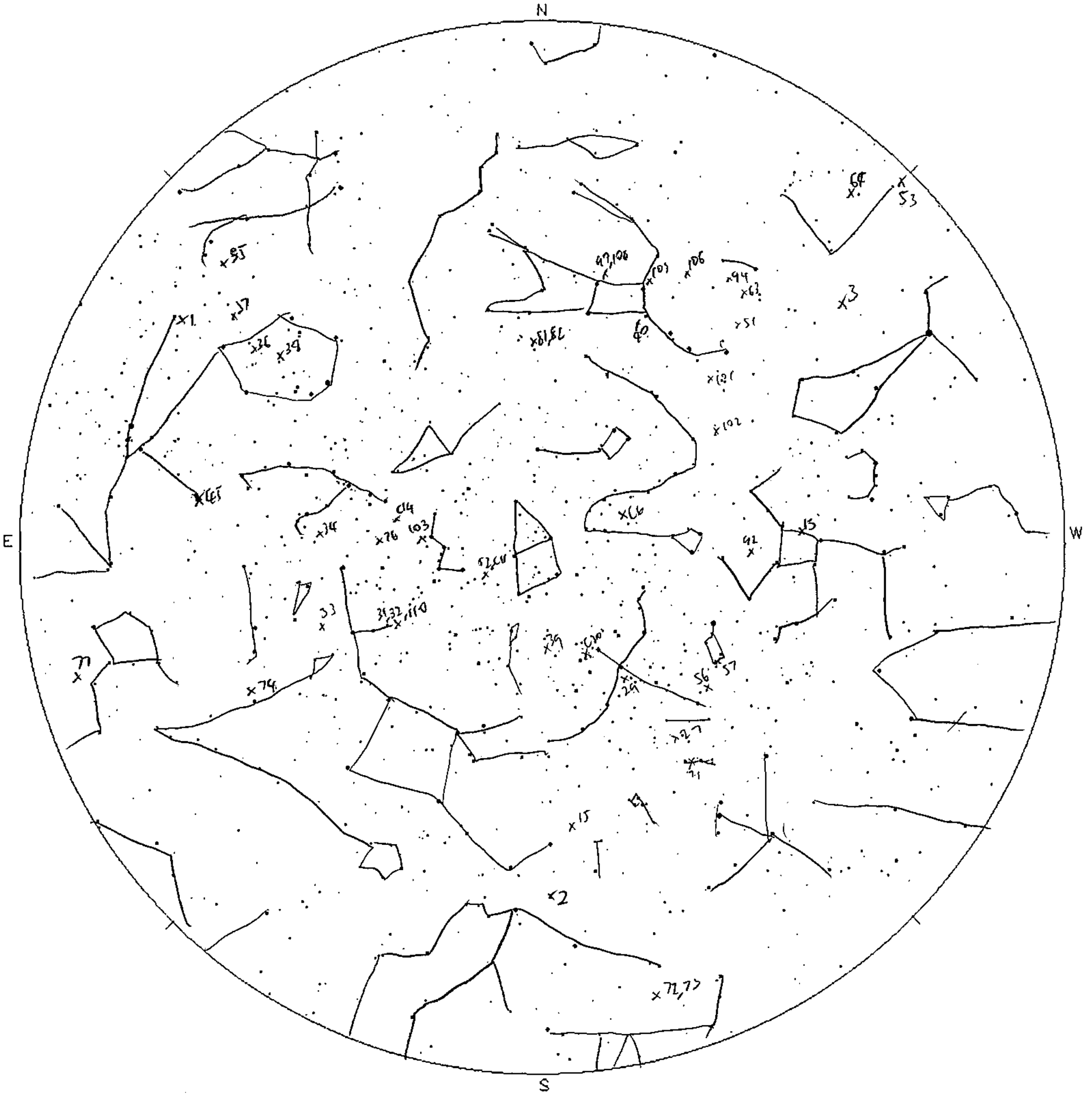
4 8 0 2

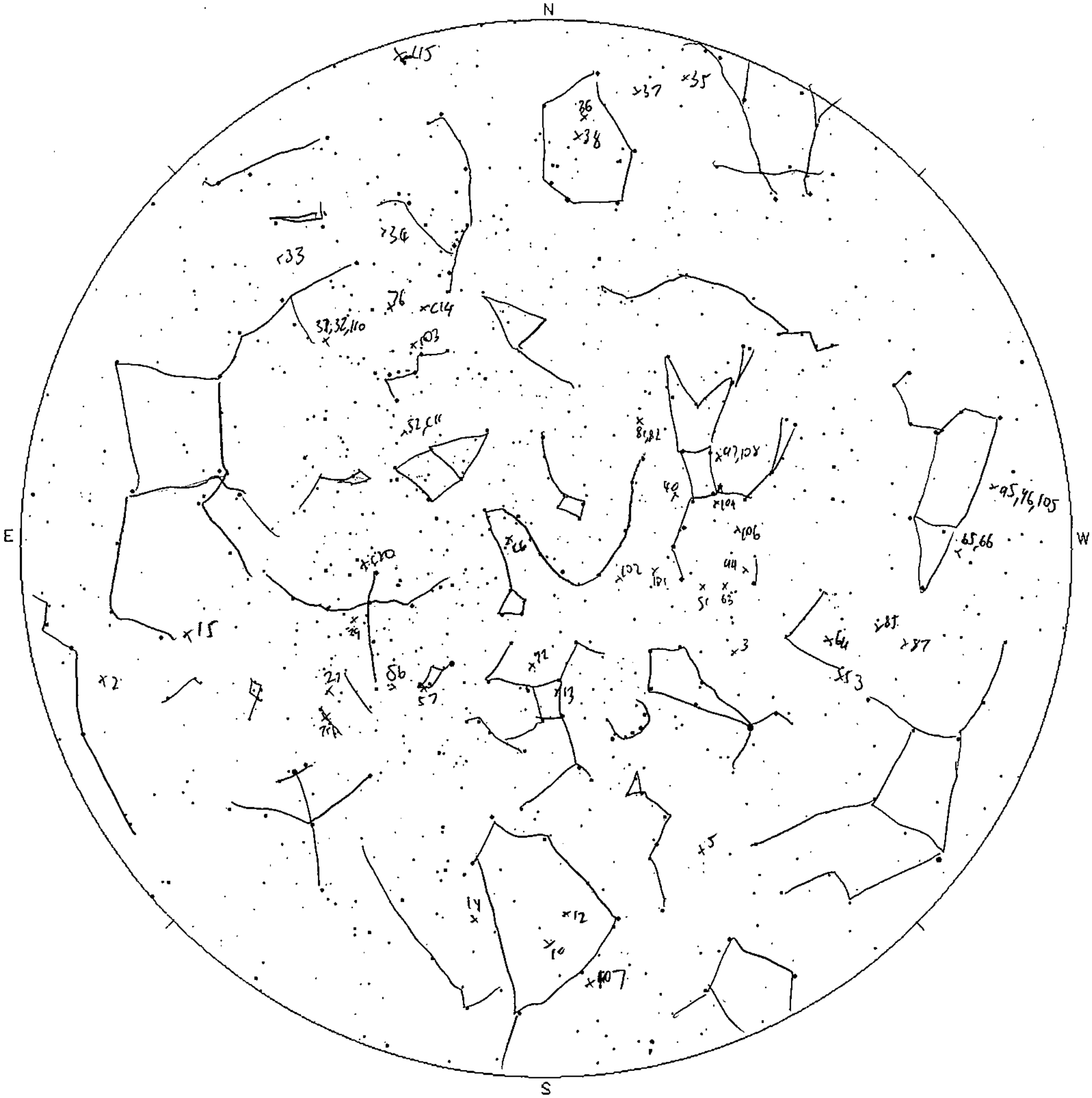
beq $t0 $zero exit

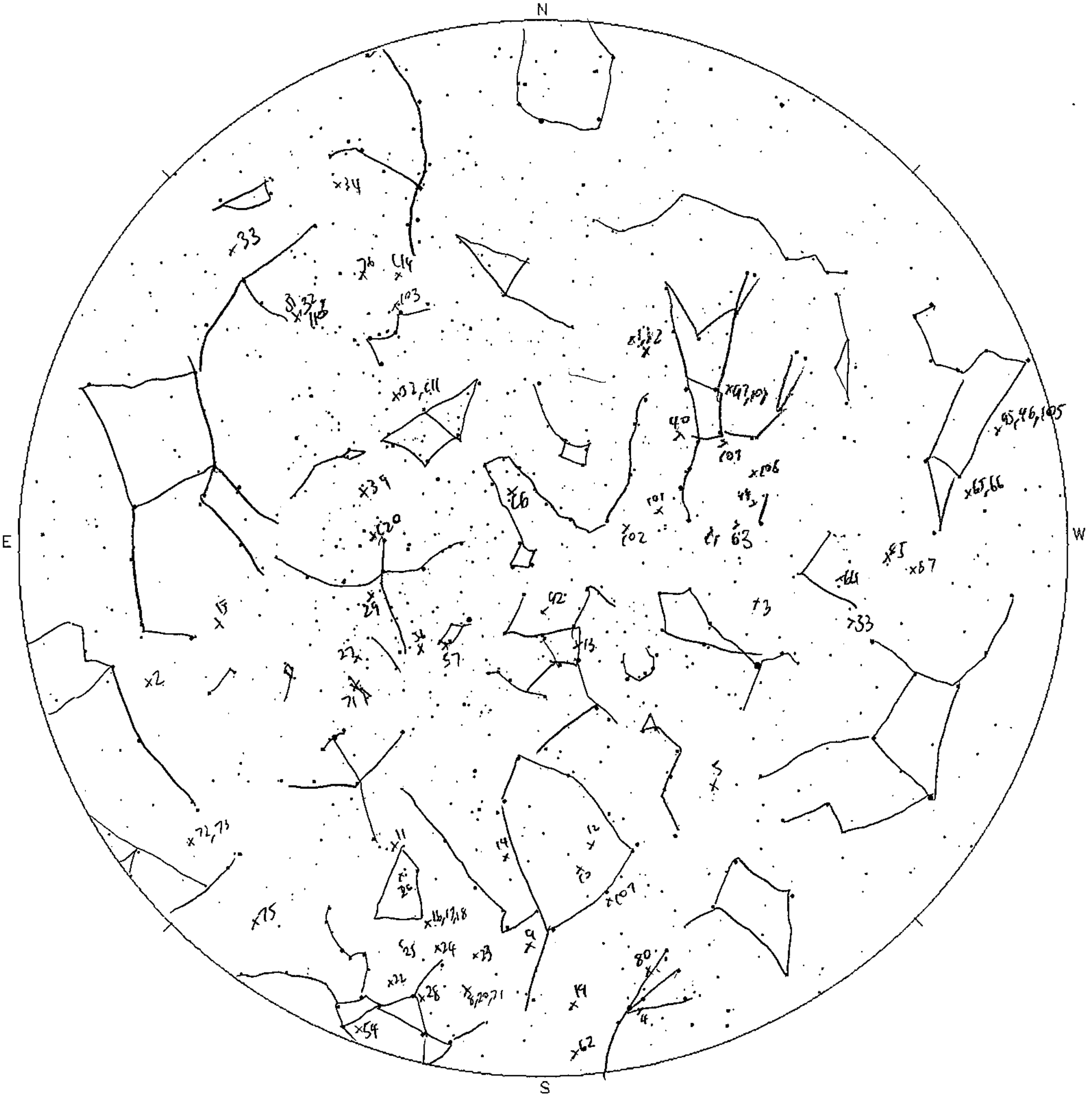
0010 0010 0011 0001 | 0000000000000001

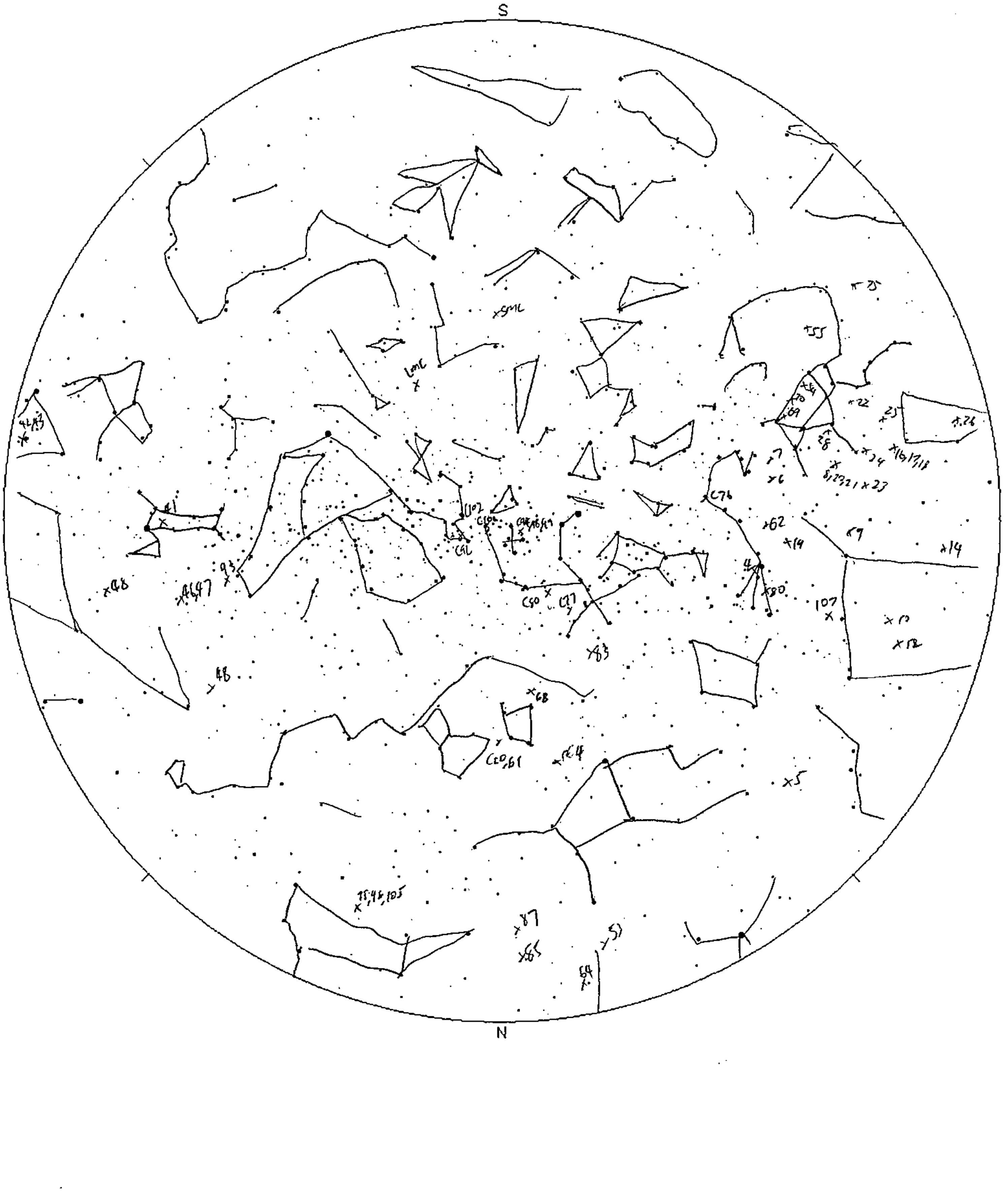
8 $s1 $s1 1

addi

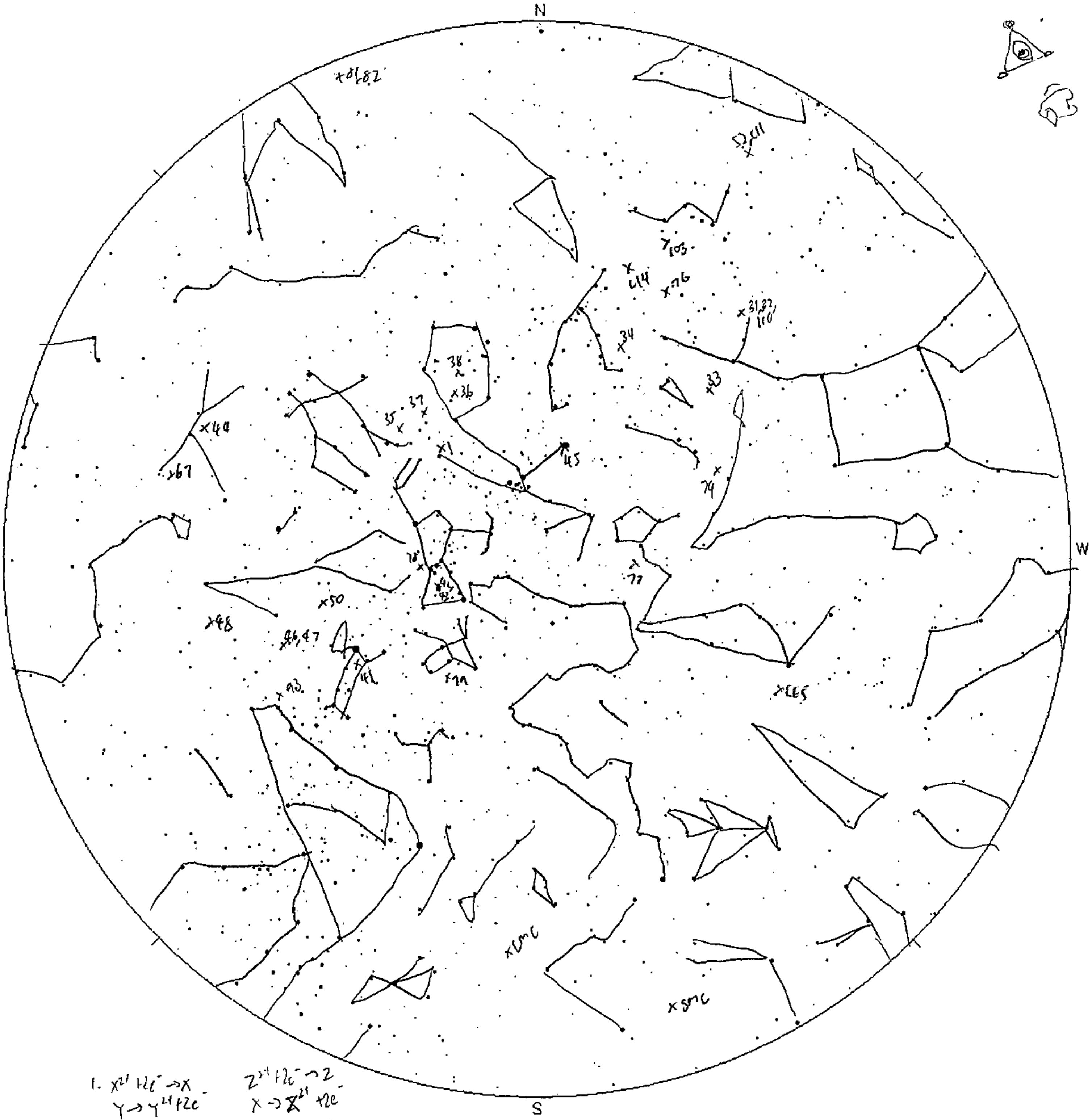

N
x55
97,106
x103
x106
x94
x63
x64
53
x3
x1
x37
x36
x39
x81,82
60
x51
x101
x102
x65
E
W
x34
x14
x76
103
52,64
x66
92
x15
33
31,32,110
77
x74
x39
x120
x29
56
57
x27
71
x15
x2
x72,73
S


N
×115
×37
×35
36
×38
×34
×33
×76
×C14
31,32,110
×103
×52,C11
×81,82
×47,108
40
×104
×106
×95,96,105
65,66
E
W
×C6
×102
101
44
51
63
×C20
×15
29
×2
27
56
57
71A
×72
×13
×3
×64
×53
×85
×87
×5
14
×12
10
×107
S


N
E
W
S
x34
x33
76
C14
x32
110
x103
x81,82
x97,101
40
103
x106
x95,96,105
x65,66
44
101
x102
C5
63
x92,C11
x39
C6
xC20
x83
x67
x64
x33
x3
15
x2
92
x13
29
22
31
57
71
5
x72,73
x11
12
C10
14
C20
x16,17,18
x107
x75
9
C25
x24
x23
x22
x28
8,20,21
19
80
4
x54
x62


S
x 75
x SMC
x 55
LMC x
x 54
x 70
x 69
x 22
x 23
x 26
42,43
x 28
x 24
x 16,17,18
x 7
x 6
8,12,21 x 23
41
x
C76
W
E
C102
C106
C96,86,89
x
C91
x 62
x 14
C9
x 14
93
x 48
x 46,47
4
x 80
C50
x
C97
107 x
x 10
x 12
x 83
48
x 68
C60,61
x 64
x 5
35,45,103 x
x 87
x 65
x 51
64 x
N


S
C80
C76
C94
C99
C100
C102
C92
6
7
8,20,21
24
18
69
25
52
54
70
55
75
LMC
93
46,47
44
50
E
W
79
72,73
7
665
41,43
78
2
77
15
74
1
45
33
31,32,110
34
13
N



1. $X^{2+} + 2e^- \to X$ $Z^{2+} + 2e^- \to Z$

$Y \to Y^{2+} + 2e^-$ $X \to Z^{2+} + 2e^-$

$X - Y = 0.47$ $Z - X = 0.31$

$Z - Y = 0.78$

$2H^+ + 2e^- \to H_2$

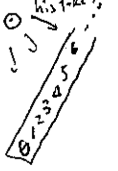
$E_{cell} = E^\circ_{cell} - k\ln Q$


$\{0|1\} = \frac{1}{2}$


$\{0|-1\}$


$\{0|*\} = \uparrow$

$\{0|\{0|-n\}\} = +_n$



$\omega = \{\mathbb{N}|\}$


$\{*|*\} = 0$


$\{0,*|0,*\} = *2$

⇒ any pyramid graph becomes nimber

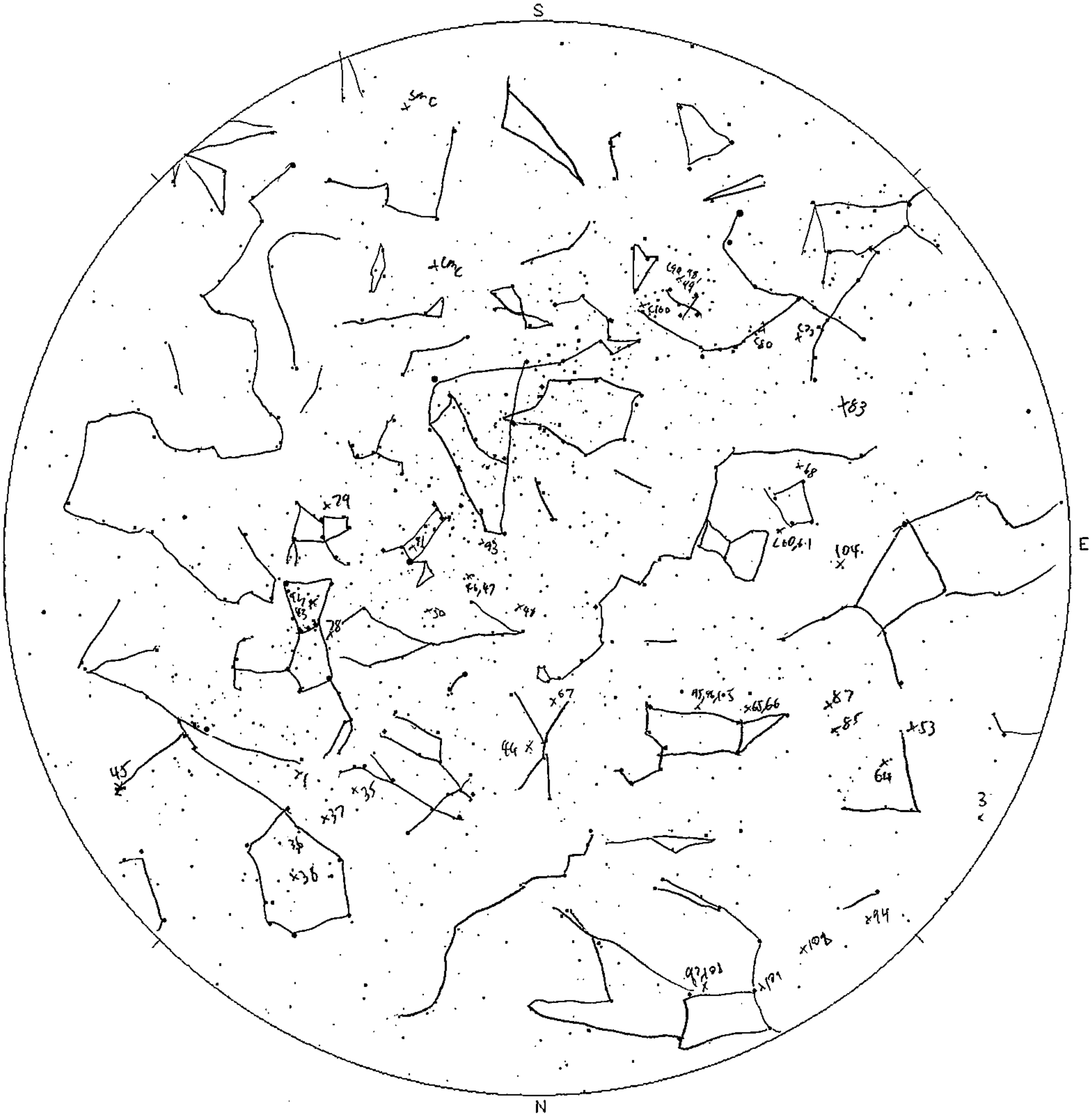
$\{0,*,*2,*3,*4|0,*,*2,*3,*4\} = *5$

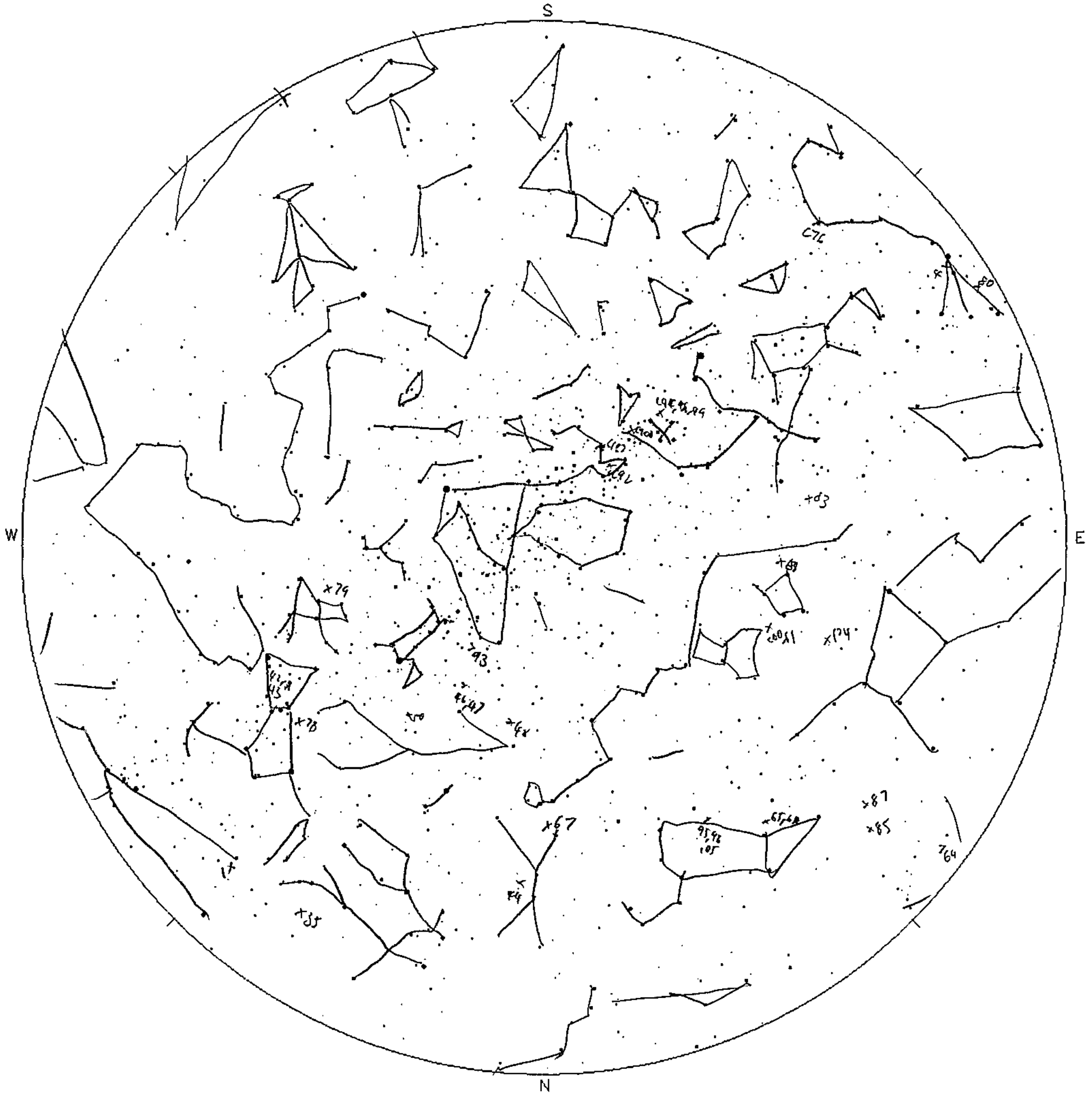
$x = \{x|\}$
on


hot

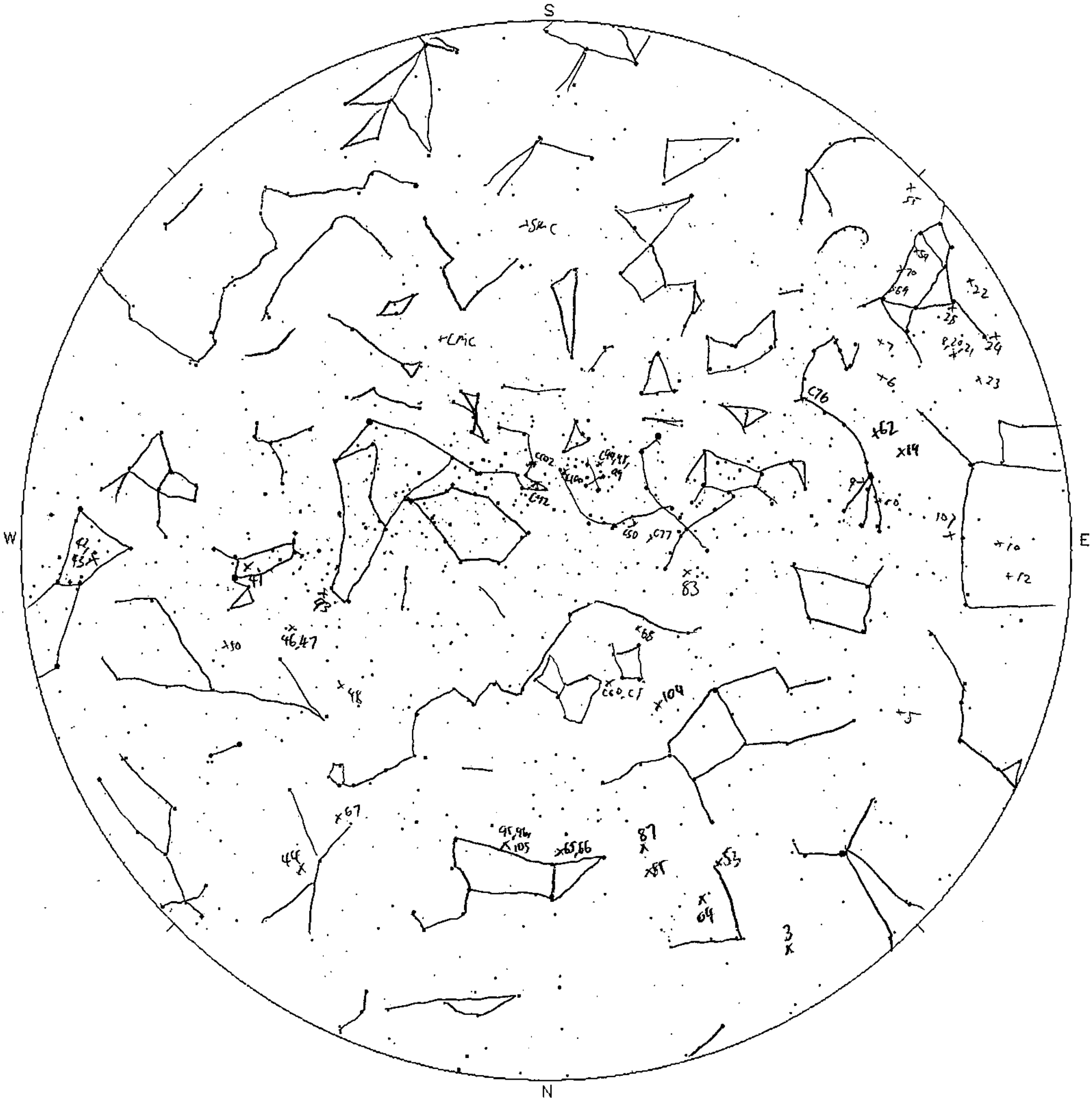

$\lambda = \{0|\lambda\}$
over


on $x = \{x|x\}$ dud


S
W
E
N
+SMC
+LMC
C49,98,
x49
xC100
C80
C73
+83
x68
C60,61
104
x79
x41
x93
x
46,47
x50
x48
94 x
83
x78
x67
44 x
95,96,105
x65,66
x87
x85
+53
x
64
3
45
71
x37
x35
36
x38
97,101
x
x101
x108
x94


S
W
E
N
C76
×
80
96,98,99
×
×100
407
×
49V
+83
+88
+60 81
×174
×79
47,48
43
×78
793
×
46,47
×48
×50
×67
95,96
105
×65,66
×87
×85
764
84
×35
1×


S
W
E
N
54
70
69
7
6
52
19
4
80
SMC
LMC
283
65
104
79
47
50
67
48
87
85



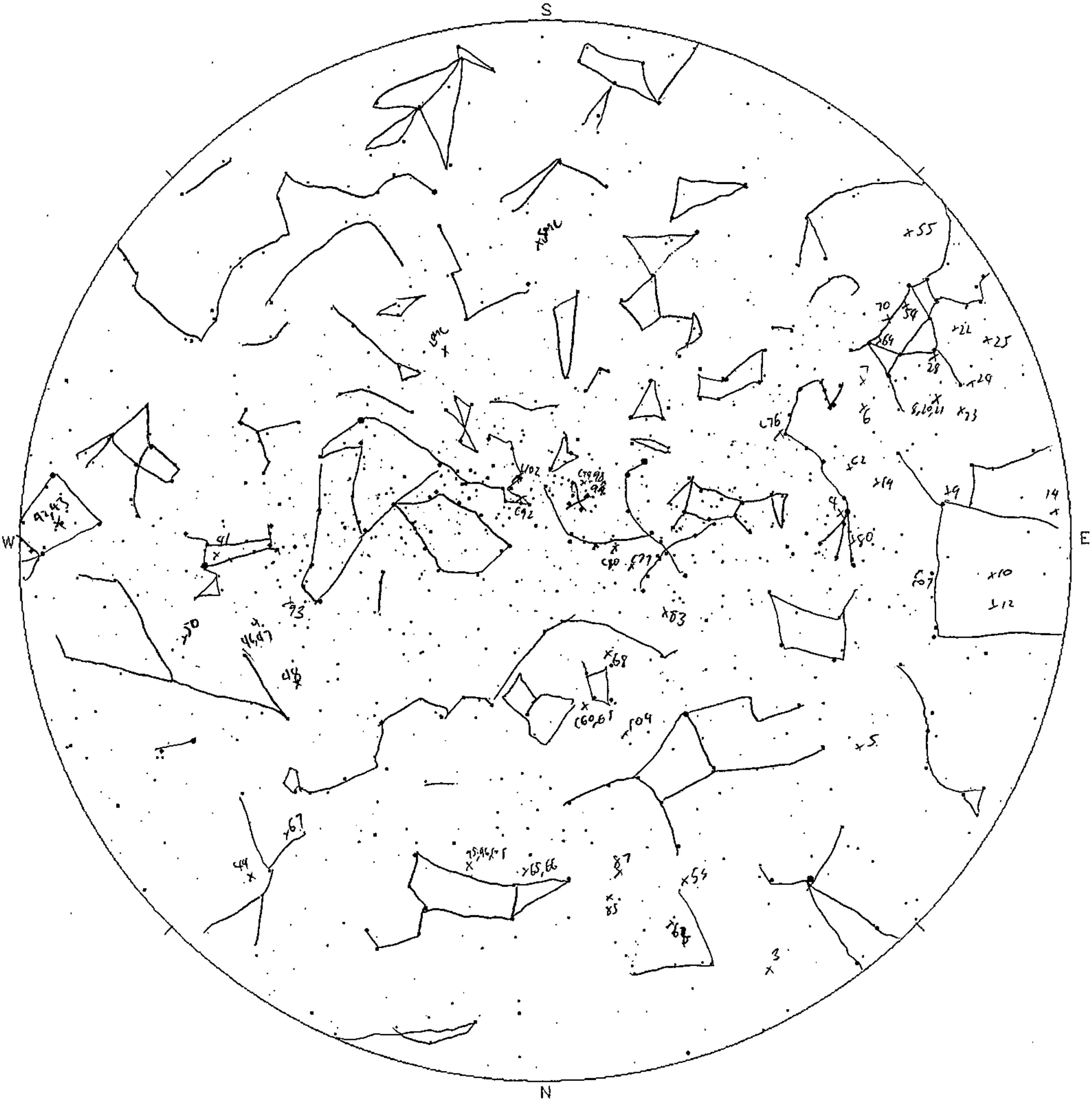
$$+\left(\frac{a-1}{2}\right)\frac{|x-0.5|}{x-0.5}+|x-1|+\left(\frac{a-1}{2}\right)$$

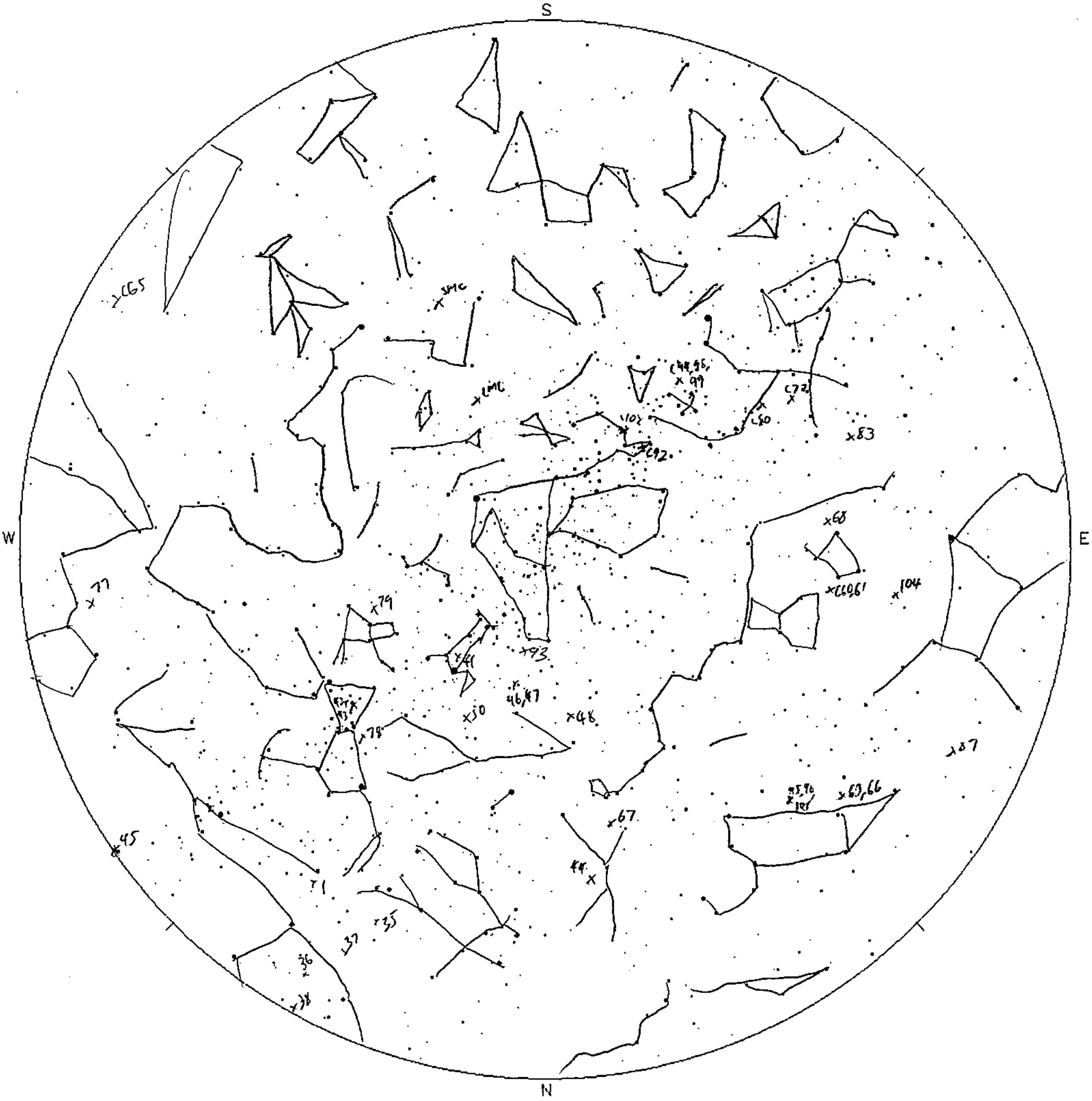

N
E
W
S
xC20
29x
27x
71x
x56
51
x
86
x92
13
x102
x101
81,82
x
40
x
x97,108
x
104
x106
51 7
94
x
x
63
x94
x67
x3
x49
x53
x85
x77
x65,66
95,96,105
x
x5
x11
x
26
14
x
12
x
x
10
x107
x16,17,18
x25
x24
x23
x22
x28
x
8,20,21
x9
x19
x62
x54
70
x
69
x7
x6
C76
x104
C60,61
x
x68
x83
xC77
xC80
C94,98x
99
C92

21/9/2023

2/3


S
83
C77
C80
C98, 99, 97
101
C92
C102
80
44
C76
14
62
x6
x7
x9
23
20, 20, 21
25
69
70
24
16, 17, 18
25
22
34
55
54
C102
C91
79
42, 43
W
E
72, 73
30
2
77
71
15
74
N


S
N
E
W
SMC
LMC
x55
70
59
64
x22
x25
28
x29
7
6
8,20,21
x23
C76
C62
x14
4
C80
19
14
C67
x10
x12
C102
C99,98
C92
C80
C77
x83
x68
C60,61
x104
x5
92,43
41
x50
46,47
48
93
x67
44
95,96,97
x65,66
87
85
x55
x68
3


S
W
E
N
C65
SMC
LMC
C94,98,
99
102
C92
C80
C72
83
68
C60,61
104
87
95,96
105
65,66
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46,47
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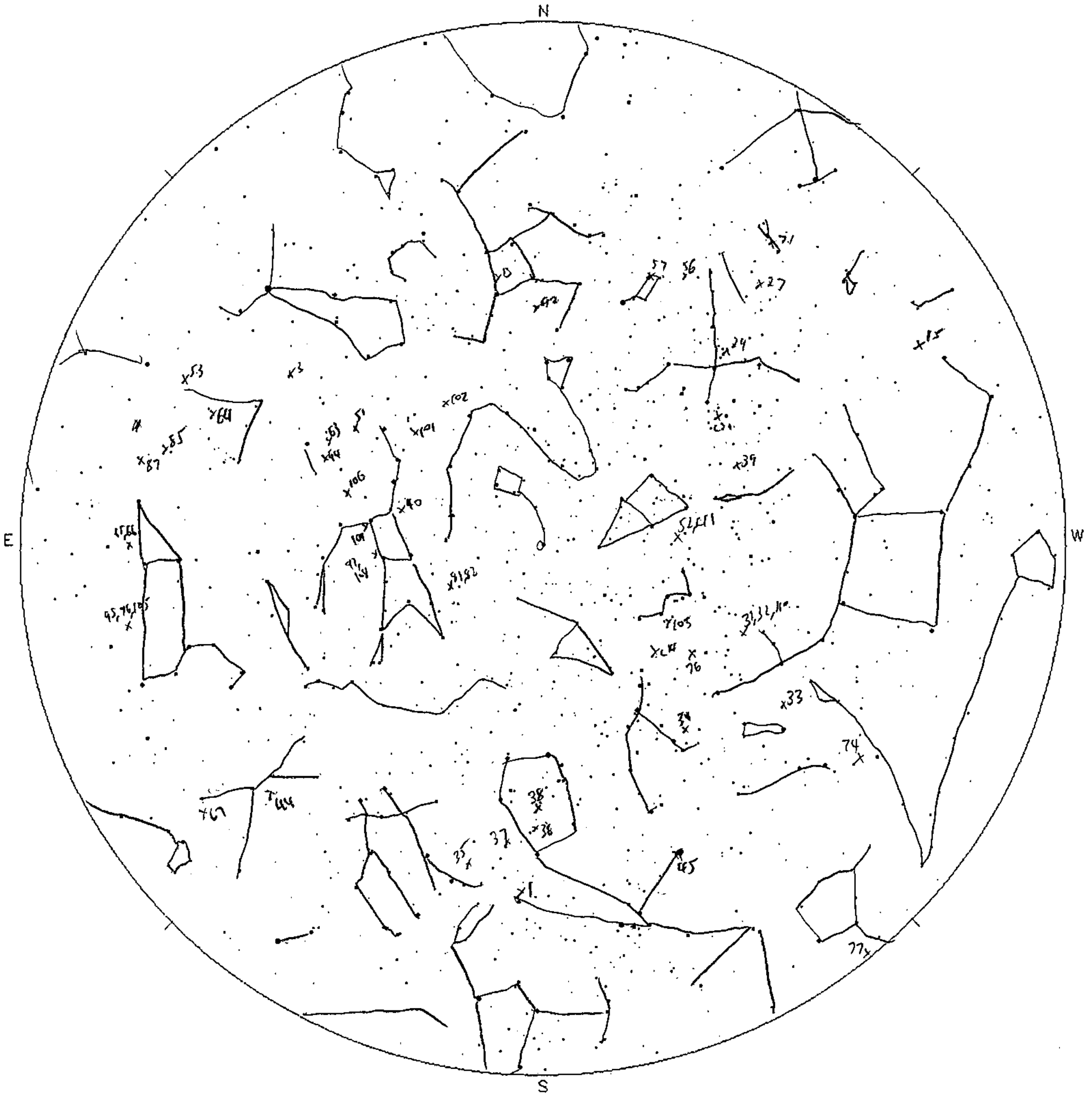
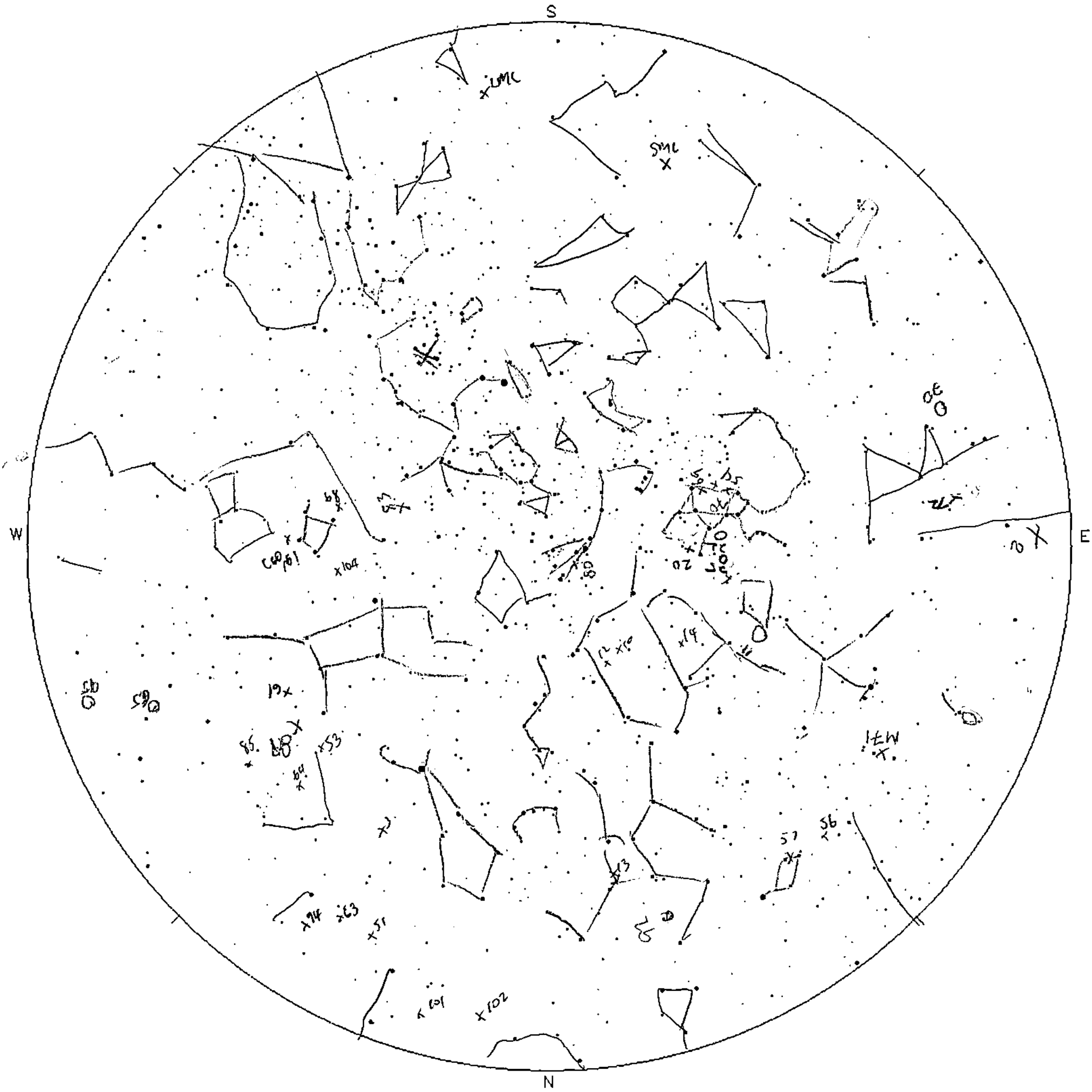
43
78
77
45
1
37
35
36
38



North pole map


S
LMC
SMC
W
E
N
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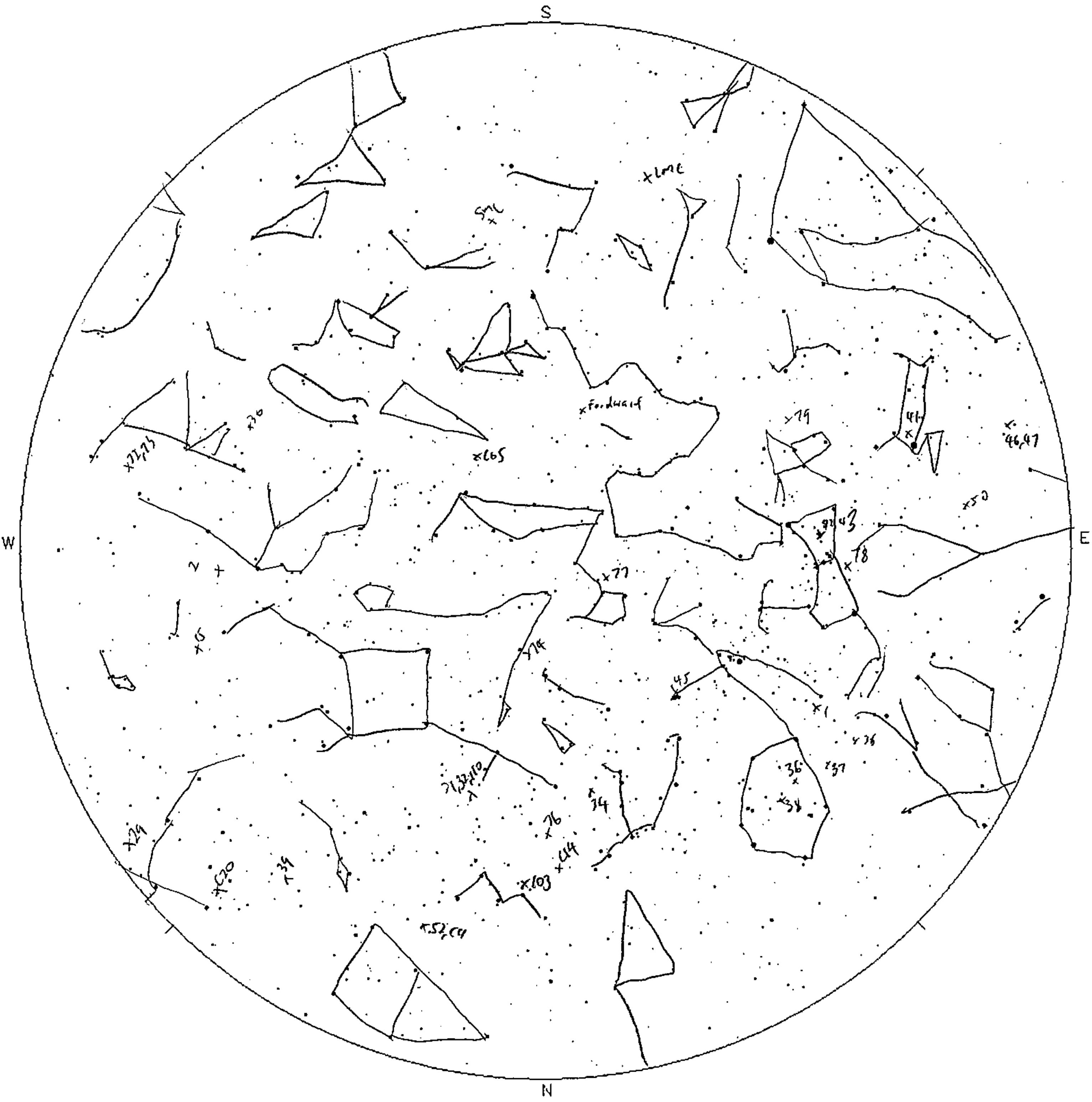
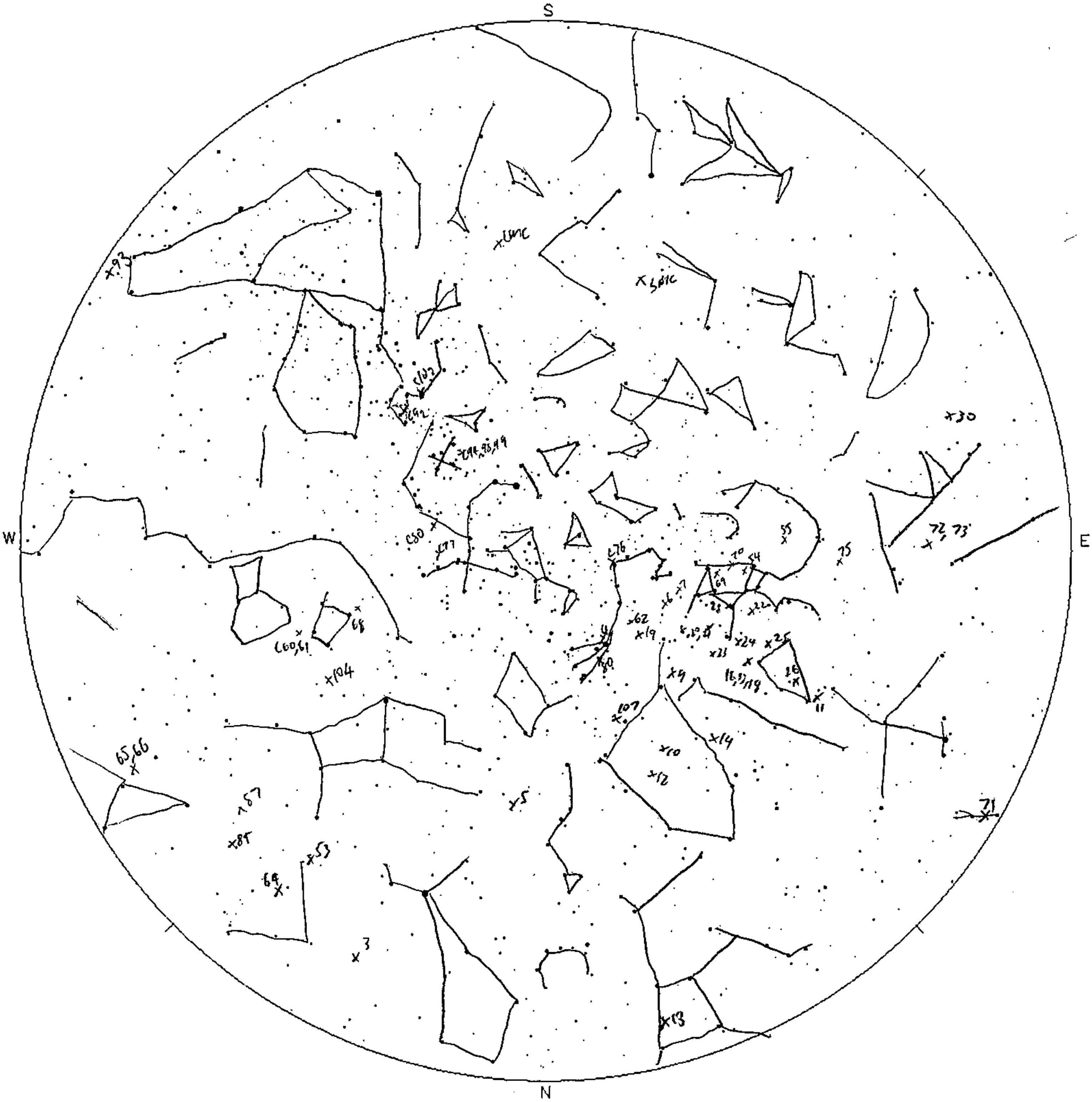
104
19
53
13
57
56
94
63
51
101
102
M71


S
W
E
N
×LMC
SMC ×
×Fordwarf
×65
×30
×72,73
×15
×79
41 ×
× 46,47
×50
×97 43
×78
×77
×74
×45
×1
×35
36 ×
×37
×38
71,72,110, ×
×76
×34
×114
×103
×52,C4
×29
×20
×39


S
W
E
N
93
M11C
581C
C102
C92
94, 98, 99
C80
77
C76
68
C60,61
104
30
72, 73
75
55
70
54
69
28
22
6
7
62
19
8, 10, 20
80
24
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16, 17, 19
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57
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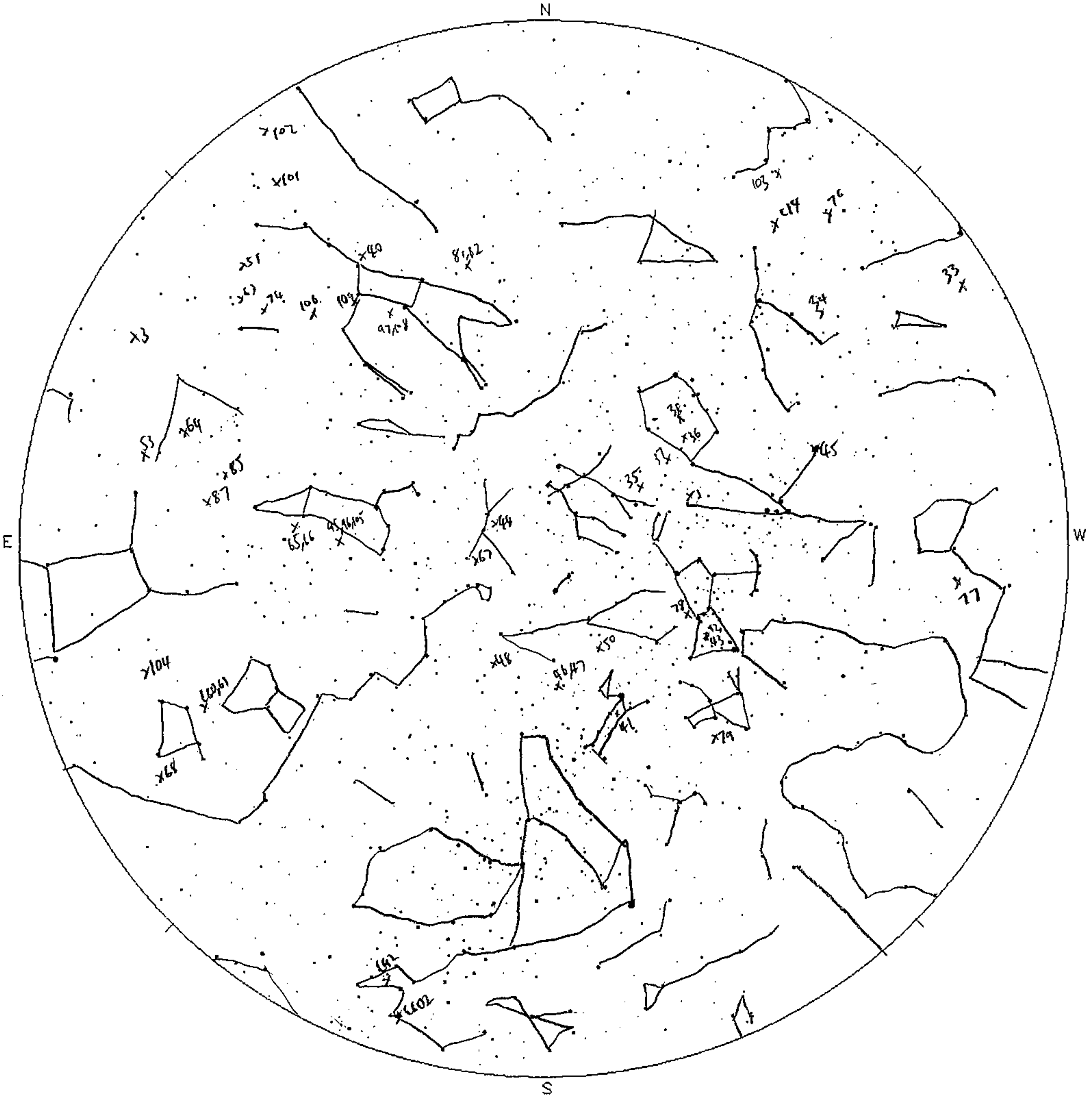
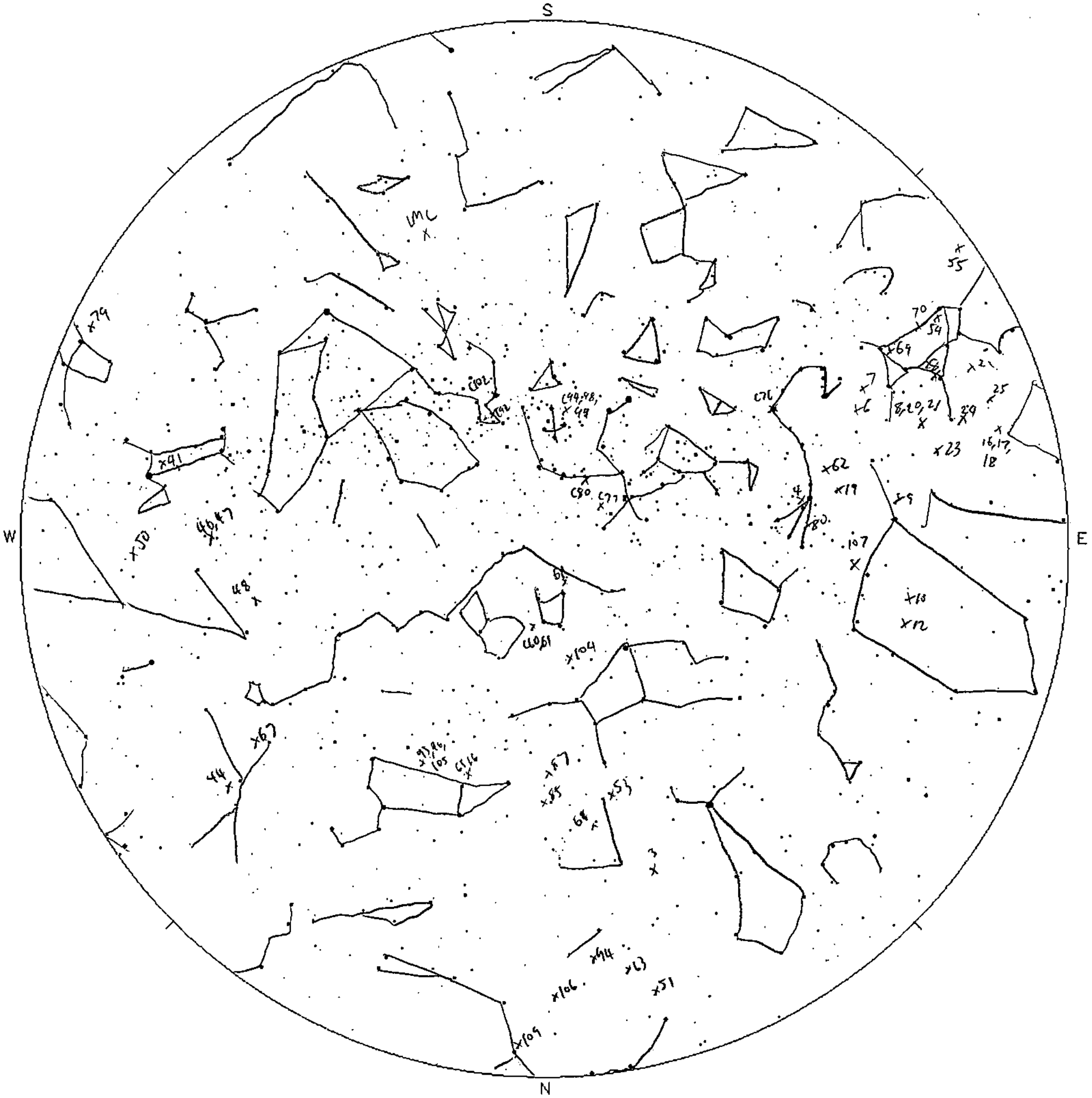
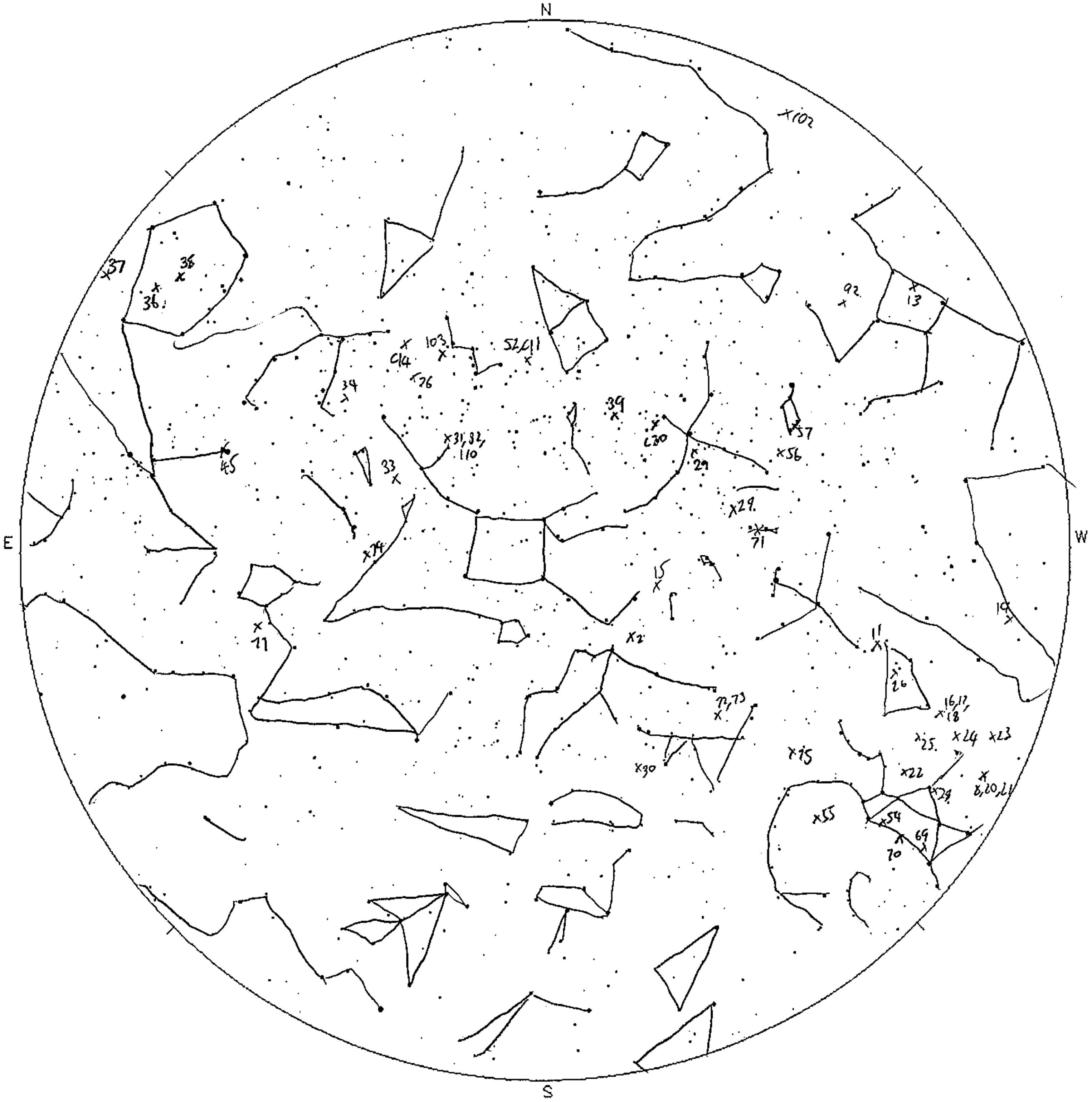
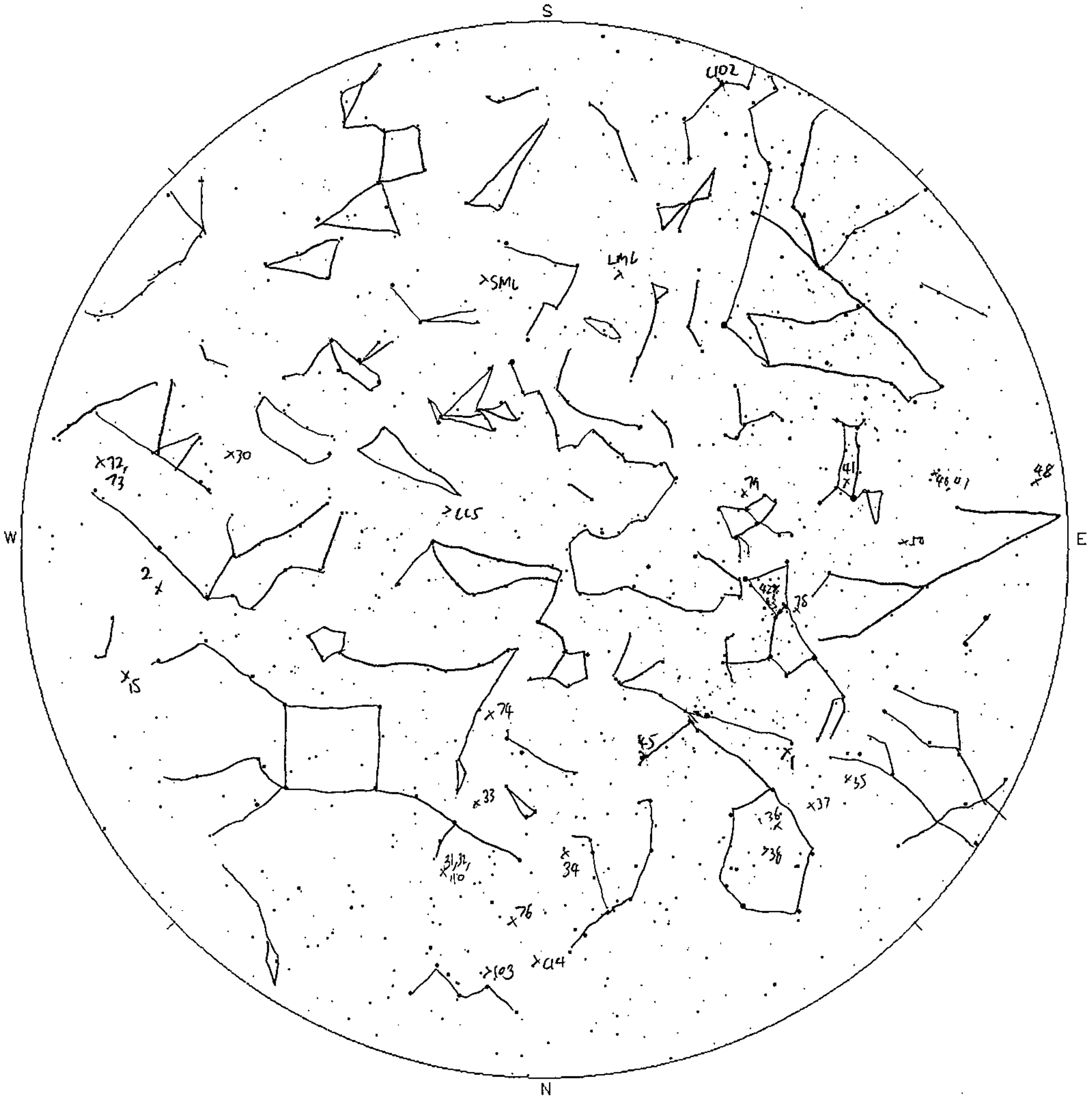
64
5
71
3
13

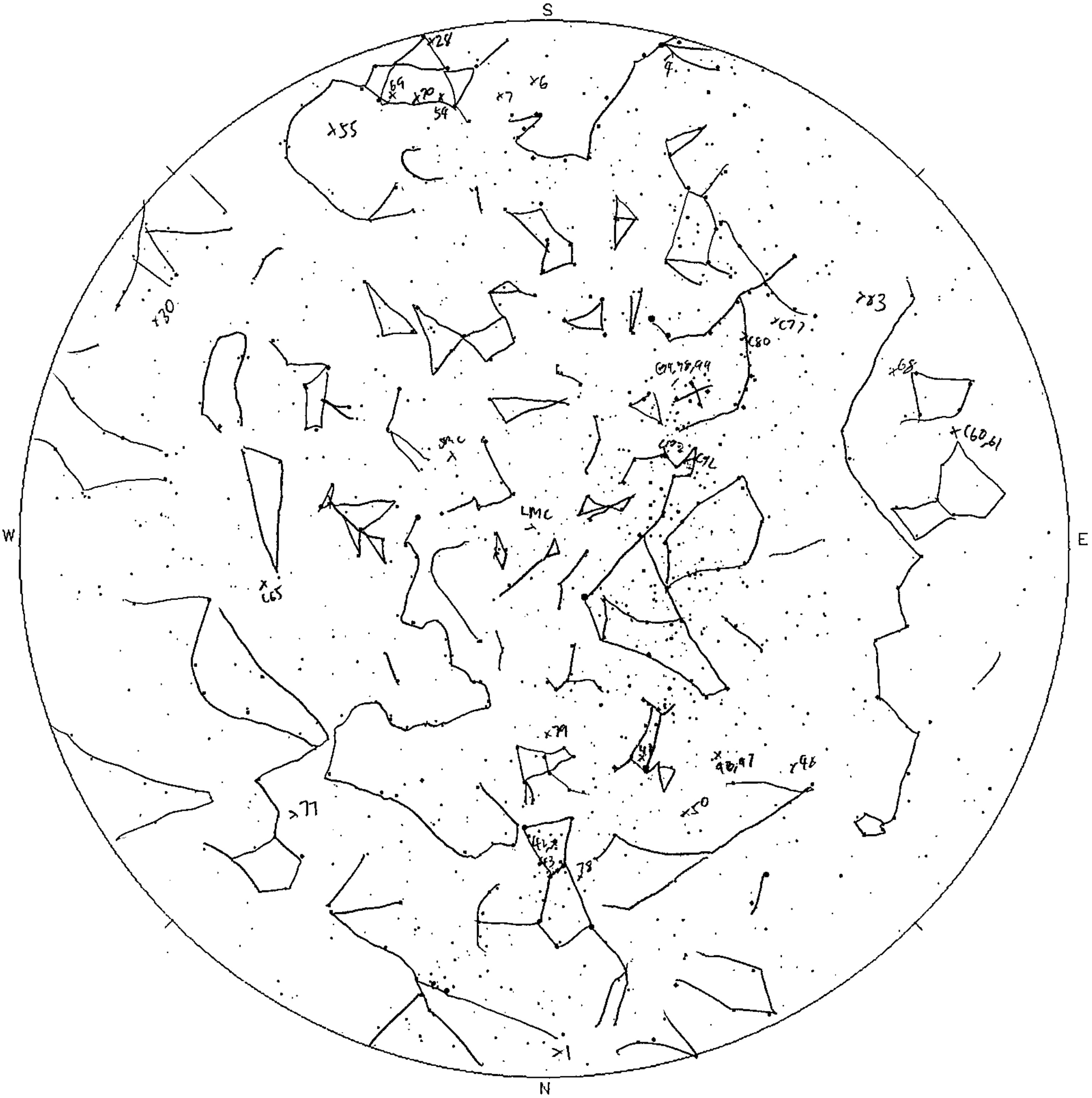

N
E
W
S
x102
x101
x51
x63
x74
106 x
109 x
x40
81,82 x
97/98
x3
53 x
x64
x85
x87
85,86
95,96,105
x88
x67
x104
60,61
x68
x48
96,97
x50
35 x
37 x
38
x36
x45
x1
78 x
42
43
x79
41
x77
33 x
34
103 x
x 104
76

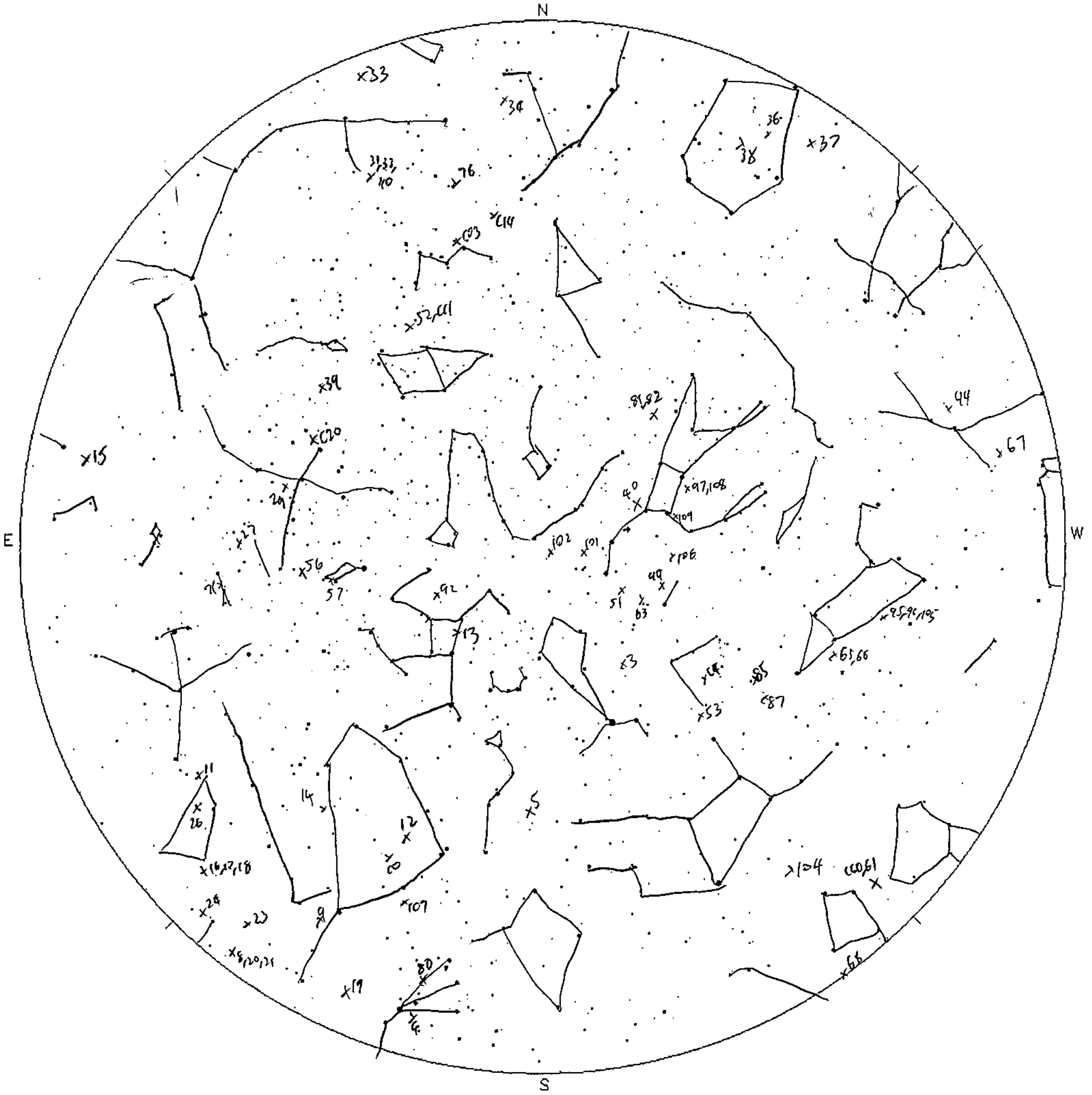

S
W
E
N
LMC
x79
x41
x50
46,47
48
44
x67
x55
70
54
x69
x21
x7
+6
8,20,21
25
29
16,17,18
x23
x62
x19
x9
4
80
107
x10
x12
C76
C102
C92
C99,98, x49
C80
C77
63
C60,61
x104
93,86,105
C116
x87
x85
x53
68
3
x94
x63
x51
x106
x109

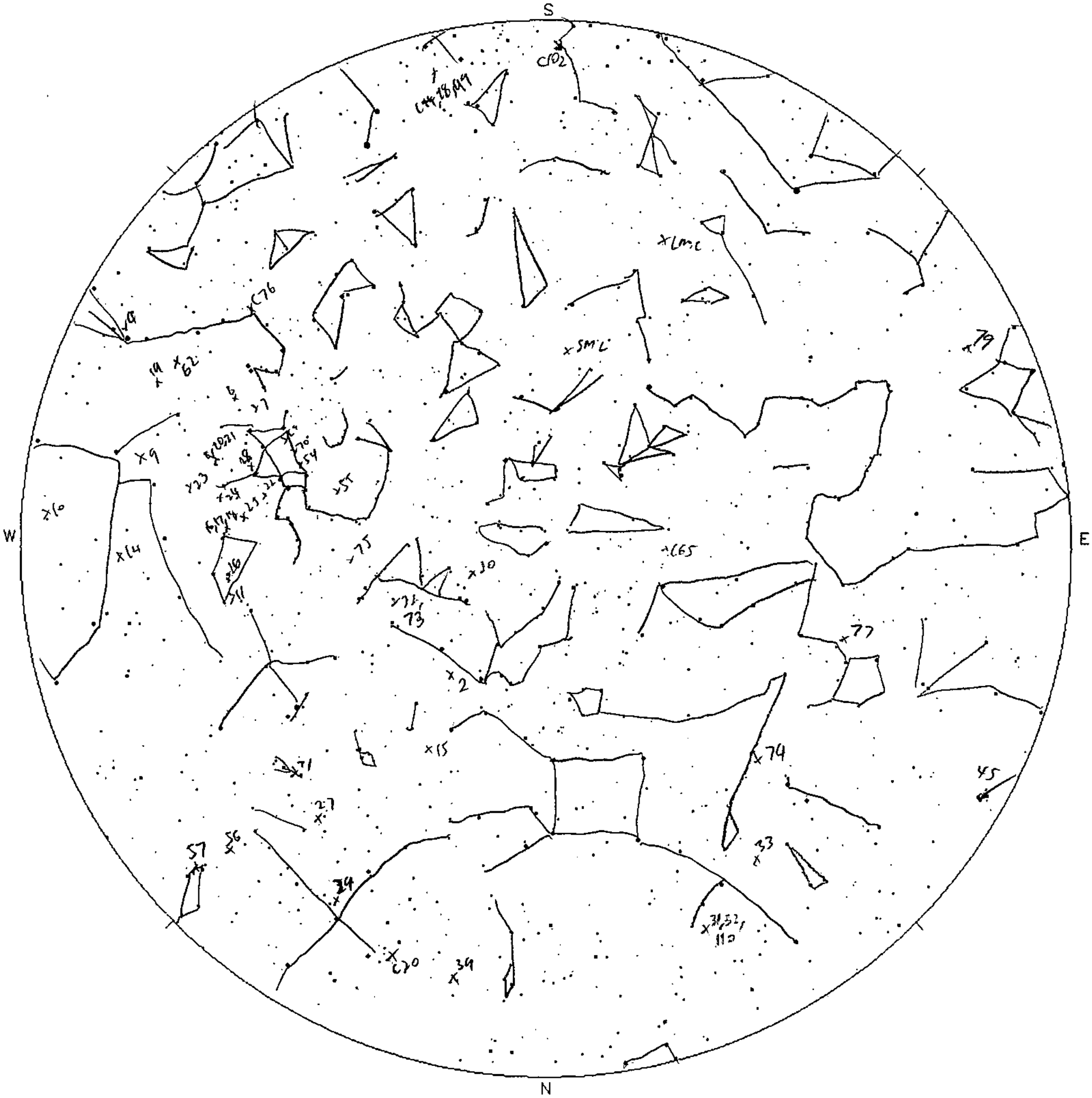

N
x102
38
37
36
103
64
76
52,61
34
92
13
39
230
57
31,32,110
45
x56
33
29
x29
E
71
W
x74
15
77
x2
11
19
26
72,73
16,17,18
x30
x25
x24
x23
x15
x22
x27
8,20,21
x55
54
69
70
S


S
102
LMC
SMC
72,
73
30
115
W
E
2
15
79
41
46,47
48
50
42,
43
78
74
45
1
35
37
36
38
33
31,32,
110
34
76
114
103
N


S
x68
x83
xC77
C80
C92
xC102
C96,98,
99
xLMC
79
xSMC
W
E
xC76
x4
80
x62
x19
x6
x7
69
72
54
8,20,21
28
x23
x24
x22
x25
35
x75
x30
77
x
12
x
x10
x14
x9
167,
18
x72,73
x2
x15
x71
x27
N


S
x28
69
x70
x
54
x7
x6
9
x55
x30
x83
xC77
xC80
C97,98,99
x68
xC60,61
SMC
x
C92
C96
LMC
W
E
x
C65
x79
41
x
x
93,47
x46
x50
x77
42,x
x43
78
x1
N


N
E
W
S
×33
×34
31,33,110
×76
×114
×103
36
38
×37
×52,111
×39
×120
81,82
×44
×67
×15
29
40
×97,108
×109
×27
×102
×101
×106
×56
57
49
51
63
×92
13
×95,96,105
×65,66
×3
×84
85
87
×53
×11
26
14
12
60
×5
×16,17,18
×104
60,61
×28
×23
×8,120,121
9
×107
×19
80
6
×68


S
C102
C44,18,19
LMC
SMC
C76
19
19
62
6
7
8,20,21
18
70
54
23
24
25
22
55
9
10
14
6,17,19
26
11
75
30
72,1
73
2
15
71
27
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57
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C20
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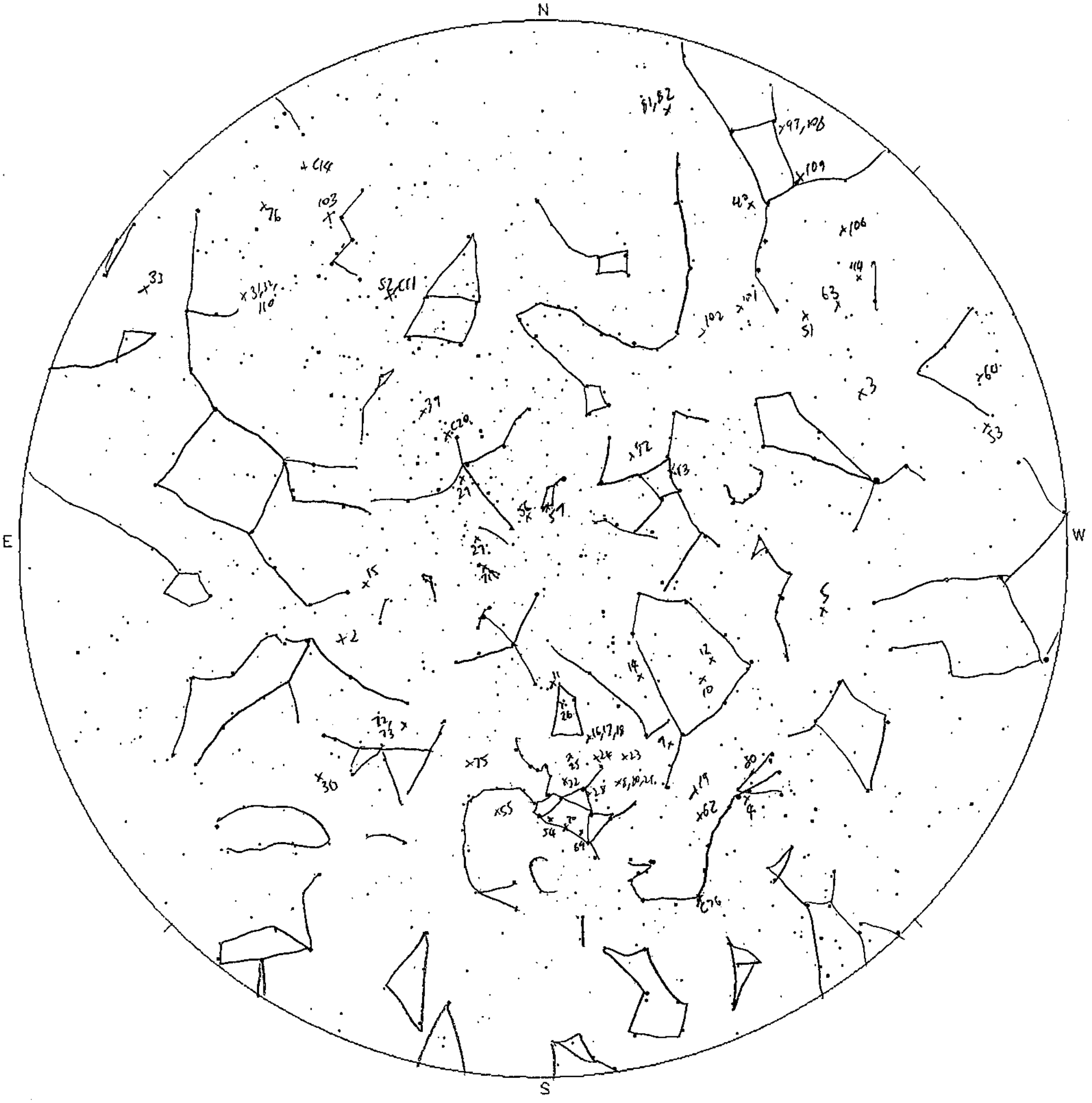
31,32,
110
33
74
77
45
79
C65
W
E
N


N
E
W
S
81,82
97,108
109
40
106
114
63
51
101
102
C14
76
103
33
31,32,110
52 C11
39
C20
27
56
57
92
13
3
60
53
15
2
5
12
10
14
11
26
16,17,18
24
23
25
22
28
8,20,21
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72,73
30
75
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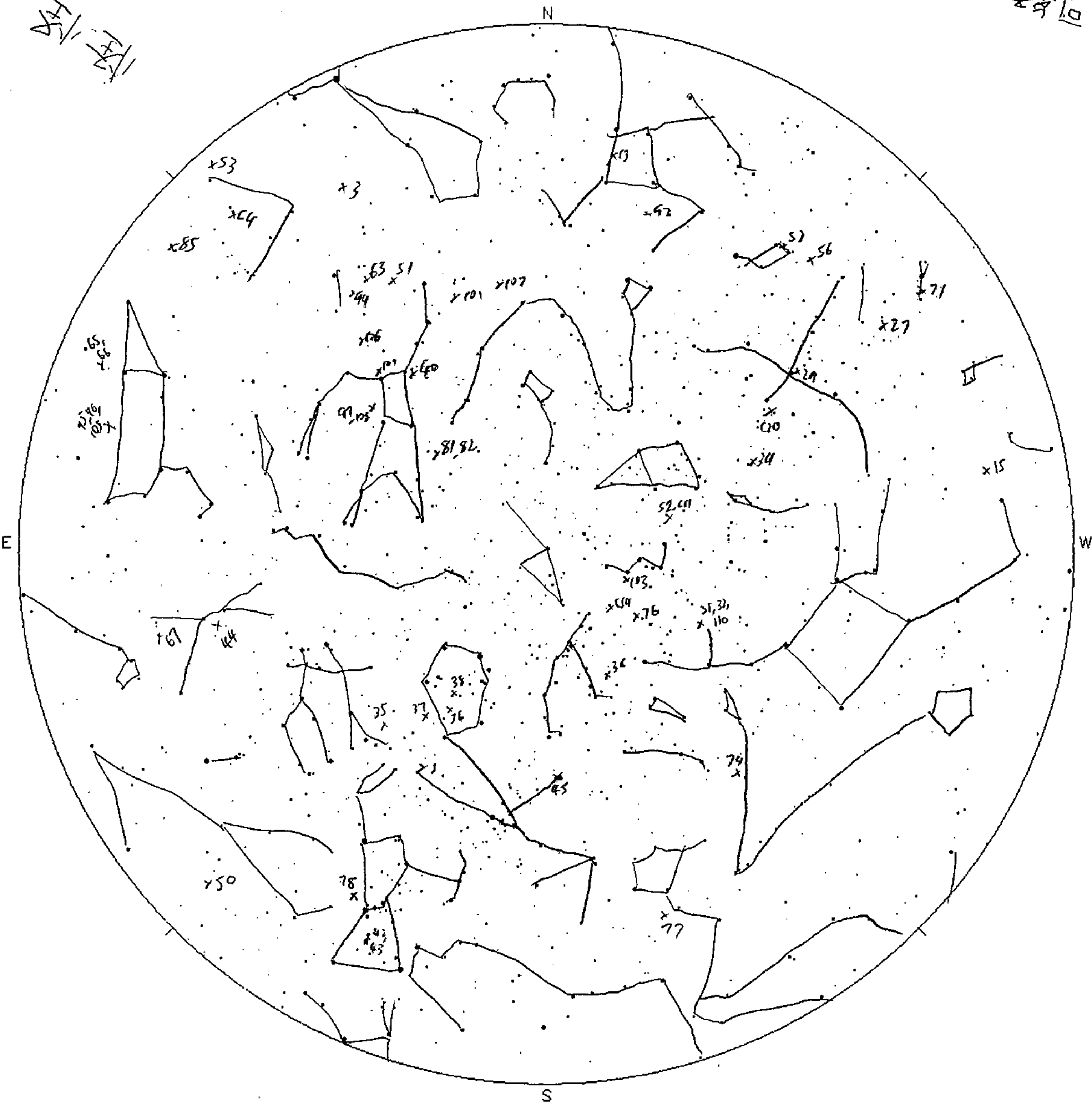
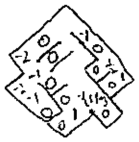
54
70
69
80
62
4
C76

[illegible]

[illegible]


N
E
W
S
x53
x3
x54
x85
x13
x52
57
x56
x71
x27
x63 x51
x94
x101
x107
x26
x109
x40
65
66
97,103
81,82
x29
120
x34
x15
52,111
x103
x104
x76
31,33,110
x36
x67
44
38
35
37
36
74
x1
45
x50
78
41,43
77

011 110




S
W
E
N
C94, 98, 99
108
C77
83
68
60, 61
104
C76
4
86
62
64
101
9
7
6
8, 20, 21
23
24
69
70
54
28
22
25
16, 17, 18
26
55
75
10
12
18
11
5
87
95, 96, 3, 103
65, 66
85
33
84
67
44
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99
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51
106
101
102
97, 108
109
40
81, 82
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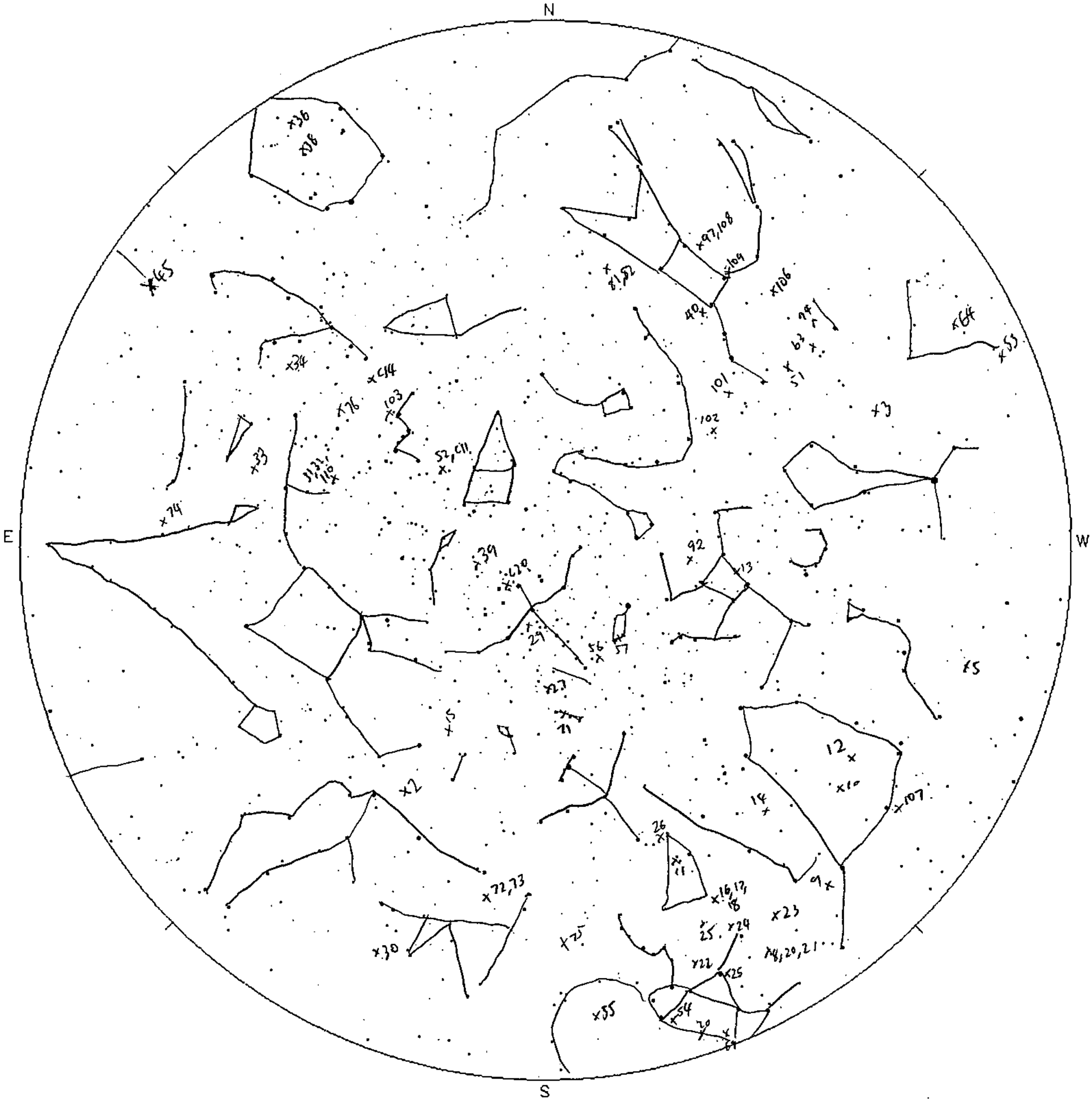
56
71
27
66


N
E
W
S
36
38
45
34
14
76
103
33
31,32,110
52,C11
74
39
C20
29
56
57
27
71
5
2
72,73
30
25
97,108
109
81,82
40
106
94
63
51
101
102
3
64
55
92
13
5
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107
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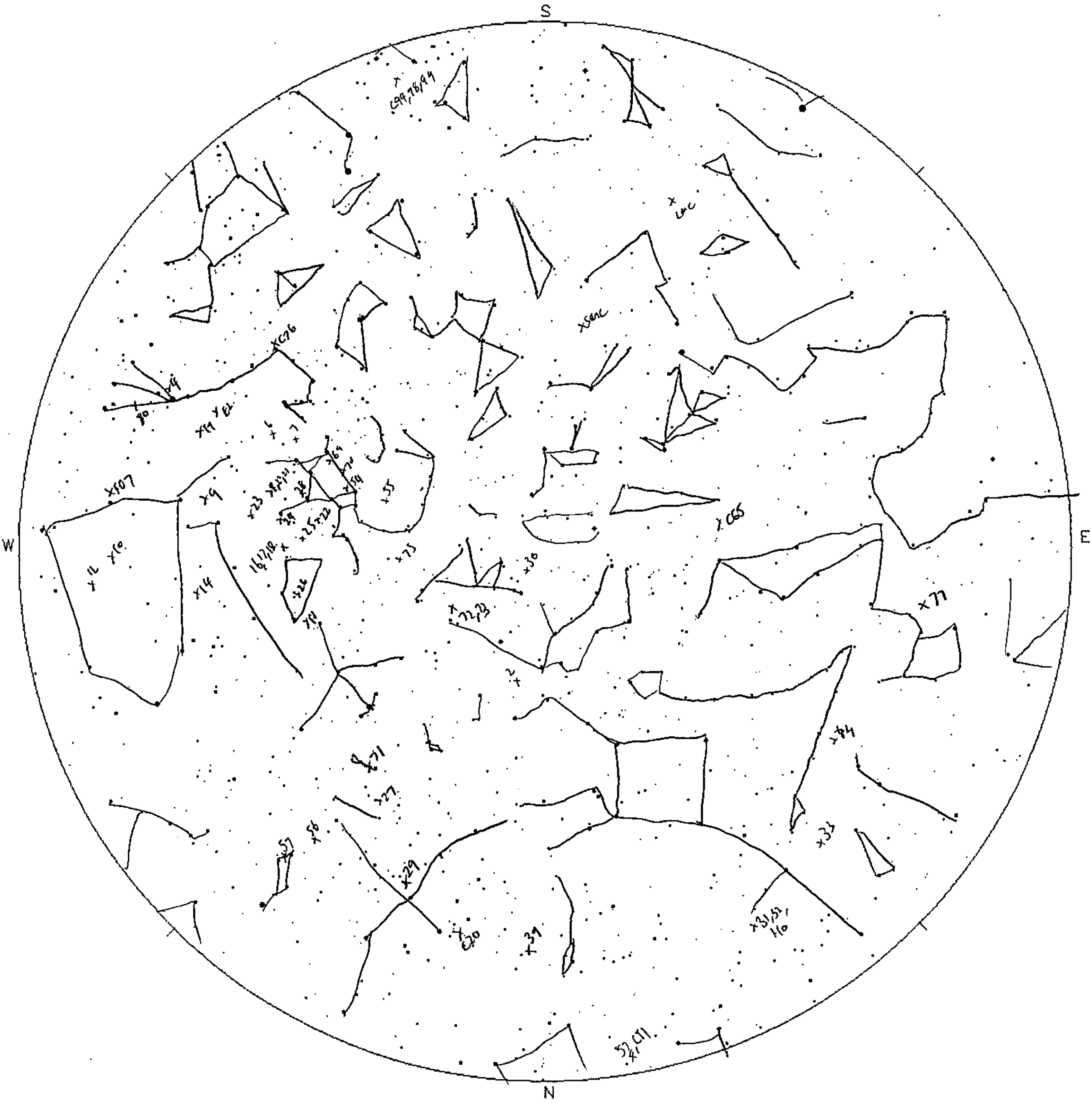
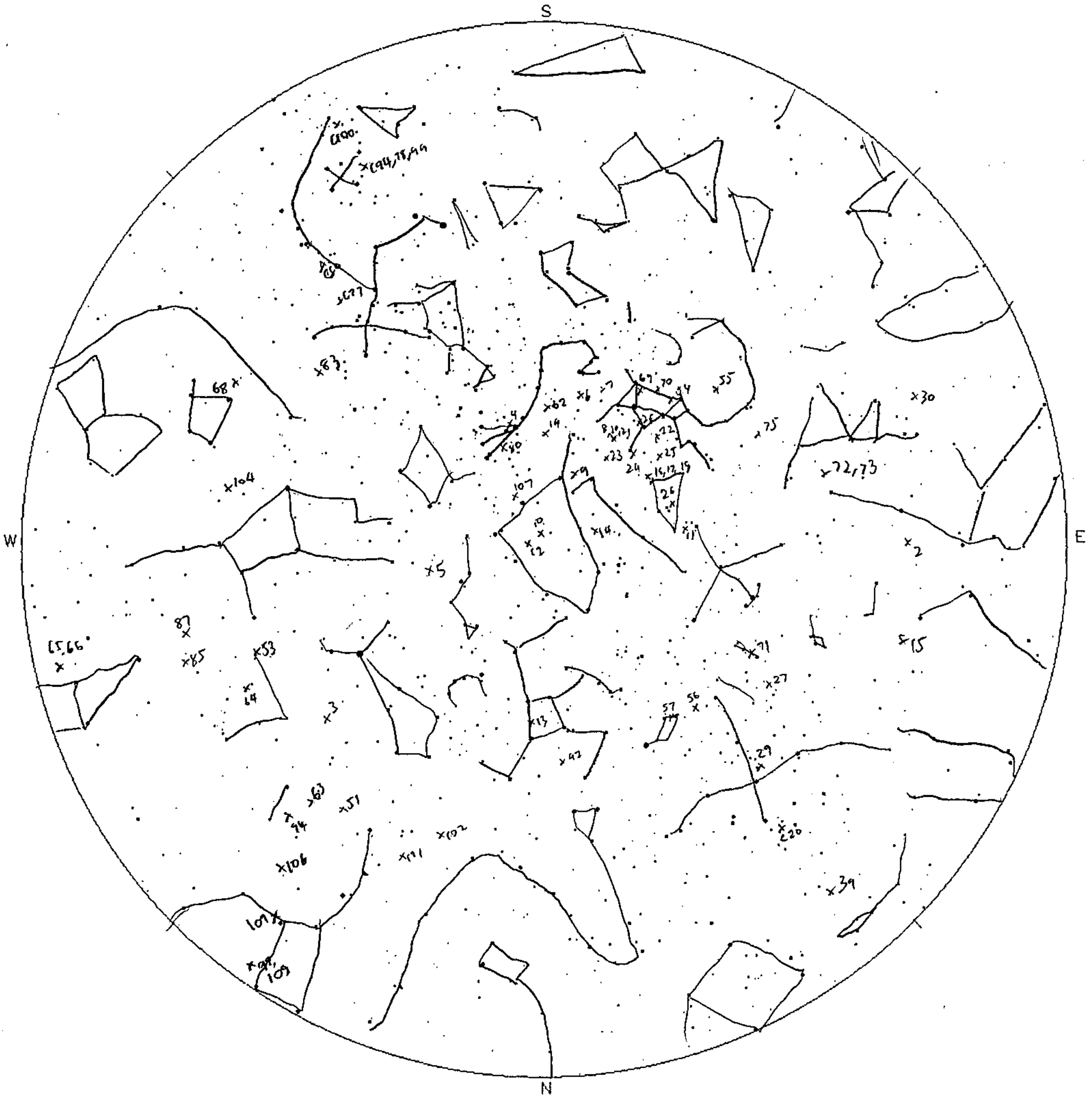
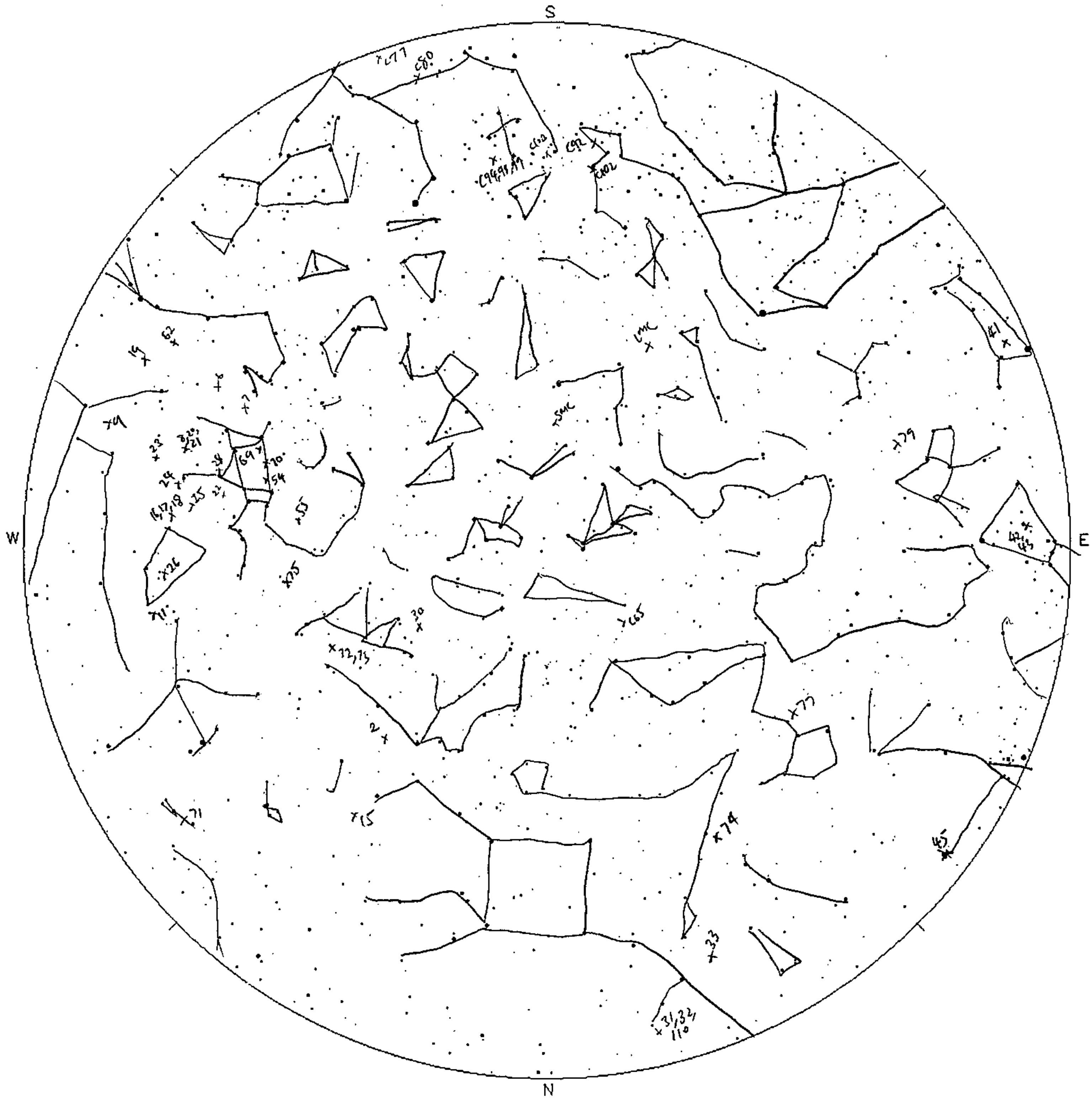
54
20
61


S
N
W
E
x C99,78,94
x LMC
x SMC
x C76
x4
80
x19
x62
6
7
x107
x9
x23
x8,21,24
28
x64
70
x54
x55
x12
x10
x14
16,17,18 x
28
x25 x22
x75
x26
x18
x36
x22,23
x65
x77
2
x44
x71
x27
x33
57
56
x29
x31,32,110
x C20
x39
57,C11,41


S
W
E
N
x65
x63
x77
C50
C92
C103
C44,48
419
x102
LMC
x79
x64
50
x82
x6
14
x7
x9
8,20,21
x
28
x29
70
54
x23
x24
x22
x25
x55
16,17
19
x26
x11
x12
x10
x14
x75
x30
x72,73
x42
x15
x71
x59.6
x665
x77


S
W
E
N
x (100)
x(94,78,99)
x(27
x83
68 x
x104
87 x
15,66 x
x85
x53
x 64
x3
x63
x 94
x51
x106
x101
x102
109
x 98, 109
x4
x40
x62
x6
x7
x19
67
70
54
x55
8,10,121
26
x22
x23
x25
24
16,12,15
26 x
x75
x30
x72,73
x107
x9
10 x
x 12
x14
x11
x5
x2
x15
x71
x27
56 x
57
x13
x42
x29
x 220
x39


S
C77
C80
C94,98,99
C103
C92
C102
LMC
SMC
62
19
6
7
9
23
8,20,21
38
69
70
54
24
16,17,18
25
22
53
26
11
75
79
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47,93
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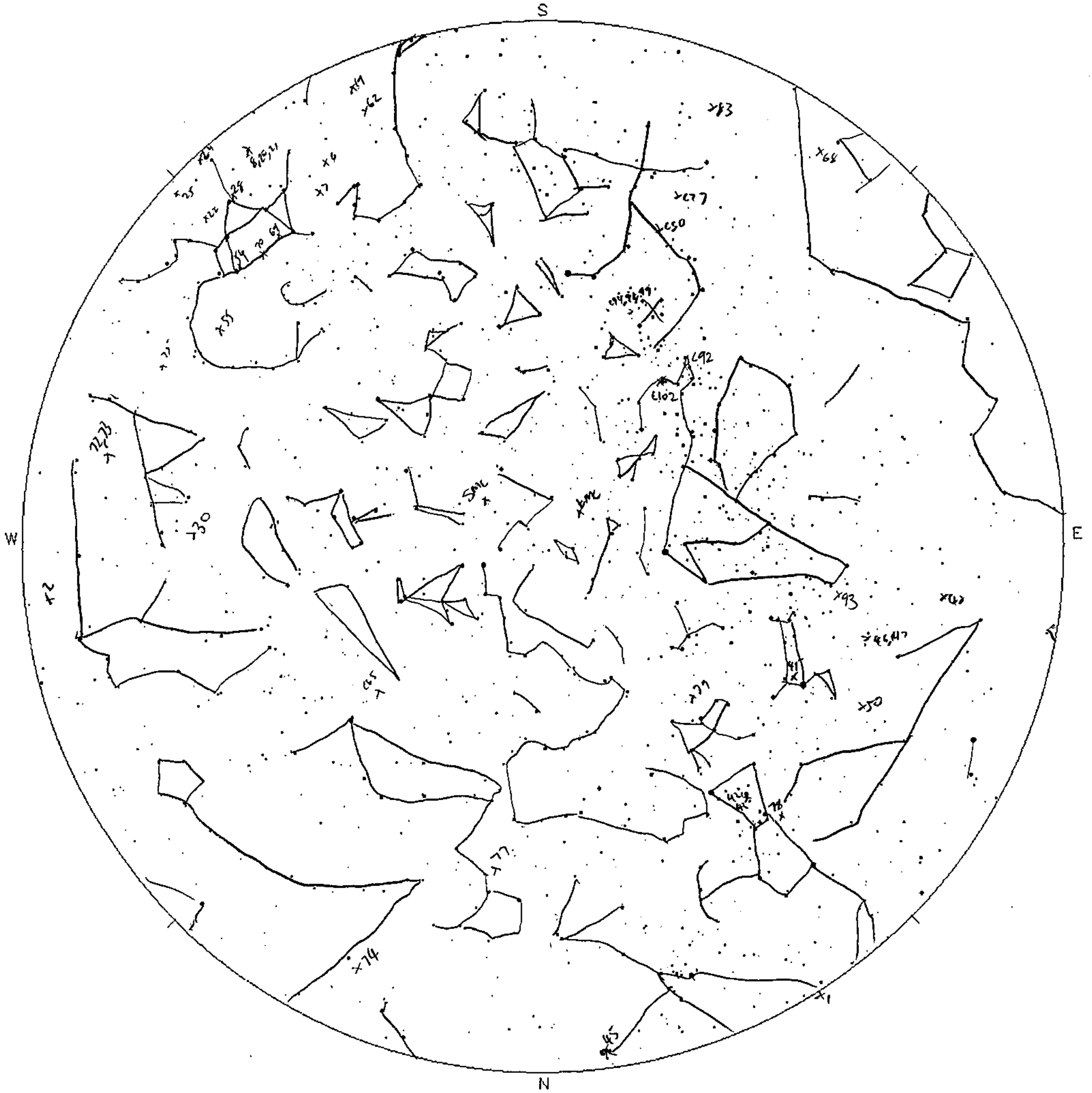
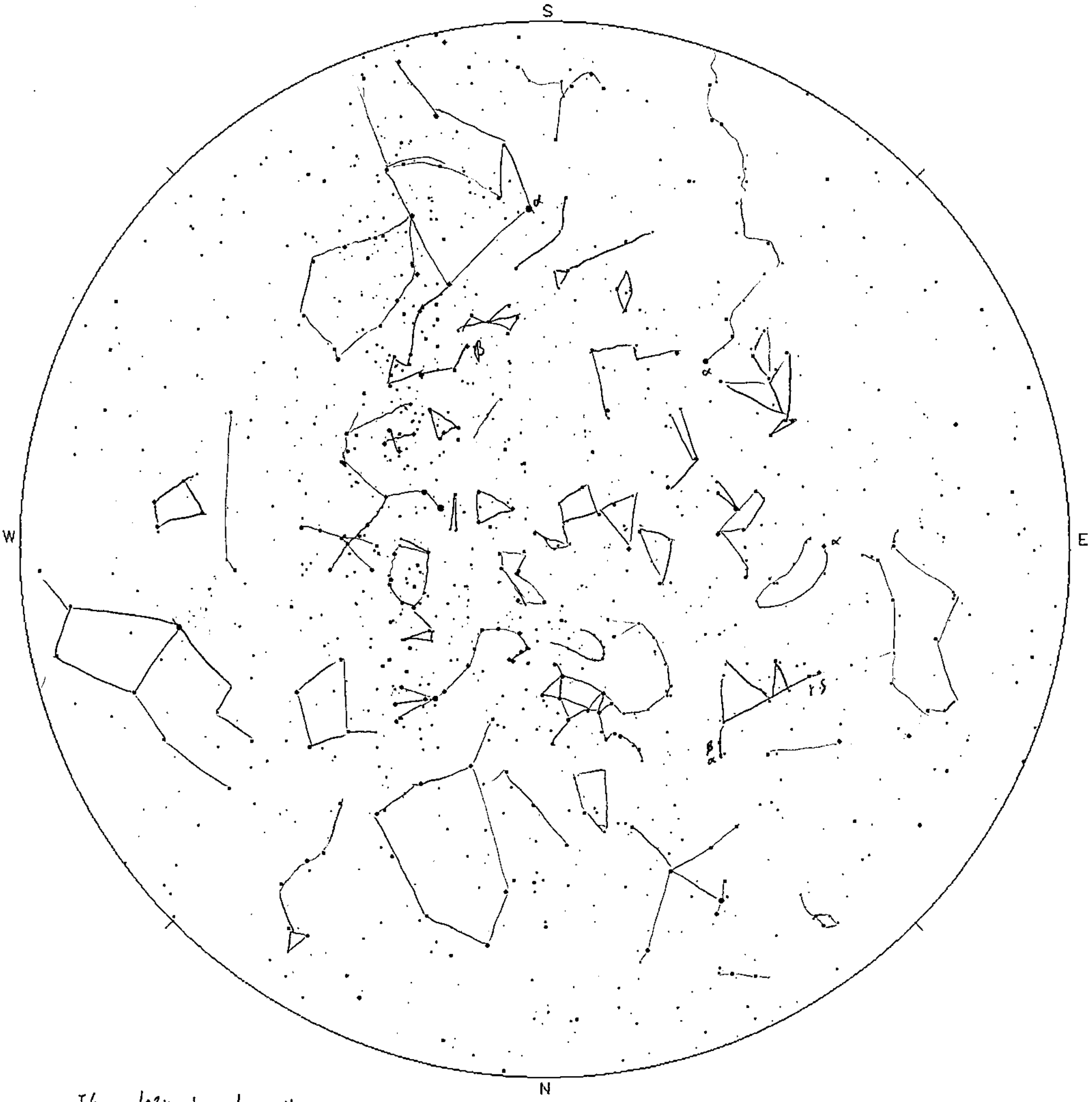
72,73
C65
2
77
15
71
74
45
33
31,32,110
W
E
N


S
W
E
N
x19
x62
x83
x68
x24
x 8,15,21
x6
x25
x28
x7
x22
x177
c50
54
70
69
x55
x27
c92
c102
x22,23
x30
x2
SMC
LMC
x93
x43
x45,47
41
x79
x50
x65
78
x77
x74
x1
65



I'm lazy to draw the messiers or the DSOs or the Galaxies


N
E
W
S
β
δ
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α
ε

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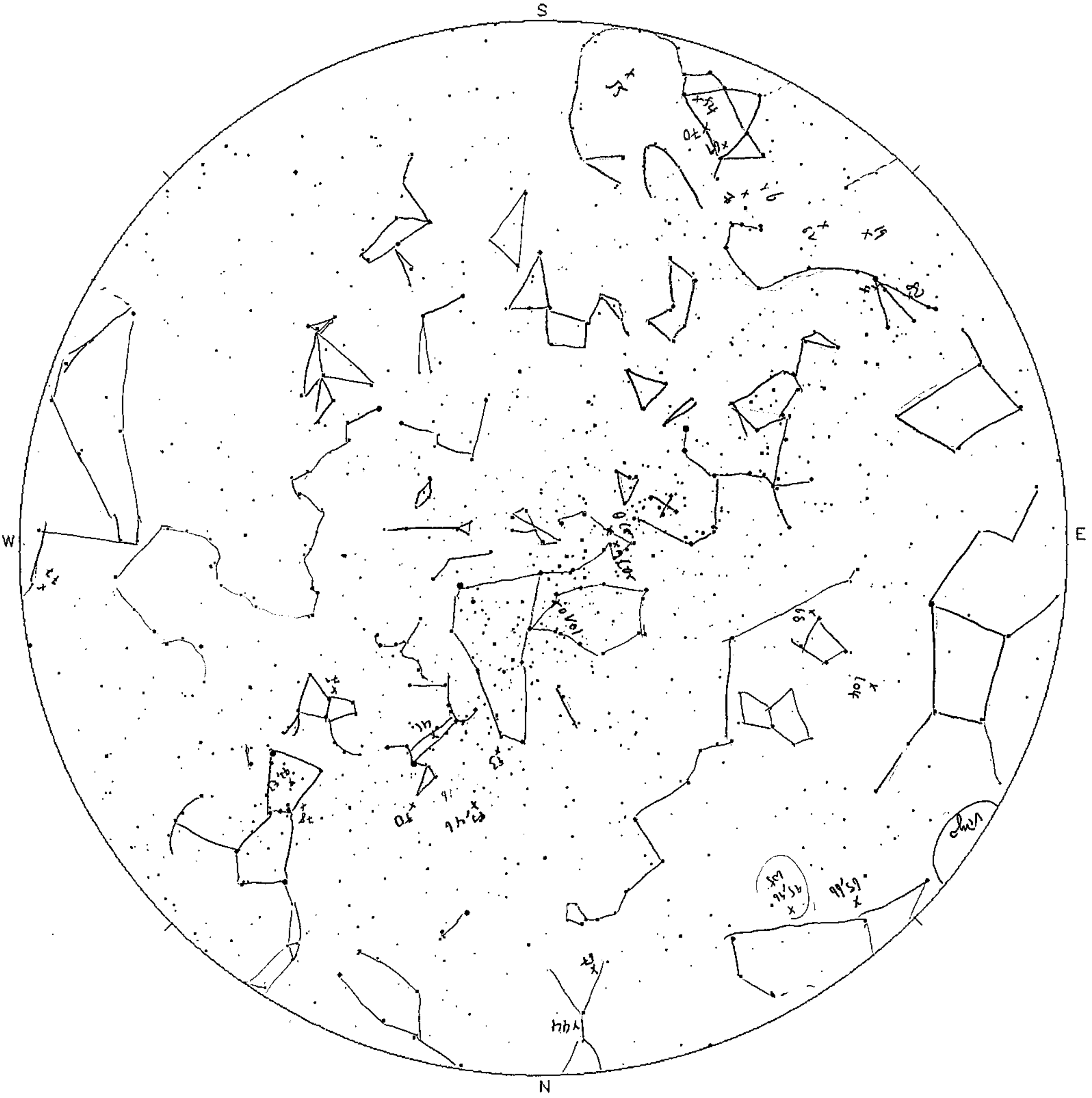
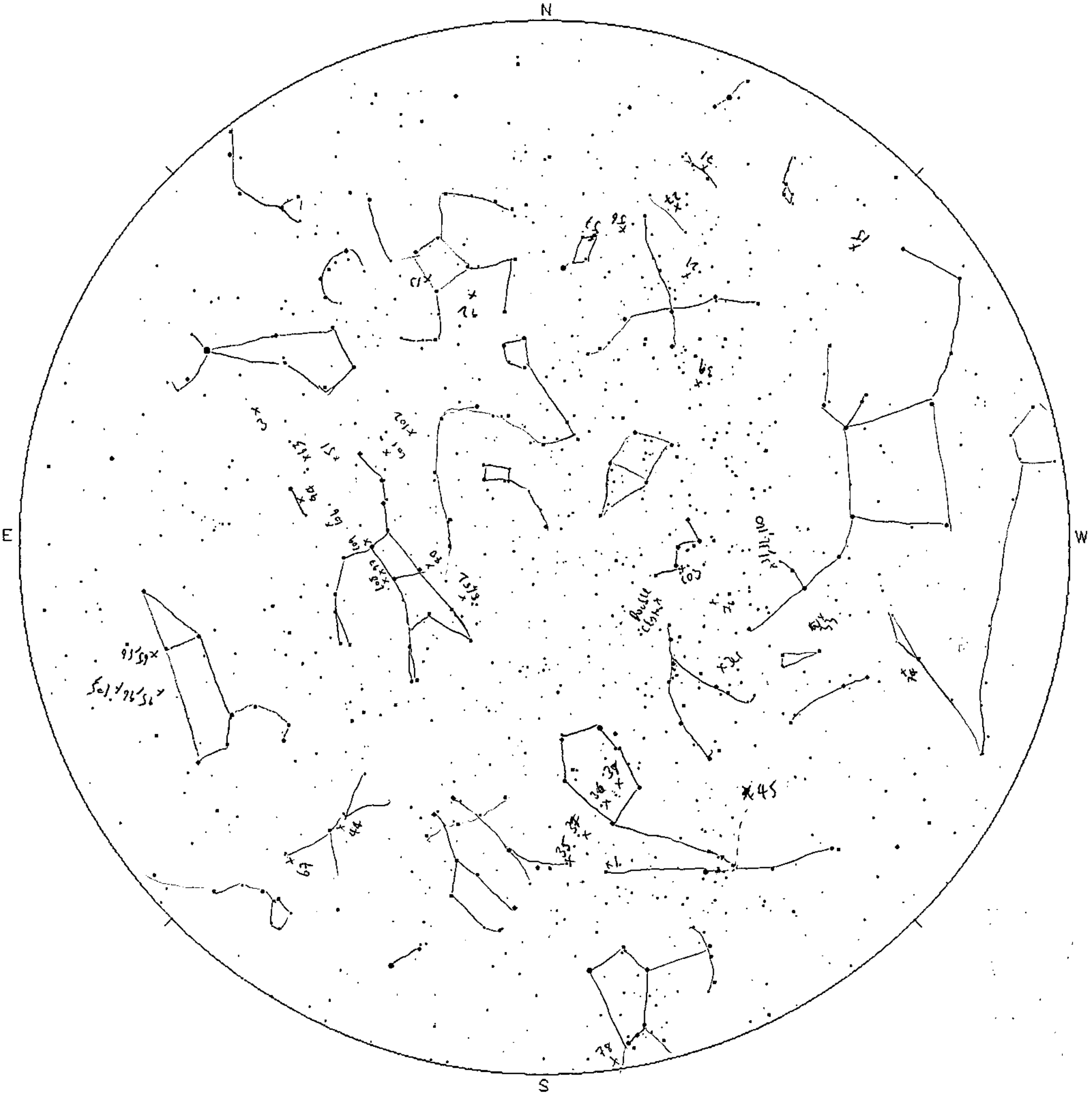
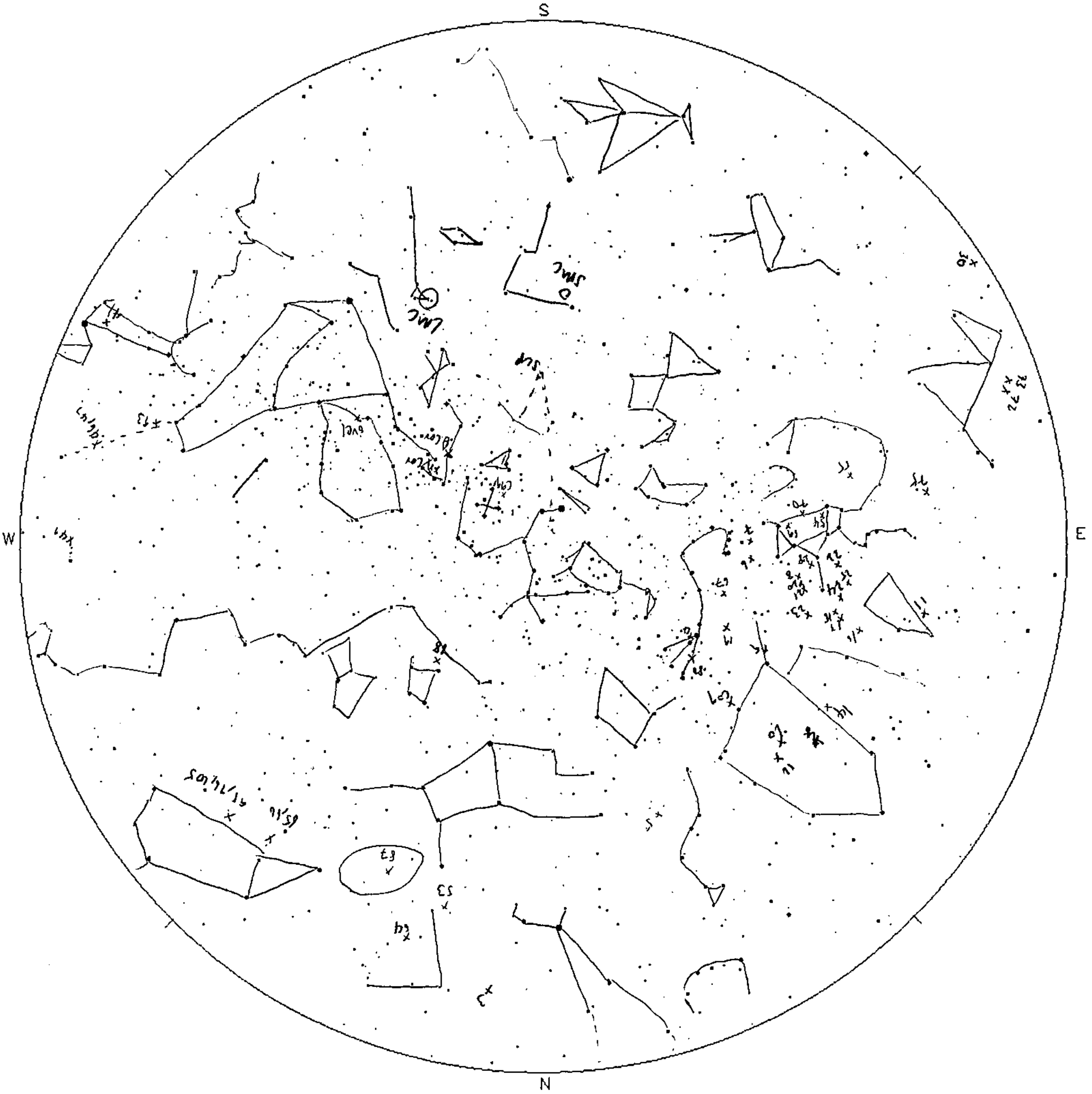
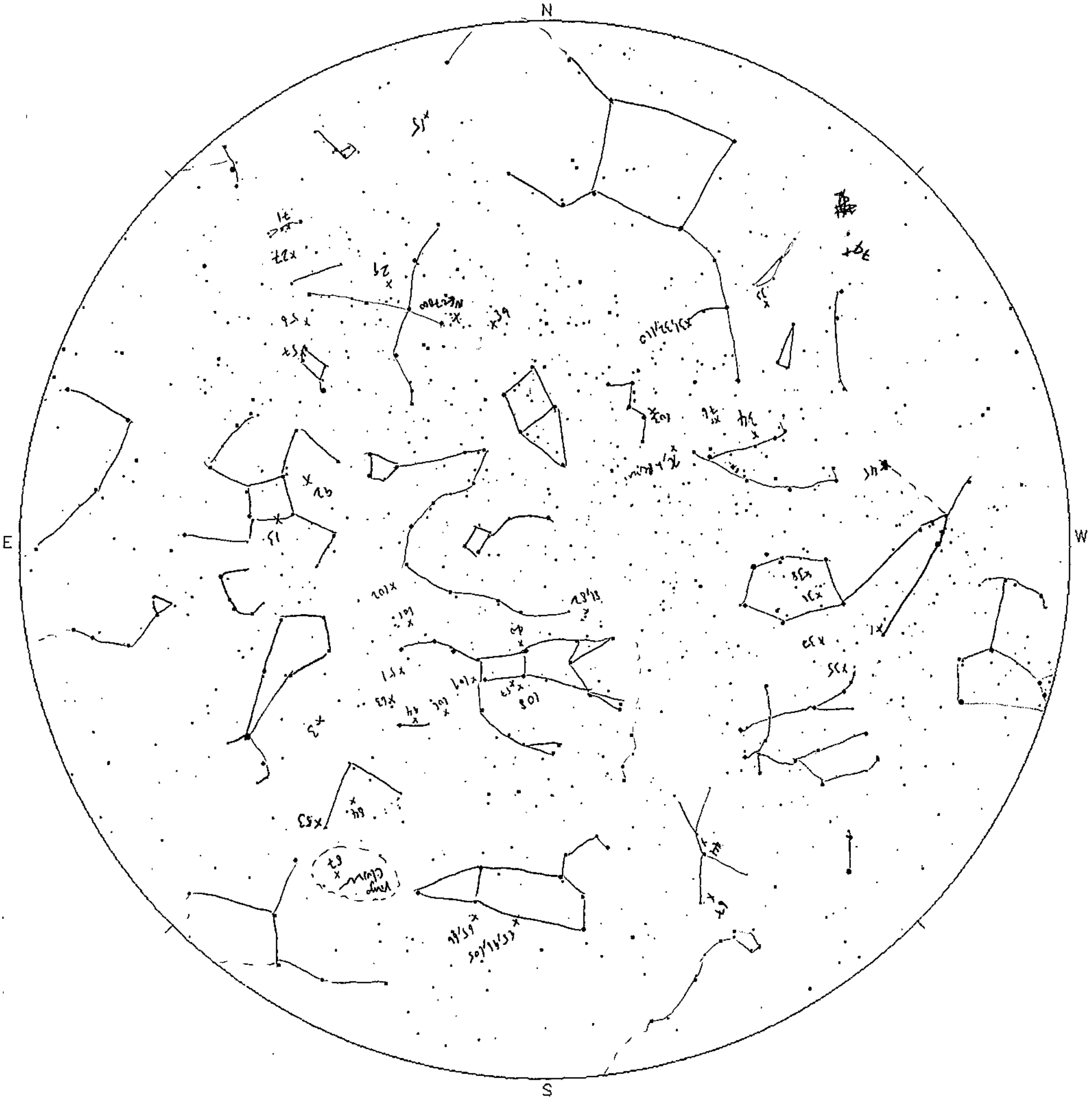

S
W
E
N


N
E
W
S
45
44
67
35
38
78
1
92
13


S
W
E
N
LMC
SMC


N
NGC7000
31/32/110
Double Cluster
45
E
W
78
50
46,47
44
S


N
E
W
S


S
×68
×83
×C77
C80
C94,98,99
80
4
C76
9
7
W
×14
×23
8,2,9,11
×6
24
28
69
1,6,17,18
25
32
70
54
×55
×26
11
×75
×72,73
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×C65
×2
×15
LMC
SMC
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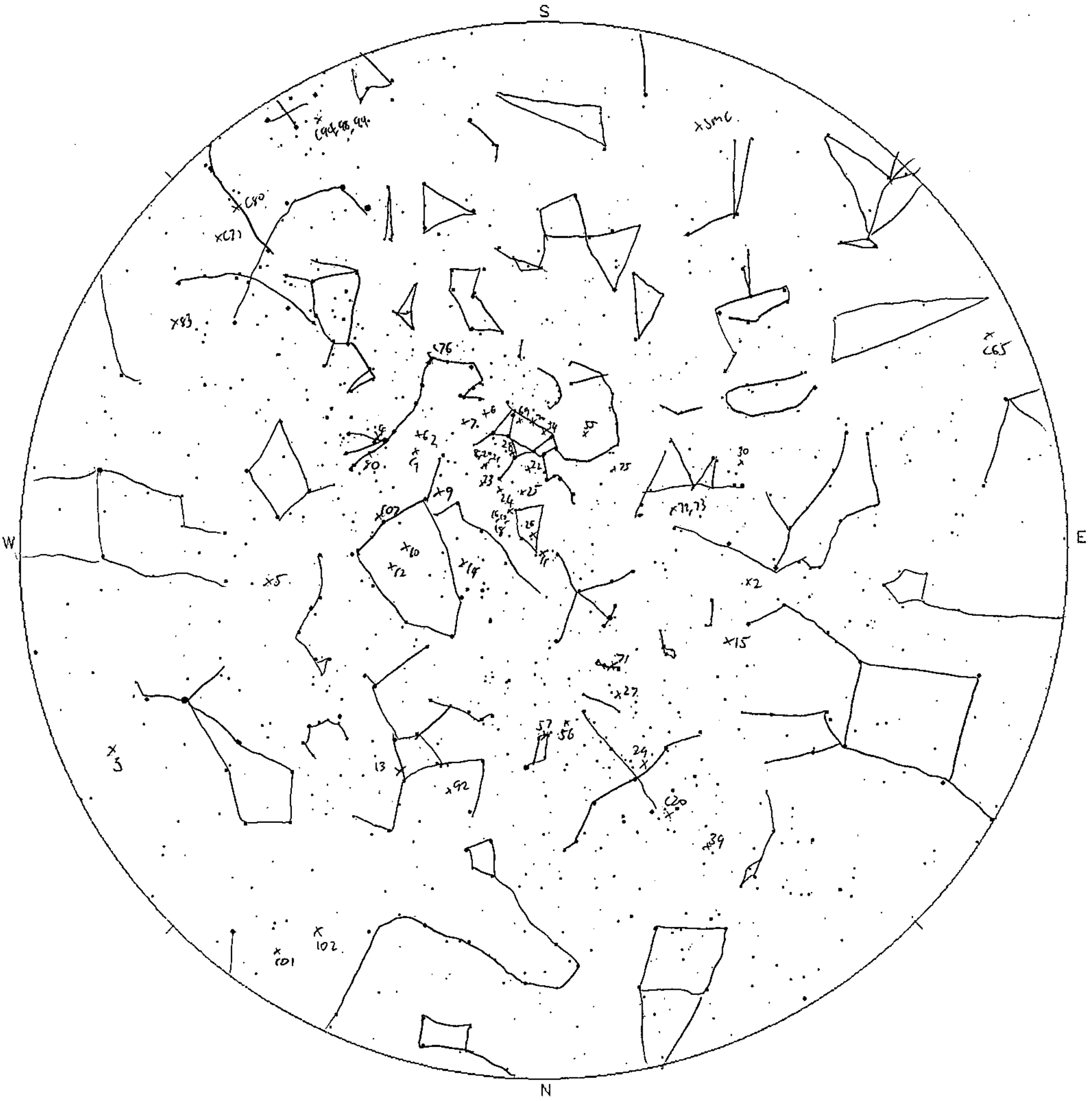
79
E
78
42,43
×77
74
N


S
W
E
N
SMC
C94, 98, 99
C80
C71
X83
C65
C76
62
C9
30
C102
10
12
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92
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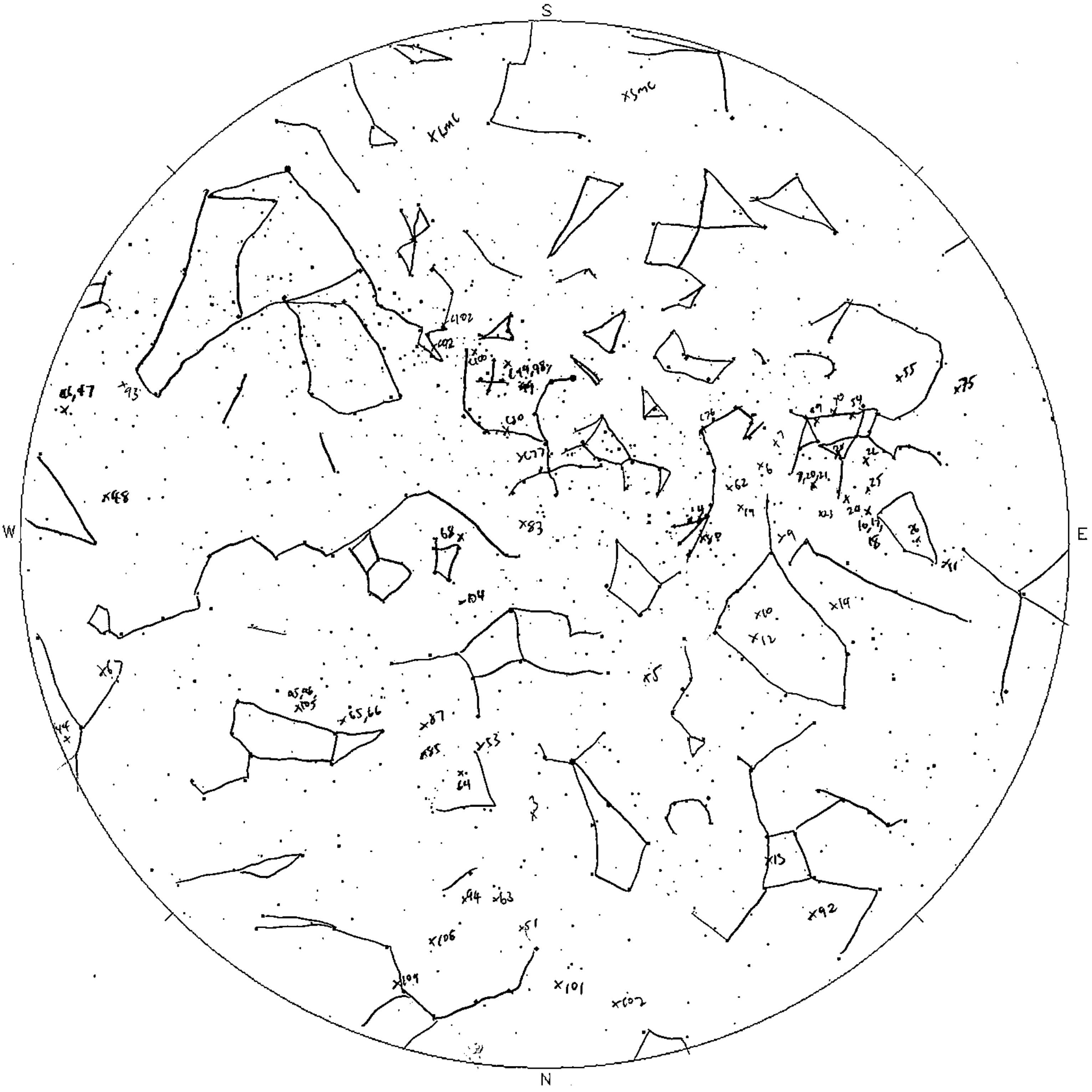
C20
39
101
102
72, 73
75
35


S
XLMC
XSMC
C102
C92
C100
C99,98
C80
C77
C76
W
E
N
85,87
x93
x48
68x
x83
104
x55
x75
49
70
54
x7
x6
x62
x19
x14
x80
x22
x25
9,20,21
x23
20x
10,17,
18
26
x11
x9
x10
x12
x19
x5
x67
44
x
95,96
x105
x65,66
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x85
x53
x
64
3
x
x13
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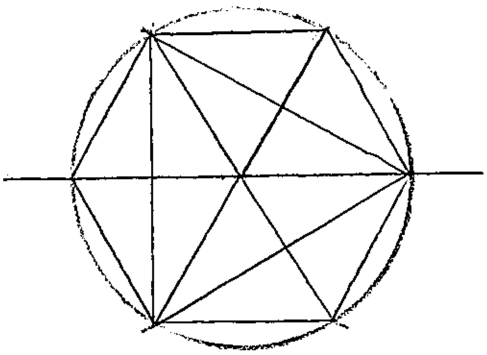
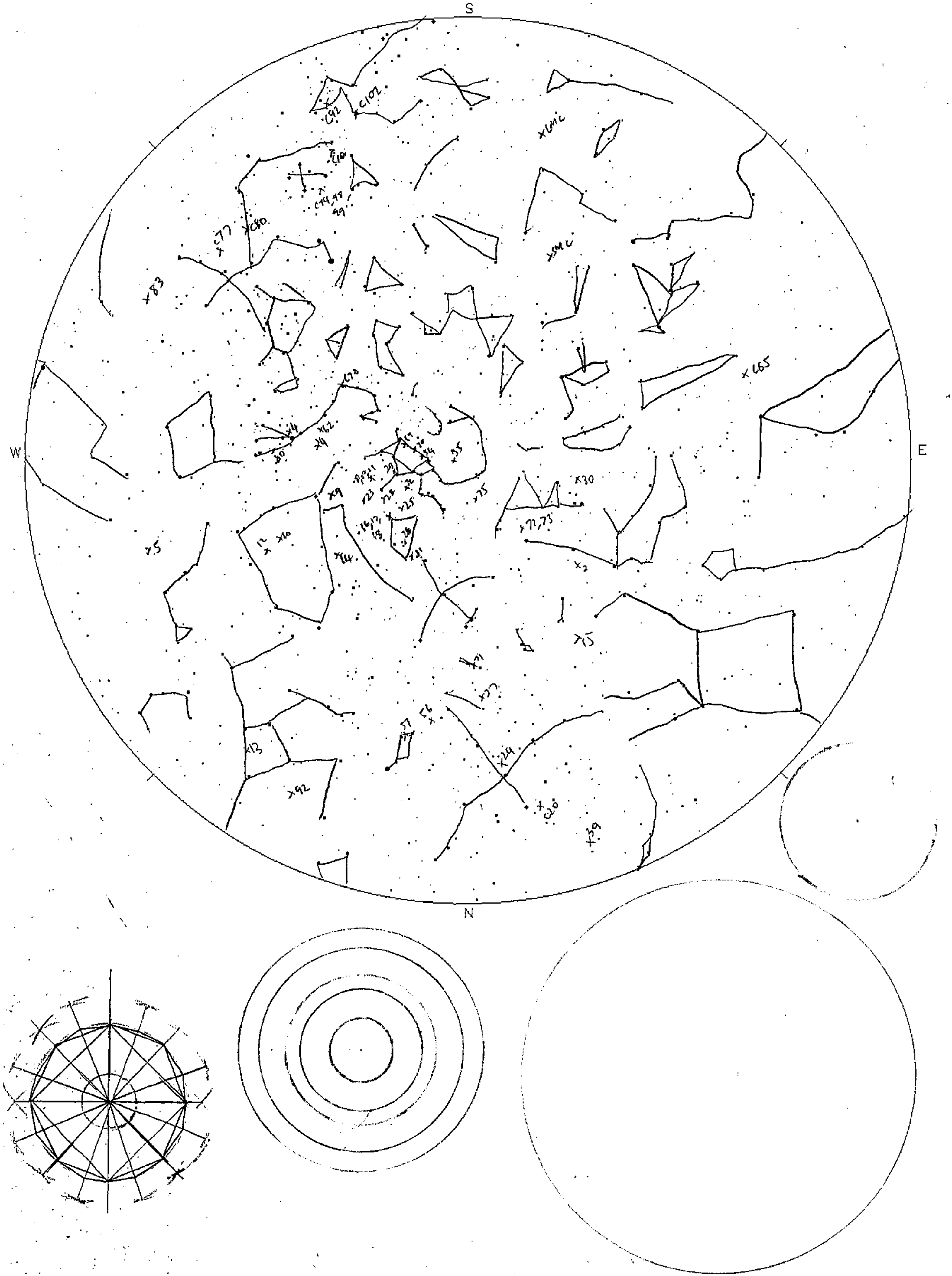
x63
x106
x51
x104
x101
x102




S
W
E
N
C92
C102
LMC
C101
C79, 98, 99
C77
C80
83
SMC
65
C70
4
62
80
55
54
9
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25
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72, 73
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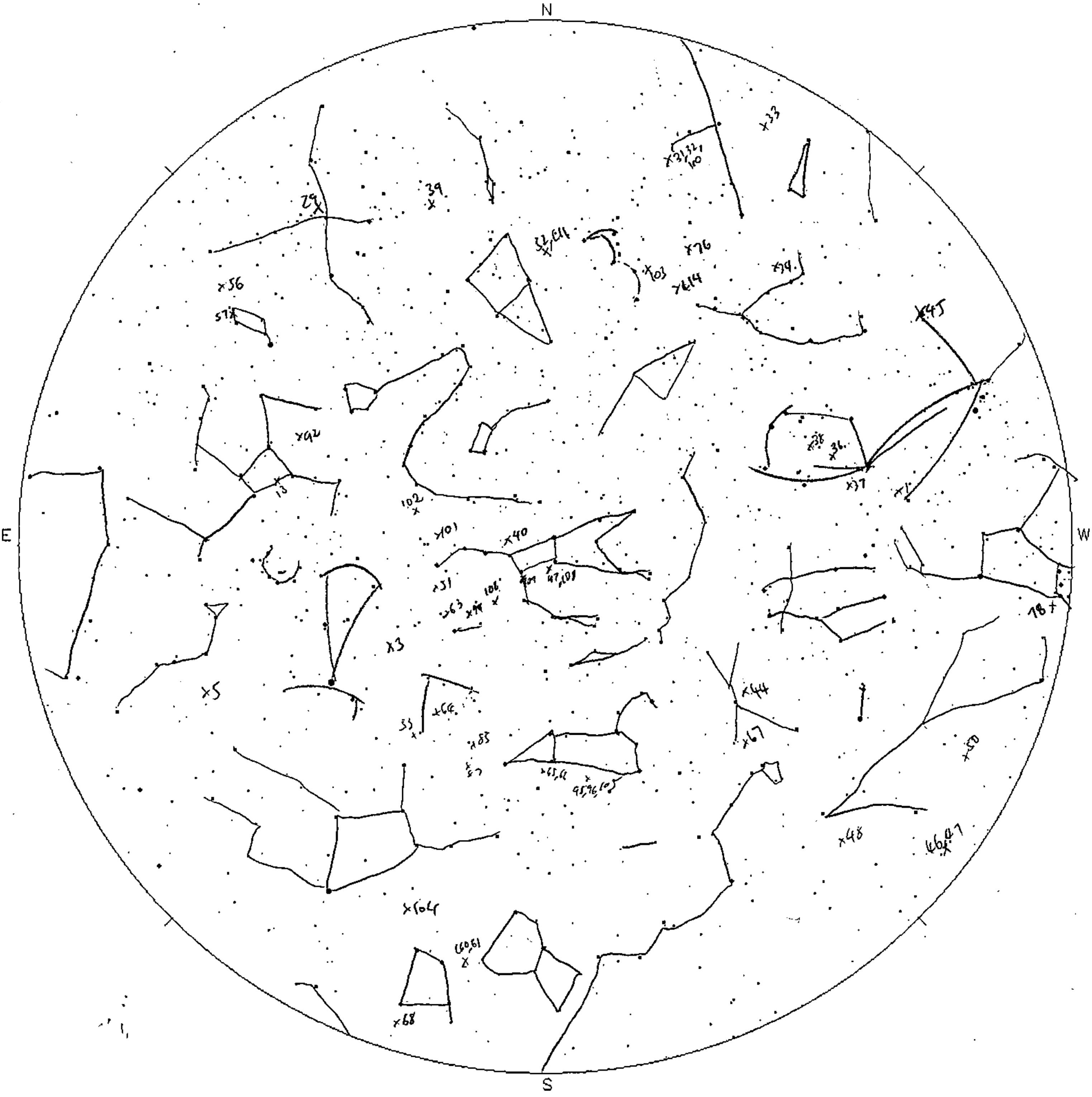
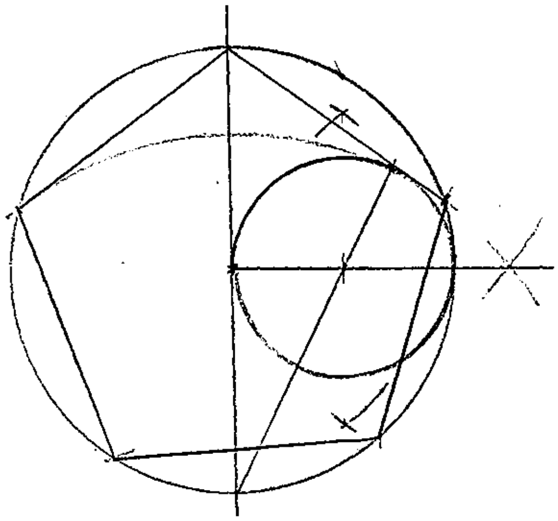
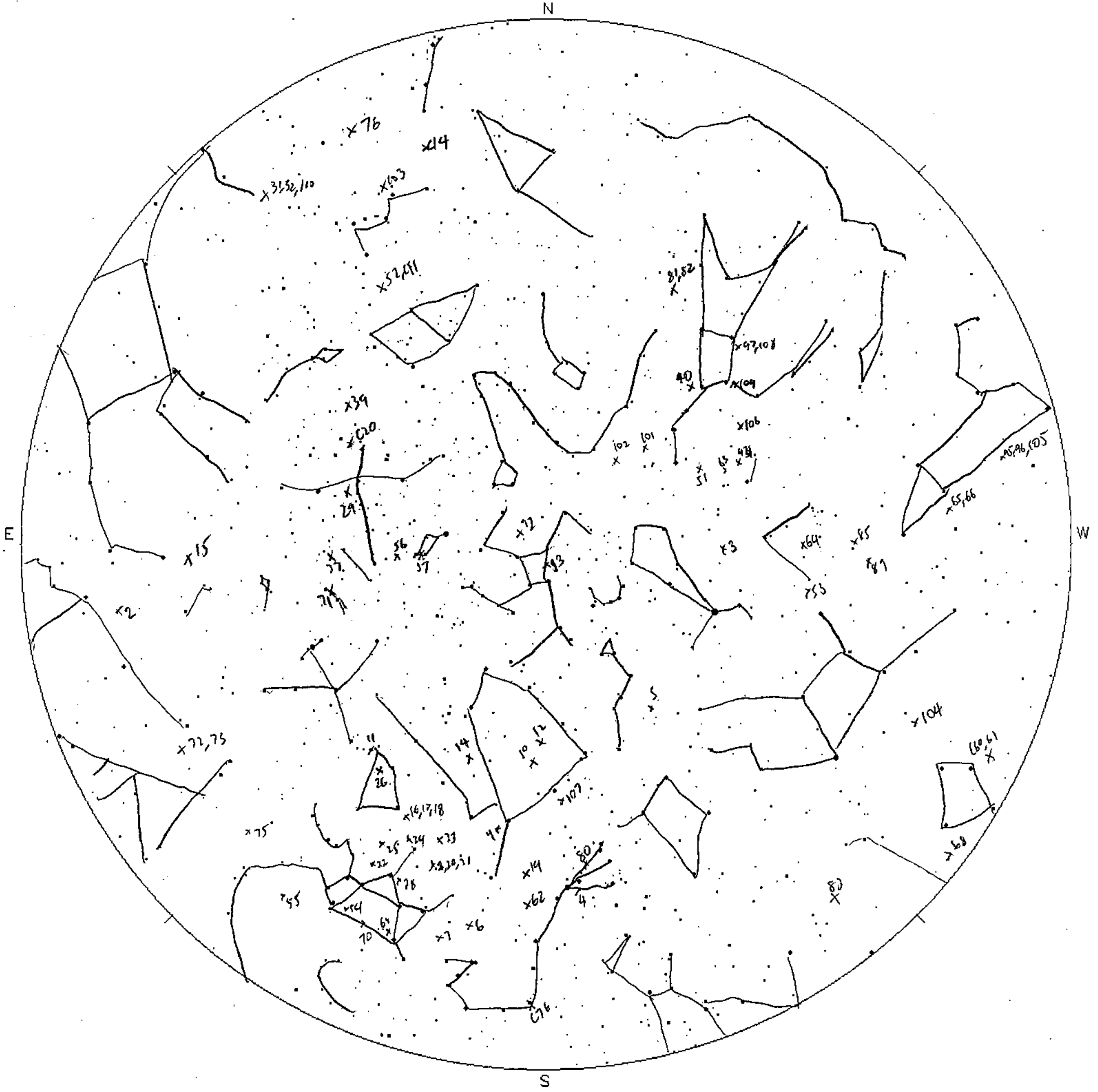
14
2
15
11
37
56
57
13
92
29
C20
39


N
E
W
S
x33
x31,32,110
39 x
29 x
32,111 x
x76
x103
x614
x79.
x56
57x
x45
x92
x38
36. x
x37
x1
13
102 x
x101
x40
x51
x63
x99
106 x
x109
x 47,108
x3
x5
x64
33 x
x44
x67
x85
x 87
x65,66
x 95,96,103
x50
x48
46,47 x
x104
60,61 x
x68
18 x

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×106
102
×
101
×
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×48
×95,96,105
×65,66
×39
×C20
×
29
×15
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(60,61)
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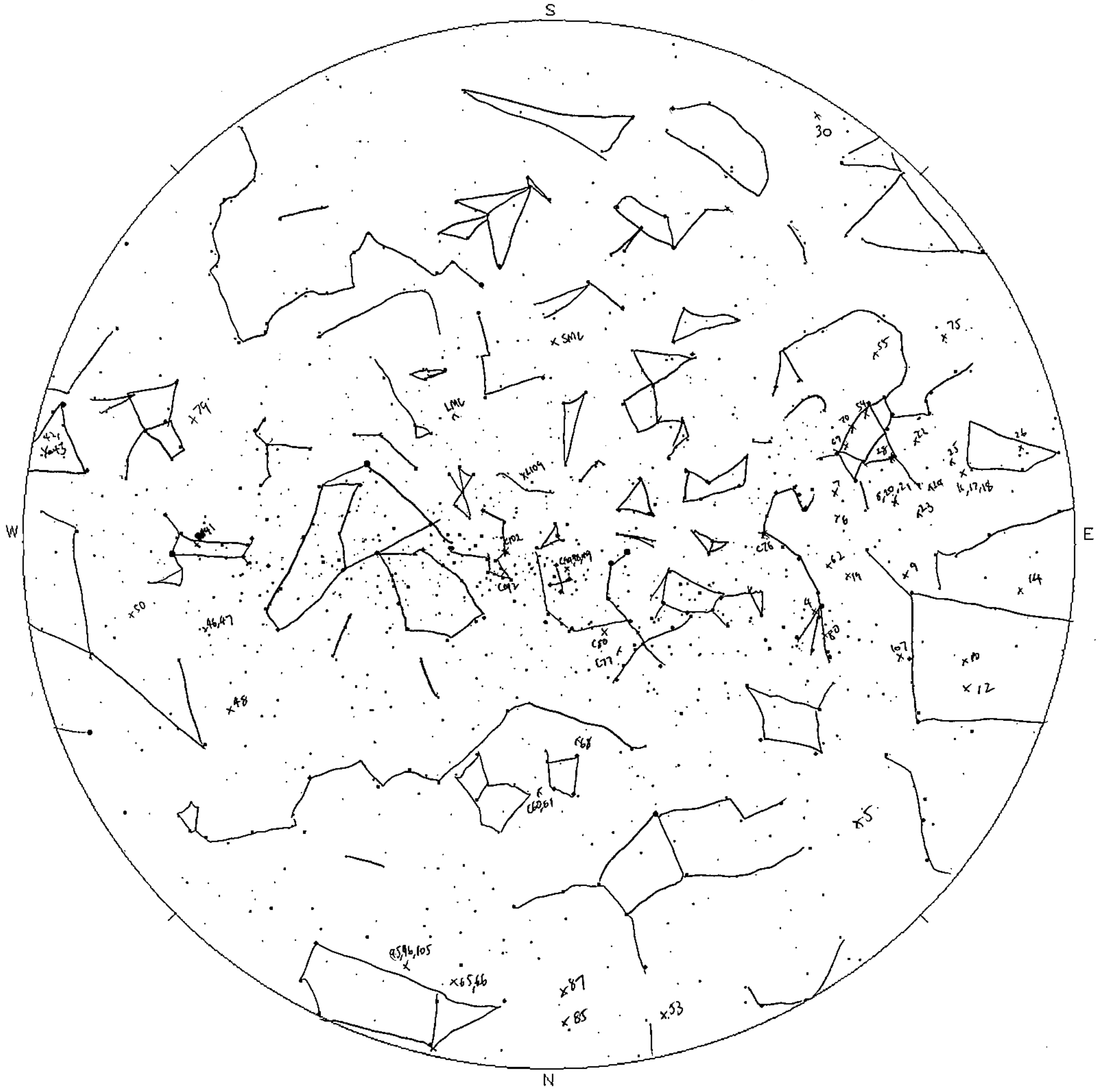
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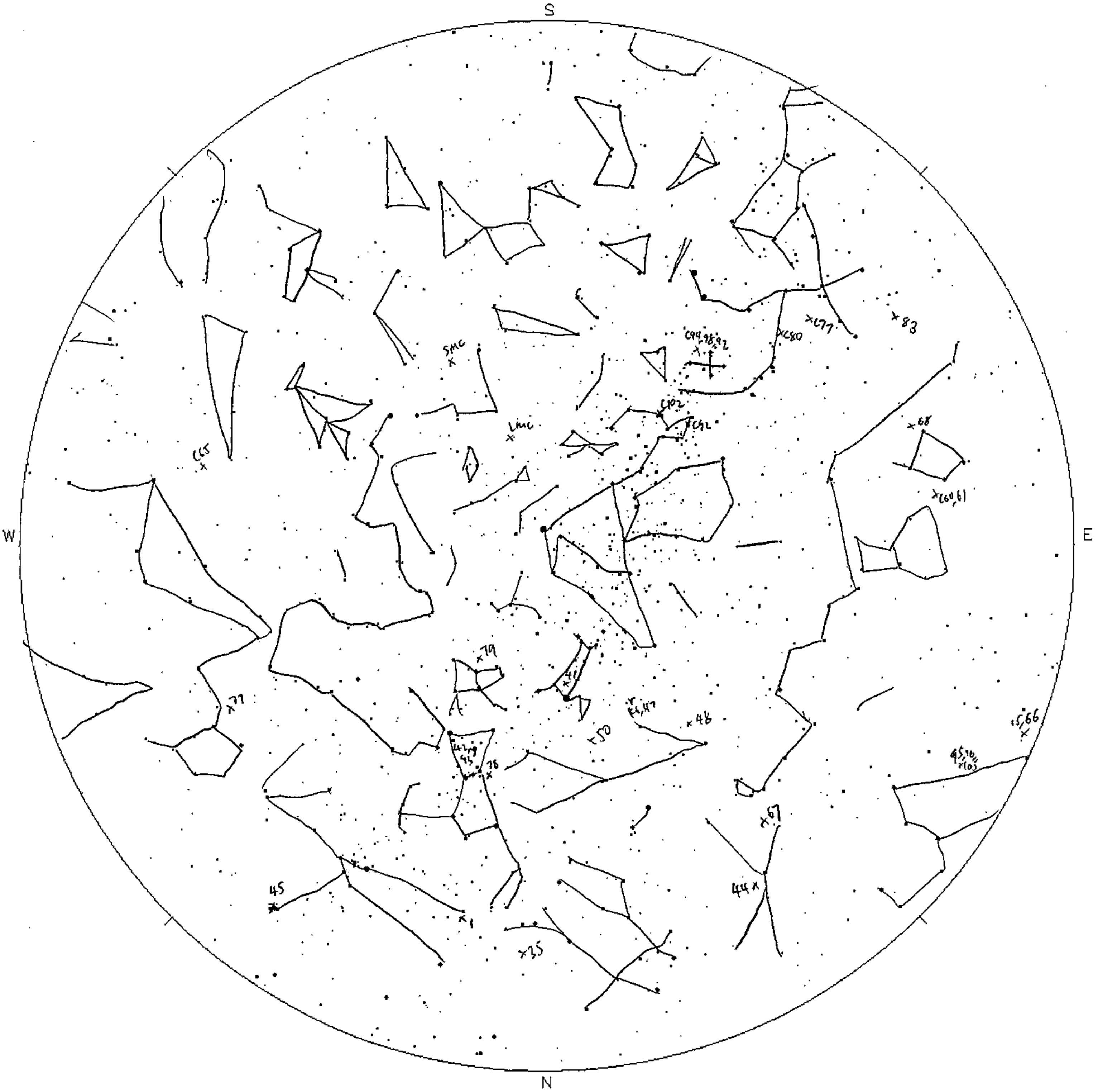
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C6
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x120
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x27
x56
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92
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C101
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C3
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x44
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C102
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LMC
SMC
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C102
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C76
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×62
SMC
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×7
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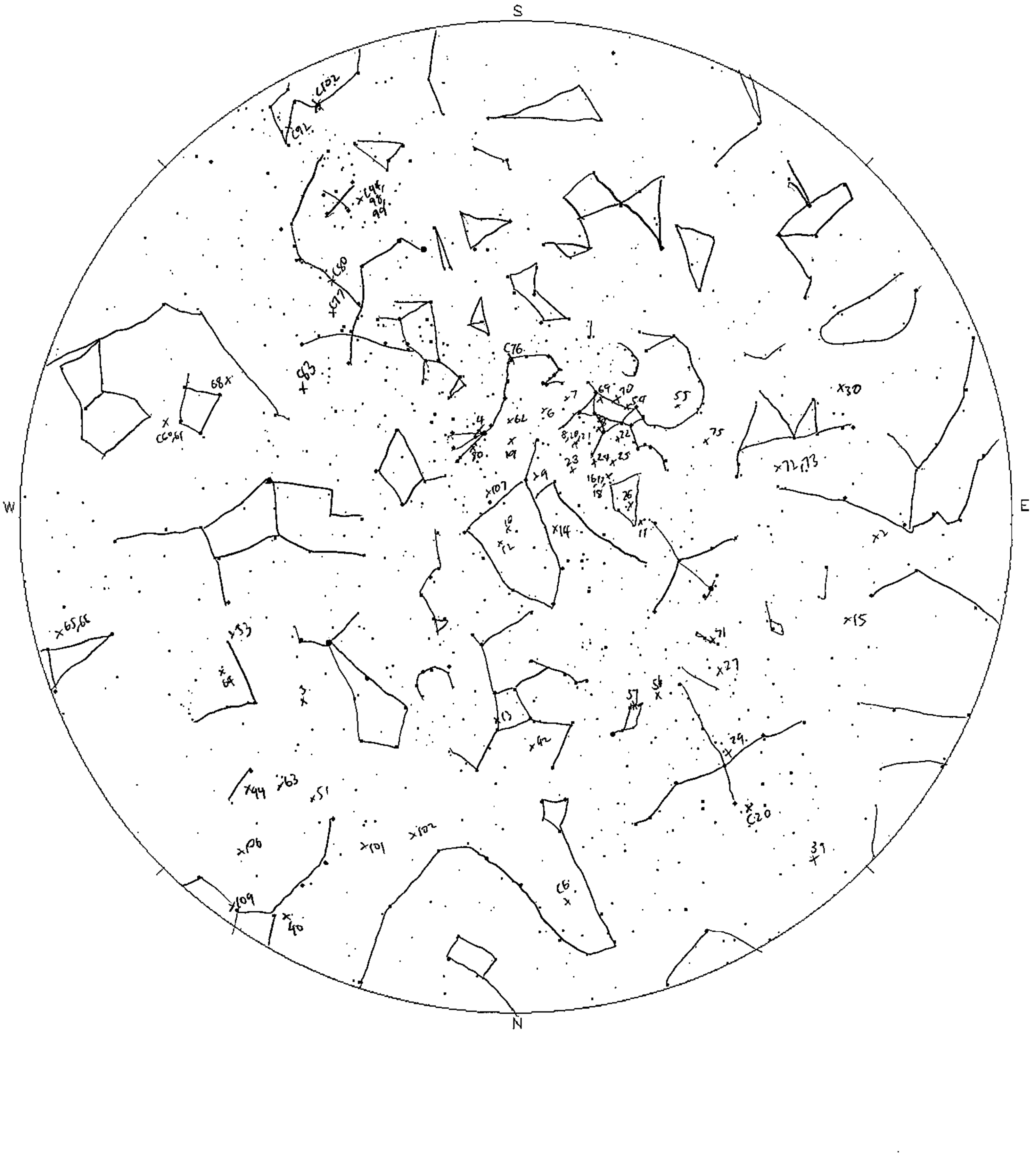
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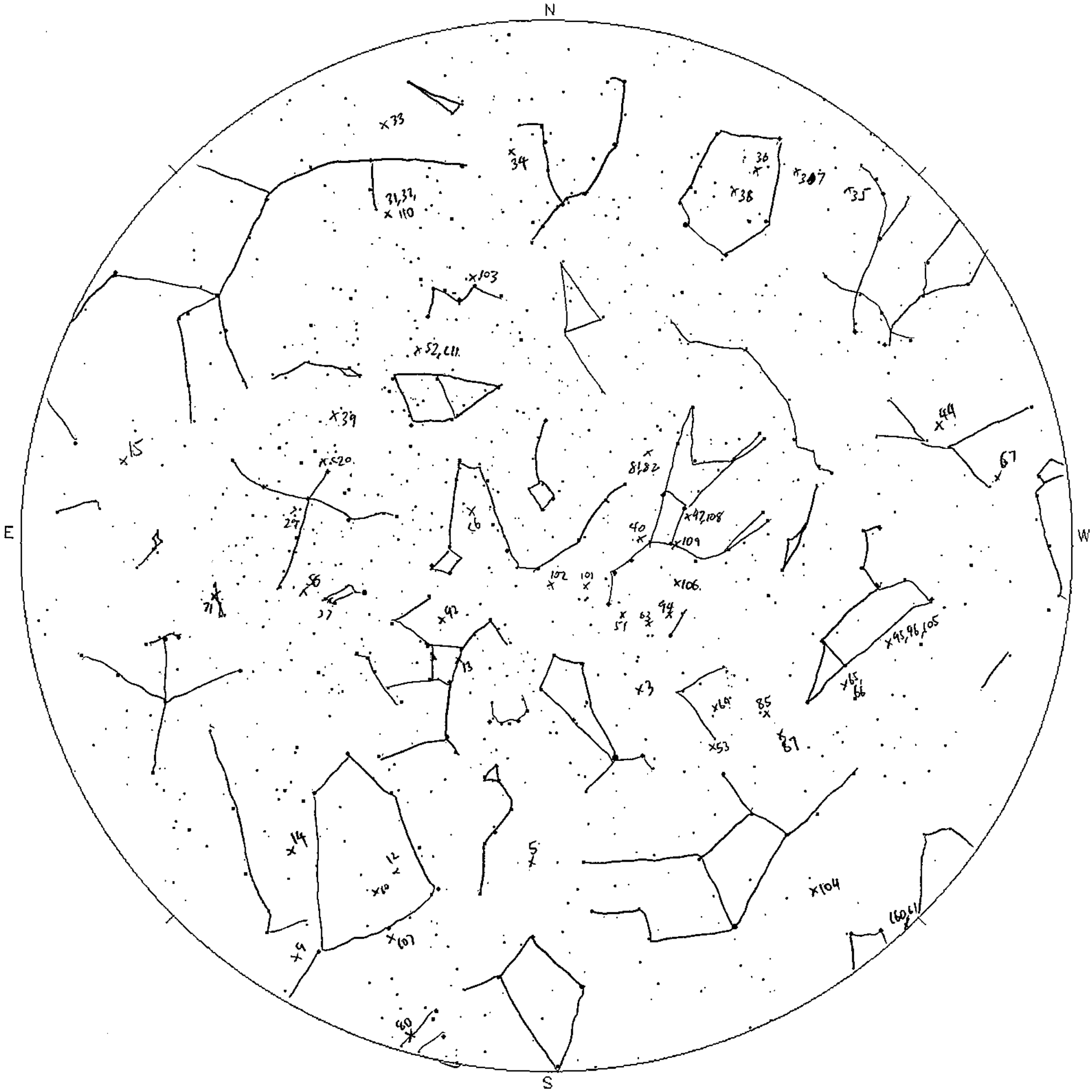
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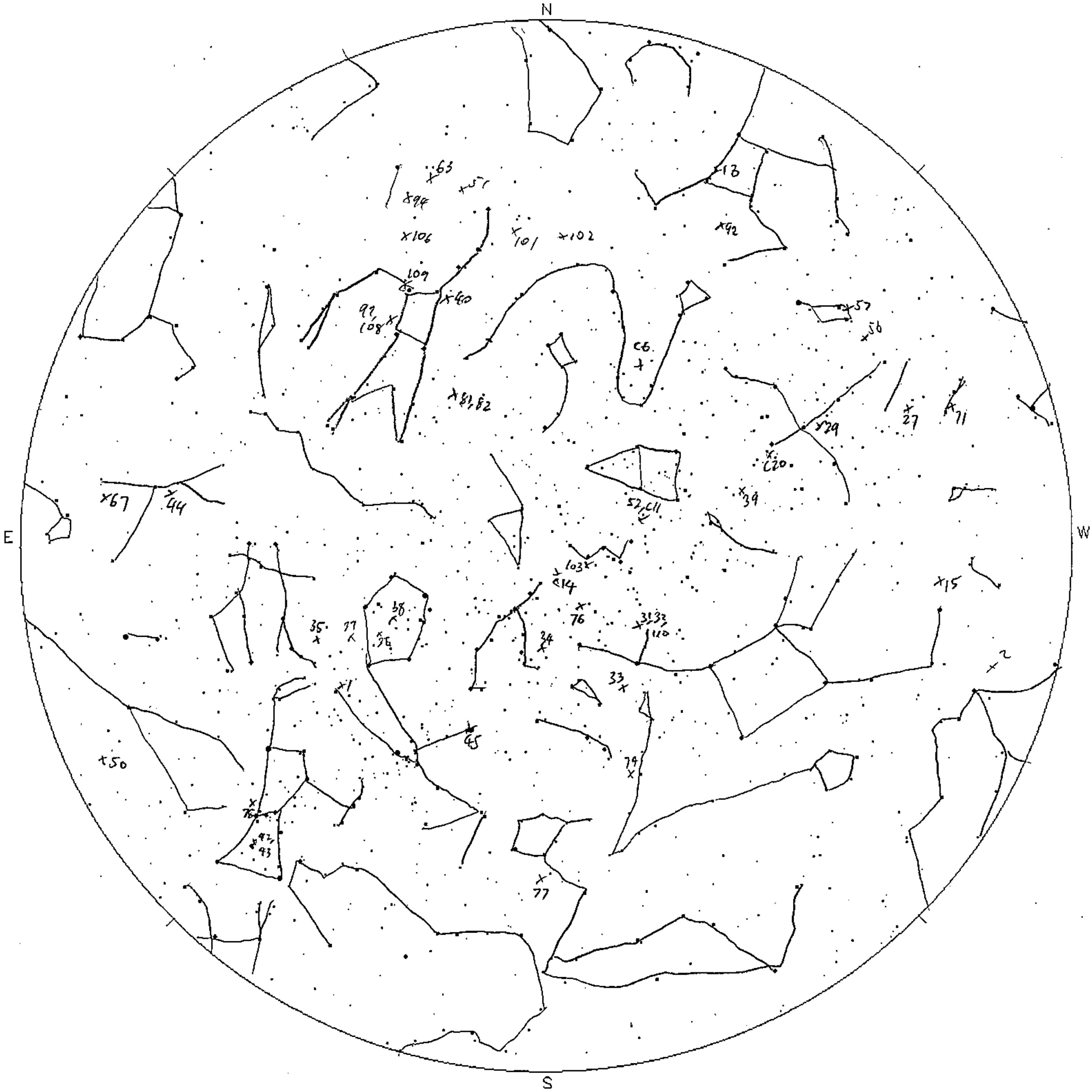
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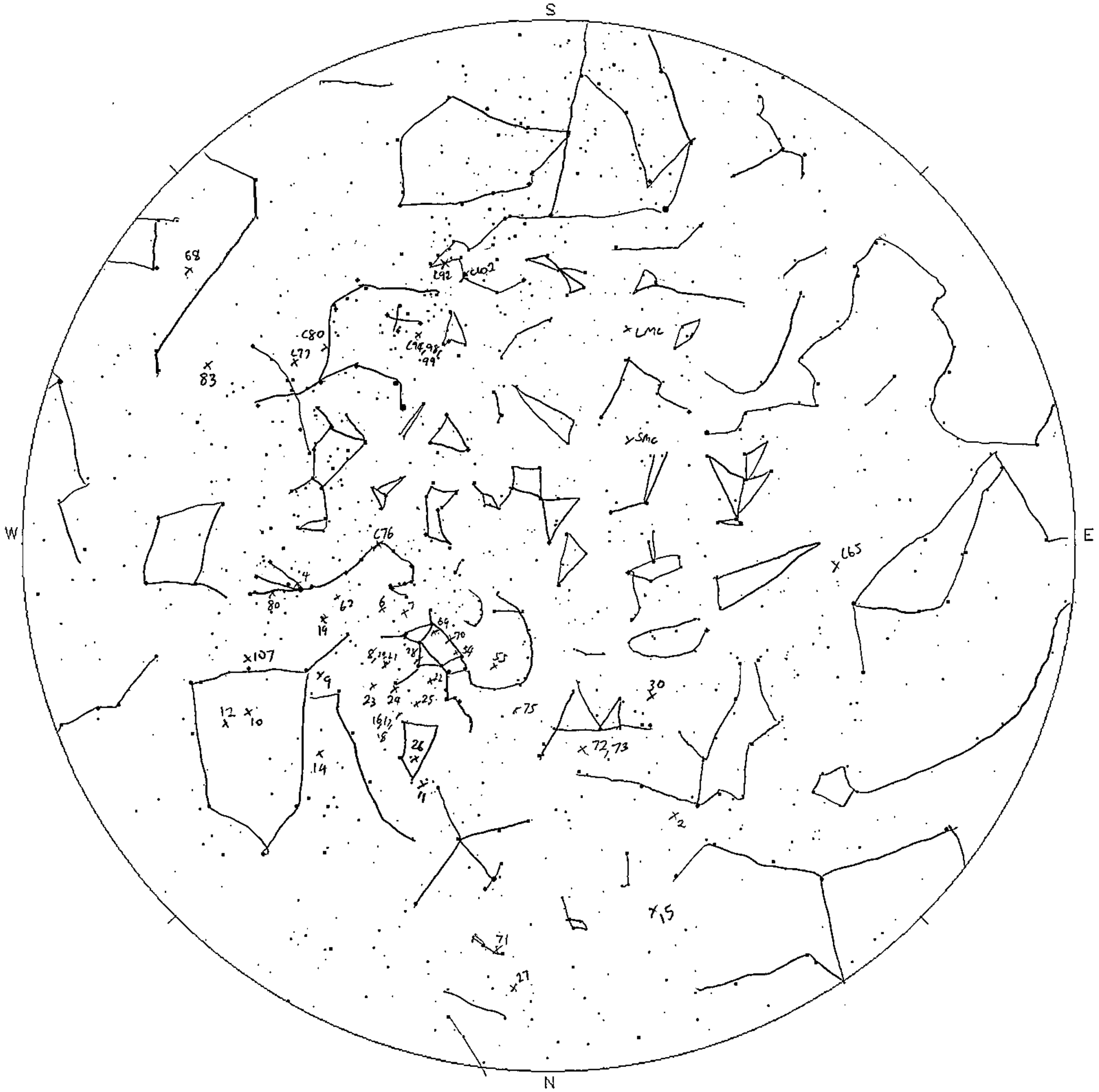
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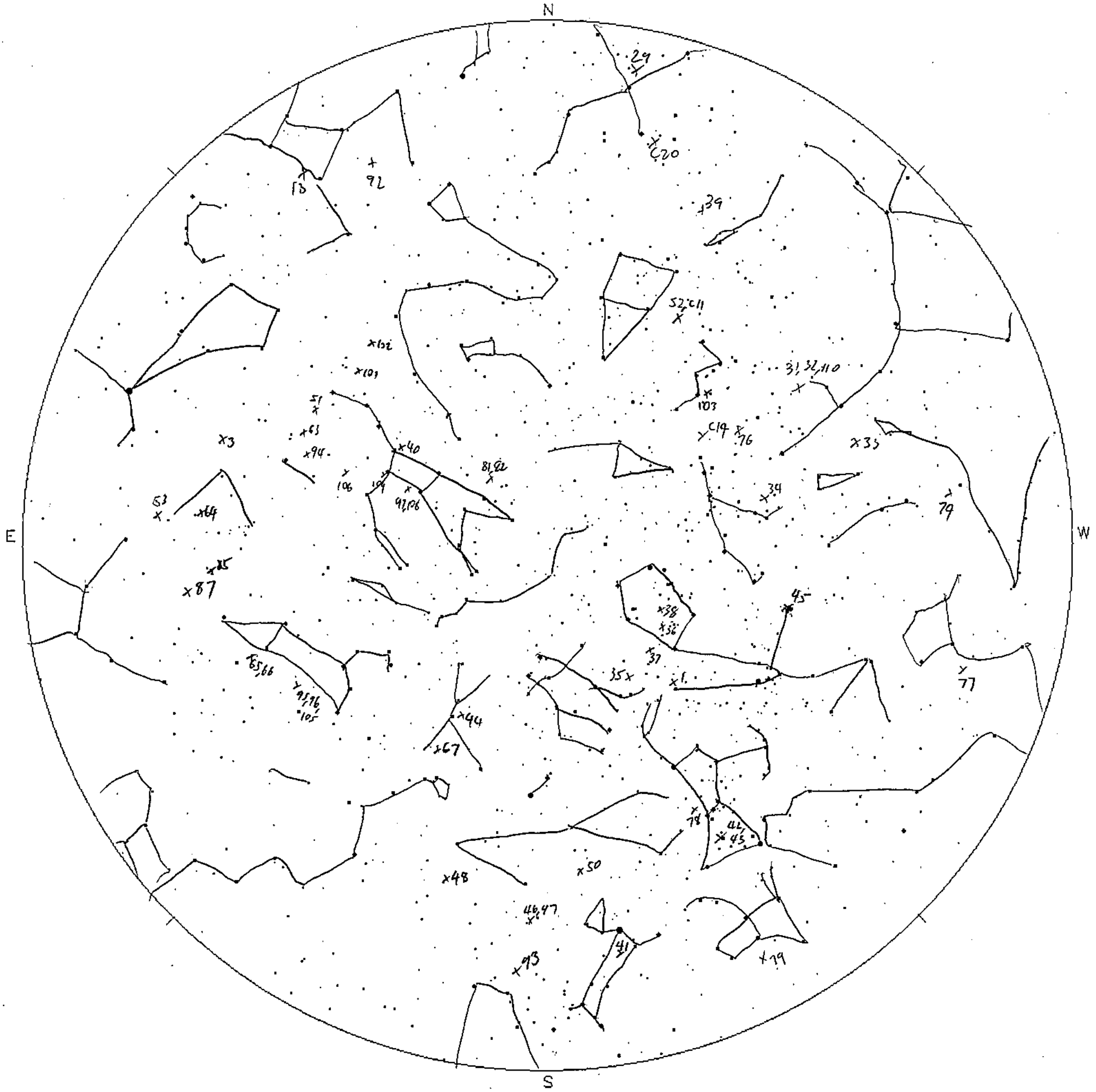
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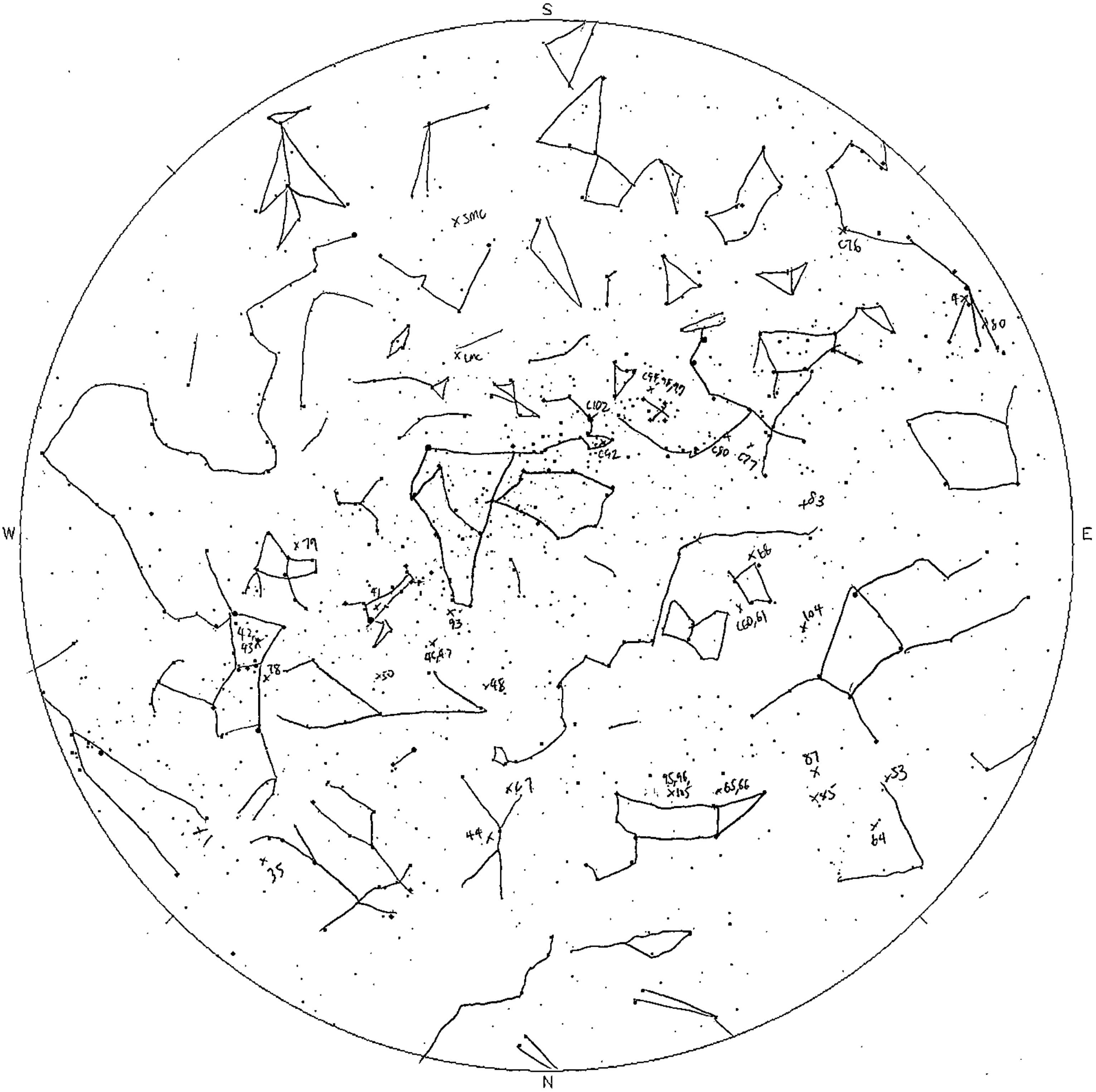
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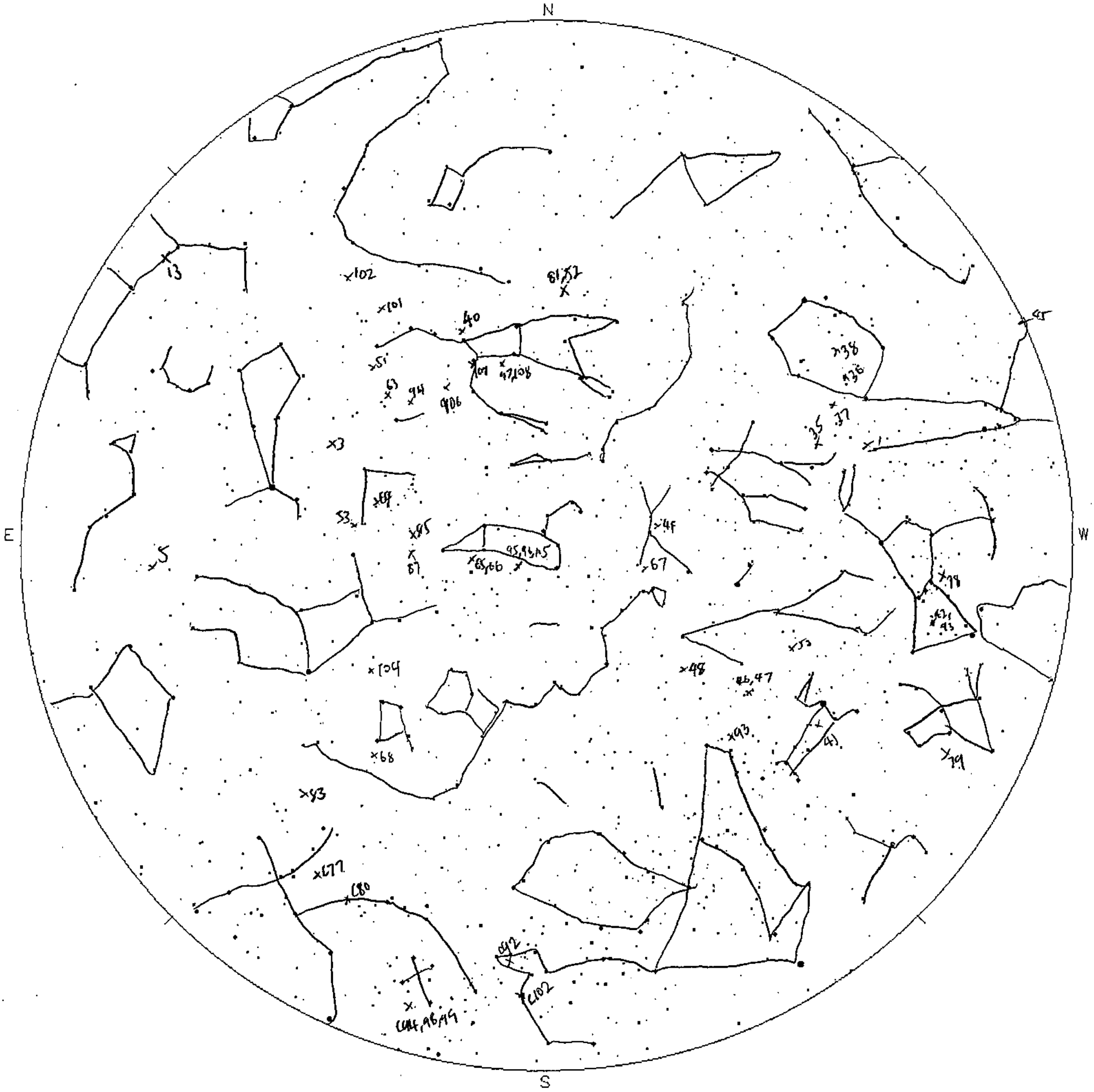
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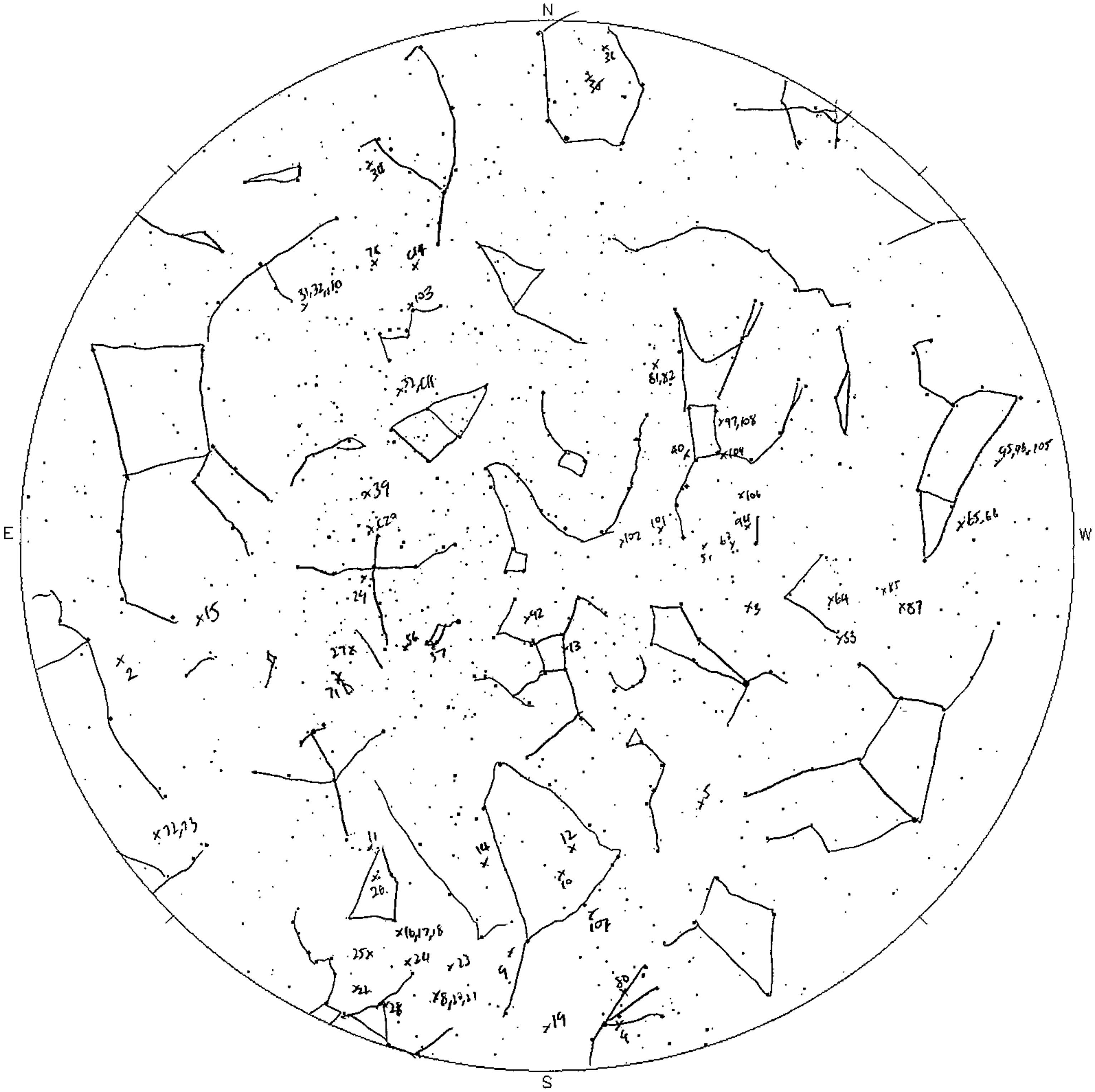
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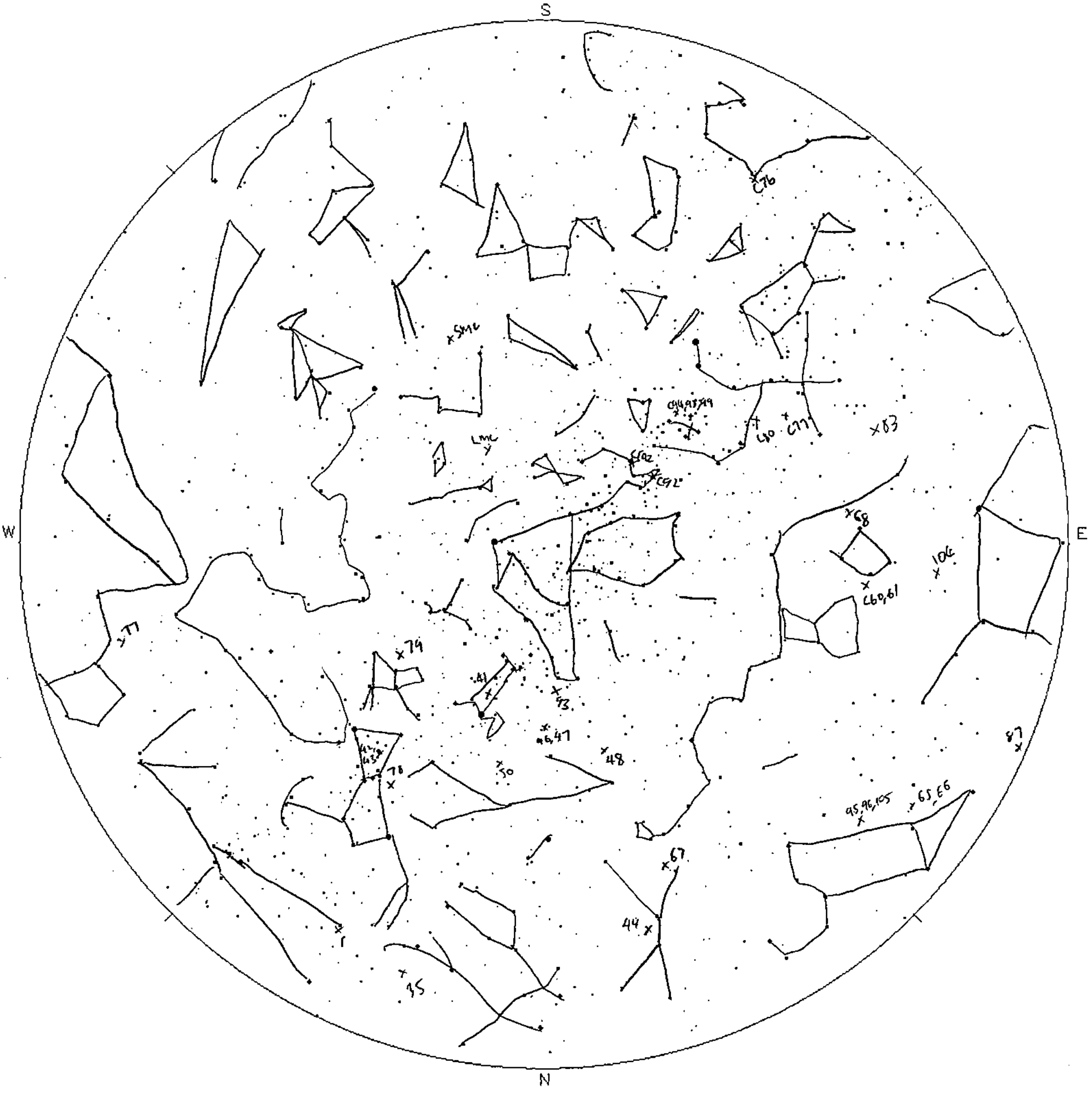
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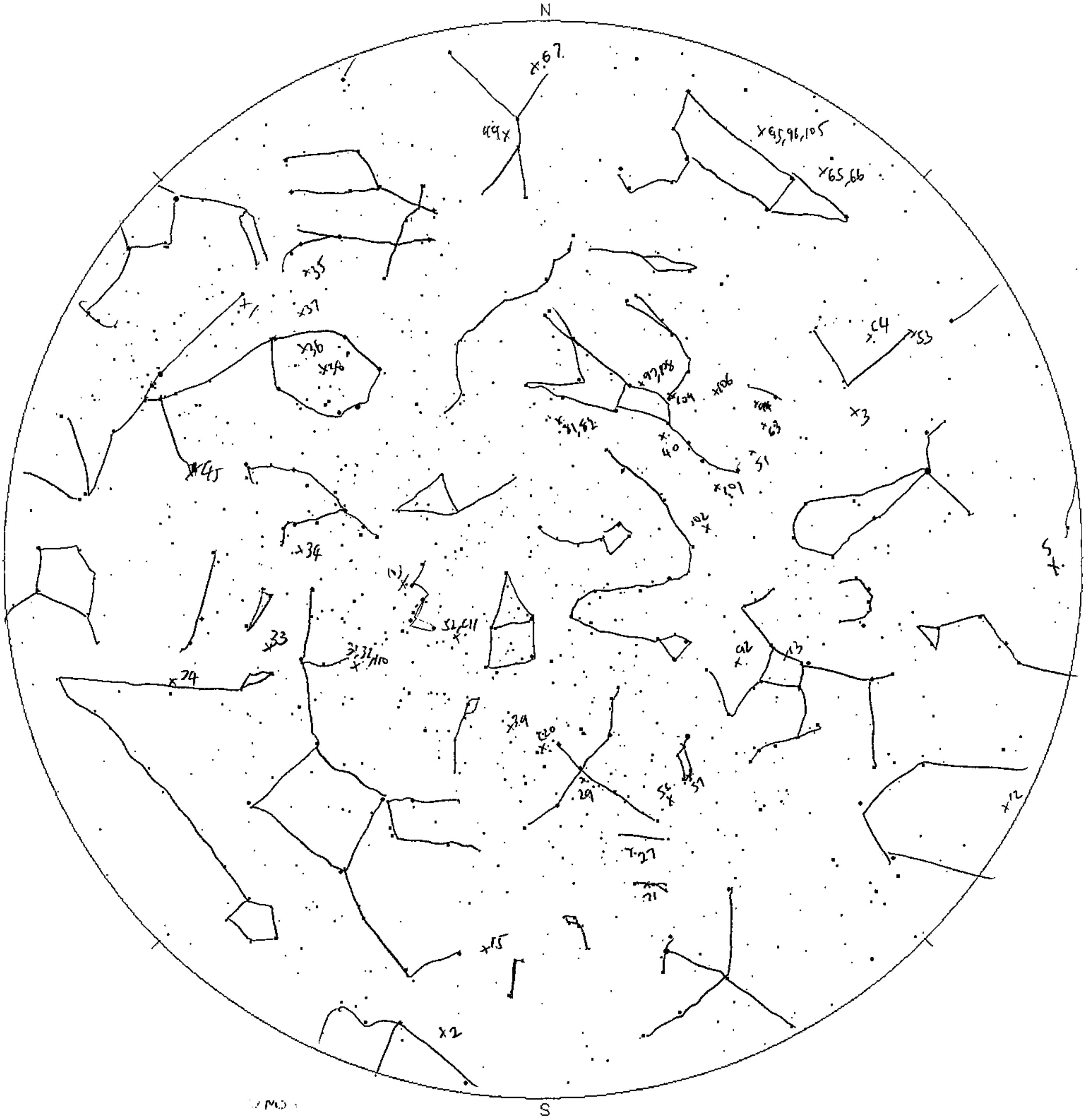
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x12
x15
x2

52
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HTSNLPMLEHRMVFDGPDDSMPAURT
101


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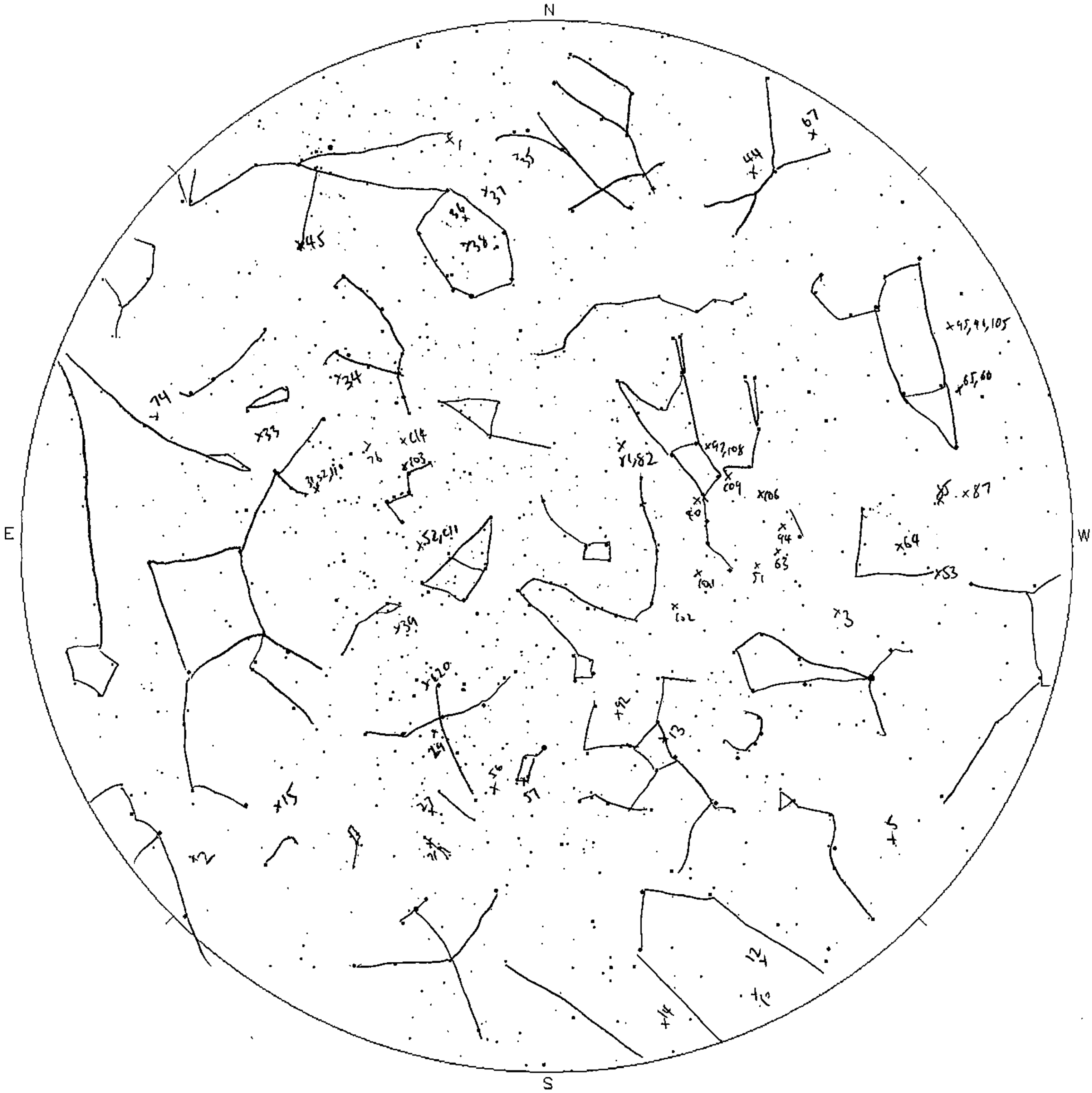
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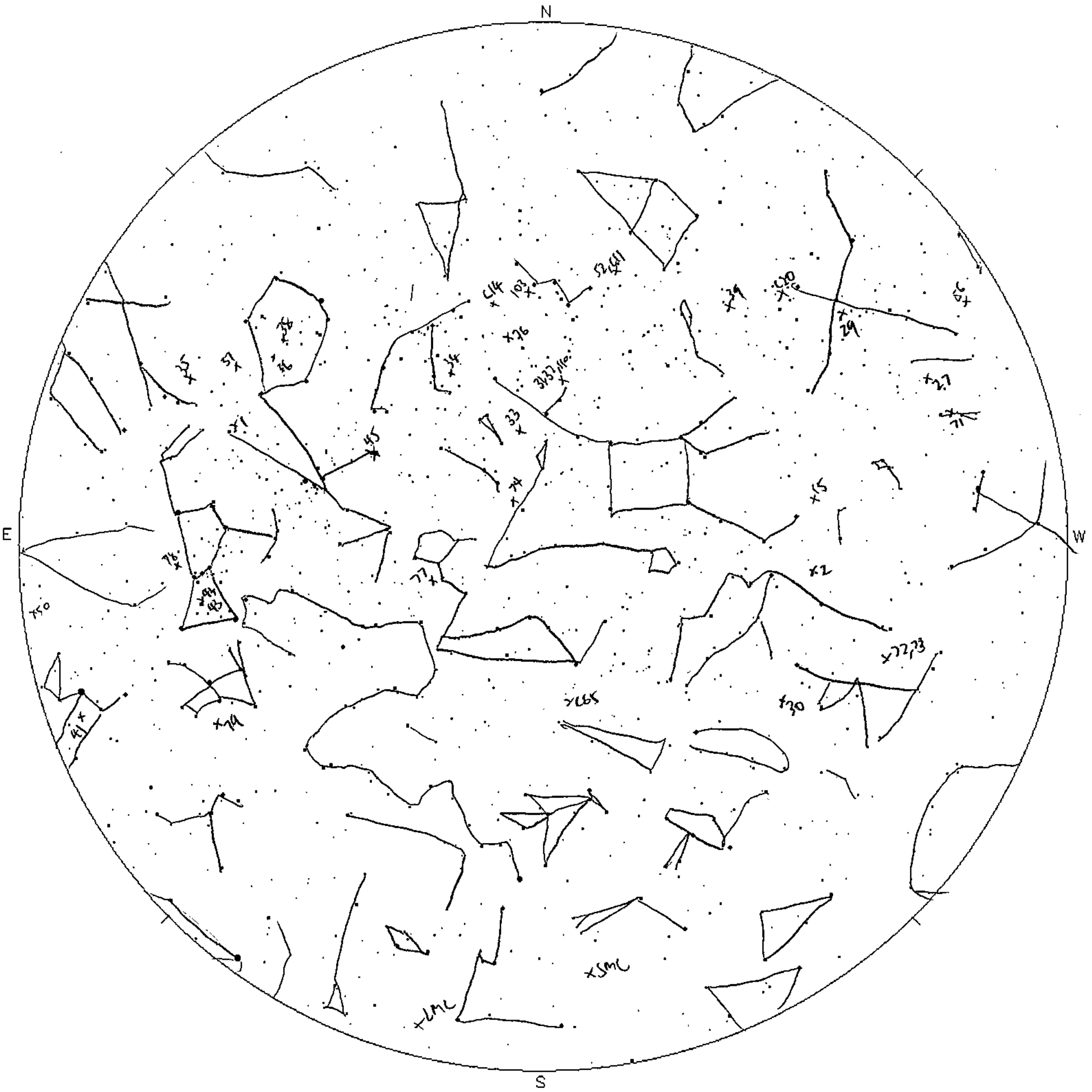
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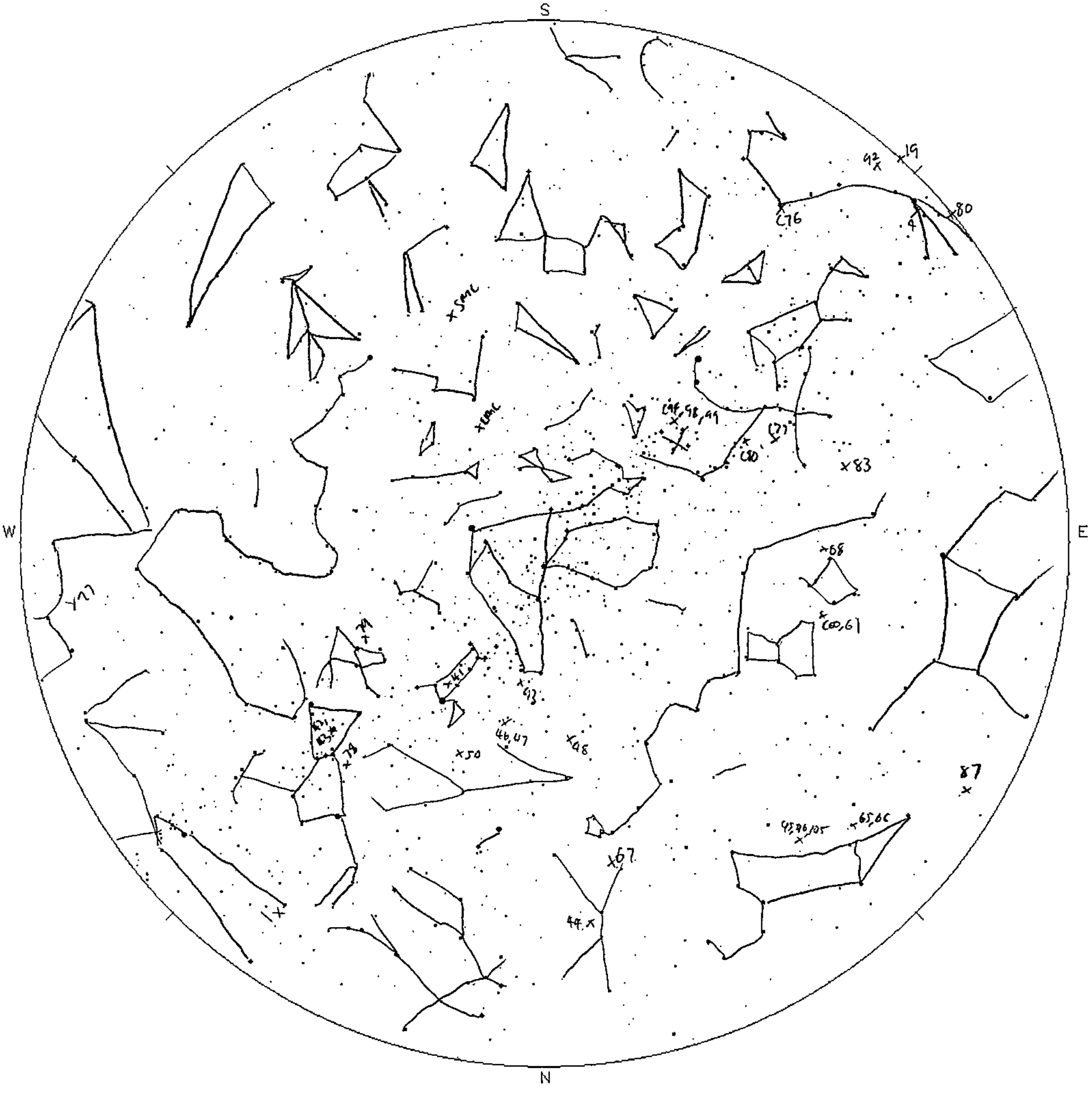
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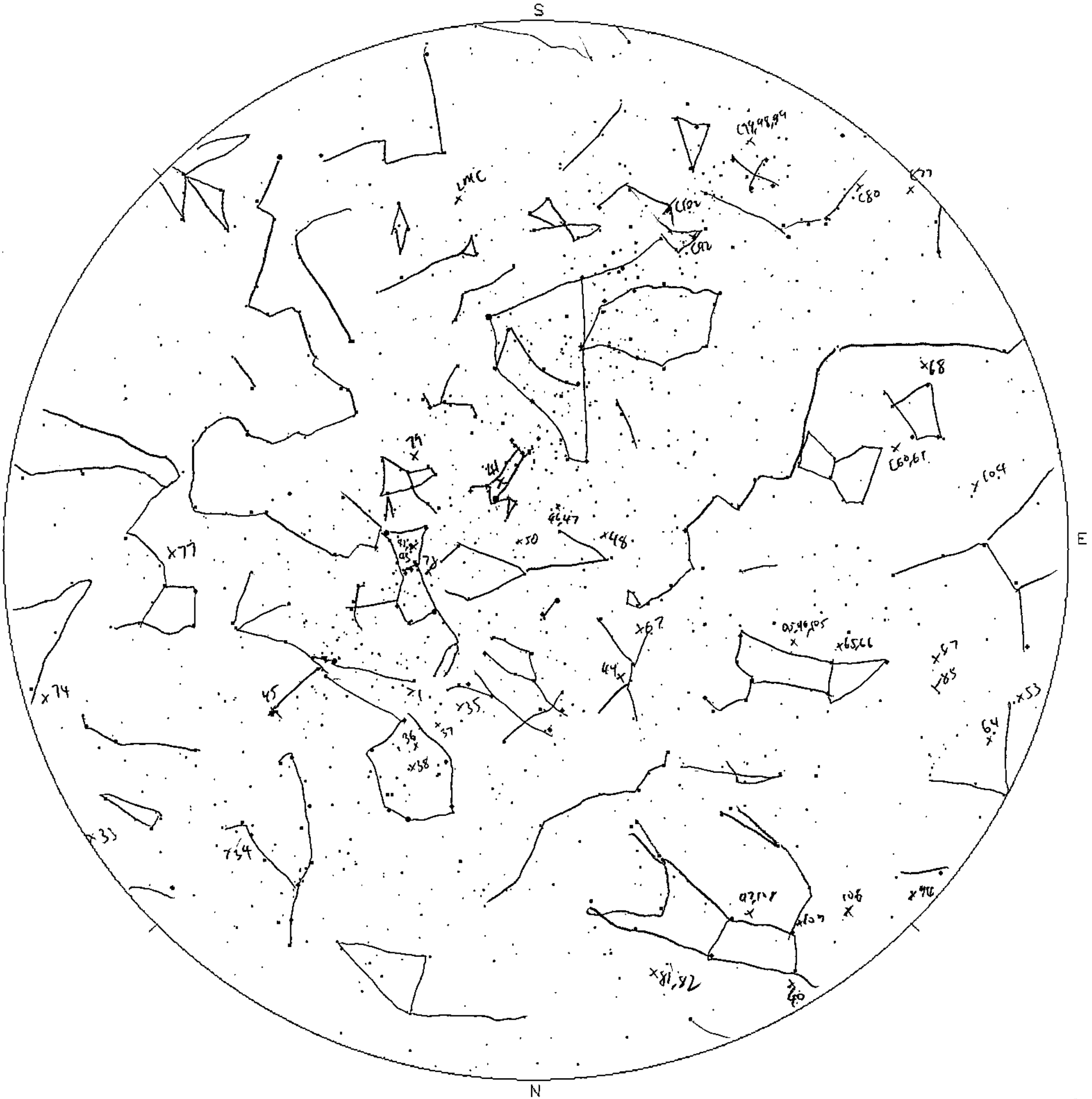
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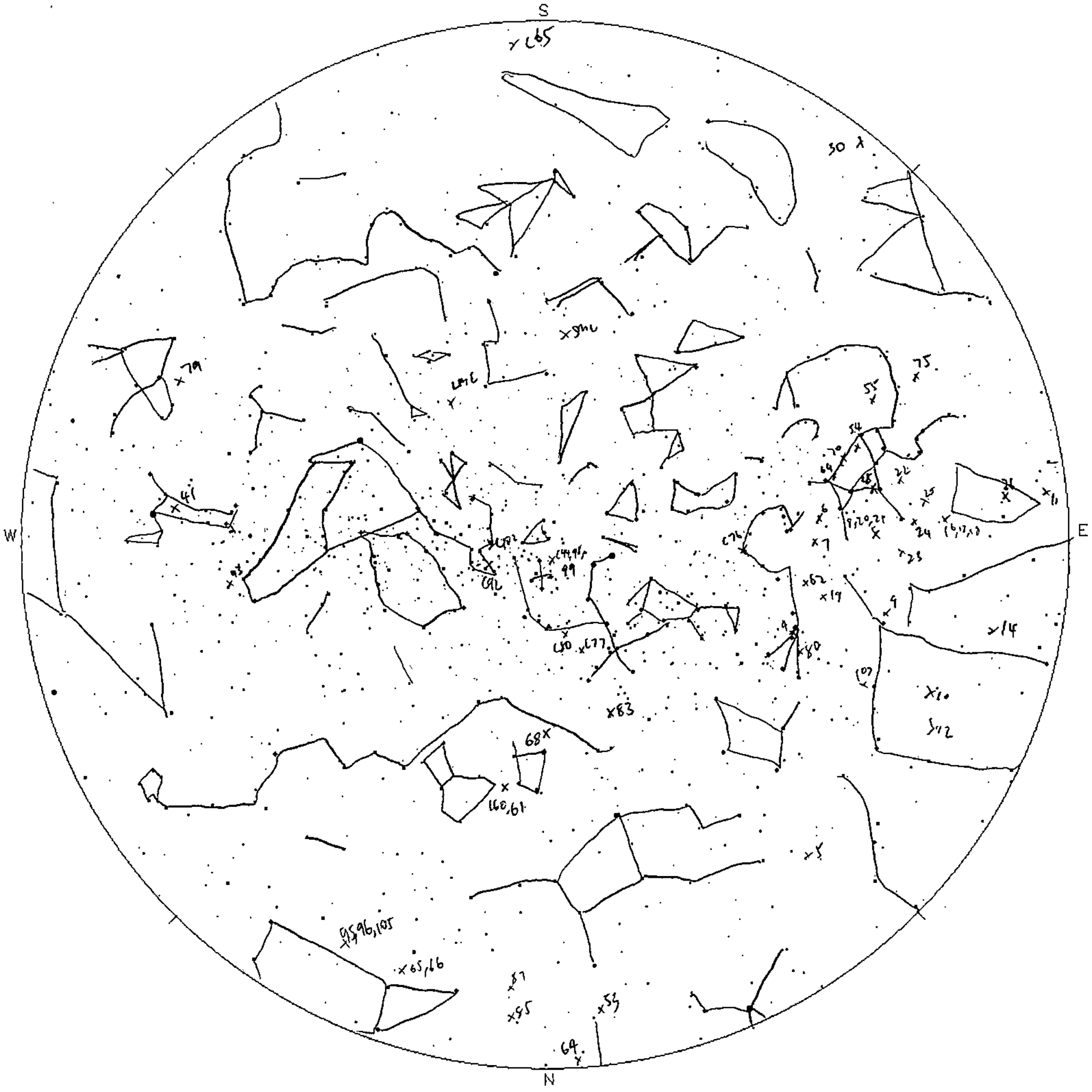
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x SMC
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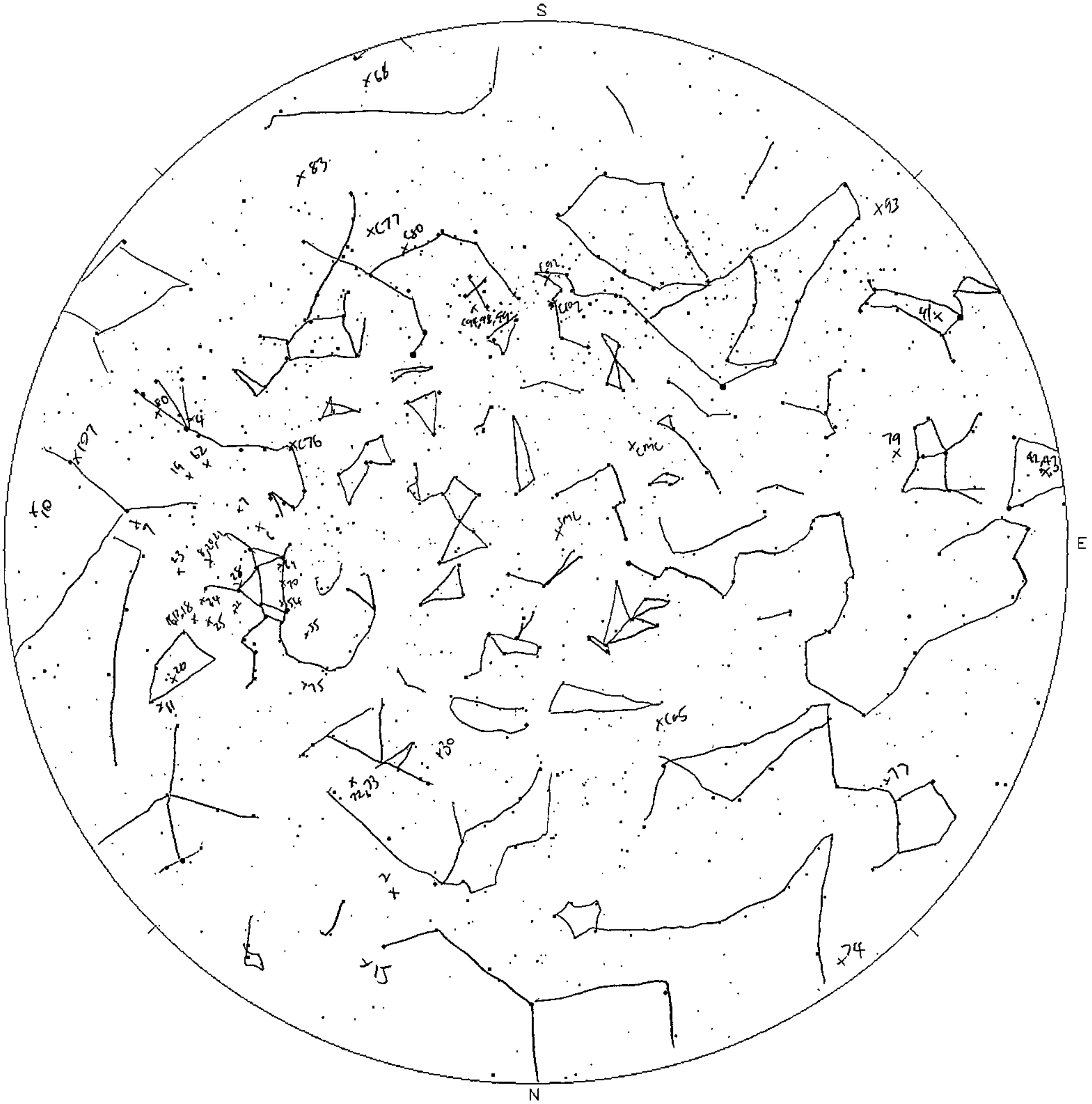
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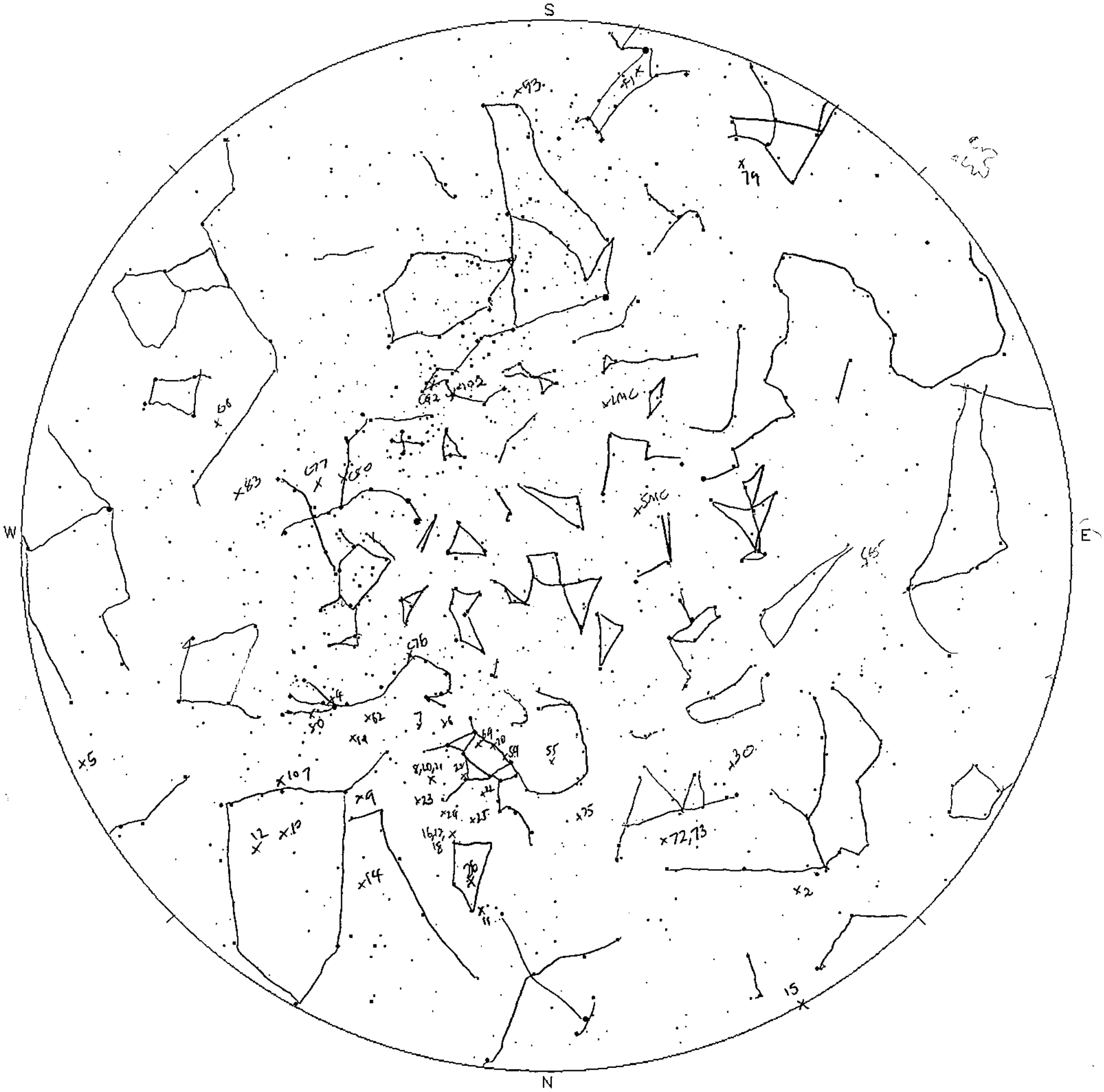
x74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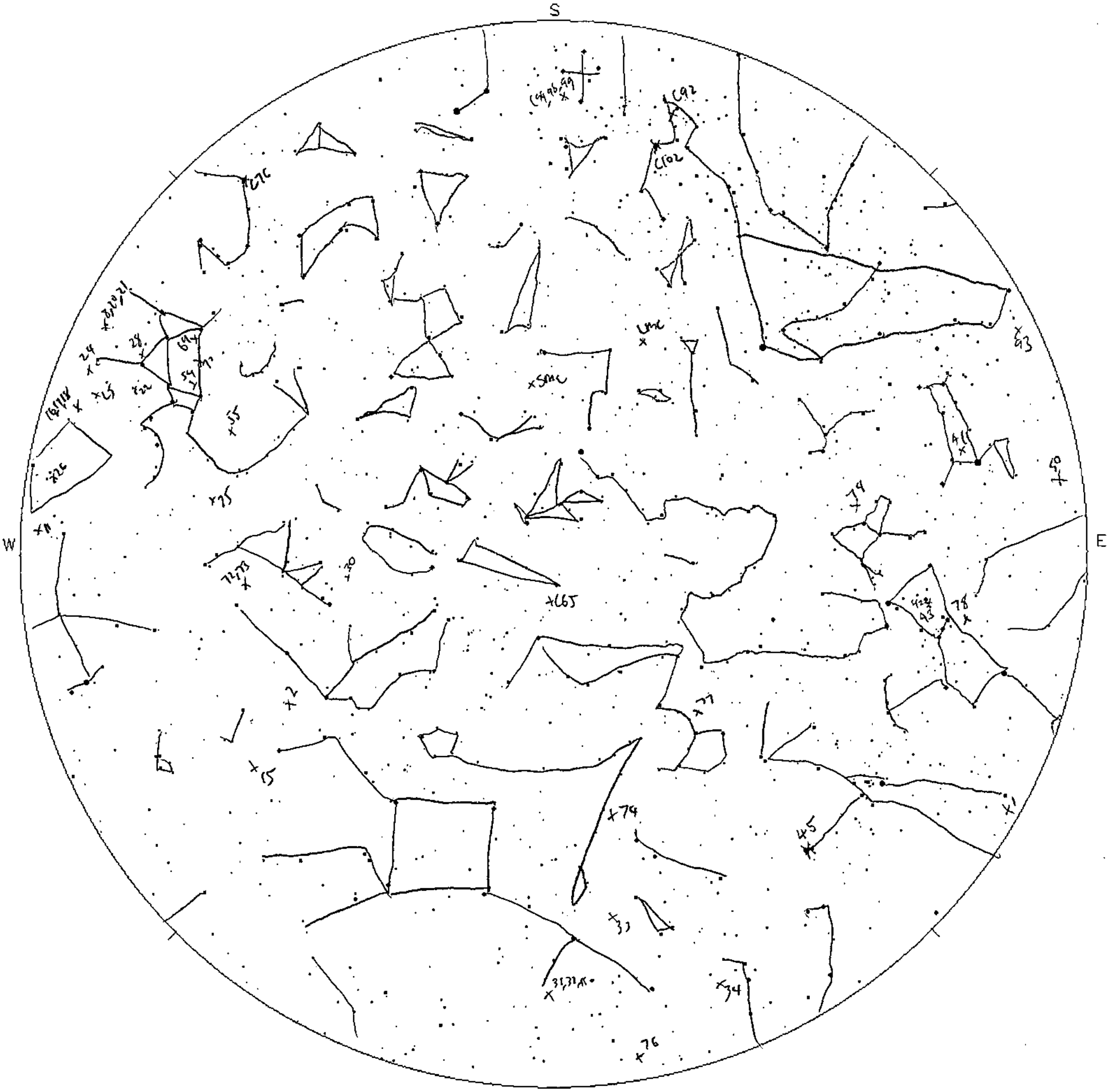
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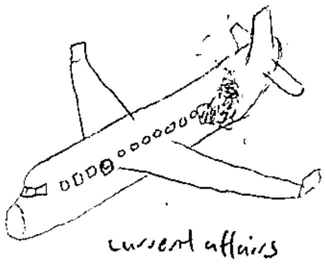
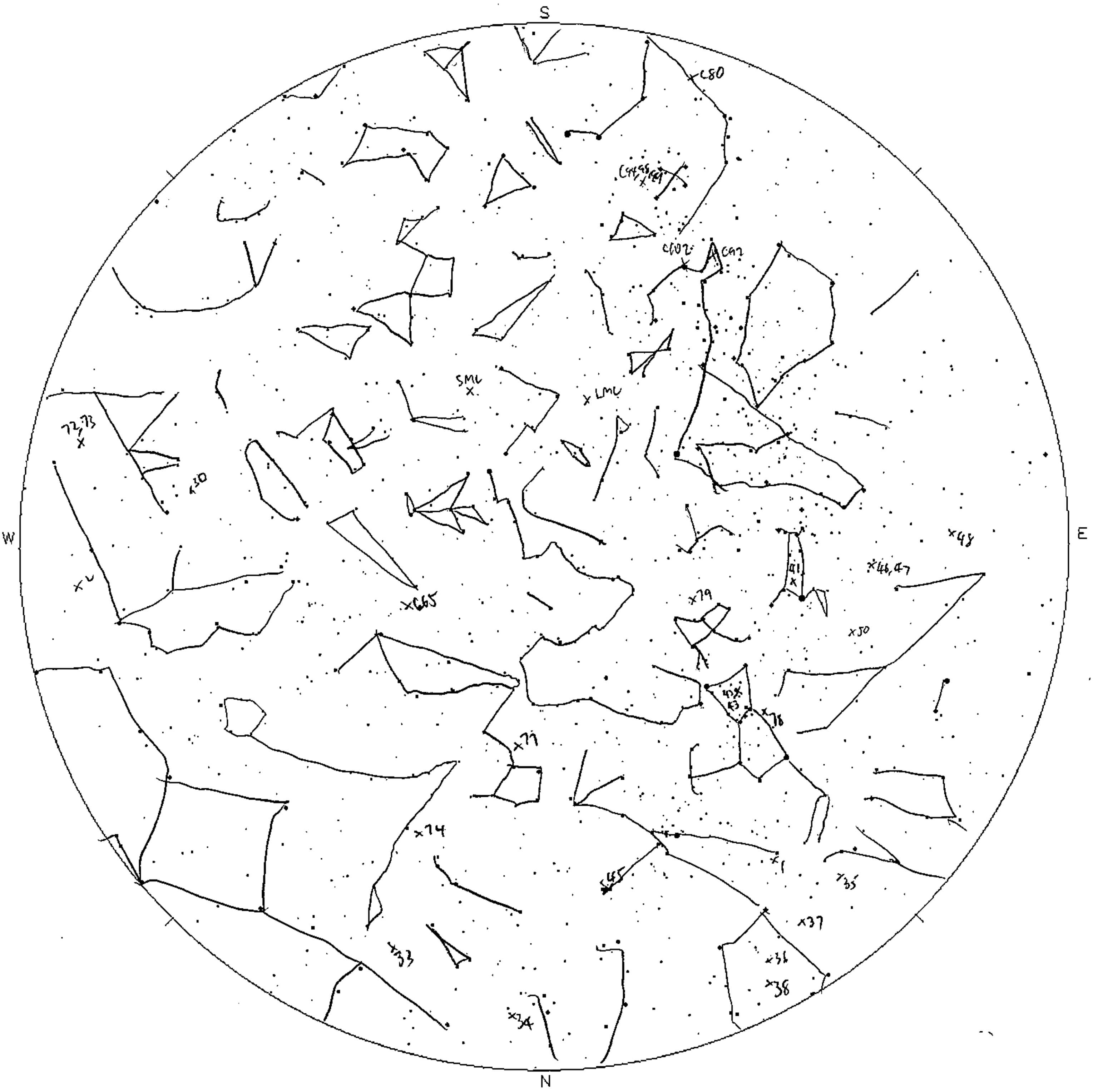


current affairs
5/1/2024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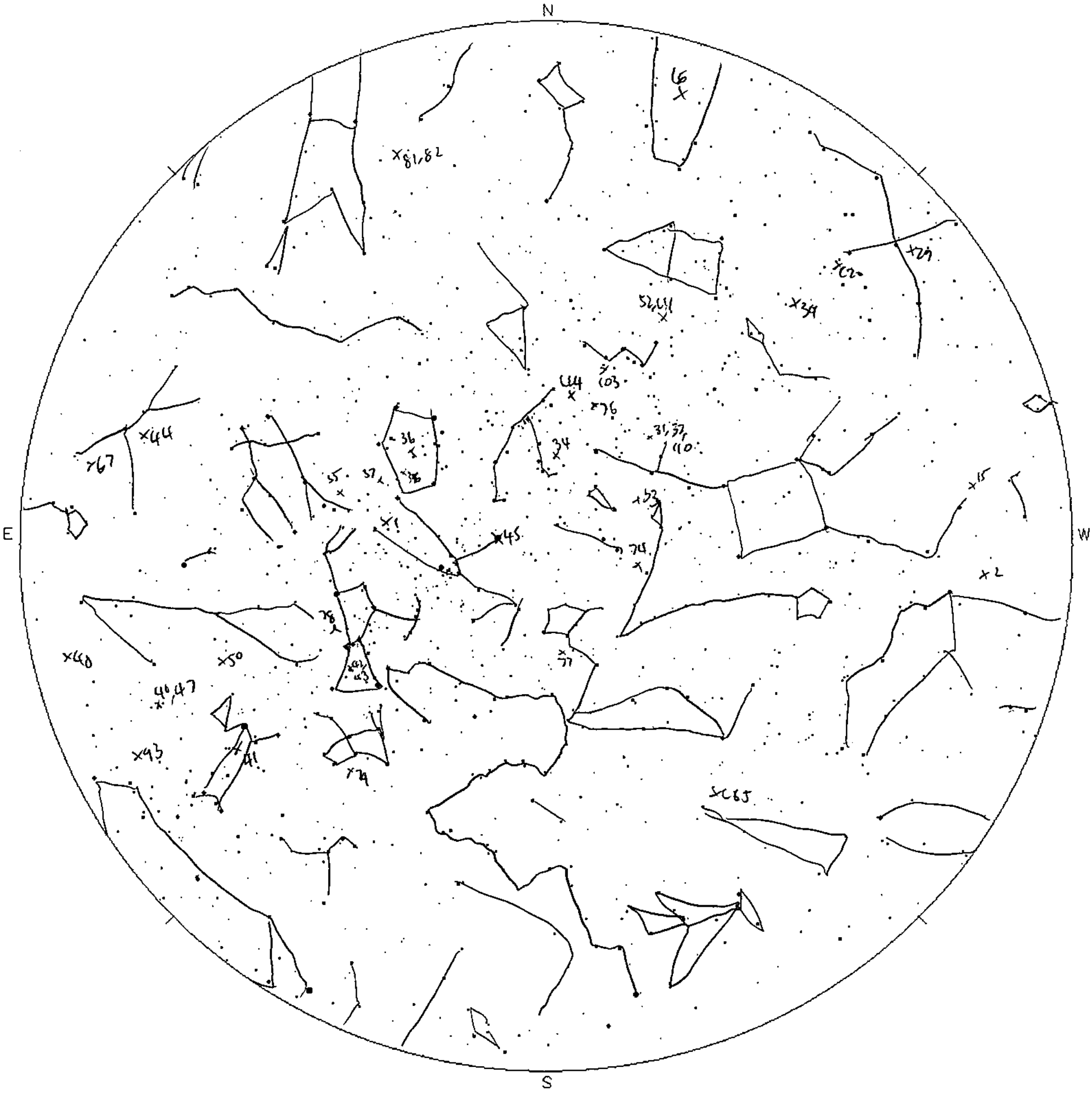
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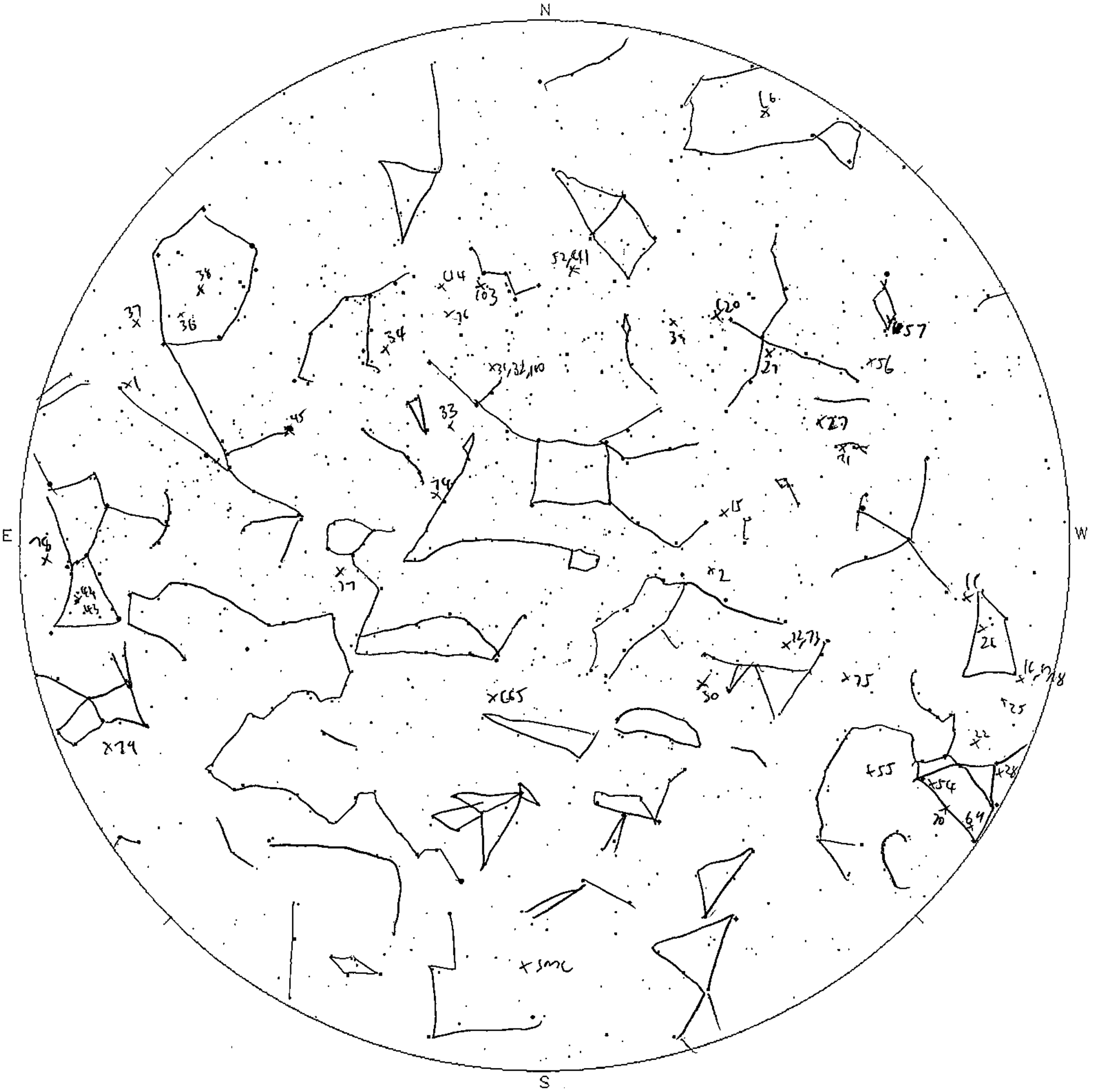
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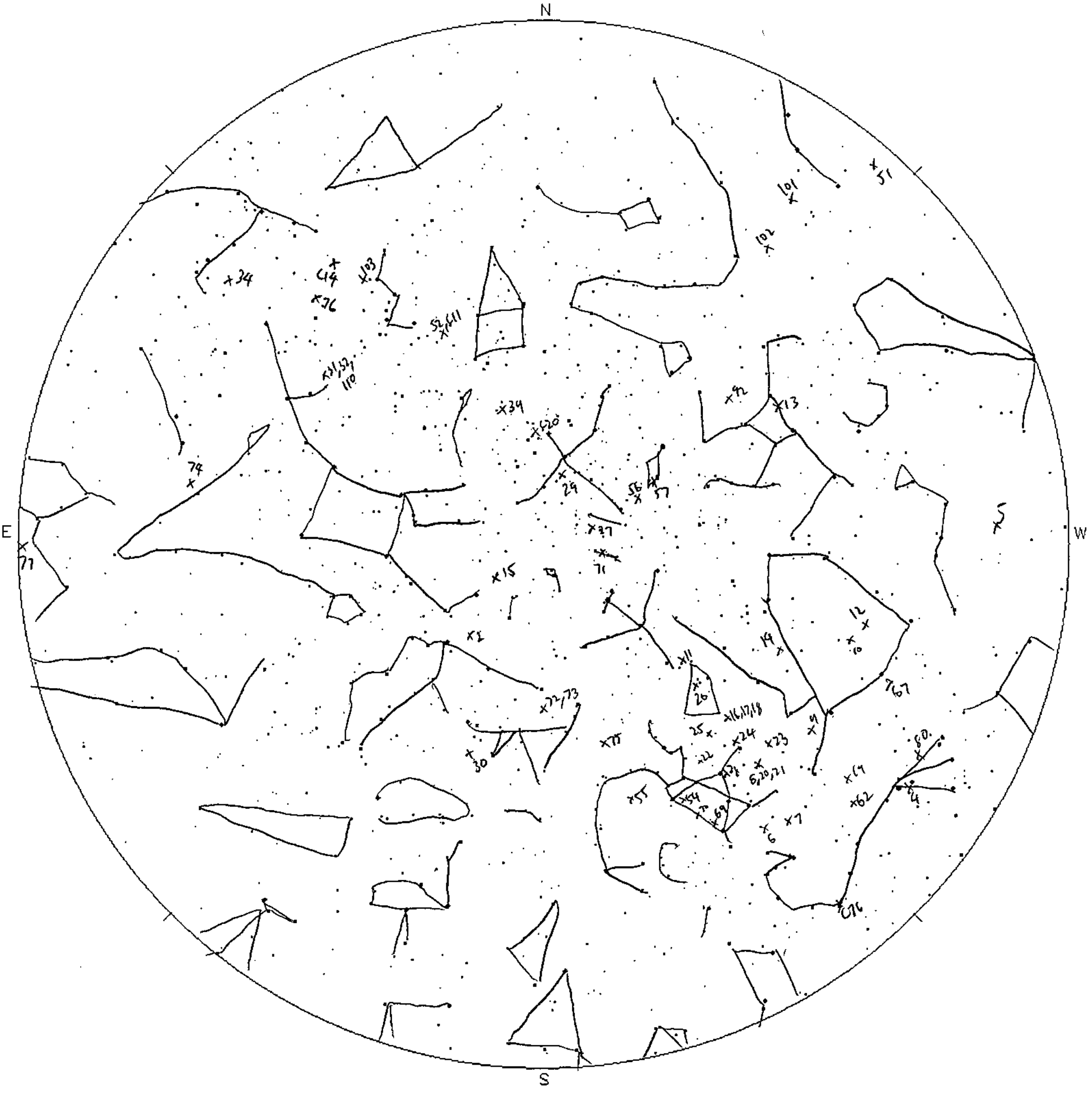
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C76


S
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x107
x10
x12
x104


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x48


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x23
x22
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x19
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x62
x75
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x6
x7
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xC76
x20
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xC80
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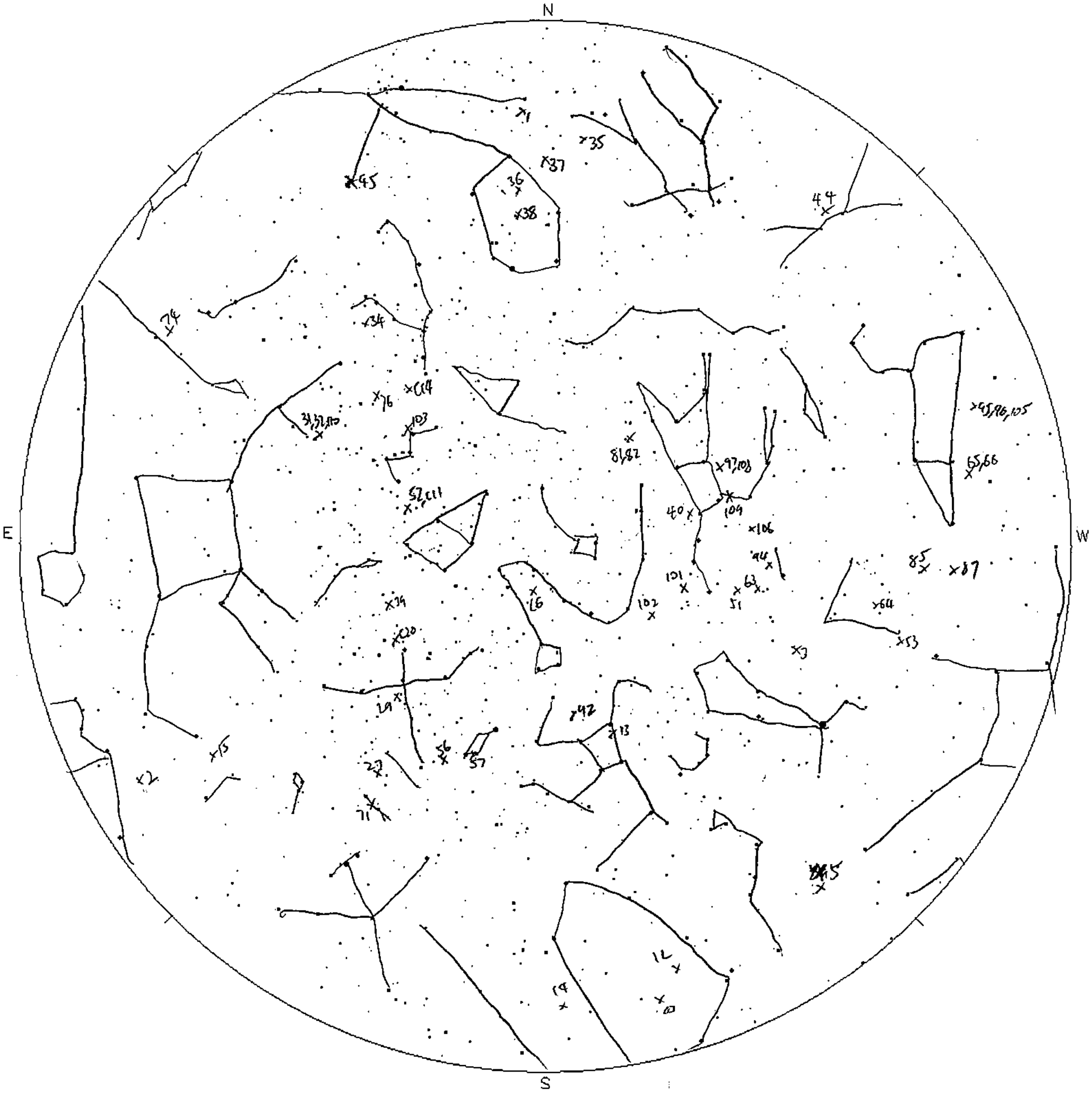
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S
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E
N
79 x
x 44
x 4447
x 43
x 48
x LMC
x SMC
C 102
C 92
x C 94, 98, 99
C 80
x C 77
x 83
x C 60, 61
65 x
CAW
104 x
C 76
69
x 7
54
55 x
75 x
x 30
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x 6
x 7
24
22 x
x 62
3, 20, 21 x
x 24
x 25
23 x
x 15, 16, 17, 18
x 26
x 11
4
x 50
x 19
x 9
127 x
x 14
x 10
x 12


S
W
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N
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C80
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99
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C76
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41
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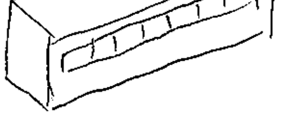


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x51
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x102
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103
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52 C11
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x74
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x27
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x15
x2
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x13
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x
12
x
x
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x
x107
11
x
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9 x
x72,73 x
x30
x78
x25
x24
x23
x22
x28
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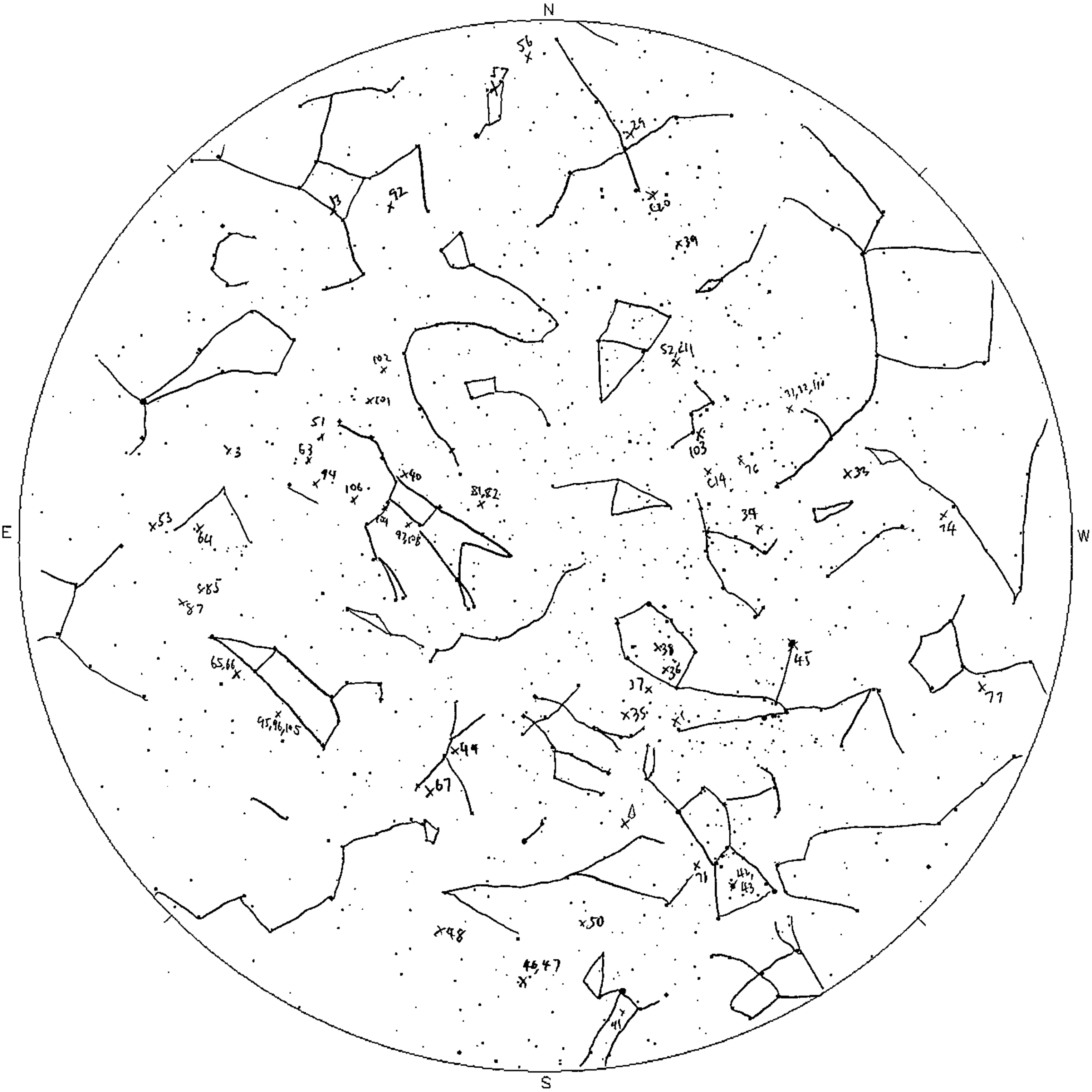
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C14
x33
x53
64
104
97,108
39
74
W
E
x85
x87
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95,96,105
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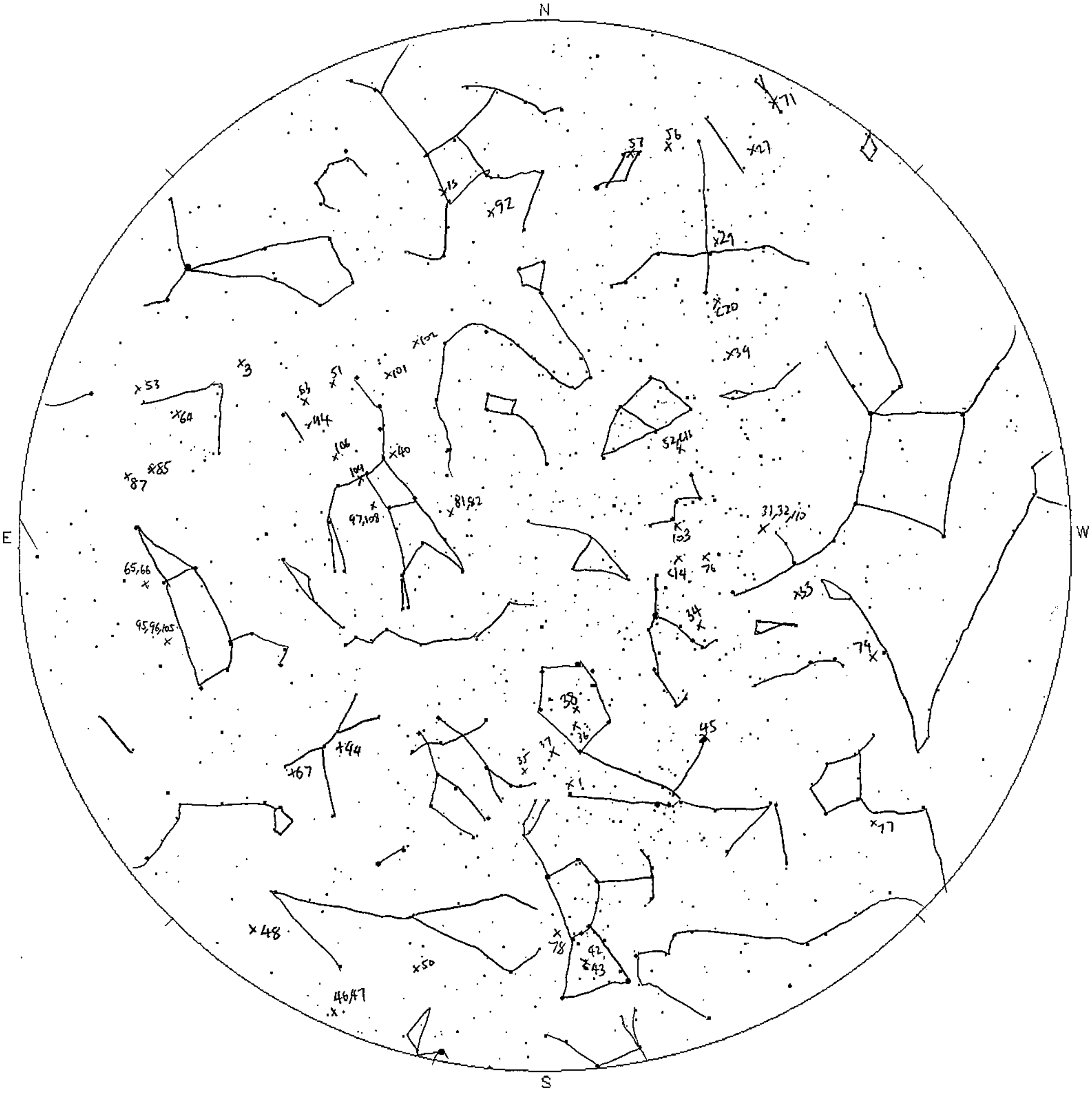
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46/47

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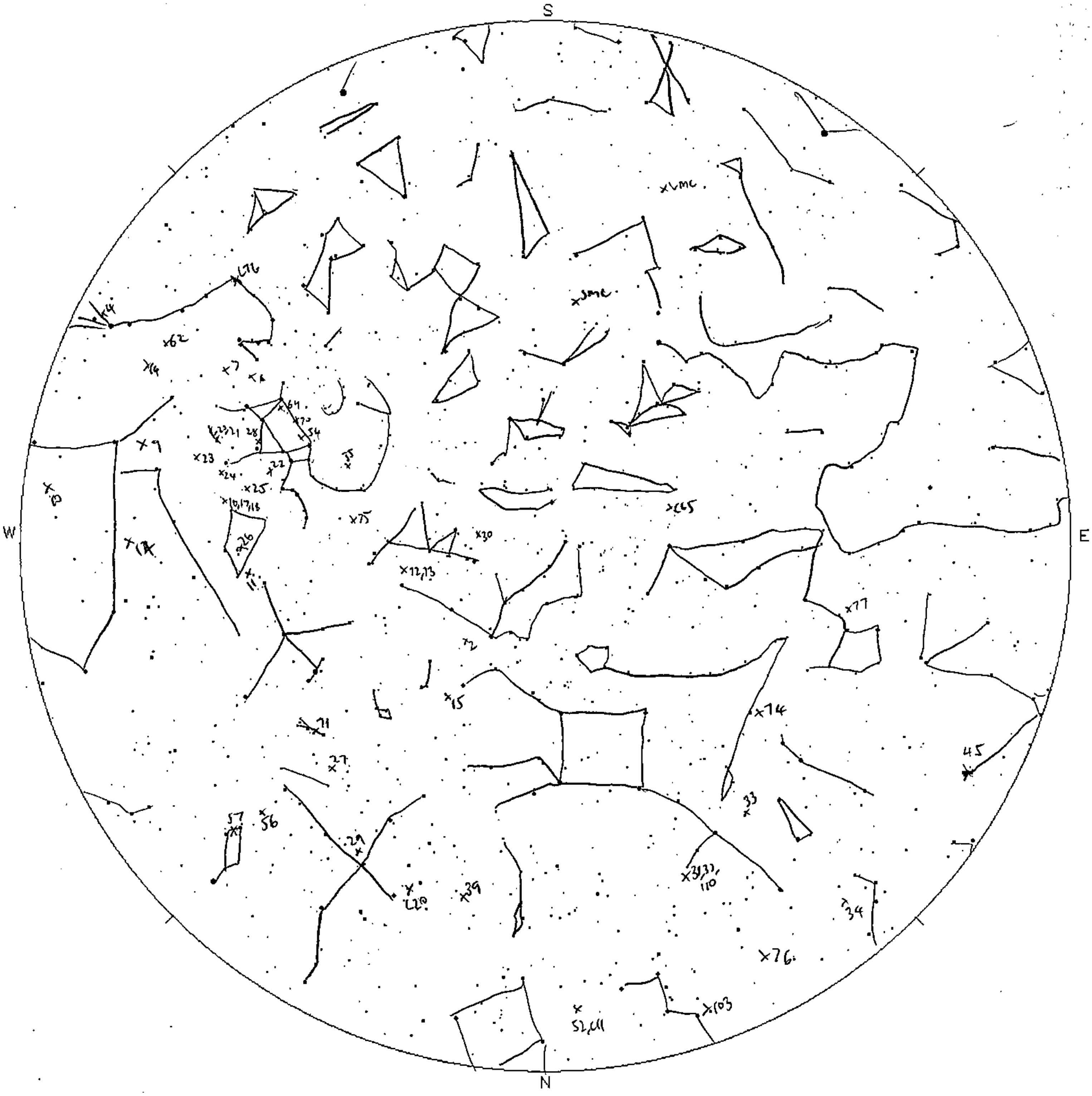
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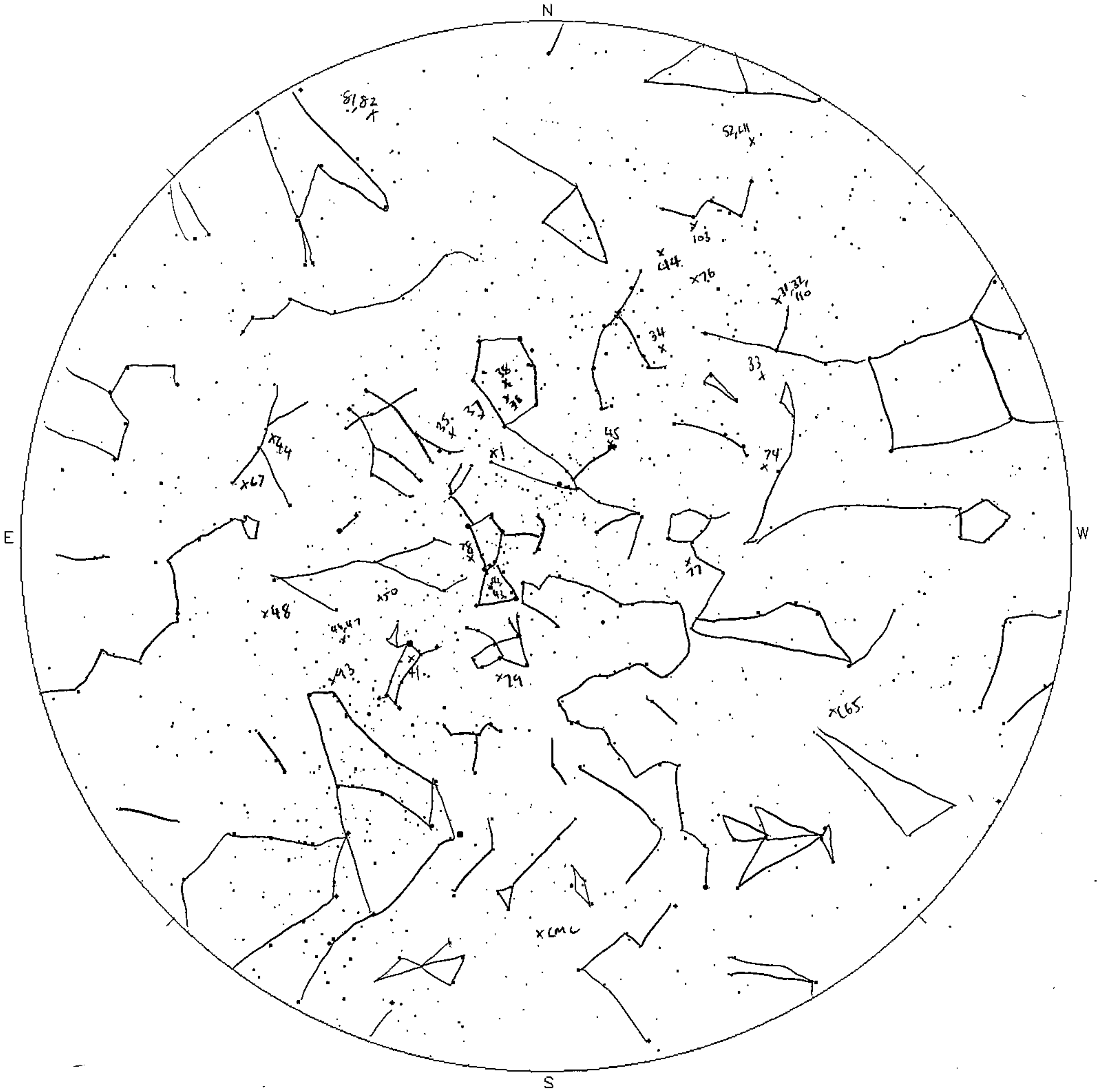
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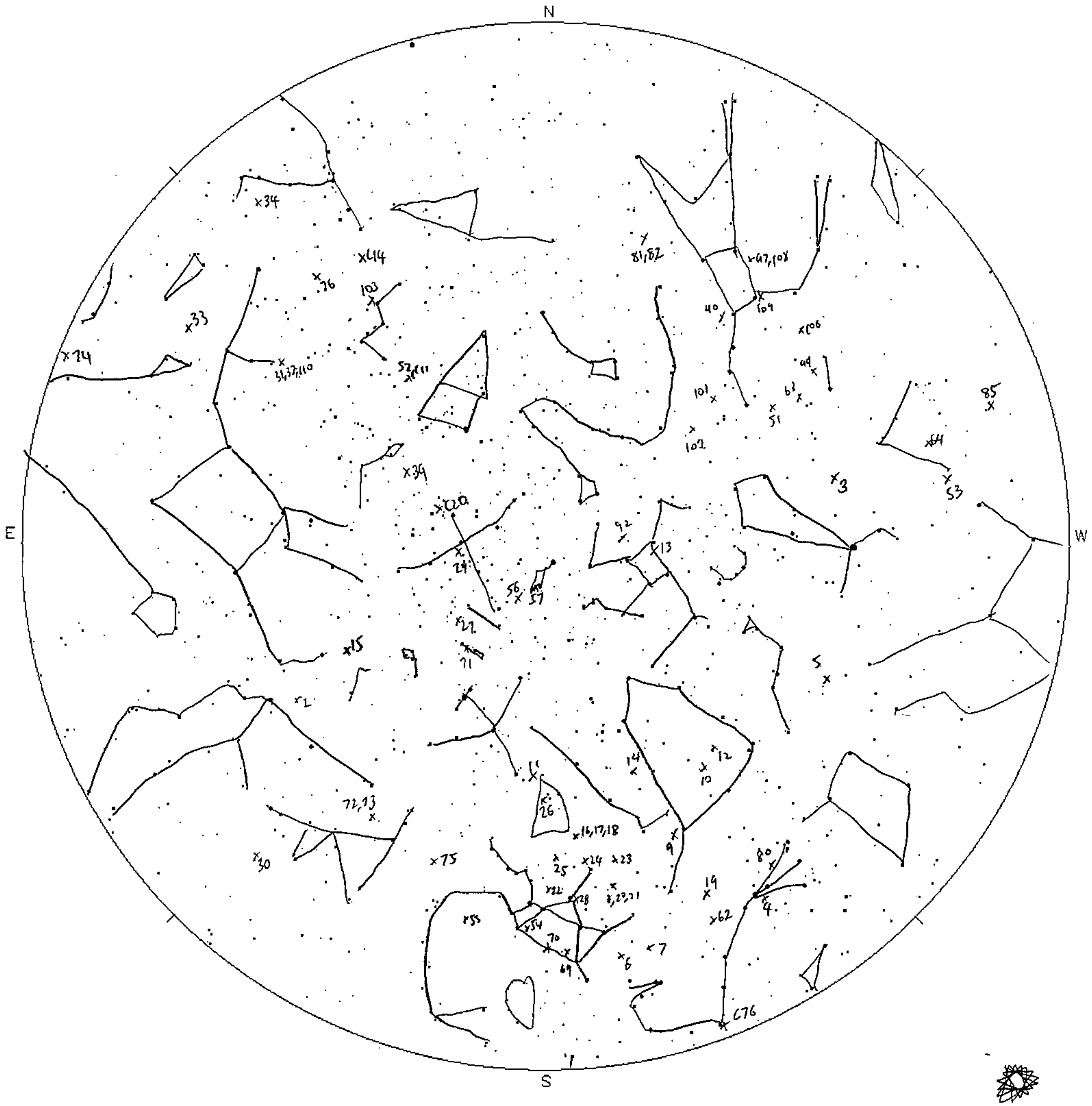
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8,20,21
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x3
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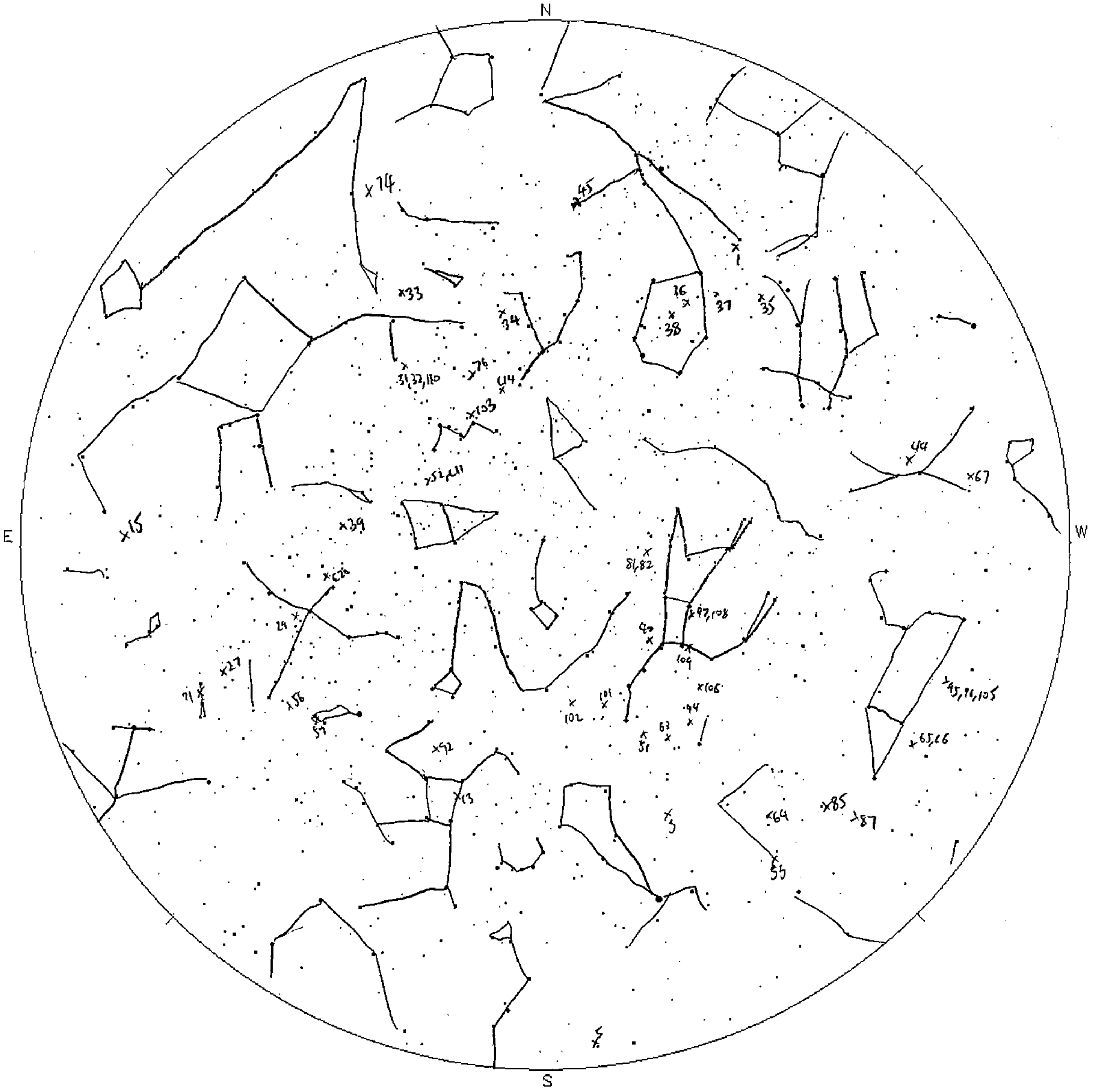
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x39
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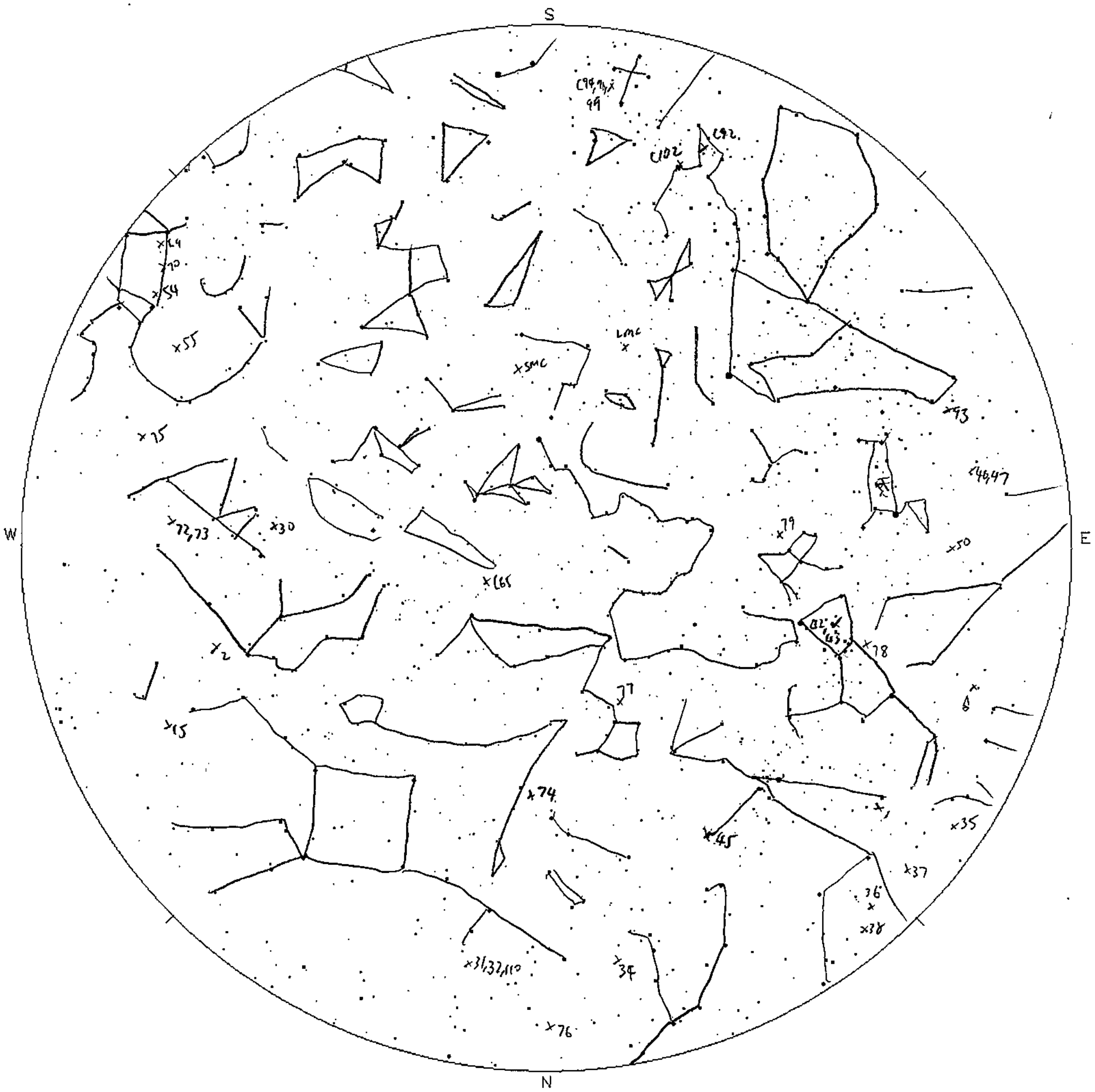
north pole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x 75
x 72,73
x 30
x 65
x 79
82, 63
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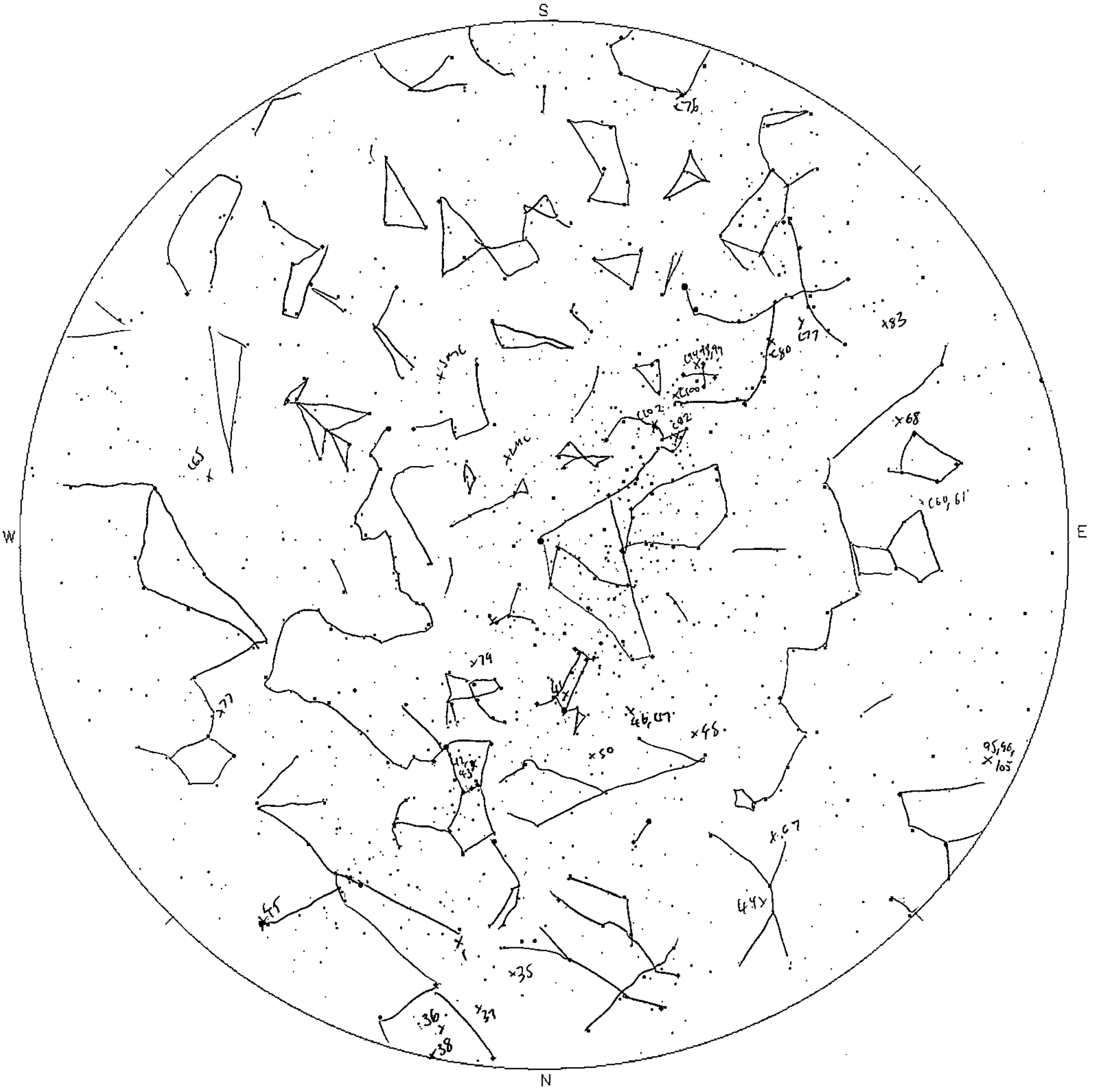
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x48
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x1
x35
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x37
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N


S
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W
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C102
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SMC
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C76
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x62
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C80
C76
C99,98,99
C92
C102


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x101
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x44
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59
x 97/108
x3
x64
53 x
x55
x 87
x61/66
x95/41/105
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x67
x38
x76
37 x
35 x
x1
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x 78
42 x 43
x50
x48
x104
C26/61 x
x68
46/47 x
x93
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x79
x83
x C77
x C50
x C69,96, 99
x C92
x C102
S


S
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x LMC
x C65
SMC x
C102
C92
C94, 98, 99
C50 x
x C27
x83
x(60,61
68 x
104 x
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x2
C16
x62
x7
x6
x4
x4
x107
x12 x10
x14
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26 x
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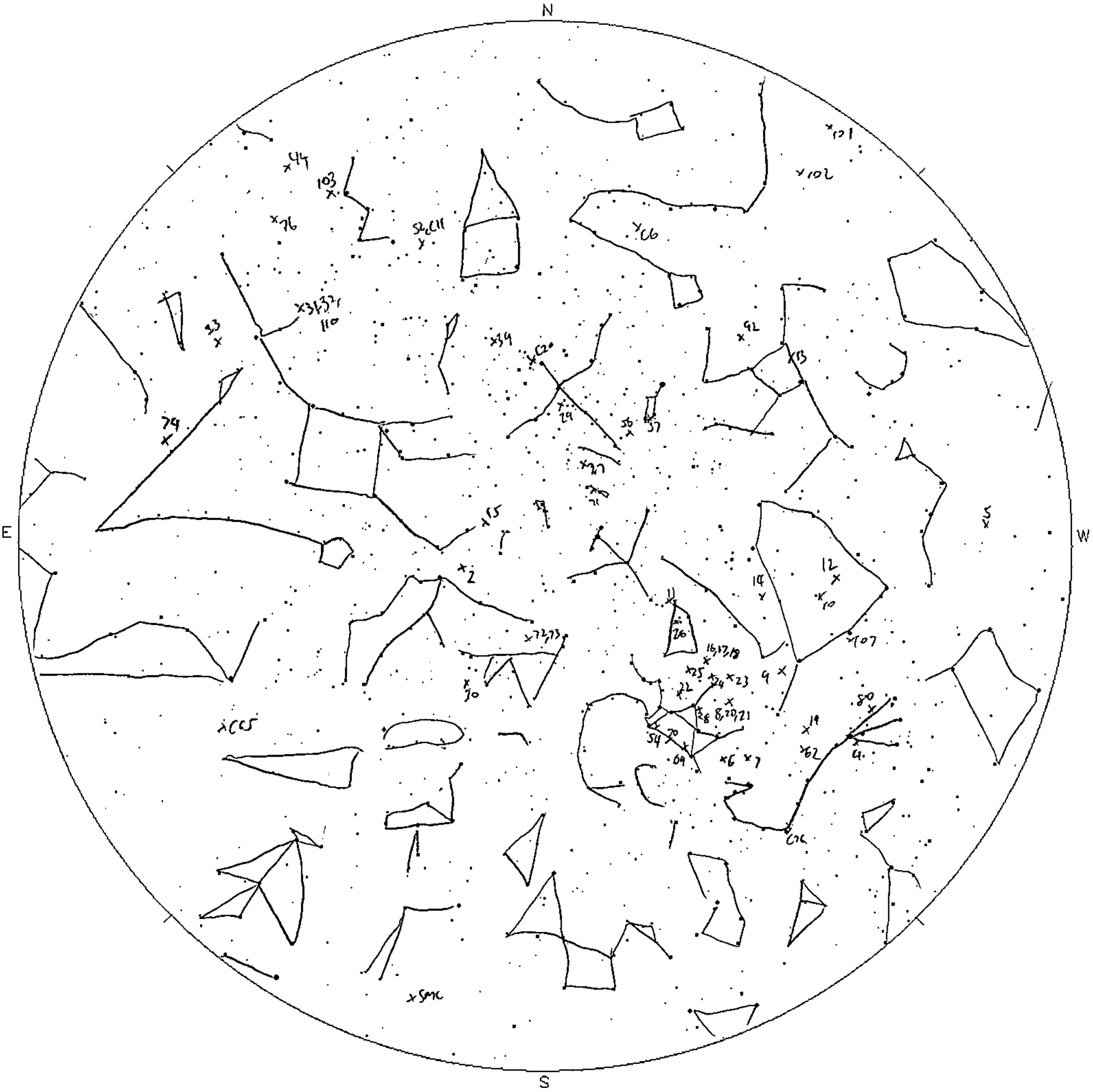
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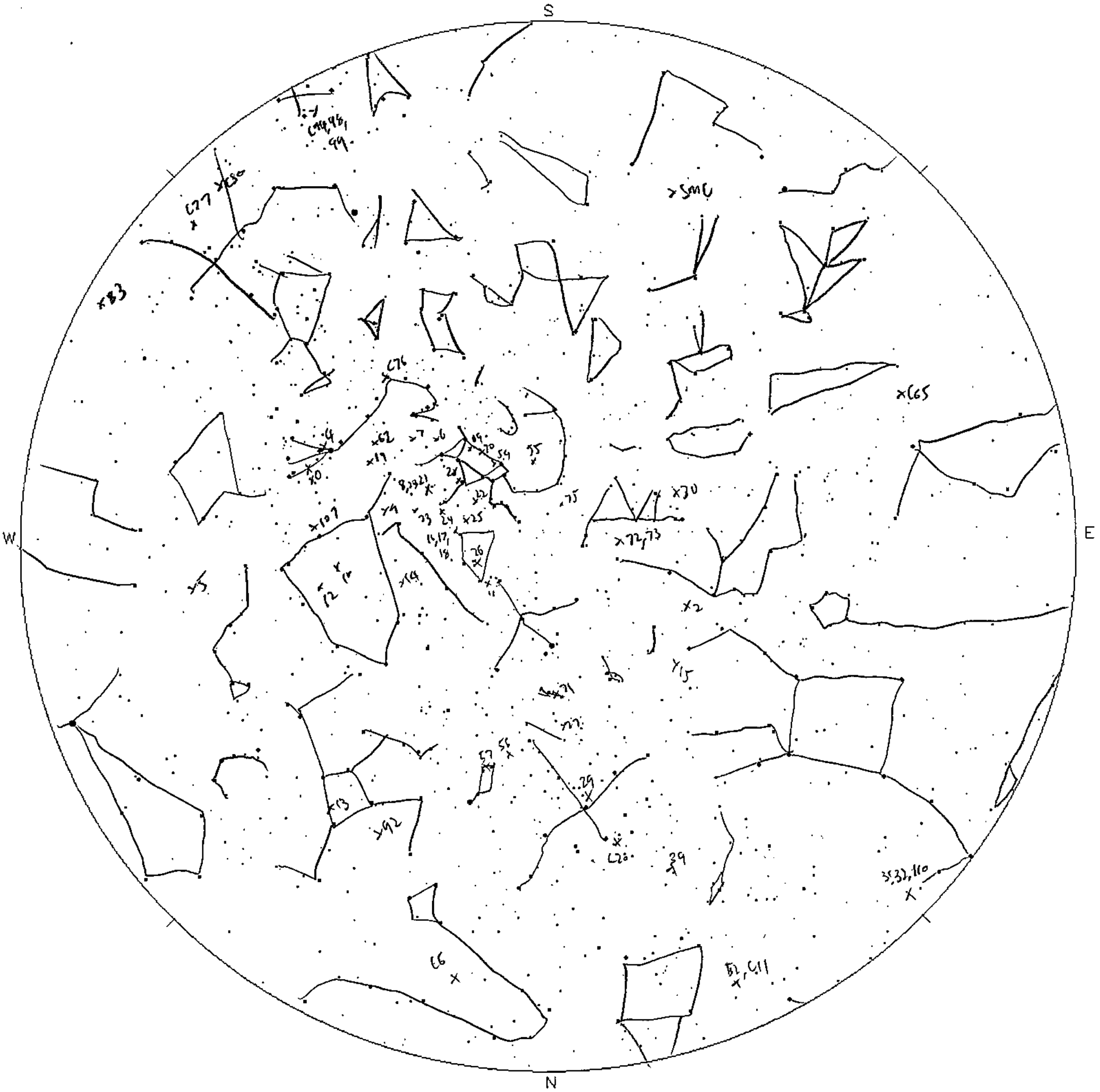
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C6
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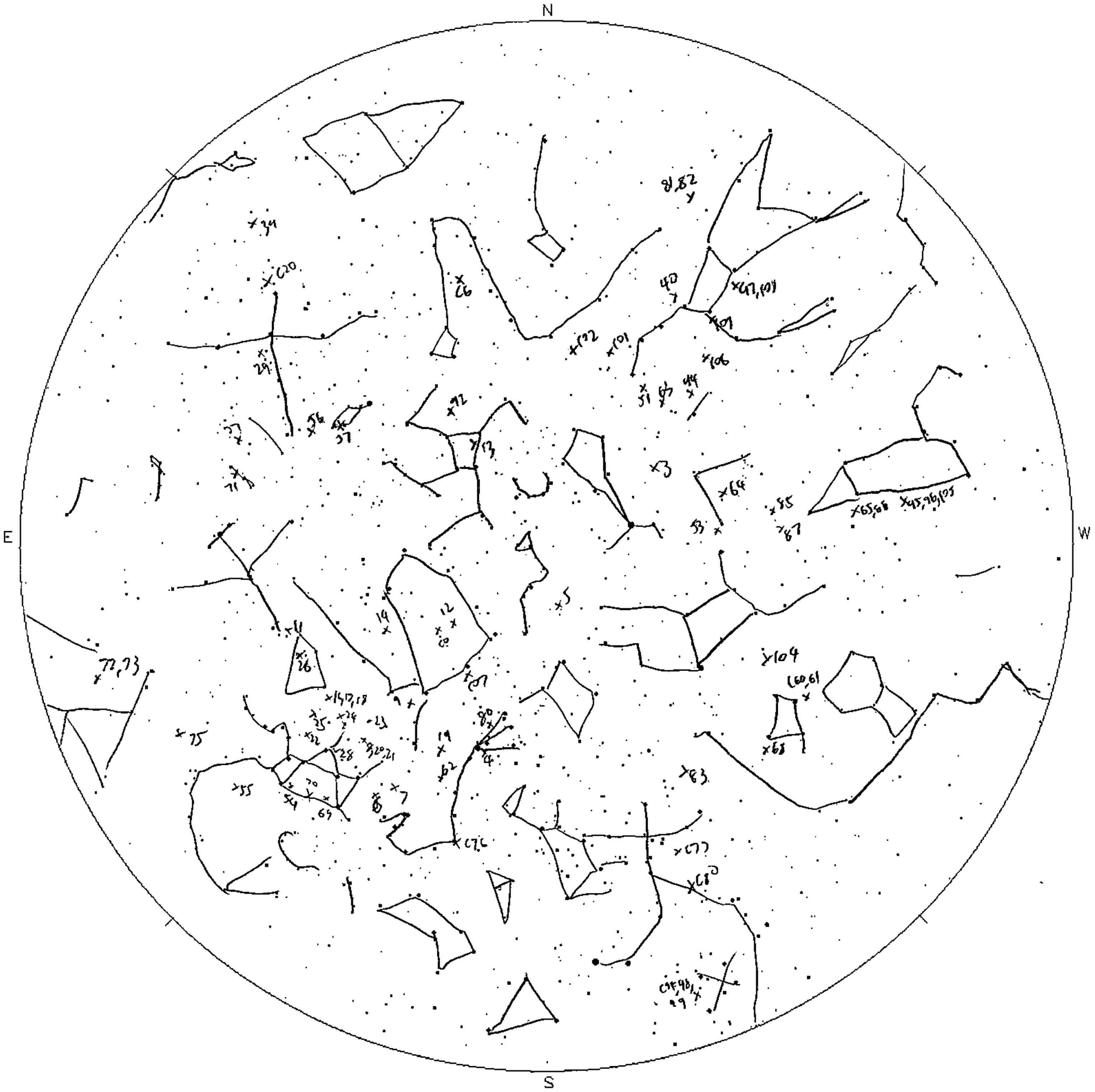
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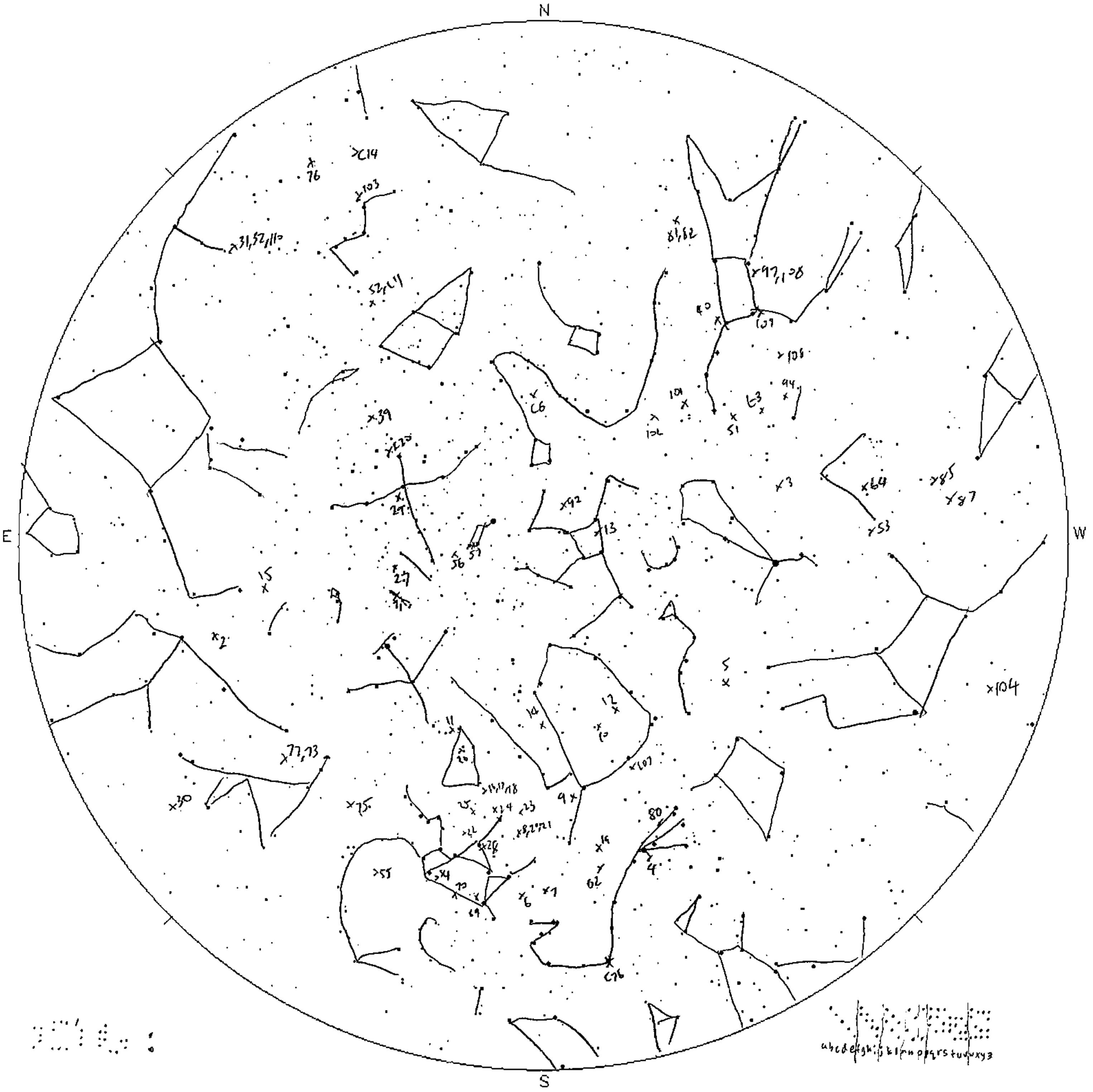

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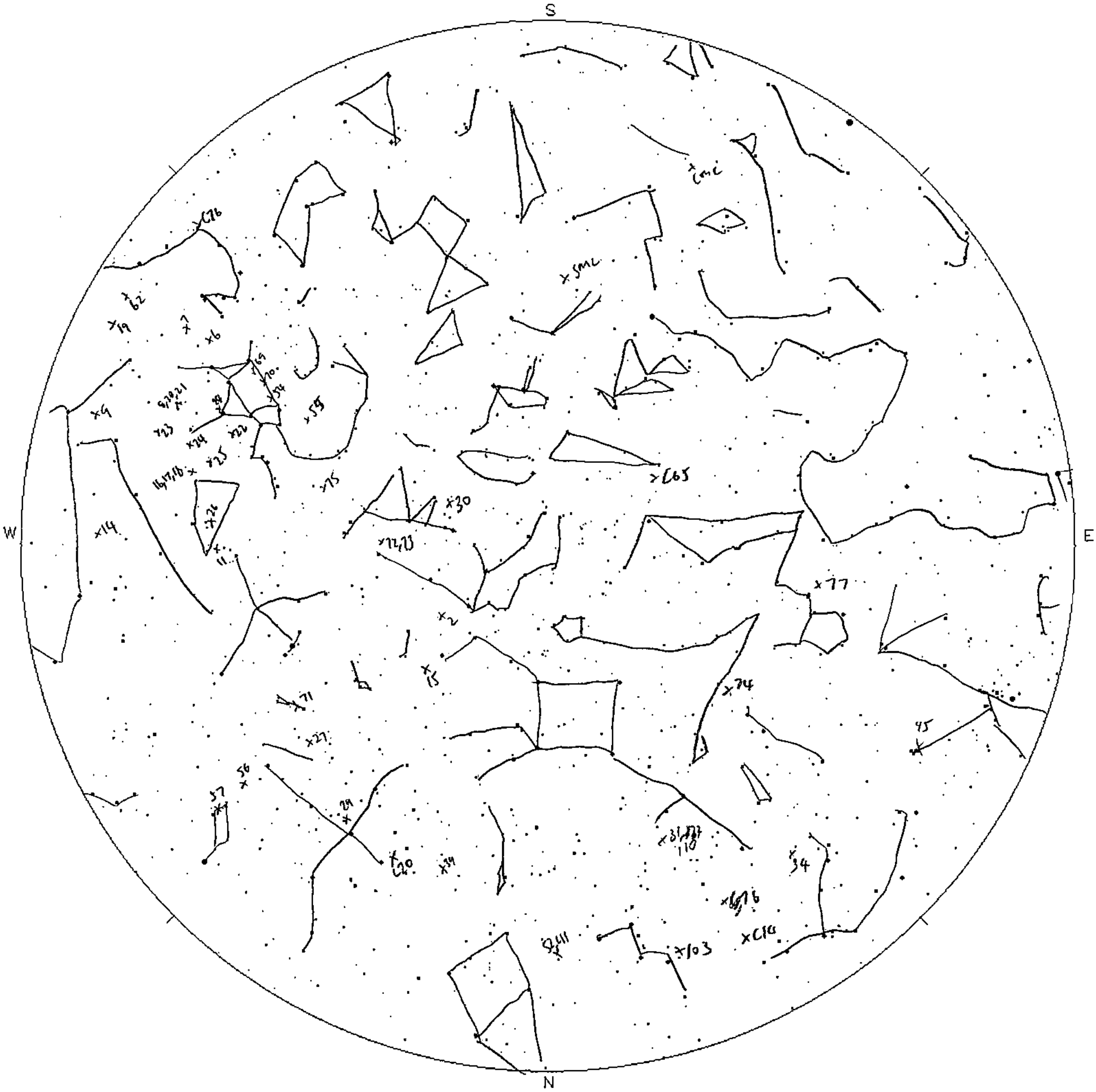
Im too tired to continue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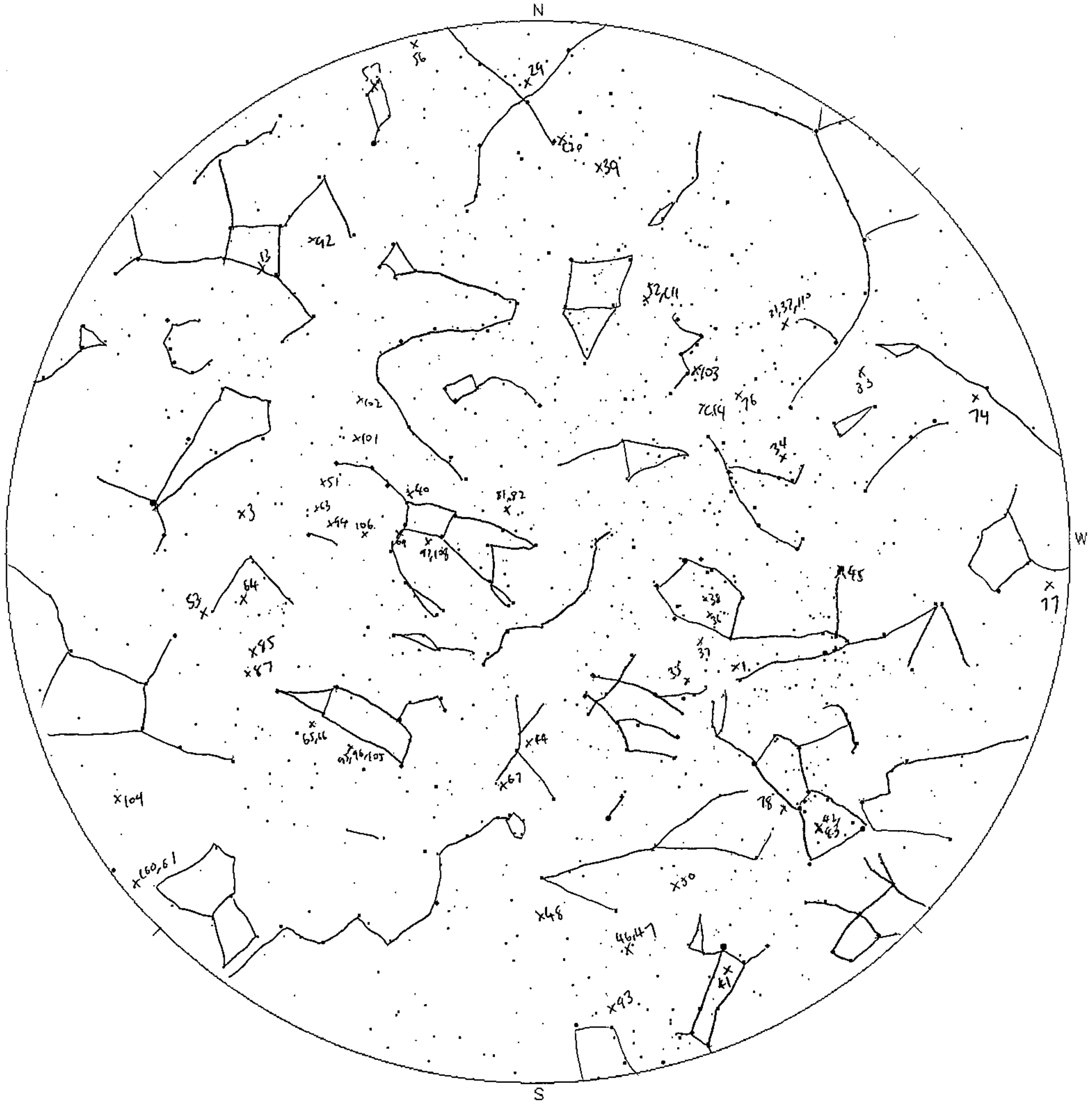
C14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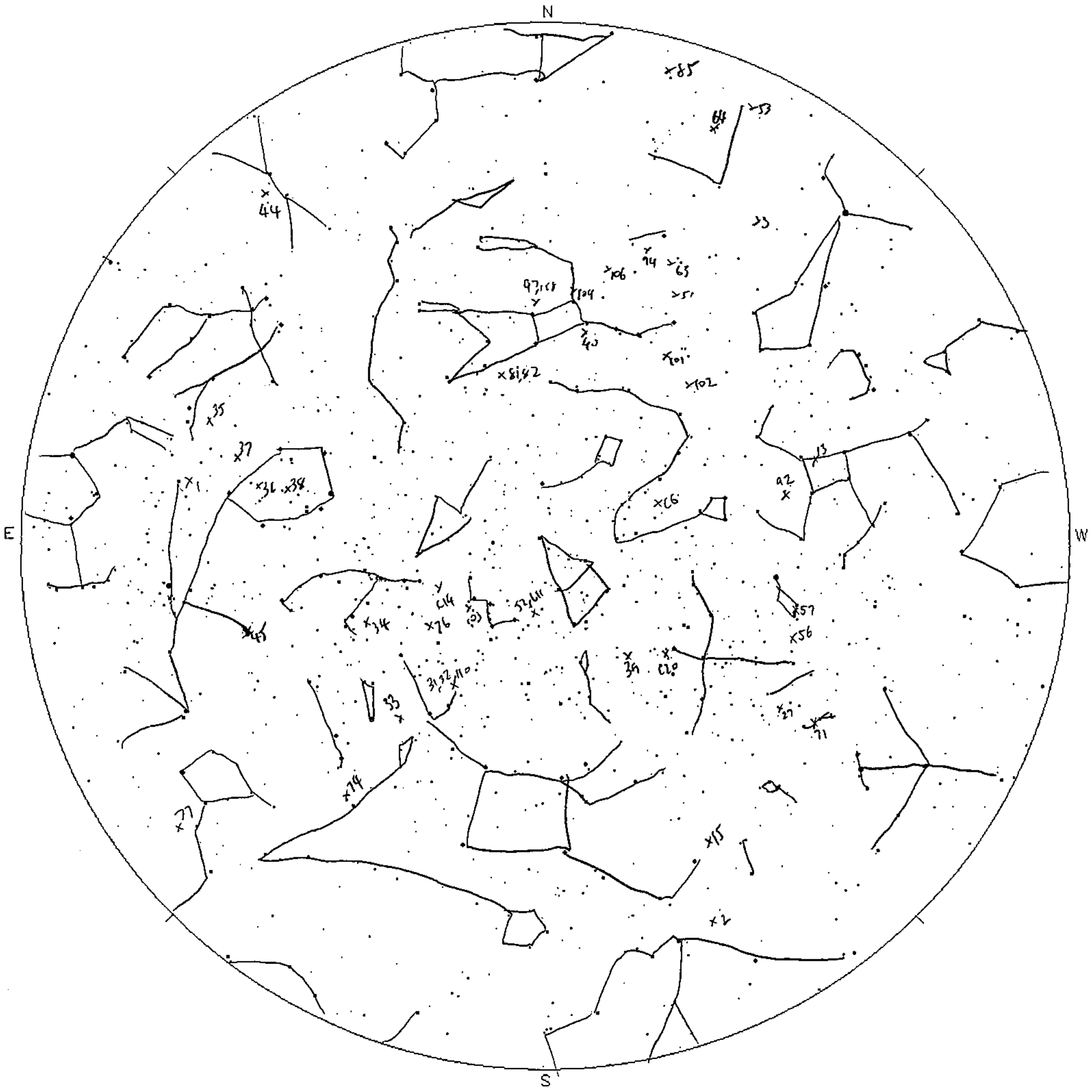
93
S

2^8.3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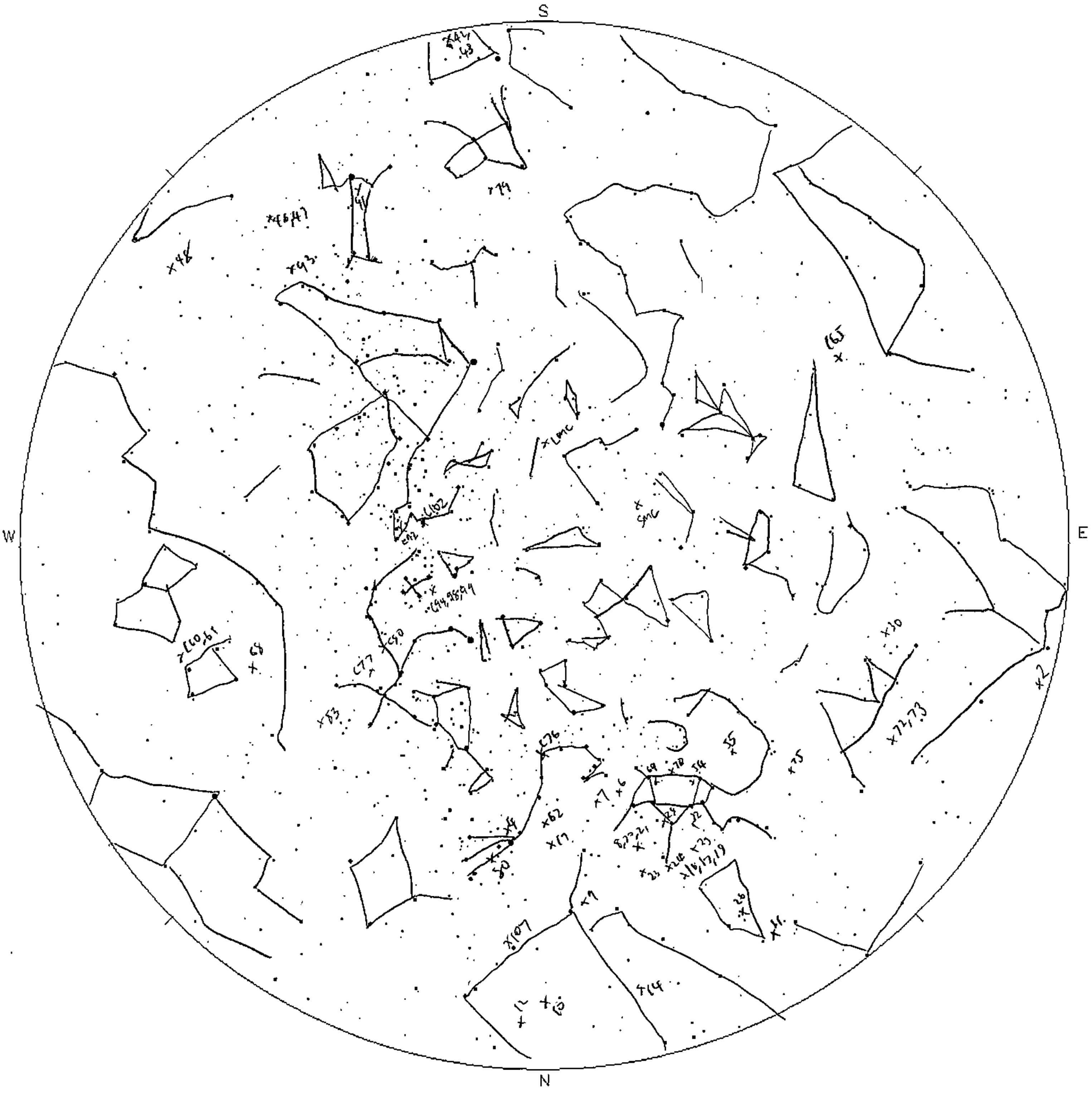
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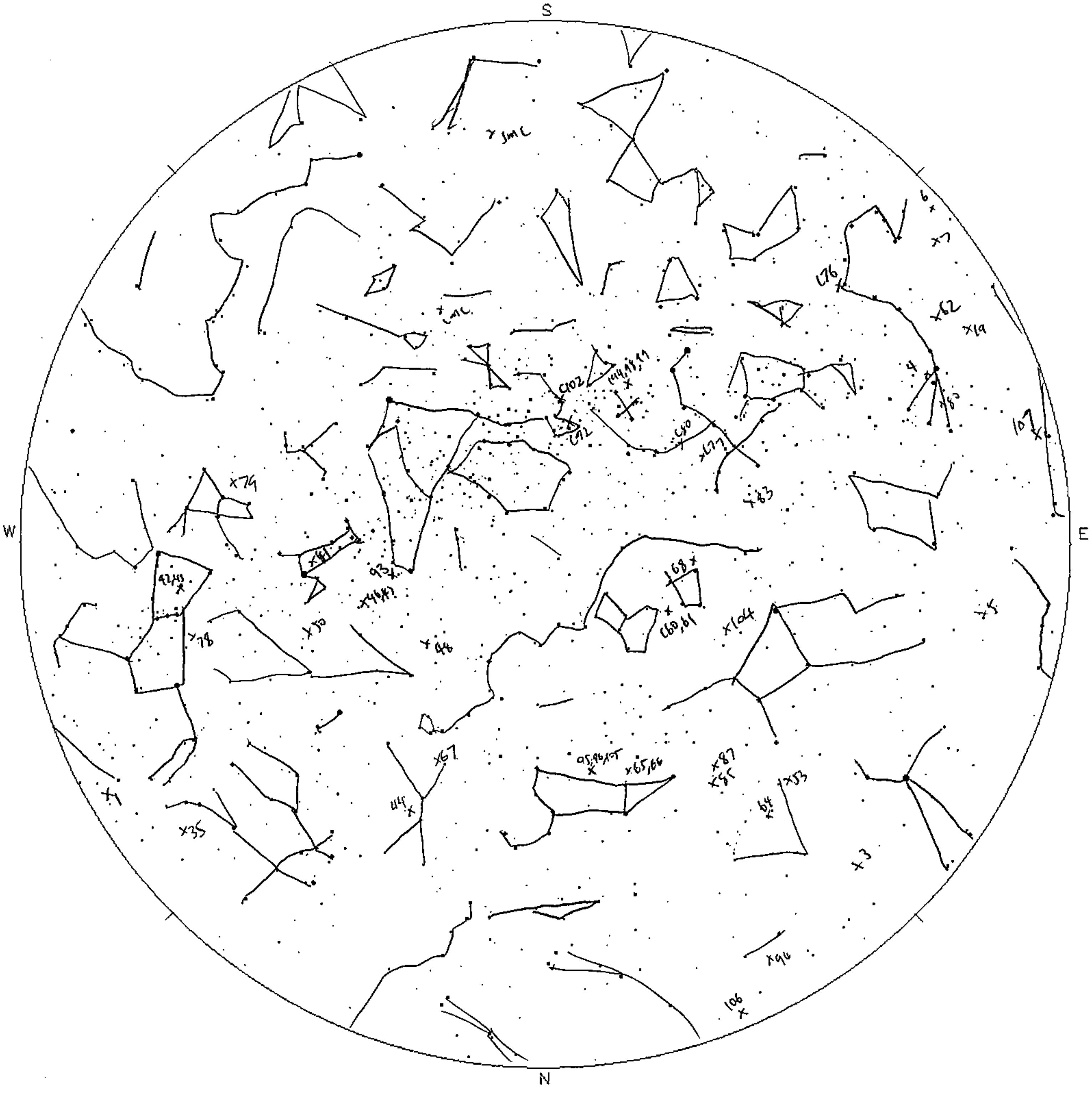
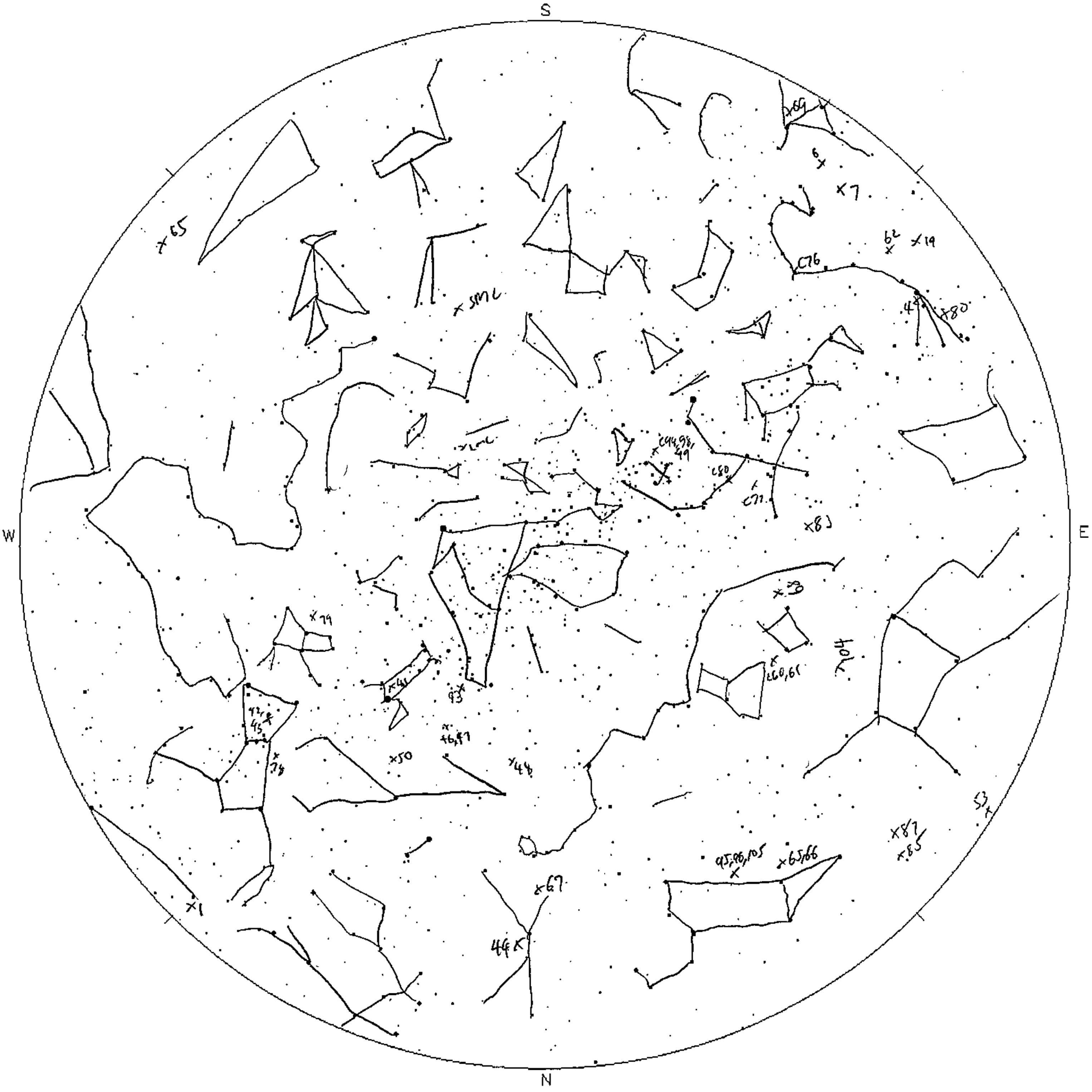
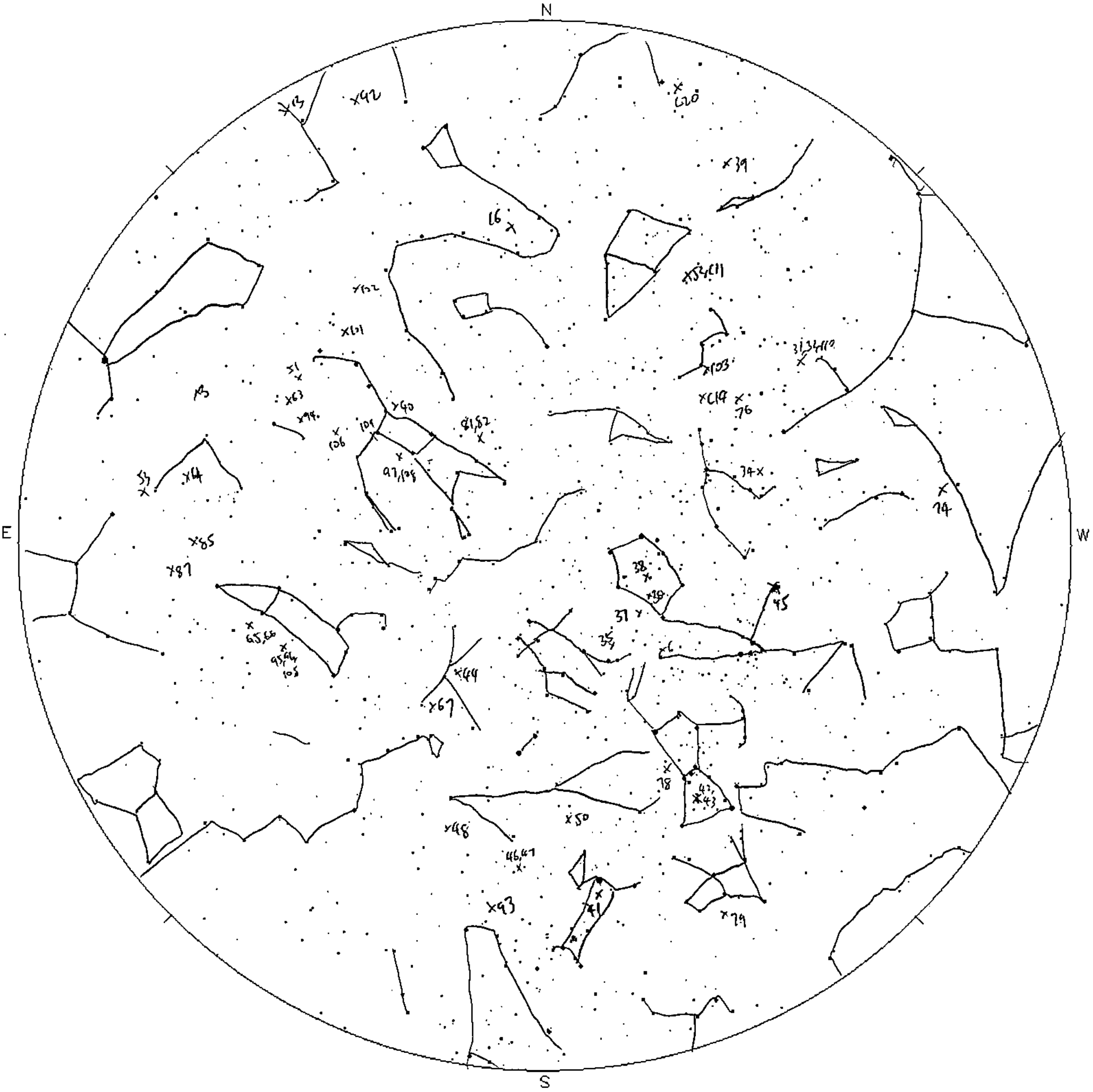
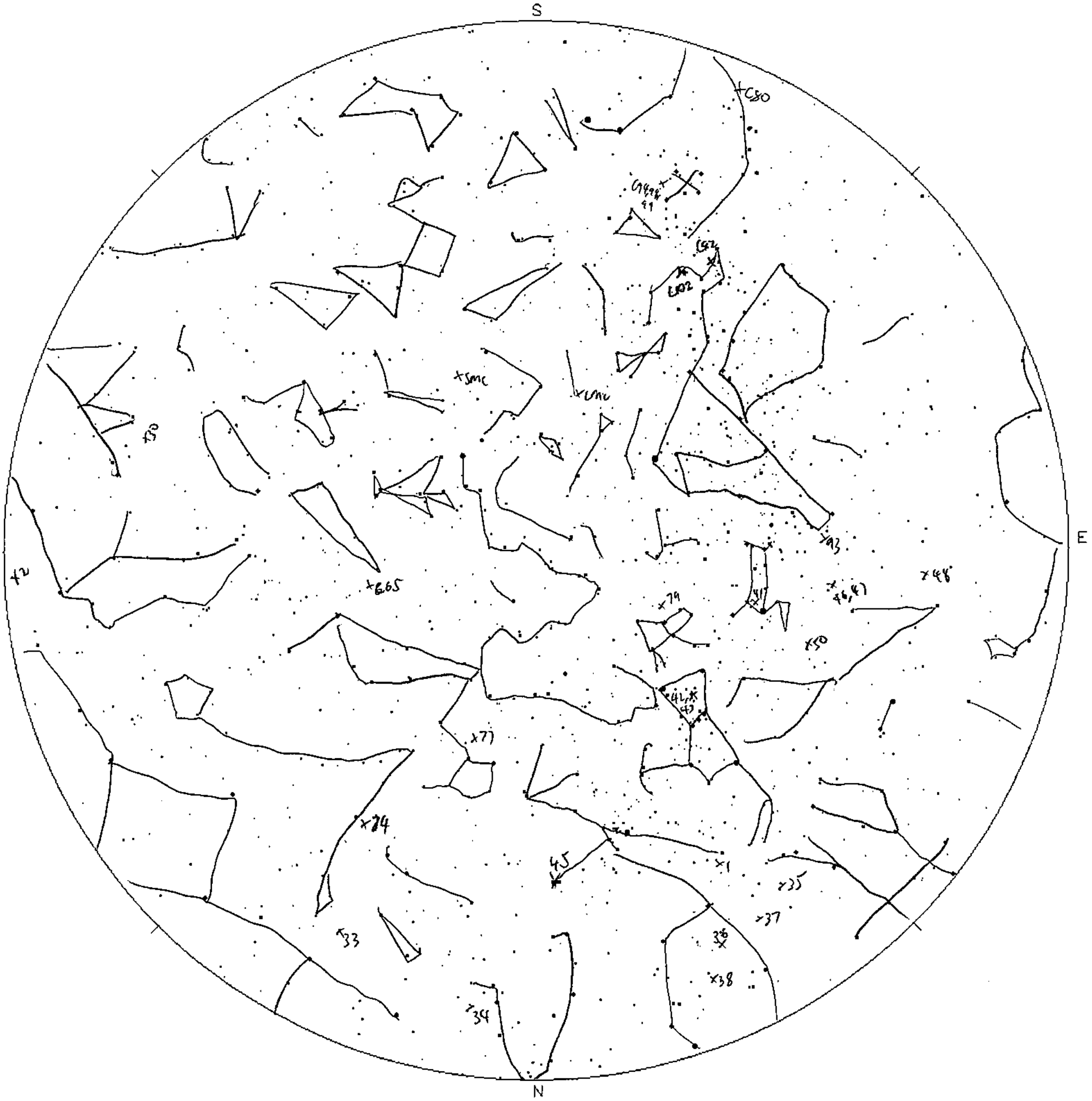
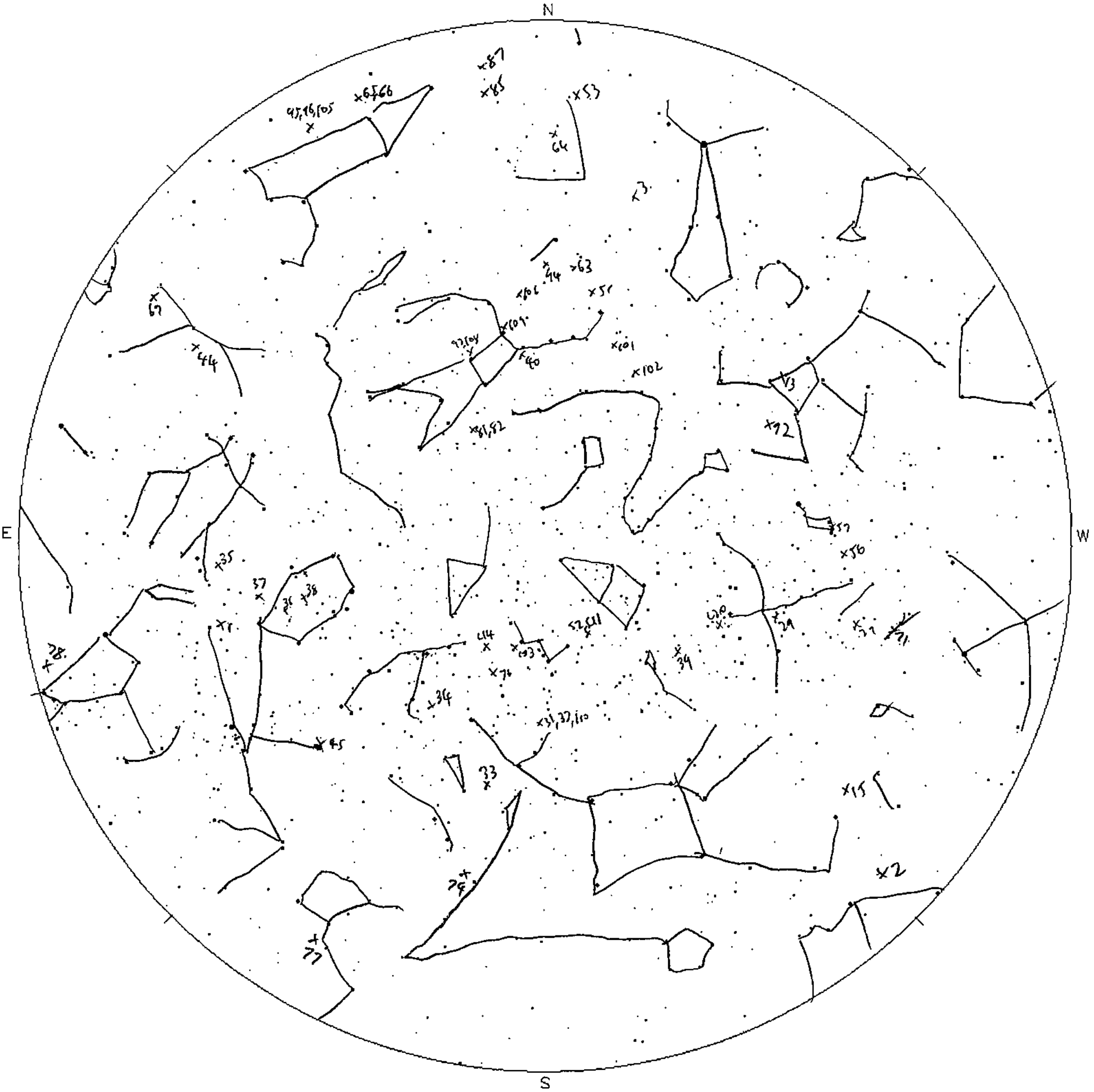
X46, 43
X79
X46,47
X48
X43
41
C65 X
X LMC
X SMC
C102
C92
C94,98,99
C90
C77
X83
X60,61
68 X
X30
X2
X72,73
X75
55
C76
X4
X62
X17
X7
X6
69
X70
54
28
52
8,20,21 X
X23
X24
X23
X18,17,19
X26
X31
X50
X9
X107
X14
X12
X10


S
SMC
6
7
176
62
19
LMC
C102
144,98,99
4
80
C92
C80
C77
107
83
79
W
E
61
93
92,43
46,47
68
C60,61
104
78
50
48
5
1
67
95,96,97
65,66
87
85
53
64
35
44
3
96
106
N

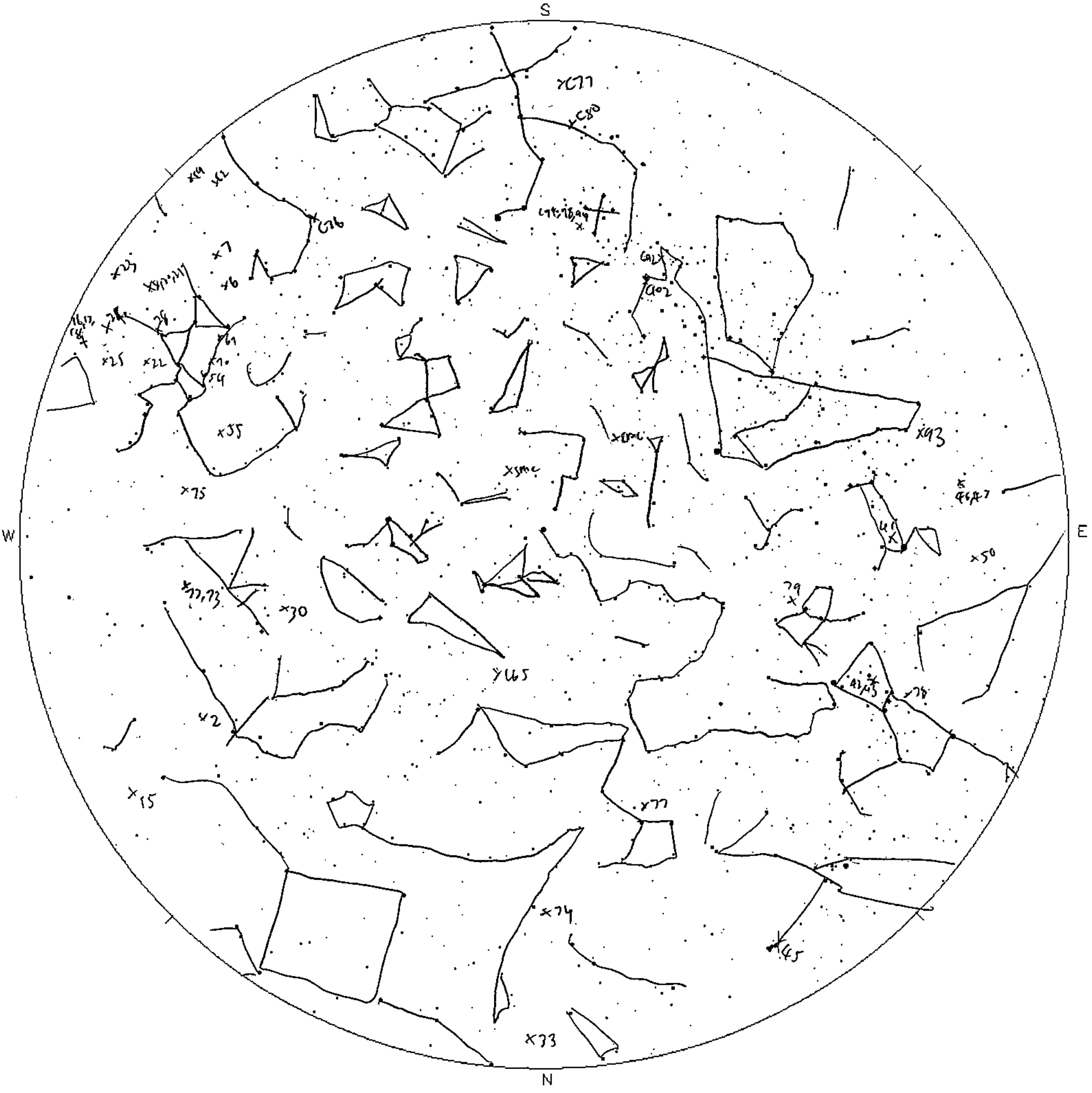

S
W
E
N
×65
×SMC
×LMC
×89
6
×7
62
×19
C76
4
×80
C94,98,
49
C80
C77
×83
×79
×41
93
42,
45
74
×50
46,47
×48
×3
×60,61
104
×1
×67
44
95,98,105
×65,66
×87
×85
53


N
E
W
S
X13
X42
X
C20
X39
16 X
X52,C11
X122
X101
31
X
X63
X98
13
X40
81,82
X
X
106
101
X
97,108
53
X
X64
X85
X87
X
65,66
X
95,96
105
31,34,110
X
XC19
X
76
X103
74X
X
74
38
X
X38
37 X
35
X6
X45
X44
X67
X
78
42
X43
X48
X50
46,47
X
X93
X
41
X79

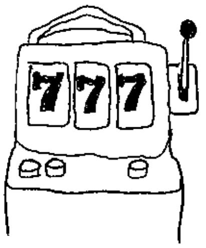

S
W
E
N
C80
C94,98
97
C92
C102
SMC
LMC
30
2
C65
93
48
46,47
41
79
50
42,43
77
74
45
1
35
37
36
38
33
34



near north pole


S
xC77
xC80
x49
x62
C76
C98,78,99
x
C92
C102
x7
x23
xM1,111
x6
16,17,
18
x24
28
x25
x22
61
70
54
x35
xSMC
xLMC
x93
x75
5
46,47
W
E
41
x
x50
x27,73
x30
79
x
x65
41/43
x
x78
x2
x15
x77
x74
x45
x33
N


S
C85
C92
C102
f C77 C50
x83
C94,98,99
xSMC
xC76
x4
80
x62
W
E
x19
x7
x6
x69
x70
x54
x55
x65
77
Y5
x107
x9
8,20,21
28
x23
x24
x25
22
12
x
x10
x14
16,17,18
x26
x75
x30
x72,73
x2
74
x45
x71
x27
57
56
x
24
x
N


777

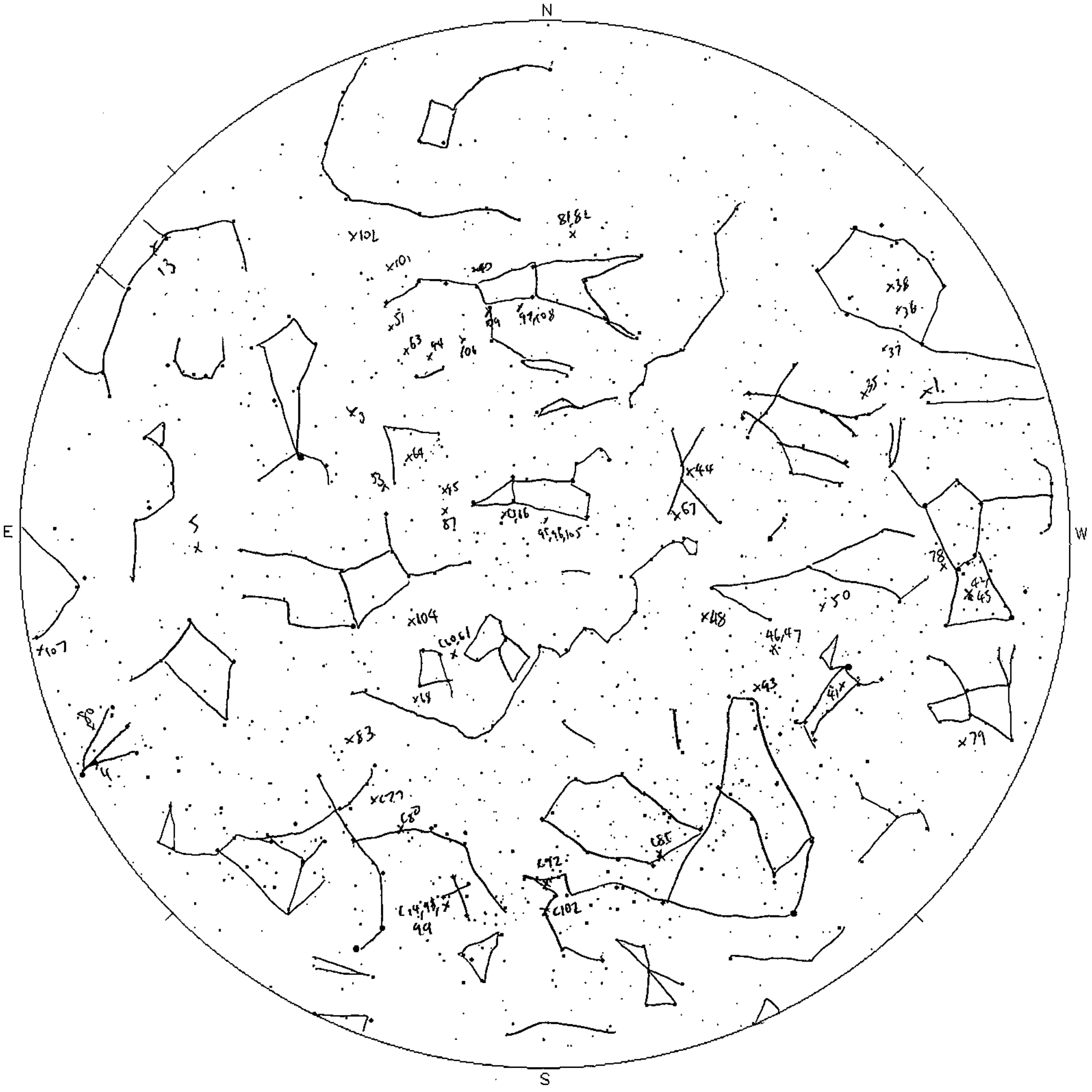
~ 7/9!

2


N
E
W
S
x40
x81,82
x106
104
x 97,108
x103
x C14
x76
x31,32,110
34
x33
38
x36
37
35 x
x1
x45
74
x85
x87
x65,66
x95,96,105
x44
x67
xθ
x78
43
x48
x50
46,47
x93
41
x79
x77
γ
x C60,61
ε
α
C85
x C92
x C102
x LMC

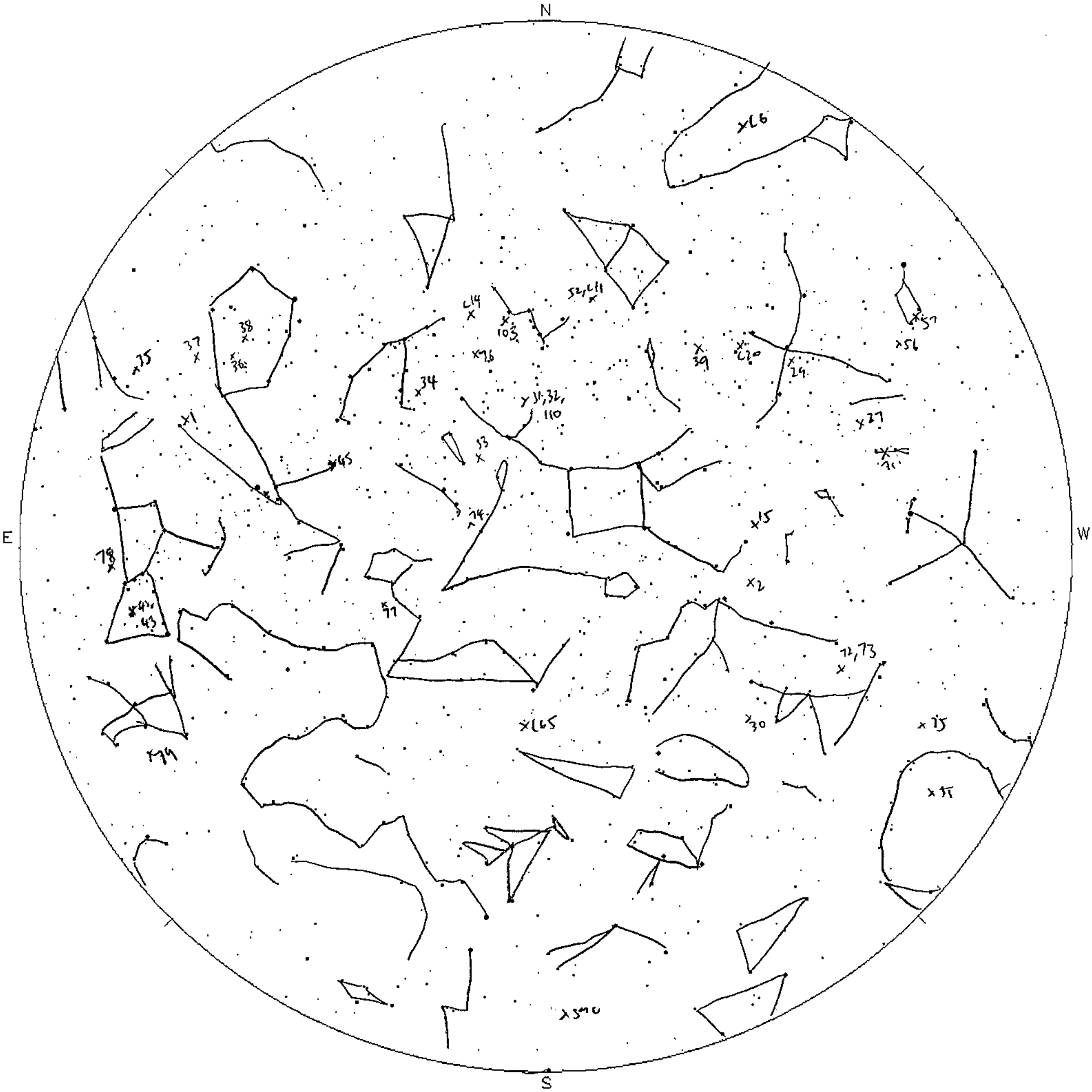

S
×6
×7
C76
×SMC
×LMC
C44,98,99
C102
C92
C80
C77
×83
C85
W
E
×79
×68
×C60,61
×104
41
42
43
×93
46,47
×50
×79
×1
×35
×67
44×
95,96,105
×65,66
×87
×85
×53
×64
N

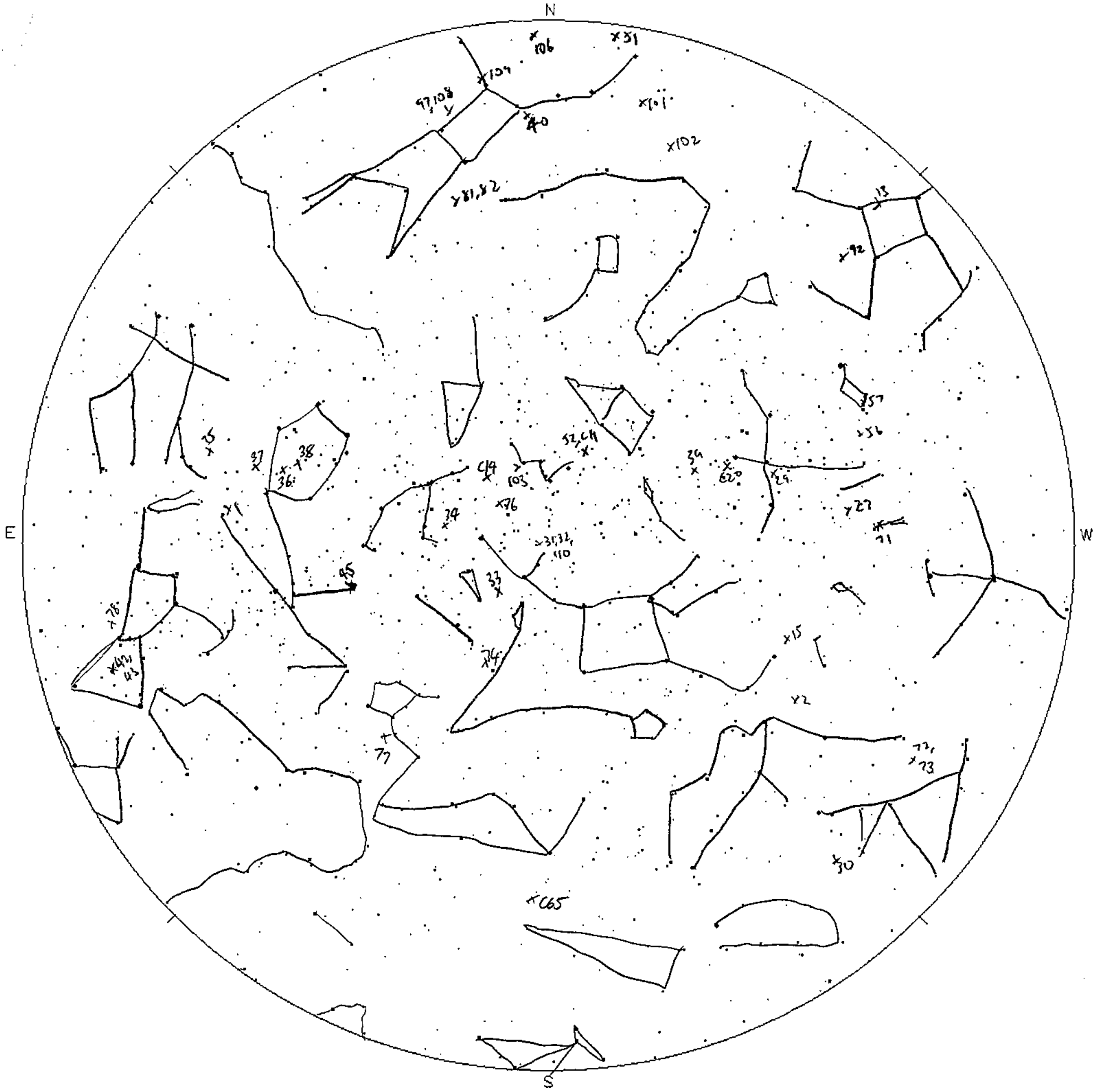

N
E
W
S
13
92
63
51
44
106
101
102
109
40
97,108
81,82
57
52
27
71
29
C20
39
53,C11
103
15
31,32,110
34
33
2
67
44
35
37
38
36
1
45
79
77
73
42,43
41
74
C65



十代
二十代
三十代
同じ人

honestly SLOWMOTION
is the GOAT


N
E
W
S
x66
38
36
37
x35
x1
C14
103
52,C11
x76
x34
31,32,110
53
x45
74
39
C20
29
x57
x56
x27
71
x15
x2
78
41,43
77
x79
x165
72,73
x30
x35
x55
x540


N
E
W
S
106
51
104
97,108
40
101
102
81,82
13
92
57
56
39
C20
29
27
71
C14
103
52,C4
35
37
38
36
4
76
34
31,32,110
33
95
78
42,43
24
15
2
77
72,73
30
C65

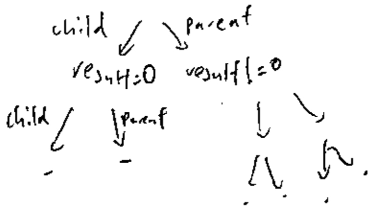
don't mess up your
ARP, kids :(

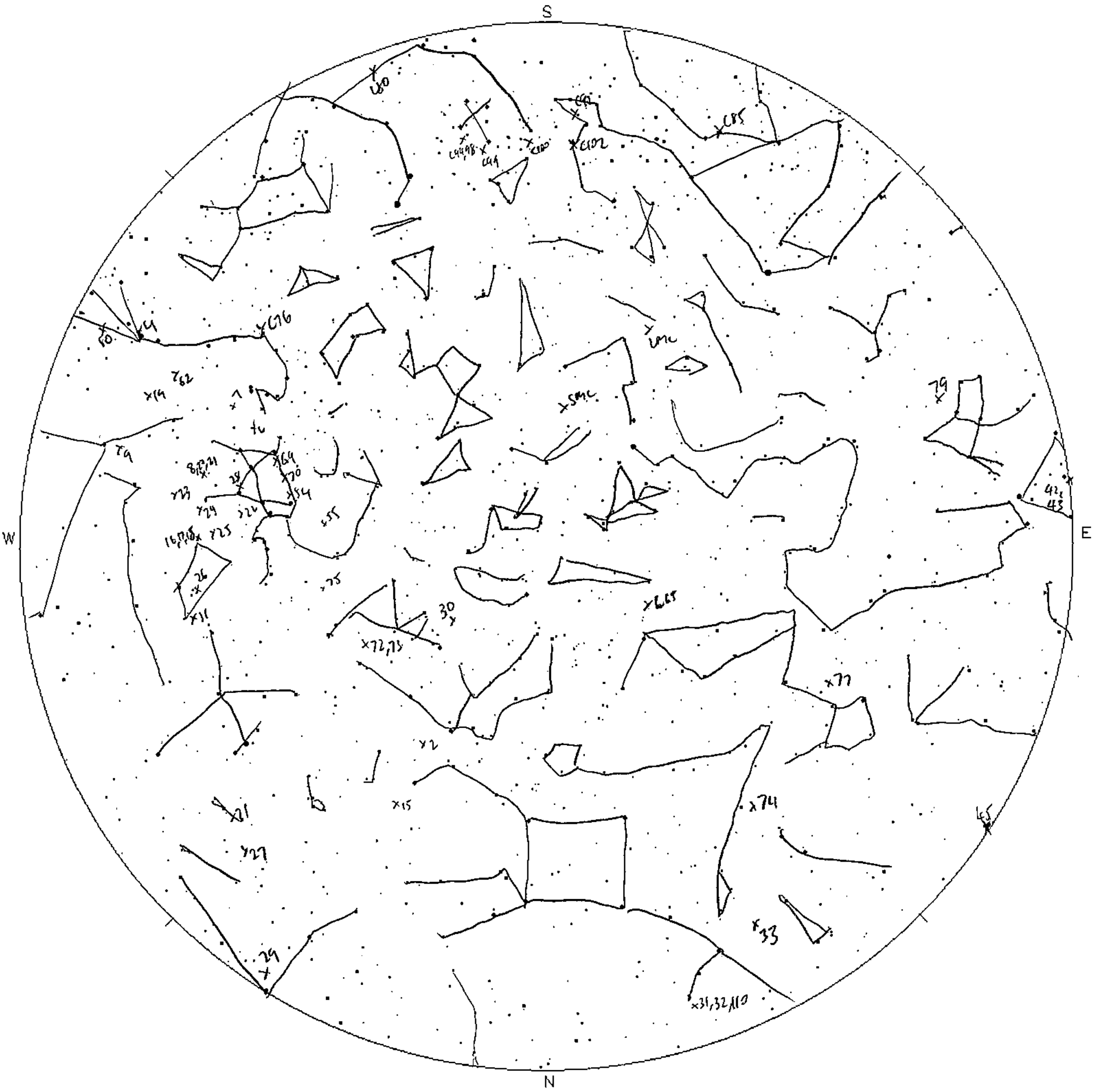
$2^4 \times 7^2$

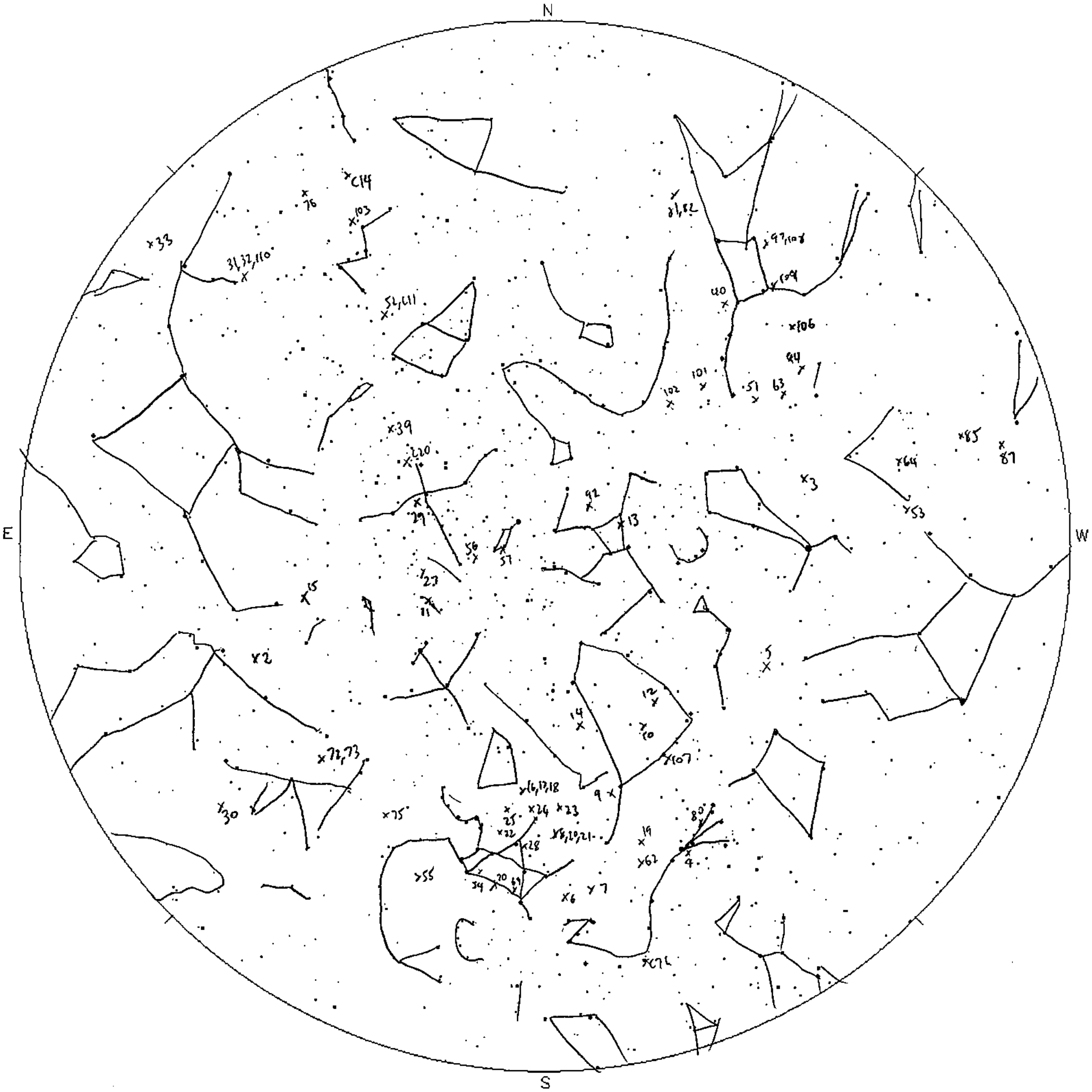
↑

784


N
E
W
S
x102
x101
81,82
x40
x51
x63
x99
106
x109
97,108
38
x36
45
x37
x1
35
x3
53
x64
x85
x87
x65,66
x95,96,105
x44
x67
x5
x104
C60,61
xC59
x68
x48
46,47
x50
78
42,43
41
x79
x83
xC77
C80
C85
C92
xC102
C94,98,99

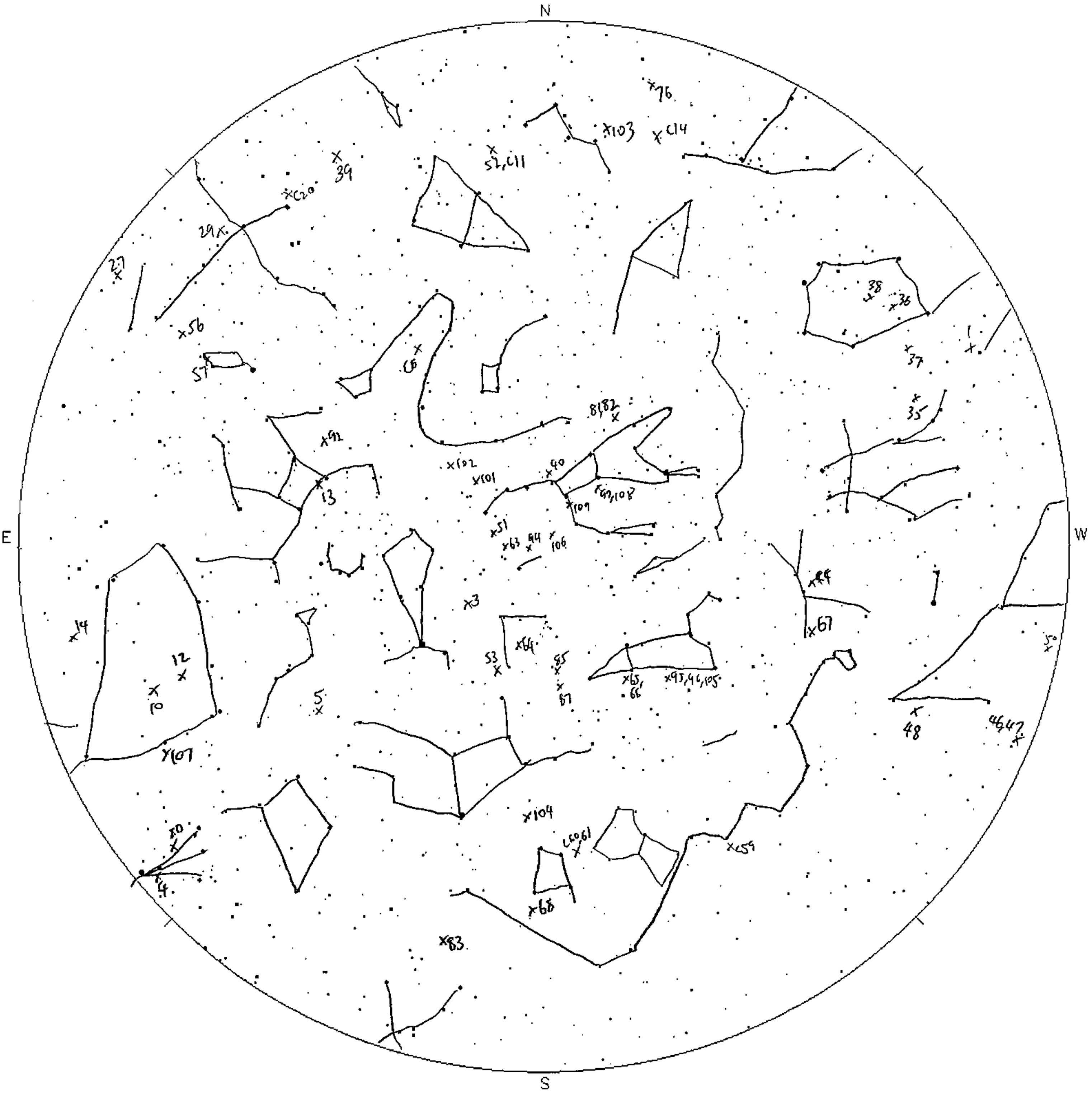

child
parent
result=0
result!=0
child
parent


S
W
E
N
C80
C94,98
C91
C100
C99
C102
C85
4
80
C76
62
19
7
6
9
8,13,21
64
70
54
28
23
29
22
25
16,17,18
55
26
11
75
72,73
30
LMC
SMC
65
79
42,
43
77
2
74
21
15
27
45
33
29
31,32,110


N
E
W
S
C14
76
33
31,32,110
103
52,111
81,82
97,108
109
40
106
94
101
102
51
63
39
220
29
56
57
92
13
23
11
15
2
64
85
87
3
53
5
12
14
10
107
72,73
30
75
16,17,18
25
24
23
22
28
8,20,21
9
19
80
62
4
55
34
70
69
6
7
C76


S
x83
4
x14
x62
xC77
xC80
x23
x8,20,21
x7
C76
x24
x6
x25
28
x22
69
54
70
C48/98
C44x
C92
C102
x55
xC85
x75
x5M6
x2M2
x48
93
72,73
x
x46,47
x30
41
x
x50
74
x
x2
xC65
42,43
x77
x74
35
W
E
N


S
N
E
W
LMC
C102
C65
C92
C96
C97
C94,98
C80
C77
C76
C59
C60
68
60,61
x48
46,47
x109
x83
x62
19
80
x6
x9
69
70
54
x55
x75
x22
28
x25
24
x23
5,20,21
x16,17,18
26
11
x14
x30
x32
x5
x67
44
43,46,105
x65,66
x87
x85
x53
64
x3
x13
x92
x44
x63
x57
x108
x109
97,108
x40
x101
x102

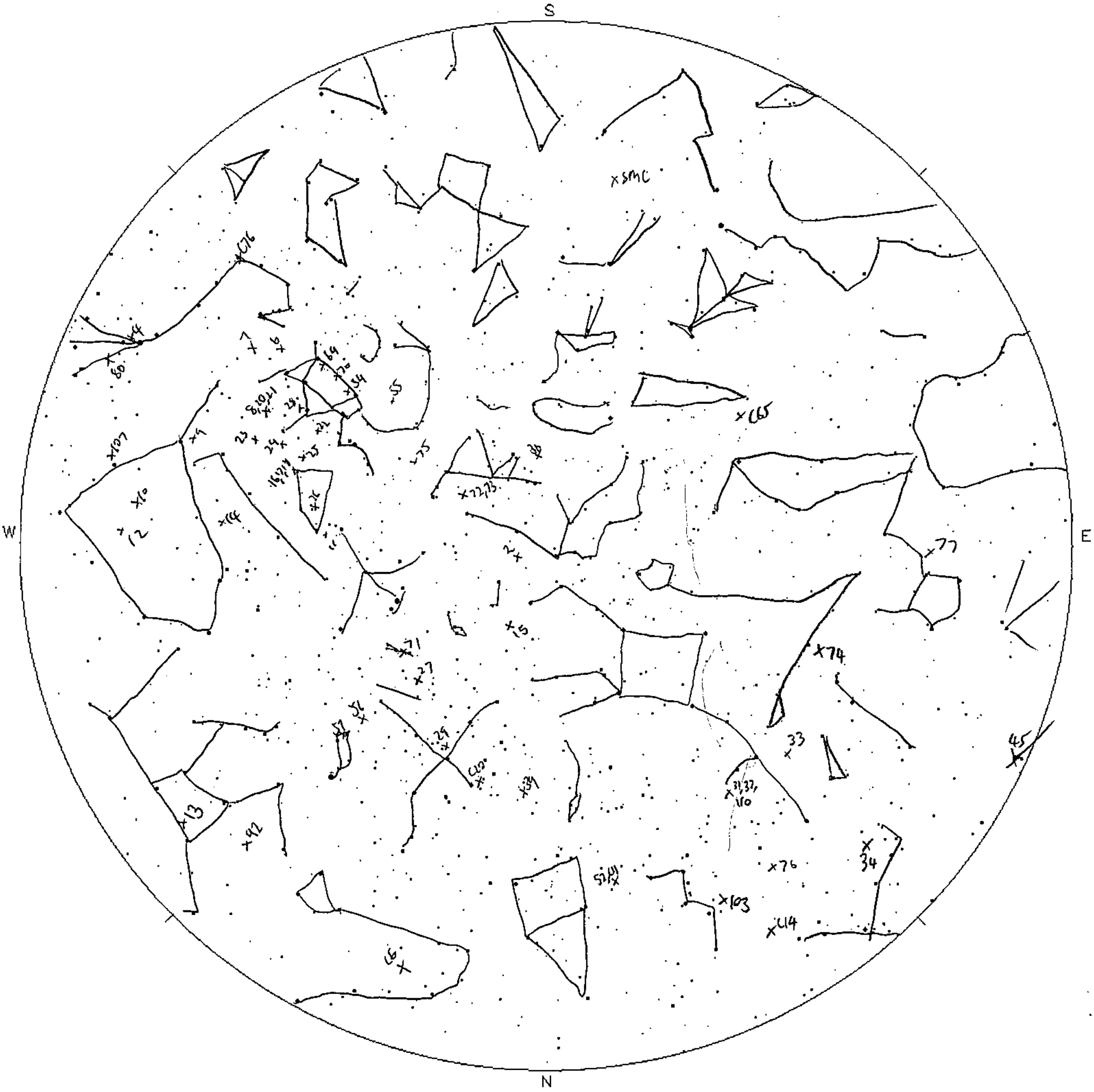


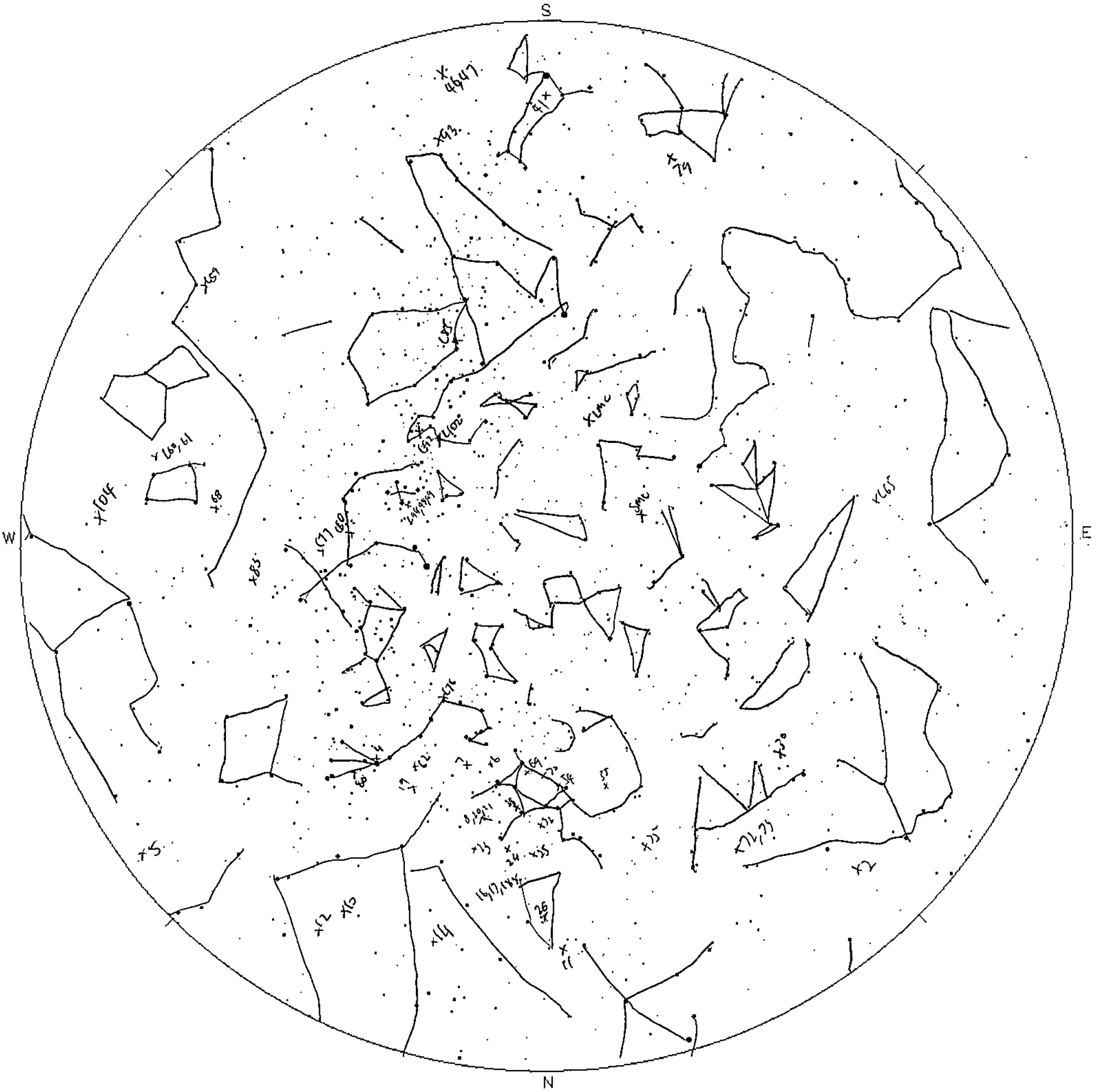
$XY^{+} \to XY$

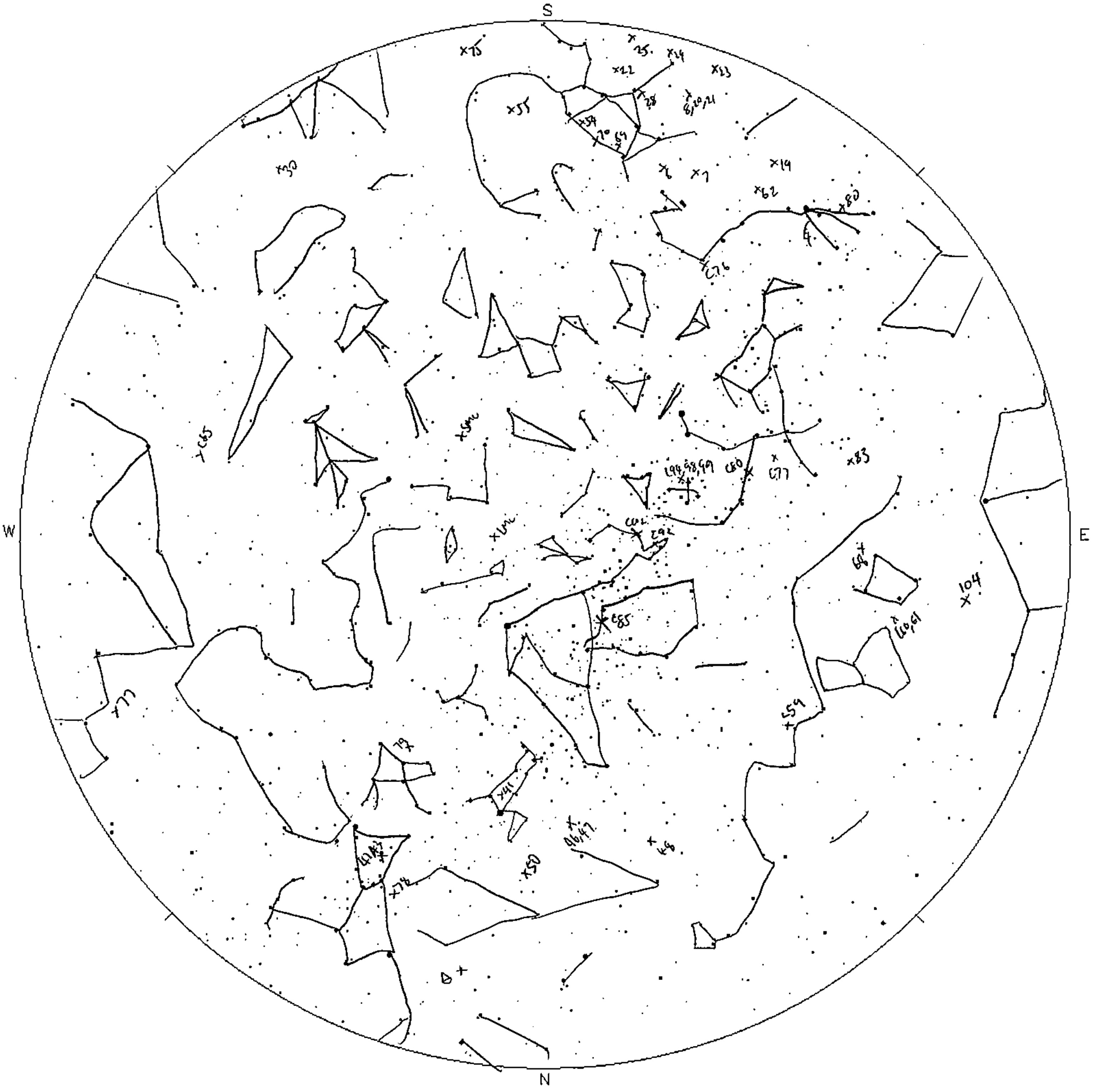
$2W^{+} \to 2XWYV$ $\qquad 2W \to VX$

$VX^{+} \to VX$

globular
cluster
appreciation

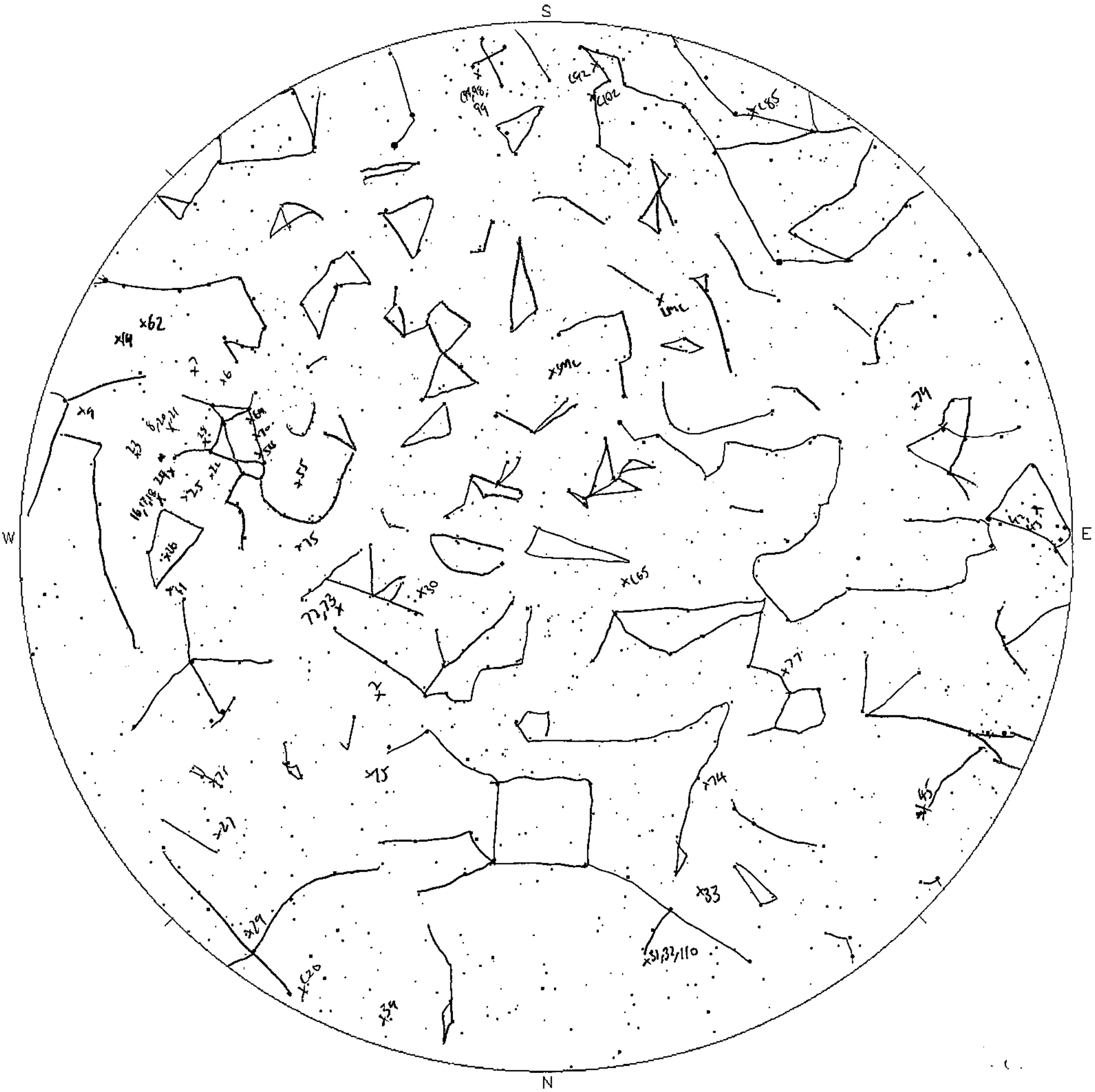

S
W
E
N
xSMC
xC65
C76
44
x
80
x107
x10
x
12
x14
x9
7
x
6
x
8,10,11
x
23 x
24
x
25
x
22
x
64
x70
x34
55
x75
16,17,18
x26
x72,73
2x
x15
x71
x27
56
x
57
29
x
C10
x
x39
x13
x92
C6
x
52/11
x
x103
x114
x76
x
34
33
x
x31,32,
110
x74
x77
45
x


S
W
E
N
x 4647
41x
x93
x 79
x59
x 60,61
x104
x68
x LMC
SMC
x165
x83
x77 80
x402
697
x 139
x 4494
x 4
80
17 x
x22
7 x
x6
x69
72
54
53 x
8,10,11 x
38 x
x32
x33
x 24
x35
x35
x36
x71,73
x2
x5
x12 x15
x14
16,17,184
26 x
x 11

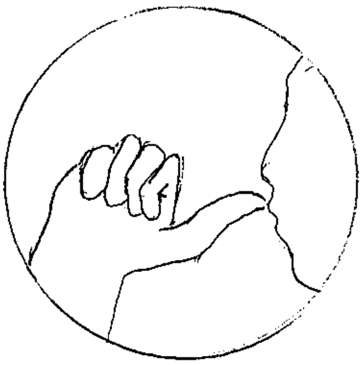

S
W
E
N
x75
x25
x24
x22
x23
x55
x28
8,20,21
x54
70
69
x30
x8
x7
x19
x62
x80
4
C76
C85
C80
C77
x83
C92
C62
x85
68
104
110,61
x77
x59
79
x41
x50
46,47
x46
x78

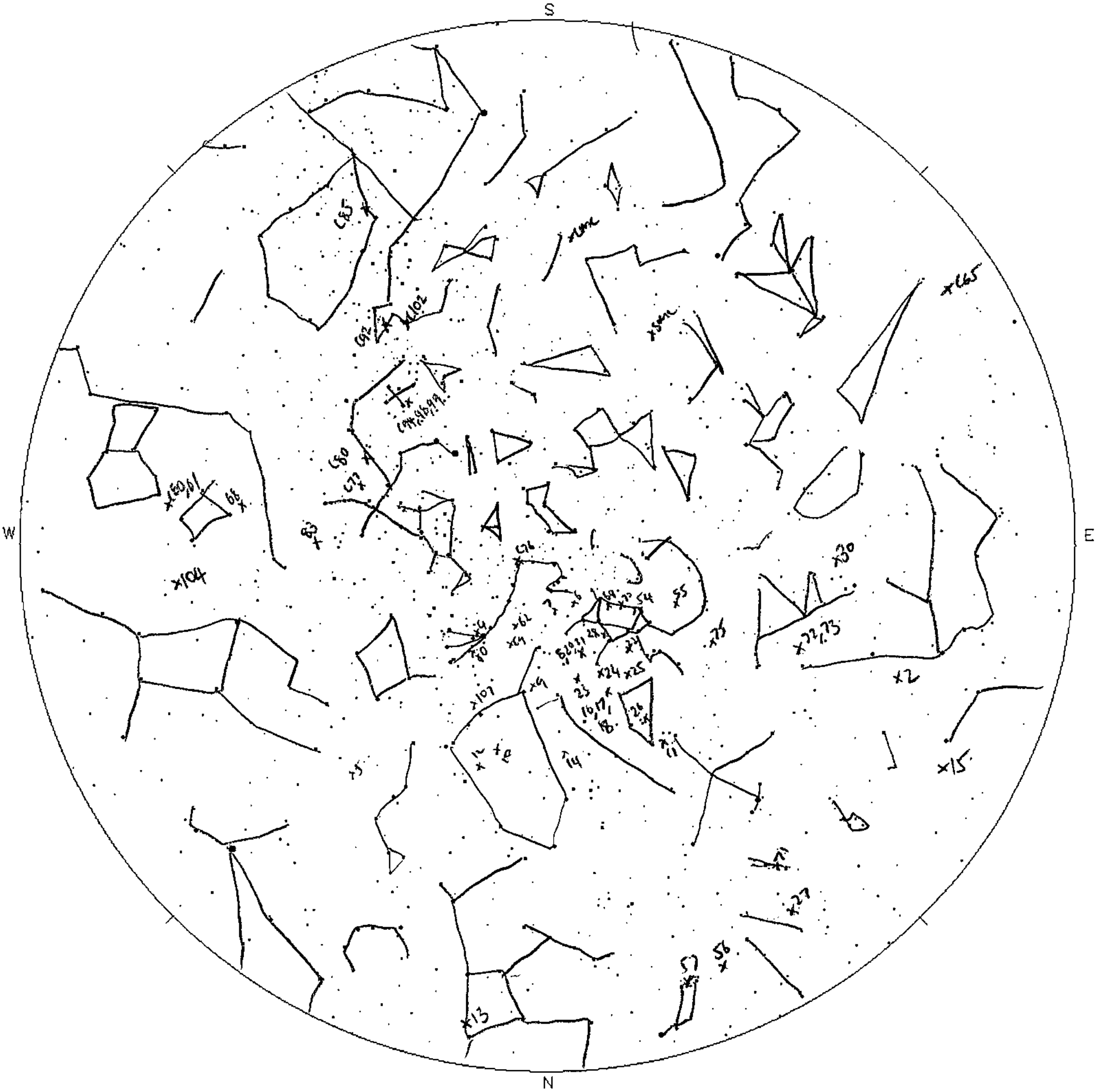

S
W
E
N
×65
×SMC
LMC ×
C95,98,99
C102
C92
C80
C77
+83
C85
79
42,43
×78
41
×50
46,47
×48
×59
68×
C60,61
×104
×70
×89
6×
×7
×62
×19
C26
4
×80
×87
×85
×53
64×
95,96,105
×65,86
×67
44
×35

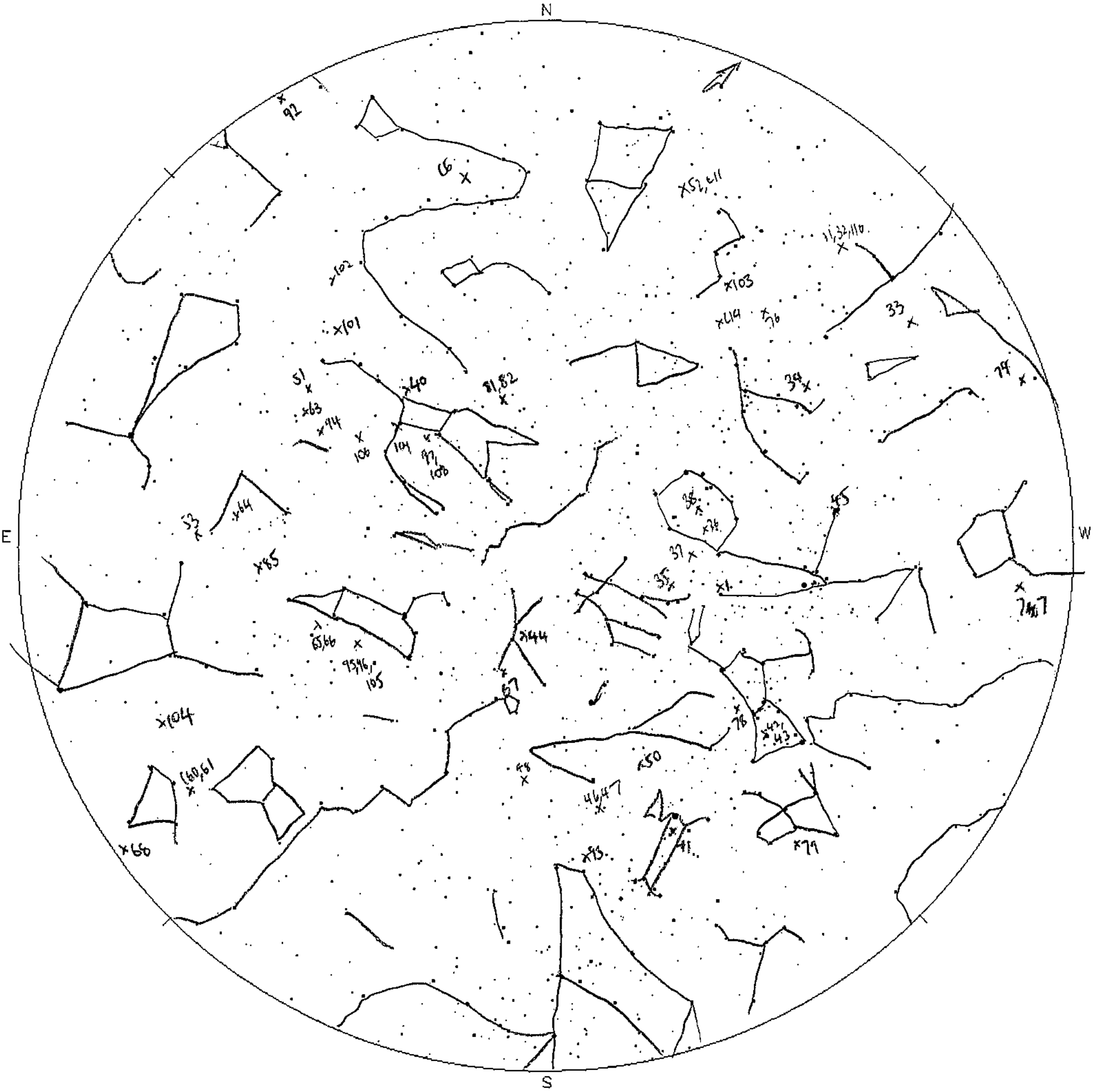
South pole map


S
W
E
N
C99,98, 99
C92
C102
C85
LMC
SMC
x62
x14
x7
x6
x9
8,20,21
23
x69
x70
x56
x24
x25
x22
16,17,18,19
x26
x55
x75
x31
x30
72,73
x65
x79
42,43
x77
x2
x15
x21
x27
x74
x45
x33
x29
C20
x31,32,110
x34

#73 : Beer




S
W
E
N
C85
C92
x102
xsun
xsun
xC65
C94,96,99
C80
C77
x80,81
68 x
83 x
x104
C76
x4
x80
x62
x64
7
x6
69
x72
54
55
8,20,31 x
28 x
x24
x24
x25
x73
x30
x22,23
x2
x107
x9
x23
10,17, 18
26 x
x11
x12
x8
x14
x5
x15
x71
x27
57
56 x
x13


N
E
W
S
92
16
X52, 211
11,32,110
x102
x103
x101
x214
76
33
79
51
x63
x94
x40
81,82
106
104
97, 100
34
53
x64
38
x36
45
37
35
x1
x85
65,66
95,96, 105
x44
87
x104
60,61
x68
58
x50
46,47
x93
91
78
42, 43
x79


S
N
E
W
C83
C102
C92
C94,90,99
xLMC
xSMC
xC65
C77
C80
x60,61
x68
x83
x104
C76
x4
x80
x62
x19
x7
x6
69
70
54
x55
28
x22
x20,21
x24
x25
x23
16,17,18
26
x11
x9
x107
x12
x17
x14
x75
50
x72,73
x2
x5
x15
x71
x29
56
57

4/5

Reached on:

14/2/2024
17:00

(in SPOT training)

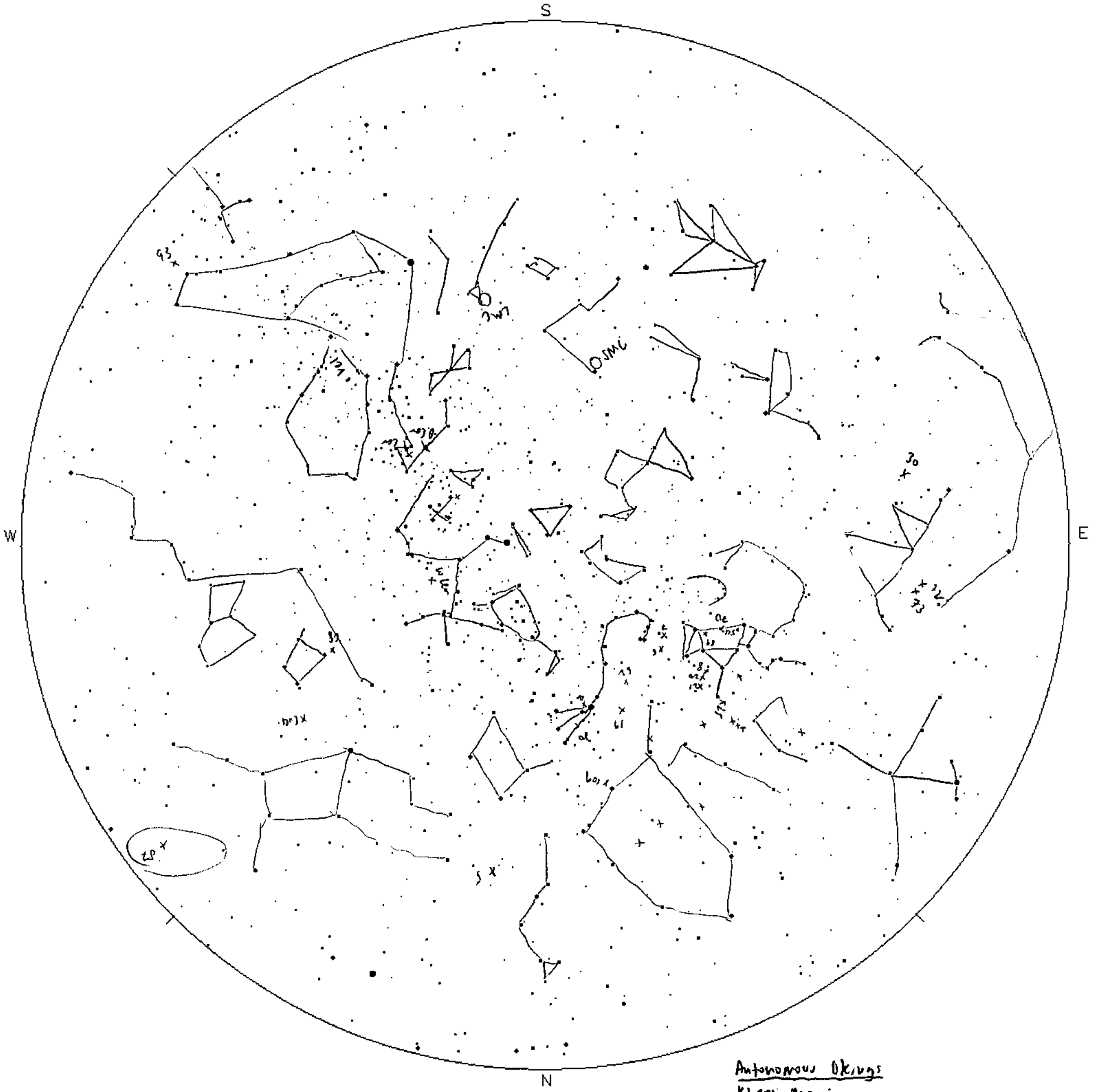
Prajinaparamita

般若波羅蜜多心經

觀自在菩薩，行深般若波羅蜜多時，照見五蘊皆空，度一切苦厄。舍利子！色不異空，空不異色；色即是空，空即是
受想行識亦復如是。舍利子！是諸法空相，不生不滅，不垢不淨，不增不減。是故空中無色，無受想行識；無
眼耳鼻舌身意；無色聲香味觸法；無眼界，乃至無意識界；無無明，亦無無明盡，乃至無老死，亦無老死盡；
無苦集滅道；無智亦無得。以無所得故，菩提薩埵。依般若波羅蜜多故，心無罣礙；無罣礙故，無有恐怖，遠
離顛倒夢想，究竟涅槃。三世諸佛，依般若波羅蜜多是大神咒，是大明咒，是無上咒，是無等等咒，能除一切苦，真實
不虛。故說般若波羅蜜多咒，即說咒曰：揭諦揭諦，波羅揭諦，波羅僧揭諦，菩提薩婆訶。

図々しい

801



<u>Republics</u>

Adygea
Bashkortostan
Buryatia
Altai
Dagestan
Ingushetia
Kabardino - Balkaria
Kalmykia
Karachay - Cherkess
Karelia
Komi
Mari El
Mordovia
Sakha
North Ossetia
Tatarstan
Tuva
Udmurt
Khakassia
Chechen
Chuvashia

<u>Krai</u>

Altai
Kamchatka
Krasnodar
Krasnoyarsk
Perm
Primorsky
Stavropol
Khabarovsk
Zabaikalsky

<u>Oblasts</u>

Amur
Arkhangelsk
Astrakhan
Belgorod
Bryansk
Vladimir
Volgograd
Vologda
Voronezh
Ivanovo
Irkutsk
Kaliningrad
Kaluga
Kemerovo
Kirov
Kostroma
Kurgan
Kursk
Leningrad
Lipetsk
Magadan
Moscow

Murmansk
Nizhny - Novgorod
Novgorod
Novosibirsk
Omsk
Orenburg
Oryol
Penza
Pskov
Rostov
Ryazan
Samara
Saratov
Sakhalin
Sverdlovsk
Smolensk
Tambov
Tver
Tomsk
Tula
Tyumen

Ulyanovsk
Chelyabinsk
Yaroslavl

<u>Federal Cities</u>

Moscow
St Petersburg

<u>Autonomous Okrugs</u>

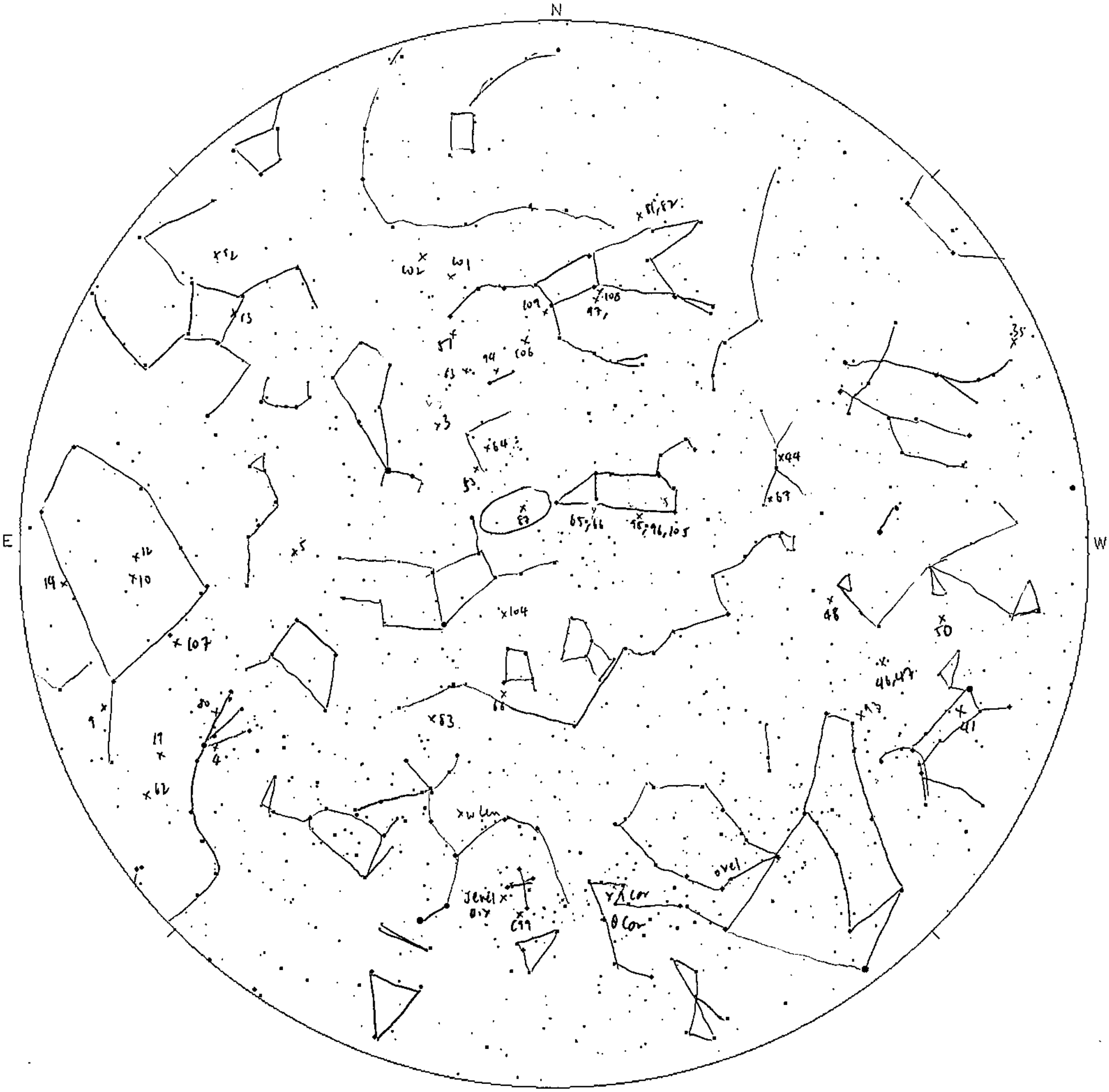
Khanti-Mansi
Chukotka
Nenets
Yamalo-Nenets

<u>Disputed</u> (de-facto controlled)

Crimea (Republic)
Sevastopol (Federal City)

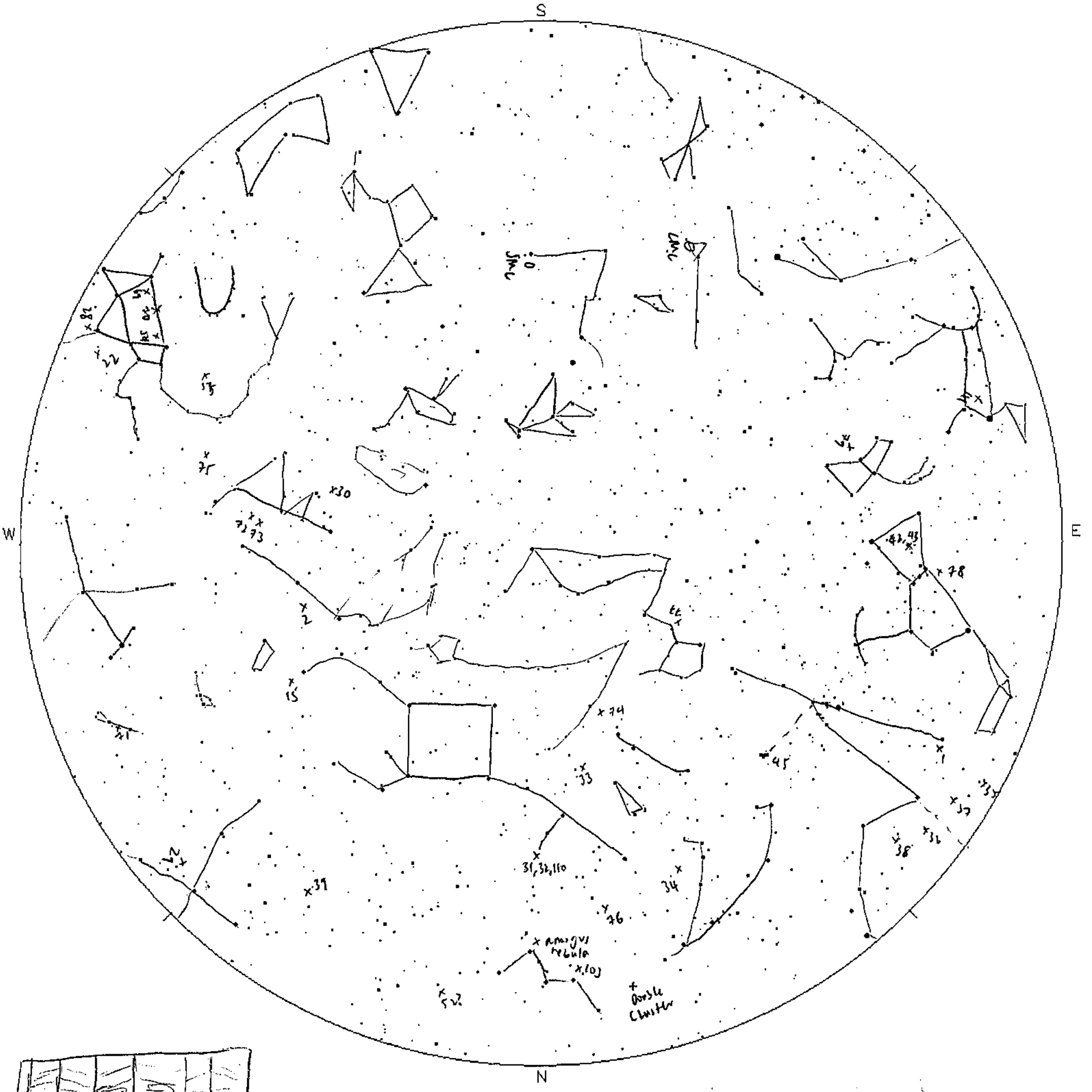
<u>Disputed</u> (partially controlled as of writing)

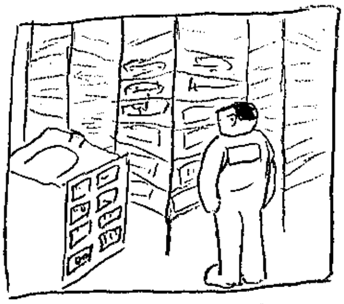
4 Ukrainian oblasts



Lines 1-37 of the bee movie script at gist.github.com/MattIPv4/045239bc27b16b2bcf7a3a9a4648c08a

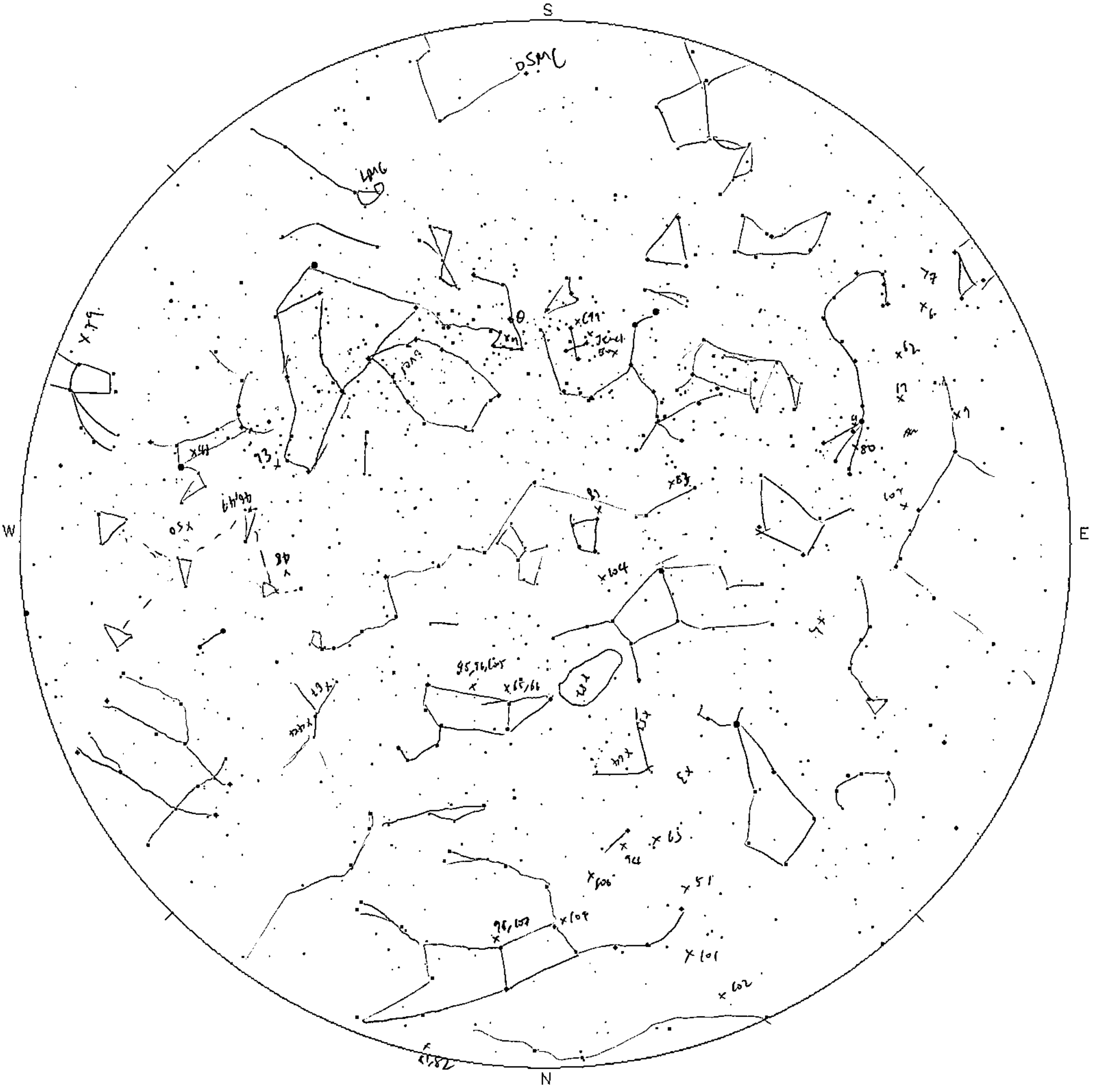
According to all known laws of aviation, there is no way a bee should be able to fly.
Its wings are too small to get its fat little body off the ground.
The bee, of course, flies anyway because bees don't care what humans think is impossible.
Yellow, black. Yellow, black. Yellow, black. Yellow, black.
Ooh, black and yellow! Let's shake it up a little.
Barry! Breakfast is ready! Coming! Hang on a second. Hello? Barry? Adam?
Can you believe this is happening? I can't. I'll pick you up. Looking sharp.
Use the stairs, Your father paid good money for those.
Sorry, I'm excited. Here's the graduate. We're very proud of you, son. A perfect report card, all B's.
Very proud. Ma! I got a thing going here. You got lint on your fuzz. Ow! That's me!
Wave to us! We'll be in row 118,000. Bye! Barry, I told you, stop flying in the house!
Hey, Adam. Hey, Barry. Is that fuzz gel? A little, Special day, graduation. Never thought I'd made it.
Three days grade school, three days high school. Those were awkward. Three days college. I'm glad I
took a day and hitchhiked around the Hive. You did come back different.

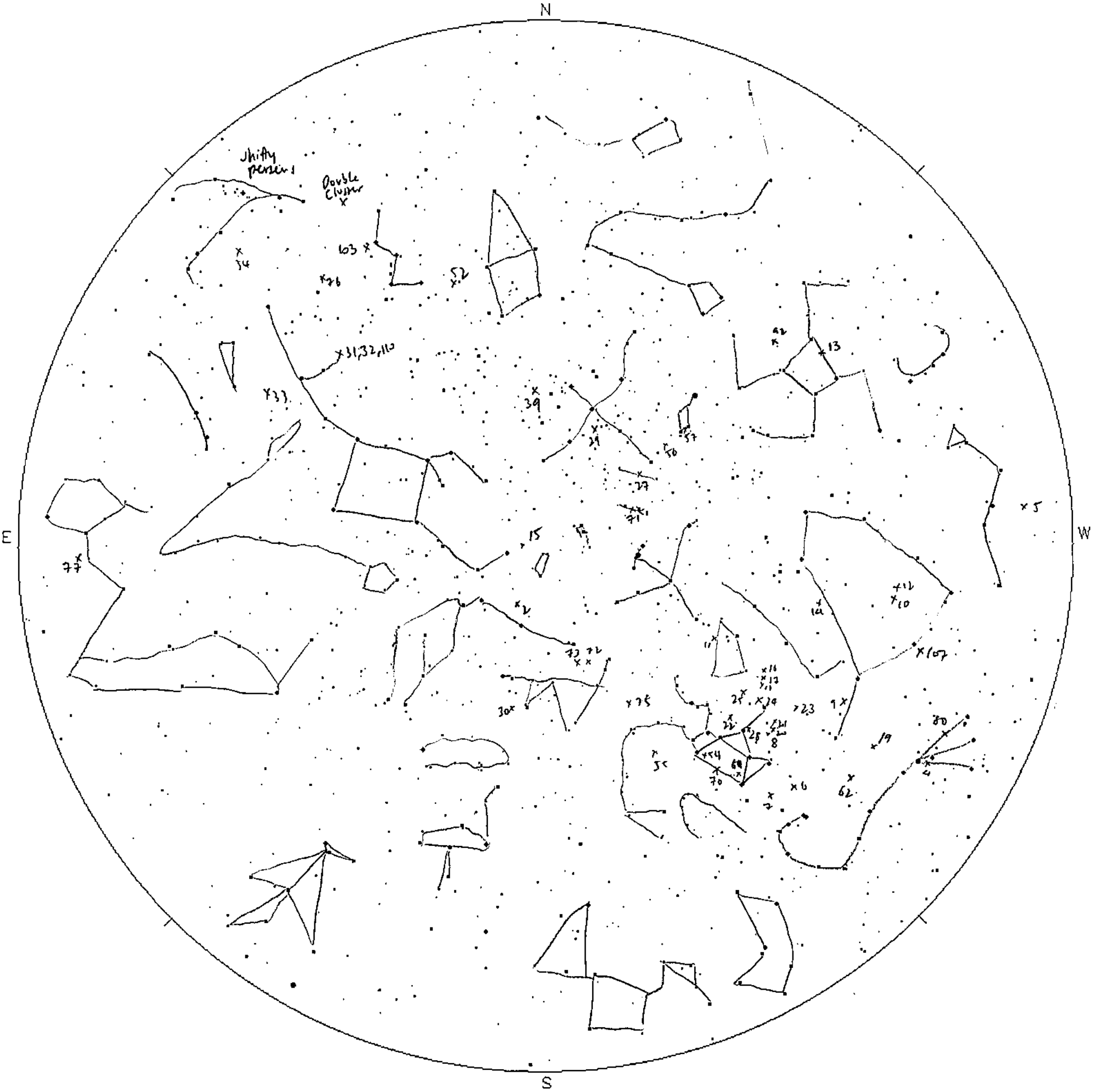




I'm into BDSM

ig
ata
ecurity
anagement


S
SMC
LMC
θ
x 7
x C99
Jewel Box
x 79
x 41
73
x 50
46,47
48
x 7
x 6
x 62
17
x 9
80
107
x 83
x 104
95,96,105
x 65,66
x 3
x 63
x 106
x 51
x 101
x 102
95,107
x 104
81,82
W
E
N


N
E
W
S
Shifty perseus
Double Cluster
63
34
76
52
31,32,110
33
39
29
50
57
27
71
15
2
77
73
72
30
75
42
13
5
12
10
14
107
11
16
17
11
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9
22
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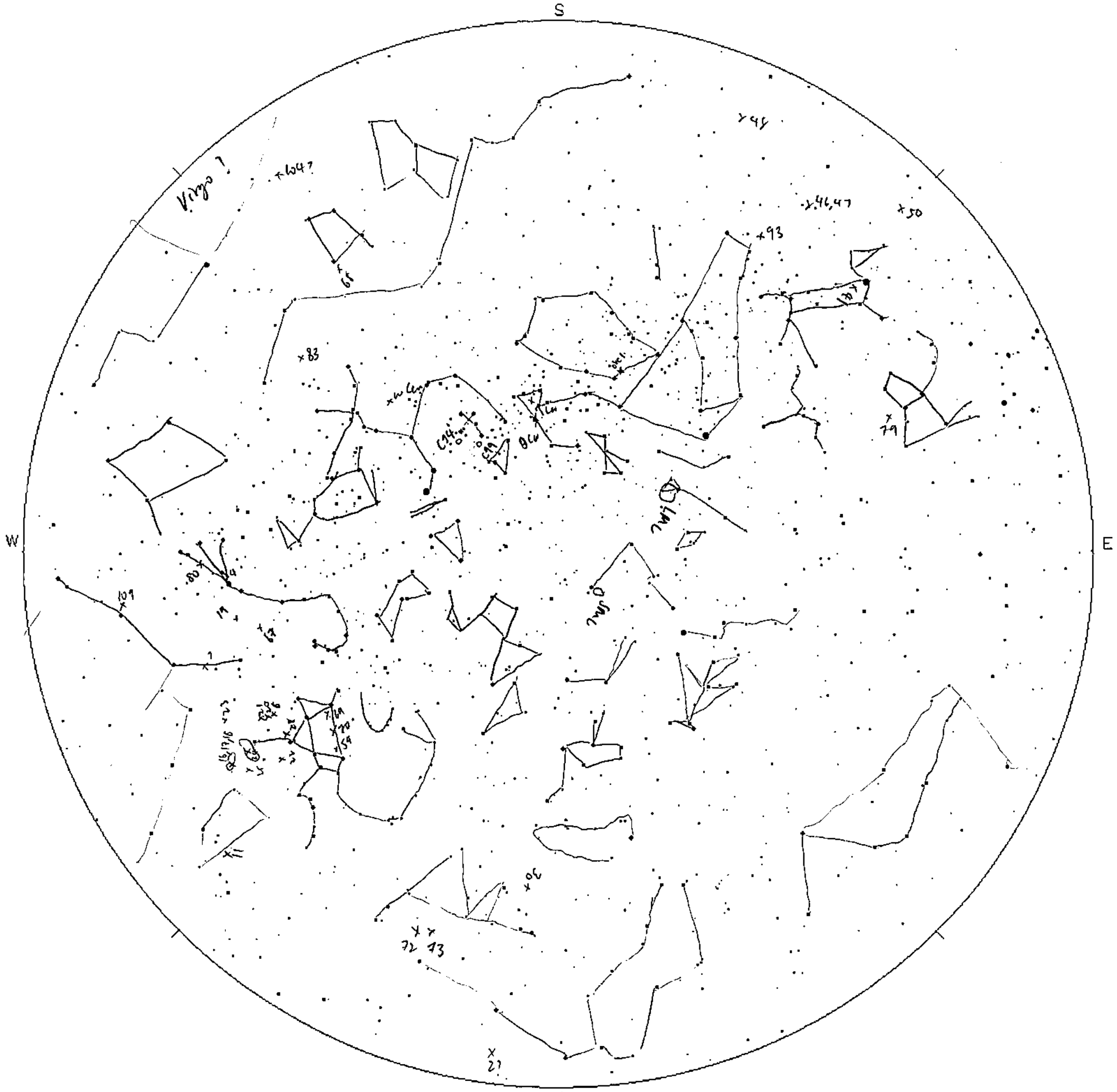
54
68
70
55
6
2
62
19
80
4

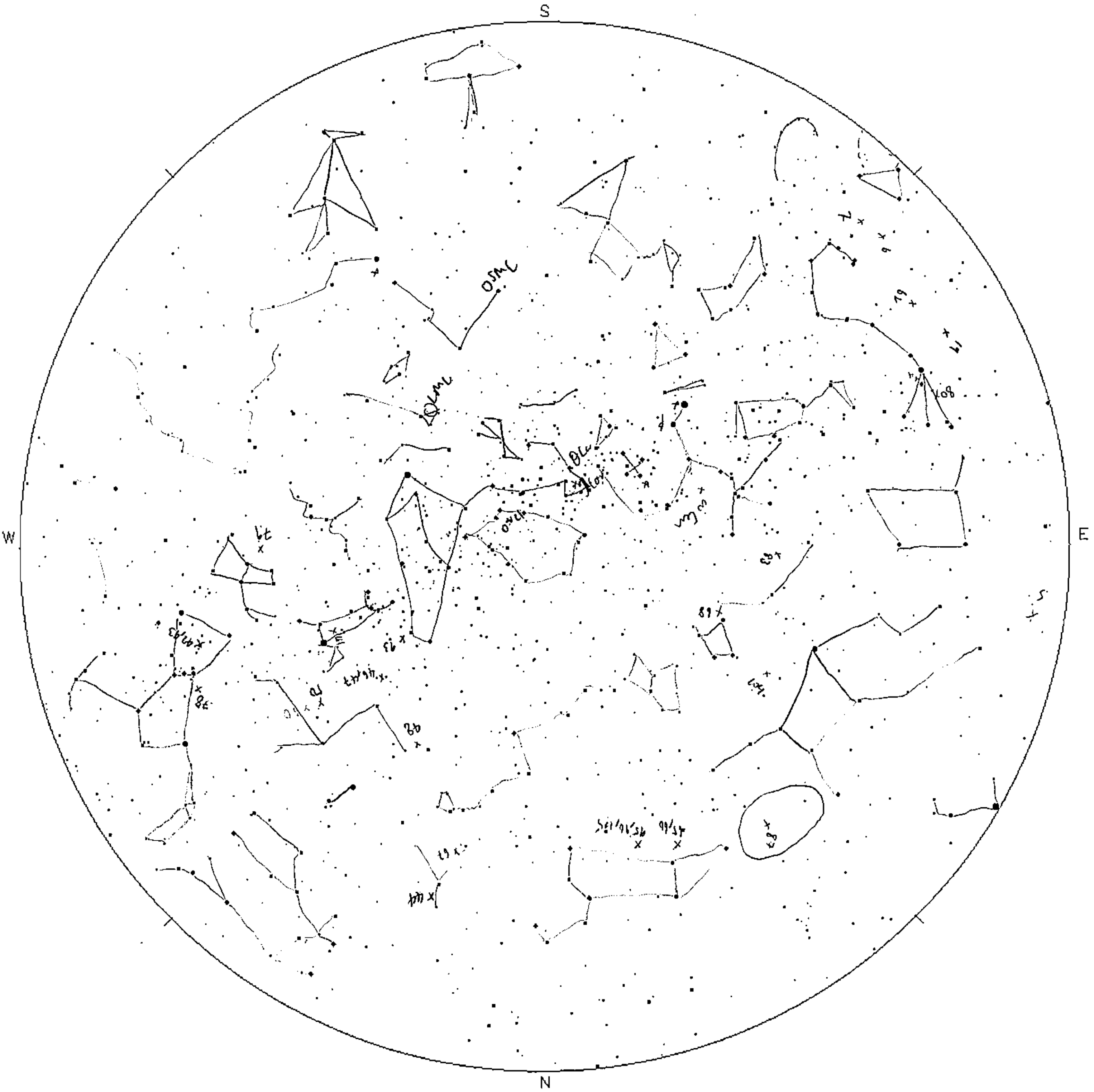


シ

アイウエオ
カキクケコ
サシスセソ
ナニヌネノ
ハヒフヘホ
マミムメモ
ヤユヨ
ラリルレロ
ワヲン

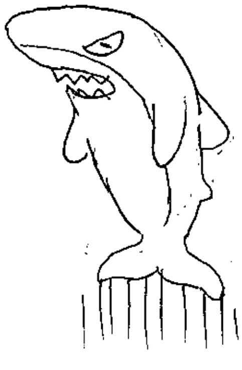
あいうえお
かきくけこ
さしすせそ
たちつてと
なにぬねの
はひふへほ
まみむめも
やゆよ
らりるれろ
わをん

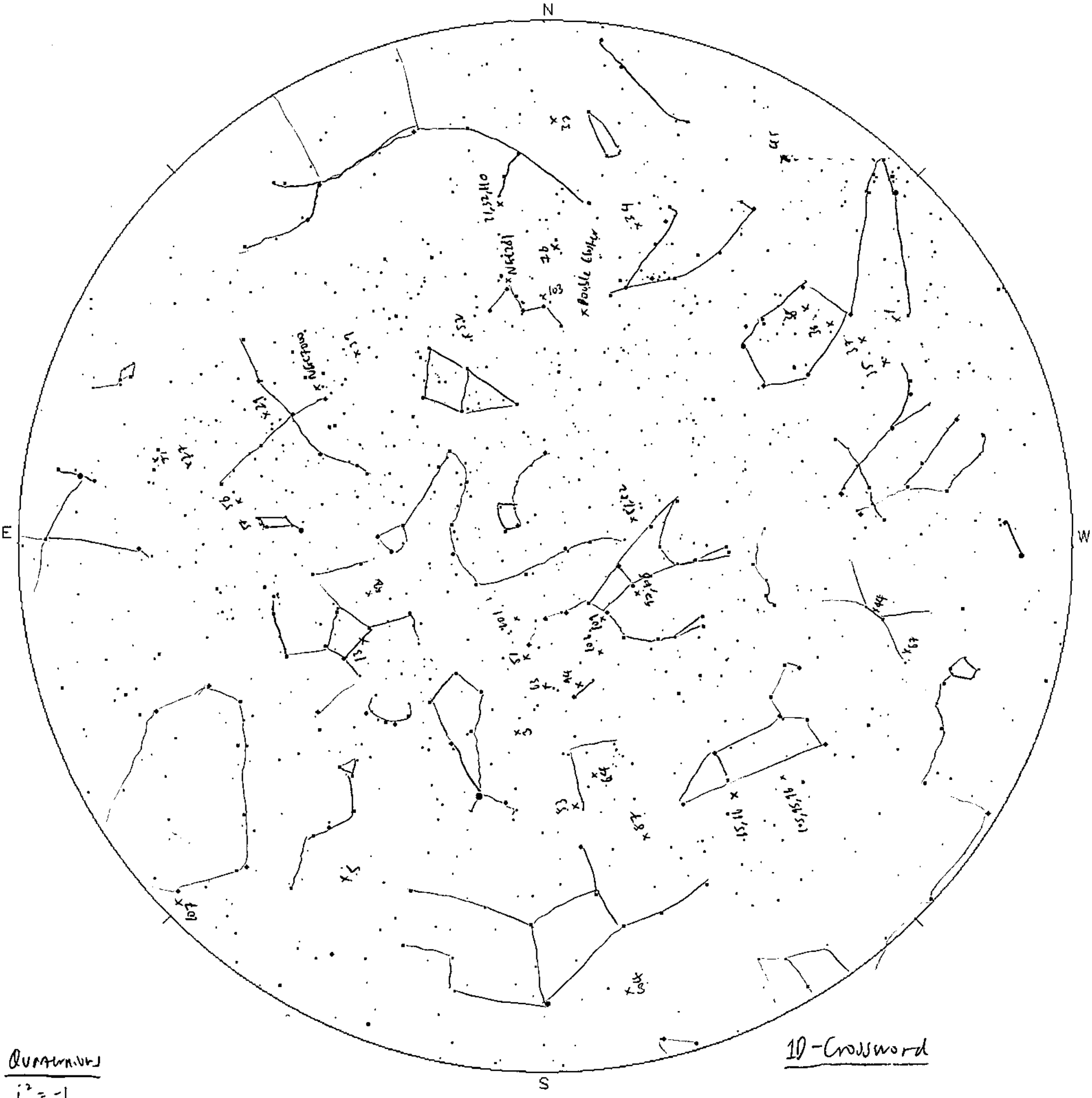
ゐゑ ヱ



即

犀罕
しゅ ぎ ゆら どう
す ぎ う ず
即擬熊頭





Quaternions

$i^2 = -1$

$j^2 = -1$

$k^2 = -1$

$ij = k \quad ik = j \quad jk = i$

$ji = -k \quad ki = -j \quad kj = -i$

$ijk = -1$

1D-Crossword

1 4		2	5	3			6	

Horizontal (Left to Right)

1 Famous American Cellist

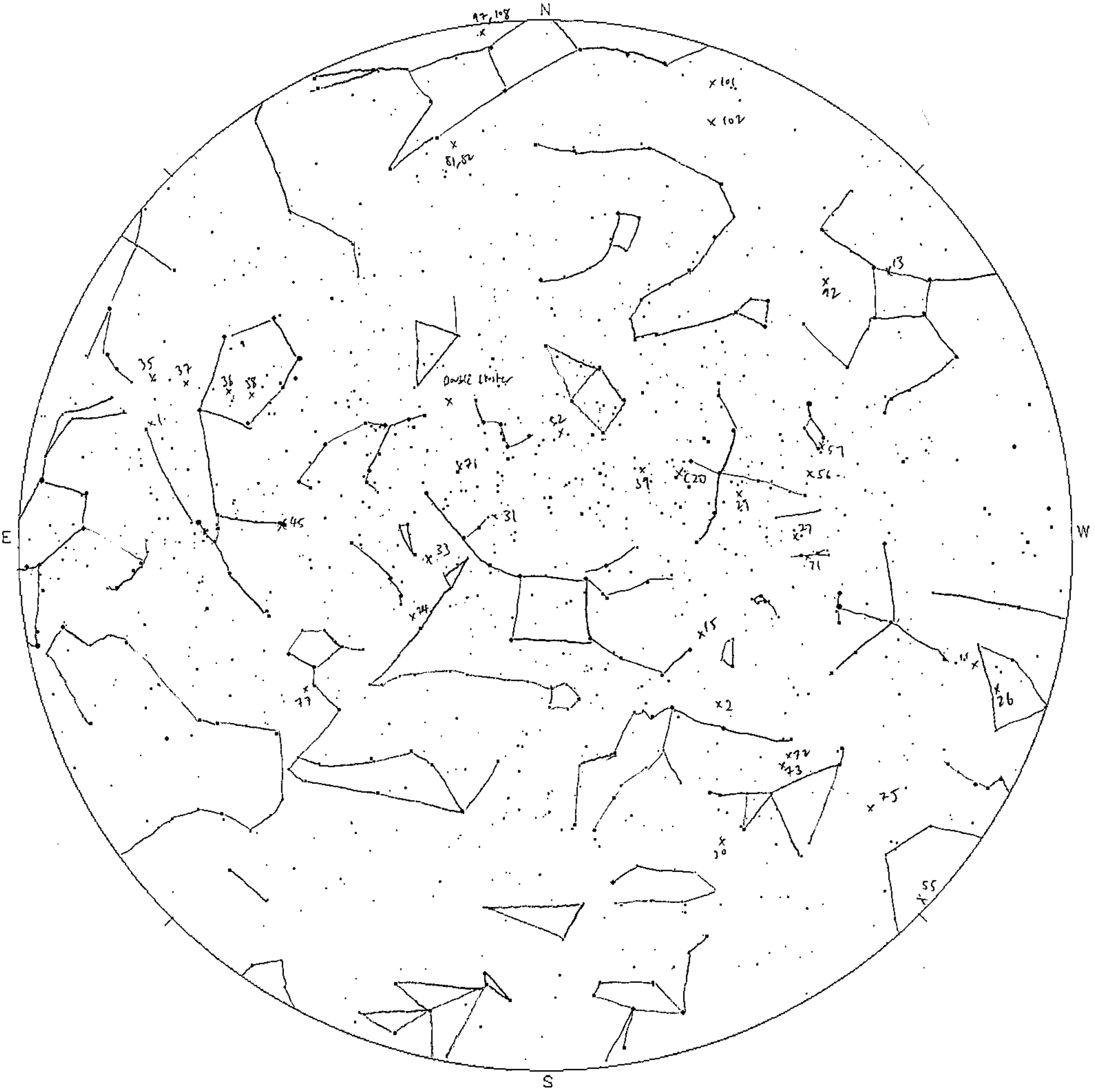
2 2 letter casual greeting

3 Shah ___ Hitesh

4 Toy in which you manipulate cylinders with your fingers via a string (Ignore dashes)

5 Airport code for Omaha, Nebraska

6 V = ___


N
97, 108
101
102
81, 82
E
35
37
36
38
1
Double Cluster
52
71
13
12
57
56
39
C20
29
27
71
45
31
33
24
15
11
26
2
77
72
73
75
30
55
W
S

Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kare kiat

Leng kane kiat
Leng kane kiat
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Leng kone kiat
Leng kane kiat
Leng kane kiat

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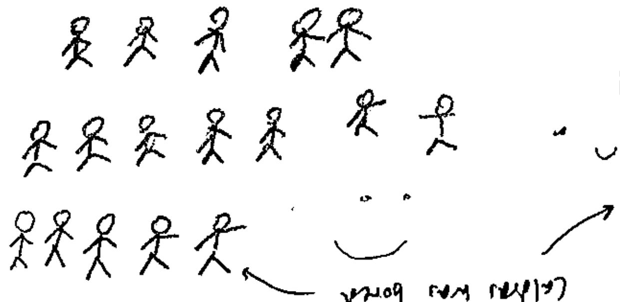
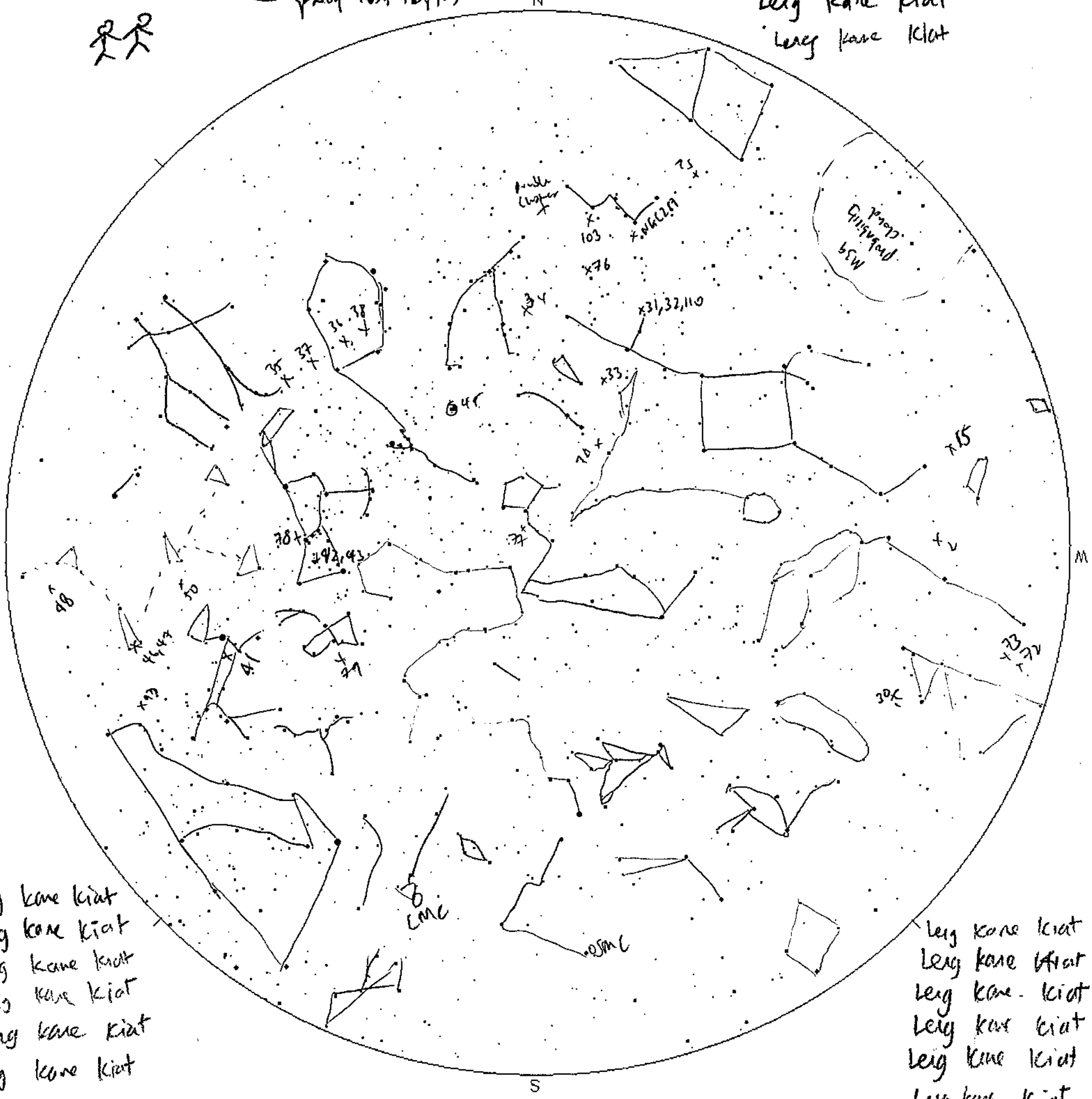
Leng kare kiat





eng kane kiat
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Leng kane kiat
Leng kane kiat

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Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat

great great great great great great great great great great great great
great great gaeat great great

Leng kane kiat
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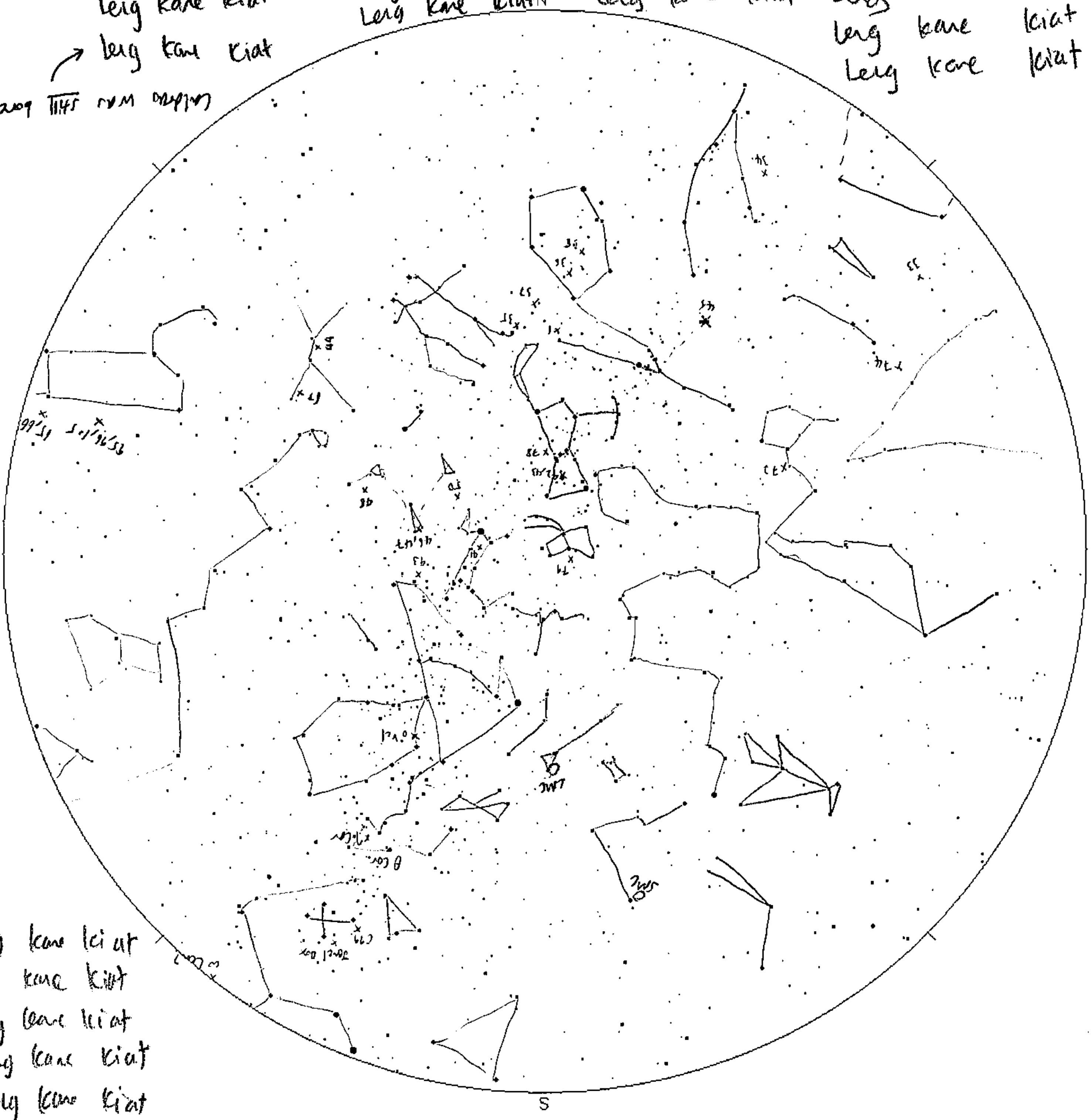
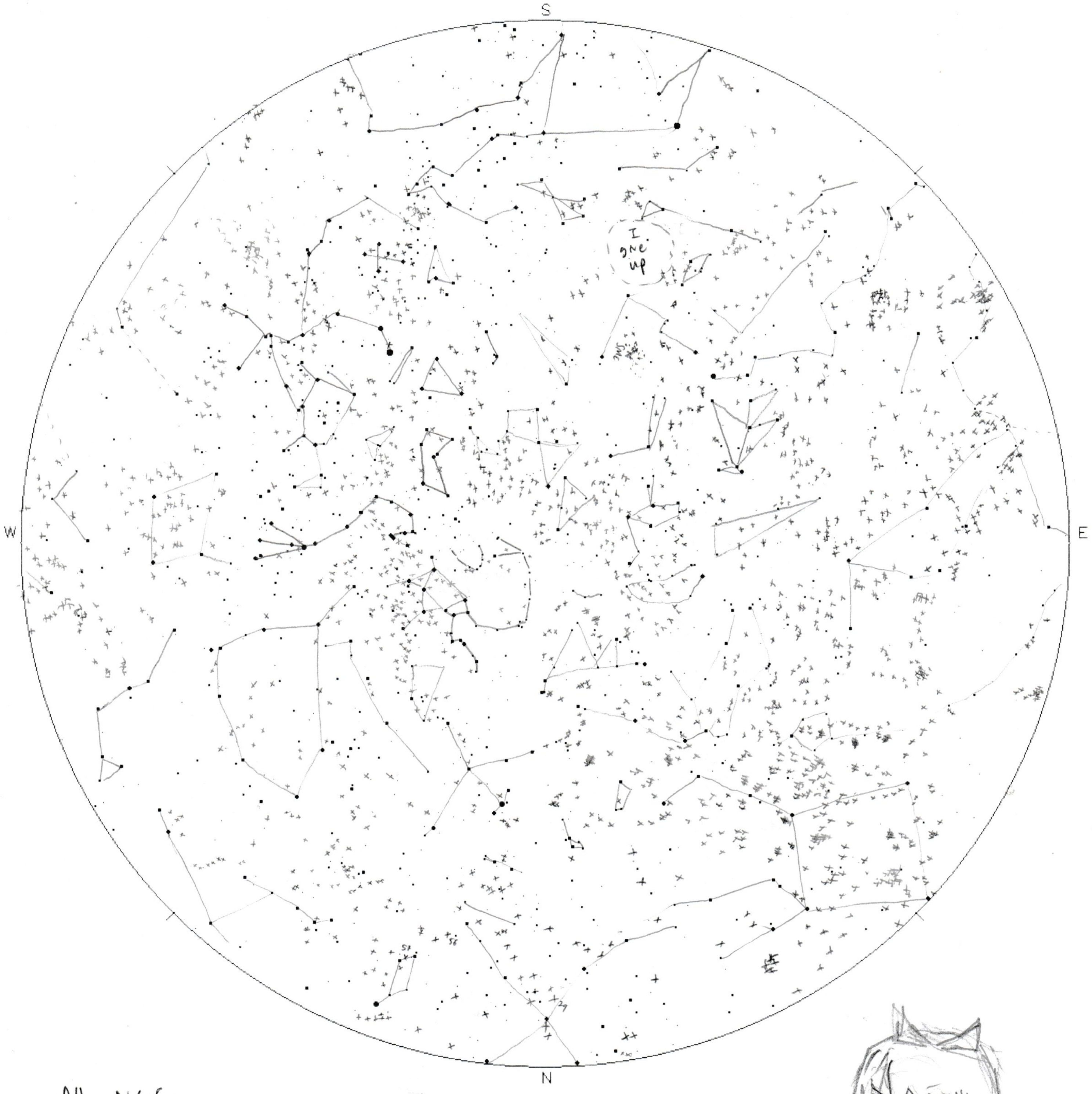
Leng kane kiat
Leng kane kiat
Leng kane kiat

Caldera was still bored

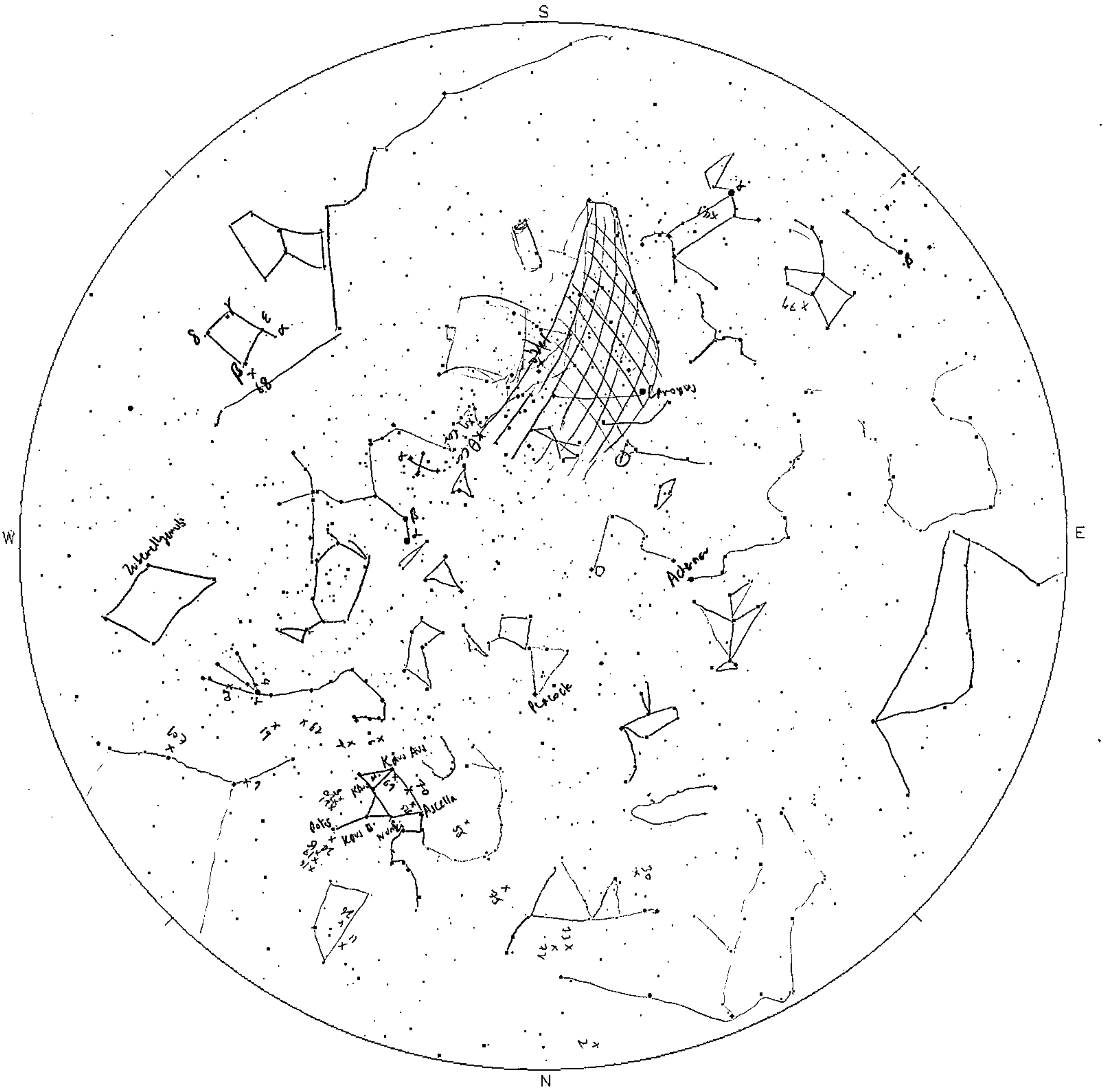


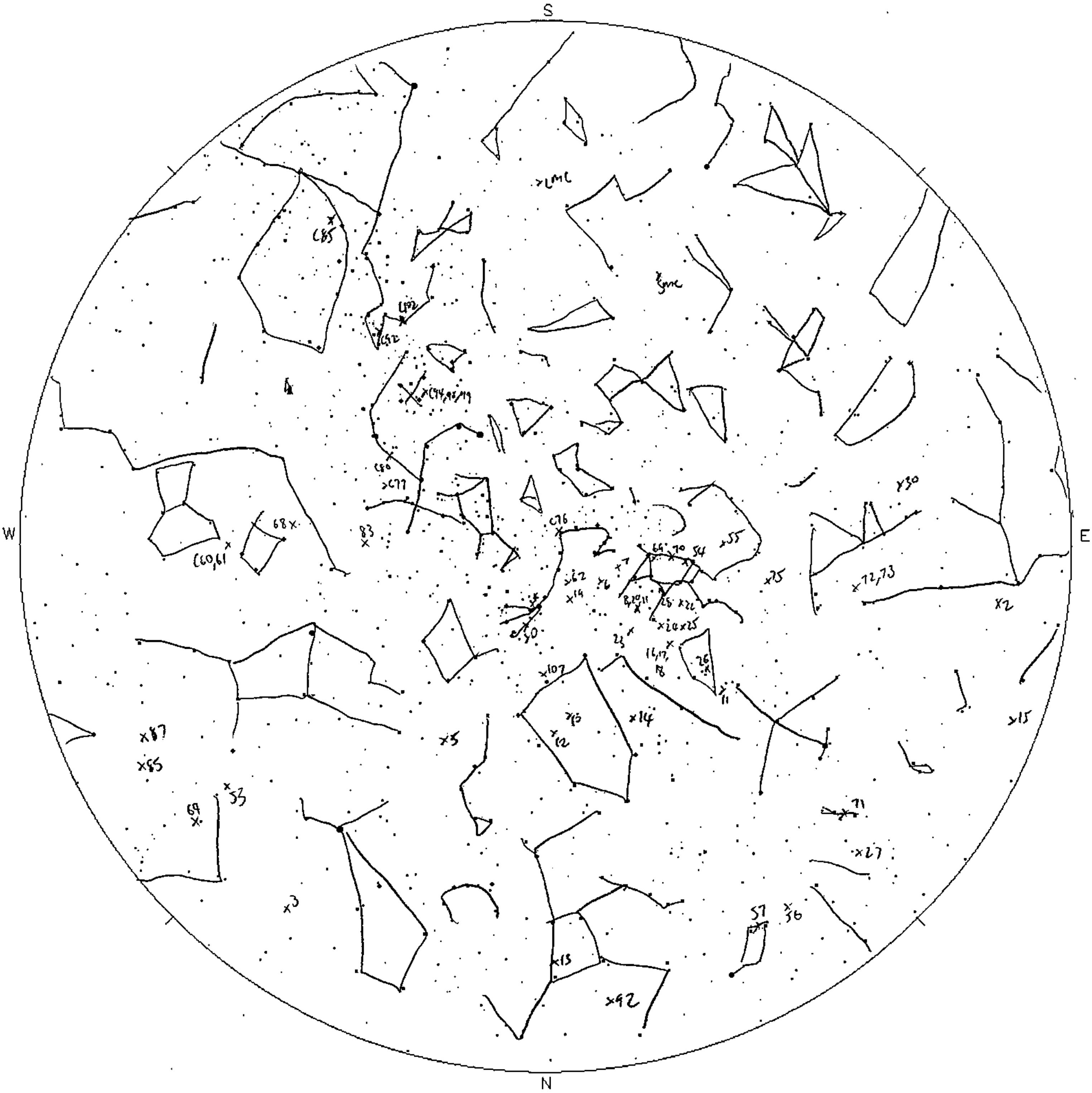
Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat
Leng kane kiat



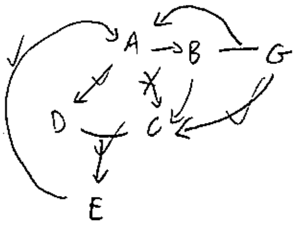
All NGCs

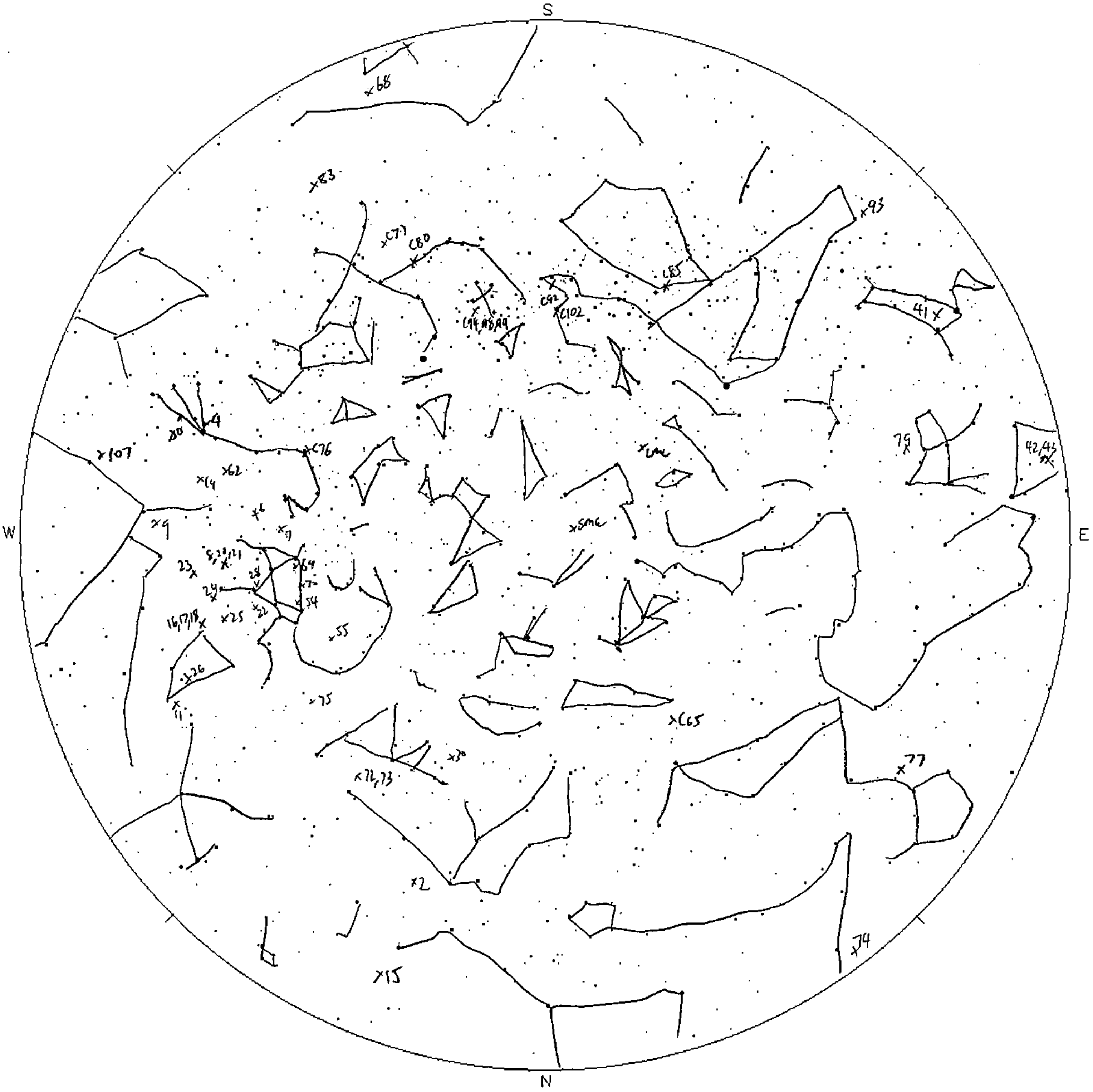
Kane this is legitimately concerning

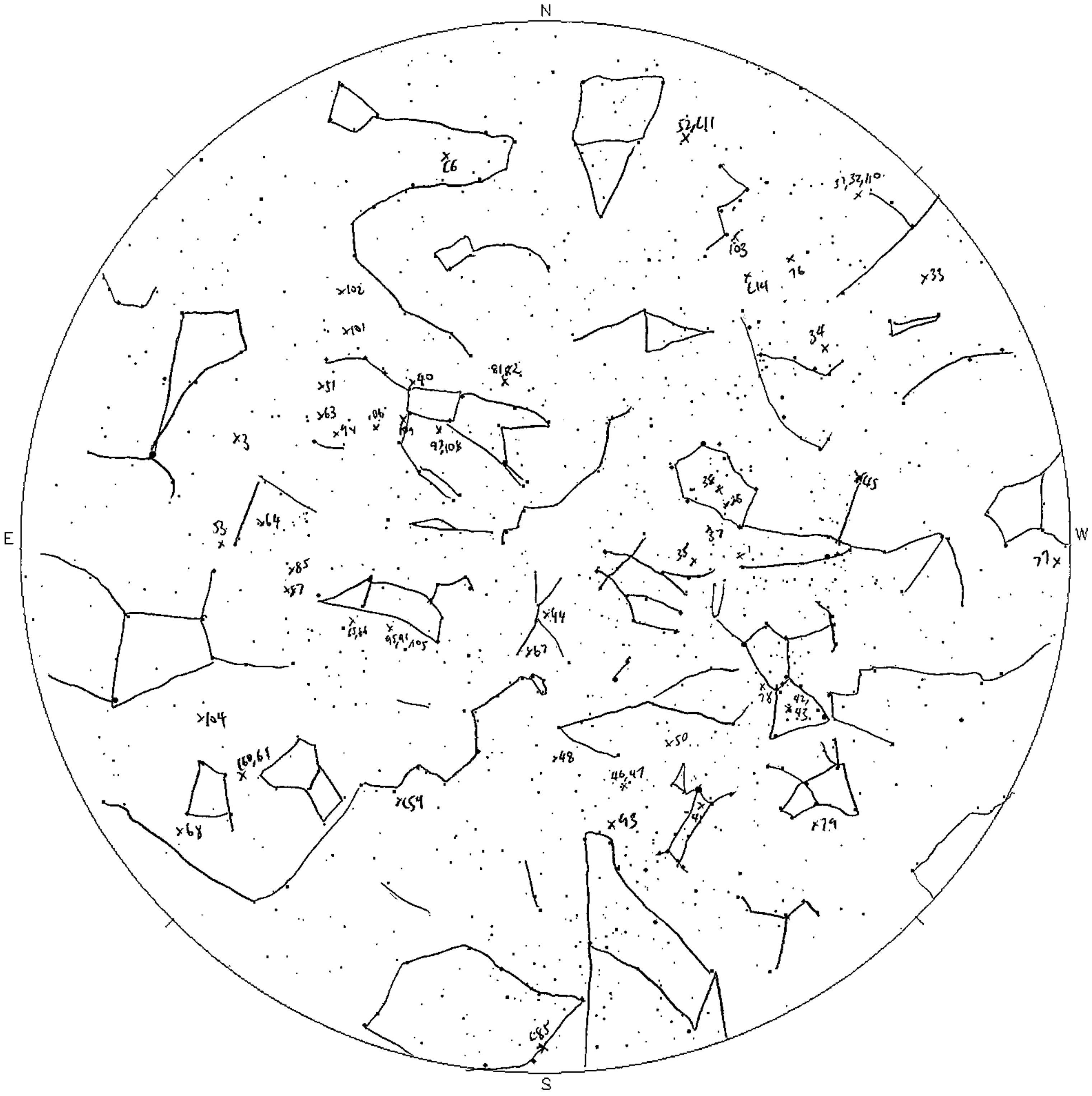

S
W
E
N
Zubenelgenubi
Canopus
Achernar
Peacock
Kaus Aus
Kaus B
Nunki
Ascella
Polis
α
β
γ
δ
ε

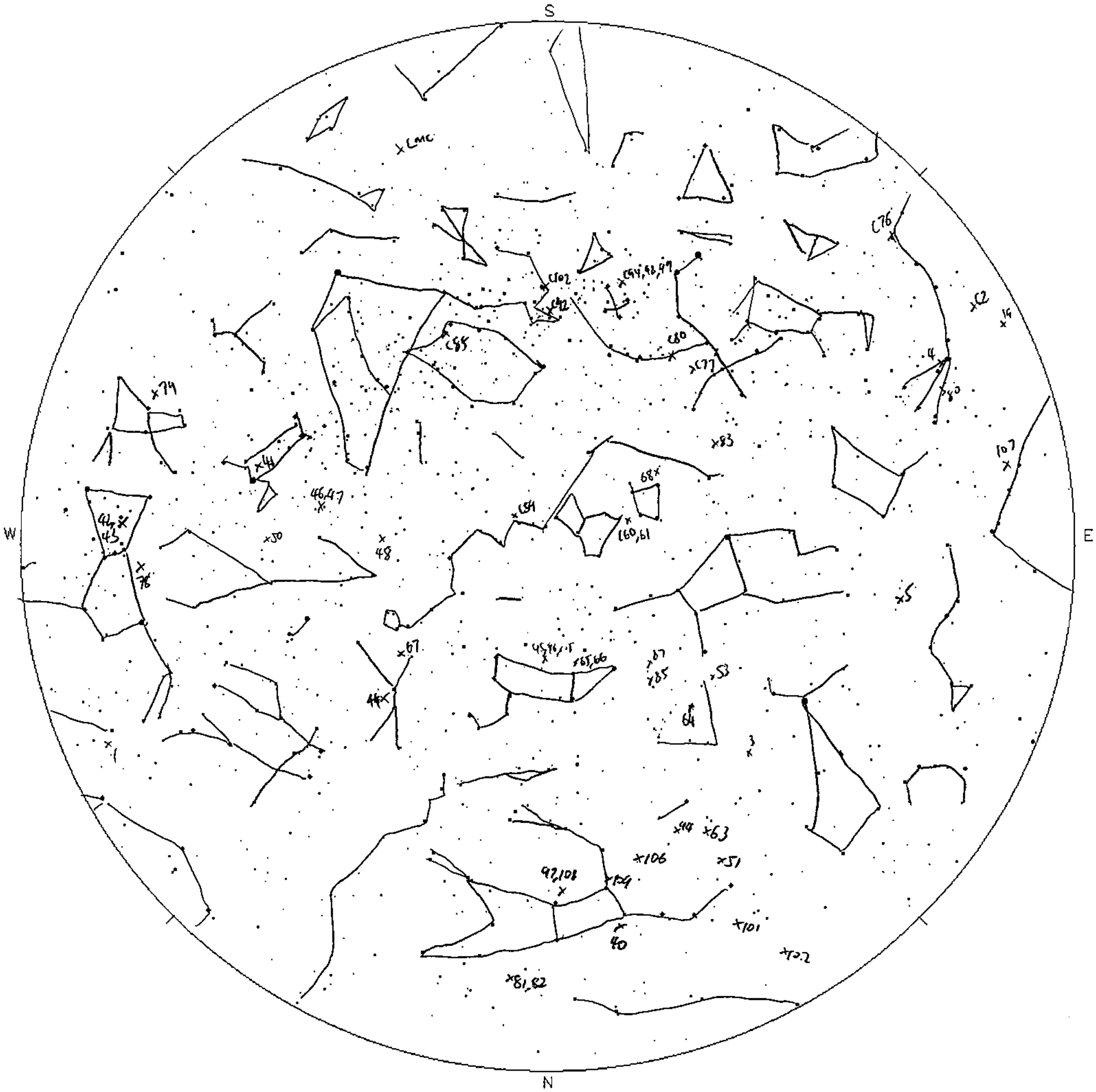

S
N
W
E
LMC
SMC
C85
C92
C72
C94,95,99
C80
C77
83
68
C60,61
C76
62
6
7
14
69
70
54
55
75
30
72,73
2
8,20,11
28
22
24
25
4
50
23
16,17,18
26
11
107
15
12
14
5
87
85
53
69
3
13
92
57
56
71
27
15


S
W
E
N
C99,93,97
C102
C92
SMC
CM6
C85
C65
C59
93
91
47
48
50
79
dude how weird is this duck
42
43
46
77
74
67
95,96,125
44
45
1
35
37
36
38
33
34
31,33,110
76
C14

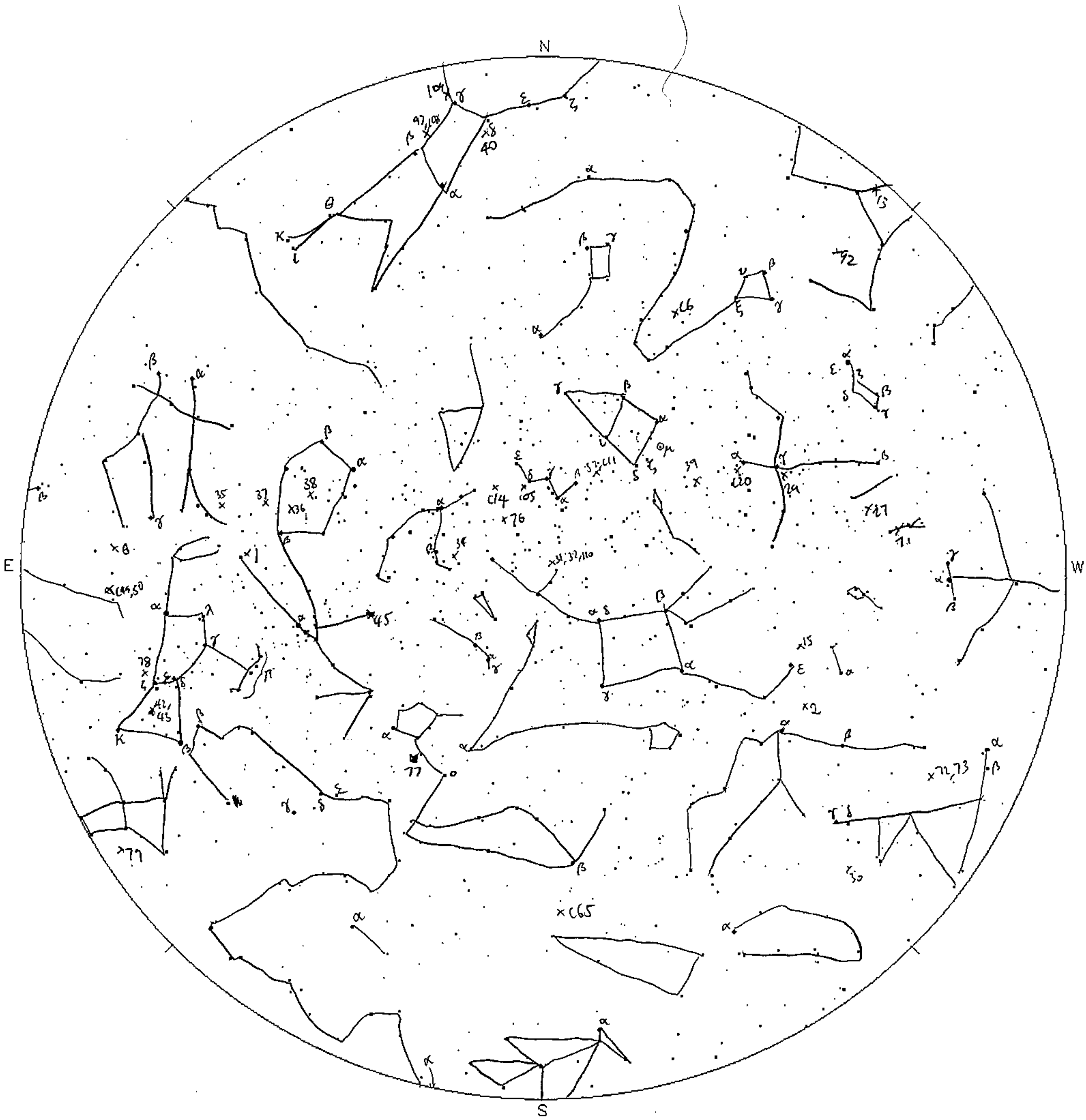

A
B
G
D
C
E

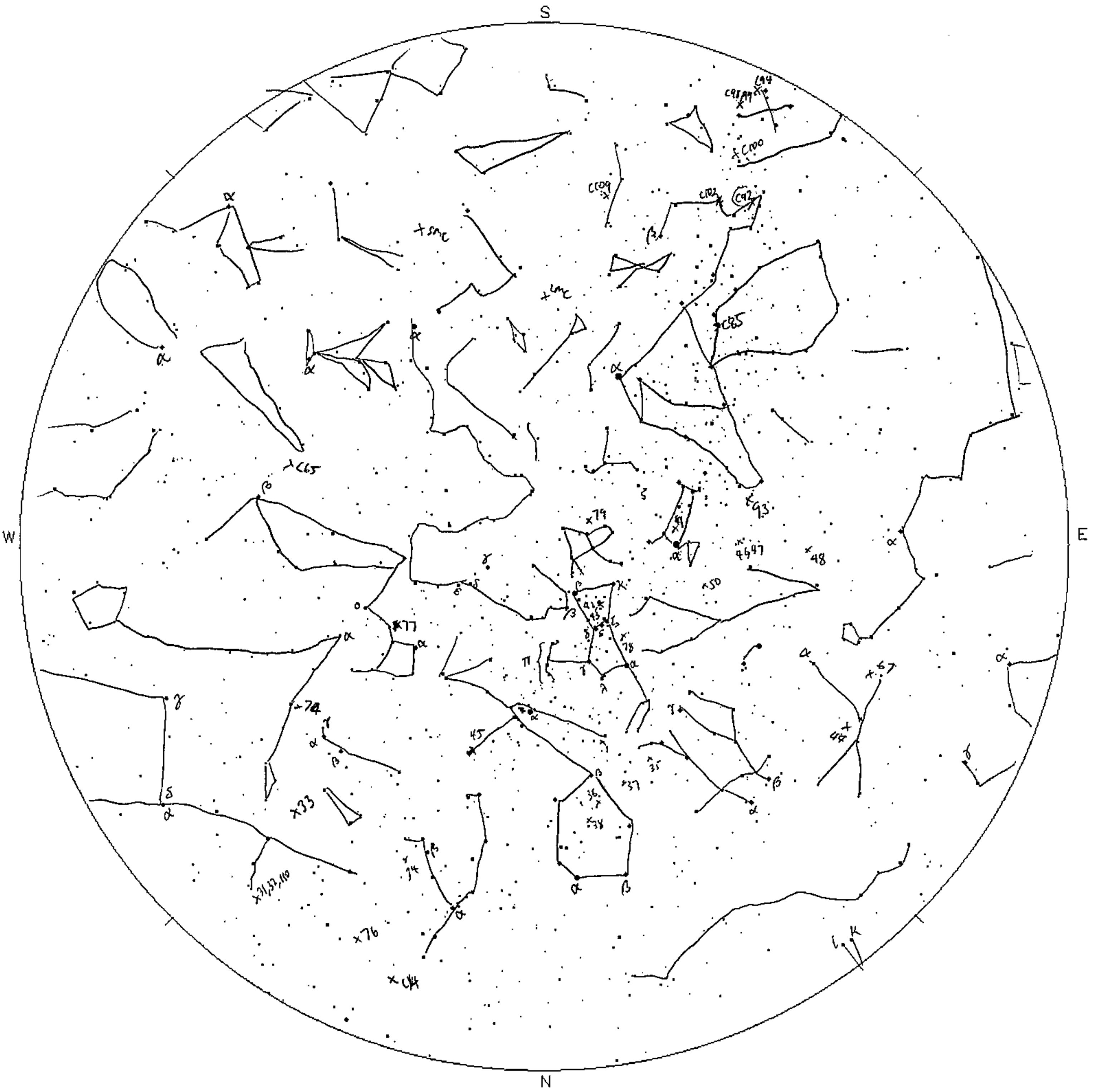

S
x68
x83
C77
C80
C94,88,89
C92
C102
C85
x93
41 x
x107
80
4
C76
x62
x14
LMC
79
42/43
W
x9
x6
x7
SMC
E
8,20,21
23
28
x64
x72
54
24
x25
x22
16,17,18
x55
x26
11
x75
C65
x30
72,73
x77
x2
74
x15
N

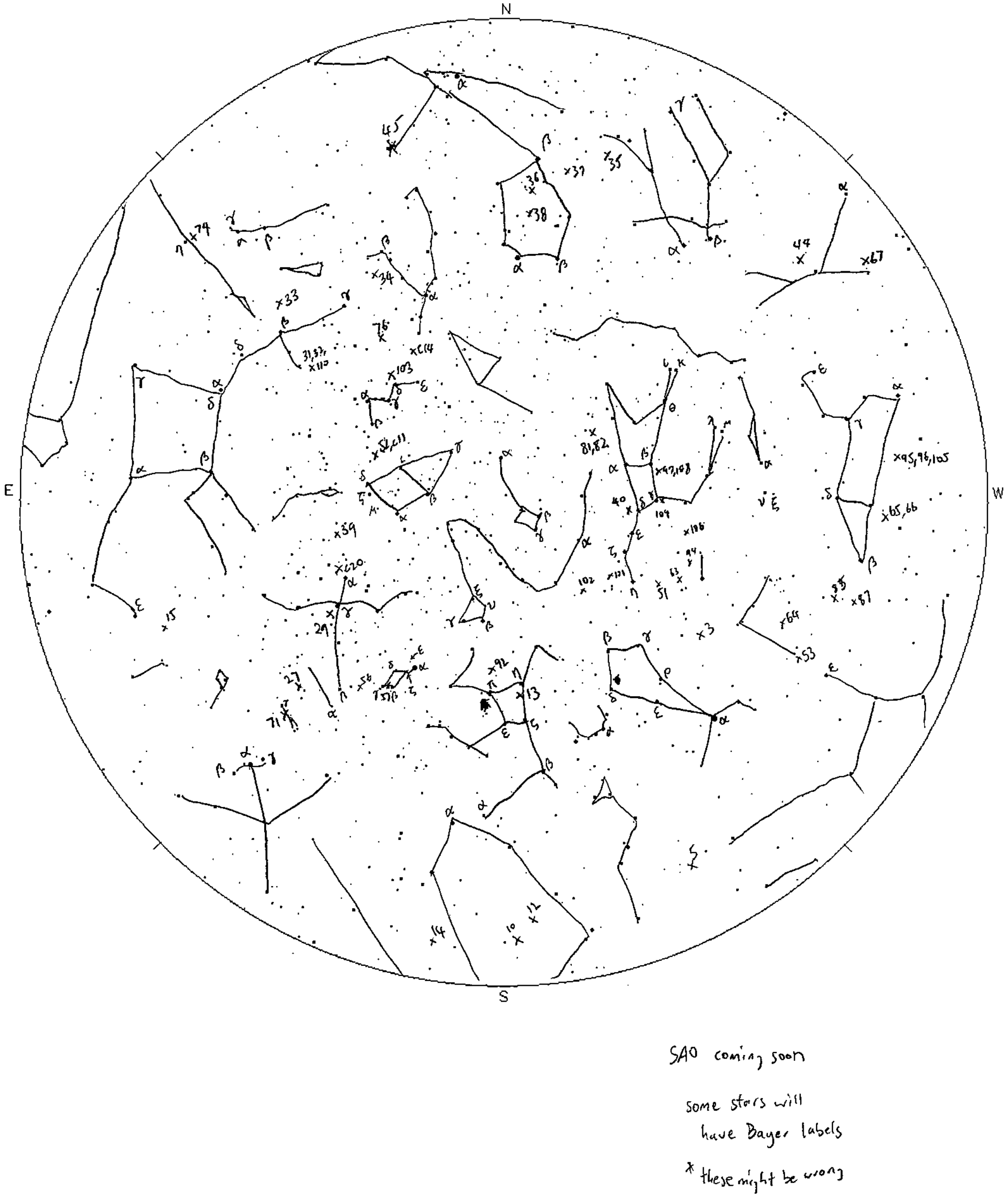

N
52,611
66
37,32,110
103
114
76
x33
x102
x101
34
81,82
x40
x51
x63
106
x94
109
93,108
x3
38
x26
x45
53
x64
37
35
x1
E
W
77x
x85
x87
15,66
95,96,105
x44
x67
78
42,
43
x104
x50
x48
60,61
46,47
x68
x59
x49
41
x79
85
S


S
W
E
N
×LMC
C102
C94, 98, 99
C92
C88
C80
C77
C76
C2
14
4
80
×79
×44
46,47
41, 42, 43
78
×50
48
C84
68×
C60, 61
×83
107
×5
×67
46×
45,46,15
×65,66
×67
×85
×53
64
×1
3
×49
×63
×106
×51
47,108
×109
40
×101
×102
×81,82


N
E
W
S
×63
×99
106
×90
109
97,108
81,82
×52,111
103
×49
×76
×3432,110
34
×85
×87
38
×36
37
35
74
65,66
95,96,105
×44
×61
×1
45
77
×78
41
43
×48
×80
46,47
×93
41
×79
C85


N
S
E
W
104
97,108
×8
40
×15
+92
×C6
C14
×76
105
×81,82,110
38
×36
35
37
×1
×8
α(44,50)
×45
78
×21
43
34
39
C20
29
×27
71
×15
×2
×72,73
×30
×77
×C65
77
θ
κ
ι
π
λ
μ


S
W
E
N
C94
C98 C99
C100
C109
C102
C92
C85
SMC
LMC
C65
C93
79
47
4647
48
50
77
74
45
44
57
33
36
34
37
35
78
41
42
21,32,110
74
76
C14
α
β
γ
δ
ε
ζ
κ
λ
π
ι
κ

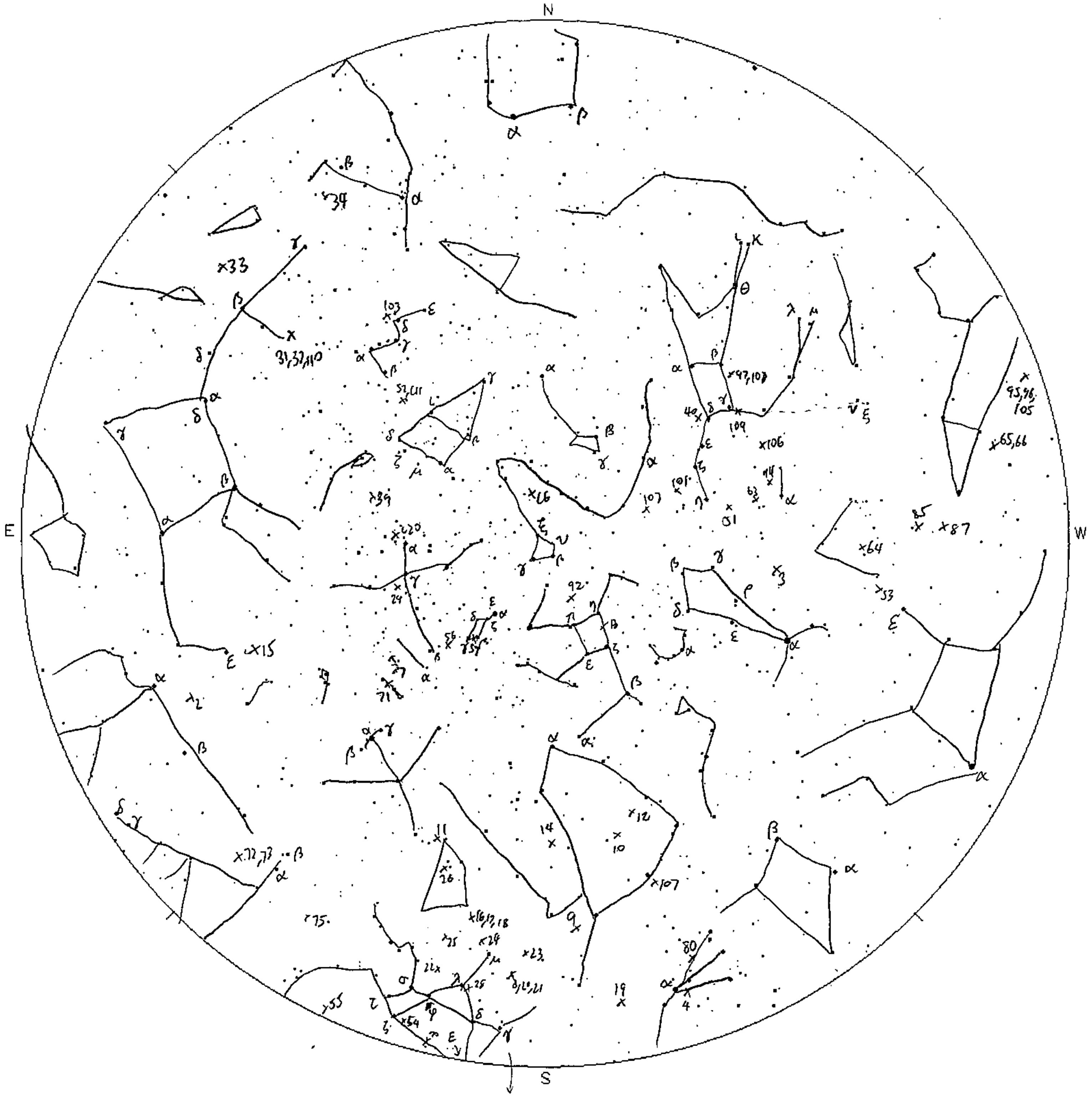


SAO coming soon

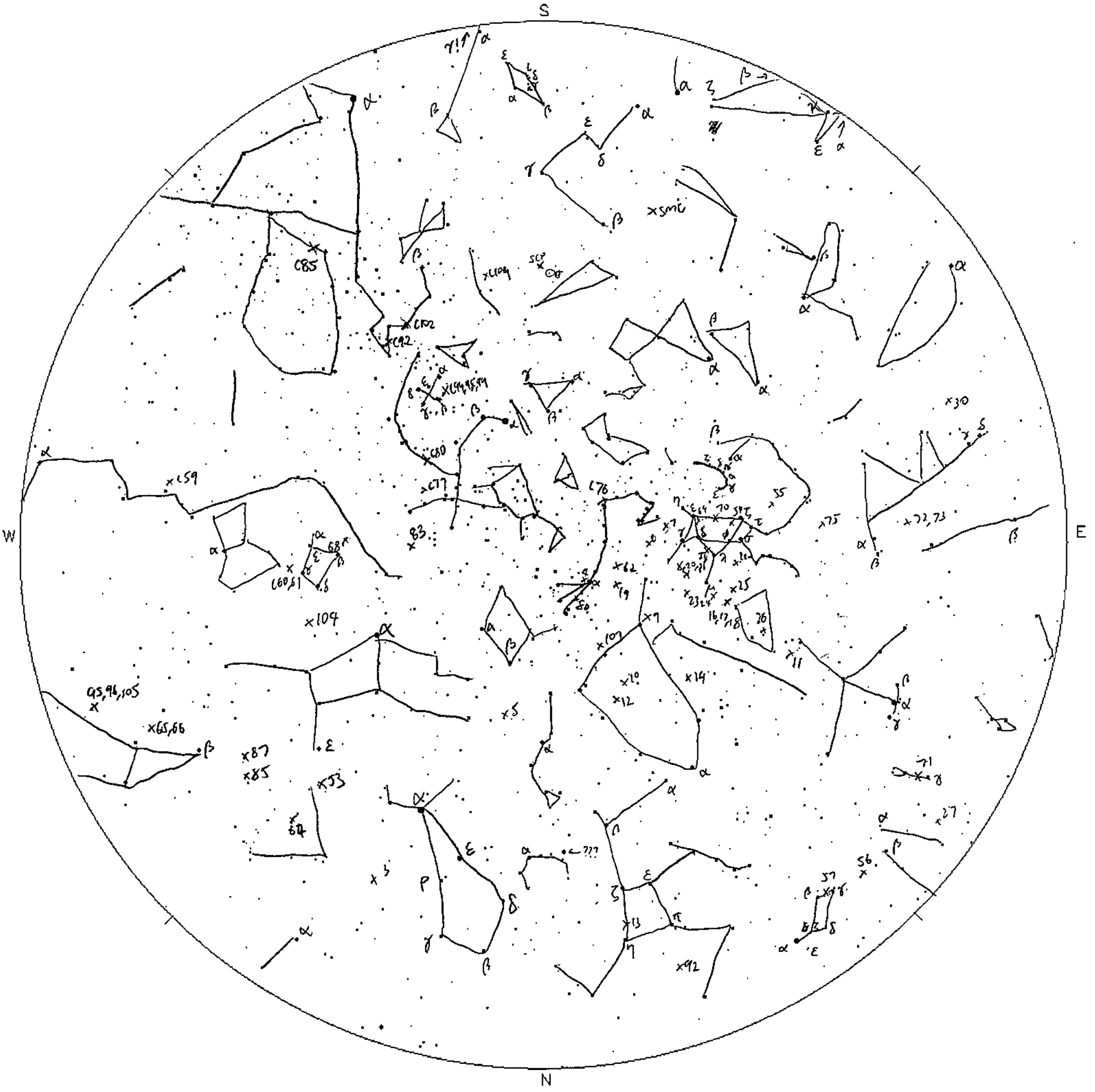
some stars will
have Bayer labels

* these might be wrong


N
E
W
S
C6
92
38
36
37
C14
103
51, L11
C20
76
34
31, 32, 110
33
45
1
97, 43
79
77
74
15
2
72, 73
30
75
27
91
56
57
29
11
26
15, 17, 18
13
24
M
22
55
54
70
59
SMC
Peacock



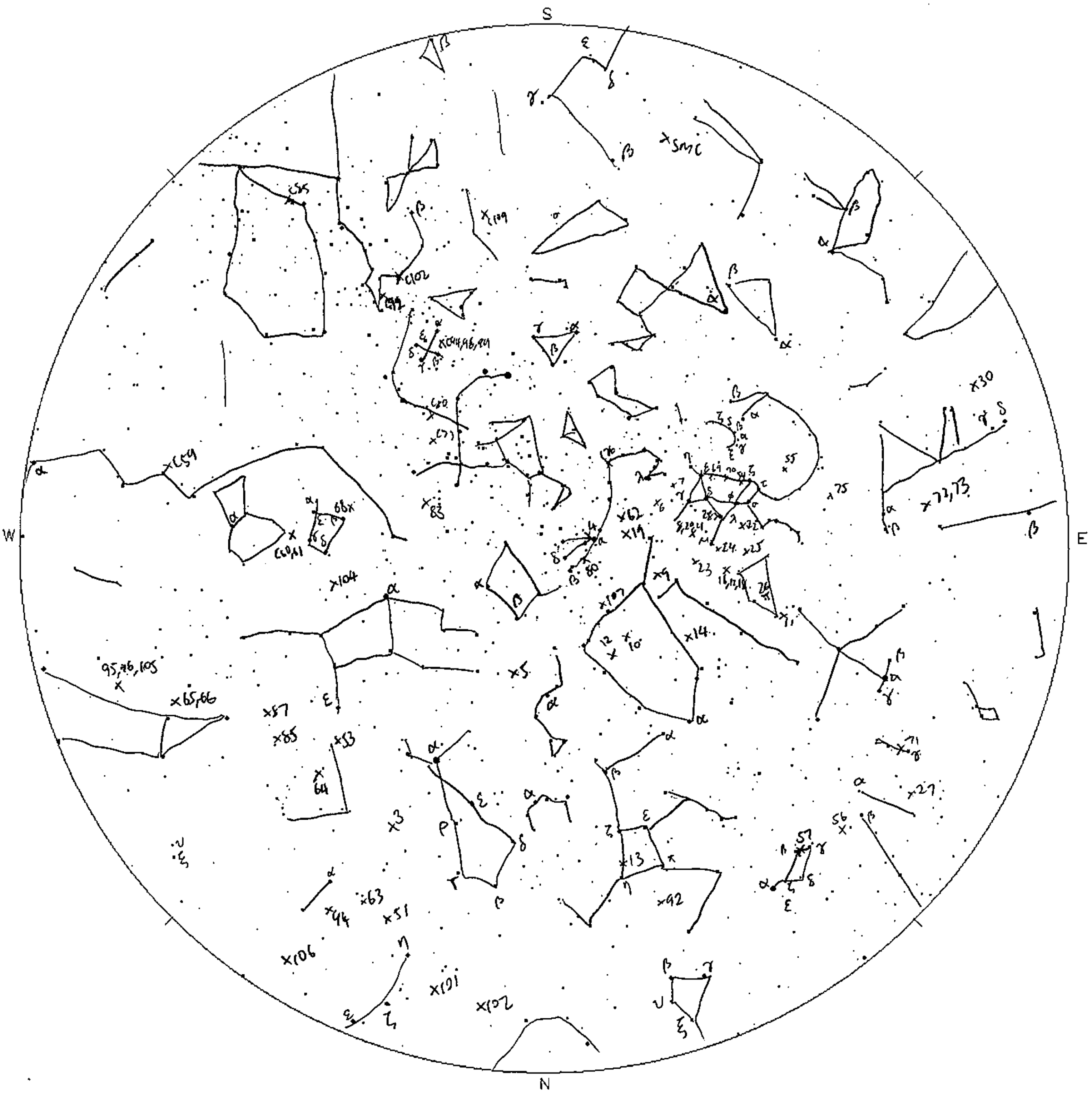
useful to remember
γ Sgr (Alnasl)
has RA ≈ 18h

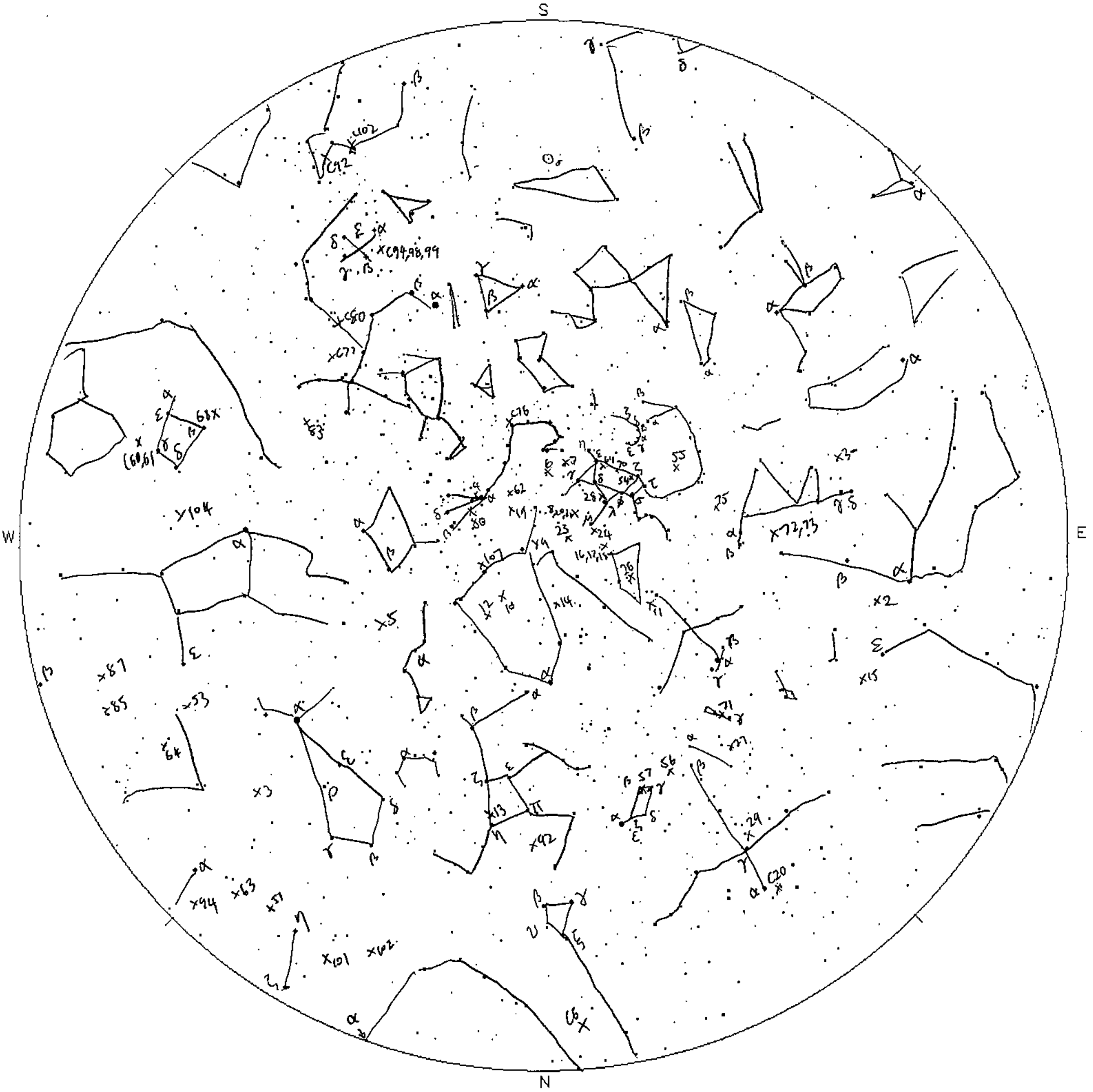


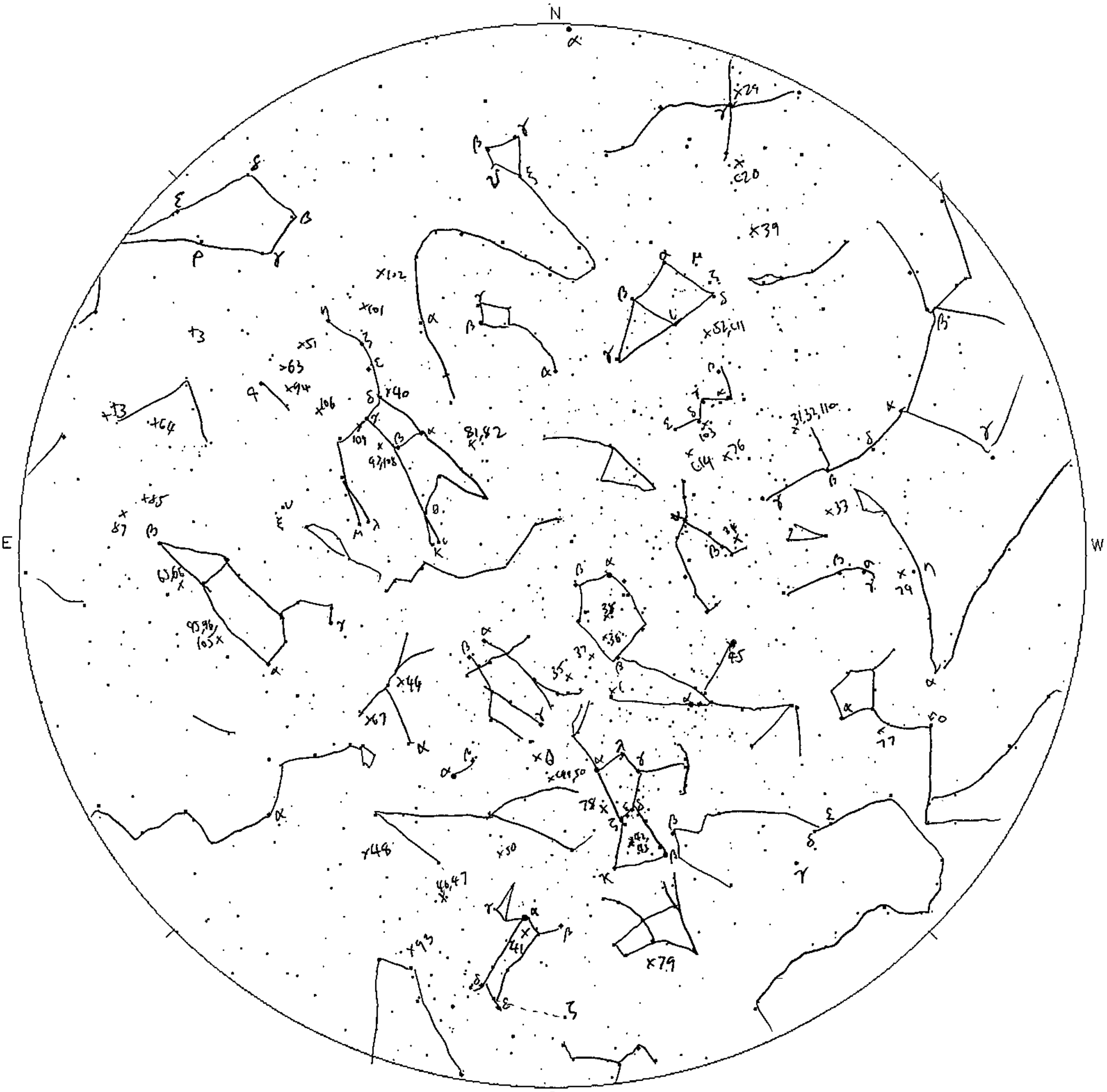
Bayer:

$$\overset{\text{very impt}}{\alpha}\,\overbrace{\beta\gamma\delta}^{\text{somewhat}}\,\underbrace{\varepsilon\zeta\eta\theta\iota\kappa\lambda\mu\nu\xi}_{\substack{\text{they may test}\\ \text{if it is part}\\ \text{of recognizable}\\ \text{shape}\\ \text{e.g. head of Draco,}\\ \text{Hercules keystone}}}\,\overbrace{o\pi\rho\sigma\tau\upsilon\phi\chi\psi\omega}^{\text{who cares}}$$

Famously not ordered by brightness, RA, dec
or anything really
(e.g. Draco, brightest in Sgr is Nunki, σ Sgr)


S
W
E
N
SMC
C55
C102
C99
C109
C100
C71
C59
C60,61
C70
C44,46,49
x104
x83
x62
x19
x9
x107
x14
12
10
x5
x7
x6
x23
x24
x25
x22
x75
x30
x72,73
x71
x27
56
57
x13
x92
x3
x53
x64
x85
x87
x65,66
95,96,105
x63
x44
x51
x106
x101
x102
68
80
55
α
β
γ
δ
ε
ζ
η
λ
ξ
υ


S
W
E
N
C102
C92
C94,98,99
C80
C77
C76
68
60,61
104
83
5
87
85
53
64
3
94
63
51
101
102
13
92
6
C20
29
56
57
71
27
15
2
3
72,73
75
55
26
11
14
12
10
107
4
30
62
19
8
20,21
23
24
16,17,15
28
54
64
70
9
7


N
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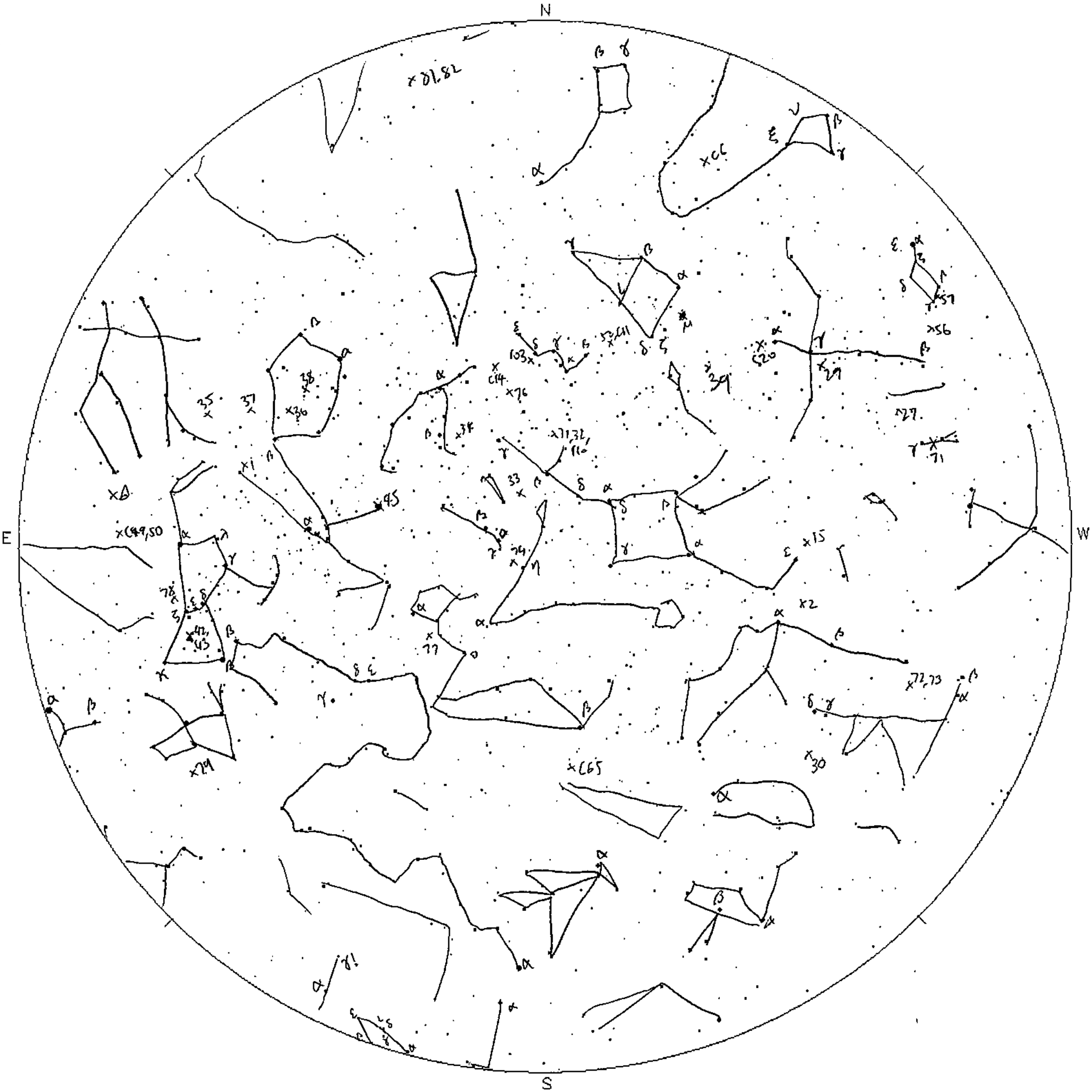
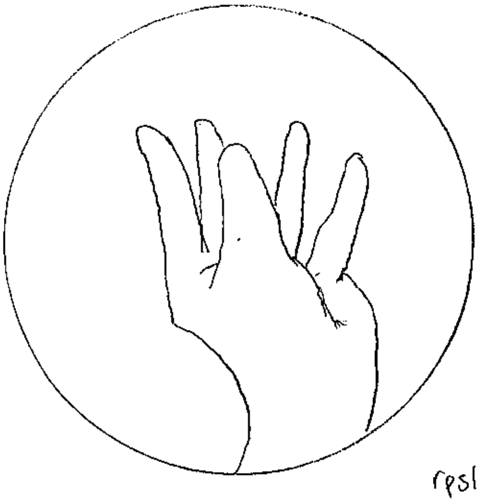
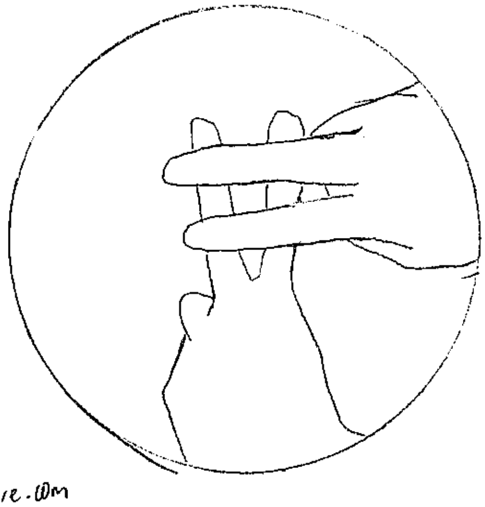
W
S
x29
C20
x39
x102
x101
x51
x63
x94
x106
x40
x3
x13
x64
81,82
93,108
109
x85
87
63,66
95,96,105
x52,41
103
C14
x76
31,32,110
x33
79
38
x36
35
37
x44
x67
x49,50
78
x82,83
x48
x50
46,47
x93
x41
x79
45
77
x1



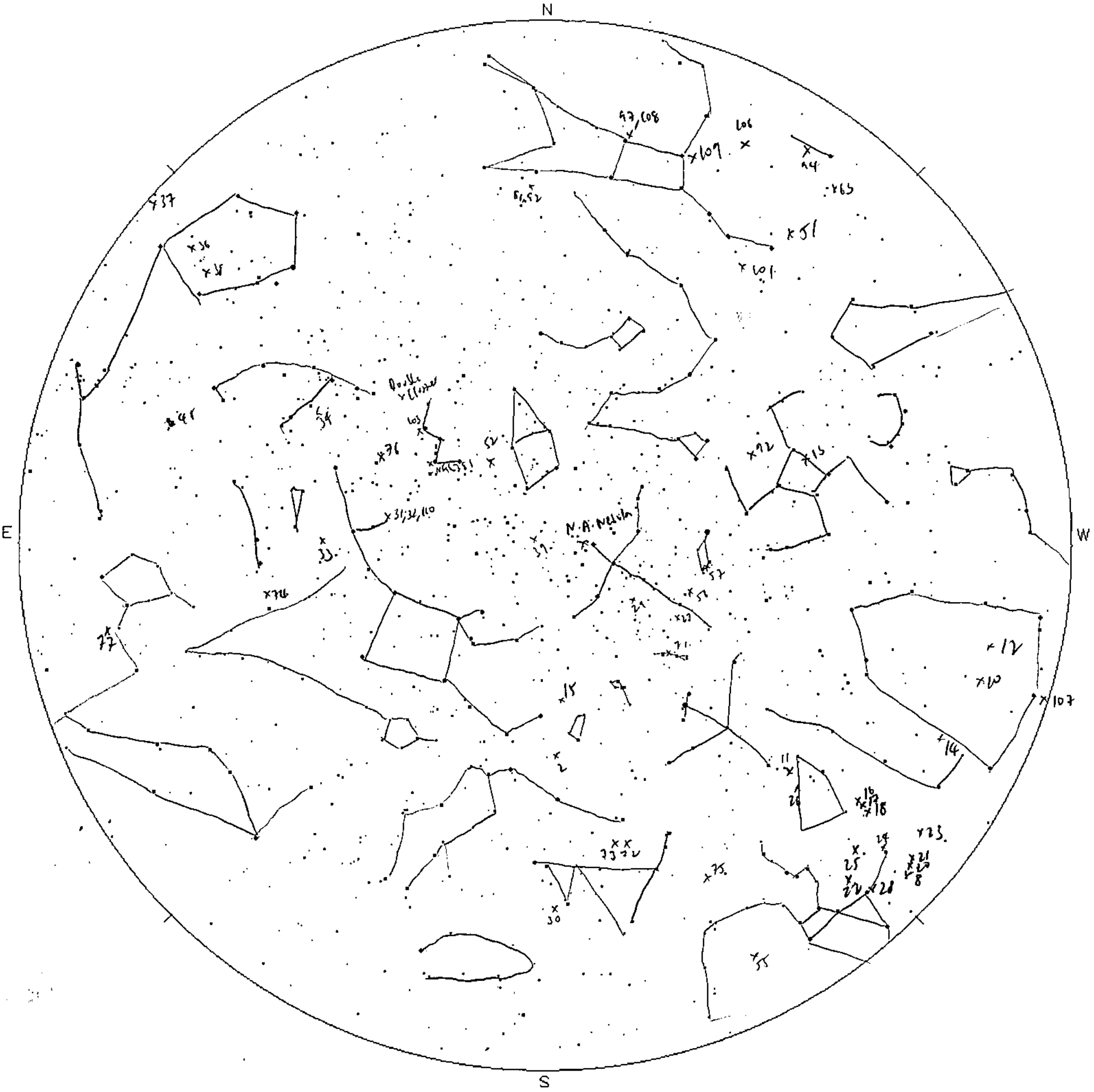
Nuke #98



Math #90

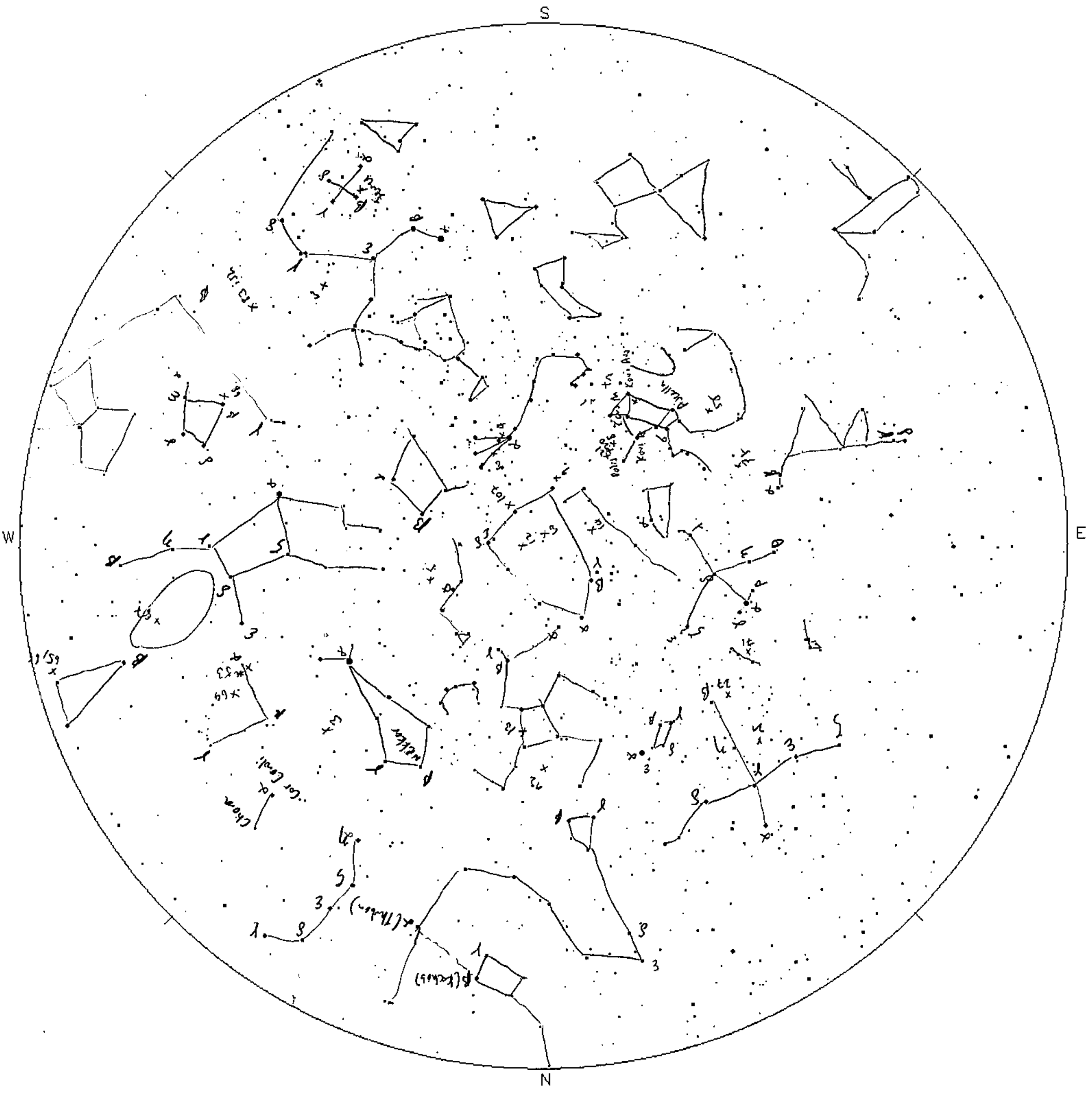


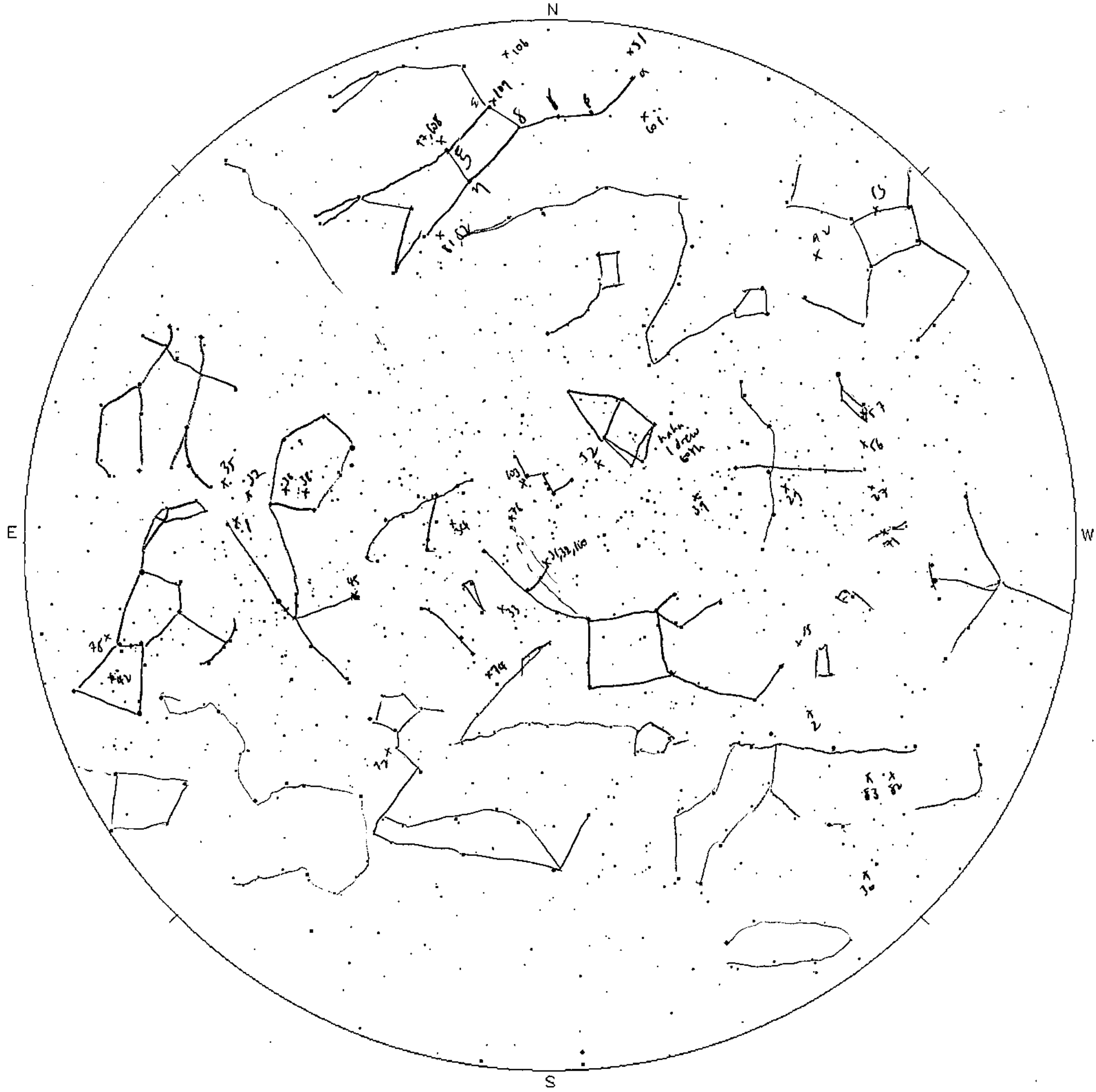
rps101.pythonanywhere.com

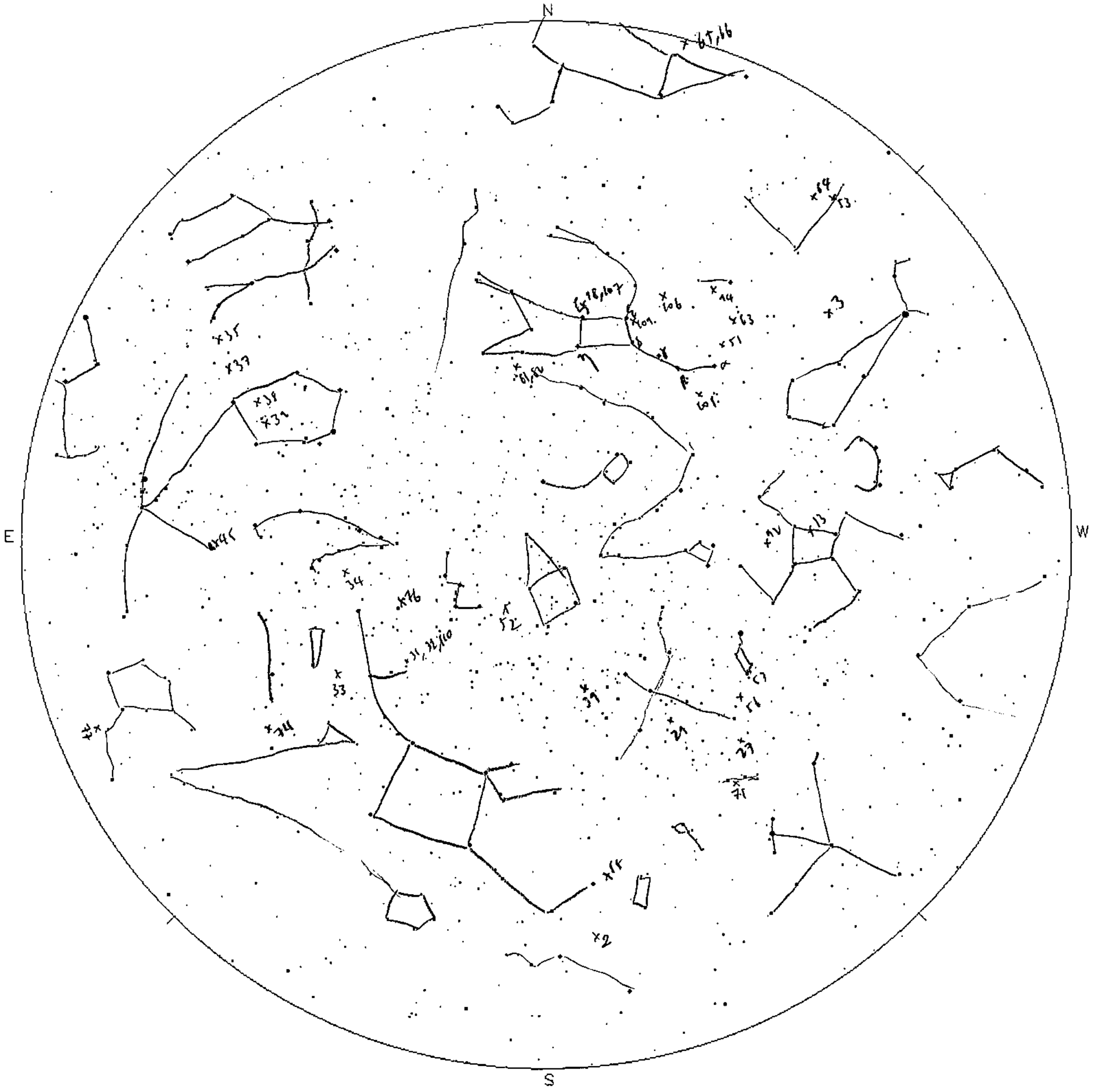

N
E
W
S
97,108
×109
106 ×
94
×63
×51
×101
81,82
×37
×36
×38
×45
34
Double ×Cluster
103
×76
×NGC751
52 ×
×31,32,110
33
39
N.A. Nebula
57
×56
×29
×27
71
×92
×13
×76
77
×15
×2
×12
×10
×107
×14
11 ×
26
16 ×17 ×18
×23
24
25
22
×28
×21 20 8
73 72
30
×75
×55


N
E
W
S
x56
x27
x52
x29
x NGC7000
x39
x3
x63
x51
x44
x106
109
53
4
x87
x57
Double cluster
103
x76
31,32,110
x33
x34
x74
x45
x77
x41
x1
x46

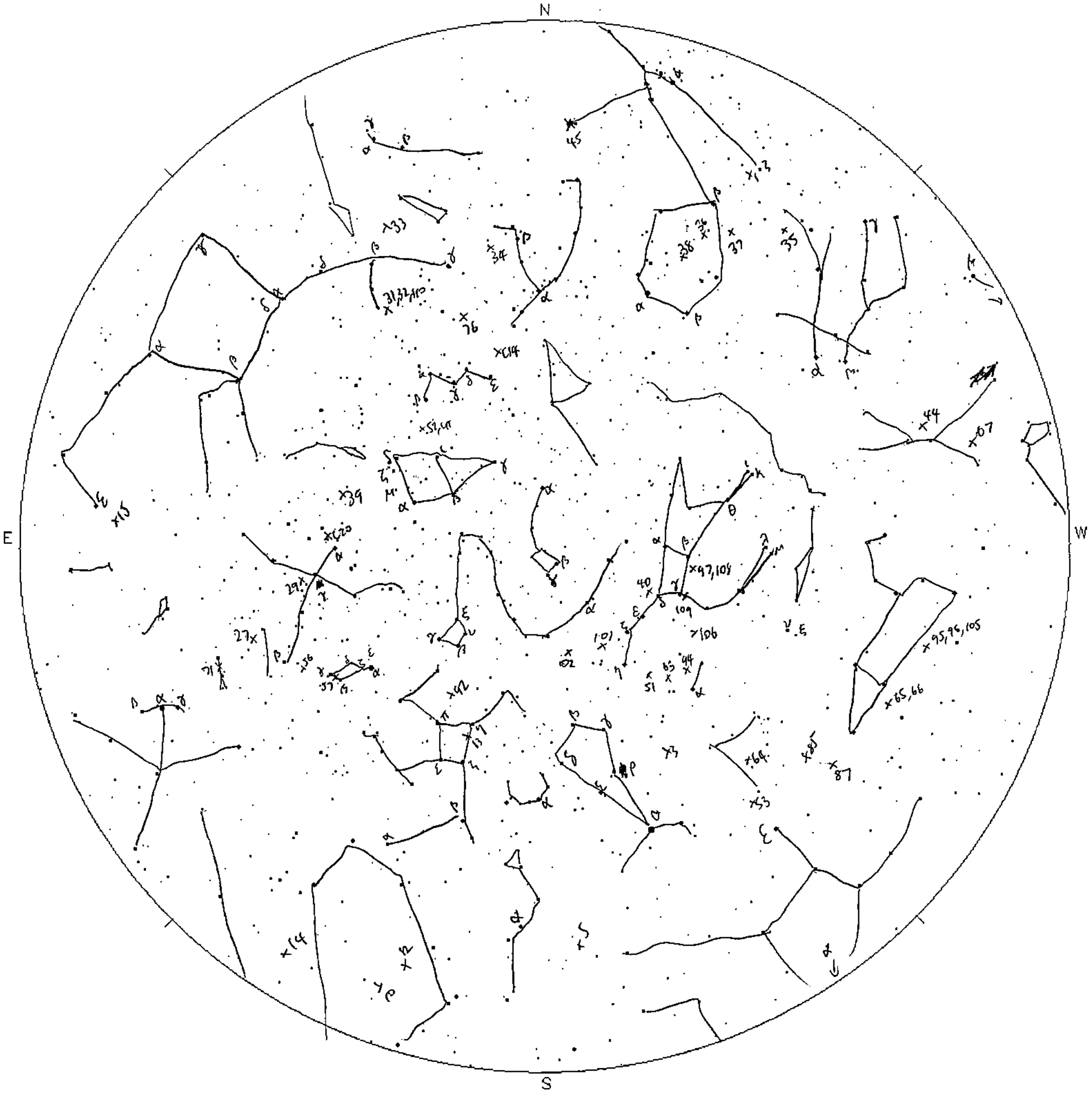

S
N
W
E
α
β
γ
δ
ε
C85
C96
C91
C92
C102
C80
C65
C60,61
68
83
30
72,73
2
5
71
27
56
57
13
14
10
22
24
70
17
18
23
ζ
π

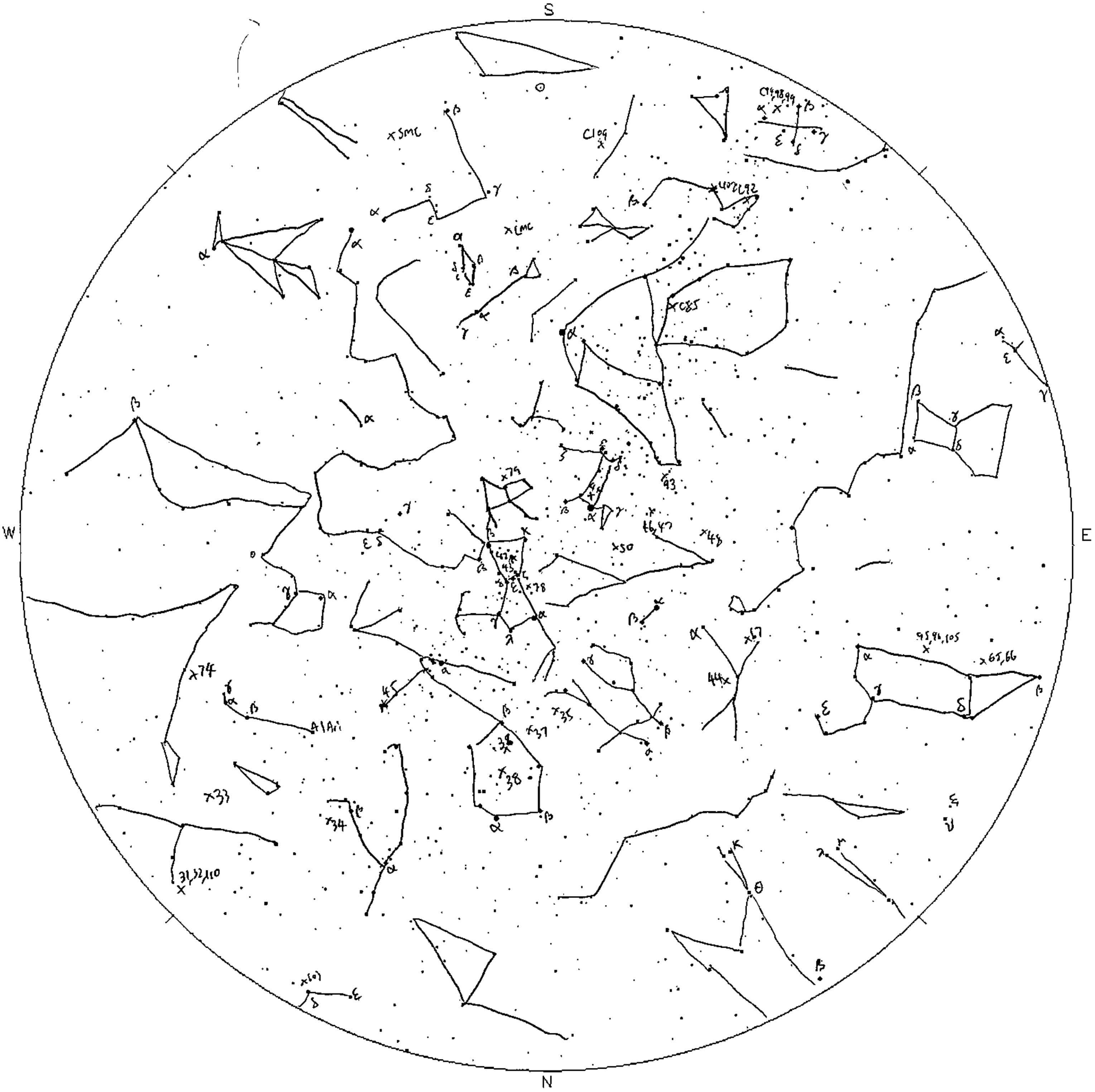

S
W
E
N


N
E
W
S
x106
x51
α
β
γ
δ
ε
x109
97,108 x
ζ
η
x 81,82
x 61
15
9V x
x57
x76
x24
x29
x39
haha I drew 6th
52 x
103 x
x76
x31,38,100
x34
35 x
32 x
73 38
x1
45
78x
x4V
x33
x74
x15
2
73x
83 82
30
x71

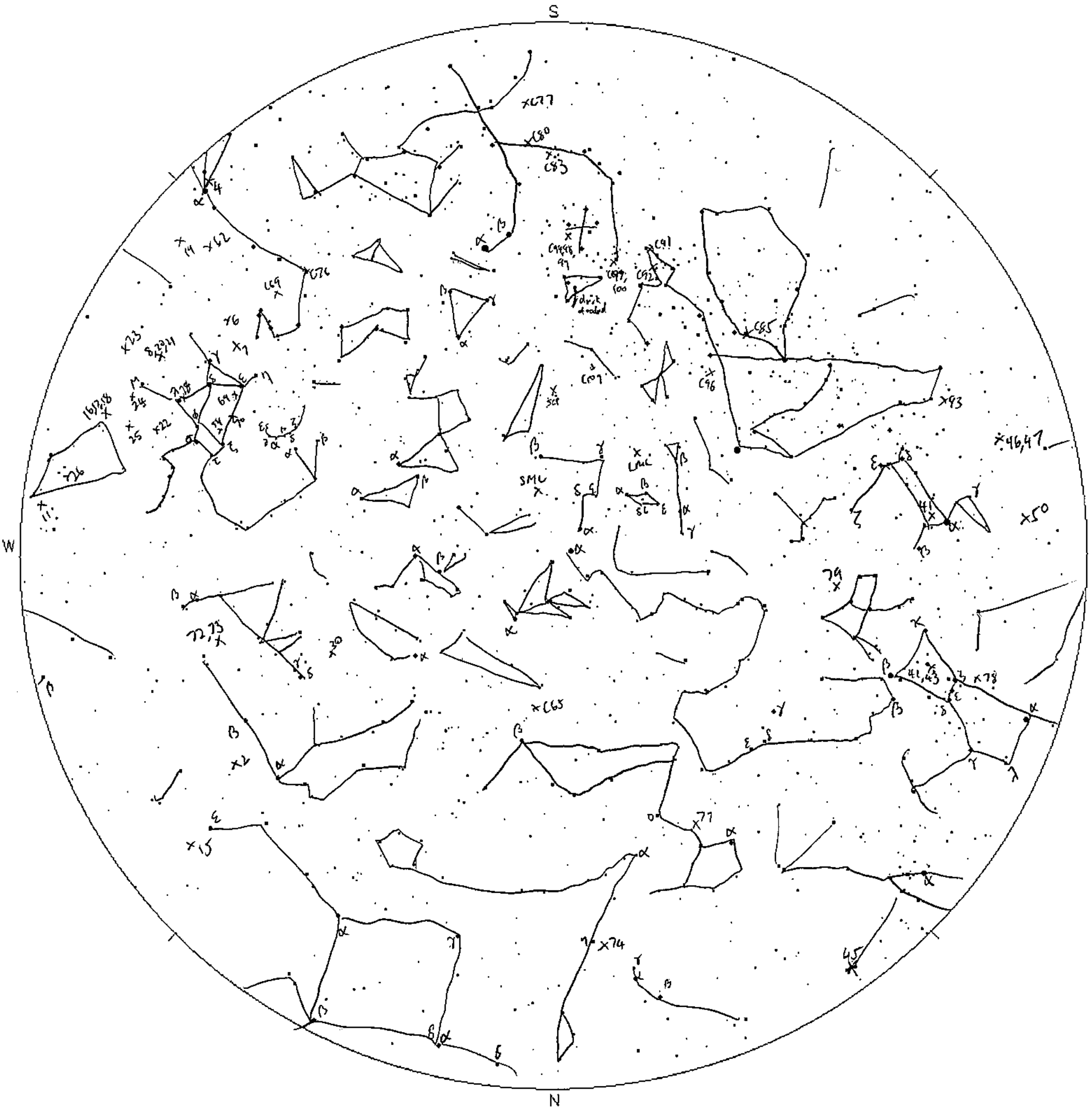

N
65,66
64
53
3
14
106
63
51
105
98,107
109
η
β
γ
α
81,82
35
37
38
39
45
E
W
92
13
34
76
52
31,32,110
33
57
56
39
24
27
71
74
47
58
2
S

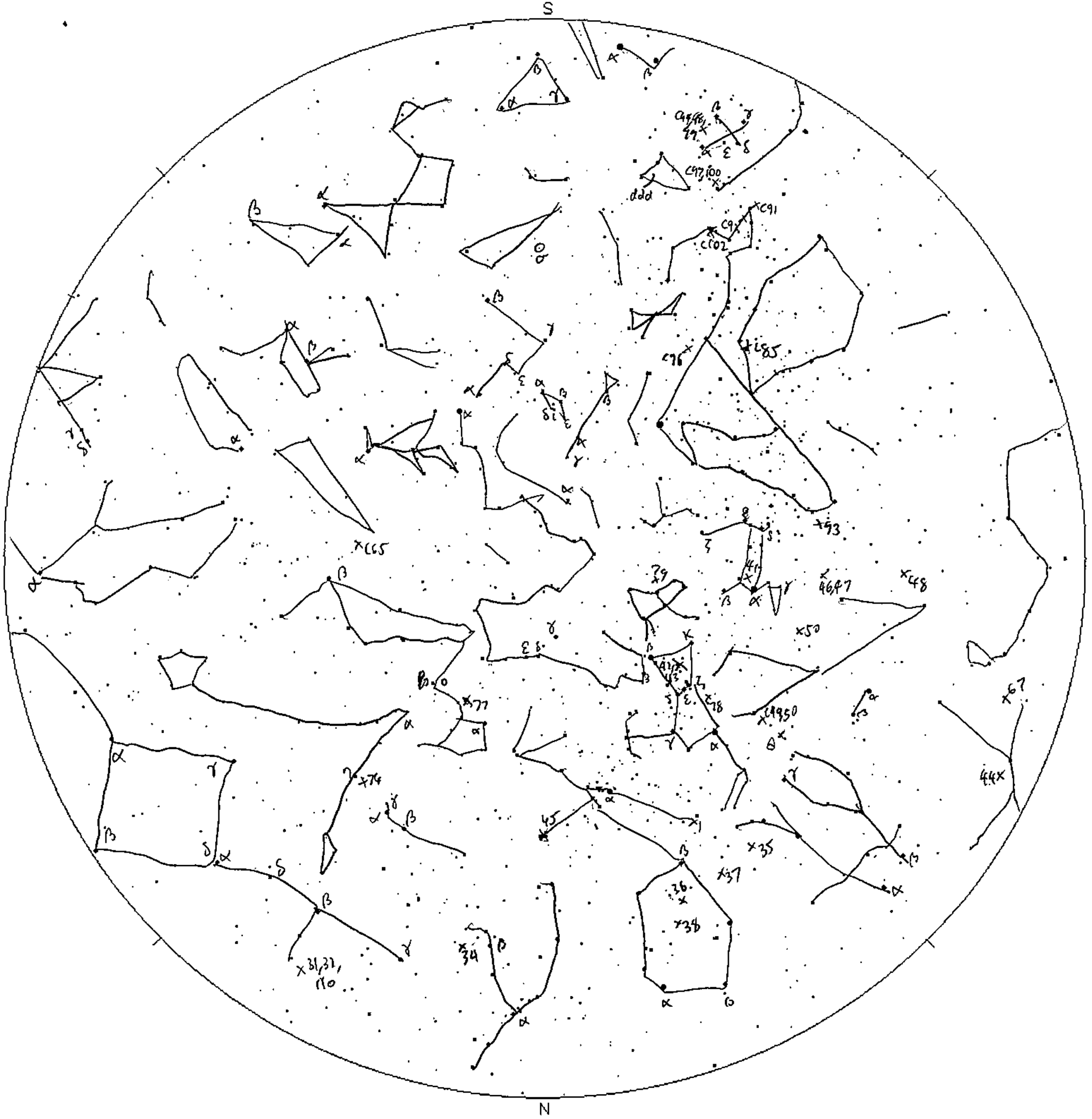

S
W
E
N
C95
C77
C92
C102
99
SMC
C65
C72
x62
x30
x77
x74
x33
x29
x27
x10
x12
x14
x9
x2
15
α
β
γ
δ
ε

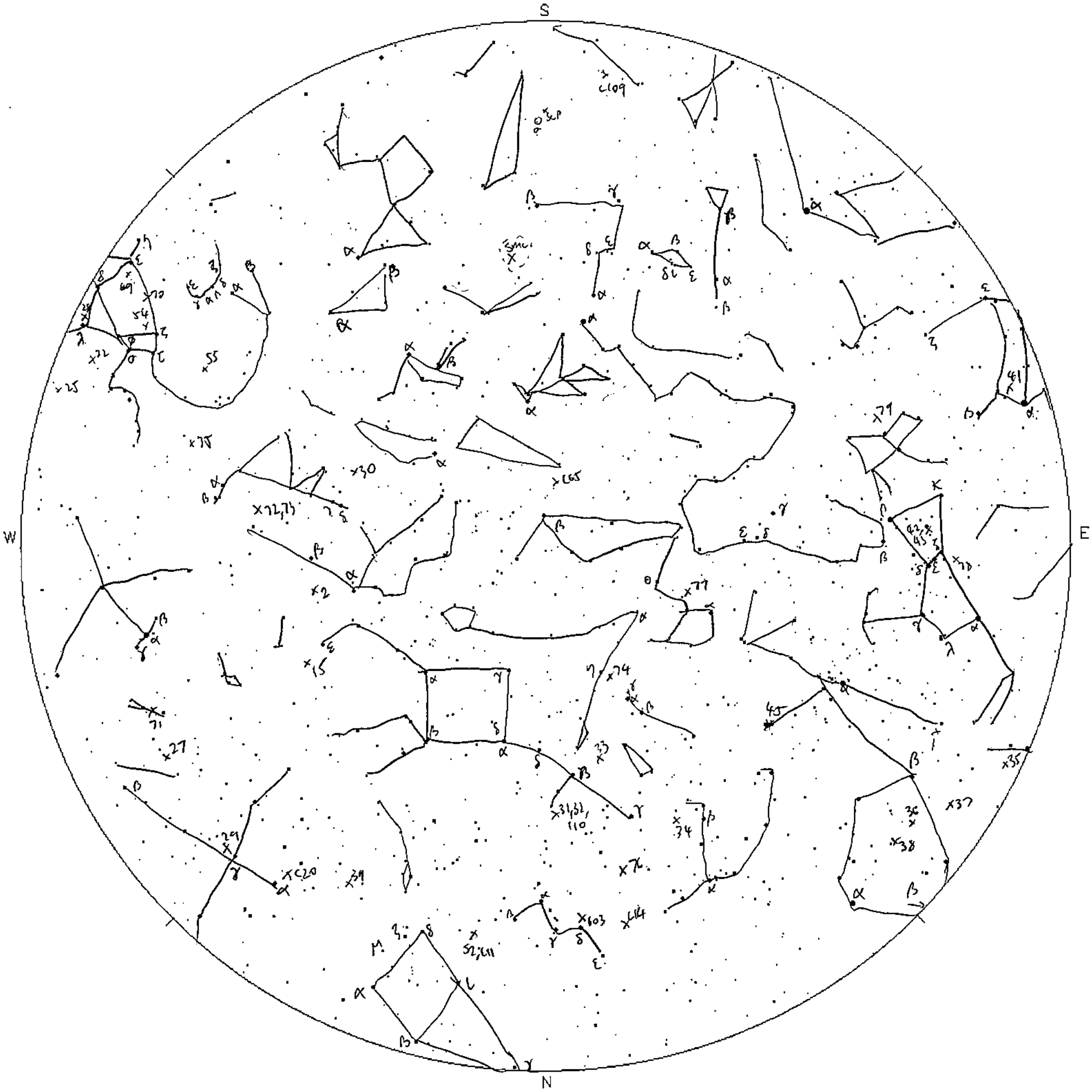

N
E
W
S
45
x33
x34
x31,32,110
76
x C14
x35
37
38
x15
x C20
x39
x52,47
29x
27x
71
36
57
x92
139
x44
x07
x97,108
40
109
x106
101
102
51
85
94
x3
x69
x53
x85
87
x95,96,105
x65,66
x14
x12
31
x1,3

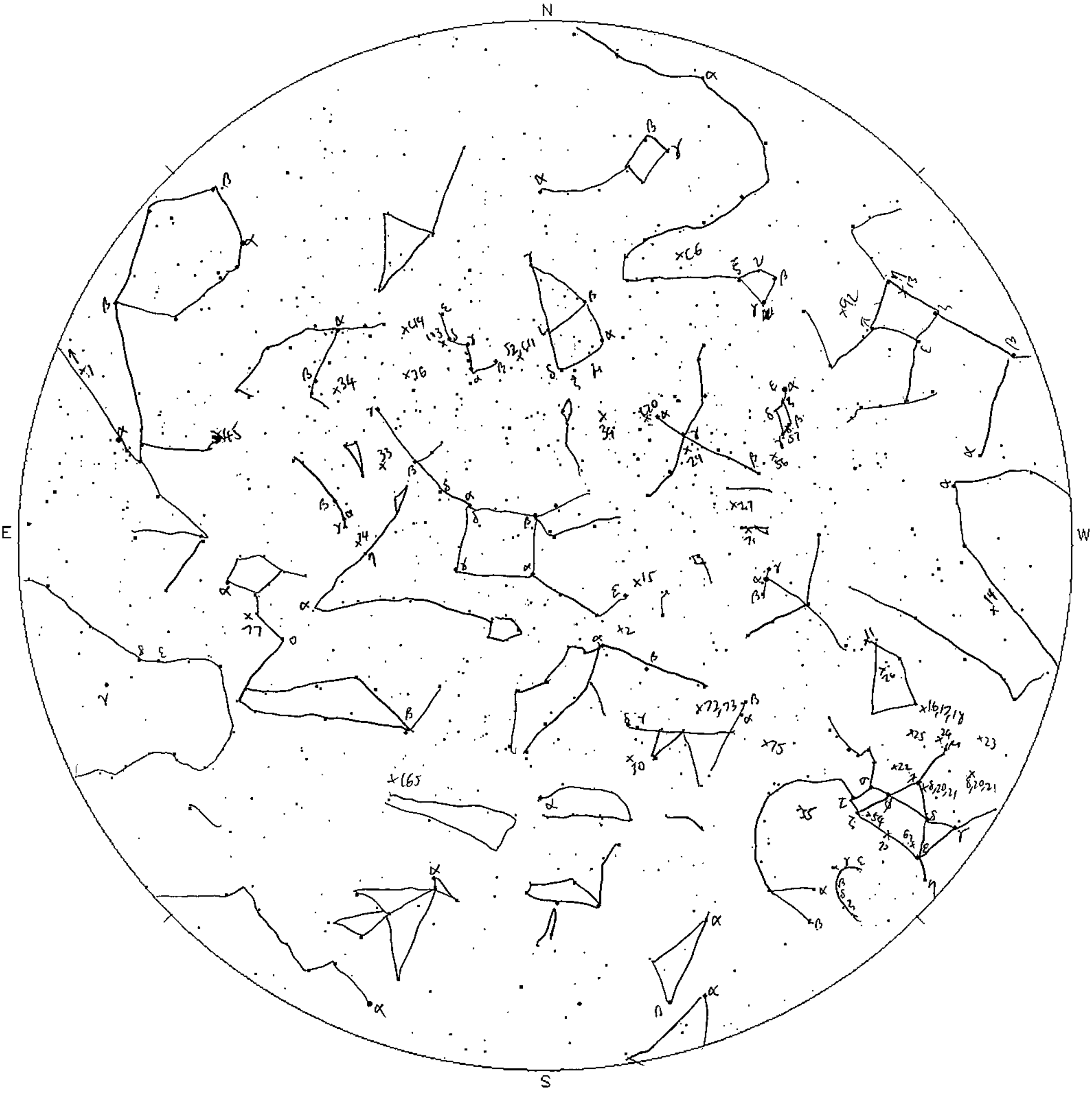


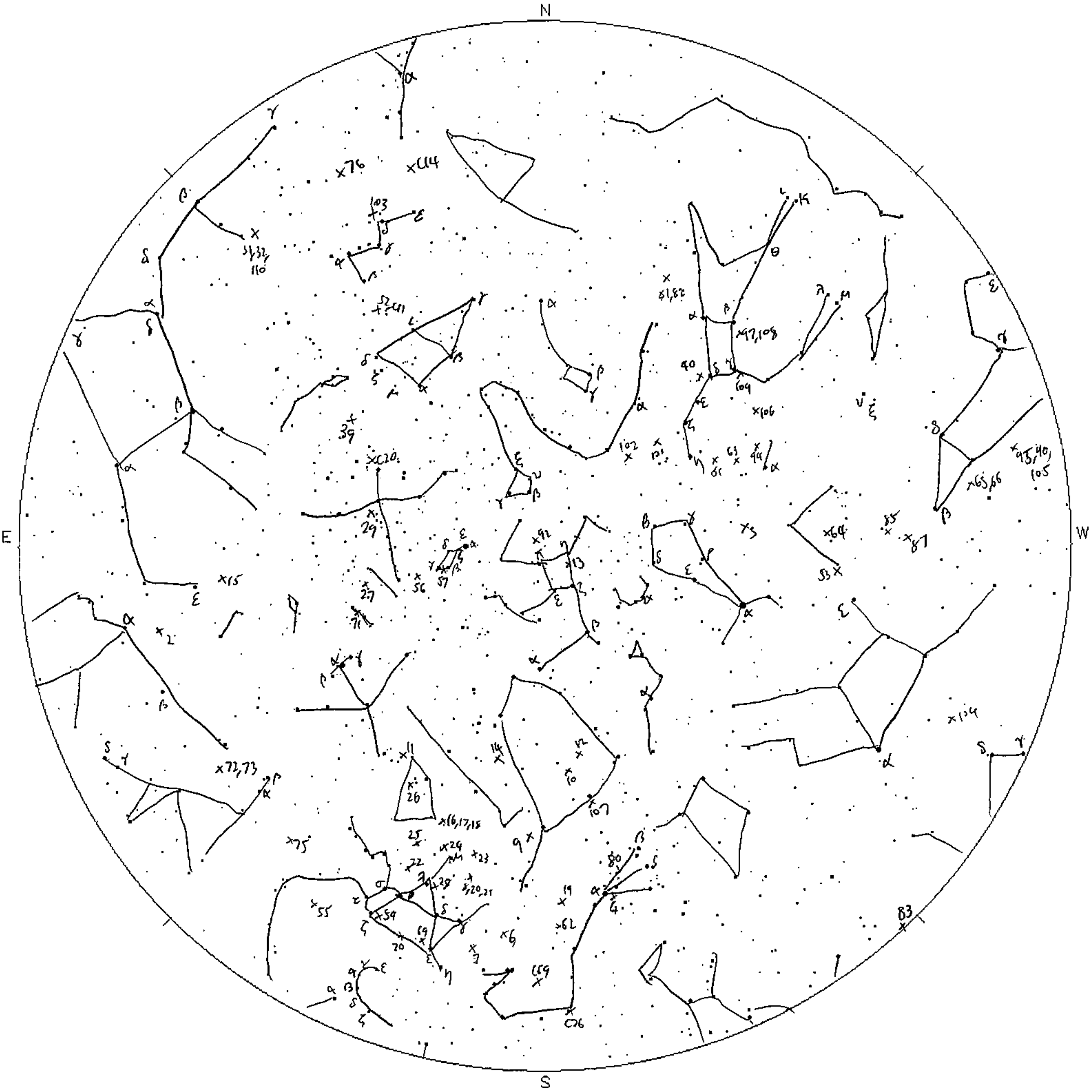
i was shocked
at crater
ok it dried up

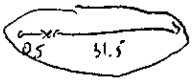

S
W
E
N
x C77
x C80
x C83
4
x 14
x 62
C76
C69
x 6
x 7
x 23
x 24
x 25
x 22
16,17,18
x 26
x 11
C91
C92
C99, 100
x C85
C96
C97
x 93
x 46,47
x 50
LMC
SMC
x 79
72,73
x 30
x C65
x 2
x 15
x 77
x 74
45
41,43
x 78
41


S
W
E
N
x165
x93
x48
4647
x50
x67
44x
x35
x37
36
x38
x34
x31,32,110
x74
x77
45
x1
x78
x4950
θx
79
41
x185
c96x
c91
c92
c102
c97,100
ddd
α
β
γ
δ
ε
ζ
κ


S
W
E
N
C109
SMC
SMC
x55
x25
x22
x70
69
54
x75
x30
x72,73
x165
x2
x15
x71
x27
x29
C20
x39
M
52,C11
103
C14
x31,32,110
x33
34
x74
x77
45
x35
x37
36
x38
x79
41
42,43
x78


N
E
W
S
x66
x34
x36
x44
x15
x2
x77
x165
x75
x30
x92
x24
x56
x57
x27
x14
x26
x16,17,18
x25
x23
x22
x72,73
x54
α
β
γ
δ
ε
ζ
η
σ





a(1-e) a(1+e)

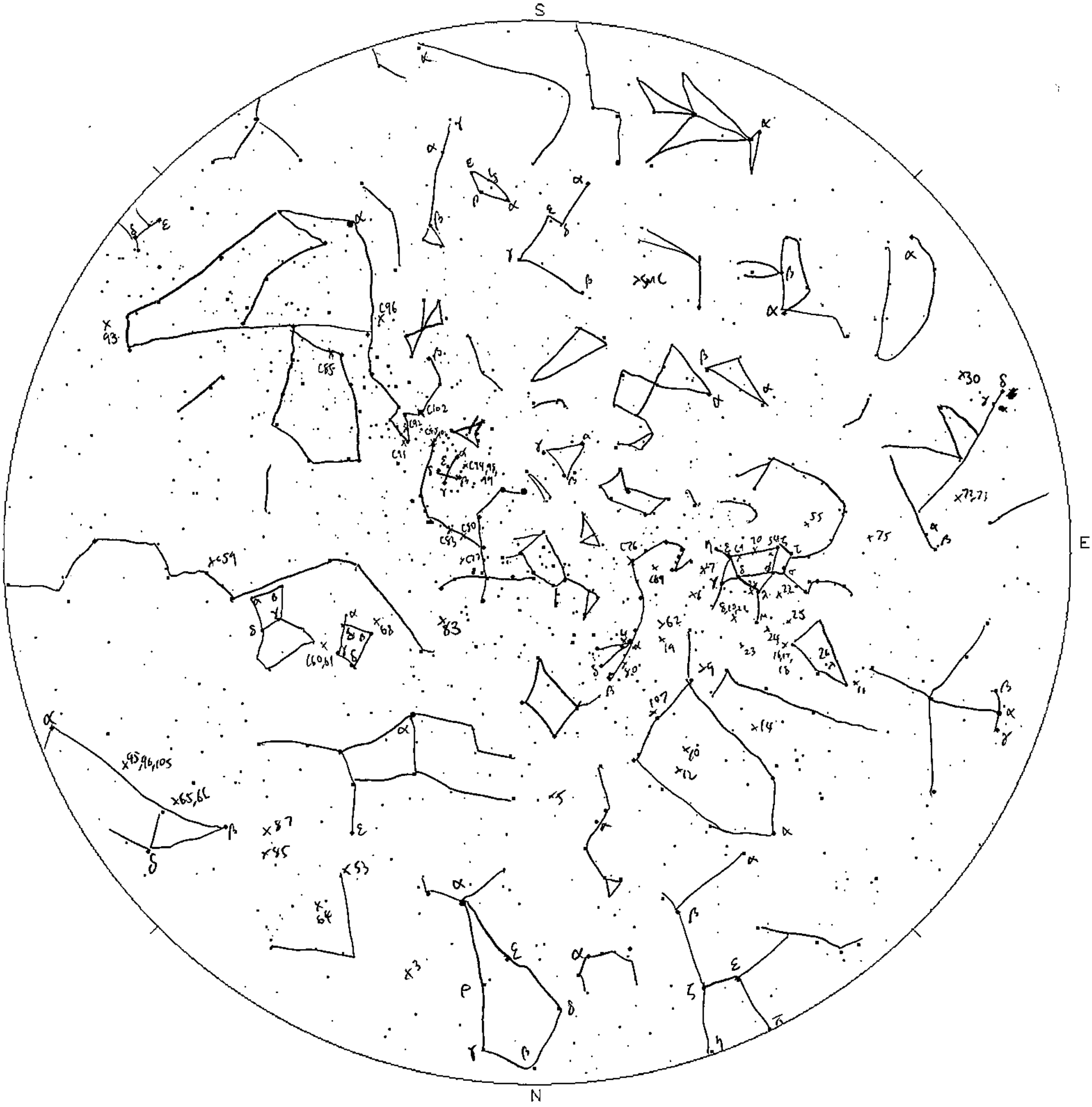
$a = 16$

$e = \frac{31}{32}$

$e = \sqrt{1 - \frac{b^2}{a^2}}$ $T = 64\,yr$

$1 - e^2 = \frac{b^2}{a^2}$ $A = 199.48$

$b = a\sqrt{1 - e^2} = 3.9686$ $\dot{A} = 3.117$ AU²/yr



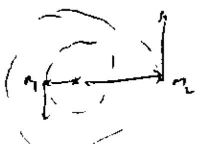
$$\cancel{mr}\dot{\theta}^2 = \frac{GM}{r^2}$$

$$\dot{\theta}^2 = \frac{GM}{r^3}$$

$$\dot{\theta} = \sqrt{\frac{GM}{r^3}}$$

$$\omega_1 = \frac{v_1}{d_1} = \frac{v_2}{d_2} \qquad v_1 = \frac{d_1}{d_2} v_2 = \frac{m_2}{m_1} v_2$$

$$v = d\omega$$



$$\omega = \sqrt{\frac{G(m_1+m_2)}{d^3}}$$

$$v = \sqrt{\frac{G(m_1+m_2)}{d}} \rightsquigarrow v_{rel}! = v_2 + v_1$$

$$= v_2\left(1 + \frac{m_2}{m_1}\right) = v_2\left(\frac{m_1+m_2}{m_1}\right)$$

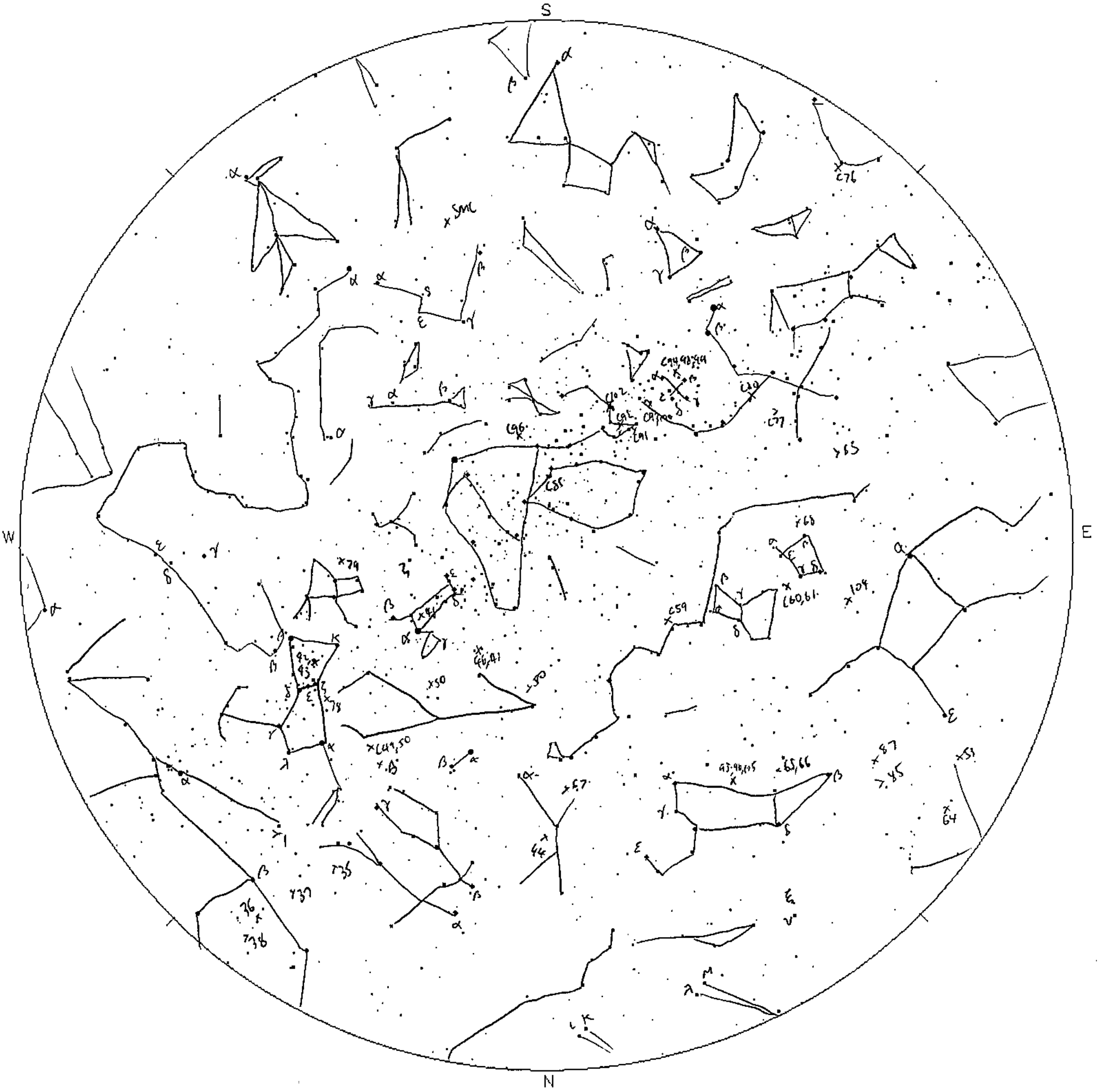
$$v_2 = \frac{m_1}{m_1+m_2}\sqrt{\frac{G(m_1+m_2)}{d}} = \sqrt{\frac{Gm_1^2}{(m_1+m_2)d}}$$

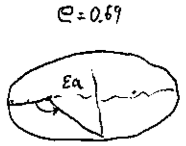
$$\cancel{\frac{Gm_1m_2}{d^2} = \frac{m_2v^2}{d_2} = \frac{m_2v^2}{\frac{m_1}{m_1+m_2}d}}$$

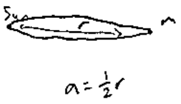
$$\cancel{\frac{Gm_1}{d^2} = \frac{(m_1+m_2)v^2}{m_1 d}}$$

$$\frac{Gm_1m_2}{d^2} = \frac{m_2v^2}{d_2}$$

$$v_2^2 = \frac{Gm_1 d_2}{d^2} = \frac{Gm_1\left(\frac{m_1}{m_1+m_2}\right)d}{d^2} = \frac{Gm_1^2}{(m_1+m_2)d}$$

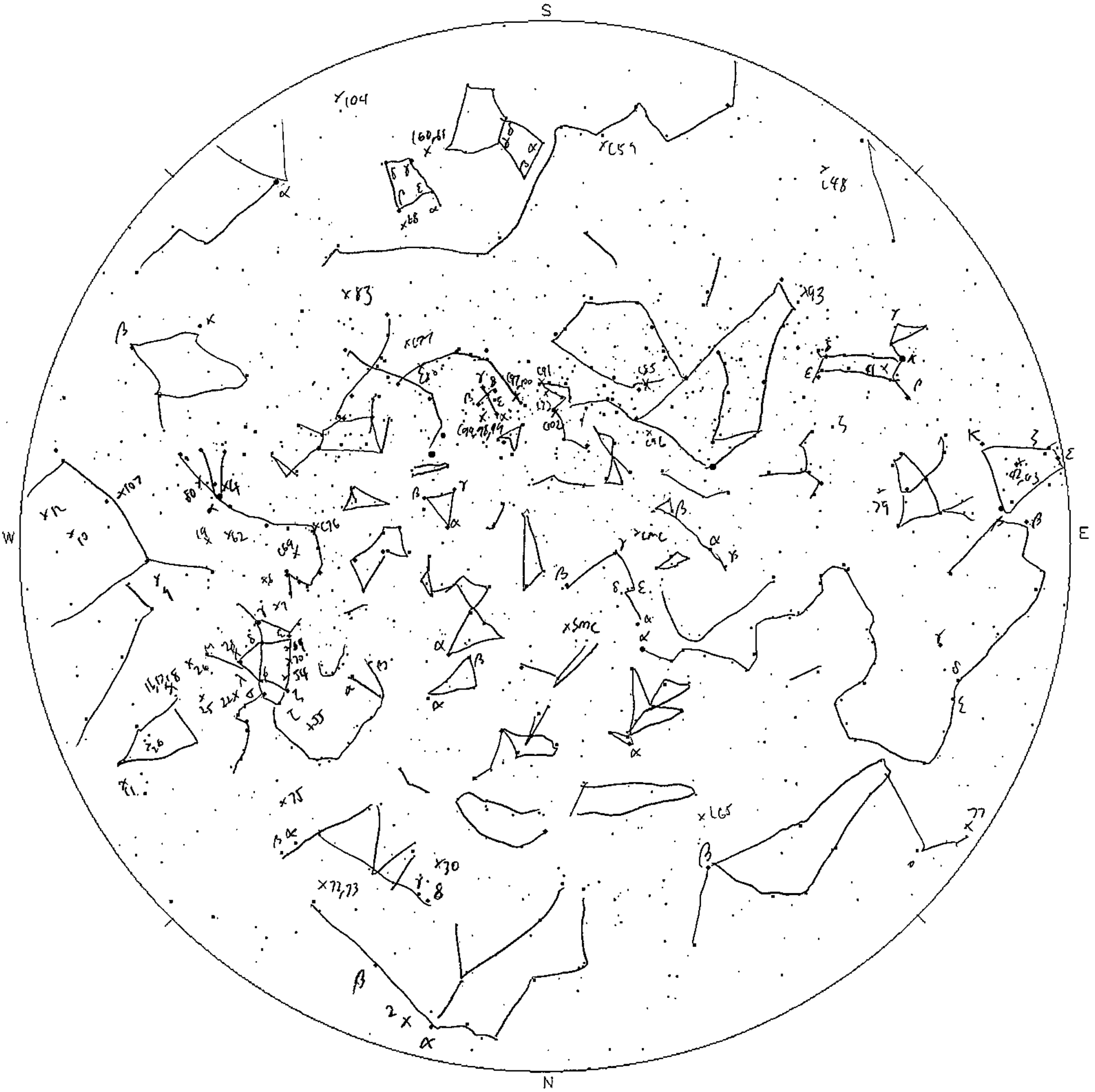

S
N
W
E
SMC
C76
C77
C94,98,99
C102
C97,100
C91
C96
C85
C59
C60,61
C49,50
65
68
104
79
47
50
46,41
93
78
87
85
53
64
57
44
37
35
76
38
93,98,105
65,66
α
β
γ
δ
ε
ζ
λ
κ
μ
ν
ξ

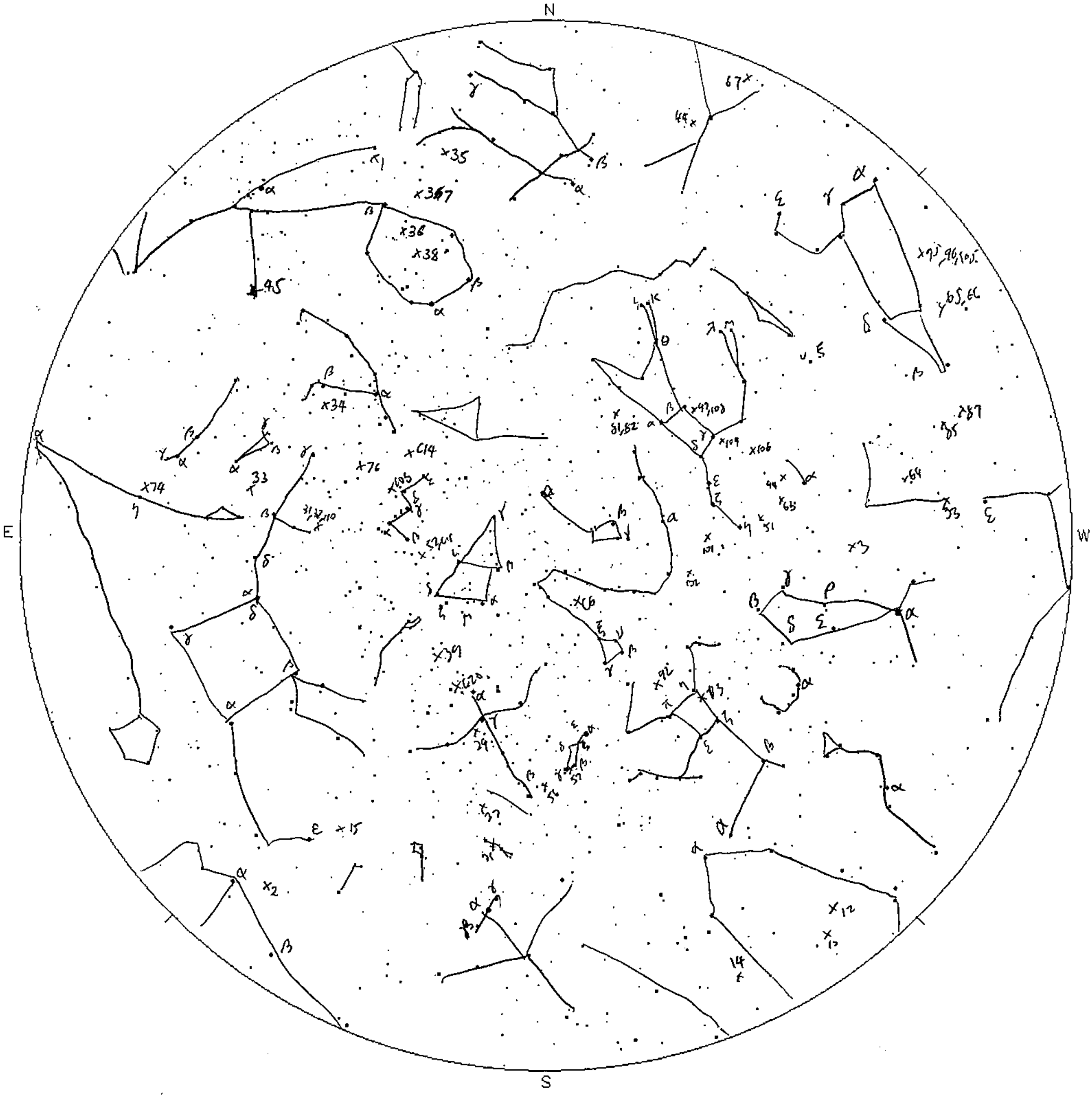

e=0.69
Ea


Su
m
a=½r

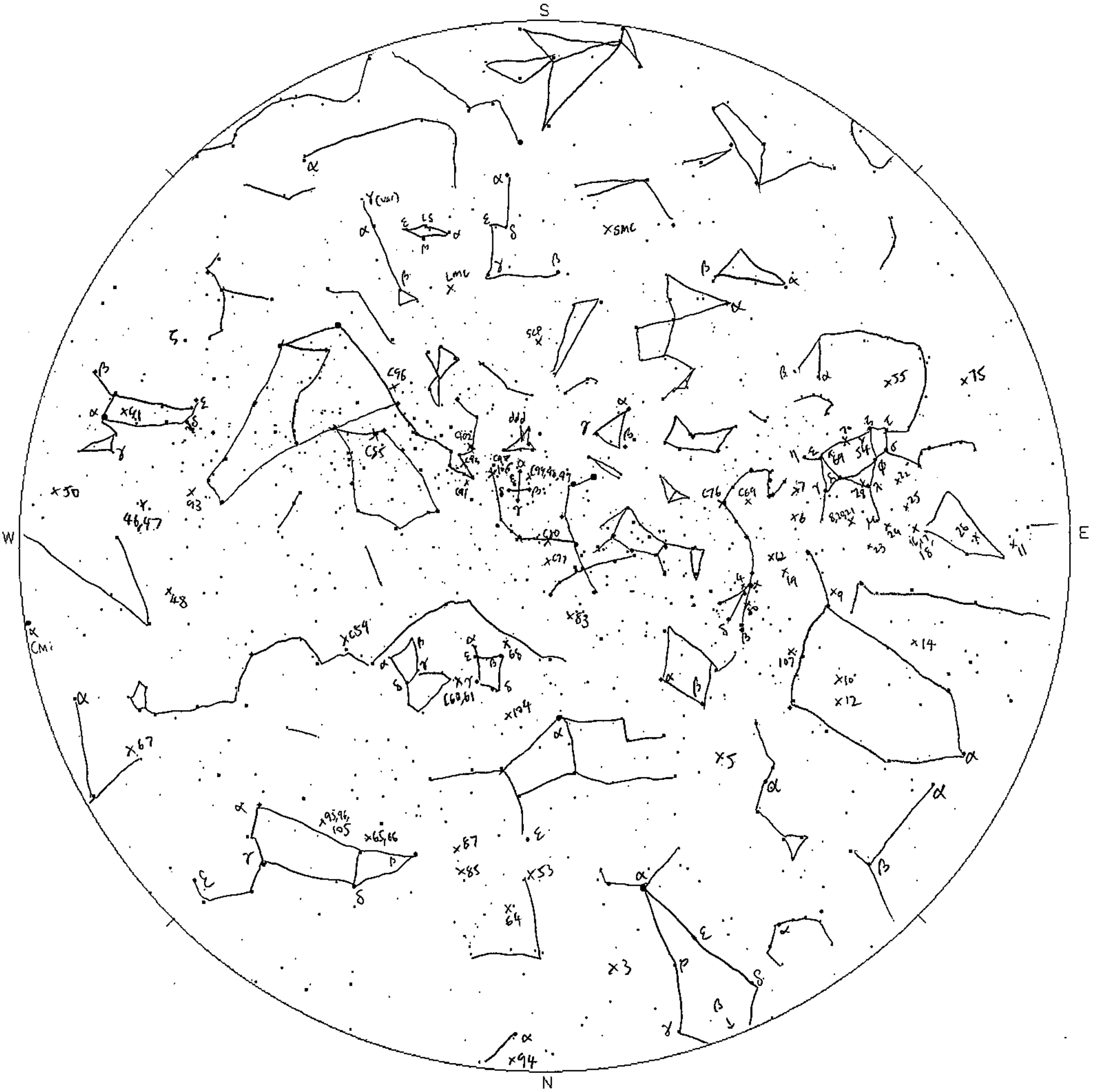
S
W
E
N
C102
C97,100
C98,95,94
C80
C77
63
C76
C65
x30
x72,73
x2
x15
x5
x13
x92
x6
x29
C28
x39
x27
x11
x25
26
24
12
x14
55

← oops


S
N
W
E
104
C59
160,61
68
C48
83
C77
93
C91
97,100
C55
C96
C99,98,94
C102
107
12
10
C76
50
64
19
62
69
6
SMC
LMC
75
30
72,73
C65
77
2
79
63
55
54
70
59
24
25
22
11,17,18
26
21
α
β
γ
δ
ε
ζ
κ
τ



$\phi = 90 - 2\tan\left(\frac{0.85}{9.6}\right)$
$= 79.88°N$



$a\{1\{a1\}\} \Rightarrow 0k\text{-}1$

$a\{\{1a\}1\} \Rightarrow 1k0$

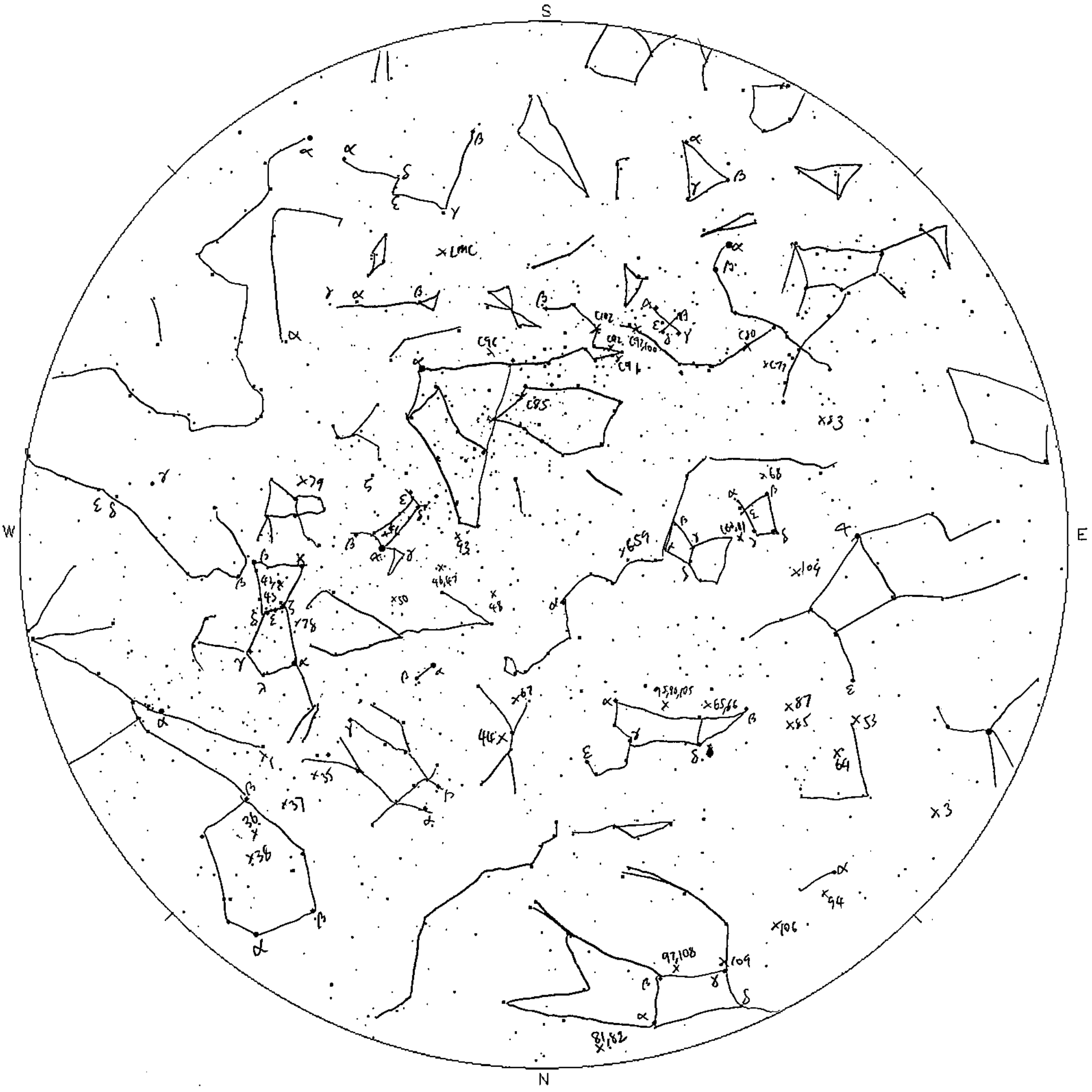
Zenith Angle

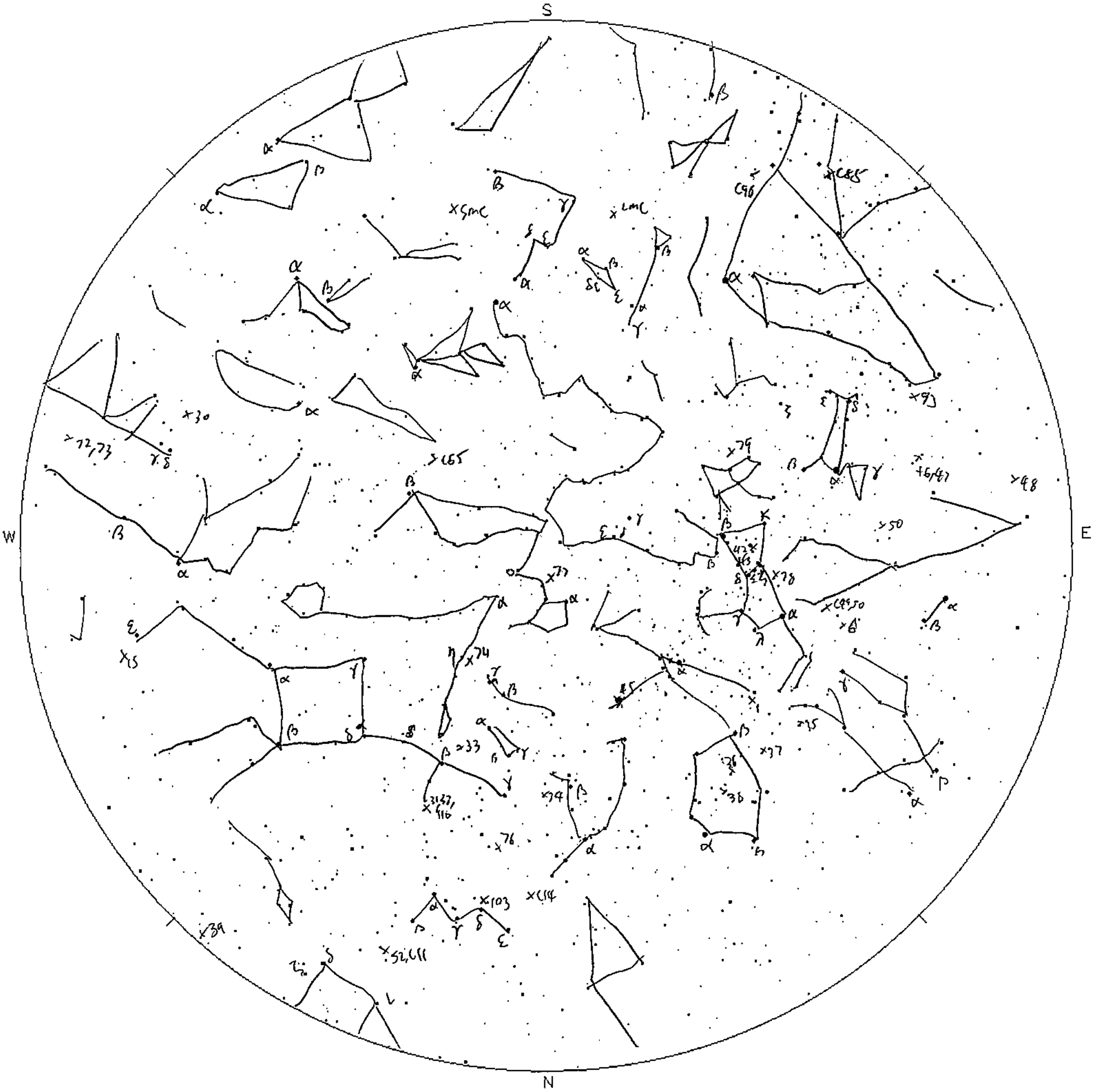
$$= 2\tan^{-1}\left(\frac{\text{Length to centre}}{\text{Radius of Map}}\right)$$

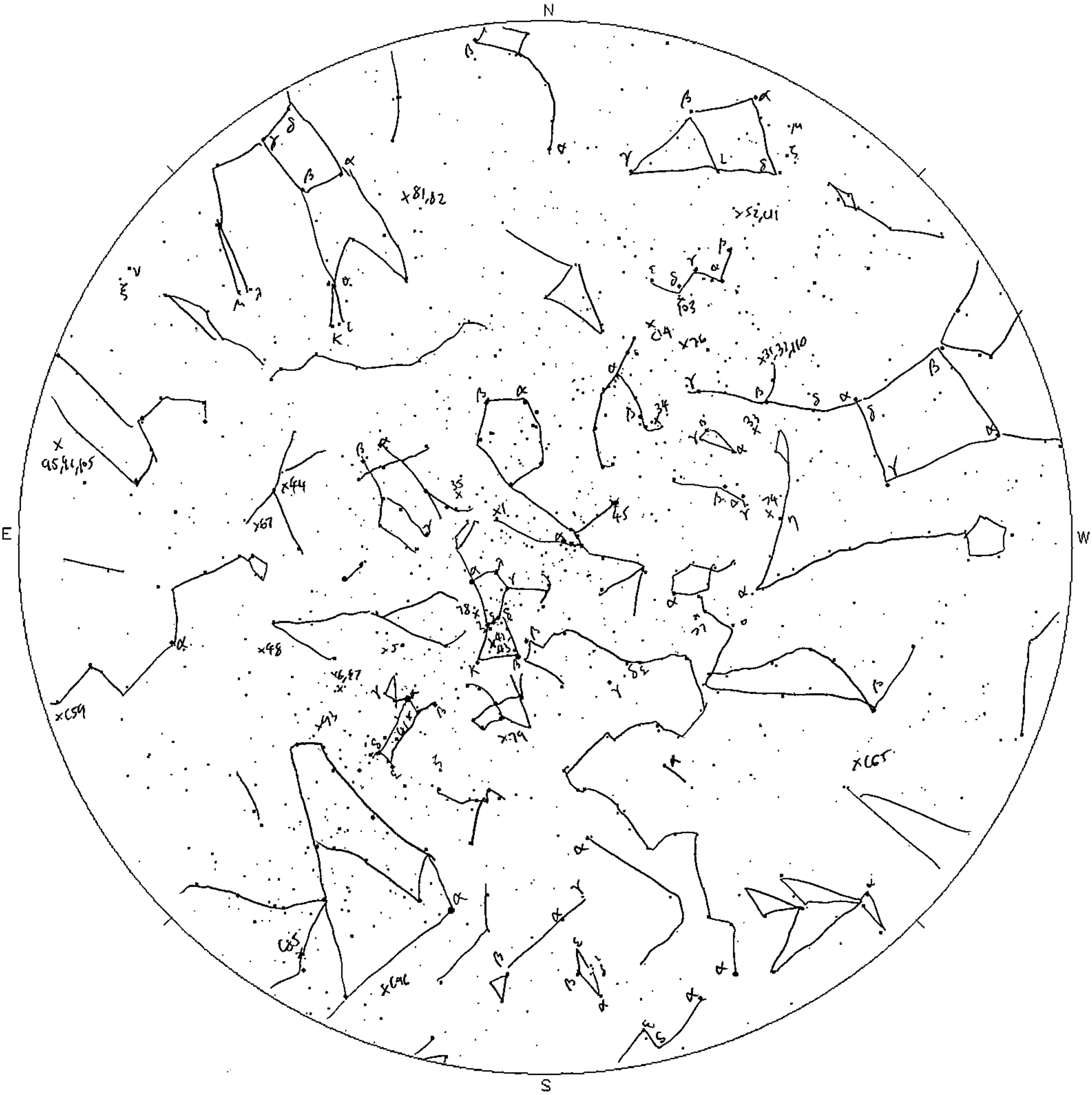
* only stereographic projectn, like these.

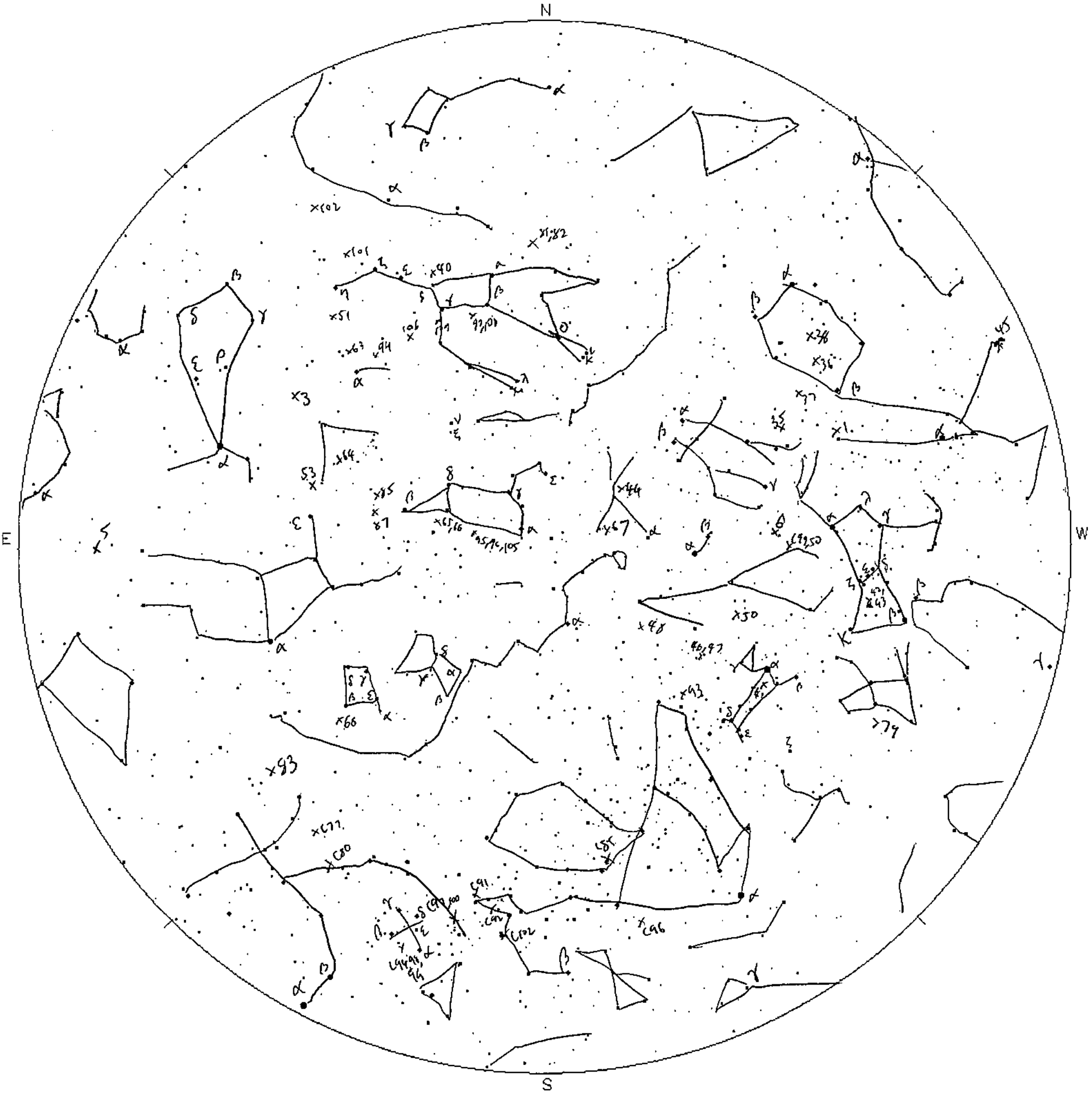
$$\phi = 90° - 2\tan^{-1}\left(\frac{3.6}{9.6}\right)$$
$$= 48.89°S$$

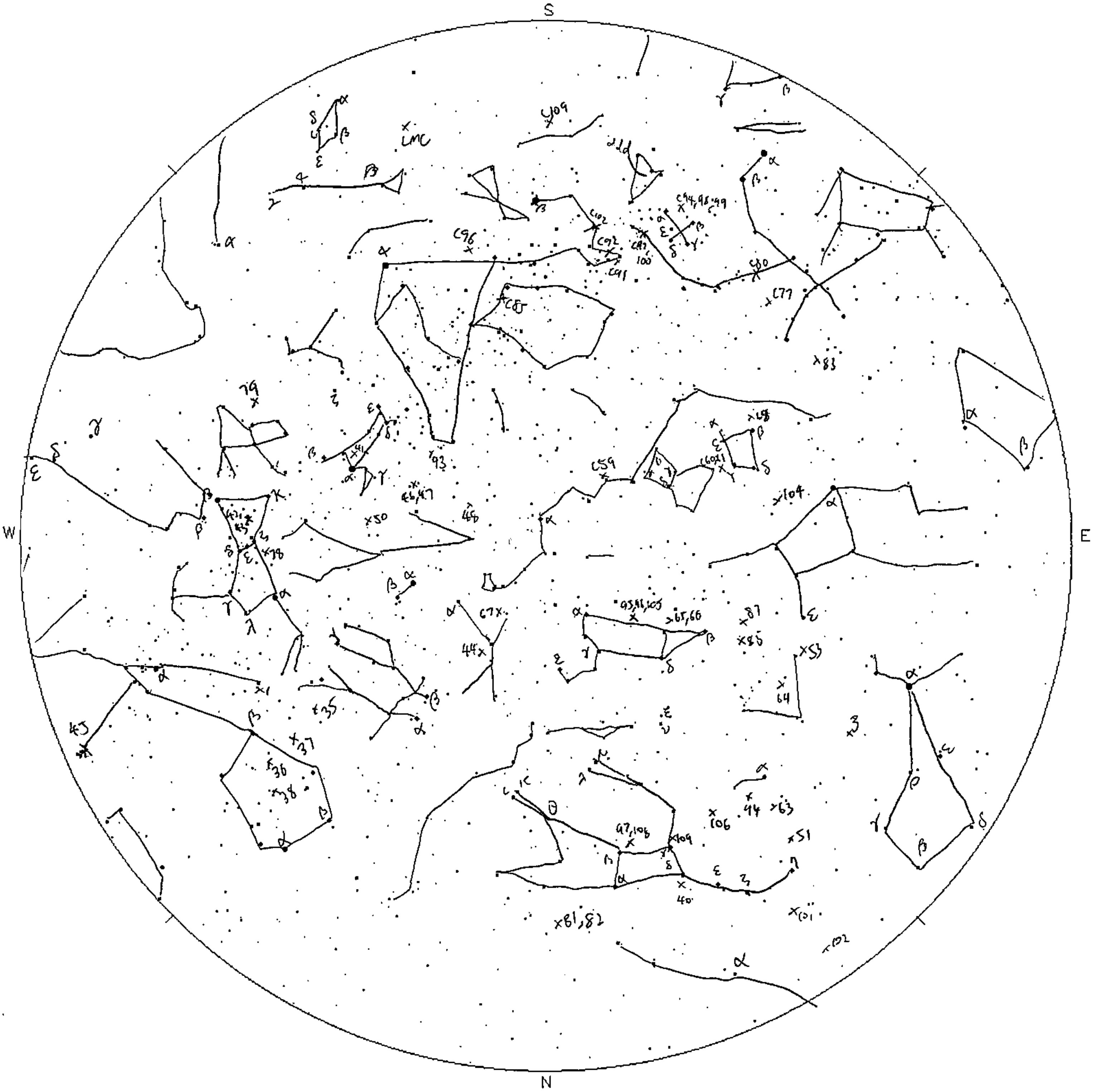
* For these star maps, radius = 9.6cm when on A4


S
W
E
N
LMC
C96
C85
C102
C92
C97/100
C91
C80
C77
83
68
68,81
79
42,78
43
78
46,47
50
48
93
59
104
87
85
53
64
3
94
106
97,108
109
81,82
67
44
95,96,105
65,66
1
35
37
36
38

S
W
E
N
×SMC
×LMC
C96
×C85
×30
×72,73
×65
×79
×93
×46,47
×48
×50
×77
×78
×C49,50
×74
×33
×35
×37
×36
×38
×76
×103
×104
×39
×52,C11
×5
×45
×31,37,46

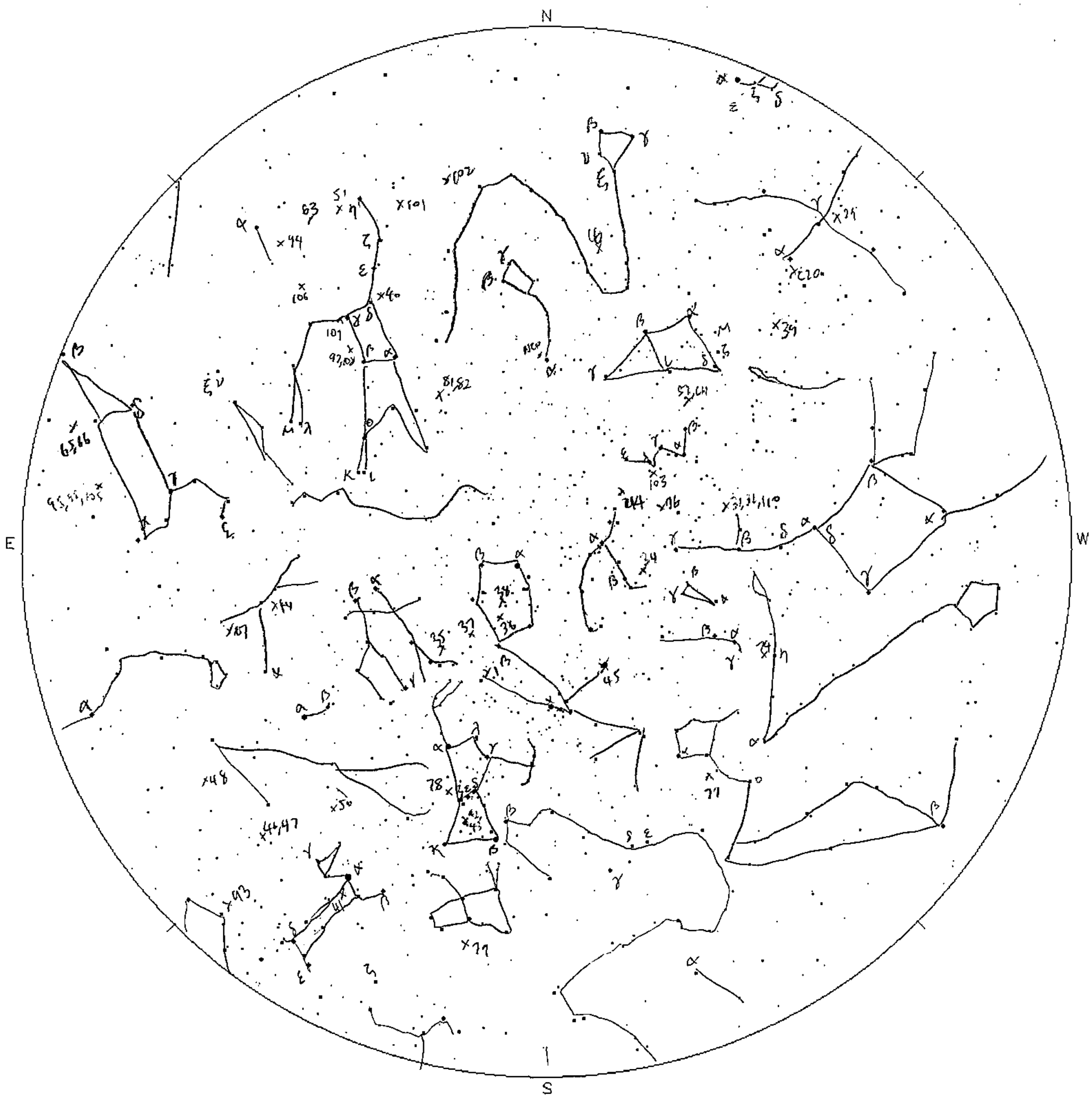

N
E
W
S
×81,82
×C14
×76
×35
×1
×45
×44
×67
×48
×5
×79
×C59
×C65
×C96
C85
×93
×74
×77
×33
×34
103
95,41,105

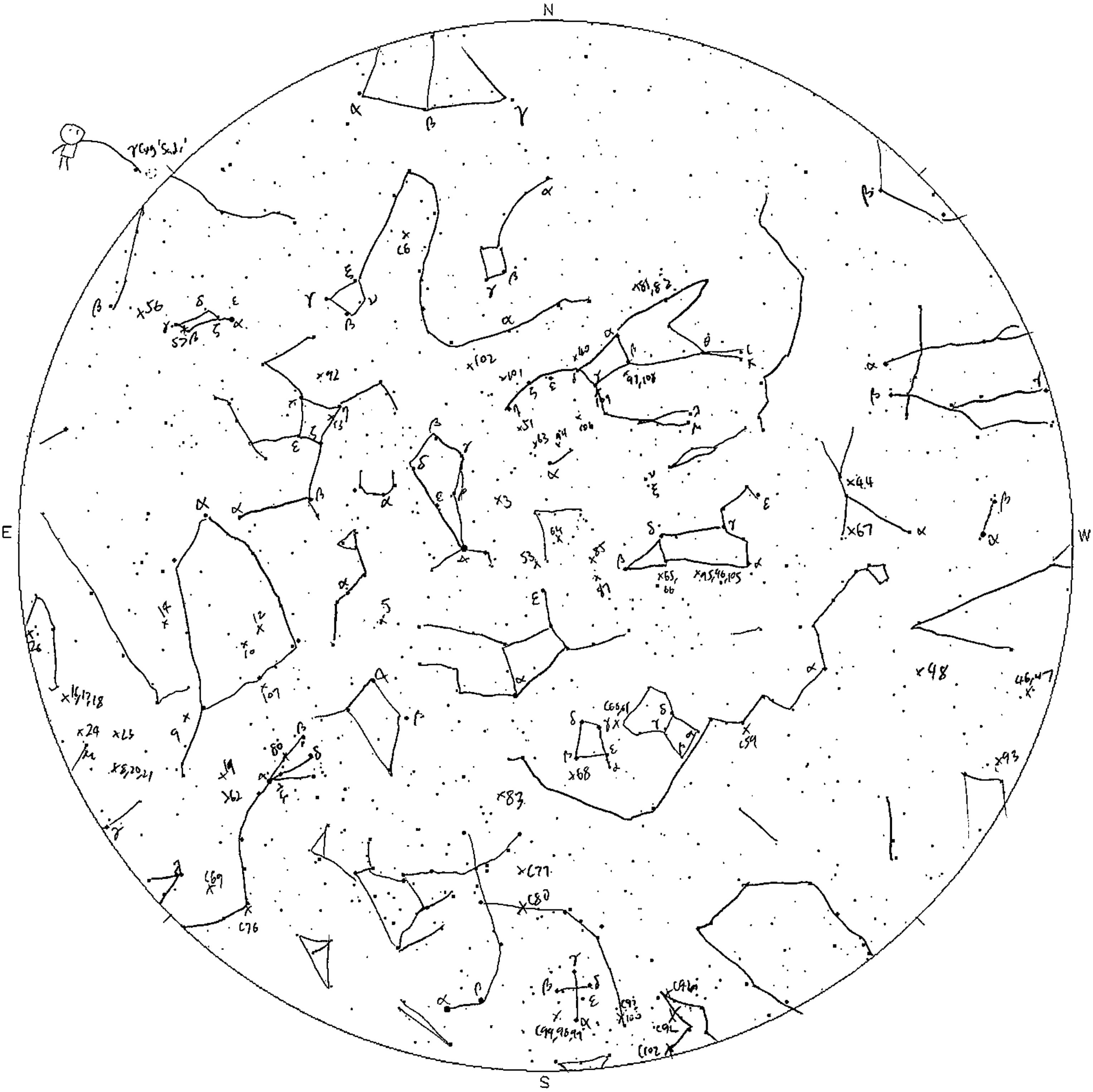

N
E
W
S
x102
x101
x40
x51
x63
94
106
93,101
81,82
x3
53
x64
x85
87
x65,66
95,96,105
x44
x67
x38
x36
x37
35
x1
45
x49,50
41
43
x48
x50
46,47
x43
x79
x5
x66
x83
C77
C80
C91
C97,100
C92
C102
C94,95,96
C85
C96

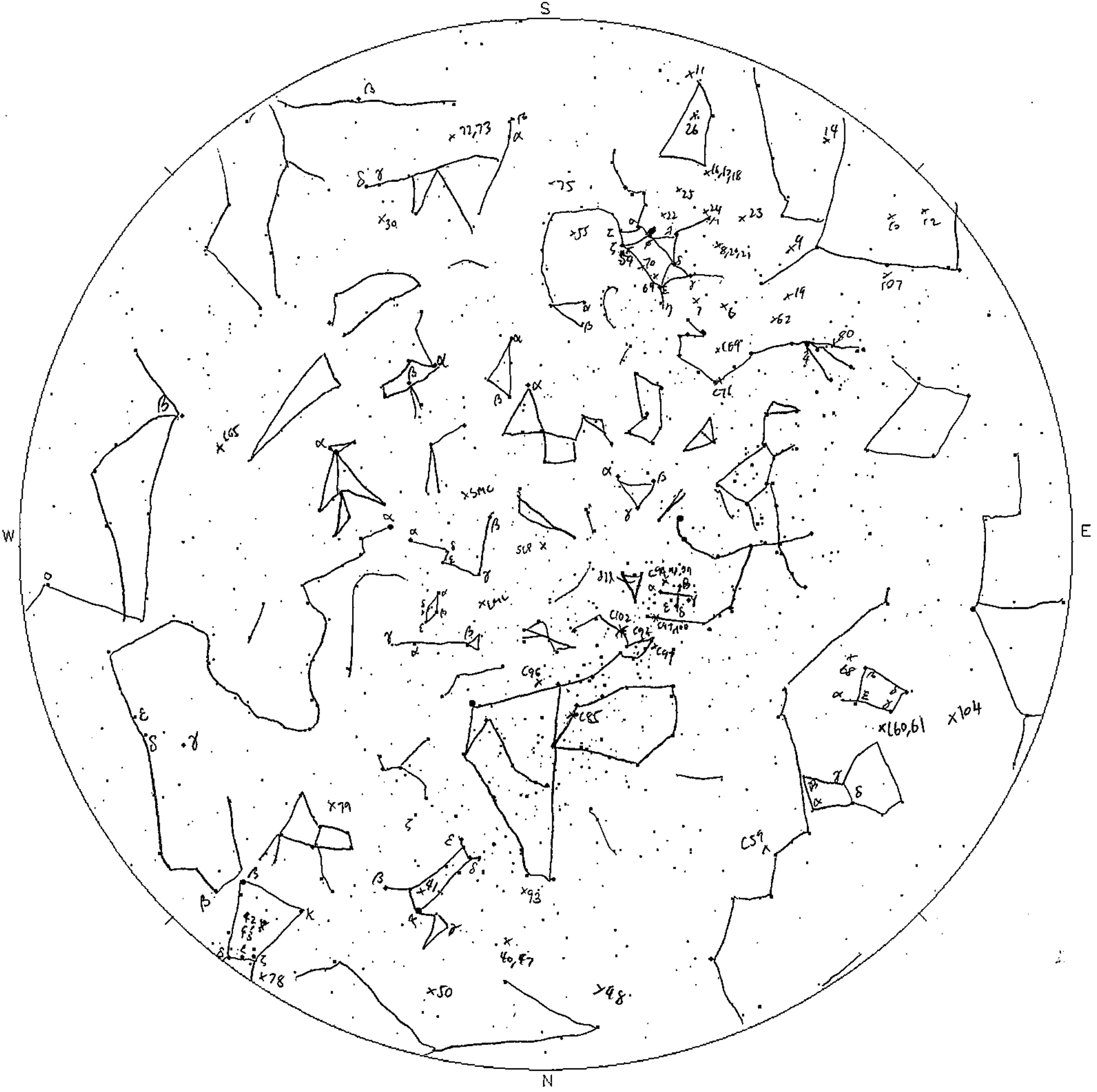

S
W
E
N
LMC
C109
C96
C102
C92
C91
C97 100
C94, 98, 99
C85
C80
C77
C59
C60, 61
C67
83
93
79
41
46, 47
46
50
48
104
78
42, 43
1
35
37
36
38
45
44
95, 96, 105
65, 66
87
85
53
64
3
97, 108
109
106
94
63
51
40
81, 82
101
102


S
W
E
N
X68
X83
X47
C85
C91
C102
C96
C80
SMC
X107
X12
X10
X14
X9
X62
X69
X76
X80
X165
X77
X74
X72,73
X30
X71
X15
X2
X24
X79
α
β
γ
δ
ε
η

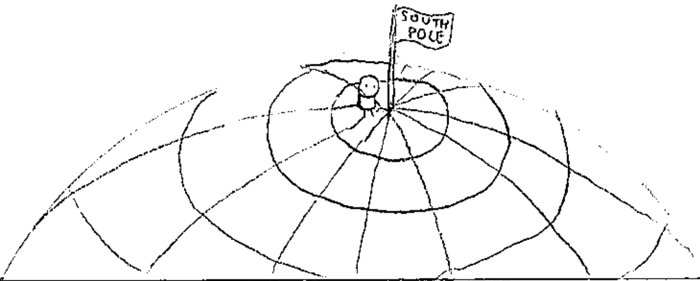

42,43
S
N
E
W
α, β, γ A21
X79
X93
46,47
X41
C59
C65
X160,61
X83
X107
X9
X14
12 10
X5
X30
X72,73
X2
X25
24
16,17,18
20
X69
X42
C96
X109
X35

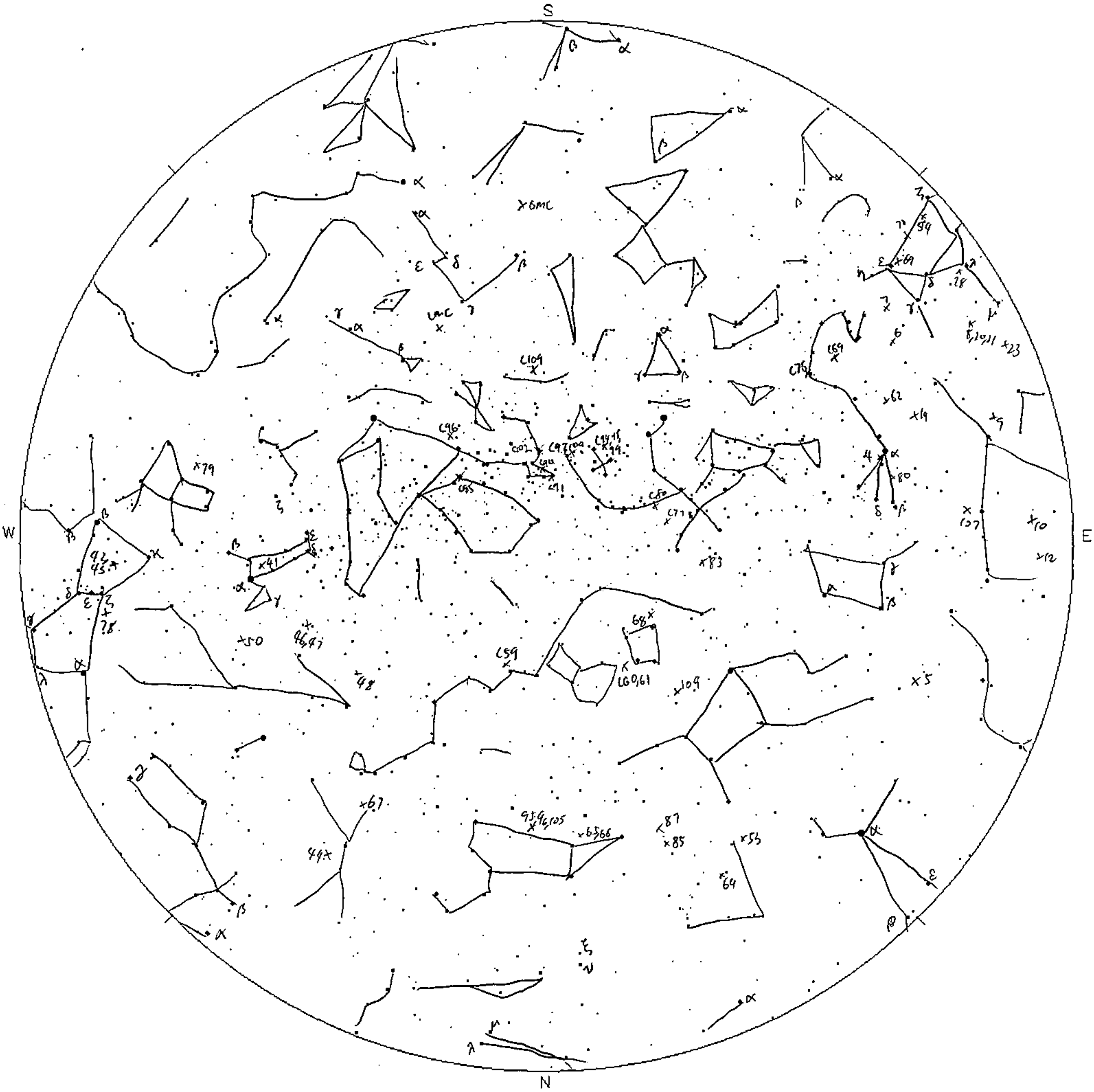

N
E
W
S
x44
63
51
x η
x101
x102
ζ
ε
x40
106
107
97,109
81,82
NCP
ξ ν
65,66
93,55,105
x29
x220
x34
M
53,64
103
x44
x76
x31,36,110
34
38
36
35
37
x1
45
x87
x84
78
41
43
x48
x50
46,47
x93
x11
77
α
β
γ
δ
ε
ζ
η
κ
λ


N
E
W
S
γCyg 'Sadr'
α
β
γ
x C6
ξ
ν
x56
δ
ε
ζ
57>β
x92
x102
x101
x40
x81,82
θ
ι
κ
x97,108
λ
μ
x13
x51
x63
x94
x106
x3
x44
x67
64
53
x85
x65, 66
x95,96,105
87
x14
x12
x10
x107
x16,17,18
x24
x26
x8,20,21
x19
x62
80
x48
46,47
C60,61
x68
x59
x93
x83
x C77
C80
C69
C76
C97
x100
C94
C96
C99,98,99
C102
x26
9
5

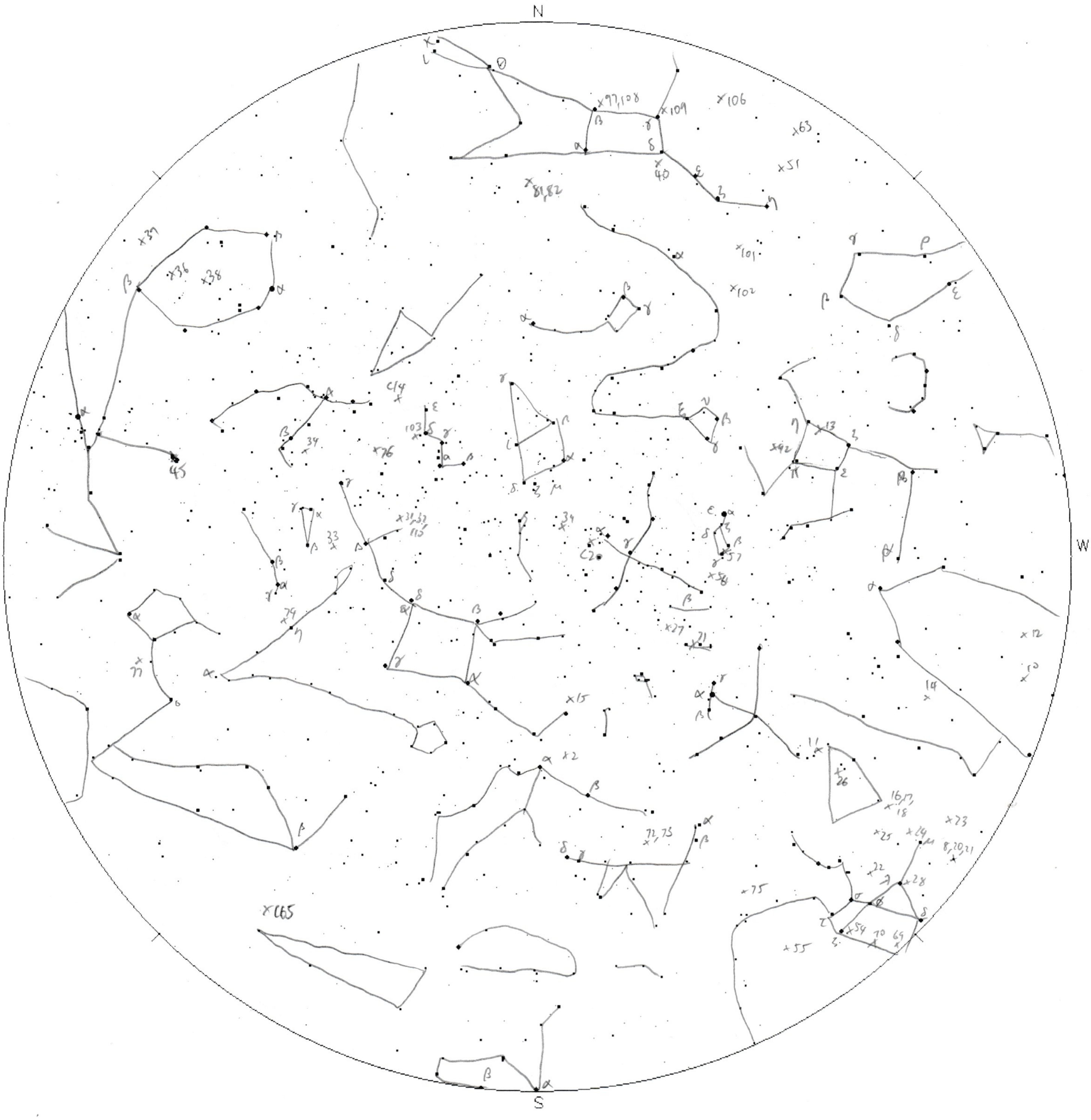


Ok this is legit South Pole
I cannot find any deviation

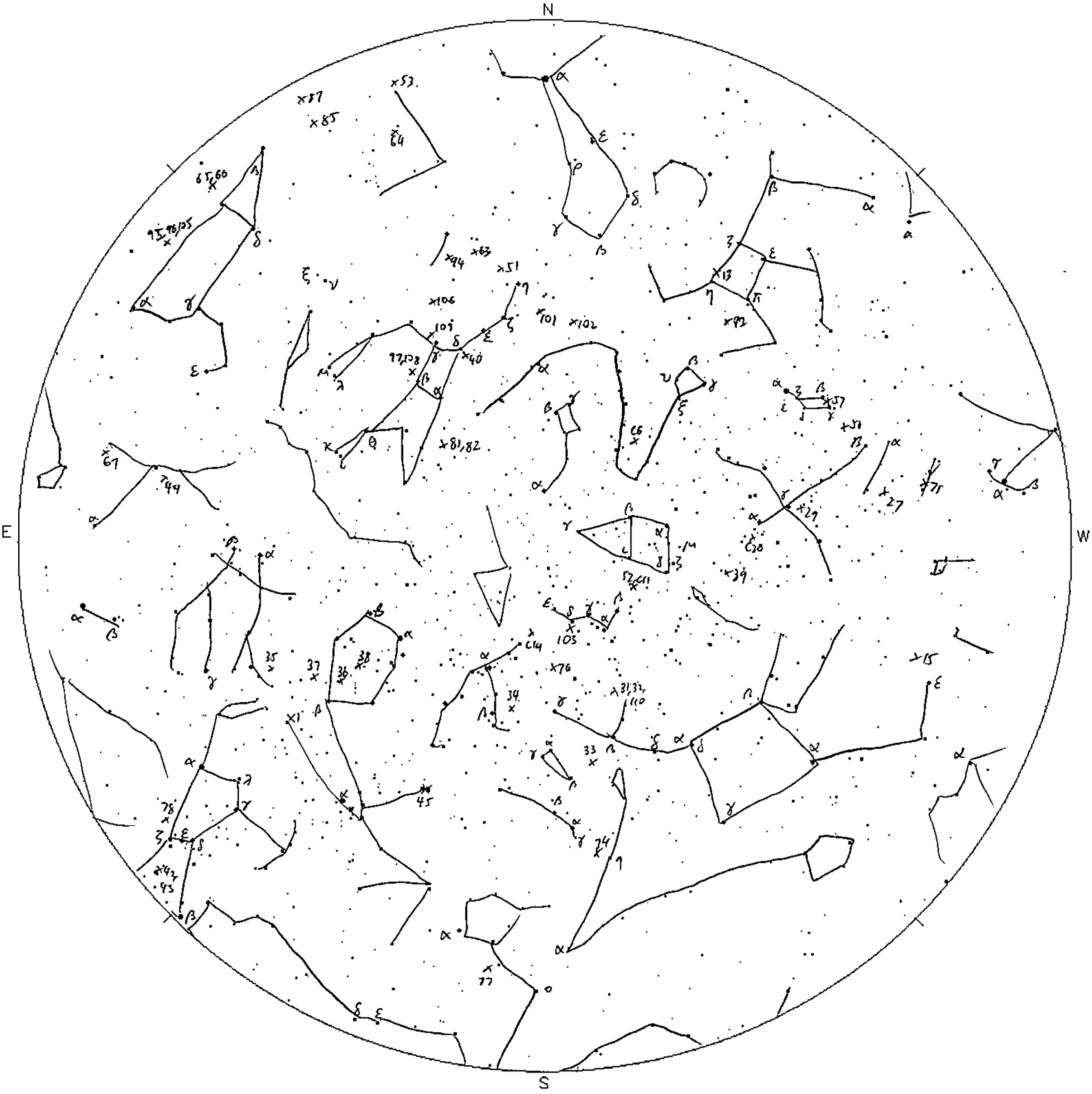




I fucked up: M6&M7 are swapped in earlier star maps that I have done
Those after 800 have been corrected



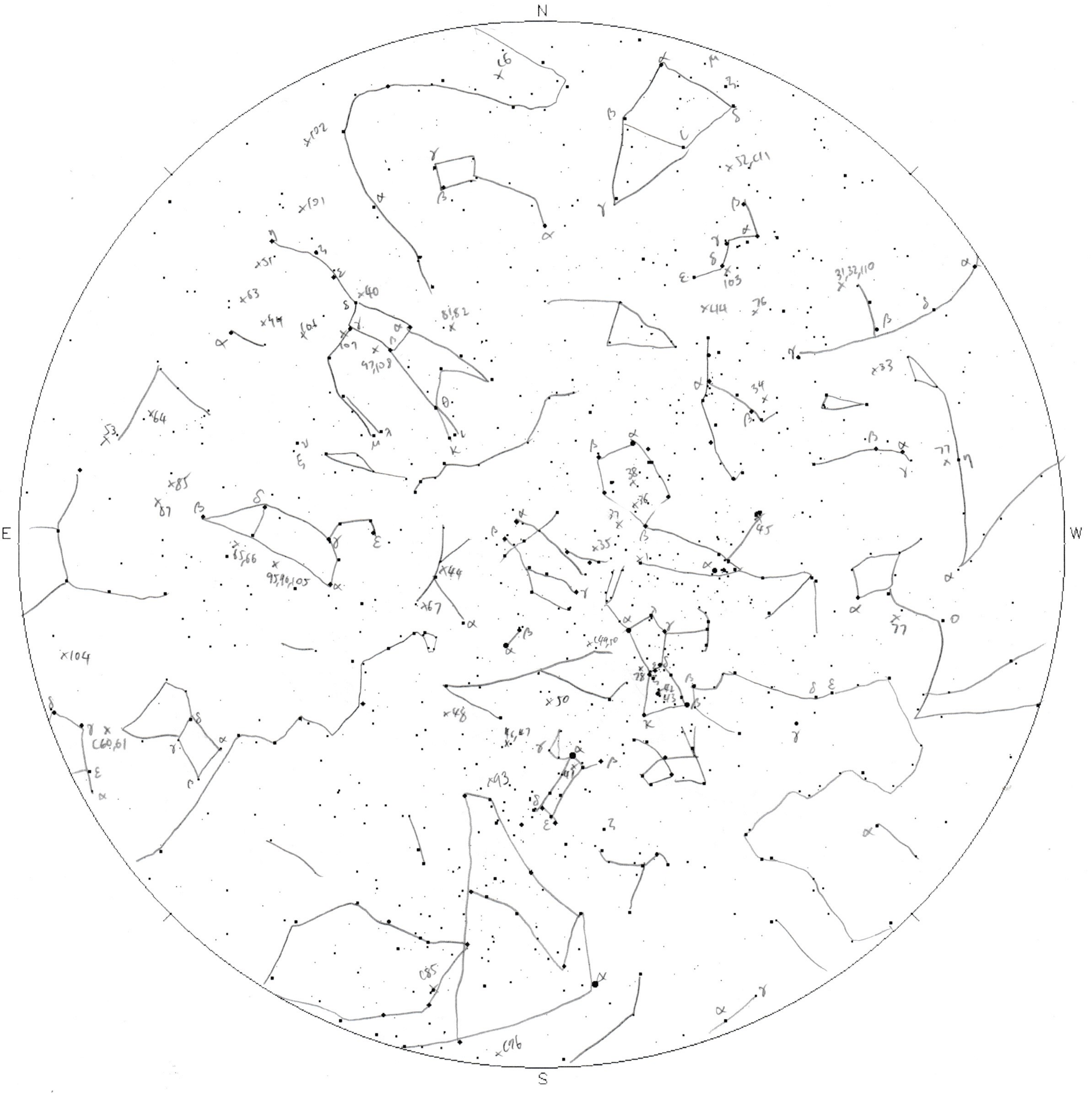
I'm not gonna spend any more
time on this
I need to study for my ~~midterms~~ S40



I dont think I'll make it into IOAA this year

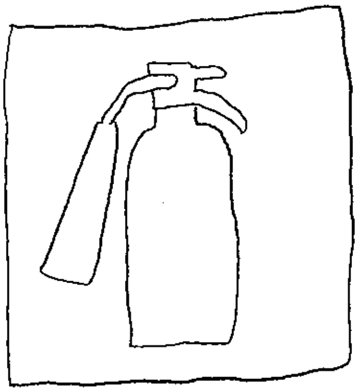
SAO became integration and no star maps

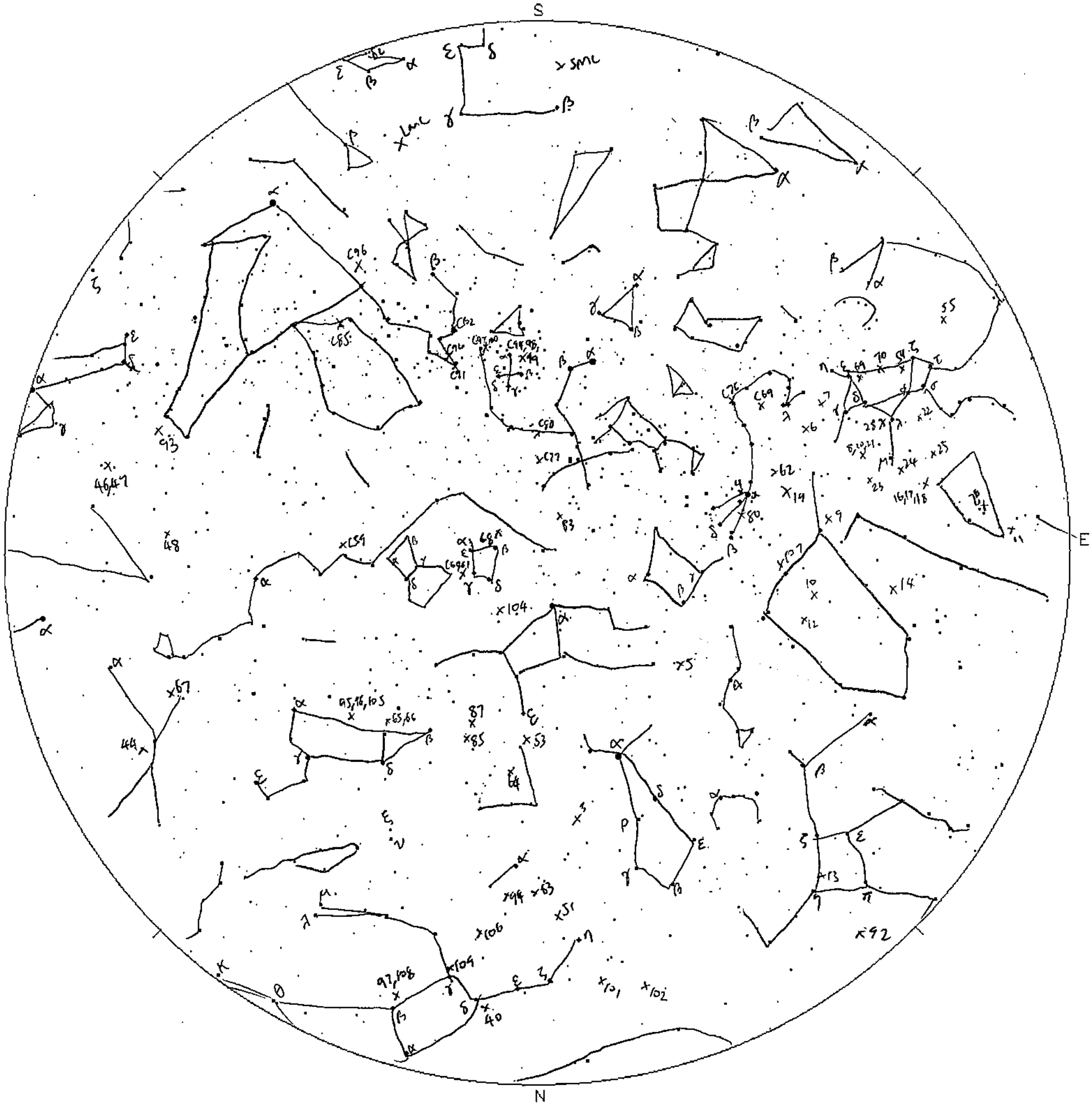
☹

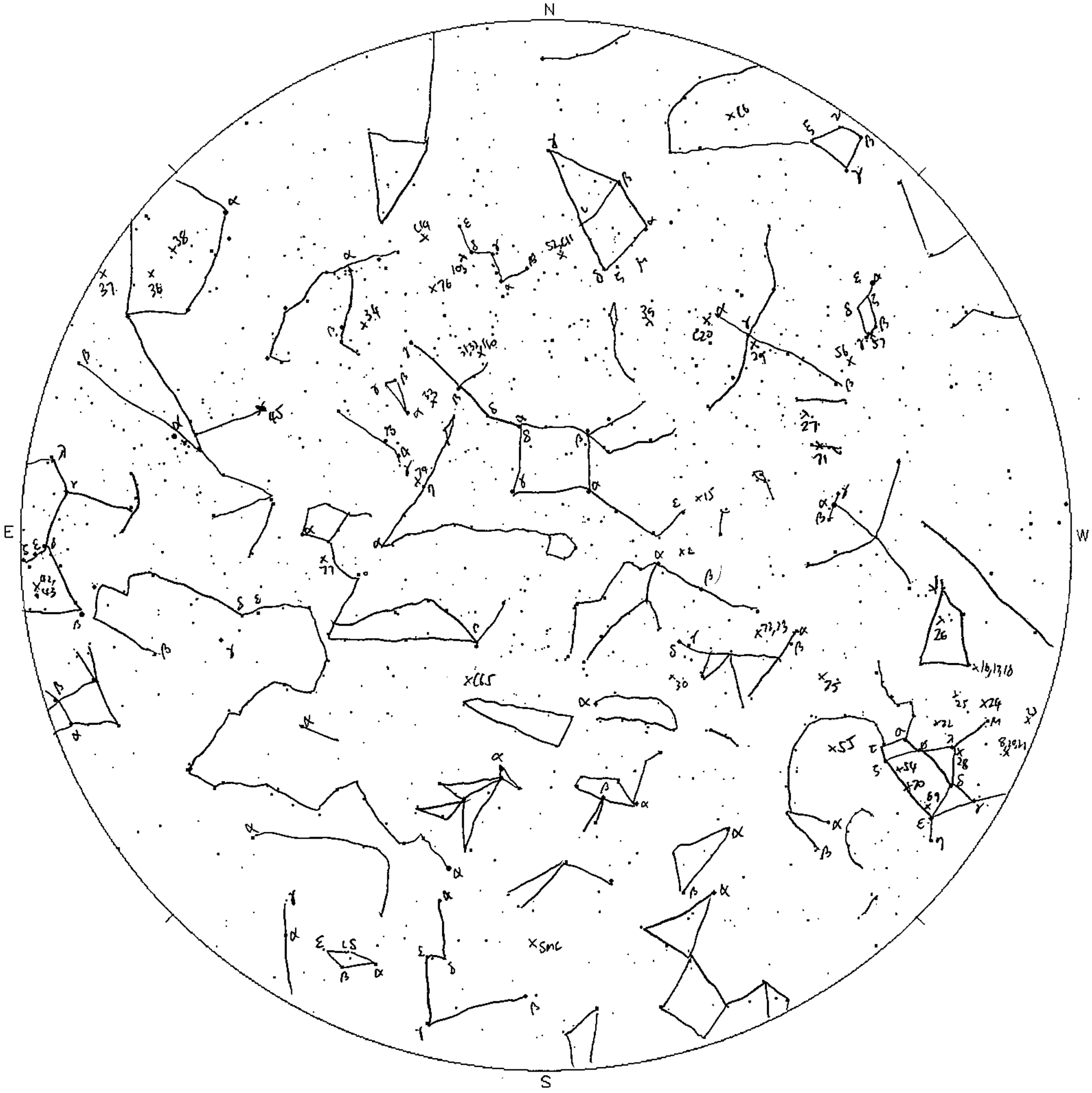


(I remembered this scene from a dream.)


S
W
E
N
x C78
x C69
x 62
x 6
x 7
x 19
x 9
x 10
x 2
x 14
x 75
x 30
x 55
x 23
x 20
x 25
x 15
x 71
x 27
x 74
x 39
C20
x 92
x 13
x C6
x 103
x 76
x 34
x C4
x 33
x 77
x 45
x 31,32,110
x 53 C11




S
N
E
W
SMC
LMC
C96
C85
93
46,47
48
C92
C96
C91
C97,100
C94,95
49
C90
C77
83
C59
68
104
C76
C69
62
19
80
7
6
9
10
12
14
55
69
70
81
28
22
24
25
M1
23
16,17,18
78
11
67
44
95,96,105
65,66
87
85
53
64
5
3
13
92
94
63
51
106
97,108
109
40
101
102
α
β
γ
δ
ε
ζ
η
θ
κ
λ
μ
π
ρ
σ
τ


N
E
W
S
×66
×38
×37
×36
C19
×76
103
52,C11
×34
35
C20
29
56
57
27
71
45
33
31,32,110
79
77
×15
×2
×73,72
×30
×25
×26
×18,13,10
25
×24
×22
28
×54
×70
69
×55
×65
83,121
142,143
×SMC
LS
α
β
γ
δ
ε
ζ
η
λ
μ
ν

8월


S
W
E
N
C49
δ
ε
η
γ
×7
×6
×C69
67
×14
C76
α
50
4
β
×C65
×SMC
C99,98,89
C97,100
C92
C91
C80
C77
×83
C96
C85
68
×60,61
×104
C59
×77
o
×11
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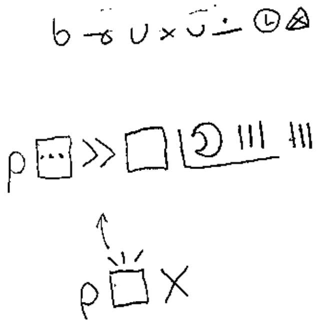
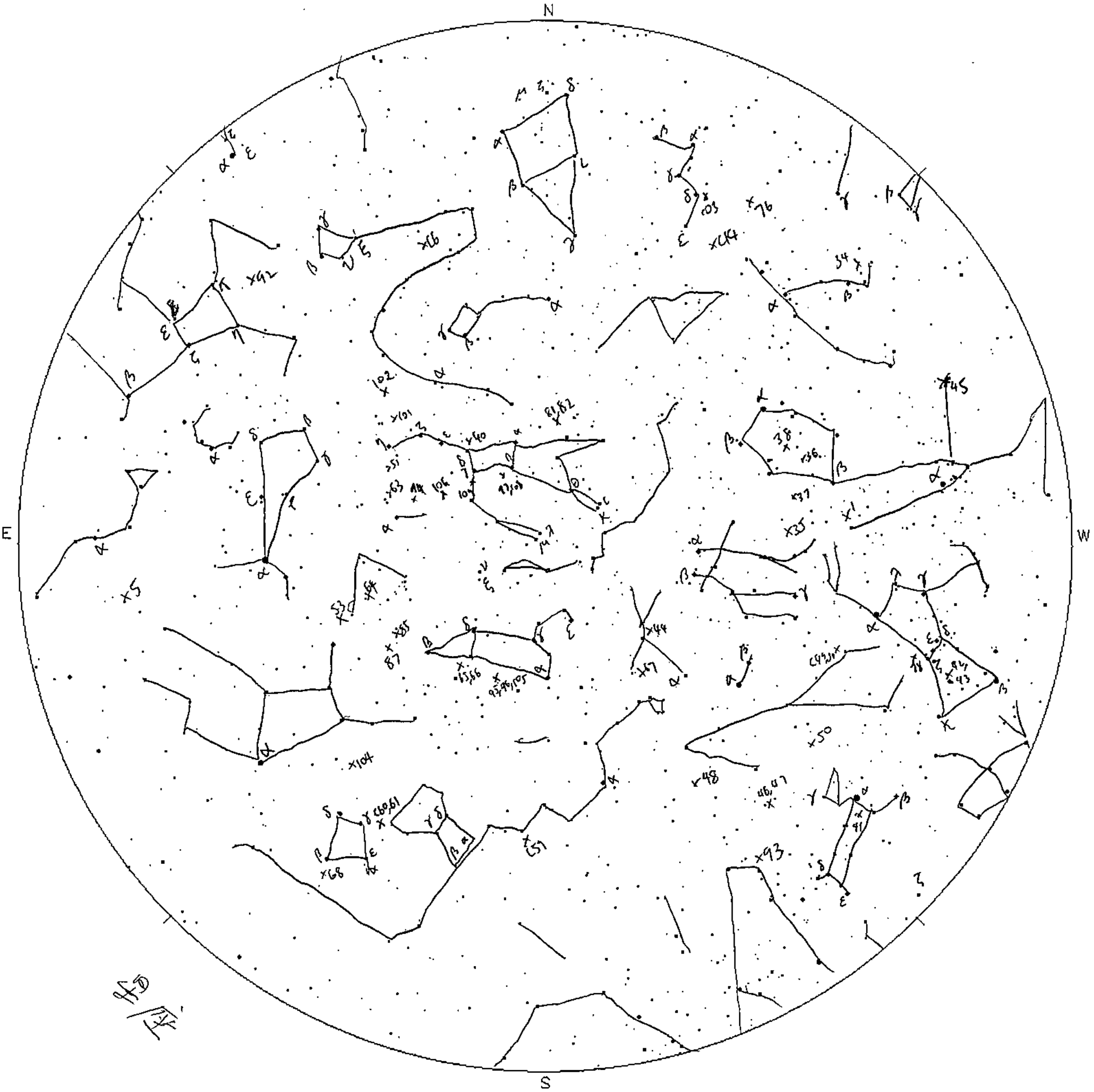
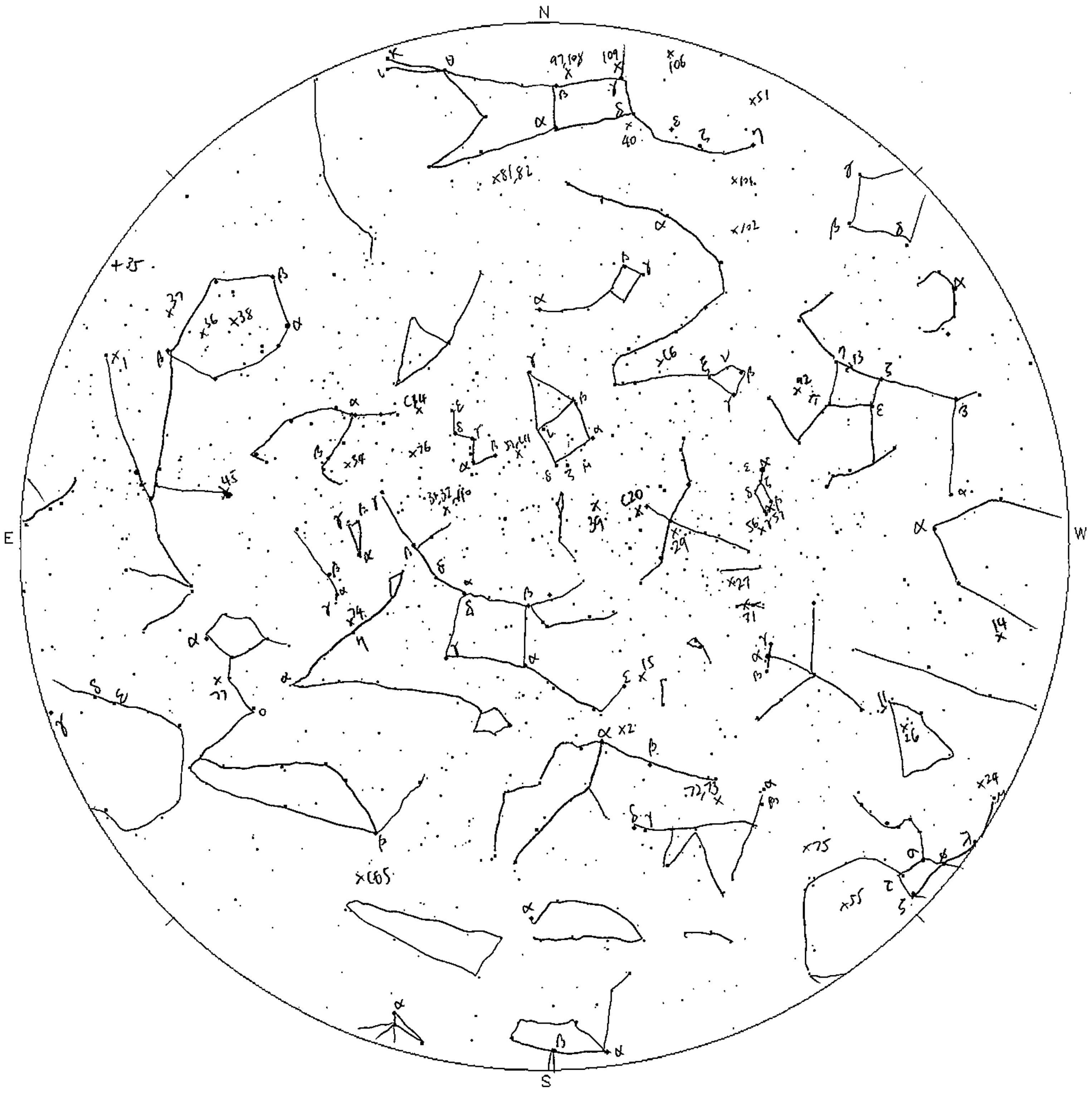
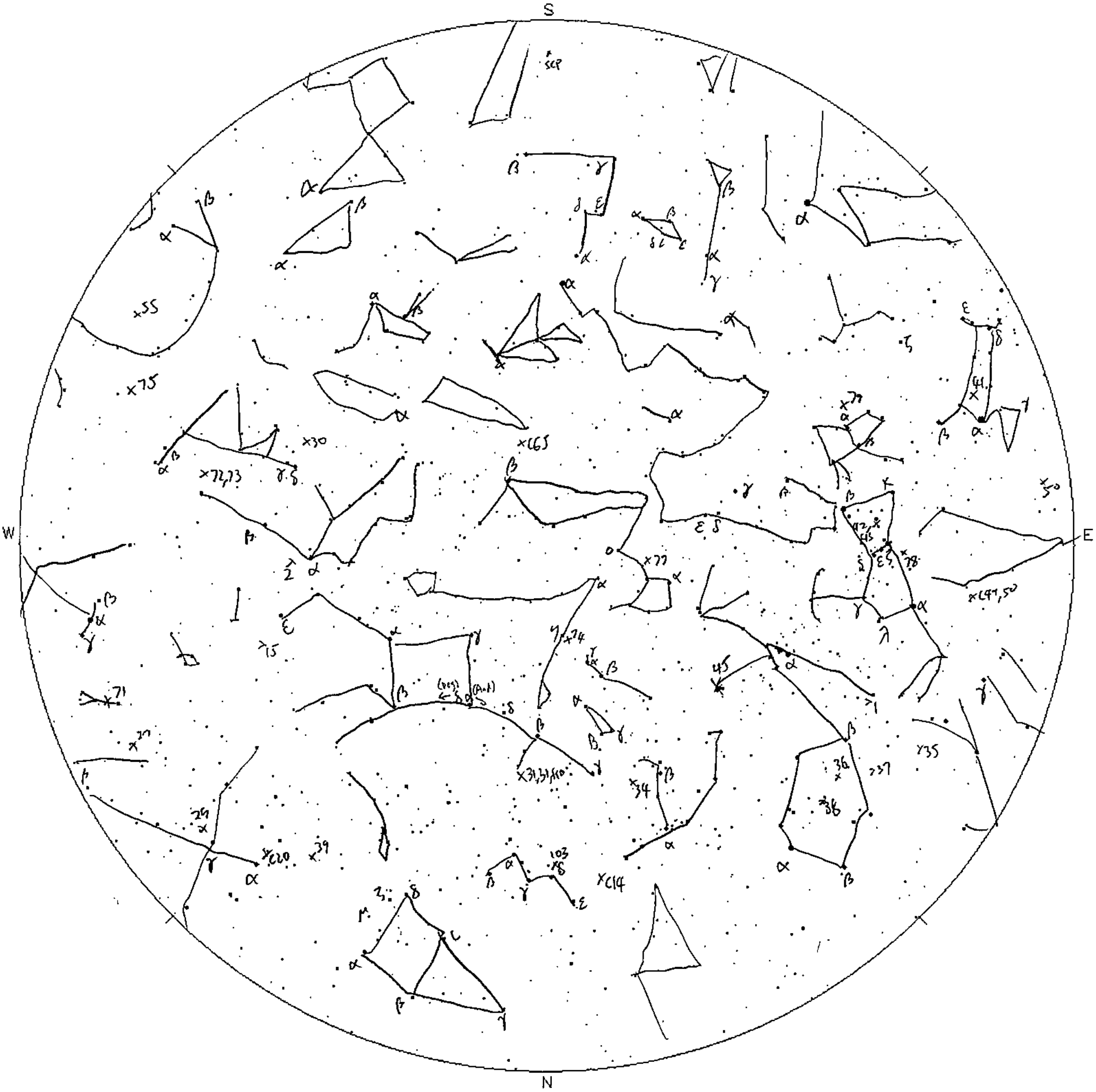
×35
9,34,46,125
×65,66
C41




N
E
W
S
x92
x66
x76
x44
x5
x102
x101
x40
81,82
38
x36
34
x45
x37
x35
x1
x44
x67
x85
87
53
x54
x104
x68
60,61
x57
x93
x50
x48
46,47
41
42,43
C43,51
55,56
93,96,105
97,108
106
x63
x51
103

b□x□öv


N
E
W
S
×106
×51
×40
×81,82
×101
×102
×35
×37
×36
×38
×1
×45
C14
×34
×76
×39
C20
×29
×66
×92
×27
×71
×14
×77
×15
×2
×72,73
×24
×75
×55
×16
×C65


S
SCP
W
E
N
×55
×75
×30
×72,73
×C65
×77
×74
×15
×71
×27
29
×C20
×39
×31,32,C110
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×C14
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×36
×38
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×35
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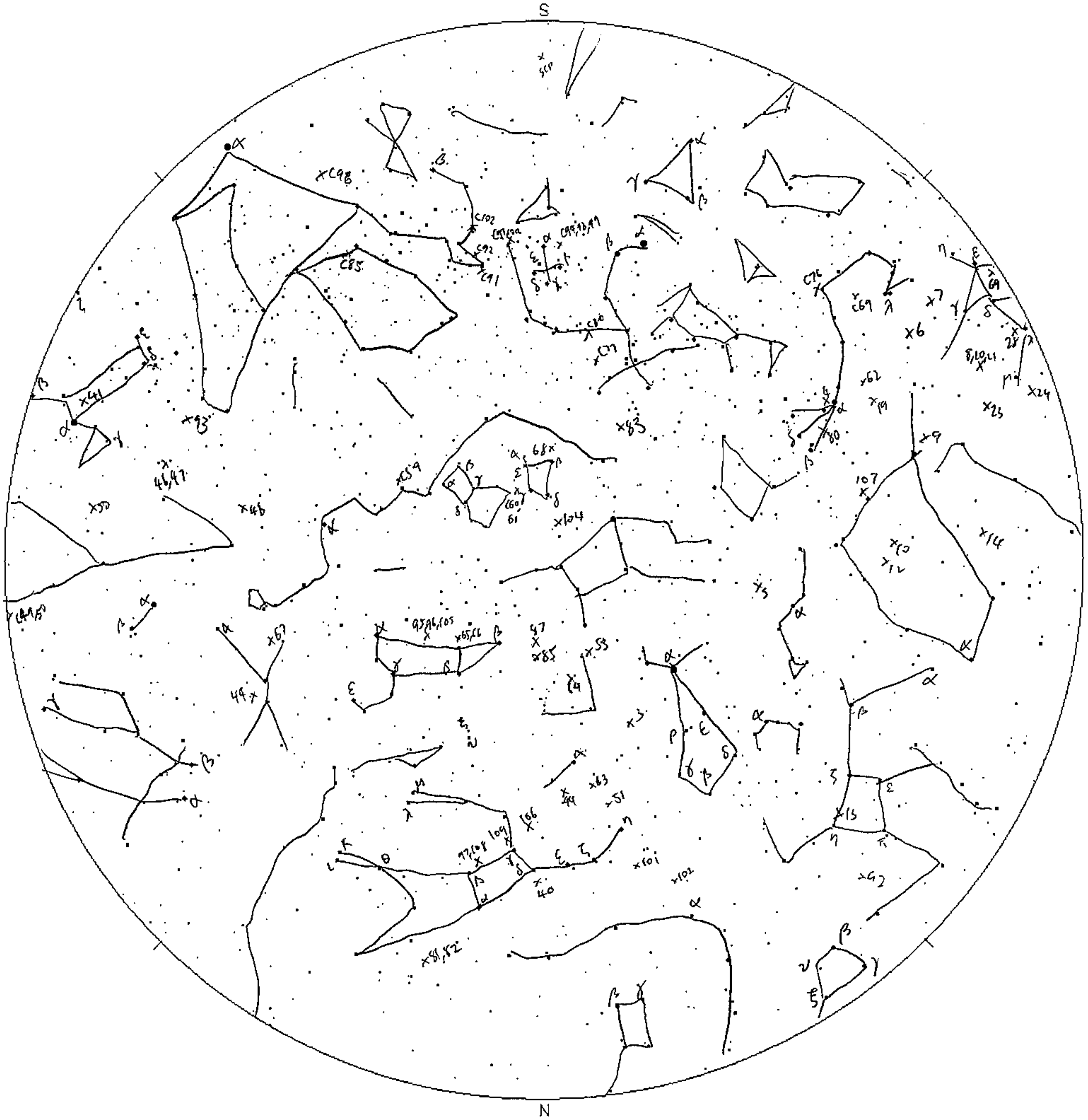
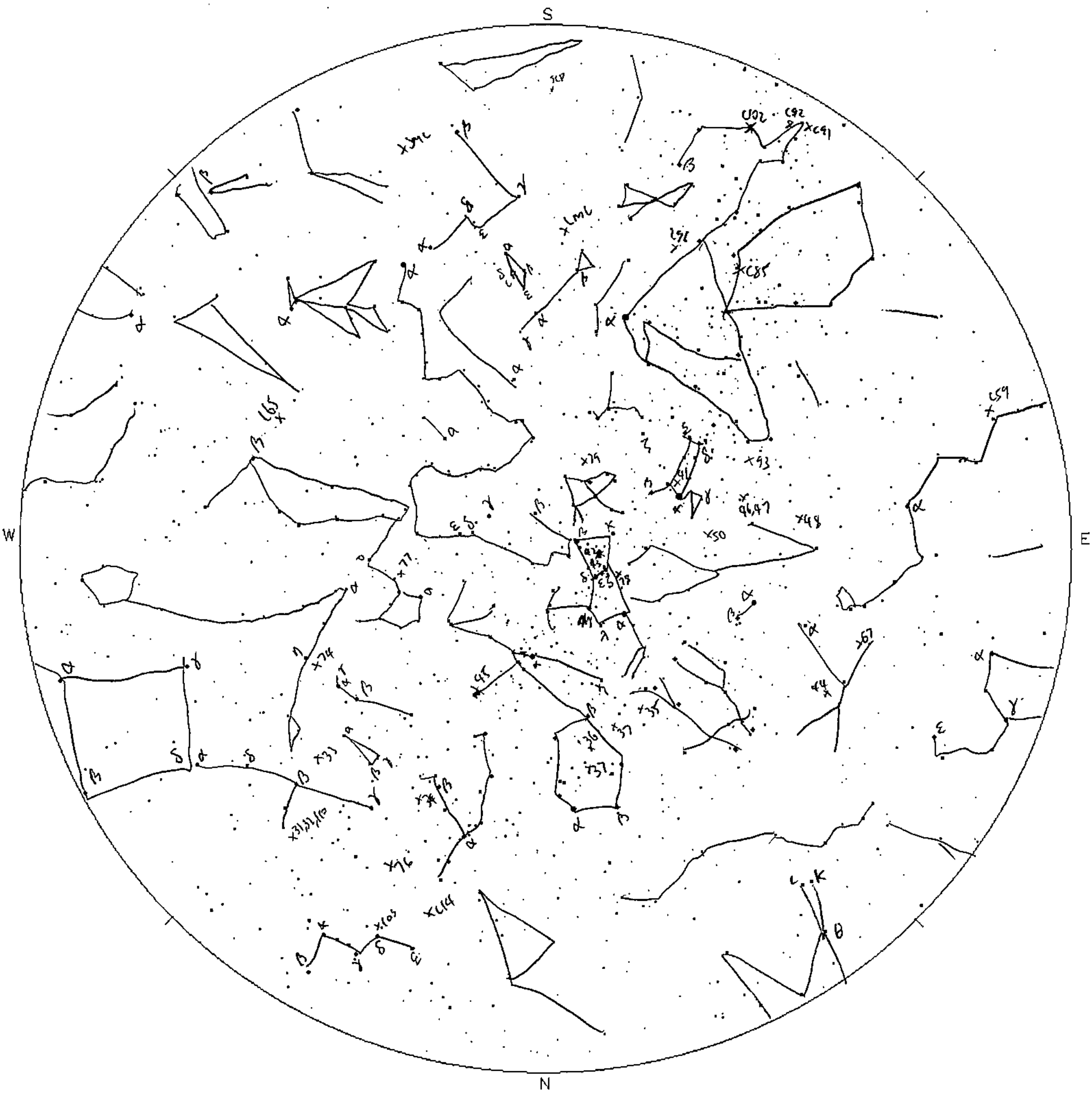
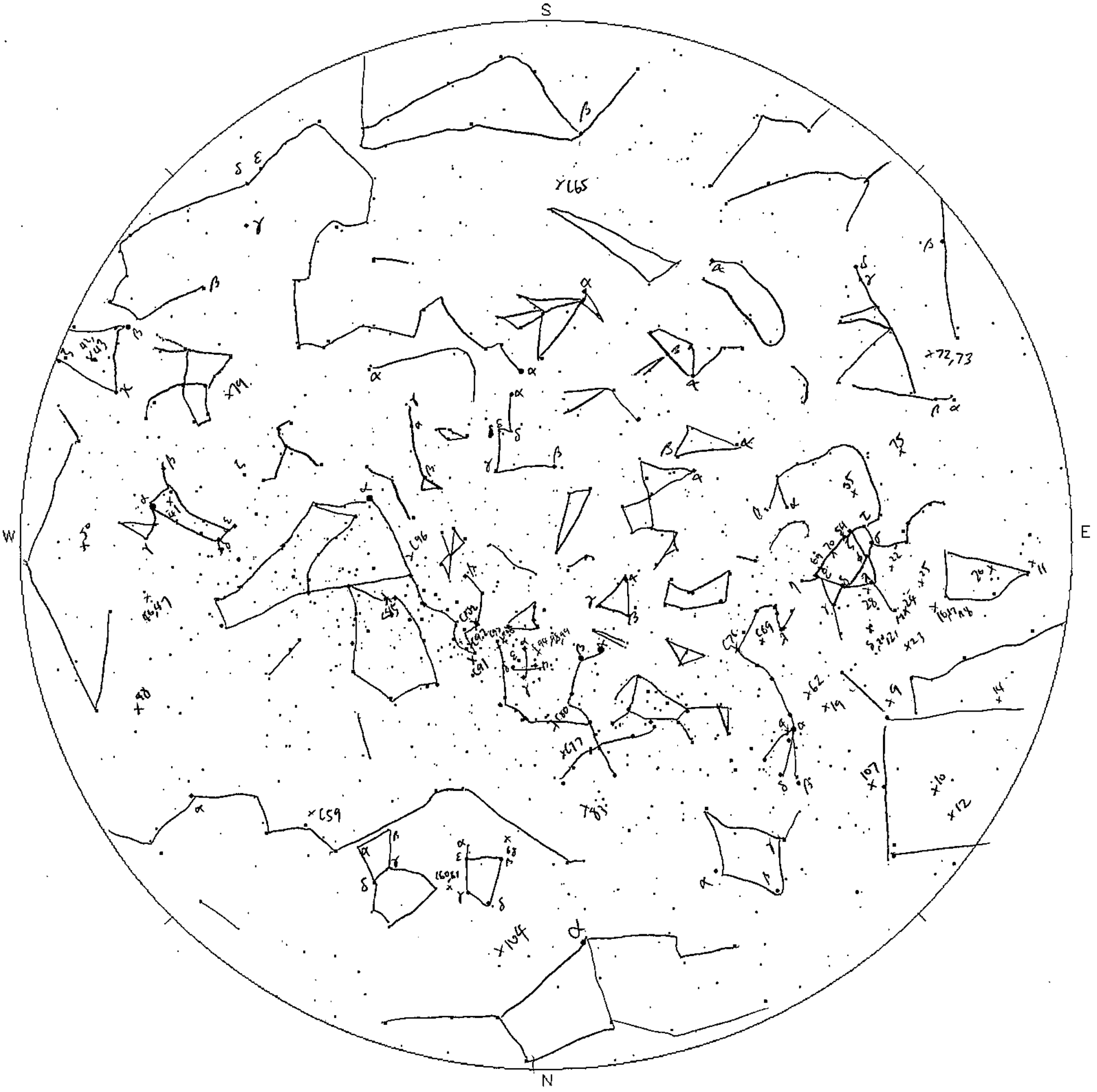
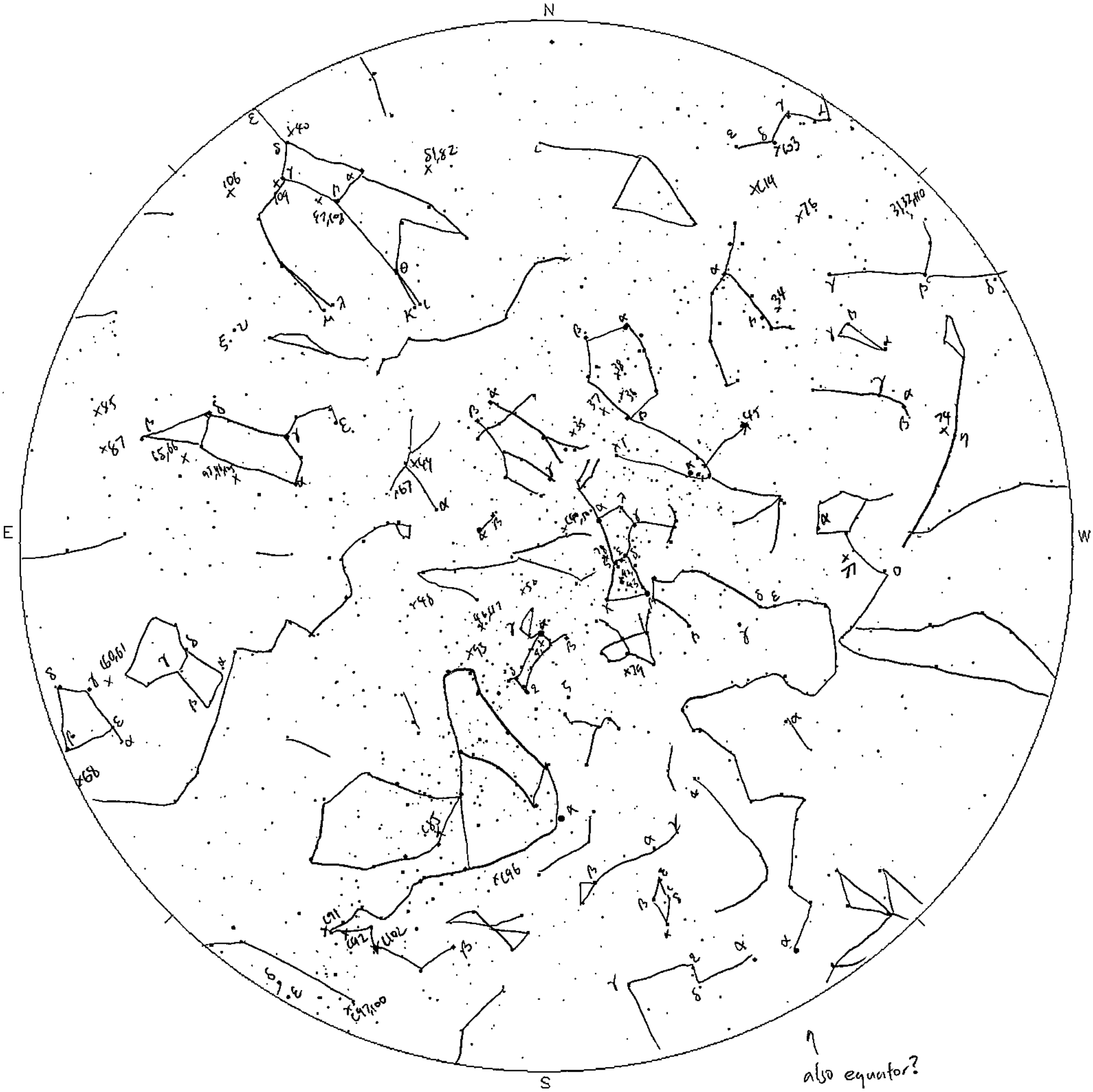
×50
×41
×79
×78
45
×1


S
W
E
N
SCP
C98
C85
C102
C92
C91
C80
C77
C76
C69
C60
61
×93
×41
×50
46,47
×46
×C59
68
×104
×83
×62
×19
×9
×7
×6
×24
×25
107
×10
×12
×14
×5
×67
49
C49,50
97
×85
×53
×3
×63
×51
×49
166
109
×40
×101
×102
×81,82
×92
×13


S
W
E
N
SCP
C102
C92
×C91
×SMC
×LMC
β
γ
δ
ε
α
C85
C59
C65
M79
M41
M93
M46,47
M48
M50
M77
M74
M45
M35
M36
M37
M38
M42
M43
M33
M31,32,110
M76
×C14
×C103
M44
M67
κ
θ
ι
λ
η
ζ

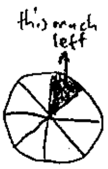

S
W
E
N
δ ε
γ
β
α
X165
X72,73
X79
X96
X159
X104
X107
X10
X12
X14
X9
X19
X62
X69
X48
X17
X80
X16,47
X21,22,23
X24
X25
X55
X75
X68
X160,61
X183

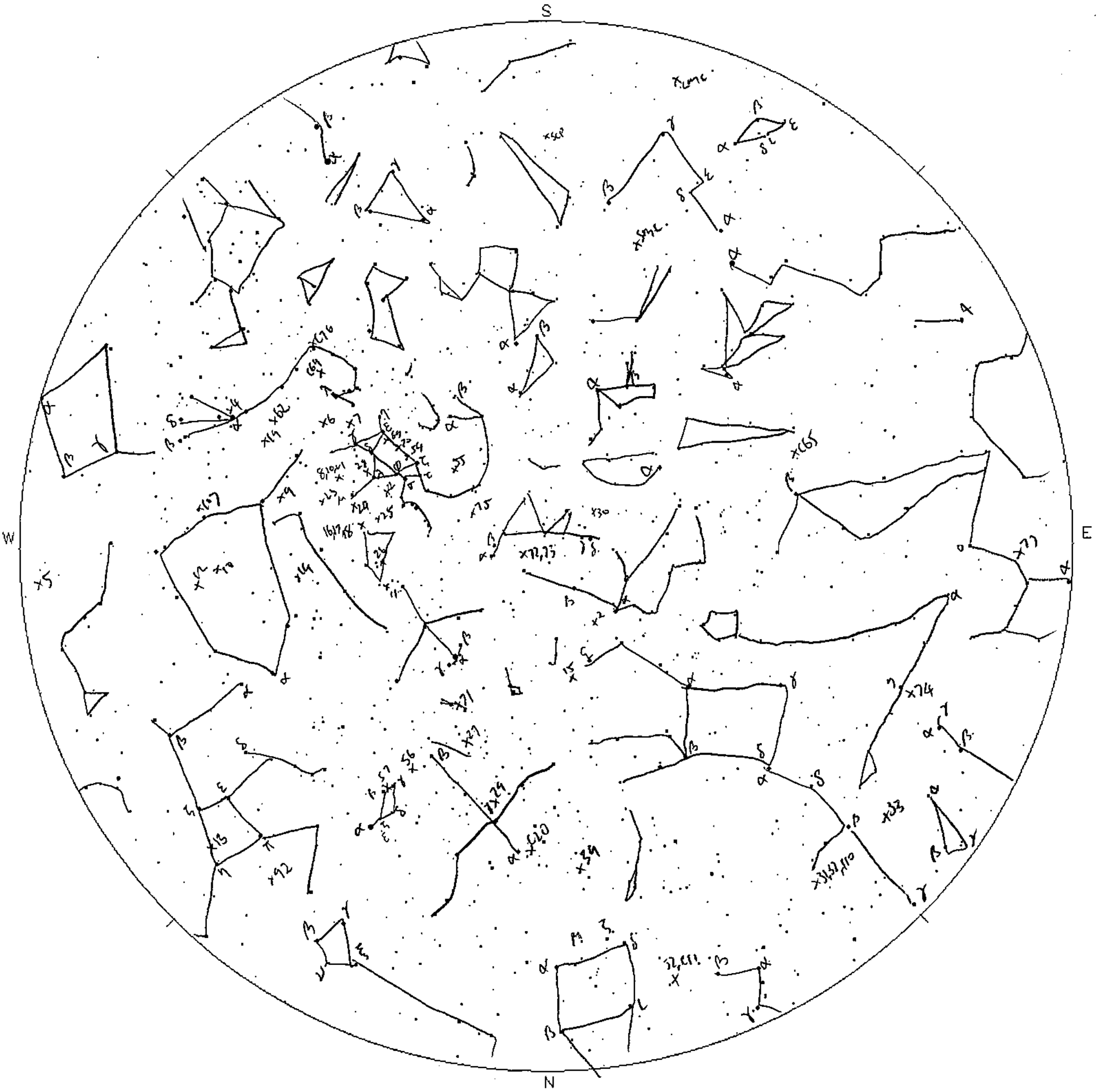


↑
also equator?

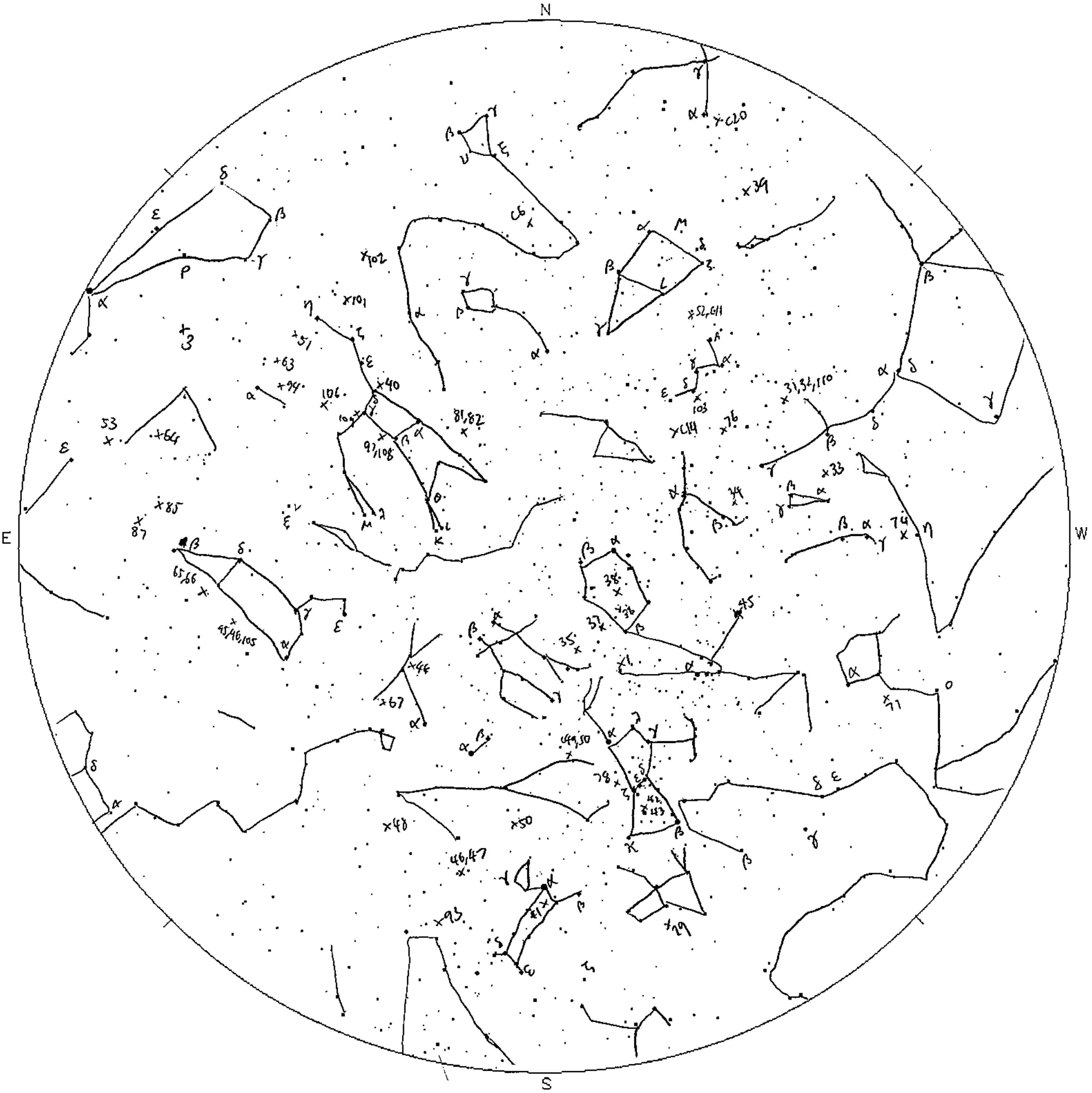
No APLO for me
(i didnt even try for it imo)

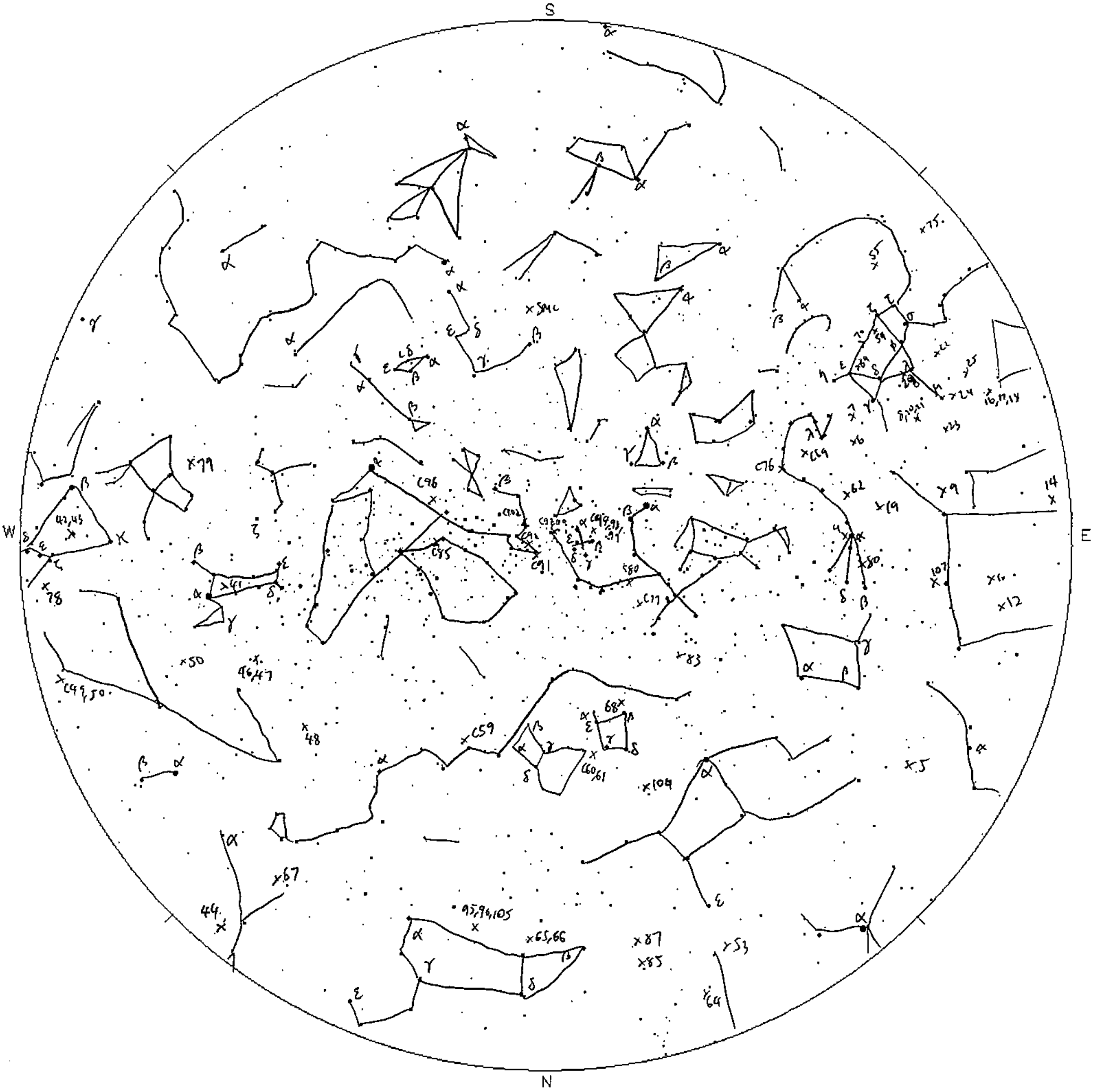
7/8

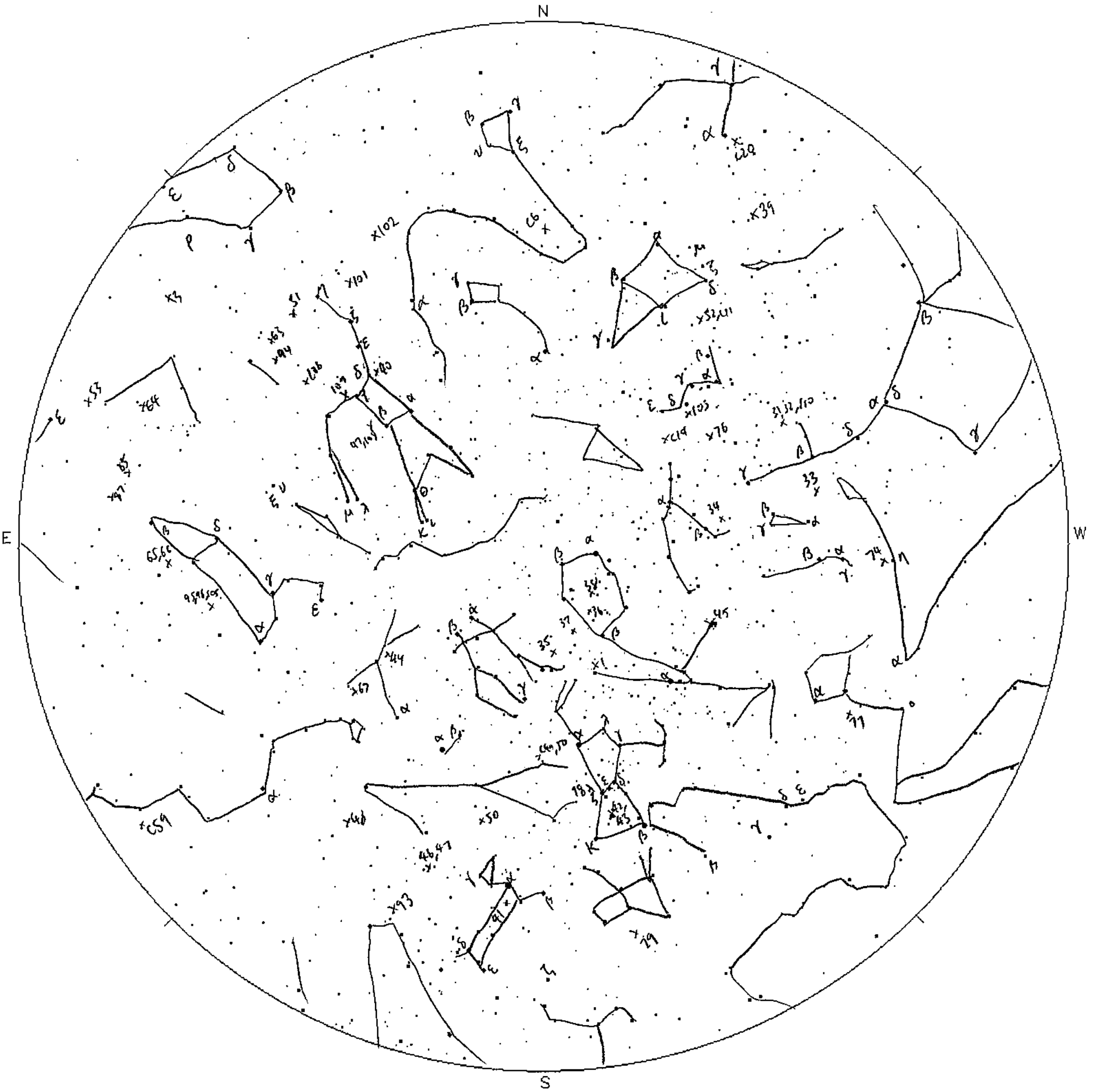


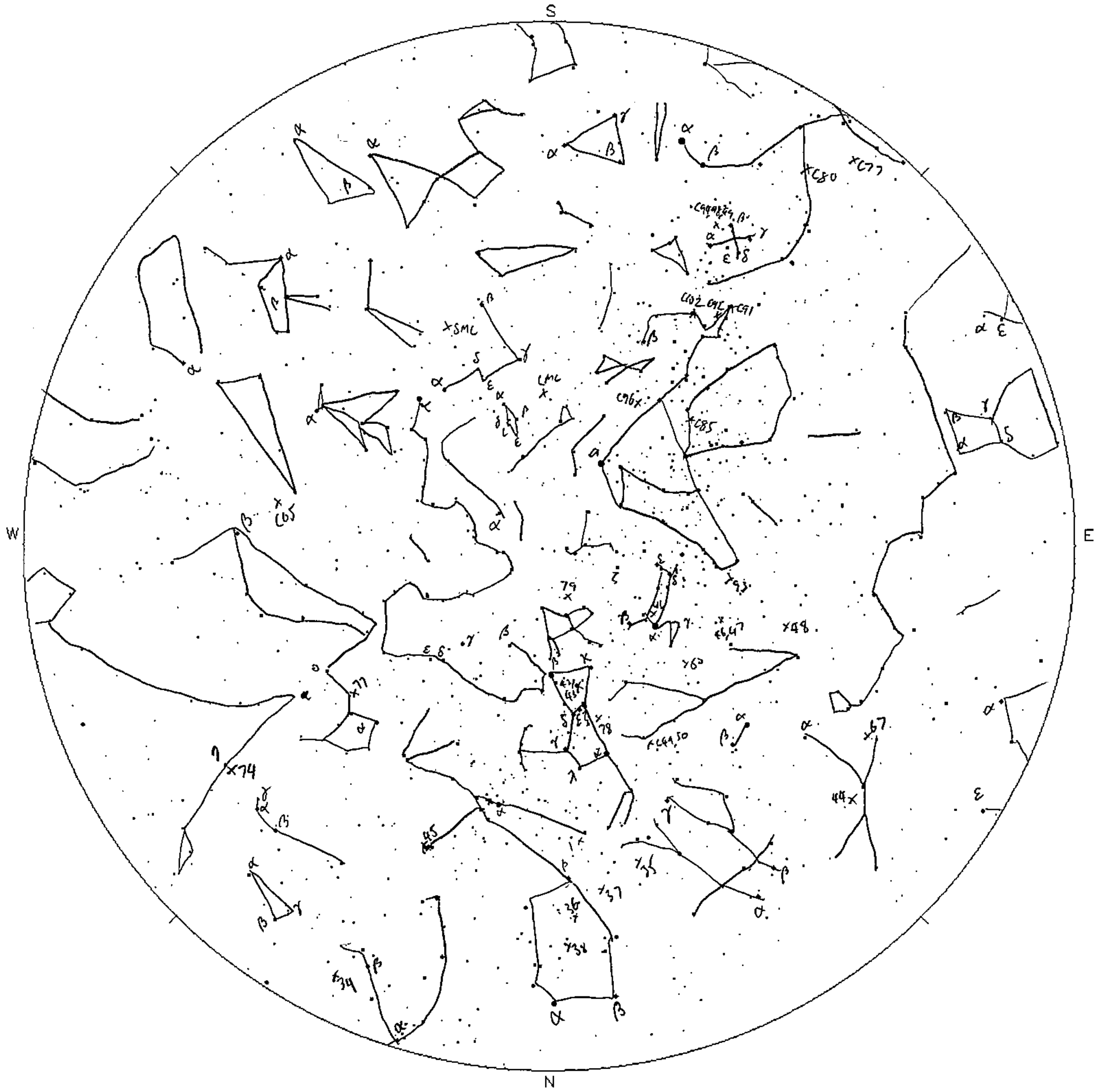

S
W
E
N
xLMC
xSMC
xSC
β
γ
α
δ
ε
x76
x69
x14
x62
x6
x7
x107
x9
x12
x10
x16
x5
x25
x24
x75
x72,73
x30
x65
x2
x15
x71
x27
x77
x74
x13
x92
x29
x220
x39
x33
x31,32,110
x56
x57
32,121

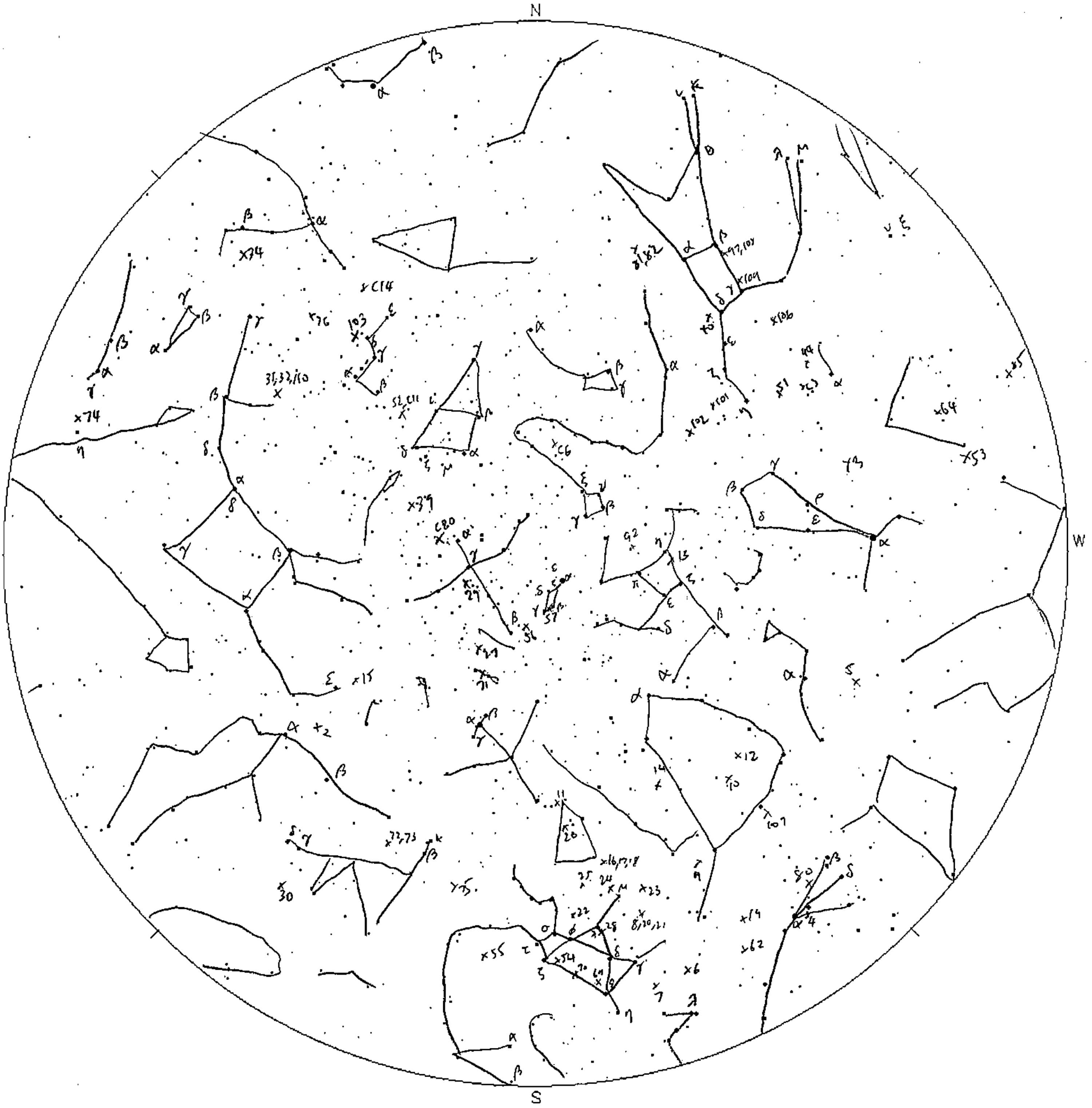

S
W
E
N
C85
C91
C92
C102
C96
C77
C80
83
79
C76
C69
62
19
6
7
107
9
10
12
14
8,20,21
23
24
22
25
16,17
18
26
28
69
70
54
75
30
72,73
2
15
71
27
11
LMC
SMC
SC
65
77
78
99,97,99


N
E
W
S
×120
×39
×102
×101
×51
+63
×94
106
×40
81,82
97,108
53
+64
×85
87
65,66
45,46,105
×52,64
103
×114
×76
×31,34,110
×33
74
74
38
×36
37
35
×45
×44
×67
×71
49,50
78
42,43
×48
×50
46,47
×93
×29
41

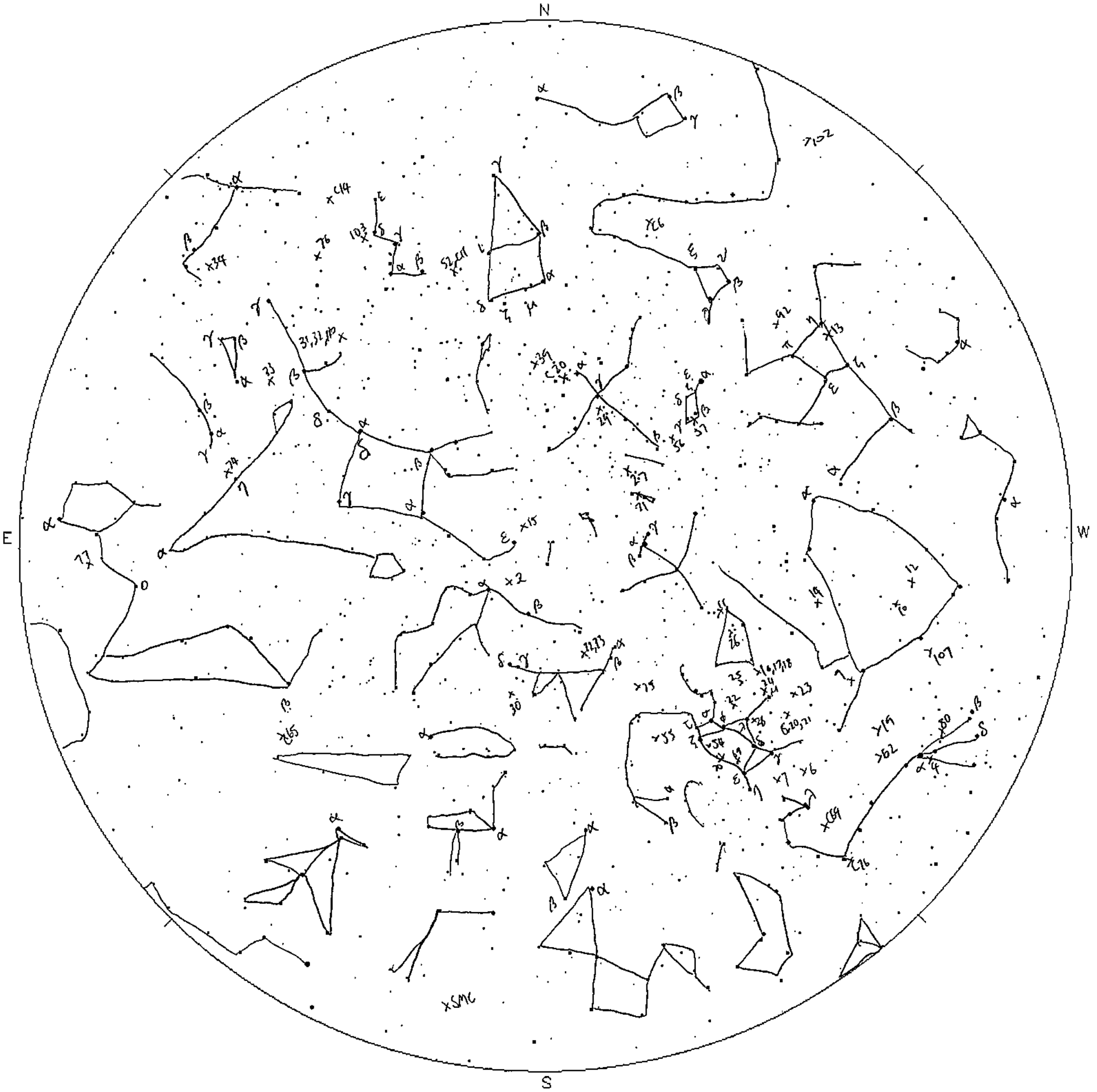

S
W
E
N
x54c
x75
55
x79
42,43
x78
x41
x50
46,47
x48
C49,50
x67
44
95,96,105
x65,66
x87
x85
x53
x64
x104
C60,61
68
C59
x83
C77
580
C91
C92
C93
C102
C96
C95
C76
C69
x62
x19
x80
x9
14
x10
x12
107
x5
x6
x22
x25
x24
16,17,18
8,10,21
x23
x29
α
β
γ
δ
ε
ζ
η
λ
σ
τ
κ


N
E
W
S
x129
x39
x102
x101
x3
x53
x64
x63
x94
x108
x52,111
x103
x114
x76
31,32,110
33
34
74
35
37
38
36
x1
45
x44
x67
11
C59
x48
x50
46,47
x93
91
29
42,43
65,66
97
85


S
W
E
N
×C80
×C77
SMC
LMC
C96×
C85
C102
C91
×C105
×77
×74
44×
×67
×48
×60
×78
×37
×38
×36
×39
×45
×35
×93
C44,50
79


N
E
W
S
x74
x74
x76
x C14
103
31,32,110
52,C11
x39
C80
29
x41
56
57
x15
x2
30
x77,73
x35
x11
x20
x16,17,18
25
24
x M
x23
x22
x28
8,20,21
x55
x54
70
69
x6
7
x14
x62
4
x12
x10
x107
14
9
5
x64
x53
x85
x3
92
13
x C6
82
x97,104
x109
x106
40
x102
x101
51
x53
44

SOUTH POLE
AGAIN!


N
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α
β
γ
δ
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η
ι
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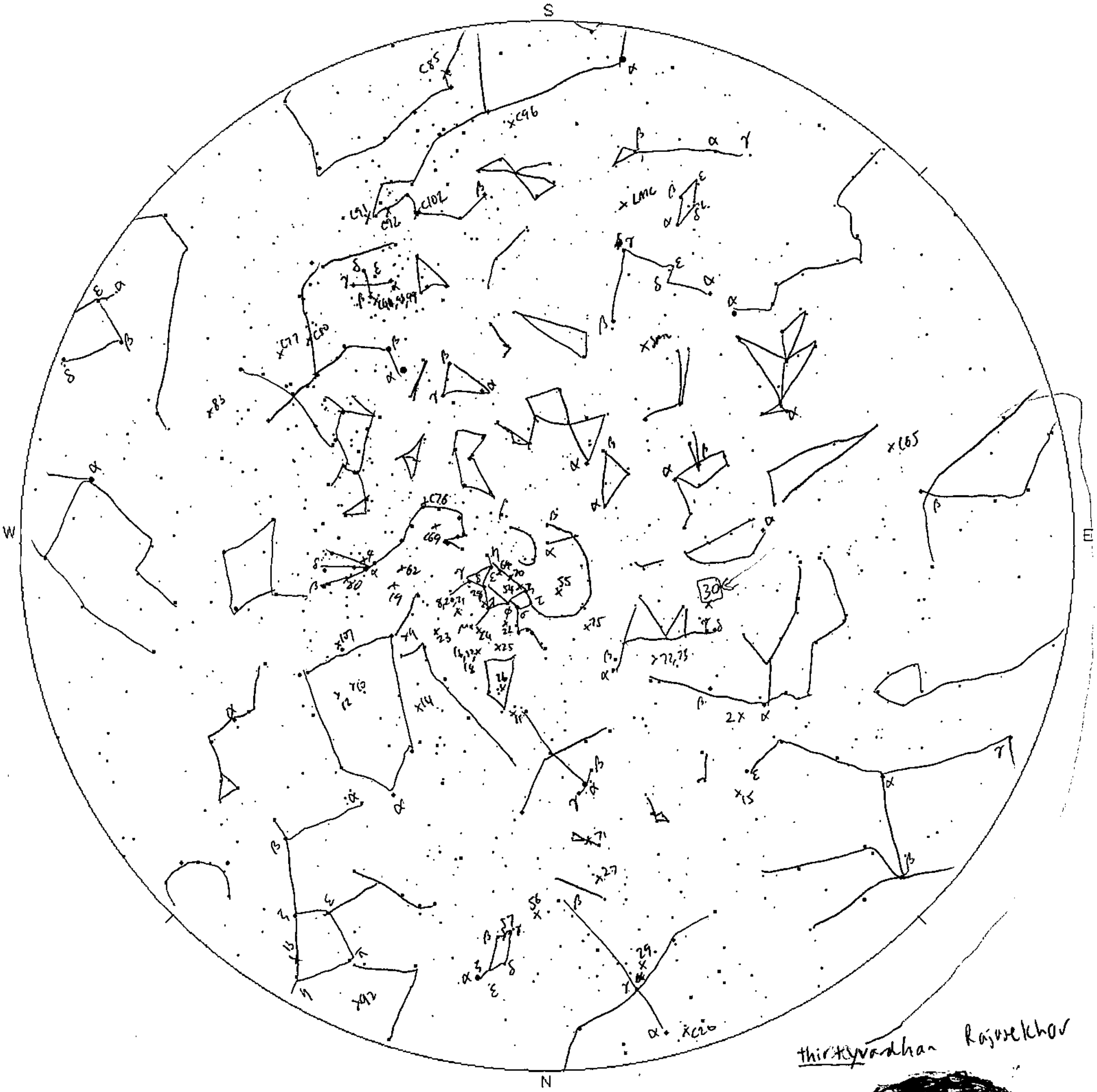
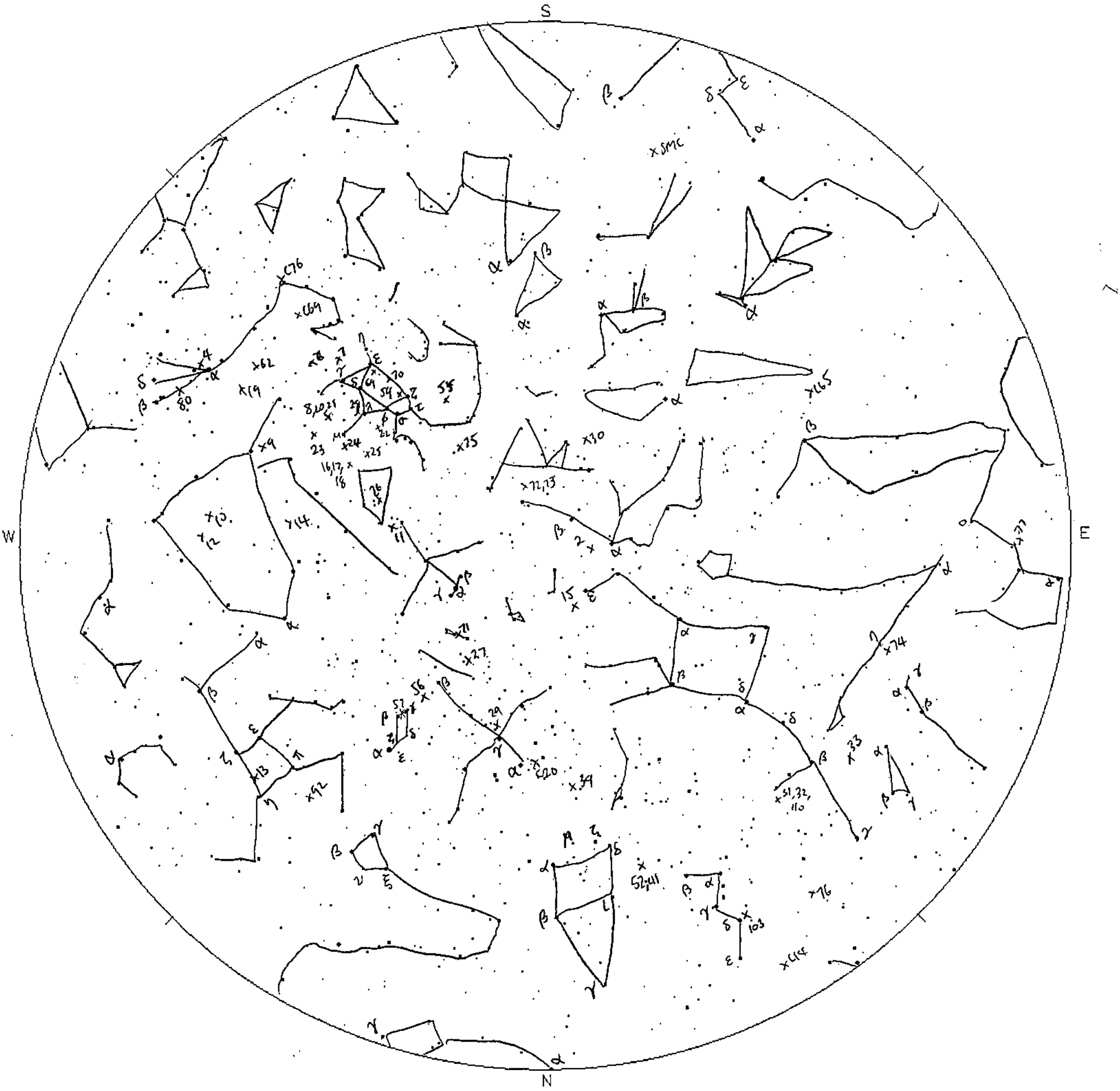
π
ν
×102
×C6
×34
×C14
×76
103
52,C11
31,32,110
×92
×13
×39
C20
×29
56
37
×27
×15
×2
×74
×11
×19
×12
×10
×107
×73
×30
×75
×26
×16,17,18
25
×24
×23
×55
×54
×22
×28
6,20,21
×7
×6
×69
×19
×62
×80
×C26
×SMC



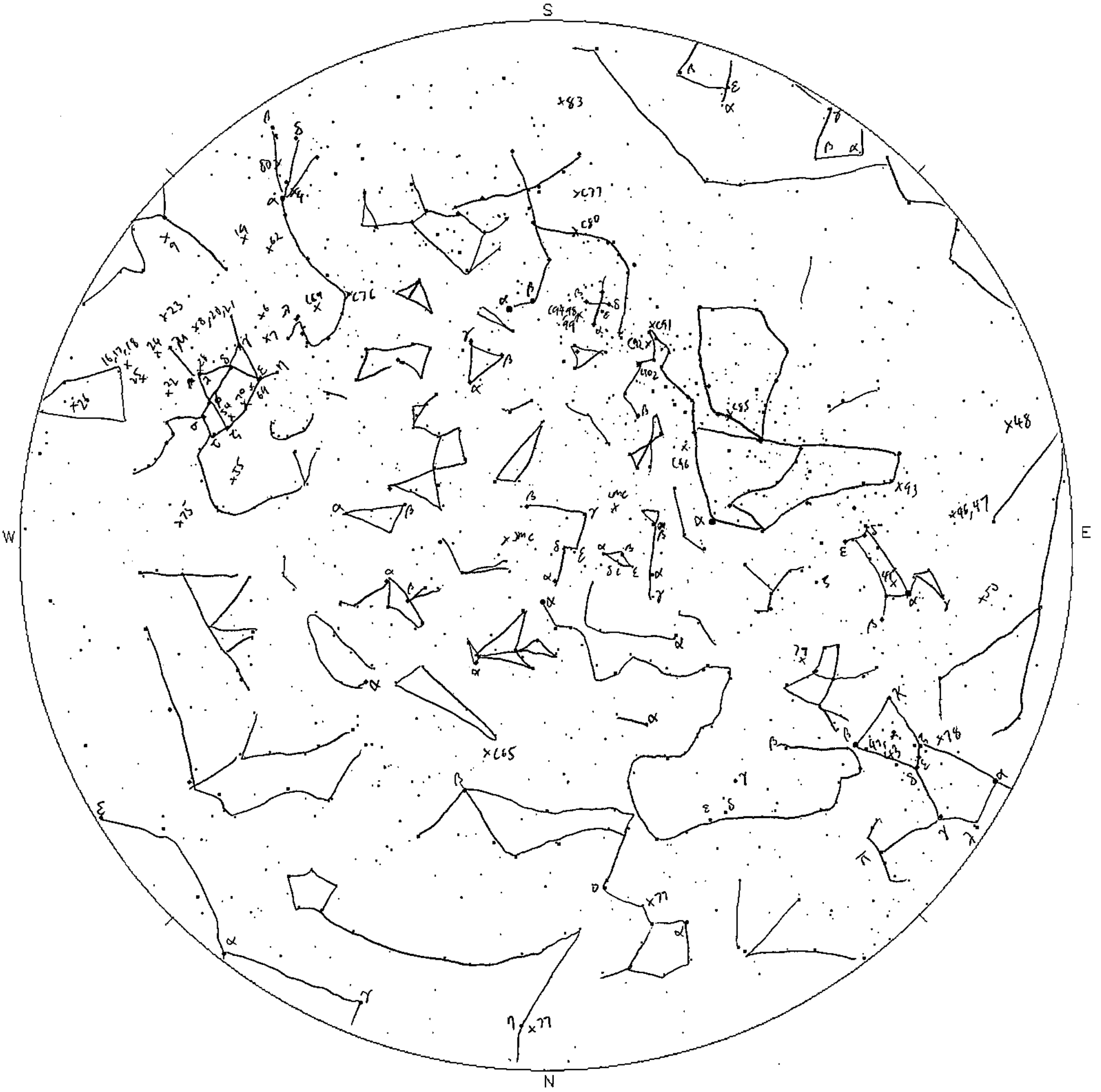
thirtyvardhan Rajasekhar



Suprisingly

Equator map

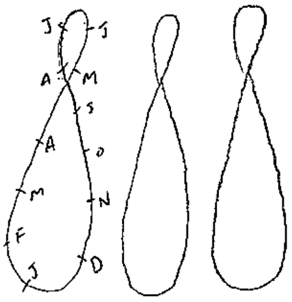

S
N
E
W
x79
x46,47
x93
C65
x30
x2
x72,73
x35
x75
C96
xLMC
SMC
C85
C102
C91
C92
C14,16,19
C80
C97
C76
C89
x83
x104
x62
x19
x9
x7
x6
x22
x24
x23
x25
16,17,18
x26
x11
x70
x12
x14
x80
C88
α
β
γ
δ
ε
ζ
η



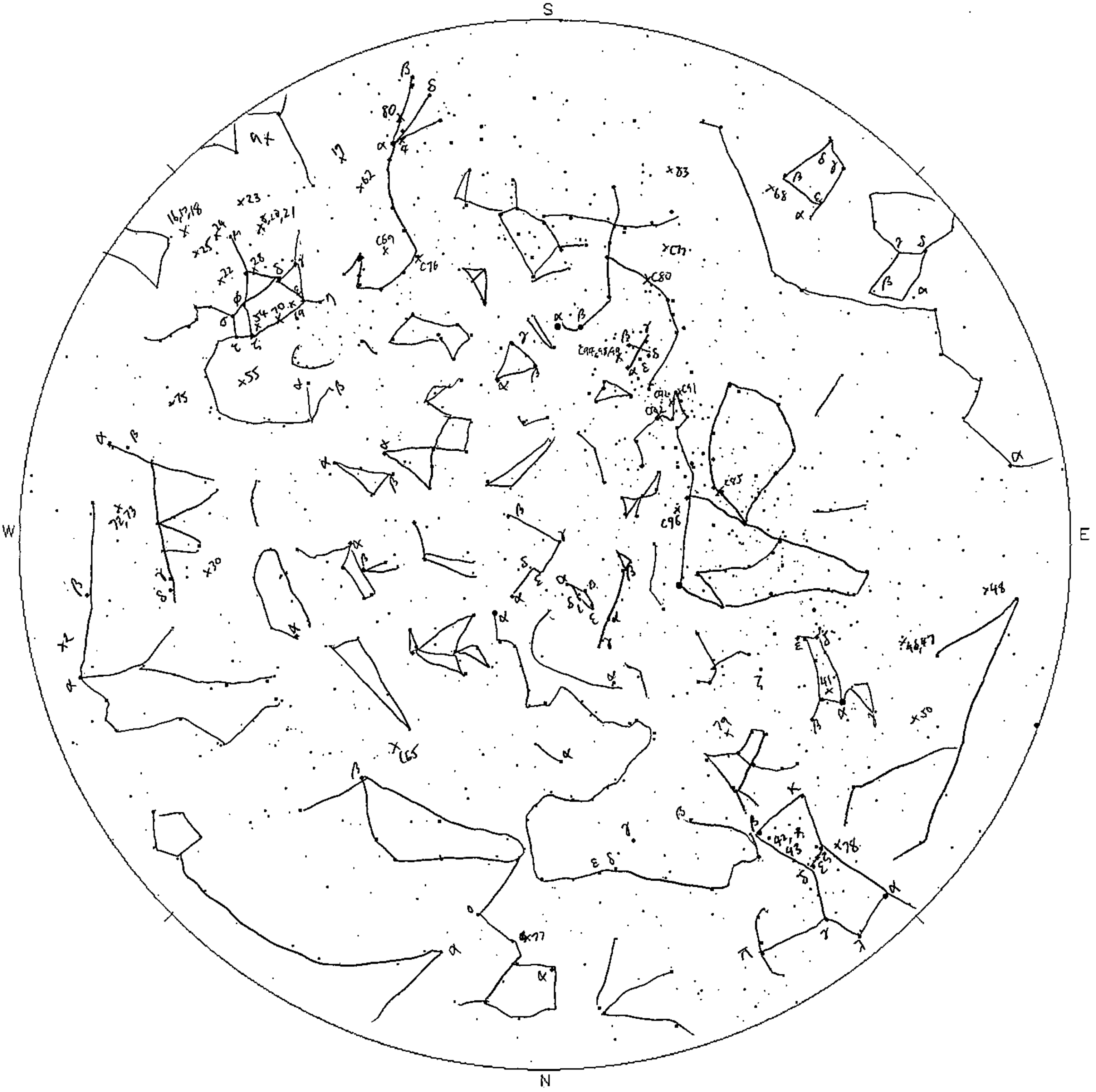
On September one, trust the Sun.
Come Halloween, subtract sixteen.
On Christmas Day, you're OK.
For your valentine true, add a dozen and two.
The mid of month four, add no more.
At the mid of May, take four away.
On June fourteen, don't add a bean.
When August begins, add seven little mins.

The rest is easy: for any date,
All you do is interpolate.

~Tad Dunne.



8/9

S
N
W
E
x83
x68
xC77
xC80
C69
C76
x62
80
x23
16,17,18
x24
x25
x22
28
54
70
69
x55
x75
72,73
x30
x2
C65
x77
79
41
x50
46,47
x48
42,43
x78
C95
C96
C91
C92
C94


N
E
W
S
C20
29
16
56
57
27
71
92
13
102
101
40
81,82
97,108
126
63
94
81
3
44
67
48
53
69
85
87
65,66
95,96,105
11
26
14
12
10
127
104
15,17,18
25
24
23
22
28
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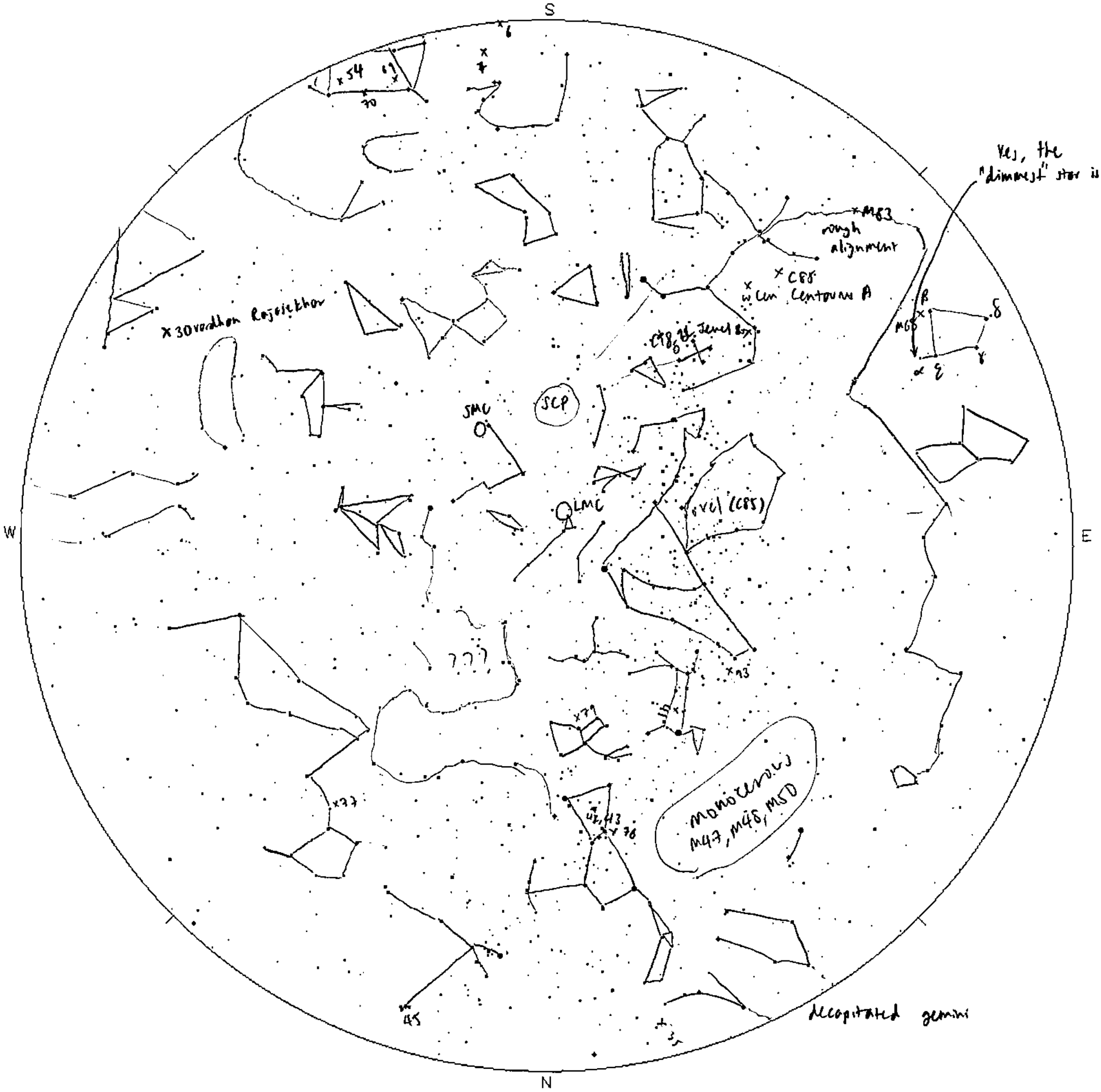
62
6
7
80
83
68
C69
C77
C80
C76
C74

Yes, the "dimmest" star is o



decapitated gemini

Block 891B HDB Woodlands

5.0 ★★★★★ (2)

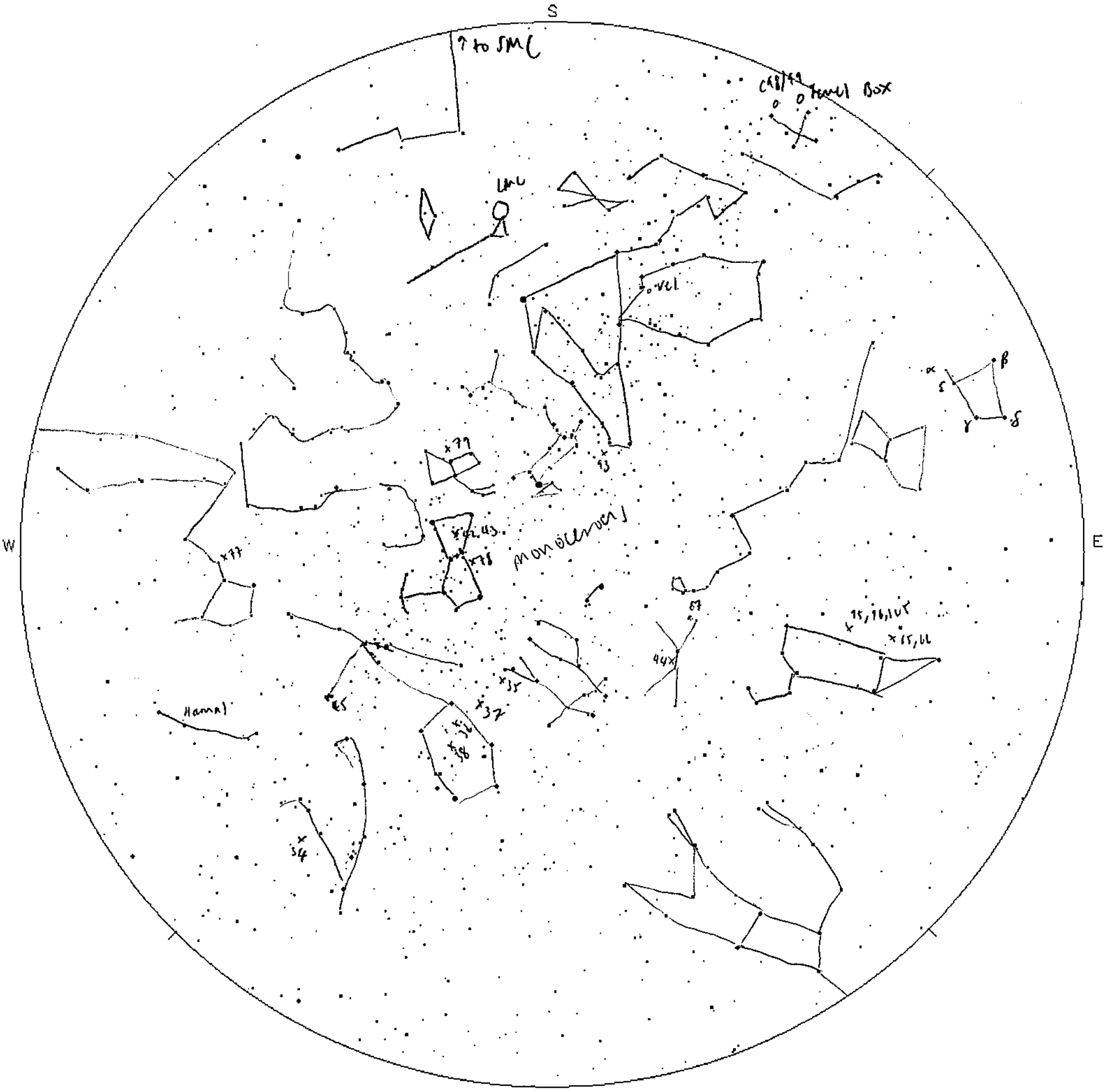
Apartment Building in Singapore

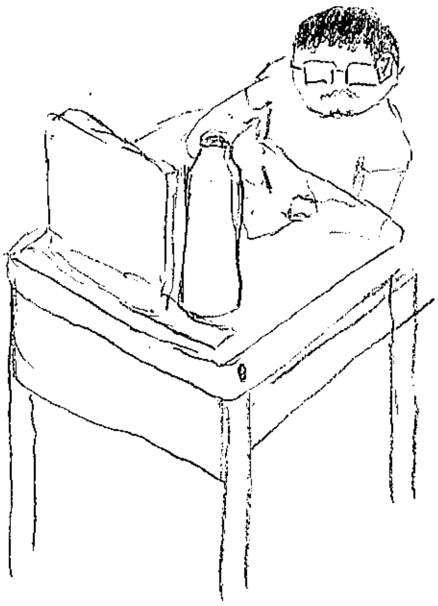
Closed

(Overview) (Photos) (Reviews) (About)

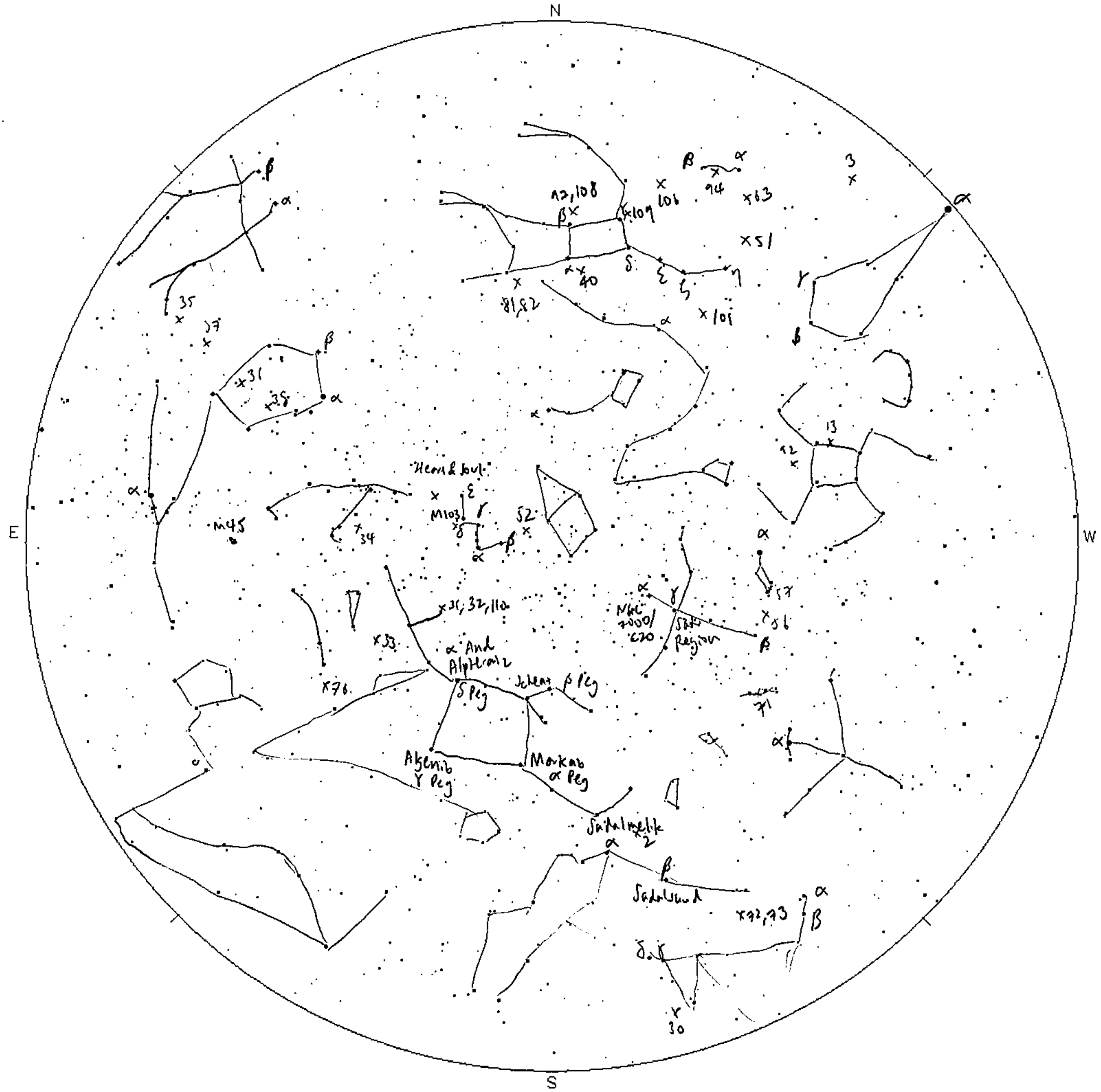
891B Woodlands Drive 50,
Singapore 731891

Closed · Opens 7:30 pm ∨

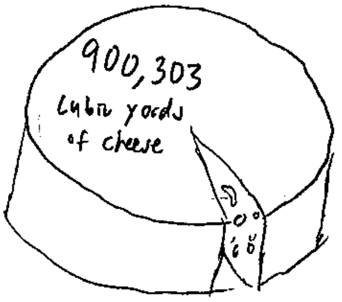

S
W
E
N
? to SMC
C98/99
Jewel Box
LMC
Vel
α
β
ε
γ
δ
x 79
x 93
x 42,43
x 78
monoceros
x 77
67
x 95,96,105
x 65,66
44x
x 35
x 37
45
Hamal
x 36
x 38
x 34

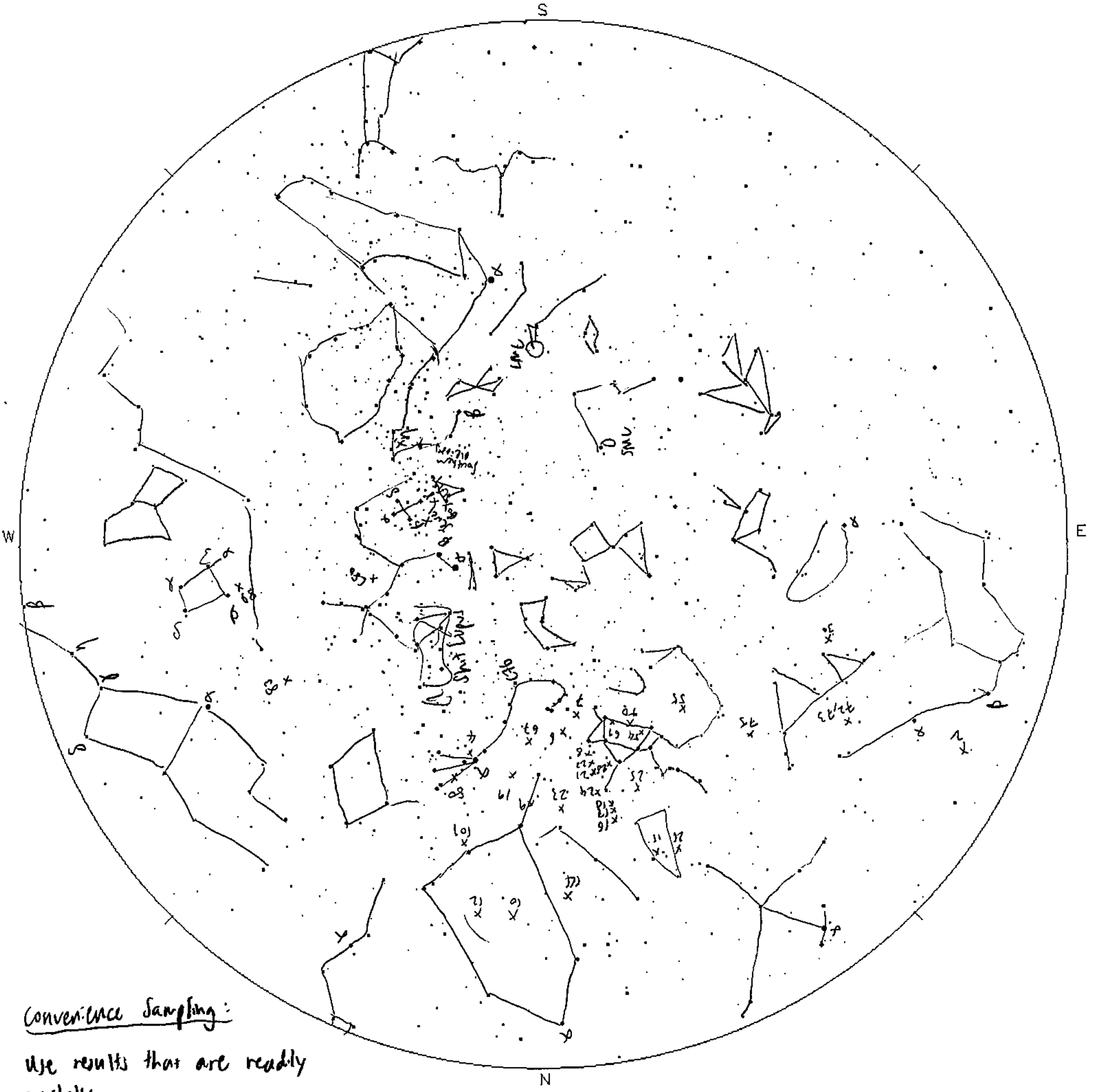


Shah



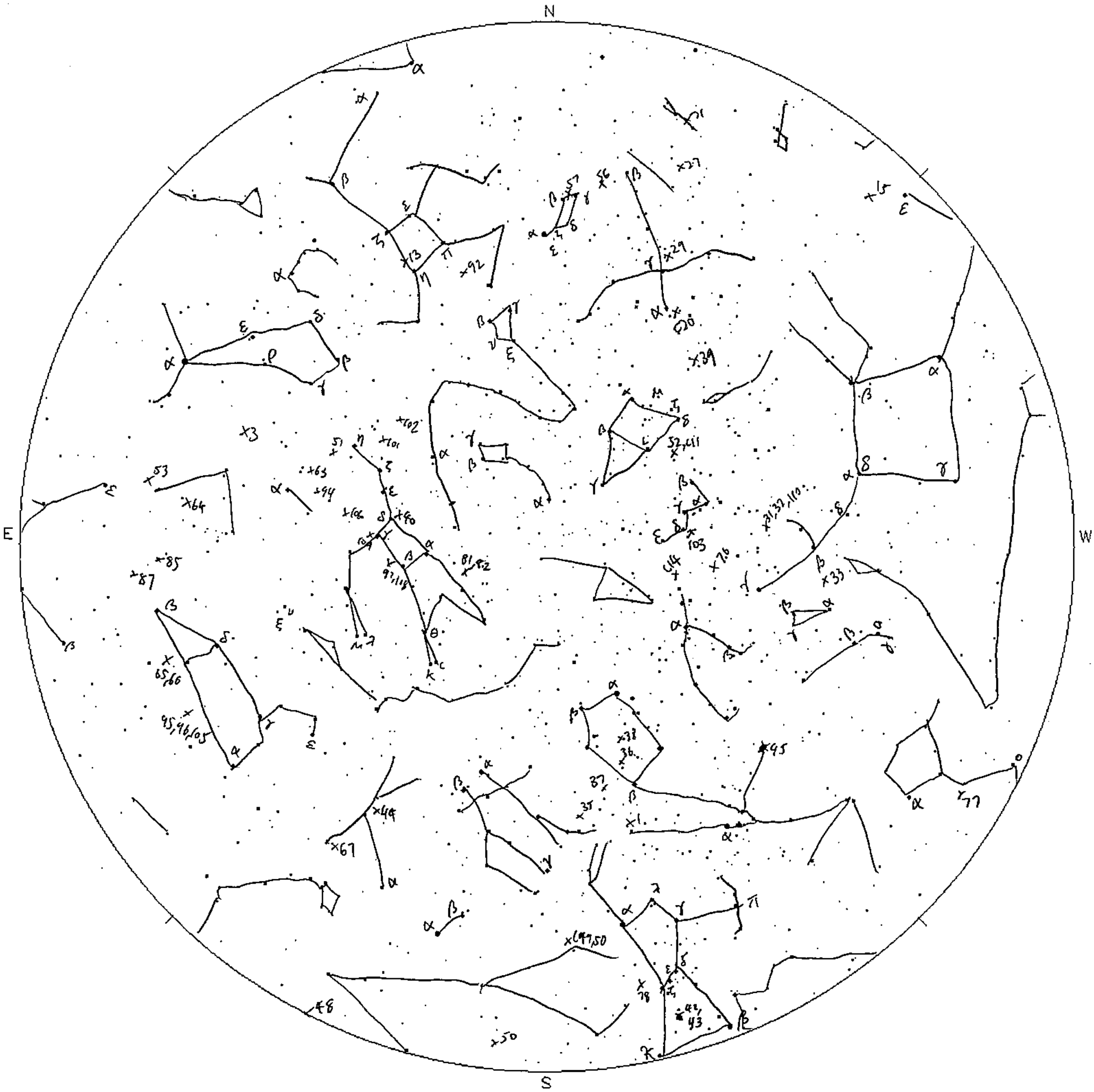
United States Capitol
(Poorly Drawn)





Convenience Sampling:

Use results that are readily available


N
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W
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β
ε
ζ
η
π
13
92
57
56
27
15
29
20
39
α
β
γ
δ
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3
51
101
102
63
94
53
64
106
80
81,82
97,118
85
87
65,66
95,96,105
52,111
103
44
76
31,32,110
33
38
36
37
35
1
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77
44
67
49,50
48
50
78
42,43
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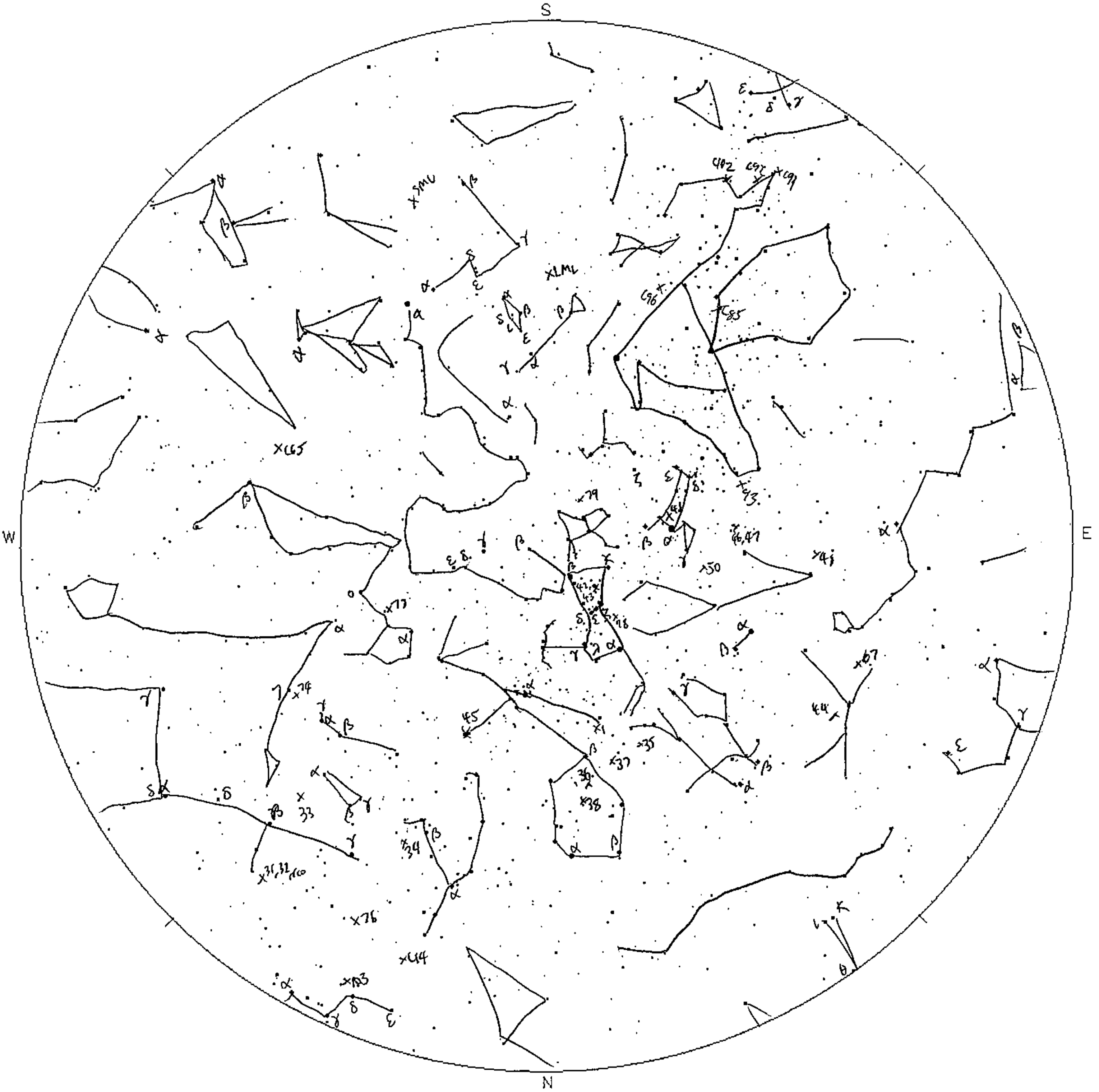
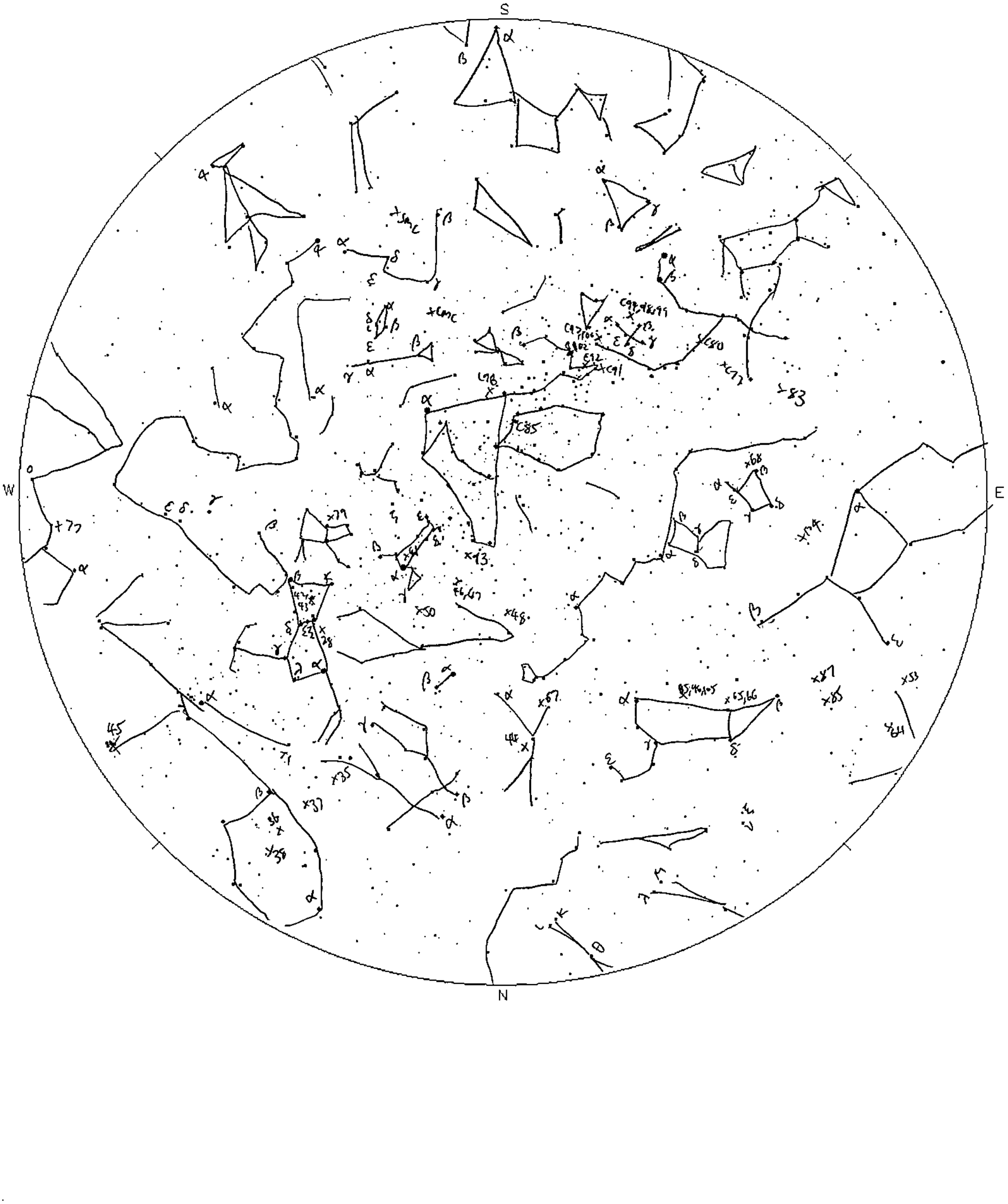

S
N
E
W
X5MU
XLML
XC65
C102
C92
XC91
C96
C85
X79
X43
X50
46,47
X49
X77
X74
X67
X44
45
X1
X35
X37
36
X38
33
X31,32,C60
X34
X76
X44
X103
α
β
γ
δ
ε
ζ
κ
θ


S
W
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SMC
LMC
C97,100
C102
C92,98,99
C91
E12
C80
C77
83
C78
C85
68
79
47,93
28
43
46,47
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95,96,105
65,66
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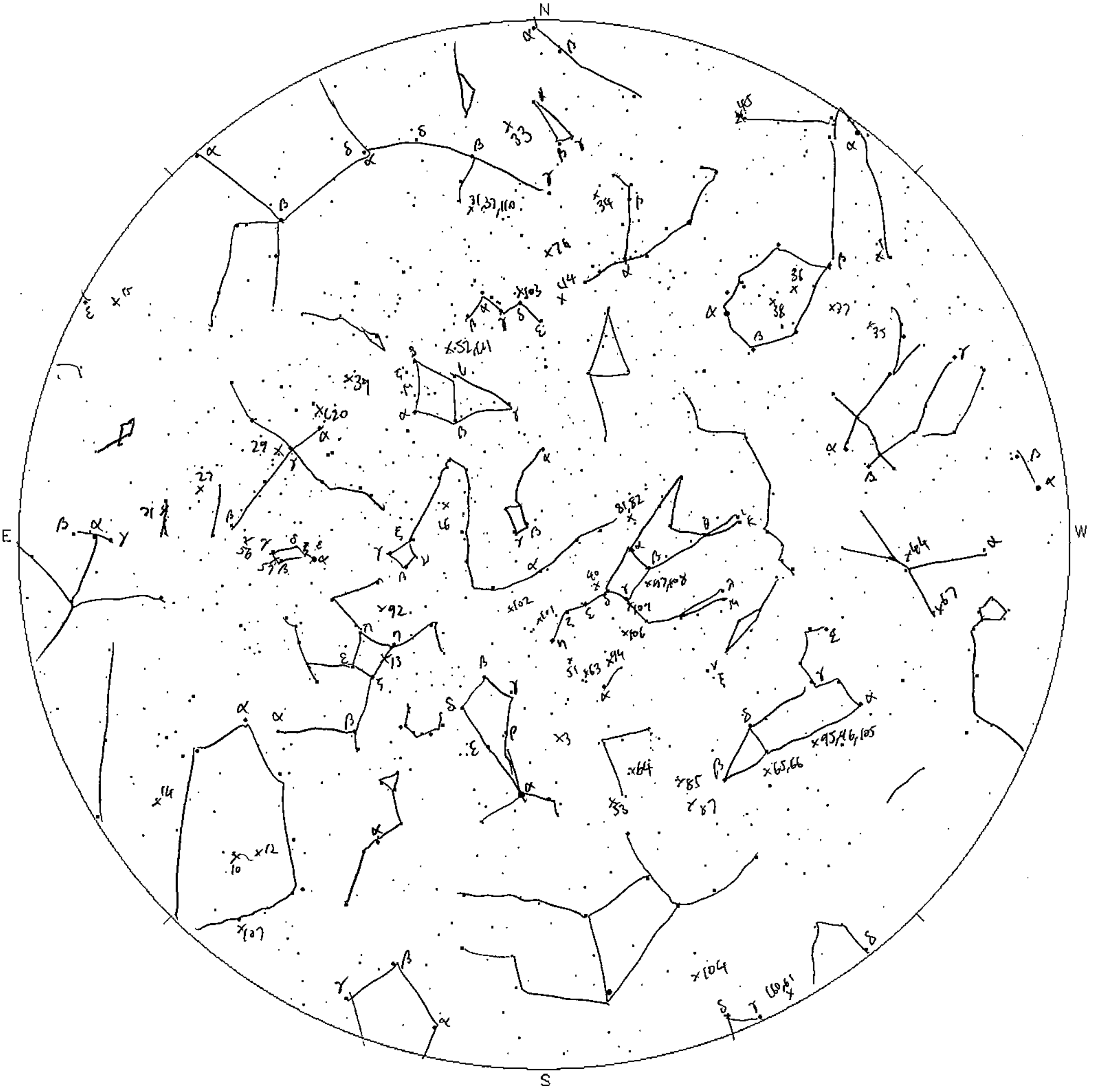
104


N
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31,37,110
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103
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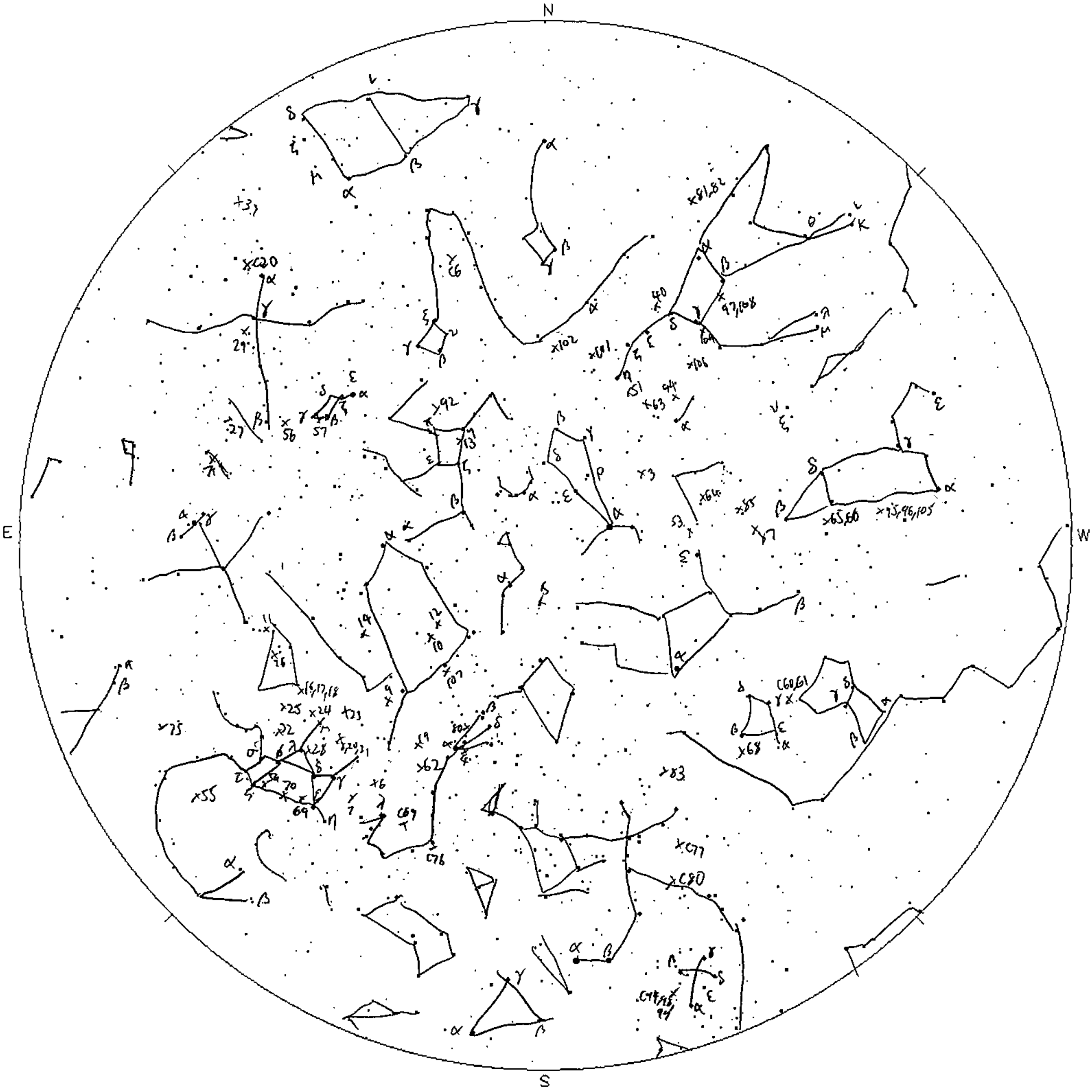
N
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×C20
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×102
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94
×92
×13
×3
×64
×65,66
×95,96,105
×85
×57
×53
×19
12
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×107
×11
×26
×15,17,18
×25
×24
×23
×22
×28
21,20,21
×75
×55
70
69
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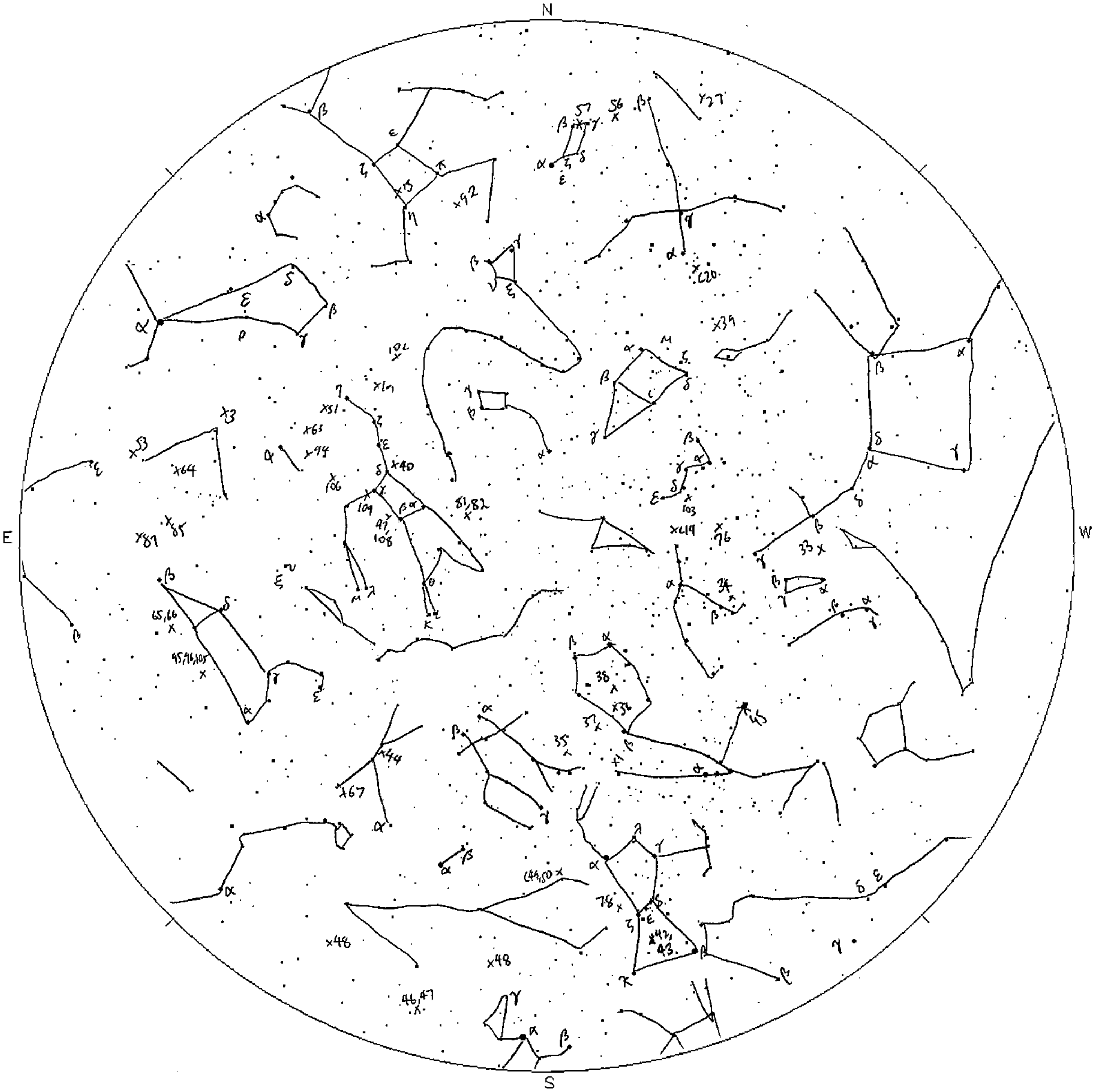
×6
C69
C76
C60,61
×68
×83
×C77
×C80
C44,98
94


N
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106
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97
108
81,82
x64
x53
x87
85
103
x44
76
33
34
65,66
95,96,105
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x36
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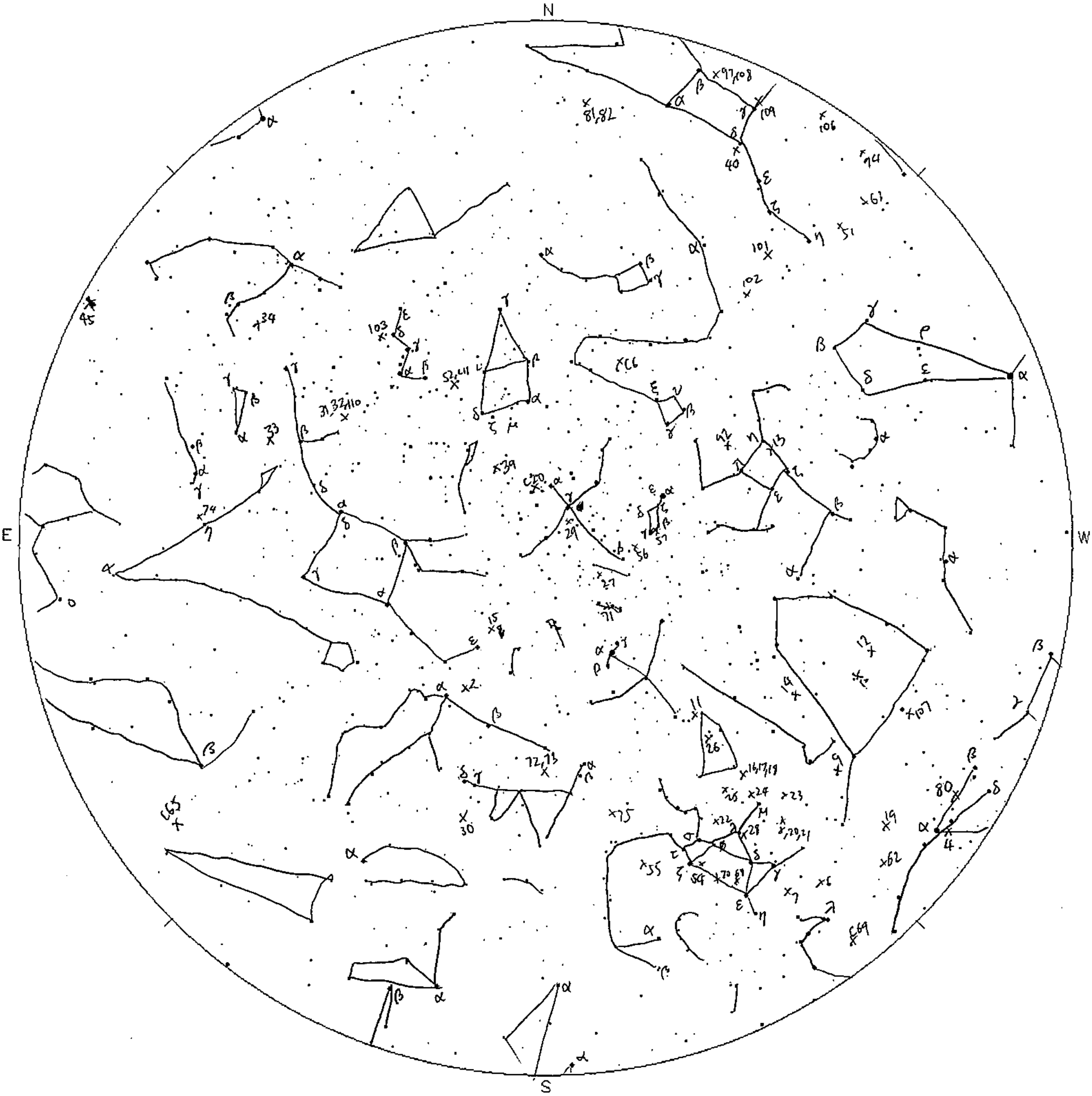
x44
x67
C49,50
78
x42,
43
x48
x48
46,47

16/4/2024

90%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74
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C20
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C65
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16,17,18
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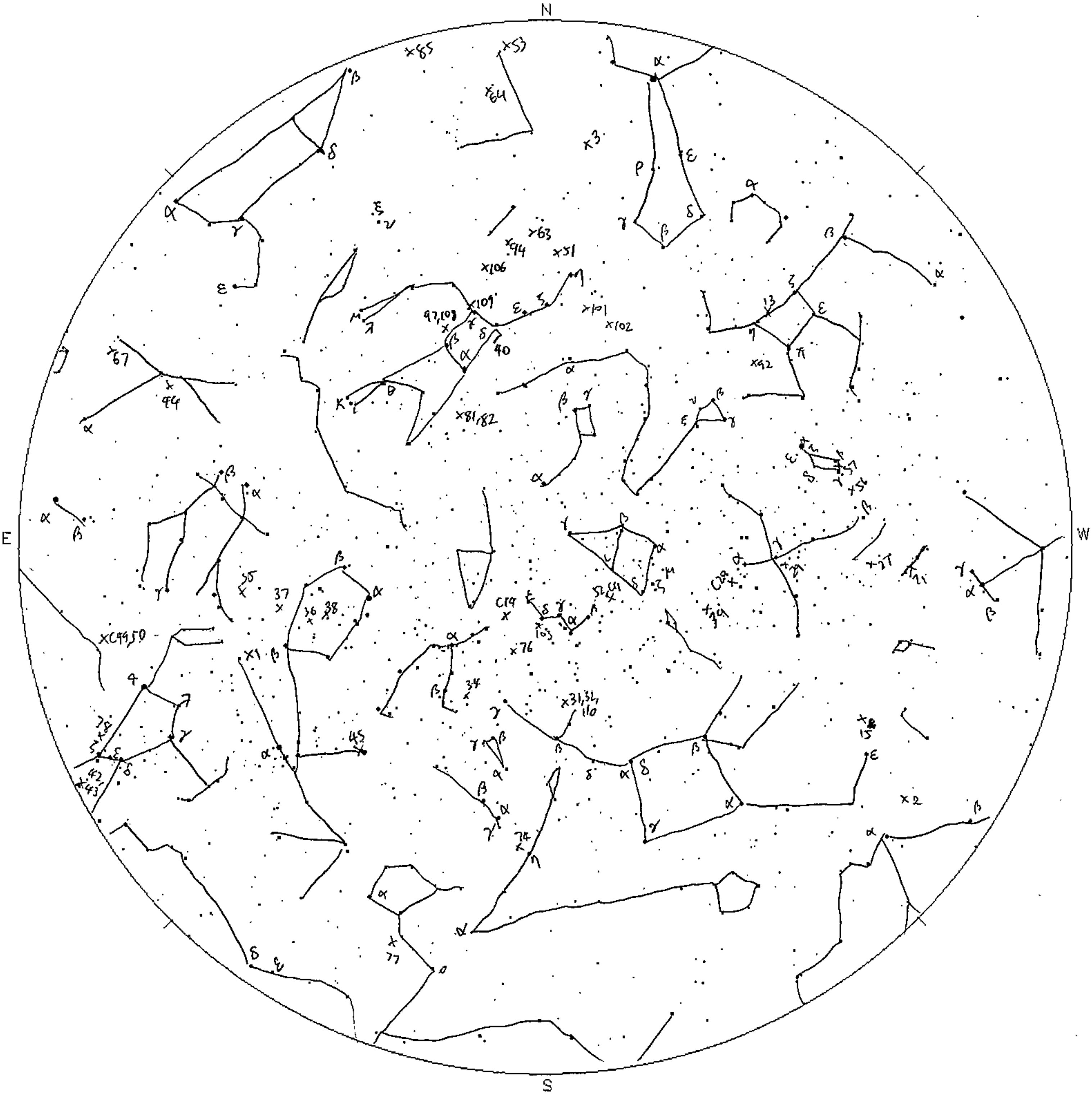
N
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x106
x109
97,108
40
x101
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x67
94
x81,82
x92
57
x56
x27
x21
C28
x39
x35
37
36
38
C14
x103
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x31,32,110
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X1
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x8
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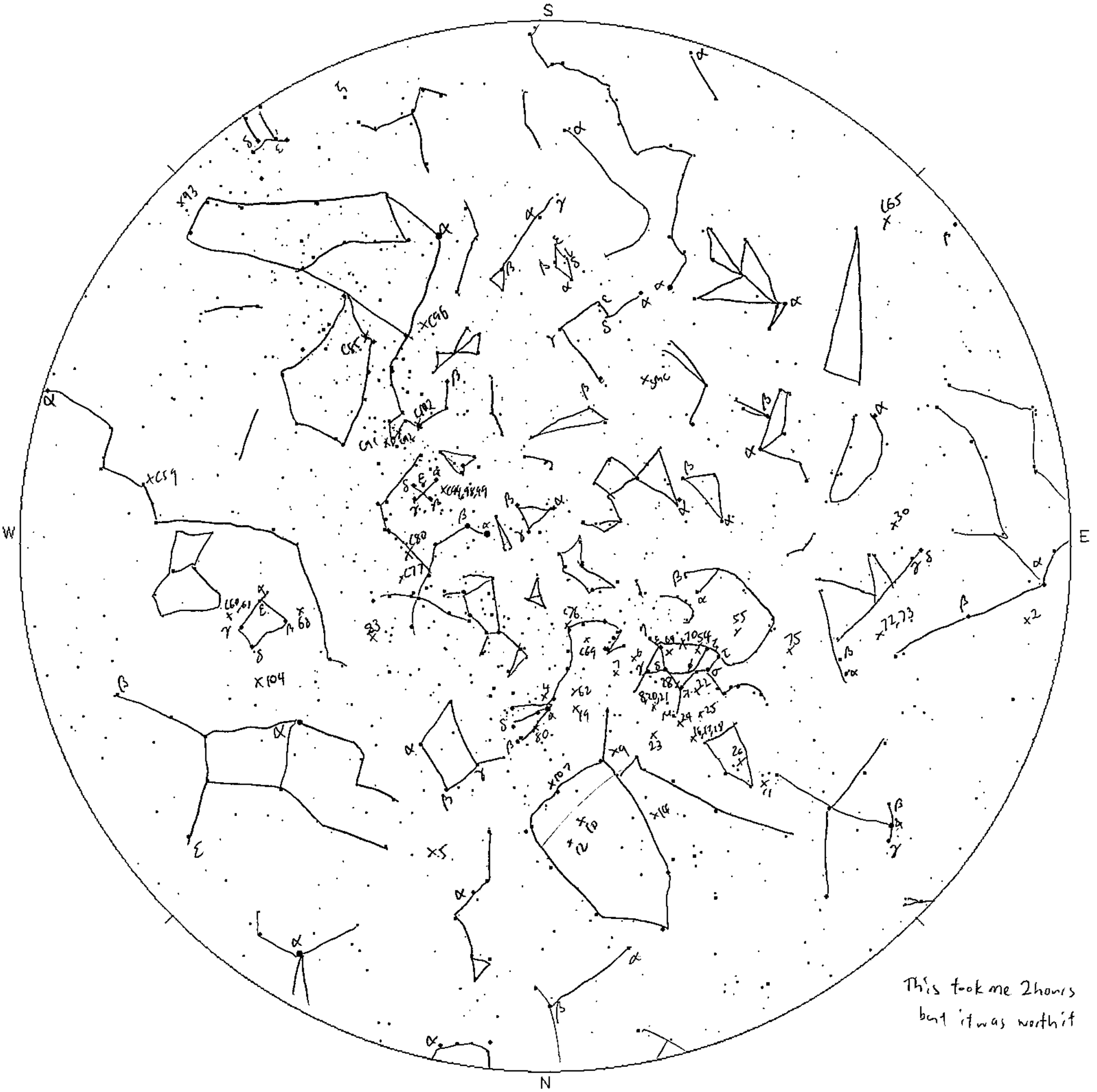
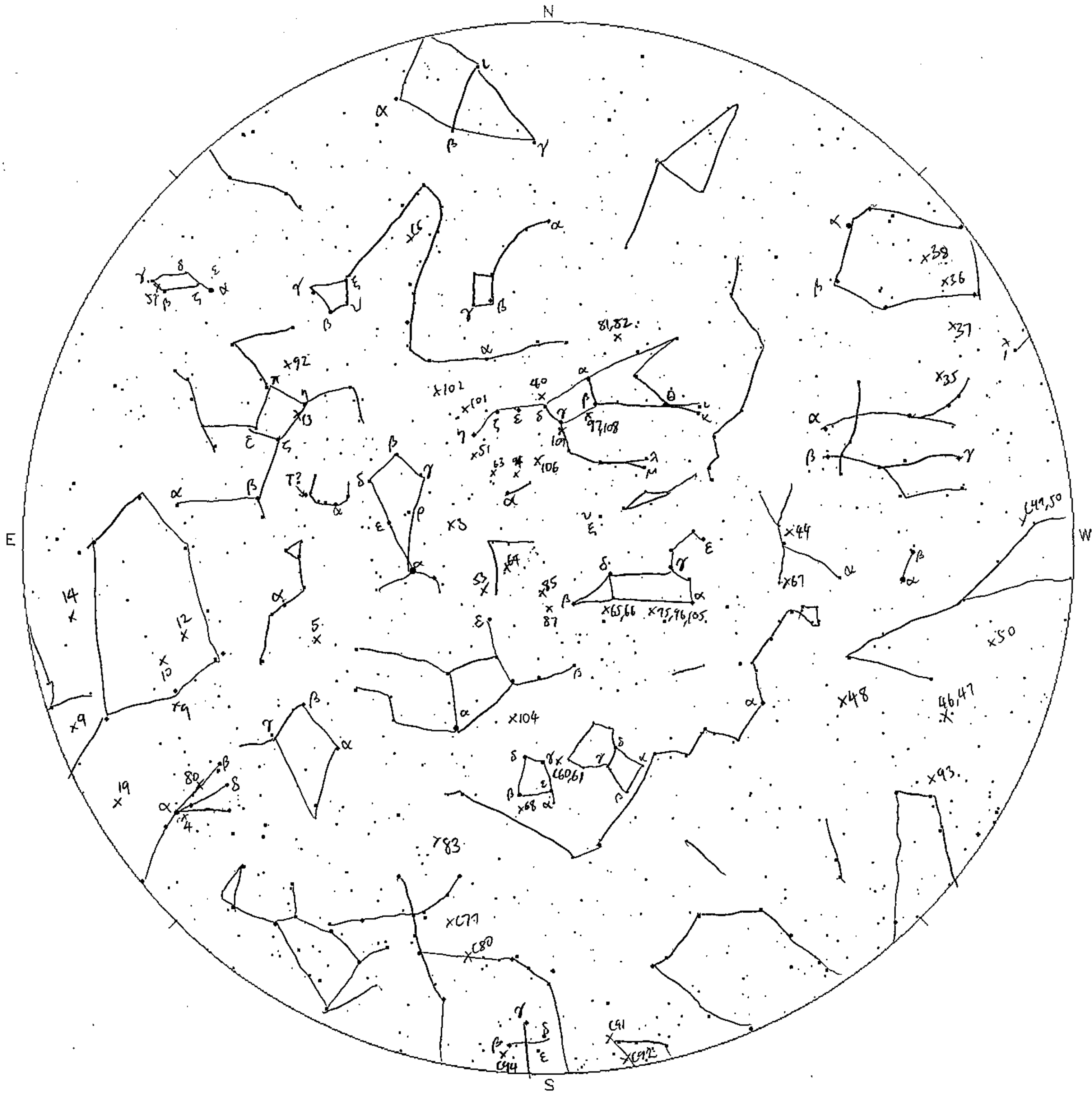
x2



This took me 2 hours but it was worth it

(it's my second time)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x9
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x85
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x65,66
x75,96,105
x44
x67
x38
x36
x37
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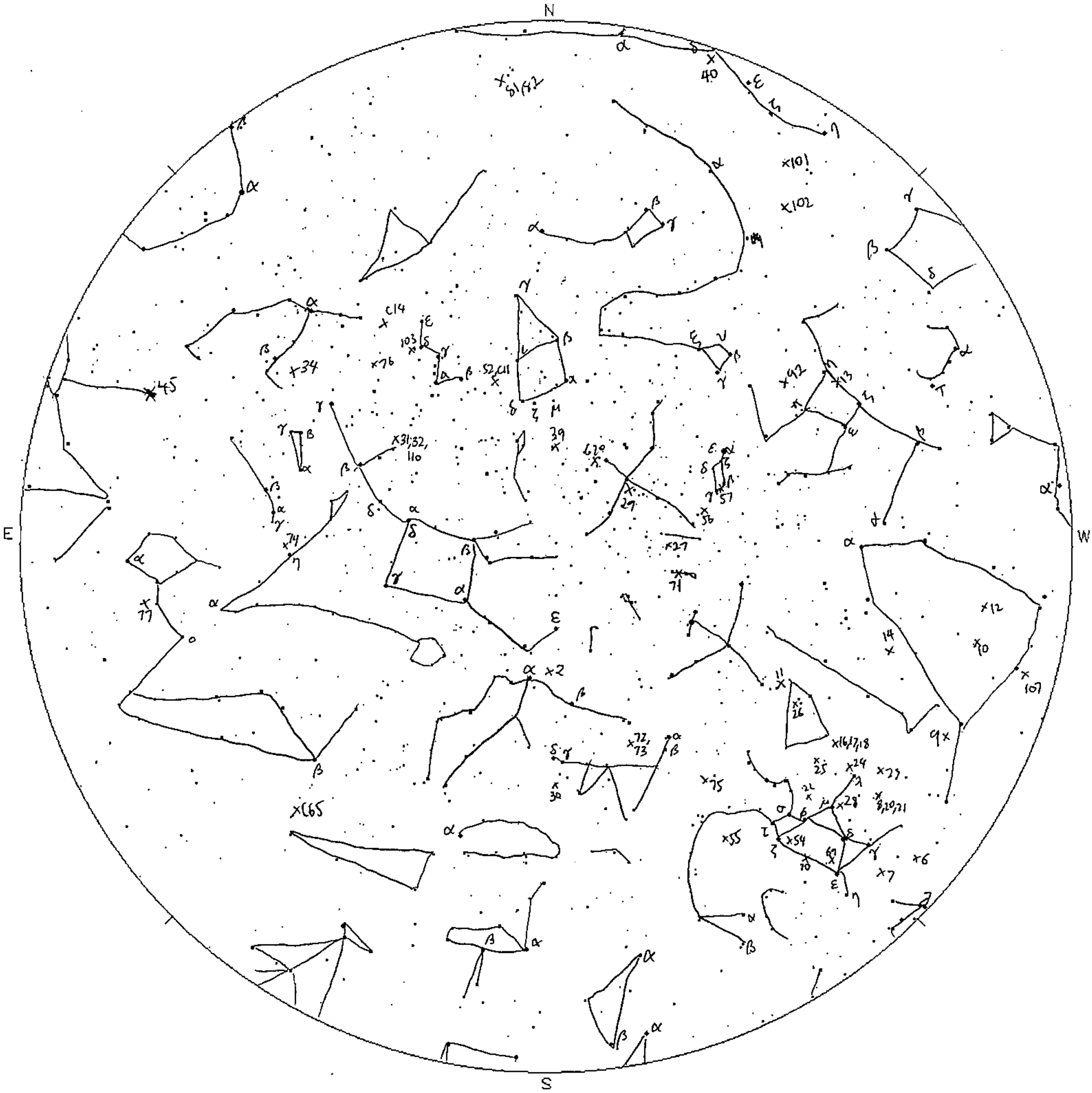
N
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x76
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52,C11
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x34
x45
γ
ι
β
α
δ
ζ
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β
x31,32,110
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C20
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x92
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ζ
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x27
71
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N
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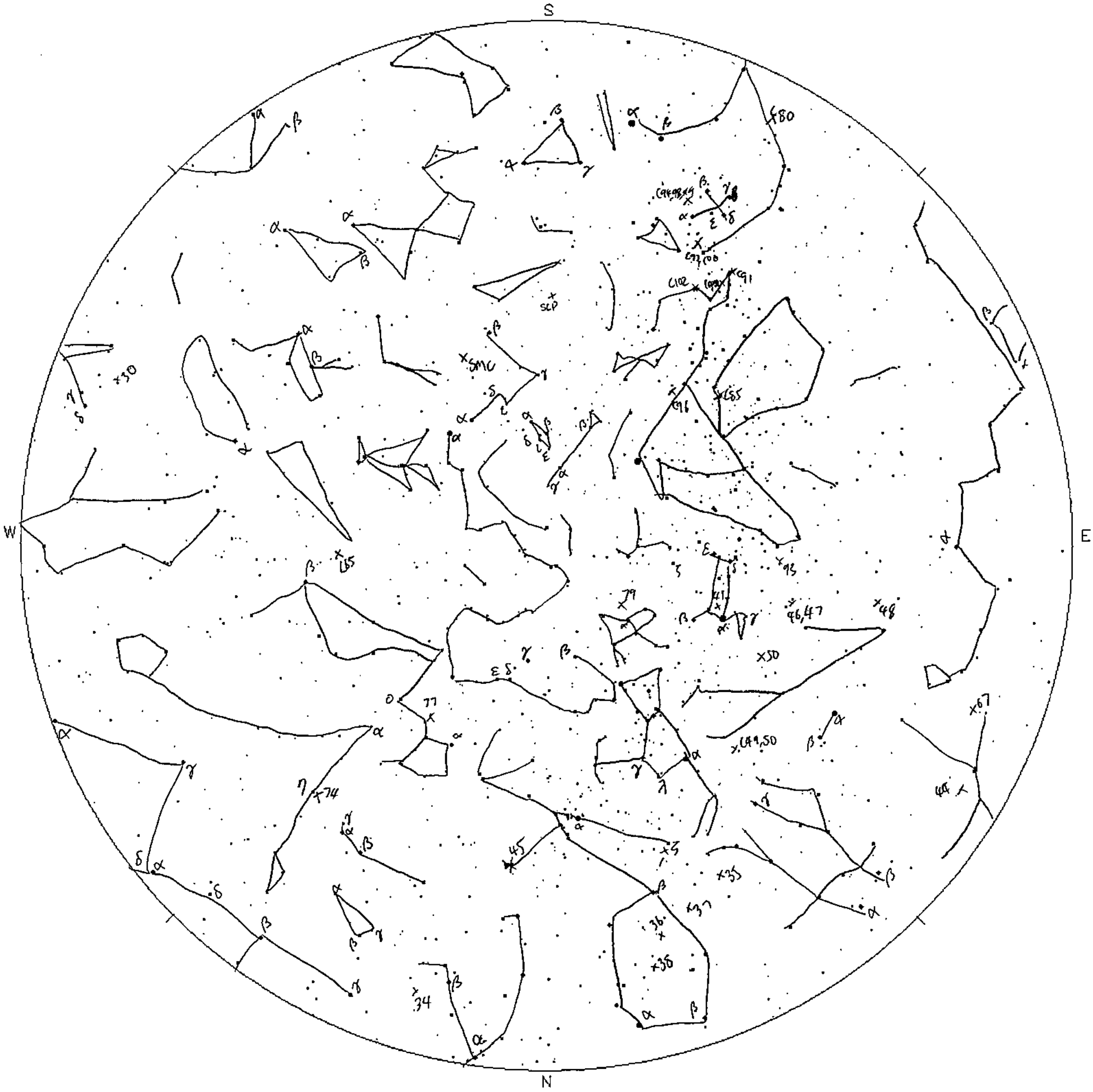
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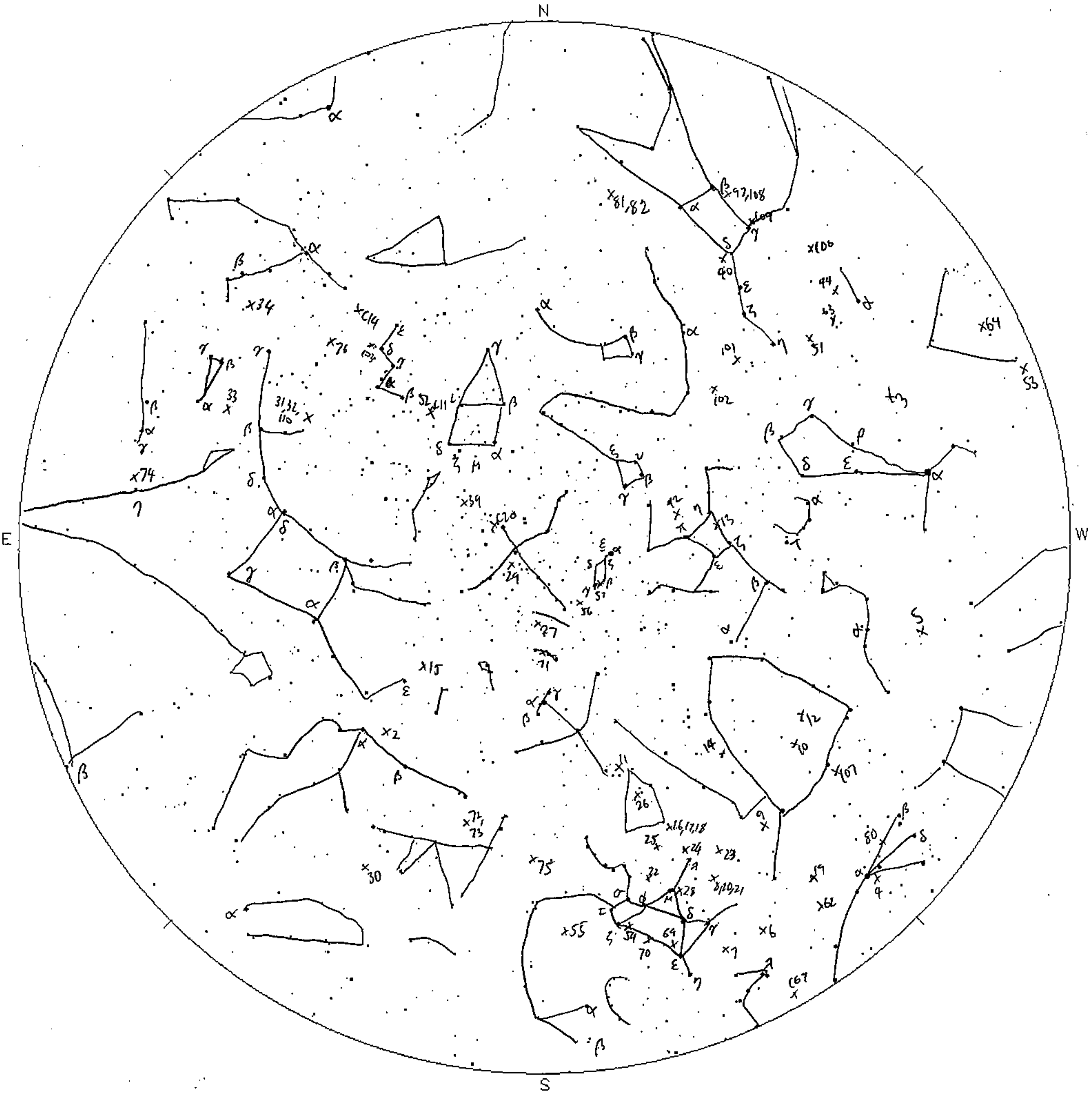
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14 ×
×107
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×26
×16,17,18
25 ×
×24
×23
×22
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×8,20,21
×72, 73
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×7
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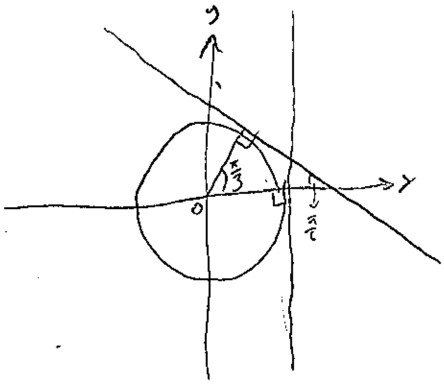
×9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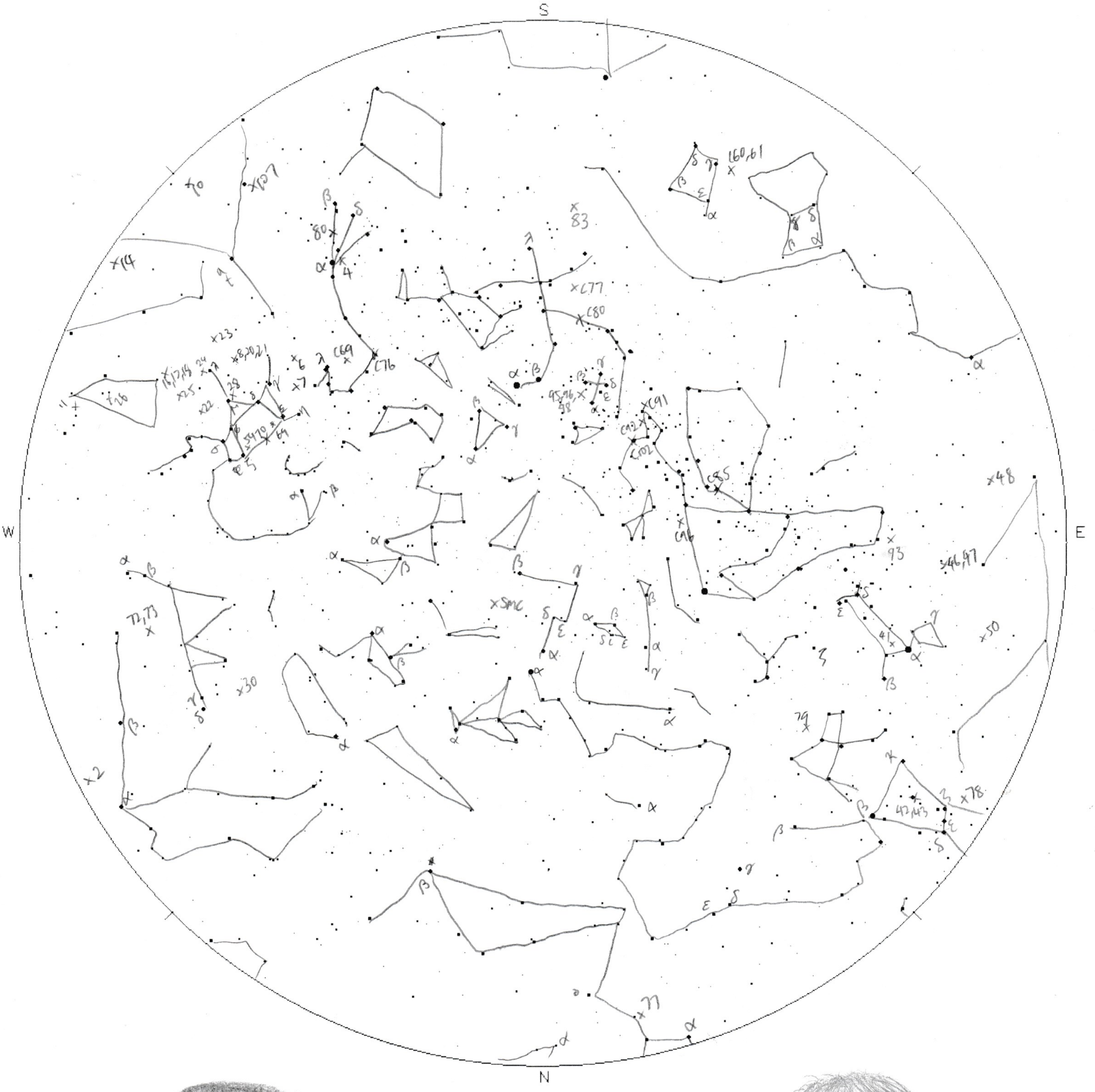
S
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x107
x14
x23
x17,18,19 24
x25
x22
x8,20,21
x6
x7
C69
C76
x80
x83
xC77
xC80
95,96,x 98
xC91
C92
C102
C85
C96
xC160,61
x48
x93
x46,97
x50
x72,73
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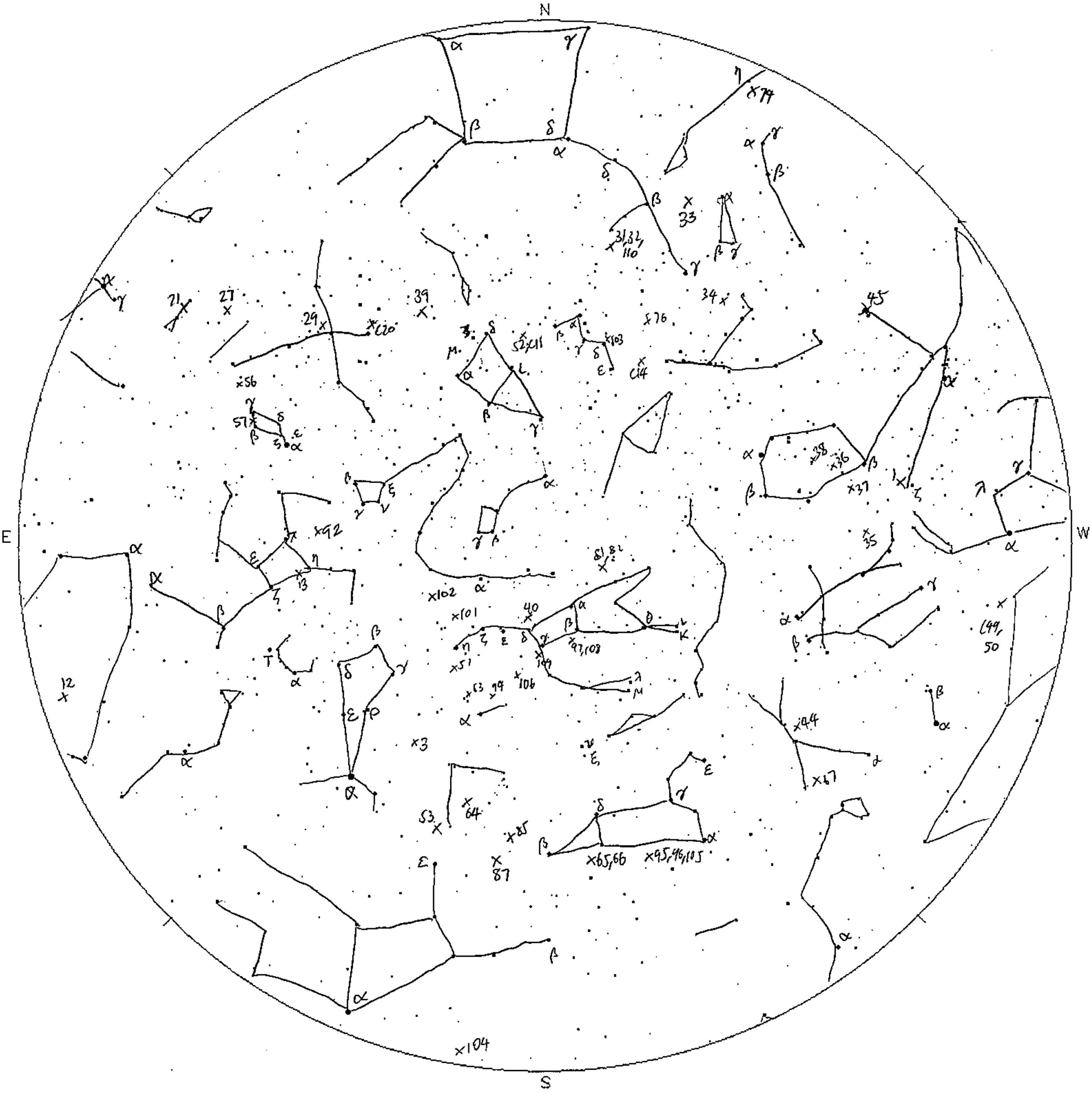
x79
x78
47,143
x77


It is unfortunate that you know this
kane
CI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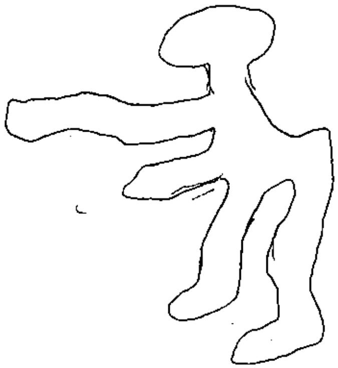

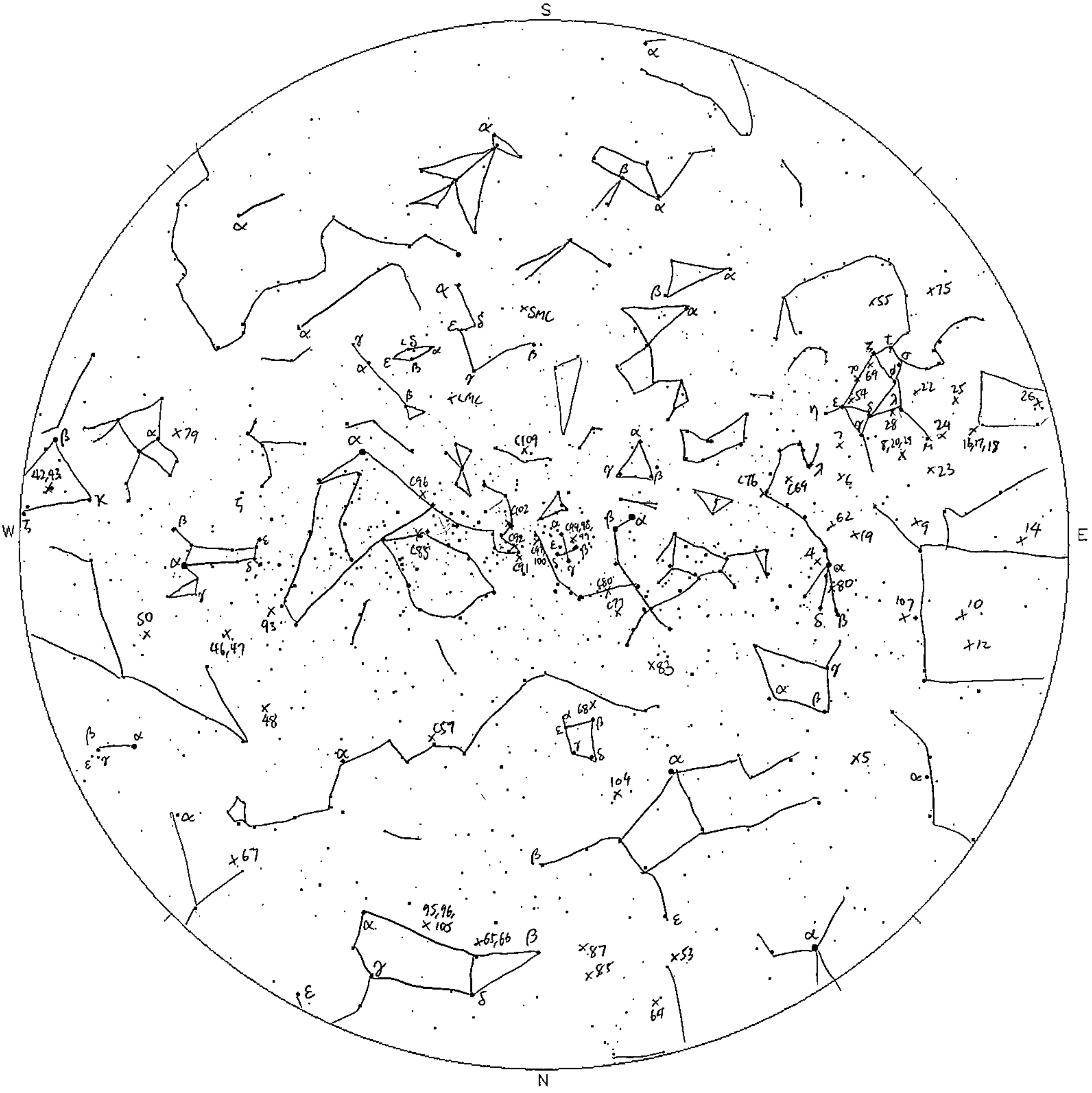

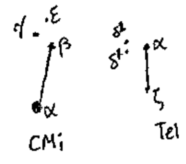

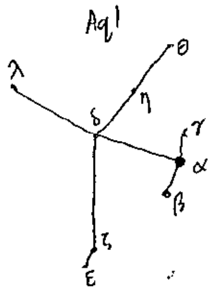

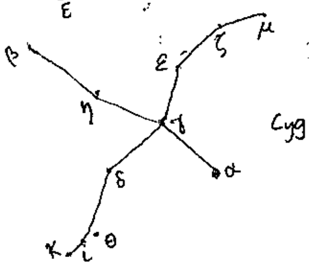

It's the camps!

~Detective Gumshoe


S
N
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C91
C92
C102
C97, 120
C94, 98, 99
C80
C77
C76
83
C60, 61
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104
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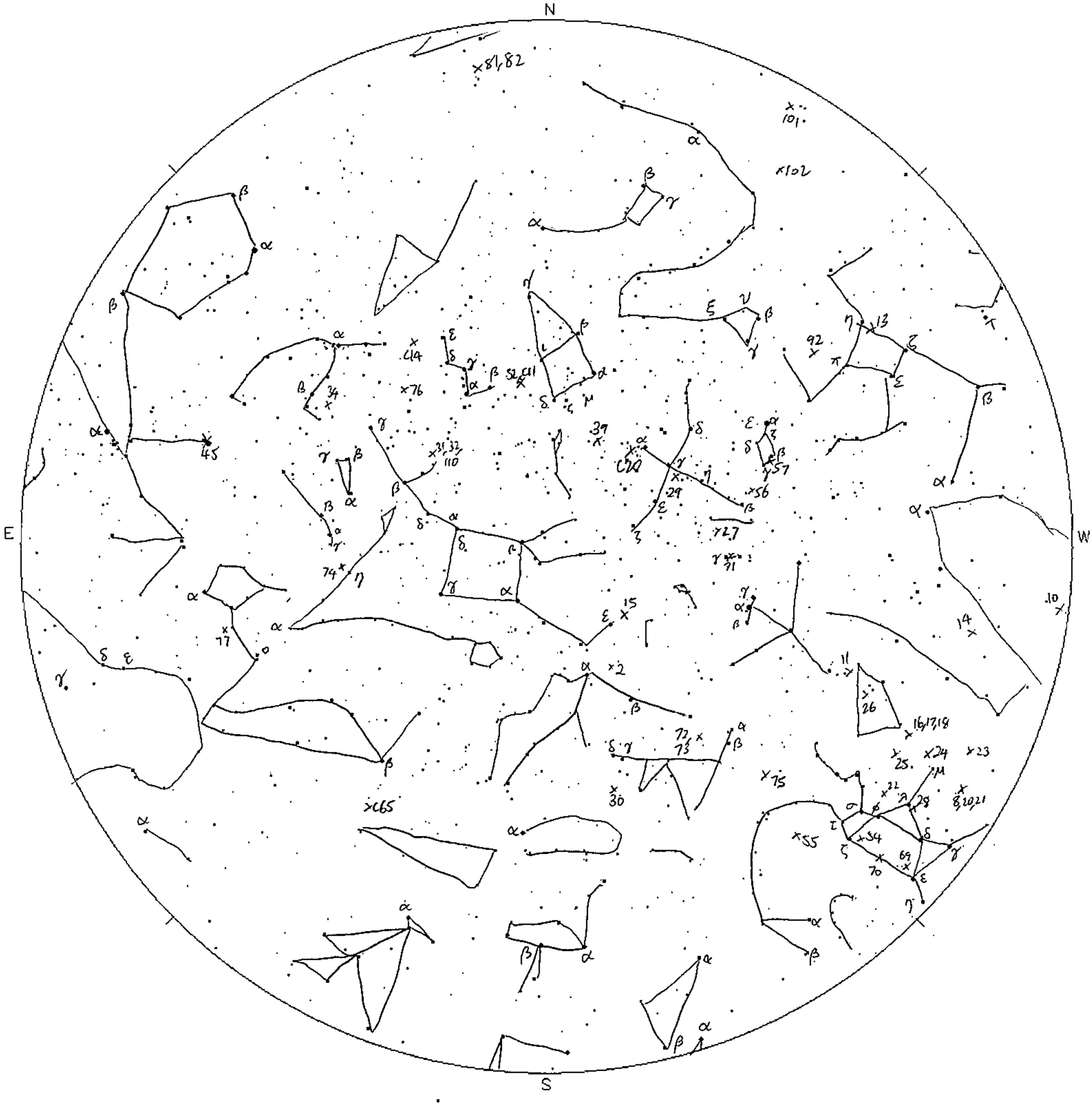
T CrB Soon !?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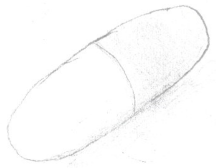
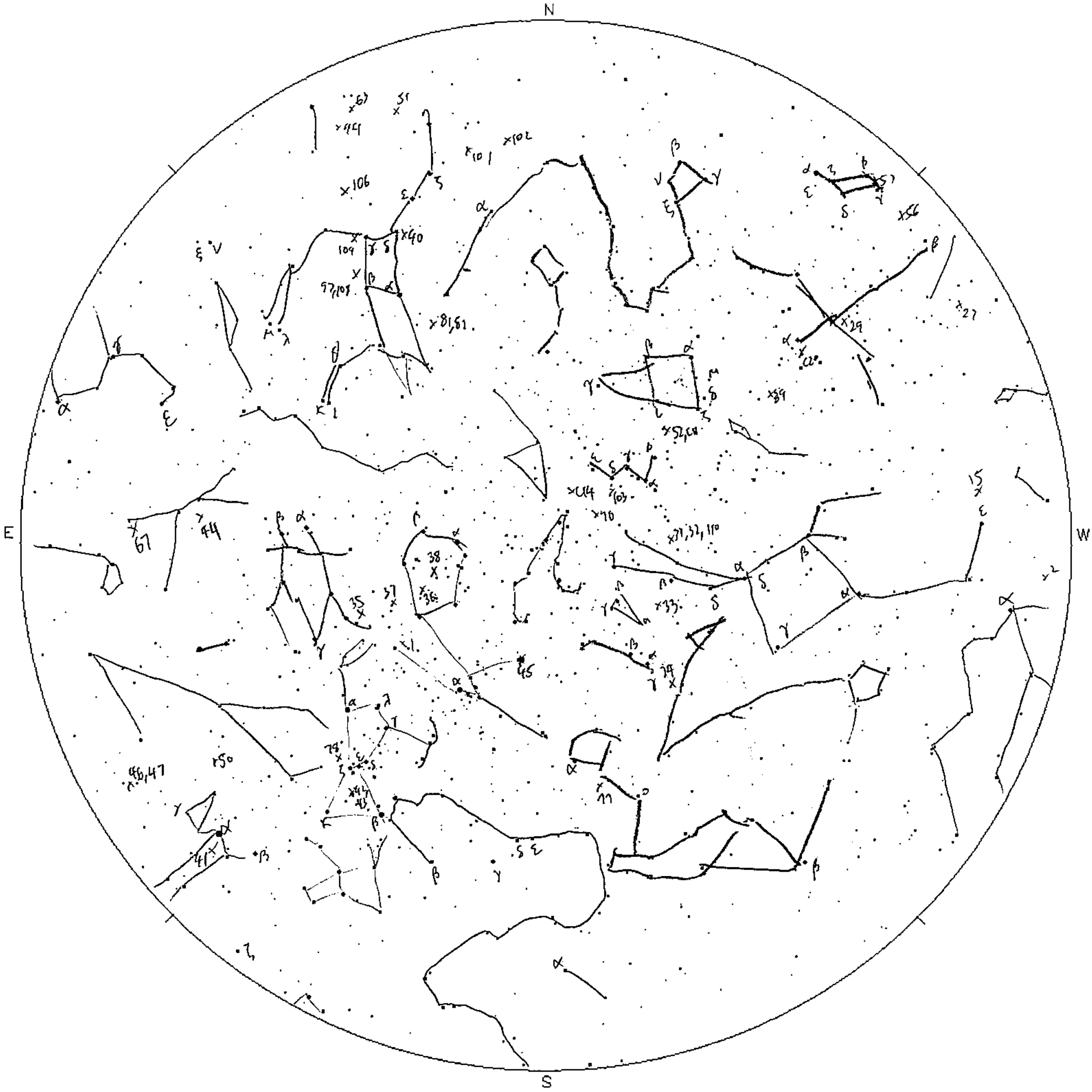


SLOWMOTION

10 years

27/5/2024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x81,82
x29
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x56
x39
x52,60
x114
103
x70
x77,32,110
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67
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x1
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LMC
SMC
C76
C69
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16, 17, 18
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72, 73
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14
C65
77
74
C41
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C20
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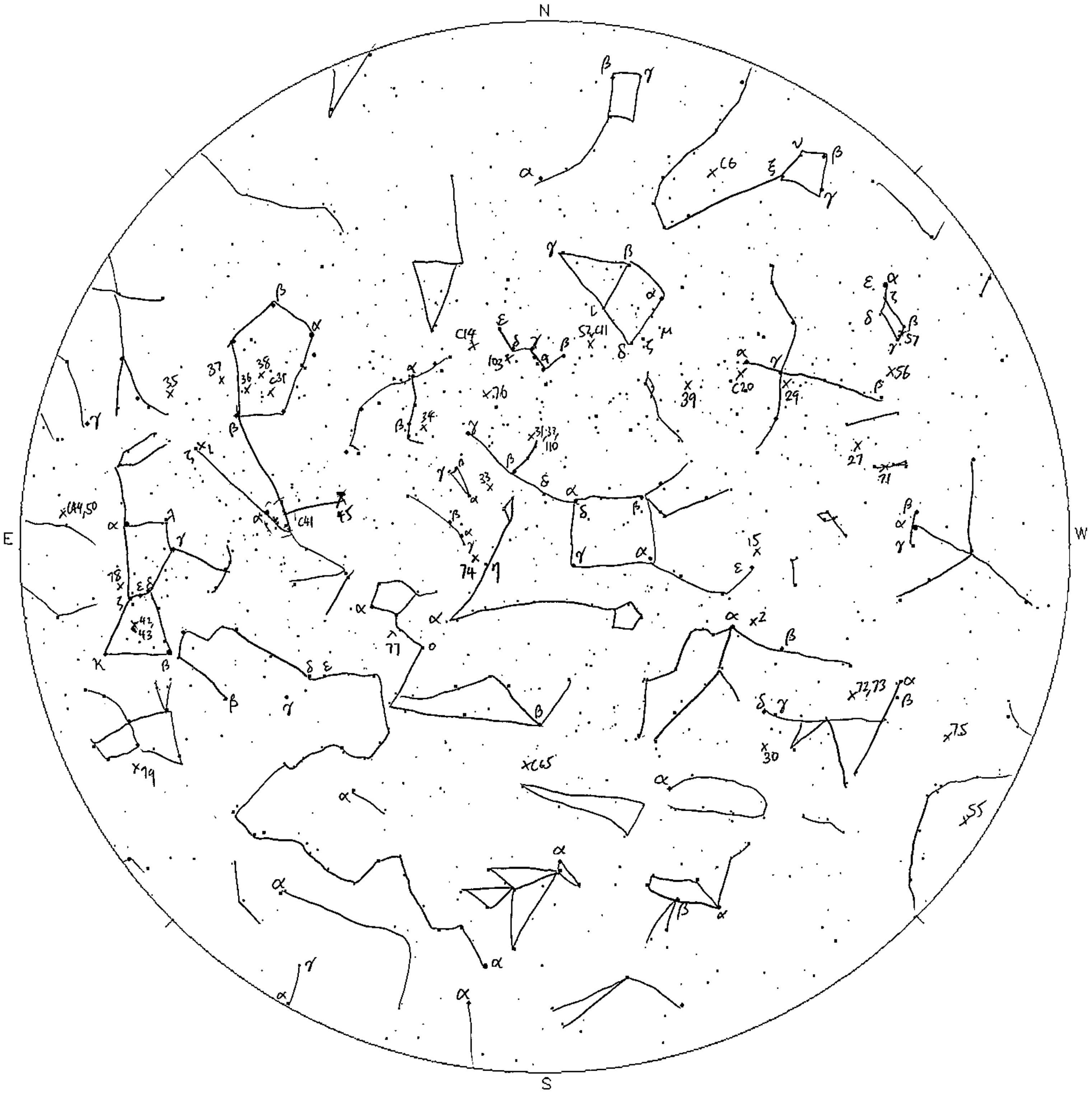
76
52, C11
103
C14
15

Very north star map


N
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C6
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52, C11
103
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C20
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36
38
C31
2
34
31, 33, 110
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C41
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C44,50
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74
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42, 43
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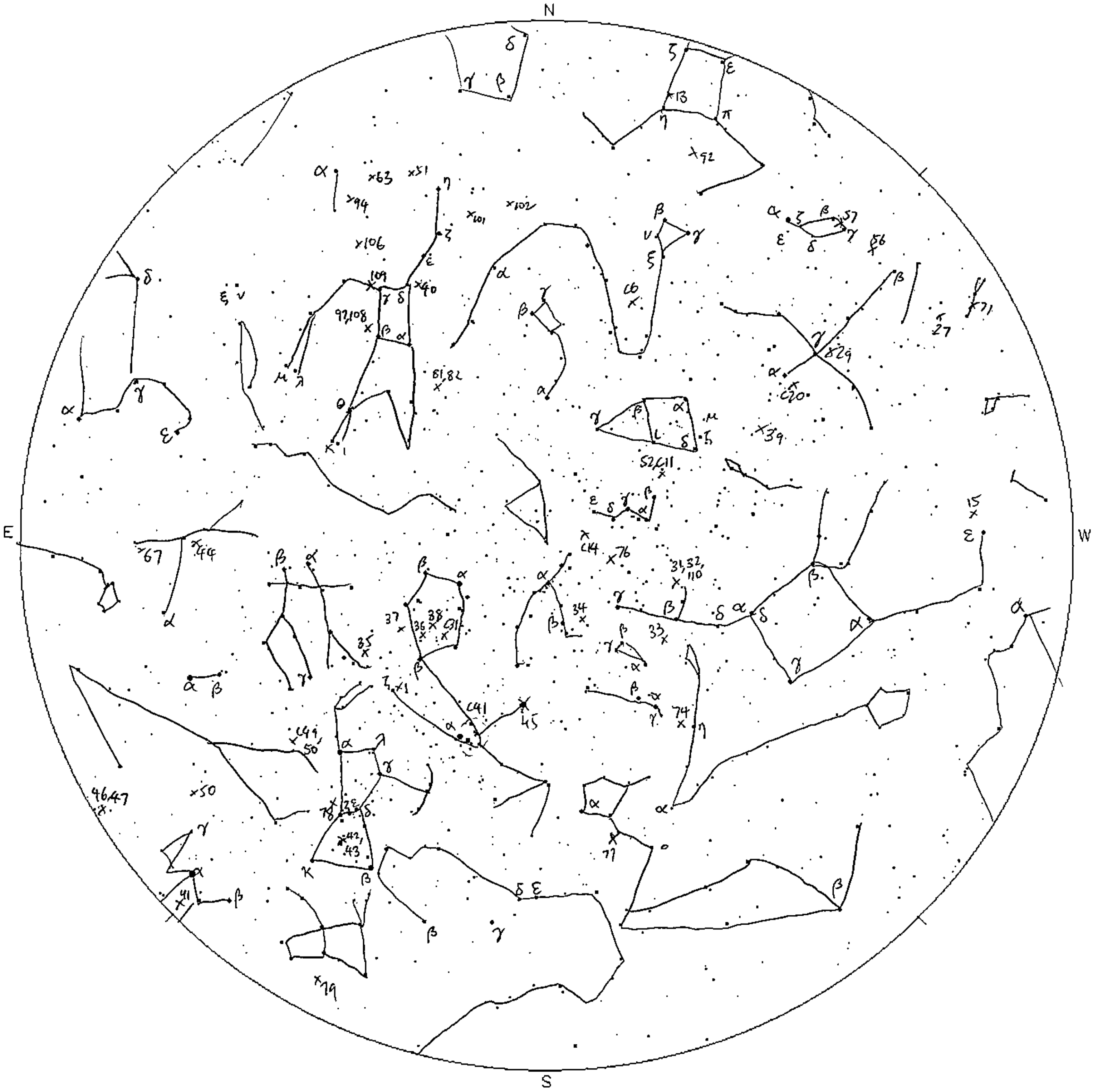
C65
55


N
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α
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η
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×102
×101
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×106
ε
δ
109
×40
γ δ
ξ ν
92,108
×
β α
β
ν
γ
ξ
C6
×
α
ζ β
57
ε
δ
γ
56
β
71
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γ
829
α
C20
81,82
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67
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ε δ γ β α
C14
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α
α β
β
γ
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C41
45
β α
γ
74
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C49, 50
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α
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×50
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γ
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κ
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α
41
β
δ ε
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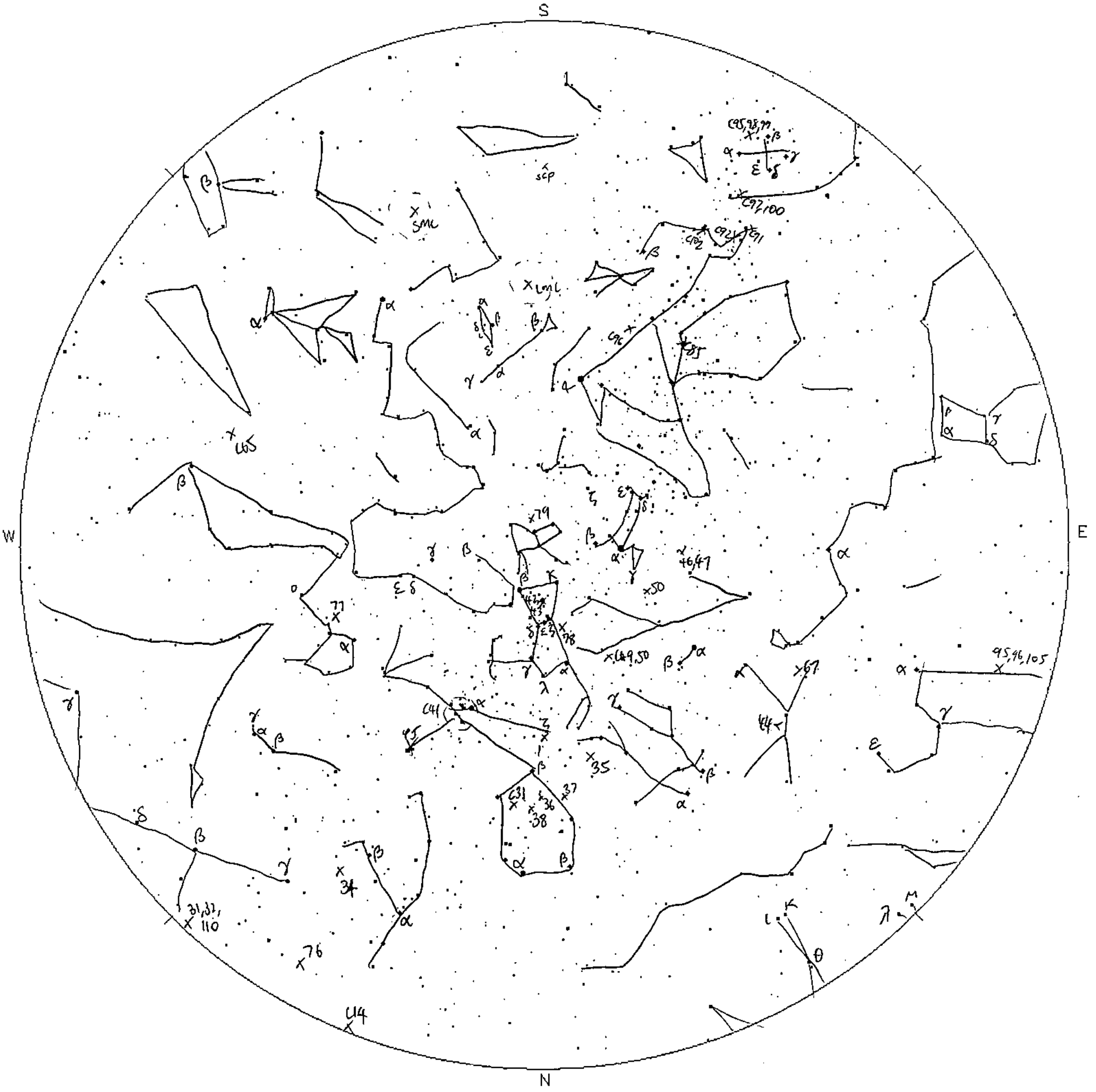
×79
S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C49,50
C44
C67
C14
C76
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95,96,105
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$X = r\cos(v)\sin(u)$

$Y = r\sin(v)\sin(u)$

$Z = r\cos(u)$

$\rightsquigarrow g_{ij}\ ,\ i,j \in \{u,v\}$

$$\vec{e}_u = \frac{\partial}{\partial u} = \frac{\partial X}{\partial u}\frac{\partial}{\partial X} + \frac{\partial Y}{\partial u}\frac{\partial}{\partial Y} + \frac{\partial Z}{\partial u}\frac{\partial}{\partial Z}$$

$$= \frac{\partial X}{\partial u}\vec{e}_X + \frac{\partial Y}{\partial u}\vec{e}_Y + \frac{\partial Z}{\partial u}\vec{e}_Z$$

$$= r\cos(v)\cos(u)\vec{e}_X + r\sin(v)\cos(u)\vec{e}_Y - r\sin(u)\vec{e}_Z$$

$$\vec{e}_v = \frac{\partial}{\partial v} = \frac{\partial X}{\partial v}\vec{e}_x + \frac{\partial Y}{\partial v}\vec{e}_Y + \frac{\partial Z}{\partial v}\vec{e}_Z$$

$$= -r\sin(v)\sin(u)\vec{e}_X + r\cos(v)\sin(u)\vec{e}_Y$$

$$\vec{e}_u\cdot\vec{e}_u = r^2\cos^2 v\cos^2 u + r^2\sin^2 v\cos^2 u - r^2\sin^2 u$$

$$= r^2(\cos^2 u + \sin^2 u) = r^2$$

$$\vec{e}_u\cdot\vec{e}_v = -r^2\underset{\sim}{\cos v}\cos u\sin v\underset{\sim}{\sin u} + r^2\sin v\cos u\underset{\sim}{\cos v}\underset{\sim}{\sin u}$$

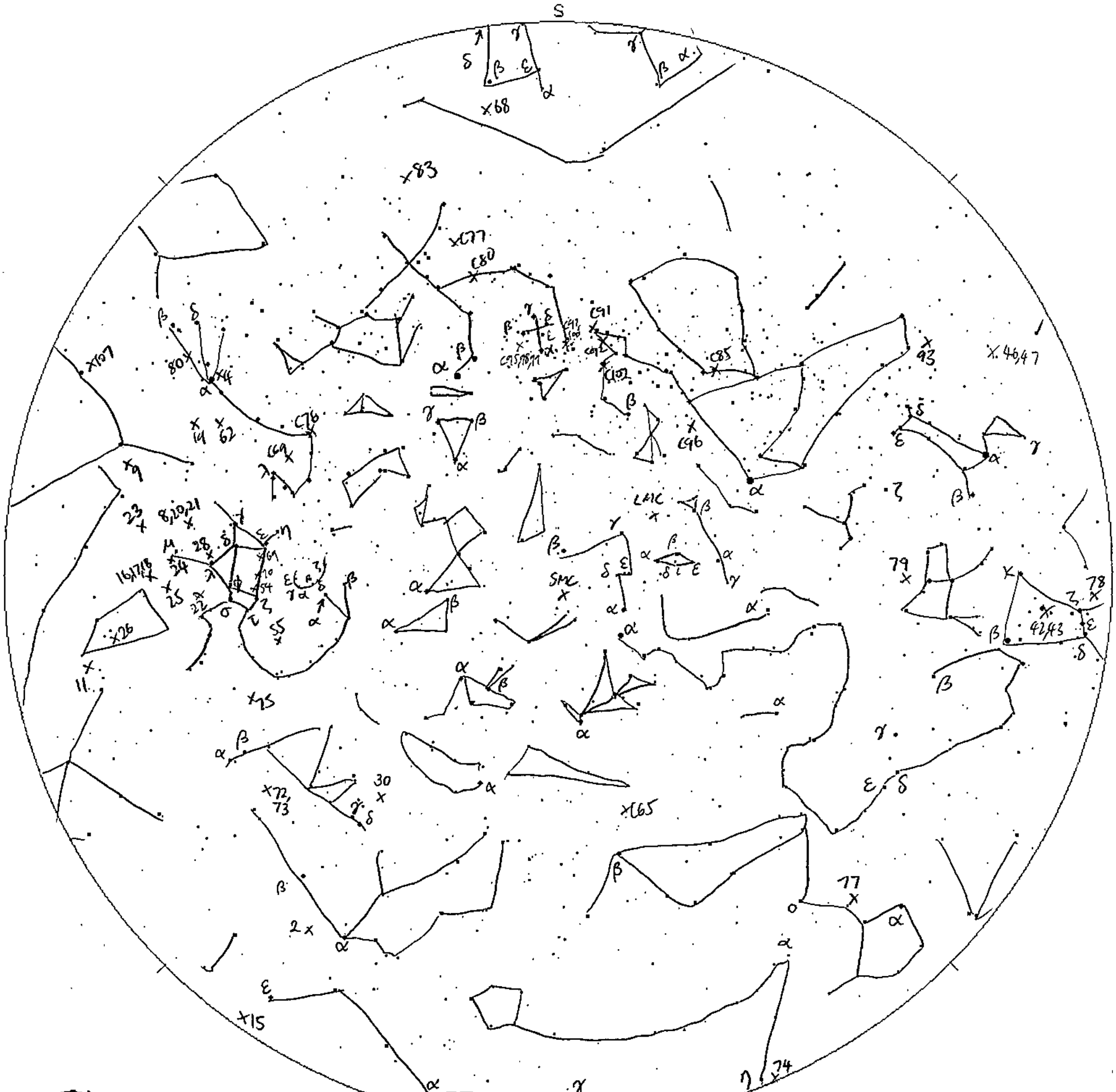
$$= 0$$

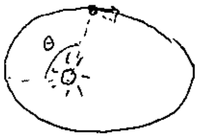
$$\vec{e}_v\cdot\vec{e}_v = (\sin^2 v\sin^2 u + \cos^2 v\sin^2 u)r^2$$

$$= r^2\sin^2 u$$

$\therefore$ Metric Tensor (for sphere) $= \begin{bmatrix} r^2 & 0 \\ 0 & r^2\sin^2 u \end{bmatrix}$

taiwan earthquake number





Find max radial velocity of body (and its true anomaly)

$L = mrv_t$

$r = \frac{a(1-e^2)}{1+e\cos\theta}$

$v = \sqrt{GM\left(\frac{2}{r}-\frac{1}{a}\right)}$

Find better expr for L:

$L = m(a(1-e))\sqrt{GM\left(\frac{2}{a(1-e)}-\frac{1}{a}\right)}$ (at peri: θ=)

$= ma(1-e)\sqrt{GM\left(\frac{1+e}{a(1-e)}\right)}$

$= m\sqrt{GMa(1+e)(1-e)}$

$= m\sqrt{GMa(1-e^2)}$

$v_t = \frac{L}{mr} = \frac{\sqrt{GMa(1-e^2)}}{\frac{a(1-e^2)}{1+e\cos\theta}}$

$= \sqrt{\frac{GM}{a(1-e^2)}}(1+e\cos\theta)$

$v^2 = v_t^2 + v_r^2$

$v_r^2 = v^2 - v_t^2$

$= GM\left(\frac{2(1+e\cos\theta)}{a(1-e^2)}-\frac{1}{a}\right) - \frac{GM}{a(1-e^2)}(1+e\cos\theta)^2$

$= GM\left(\frac{2+2e\cos\theta-(1-e^2)-(1+e\cos\theta)^2}{a(1-e^2)}\right)$

$= GM\left(\frac{2+2e\cos\theta-1+e^2-1-2e\cos\theta-e^2\cos^2\theta}{a(1-e^2)}\right)$

$v_r^2 = GM\left(\frac{e^2-e^2\cos^2\theta}{a(1-e^2)}\right) = GM\left(\frac{e^2(1-\cos^2\theta)}{a(1-e^2)}\right) = \frac{GMe^2}{a(1-e^2)}\sin^2\theta$

$v_r = \sqrt{\frac{GM}{a(1-e^2)}}(e\sin\theta)$

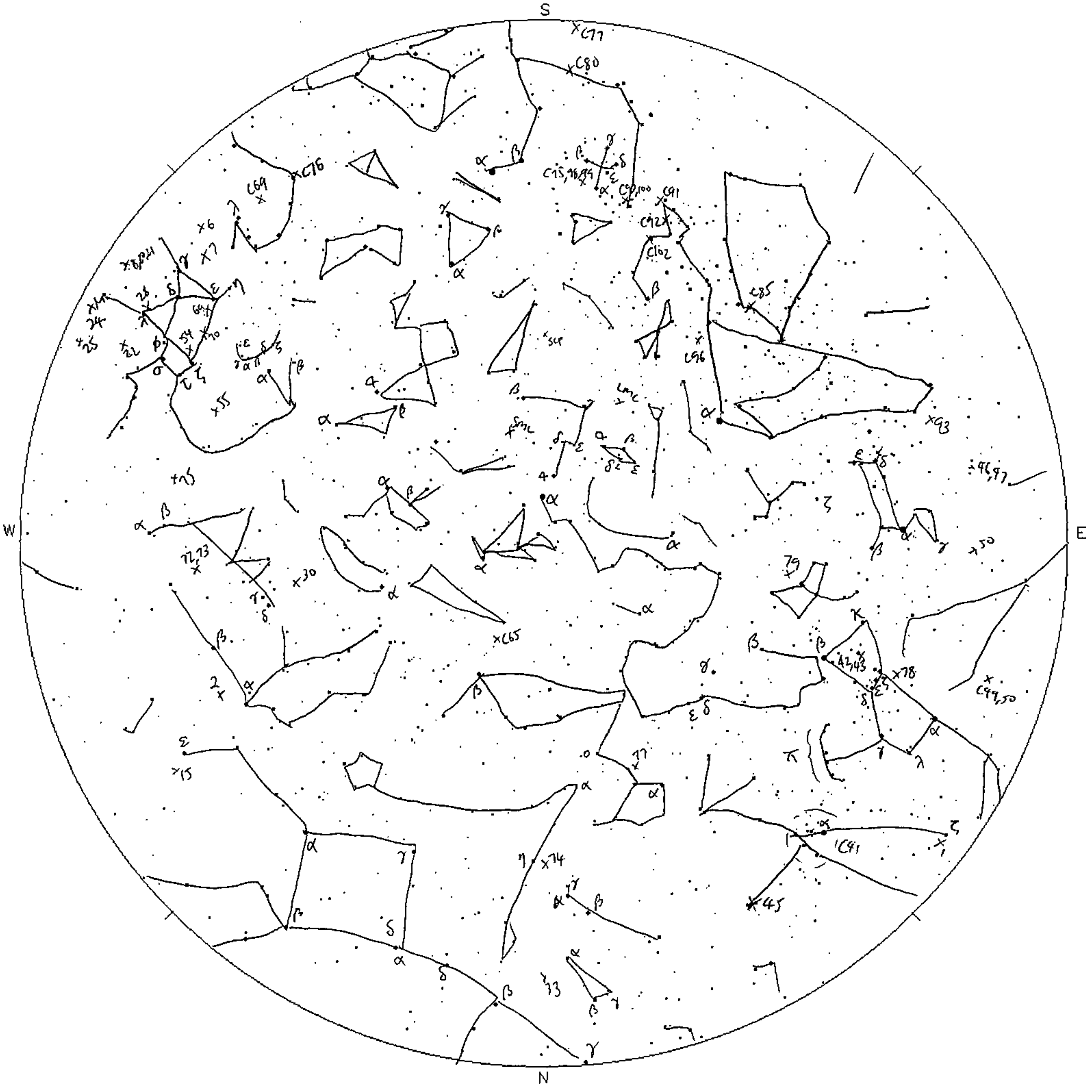
Max $v_r \rightarrow e\sqrt{\frac{GM}{a(1-e^2)}}$ at $\theta = 90°$ or $270°$ (going inward)

Bonus: find max redshift of Sun from Earth (only consider longitudinal Doppler effect) (transverse is way too much to handle)

$z \approx \frac{v_r}{c} = \frac{e}{c}\sqrt{\frac{GM}{a(1-e^2)}}$

Sub values $\Rightarrow$

$z \approx 1.45 \times 10^{-6}$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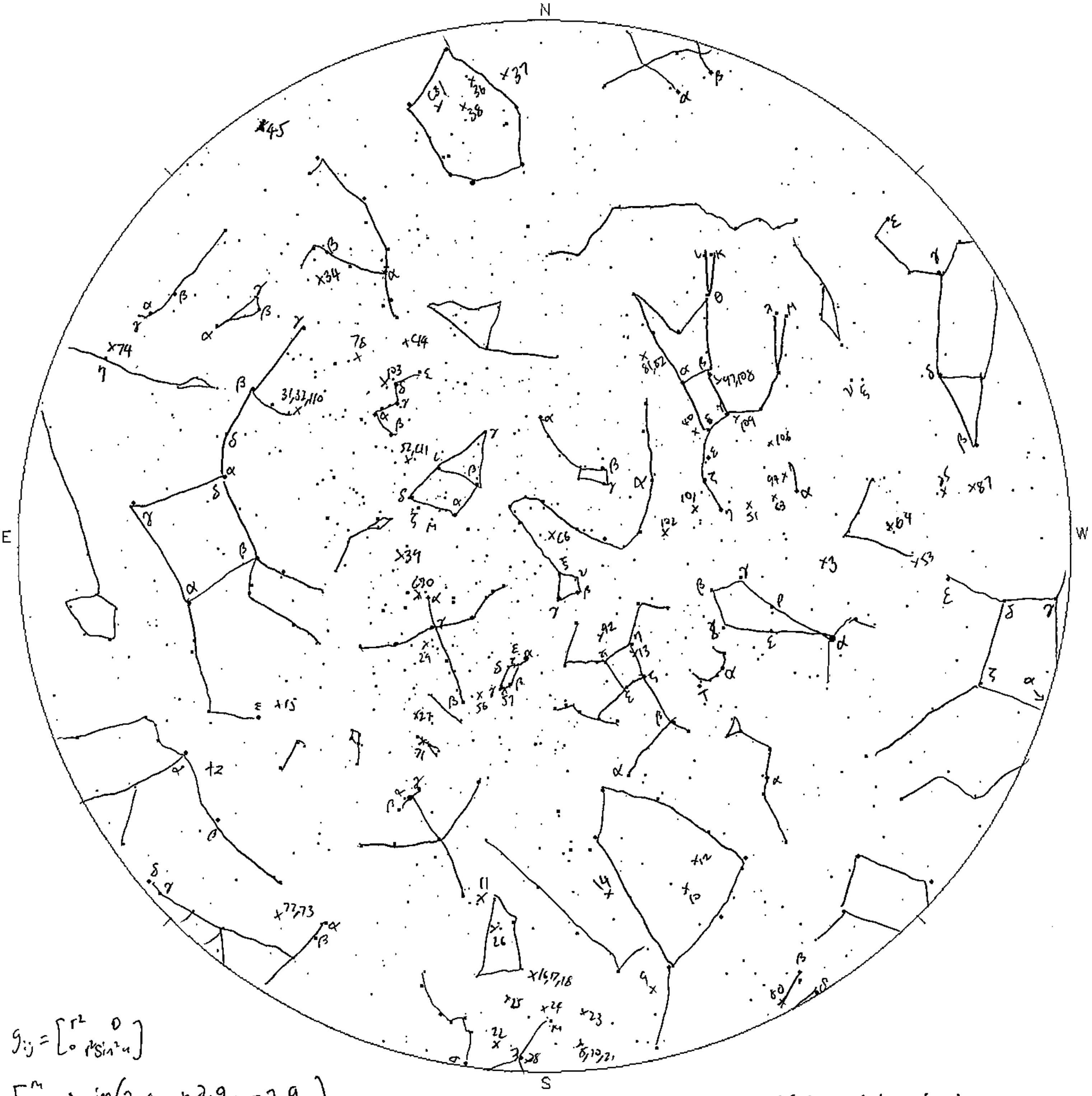


$$g_{ij} = \begin{bmatrix} r^2 & 0 \\ 0 & r^2\sin^2 u \end{bmatrix}$$

$$\Gamma^m_{jk} = \frac{1}{2} g^{im}\left(\partial_k g_{ij} + \partial_j g_{ki} - \partial_i g_{jk}\right)$$

$$g^{ij} = \begin{bmatrix} 1/r^2 & 0 \\ 0 & 1/r^2\sin^2 u \end{bmatrix}$$

$$\Gamma^1_{11} = \frac{1}{2} g^{11}\left(\partial_1 g_{11}\right) = 0$$

$$\Gamma^1_{12} = \Gamma^1_{21} = \frac{1}{2} g^{11}\left(\partial_2 g_{11} + \partial_1 g_{21} - \partial_1 g_{12}\right) = 0$$

$$\Gamma^1_{22} = \frac{1}{2} g^{11}\left(\partial_2 g_{12} + \partial_2 g_{21} - \partial_1 g_{22}\right)$$
$$= \frac{1}{2} \cdot \left(\frac{1}{r^2}\right)\left(-\frac{\partial r^2\sin^2 u}{\partial u}\right)$$
$$= \frac{1}{2}\left(-2\sin u\cos u\right) = -\sin u\cos u$$

$$\Gamma^2_{11} = \frac{1}{2} g^{22}(0) = 0$$

$$\Gamma^2_{12} = \Gamma^2_{21} = \frac{1}{2} g^{22}\left(\partial_1 g_{22}\right)$$
$$= \frac{1}{\cancel{2}}\frac{1}{\cancel{r^2}\sin^2 u}\left(\cancel{2}\sin u\cos u\right)\left(\cancel{r^2}\right)$$
$$= \cot u$$

$$\Gamma^2_{22} = \frac{1}{2} g^{22}\left(\partial_2 g_{22}\right)$$
$$= \frac{1}{2r^2\sin^2 u}\frac{\partial r^2\sin^2 u}{\partial v} = 0$$

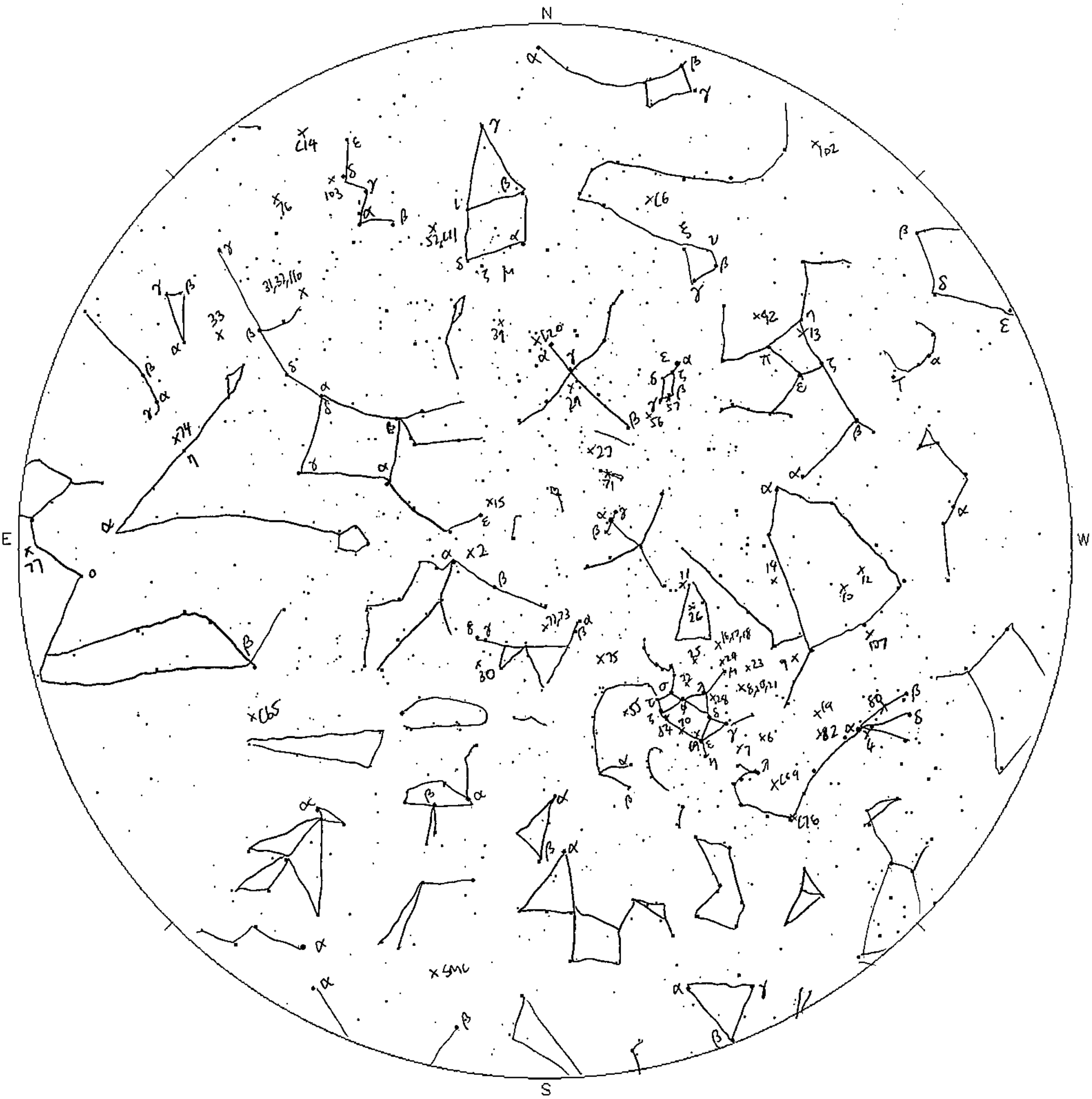
so christoffel symbols for sphere:

$$\Gamma^1_{22} = -\sin u\cos u$$

$$\Gamma^2_{21} = \Gamma^2_{12} = \cot u$$

All others are 0

Does not depend on r!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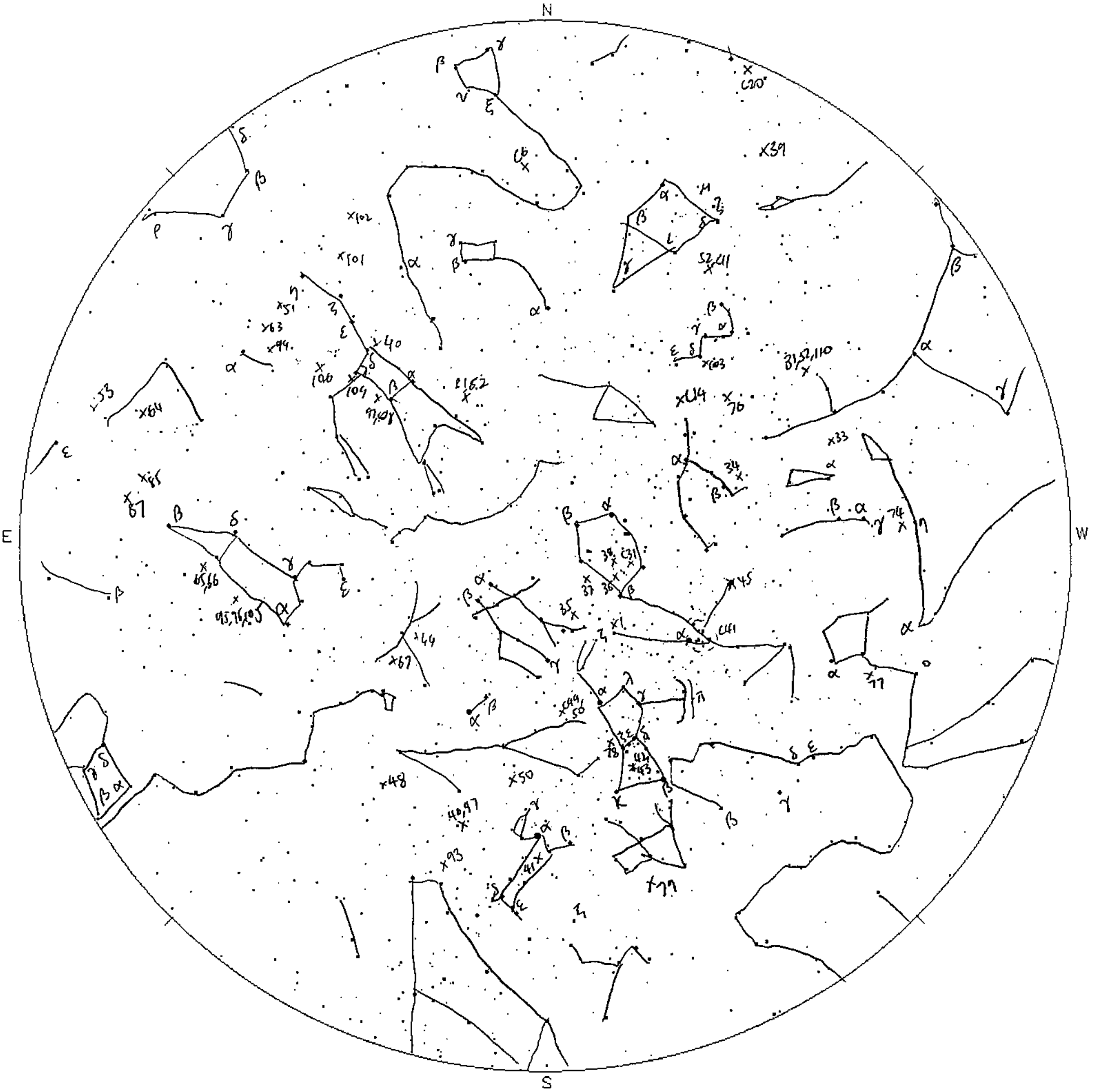
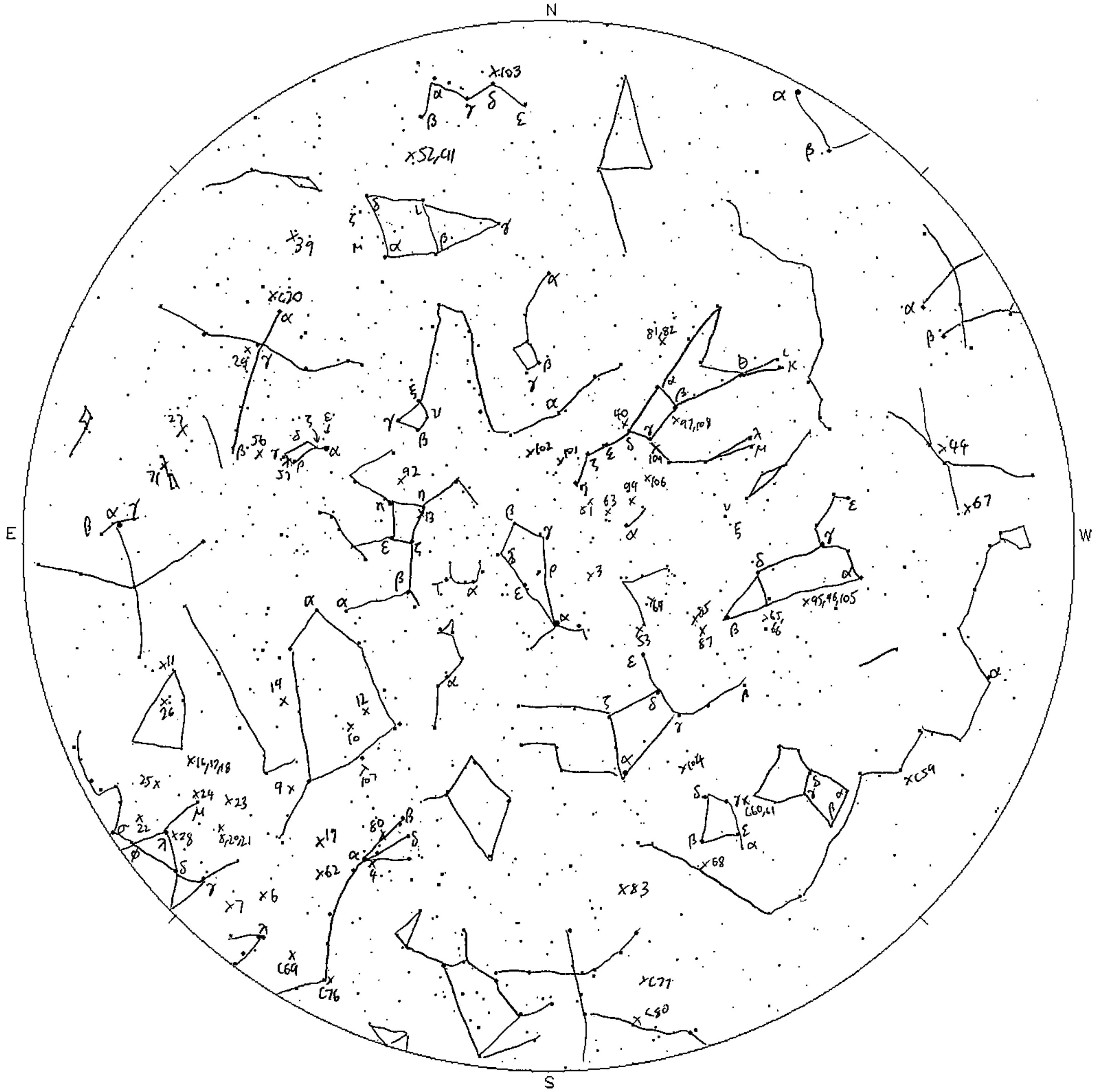
SMC

9 to 5 job



DYNAMITE – TORNADO – QUICKSAND – PIT – CHAIN – GUN – LAW – WHIP – SWORD – ROCK – DEATH – WALL – SUN – CAMERA – FIRE – CHAINSAW – SCHOOL – SCISSORS – POISON – CAGE – AXE – PEACE – COMPUTER – CASTLE – SNAKE – BLOOD – PORCUPINE – VULTURE – MONKEY – KING – QUEEN – PRINCE – PRINCESS – POLICE – WOMAN – BABY – MAN – HOME – TRAIN – CAR – NOISE – BICYCLE – TREE – TURNIP – DUCK – WOLF – CAT – BIRD – FISH – SPIDER – COCKROACH – BRAIN – COMMUNITY – CROSS – MONEY – VAMPIRE – SPONGE – CHURCH – BUTTER – BOOK – PAPER – CLOUD – AIRPLANE – MOON – GRASS – FILM – TOILET – AIR – PLANET – GUITAR – BOWL – CUP – BEER – RAIN – WATER – TV – RAINBOW – UFO – ALIEN – PRAYER – MOUNTAIN – SATAN – DRAGON – DIAMOND – PLATINUM – GOLD – DEVIL – FENCE – VIDEO GAME – MATH – ROBOT – HEART – ELECTRICITY – LIGHTNING – MEDUSA – POWER – LASER – NUKE – SKY – TANK – HELICOPTER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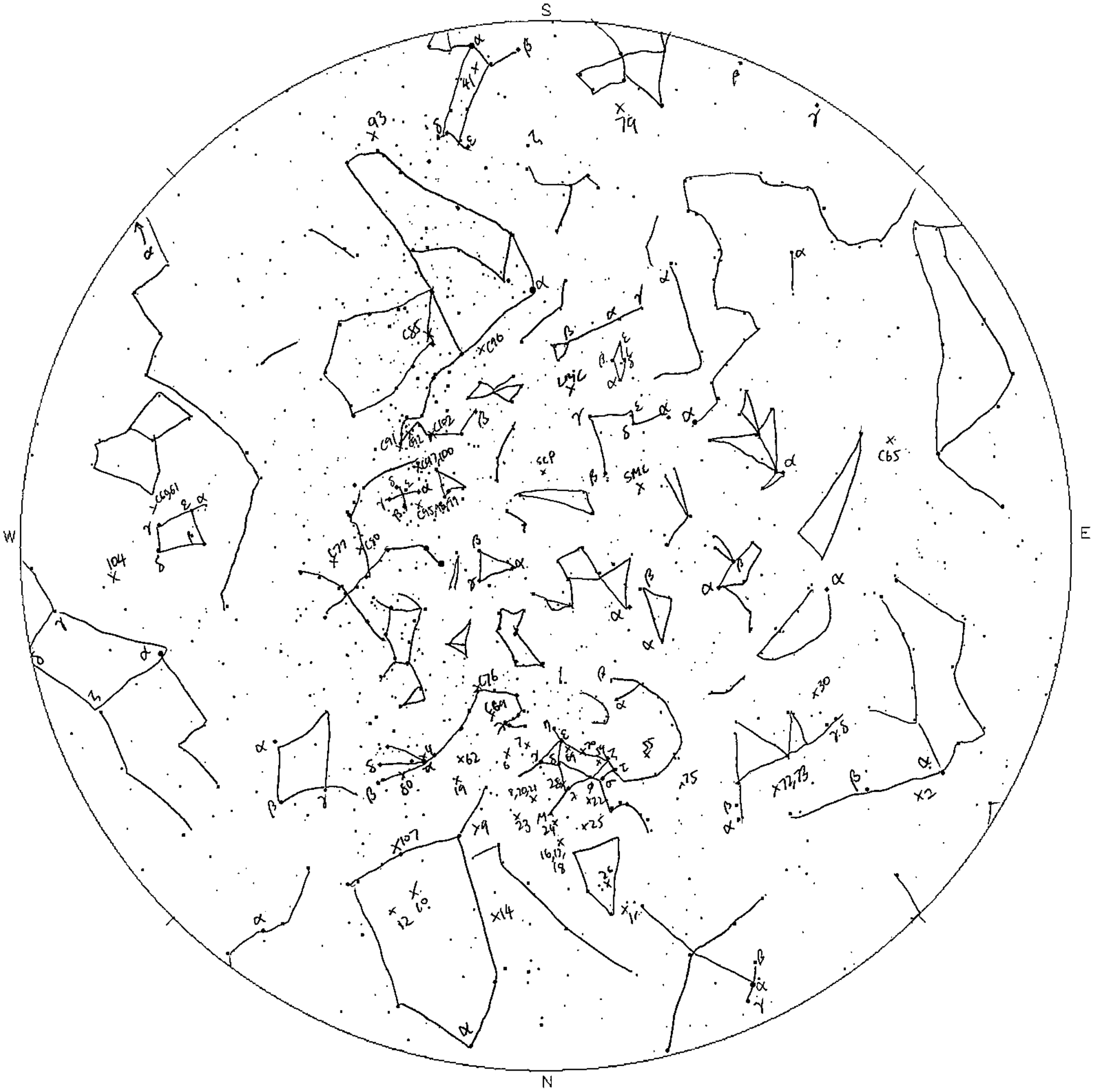S
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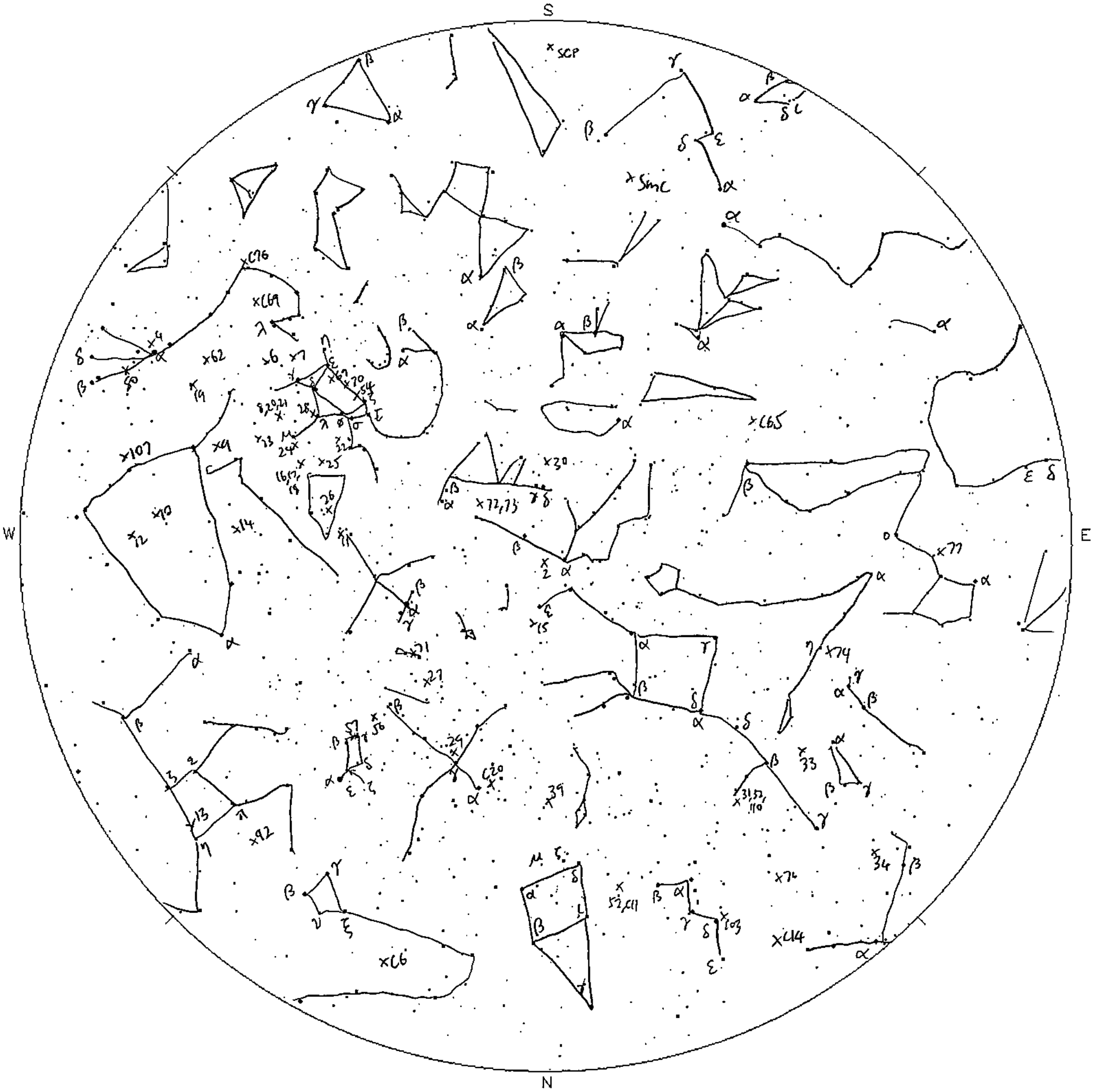
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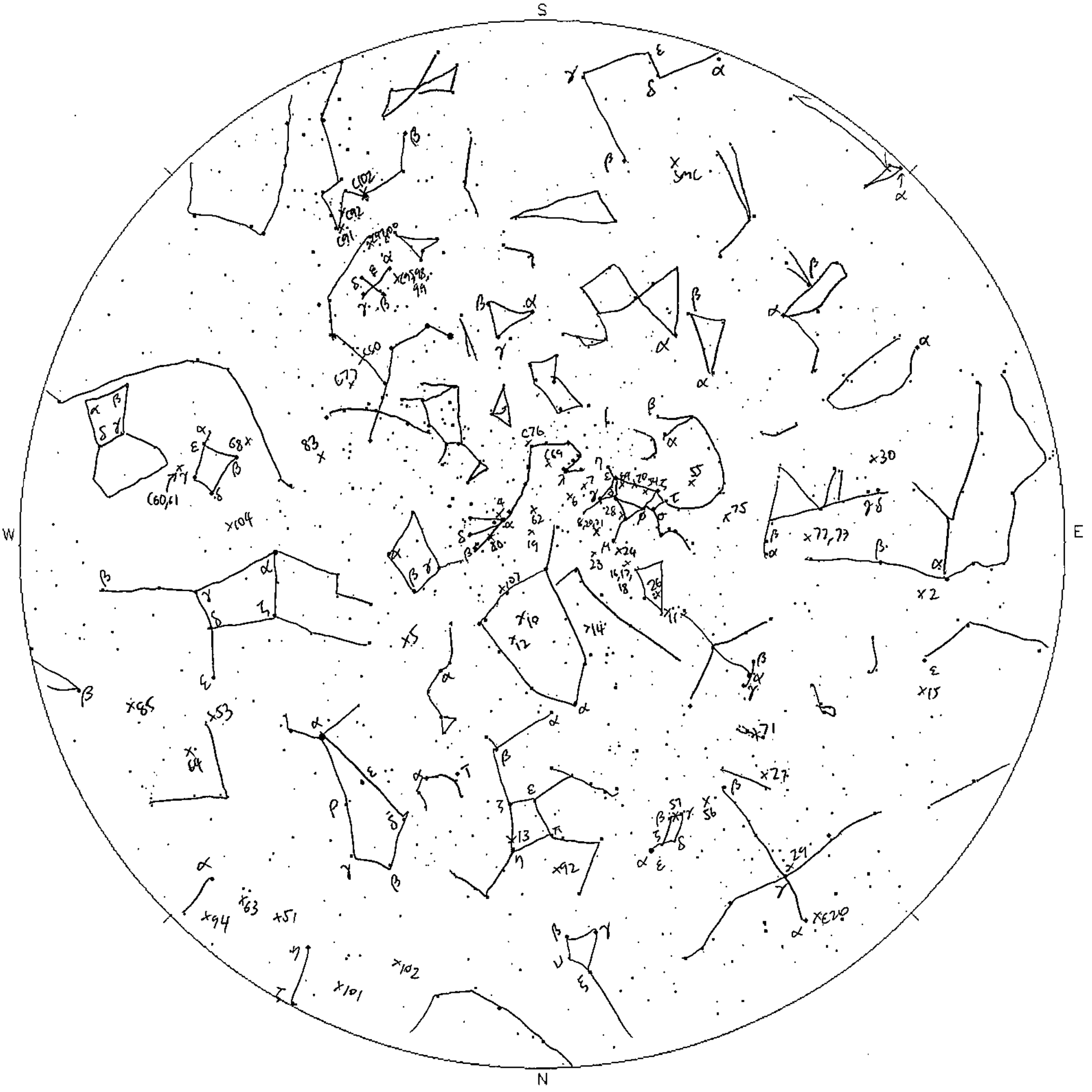
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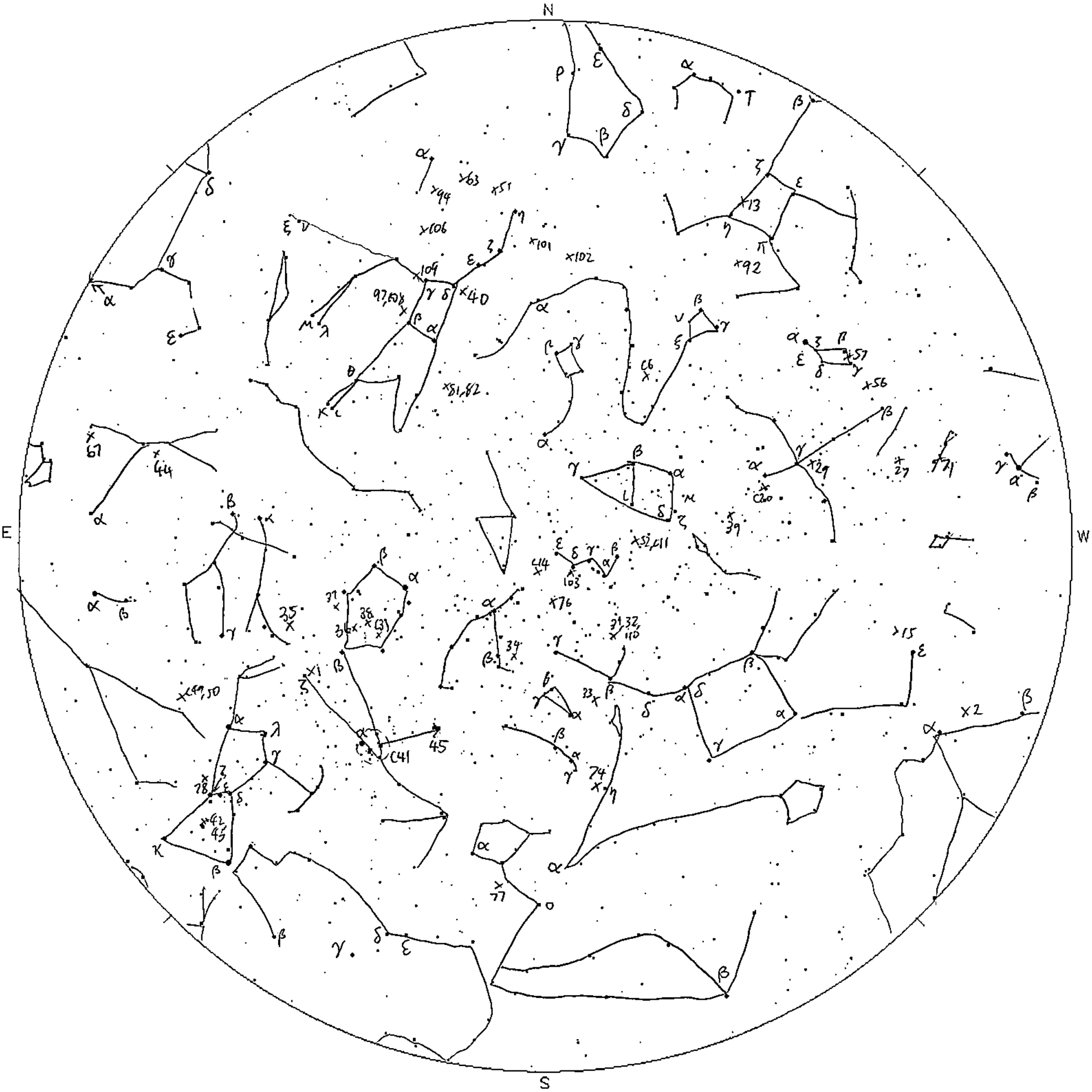
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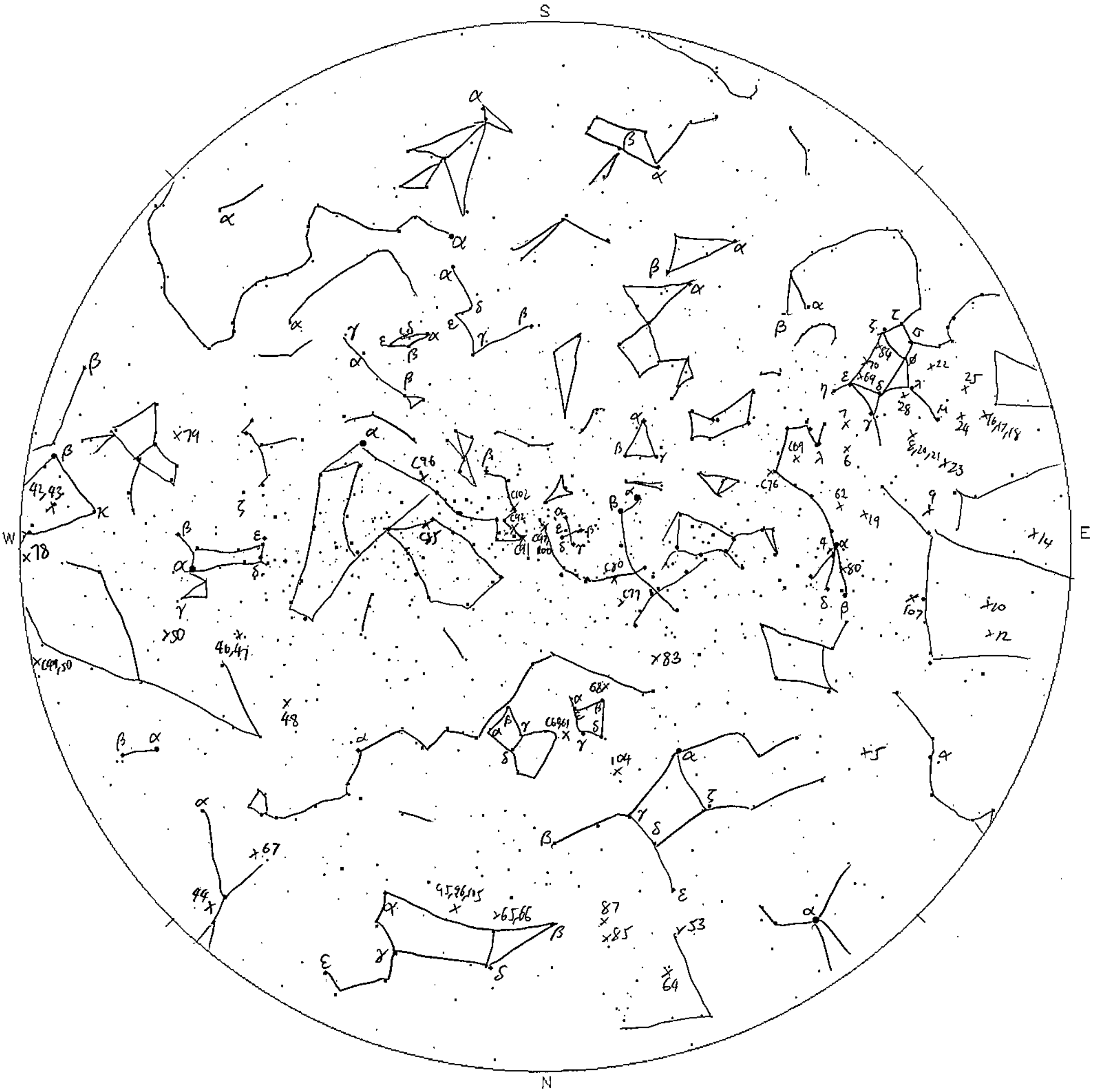
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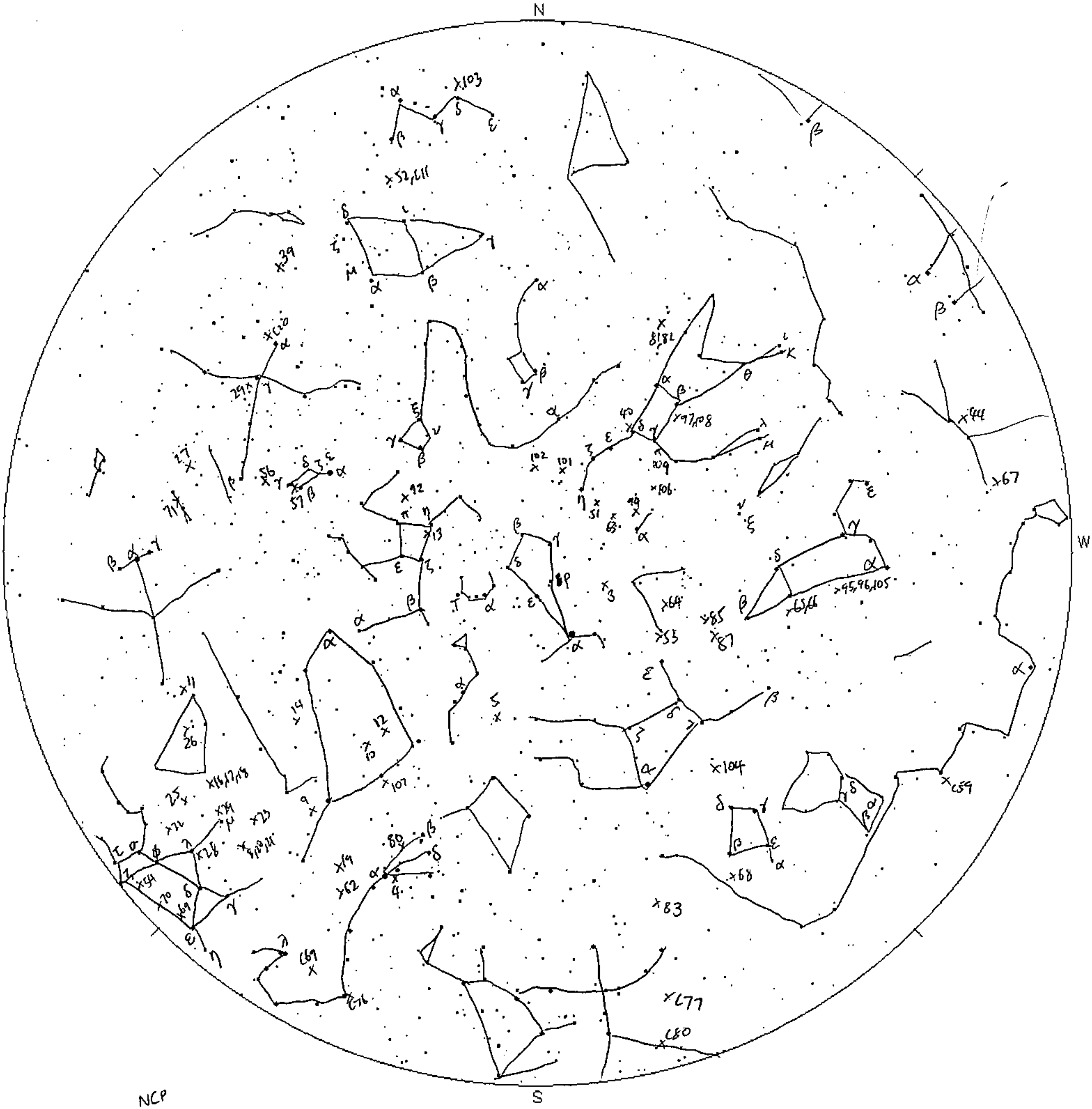
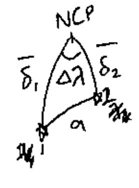




$$\cos a = \cos\bar\delta_1 \cos\bar\delta_2 + \sin\bar\delta_1 \sin\bar\delta_2 \cos\Delta\lambda$$

$$= \sin\delta_1 \sin\delta_2 + \cos\delta_1 \cos\delta_2 \cos\Delta\lambda$$

Solid∡ of summer Δ

Vega → 18^h36^m $+38°47'$

Deneb → 20^h41^m $+45°16'$

Altair → 19^h50^m $+08°52'$

279°

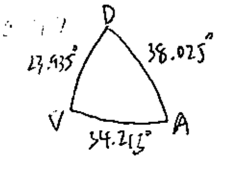
310.25°

297.5°

V-D → 23.935°

D-A → 38.025°

V-A → 34.213°



$$\cos A = \frac{\cos a - \cos b \cos c}{\sin b \sin c}$$

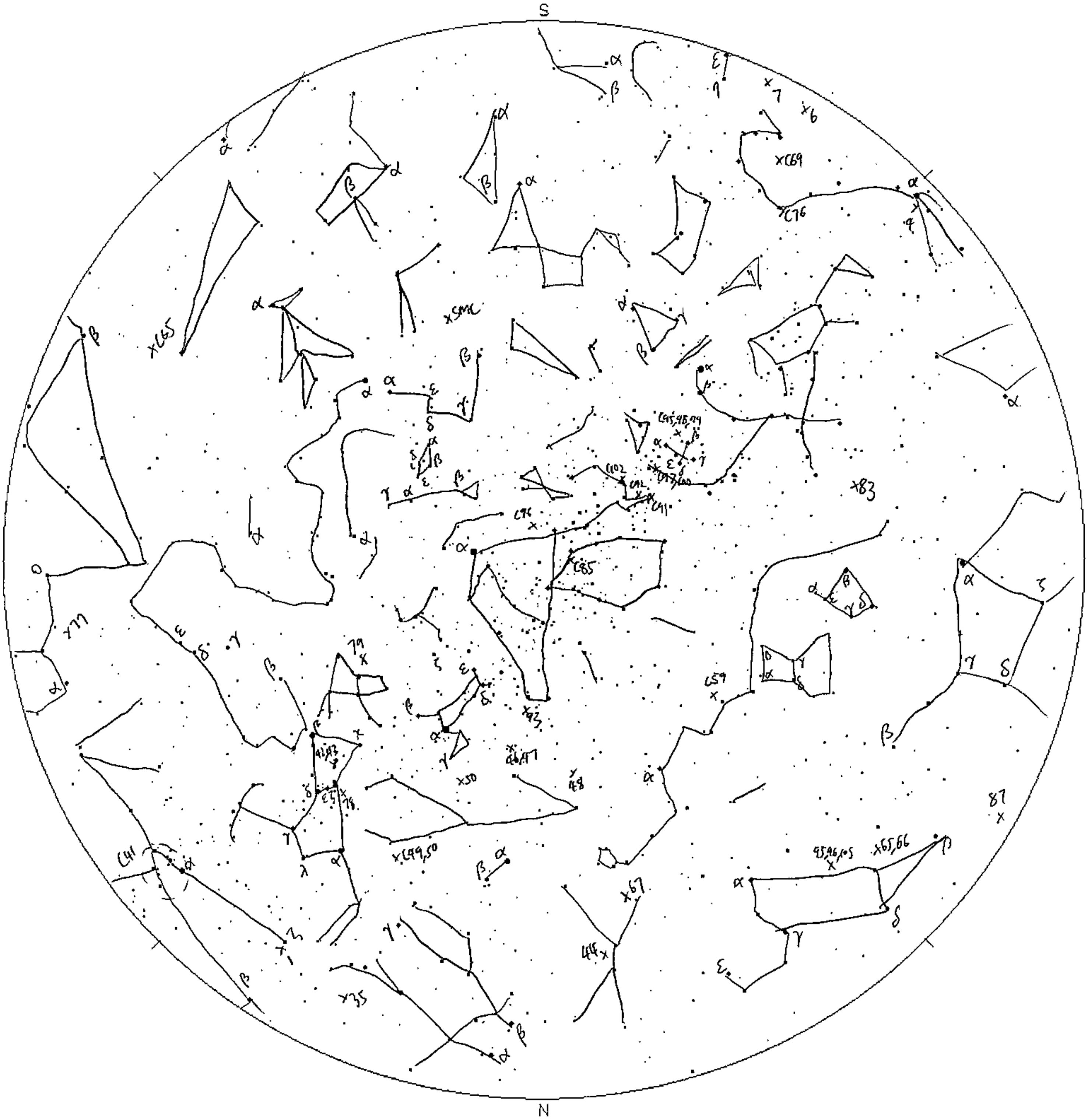
∠V-D → 40.702° → 0.7104

∠D-A → 81.961° → 1.4305

∠V-A → 64.662° → 1.1286

Solid ∡ = E = A+B+C−π

= 0.1279 steradian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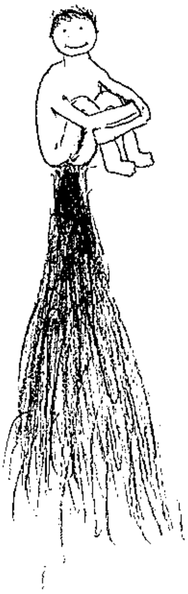
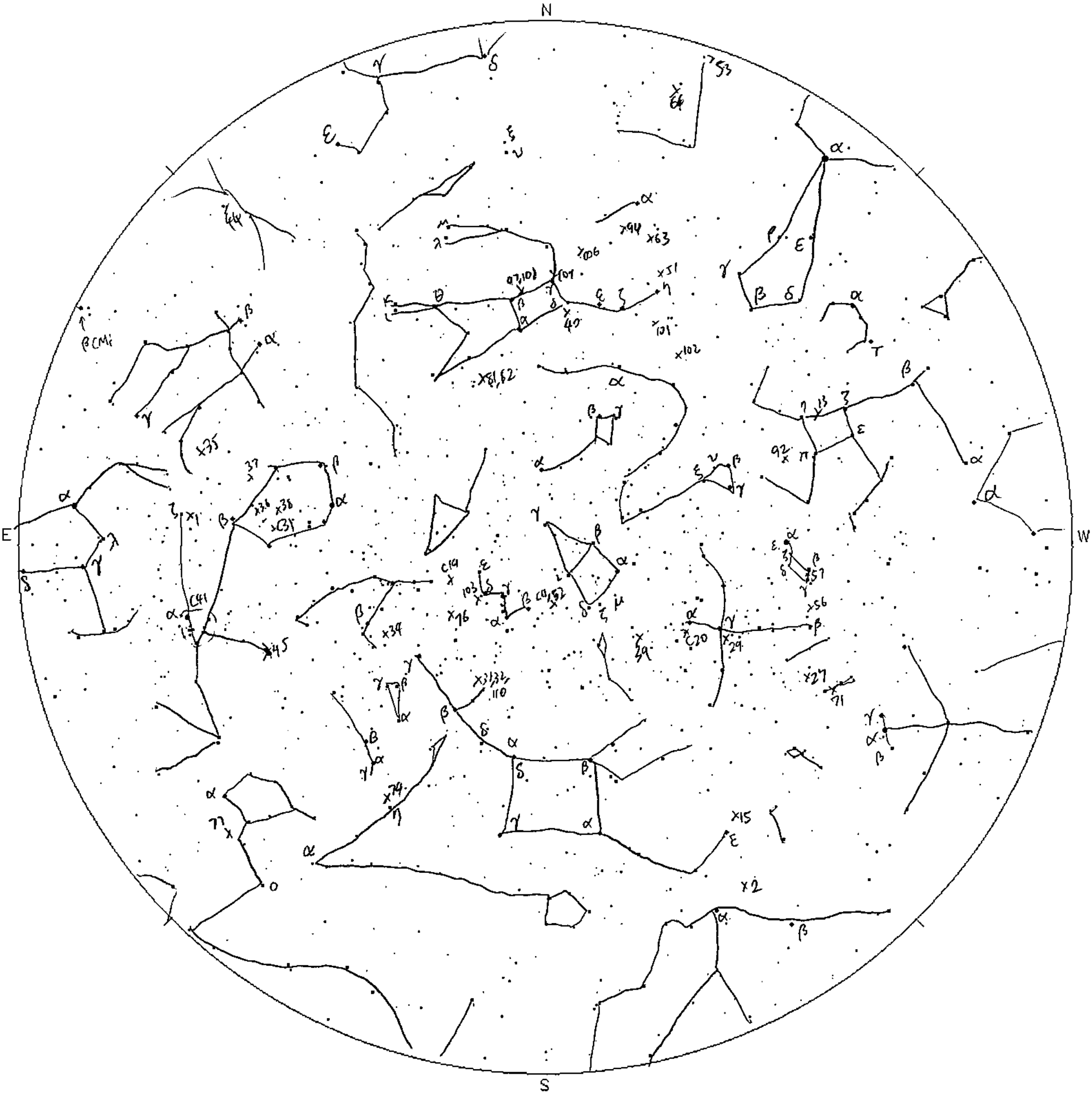
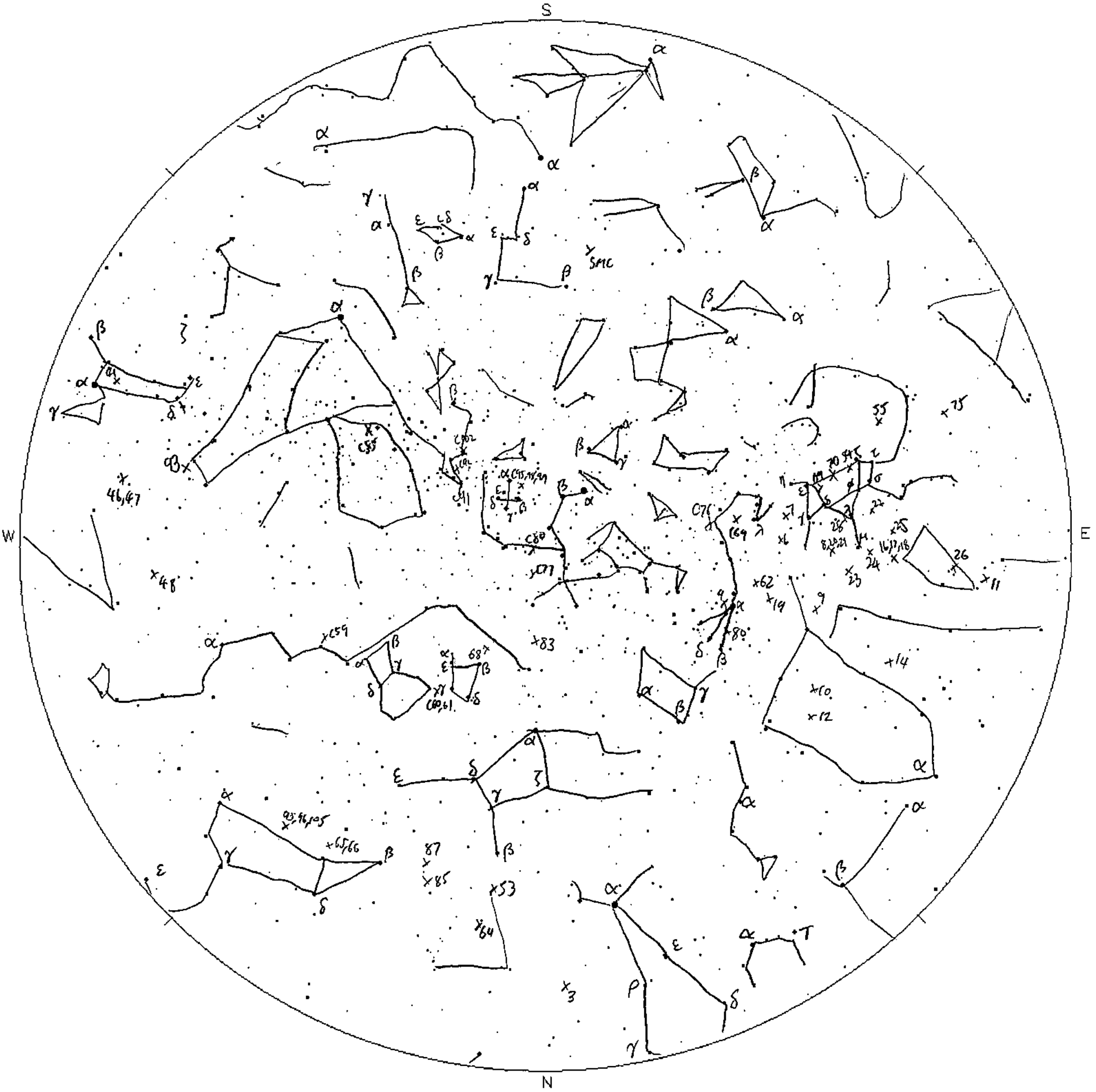




‘When you want to sleep, the stars come out’ ~Me doing star maps in class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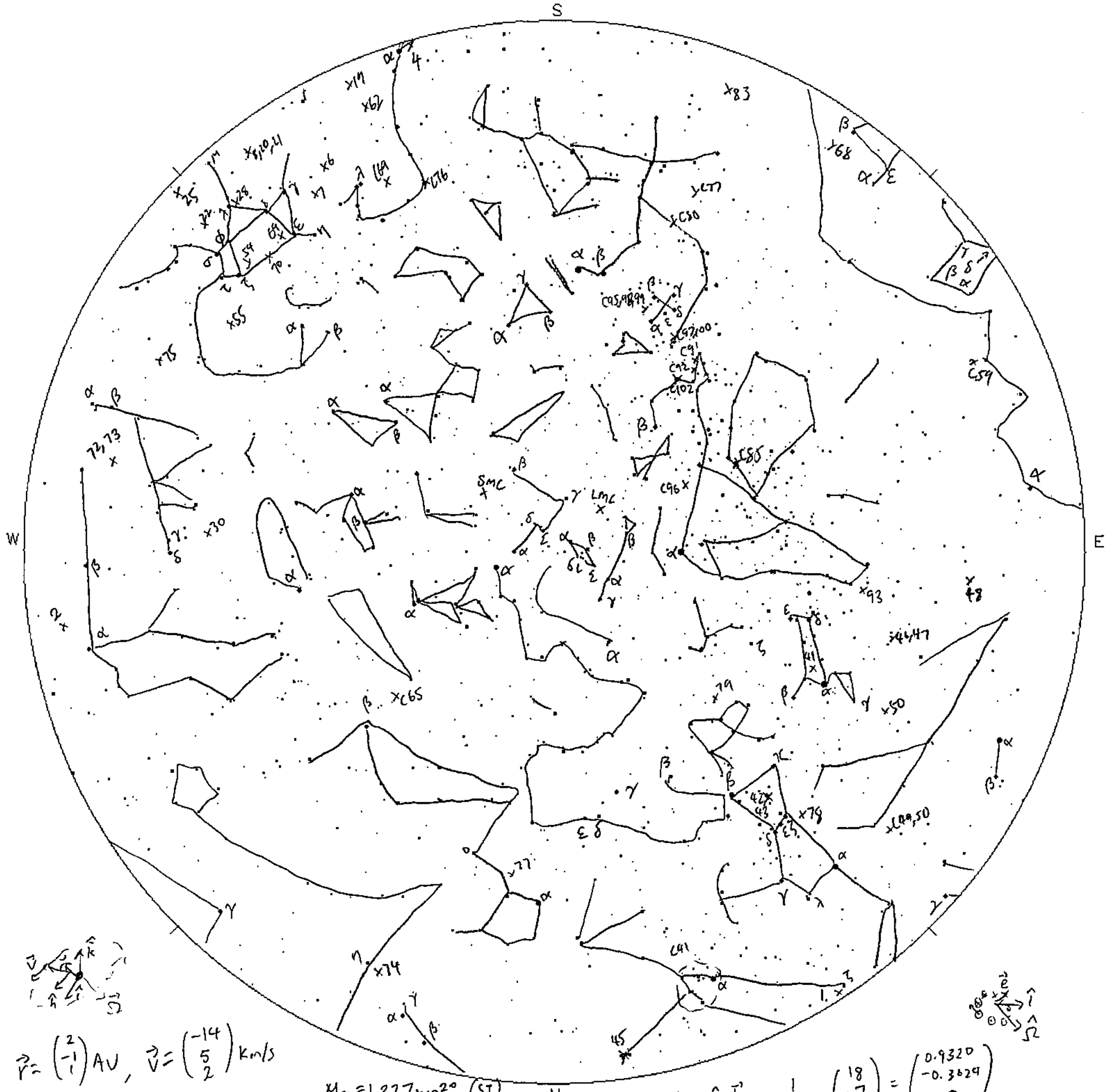


$\vec{r} = \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}$ AU, $\vec{V} = \begin{pmatrix} -14 \\ 5 \\ 2 \end{pmatrix}$ km/s

$\mu_\odot = 1.327 \times 10^{20}$ (SI)

Find $a, e, i, \Omega, \omega, (\nu)$?

$r = \sqrt{2^2+1^2+1^2} = \sqrt{6}$ AU

$V = \sqrt{14^2+5^2+2^2} = 15$ km/s

(a) $V = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$

$\frac{1}{a} = \frac{2}{r} - \frac{V^2}{GM}$

$a = \dfrac{1}{\frac{2}{r} - \frac{V^2}{GM}}$

$= 2.658 \times 10^{11}$ m

$= 1.777$ AU

(e) $\vec{h} = \vec{r} \times \vec{V} = \begin{pmatrix} -7 \\ -18 \\ -4 \end{pmatrix}$

$\vec{e} = \frac{\vec{V} \times \vec{h}}{\mu} - \frac{\vec{r}}{r}$

$= \frac{1000^2 \times 1.496 \times 10^{11}}{1.327 \times 10^{20}} \begin{pmatrix} 16 \\ -70 \\ 287 \end{pmatrix} - \frac{1}{\sqrt{6}} \begin{pmatrix} 2 \\ -1 \\ 1 \end{pmatrix}$

$= \begin{pmatrix} -0.7985 \\ -0.3293 \\ -0.0847 \end{pmatrix}$

$|\vec{e}| = 0.8679$

(i) $\cos i = \frac{\vec{h} \cdot \hat{k}}{|\vec{h}|} = \frac{-4}{\sqrt{7^2+18^2+4^2}} = -0.203$

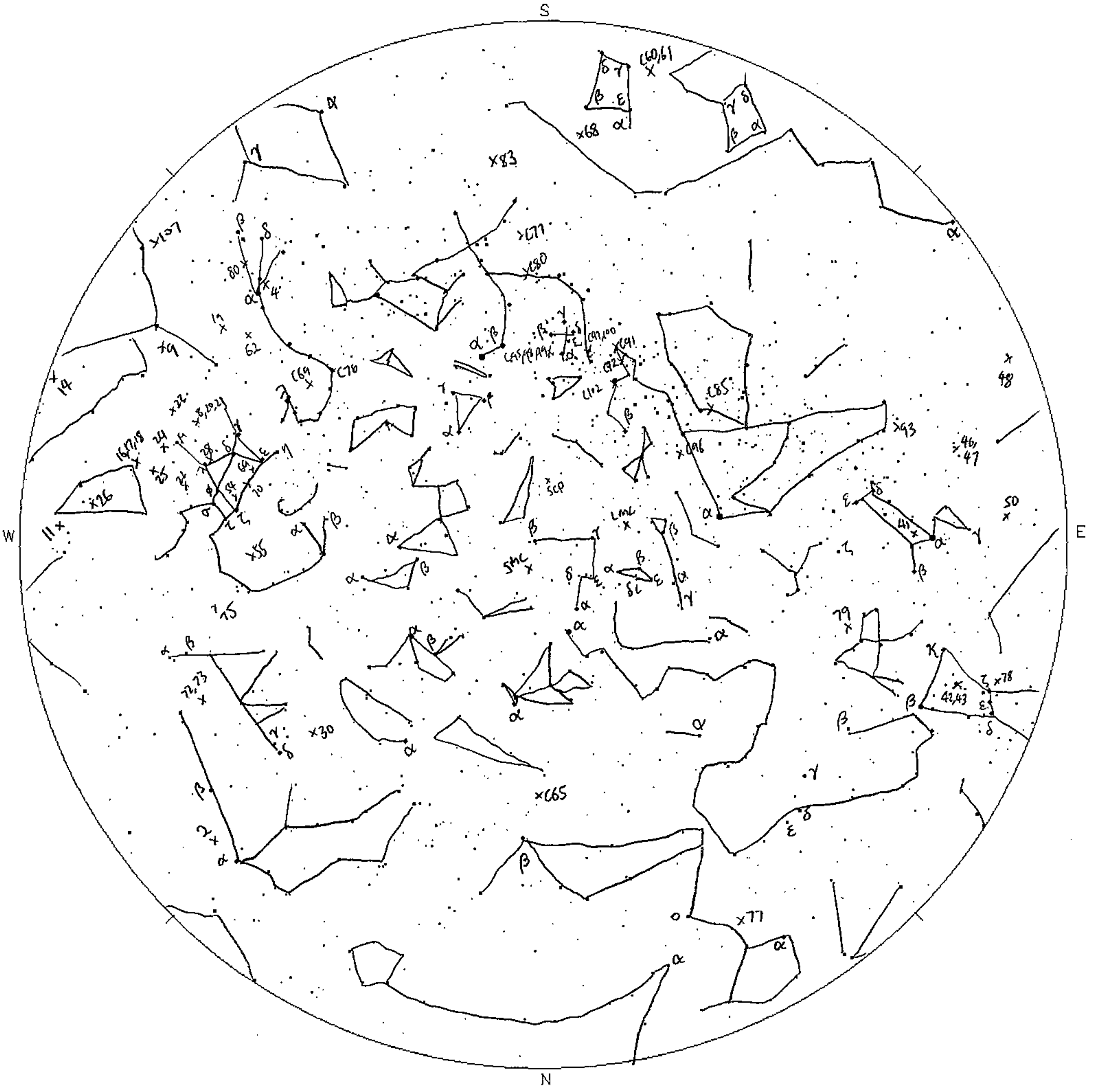
$i = 101.7^\circ$

(Ω) $\hat{\Omega} = \frac{\hat{k} \times \vec{h}}{|\hat{k} \times \vec{h}|} = \frac{1}{\sqrt{18^2+7^2}} \begin{pmatrix} 18 \\ -7 \\ 0 \end{pmatrix} = \begin{pmatrix} 0.9320 \\ -0.3629 \\ 0 \end{pmatrix}$

$\Omega = \overset{360^\circ-}{\cos^{-1}}(0.9320) = 338.7^\circ$

(ω) $\omega = \overset{360^\circ-}{\cos^{-1}}\left(\frac{\hat{\Omega} \cdot \vec{e}}{|\vec{e}|}\right) = 360^\circ - 174.3^\circ = 185.7^\circ$

(ν) $\nu = \cos^{-1}\left(\frac{\vec{r} \cdot \vec{e}}{|\vec{r}||\vec{e}|}\right) = 161.1^\circ$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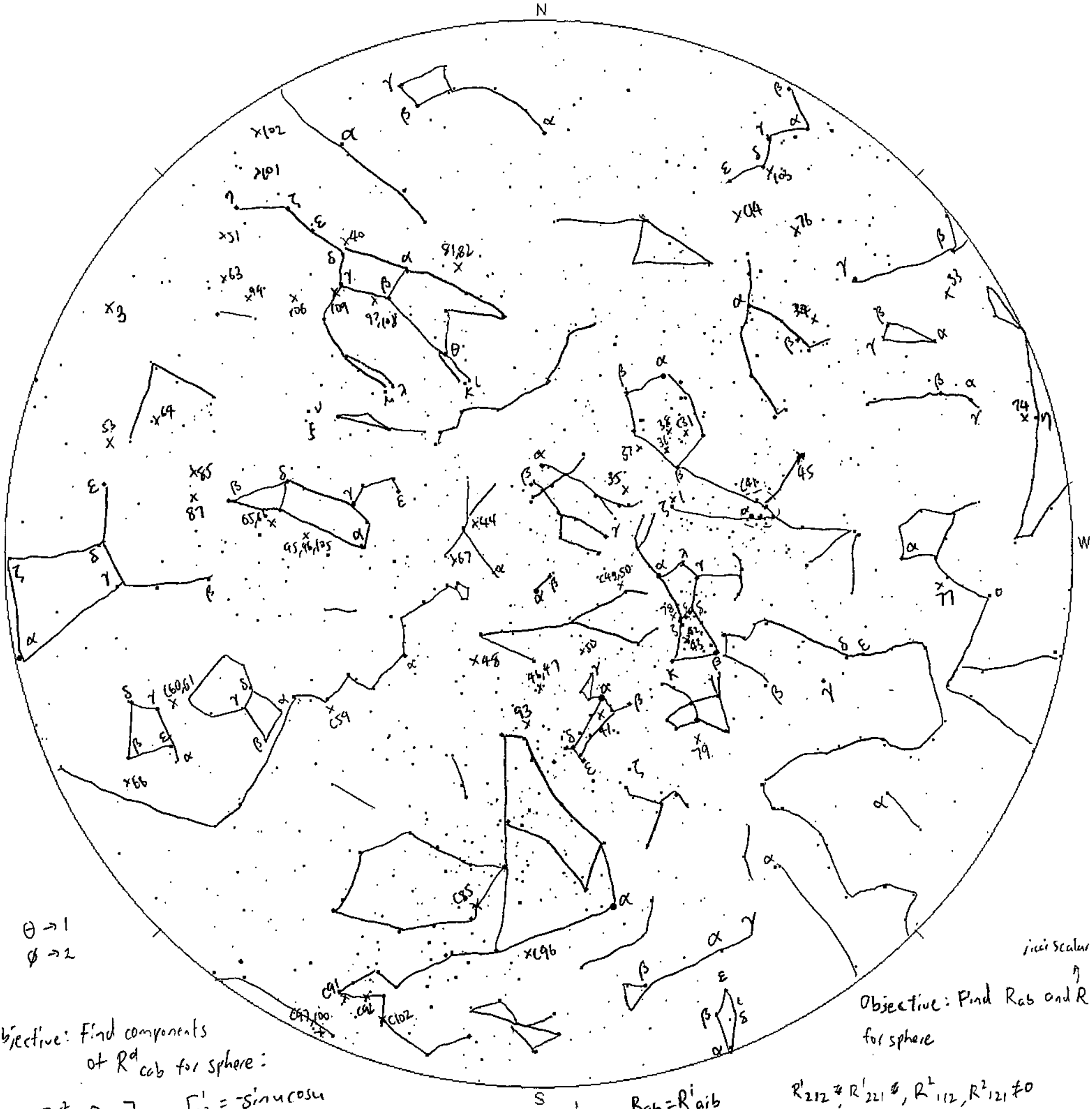


$\theta \to 1$
$\phi \to 2$

Objective: Find components of $R^a{}_{cab}$ for sphere:

$g = \begin{bmatrix} r^2 & 0 \\ 0 & r^2\sin^2 u \end{bmatrix}$, $\Gamma^1_{22} = -\sin u\cos u$, $\Gamma^2_{21} = \Gamma^2_{12} = \cot u$

$R^1{}_{111} = R^1{}_{211} = R^2{}_{111} = R^2{}_{211} = R^1{}_{\cancel{1}22} = R^1{}_{222} = R^2{}_{122} = R^2{}_{222} = 0$

$R^1{}_{121} = R^1{}_{112} = g^{1\mu}R_{\mu 112} = g^{11}R_{1112} = 0$

$R^2{}_{212} = R^2{}_{221} = g^{22}R_{2212} = 0$

Only non-0 components are: $R^1{}_{212} = -R^1{}_{221} = g^{11}R_{1212} = R_{1212}\cdot\frac{1}{r^2}$
$= -\frac{1}{r^2}R_{2112} = -\frac{1}{r^2}g_{22}R^2{}_{112} = -\sin^2 u\, R^2{}_{112} = +\sin^2 u\, R^2{}_{121}$

$\Rightarrow R^1{}_{212} = -R^1{}_{221} = -\sin^2 u\, R^2{}_{112} = +\sin^2 u\, R^2{}_{121}$

$\underset{cab}{R^1{}_{212}} = \partial_1\Gamma^1_{22} - \partial_2\Gamma^1_{12} + \Gamma^i_{22}\Gamma^1_{1i} - \Gamma^j_{12}\Gamma^1_{2j}$

$= \frac{\partial}{\partial u}\left(-\frac{1}{2}\sin 2u\right) \cancel{+} - \cot u \times -\sin u\cos u$

$= -\cos 2u + \cos^2 u$

$= -\cos^2 u + \sin^2 u + \cos^2 u = \sin^2 u$

ricci Scalar

Objective: Find R_{ab} and R for sphere

$R_{ab} = R^i{}_{aib}$ $R^1{}_{212}$, $R^1{}_{221}$, $R^2{}_{112}$, $R^2{}_{121} \neq 0$

$R_{11} = R^1{}_{111} + R^2{}_{121} = R^2{}_{121} = 1$

$R_{12} = 0$

$R_{21} = 0$

$R_{22} = R^1{}_{212} = \sin^2 u$

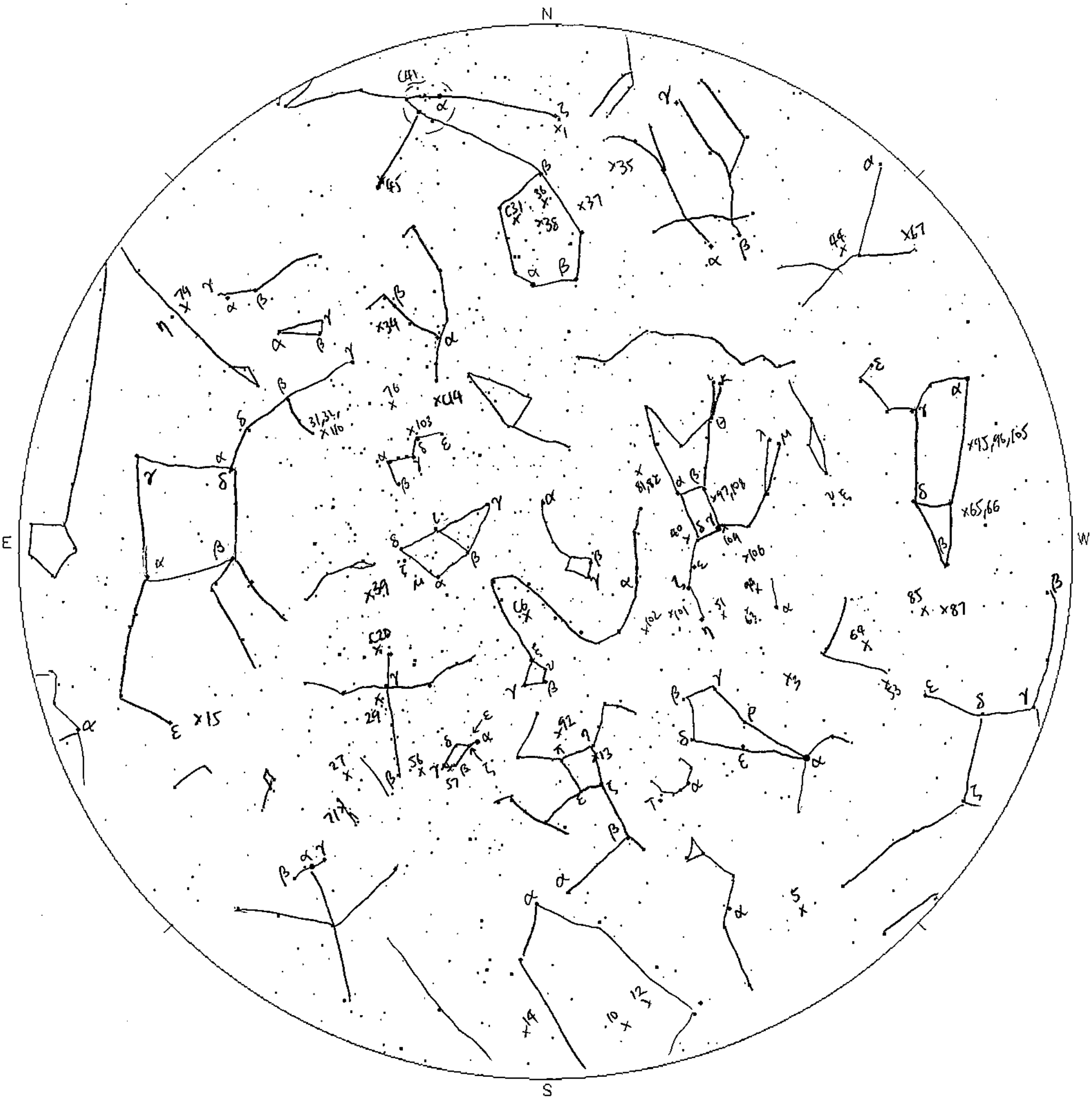
$\Rightarrow \text{Ricci} = \begin{bmatrix} 1 & 0 \\ 0 & \sin^2 u \end{bmatrix}$

$R = R^\mu{}_\mu = g^{\mu\nu}R_{\nu\mu}$

$= g^{11}R_{11} + g^{22}R_{22}$

$= \frac{1}{r^2}(1) + \frac{1}{r^2\sin^2 u}\sin^2 u$

$= \underline{\underline{\frac{2}{r^2}}}$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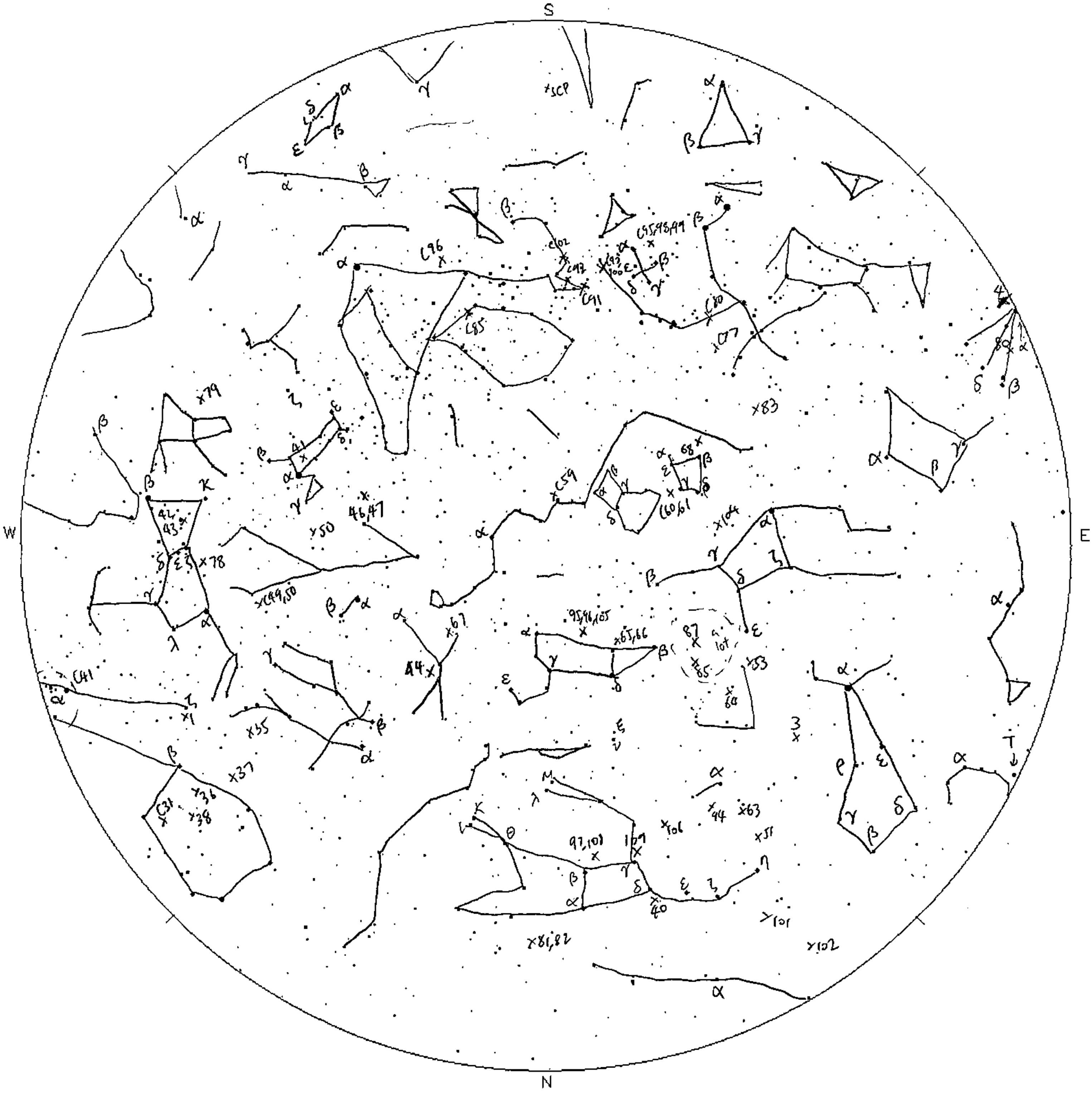
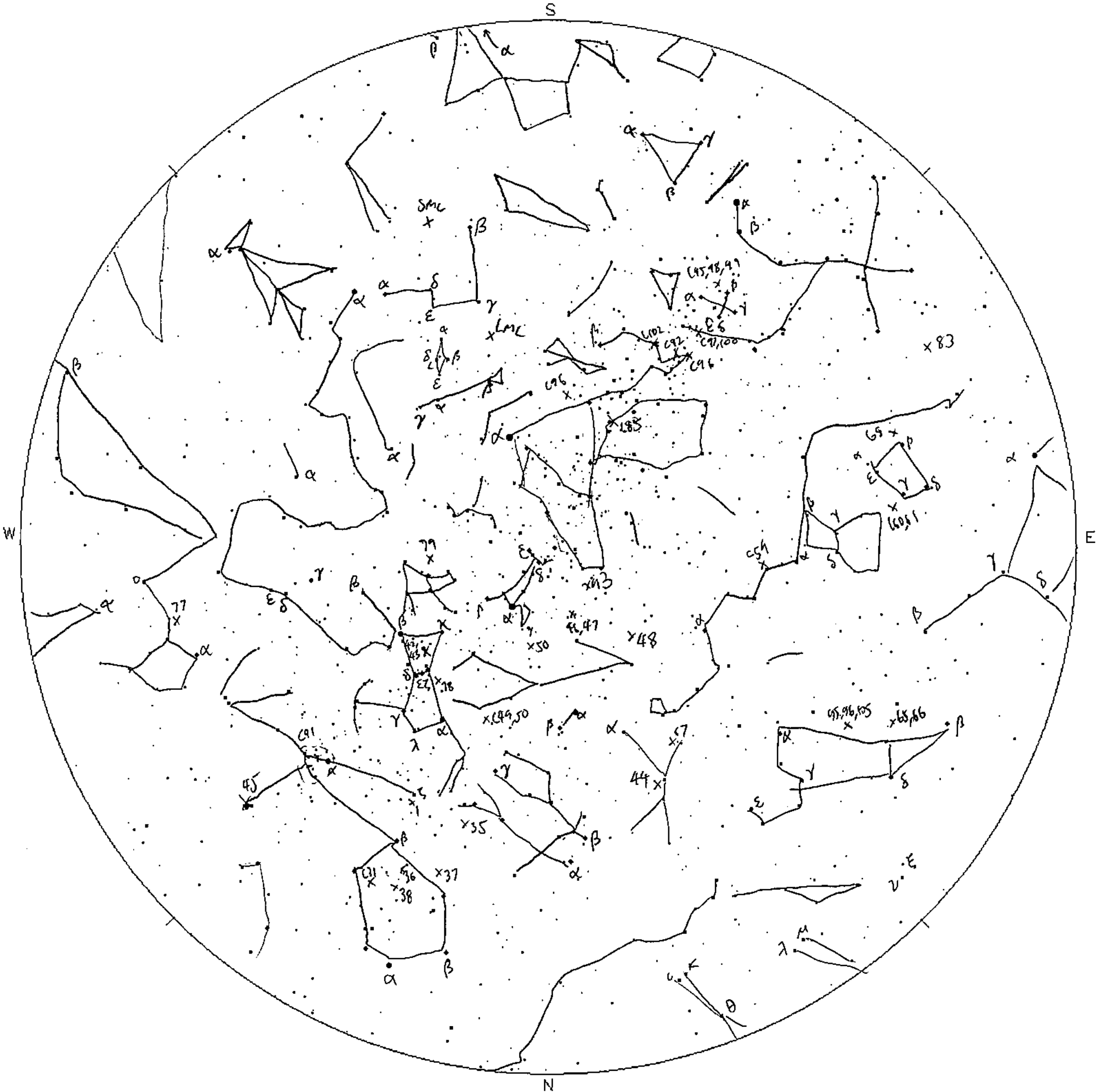
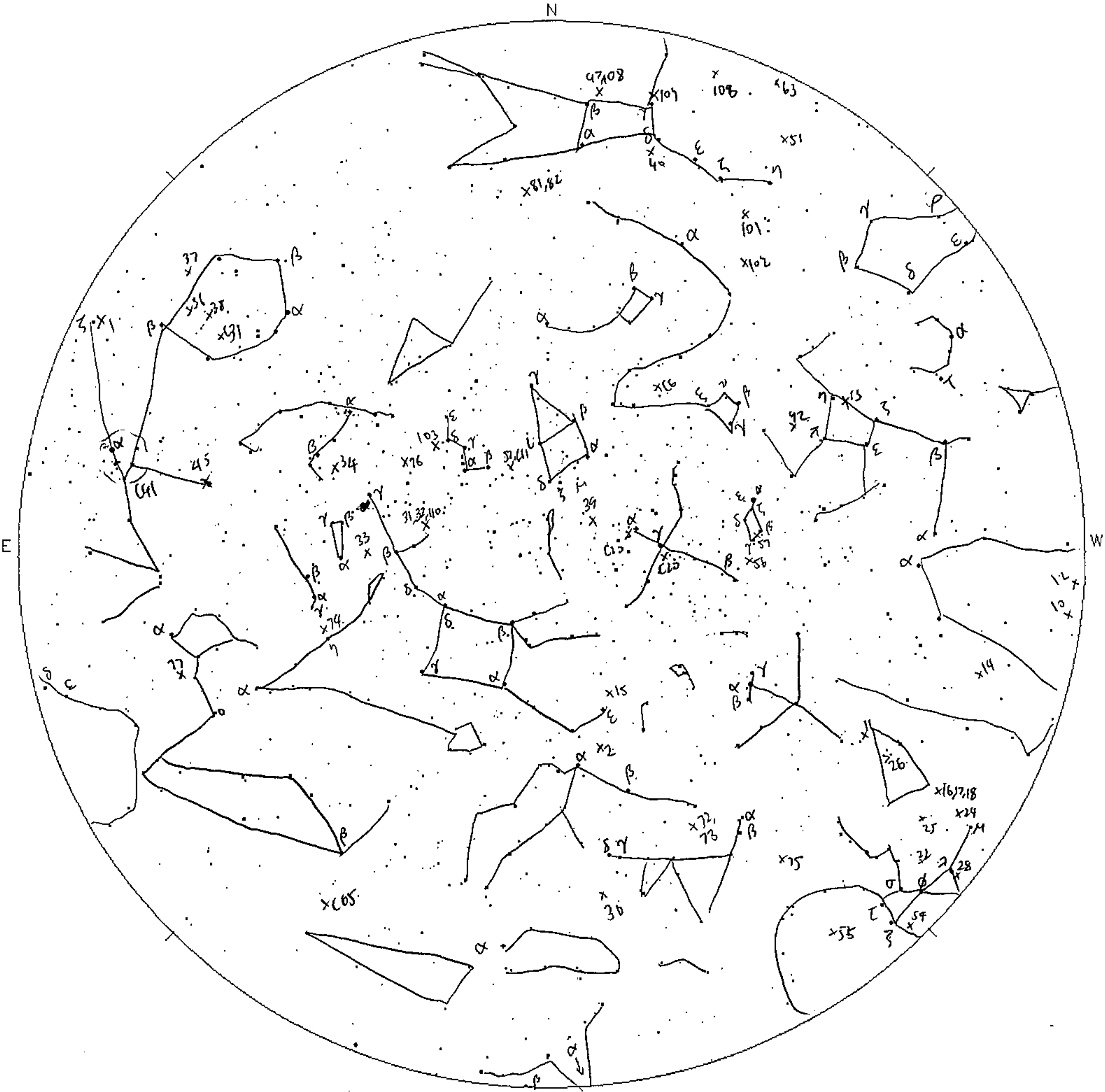
10
14


S
W
E
N
SCP
C96
C85
C102
C97
C93
C100
C95,98,99
C91
C80
C107
X79
41
42
43
X78
C59
68
C60,61
X104
46,47
X50
C49,50
X83
4
8
X67
44
95,96,105
X65,66
87
103
85
X53
60
C41
X1
X35
X37
X36
X38
C31
3
X106
X94
X63
X51
97,101
109
X40
X101
X102
X81,82
T
α
β
γ
δ
ε
ζ
η
θ
ι
κ
λ
μ
ρ


S
N
W
E
×30
×C65
×75
×55
×5MC
×C69
C76
×79
×C96
C102
C95,98,99
97,100
C92
C91
C85
C80
C77
×83
92,93
×78
×41
46,47
×93
50
C49,50
68
104
C60,61
×C59
95,96,105
×65,66
87
×22
25
×16,17,18
×24
×23
×28
19,20,21
×6
×9
×8a
10
12
107
×94
×C45
1000
950
900
850
00



but would you do this in Catalyzr camp?



rad $p = \frac{1}{3} n \langle \vec{v} \cdot \vec{p} \rangle$

$= \frac{1}{3} n \left(c \cdot \frac{E}{c} \right)$

$= \frac{1}{3} \frac{N}{V} E$

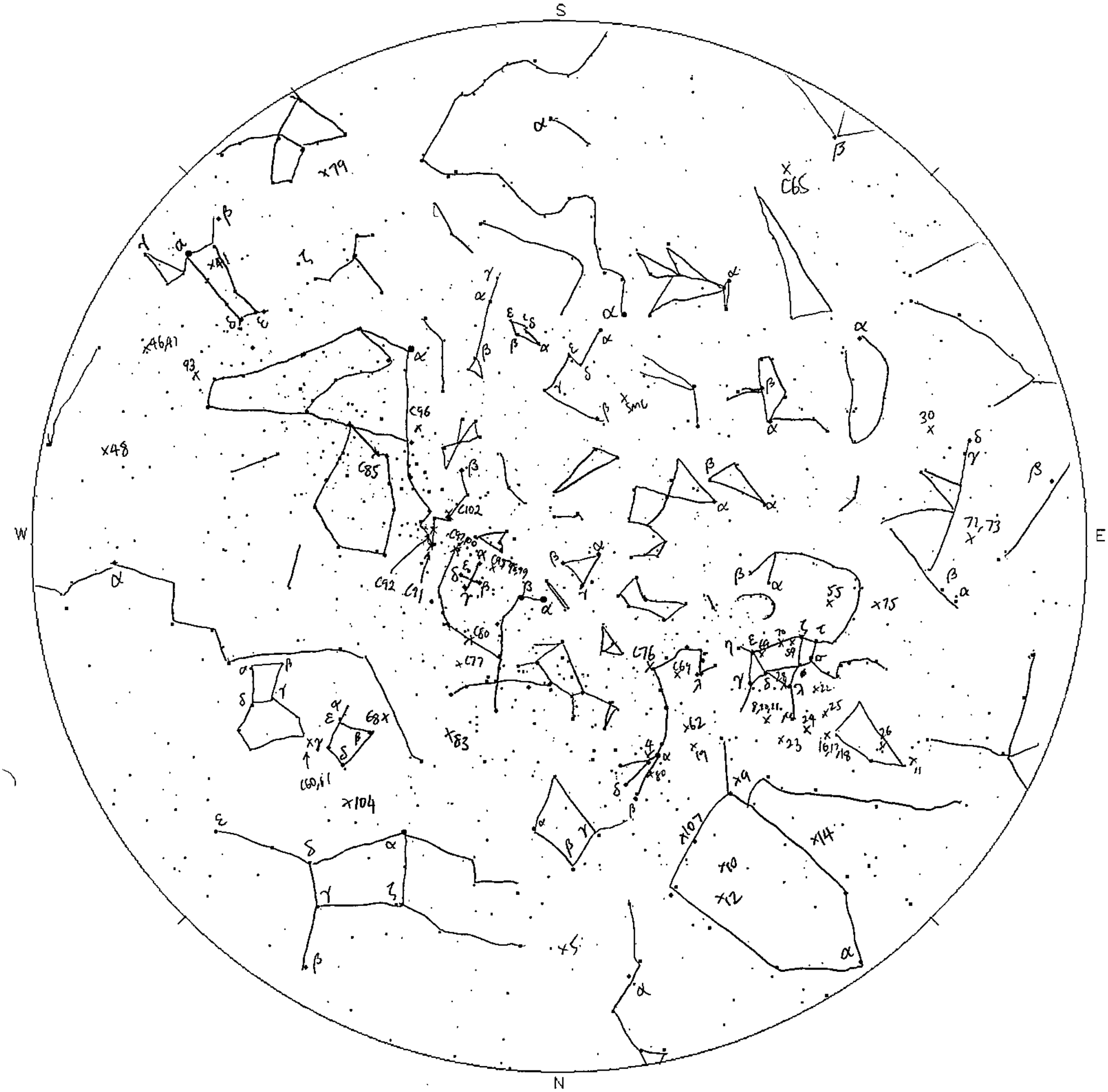
$= \frac{1}{3} \epsilon = \frac{1}{3} \rho c^2$

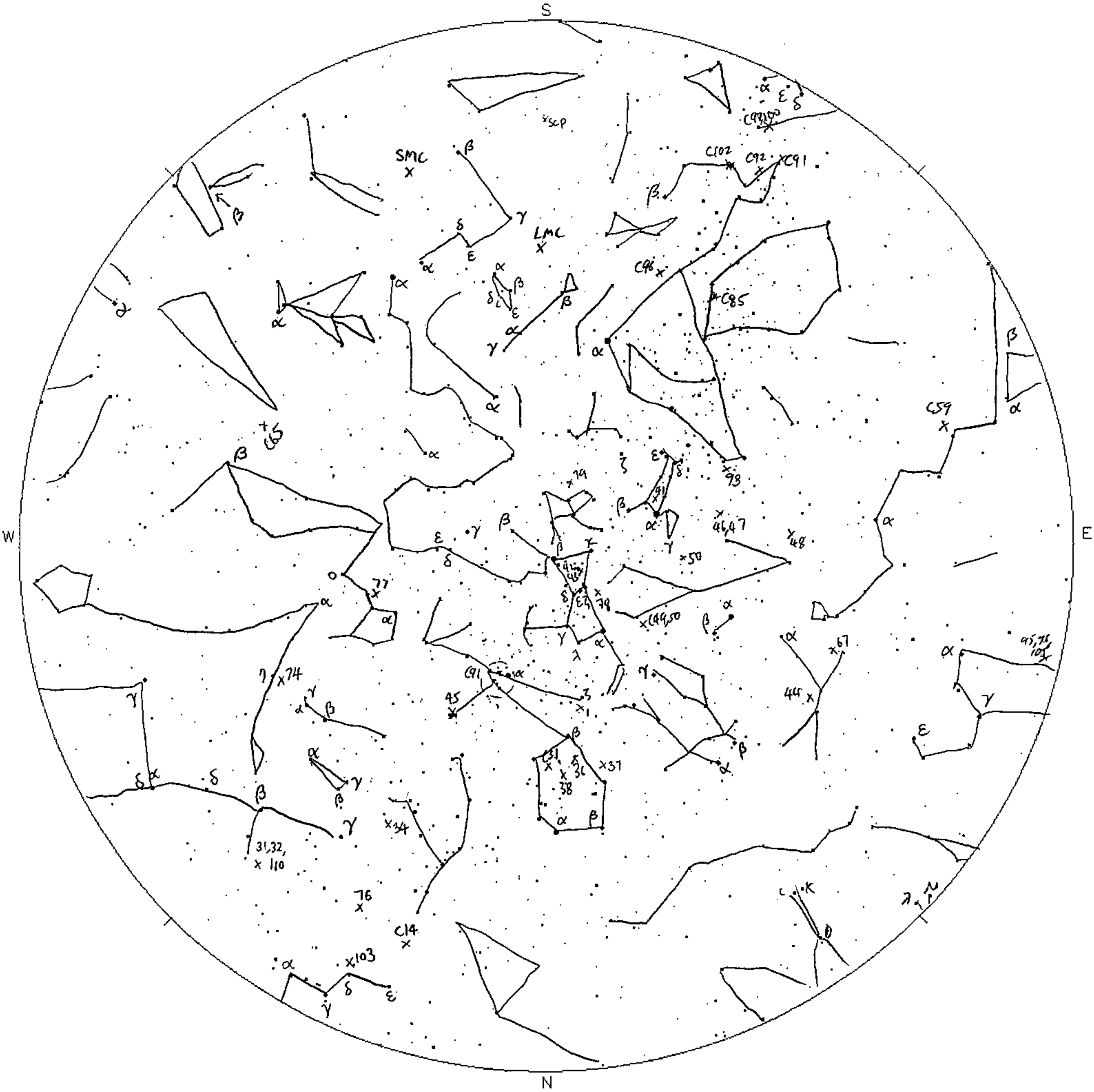
$\Rightarrow T_{\mu\nu} = \begin{bmatrix} \rho c^2 & 0 & 0 & 0 \\ 0 & \frac{1}{3}\rho c^2 & 0 & 0 \\ 0 & 0 & \frac{1}{3}\rho c^2 & 0 \\ 0 & 0 & 0 & \frac{1}{3}\rho c^2 \end{bmatrix}$

$w = \frac{1}{3}$

mat $p = 0 \Rightarrow T_{\mu\nu} = \begin{bmatrix} \rho c^2 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix}$ $w = 0$

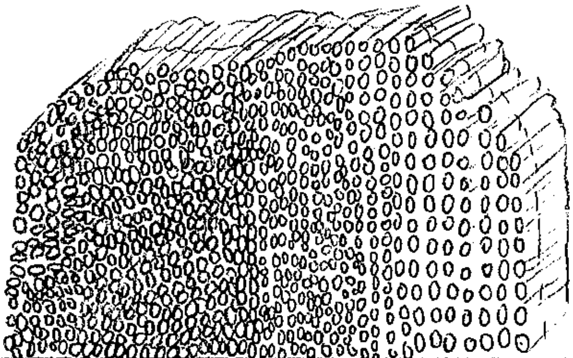
$\Lambda \dashrightarrow T_{\mu\nu} = \Lambda g = \begin{bmatrix} \rho c^2 & 0 & 0 & 0 \\ 0 & -\rho c^2 & 0 & 0 \\ 0 & 0 & -\rho c^2 & 0 \\ 0 & 0 & 0 & -\rho c^2 \end{bmatrix}$ $w = -1$

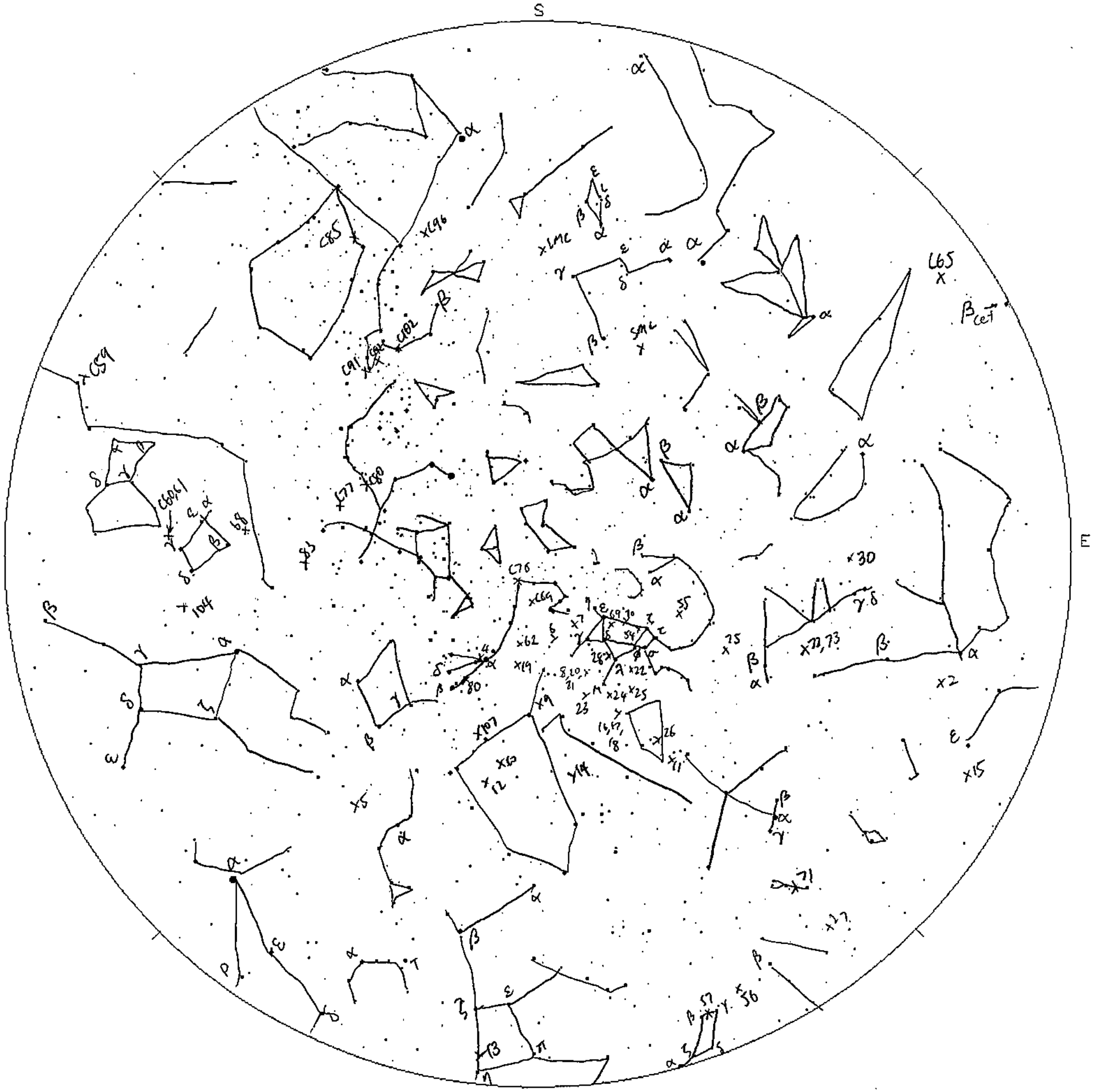

S
W
E
N
x79
x C65
β
α
γ
α
β
x41
ζ
δ
ε
x46,47
93 x
x48
α
C96 x
C85
γ
α
β
ε
ε
δ
β
α
ε
α
δ
γ
β
x SMC
α
α
β
α
30 x
δ
γ
β
71,73 x
β
α
β
α
55 x
x75
β
C102
C92
C91
C97,100
C93,98,99
ε
δ
γ
β
β
α
β
α
γ
C80
x C77
C76
C64
η
ε
70
ζ
τ
59
σ
γ
δ
78
λ
x22
8,10,11
x25
24
x23
16,17,18
26
x11
x62
x19
x9
x107
x14
x80
x12
α
α
δ
β
α
β
γ
x80
x83
α
β
δ
γ
α
ε
β
δ
68 x
x γ
C60,61
x104
ε
δ
α
γ
ζ
β
x5
α


S
W
E
N
SMC
LMC
x SCP
C102
C92
C91
C99,100
C96
C85
C59
C65
C91
C14
C31
x 79
x 77
x 78
x 74
x 34
x 76
x 103
x 110
31,32,
x 37
38
36
x 50
x 48
46,47
x 93
x 67
44
45
x 49,50
93,75,
105
x 3
x 1
41,42
α
β
γ
δ
ε
ζ
η
θ
κ
λ
ν

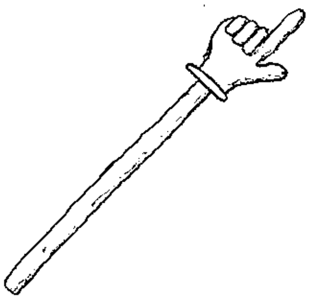
actually 743

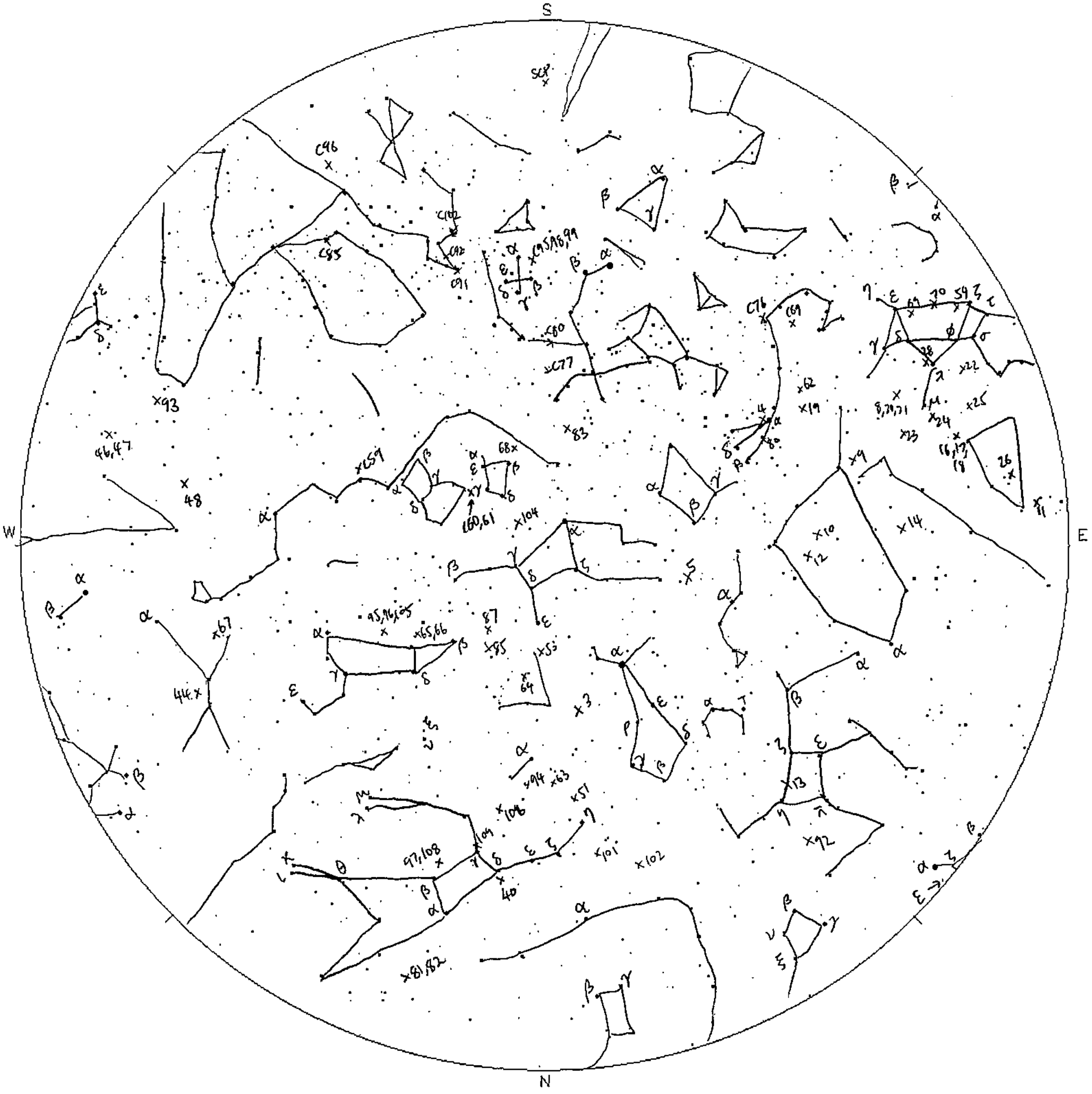
500 cigarettes



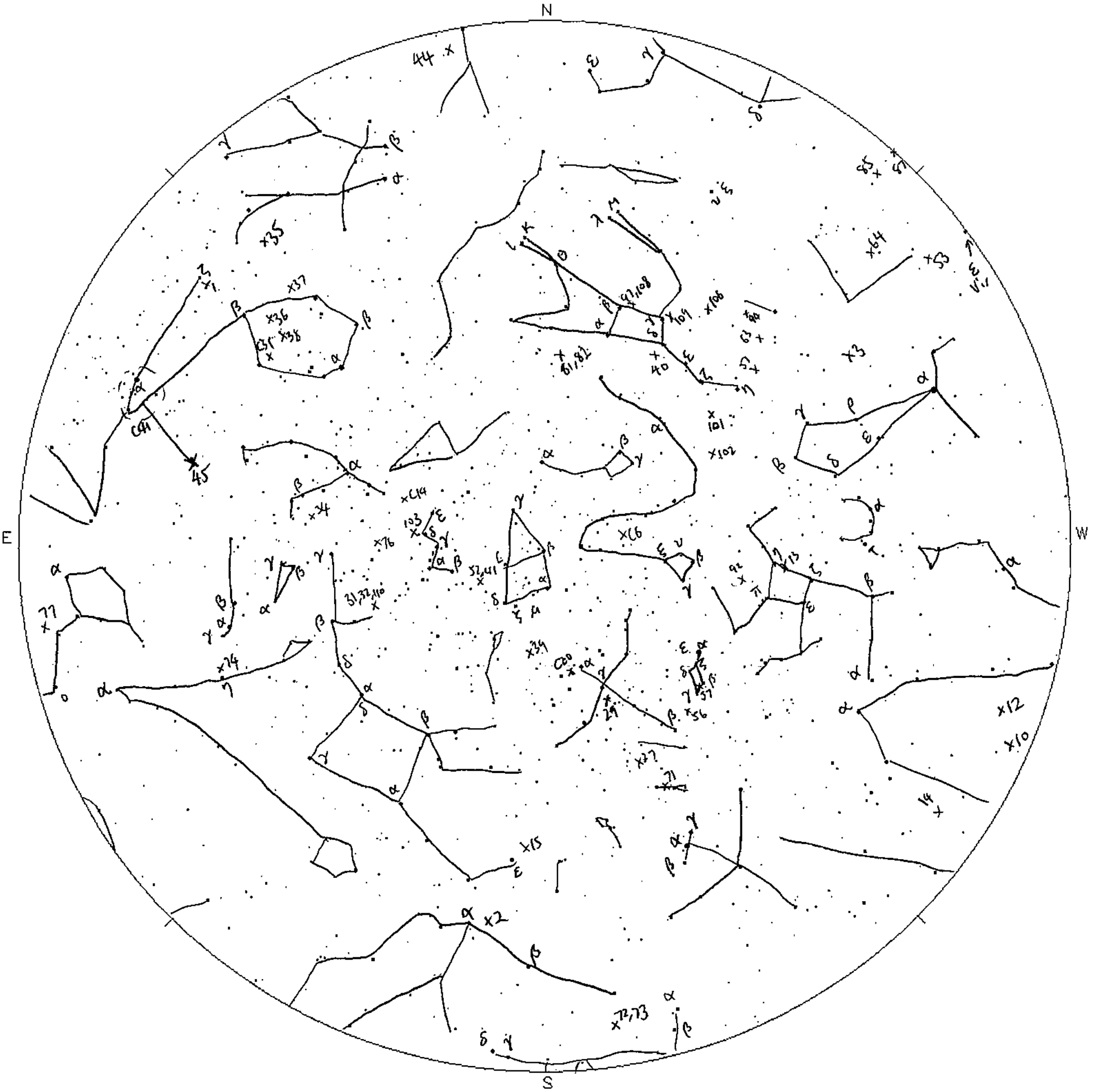


LTC
teaching
instrument



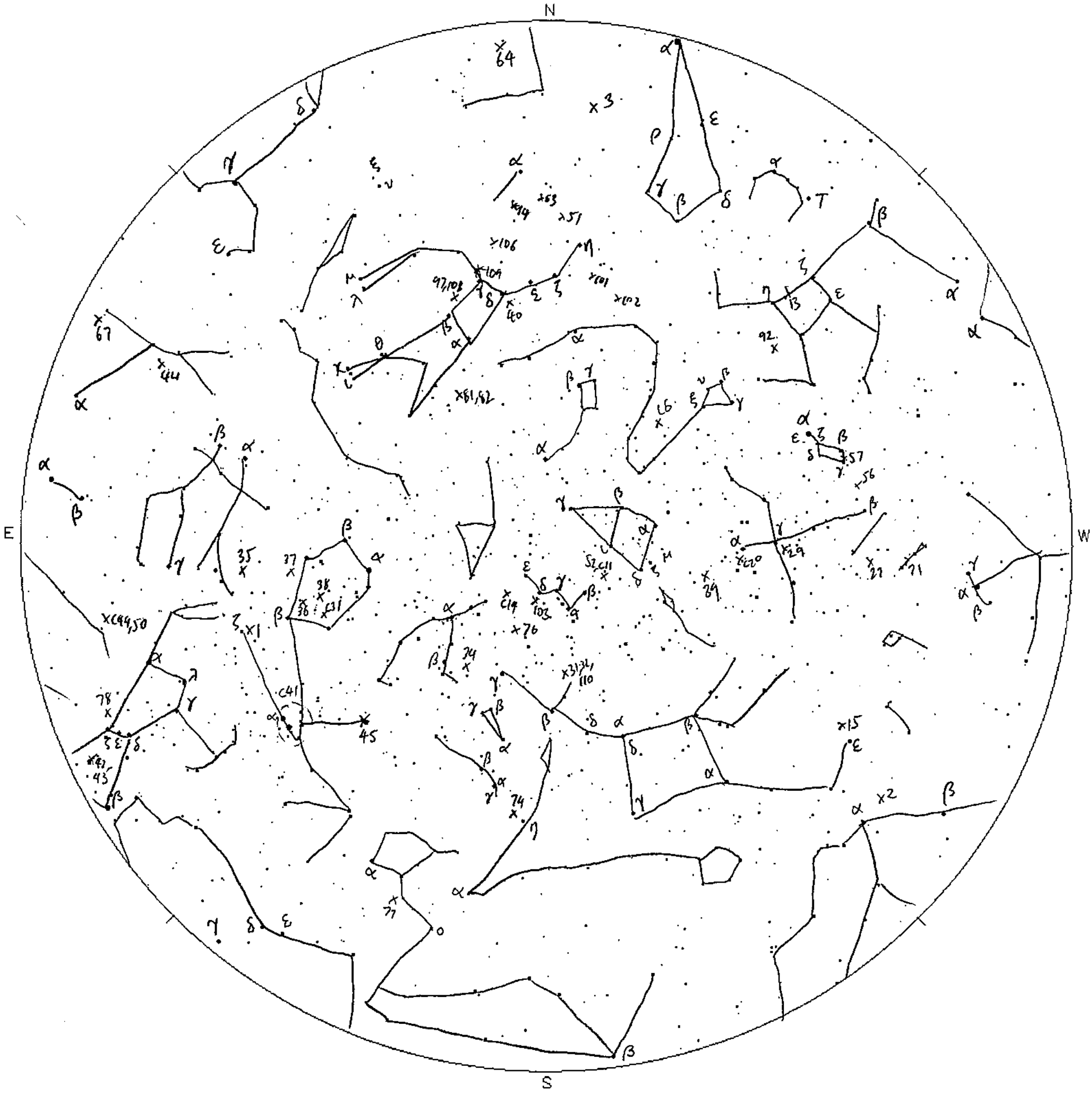


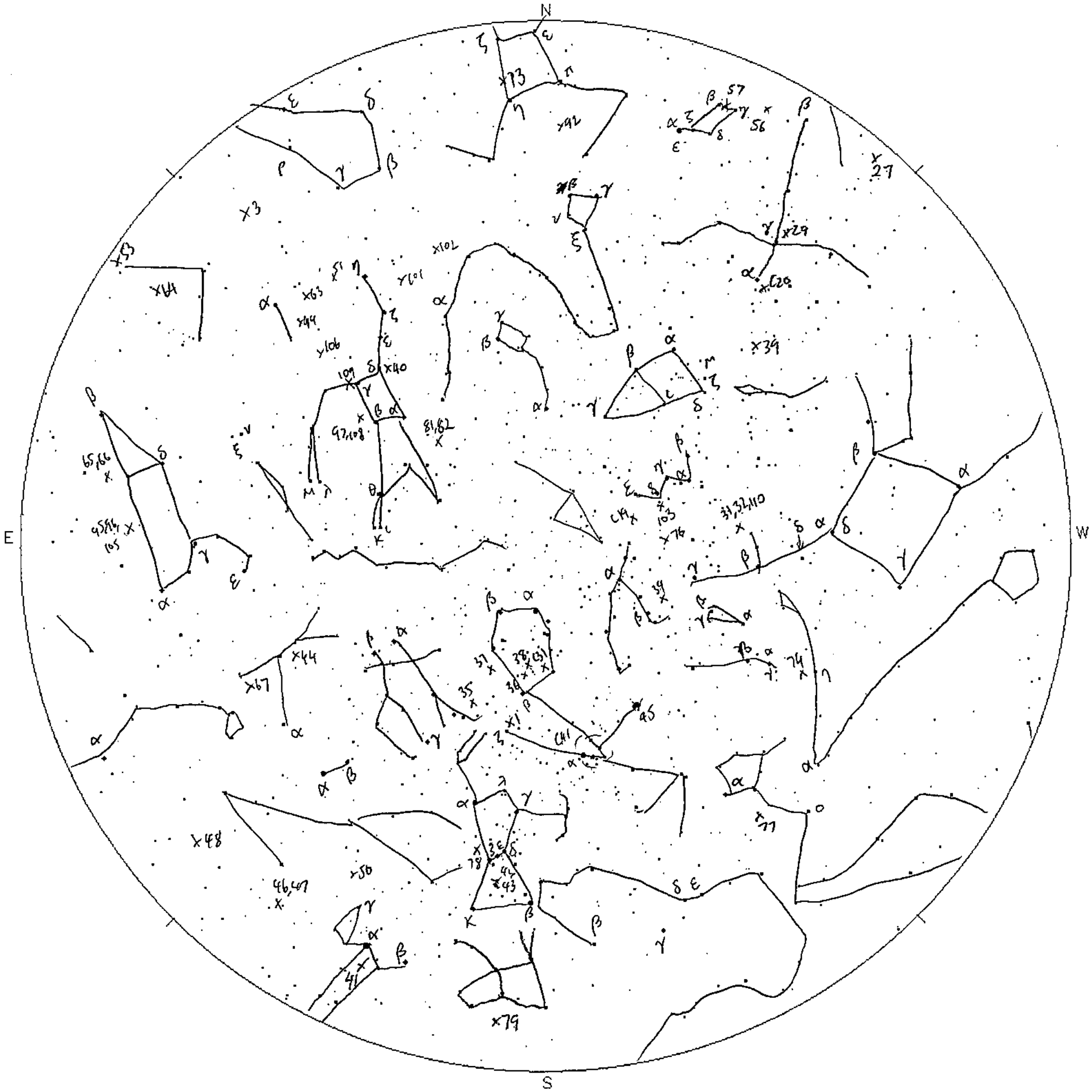
oh hey its
the fourth of July



95%

4/7/2024, 16:50


N
E
W
S
64
3
67
44
35
37
38
36
31
1
41
45
78
47
43
71
74
76
19
103
52
11
34
29
20
27
71
15
2
92
26
57
56
97
108
109
106
94
53
51
101
102
40
81, 82
49, 50
31, 32, 110


N
E
W
S
x73
x92
57
56
27
x3
x53
x44
x63
x51
x101
x102
x99
x106
109
x40
x29
C20
x39
65,66
45,56, 105
97,108
81,82
C14
103
x76
31,32,110
39
74
x67
x44
37
38
C31
35
36
x1
C41
45
x77
x48
46,47
x50
78
42
43
41
x79

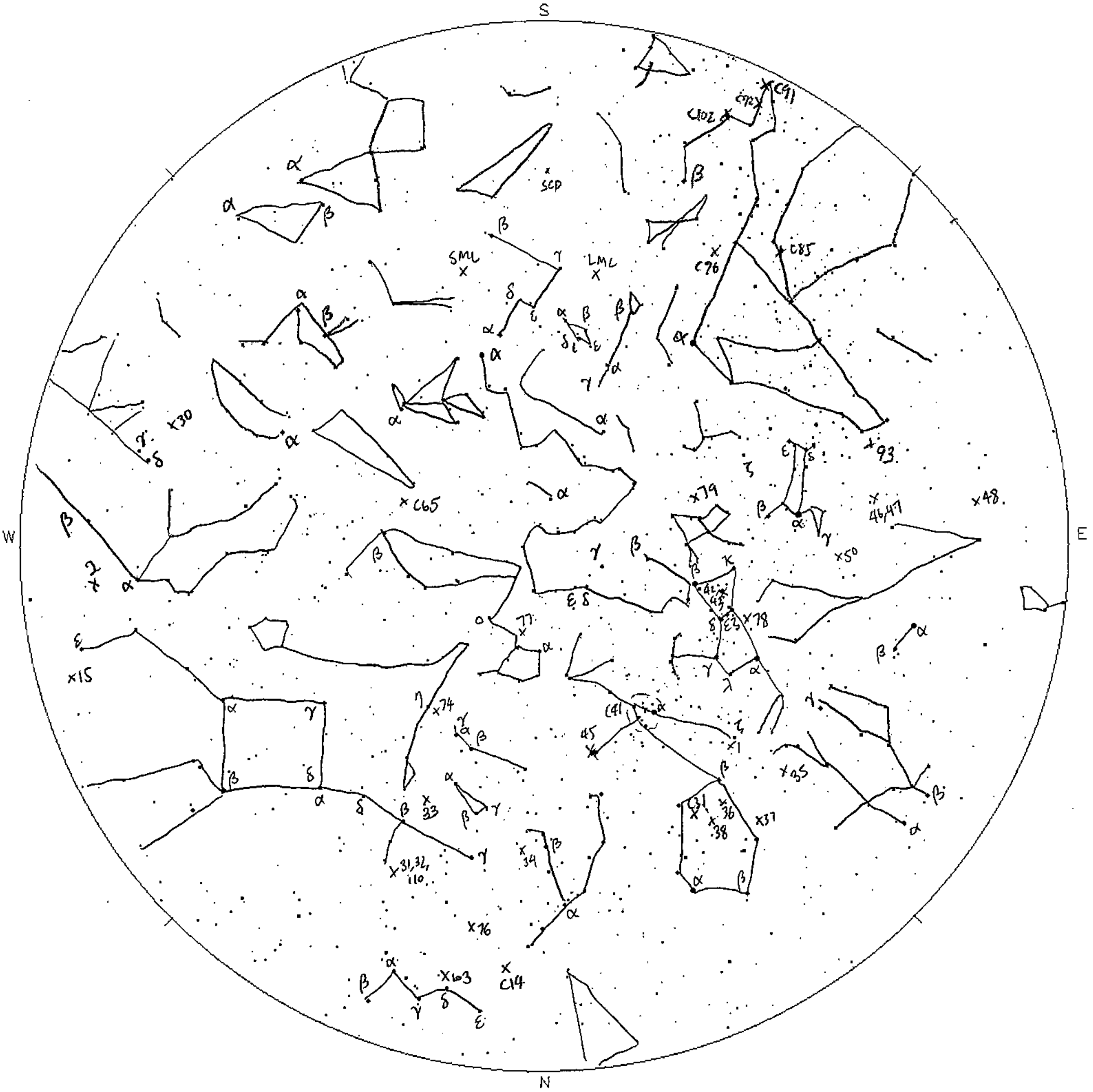
SPHL 2024

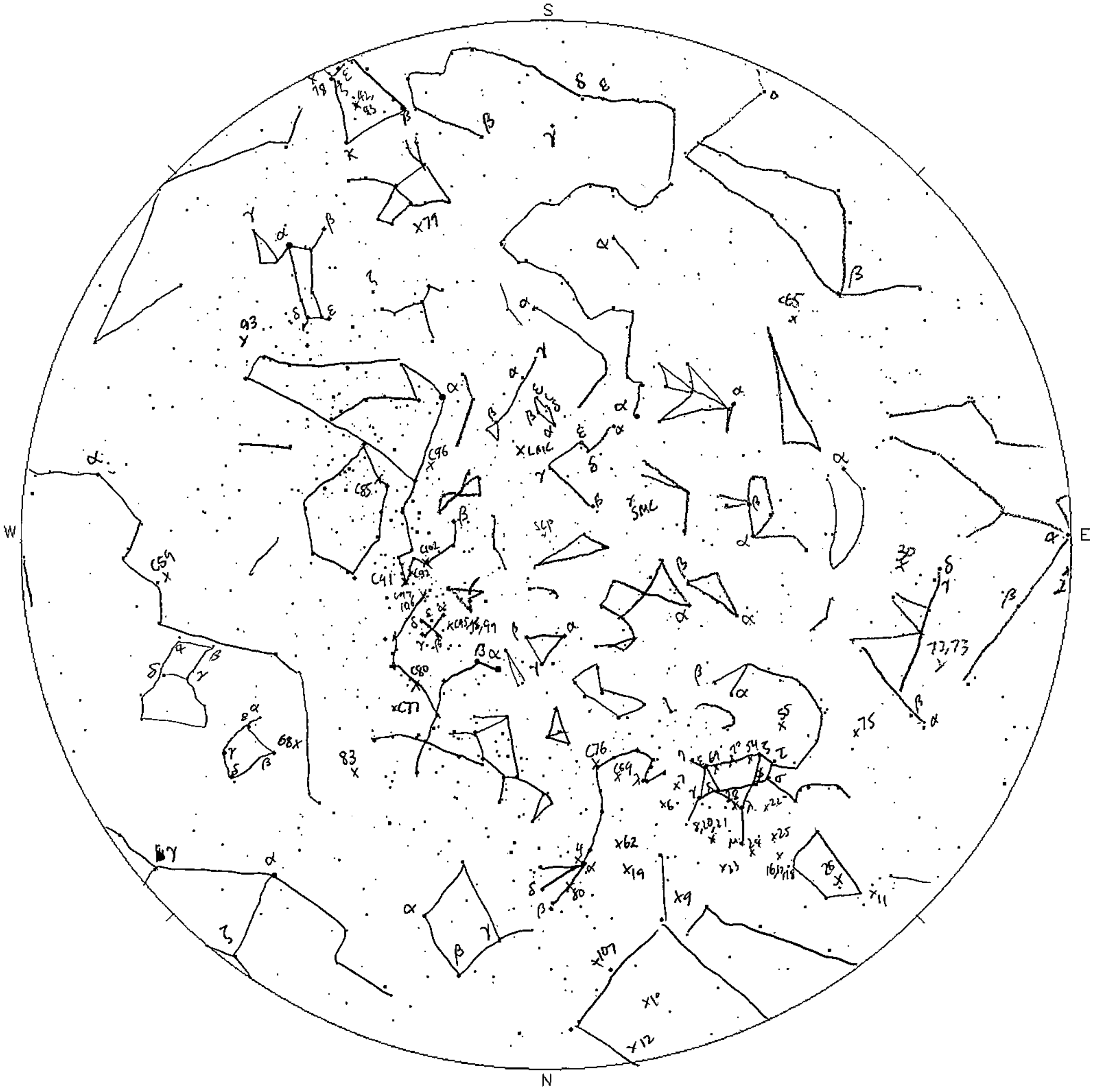
Real elements

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og

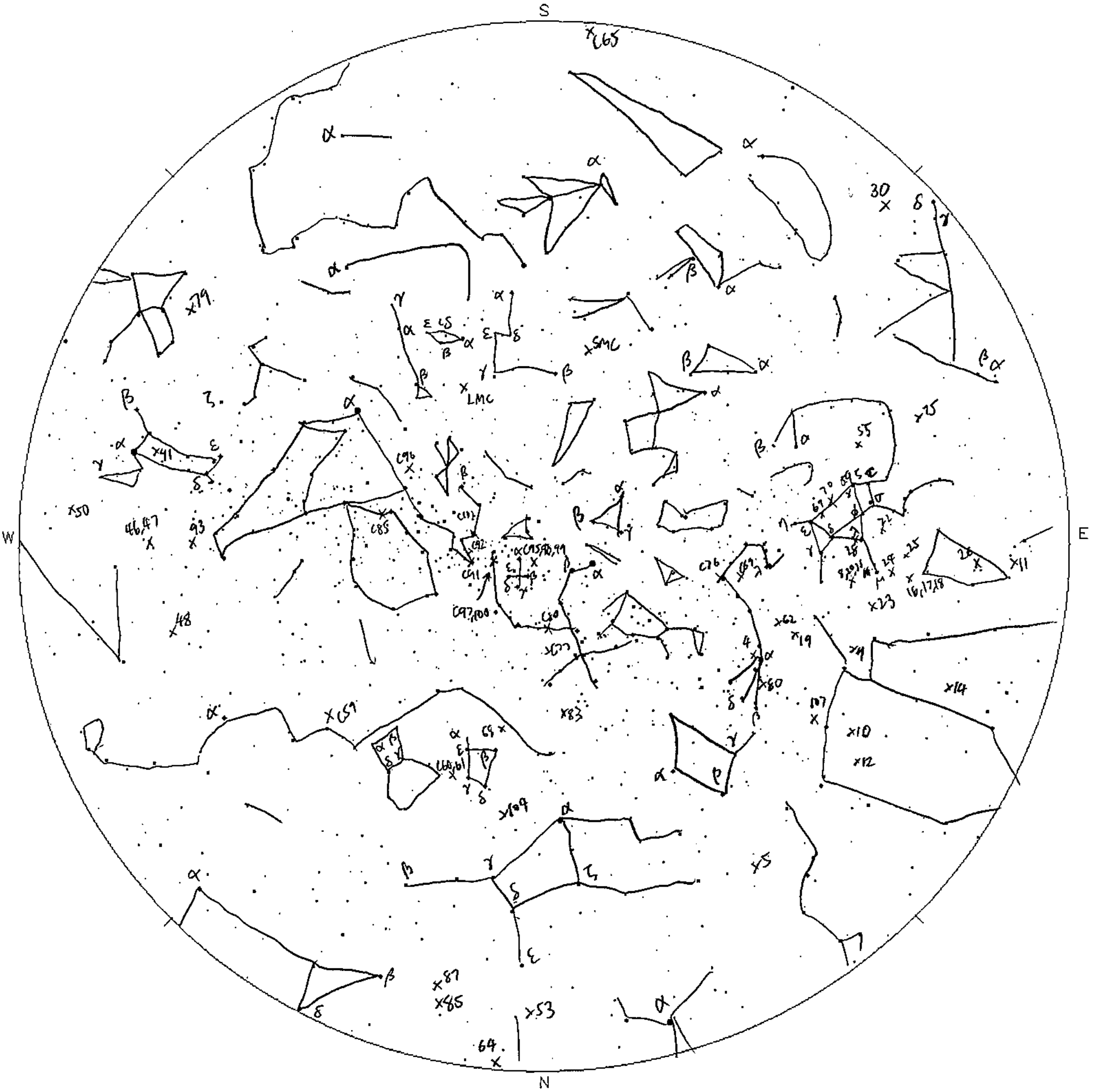
Mextal ~~Illnesses~~

La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

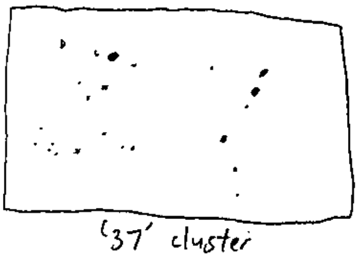

S
W
E
N
SCP
SML
LML
C91
C92
C102
C85
C96
β
α
α
β
β
γ
δ
ε
α
α
β
δ
ε
β
γ
α
α
α
x30
γ
δ
α
α
α
C65
93
ε
δ
ζ
β
α
γ
46,47
x48
x79
x50
β
2
α
β
γ
β
κ
ε δ
42,43
δ
ε
x78
α
ε
x15
77
α
α
β
γ
λ
α
γ
γ
η
x74
γ
α
β
C41
α
45
ζ
x1
x35
β
α
α
γ
β
δ
α
δ
β
x33
α
β
γ
β
γ
C31
x36
x38
x37
x34
β
x31,32,110
α
β
α
x76
β
α
x63
C14
γ
δ
ε



South pole map


S
C65
30
X79
SMC
LMC
C96
C85
C92
C91
C97,100
C95,98,99
C80
C77
C83
C76
55
X25
46,47
93
X50
X48
X41
X62
X19
X4
X80
107
X14
X10
X12
X11
26
X23
16,17,18
C59
C68
C60,61
X109
X5
X87
X85
X53
64
W
E
N

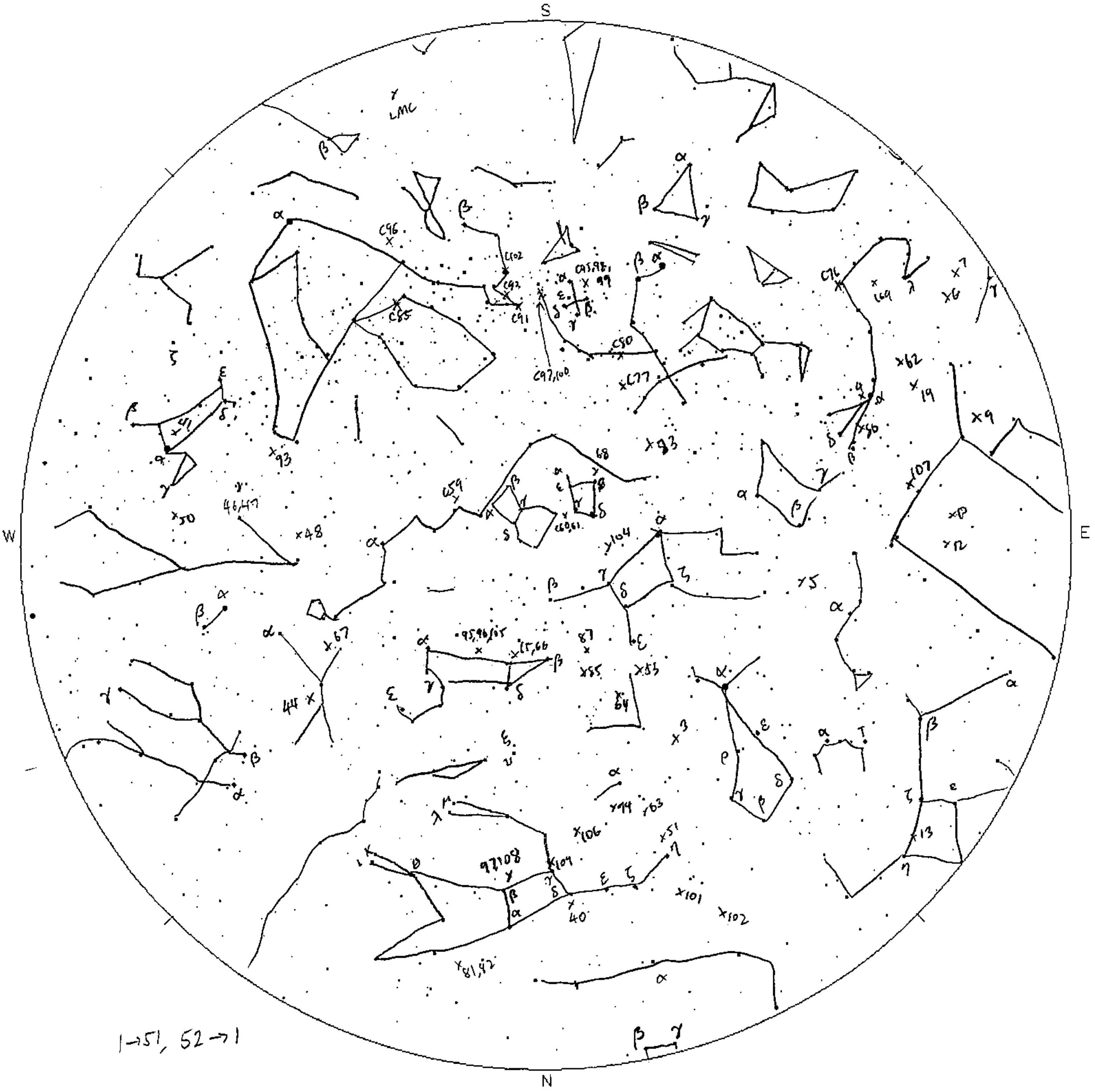
E nebula (Barnard 142 & 143)



'37' cluster

(Collinder 38, Collinder 83)

NGC 2169



1→51, 52→1

77, 67, 20, 84, 52, 8, 1, 97, 9, 84, 56

1 2 3
↕ ↕ ↕
4 , 5 , 6 :

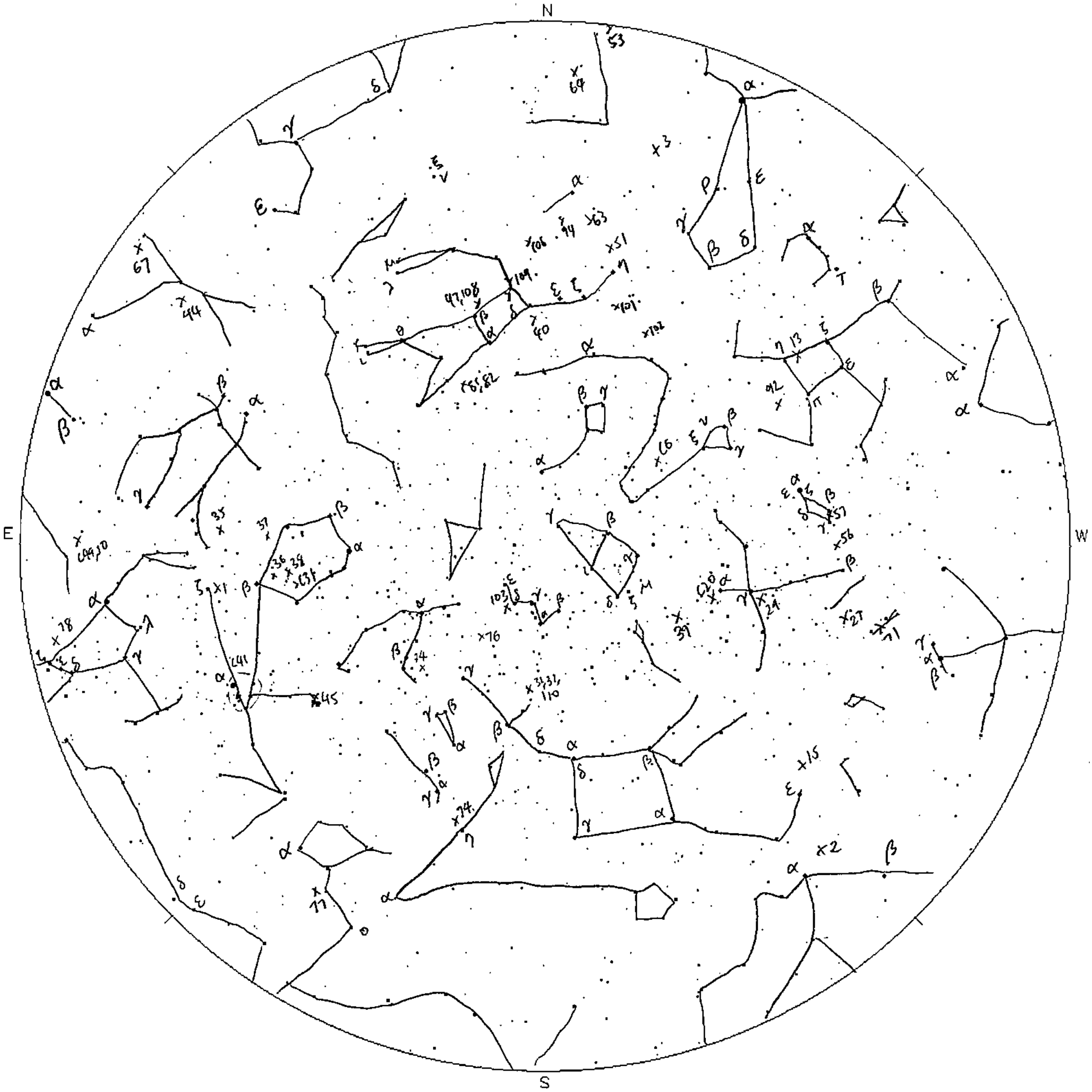
Same as prev. strategies, but now probabilistic based on the 'score' for each sign computed

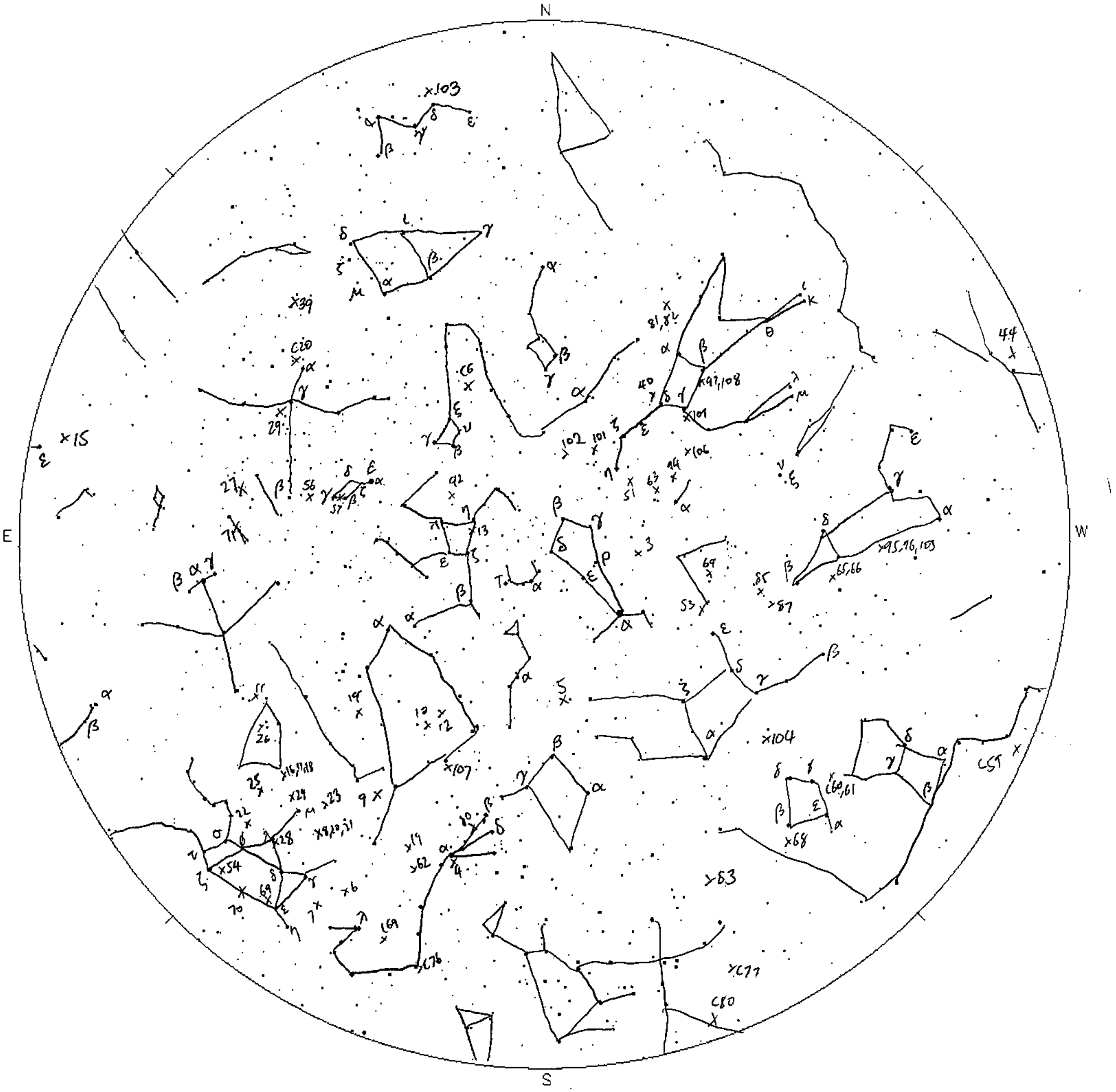
0:
RNG

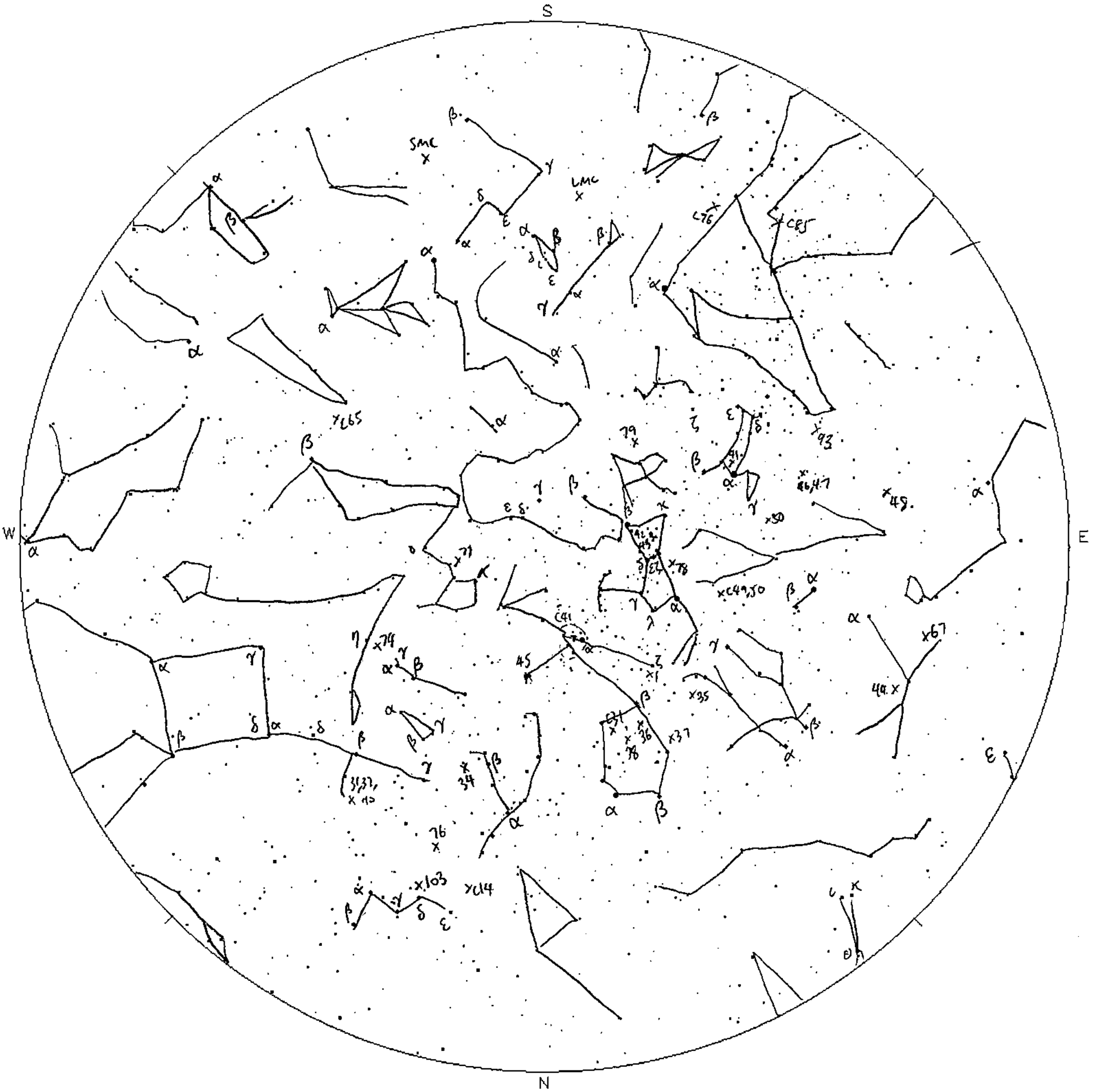
1:
Score for past played in list
Counts amt of times hand played
↳ Finds best sign to beat

2:
Same as 1, but after every round all scores multiplied by $\alpha<1$
⇒ prioritises recent throws

3:
Same as 1, but only considers most recent N signs


N
53
69
δ
γ
×3
ε
ξ
ν
α
ρ
ε
γ
×106
94
×63
μ
β
δ
α
67
×51
η
λ
×109
T
44
47,108
ξ
ξ
α
β
×101
β
θ
δ
γ
40
ι
α
×102
η
13
ξ
×85,82
α
ε
α
α
β
γ
42
π
α
β
β
α
α
×16
ξ
ν
β
γ
γ
α
ε
ξ
β
35
37
β
γ
δ
×57
E
α
γ
×56
W
44,10
36
×38
×131
γ
β
ξ
×1
β
ι
α
103
ε
δ
γ
β
δ
ξ
μ
120
α
γ
×24
×27
×71
α
×78
λ
ι
ε
δ
γ
×76
39
24
γ
α
β
141
α
×45
γ
×31,37,110
γ
β
α
β
δ
γ
β
α
β
δ
α
β
×15
γ
α
ε
×74
δ
γ
α
α
η
×2
β
α
δ
ε
77
α
S


N
E
W
S
x103
α
β
γ
δ
ε
ι
ζ
μ
x39
C20
29
x15
27
71
56
57
C6
92
x13
81,82
40
x97,108
x101
102
101
51
63
94
x106
x3
44
x95,96,103
x65,66
69
53
85
x87
19
10
x12
x107
26
x16,17,18
25
22
x24
x23
x28
x9,20,31
9
x54
70
69
x6
7
x19
x62
80
x4
C69
C76
x104
C60,61
x68
C57
x83
C77
C80

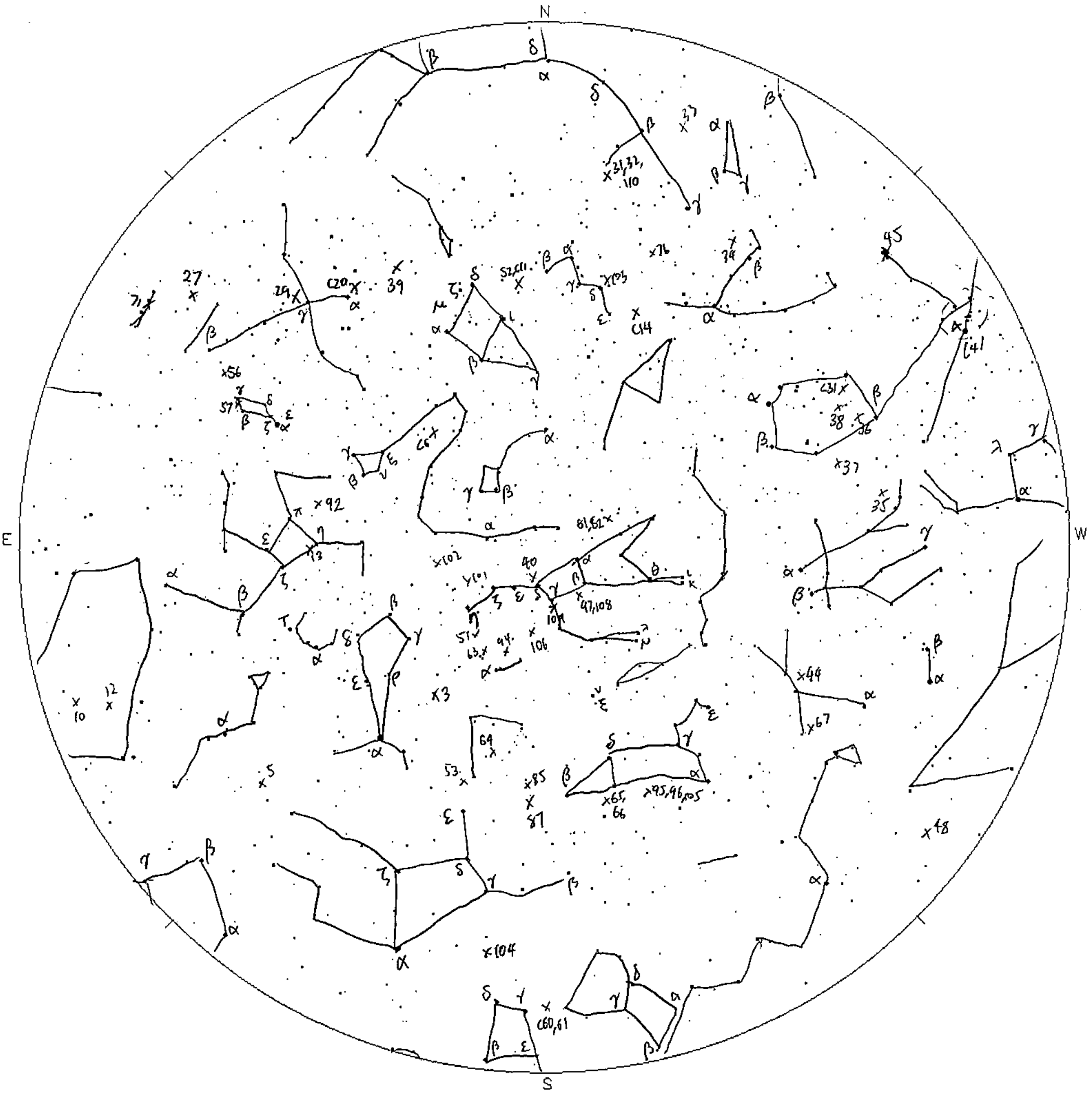


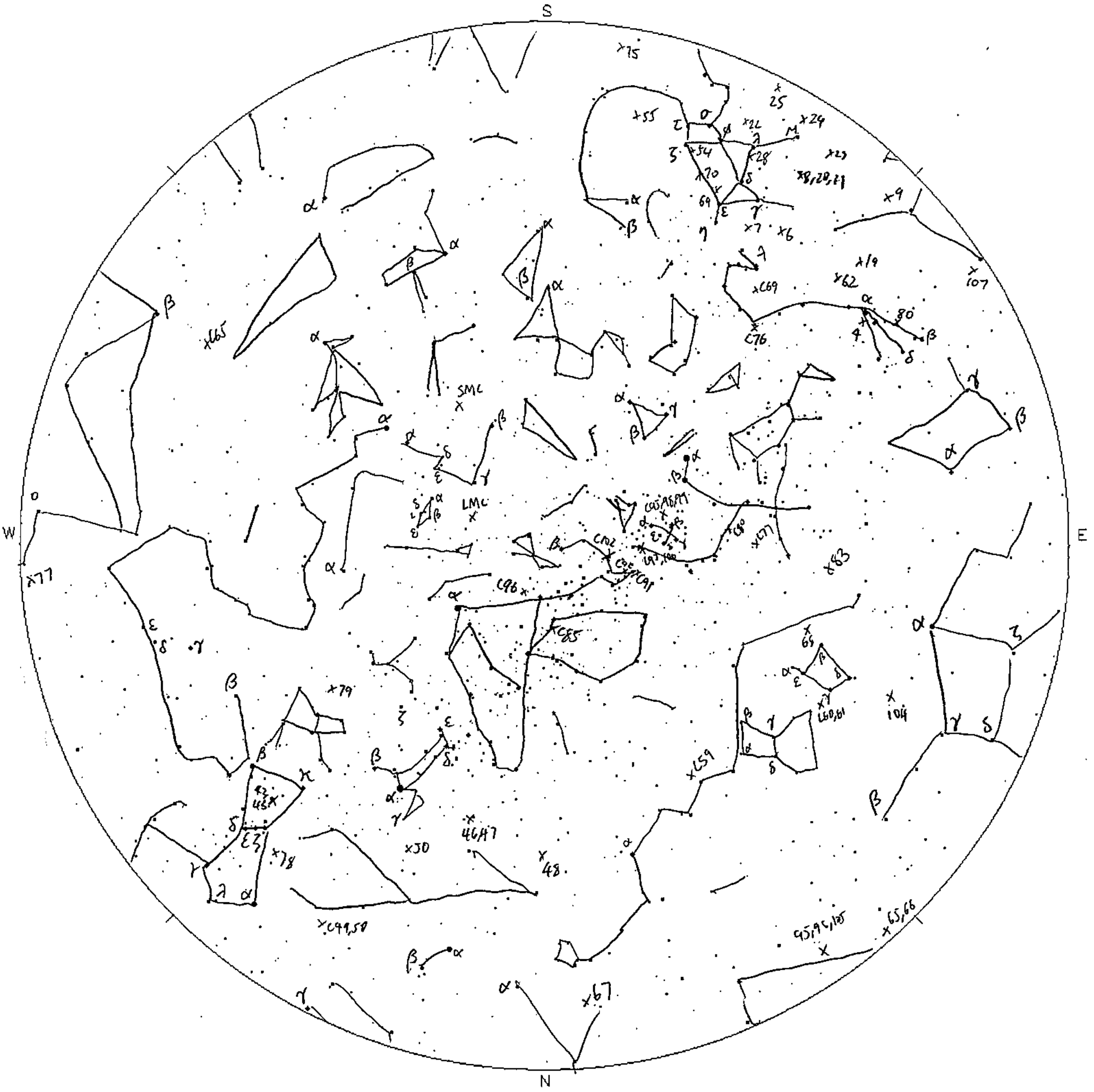
31^2(!)

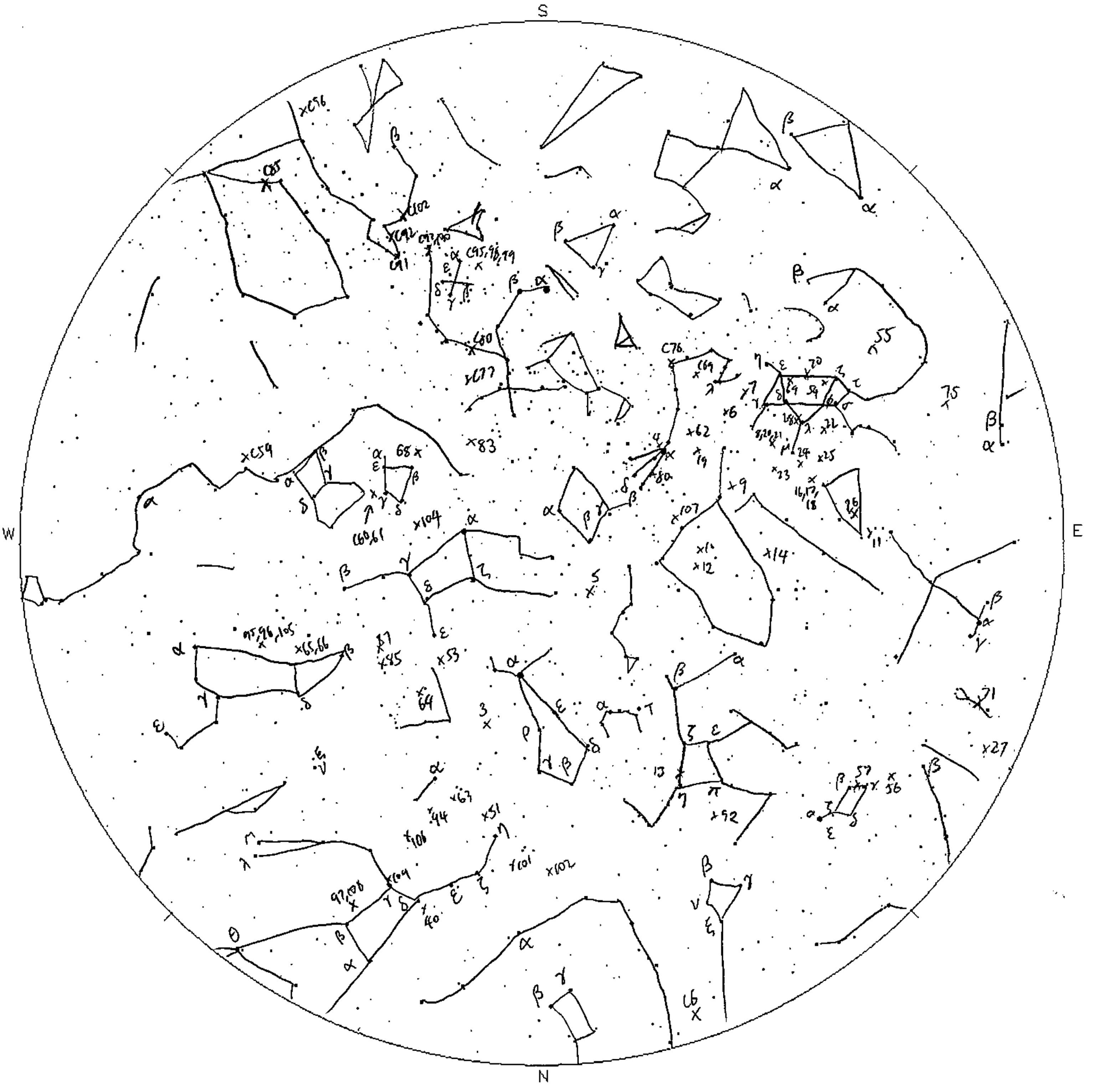
Last square number before 1000

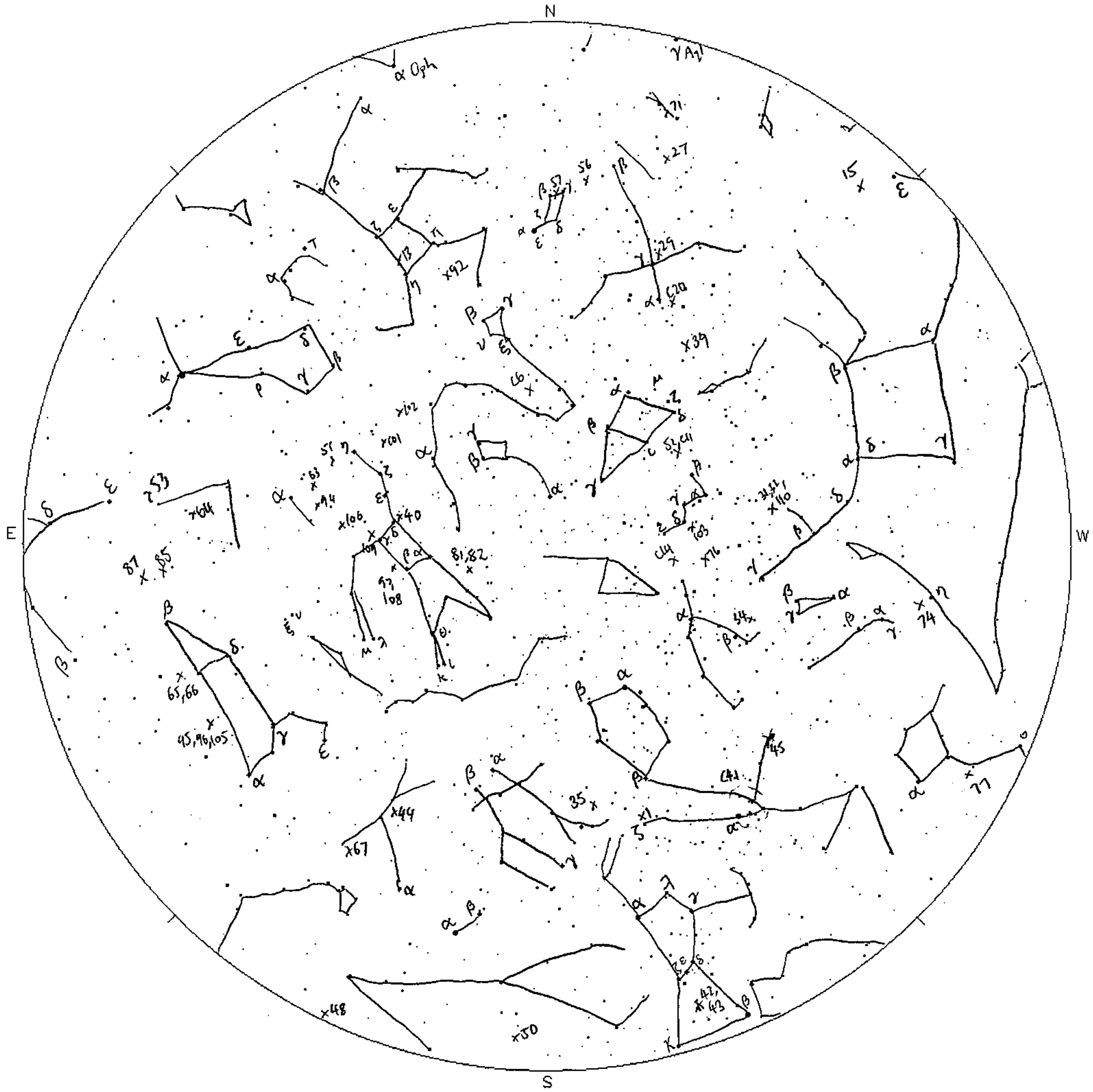
$(32^2 = 1024 > 1000)$

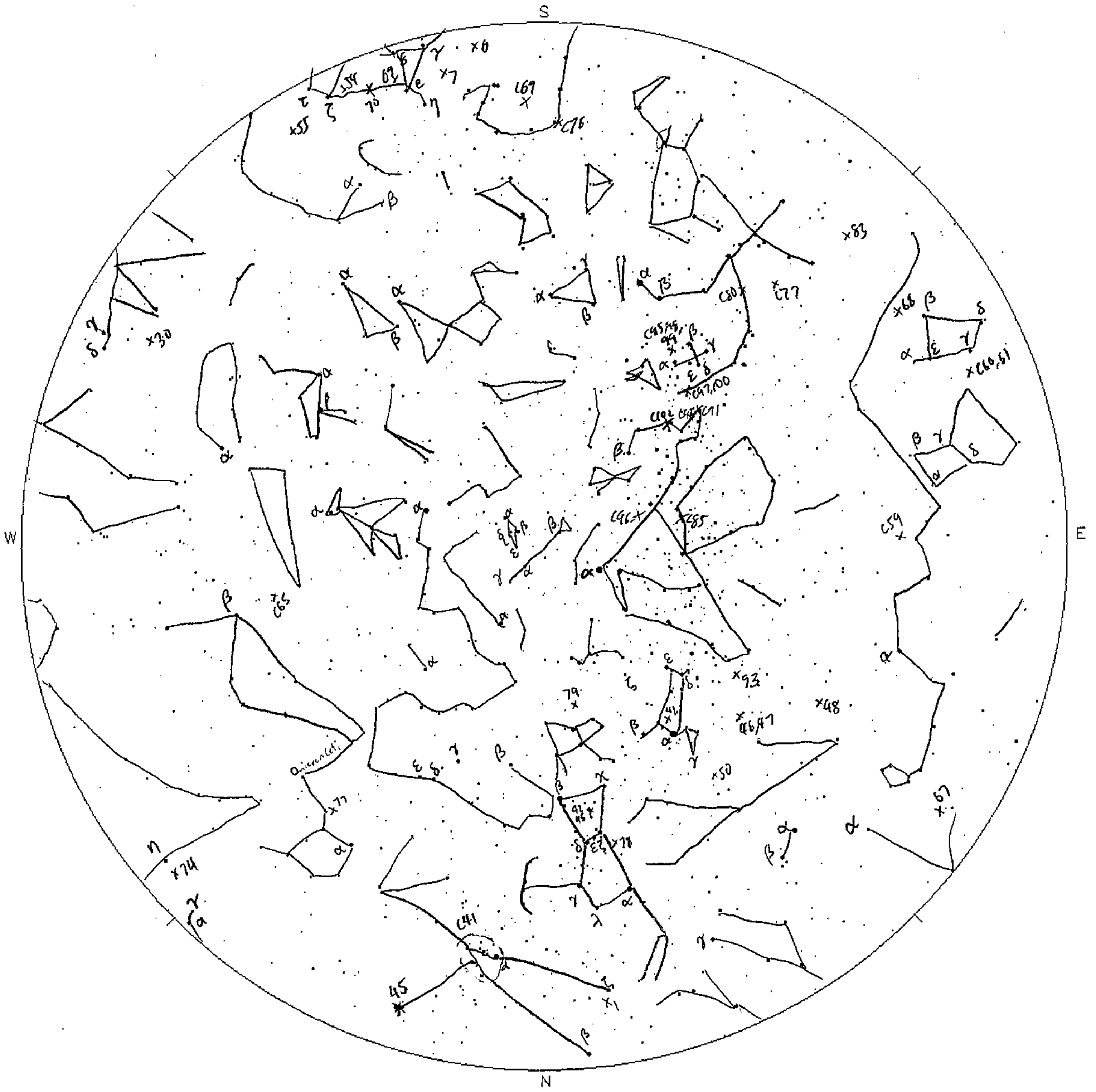
961


N
E
W
S
δ
α
β
δ
β
γ
x 37
α
β
γ
β
x 31,32,110
x 76
x 34
β
α
45
x C41
α
27
71 x
29 x
C20 x
39
γ
β
α
δ
ζ
μ
α
ι
β
γ
52,C11 x
β
α
γ
δ
ε
x C103
x C14
x 56
57 x
γ
δ
β
ζ
ε
α
γ
β
ν
ε
C6 x
α
γ
β
α
C31 x
38 x
36
β
x 37
x 92
π
ε
η
13
ζ
α
β
α
81,82 x
x 102
x C101
40
η
ζ
ε
δ
γ
β
α
x 47,108
104
θ
ι
κ
λ
μ
γ
λ
α
35
γ
α
β
β
α
τ
α
δ
β
γ
ε
ρ
α
51 x
63 x
94 x
x 106
α
x 3
x 44
α
x 67
ν
ξ
ε
γ
δ
β
α
x 65, 66
x 95,96,105
x 10
12 x
α
x 5
64 x
53 x
x 85
x 87
x 48
ε
ζ
δ
γ
β
γ
β
α
α
α
x 104
δ
γ
x C60,61
β
ε
δ
γ
α
β

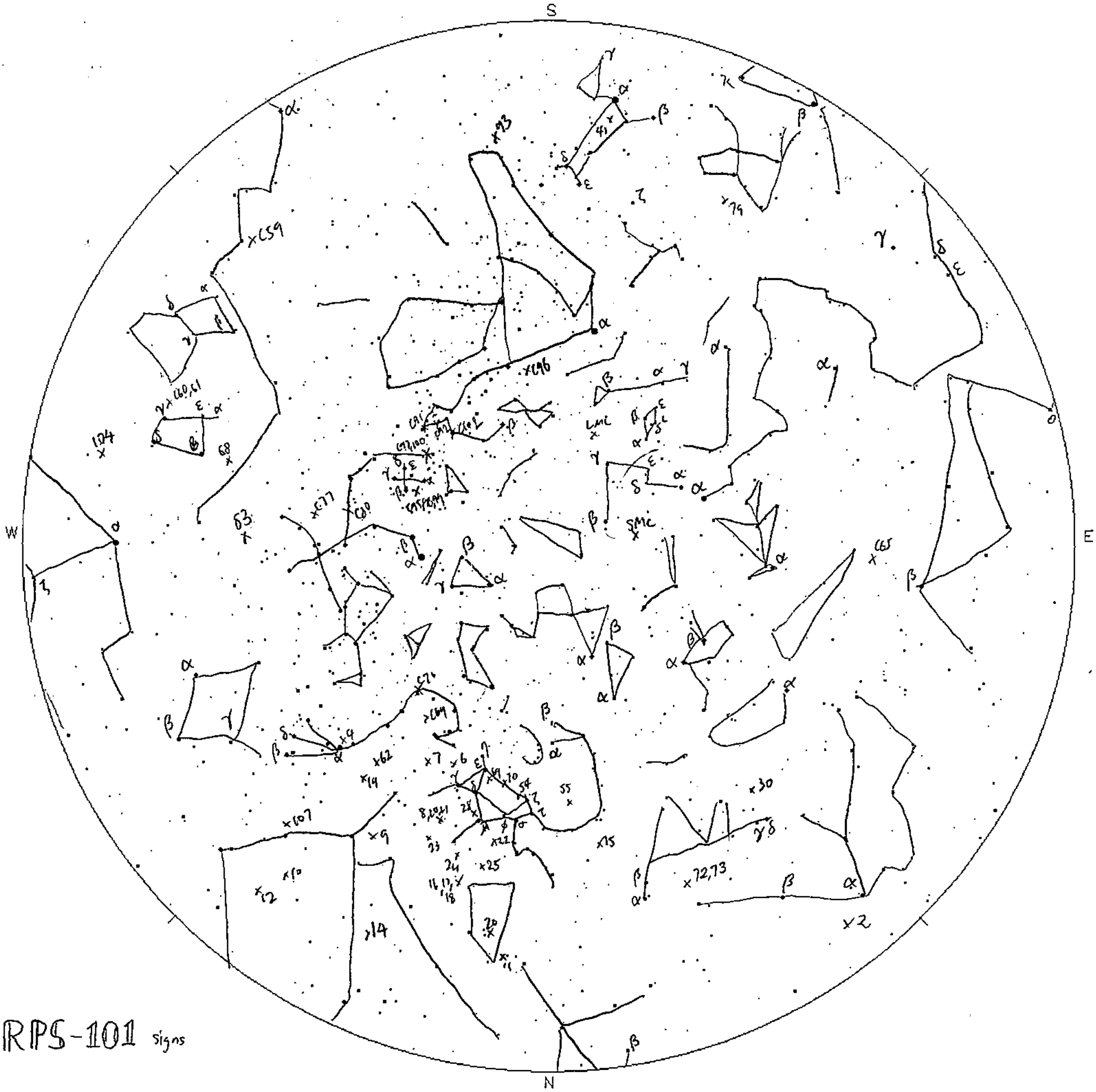

S
N
E
W
SMC
LMC
x15
x25
x55
x22
x24
x23
x54
x28
x70
69
x8,20,21
x9
x7
x6
x19
x62
x107
x69
x76
80
x65
C96
C85
C102
C80
x77
x83
x79
42
43
x78
x59
65
x7
C60,61
x104
x50
46,47
x48
x99,50
95,96,105
x65,66
x67
x77
α
β
γ
δ
ε
ζ
η
λ
κ
σ
τ


S
W
E
N
xC56
C85
xC102
xC92
C91
C93,100
C95,98,99
x80
xC77
x83
C76
C69
55
75
xC59
68
C60,61
x104
x107
x9
x11
x12
x14
x62
x19
x80
x6
x7
x20
x22
x23
x24
x25
x26
x18
16,17,18
5
95,96,105
x65,66
87
x85
x53
64
3
x67
x44
x51
x101
x102
x106
97,108
x109
40
x92
13
57
56
71
x27
C6

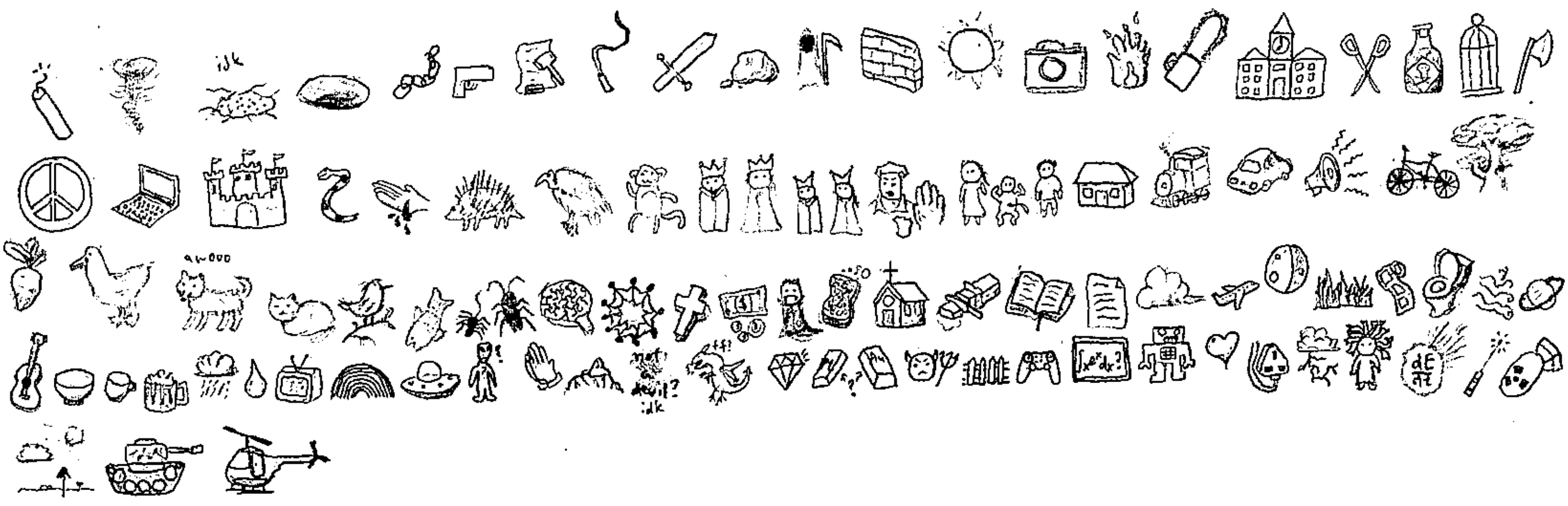

N
γ Aql
α Oph
x71
x27
15 x
ε
α
β
ζ
ε
π
β
η
x92
β 57
γ
56
β
α
ε
δ
γ
x29
α
C20
x39
τ
α
ε
δ
β
γ
ρ
α
β
γ
ν
ξ
C6 x
α
μ
ζ
δ
β
ι
53 C11
γ
α
β
δ
γ
α
E
δ
ε
γ 53
x64
α
x94
x102
x101
57
η
ζ
ε
x40
x106
x
γ
δ
β
α
81,82
x
97
108
θ
μ
λ
ι
κ
ξ υ
87
85
β
δ
65,66
95,98,105
γ
α
ε
β
α
x110
β
δ
γ
β
α
ε
δ
C14 x
x76
γ
β
α
x
74
β
α
γ
34x
α
β
η
W
β
α
β
x45
C41
α
x
77
β
α
35 x
x1
ζ
α
x44
x67
α
α
β
α
λ
γ
ε
δ
x47,43
β
κ
x48
x50
S

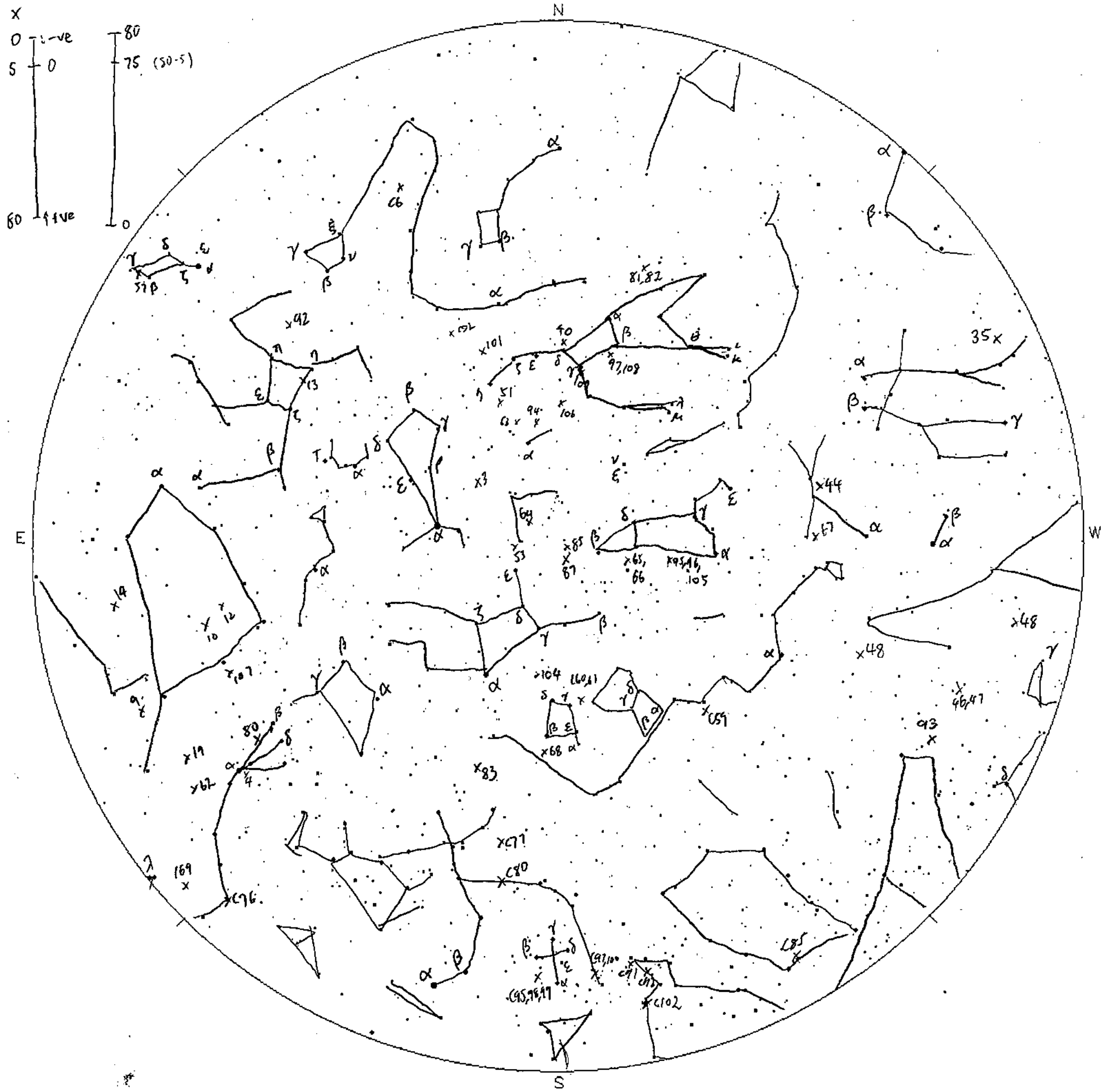


αβγδεζηθικλμνξοπρστυφχψω
Α ΒΓΔΕΖΗΘΙΚΛΜΝΞΟΠΡΣΤΥΦΧΨΩ



RPS-101 signs




x
0 i-ve
5 0
60 five
80
75 (50-5)
0
N
E
W
S
α
β
γ
δ
ε
ζ
η
θ
ξ
x66
81,82
x92
x101
x102
90
97,108
x13
x3
64
53
x85
87
x65, 66
x95,96, 105
35x
x44
x67
x48
x48
46,47
93
x14
x10
12
x107
x19
x62
80
4
x104
60,61
x68
x83
x77
c80
c59
c85
c76
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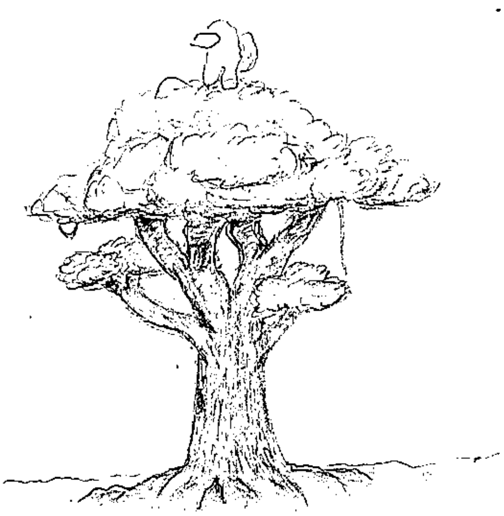
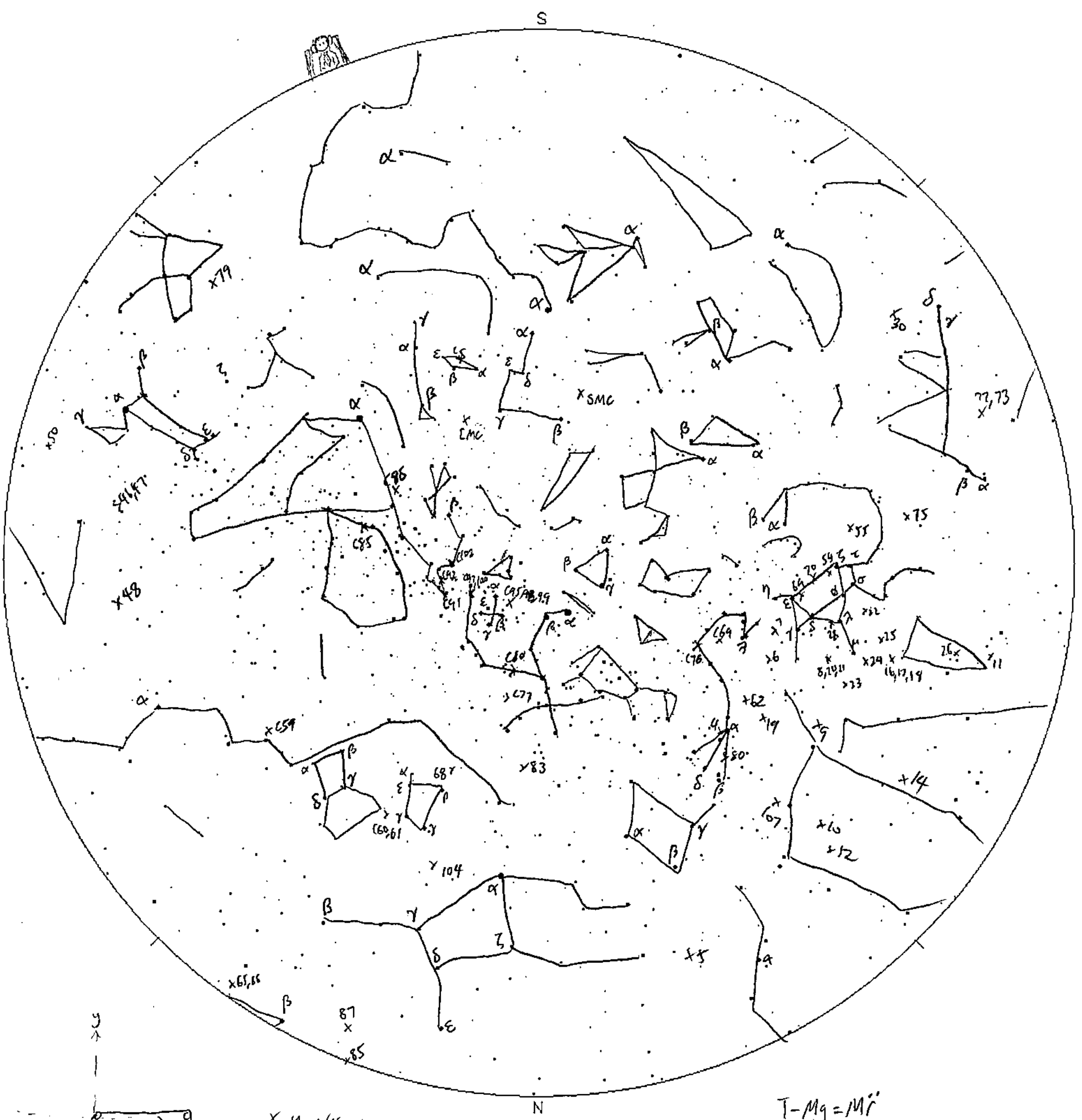
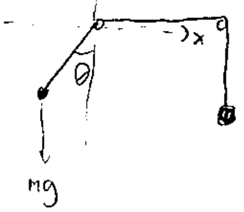
c95,98,99
c97,100
c91
c102

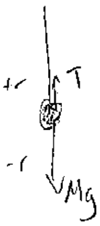






x, y, vx, vy

T - Mg = Mr̈
T = Mr̈ + Mg



$a_r = g\cos\theta - \frac{T}{m} = g\cos\theta - \mu\ddot{r} - \mu g = \ddot{r} - r\dot{\theta}^2$ $\quad \frac{g(\cos\theta - \mu) + r\dot{\theta}^2}{1+\mu} = \ddot{r}$

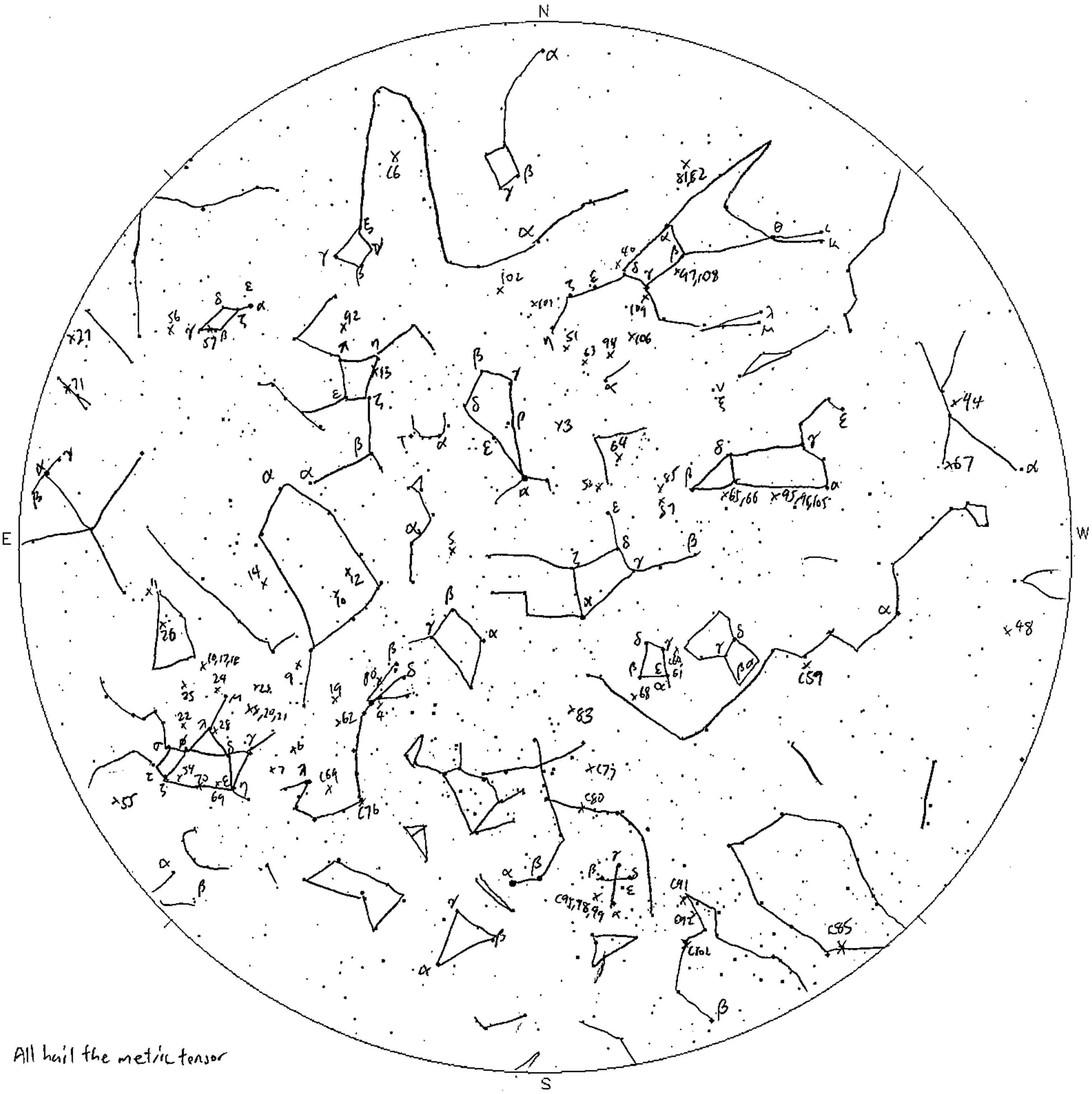
$a_\theta = -g\sin\theta = r\ddot{\theta} + 2\dot{r}\dot{\theta}$

$\frac{-g\sin\theta - 2\dot{r}\dot{\theta}}{r} = \ddot{\theta}$

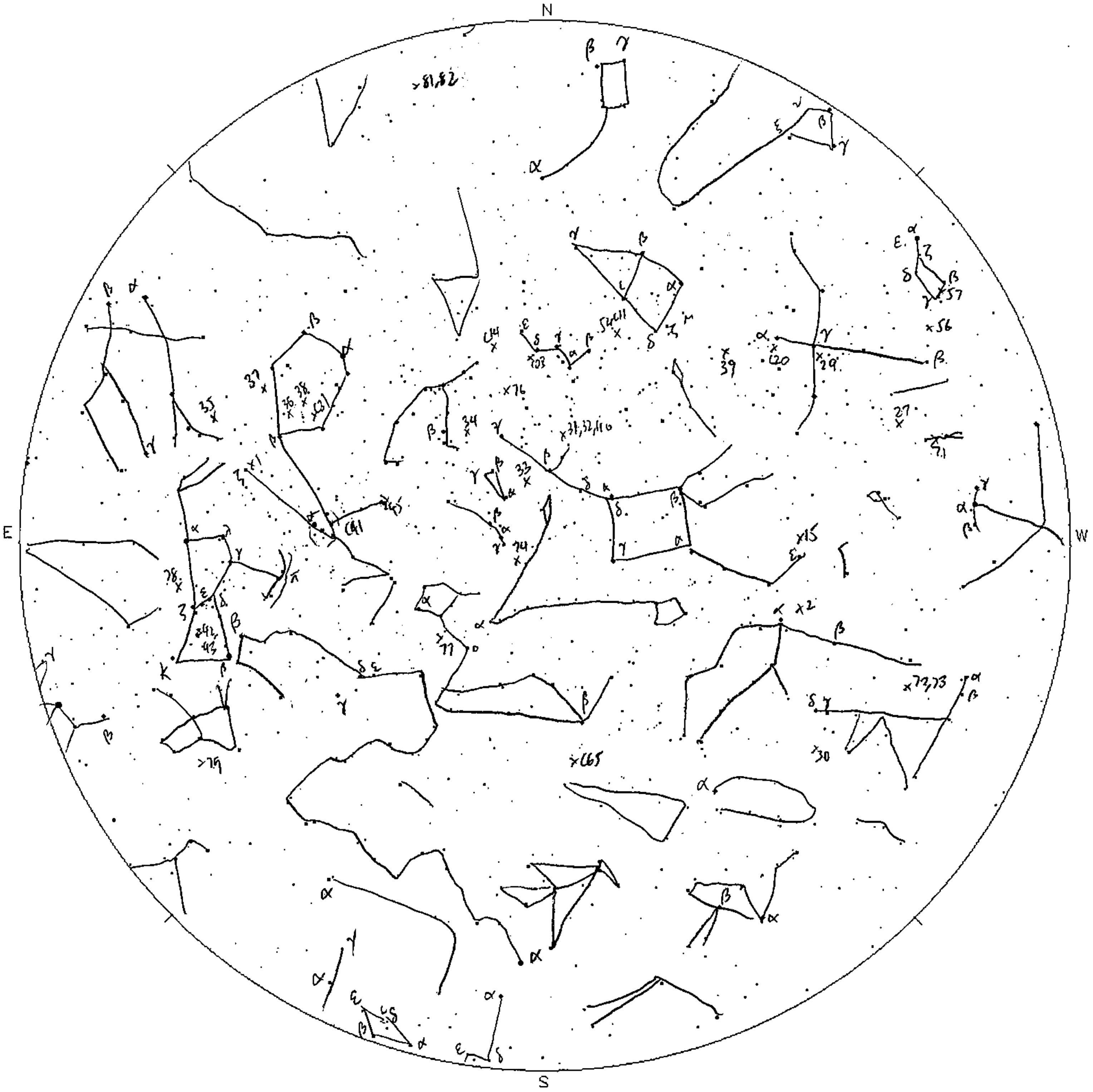
nicely done

\
V

696969696969696969696969696969696969696969696969696969696969696969696969696969696 $\boxed{969}$ 6



All hail the metric tensor


N
E
W
S
81,82
C4
103
54, C11
76
31, 32, 110
39
C20
29
56
57
27
71
37
35
36
38
C21
34
33
74
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C41
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2
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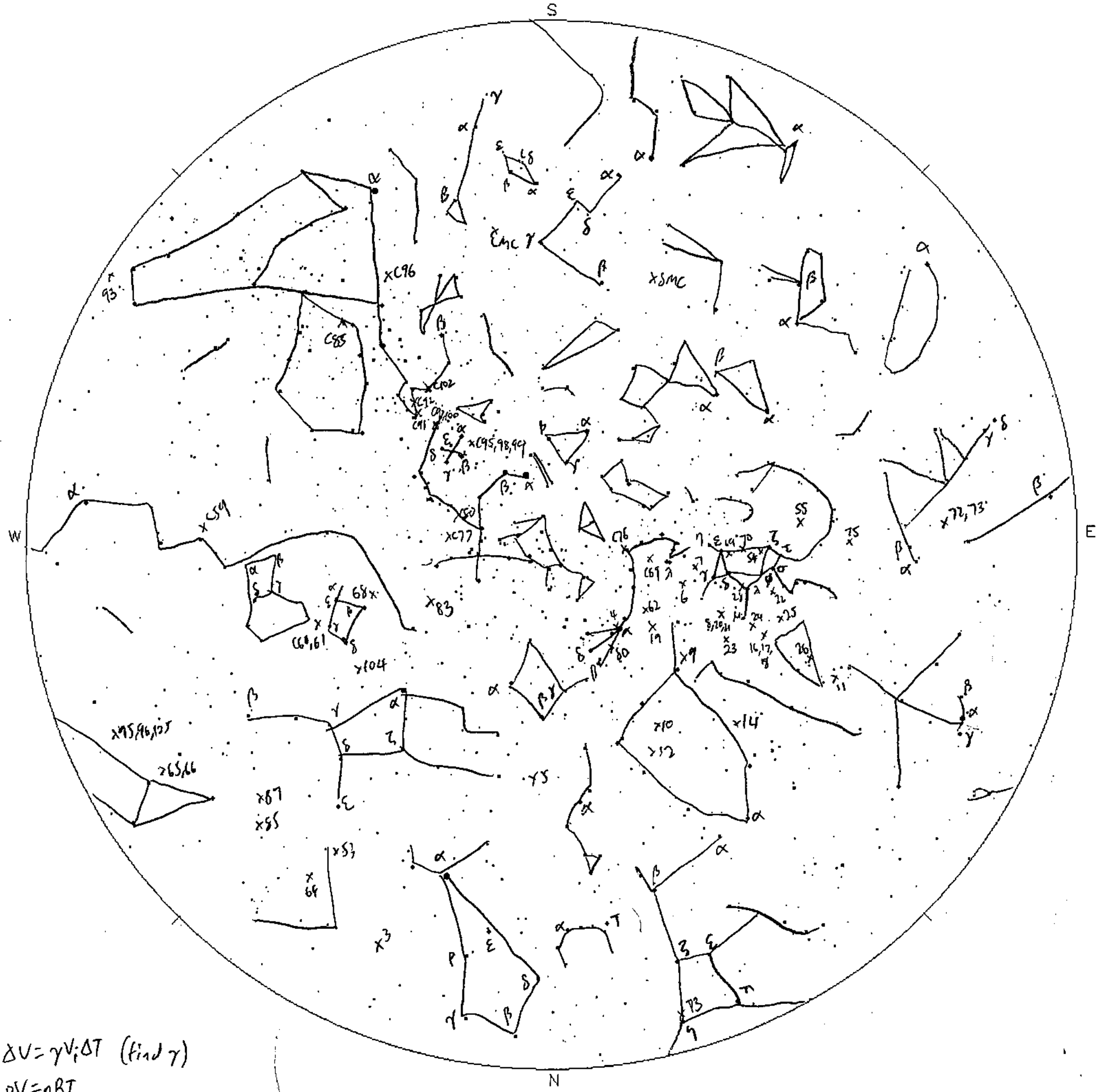
42, 43
77
72, 73
79
C65
30



$\Delta V = \gamma V_i \Delta T$ (find γ)

$pV = nRT$

Since p, n are constant,

$p\Delta V = nR\Delta T$

$\frac{\Delta V}{V} = \frac{\Delta T}{T}$

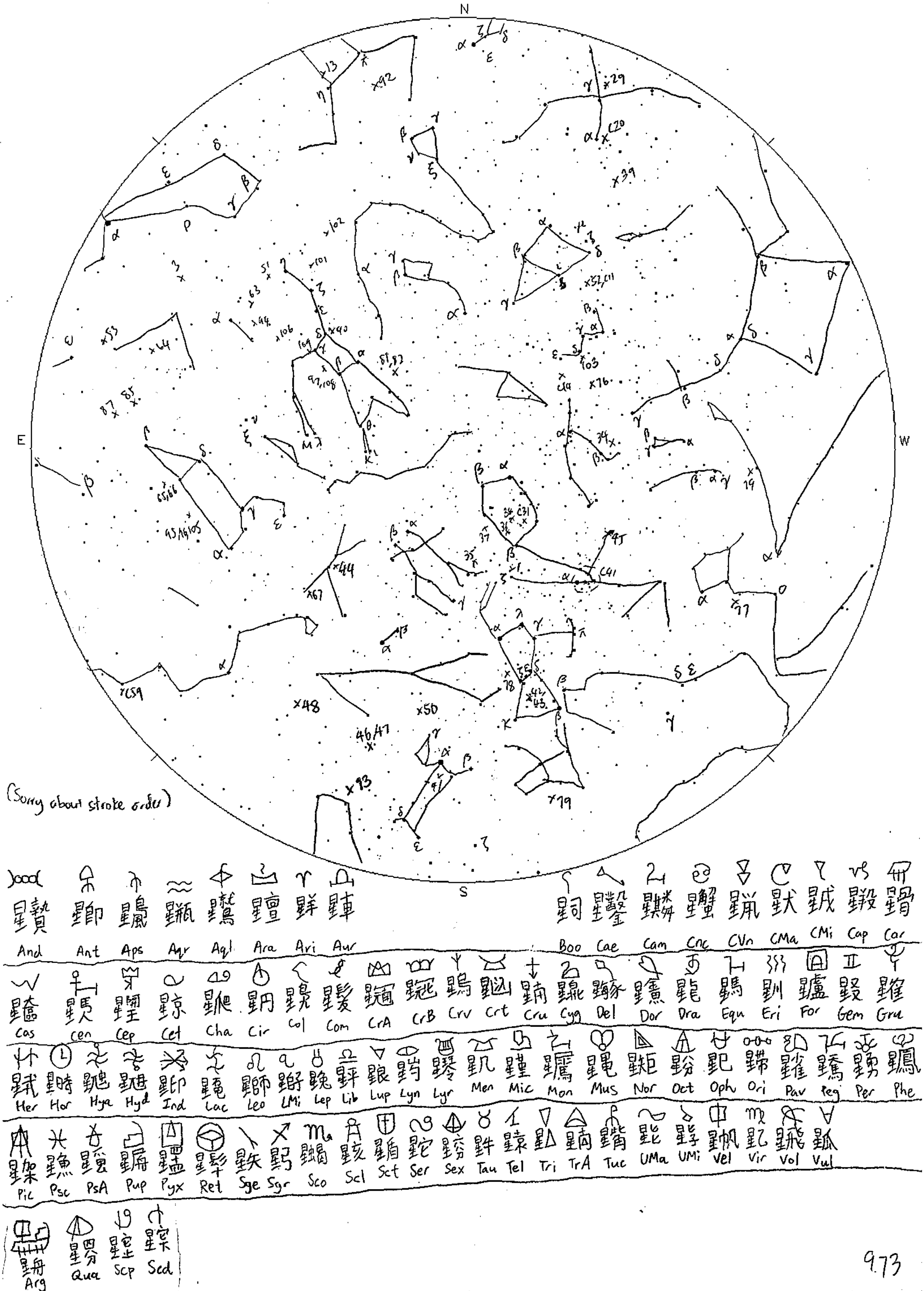
$\Delta V = \left(\frac{1}{T}\right)\Delta T V_i$

$\therefore \gamma = \frac{1}{T}$

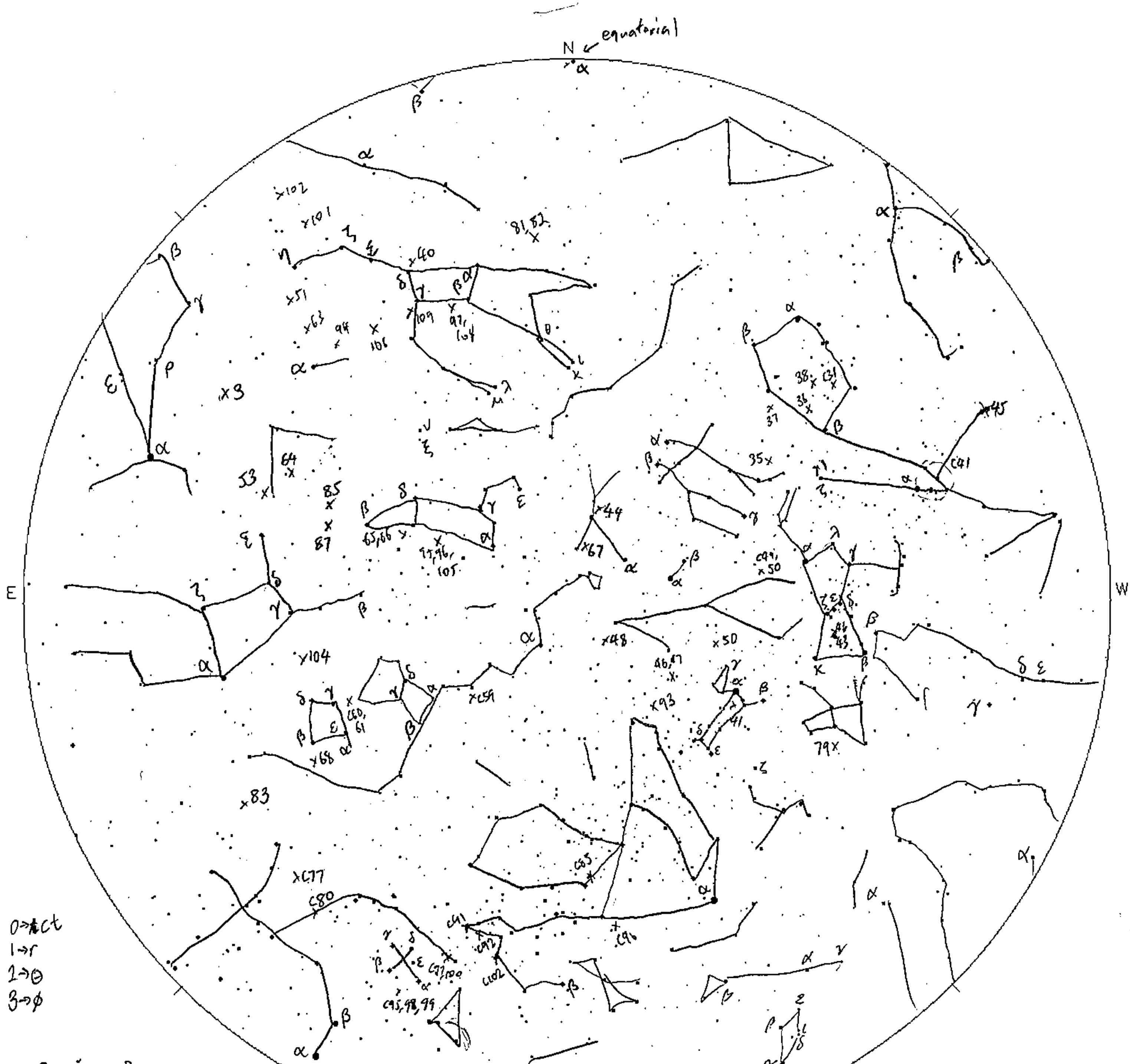
So, for gas at 37°C

$\gamma = \frac{1}{37+273.15} = 0.0032\ K^{-1}$ (2sf)

All other details, including Mahir, are unnecessory and distracting.



(Sorry about stroke order)



$0 \to ct$

$1 \to r$

$2 \to \theta$

$3 \to \phi$

$$g_{\mu\nu} = \begin{bmatrix} +1 & 0 & 0 & 0 \\ 0 & \frac{-a(t)^2}{1-kr^2} & 0 & 0 \\ 0 & 0 & -a(t)^2 r^2 & 0 \\ 0 & 0 & 0 & -a(t)^2 r^2 \sin^2\theta \end{bmatrix}$$

$$g^{\mu\nu} = \begin{bmatrix} +1 & 0 & 0 & 0 \\ 0 & \frac{1-kr^2}{-a(t)^2} & 0 & 0 \\ 0 & 0 & \frac{1}{-a(t)^2 r^2} & 0 \\ 0 & 0 & 0 & \frac{1}{-a(t)^2 r^2 \sin^2\theta} \end{bmatrix}$$

$$\Gamma^\rho_{\mu\nu} = \frac{1}{2} g^{\sigma\rho}\left(\partial_\nu g_{\sigma\mu} + \partial_\mu g_{\nu\sigma} - \partial_\sigma g_{\mu\nu}\right)$$

$$= \frac{1}{2} g^{\rho\rho}\left(\partial_\nu g_{\rho\mu} + \partial_\mu g_{\nu\rho} - \partial_\rho g_{\mu\nu}\right)$$

$\boxed{\rho=0}$

$\Gamma^0_{00} = 0$,

$\Gamma^0_{0i} = \Gamma^0_{i0} = \frac{1}{2}\left(\partial_i g_{00} + \partial_0 g_{0i} - \partial_0 g_{0i}\right) = 0$

$\Gamma^0_{ii} = \frac{1}{2}\left(2\partial_i g_{0i} - \partial_0 g_{ii}\right) = -\frac{1}{2}\partial_0 g_{ii}$

$\Gamma^0_{11} = \frac{a\dot{a}}{c(1-kr^2)}$, $\Gamma^0_{22} = \frac{a\dot{a}r^2}{c}$, $\Gamma^0_{33} = \left(\frac{a\dot{a}}{c}\right) r^2 \sin^2\theta \leftarrow !$

$\Gamma^0_{ij} = \frac{1}{2}\left(\partial_j g_{0i} + \partial_i g_{0j} - \partial_0 g_{ij}\right) = 0 \quad (i \neq j)$ $\left[\text{If } \mu \neq \nu \neq \rho,\ \Gamma^\rho_{\mu\nu} = 0\right]$

$\boxed{\rho=i}$

$\Gamma^i_{00} = \frac{1}{2} g^{ii}\left(\partial_0 g_{0i} + \partial_0 g_{0i} - \partial_i g_{00}\right) = 0$

$\Gamma^i_{0i} = \Gamma^i_{i0} = \frac{1}{2} g^{ii}\left(\partial_i g_{0i} + \partial_0 g_{ii} - \partial_i g_{0i}\right) = \frac{1}{2} g^{ii}\left(\partial_0 g_{ii}\right)$

$\Gamma^1_{01} = \frac{\dot{a}}{ca} = \Gamma^1_{10}$, $\Gamma^2_{02} = \frac{-2\dot{a}ar^2}{2a^2r^2c} = \frac{\dot{a}}{ca} = \Gamma^2_{20}$, $\Gamma^3_{03} = \Gamma^3_{30} = \frac{\dot{a}}{ca} \leftarrow !$

$\boxed{\rho=1}$

$\Gamma^1_{11} = \frac{1}{2} g^{11}\partial_1 g_{11} = \frac{1}{2}(1-kr^2)\partial_1 \frac{\overset{S}{1}}{1-kr^2}$

$= \frac{1}{2}(1-kr^2)\frac{2kr}{(1-kr^2)^2} = \frac{kr}{1-kr^2}$!

$\Gamma^1_{12} = \frac{1}{2}\frac{1-kr^2}{-a^2}\partial_2 g_{11} = 0 = \Gamma^1_{21} = \Gamma^1_{13} = \Gamma^1_{31}$

$\Gamma^1_{22} = \frac{1}{2}\frac{(1-kr^2)}{-a^2}\left(2\partial_2 g_{12} - \partial_1 g_{22}\right)$

$= \frac{1}{2}(1-kr^2)\partial_1 r^2 = -r(1-kr^2)$!

$\Gamma^1_{33} = \frac{1}{2}\frac{1-kr^2}{-a^2}\left(2\partial_3 g_{13} - \partial_1 g_{33}\right)$

$= -r\sin^2\theta(1-kr^2)$!

$\boxed{\rho=2}$

$\Gamma^2_{11} = \frac{1}{-2a^2r^2}\left(-\partial_2 g_{11}\right) = 0$

$\Gamma^2_{22} = \frac{1}{-2a^2r^2}\left(\partial_2 g_{22}\right) = 0$

$\Gamma^2_{33} = \frac{1}{-2a^2r^2}\left(-\partial_2 g_{33}\right) = -\frac{1}{2} 2\sin\theta\cos\theta = -\sin\theta\cos\theta$!

$\Gamma^2_{12} = \frac{1}{-2a^2r^2}\partial_1 g_{22} = \frac{1}{r}$!

$\Gamma^2_{23} = \frac{1}{-2a^2r^2}\partial_3 g_{22} = 0$

$\boxed{\rho=3}$ $\Gamma^3_{11} = \Gamma^3_{22} = \Gamma^3_{33} = 0$ (no dependence on ϕ)

$\Gamma^3_{13} = \frac{1}{-2a^2r^2\sin^2\theta}\left(-2a^2 r \sin^2\theta\right) = \frac{1}{r}$!

$\Gamma^3_{23} = \frac{1}{-2a^2r^2\sin^2\theta}(-2a^2r^2\sin\theta\cos\theta = \frac{\cos\theta}{\sin\theta}$!

FLRW metric connection coeffs

$\Gamma^0_{11} = \frac{a\dot{a}}{c(1-kr^2)}$, $\Gamma^0_{22} = \frac{a\dot{a}r^2}{c}$, $\Gamma^0_{33} = \frac{a\dot{a}}{c} r^2 \sin^2\theta$

$\Gamma^1_{01} = \Gamma^1_{10} = \Gamma^2_{02} = \Gamma^2_{20} = \Gamma^3_{03} = \Gamma^3_{30} = \frac{\dot{a}}{ca}$

$\Gamma^1_{11} = \frac{kr}{1-kr^2}$, $\Gamma^1_{22} = -r(1-kr^2)$, $\Gamma^1_{33} = -r\sin^2\theta(1-kr^2)$

$\Gamma^2_{12} = \Gamma^2_{21} = \Gamma^3_{13} = \Gamma^3_{31} = \frac{1}{r}$, $\Gamma^2_{33} = -\sin\theta\cos\theta$, $\Gamma^3_{23} = \Gamma^3_{32} = \frac{\cos\theta}{\sin\theta}$

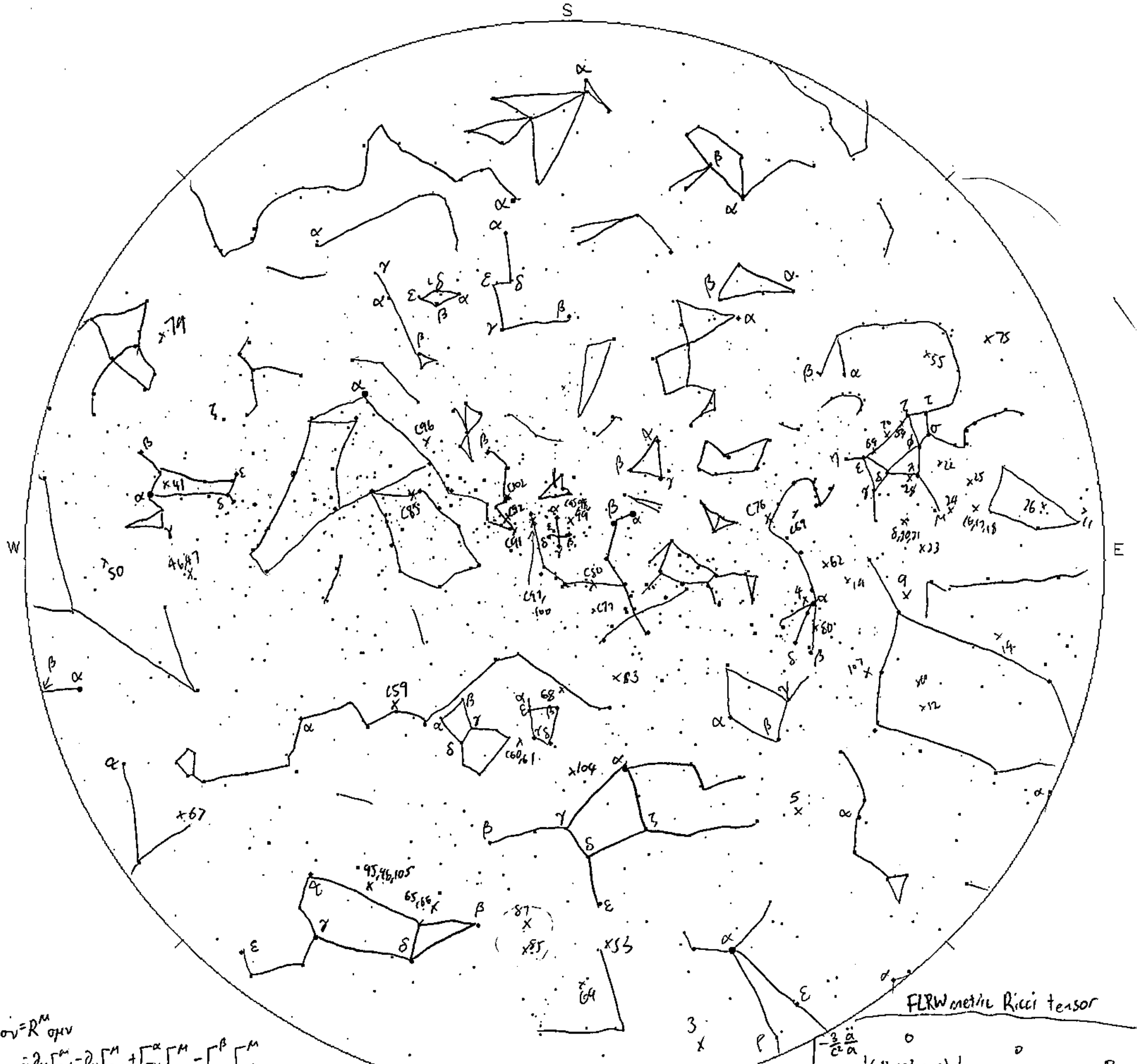
$$R^\rho{}_{\sigma\mu\nu} = \partial_\mu \Gamma^\rho_{\sigma\nu} - \partial_\nu \Gamma^\rho_{\sigma\mu} + \Gamma^\alpha_{\sigma\nu}\Gamma^\rho_{\mu\alpha} - \Gamma^\beta_{\mu\sigma}\Gamma^\rho_{\nu\beta}$$

$$R_{\sigma\nu} = R^\mu{}_{\sigma\mu\nu} = \partial_\mu \Gamma^\mu_{\sigma\nu} - \partial_\nu \Gamma^\mu_{\sigma\mu} + \Gamma^\alpha_{\sigma\nu}\Gamma^\mu_{\mu\alpha} - \Gamma^\beta_{\mu\sigma}\Gamma^\mu_{\nu\beta}$$

* note on appearance of c if some indexes are 0:
this is because of the partial derivative ∂_0.

$\partial_0 = \frac{\partial}{\partial ct} = \frac{1}{c}\frac{\partial}{\partial t}$

This is not a very important point as we can (and usually do) set units such that $c=1$



$$R_{\sigma\nu}=R^{\mu}{}_{\sigma\mu\nu}$$
$$=\partial_\mu\Gamma^{\mu}_{\sigma\nu}-\partial_\nu\Gamma^{\mu}_{\sigma\mu}+\Gamma^{\alpha}_{\sigma\nu}\Gamma^{\mu}_{\mu\alpha}-\Gamma^{\beta}_{\mu\alpha}\Gamma^{\mu}_{\nu\beta}$$

$\boxed{\sigma=0}$

$$R_{00}=R^{\mu}{}_{0\mu0}=-\partial_0\Gamma^{\mu}_{0\mu}-\Gamma^{\beta}_{\mu0}\Gamma^{\mu}_{0\beta}\quad(\beta=\mu)$$
$$=-3\frac{\partial}{\partial ct}\left(\frac{\dot a}{ca}\right)-3\left(\frac{\dot a}{ca}\right)^2=-\frac{3}{c^2}\left(\frac{\partial}{\partial t}\frac{\dot a}{a}+\left(\frac{\dot a}{a}\right)^2\right)$$
$$=-\frac{3}{c^2}\left(\frac{a\ddot a-\dot a^2}{a^2}+\frac{\dot a^2}{a^2}\right)=-\frac{3}{c^2}\frac{\ddot a}{a}\ !$$

$$R_{0i}=R^{\mu}{}_{0\mu i}\qquad(\text{since }\beta=\mu\ \&\ \Gamma^{\mu}_{0\mu}=\Gamma^{1}_{01})$$
$$=\Gamma^{i}_{0i}\Gamma^{\mu}_{\mu i}-\Gamma^{\beta}_{\mu0}\Gamma^{\mu}_{i\beta}=\Gamma^{1}_{01}\Gamma^{\mu}_{\mu1}-\Gamma^{1}_{10}\Gamma^{\mu}_{1\mu}=0$$

$\boxed{\sigma=1}$

$$R_{11}=\partial_0\Gamma^{0}_{11}+\partial_1\Gamma^{1}_{11}-\partial_1\Gamma^{\mu}_{1\mu}+\Gamma^{\alpha}_{11}\Gamma^{\mu}_{\mu\alpha}-\Gamma^{\beta}_{\mu1}\Gamma^{\mu}_{1\beta}$$
$$=\partial_0\Gamma^{0}_{11}+\cancel{\partial_1\Gamma^{1}_{11}}-\cancel{\partial_1\Gamma^{1}_{11}}-\partial_1\Gamma^{2}_{12}-\partial_1\Gamma^{3}_{13}$$
$$+\Gamma^{0}_{11}\Gamma^{\mu}_{\mu0}+\Gamma^{1}_{11}\Gamma^{\mu}_{\mu1}-\Gamma^{0}_{\mu1}\Gamma^{\mu}_{10}-\Gamma^{1}_{\mu1}\Gamma^{\mu}_{11}-\Gamma^{2}_{\mu1}\Gamma^{\mu}_{12}-\Gamma^{3}_{\mu1}\Gamma^{\mu}_{13}$$
$$=\partial_0\Gamma^{0}_{11}-2\partial_1\Gamma^{2}_{12}+\overset{1}{\cancel{3}}\Gamma^{0}_{11}\Gamma^{1}_{01}+\cancel{(\Gamma^{1}_{11})^2}+2\Gamma^{1}_{11}\Gamma^{2}_{12}-\cancel{\Gamma^{0}_{11}\Gamma^{1}_{10}}$$
$$-\cancel{\Gamma^{1}_{01}}\Gamma^{0}_{11}-(\Gamma^{1}_{11})^2-2\left(\Gamma^{2}_{12}\right)^2$$
$$=\partial_0\Gamma^{0}_{11}-2\partial_1\Gamma^{2}_{12}+\Gamma^{0}_{11}\Gamma^{1}_{01}+2\Gamma^{1}_{11}\Gamma^{2}_{12}-2\left(\Gamma^{2}_{12}\right)^2$$
$$=\frac{a\ddot a+\dot a^2}{c^2(1-kr^2)}+\frac{2}{r^2}+\frac{\dot a^2}{c^2(1-kr^2)}+\frac{2k}{1-kr^2}-\frac{2}{r^2}$$
$$=\frac{1}{c^2}\left(a\ddot a+2\dot a^2+2kc^2\right)\frac{1}{1-kr^2}\ !$$

$$R_{12}=\Gamma^{2}_{12}\Gamma^{3}_{23}-\Gamma^{\beta}_{\mu1}\Gamma^{\mu}_{2\beta}=\Gamma^{2}_{12}\Gamma^{3}_{23}-\Gamma^{3}_{13}\Gamma^{3}_{23}=0$$
$$R_{13}=\Gamma^{3}_{13}\Gamma^{\mu}_{\mu3}-\Gamma^{\beta}_{\mu1}\Gamma^{\mu}_{3\beta}=0-0=0$$

(∵ ~~13 31 33 32~~

$\boxed{\sigma=2}$

$$R_{22}=R^{\mu}{}_{2\mu2}=\partial_0\Gamma^{0}_{22}+\partial_1\Gamma^{1}_{22}-\partial_2\Gamma^{\mu}_{2\mu}+\Gamma^{\alpha}_{22}\Gamma^{\mu}_{\mu\alpha}-\Gamma^{\beta}_{\mu2}\Gamma^{\mu}_{2\beta}$$
$$=\partial_0\Gamma^{0}_{22}+\partial_1\Gamma^{1}_{22}-\partial_2\Gamma^{3}_{23}+\Gamma^{0}_{22}\Gamma^{\mu}_{\mu0}+\Gamma^{1}_{22}\Gamma^{\mu}_{\mu1}$$
$$-2\Gamma^{2}_{02}\Gamma^{0}_{22}-2\Gamma^{2}_{12}\Gamma^{1}_{22}-\left(\Gamma^{3}_{23}\right)^2$$
$$=\partial_0\Gamma^{0}_{22}+\partial_1\Gamma^{1}_{22}-\partial_2\Gamma^{3}_{23}+\Gamma^{0}_{22}\Gamma^{1}_{01}+\Gamma^{1}_{22}\Gamma^{1}_{11}-\left(\Gamma^{3}_{23}\right)^2$$
$$=\frac{a\ddot a+\dot a^2}{c^2}r^2-(1-3kr^2)+\cancel{\frac{1}{\sin^2\theta}}+\frac{\dot a^2}{c^2}r^2-kr^2-\cancel{\frac{\cos^2\theta}{\sin^2\theta}}$$
$$=\frac{a\ddot a+\dot a^2}{c^2}r^2+2kr^2+\frac{\dot a^2}{c^2}r^2=\frac{1}{c^2}\left(a\ddot a+2\dot a^2+2kc^2\right)r^2\ !$$

$$R_{23}=\Gamma^{3}_{23}\Gamma^{\mu}_{3\mu}-\Gamma^{\beta}_{\mu2}\Gamma^{\mu}_{3\beta}=0-0=0$$

$\boxed{\sigma=3}$

$$R_{33}=R^{\mu}{}_{3\mu3}=\partial_\mu\Gamma^{\mu}_{33}-\cancel{\partial_3\Gamma^{\mu}_{3\mu}}+\Gamma^{\alpha}_{33}\Gamma^{\mu}_{\mu\alpha}-\Gamma^{\beta}_{\mu3}\Gamma^{\mu}_{3\beta}$$
$$=\partial_0\Gamma^{0}_{33}+\partial_1\Gamma^{1}_{33}+\partial_2\Gamma^{2}_{33}+\Gamma^{0}_{33}\Gamma^{\mu}_{0\mu}+\Gamma^{1}_{33}\Gamma^{\mu}_{1\mu}+\Gamma^{2}_{33}\Gamma^{\mu}_{2\mu}$$
$$-2\Gamma^{0}_{33}\Gamma^{3}_{03}-2\Gamma^{1}_{33}\Gamma^{3}_{13}-2\Gamma^{2}_{33}\Gamma^{3}_{23}$$
$$=\partial_0\Gamma^{0}_{33}+\partial_1\Gamma^{1}_{33}+\partial_2\Gamma^{2}_{33}+\Gamma^{0}_{33}\Gamma^{1}_{01}+\Gamma^{1}_{33}\Gamma^{1}_{11}-\Gamma^{2}_{33}\Gamma^{3}_{23}$$
$$=\frac{a\ddot a+\dot a^2}{c^2}r^2\sin^2\theta-\sin^2\theta(1-3kr^2)+\sin^2\theta-\cos^2\theta$$
$$+\frac{\dot a^2}{c^2}r^2\sin^2\theta-kr^2\sin^2\theta+\cos^2\theta$$
$$=\frac{a\ddot a+\dot a^2}{c^2}r^2\sin^2\theta+2kr^2\sin^2\theta+\frac{\dot a^2}{a^2}r^2\sin^2\theta$$
$$=\frac{1}{c^2}\left(a\ddot a+2\dot a^2+2kc^2\right)r^2\sin^2\theta\ !$$

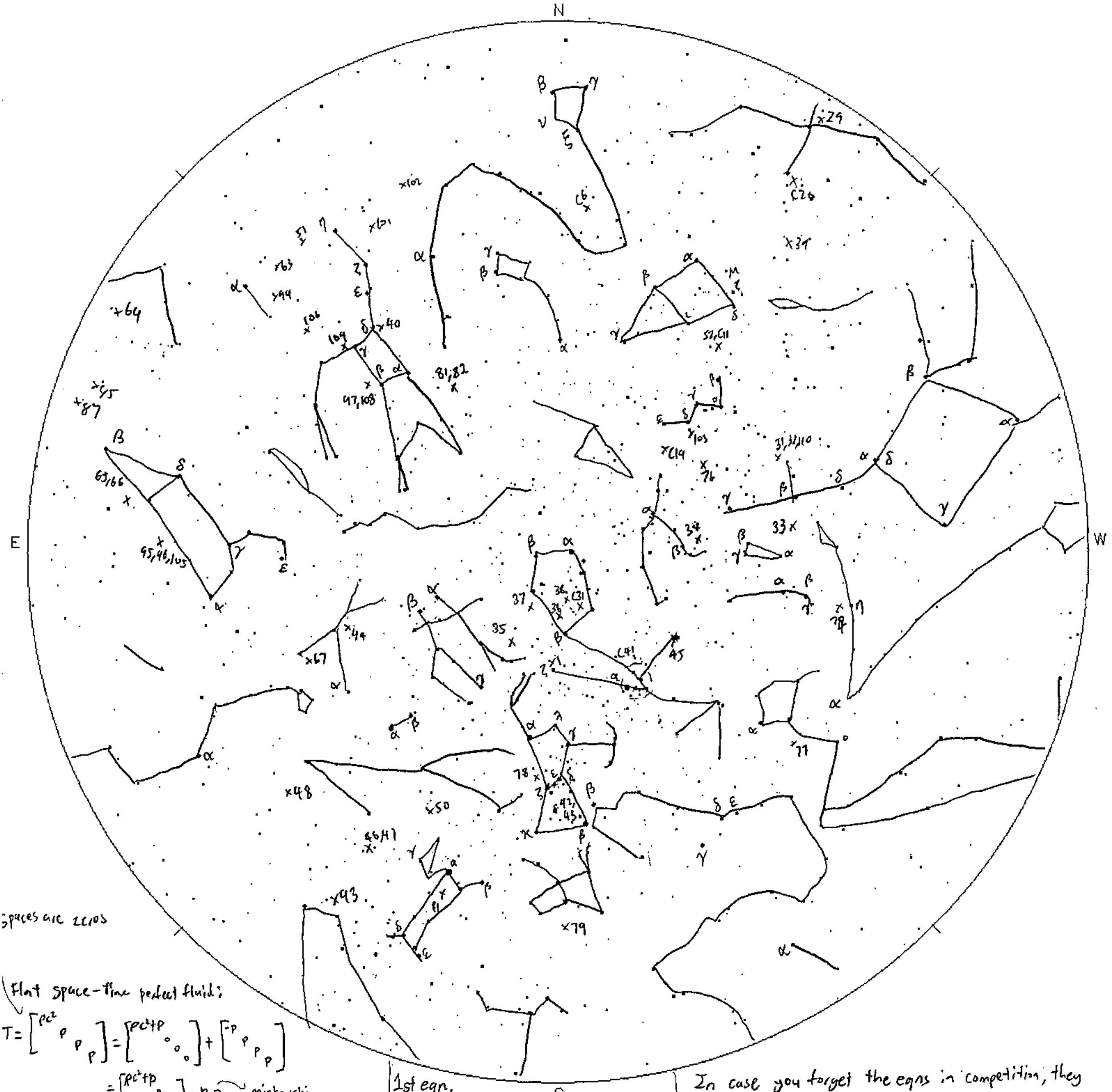
FLRW metric Ricci tensor

$$Ric=\left[\begin{array}{cccc}-\frac{3}{c^2}\frac{\ddot a}{a} & 0 & 0 & 0\\ 0 & \frac{1}{c^2}(a\ddot a+2\dot a^2+2kc^2)\frac{1}{1-kr^2} & 0 & 0\\ 0 & 0 & \frac{1}{c^2}(a\ddot a+2\dot a^2+2kc^2)r^2 & 0\\ 0 & 0 & 0 & \frac{1}{c^2}(a\ddot a+2\dot a^2+2 \\ & & & \times r^2\sin^2\theta\end{array}\right.$$

Ricci Scalar $R=R^{\nu}{}_{\nu}=R_{\mu\nu}g^{\mu\nu}$

$$=-\frac{3}{c^2}\frac{\ddot a}{a}+\frac{1}{c^2}(a\ddot a+2\dot a^2+2kc^2)\frac{1}{1-kr^2}\times\frac{1-kr^2}{-a^2}$$
$$+\frac{1}{c^2}(a\ddot a+2\dot a^2+2kc^2)r^2\times-\frac{1}{a^2r^2}$$
$$+\frac{1}{c^2}(a\ddot a+2\dot a^2+2kc^2)r^2\sin^2\theta\times-\frac{1}{a^2r^2\sin^2\theta}$$
$$=-\frac{3}{c^2}\frac{\ddot a}{a}-\frac{3}{c^2a^2}(a\ddot a+2\dot a^2+2kc^2)$$
$$=-\frac{3}{c^2a^2}(2a\ddot a+2\dot a^2+2kc^2)=\boxed{-\frac{6}{c^2a^2}(a\ddot a+\dot a^2+kc^2)}$$

Friedmann eqns next page →



Spaces are zeros

Flat space-time perfect fluid:

$$T=\begin{bmatrix}\rho c^2&&&\\&p&&\\&&p&\\&&&p\end{bmatrix}=\begin{bmatrix}\rho c^2+p&&&\\&0&&\\&&0&\\&&&0\end{bmatrix}+\begin{bmatrix}-p&&&\\&p&&\\&&p&\\&&&p\end{bmatrix}$$

$$=\begin{bmatrix}\rho c^2+p&&&\\&0&&\\&&0&\\&&&0\end{bmatrix}-\eta p \quad \text{minkowski metric}$$

$$=\left(\rho+\frac{p}{c^2}\right)\begin{bmatrix}c\\0\\0\\0\end{bmatrix}\begin{bmatrix}c&0&0&0\end{bmatrix}-\eta p$$

$$=\left(\rho+\frac{p}{c^2}\right)\vec{U}\otimes\vec{U}-\eta p \qquad \vec{U}\rightarrow \text{at rest (cosmic rest frame)}$$

curved space

$$T^{\mu\nu}=\left(\rho+\frac{p}{c^2}\right)U^\mu U^\nu-pg^{\mu\nu}$$

Note: $T^\mu{}_\nu=T^{\mu\alpha}g_{\nu\alpha}=\left(\rho+\frac{p}{c^2}\right)U^\mu U_\nu-p\delta^\mu_\nu$

$U^0=U_0=c$, since $g_{00}=+1$, and $g_{0i}=0\ (i=1,2,3)$

$$T^\mu{}_\nu\Rightarrow\begin{bmatrix}\rho c^2&&&\\&-p&&\\&&-p&\\&&&-p\end{bmatrix}\ !\ \xrightarrow{g_{\mu\nu}} T_{\mu\nu}\Rightarrow\begin{bmatrix}\rho c^2&\\&\boxed{-pg_{ij}}\end{bmatrix}\ !$$

Reference:

$$R_{\mu\nu}-\frac{1}{2}Rg_{\mu\nu}-\Lambda g_{\mu\nu}=\kappa T_{\mu\nu} \qquad \left(\kappa=\frac{8\pi G}{c^4}\right)$$

$$R^\mu{}_\nu-\frac{1}{2}R\delta^\mu_\nu-\Lambda\delta^\mu_\nu=\kappa T^\mu{}_\nu \qquad \left(g_{\alpha\nu}g^{\mu\alpha}=\delta^\mu_\nu\right)$$

1st eqn.

Look at 00 component

$$-\frac{3}{c^2}\frac{\ddot{a}}{a}-\frac{1}{2}\left(-\frac{6}{c^2a^2}\left(a\ddot{a}+\ddot{a}^2+kc^2\right)\right)-\Lambda=\kappa\rho c^2$$

$$-\cancel{\frac{3\ddot{a}}{c^2a}}+\cancel{\frac{3\ddot{a}}{c^2a}}+\frac{3\dot{a}^2}{c^2a^2}+\frac{3kc^2}{c^2a^2}-\Lambda=\kappa\rho c^2$$

$$\boxed{\frac{\dot{a}^2}{a^2}=\frac{8\pi G}{3}\rho-\frac{kc^2}{a^2}+\frac{\Lambda c^2}{3}}$$

2nd eqn.

Look at trace of mixed EFE

$$R^\mu{}_\mu-\frac{1}{2}R\delta^\mu{}_\mu-\Lambda\delta^\mu_\mu=\kappa T^\mu_\mu$$

$$R-\frac{1}{2}R(4)-\Lambda(4)=\kappa\left(\rho c^2-3p\right)$$

$$-R=\kappa(\rho c^2-3p)+4\Lambda$$

$$*\ \frac{6\ddot{a}}{c^2a}+\frac{6}{c^2}\frac{\dot{a}^2+kc^2}{a^2}=\kappa(\rho c^2-3p)+4\Lambda$$

$$\frac{\ddot{a}}{a}+\left(\frac{8\pi G}{3}\rho+\frac{\Lambda c^2}{3}\right)=\frac{4\pi G}{3c^2}\left(\rho c^2-3p\right)+\frac{2\Lambda c^2}{3}$$

$$\boxed{\frac{\ddot{a}}{a}=-\frac{4\pi G}{3}\left(\rho+\frac{3p}{c^2}\right)+\frac{\Lambda c^2}{3}}$$

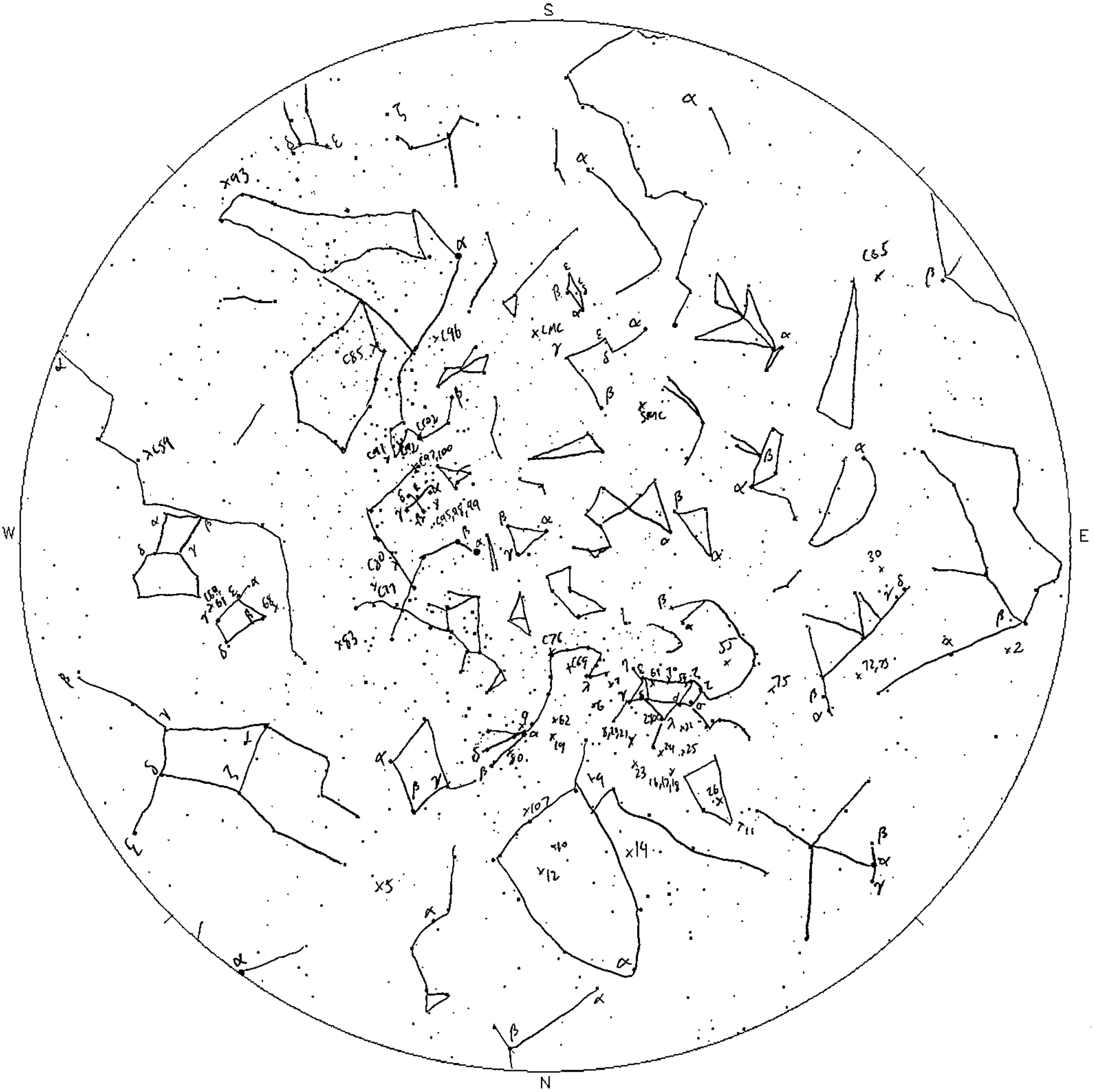
In case you forget the eqns in competition, they can be easily derived in a span of a couple hours using the approach given on the past few star maps.

Note that we have started this derivation with the metric tensor $g_{\mu\nu}$ in hand. $g_{\mu\nu}$ can be derived from the Cosmological Principle and the metric tensor g_{ij} for spherical coordinates. This derivation will not be shown here (just outlined)

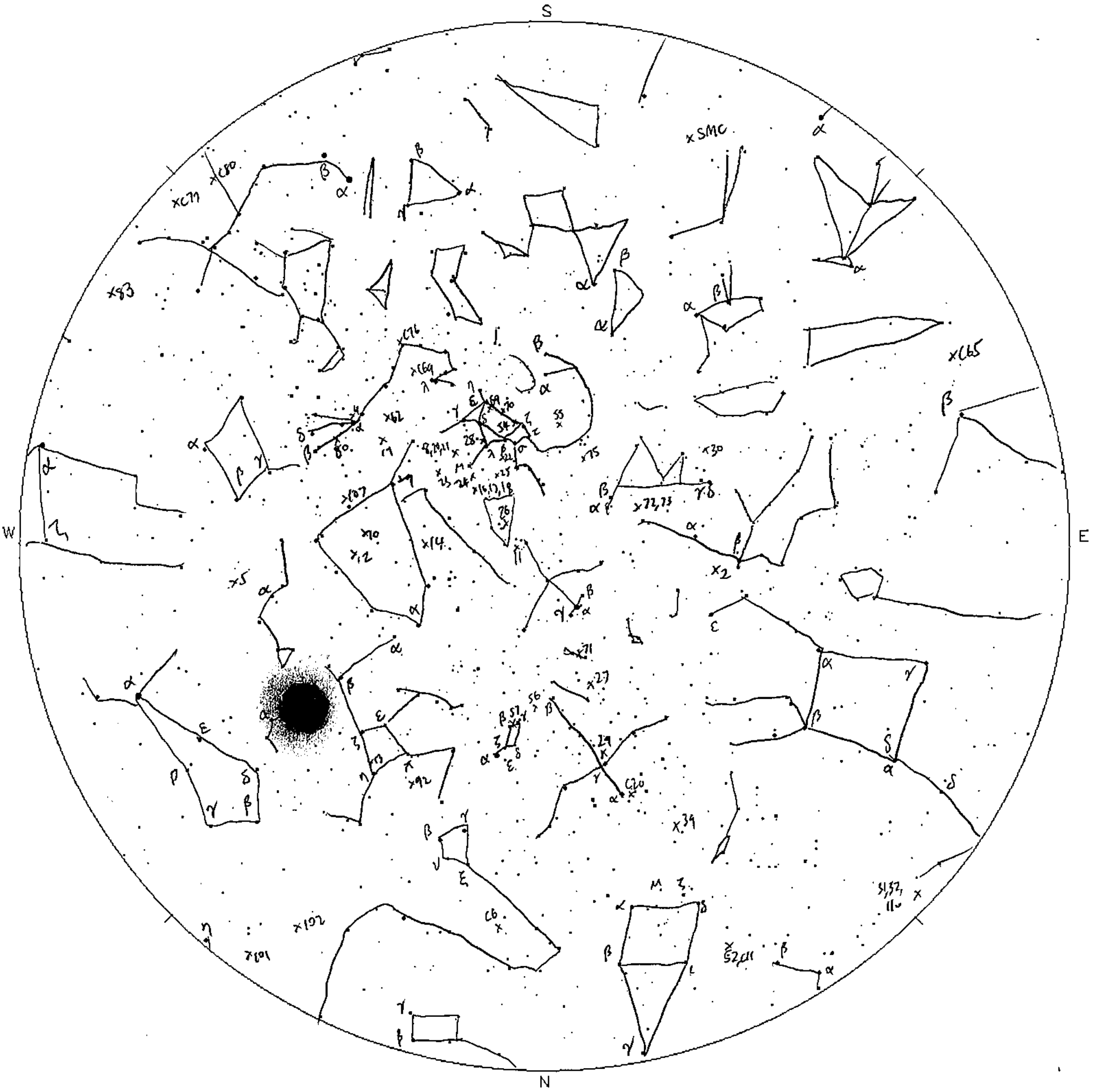
$$g_{ij}\ \begin{array}{ll}\xrightarrow{\text{sphere}}\begin{bmatrix}1&&\\&\sin^2\chi&\\&&\sin^2\chi\sin^2\theta\end{bmatrix}k=1 & \xrightarrow{r=\sin\chi}\left(\frac{dr}{d\chi}\right)^2=1-r^2\\ \xrightarrow{\text{flat}}\begin{bmatrix}1&&\\&\chi^2&\\&&\chi^2\sin^2\theta\end{bmatrix}k=0 & \xrightarrow{r=\chi}\left(\frac{dr}{d\chi}\right)^2=1\\ \xrightarrow{\text{hyperbola}}\begin{bmatrix}1&&\\&\sinh^2\chi&\\&&\sinh^2\chi\sin^2\theta\end{bmatrix}k=-1 & \xrightarrow{r=\sinh\chi}\left(\frac{dr}{d\chi}\right)^2=1+r^2\end{array}\Bigg\}\,1-kr^2$$

$$g_{rr}=\left(\frac{d\chi}{dr}\right)^2g_{\chi\chi}=\frac{1}{1-kr^2}g_{\chi\chi}$$

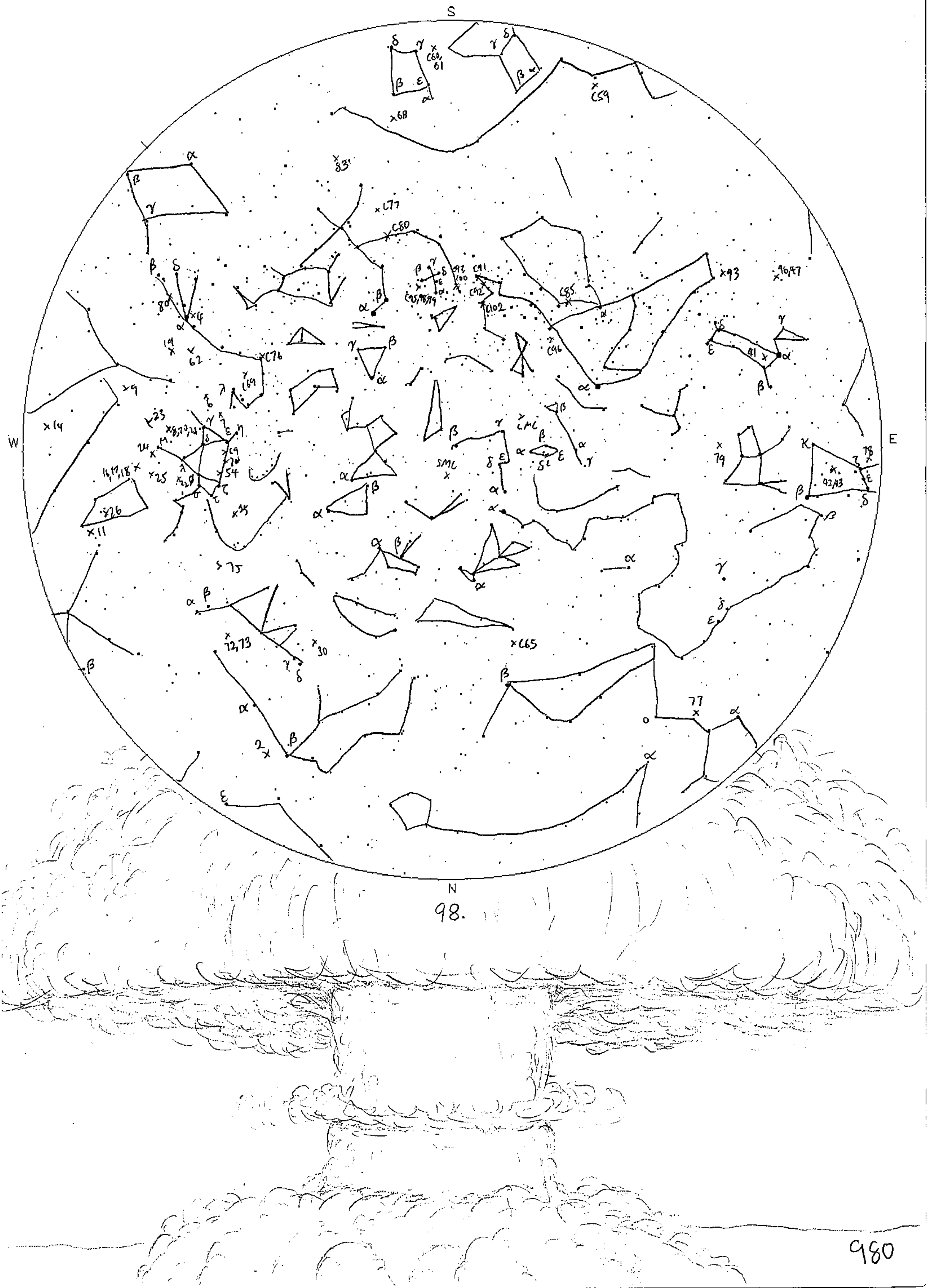
$$\begin{bmatrix}1&\\&\boxed{g}\end{bmatrix}\Rightarrow\begin{bmatrix}1&&&\\&-\frac{1}{1-kr^2}&&\\&&-r^2&\\&&&-r^2\sin^2\theta\end{bmatrix}\xrightarrow[\text{spatial}]{a(t)\text{ for}}\begin{bmatrix}1&&&\\&-\frac{a^2}{1-kr^2}&&\\&&-a^2r^2&\\&&&-a^2r^2\sin^2\theta\end{bmatrix}$$

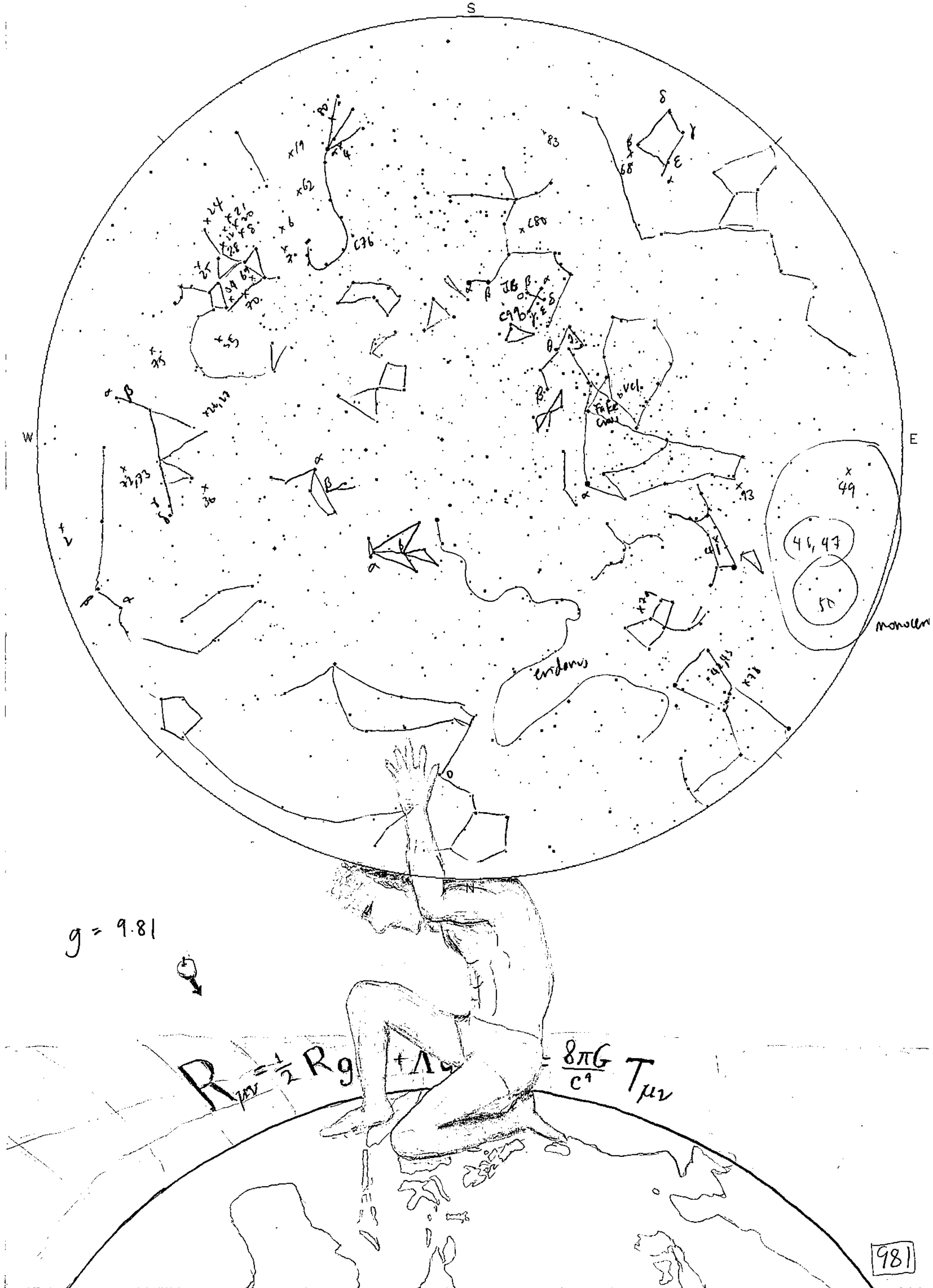

S
N
W
E
X93
ζ
δ
ε
α
C85
C65
β
C96
LMC
SMC
γ
δ
ε
β
α
C59
C91
C92
C102
C97,100
C95,98,99
C80
C77
C68
C61
68
x83
C76
C69
x7
x6
x62
x19
x80
λ
η
ε
61
ζ
σ
53
55
x75
30
x72,73
x2
22
x21
8,20,21
x24
x25
x23
16,17,18
26
11
x9
x107
x10
x12
x14
X5

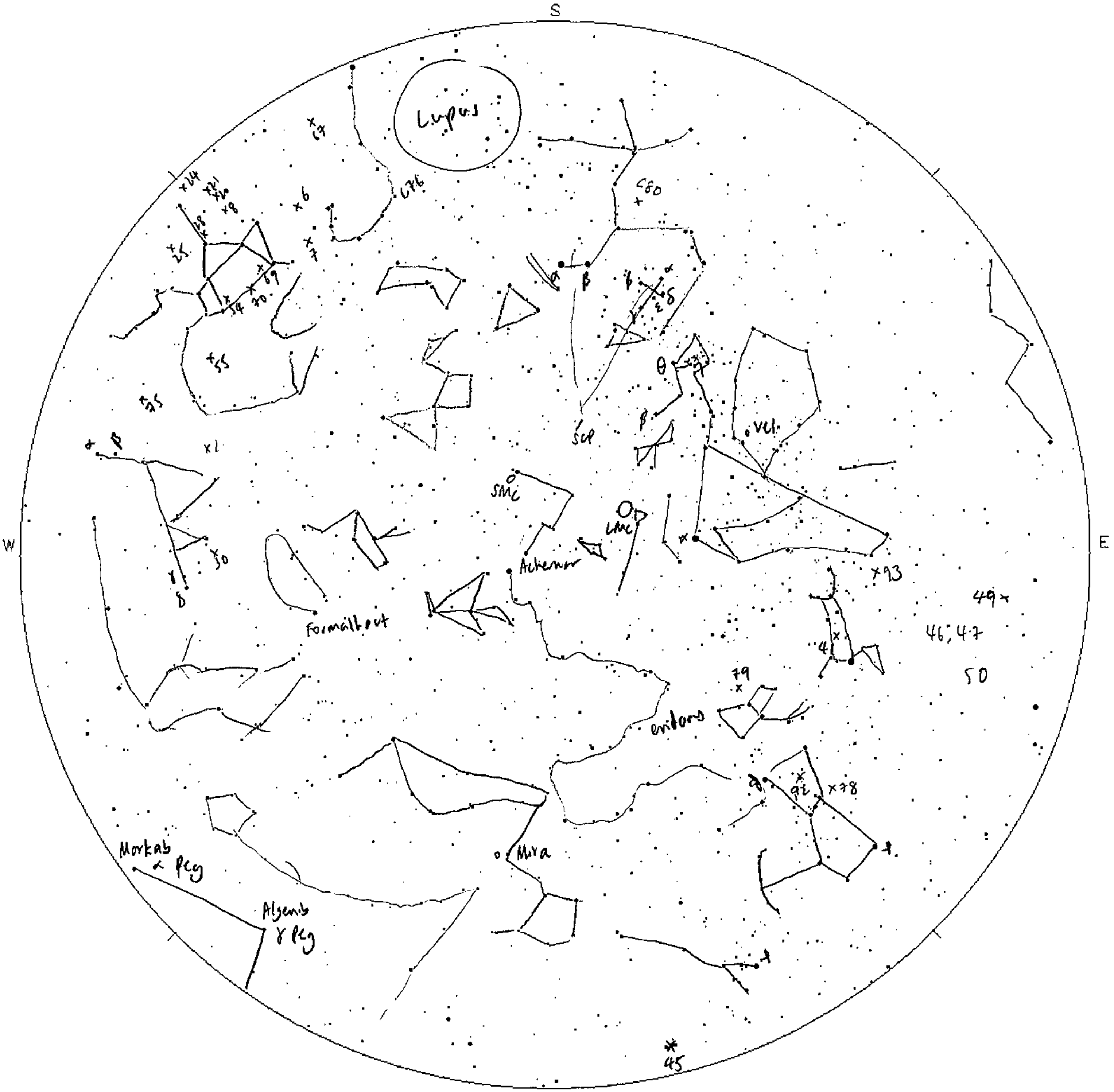

S
N
W
E
×SMC
×LMC
C76
C102
C92
C91, 160
C95, 98, 97
C80
C77
C98
×55
×59
×70
×69
×22
25
×24
16, 17, 18
×28
×8, 10, 21
×23
×7
×6
×9
×C69
C76
×62
×14
4×
×80
107
×79
×83
×68
×60, 61
×41
×50
×46, 47
93
48
62, 92
×67
44×
45, 96, 105
×65, 66
87
×85

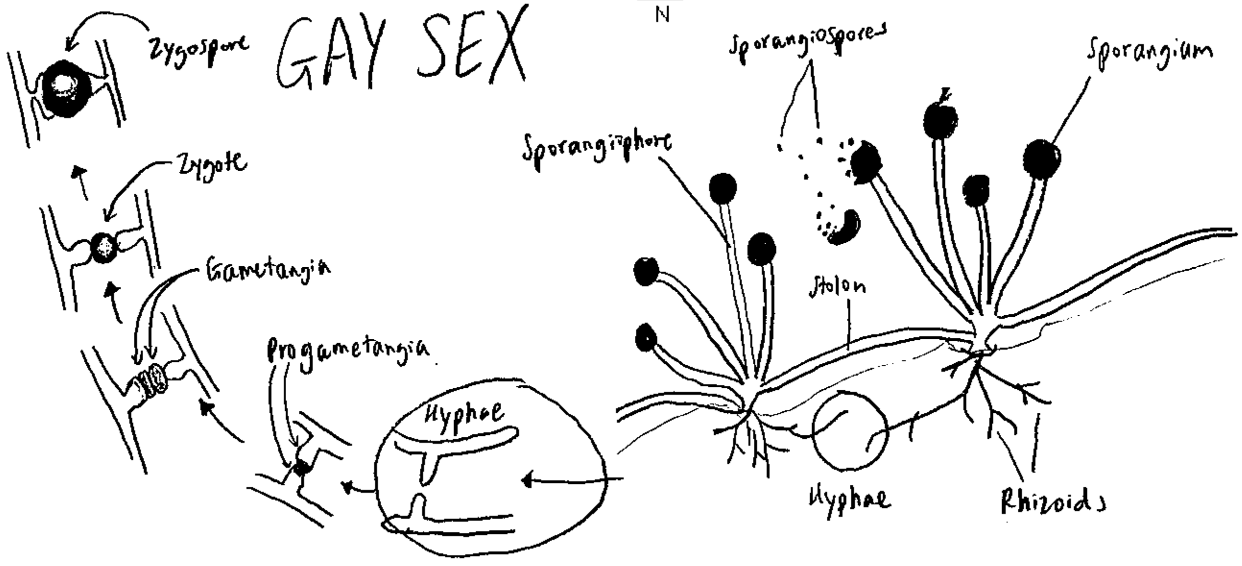


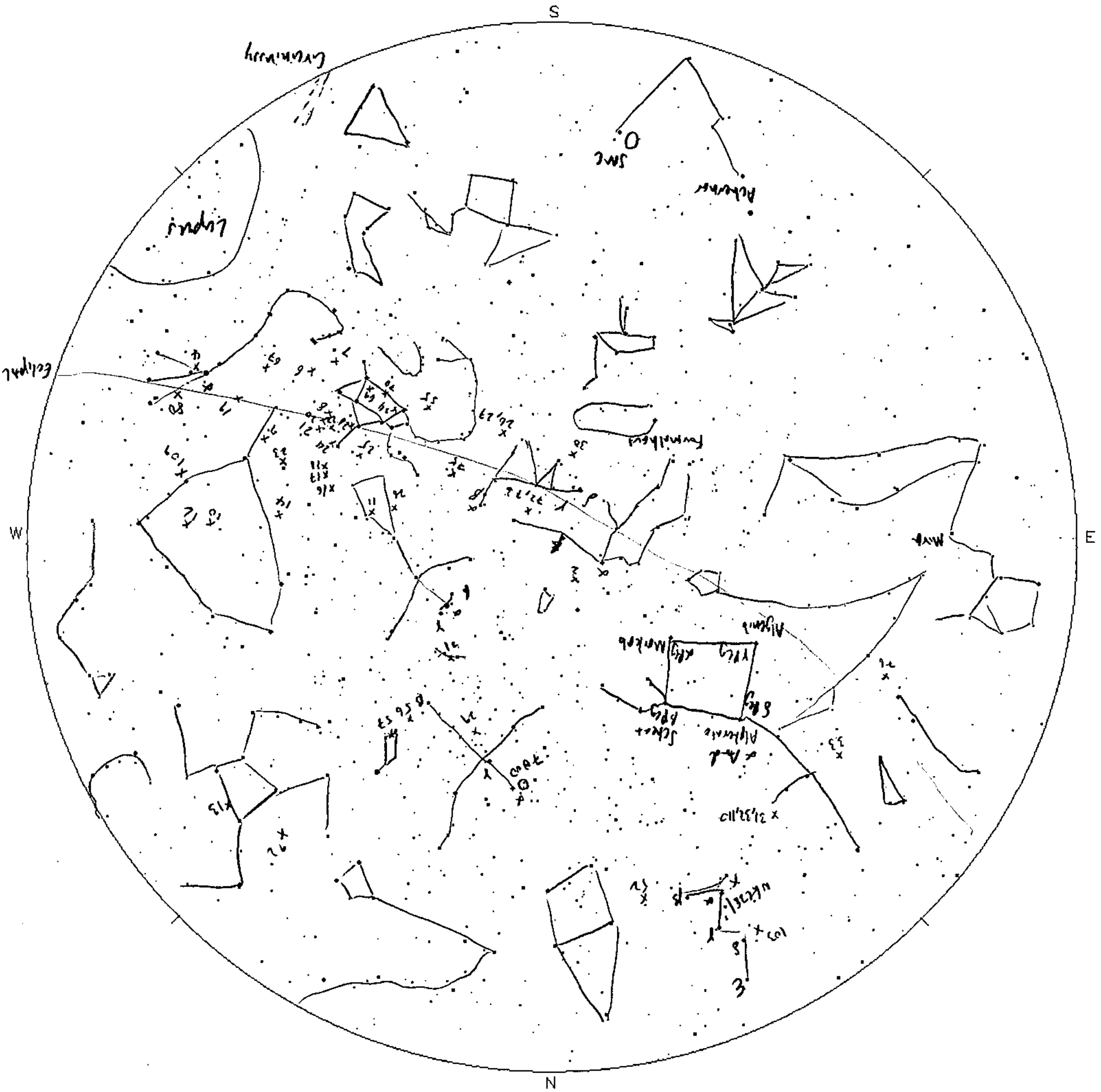
Very bright T CrB

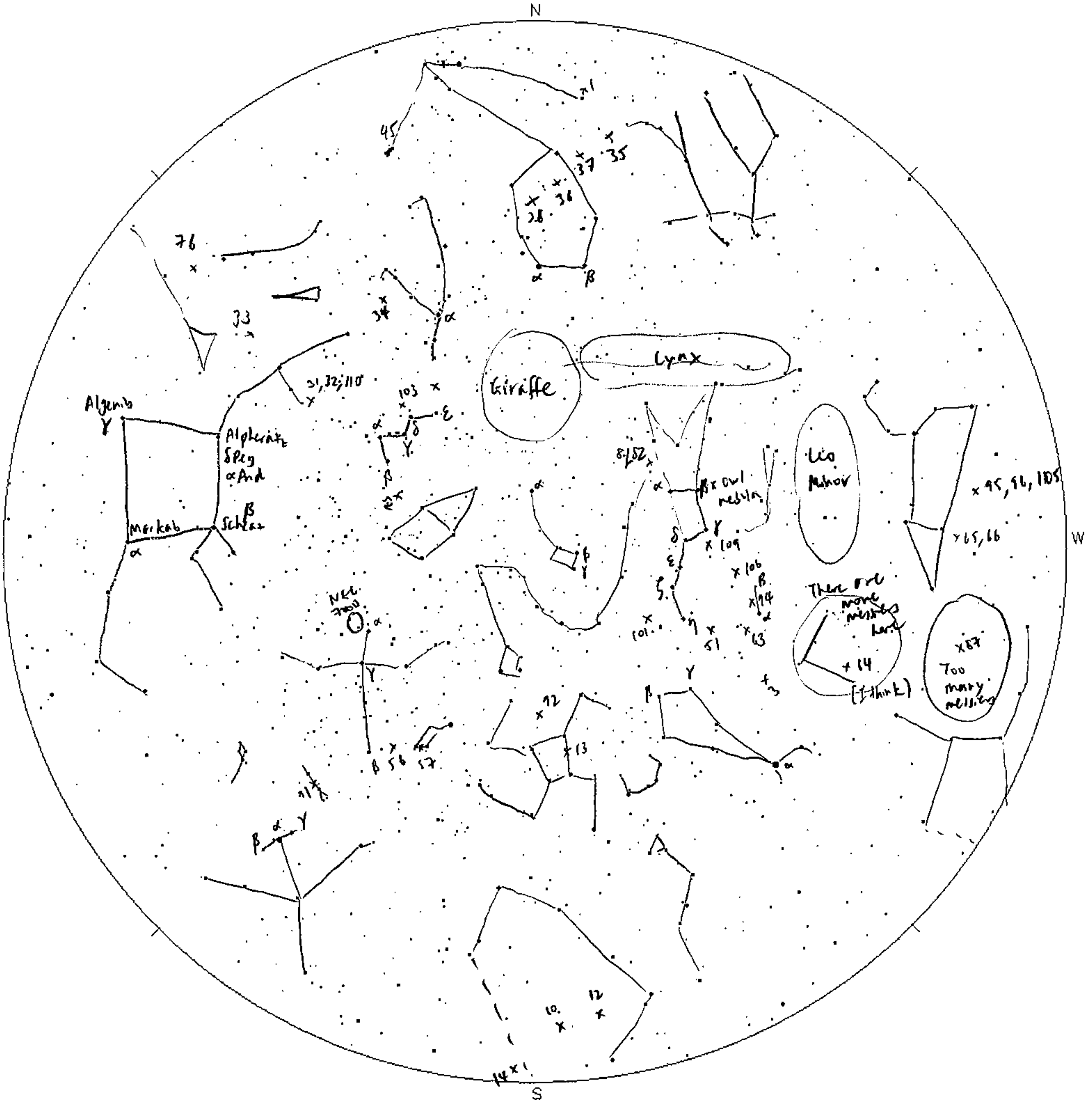

S
W
E
N
C68, 61
C59
×68
83'
×C77
C80
C91
C92
C85
×93
96,97
C102
C96
C95,98,99
×4
80
19
62
C76
C69
×9
×14
×23
×8,20,21
×C9
×54
24
×25
16,17,18
×26
×11
×34
SMC
CMC
SL
41
79
78
92,93
73
72,73
30
×C65
77
2
98.


S
W
E
N
δ
γ
β
68
ε
α
80
x19
4
x83
x62
x C80
C76
x24
21
20
8
28
x6
7
25
84
69
70
x55
35
α
β
x26,27
x32,33
36
δ
2
α
β
JB
β
α
C99
γ
ε
δ
θ
β
Fake Crux
vel
α
x93
49
46,47
50
monocerus
x29
41
eridanus
42,43
x78
α
g = 9.81
$R_{\mu\nu} - \frac{1}{2} R g \; + \Lambda \quad \frac{8\pi G}{c^4} T_{\mu\nu}$


S
Lupus
C76
C80
x17
x24
x21
x20
x8
x6
28
x25
x7
x69
54
70
x55
x25
α β
x1
30
γ
δ
β
ε
δ
α
θ
β
Vel
Scl
SMC
LMC
Achernar
Formalhaut
W
E
x93
49x
46, 47
50
4
79
eridanus
92
x78
Mira
Merkab
α Peg
Algenib
γ Peg
45
N

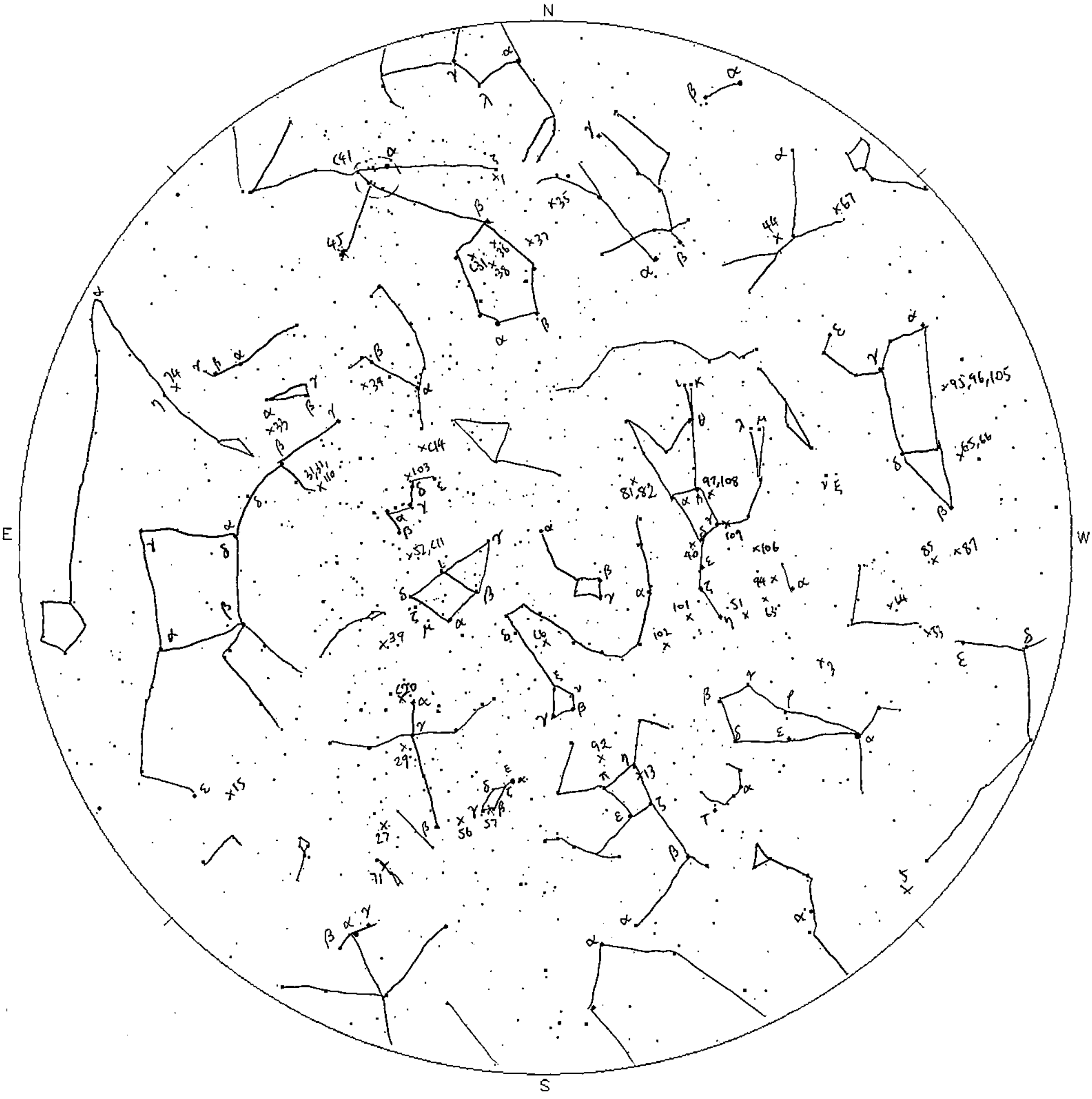

GAY SEX
Zygospore
Zygote
Gametangia
Progametangia
Hyphae
Sporangiospores
Sporangiophore
Sporangium
Stolon
Hyphae
Rhizoids


S
W
E
N
Circinus
Lupus
Ecliptic
SMC
Achernar
Fomalhaut
Mira
Algenib
Markab
α Peg
γ Peg
δ Peg
Scheat β Peg
α And Alpheratz
31,32,110
33
76
52
103
11
13
14
16
17
22
23
24
26,27
30
53
56 57
63
67
72,73
80
109



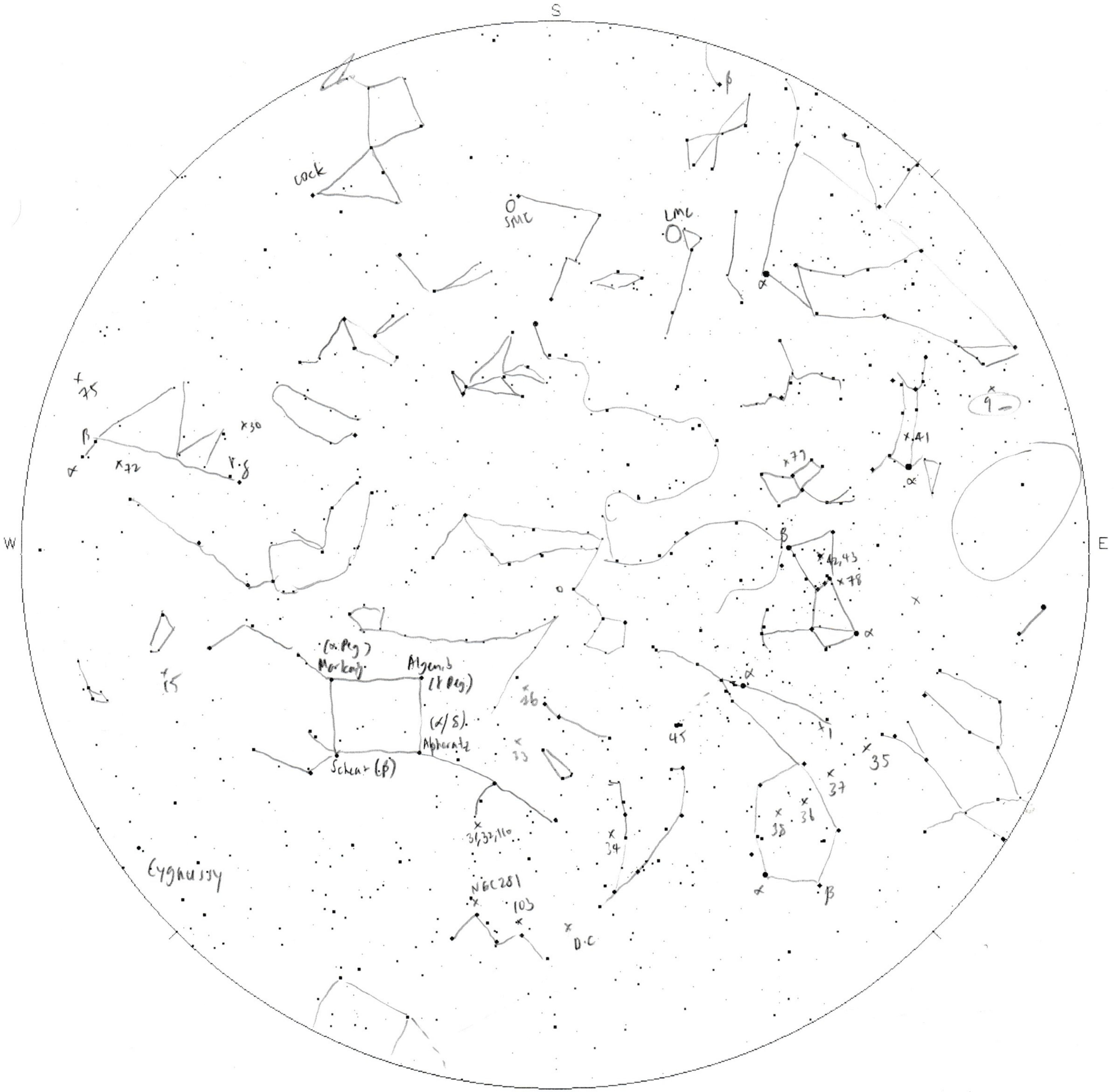
NUKE

JUST DO IT


N
E
W
S
C41
45
x35
x37
x36
C31
x38
x67
44
x74
x33
x34
31,33
x110
x114
x103
x52, C11
x39
81,82
97,108
109
x106
90
101
102
51
94
63
x95,96,105
x65,66
85
x87
x14
x33
x3
x15
C20
29
27
71
56
57
46
92
x13
x5

986 986 986

986 ← it's the same if you read it this way!



$$\mathcal{L}_{SM} = -\frac{1}{2}\partial_\nu g^a_\mu \partial_\nu g^a_\mu - g_s f^{abc}\partial_\mu g^a_\nu g^b_\mu g^c_\nu - \frac{1}{4}g_s^2 f^{abc} f^{ade} g^b_\mu g^c_\nu g^d_\mu g^e_\nu + \frac{1}{2} i g_s^2 (\bar{q}^\sigma_i \gamma^\mu q^\sigma_j) g^a_\mu + G^a \partial^2 G^a + g_s f^{abc}\partial_\mu G^a G^b g^c_\mu - \partial_\nu W^+_\mu \partial_\nu W^-_\mu - M^2 W^+_\mu W^-_\mu$$

$$-\frac{1}{2}\partial_\nu Z^0_\mu \partial_\nu Z^0_\mu - \frac{1}{2c_w^2} M^2 Z^0_\mu Z^0_\mu - \frac{1}{2}\partial_\mu A_\nu \partial_\mu A_\nu - \frac{1}{2}\partial_\mu H \partial_\mu H - \frac{1}{2} m_h^2 H^2 - \partial_\mu \phi^+ \partial_\mu \phi^- - M^2 \phi^+ \phi^- - \frac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \frac{1}{2c_w^2} M \phi^0 \phi^0 - \beta\left[\frac{2M^2}{g^2} + \frac{2M}{g}H + \frac{1}{2}(H^2 + \phi^0\phi^0 + 2\phi^+\phi^-\right.$$

$$\left.)\right] + \frac{2M^4}{g^4}\alpha_h - igc_w[\partial_\nu Z^0_\mu (W^+_\mu W^-_\mu - W^+_\nu W^-_\nu) - Z^0_\nu (W^+_\mu \partial_\nu W^-_\mu - W^-_\mu \partial_\nu W^+_\mu)] - \frac{1}{2} g^2 W^+_\mu W^-_\mu - W^+_\nu W^-_\nu + \frac{1}{2} g^2 W^+_\mu W^-_\nu W^+_\mu W^-_\nu + g^2 c_w^2 (Z^0_\mu W^+_\mu Z^0_\nu W^-_\nu - Z^0_\mu Z^0_\mu W^+_\nu W^-_\nu$$

$$) + g^2 s_w^2 (A_\mu W^+_\mu A_\nu W^-_\nu - A_\mu A_\mu W^+_\nu W^-_\nu) + g^2 s_w c_w [A_\mu Z^0_\nu (W^+_\mu W^-_\nu - W^+_\nu W^-_\mu) - 2A_\mu Z^0_\mu W^+_\nu W^-_\nu] - g\alpha[H^3 + H\phi^0\phi^0 + 2H\phi^+\phi^-] - \frac{1}{8} g^2 \alpha_h [H^4 + (\phi^0)^4 + 4(\phi^+\phi^-$$

$$)^2 + 4(\phi^0)^2 \phi^+\phi^- + 4H^2\phi^+\phi^- + 2(\phi^0)^2 H^2] - gM W^+_\mu W^-_\mu H - \frac{1}{2} g \frac{M}{c_w^2} Z^0_\mu Z^0_\mu H - \frac{1}{2} ig[W^+_\mu(\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) - W^-_\mu(\phi^0 \partial_\mu \phi^+ - \phi^+ \partial_\mu \phi^0)] + \frac{1}{2} g[W^+_\mu (H \partial_\mu \phi^-$$

$$- \phi^- \partial_\mu H) - W^-_\mu (H \partial_\mu \phi^+ - \phi^+ \partial_\mu H)] + \frac{1}{2} g \frac{1}{c_w} (Z^0_\mu (H \partial_\mu \phi^0 - \phi^0 \partial_\mu H) - ig \frac{s_w^2}{c_w} M Z^0_\mu (W^+_\mu \phi^- - W^-_\mu \phi^+) + igs_w M A_\mu (W^+_\mu \phi^- - W^-_\mu \phi^+) - ig \frac{1-2c_w^2}{2c_w} Z^0_\mu (\phi^+ \partial_\mu \phi^- -$$

$$\phi^- \partial_\mu \phi^+) + igs_w A_\mu (\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \frac{1}{4} g^2 W^+_\mu W^-_\mu [H^2 + (\phi^0)^2 + 2\phi^+\phi^-] - \frac{1}{4} g^2 \frac{1}{c_w^2} Z^0_\mu Z^0_\mu [H^2 + (\phi^0)^2 + 2(2s_w^2 - 1)^2 \phi^+\phi^-] - \frac{1}{2} g^2 \frac{s_w^2}{c_w} Z^0_\mu \phi^0 (W^+_\mu \phi^- +$$

$$W^-_\mu \phi^+) + \frac{1}{2} ig^2 s_w A_\mu H (W^+_\mu \phi^- - W^-_\mu \phi^+) - g^2 \frac{s_w}{c_w} (2c_w^2 - 1) Z^0_\mu A_\mu \phi^+ \phi^- - g^2 s_w^2 A_\mu A_\mu \phi^+ \phi^- - \bar{e}^\lambda (\gamma\partial + m_e^\lambda) e^\lambda - \bar{\nu}^\lambda \gamma\partial \nu^\lambda - \bar{u}^\lambda_j (\gamma\partial + m_u^\lambda) u^\lambda_j - \bar{d}^\lambda_j (\gamma\partial + m_d^\lambda) d^\lambda_j$$

$$+ igs_w A_\mu [-(\bar{e}^\lambda \gamma^\mu e^\lambda) + \frac{2}{3}(\bar{u}^\lambda_j \gamma^\mu u^\lambda_j) - \frac{1}{3}(\bar{d}^\lambda_j \gamma^\mu d^\lambda_j)] + \frac{ig}{4c_w} Z^0_\mu [(\bar{\nu}^\lambda \gamma^\mu (1+\gamma^5) \nu^\lambda) + (\bar{e}^\lambda \gamma^\mu (4s_w^2 - 1 - \gamma^5) e^\lambda) + (\bar{u}^\lambda_j \gamma^\mu (\frac{4}{3}s_w^2 - 1 - \gamma^5) u^\lambda_j) + (\bar{d}^\lambda_j \gamma^\mu (1 - \frac{8}{3}s_w^2 - \gamma^5) d^\lambda_j)] +$$

$$\frac{ig}{2\sqrt{2}} W^+_\mu [(\bar{\nu}^\lambda \gamma^\mu (1+\gamma^5) e^\lambda) + (\bar{u}^\lambda_j \gamma^\mu (1+\gamma^5) C_{\lambda\kappa} d^\kappa_j)] + \frac{ig}{2\sqrt{2}} W^-_\mu [(\bar{e}^\lambda \gamma^\mu (1+\gamma^5) \nu^\lambda) + (\bar{d}^\kappa_j C^\dagger_{\lambda\kappa} \gamma^\mu (1+\gamma^5) u^\lambda_j)] + \frac{ig}{2\sqrt{2}} \frac{m_e^\lambda}{M} [-\phi^+ (\bar{\nu}^\lambda (1-\gamma^5) e^\lambda) + \phi^- (\bar{e}^\lambda (1+\gamma^5) \nu^\lambda)] - \frac{g}{2} \frac{m_e^\lambda}{M} [H($$

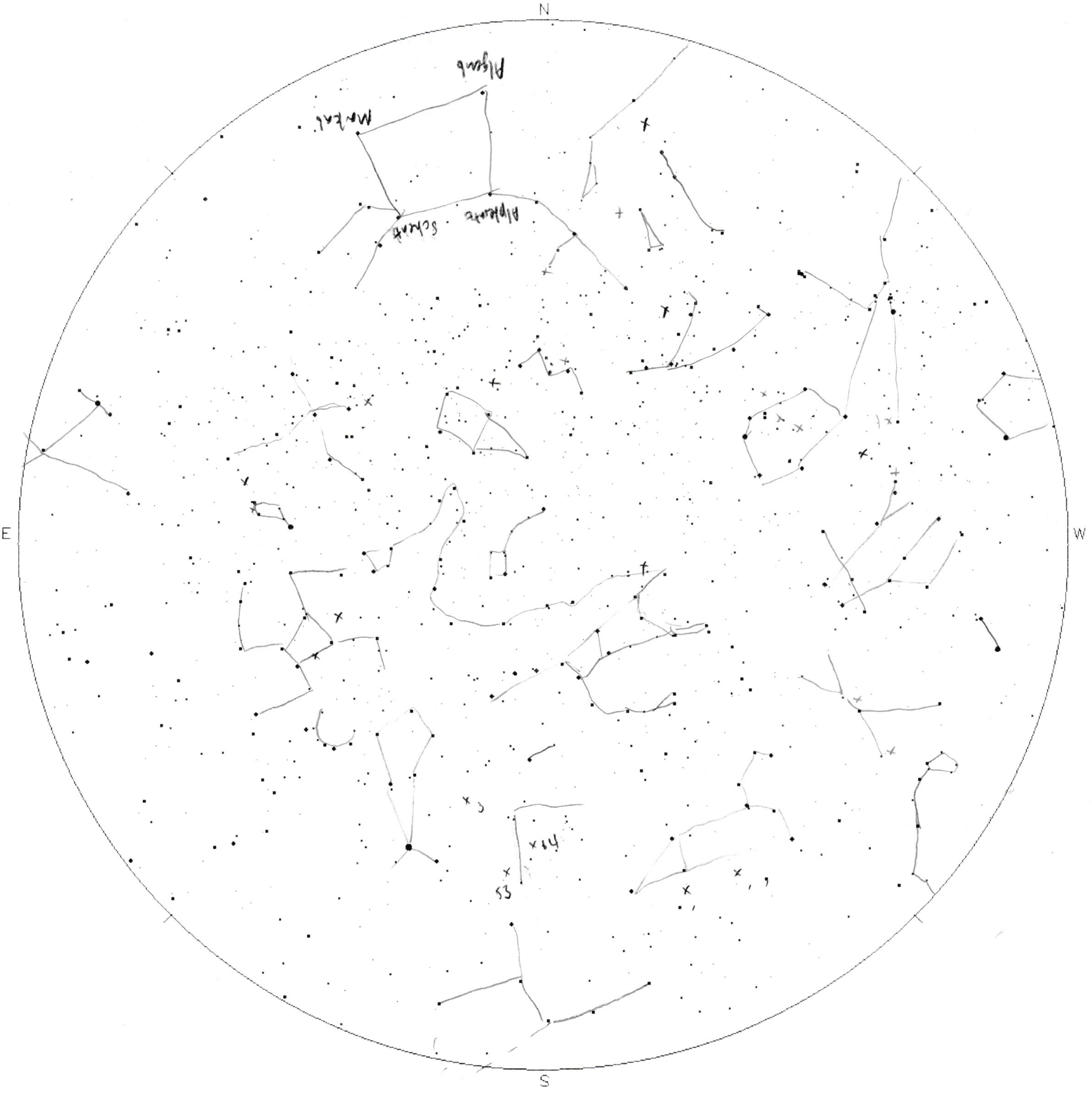
$$\bar{e}^\lambda e^\lambda) + i\phi^0 (\bar{e}^\lambda \gamma^5 e^\lambda)] + \frac{ig}{2M\sqrt{2}} \phi^+ [-m_d^\kappa (\bar{u}^\lambda_j C_{\lambda\kappa} (1-\gamma^5) d^\kappa_j) + m_u^\lambda (\bar{u}^\lambda_j C_{\lambda\kappa} (1+\gamma^5) d^\kappa_j] + \frac{ig}{2M\sqrt{2}} \phi^- [m_d^\lambda (\bar{d}^\lambda_j C^\dagger_{\lambda\kappa} (1+\gamma^5) u^\kappa_j) - m_u^\kappa (\bar{d}^\lambda_j C^\dagger_{\lambda\kappa} (1-\gamma^5) u^\kappa_j] - \frac{g}{2} \frac{m_u^\lambda}{M} H (\bar{u}^\lambda_j u^\lambda_j) -$$

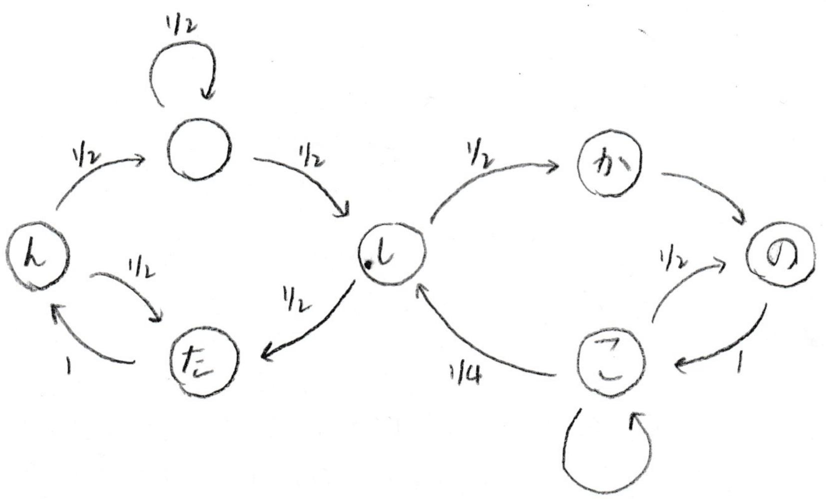
$$-\frac{g}{2} \frac{m_d^\lambda}{M} H (\bar{d}^\lambda_j d^\lambda_j) + \frac{ig}{2} \frac{m_u^\lambda}{M} \phi^0 (\bar{u}^\lambda_j \gamma^5 u^\lambda_j) - \frac{ig}{2} \frac{m_d^\lambda}{c_w^2} \phi^0 (\bar{d}^\lambda_j \gamma^5 d^\lambda_j) + \bar{X}^+ (\partial^2 - M^2) X^+ + \bar{X}^- (\partial^2 - M^2) X^- + \bar{X}^0 (\partial^2 \frac{M^2}{c_w^2}) X^0 + \bar{Y} \partial^2 Y + igc_w W^+_\mu (\partial_\mu \bar{X}^0 X^- - \partial_\mu \bar{X}^+$$

$$X^0) + igs_w W^+_\mu (\partial_\mu \bar{Y} X^- - \partial_\mu \bar{X}^+ Y) + igc_w W^-_\mu (\partial_\mu \bar{X}^- X^0 - \partial_\mu \bar{X}^0 X^+) + igs_w W^-_\mu (\partial_\mu \bar{X}^- Y - \partial_\mu \bar{Y} X^+) + igc_w Z^0_\mu (\partial_\mu \bar{X}^+ X^+ - \partial_\mu \bar{X}^- X^-) + igs_w A_\mu (\partial_\mu \bar{X}^+ X^+ - \partial_\mu \bar{X}^-$$

$$X^-) - \frac{1}{2} gM (\bar{X}^+ X^+ H - \bar{X}^- X^- H + \frac{1}{c_w^2} \bar{X}^0 X^0 H] + \frac{1-2c_w^2}{2c_w} igM [\bar{X}^+ X^0 \phi^+ - \bar{X}^- X^0 \phi^-] + \frac{1}{2c_w} igM [\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-] + igMs_w [\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-] + \frac{1}{2} igM [\bar{X}^+$$

$$X^+ \phi^0 - \bar{X}^- X^- \phi^0]$$


N
Algenib
Markab
Alpheratz
Scheat
E
W
x3
x14
53
S


1/2
1/2
1/2
1/2
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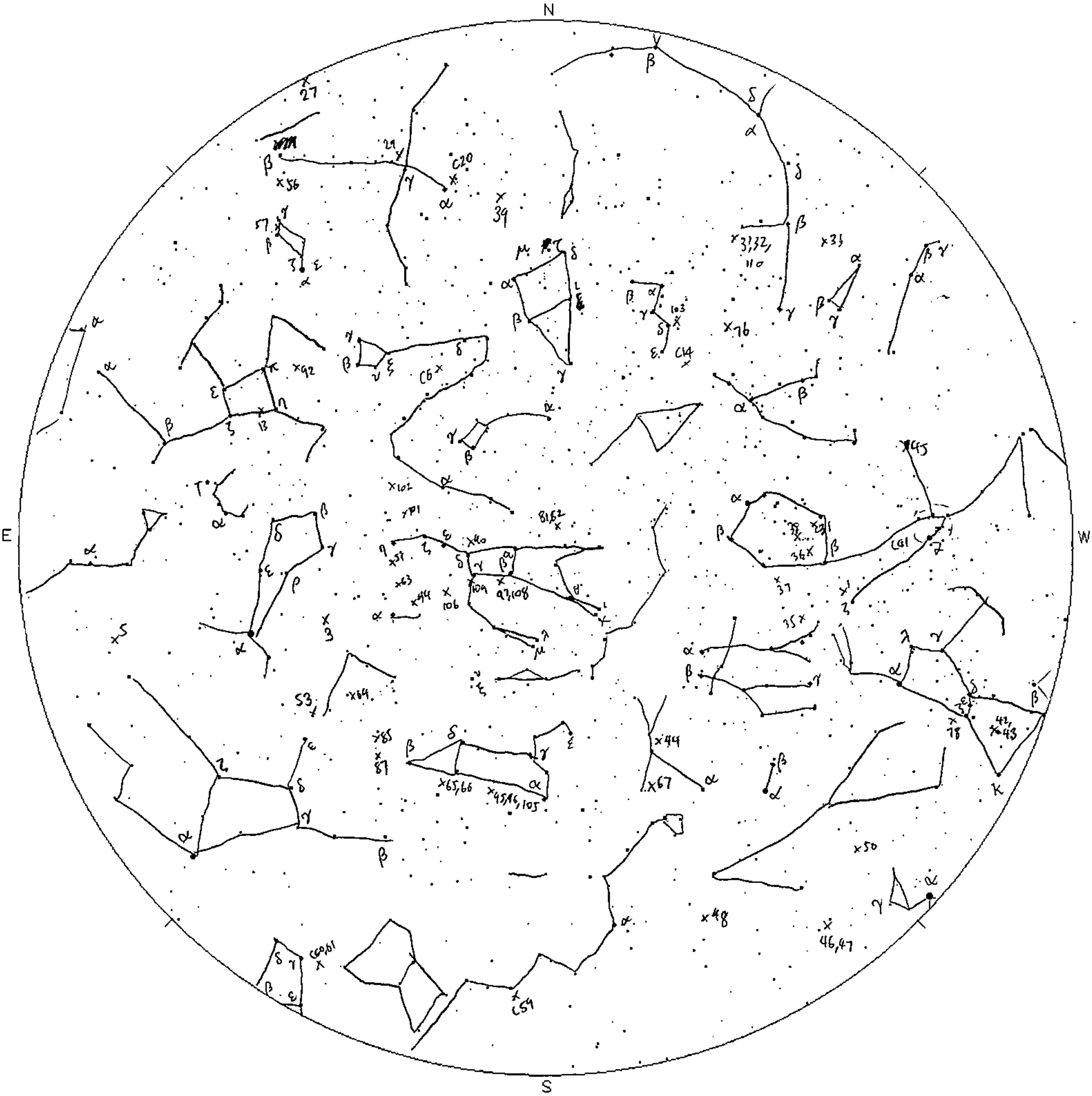
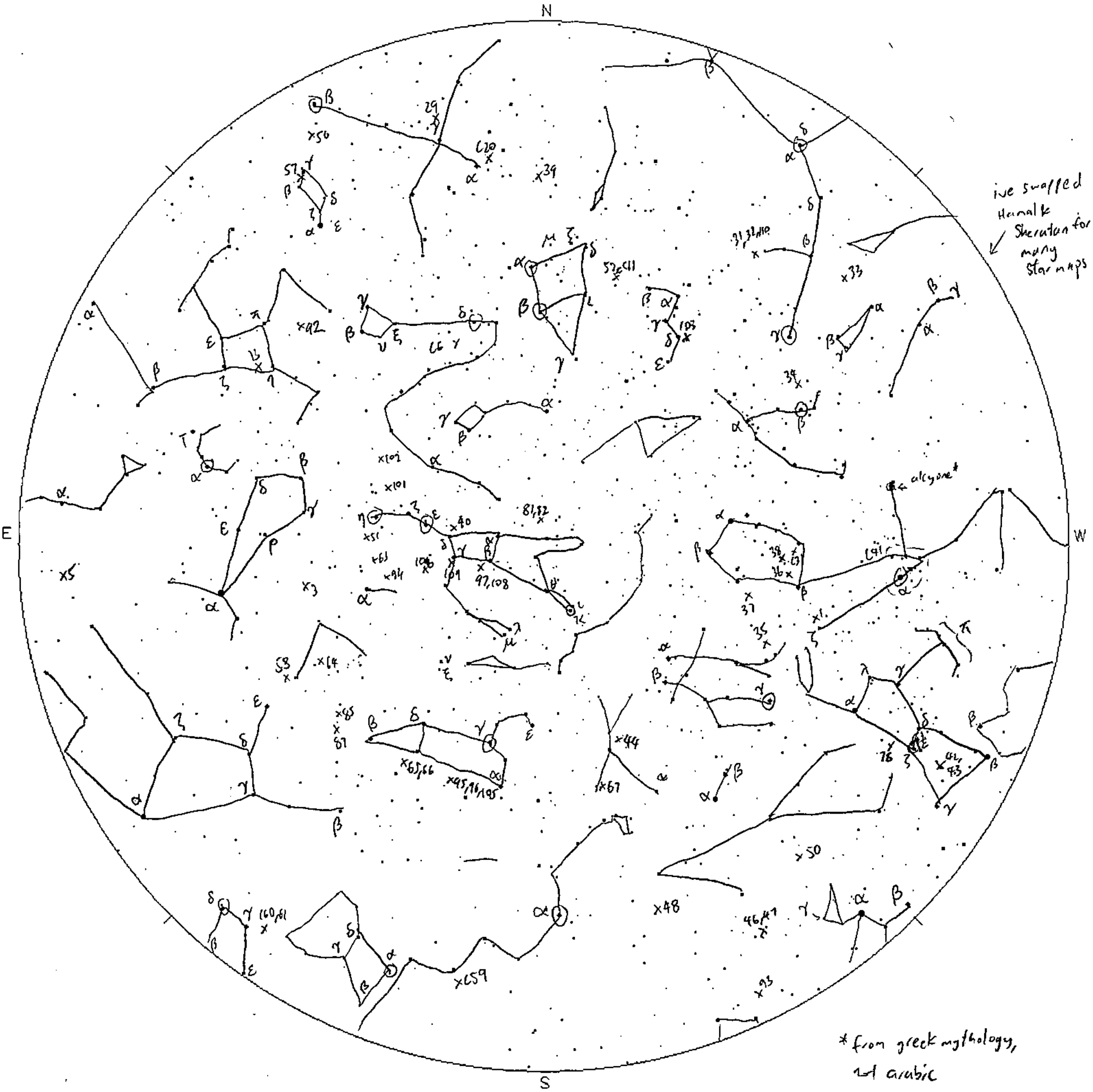
1/2
1/2
た
こ
1
1/4
1
1/4


N
27
β
×56
29
C20
γ
α
39
57
β
ζ
ε
α
μ
γ
δ
α
β
γ
β
δ
α
δ
β
×31,32,110
×33
β
α
γ
β
α
β
α
β
γ
β
δ
ε
103
C14
×76
α
α
ε
κ
×92
β
ζ
13
η
γ
β
ν
ξ
C6
δ
α
β
γ
α
β
×45
E
α
T
α
β
δ
γ
ε
ρ
α
×5
×102
×91
81,82
η
×37
ζ
ε
×40
δ
γ
β
α
×63
×44
α
106
109
97,108
θ
ι
λ
μ
3
×70
×21
β
36×
C61
α
W
×37
×1
ζ
35×
α
β
γ
γ
λ
α
δ
ξ
ε
β
78
42,43
κ
53
×64
ν
ξ
×85
×87
β
δ
γ
ε
×65,66
α
×45,46,105
×44
×67
α
β
α
ζ
ε
δ
γ
α
β
×50
γ
α
×48
×46,47
α
δ
γ
β
ε
C60,61
C59
S

we
are
here

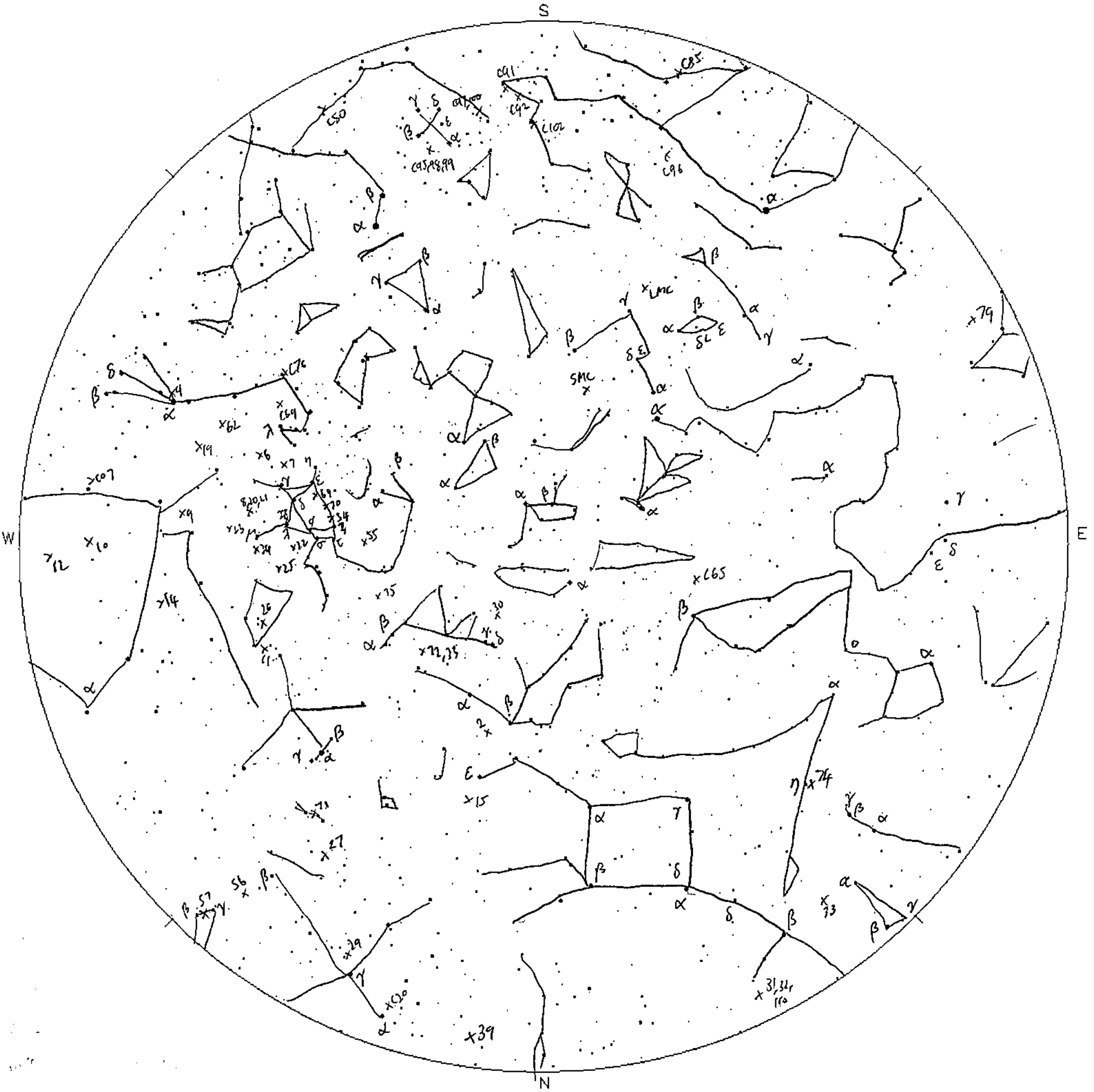
990



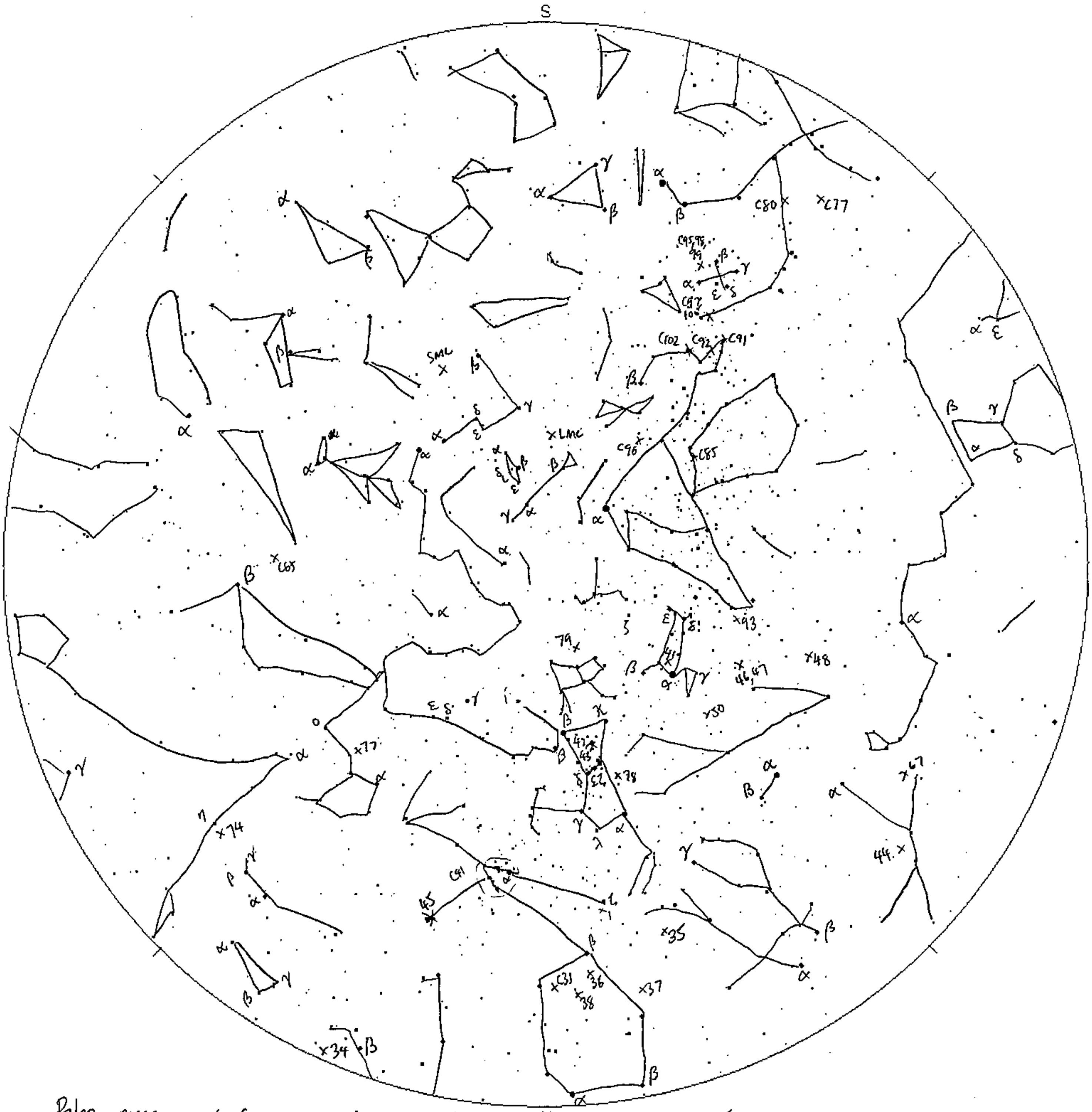
ive swapped Hamalk Sheratan for many starmaps

* from greek mythology, and arabic

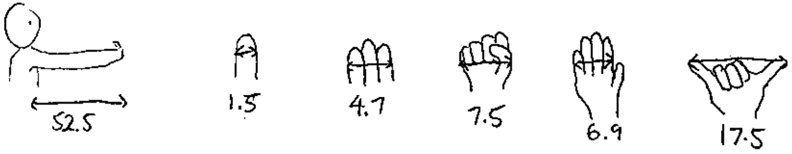
Circle all stars beginning with 'al'

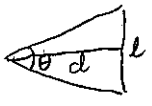

S
W
E
N
C85
C91
C92
C102
C50
C97,100
C95,98,99
C96
LMC
SMC
C76
C69
62
19
6
7
107
9
10
12
14
8,20,21
33
24
22
25
26
11
69
70
34
35
55
75
30
72,73
C65
79
74
2
15
71
27
56
57
29
C120
39
31,32,110
73


S
×SMC
×LMC
×55
×79
41, ×43
κ
W
×41
×50
46,47
×48
C96
C85
C102
C92
C91
C97, 100
C95,98
×99
C90
C77
×83
C76
C69
×62
×19
4×
×80
×70
×69
54
×22
×25
×28
8,20,21
×24
16,17, 18
×23
×9
E
×14
×10
×12
107
C68
C60, 61
×104
×5
×67
44 ×
95,96,105
×65,66
×87
×85
×53
N



Palm measurements for prac since IOAA is soon.





$\tan\frac{\theta}{2} = \frac{l}{2d}$

$\theta = 2\tan^{-1}\left(\frac{l}{2d}\right)$

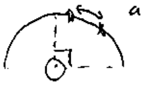
θ	1.63°	5.12°	8.17°	7.52°	18.9°
θ_c	1.1°	3.4°	~~8.4°~~	~~5.0°~~	~~12.6°~~ ~~~12.5°~~
	~1.2°	~4ish	≈8	~7.5	[illegible] ~19

Sus, 1.5 w̄ offsets from moon

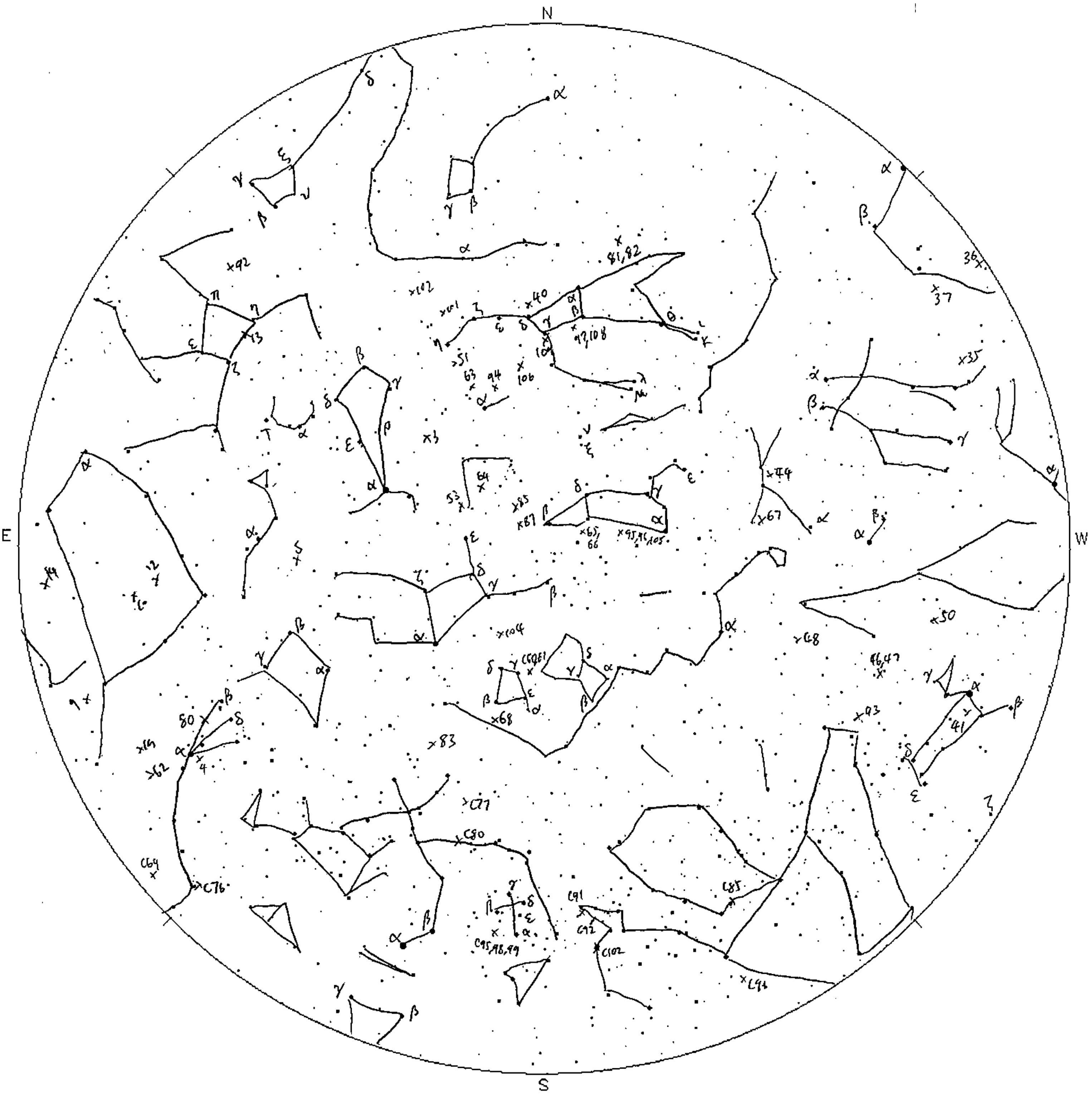
nah uh

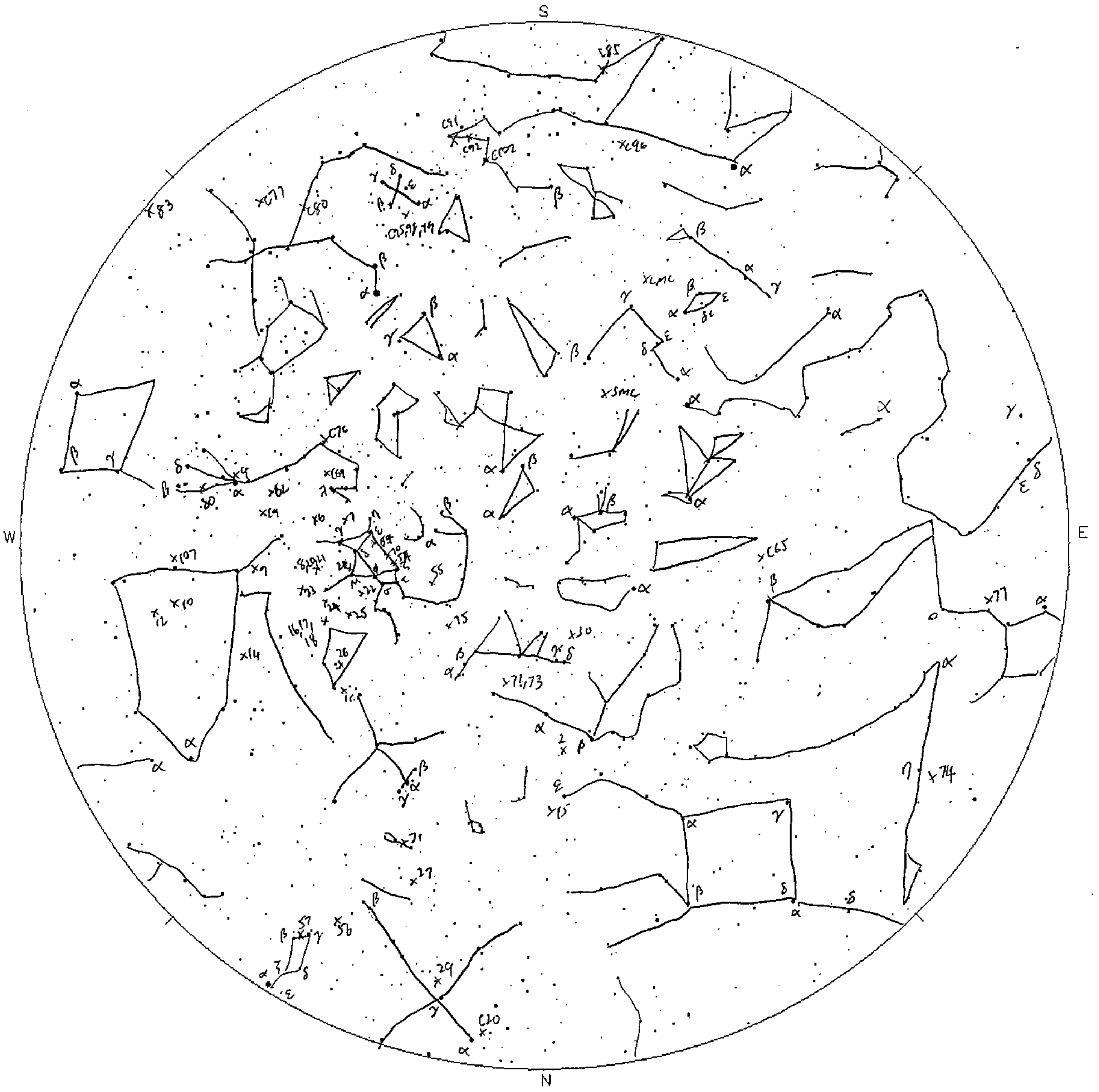
⇒ estimates only,
planetarium distortion will be worse

often better to judge with fraction of sky



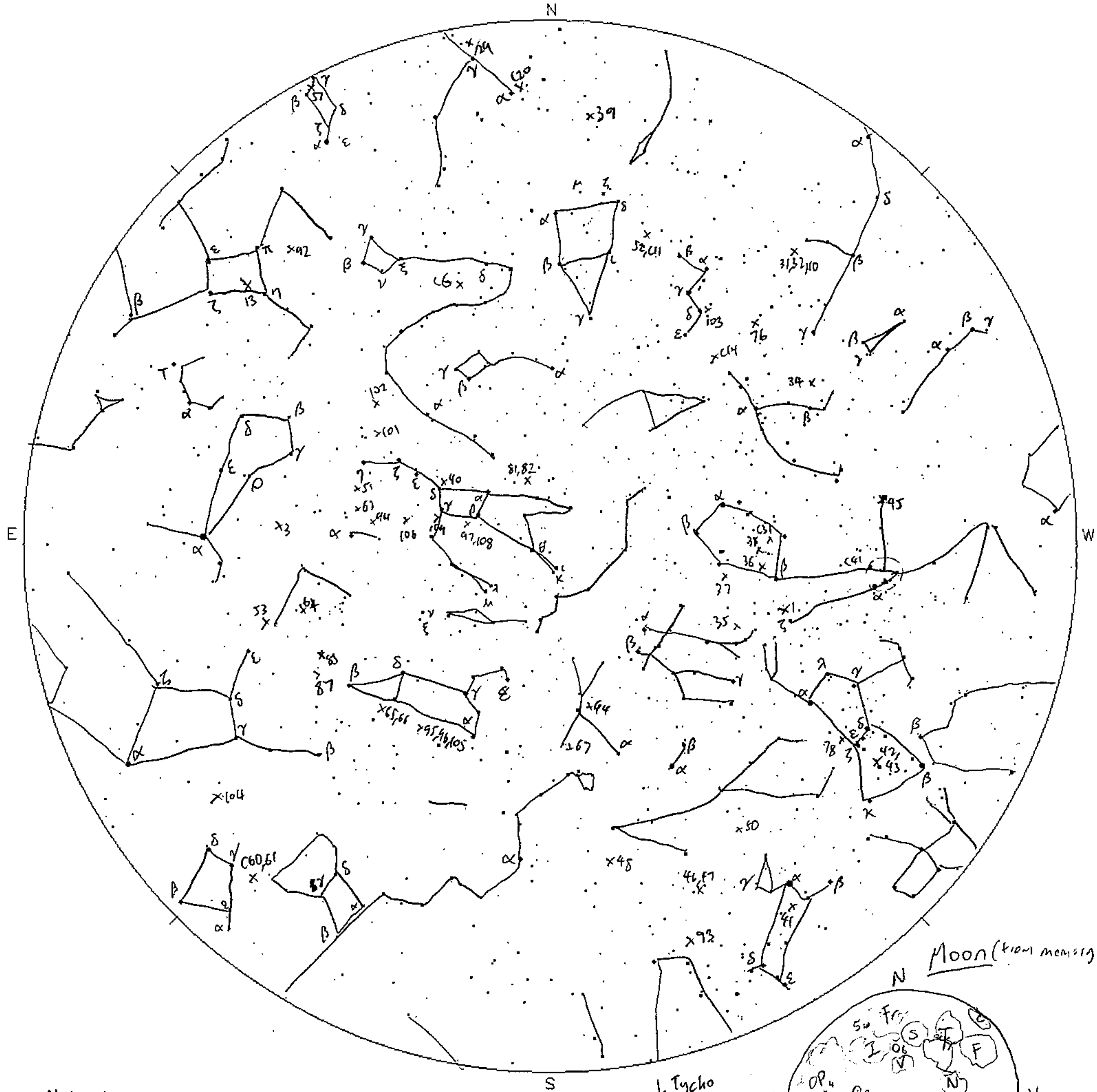
around ½ Z → horizon, so ~40-45°


N
E
W
S
α
γ
β
δ
ξ
γ
β
ν
α
×92
π
η
ε
ζ
×13
×102
×101
ζ
ε
δ
γ
×40
α
β
×81,82
θ
ι
κ
η
×51
63
94
106
10
97,108
λ
μ
β
γ
δ
ε
ρ
α
T
α
×3
ν
ξ
64
53
×85
×87
β
δ
γ
ε
α
×65,66
×95,96,105
×44
×67
α
β
α
36
37
×35
α
β
γ
α
×19
12
γ
ε
ζ
α
ε
δ
γ
β
ζ
α
×104
β
γ
α
δ
γ
C59,61
ε
δ
β
×68
γ
δ
α
β
α
×48
×50
46,47
γ
α
β
41
δ
ε
ζ
9
80
β
δ
×19
α
4
×62
×83
×93
×C77
×C80
C69
×C76
γ
β
δ
ε
α
C95,98,99
α
β
C91
C92
C102
C85
×C94
γ
β

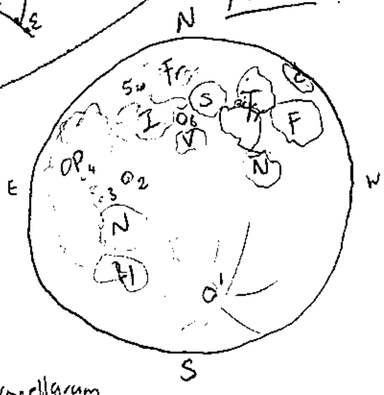


my working hours :)

996



Moon (from memory)



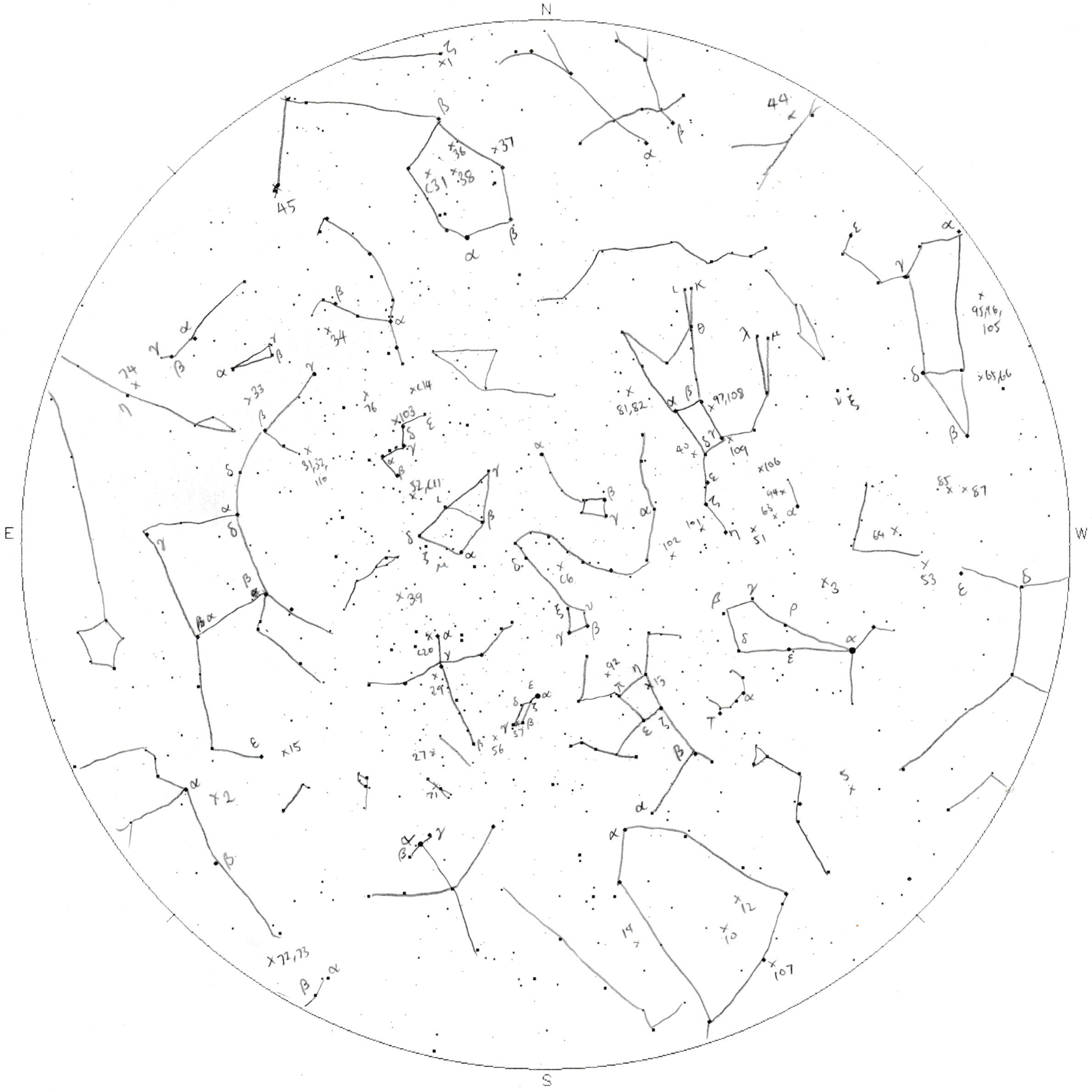
Alpheratz	(α And)	0h
Hamal	(α Ari)	2h
Betelgeuse	(α Ori)	6h
Regulus	(α Leo)	10h
Denebola	(β Leo)	12h
Spica	(α Vir)	13h30m
Antares	(α Sco)	16h30m
Alnasl	(γ Sgr)	18h
Altair	(α Aql)	20h
Markab	(α Peg)	23h
Kochab	(β UMi)	15h

Dubhe Merak	(α UMa) (β UMa)	11h
Hadar	(β Cen)	14h
Acrux Gacrux	(α Cru) (γ Cru)	12h30m
Canopus	(α Car)	6h30m
Peacock	(α Pav)	20h30m
Alnair	(α Gru)	22h
Fomalhaut	(α PsA)	23h

more South

1. Tycho
2. Copernicus
4. Aristarchus
3. Kepler
5. Plato
6. Archimedes

OP: Oceanus Procellarum
N: Mare Nubium
I: Mare Imbrium
V: Mare Vaporium
Fr: Mare Frigorium
S: Mare Serenetatis
T: Mare Tranquillitatis
N: Mare Nectaris
F: Mare Fecunditatis
C: Mare Crisium
H: Mare Humorum

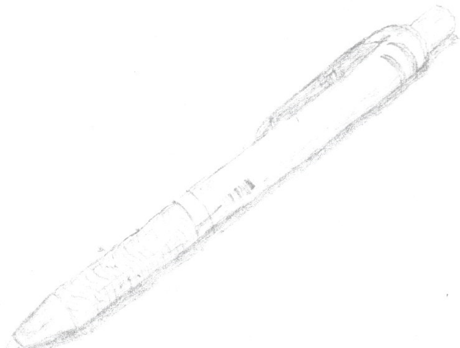


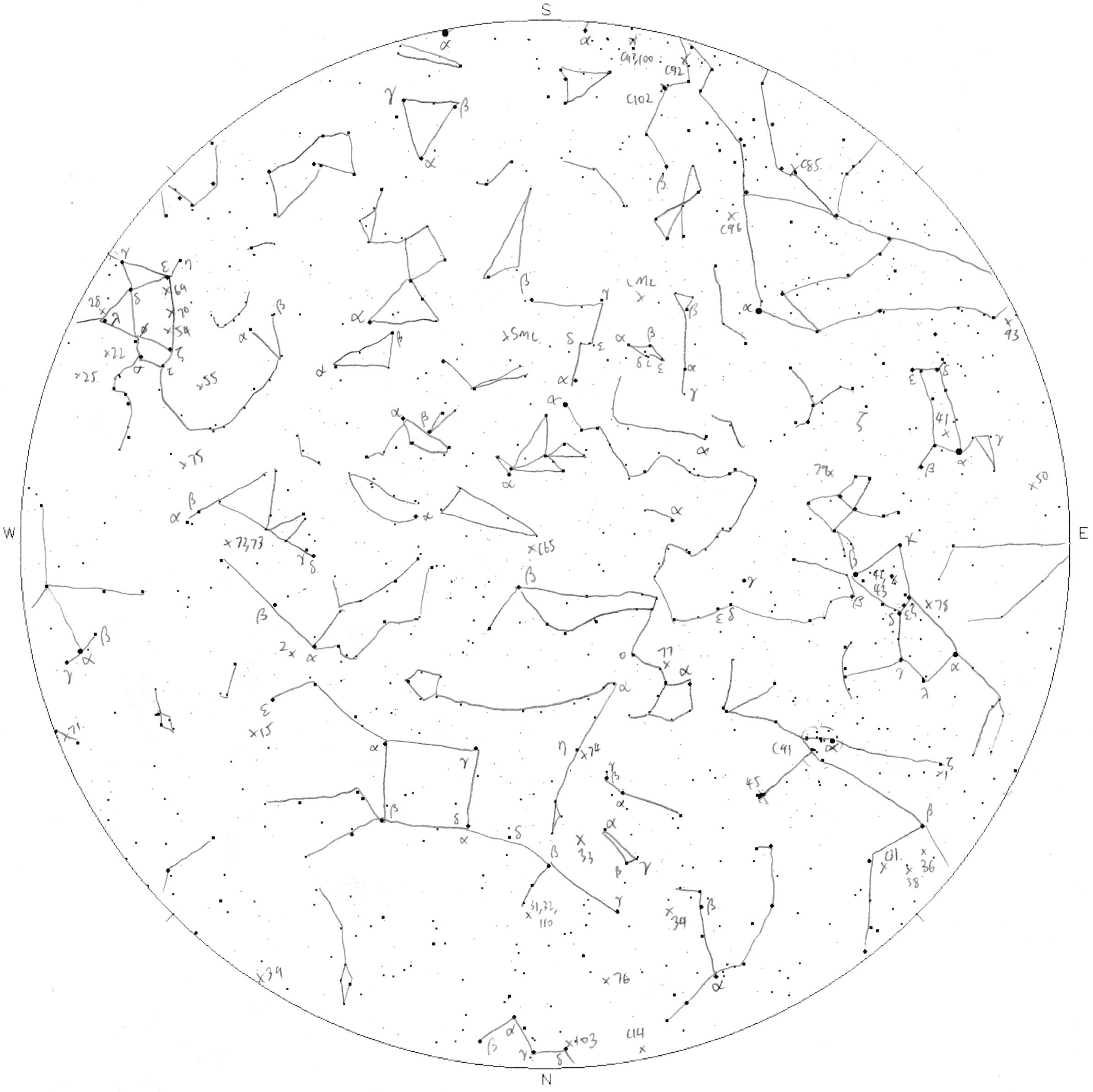
(Written & drawn after IOAA)

He drew number 1 & 1000

He was there in IOAA 2023 & 2024

(He also drew this and wrote this text)



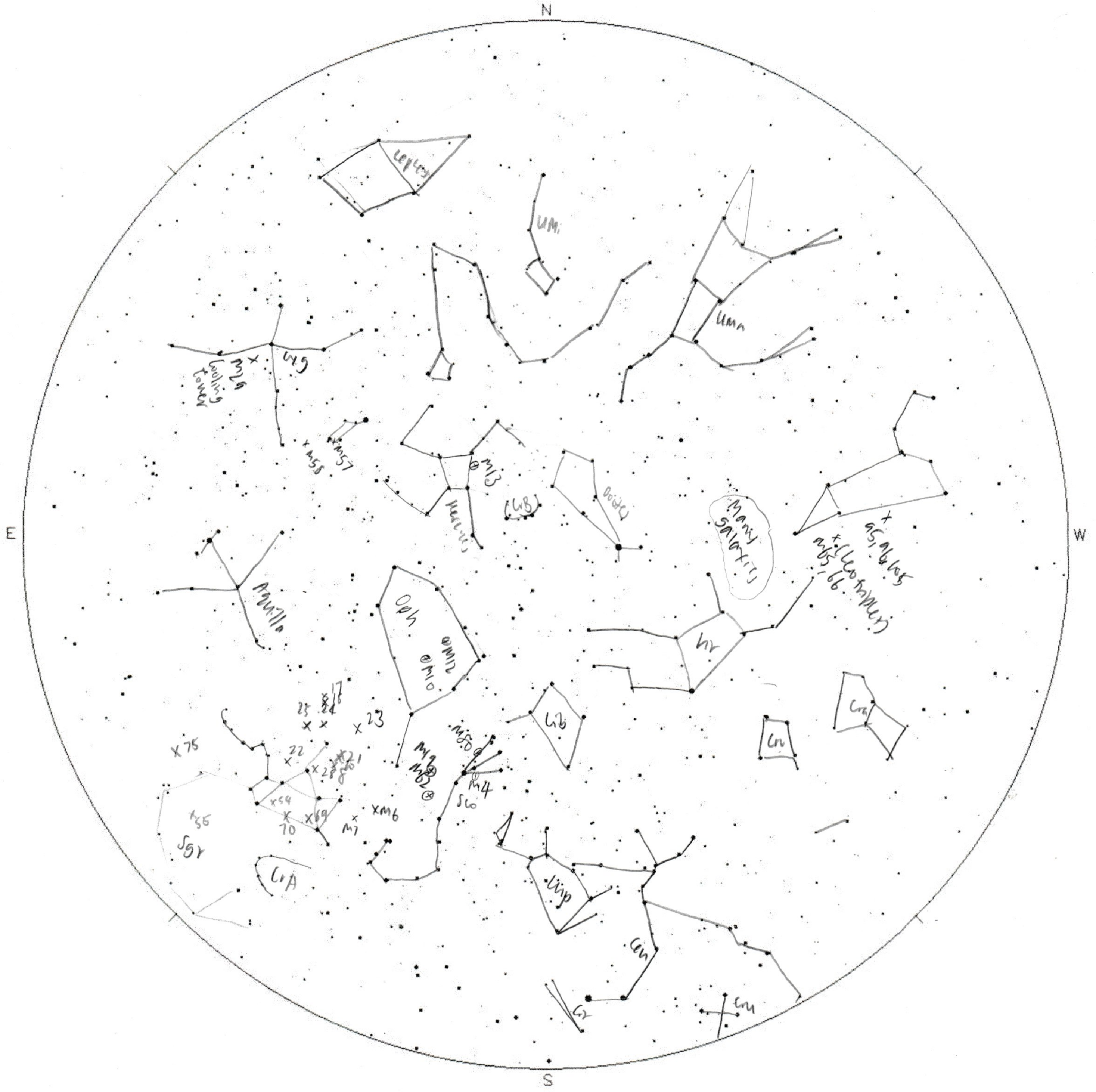

S
N
W
E
C97,100
C92
C102
C85
C96
LMC
SMC
C41
28
69
70
54
22
25
55
75
72,73
2
15
71
39
74
33
31,32,110
34
76
103
114
45
31
36
38
79
41,42,43
78
41
50
93
77
165

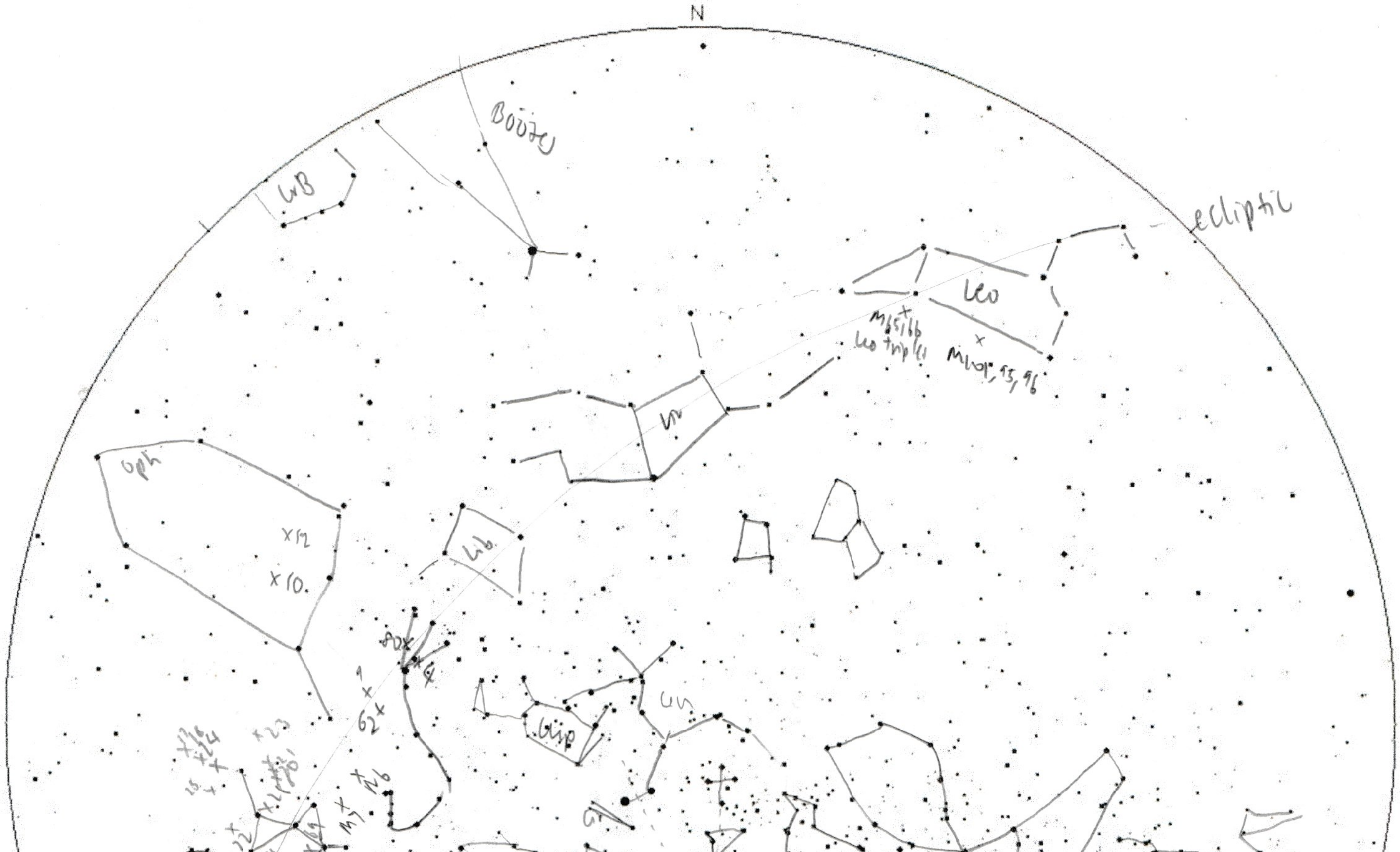
cops

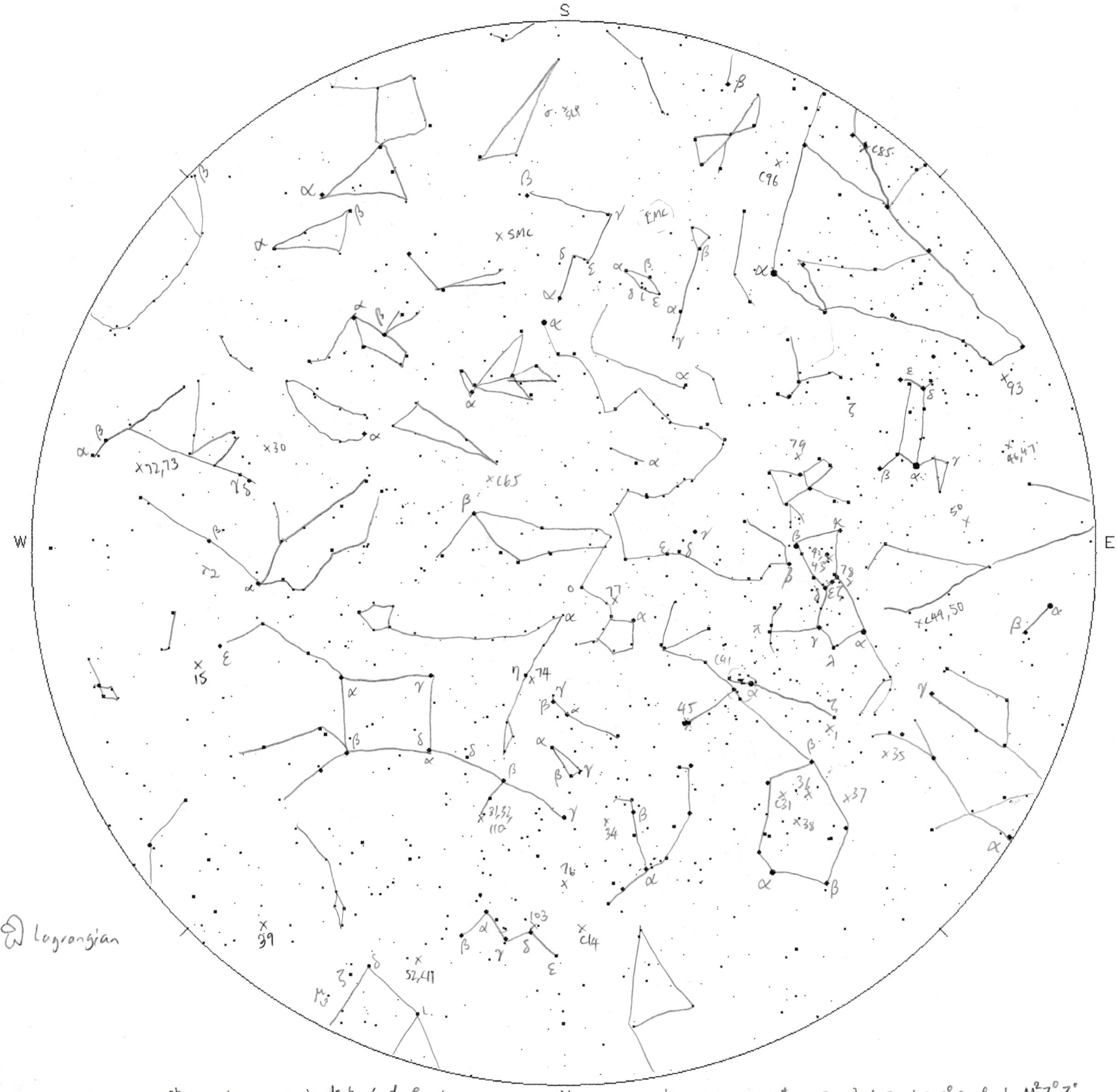
13/8/2024
7:36 am

Addendum

The following star maps are included due to printing errors and miscommunication. They are duplicates of the star maps featured above.

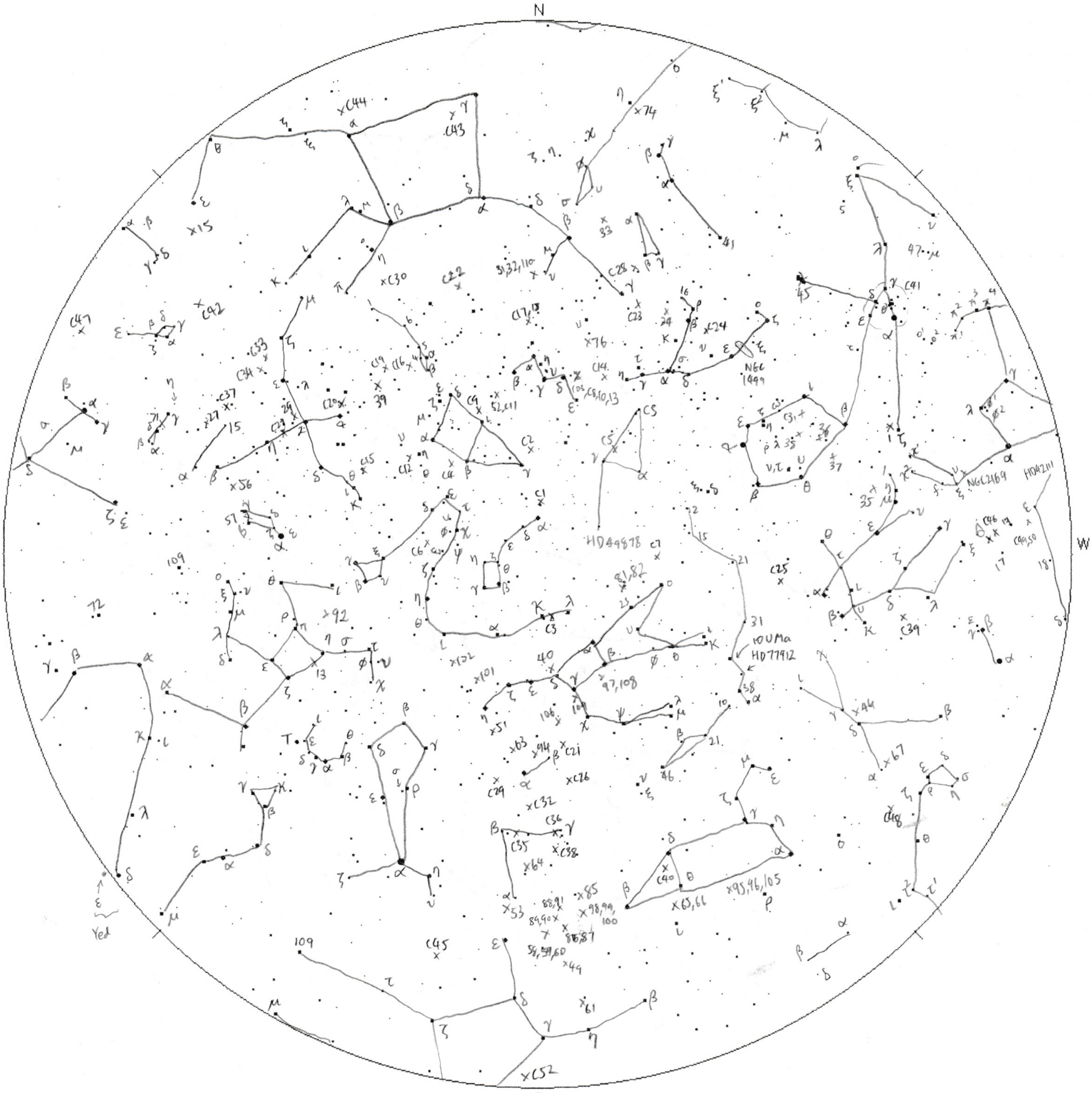
N
E
W
S
Cepheus
UMi
UMa
Cyg
M29
Cooling tower
M56
M57
Hercules
M13
CrB
Bootes
Many galaxies
95, 96, 105
(Leo triplet)
M65, 66
Aquilla
Oph
M12
M10
Vir
Crv
Cra
Lib
17
16
25
24
23
22
21
28
8
20
75
54
55
69
70
M7
M6
M19
M62
M80
M4
Sco
Sgr
CrA
Lup
Cen
Cr
Cru


N
Boötes
CrB
ecliptic
Leo
M65,66
Leo triplet
M105, 95, 96
Vir
Lib
Oph
x12
x10.
80x
x4
x9
62x
x23
x M7
M6
x69
x54
x22
x28
70
x55
x76
x Cen
Lup
Cir
OSCp
SMC
47 Tuc
E
W
S



ᗣ Lagrangian

$$\mathcal{L}_{SM}=-\frac{1}{2}\partial_\nu g^a_\mu\partial_\nu g^a_\mu-g_sf^{abc}\partial_\mu g^a_\nu g^b_\mu g^c_\nu-\frac{1}{4}g_s^2f^{abc}f^{ade}g^b_\mu g^c_\nu g^d_\mu g^e_\nu+\frac{1}{2}ig_s^2(\bar{q}^\sigma_i\gamma^\mu q^\sigma_j)+G^a\partial^2G^a+g_sf^{abc}\partial_\mu G^aG^bg^c_\mu-\partial_\nu W^+_\mu\partial_\nu W^-_\mu-M^2W^+_\mu W^-_\mu-\frac{1}{2}\partial_\nu Z^0_\mu\partial_\nu Z^0_\mu-\frac{1}{2c_w^2}M^2Z^0_\mu Z^0_\mu$$
$$-\frac{1}{2}\partial_\mu A_\nu\partial_\mu A_\nu-\frac{1}{2}\partial_\mu H\partial_\mu H-\frac{1}{2}m_h^2H^2-\partial_\mu ᗣ^+\partial_\mu ᗣ^--M^2ᗣ^+ᗣ^--\frac{1}{2}\partial_\mu ᗣ^0\partial_\mu ᗣ^0-\frac{1}{2c_w^2}Mᗣ^0ᗣ^0-\beta_h\left[\frac{2M^2}{g^2}+\frac{2M}{g}H+\frac{1}{2}(H^2+ᗣ^0ᗣ^0+2ᗣ^+ᗣ^-)\right]+\frac{2M^4}{g^2}\alpha_h-igc_w[\partial_\nu Z^0_\mu(W^+_\mu W^-_\nu-W^+_\nu W^-_\mu)$$
$$-Z^0_\nu(W^+_\mu\partial_\nu W^-_\mu-W^-_\mu\partial_\nu W^+_\mu)+Z^0_\mu(W^+_\nu\partial_\nu W^-_\mu-W^-_\nu\partial_\nu W^+_\mu)]-igs_w[\partial_\nu A_\mu(W^+_\mu W^-_\nu-W^+_\nu W^-_\mu)-A_\nu(W^+_\mu\partial_\nu W^-_\mu-W^-_\mu\partial_\nu W^+_\mu)+A_\mu(W^+_\nu\partial_\nu W^-_\mu-W^-_\nu\partial_\nu W^+_\mu)]-\frac{1}{2}g^2W^+_\mu W^-_\mu W^+_\nu W^-_\nu+\frac{1}{2}g^2W^+_\mu W^-_\nu W^+_\mu W^-_\nu$$
$$+g^2c_w^2(Z^0_\mu W^+_\mu Z^0_\nu W^-_\nu-Z^0_\mu Z^0_\mu W^+_\nu W^-_\nu)+g^2s_w^2(A_\mu W^+_\mu A_\nu W^-_\nu-A_\mu A_\mu W^+_\nu W^-_\nu)+g^2s_wc_w[A_\mu Z^0_\nu(W^+_\mu W^-_\nu-W^+_\nu W^-_\mu)-2A_\mu Z^0_\mu W^+_\nu W^-_\nu]-g\alpha[H^3+Hᗣ^0ᗣ^0+2Hᗣ^+ᗣ^-]-\frac{1}{8}g^2\alpha_h[H^4+(ᗣ^0)^4+4(ᗣ^+ᗣ^-)^2$$
$$+4(ᗣ^0)^2ᗣ^+ᗣ^-+4H^2ᗣ^+ᗣ^-+2(ᗣ^0)^2H^2]-gMW^+_\mu W^-_\mu H-\frac{1}{2}g\frac{M}{c_w^2}Z^0_\mu Z^0_\mu H-\frac{1}{2}ig[W^+_\mu(ᗣ^0\partial_\mu ᗣ^--ᗣ^-\partial_\mu ᗣ^0)-W^-_\mu(ᗣ^0\partial_\mu ᗣ^+-ᗣ^+\partial_\mu ᗣ^0)]+\frac{1}{2}g[W^+_\mu(H\partial_\mu ᗣ^--ᗣ^-\partial_\mu H)-W^-_\mu(H\partial_\mu ᗣ^+-ᗣ^+\partial_\mu H)]+\frac{1}{2}g\frac{1}{c_w}(Z^0_\mu($$
$$H\partial_\mu ᗣ^0-ᗣ^0\partial_\mu H)-ig\frac{s_w^2}{c_w}MZ^0_\mu(W^+_\mu ᗣ^--W^-_\mu ᗣ^+)+igs_wMA_\mu(W^+_\mu ᗣ^--W^-_\mu ᗣ^+)-ig\frac{1-2c_w^2}{2c_w}Z^0_\mu(ᗣ^+\partial_\mu ᗣ^--ᗣ^-\partial_\mu ᗣ^+)+igs_wA_\mu(ᗣ^+\partial_\mu ᗣ^--ᗣ^-\partial_\mu ᗣ^+)-\frac{1}{4}g^2W^+_\mu W^-_\mu[H^2+(ᗣ^0)^2+2ᗣ^+ᗣ^-]-\frac{1}{4}g^2\frac{1}{c_w^2}Z^0_\mu Z^0_\mu[$$
$$H^2+(ᗣ^0)^2+2(2s_w^2-1)^2ᗣ^+ᗣ^-]-\frac{1}{2}g^2\frac{s_w^2}{c_w}Z^0_\mu ᗣ^0(W^+_\mu ᗣ^-+W^-_\mu ᗣ^+)-\frac{1}{2}ig^2\frac{s_w^2}{c_w}Z^0_\mu H(W^+_\mu ᗣ^--W^-_\mu ᗣ^+)+\frac{1}{2}g^2s_wA_\mu ᗣ^0(W^+_\mu ᗣ^-+W^-_\mu ᗣ^+)+\frac{1}{2}ig^2s_wA_\mu H(W^+_\mu ᗣ^--W^-_\mu ᗣ^+)-g^2\frac{s_w}{c_w}(2c_w^2-1)Z^0_\mu A_\mu ᗣ^+ᗣ^--g^2s_w^2A_\mu A_\mu ᗣ^+ᗣ^-$$
$$-\bar{e}^\lambda(\gamma\partial+m_e^\lambda)e^\lambda-\bar{\nu}^\lambda\gamma\partial\nu^\lambda-\bar{u}^\lambda_j(\gamma\partial+m_u^\lambda)u^\lambda_j-\bar{d}^\lambda_j(\gamma\partial+m_d^\lambda)d^\lambda_j+igs_wA_\mu\left[-(\bar{e}^\lambda\gamma^\mu e^\lambda)+\frac{2}{3}(\bar{u}^\lambda_j\gamma^\mu u^\lambda_j)-\frac{1}{3}(\bar{d}^\lambda_j\gamma^\mu d^\lambda_j)\right]+\frac{ig}{4c_w}Z^0_\mu[(\bar{\nu}^\lambda\gamma^\mu(1+\gamma^5)\nu^\lambda)+(\bar{e}^\lambda\gamma^\mu(4s_w^2-1-\gamma^5)e^\lambda)+(\bar{u}^\lambda_j\gamma^\mu(\tfrac{4}{3}s_w^2-1-\gamma^5)u^\lambda_j)$$
$$+(\bar{d}^\lambda_j\gamma^\mu(1-\tfrac{8}{3}s_w^2-\gamma^5)d^\lambda_j)]+\frac{ig}{2\sqrt{2}}W^+_\mu[(\bar{\nu}^\lambda\gamma^\mu(1+\gamma^5)e^\lambda)+(\bar{u}^\lambda_j\gamma^\mu(1+\gamma^5)C_{\lambda\kappa}d^\kappa_j)]+\frac{ig}{2\sqrt{2}}W^-_\mu[(\bar{e}^\lambda\gamma^\mu(1+\gamma^5)\nu^\lambda)+(\bar{d}^\kappa_jC^\dagger_{\lambda\kappa}\gamma^\mu(1+\gamma^5)u^\lambda_j)]+\frac{ig}{2\sqrt{2}}\frac{m_e^\lambda}{M}[-ᗣ^+(\bar{\nu}^\lambda(1-\gamma^5)e^\lambda)+ᗣ^-(\bar{e}^\lambda(1+\gamma^5)\nu^\lambda)]-\frac{g}{2}\frac{m_e^\lambda}{M}[$$
$$H(\bar{e}^\lambda e^\lambda)+iᗣ^0(\bar{e}^\lambda\gamma^5e^\lambda)]+\frac{ig}{2M\sqrt{2}}ᗣ^+[-m_d^\kappa(\bar{u}^\lambda_jC_{\lambda\kappa}(1-\gamma^5)d^\kappa_j)+m_u^\lambda(\bar{u}^\lambda_jC_{\lambda\kappa}(1+\gamma^5)d^\kappa_j)]+\frac{ig}{2M\sqrt{2}}ᗣ^-[m_d^\lambda(\bar{d}^\lambda_jC^\dagger_{\lambda\kappa}(1+\gamma^5)u^\kappa_j)-m_u^\kappa(\bar{d}^\lambda_jC^\dagger_{\lambda\kappa}(1-\gamma^5)u^\kappa_j)]-\frac{g}{2}\frac{m_u^\lambda}{M}H(\bar{u}^\lambda_ju^\lambda_j)-\frac{g}{2}\frac{m_d^\lambda}{M}H(\bar{d}^\lambda_jd^\lambda_j)+\frac{ig}{2}\frac{m_u^\lambda}{M}ᗣ^0$$
$$(\bar{u}^\lambda_j\gamma^5u^\lambda_j)-\frac{ig}{2}\frac{m_d^\lambda}{M}ᗣ^0(\bar{d}^\lambda_j\gamma^5d^\lambda_j)+\bar{X}^+(\partial^2-M^2)X^++\bar{X}^-(\partial^2-M^2)X^-+\bar{X}^0(\partial^2-\frac{M^2}{c_w^2})X^0+\bar{Y}\partial^2Y+igc_wW^+_\mu(\partial_\mu\bar{X}^0X^--\partial_\mu\bar{X}^+X^0)+igs_wW^+_\mu(\partial_\mu\bar{Y}X^--\partial_\mu\bar{X}^+Y)+igc_wW^-_\mu(\partial_\mu\bar{X}^-X^0-\partial_\mu\bar{X}^0X^+)+igs_wW^-_\mu$$
$$(\partial_\mu\bar{X}^-Y-\partial_\mu\bar{Y}X^+)+igc_wZ^0_\mu(\partial_\mu\bar{X}^+X^+-\partial_\mu\bar{X}^-X^-)+igs_wA_\mu(\partial_\mu\bar{X}^+X^+-\partial_\mu\bar{X}^-X^-)-\frac{1}{2}gM[\bar{X}^+X^+H+\bar{X}^-X^-H+\frac{1}{c_w^2}\bar{X}^0X^0H]+\frac{1-2c_w^2}{2c_w}igM[\bar{X}^+X^0ᗣ^+-\bar{X}^-X^0ᗣ^-]+\frac{1}{2c_w}igM[\bar{X}^0X^-ᗣ^+-\bar{X}^0X^+ᗣ^-]+$$
$$igMs_w[\bar{X}^0X^-ᗣ^+-\bar{X}^0X^+ᗣ^-]+\frac{1}{2}igM[\bar{X}^+X^+ᗣ^0-\bar{X}^-X^-ᗣ^0].$$



(we lost this particular star map in IOAA so it is a reprint)

Labels next to dots → Star names

- ↳ Greek letters α β γ δ … ⇒ Bayer designations
- ↳ Numbers 1, 2, 109 … ⇒ Flamsteed codes
- ↳ Prefix HD ⇒ Henry Draper catalogue

Labels next to crosses → DSOs

- ↳ Numbers ⇒ Messier Objs
- ↳ Prefix C ⇒ Caldwell Objs

$\overset{103,\,C8,10,13}{\times}$ ⇝ Messier 103, Caldwell 8, 10, 13.

(these are around this cross to some radius)