

## CHAPTER TWO



# Long Tails of Two Bears

April–July

URSA MAJOR	URSA MINOR	DRACO
The Big Bear	The Little Bear	The Dragon

These three constellations are a good starting point since they are visible to most people in the northern hemisphere at some time of the night throughout most of the year. They also contain two asterisms familiar to many people. The brighter stars in Ursa Major and Ursa Minor form the big and little dippers, which are well known and easily recognized. In addition, the star marking the end of the Little Bear’s tail is Polaris, the North Star, and two of the stars in the bowl of the big dipper always point toward Polaris. These three stars can be used to help you find your directions at night.

After the two dippers are located, it is easy to add the other stars to the big dipper to form the entire constellation of Ursa Major, the big bear. The stars forming the little dipper include almost all the easily visible stars in Ursa Minor, so the asterism and the constellation figure are virtually the same. Using pairs of stars from these constellations, we can draw imaginary lines across the sky which point to other constellations or bright stars. As additional constellations are recognized, they can then be used as guides to still more constellations or bright stars.

The ancient Greeks envisioned their gods as literally being “super-humans,” with all the normal human virtues and faults. The biggest differences that distinguished the gods from humans were their immortality and their power to accomplish magical things.

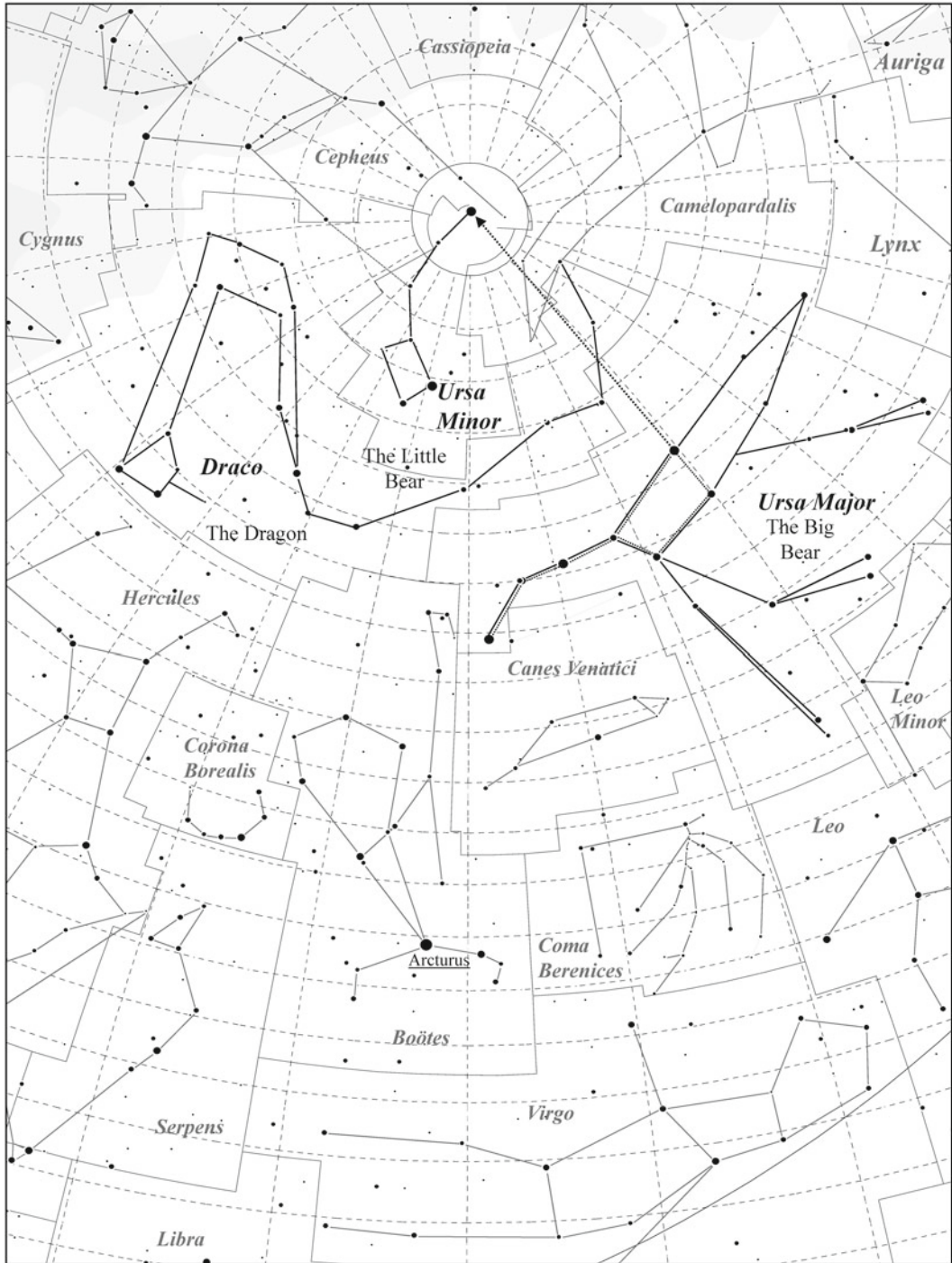
Partly by chance and partly by choice, the Olympian gods and goddesses acquired realms of special interest in which each was supreme. Also, although each had magical powers, there were also limitations, and no deity could directly undo the acts of another. At best, one could only cast another spell to modify or lessen the effects of the earlier spell. These powers and limitations play important parts in many of the myths used by the ancient Greeks to explain the constellations.

Zeus, the king of the gods, was envisioned as being quite a woman chaser, while his wife Hera was depicted as jealous and vindictive. Zeus was supposed to have loved many mortal women and to have had many children by them, some of whom were immortal while others were mortal. These affairs were important to mortals since many of the great heroes, kings, and founders of new countries traced their ancestry back to the supposed affairs between Zeus and mortal women. Their celestial heritage both explained their extraordinary strength, skill, or ability, and at the same time, justified their positions as king, leader, or prophet.

One of the women who attracted the attention of Zeus was Callisto, the beautiful daughter of Lycaon, the king of Arcadia. Callisto bore Zeus a son named Arcas. Hera discovered Zeus' infidelity and was furious at him, and extremely jealous of the beautiful Callisto. Since she was less powerful than Zeus and could not harm him directly, Hera vented her anger by changing Callisto into the ugliest animal she could imagine – a bear with shaggy fur and long teeth and claws, unable to make any sounds except growls. Callisto tried to communicate her identity and plight, but the citizens of Arcadia saw only a wild bear and drove the unfortunate woman into the forests, forever cut off from the company of humans.

After the unexplained disappearance of Callisto, Arcas was raised by his grandparents, the king and queen. As he grew into a handsome young man, Arcas became a skilled hunter. While he was hunting one day, Callisto saw and recognized Arcas. She cried out and rushed toward him. Of course, Arcas didn't recognize his mother and to protect himself, he raised his spear and aimed it at her heart. Zeus had been watching over his son, and immediately intervened to prevent the impending tragedy. He changed Arcas into a bear cub so that the mother and son could be reunited. Then he picked up each bear by its short tail to avoid being scratched by its sharp claws. He whirled them around his head and threw them up into the heavens, where we still see them to this day. In doing this, Zeus had to whirl them so hard that their tails were stretched to great lengths, and thus the heavenly bears have much longer tails than earthly ones.

Although Callisto was no longer a threat to her, Hera was still angry and determined to have her revenge, so she persuaded the gods of the seas to forbid the bears to enter their kingdom. Thus the bears are never allowed to set beneath the seas where they could rest like other heavenly beings but must endlessly circle about the cold northern sky. Even this was not enough to satisfy Hera, so she took Ladon, the dragon which had guarded the golden apples of the Hesperides sought by Heracles in his twelfth labor, and coiled him around Arcas so that he and Callisto could never be reunited, thwarting Zeus' planned reunion of the pair.



**Fig. 2.1.** Group finder chart. (Looking south on June 6, about 9:00 PM).

**URSA MAJOR** (er-sah may-jor)**URSAE MAJORIS** (er-sigh muh-jor-is)**UMa****The Big Bear****9:00 P.M. Culmination:** May 1**AREA:** 1,280 sq. deg., 3rd in size

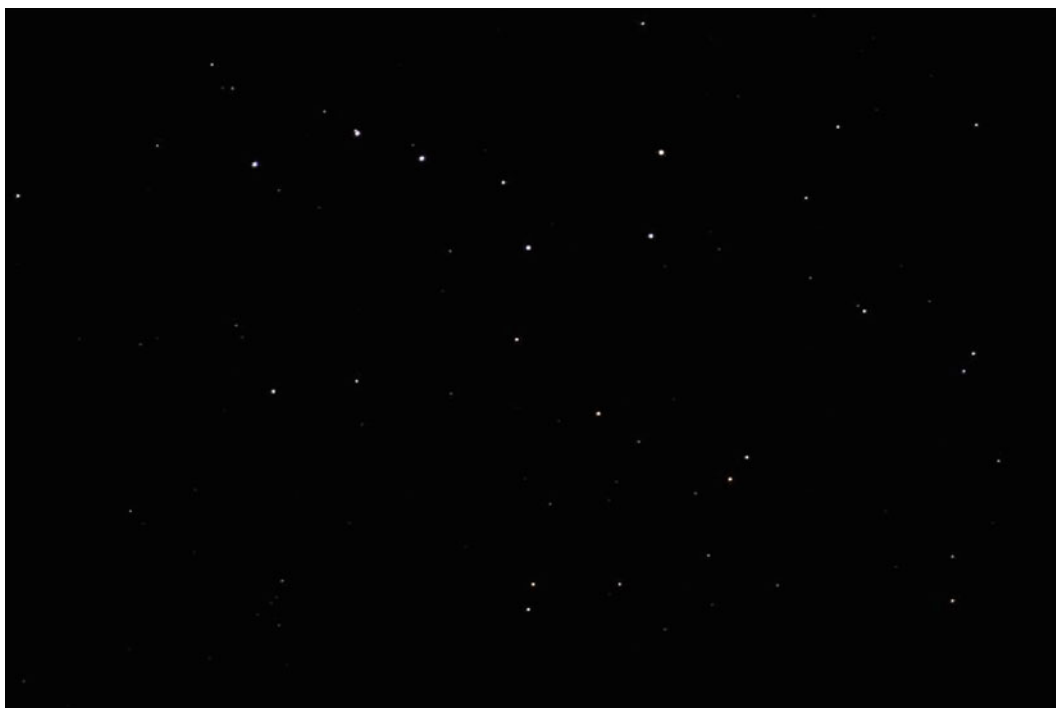
**TO FIND:** At 9:00 PM on May 1 (or one half hour earlier [later] for each week after [before] May 1), face north and look high in the sky, almost overhead in the Europe and the northern USA or somewhat lower from the southern USA. The seven stars of the big dipper are all fairly bright and the shape is very distinctive, so look for it first, then use the chart to trace out the rest of the constellation. The three star arc of the dipper's handle is also the large bear's tail. The four stars of the dipper's bowl form the bear's rump and flank. A line drawn through the two northern stars of the bowl, ( $\delta$ , Megrez and  $\alpha$ , Dubhe) extended  $11^\circ$  W ends near  $\epsilon$  UMa (m3.65). From there  $\epsilon$  UMa is about  $8^\circ$  WSW.  $\epsilon$  UMa marks the tip of the bear's nose. To find  $\epsilon$  UMa, draw a line through the southern stars of the dipper's bowl ( $\gamma$ , Phecda and  $\beta$ , Merak) and extend it about  $10^\circ$ . This line terminates about  $1^\circ$  or  $2^\circ$  south of  $\nu$  UMa (m3.78).  $\epsilon$  UMa is about  $10^\circ$  WNW of  $\nu$ . The two series of lines you have traced out outline the bear's body from the tail to the tip of its nose. Note that the two stars forming the top of the bowl are about  $10^\circ$  apart, and the two forming the outside edge of the bowl are about  $5^\circ$  apart. These two distances are convenient references for estimating distances between celestial objects.\*<sup>1</sup> Using the drawing of the large bear's figure and these reference distances, you can trace out the bear's legs to complete the constellation. See Figs. 2.1–2.3.

## Key Star Names:

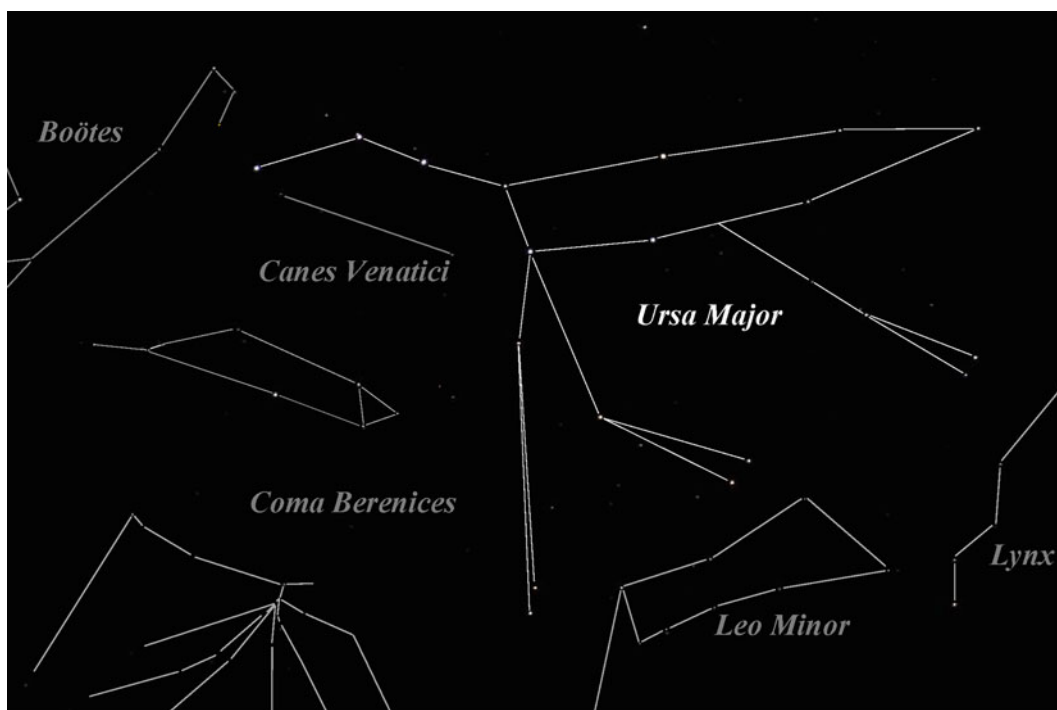
Name	Pronunciation	Source
$\alpha$ Dubhe	<b>dub</b> -ee	Thahr al Dubb al Akbar (Arabic), "back of the great bear"
$\beta$ Merak	<b>mee</b> -rak	al Marakh (Arabic), "loin of the bear"
$\gamma$ Phecda	<b>fek</b> -dah	Fakhidh al dubb al akbar (Arabic), "the thigh of the greater bear"
$\delta$ Megrez	<b>mee</b> -grez	al Maghrez (Arabic), "the root of the tail"
$\varepsilon$ Alioth	<b>al</b> -e-oth	probably a corruption of <u>al jaun</u> (Arabic), "the black horse or bull"
$\zeta$ Mizar	<b>my</b> -zar	al mi'zar (Arabic), "the girdle, veil, or trousers"
$\eta$ Alkaid	<b>al-kade</b>	al Ka'id Banat al Na'ash (Arabic), "the leader of the daughters of the bier"
$\iota$ Talitha	<b>tah</b> -lih-thah	al-aqafza al-thalitha (Arabic), "the third leap"
$\lambda$ Tania Borealis	<b>tah</b> -nih-yuh <b>boh</b> -reh- <b>AH</b> -liss	al-aqafza al-thaniya (Ind-Arabic), "the second leap" + borealis (Latin), "northern"
$\mu$ Tania Australis	<b>tah</b> -nih-yuh ous- <b>trah</b> -liss	al-aqafza al-thaniya (Ind-Arabic), "the second leap" + australis (Latin), "southern"
$\nu$ Alula Borealis	ul- <b>uh</b> -lah <b>boh</b> -reh- <b>AH</b> -liss	Al-qafza al-ula (Arabic), "the first leap" + borealis (Latin), "northern"
$\xi$ Alula Australis	ul- <b>uh</b> -lah ous- <b>trah</b> -liss	Al-qafza al-ula (Arabic), "the first leap" + australis (Latin), "southern"
$\omicron^1$ Muscida	<b>muh</b> -si-dah	musida (Latin), "muzzle"
80 Alcor	<b>al</b> -kore	(al) Khwar or Khawwar, Persian (with added "al"), "the faint one"

## Magnitudes and spectral types of principal stars:

Bayer desig.	Mag. ( $m_v$ )	Spec. type	Bayer desig.	Mag. ( $m_v$ )	Spec. type	Bayer desig.	Mag. ( $m_v$ )	Spec. type
$\alpha$	1.81	F7 V	$\beta$	2.34	A1 V	$\gamma$	2.41	A0 V Sb
$\delta$	3.32	A3 V var	$\varepsilon$	1.76	A0p	$\zeta$	2.23	A2 V
$\eta$	1.85	B3 V Sb	$\theta$	2.52	F6 IV	$\iota$	3.12	A7 IV
$\kappa$	3.57	A1 Vn	$\lambda$	3.45	A2 IV	$\mu$	3.06	M0 III Sb
$\nu$	3.49	K3 III Sb	$\xi$	3.79	G0 V	$\omicron$	3.35	G4 II/III
$\pi^1$	5/63	G1.5 Vb	$\pi^2$	4.59	K2 III	$\rho$	4.74	M3 III
$\sigma^1$	4.15	K5 III	$\sigma^2$	4.80	F7 IV/V	$\tau$	4.67	Am
$\upsilon$	3.78	F0 IV	$\phi$	4.55	A3 IV	$\chi$	3.69	K0 III
$\psi$	3.00	K1 III	$\omega$	4.66	A2 Vs	80	3.99	A5 V Sb



**Fig. 2.2a.** The stars of Ursa Major and adjacent constellations.



**Fig. 2.2b.** The figures of Ursa Major and adjacent constellations.



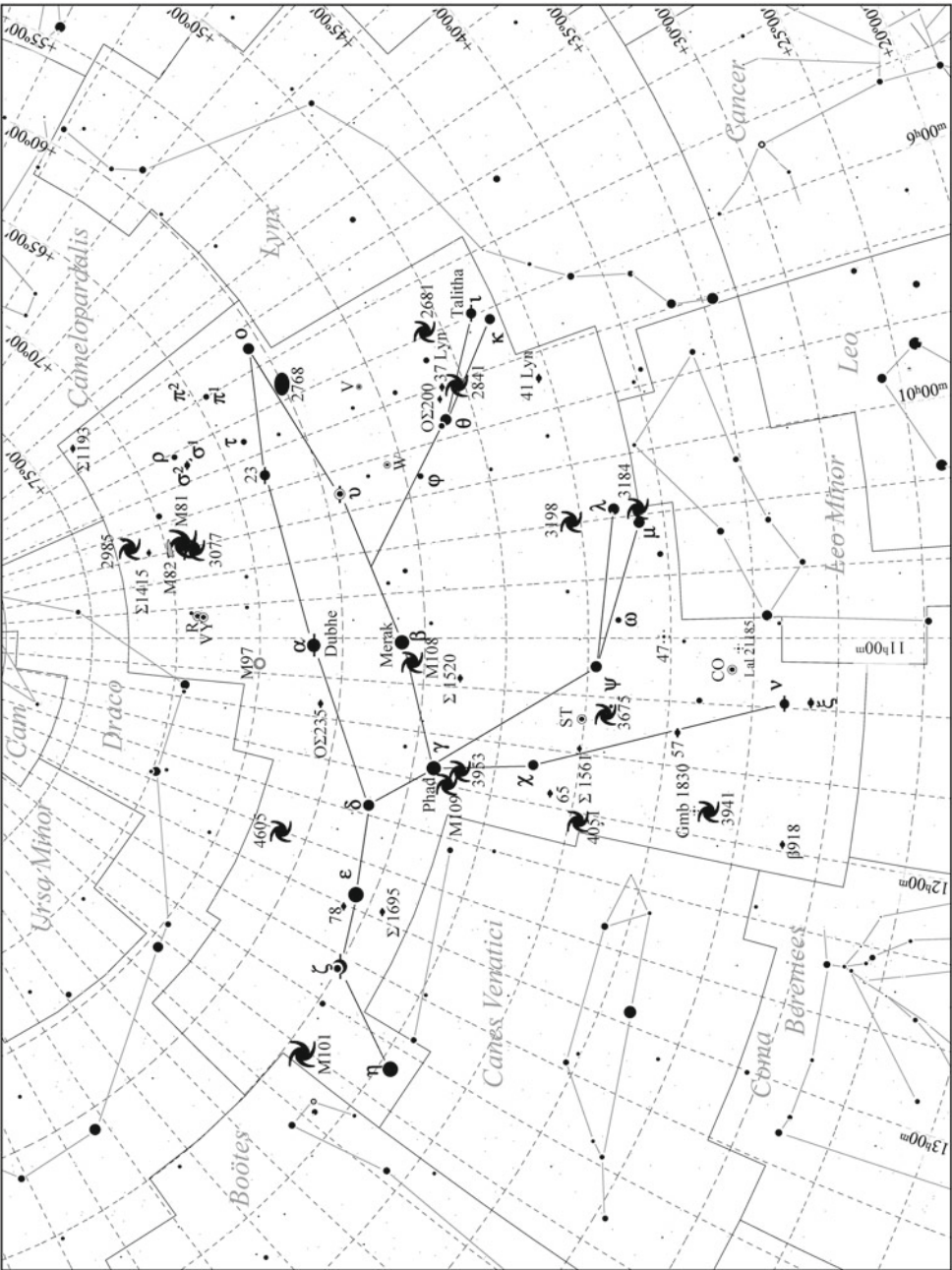


Fig. 2.3. Ursa Major details.

Table 2.1. Selected telescopic objects in Ursa Major.

Multiple stars:												
Designation	R.A.	Decl.	Type	m <sub>1</sub>	m <sub>2</sub>	Sep. (")	PA (°)	Colors	Date/ Period	Aper. Recm.	Rating	Comments
Σ1193	08 <sup>h</sup> 20.7 <sup>m</sup>	+72° 24'	A-B	6.2	9.7	42.7	090	dO, bGr	2001	2/3"	*****	Great at low power
9, ι Ursae Majoris	08 <sup>h</sup> 59.2 <sup>m</sup>	+48° 02'	A-BC	3.1	9.2	<b>2.64</b>	<b>198</b>	yW, R	<b>817.91</b>	3/4"	*****	a.k.a. h2477A-BC. PA increasing
			B-C	3.1	10.1	<b>0.42</b>	<b>232</b>	yW, R	<b>39.69</b>	>20"	**	a.k.a. Hu 6288C. Max Sep = 0.88" in 2020
13, σ <sup>2</sup> Ursae Majoris	09 <sup>h</sup> 10.4 <sup>m</sup>	+67° 08'	A-B	4.9	8.9	<b>4.15</b>	<b>350</b>	Y, B ?	<b>1,141.3</b>	2/3"	****	a.k.a. Σ1306AB. Slowly widening
			A-C	4.9	10.3	206.3	148	Y, ?	1999	2/3"	***	a.k.a. Σ1306AC
37 Lyncis	09 <sup>h</sup> 20.7 <sup>m</sup>	+51° 16'	A-B	6.2	10.0	5.6	138	W, ?	1998	3/4"	****	a.k.a. Σ199AB
			A-C	6.2	10.7	130.0	007	W, ?	1998	3/4"	***	a.k.a. OΣ199AC
OΣ 200	09 <sup>h</sup> 24.9 <sup>m</sup>	+51° 34'	A-B	6.5	8.6	1.3	335	Y, ?	2003	7/8"	****	Good test of seeing
41 Lyncis	09 <sup>h</sup> 28.7 <sup>m</sup>	+45° 36'	A-B	5.5	7.8	70.1	162	dY, grB	2005	6×30"	*****	a.k.a. S 598AB
			A-C	5.5	9.8	84.1	075	dY, ?	1999	15×80"	*****	a.k.a. S 598AC
23 Ursae Majoris	09 <sup>h</sup> 31.5 <sup>m</sup>	+63° 04'	A-B	3.7	9.2	23.2	269	Y, brB	2003	2/3"	*****	a.k.a. Σ1351AB
29, υ Ursae Majoris	09 <sup>h</sup> 51.0 <sup>m</sup>	+59° 02'	A-B	3.8	11.5	11.8	296	pY, ?	1999	3/4"	***	a.k.a. OΣ521
Σ1415	10 <sup>h</sup> 17.8 <sup>m</sup>	+71° 04'	A-B	6.7	7.3	16.5	167	Y, W	2003	15×80"	*****	
50, α Ursae Majoris	11 <sup>h</sup> 03.7 <sup>m</sup>	+61° 45'	A-B	2.0	5.0	<b>0.56</b>	<b>032</b>	O, ?	<b>44.5</b>	16/18"	***	a.k.a. β1077. PA increasing rapidly, opening to 0.82" in 2024
Σ1520	11 <sup>h</sup> 16.1 <sup>m</sup>	+52° 46'	A-B	6.5	7.8	12.3	344	O, W	2003	2/3"	*****	Showcase pair
53, ξ Ursae Majoris	11 <sup>h</sup> 18.2 <sup>m</sup>	+31° 32'	A-B	4.3	4.8	<b>1.61</b>	<b>211</b>	pY, oY	<b>59.878</b>	6/8"	*****	a.k.a. Σ1523. Showcase pair
54, ν Ursae Majoris	11 <sup>h</sup> 18.5 <sup>m</sup>	+33° 06'	A-B	3.5	10.1	7.4	149	pO, pB	2005	2/3"	****	a.k.a. Σ1524.
57 Ursae Majoris	11 <sup>h</sup> 29.1 <sup>m</sup>	+39° 20'	A-B	5.3	10.6	354	184	W, B	2003	3/4"	*****	a.k.a. Σ1543AB.
OΣ 235	11 <sup>h</sup> 32.3 <sup>m</sup>	+61° 05'	A-B	5.5	7.0	<b>0.80</b>	<b>021</b>	W, ?	<b>72.7</b>	12/14"	***	a.k.a. Σ235. Max separation = 1.00" in 2027
Σ1561	11 <sup>h</sup> 38.7 <sup>m</sup>	+45° 07'	A-B	6.5	8.2	<b>8.96</b>	<b>247</b>	dY, rW	<b>2050</b>	2/3"	****	Easy object for small scopes. Subtle but nice colors
65 Ursae Majoris	11 <sup>h</sup> 55.1 <sup>m</sup>	+46° 29'	AB-C	6.5	8.32	3.9	042	Y, B	2006	2/3"	****	a.k.a. A1777AB. A-B is a binary, but maximum separation is only 0.33"
β 918	11 <sup>h</sup> 58.1 <sup>m</sup>	+32° 16'	AB-D	6.5	6.97	63.2	114	Y, ?	2002	6×30	****	a.k.a. Σ1579AB-C
			A-B	6.4	12.5	6.9	236	bW, ?	1999	4/5"	***	
Σ1695	12 <sup>h</sup> 56.3 <sup>m</sup>	+54° 06'	A-B	6.0	7.8	3.6	281	W, gW	2006	2/3"	****	
78 Ursae Majoris	13 <sup>h</sup> 00.7 <sup>m</sup>	+56° 22'	A-B	5.0	7.9	1.2	120	oW, grB	2005	8/10"	*****	a.k.a. β1082
79, ζ Ursae Majoris	13 <sup>h</sup> 23.9 <sup>m</sup>	+54° 56'	A-B	2.2	3.9	14.3	153	W, W	2005	15×80	*****	a.k.a. Σ1744AB
											****	*4



Variable stars:										
Designation	R.A.	Decl.	Type	Range (m <sub>v</sub> )	Period (days)	F (f <sub>v</sub> /f <sub>i</sub> )	Spectral Range	Aper. Recm.	Rating	Comments
V Ursae Majoris	09 <sup>h</sup> 08.2 <sup>m</sup>	+51° 07'	SRb	9.5	11.5	–	M5–M6	4/6"	****	##
W Ursae Majoris	09 <sup>h</sup> 43.8 <sup>m</sup>	+55° 57'	EW/ KW	7.75	8.48	–	F8Vp + F8Vp	7 x 50	****	Two similar stars, in contact, sharing outer atmospheres
										Minimum is ~0.1 mag. fainter than the secondary. ##\$
29, υ Ursae Majoris	09 <sup>h</sup> 51.0 <sup>m</sup>	+59° 02'	δ Sct	3.68	3.86	0.64	F2IV	Eye	****	
R Ursae Majoris	10 <sup>h</sup> 44.6 <sup>m</sup>	+68° 47'	M	6.5	13.7	0.39	Me3–M9e	8/10"	****	Peak luminosity ~250 suns. ##
VY Ursae Majoris	10 <sup>h</sup> 45.1 <sup>m</sup>	+67° 25'	Lb	5.7	7.5	–	C6,3(NO)	7 x 50	*****	Carbon star, extremely red. ##
CO Ursae Majoris	11 <sup>h</sup> 09.3 <sup>m</sup>	+36° 19'	Lb	5.74	5.95	–	M3.5IIab	6 x 30	****	
ST Ursae Majoris	11 <sup>h</sup> 27.8 <sup>m</sup>	+45° 11'	SRb	6	7.6	–	M4–M5III	7 x 50	****	##\$

Star clusters:										
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size (')	Brist. Star	Dist. (ly)	dia. (ly)	Aper. Recm.	Rating
None										Comments

Nebulae:										
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size (')	Brist./ Cent. star	Dist. (ly)	dia. (ly)	Aper. Recm.	Rating
M97, NGC 3587	11 <sup>h</sup> 14.8 <sup>m</sup>	+55° 01'	Plan- etary	9.9	194	<b>16.0</b>	1 300	1	4/6"	*****
										Owl Nebula. Requires >12" scope to see "owl's eyes" pattern

Galaxies:										
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size (')	Dist. (ly)	dia. (ly)	Lum. (suns)	Aper. Recm.	Rating
NGC 2681	08 <sup>h</sup> 53.5 <sup>m</sup>	+51° 19'	SAB	10.3	3.6 x 3.6	43M	46K	11G	8/10"	****
										Moderately bright halo, very small brighter core
NGC 2768	09 <sup>h</sup> 11.6 <sup>m</sup>	+60° 02'	E6	9.9	6.6 x 3.2	77M	144K	44G	8/10"	****
										Large, bright, elongated halo, slowly brightens toward center
NGC 2841	09 <sup>h</sup> 22.0 <sup>m</sup>	+50° 58'	SA	9.2	6.6 x 3.5	39M	65K	26G	8/10"	****
										Large, bright, elongated halo, bright, round core

(continued)

Table 2.1. (continued)

Galaxies:

Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size ( <sup>l</sup> )	Dist. (ly)	dia. (ly)	Lum. (suns)	Aper. Recm.	Rating	Comments
NGC 2985	09 <sup>h</sup> 50.4 <sup>m</sup>	+72° 17'	SA	10.4	3.9×3.0	73M	96K	28G	8/10"	****	Large, bright, slightly elongated halo, slowly brightens toward center
M81, NGC 3031	09 <sup>h</sup> 55.6 <sup>m</sup>	+69° 04'	SB	6.9	22.1×11.1	10M	70K	11G	7×50	*****	Bright center, faint arms. 2° ESE of 24 UMa
M82, NGC 3034	09 <sup>h</sup> 55.8 <sup>m</sup>	+69° 41'	IO	8.4	11.7×4.8	17M	52K	9.1G	4/6"	*****	Very elongated, faint, mottled appearance. 0.6° NW of M18
NGC 3077	10 <sup>h</sup> 03.3 <sup>m</sup>	+68° 44'	SB	9.8	5.4×3.9	7M	10K	1.2G	8/10"	****	Fainter member of M81 group.
NGC 3184	10 <sup>h</sup> 18.3 <sup>m</sup>	+41° 25'	SB	9.8	7.5×6.7	28M	61K	8.5G	8/10"	****	Moderately bright, moderately large
NGC 3198	10 <sup>h</sup> 19.9 <sup>m</sup>	+45° 33'	SB	10.3	8.8×2.9	35M	75K	11G	8/10"	****	Pretty bright, very large, gradually brighter toward center
M108, NGC 3656	11 <sup>h</sup> 11.5 <sup>m</sup>	+55° 40'	SB	10.0	8.1×2.1	42M	73K	19G	4/6"	***	Pretty bright, very large, gradually brighter toward center, elongated
NGC 3675	11 <sup>h</sup> 26.1 <sup>m</sup>	+43° 35'	SB	10.2	5.8×3.0	42M	62K	13G	8/10"	****	Mottled edge-on galaxy, fairly bright
NGC 3941	11 <sup>h</sup> 52.9 <sup>m</sup>	+36° 59'	SB	10.3	3.9×2.6	62M	65K	15G	8/10"	****	Elongated, smooth halo, stellar nucleus
NGC 3953	11 <sup>h</sup> 53.8 <sup>m</sup>	+52° 20'	SB	10.1	5.9×2.9	46M	100K	28G	8/10"	****	Elongated halo, bright center
M109, NGC 3992	11 <sup>h</sup> 57.6 <sup>m</sup>	+53° 23'	SB	9.8	7.4×3.8	55M	107K	31G	4/6"	****	Elongated halo, bright round center
NGC 4051	12 <sup>h</sup> 03.2 <sup>m</sup>	+44° 32'	SAB	10.2	5.4×4.4	55M	84K	19G	8/10"	****	Faint oval halo, small bright core
NGC 4605	12 <sup>h</sup> 40.0 <sup>m</sup>	+61° 37'	SB	10.3	5.7×2.0	13M	56K	9G	8/10"	****	Smooth, slightly oval halo, small core, stellar nucleus
M101, NGC 5457	14 <sup>h</sup> 03.2 <sup>m</sup>	+54° 21'	SAB	7.9	23.8×23.8	18M	122K	23G	4/6"	*****	Bright edge-on galaxy, long thin core
											Pinwheel galaxy, gorgeous, esp. in medium/large amateur scopes

Meteor showers:

Designation	R.A.	Decl.	Period (yr)	Duration	Max Date	ZHR (max)	Comet/ <b>Asteroid</b>	First Obs.	Vel. (mi/ <b>km/sec</b> )	Rating	Comments
None											

Other interesting objects:

Designation	R.A.	Decl.	Type	m <sub>v</sub>	Mass (suns)	Dist. (ly)	dia. (ly)	Lum. (suns)	Aper. Recm.	Rating	Comments
47 Ursae Majoris	10 <sup>h</sup> 59.5 <sup>m</sup>	+40° 26'	SolSys	ExoPlnt		42			Eye	****	Center of 1st extra-solar system
Lalande 21185	11 <sup>h</sup> 03.2 <sup>m</sup>	+35° 58'	Red Dwf	7.49		8.1			7×50	****	planetary system similar to our own
Groombridge 1830	11 <sup>h</sup> 52.9 <sup>m</sup>	+37° 43'	Hi PM	6.45		28			7×50	****	4th nearest star, 8th largest PM = 4.78"/year, Lum. = 0.0048 Sun Runaway star, proper motion = 7.04"/ year, 3rd greatest known



**Fig. 2.4a.** M81 and M82, spiral galaxies in Ursa Major. Astrophoto by Gian Michele Ratto.



**Fig. 2.4b.** M81 and M82, astrophoto processed to simulate visual appearance in a medium sized amateur telescope.



**Fig. 2.5a.** M97 (NGC 3587) and M108 (NGC 3556), planetary nebula and spiral galaxy in Ursa Major. Astrophoto by Gian Michele Ratto.



**Fig. 2.5b.** M97 and M108, astrophoto processed to simulate visual appearance in medium sized amateur telescope.



**Fig. 2.6a.** M101 (NGC 5457), Spiral Galaxy in Ursa Major. Astrophoto by Steve Pastor.



**Fig. 2.6b.** M101, astrophoto processed to simulate visual appearance in medium to large amateur telescope.





**Fig. 2.7a.** M109 (NGC 3992), spiral galaxy in Ursa Major. Astrophoto by Gian Michele Ratto.



**Fig. 2.7b.** M109 (3992), spiral galaxy in Ursa Major. Astrophoto processed to simulate visual appearance in moderate sized telescopes.

**URSA MINOR** (er-sah **my**-nor)  
**URSAE MINORIS** (er-sigh my-**nor**-iss)  
**UMi**

**The Little Bear**  
**9:00 P.M. Culmination:** June 21  
**AREA:** 256 sq. deg., 56th in size

**TO FIND:** The two westernmost stars in the bowl of the big dipper (Dubhe and Merak) point toward Polaris, the North Star. Polaris is about  $30^\circ$  from Dubhe and is the end star of the bear's tail (the little dipper's handle). The rest of the small bear or little dipper will be directly above Polaris, stretching out toward the end of the Big Bear's tail or the end of the big dipper's handle. Kochab and Pherkad mark the end of the little bear's body. These two stars appear to circle Polaris continuously and are sometimes called "the Guardians" (See Fig. 2.9).

## KEY STAR NAMES:

Name	Pronunciation	Source
$\alpha$ Polaris	po- <b>lair</b> -is	polaris, Latin, "of the pole"
$\beta$ Kochab	<b>koe</b> -kab	al Kaukab (Arabic), "the star"
$\gamma$ Pherkad	<b>fur</b> -kad	Anwar al Farkadain, (Arabic), "dim one of the two calves"
$\delta$ Yildun	yil- <b>doon</b>	yildiz (Turkish), "the star" (originally applied to Polaris and later misapplied to $\delta$ ).
$\epsilon$ Pherkad Minor	<b>fur</b> -kad <b>my</b> -nor	Al-farqudan (Arabic), from the asterism of "the two calves" plus minor (Latin), "smaller"

## Magnitudes and spectral types of principal stars:

Bayer desig.	Mag. ( $m_v$ )	Spec. type	Bayer desig.	Mag. ( $m_v$ )	Spec. type	Bayer desig.	Mag. ( $m_v$ )	Spec. type
$\alpha$	1.97	F7 Ib/IIv	$\beta$	2.07	K4 III var	$\gamma$	3.00	A3 II/III
$\delta$	4.35	A1 Vn	$\epsilon$	4.21	G5 III var	$\zeta$	4.29	A3 Vn
$\eta$	4.95	F5 V	$\theta$	5.00	K5 III			
$\pi^1$	6.57	G8 IV/V	$\lambda$	6.31	M1 III			
			$\pi^2$	6.89	G8 IV/V			





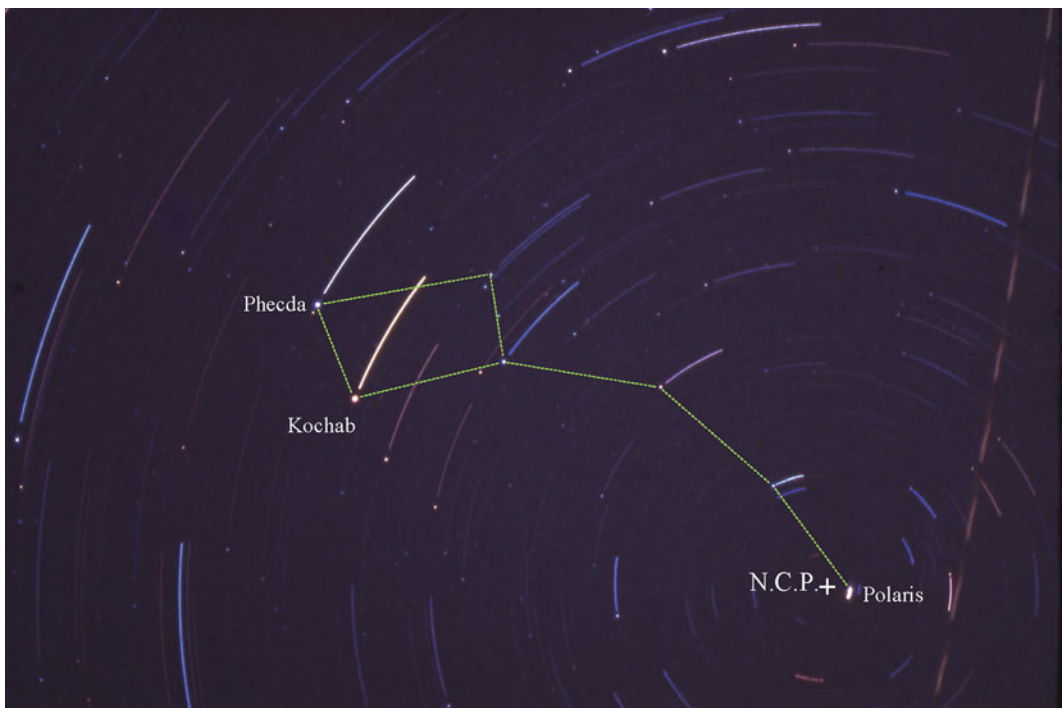
**Fig. 2.8a.** The Stars of Draco, Ursa Minor and surrounding constellations.



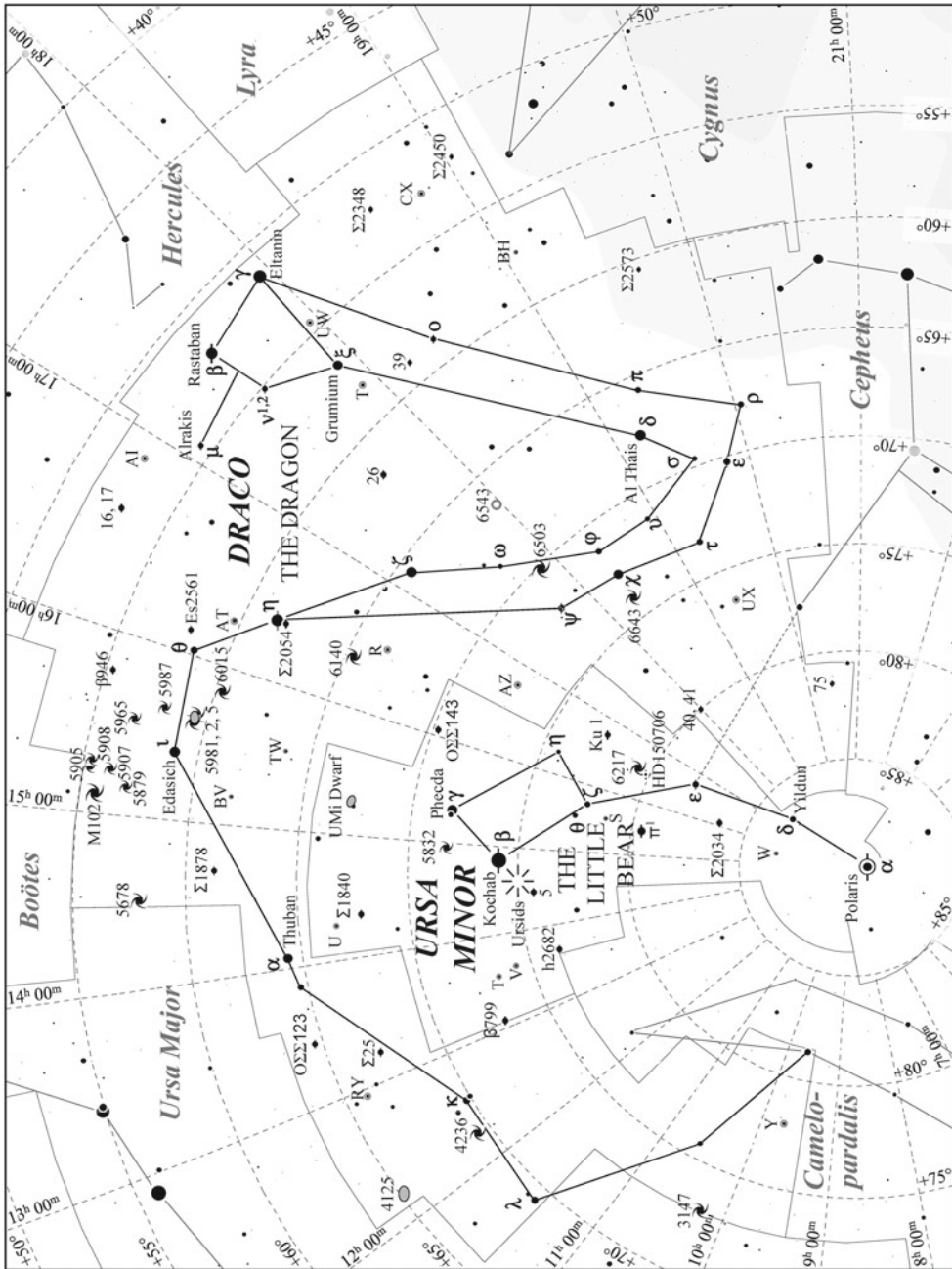
**Fig. 2.8b.** The figures of Draco, Ursa Minor, and surrounding constellations.



**Fig. 2.9a.** Rotation of the stars about the north celestial pole in a one hour period.



**Fig. 2.9b.** Same as above, with the Little Dipper and north celestial pole added.



**Fig. 2.10.** Ursa Minor and Draco details.

Table 2.2. Selected telescopic objects in Ursa Minor.												
Multiple stars:												
Designation	R.A.	Decl.	Type	m <sub>1</sub>	m <sub>2</sub>	Sep. (")	PA (°)	Colors	Date/ Period	Aper. Recm.	Rating	Comments
1 = α Ursae Minoris	02 <sup>h</sup> 31.8 <sup>m</sup>	+89° 16'	A-B	2.0	9.1	18.5	233	oY, pW	2005	2/3"	****	Polaris. Showcase pair. Always visible in northern hemisphere
β799	13 <sup>h</sup> 04.8 <sup>m</sup>	+73° 02'	A-B	6.6	8.5	1.3	265	W, ?	2004	7/8"	****	
h2682	13 <sup>h</sup> 40.7 <sup>m</sup>	+76° 51'	A-B	6.7	10.3	25.6	282	W, bW	2003	2/3"	****	Nice brightness contrast
			A-C	6.7	9.0	43.8	318	W, ?	2003	7×50	****	
Σ1840	14 <sup>h</sup> 19.9 <sup>m</sup>	+67° 47'	A-B	7.0	10.1	27.1	221	bW, ?	2003	2/3"	****	
			A-C	7.0	10.7	144.8	239	bW, ?	1999	3/4"	****	
5 Ursae Minoris	14 <sup>h</sup> 27.5 <sup>m</sup>	+75° 42'	A-B	4.3	13.4	22.6	124	yO, ?	1958	7/8"	****	
			A-C	4.3	9.9	58.6	132	O, ?	1999	2/3"	****	
7 = β Ursae Minoris	14 <sup>h</sup> 50.7 <sup>m</sup>	+74° 09'	A-B	2.1	11.4	212.3	341	O, ?	1999	3/4"	***	Kochab
π <sup>1</sup> Ursae Minoris	15 <sup>h</sup> 29.2 <sup>m</sup>	+80° 27'	A-B	6.6	7.3	31.1	078	yW, W	2000	10×50	****	Very good binocular object. Very moderate brightness diff.
Σ2034	15 <sup>h</sup> 48.7 <sup>m</sup>	+83° 37'	A-C	6.6	11.4	153.8	102	yW, ?	1983	3/4"	****	
			A-B	7.7	8.0	1.1	111	W, W	2001	8/10"	****	Nearly equal pair, but requires excellent seeing
OΣΣ143	16 <sup>h</sup> 04.8 <sup>m</sup>	+70° 16'	A-B	6.9	8.8	46.9	084	W, ?	1999	7×50	****	Good binocular object
Ku 1	16 <sup>h</sup> 43.1 <sup>m</sup>	+77° 31'	A-B	6.1	10.2	2.6	179	yW, ?	1991	4/8"	****	
			A-C	6.0	9.8	106.6	013	O, ?	1999	2/3"	****	Easy object for small scopes
22 = ε Ursae Minoris	16 <sup>h</sup> 46.0 <sup>m</sup>	+82° 02'	A-B	4.2	11.2	77.0	003	Y, ?	1959	3/4"	****	
Variable stars:												
Designation	R.A.	Decl.	Type	Range m <sub>v</sub>	Period (days)	F (f <sub>v</sub> /f <sub>1</sub> )	Spectral Range	Aper. Recm.	Rating	Comments		
1 = α Ursae Minoris	02 <sup>h</sup> 31.8 <sup>m</sup>	+89° 16'	Cδ	1.92	2.07	0.50	F7:lb-llv	2/3"	****	Polaris, Cepheid variable with small range		
T Ursae Minoris	13 <sup>h</sup> 34.7 <sup>m</sup>	+73° 26'	M	7.8	15.0	0.45	M4e– M6e	7×50	***	2°30' WSW (PA 246°) of 3 UMi (6.43). ##		
V Ursae Minoris	13 <sup>h</sup> 38.7 <sup>m</sup>	+74° 19'	SRb	8.8	<b>9.9</b>	–	M5III	2/3"	****	1°55' W (PA 265°) of 3 UMi (m6.43). #§		

(continued)

Table 2.2. (continued)												
Variable stars:												
Designation	R.A.	Decl.	Type	Range m <sub>v</sub>	Period (days)	F (f/f)	Spectral Range	Aper. Recm.	Rating	Comments		
U Ursae Minoris	14 <sup>h</sup> 17.3 <sup>m</sup>	+66° 48'	M	7.4	12.7	0.50	M56e– M8e	6/8"	****	#		
RR Ursae Minoris	14 <sup>h</sup> 57.6 <sup>m</sup>	+66° 56'	SRb	4.53	43.3	–	M5III	Eye	****			
S Ursae Minoris	15 <sup>h</sup> 29.4 <sup>m</sup>	+78° 38'	M	8.3	11.5	0.50	M7e– M9e	3/4"	****	1°07' NW (PA 320°) of ζ UMi (m4.29). ##		
W Ursae Minoris	16 <sup>h</sup> 21.2 <sup>m</sup>	+86° 19'	EA/SD	8.51	9.59	0.023	A3	7 × 50	****	1°22'W (PA 264°) of δ UMi (m4.34). #		
Star clusters:												
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size (')	Brist. Star	Dist. (ly)	dia. (ly)	Number of Stars	Aper. Recm.	Rating	Comments
None												
Nebulae:												
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size (')	Brist./ Cent. star	Dist. (ly)	dia. (ly)	dia. (ly)	Aper. Recm.	Rating	Comments
None												
Galaxies:												
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size (')	Dist. (ly)	dia. (ly)	Lum. (suns)	Aper. Recm.	Rating	Comments	
NGC 5832	14 <sup>h</sup> 57.8 <sup>m</sup>	+71° 41'	SBb	12.2	3.7 × 2.2	–	–	–	12/14	***	Diffuse center, faint halo. Difficult	

Ursa Minor Dwarf	15 <sup>h</sup> 09.1 <sup>m</sup>	+67° 13'	E	11.9	30.2×19.1	0.2M	1,800	5.5K	—	**	Photographic object only	*6
NGC 6217	16 <sup>h</sup> 32.6 <sup>m</sup>	+74° 19'	SBbc	11.0	3.6×3.5	78M	82K	19G	8/10"	***	Faint, diffuse 1.5'×1' NNW-SSE halo, stellar nucleus	

Meteor showers:

Designation	R.A.	Decl.	Period (yr)	Duration	Max Date	ZHR (max)	Comet/ <b>Asteroid</b>	First Obs.	Vel. (mi/ <b>km</b> /sec)	Rating	Comments	
Ursids	14 <sup>h</sup> 38 <sup>m</sup>	+75°	16.7	12/17	Nov. 14/15	10	Tuttle	~1900	22	I		*7

Othe interesting objects:

Designation	R.A.	Decl.	Type	m <sub>v</sub>	Mass (suns)	Dia. (suns)	Dist. (ly)	Planet Mass (J)	Dist. (AU)	Period (days)	Rating	Comments	
HD 150706	16 <sup>h</sup> 31.3 <sup>m</sup>	+74° 47'	ExoPlnt	7.03	—	—	88.76	>1.0	0.82	264	**	Sun-like star (type G0), one planet	*8

**DRACO** (dray-koe)**DRACONIS** (druh-koe-niss)**Dra****The Dragon****9:00 P.M. Culmination:** July 9**AREA:** 1,083 sq. deg., 8th in size

**TO FIND:**  $\alpha$  Draconis, or Thuban, is located almost precisely half-way between Mizar (in UMa) and Pherkad (in UMi). The rest of the lines of relatively faint stars delineating the dragon's tail and body can be traced out by using the chart. Although Thuban is not the brightest star in Draco, it received the designation of  $\alpha$  because it was our pole star for a long period around 3000 BC. The tip of the dragon's tail lies at the extreme NW corner of the constellation. It is marked by an unnamed 4th magnitude star (catalog numbers SAO 1551 and HD 81817). This star lies directly between Polaris and 23 Uma (the top of the big bear's head) and about one-third of the distance from Polaris to 23 Uma. From there, a line of relatively faint stars goes SE, then ESE to a point south of the little dipper's bowl. The single line then splits into two lines forming the dragon's thicker body. These lines gradually diverge and go to the NE, then SE, and finally to the SW where they end in a distinctive group of four stars representing the dragon's head. A faint star ( $\mu$  Dra) represents the tip of the dragon's tongue.  $\mu$  is west of the dragon's head. Do not be fooled by a somewhat brighter star to the south. Although it looks as if it would combine with the four stars to its N to form a snake-like head, it is actually in Hercules, and represents the strongman's left ankle (See Fig. 6.3).

## KEY STAR NAMES:

Name	Pronunciation	Source
$\alpha$ Thuban	thu- <b>ban</b> or thu- <b>w</b> -ban	Ra's al Tinn n (sci-Arabic), "The Serpent's Head," transliterated into thu <sup>l</sup> -ban (Arabic), "serpent"
$\beta$ Rastaban	<b>ras</b> -tuh-ban	al Ras al Tinn n (sci-Arabic), "The Serpent's Head," originally applied to $\gamma$ transliterated as above and transferred to $\beta$ in error
$\gamma$ Eltanin	el-tuh- <b>nin</b>	al Tinnin the medieval name for "the Serpent"
$\delta$ Al Thais	<b>al</b> -tase	Misreading of al Tinnin. (al Tais [sci-Arabic] actually means "The Goat")
$\iota$ Edasich	<b>eh</b> -duh-sik	al dhikh (Indo-Arabic) "The Male Hyena," a late Arabic name for this star
$\lambda$ Giasar	jou- <b>zur</b> -or	Jauzhar (Persian), a technical term for the lunar and planetary nodes, which were called the "Head and Tail of the Dragon"
$\mu$ Alrakis	al- <b>rah</b> -kiss	al raquis (Arabic), "the Trotting Camel"
$\xi$ Grumium	<b>grew</b> -mih-um	grunnum (late Latin), "snout" or "muzzle." According to Ptolemy, this star was on the serpent's jawbone



## Magnitudes and spectral types of principal stars:

Bayer desig.	Mag. ( $m_v$ )	Spec. type	Bayer desig.	Mag. ( $m_v$ )	Spec. type	Bayer desig.	Mag. ( $m_v$ )	Spec. type
$\alpha$	3.65	A0 III	$\beta$	2.79	G2 II	$\gamma$	2.23	K5 III
$\delta$	3.07	G9 III	$\varepsilon$	3.83	G8 III	$\zeta$	3.17	B6 III
$\eta$	2.74	G8 III	$\theta$	4.01	F8 IV	$\iota$	3.29	K2 III
$\kappa$	3.87 <sub>v</sub>	B6 III	$\lambda$	3.82	M0 III var	$\mu$	4.91	F5
$\nu^1$	4.89	Am	$\nu^2$	4.86	Am	$\xi$	3.73	K2 III
$\omicron$	4.63	K0 II/IIIi	$\pi$	4.60	A2 IIIs	$\rho$	4.51	K3 III
$\sigma$	4.67	K0 V	$\tau$	4.45	K3 III	$\upsilon$	4.82	K0 III
$\phi$	4.22	A0p (Si)	$\chi$	3.55	F7 V var	$\psi$	4.57	F5 IV–V
$\omega$	4.77	F5 V						

Table 2.3. Selected telescopic objects in Draco.

Multiple stars:

Designation	R.A.	Decl.	Type	m <sub>1</sub>	m <sub>2</sub>	Sep. (")	PA (°)	Colors	Date/ Period	Aper. Recm.	Rating	Comments
Σ 25	13 <sup>h</sup> 13.5 <sup>m</sup>	+67° 17'	A-B	6.6	7.1	179.0	296	oW, W	1999	6×30	****	Easy, very wide binocular pair
OΣΣ 123	13 <sup>h</sup> 27.1 <sup>m</sup>	+64° 44'	A-C	6.6	8.9	105.9	224	oW, ?	1999	7×50	****	Striking pair, nearly equal, both unusually blue
			A-B	6.7	7.0	68.9	147	B, B	2000	6×30	*****	
Σ1878 β 946 Es 2651	14 <sup>h</sup> 42.1 <sup>m</sup>	+61° 16'	B-C	7.0	12.2	38.5	095	B, ?	2000	4/6"	***	Difficult, but very nice
			A-B	6.3	9.2	4.2	317	W, ?	2004	2/3"	****	Very difficult in small scopes
			A-B	5.9	9.5	2.2	132	bW, pB	1991	4/6"	****	Companion seems brighter than listed. ~1° ESE of θ Dra.
			A-B	6.3	12.1	12.3	140	W, pB	1999	4/6"	****	Companion seems fainter than listed.
Σ2054	16 <sup>h</sup> 23.8 <sup>m</sup>	+61° 42'	A-B	6.2	7.1	1.1	353	Y, ?	2005	8/10"	****	Very difficult in small scopes
14, η Dra- conis	16 <sup>h</sup> 24.0 <sup>m</sup>	+61° 31'	A-B	2.8	8.2	4.8	139	Y, Y	1996	2/3"	****	A fine yellow pair. a.k.a. Σ312
16 and 17 Draconis	16 <sup>h</sup> 36.2 <sup>m</sup>	+52° 55'	A-B	5.4	6.4	3.1	105	pY, pP	2006	3/4"	****	Beautiful triplet for small scopes. A-B a.k.a. Σ207
21, μ Dra- conis	17 <sup>h</sup> 05.3 <sup>m</sup>	+54° 28'	A-C	5.4	5.5	89.8	196	pY, W	2003	6×30	****	Nearly equal binocular pair
β 1088AC	17 <sup>h</sup> 05.3 <sup>m</sup>	+54° 28'	A-B	5.7	5.7	<b>2.36</b>	<b>006</b>	yW, yW	<b>672</b>	4/6"	****	Nice nearly equal pair, but fairly difficult. B-b is binary, 0.01" sep.
25, ν <sup>1,2</sup> Dra- conis	17 <sup>h</sup> 32.2 <sup>m</sup>	+55° 11'	A-B	5.7	13.8	12.9	177	yW, B	2006	8/10"	***	Faint companion makes this one more difficult than expected
26 Draconis	17 <sup>h</sup> 35.0 <sup>m</sup>	+61° 52'	A-B	4.9	4.9	62.6	312	W, W	2005	6×30	*****	Identical twins, nice at any aperture, a.k.a. ΣA 35. Great binocular object
31, ψ Dra- conis	17 <sup>h</sup> 41.9 <sup>m</sup>	+72° 09'	AB-C	5.2	8.1	<b>1.05</b>	<b>317</b>	Y, ?	<b>76.1</b>	8/10"	****	AKA β962. Closing to 0.3" in 2017, then opening to 1.35" in 2032
40 + 41 Draconis	18 <sup>h</sup> 00.2 <sup>m</sup>	+80° 00'	A-B	4.6	5.6	<b>29.8</b>	<b>016</b>	Y, ?	1999	15×80	****	Nice pair for large binoculars
39 Draconis	18 <sup>h</sup> 23.9 <sup>m</sup>	+58° 48'	A-B	5.7	6.0	19.2	232	pY, pY	<b>12,500</b>	10×50	****	Nice pair for binoculars. Orbit poorly determined. See notes
									2006	15×80	****	Two slightly unequal pale yellow stars. a.k.a. Σ2308AB
									2005	2/3"	****	A is an extremely close binary, with maximum separation of only ~0.025". B and C, plus four other stars mag. 11-14 are within 200 arcsec, but are not physically related to A. a.k.a. Σ2303AB, AC
Σ2348	18 <sup>h</sup> 33.9 <sup>m</sup>	+52° 21'	AB-C	5.1	8.1	3.8	349	W, bW	2001	7×50	****	A-B is binary, max sep. = 0.273"
				5.5	8.7	25.3	271	pY, pGr	2002	10×50	***	

47, o Draconis	18 <sup>h</sup> 51.2 <sup>m</sup>	+59° 23'	A-B	4.8	8.3	36.5	319	Y, grB	2003	6 × 30	****	Separated in large binoculars. a.k.a. Σ2420
Σ2450	19 <sup>h</sup> 02.1 <sup>m</sup>	+52° 16'	A-BC	6.5	9.5	5.2	299	yO, pB	2005	2/3"	***	Subtle, but nice colors
Σ2573	19 <sup>h</sup> 40.2 <sup>m</sup>	+60° 30'	A-B	6.5	8.9	18.4	025	bG, W	2006	15 × 80	****	Good object for large binoculars or small telescope
Draconis	19 <sup>h</sup> 48.2 <sup>m</sup>	+70° 16'	A-B	4.0	6.9	3.2	019	dY, pB	2005	3/4"	****	a.k.a. Σ2603
75 Draconis	20 <sup>h</sup> 28.2 <sup>m</sup>	+81° 25'	A-B	5.4	11.34	109.6	011	rW, ?	2000	3/4"	***	a.k.a. BUP 211 AB
			A-C	5.4	6.7	196.6	282	rW, W	2000	6 × 30	****	a.k.a. STH 7AC

**Variable stars:**

Designation	R.A.	Decl.	Type	Range (m.)	Period (days)	F (f./f.)	Spectral Range	Aper. Recm.	Rating	Comments
Y Draconis	09 <sup>h</sup> 42.4 <sup>m</sup>	+77° 51'	M	6.2	15	325.79	M5e	18/20"	***	Entire cycle can be observed with a 14/16" scope. ##
RY Draconis	12 <sup>h</sup> 56.4 <sup>m</sup>	+66° 00'	SRb	6.0	8.0	172.5	C4.5I(N4p)	6 × 30	*****	Cool carbon star with deep red tint. Use 3-6" scope to enhance color. #
BV Draconis	15 <sup>h</sup> 11.8 <sup>m</sup>	+61° 51'	EW/KW	7.88	0.35007		F7V	6 × 30	****	#
TW Draconis	15 <sup>h</sup> 33.9 <sup>m</sup>	+63° 54'	EA/SD	8.0p	2.80695	0.17	A8V + K0III	2/3"	****	Visual magnitudes would be about the same. ##\$
AT Draconis	16 <sup>h</sup> 17.3 <sup>m</sup>	+59° 45'	Lb	6.8p	7.5p	-	M4IIIa	6 × 30	****	Visual magnitudes would be ~ 1.5 mag brighter. ##\$
R Draconis	16 <sup>h</sup> 32.7 <sup>m</sup>	+66° 45'	M	6.7	13.2	245.6	M5e- M9ellI	8/10"	****	##
AZ Draconis	16 <sup>h</sup> 40.7 <sup>m</sup>	+72° 40'	Lb	6.7	7.9	-	M2	6 × 30	****	##
AI Draconis	16 <sup>h</sup> 56.3 <sup>m</sup>	+52° 42'	EA/SD	7.05	8.09	1.98815	A0V	6 × 30	****	Secondary minimum can be detected in visual measurement. ##\$
T Draconis	17 <sup>h</sup> 56.4 <sup>m</sup>	+58° 13'	M	7.2	13.5	421.62	M2e	8/10"	****	Deep red color. ##\$
UW Draconis	17 <sup>h</sup> 57.5 <sup>m</sup>	+54° 40'	Lb	7.0	8.2	-	K5p	6 × 30	****	#
CX Draconis	18 <sup>h</sup> 46.7 <sup>m</sup>	+52° 59'	γ Cas	5.68	5.99	-	B2.5V + F5III	6 × 30	****	The two stars in this system are elliptical, and undergo partial eclipses. ##
BH Draconis	19 <sup>h</sup> 03.7 <sup>m</sup>	+57° 27'	EA/SD	8.38	9.27	1.81724	A2V + Ap	7 × 50	****	#
UX Draconis	19 <sup>h</sup> 21.6 <sup>m</sup>	+76° 34'	SRa	5.9	7.1	168	C7.3(NO)	6 × 30	*****	Striking crimson color. #

(continued)

Table 2.3. (continued)												
Star clusters:												
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size ( <sup>h</sup> )	Brtst. Star	Dist. (ly)	dia. (ly)	Number of Stars	Aper. Recm.	Rating	Comments
None												
Nebulae:												
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size ( <sup>h</sup> )	Brtst. Cent. star	Dist. (ly)	dia. (ly)	Aper. Recm.	Rating	Comments	
NGC 6543	17 <sup>h</sup> 58.6 <sup>m</sup>	+66° 38'	Planetary	8.3	16×22"	<b>11.3</b>			4/6"	*****	Cat's Eye nebula, greenish/bluish disk. Best deep sky object in Draco	
Galaxies:												
Designation	R.A.	Decl.	Type	m <sub>v</sub>	Size ( <sup>h</sup> )	Dist. (ly)	dia. (ly)	Lum. (suns)	Aper. Recm.	Rating	Comments	
NGC 3147	10 <sup>h</sup> 16.9 <sup>m</sup>	+73° 24'	SA	10.6	4.3×3.7	133M	58K	10G	4/6"	****	Faint oval, moderately bright core	
NGC 4125	12 <sup>h</sup> 08.1 <sup>m</sup>	+65° 11'	E6 pec	9.7	6.1×5.1	79M	147K	54G	8/10"	****	Very elongated core. Faint companion (4121) visible in large scopes	
NGC 4236	12 <sup>h</sup> 16.7 <sup>m</sup>	+69° 28'	SBdm	9.6	21.9×7.2	7M	12.5K	500M	10/12"	**	Large, but very low surface brightness. Difficult	
NGC 5678	14 <sup>h</sup> 32.1 <sup>m</sup>	+57° 55'	SBb	11.4	3.3×1.4	100M	90K	22G	12/14"	***	4° SW of Edasich (ι Dra), edge on, bright even in small scopes	
M102, NGC 5866	15 <sup>h</sup> 06.5 <sup>m</sup>	+55° 46'	SA0	9.9v	6.6×3.2	50M	90K	17G	4/6"	*****		
NGC 5879	15 <sup>h</sup> 09.8 <sup>m</sup>	+57° 00'	Sbc	11.4	4.2×1.3	44M	55K	4.3G	8/10"	***	Thin, faint, slightly brighter midline	
NGC 5905	15 <sup>h</sup> 15.4 <sup>m</sup>	+55° 31'	SB	11.7	4.7×3.6	–	–	–	6/8"	***	50° S of 5907, same FOV as 5908 and Wirtz 13, dust lane in large scopes	
NGC 5907	15 <sup>h</sup> 15.9 <sup>m</sup>	+56° 19'	Sc	10.3	11.5×1.7	49M	112K	26G	8/10"	*****	"Splinter Galaxy" edge on, very faint, almost needle-like strip	
NGC 5908	15 <sup>h</sup> 16.7 <sup>m</sup>	+55° 25'	SA	11.8	3.2×1.6	150M	140K	28G	8/10"	***	Nearly edge-on, large scopes show nuclear bar	





**Fig. 2.11.** NGC 4236, edge-on spiral galaxy in Draco. Astrophoto by Mark Komsa.



**Fig. 2.12.** Spiral galaxies NGC 5908 (left) and 5905 in Draco. Astrophoto by Rob Gendler.



**Fig. 2.13.** Edge-on spiral galaxy NGC 5907 in Draco. Astrophoto by Rob Gendler.



**Fig. 2.14.** Spiral galaxies NGC 5963 and 5965 in Draco. Astrophoto by Rob Gendler.





**Fig. 2.15.** Galaxies NGC 5985, 5982 and 5981 in Draco. Astrophoto by Rob Gendler.



**Fig. 2.16.** NGC 6503, spiral galaxy in Draco. Astrophoto by Mark Komsa.

## NOTES:

1. Hold your fist up at arm's length in front of the two stars at the top of the big dipper's bowl ( $\alpha$  and  $\delta$  UMa). Your knuckles should just about fit between them. These two stars are about  $10^\circ$  apart. Your fist can thus be used as a convenient reference for angular distances in the sky. The two stars at the end of the dipper's bowl ( $\alpha$  and  $\beta$ ) are approximately  $5^\circ$  apart. They are also convenient as a reference for distances in the sky. The latter two stars are called "the Pointers" because a line from  $\beta$  to  $\alpha$  extended about  $28^\circ$  takes you to Polaris, the North Star.
2. The stars Flamsteed designated as 37, 39, 41, and 44 Lyncis became part of Ursa Major when the IAU defined the official boundaries of all 88 constellations. 44 Lyncis is now actually  $15^\circ$  from the nearest part of Lyncis! The original designations are occasionally still used in modern references.
3.  $\xi$  Ursae Majoris was the first binary star to have its orbit calculated (M. Savary, 1828). It is one of the closest binaries to the earth, and both stars are very similar to our sun in size, luminosity, and spectral type. In addition, each star is a spectroscopic binary. The A-a pair has a period of 1.832 years, and the B-b pair about 4 days. The A-a pair has a maximum separation of  $<0.03$  and a minimum separation of  $<0.003$ . The A-B pair has the fastest binary motion which is easily visible in small telescopes.
4. Mizar has an unaided eye companion, magnitude 4.0 Alcor,  $11.8'$  distant. Arab cultures of a few hundred years ago used Alcor as a test of satisfactory vision. There is also a 9th magnitude star slightly off the line joining Mizar and Alcor. This group is lovely at all apertures.
5. In addition to having a distant companion, Polaris is a spectroscopic binary with a maximum separation of 0.04. The Hubble Space Telescope resolved it into two separate stars.
6. The Ursa Minor Dwarf Galaxy is an extremely small elliptical satellite galaxy of the Milky Way Galaxy. Its entire light output is less than that of the single star Deneb and only about 30% more than that of Rigel.
7. Around 1900, William F. Denning noticed that every year between 18 and 22 December, he observed several meteors with a radiant point in Ursa Minor. This shower was not studied in detail until 1945, when Anton Becvár and other observers at the Skalnaté Pleso Observatory in Czechoslovakia observed a shower which they estimated to average about 108/h. The following year, Becvár again observed the shower, but rates only about one-tenth as high. Since then, high rates have been observed in 1986 (110/h) and 2000 (90/h). Because Comet Tuttle is locked into a 15/13 resonance with Jupiter, it has a period of  $\sim 13.6$  years, and enhanced meteor showers were also expected in 1959 and 1972. If these occurred, they apparently went unobserved. In addition to these showers at each return of Comet Tuttle, there is also a shower which appears half-way between the comet returns. This shower is due to dust ejected from the comet getting locked into a 7/6 resonant orbit. The difference in periods has delayed this dust until it is now near the earth when Comet Tuttle is at aphelion. Peter Jenniskens and Esko Lyytinen have calculated the paths of Comet Tuttle and its ejected dust streams and predicted enhanced meteor showers ( $\sim 50$  or more per hour) in 2016, 2017, 2018, 2020, 2028, 2030, 2032, 2044, 2047, and 2049. Of these, the ones in 2017, 2030, 2044, and 2049 occur near new moon and should offer the best opportunities for observation.
8. HD 150706 is very sun-like with a mass of  $0.98 M_\odot$ , and a temperature of  $\sim 5,930$  K ( $\sim 10,700^\circ\text{F}$ ) compared with  $\sim 5,830$  K ( $\sim 10,525^\circ\text{F}$ ) for our sun. Its lone planet was discovered in 2002. This planet is 0.82 AU distant from its star, has a mass of  $>1 M_J$ , and an orbital period of 264 days (Venus orbits the sun in 225 days). It has an orbital eccentricity of 0.38, significantly greater than Pluto, which has the most eccentric orbit in our solar system.
9. NGC 5866 is a beautiful edge-on galaxy, bright even in small telescopes, and a dust lane is visible in larger amateur instruments. NGC 5866 is sometimes used as a replacement for number 102 in Messier's famous list. His original list contained a duplicated observation of M101 with a position error.
10. The Rev. M. Davidson was one of the astronomers who made calculations of the orbit of the 1900 Comet Giacobinni-Zinner. From his results, Davidson predicted that there could be a meteor shower when the earth passed near the path of Giacobinni-Zinner in early October, 1915. Observer William F. Denning reported seeing several meteors from that shower. In 1926, the earth passed through the comet's orbit 70 days before the comet's arrival. On Oct. 9 of that year, a fireball witnessed by hundreds of people in the British Isles alerted observers who reported a shower of very slowly moving meteors peaking at rate of about 14/h on Oct. 10. Conditions were very favorable in 1933, and a meteor storm of about 6,000–10,000/h was observed in several countries. No further major showers were observed until 1946 when estimates were as

high as 10,000/h. The 1952 return was down to  $\sim 250$ /h, and was detected by radar during daytime, but not by visual observers. A 1985 outburst reached 700–800/h, but in 1986 the activity was less than 2/h! In 1998, an outburst of  $\sim 1,000$ /h occurred, and there are predictions of possible major showers in 2011 and 2018. Comet Giacobini–Zinner had close encounters with Jupiter in 1626 and 1628 in which it was deflected into an erratic orbit whose period varied between 6 and 8 years. It has now settled into a fairly stable orbit whose parameters vary slowly. Its perihelion is predicted to remain near the earth's orbit until at least 2400 AD, so periodic outbursts are likely for some time.

11. While Thuban is considerably fainter than Polaris, it was our pole star during the time when Egypt first achieved a high level of civilization and became the richest and most advanced culture in the world, but before the pyramid building period, and thus became quite famous. At its closest approach to the true celestial pole, Thuban was only 10' away, or one-third the closest approach that Polaris will make.

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