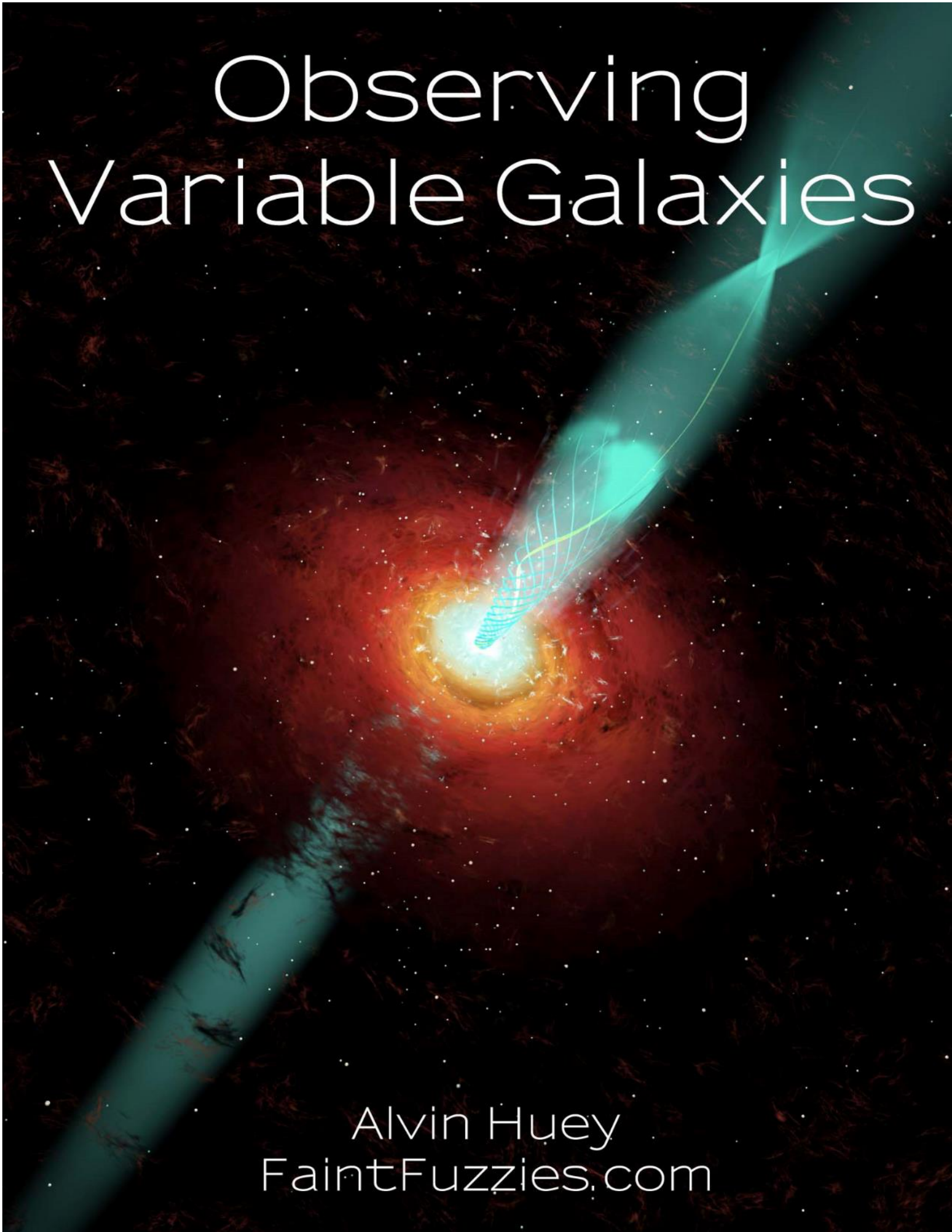
Observing Variable Galaxies



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Variable Galaxies

Alvin Huey

www.FaintFuzzies.com

Updated: March 2024

Observing Books by Alvin Huey

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Observing the Arp Peculiar Galaxies, Revised edition

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Herschel Objects – Parts I, II, and III

Selected Small Galaxy Groups

Galaxy Trios and Triple Systems

Globular Clusters – North of -50°

Planetary Nebulae and Supernovae Remnants

The Local Group

Flat Galaxies

Abell Galaxy Clusters

Voronstov-Velyaminov Catalogue – Part I and II

Rose Catalogue of Compact Galaxies

Variable Galaxies

Selected Shakhbazian Groups

Ring Galaxies

Palomar Compact Galaxy Catalogue

Object of the Week 2012 and 2013 – Deep Sky Forum

All Maps by MegaStar™ v5
All DSS images (Digital Sky Survey) archive.stsci.edu/dss/acknowledging.html

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Contents

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Variable Galaxy Catalogue

Page	Object	Type	RA	Dec	Con	Magnitude Range	Redshift (z)	Dist. (Mly)	Other name
14	3C 454.3	BL	22 53 57.7	+16 08 54	Peg	13.3 - 16.4	0.859	7592	OY 158
16	1ES 2344+51.4	BL	23 47 04.8	+51 42 18	Cas	13.5 - 15.9	0.044	593	B2344+514
18	S10721 And	AGN	00 38 33.1	+41 28 50	And	16.9 - 19.	0.073	963	PGC 2304
20	IV Zw 29	AGN	00 42 15.9	+40 19 38	And	16.8 - 18.2	0.103	1341	PGC 2524
22	IO And	QSO	00 48 19.0	+39 41 09	And	15.3 - 17.6	0.134	1723	S10785
24	3C 66A	BL	02 22 39.6	+43 02 08	And	13.5 - 15.6	0.444	4845	0219+428
26	I Zw 1	AGN	00 53 35.1	+12 41 35	Psc	13.2 - 14.7	0.059	787	UGC 545
28	UX Psc	AGN	01 11 45.4	+22 04 10	Psc	13.4 - 16.3	0.046	614	NPM1G +21.0054
30	XX Cet	QSO	02 22 39.9	-19 32 50	Cet	18.0 - 19.7	0.736	6911	PHL 4037
32	1ES 0229+200	BL	02 32 48.6	+20 17 17	Ari	14.7	0.140	1795	
34	OD 160	BL	02 38 38.9	+16 36 59	Ari	14.3 - 18.7	0.940	7991	AO 0235+164
36	J0245+1047	BL	02 45 13.5	+10 47 20	Ari	16.5	0.070	931	
38	H0323+022	BL	03 26 14.0	+02 25 15	Tau	15.7 - 18.6	0.147	1877	
40	1ES 0414+009	BL	04 16 52.4	+01 05 24	Tau	15.9 - 17.1	0.287	3404	1H 0414+009
42	OF 038	BL	04 24 46.8	+00 36 06	Tau	14.6 - 16.7	0.310	3632	0422+004
44	BW Tau	AGN	04 33 11.1	+05 21 14	Tau	13.7 - 16.4	0.033	447	3C 120
46	3C 147	QSO	05 42 36.1	+49 51 07	Aur	17 - 18	0.545	5641	
48	S10838 Aur	AGN	05 54 53.6	+46 26 22	Aur	14.4 - 15.5	0.021	279	UGC 3374
50	BL 0647+250	BL	06 50 46.5	+25 03 00	Gem	15.3	0.203	2517	1ES 0647+250
52	OI 158	BL	07 38 07.4	+17 42 19	Gem	14.5 - 16	0.424	4676	PKS 0735+178
54	S5 0716+71	BL	07 21 53.4	+71 20 36	Cam	13 - 15	0.300	3533	PKS 0716+714
56	0816.0-0736	BL	08 16 04.2	-07 35 59	Hya	16.1	0.040	540	MAC 0816-0735
58	OJ 049	BL	08 31 48.9	+04 29 39	Hya	11.6 - 14.8	0.021	286	PKS 0829+046
60	OJ 287	OVV	08 54 48.9	+20 06 31	Cnc	12.2 - 15	0.306	3592	PKS 0851+202
62	1ES 0806+524	BL	08 09 49.2	+52 18 58	UMa	15.2 - 15.7	0.138	1771	
64	1ES 0954+658	BL	09 58 47.2	+65 33 55	UMa	15.8 - 16.7	0.368	4180	
66	1ES 1011+496	BL	10 15 04.1	+49 26 01	UMa	14.3 - 15.4	0.200	2484	
68	Markarian 421	BL	11 04 27.3	+38 12 32	UMa	12.0 - 14.4	0.030	407	UGC 6132
70	4C 29.45	AGN	11 59 31.8	+29 14 44	UMa	13.0 - 18.1	0.729	6869	Ton 599
72	3C 232	BL	09 58 21.0	+32 24 02	Leo	15.3 - 16.2	0.530	5529	
74	AU Leo	AGN	11 30 14.3	+23 48 09	Leo	17.0	0.025	340	A 1127+24
76	GQ Com	QSO	12 04 42.1	+27 54 12	Com	14.7 - 16.1	0.165	2087	PG 1202+281
78	ON 325	BL	12 17 52.1	+30 07 01	Com	14.4 - 16.8	0.237	2886	
80	W Com	BL	12 21 31.7	+28 13 58	Com	11.5 - 17.5	0.102	1334	ON 231
82	1231.7+2848	BL	12 31 55.6	+28 49 13	Com	17.0	1.0	8265	
84	X Com	AGN	13 00 22.5	+28 24 03	Com	12.5 - 17.9	0.092	1209	PGC 44750
86	3C 273	QSO	12 29 06.7	+02 03 09	Vir	11.7 - 13.2	0.158	2006	
88	3C 279	OVV	12 56 11.1	-05 47 22	Vir	13.3 - 16.3	0.540	5604	
90	AU CVn	QSO	13 10 28.6	+32 20 44	CVn	13.9 - 19.6	0.996	8247	B2 1308+32
92	S10764 CVn	QSO	13 42 10.9	+28 28 48	CVn	18.3 - 19.8	0.330	3825	B2 1339+28
94	CC Boo	QSO	13 40 22.8	+27 40 58	Boo	17.8 - 19.5	0.172	2168	S10762
94	CD Boo	QSO	13 41 23.3	+27 49 55	Boo	18.9 - 19.7	1.045	8458	S10763
96	S10765 Boo	AGN	13 46 47.2	+29 54 20	Boo	17.0 - 18.8	0.063	841	NGP9 F324-276706

Page	Object	Type	RA	Dec	Con	Magnitude Range	Redshift (z)	Dist. (Mly)	Other name
98	OQ 530	BL	14 19 46.6	+54 23 15	Boo	14.6 - 15.9	0.151	1924	PG 1418+546
100	1ES 1426+428	BL	14 28 32.6	+42 40 21	Boo	13.8 - 16.4	0.129	1663	
102	PKS 1510-089	BL	15 12 50.5	-09 06 00	Lib	11.8 - 17.8	0.360	4107	OR-017
104	AP Lib	BL	15 17 41.9	-24 22 22	Lib	14.0 - 16.7	0.042	566	PKS 1514-04
106	PG 1553+113	BL	15 55 43.0	+11 11 24	Ser	13.1 - 13.9	0.360	4107	
108	3C 345	BL	16 42 58.8	+39 48 37	Her	14.3 - 17.3	0.593	5986	
110	Markarian 501	BL	16 53 52.2	+39 45 37	Her	13.2 - 13.9	0.034	456	UGC 10599
112	V395 Her	AGN	17 22 34.1	+24 45 00	Her	16.1 - 17.7	0.064	851	8 Zw 476
112	V396 Her	QSO	17 22 41.2	+24 36 18	Her	15.7 - 16.7	0.175	2202	Q1720+246
114	I Zw 187	BL	17 28 18.6	+50 13 10	Her	14.2 - 16.8	0.055	737	OT 546
116	PKS 1749+096	QSO	17 51 32.8	+09 39 02	Oph	14.1 - 18.4	0.322	3748	OT 081
118	Markarian 180	BL	11 36 26.4	+70 09 27	Dra	14.0 - 15.1	0.046	619	CGCG 334-43
120	Markarian 205	AGN	12 21 44.1	+75 18 38	Dra	13.9 - 15.2	0.070	931	PGC 39975
122	3C 351	QSO	17 04 41.4	+60 44 31	Dra	15 - 16	0.372	4217	
124	S5 1803+78	BL	18 00 45.7	+78 28 04	Dra	14.0 - 16.5	0.684	6593	
126	3C 371	BL	18 06 50.7	+69 49 28	Dra	13.5 - 15.0	0.051	685	UGC 11130
128	1ES 1959+650	BL	19 59 59.9	+65 08 55	Dra	14.1 - 15.2	0.047	632	
130	3C 382	BL	18 35 03.4	+32 41 47	Lyr	12.5 - 14.5	0.058	776	CGCG 173-14
132	V1102 Cyg	AGN	19 10 37.2	+52 13 13	Cyg	15.5 - 17.	0.027	367	PGC 62859
134	V362 Vul	AGN	20 02 48.6	+22 28 27	Vul	16.0 - 17.7	0.029	394	E 2000+223
136	BL Lac	BL	22 02 43.3	+42 16 39	Lac	12.4 - 17.2	0.069	918	VRO 42.22.01
138	Markarian 509	BL	20 44 09.8	-10 43 35	Aqr	12.6 - 15.65	0.033	447	PGC 65282
140	PKS 2155-304	BL	21 58 52.0	-30 13 32	PsA	11.9 - 13.4	0.116	1506	

Quasar Catalog Designations

3C – Third Cambridge Catalog of Radio Sources (1959)
4C – Fourth Cambridge Survey of Radio Sources (1965, 1967)
S2, S3, S5 – 2nd, 4th and 5th Max Plank Institute Radio Survey Catalog
S + Number + Constellation – Sonneberg Observatory designation
PKS – Parkes Radio Sources Catalog
1ES – Einstein Slew Survey
Roman numeral + Zw + number – Zwicky Catalogue of Galaxies and Clusters of Galaxies (1 to 7)
V + number + constellation – Variable Star designation
Two letters + constellation – Variable Star designation

Variable Stars…err…Variable Galaxies?

Amateur astronomers have observed or heard of variable stars, but variable galaxies? My first impression is, "How can galaxies consisting of many stars be variable?". In 1965, Dr. Fritz Zwicky discovered a nearly stellar variable galaxy, IV Zw 29 near M-31. After that discovery, astronomers started to search through the General Catalog of Variable Stars (GCVS) list published by the Academy of Sciences of the USSR and edited by B.V. Kukarkin and P.P. Parenago in 1948 for extragalactic objects[1]. They compared the locations of radio sources versus the locations of the "variable stars" in the GCVS. The first four discovered were BW Tauri (Penston 1968), BL Lacertae (Schmitt 1968), W Comae (Brown 1971), and AP Librae (Bond 1971; Biruad 1971). Once they discovered these four, astronomers got excited and started to dig deeper…

Astronomers decided to compare the coordinates of variable stars in the GCVS catalog to the POSS images for any non-stellar objects, which led to the first discovery, V395 Her[2]. That object has some large optical variations reported earlier in variable star literature. Eventually, 700 objects have been looked at led to several other discoveries, namely, X Comae and V1102 Cygni. The variability of X Comae was reported more than 50 years ago with a magnitude range from 12.5 to 16, a 3.5 mag difference or 25x brightness difference! V1102 Cygni usually sits at magnitude 17, with occasional outbursts to mag 15.5, then dimming back to mag 17.

This work has led Dr. Strittmatter *et al*[3] to propose a class of type of objects, BL Lacertae object, in 1972. Since most BL Lacertae objects have radio-loud sources or active nuclei in galaxies, they determined that the primary differences between the BL Lac object and quasars (QSOs) are:

- Continuous spectrum with no emission lines (later research shows that the continuum may be due to viewing angles from Seyferts through BL Lacertae's)
- Nonthermal optical continuum is usually steeper than the average quasar.
- The brighter BL Lac objects are not associated with large extended radio sources. Louder radio source relative to the size of the radio source.
- The variations in BL Lac objects are more rapid than a QSO.

Figure 1: Artist rendition of the accretion disc with relativistic jet

[1] Bend, H.E. "A Search for Extragalactic Objects in the General Catalog of Variable Stars." *Astrophysical Journal,* Vol 181 (April 1973), L23-L24

[2] Bond, H.E. "The Optically Variable Galaxy V395 Herculis*" Astrophysical Journal*, Vol 174 (June 1972), L163

[3] Strittmatter, P.A. et al. "Compact Extragalactic Nonthermal Sources." *Astrophysical Journal,* Vol 175 (July 1972), L7-L13

During this work[4], it was noticed that the BL Lacertae objects have short outbursts of brightness by a magnitude, sometimes as high as 5+ magnitudes. OJ 287, showed four large optical bursts since 1894, peaking at mag 12.2, before settling back to mag 15. PKS 0735+178 exhibited a difference of 1.5 magnitudes. Some wonder why the objects show a short outburst then settling at a "base" brightness, then repeat.

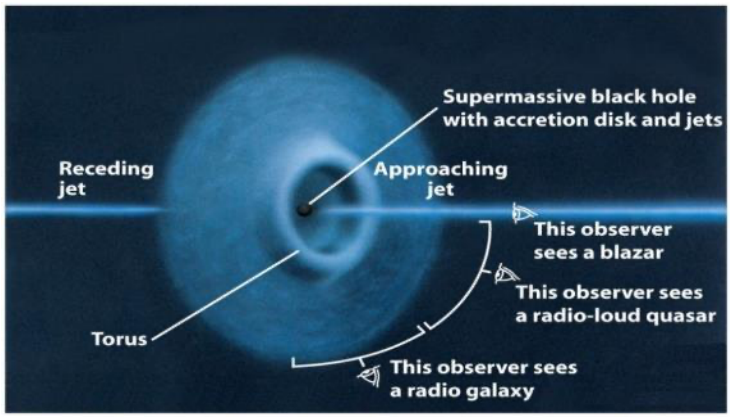


Figure 2: Illustrates the classification of the AGN depending on observer location

Another class of variable galaxies was classified as an optically violent variable quasar (OVV quasar). They are similar to BL Lac objects, but have a stronger broad emission line and have visible light outbursts by 50% in a day. Along with BL Lac objects, their variability is attributed to the orientation of the relativistic jet, but the distinction[5] between the OVV and BL Lac objects is the luminosity. The other distinction is that all OVV are radio loud. High luminosity variable galaxies are generally classified as OVV while the lower luminosity are BL Lac objects.

In 1978, Dr. Edward Spiegel came up with the term "blazar", which is a combination of BL Lac objects and OVV quasars. A few rare objects may be an intermediate blazar which is a mixture of properties from both BL Lac objects and OVV quasars. All quasars have a relativistic jet that emanates in opposite directions from near its poles. Some are by chance, sometimes pointed directly at the earth as it rotates, which explains the short-termed outbursts of optical brightness; hence this class of objects is called blazars. Astronomers classified a blazar if the Active Galaxy Nucleus (AGN) meets with one of the following properties:

- High radio-brightness with flat radio spectrum,
- High optical polarization,
- Strong optical variability on very short timescales (few days or less)

Blazars is a subcategory of a larger group of galaxies that host AGN. AGN is basically a compact region in the center of the galaxy that has a much higher than normal brightness, in many cases, brighter than the rest of the galaxy itself. The radiation from the active nuclei is thought to be an accretion mass by a supermassive black hole in the center of the host galaxy. Variability of the accretion disk results in optical variability over time.

[4] Stein, W.A., O'Dell, S.L., Strittmatter, P.A. "The BL Lacertae Objects." *Annual Review of Astronomy and Astrophysics*. Vol 14 (1976), 173-195

[5] Wright, S.C. et al. "Host galaxies of the optically violently variable quasars PKS 0736+017, OJ 287 and LB 2136." *Mon. Not. R. Astron. Soc.*, Vol 295 (1998), 799-812

Classification of Variable Galaxies

So basically, the classification of each variable galaxy depends on the orientation of the jet relative to our line of sight. See Figures 2 and 3, where the AGN relativistic jet orientation determines the "type" of object we see from earth.

Even with the definitions of the classifications of variable galaxies, astronomers are still inconsistent in the classifications of these objects. Trying to bucket classifications in astronomy is never easy and variable galaxies in my opinion is more subjective than most classes of objects. I've looked at several professional sources and found that some variable galaxies have differing classifications.

So…I'm still a bit confused about the classification. For this observing guide, I just took the "majority" classification for each object.

Think about these classes of objects as you observe them from the eyepiece and wonder about the power of these objects. It just makes us very insignificant, let alone live next to one of these things.

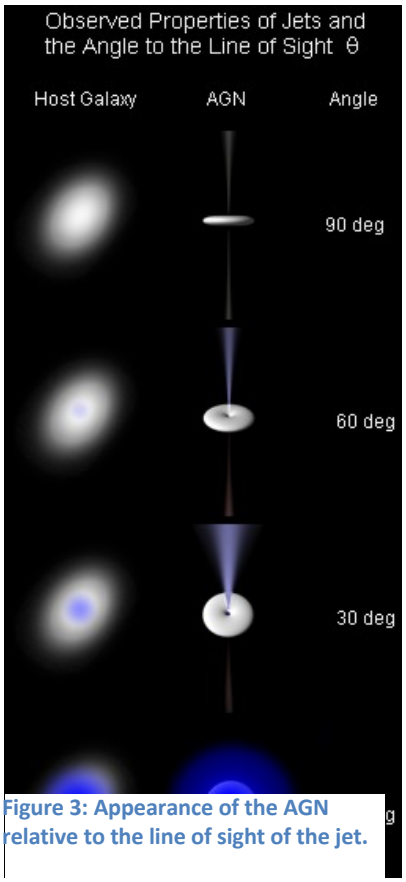


Figure 3: Appearance of the AGN relative to the line of sight of the jet.

Observing Variable Galaxies

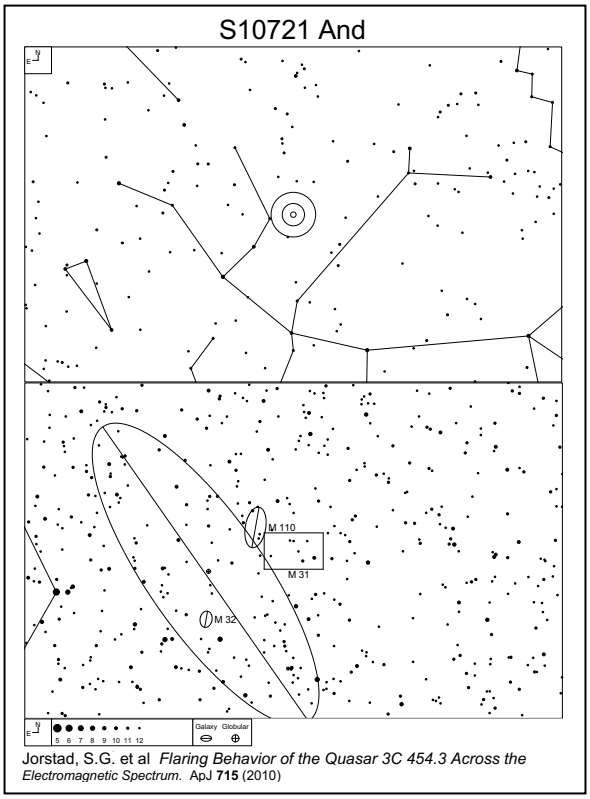
Most variable galaxies are stellar. After you find it, attempt to estimate the magnitude by using these charts or the AAVSO variable star plotter. If you are a member/observer, you can report the observation to AASVO.

The AAVSO variable star plotter (www.aavso.org/vsp) is a web resource to plot based on name or coordinates.

The AAVSO light curve generator (www.aavso.org/lcg) is a great resource for historical observations over time.

The AASVO WebObs (www.aavso.org/webobs), search the AID or submit your observations.

How to Use the Atlas



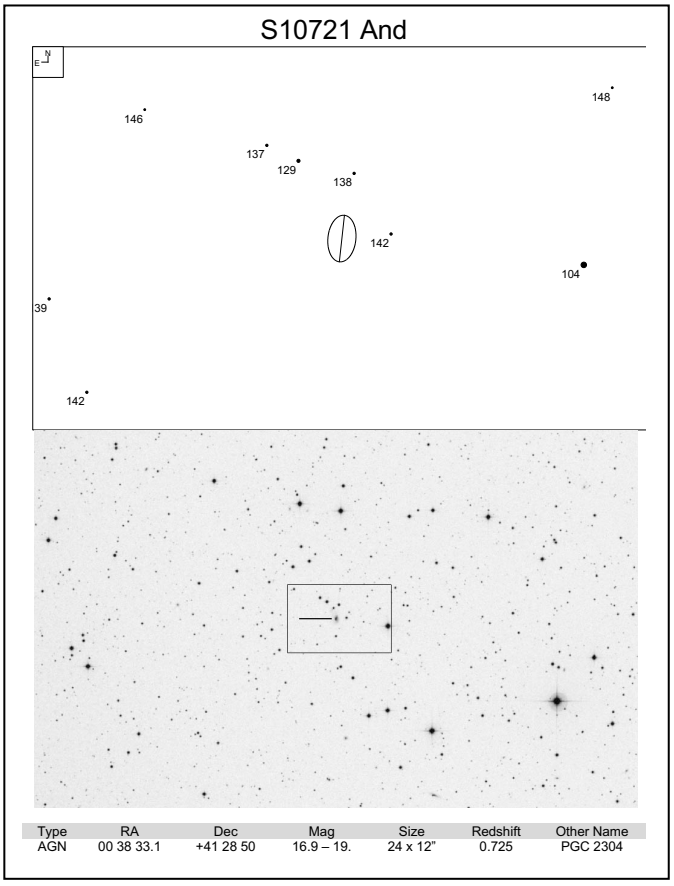
Jorstad, S.G. et al *Flaring Behavior of the Quasar 3C 454.3 Across the Electromagnetic Spectrum.* ApJ **715** (2010)

Left Page: The top panel contains the naked eye field with the TelRad™ superimposed on the center of the variable galaxy.

The bottom panel is a finder chart of about 4.8º across and 3.0º high. The finder field is wide enough for the finder scope and detailed enough for those who choose to use a low-power eyepiece as a "finder". The limiting magnitude of the field stars is generally set to 12.0 but set to a lower limit in star-rich regions. A magnitude scale is provided on the bottom left. The rectangular field of the DSS image is superimposed on the finder chart.
For some objects, references to papers, articles, or websites are provided.

Right Page: The top panel contains a "close-up" view with stellar magnitudes up to mag 20 to assist in estimating the magnitude of the variable galaxy. Stars above mag 16 are labeled. The field is typically 7.0 x 4.5'.
The bottom panel contains the 30x20' DSS image with the labeled variable galaxy. It also contains the rectangular field of the "close-up" view.
A table is provided, listing the following fields:

- **Type:**
  - AGN – Active Galaxy Nucleus
  - BL – BL Lacertae object
  - OVV – Optically Violent Variable Quasar
  - QSO – Quasar without strong radio emissions
- **RA** and **Dec** in Epoch 2000.0
- **Size**
- **Mag**nitude range
- **Redshift** (z)
- **Other name**

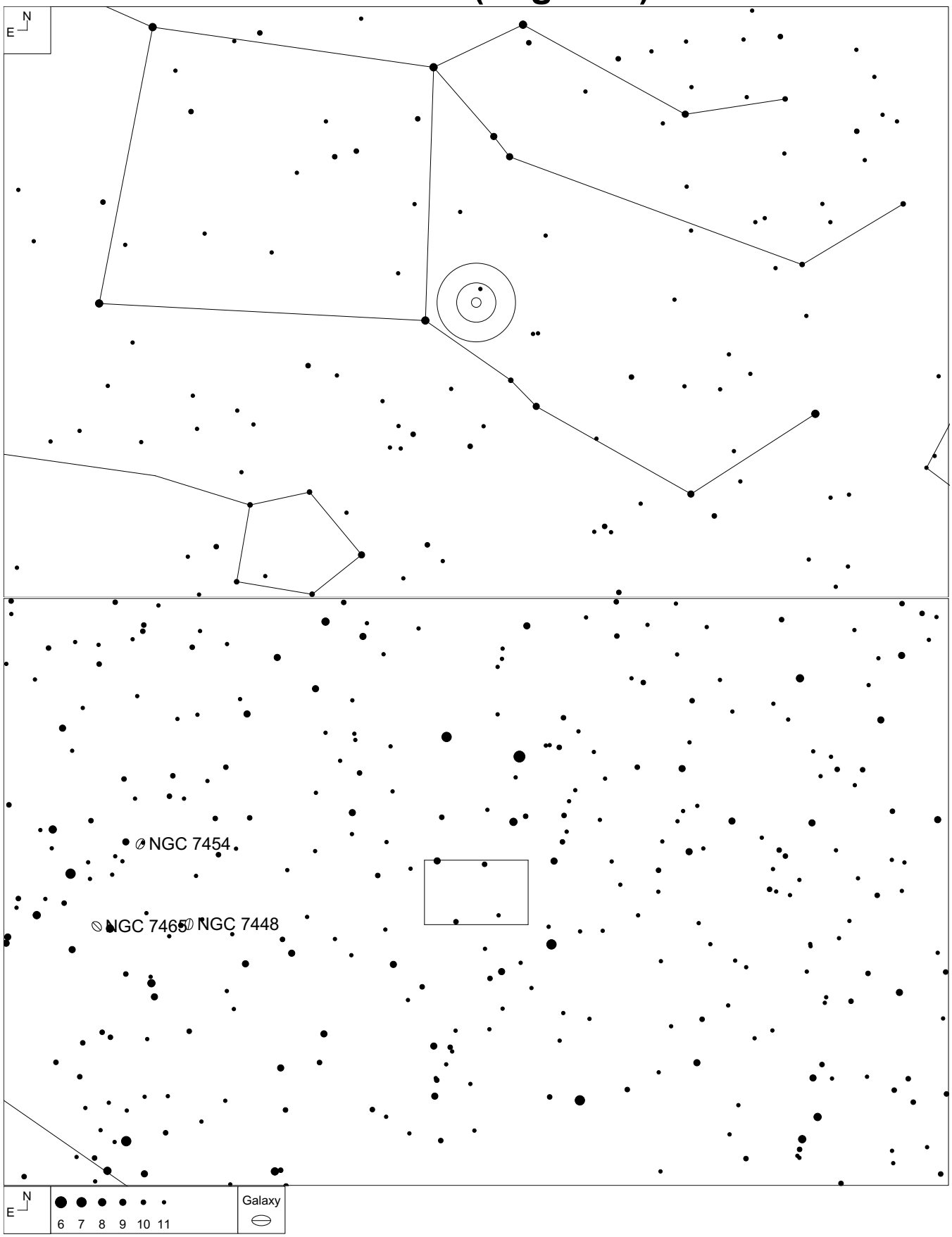


Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	00 38 33.1	+41 28 50	16.9 – 19.	24 x 12"	0.725	PGC 2304

Any comments or to share any observations, send them to Alvin.Huey@FaintFuzzies.com.
Any feedback or suggestions would be greatly appreciated. I hope to keep this resource updated and made available to all of you, the deep sky observer.

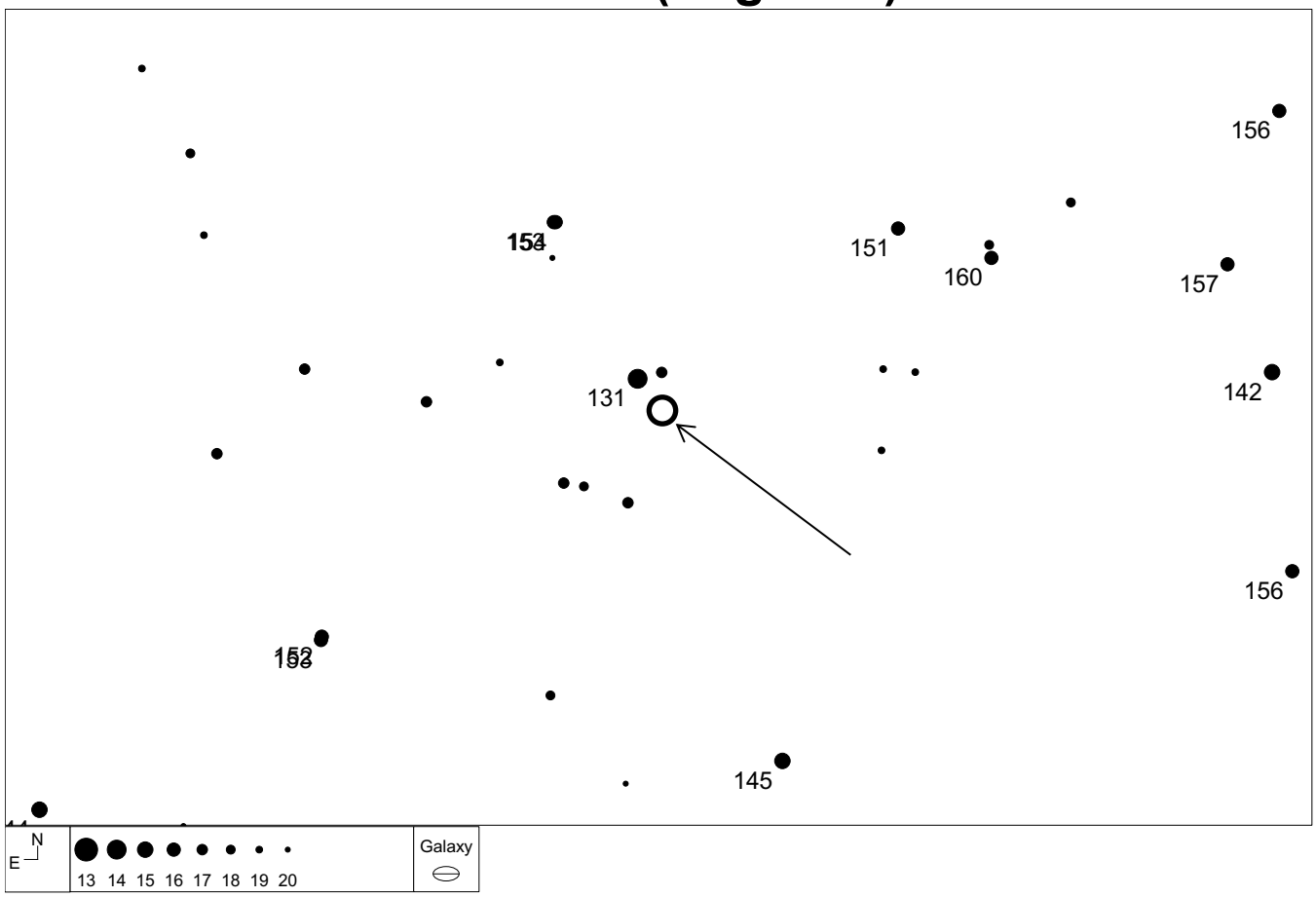
Variable Galaxies Atlas

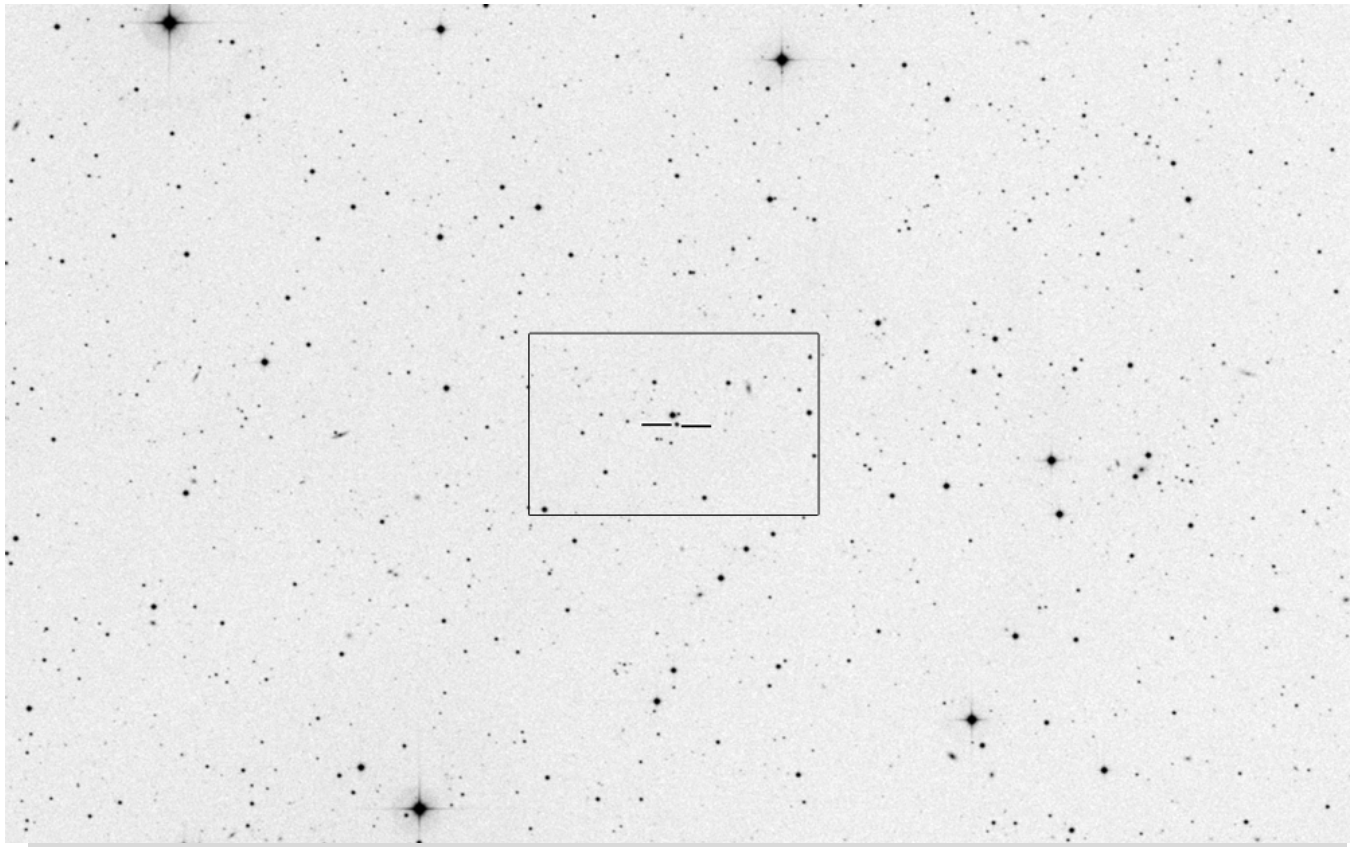
3C 454.3 (Pegasus)



Jorstad, S.G. et al "Flaring Behavior of the Quasar 3C 454.3 Across the Electromagnetic Spectrum." *Astrophysical Journal*, Vol 715 (2010), 362-384

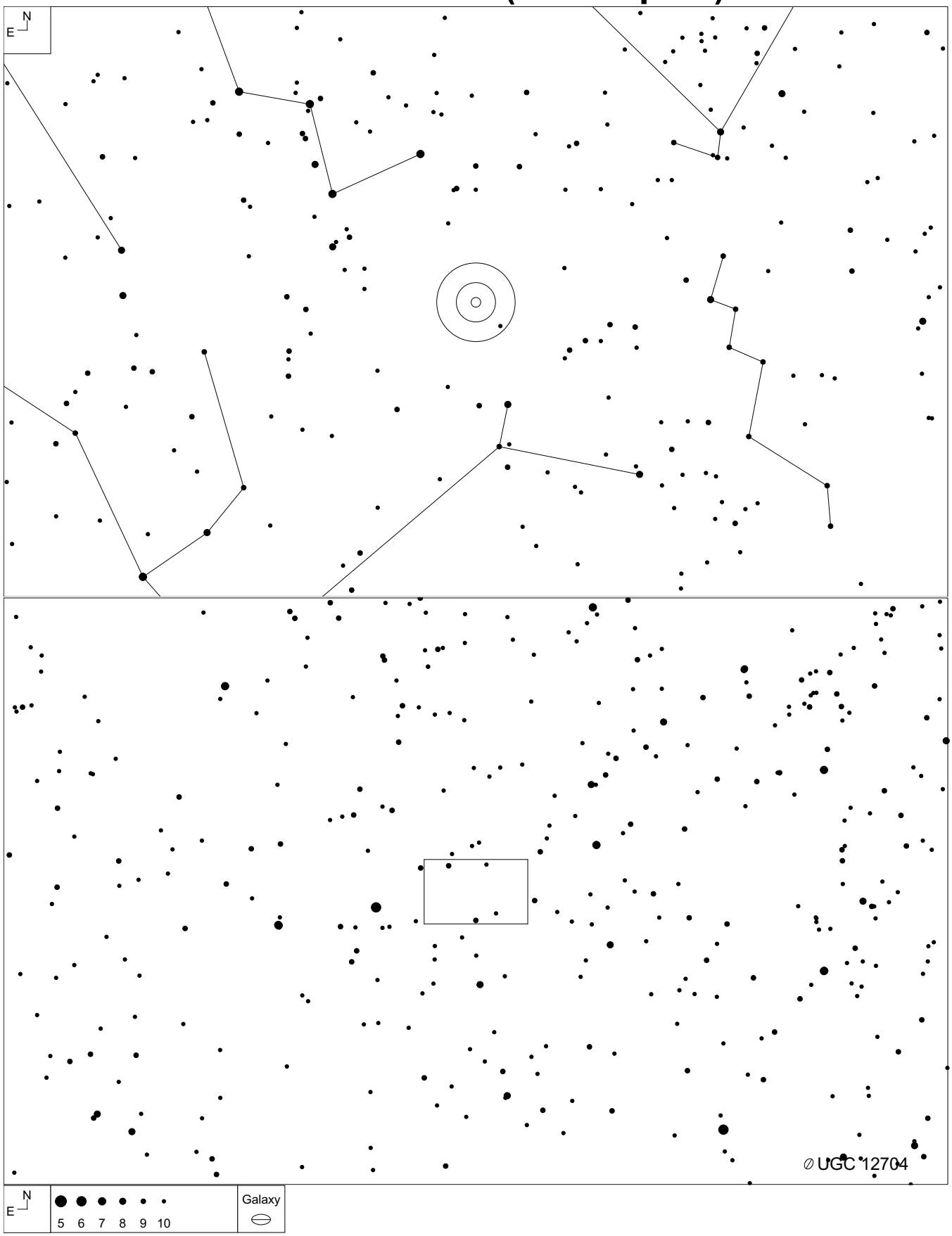
3C 454.3 (Pegasus)





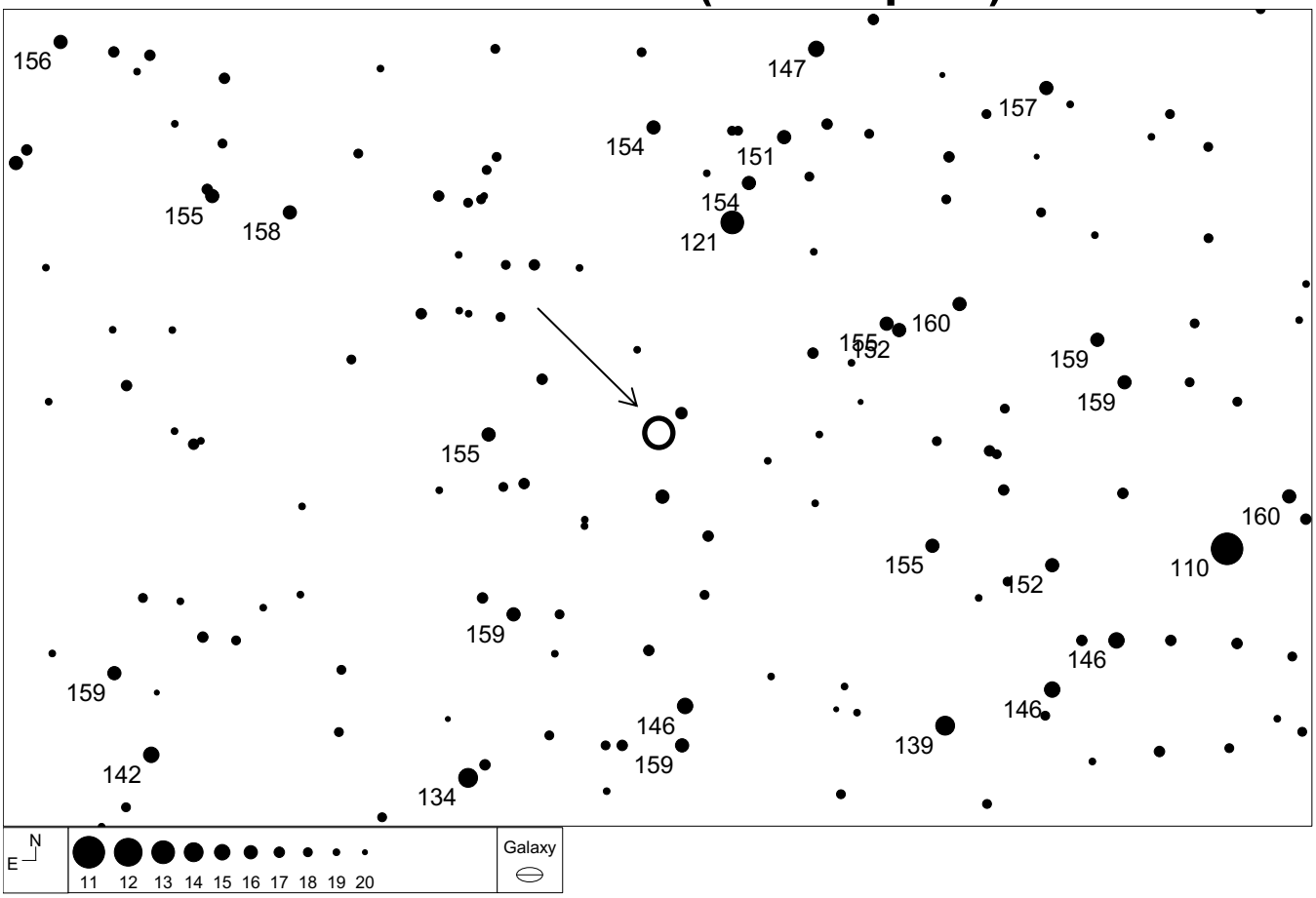
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	22 53 57.7	+16 08 54	13.3 - 16.4	stellar	0.859	OY 158

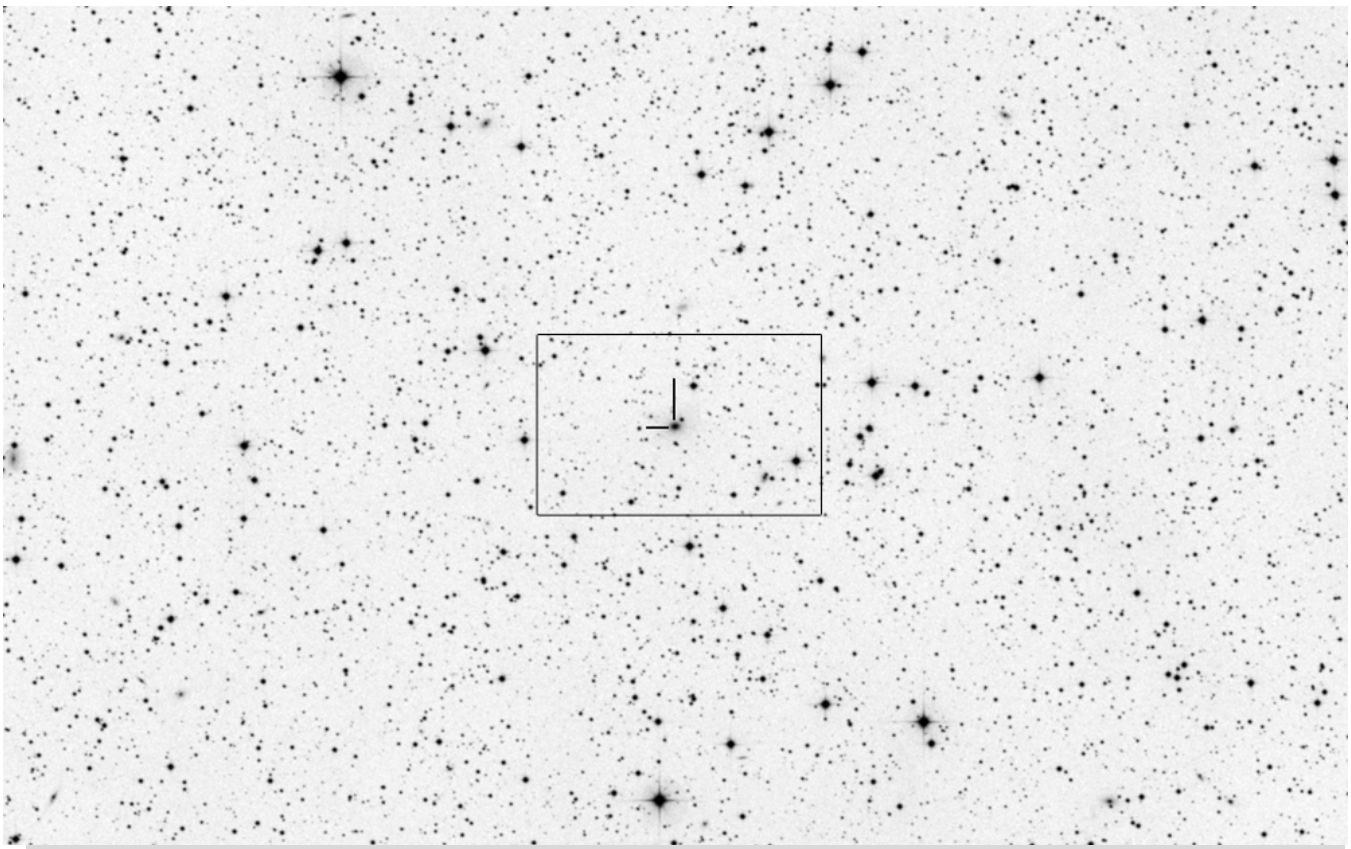
1ES 2344+51.4 (Cassiopeia)



Weidinger, M. Spanier, F. “Variability along the Blazar-Sequence - Hints for extragalactic Cosmic Rays?” *32nd ICRC*, Beijing 2011

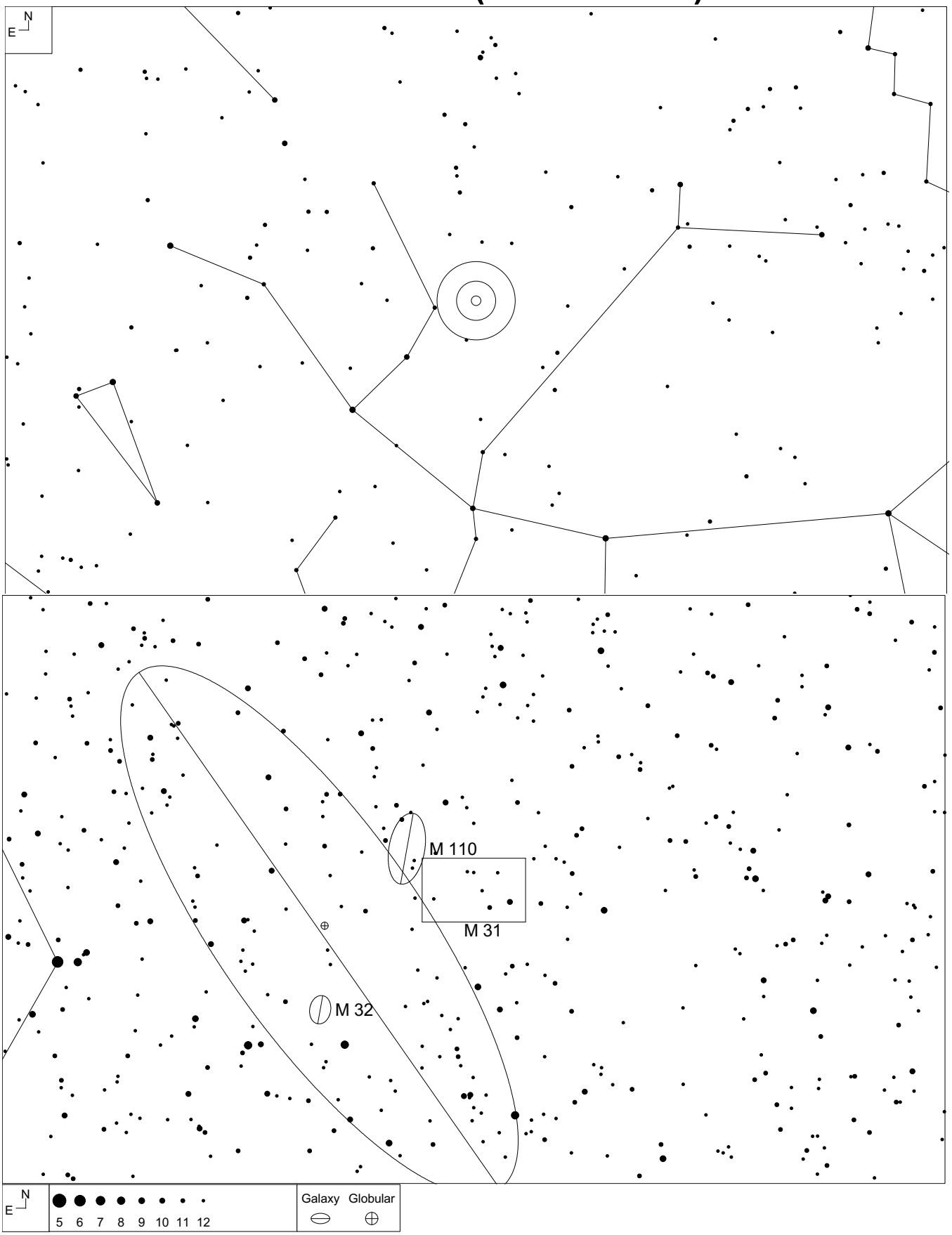
1ES 2344+51.4 (Cassiopeia)



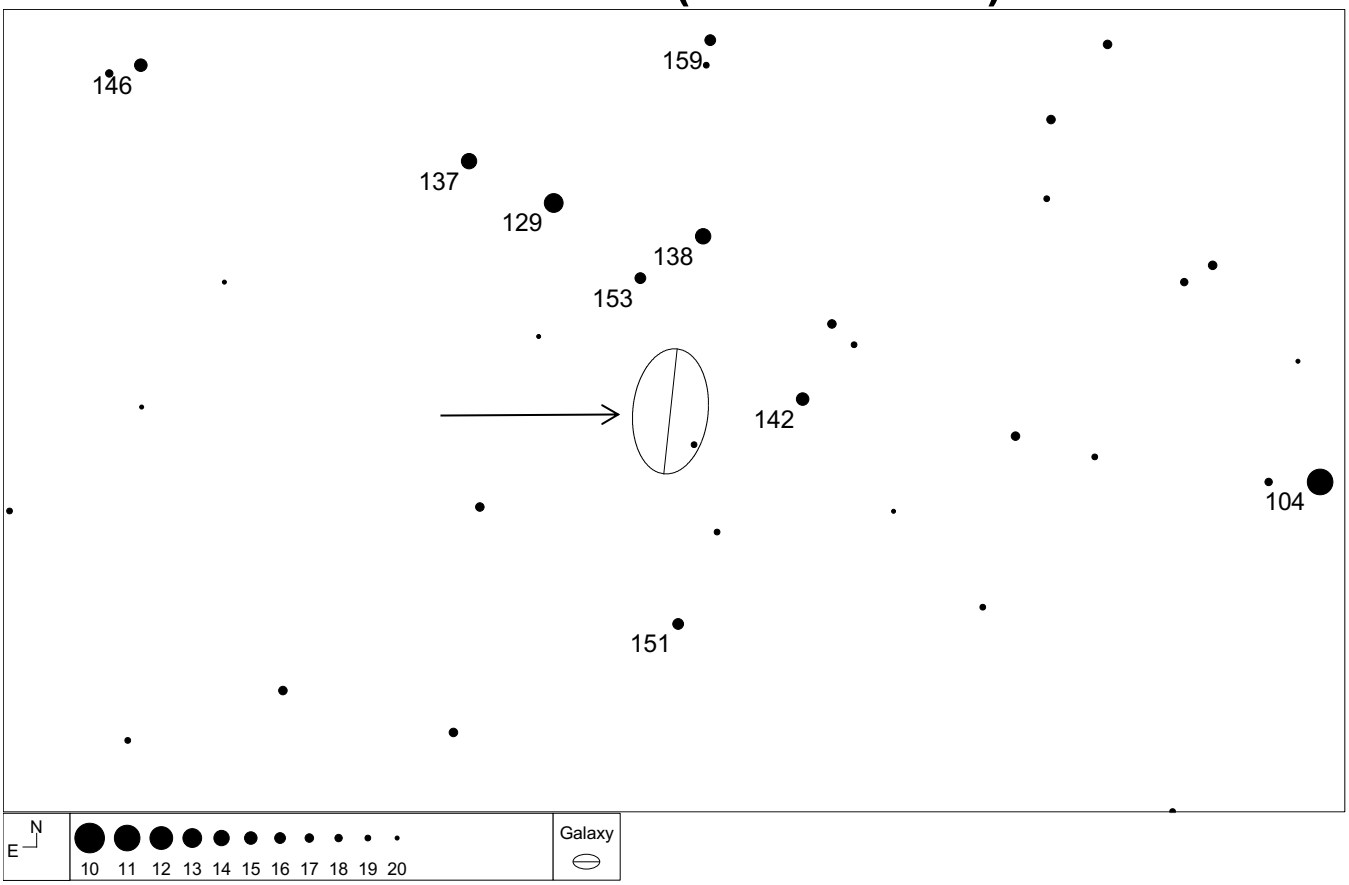


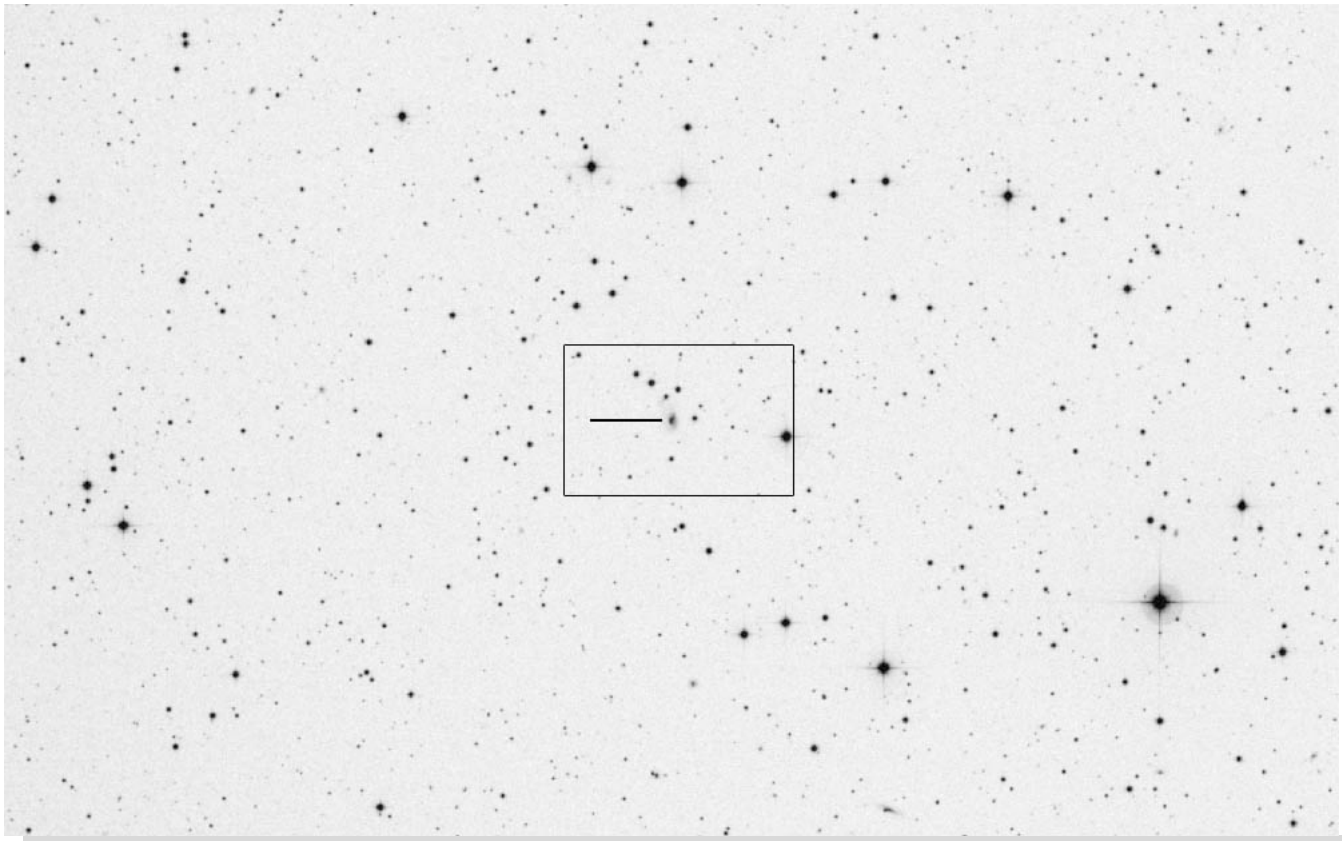
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	23 47 04.8	+51 42 18	13.5 - 15.9	stellar	0.044	B2344+514

S10721 And (Andromeda)



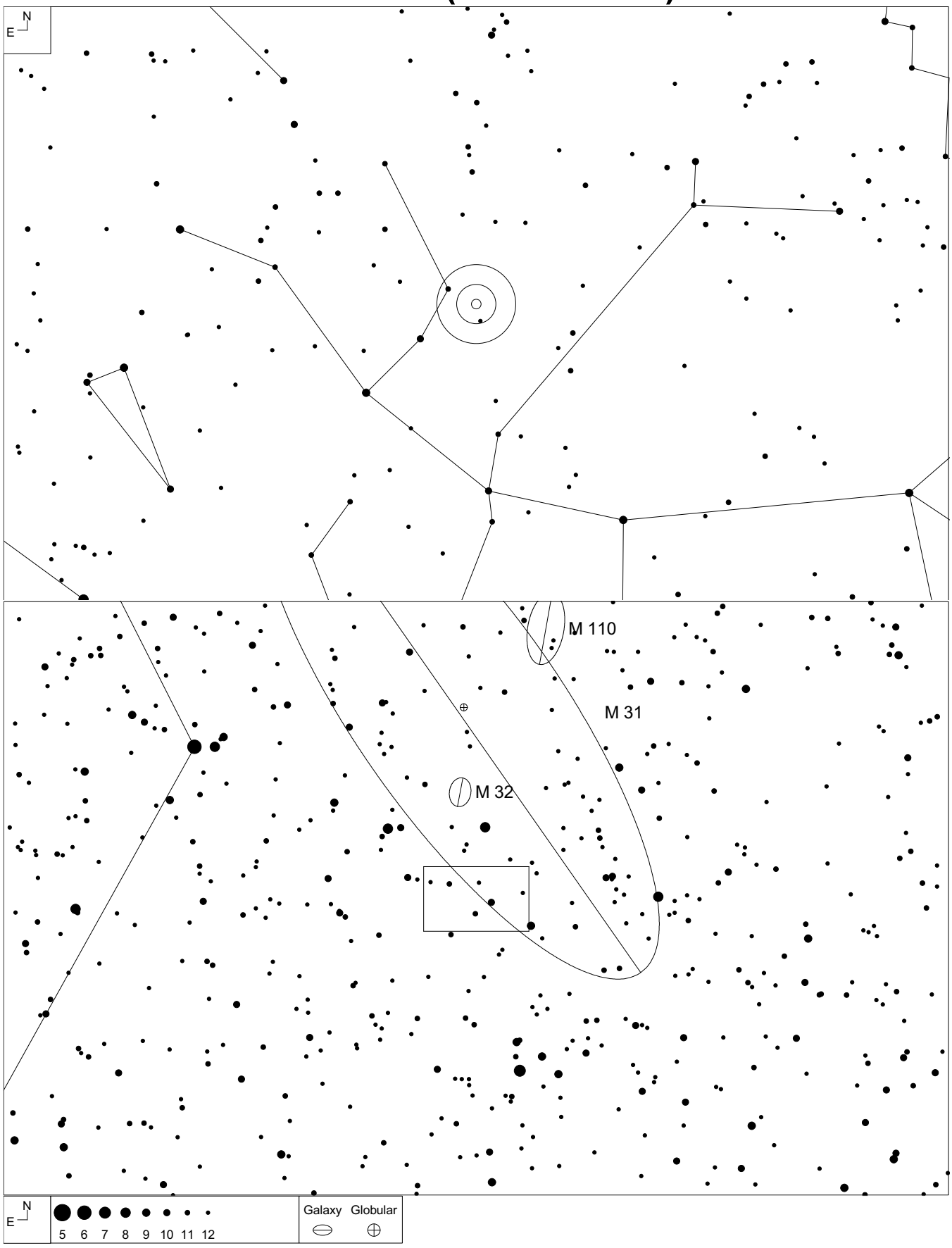
S10721 And (Andromeda)





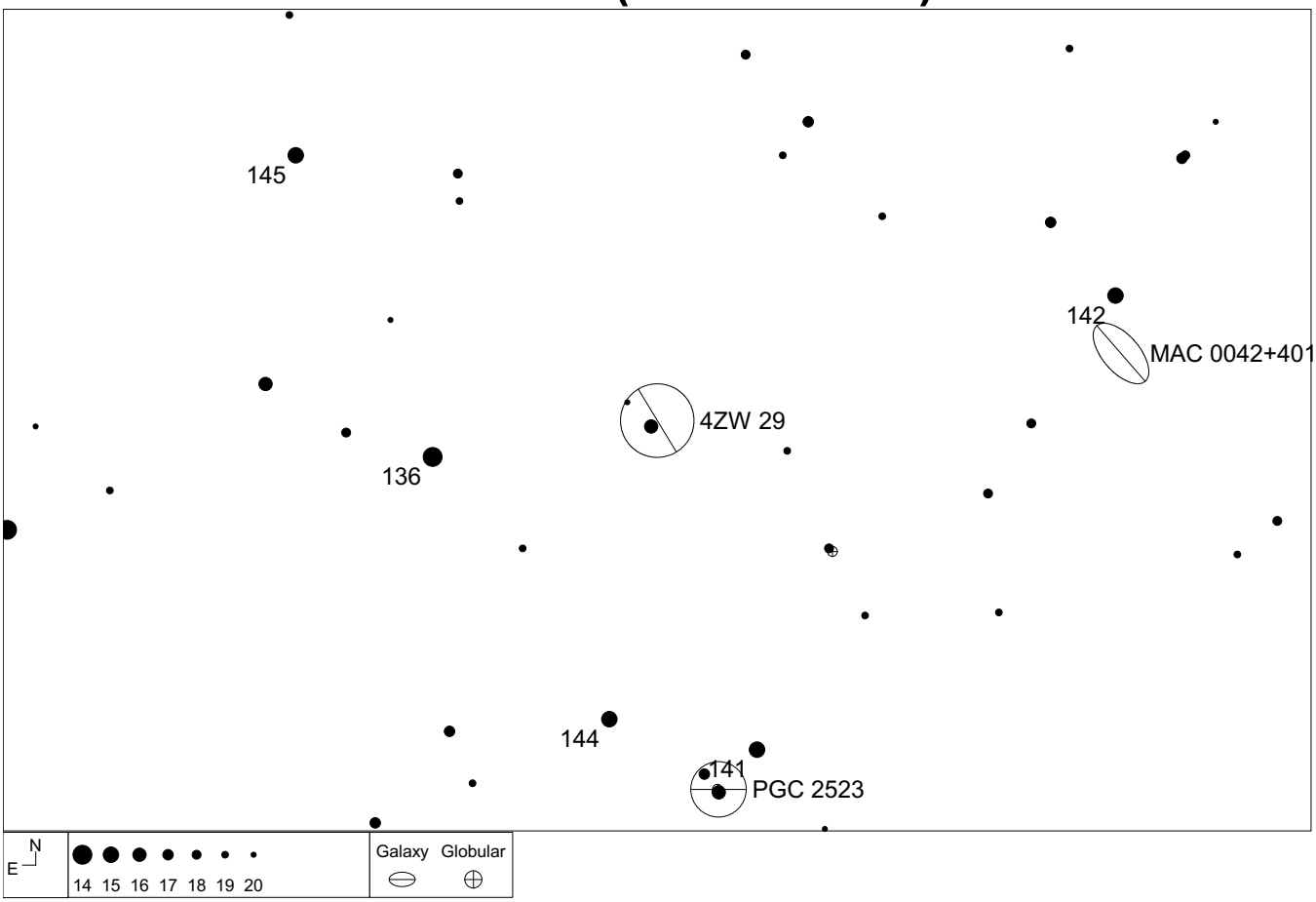
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	00 38 33.1	+41 28 50	16.9 – 19.	24 x 12”	0.0725	PGC 2304

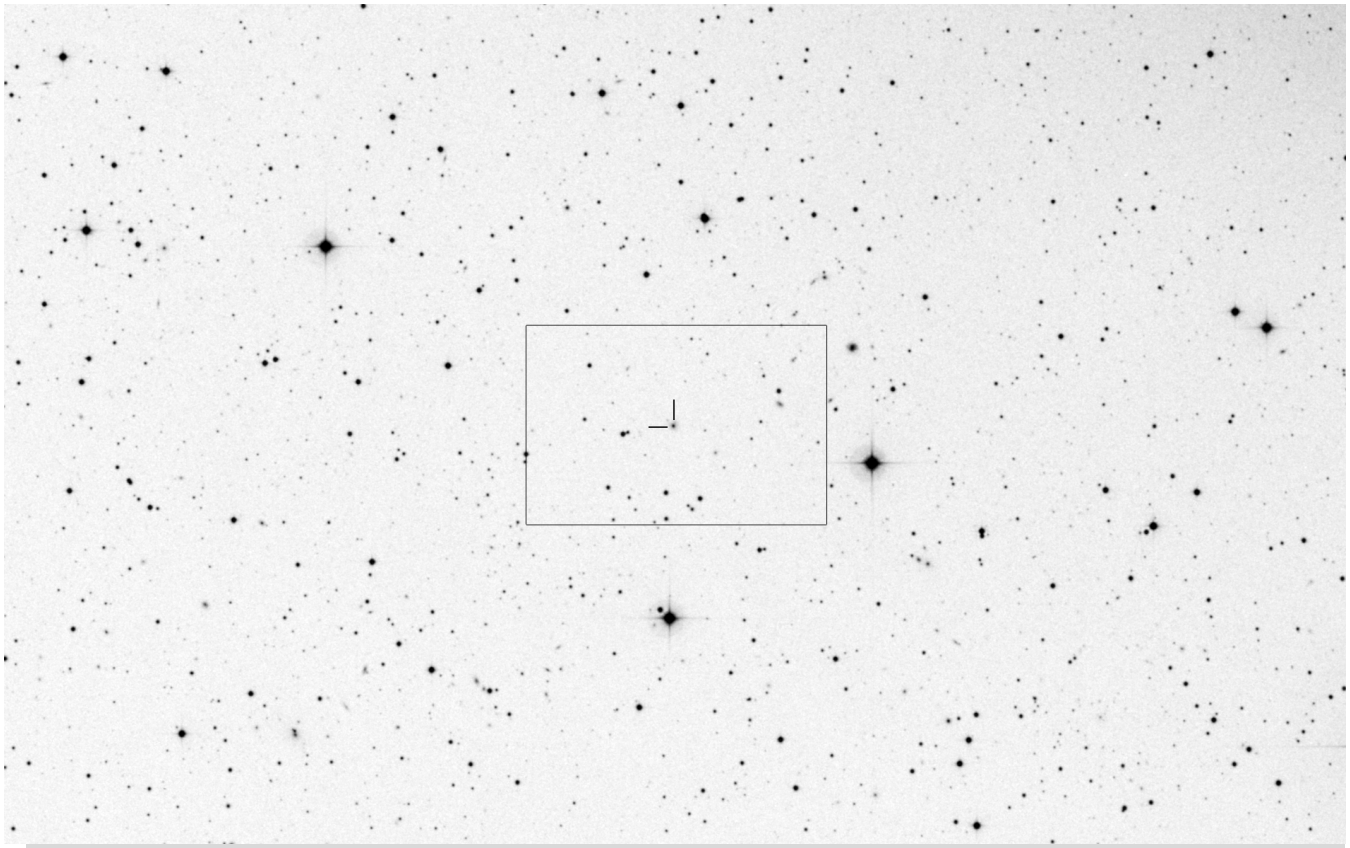
IV Zw 29 (Andromeda)



This was the object that Dr. Fritz Zwicky discovered in 1965, that started the Variable Galaxy work.
Sharov, A.S. "The optical variability of the Seyfert Galaxy IV Zw 29=Zw 0039.5+4003." *Astronomy Letters*, Vol 20 (May 1994): 305-308

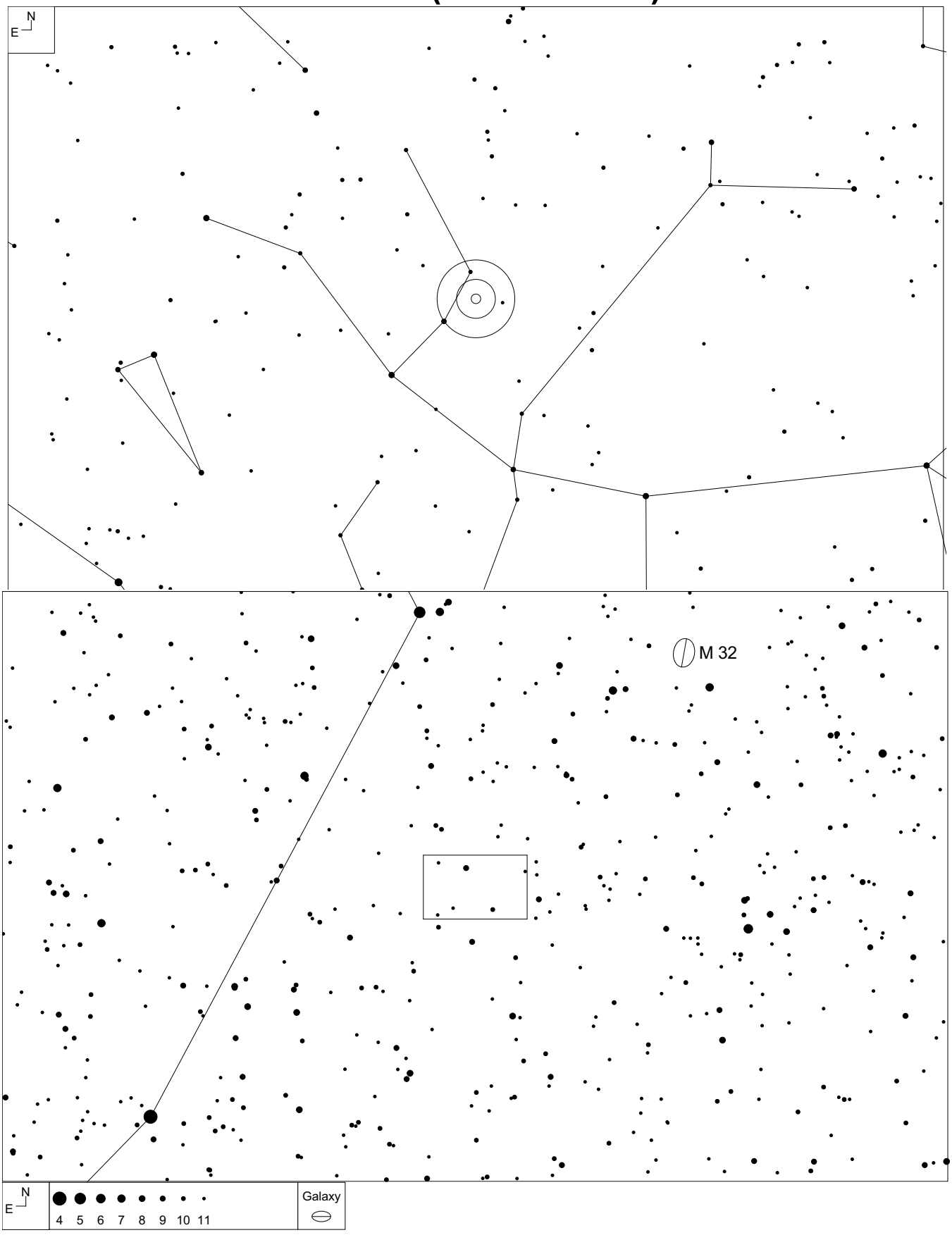
IV Zw 29 (Andromeda)



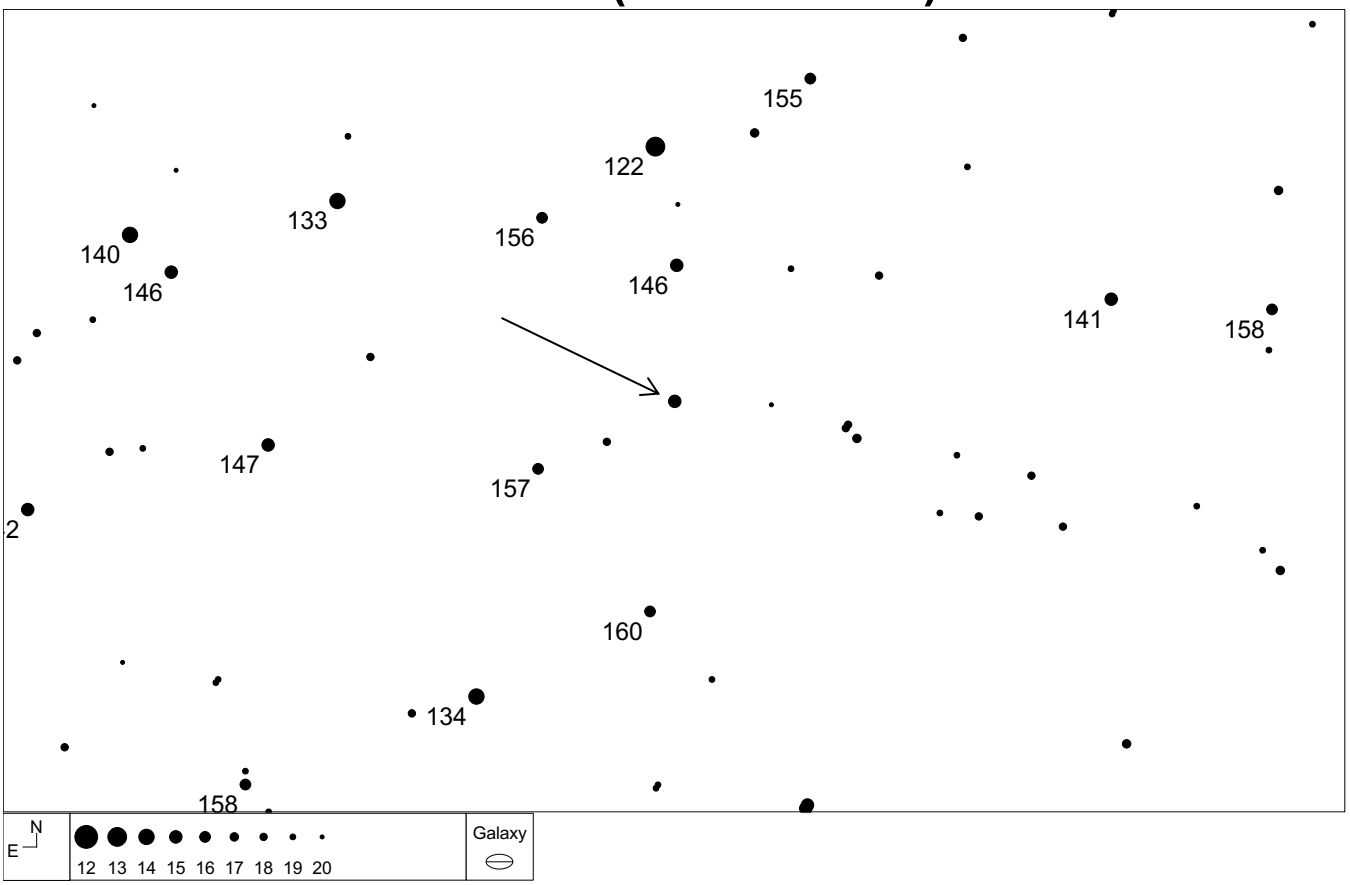


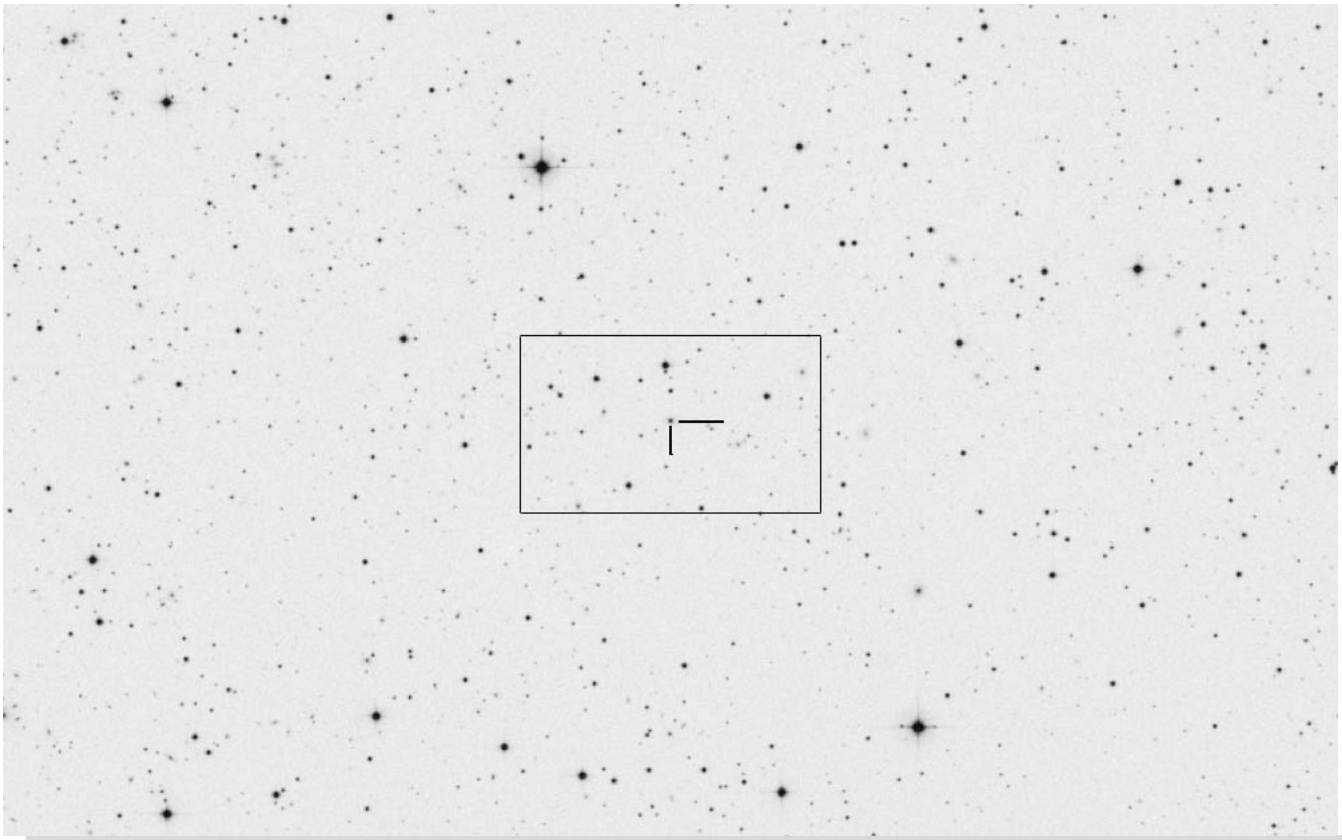
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	00 42 15.9	+40 19 38	16.8 - 18.2	0.4’	0.103	PGC 2524

IO And (Andromeda)



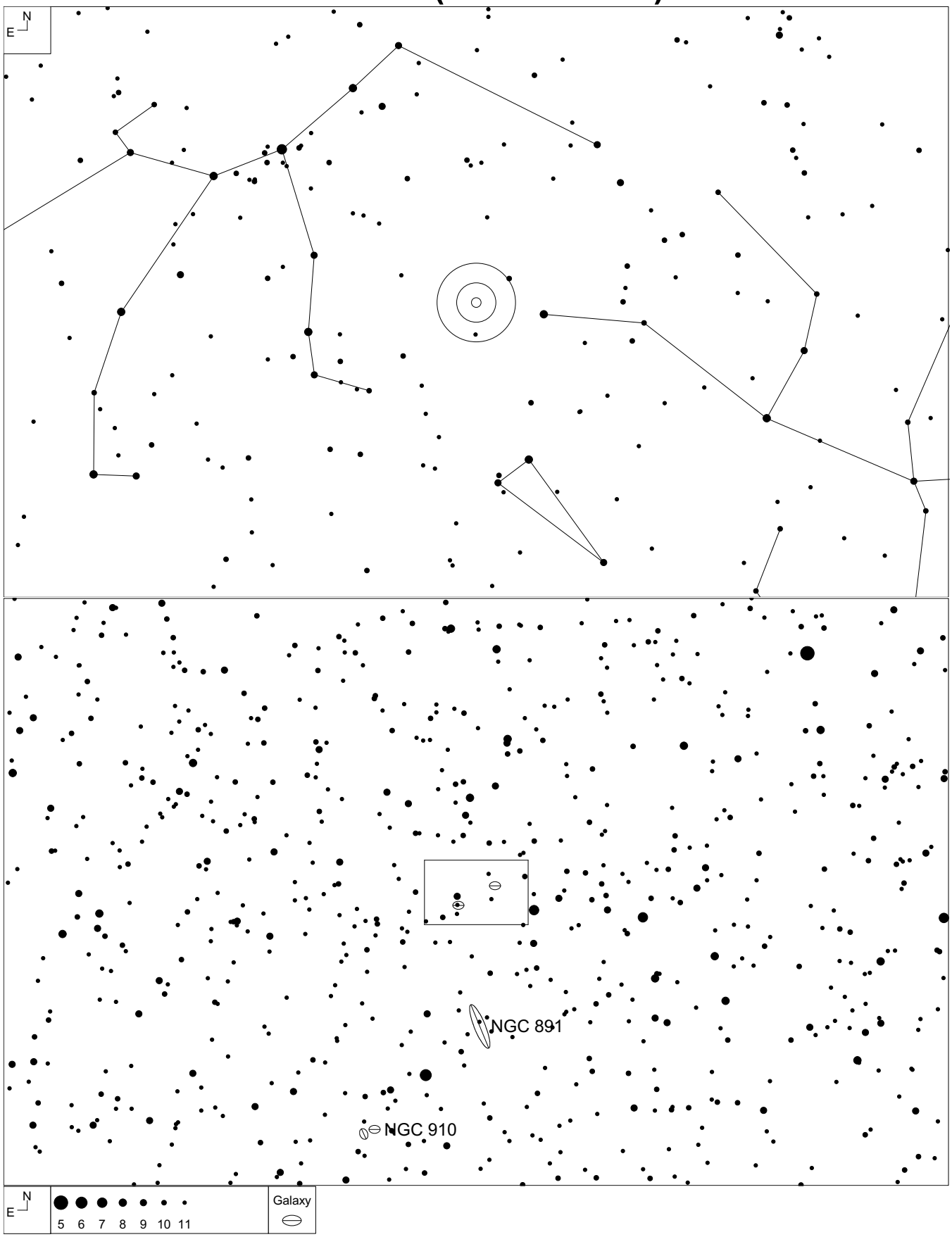
IO And (Andromeda)





Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	00 48 19.0	+39 41 09	15.3 – 17.6	10”	0.134	S10785

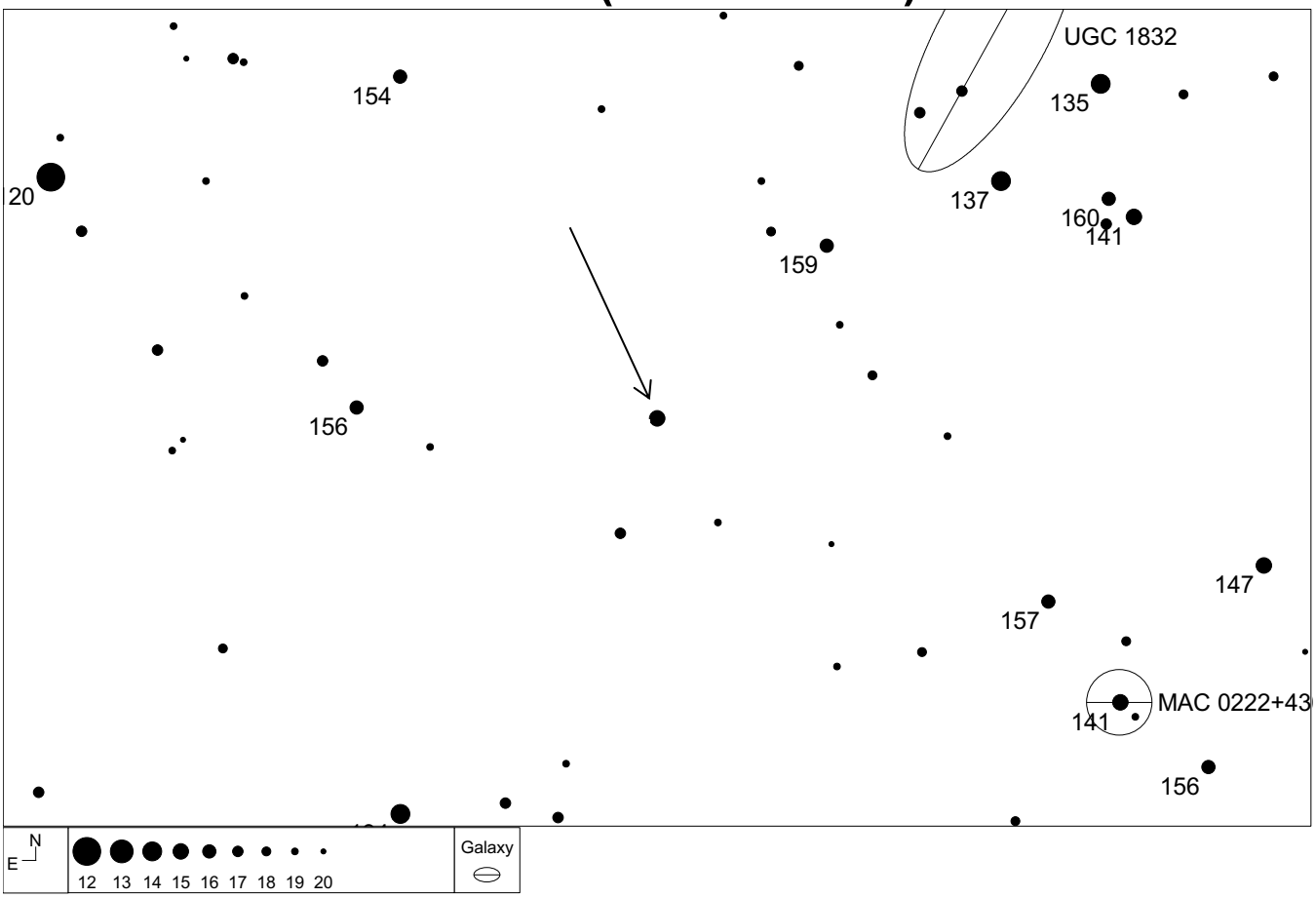
3C 66A (Andromeda)

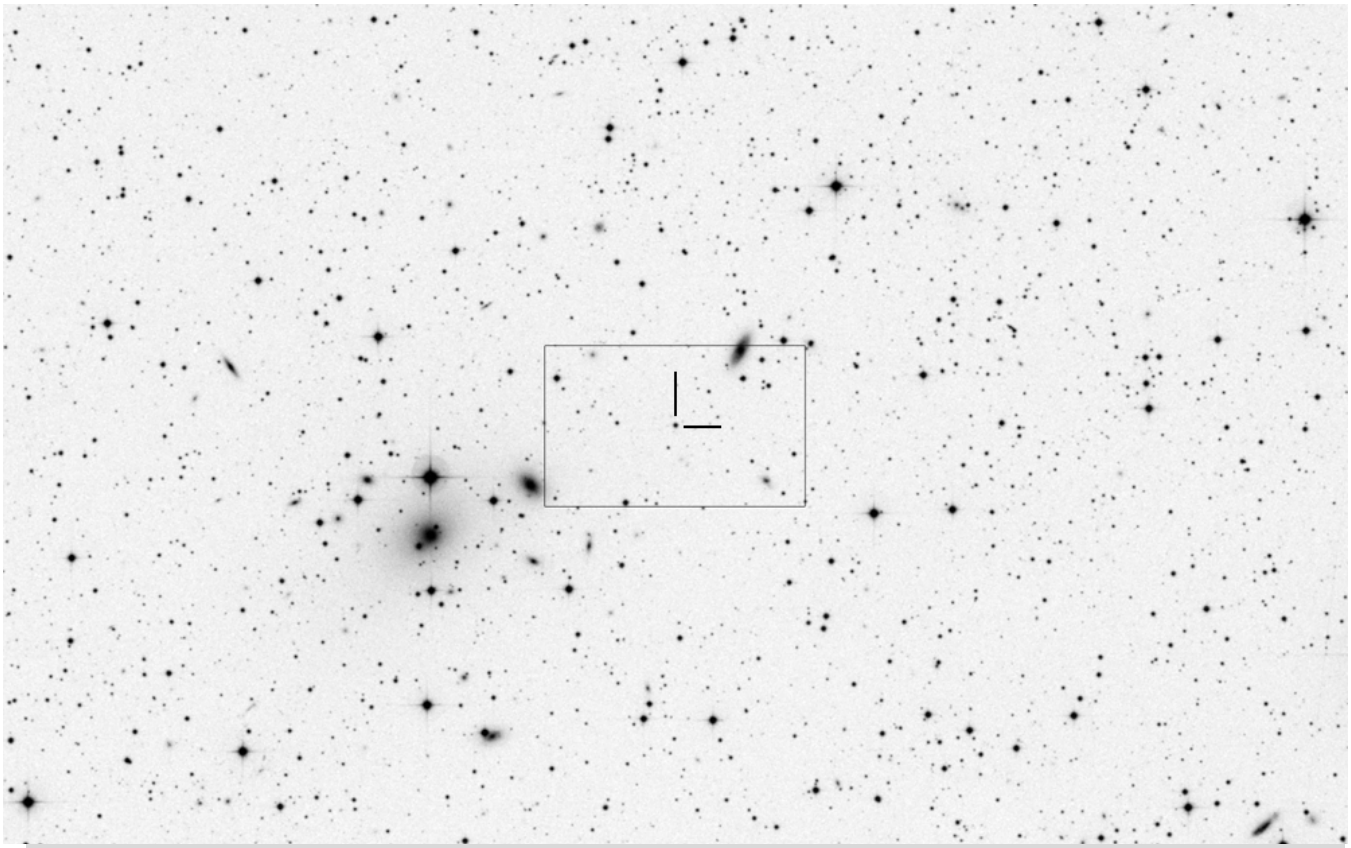


Furniss, A. et al. "On the Redshift of the Very High Energy Blazar 3C 66A" *Astrophysical Journal*, Vol 766 (2013), 35-40

Errando, M. "A TeV source in the 3C 66AB region" *Proceedings of the 31st ICRC* (2009)

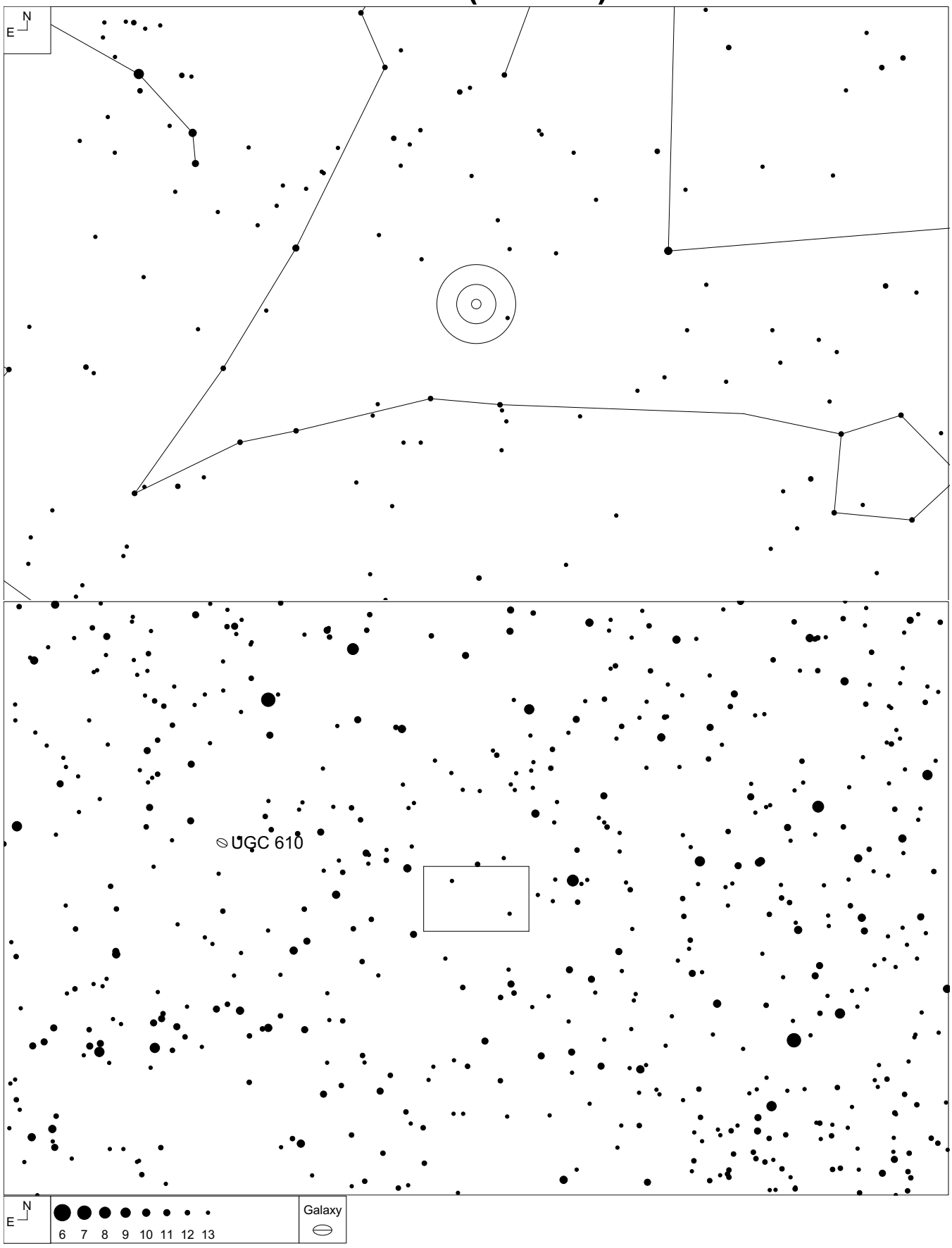
3C 66A (Andromeda)





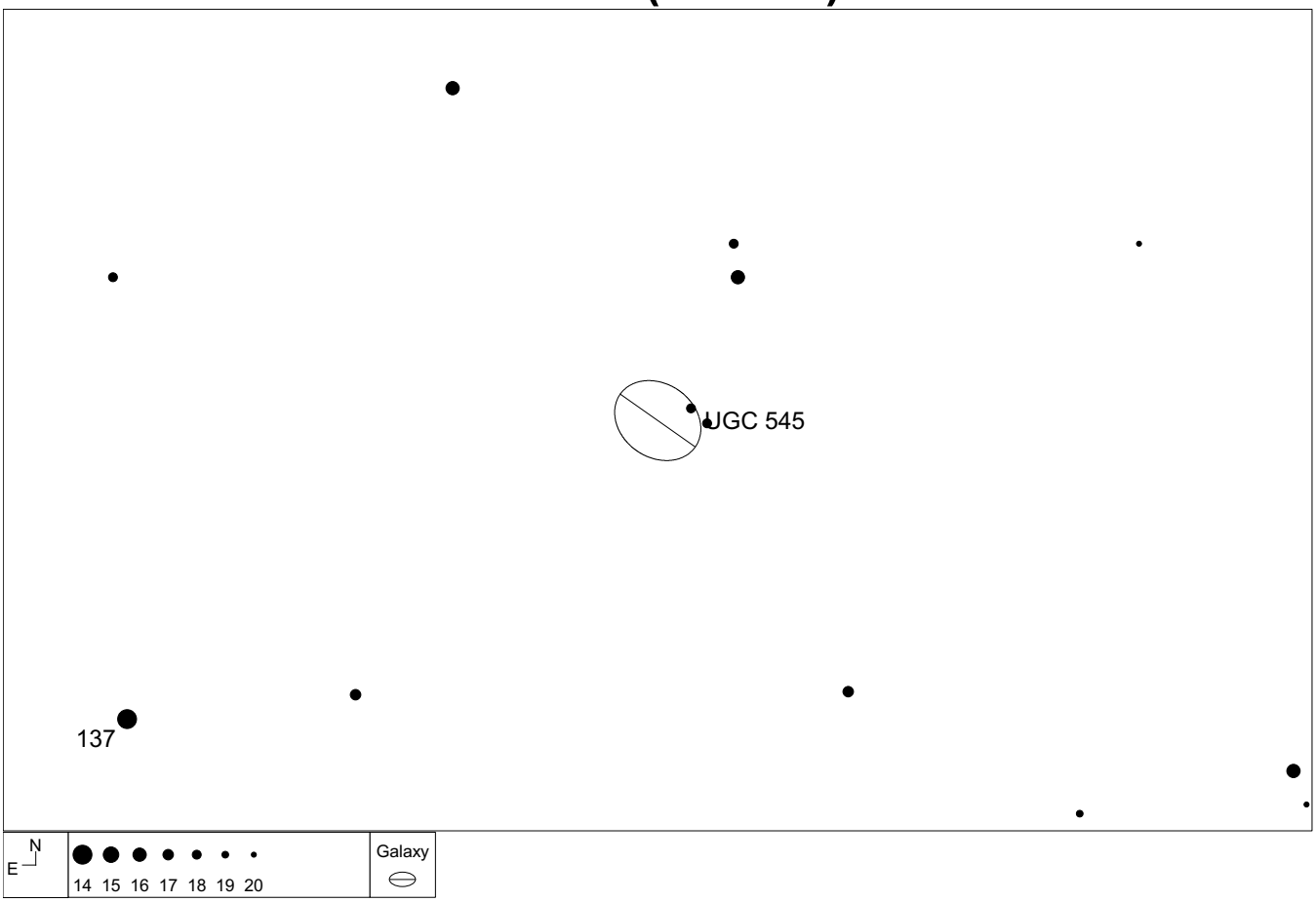
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	02 22 39.6	+43 02 08	13.5 - 15.6	stellar	0.444	0219+428

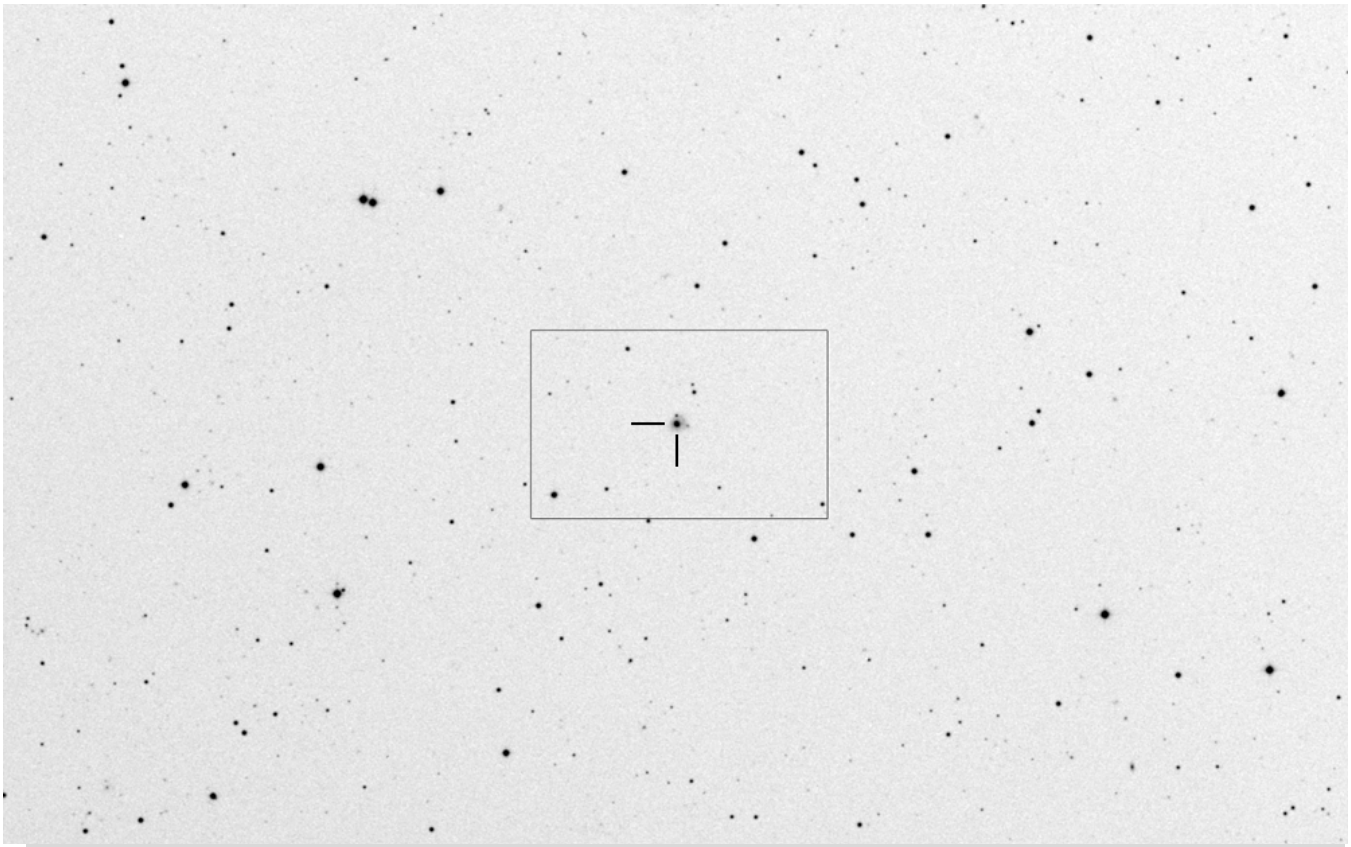
I Zw 1 (Pisces)



Usher, P.D. et al. "I ZW 1: a Variable Compact Galaxy." *Astrophysical Journal*, Vol 165 (1971), 647 - 650

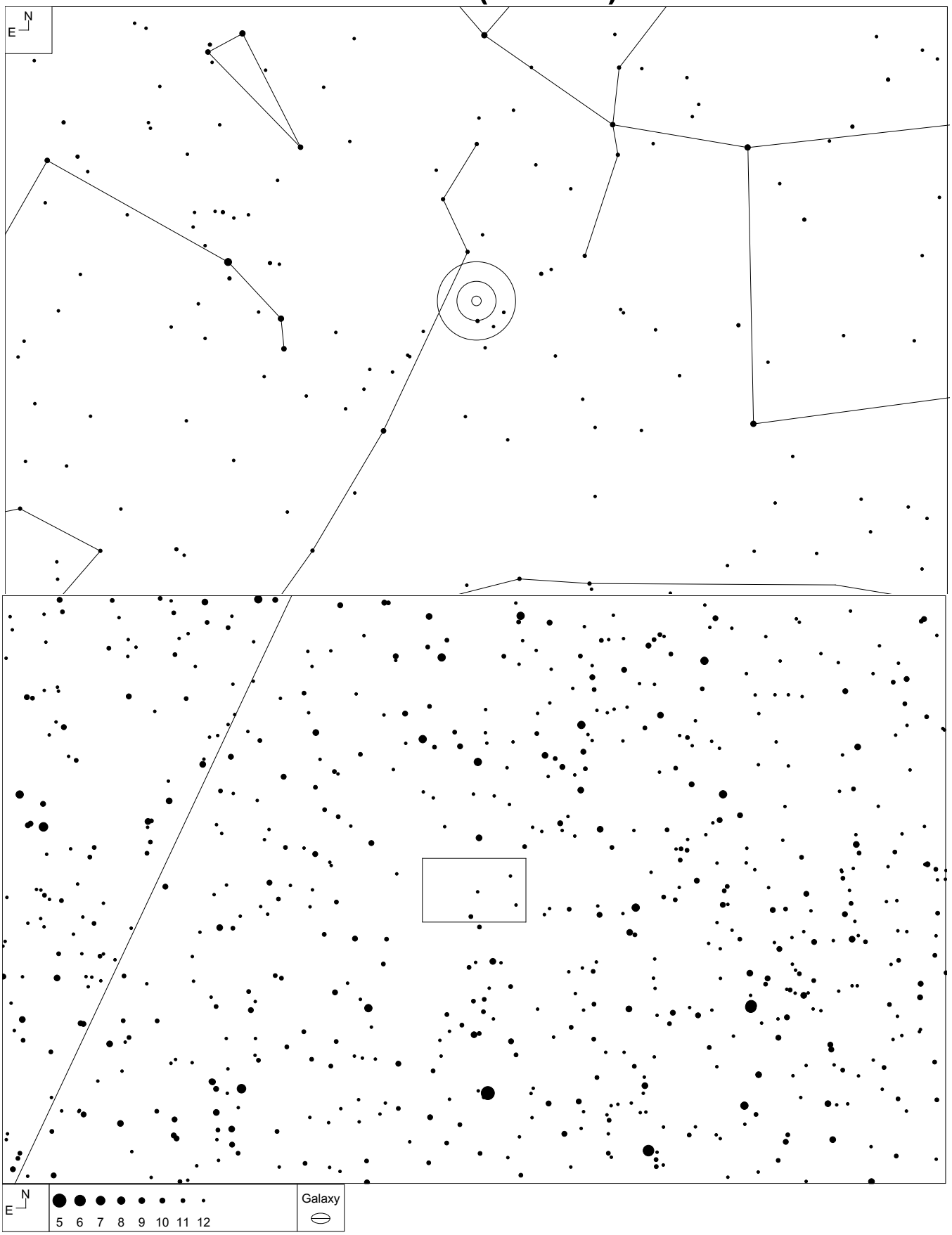
I Zw 1 (Pisces)



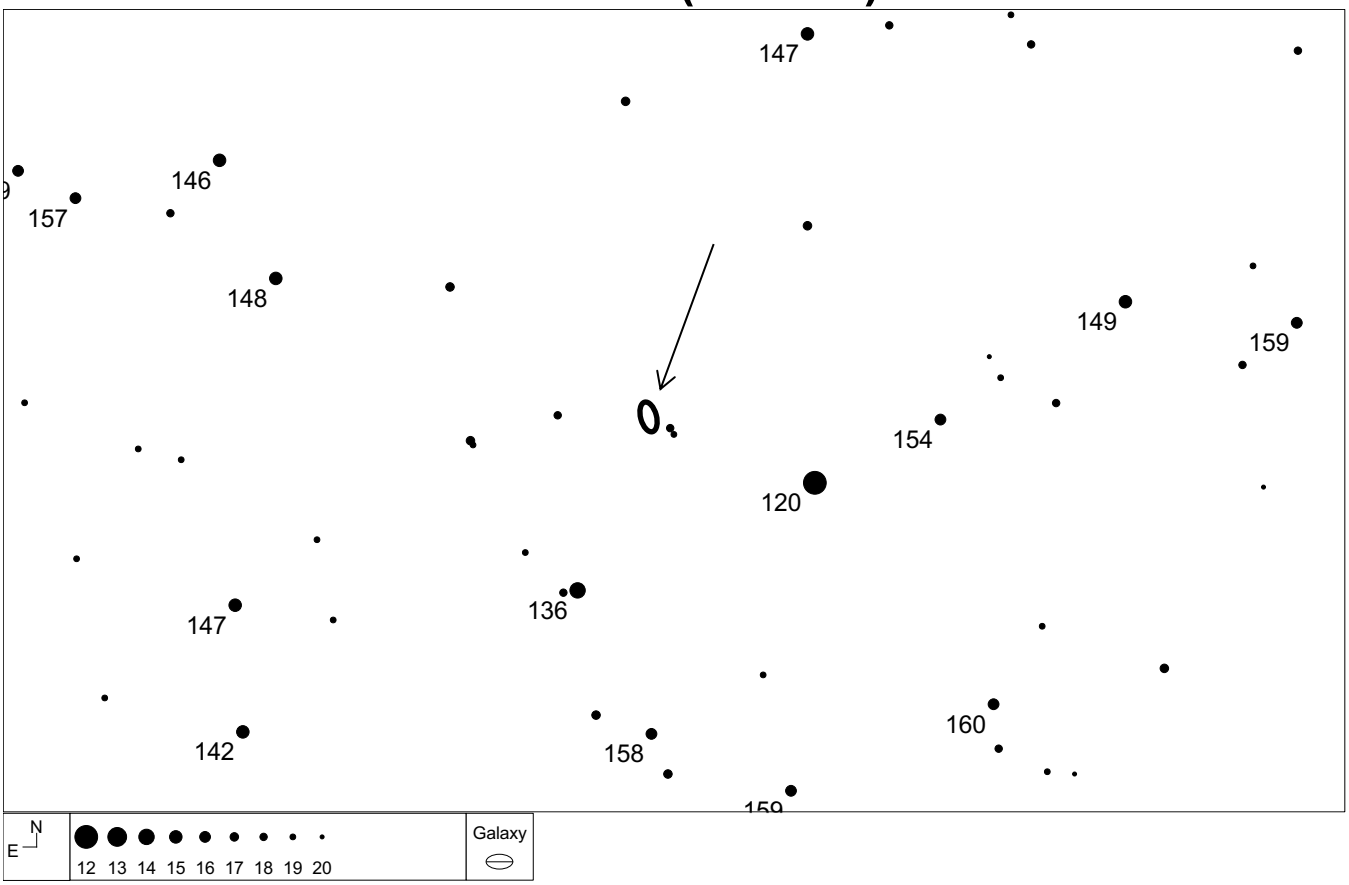


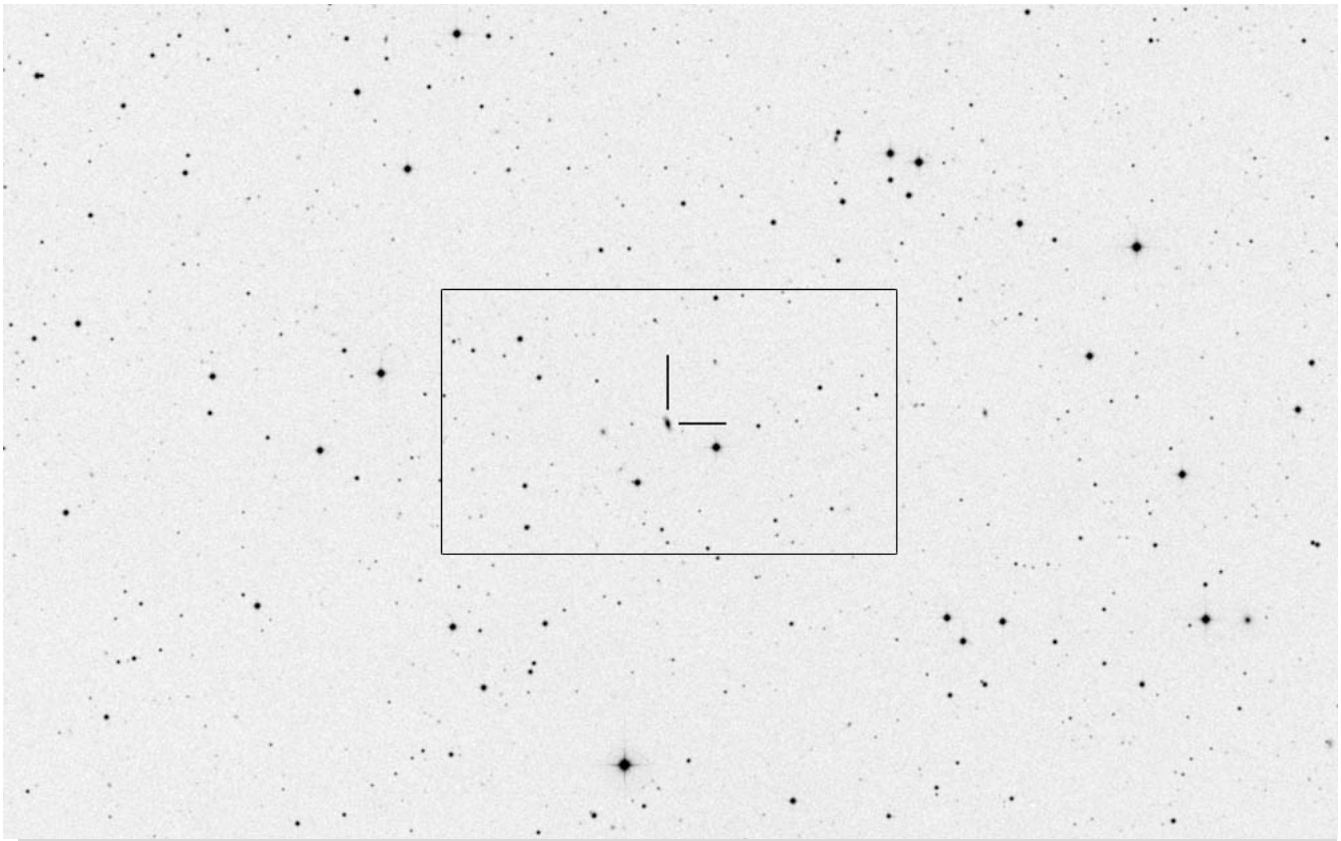
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	00 53 35.1	+12 41 35	13.2 - 14.7	0.5 x 0.4’	0.059	UGC 545

UX Psc (Pisces)



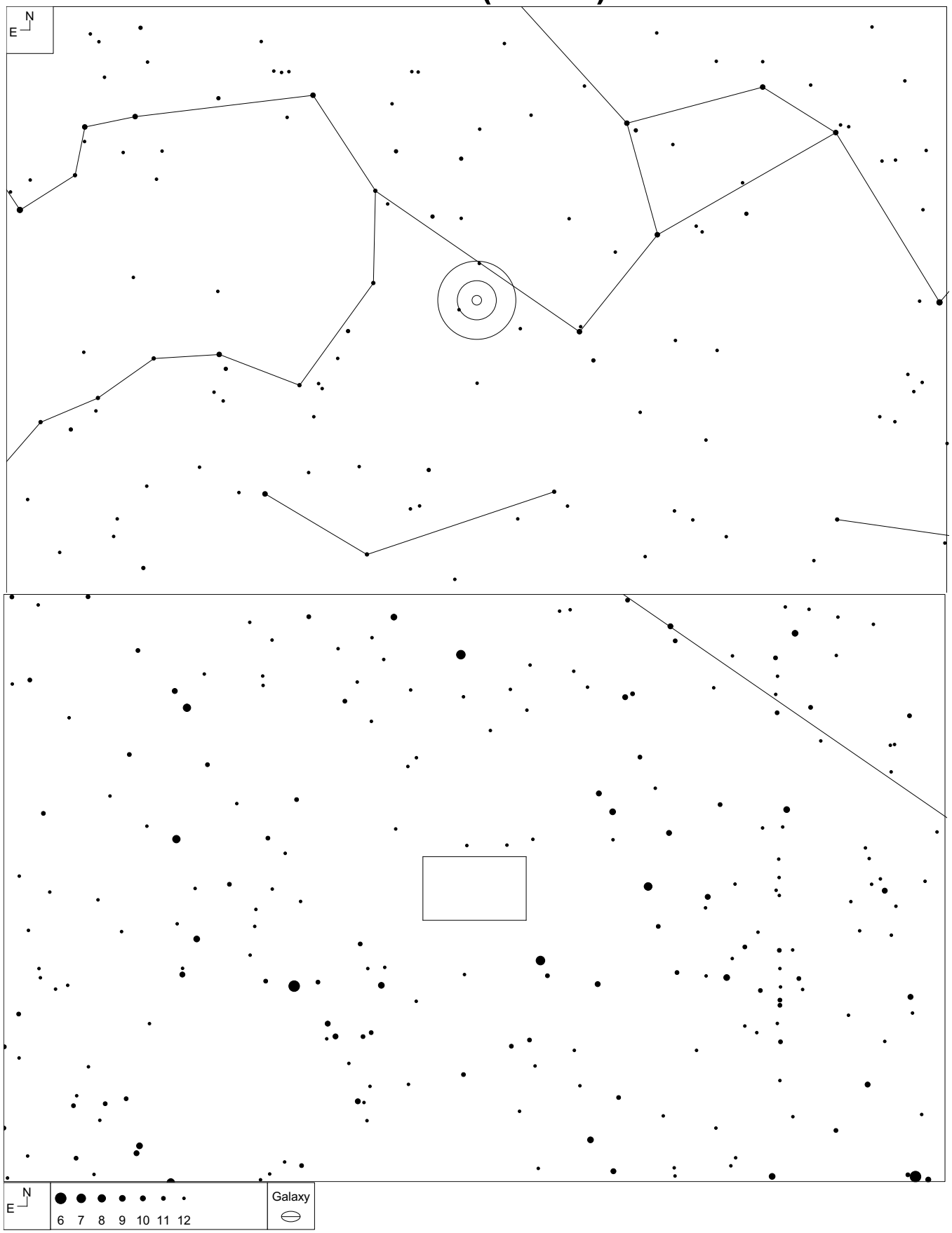
UX Psc (Pisces)



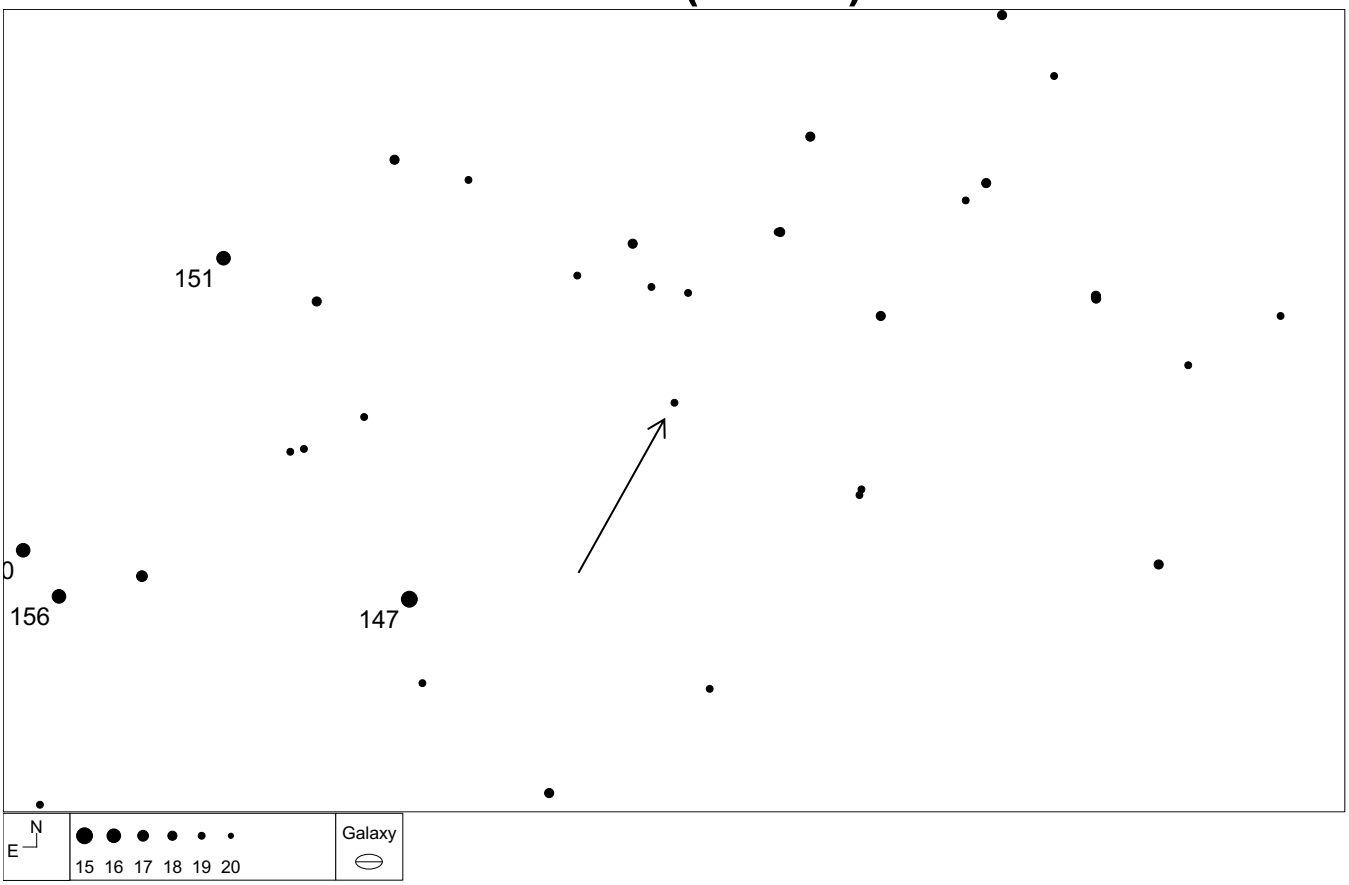


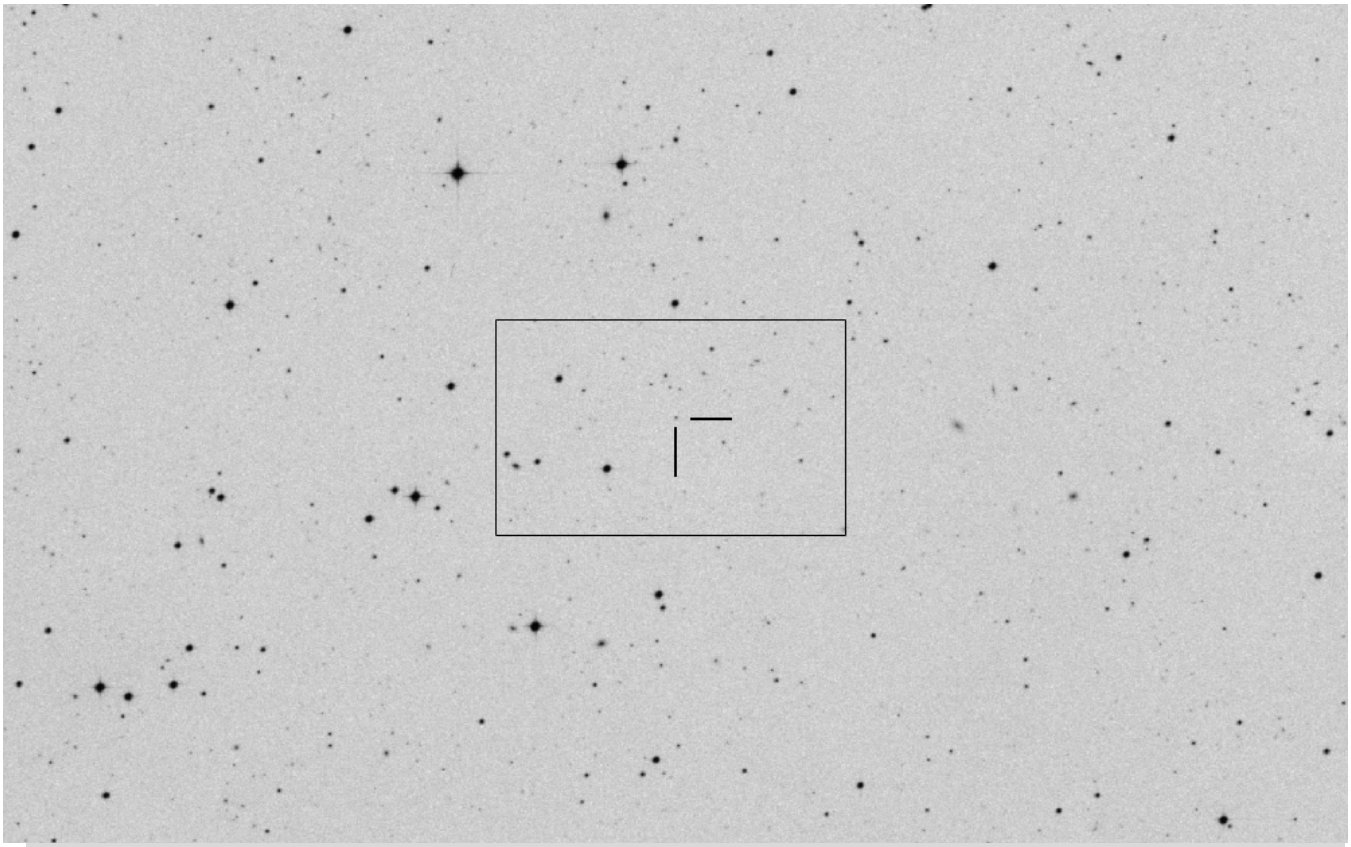
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	01 11 45.4	+22 04 10	13.4 – 16.3	25 x 12”	0.0456	NPM1G+21.0054

XX Cet (Cetus)



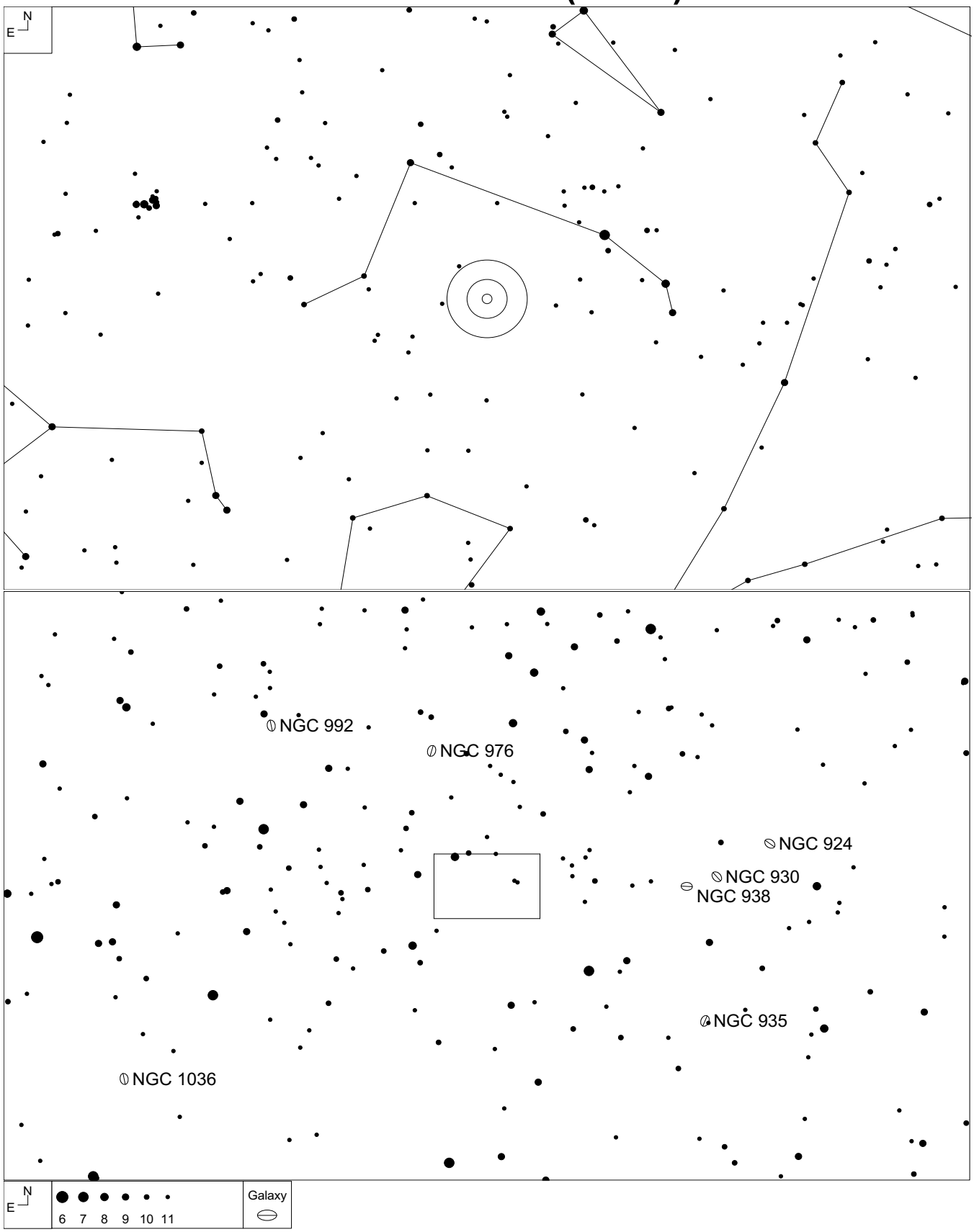
XX Cet (Cetus)





Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	02 22 39.9	-19 32 50	18.0 – 19.7	stellar	0.736	PHL 4037

1ES 0229+200 (Aries)



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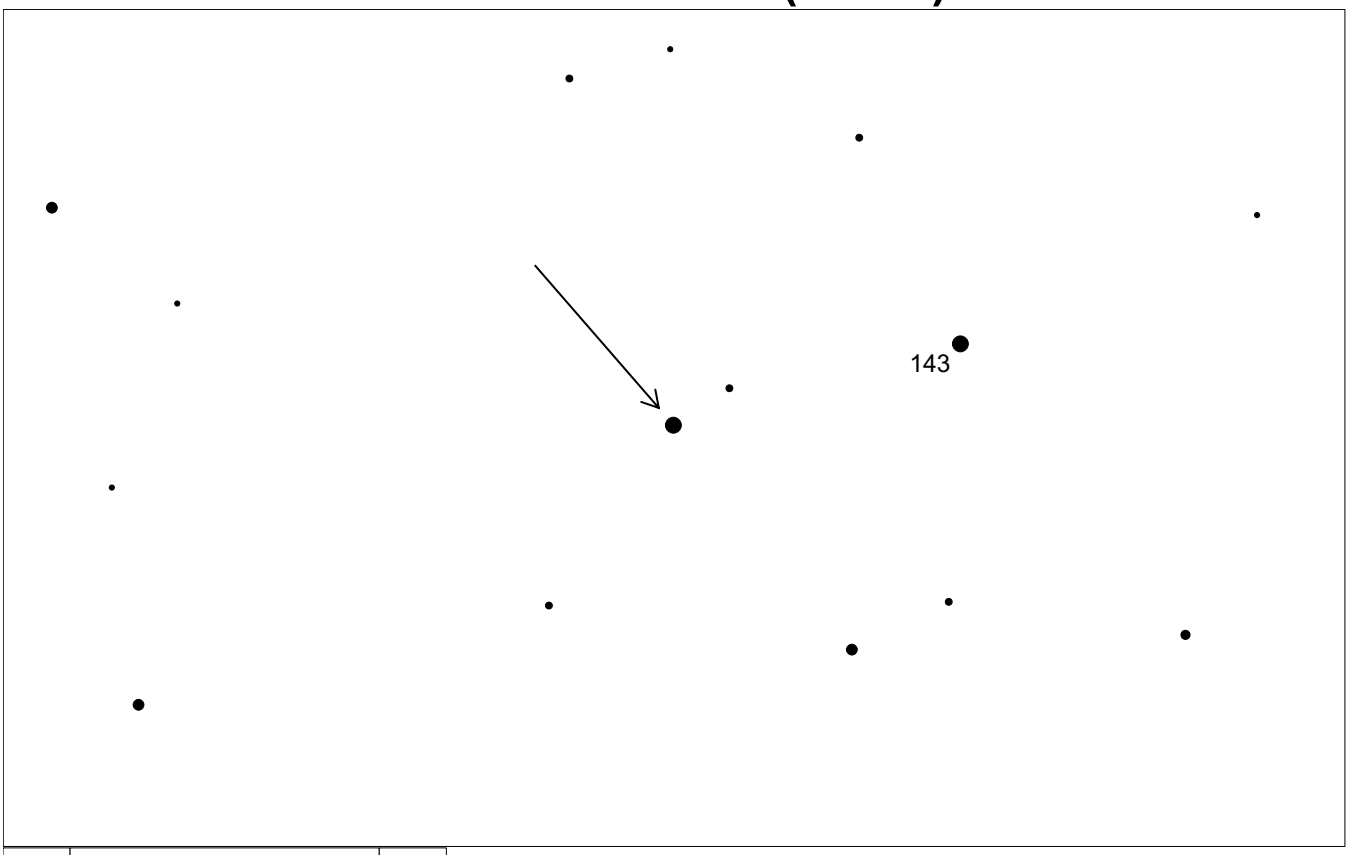
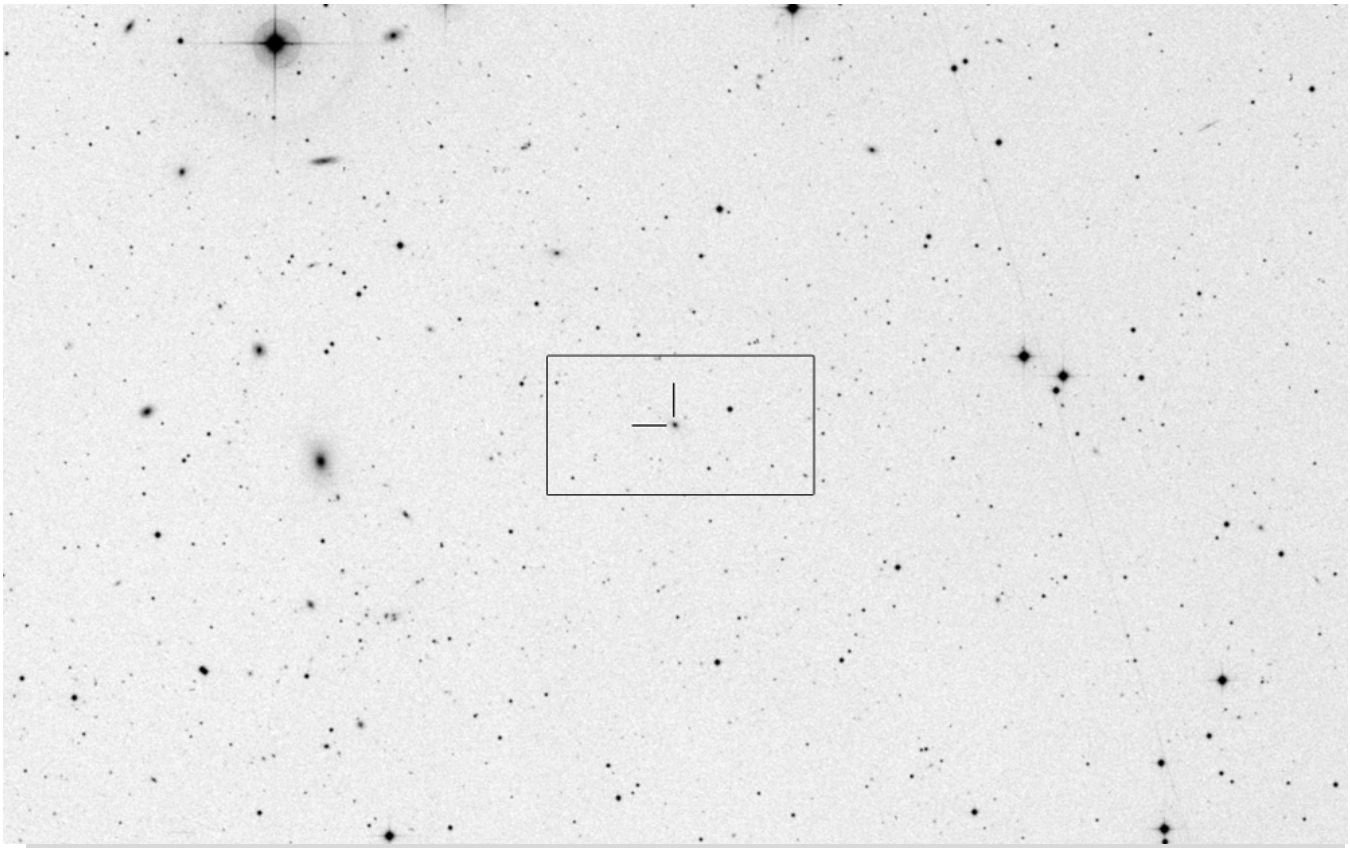
Kaufmann, S., et al "1ES 0229+200: an extreme blazar with a very high minimum Lorentz factor" *Astronomy and Astrophysics,* Vol 534 (2011), A130-137

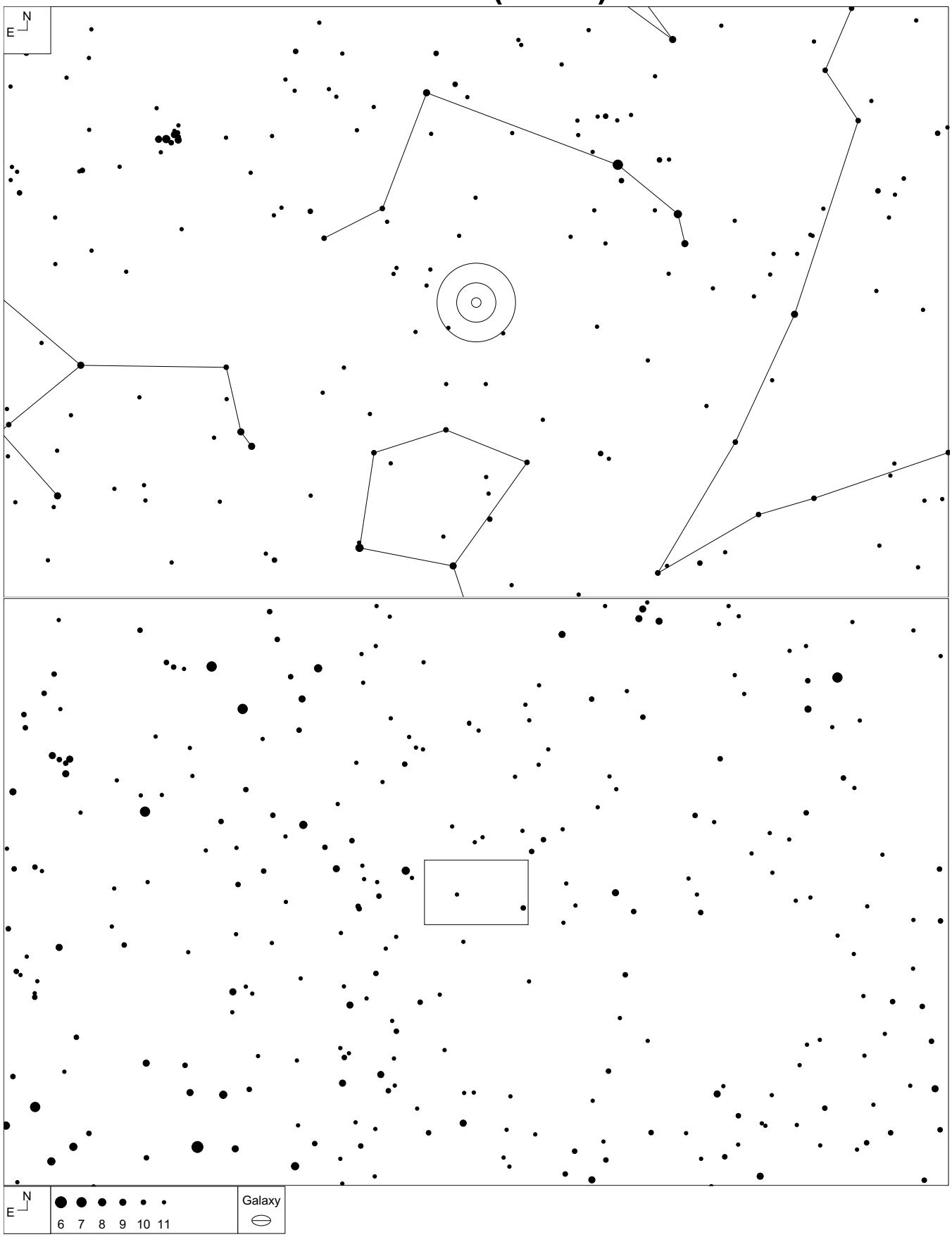
1ES 0229+200 (Aries)





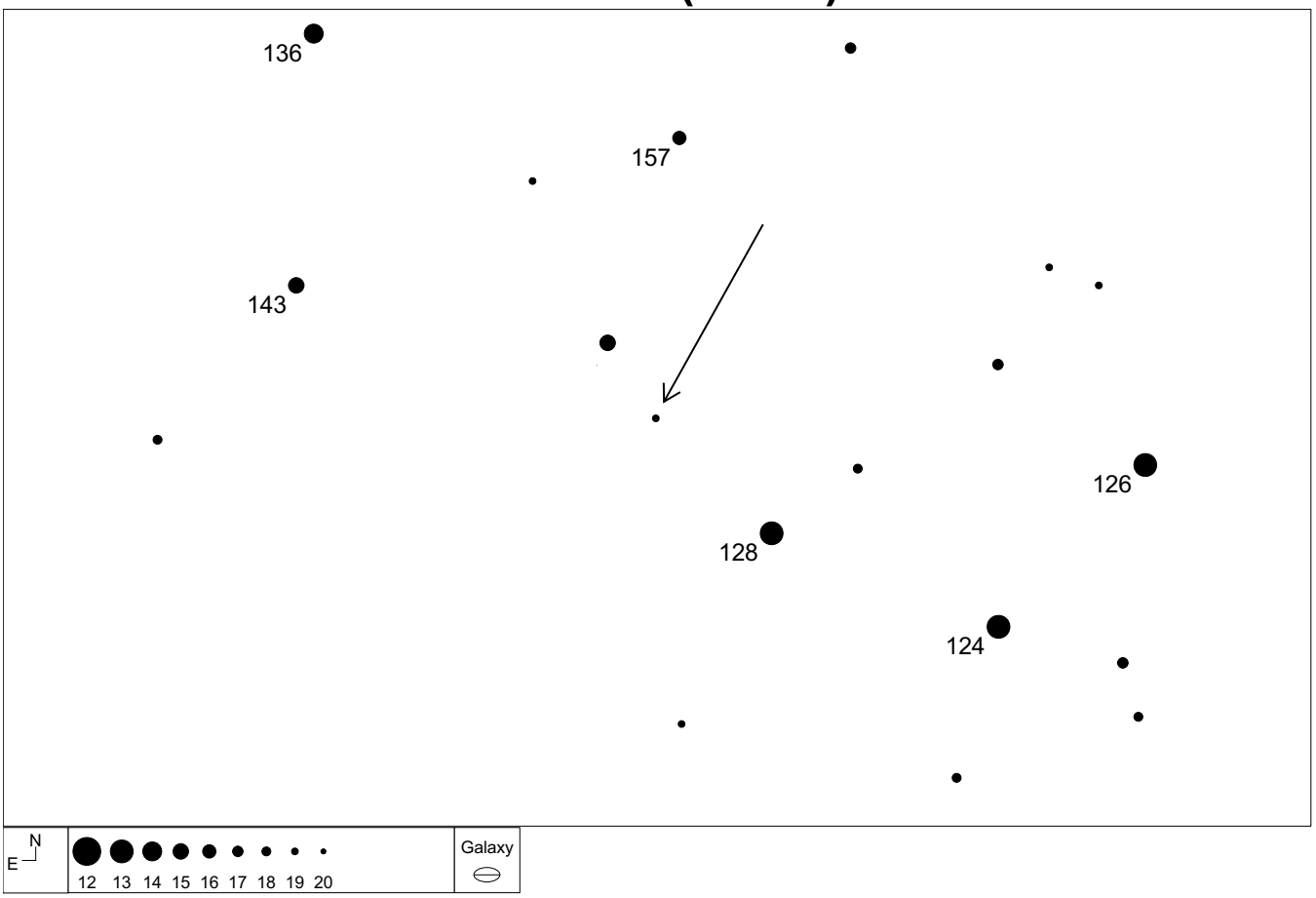
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	02 32 48.6	+20 17 17	14.7	stellar	0.140	

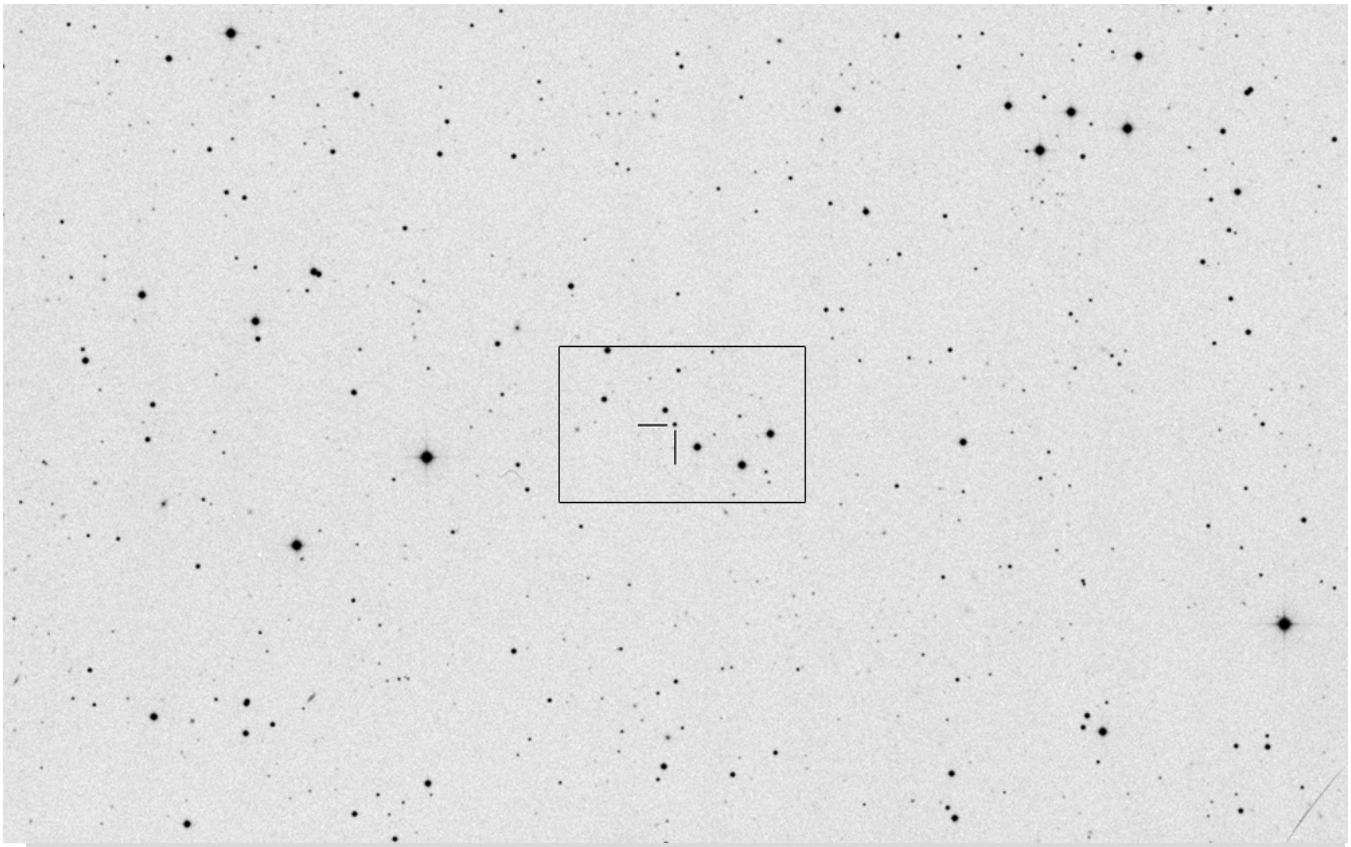
OD 160 (Aries)



Stickel, M. “Gravitational Lensing of BL Lac Objects and Related AGN” *Lecture Notes in Physics,* Vol 406 (1992)
http://link.springer.com/content/pdf/10.1007%2F3-540-55797-0_119

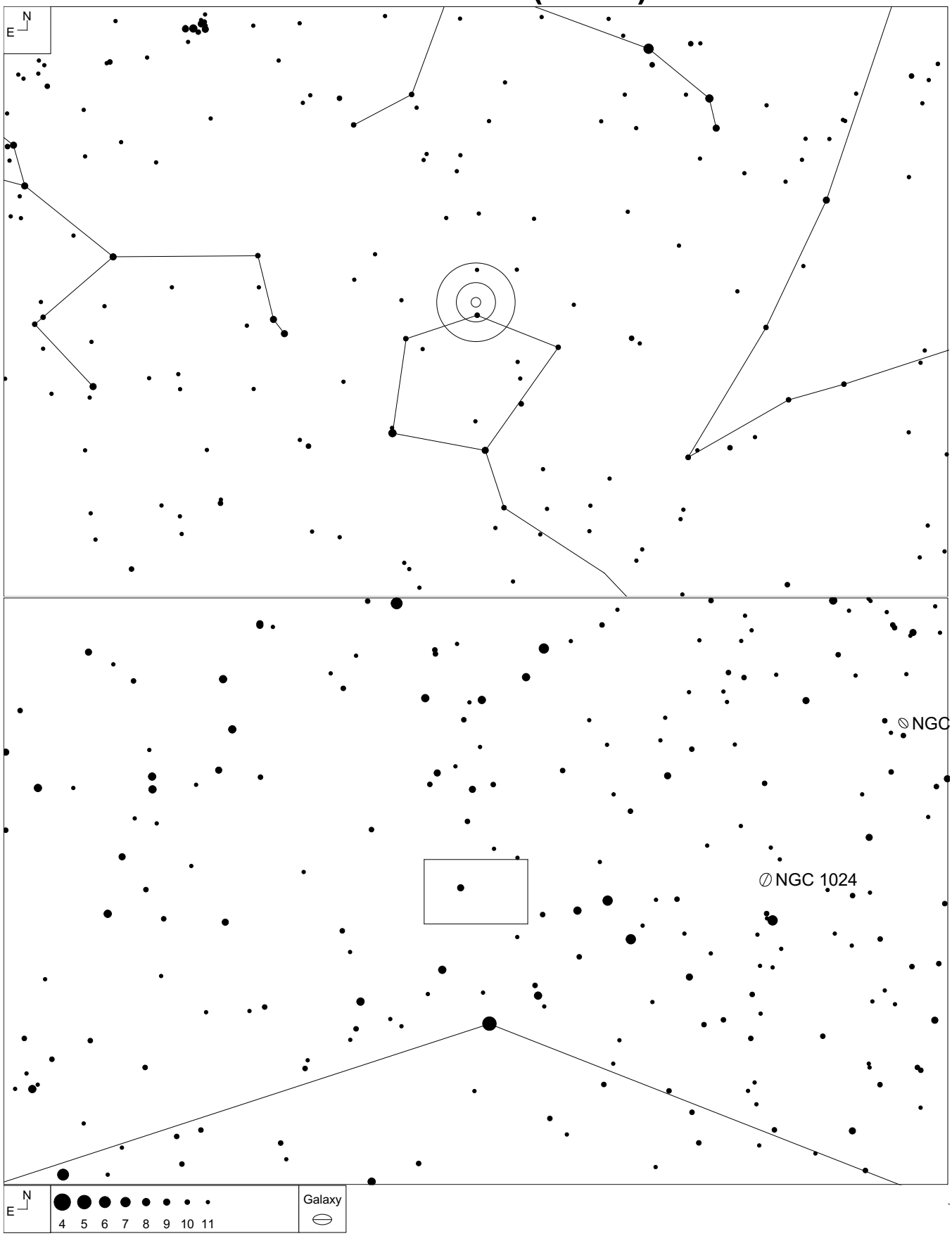
OD 160 (Aries)



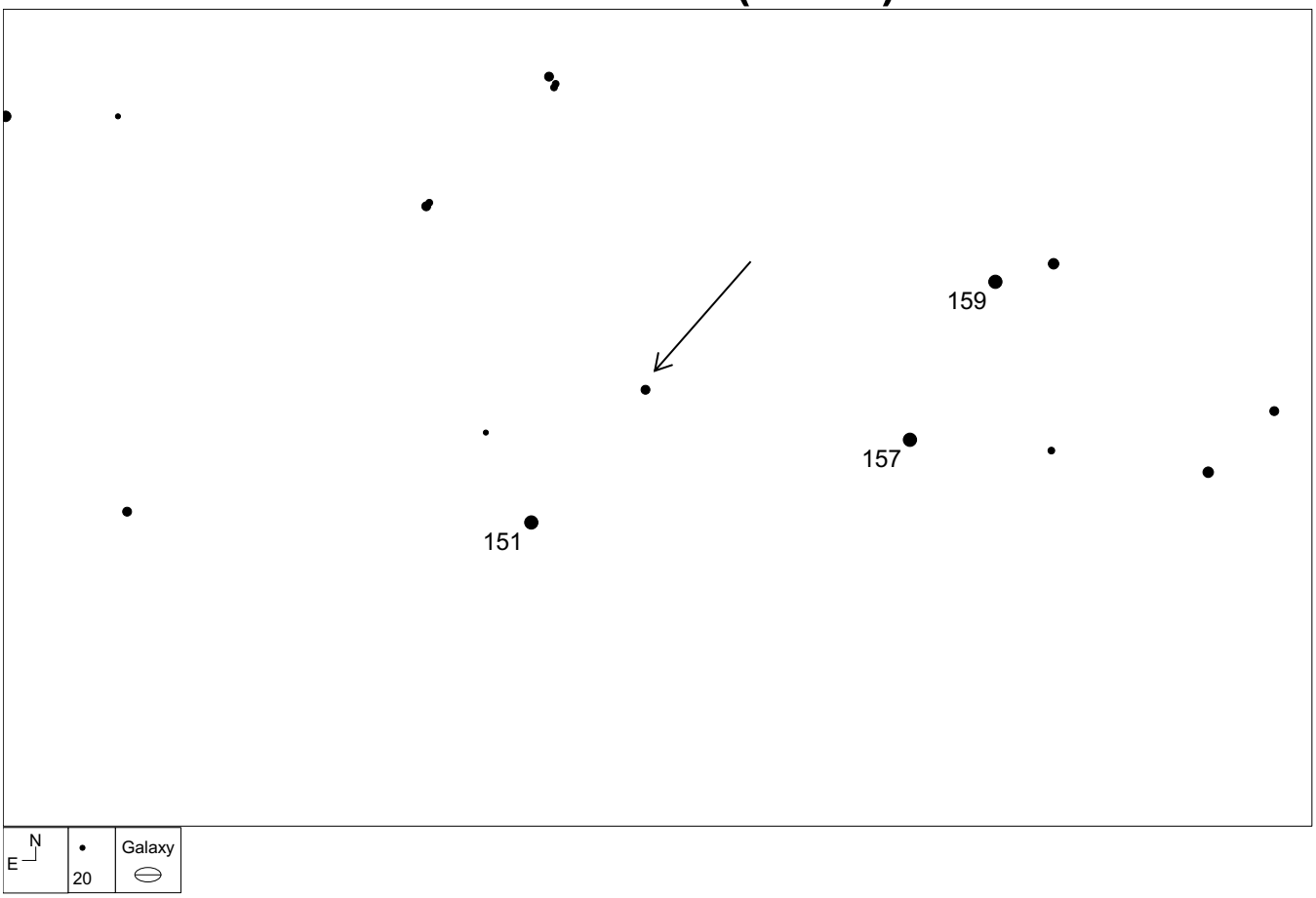


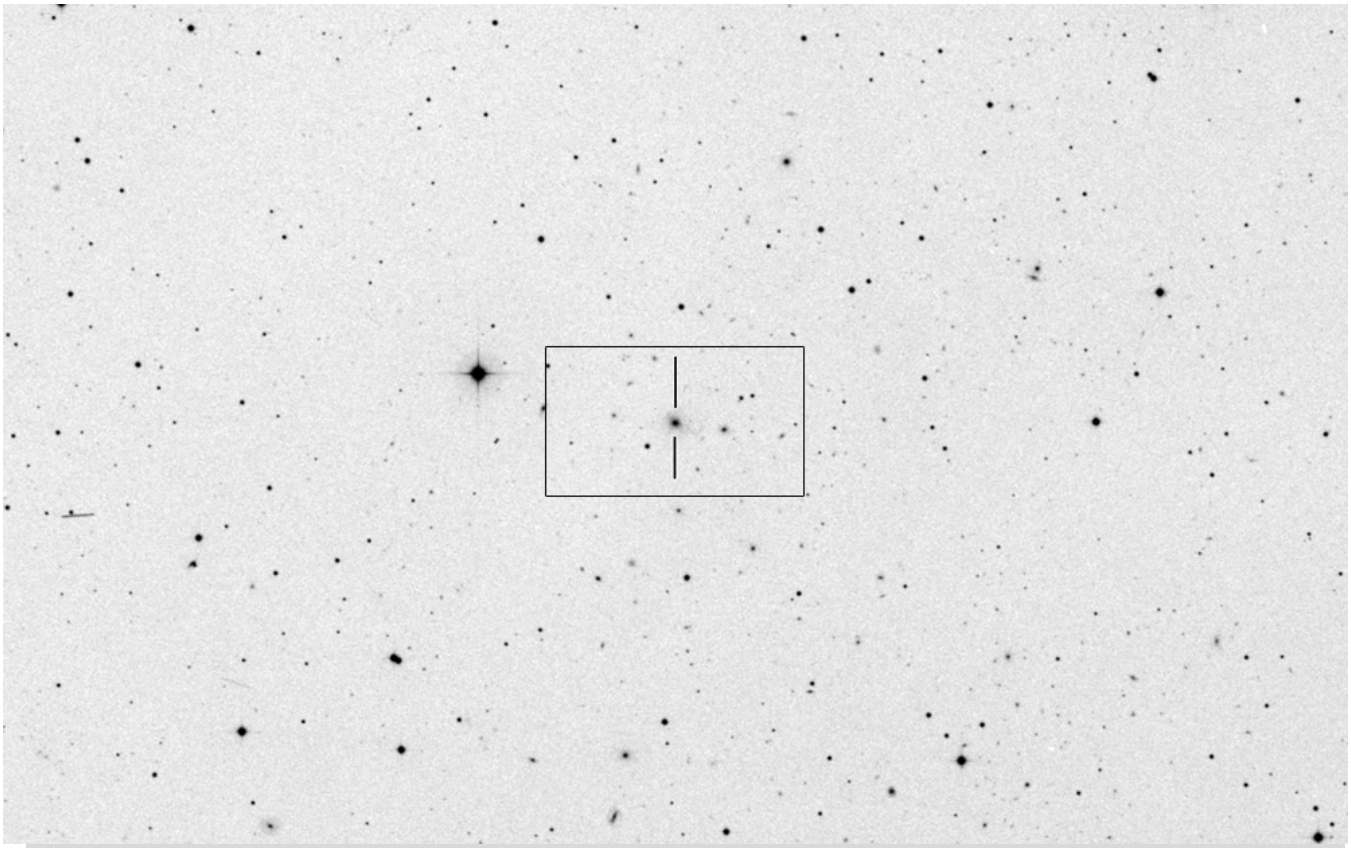
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	02 38 38.9	+16 36 59	14.3 - 18.7	stellar	0.94	AO 0235+164

J0245+1047 (Aries)



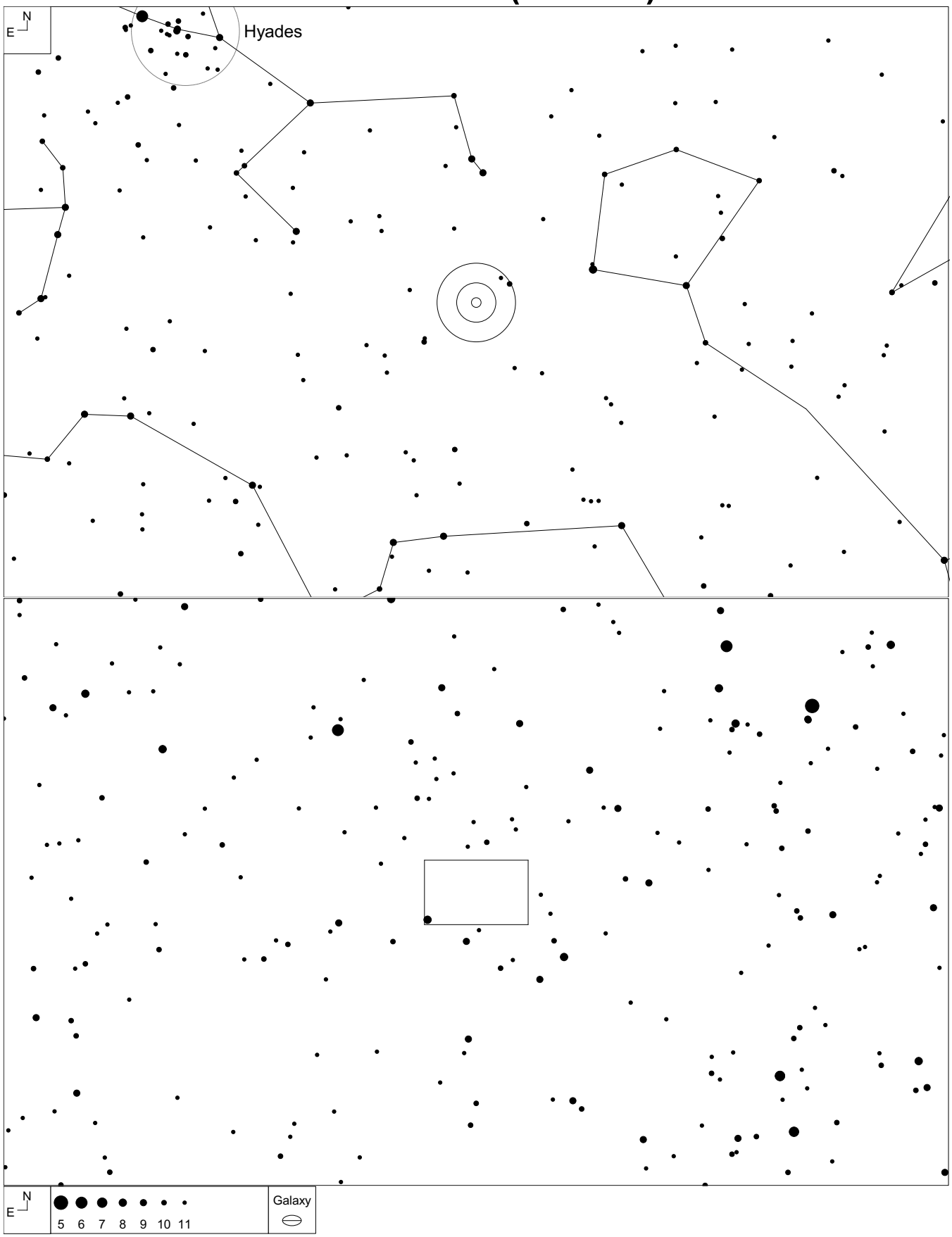
J0245+1047 (Aries)





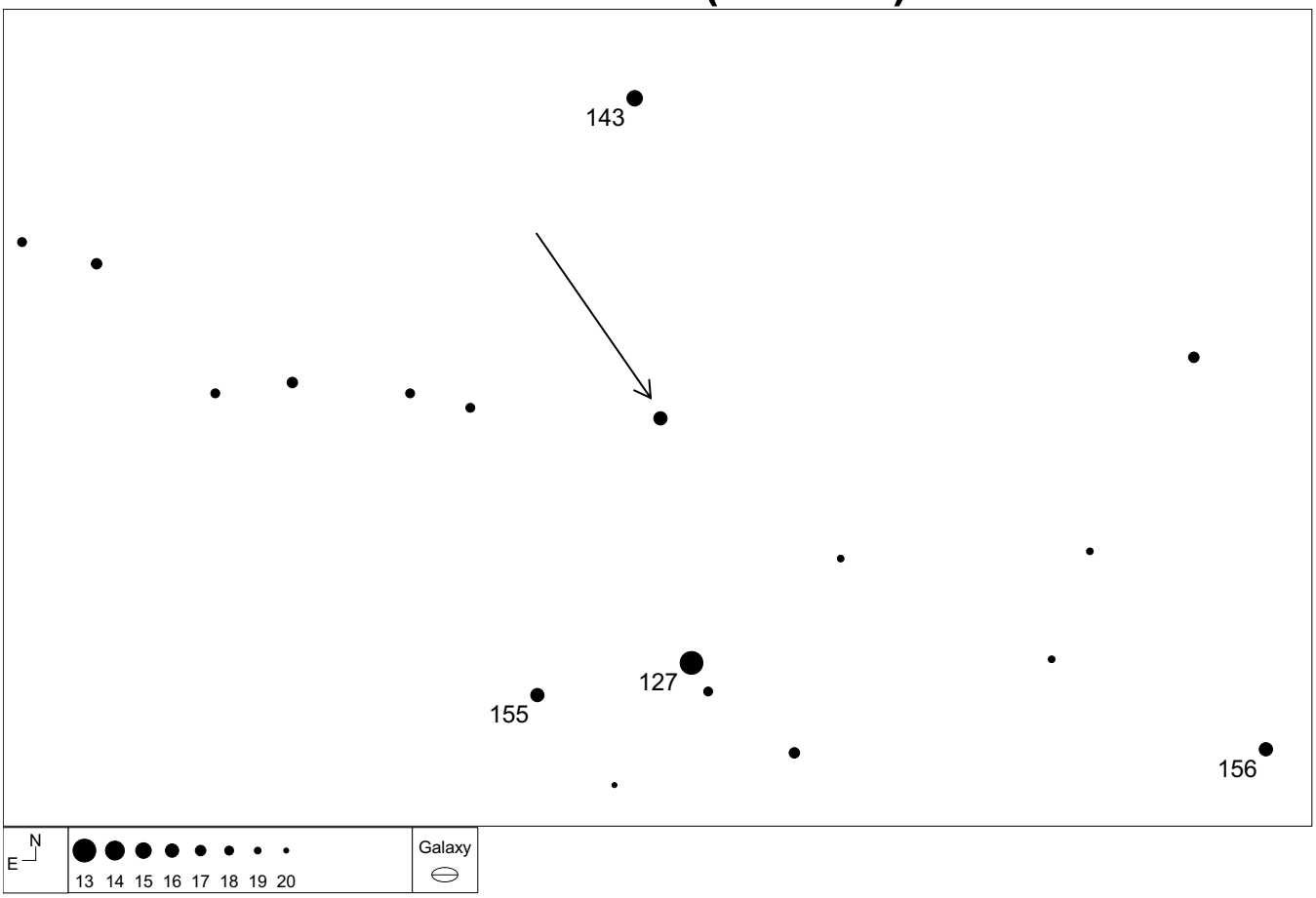
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	02 45 13.5	+10 47 20	16.5	3.0”	0.07	

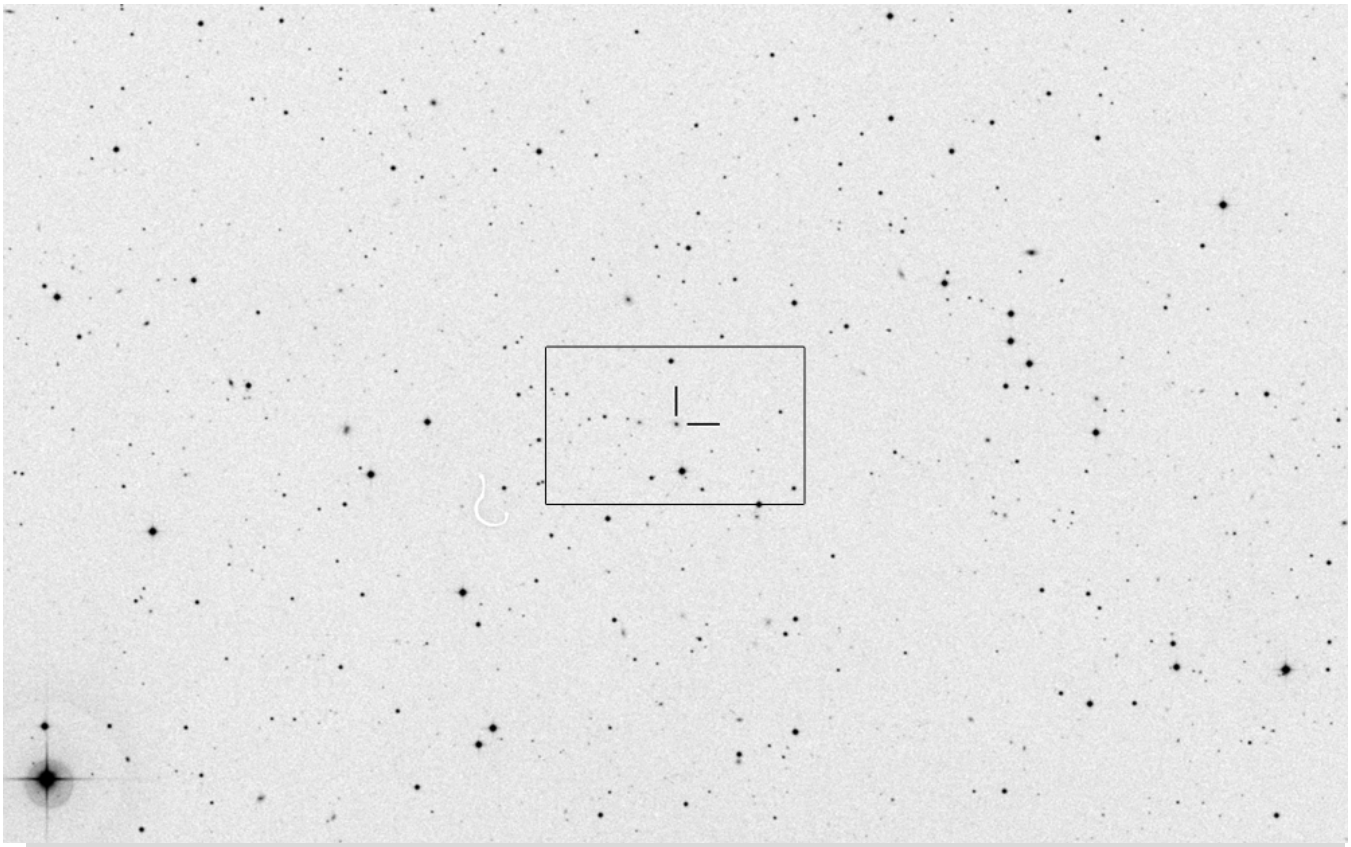
H0323+022 (Taurus)



Zhang, X. et al "CCD Photometry and Optical Variability of the BL Lacertae Object H0323+022" *Astrophysical Journal Supplement Series,* Vol 174 (2008), 111-116

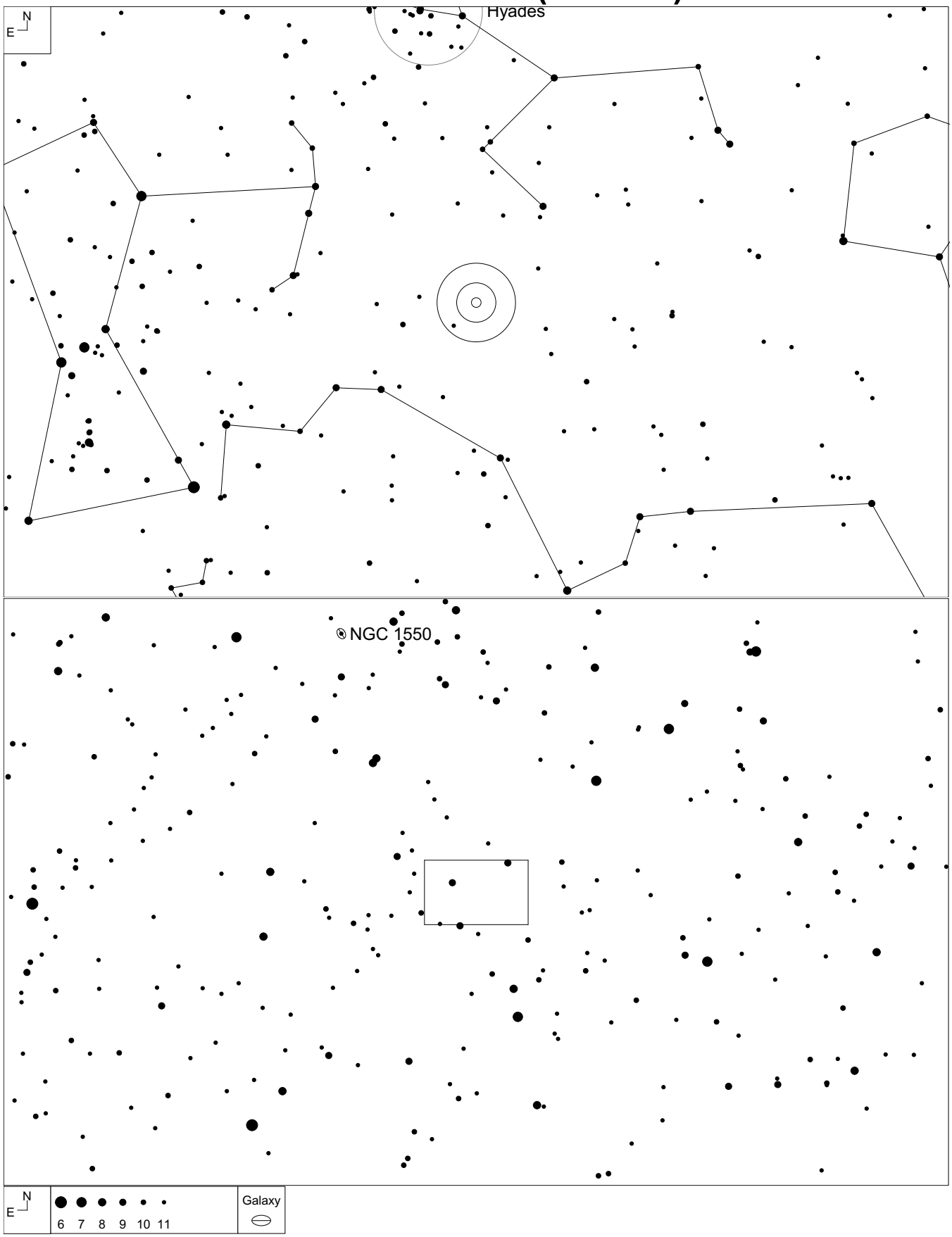
H0323+022 (Taurus)





Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	03 26 14.0	+02 25 15	15.7 - 18.6	stellar	0.147	

1ES 0414+009 (Taurus)



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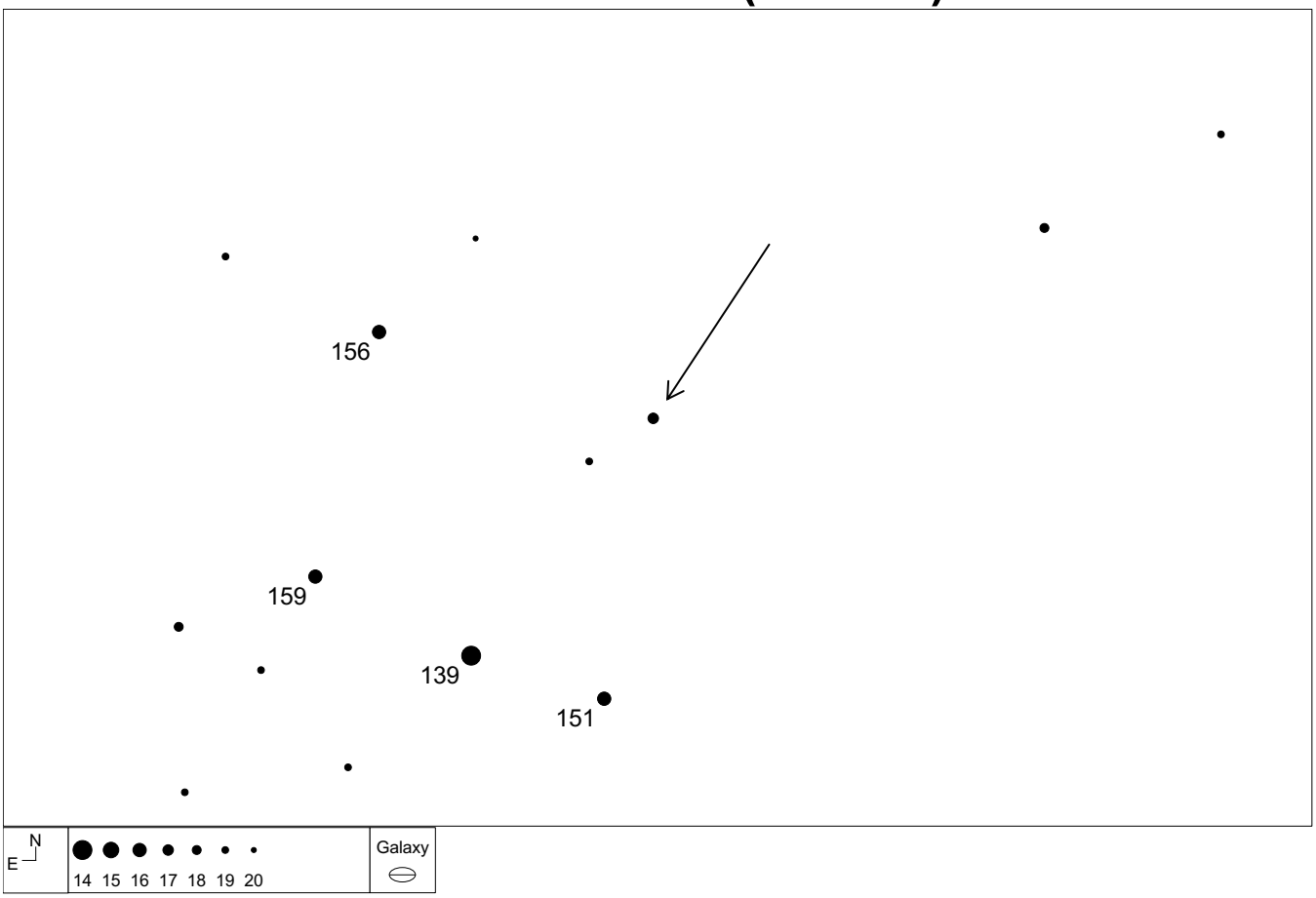
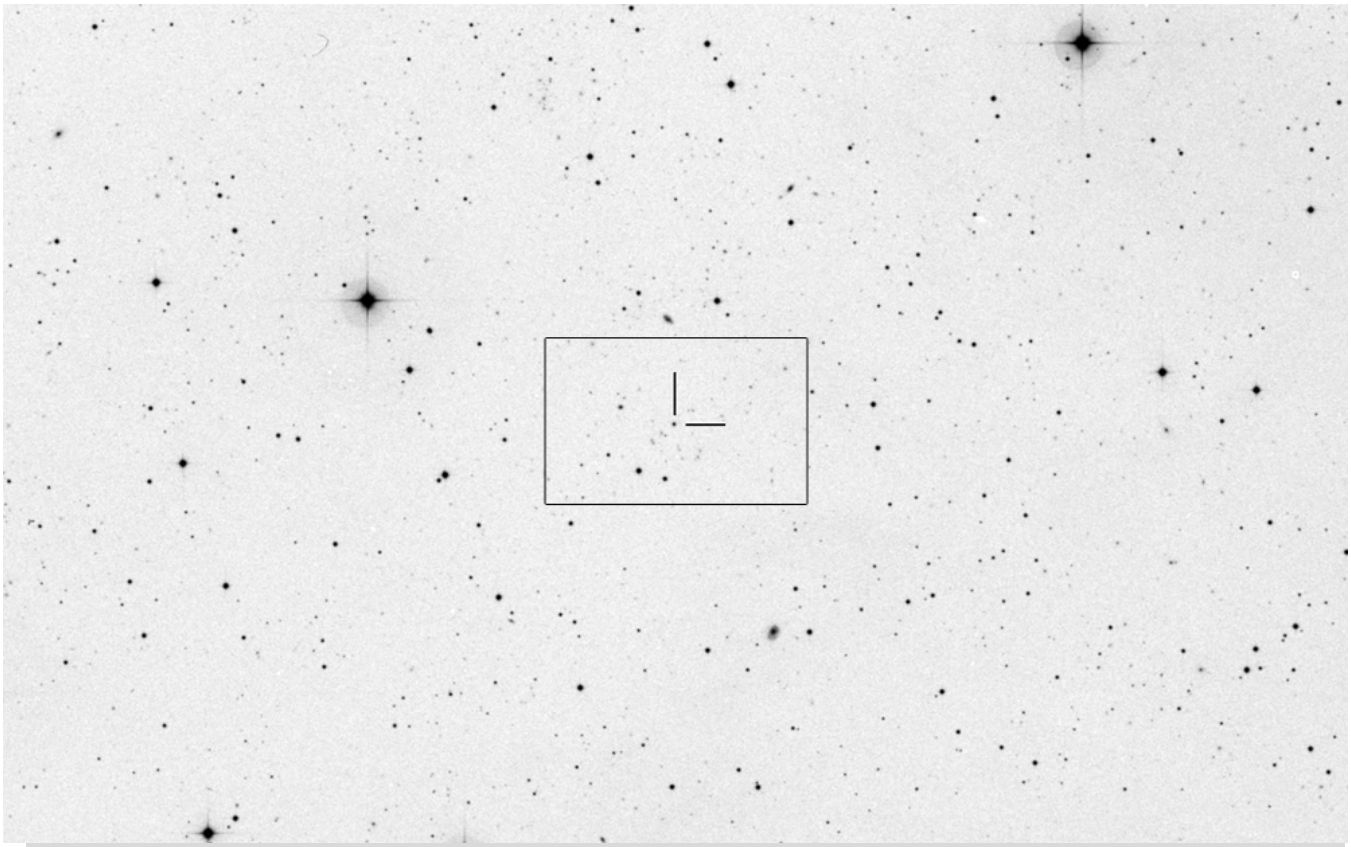
25th Texas Symposium on Relativistic Astrophysics – Texas 2010

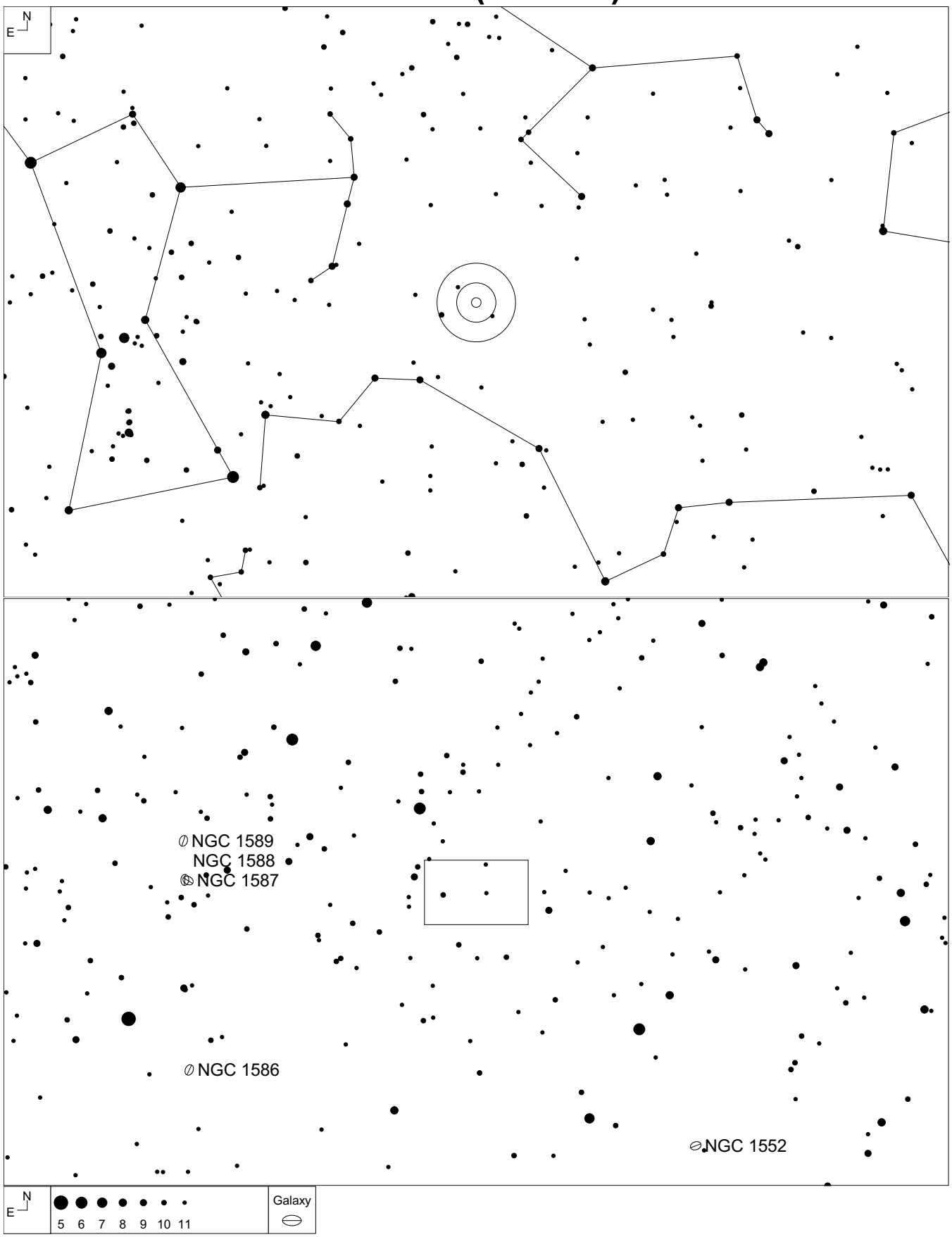
1ES 0414+009 (Taurus)





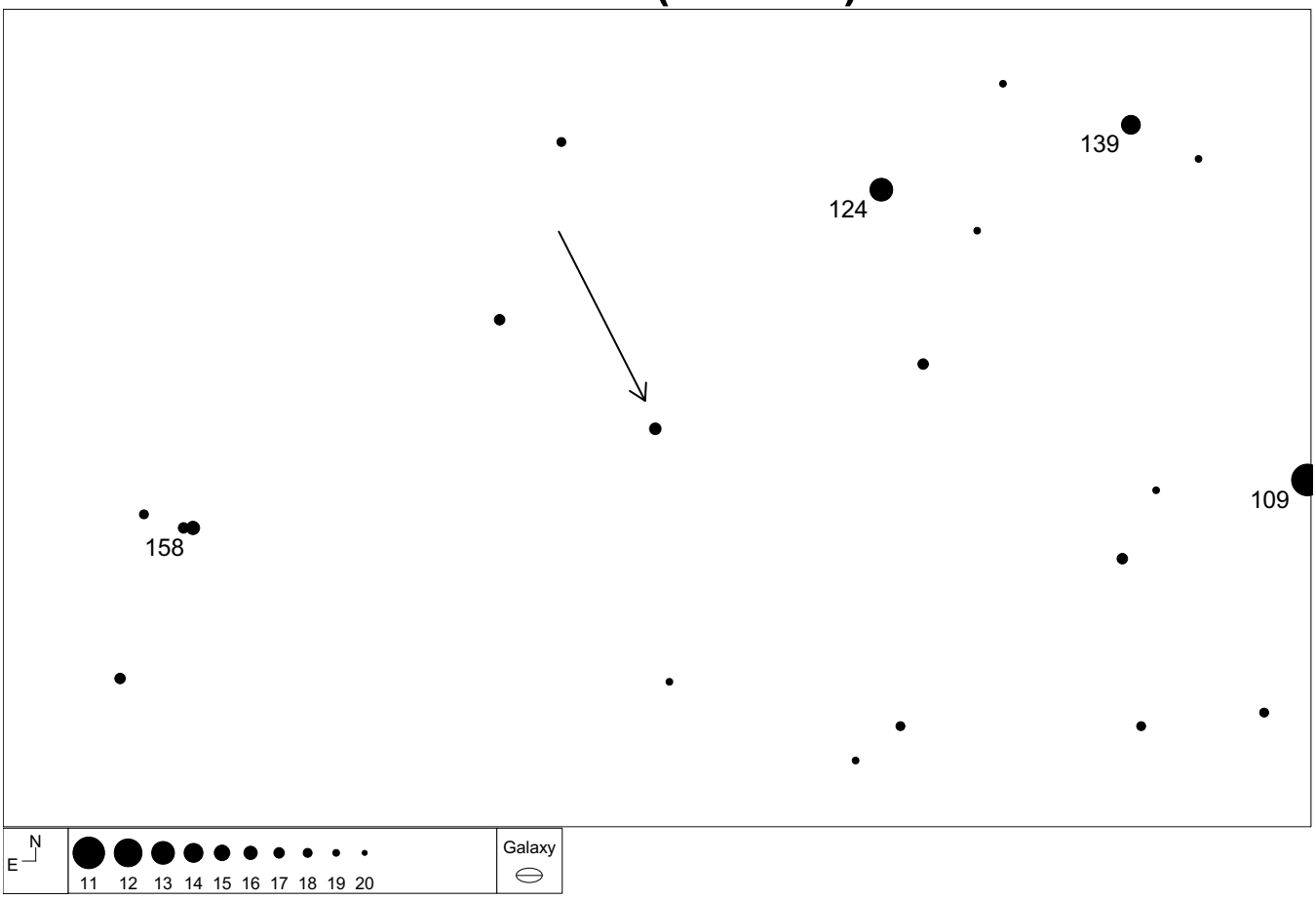
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	04 16 52.4	+01 05 24	15.9 - 17.1	stellar	0.287	1H 0414+009

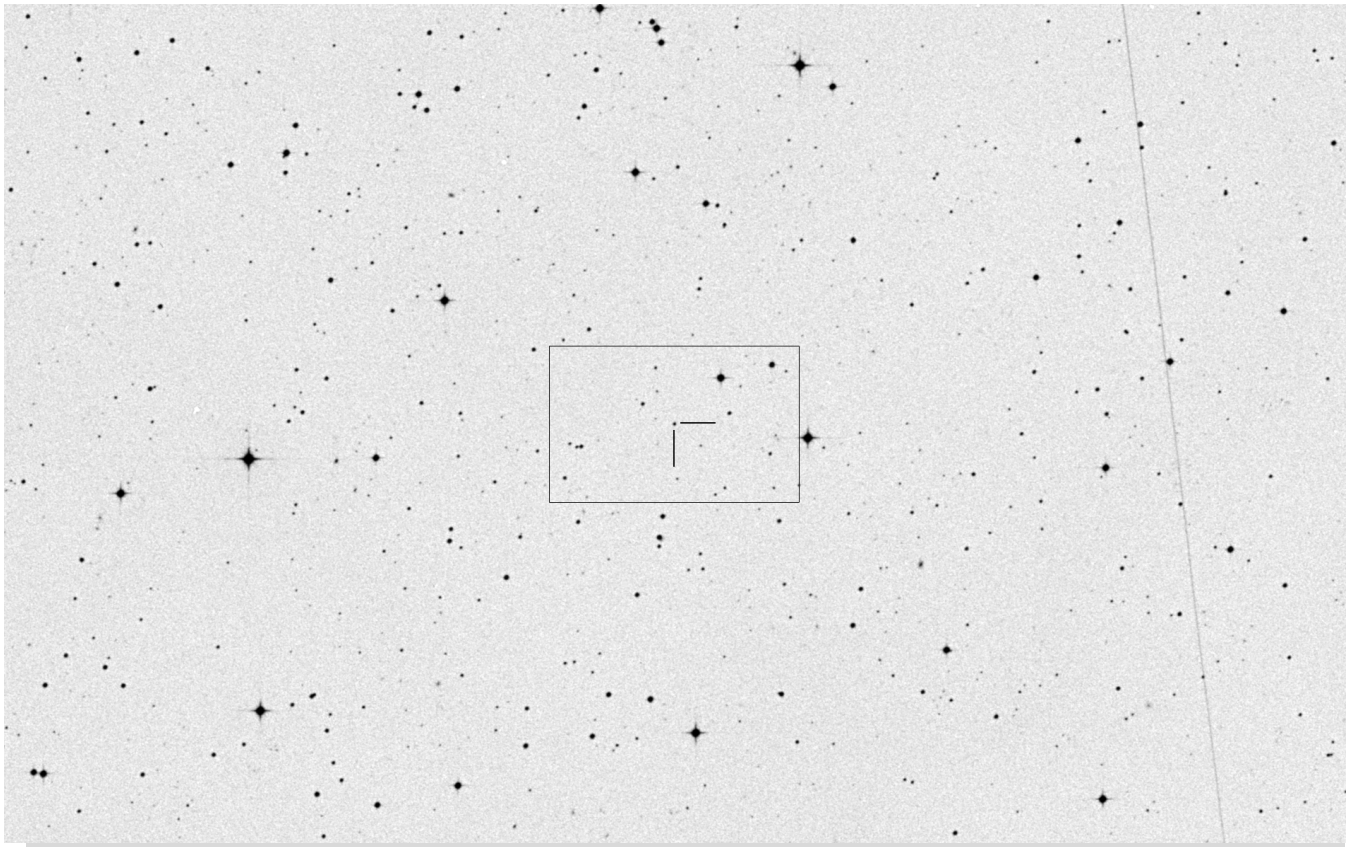
OF 038 (Taurus)



Miller, H.R., et al "Photoelectric Comparison Sequences in the Fields of Four BL Lacertae Objects." *The Astronomical Journal*, Vol 88 (Sept 1983): 1301-1303

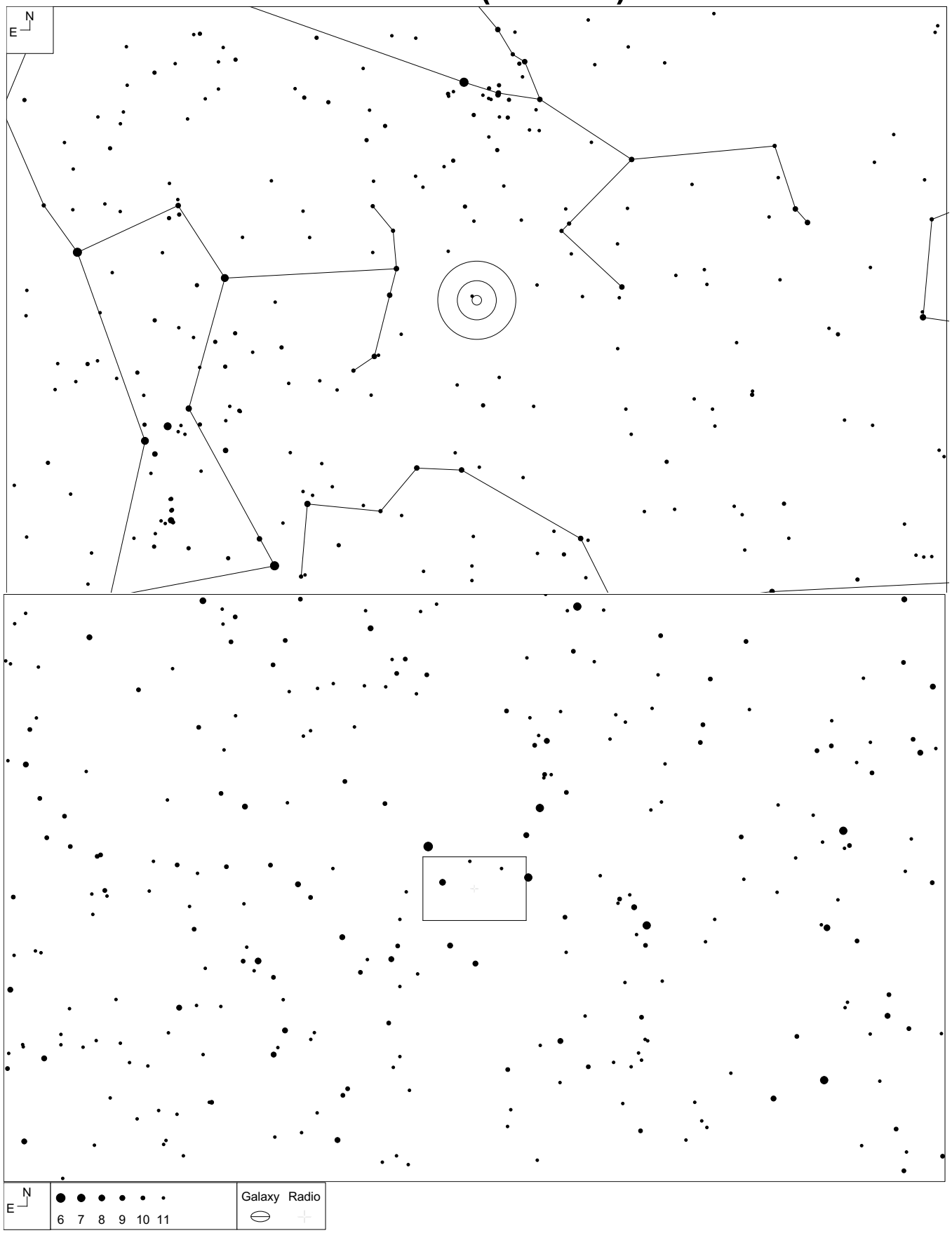
OF 038 (Taurus)



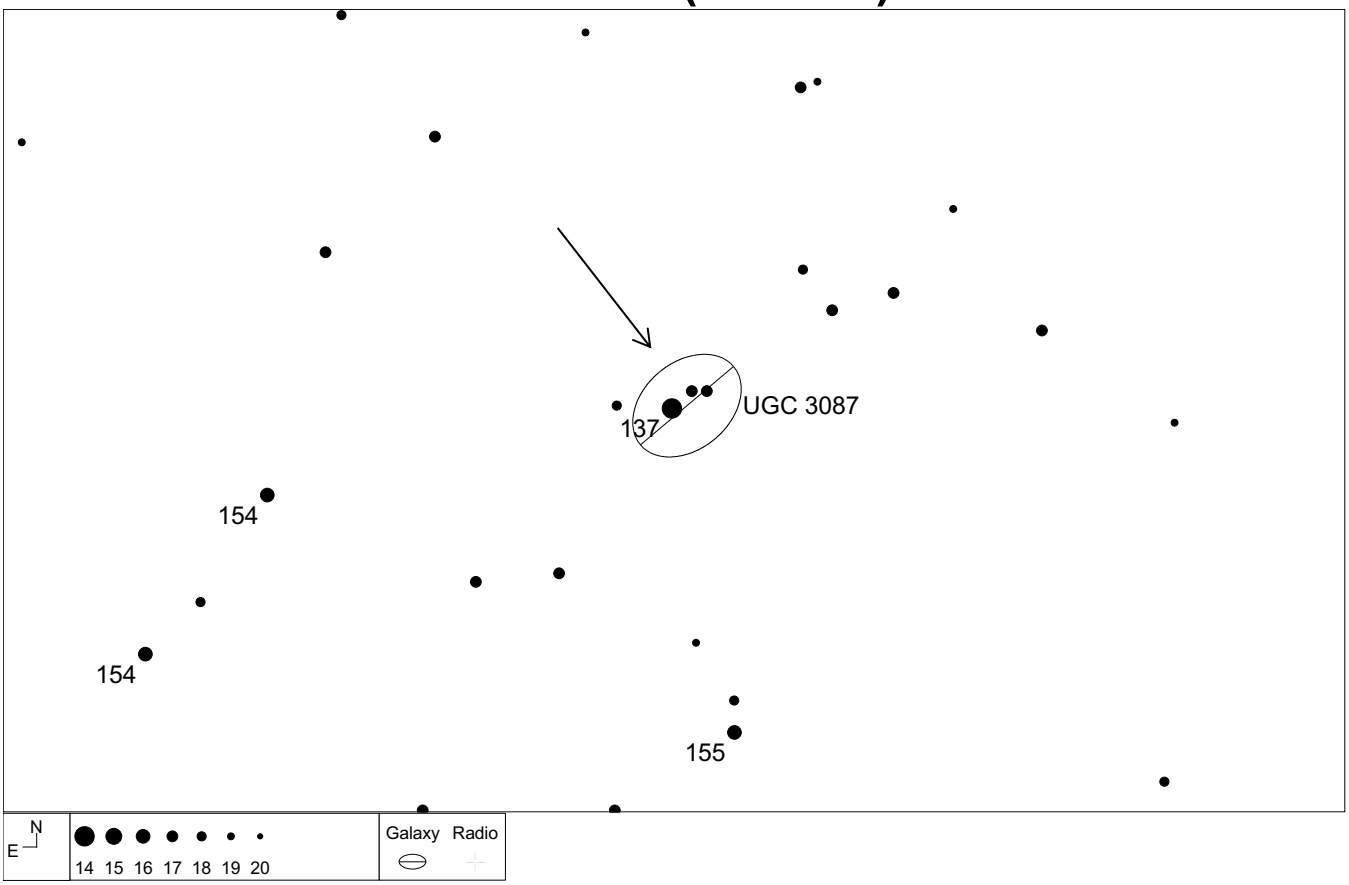


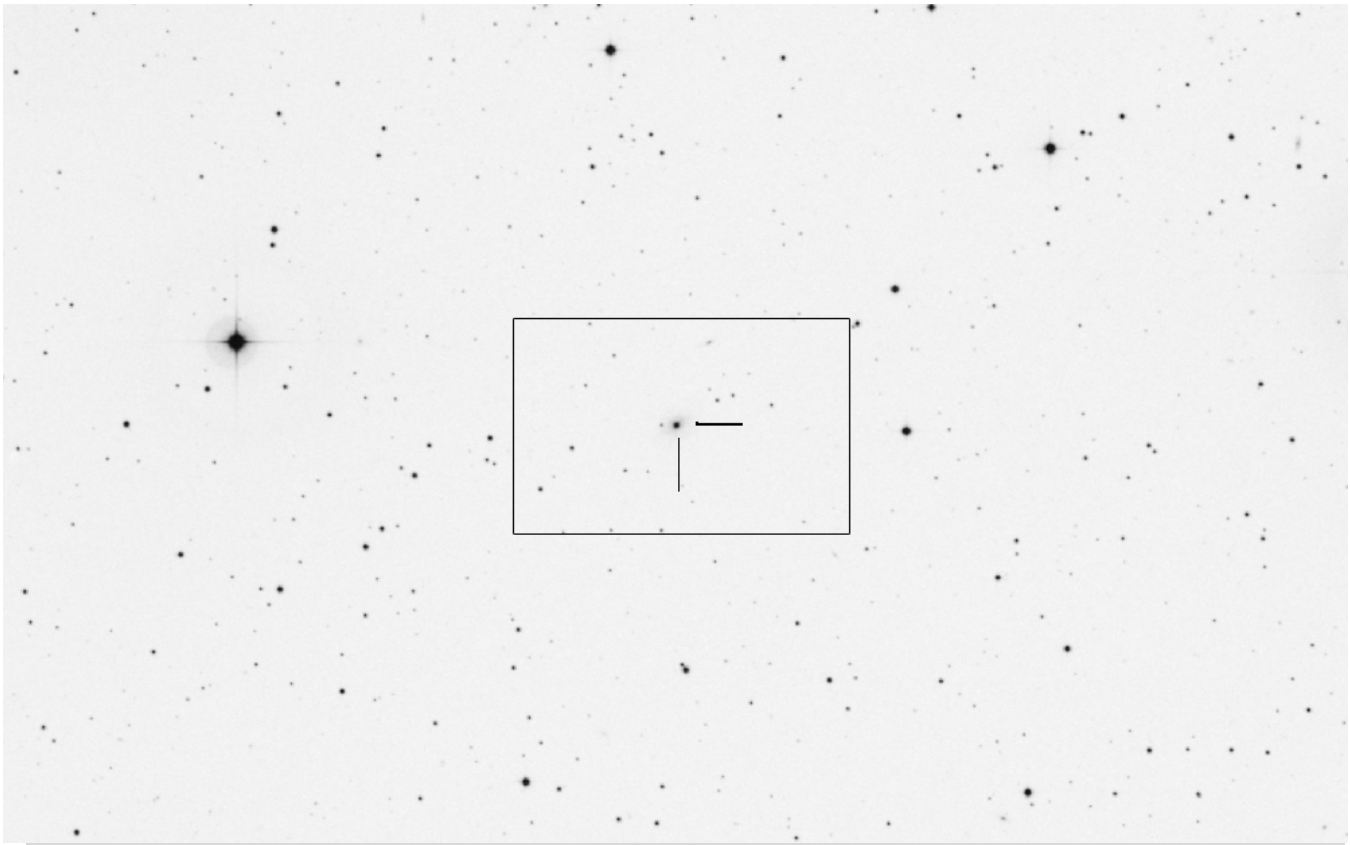
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	04 24 46.8	+00 36 06	14.6 - 16.7	stellar	0.31	0422+004

BW Tau (Taurus)



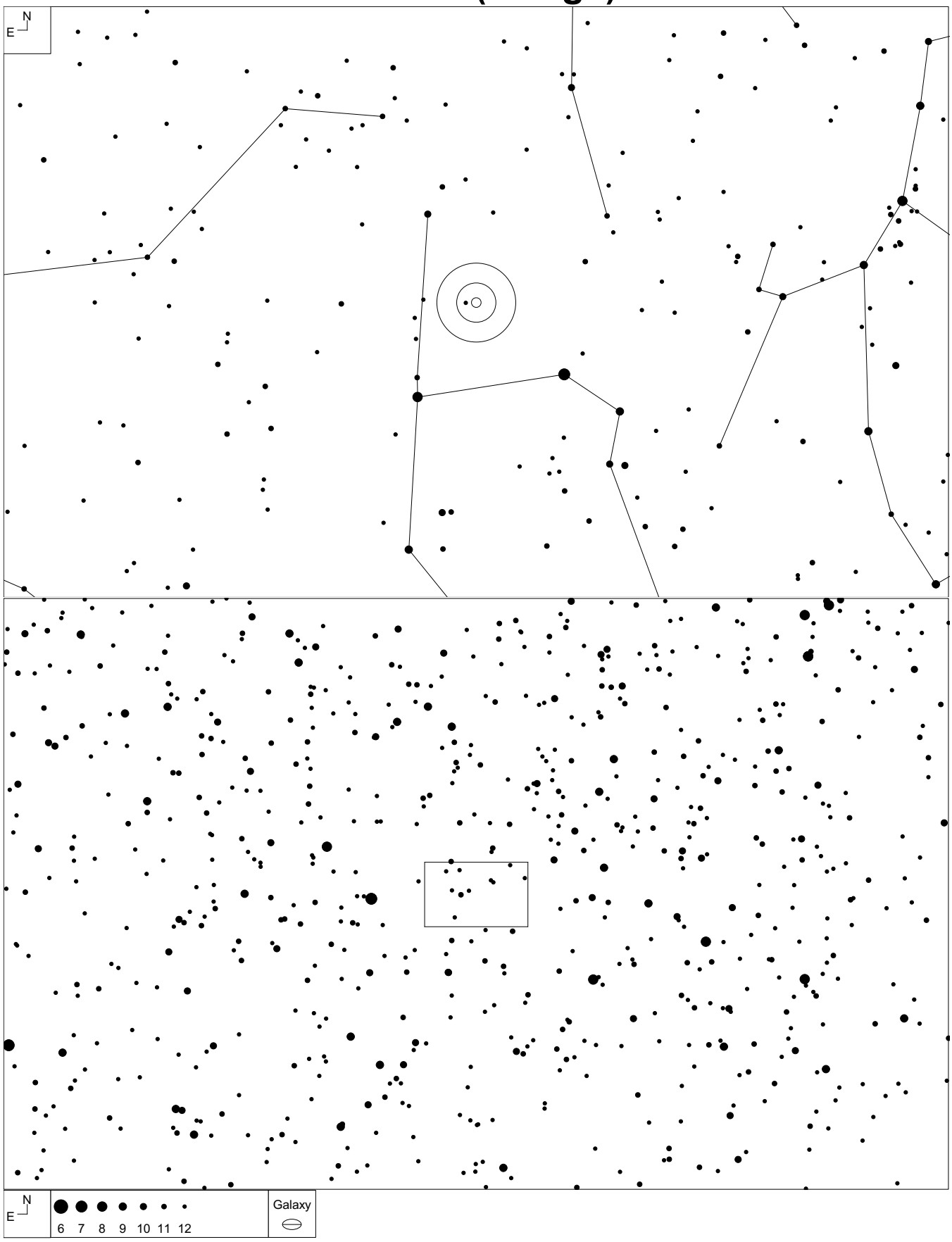
BW Tau (Taurus)



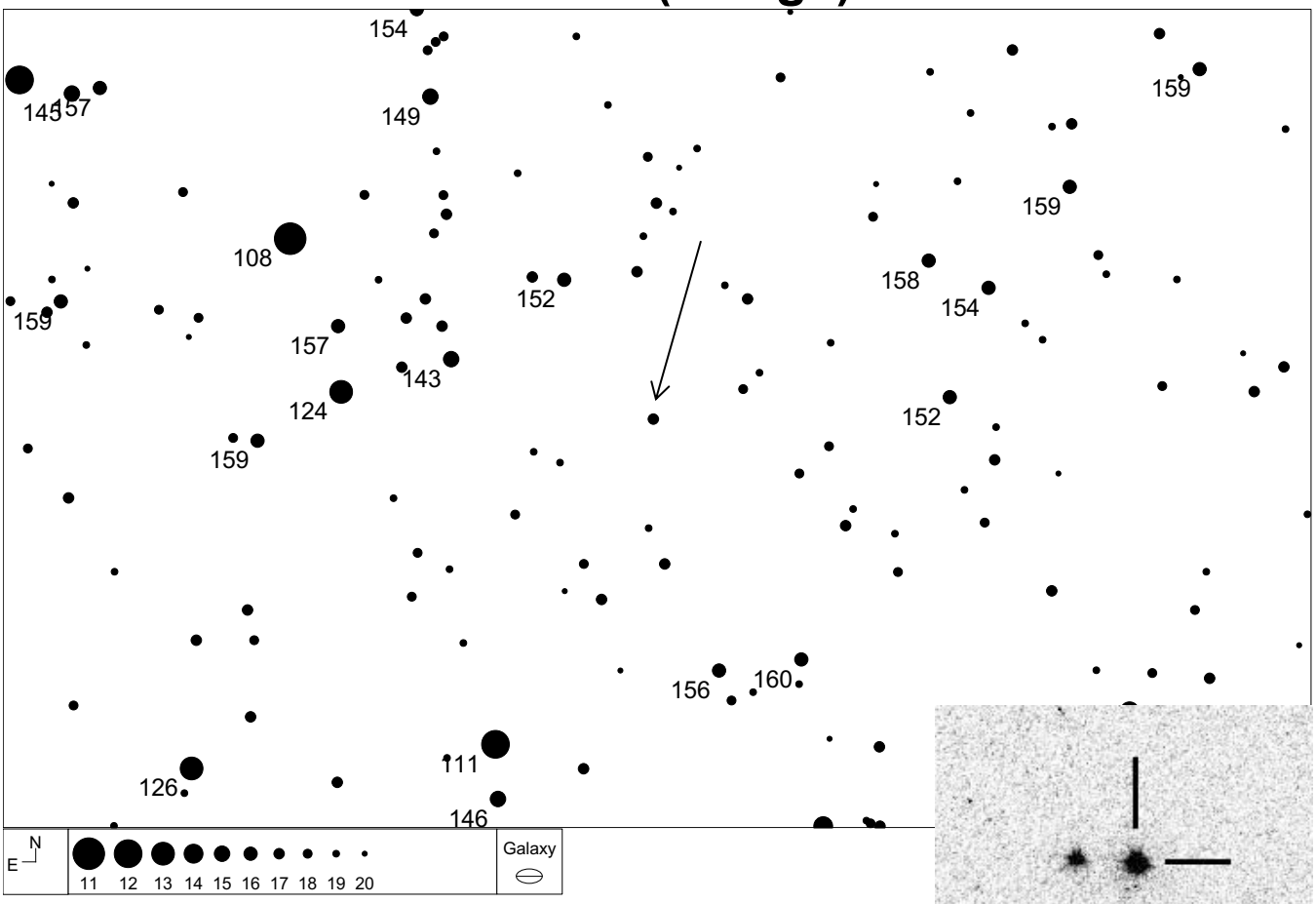


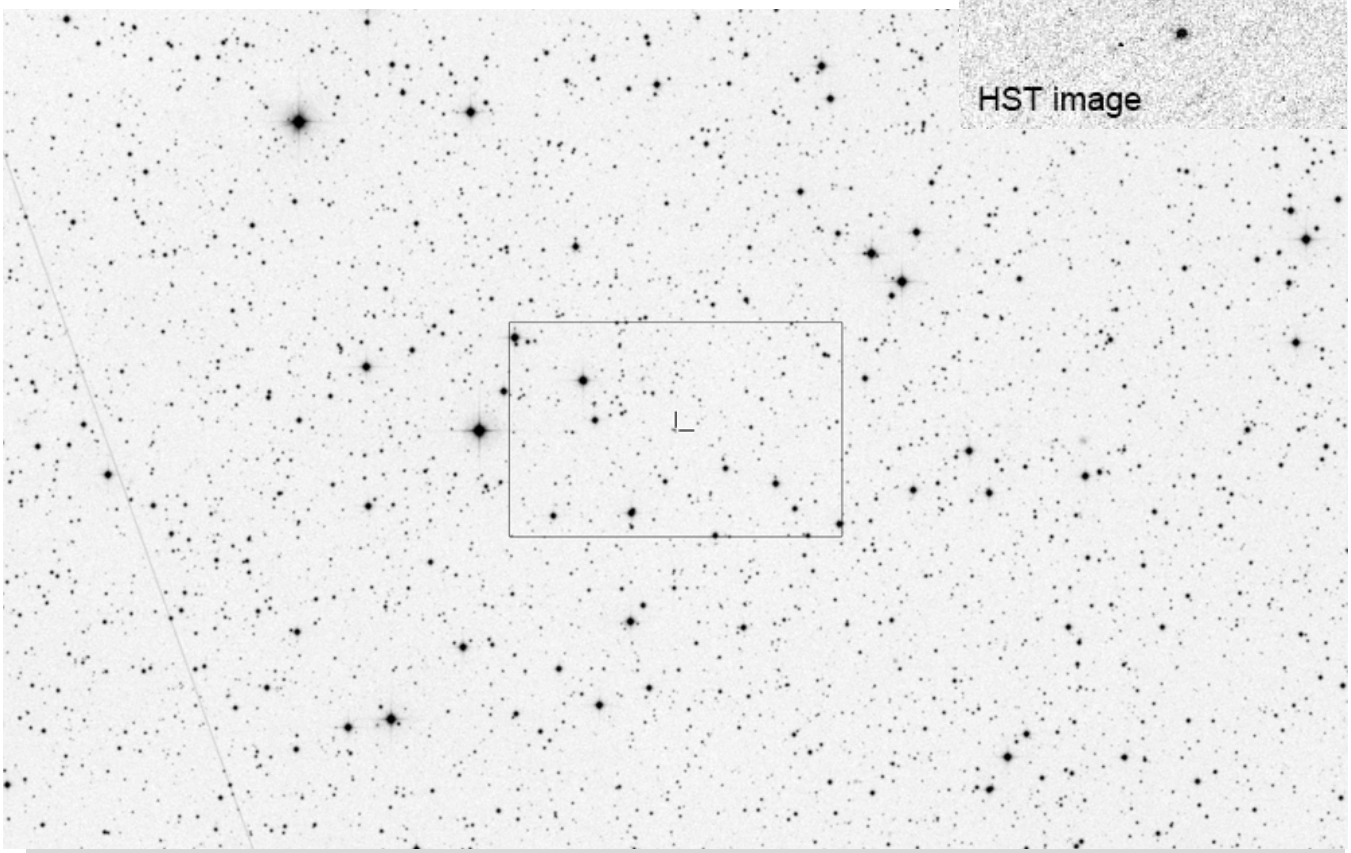
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	04 33 11.1	+05 21 14	13.7 – 16.4	0.8 x 0.6’	0.033	3C 120

3C 147 (Auriga)



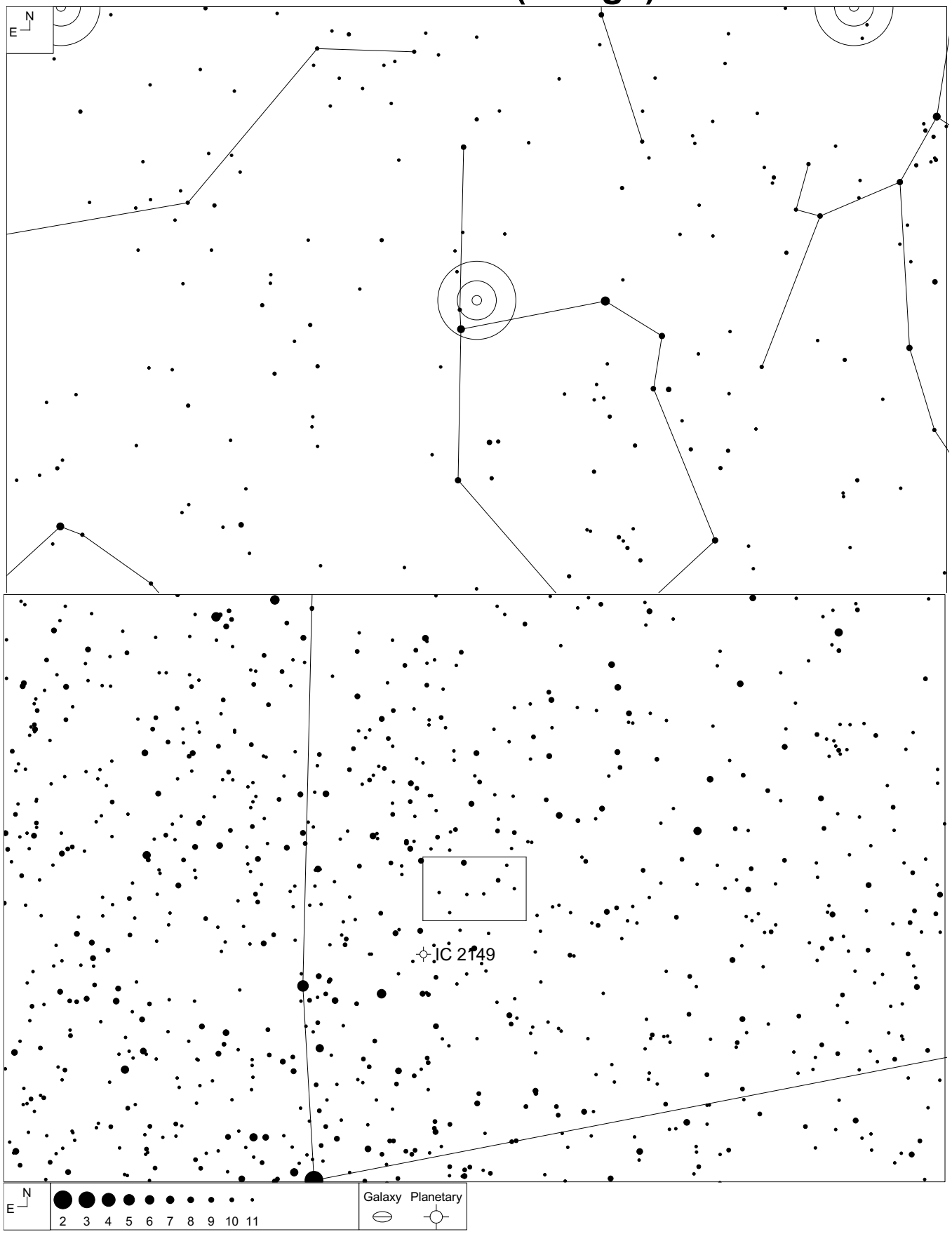
3C 147 (Auriga)





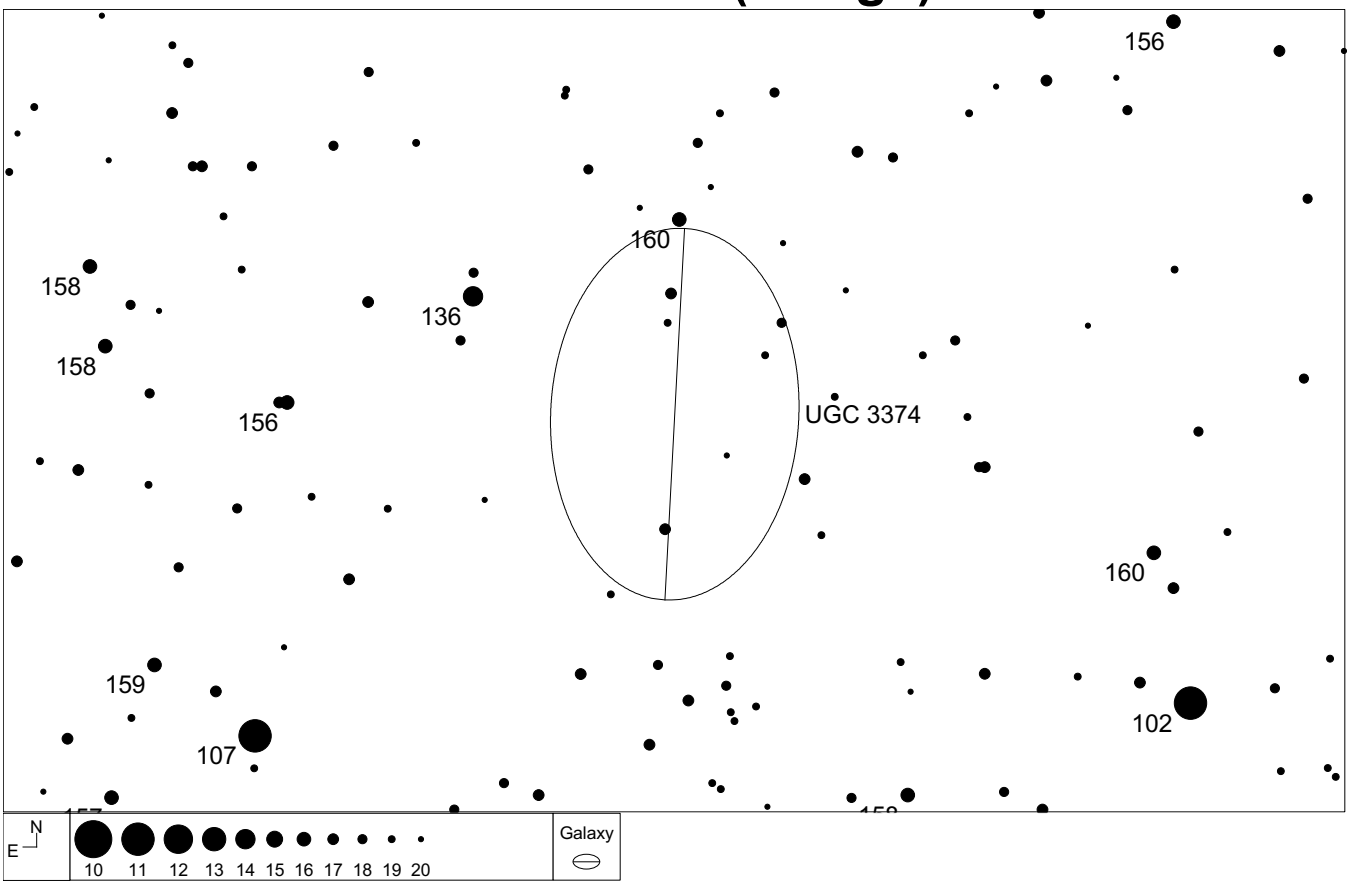
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	05 42 36.1	+49 51 07	17 - 18	stellar	0.545	

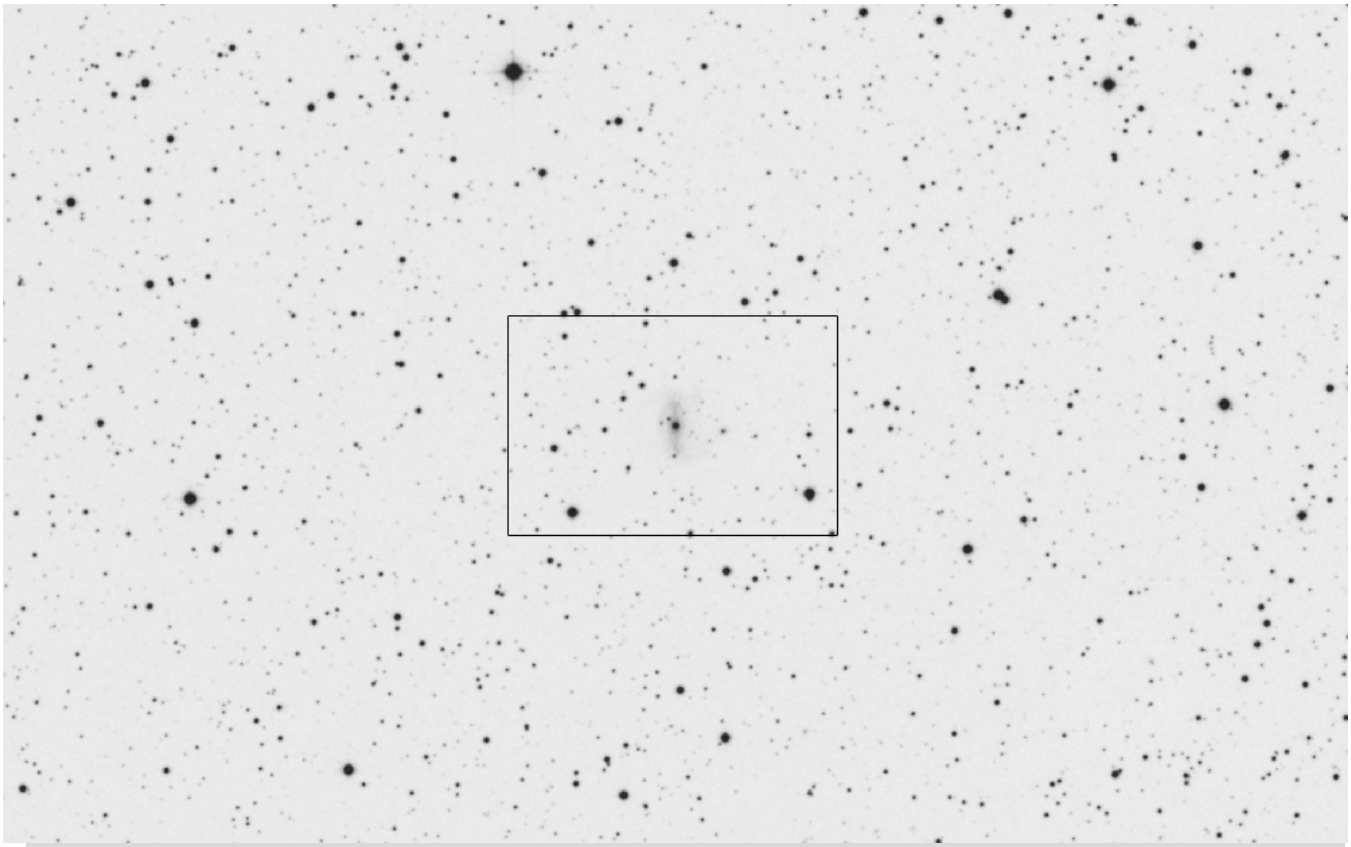
S10838 Aur (Auriga)



Gessner, H. "Variability of Nebulous Object at 15h44m +46.4°" *Information Bulletin on Variable Stars* No 1789
http://adsabs.harvard.edu/full/1980IBVS.1789....1G

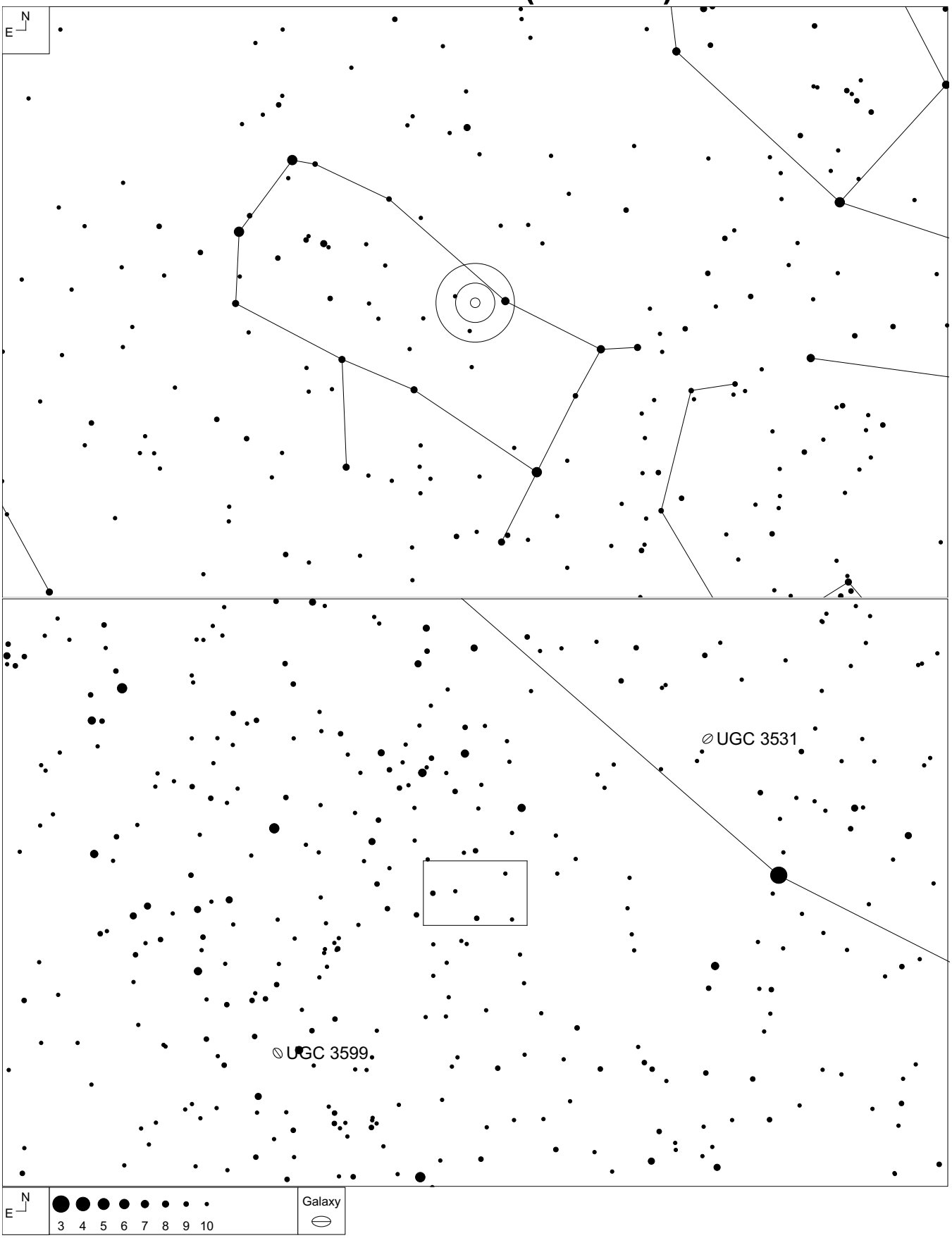
S10838 Aur (Auriga)





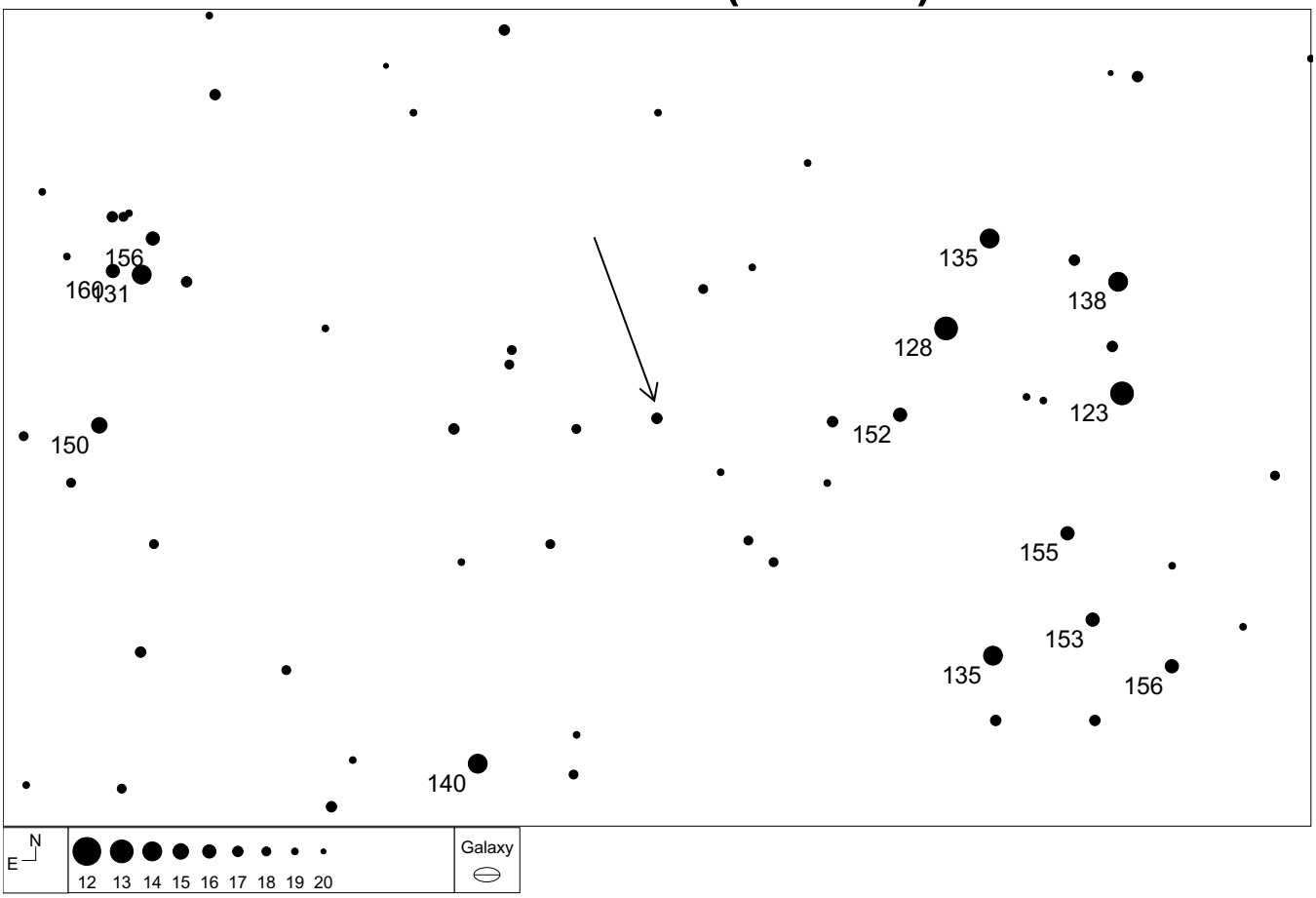
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	05 54 53.6	+46 26 22	14.4 – 15.5	2.1 x 1.5’	0.0205	UGC 3374

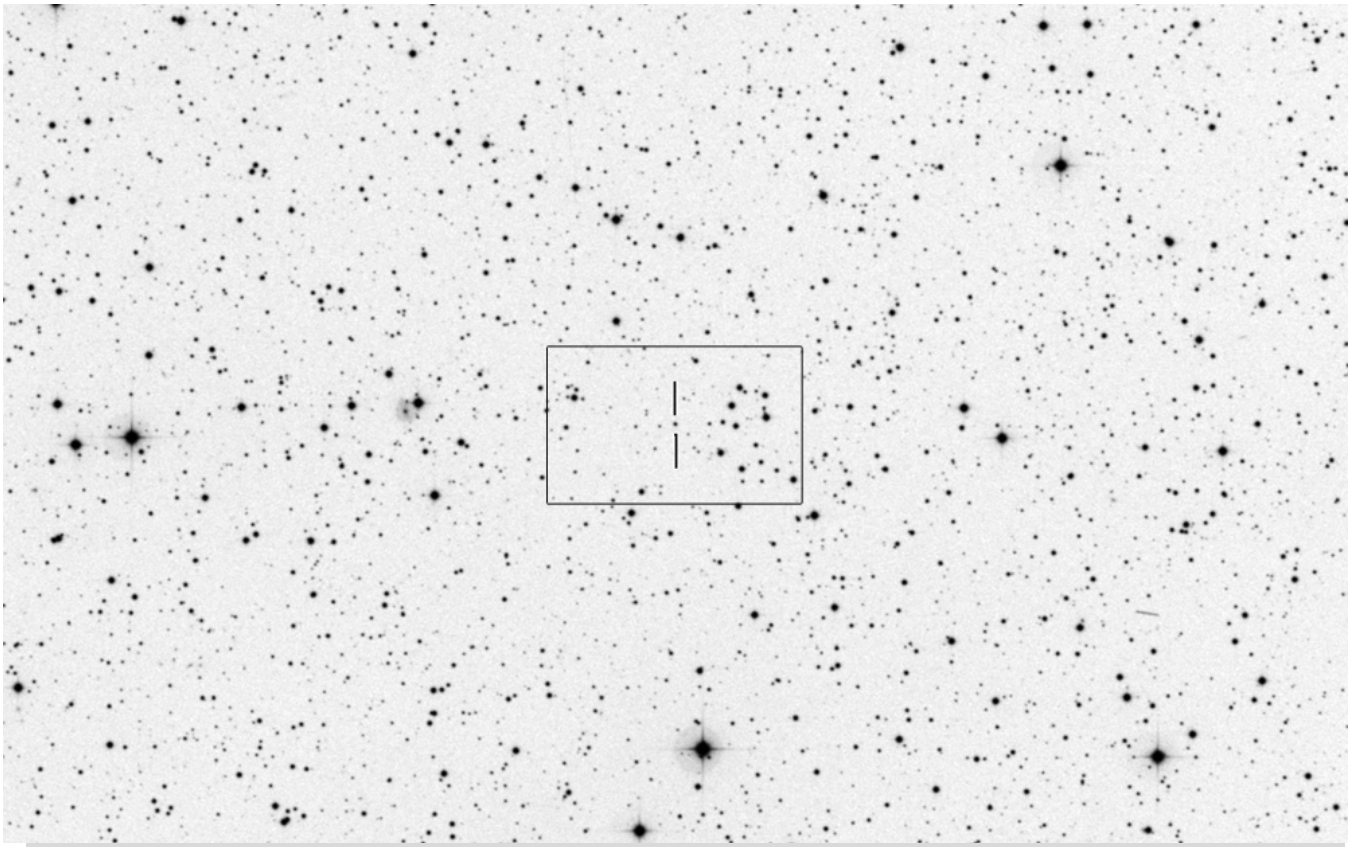
BL 0647+250 (Gemini)



Kotilainen, J.K. et al "The host galaxy of the BL Lacertae Object 1ES 0647+250 and its Imaging Redshift." *Astronomy and Astrophysics*, Vol 534 (2011): L2 (5pp)

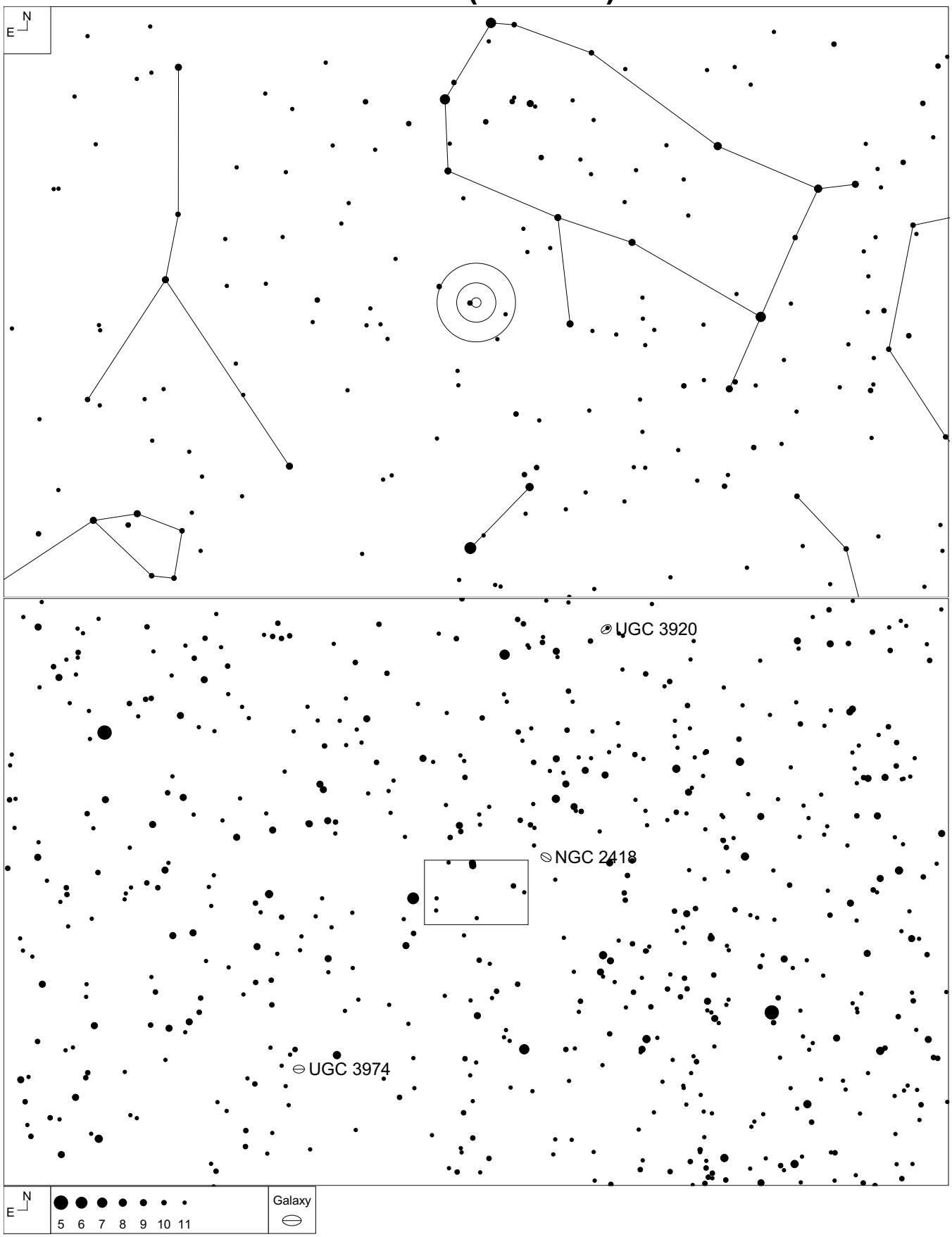
BL 0647+250 (Gemini)



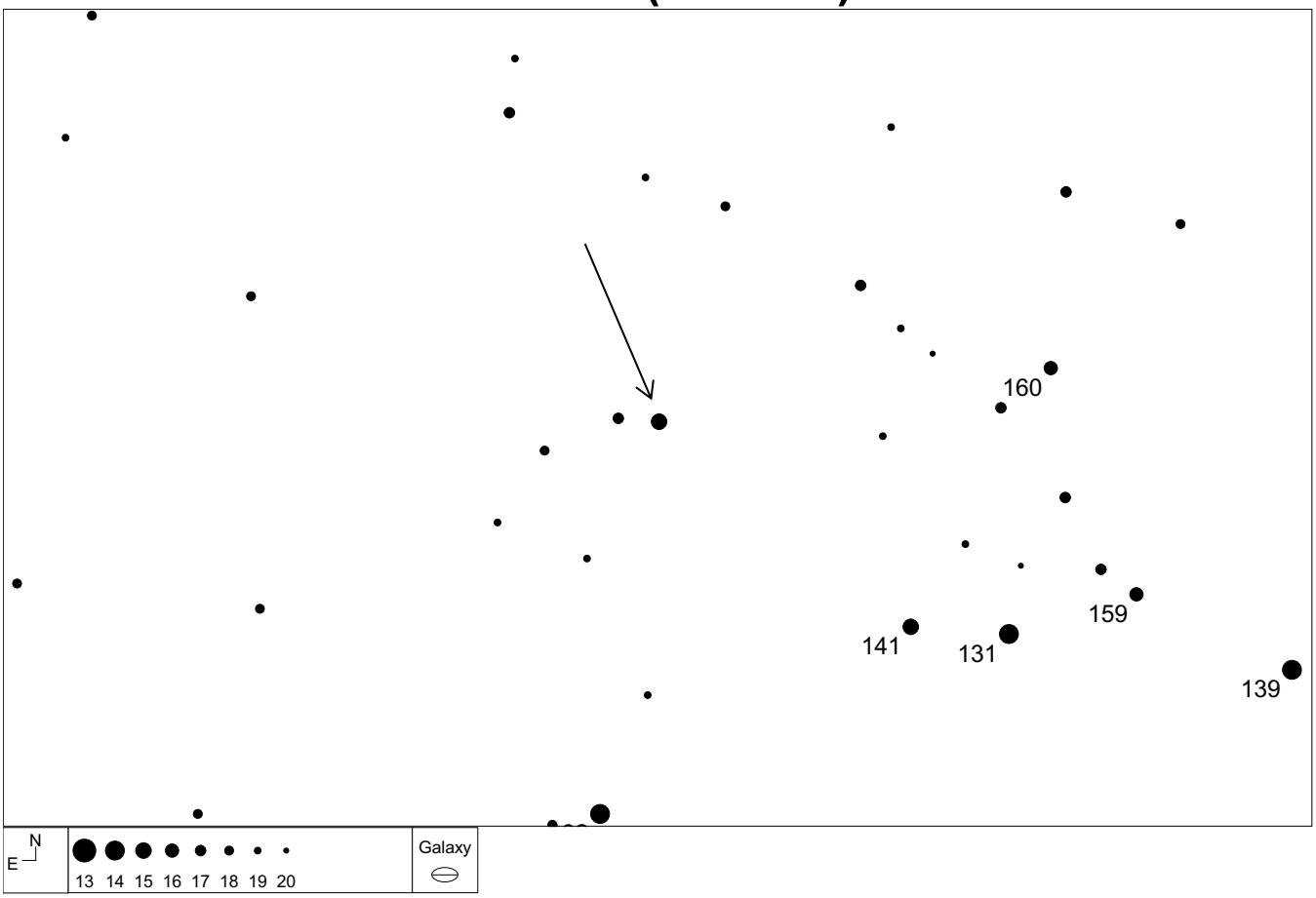


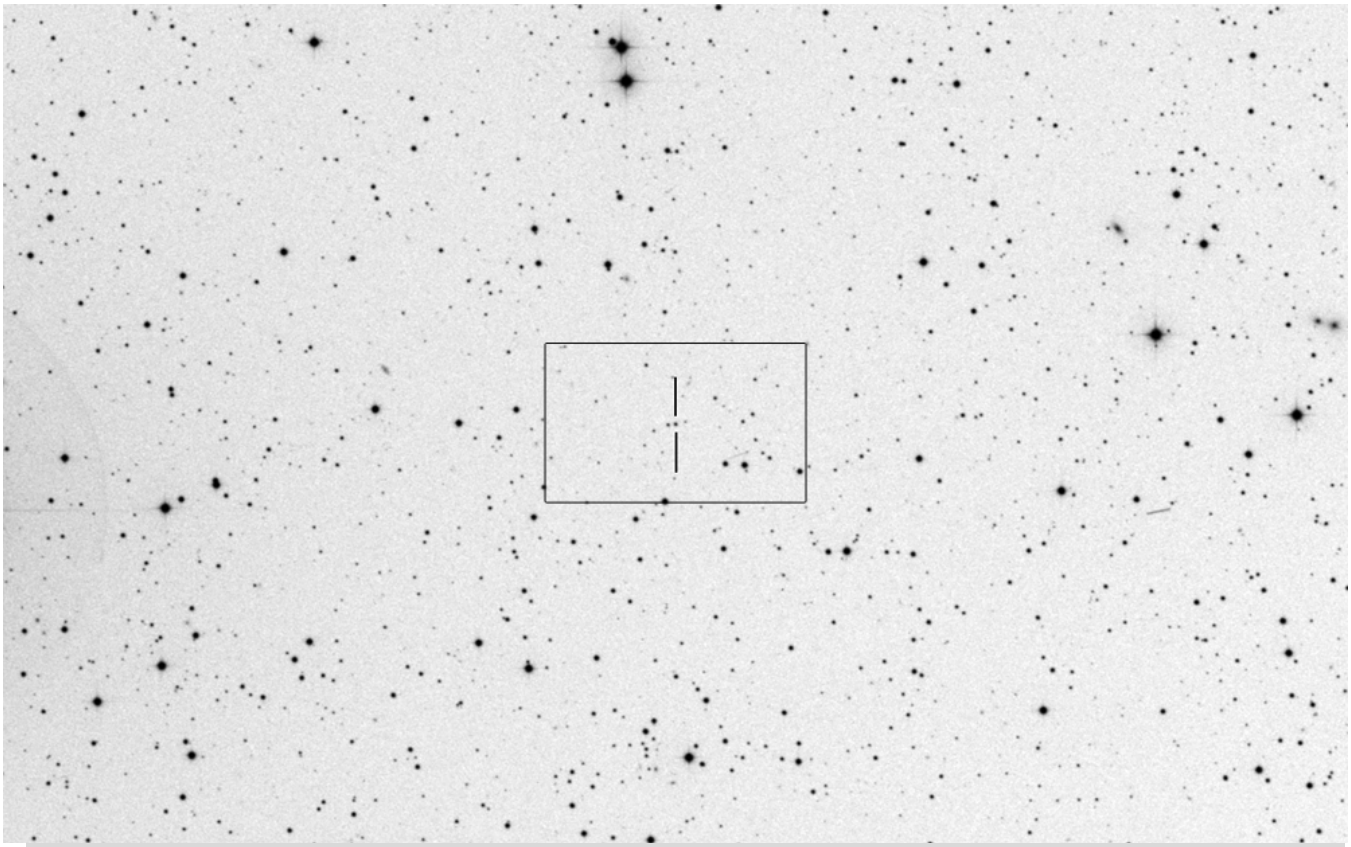
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	06 50 46.5	+25 03 00	15.3	stellar	0.203	1ES 0647+250

Ol 158 (Gemini)



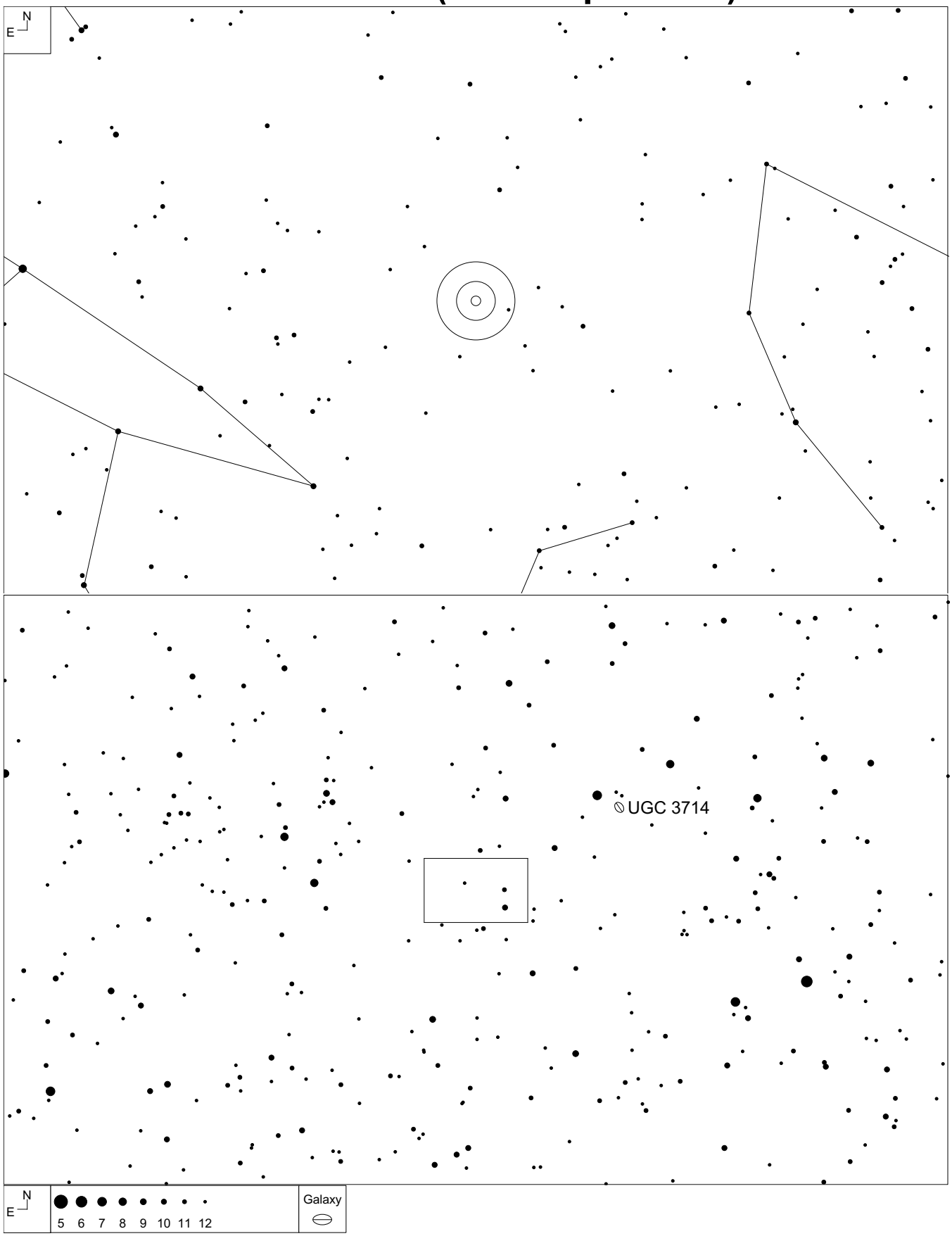
OI 158 (Gemini)





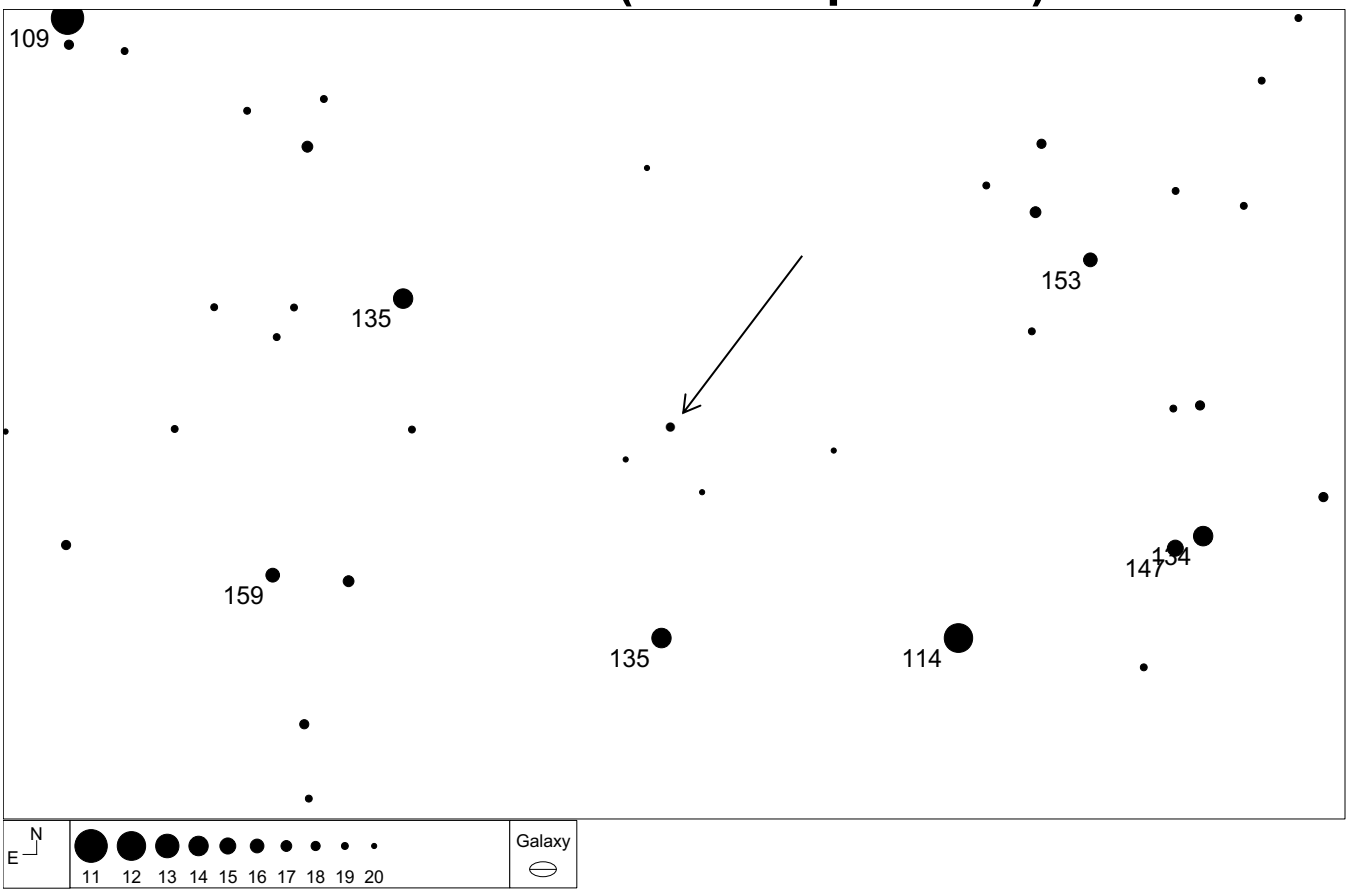
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	07 38 07.4	+17 42 19	14.5 - 16	stellar	0.424	PKS 0735+178

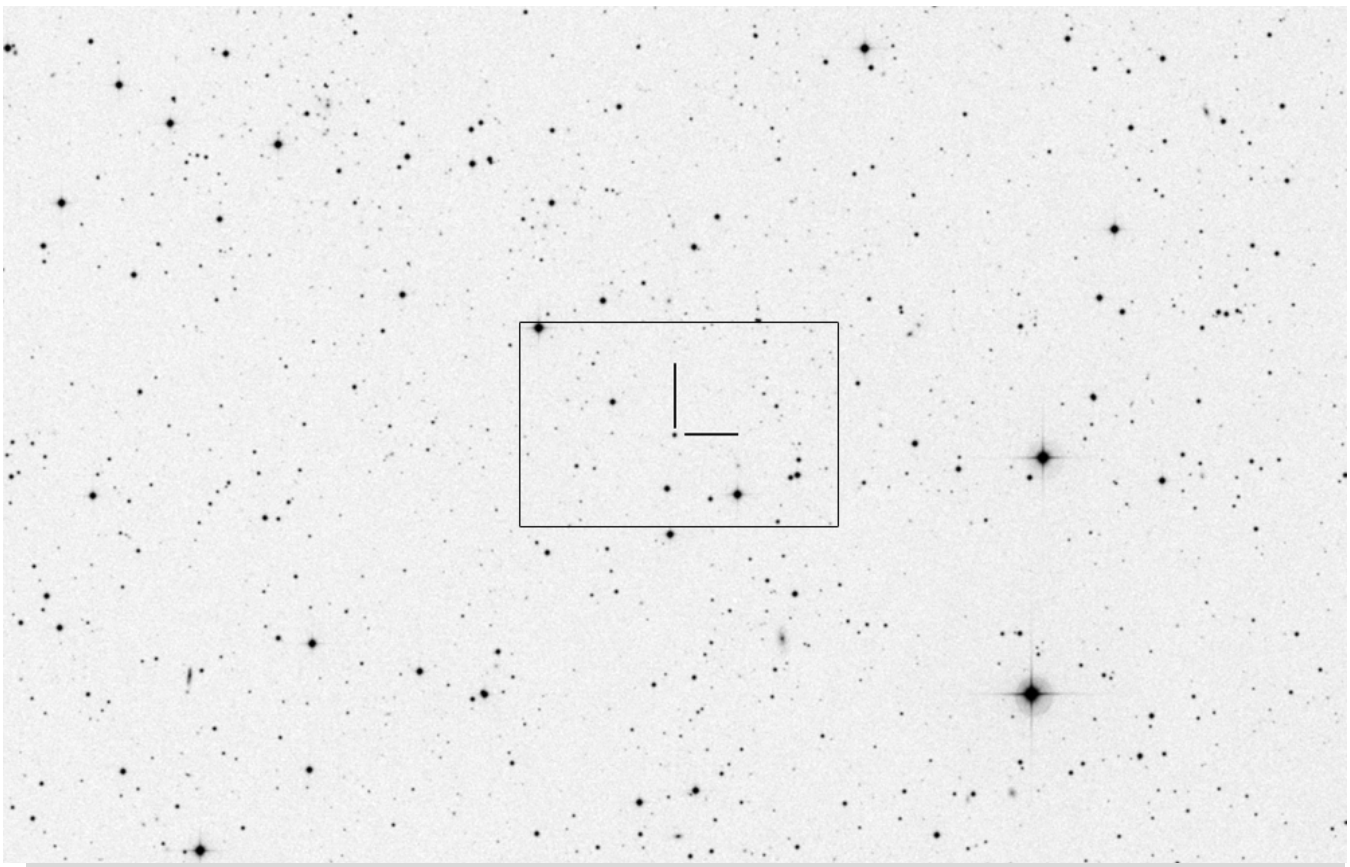
S5 0716+71 (Camelopardalis)



Larionov, V.M., et al. "The outburst of the Blazar S5 0716+71 in 2011 October: Shock in a Helical Jet." *The Astrophysical Journal*, Vol 768 (2013): 40-48

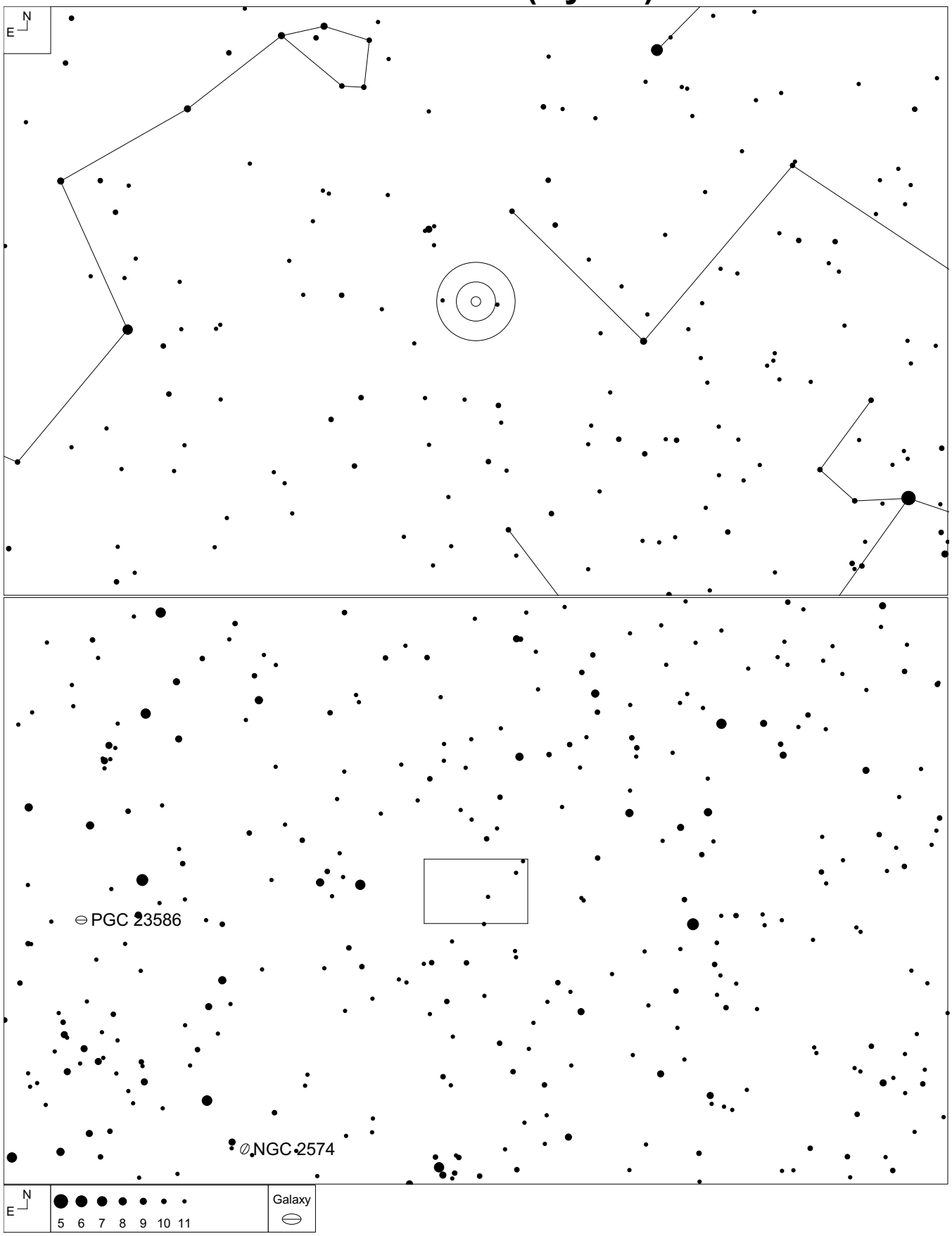
S5 0716+71 (Camelopardalis)



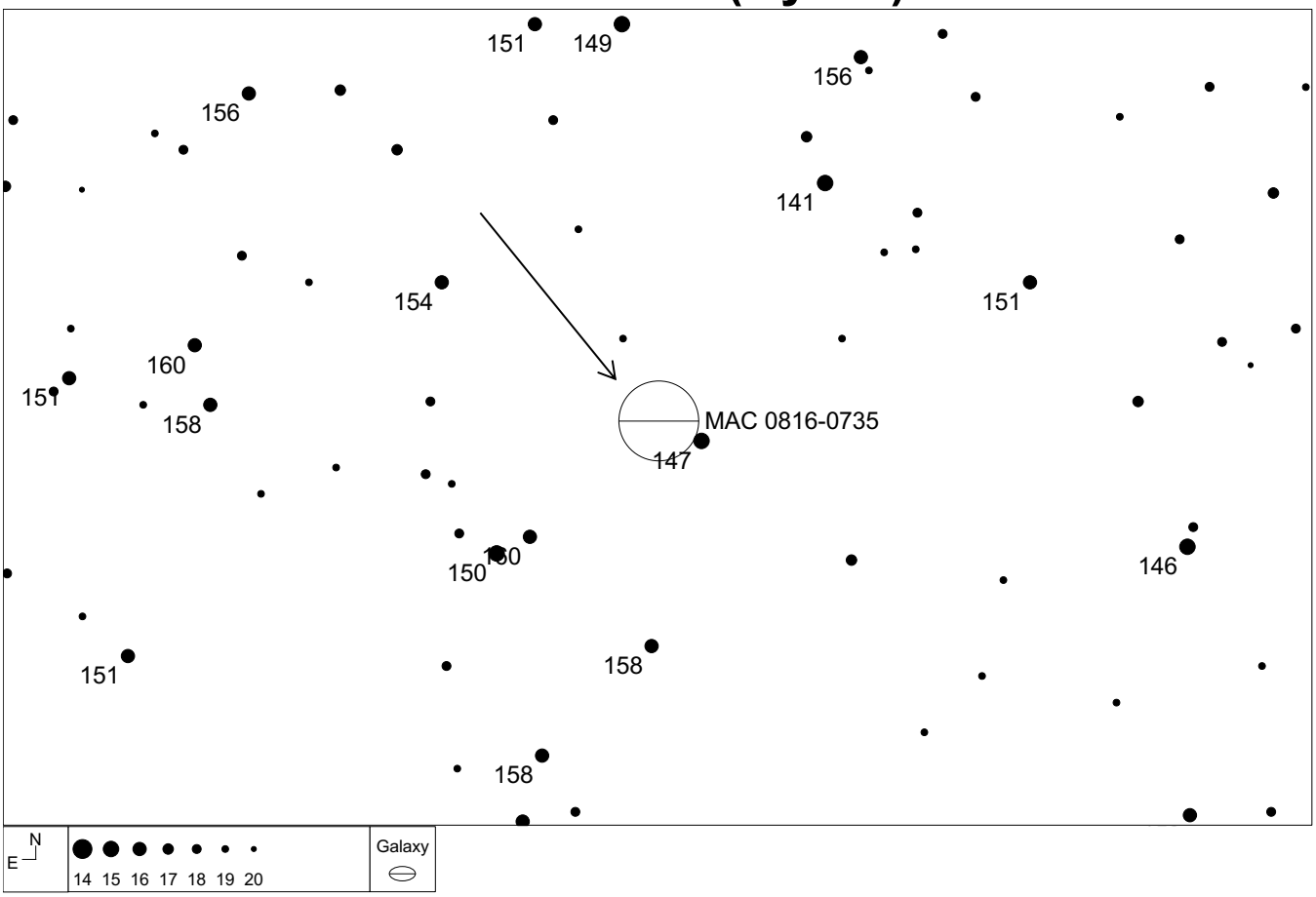


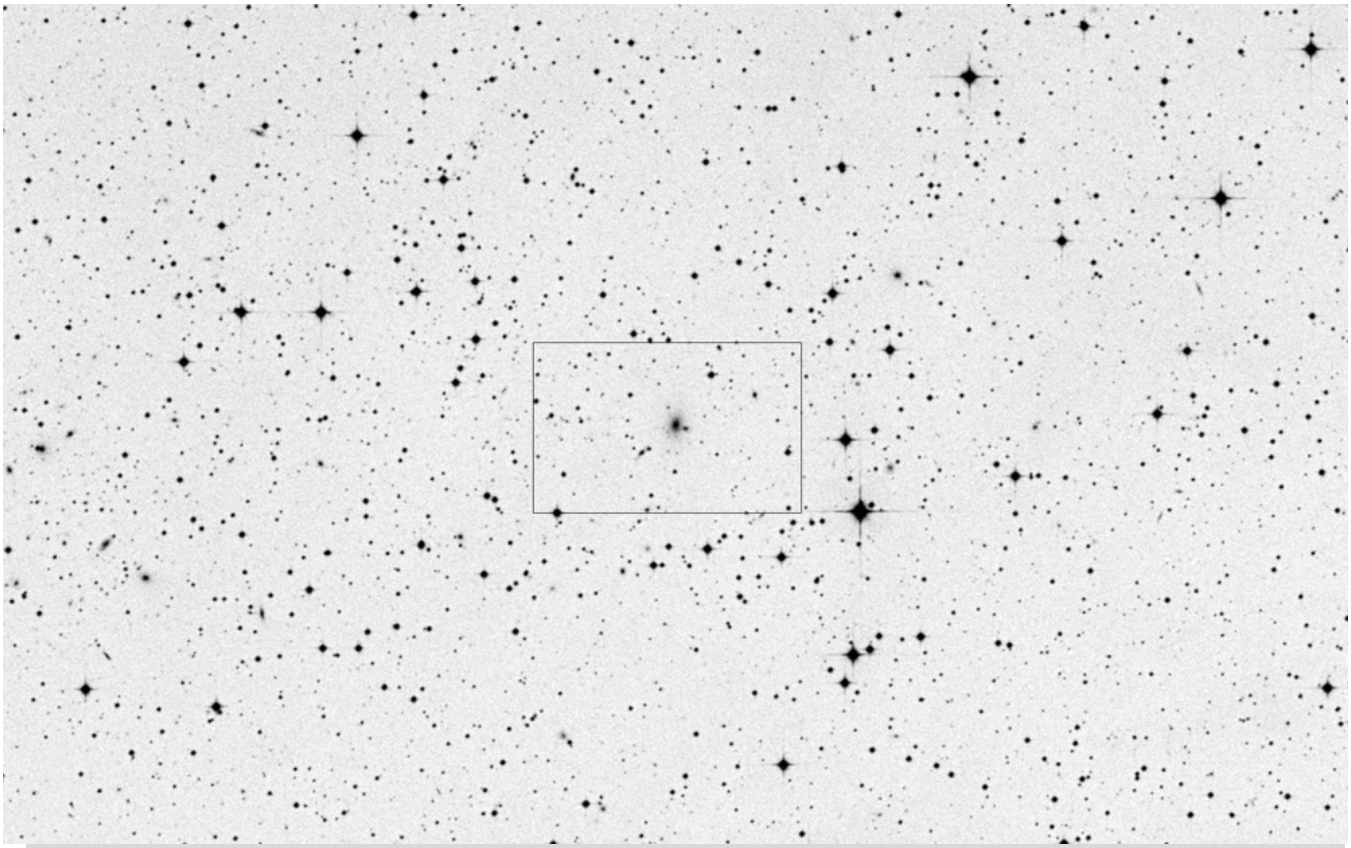
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	07 21 53.4	+71 20 36	13 - 15	stellar	0.3	PKS 0716+714

0816.0-0736 (Hydra)



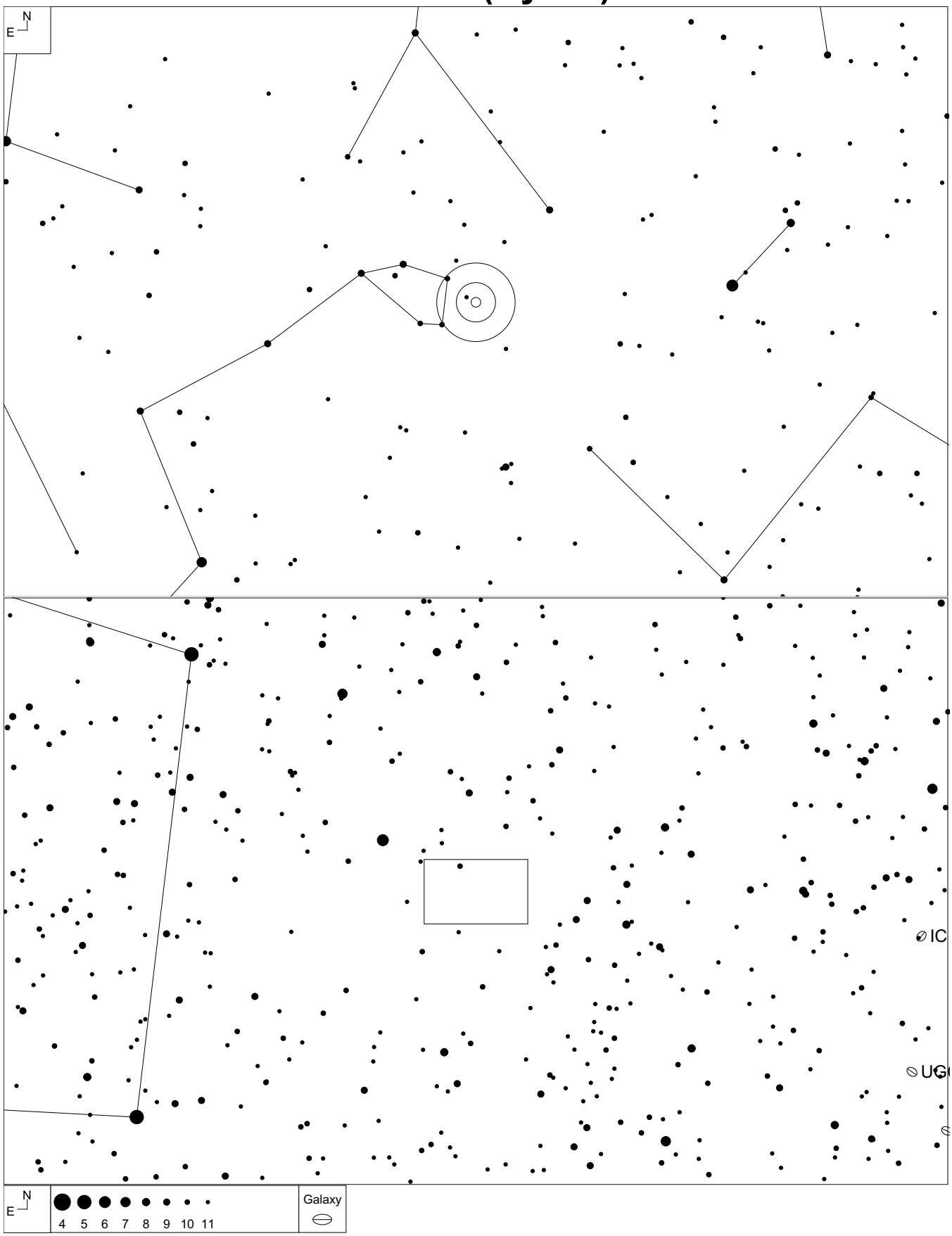
0816.0-0736 (Hydra)





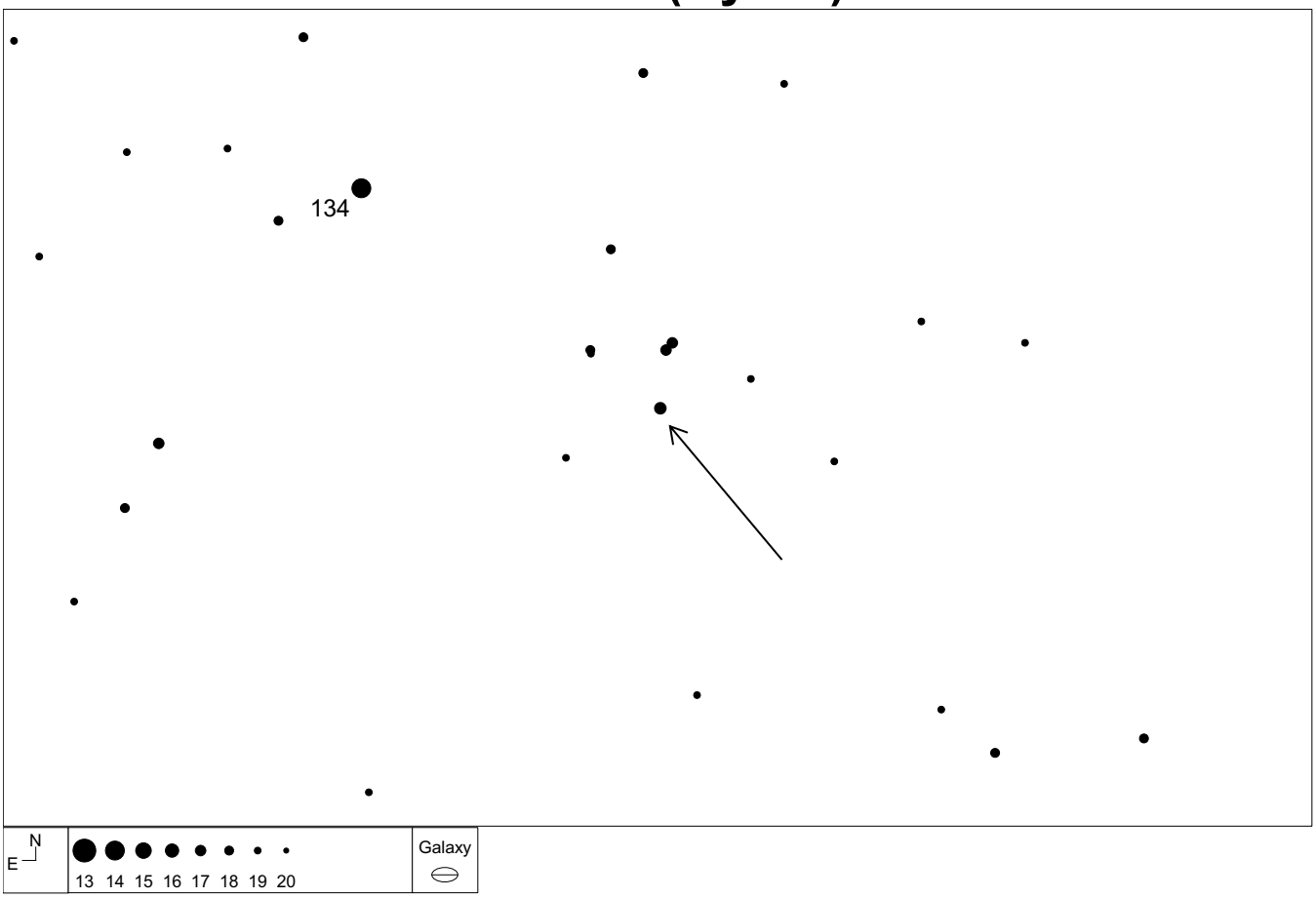
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	08 16 04.2	-07 35 59	16.1	0.5 x 0.3’	0.04	MAC 0816-0735

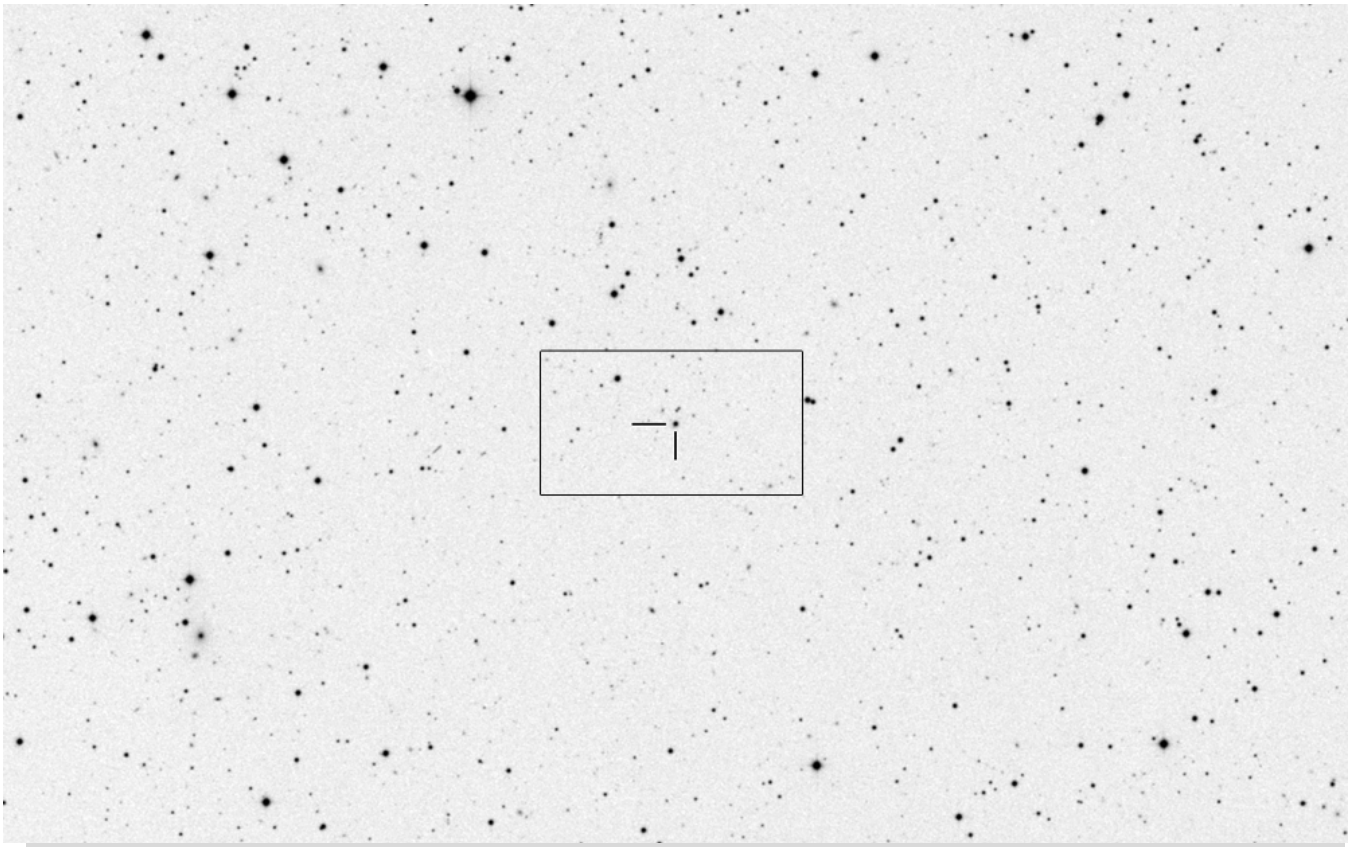
OJ 049 (Hydra)



Source for Magnitude Range: Fiorucci, M & Tosti, G. "Automatic optical monitoring of 10 blazars". *Astronomy and Astrophysics,* Vol 117 (1996): 475-486

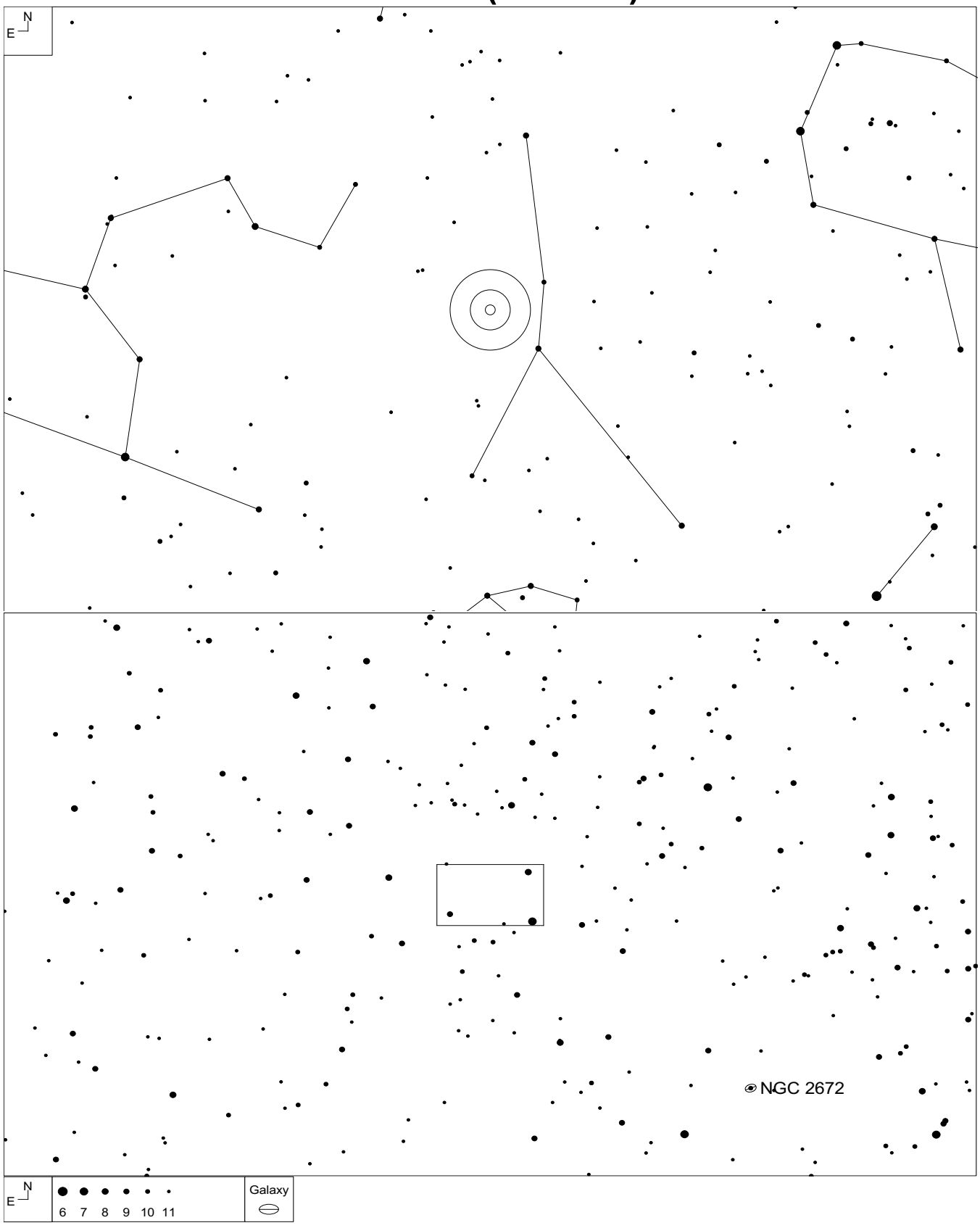
OJ 049 (Hydra)





Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	08 31 48.9	+04 29 39	11.6 - 14.8	stellar	0.021	PKS 0829+046

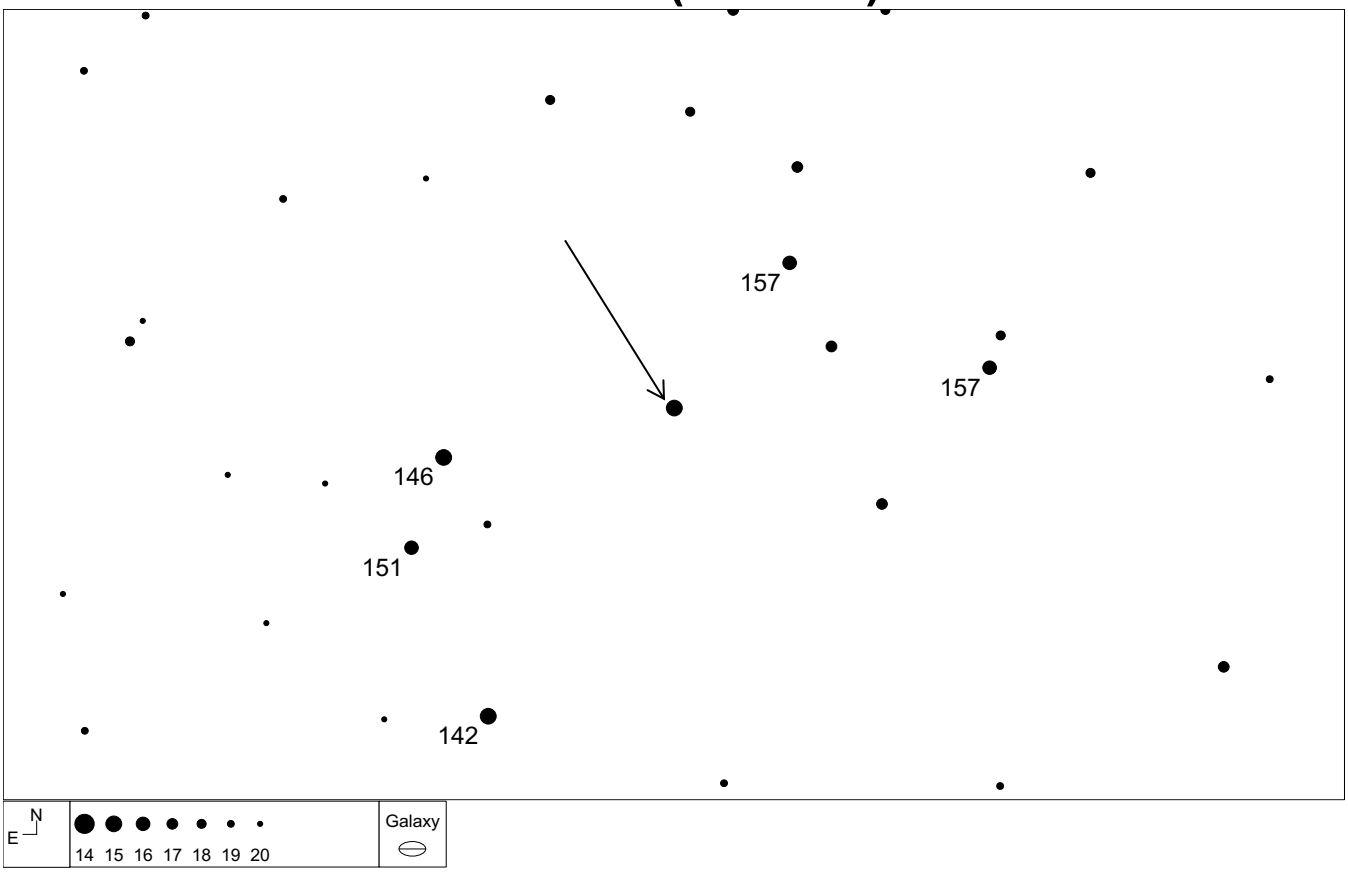
OJ 287 (Cancer)

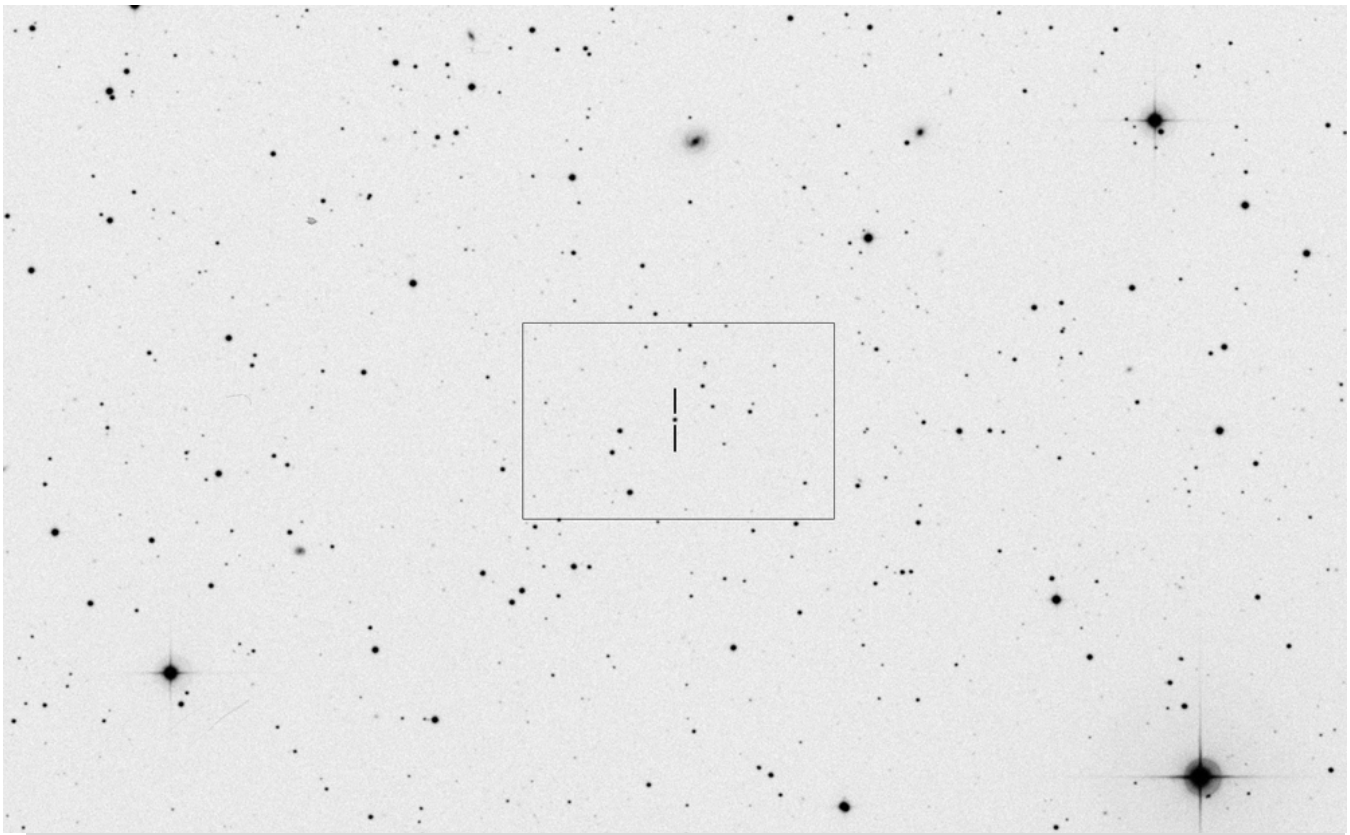


Valtonen, M.J. et al "A massive binary black-hole system in OJ 287 and a test of general relativity." *Nature*, Vol 452 (2008): 851-853

Wright, S.C. et al "Host Galaxies of the optically violently Variable Quasars PKS 0736+017, OJ 287 and LB 2136" *Monthly Notices of the Royal Astronomical Society*, Vol 295 (1998): 799-812.

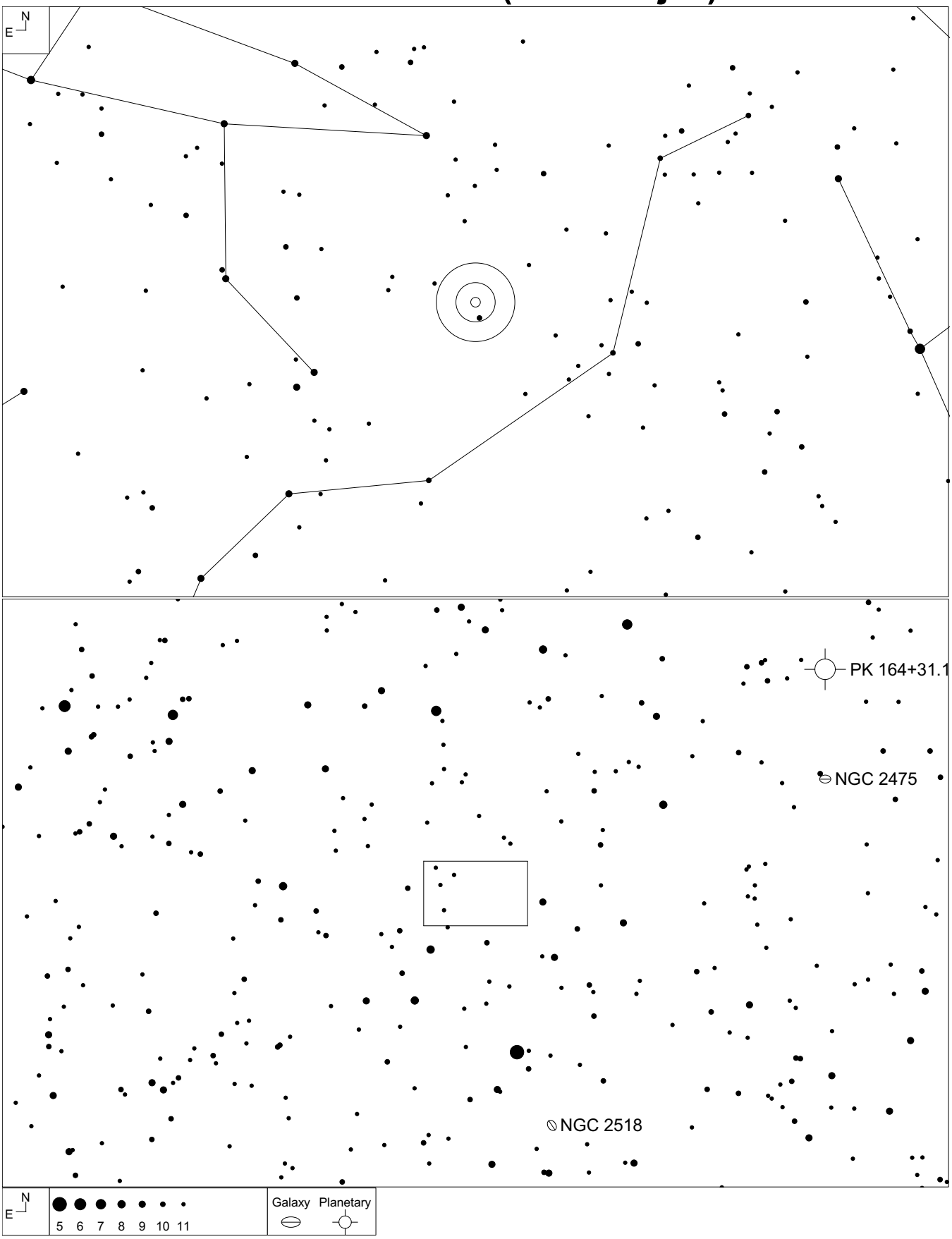
OJ 287 (Cancer)





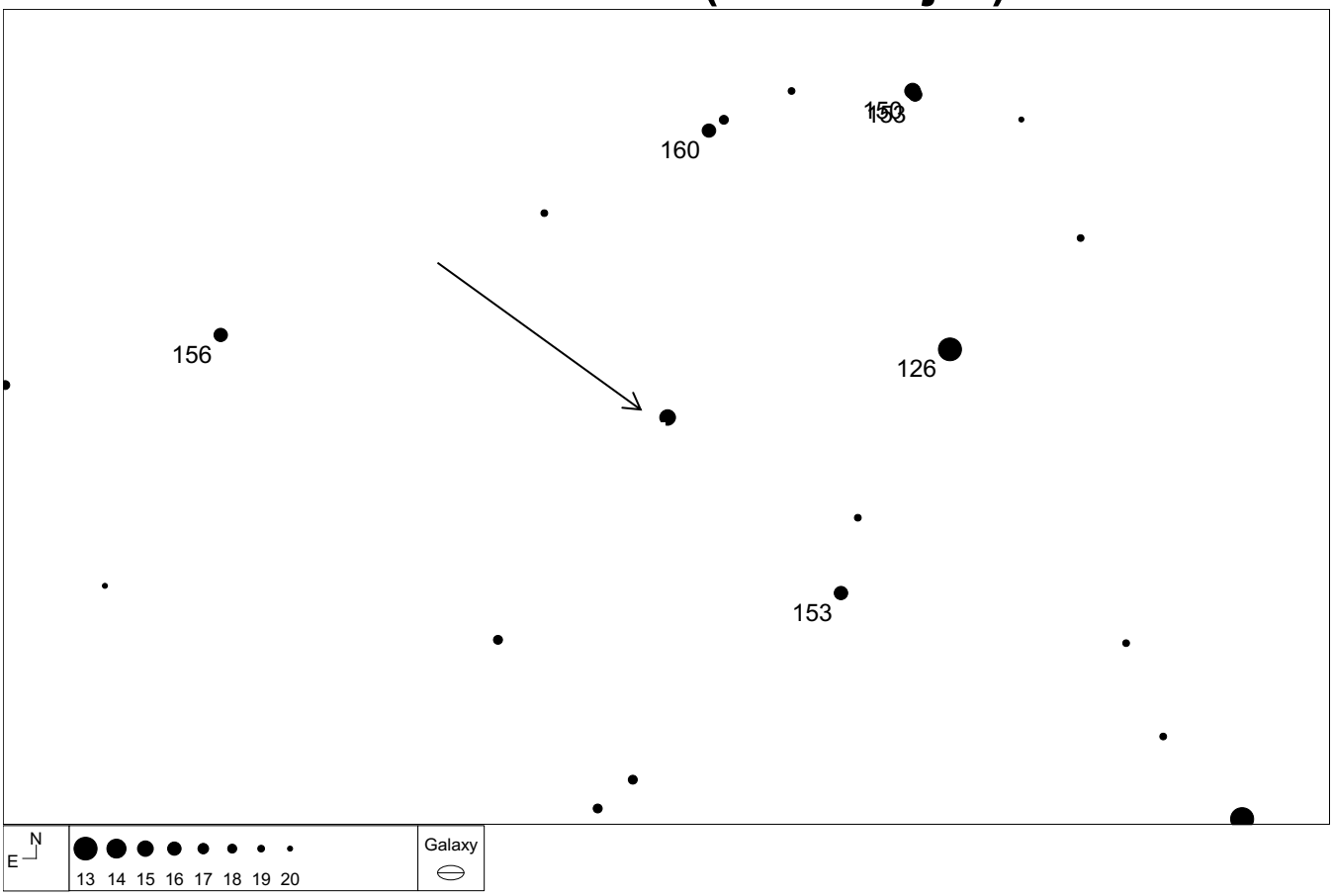
Type	RA	Dec	Mag	Size	Redshift	Other Name
OVV	08 54 48.9	+20 06 31	12.5 - 15	stellar	0.306	PKS 0851+202

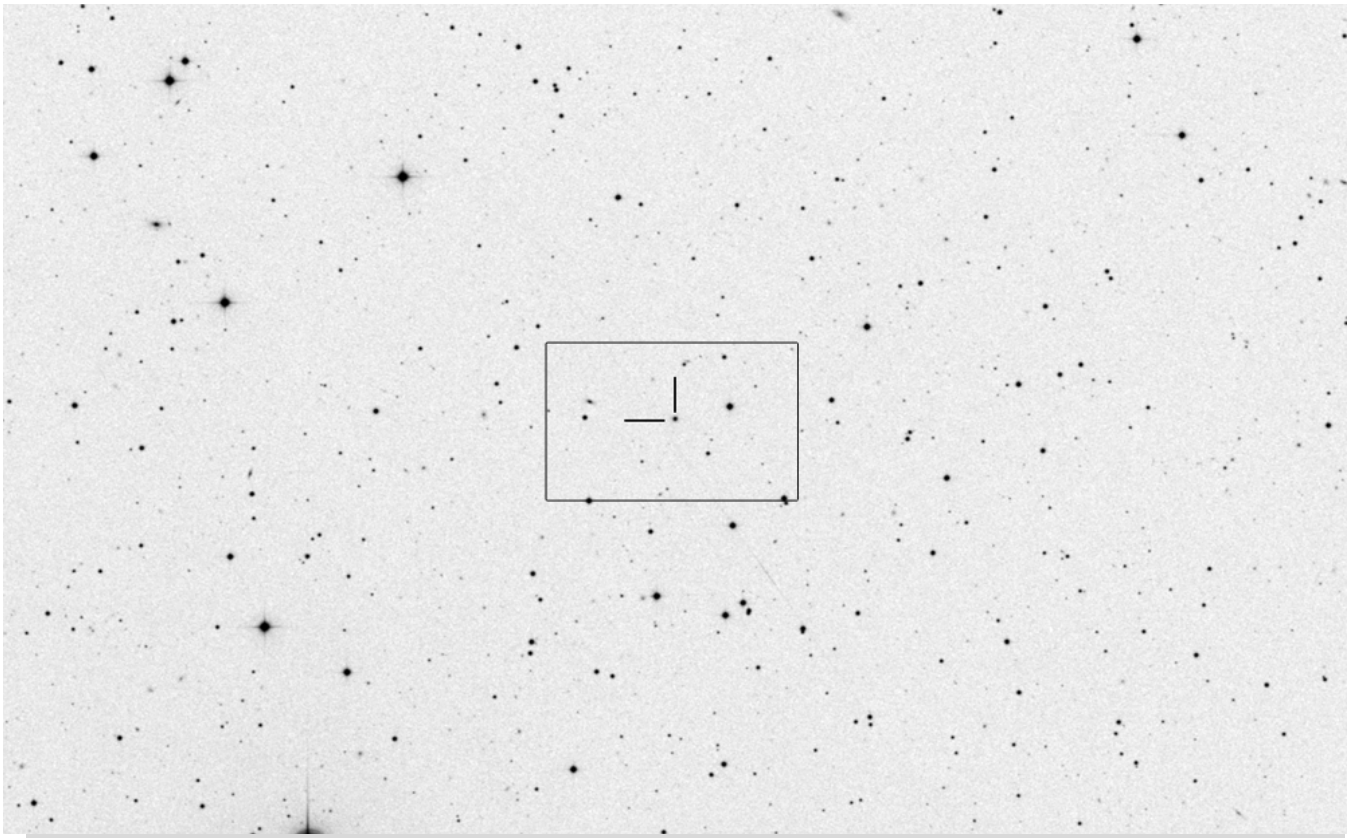
1ES 0806+524 (Ursa Major)



V. Acciari et al. "Discovery of Very High Energy Gamma-Ray Radiation from the BL Lac 1ES 0806+524." *Astrophysical Journal*, Vol 690 (2009): L126-L129

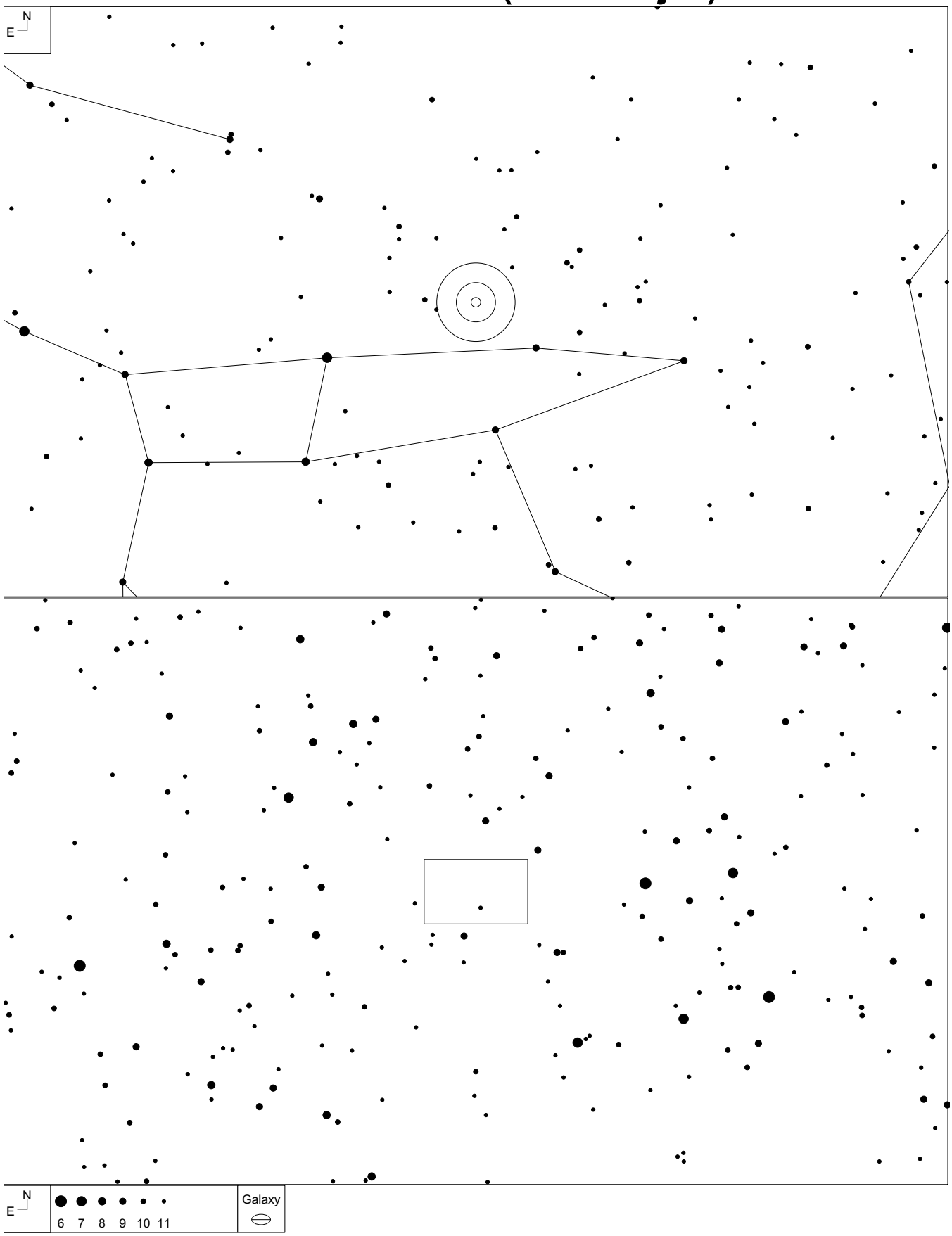
1ES 0806+524 (Ursa Major)



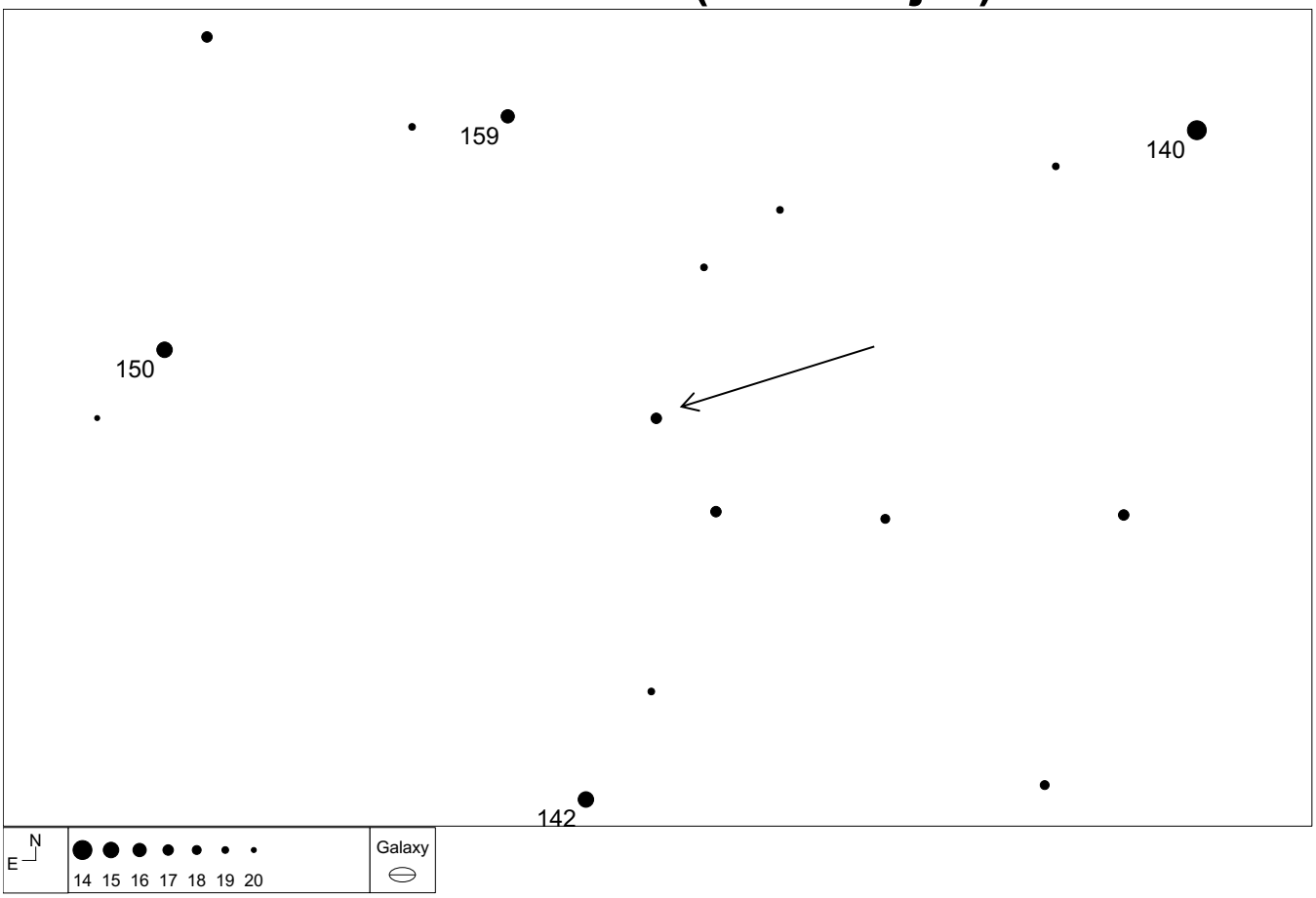


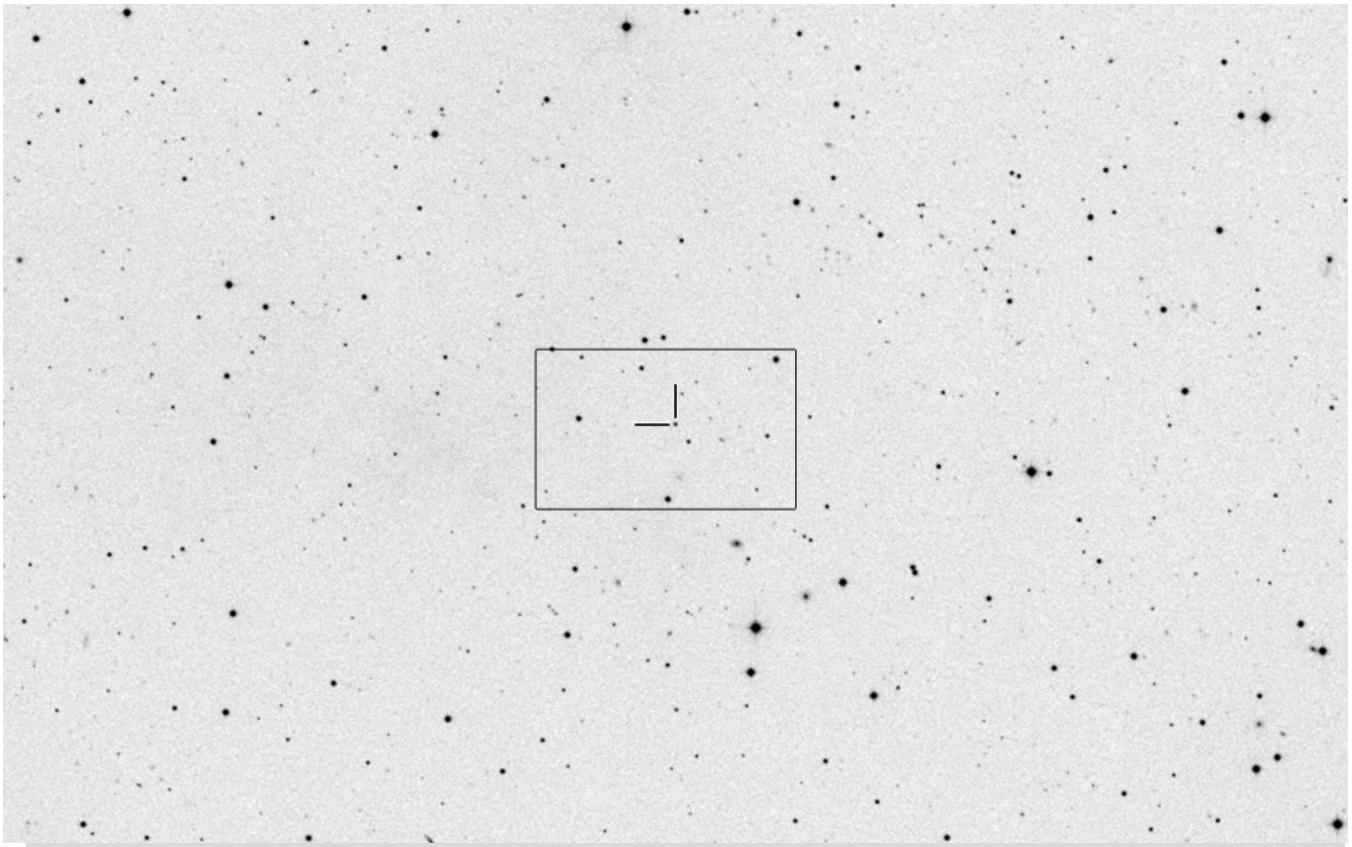
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	08 09 49.2	+52 18 58	15.2 - 15.7	stellar	0.138	

1ES 0954+658 (Ursa Major)



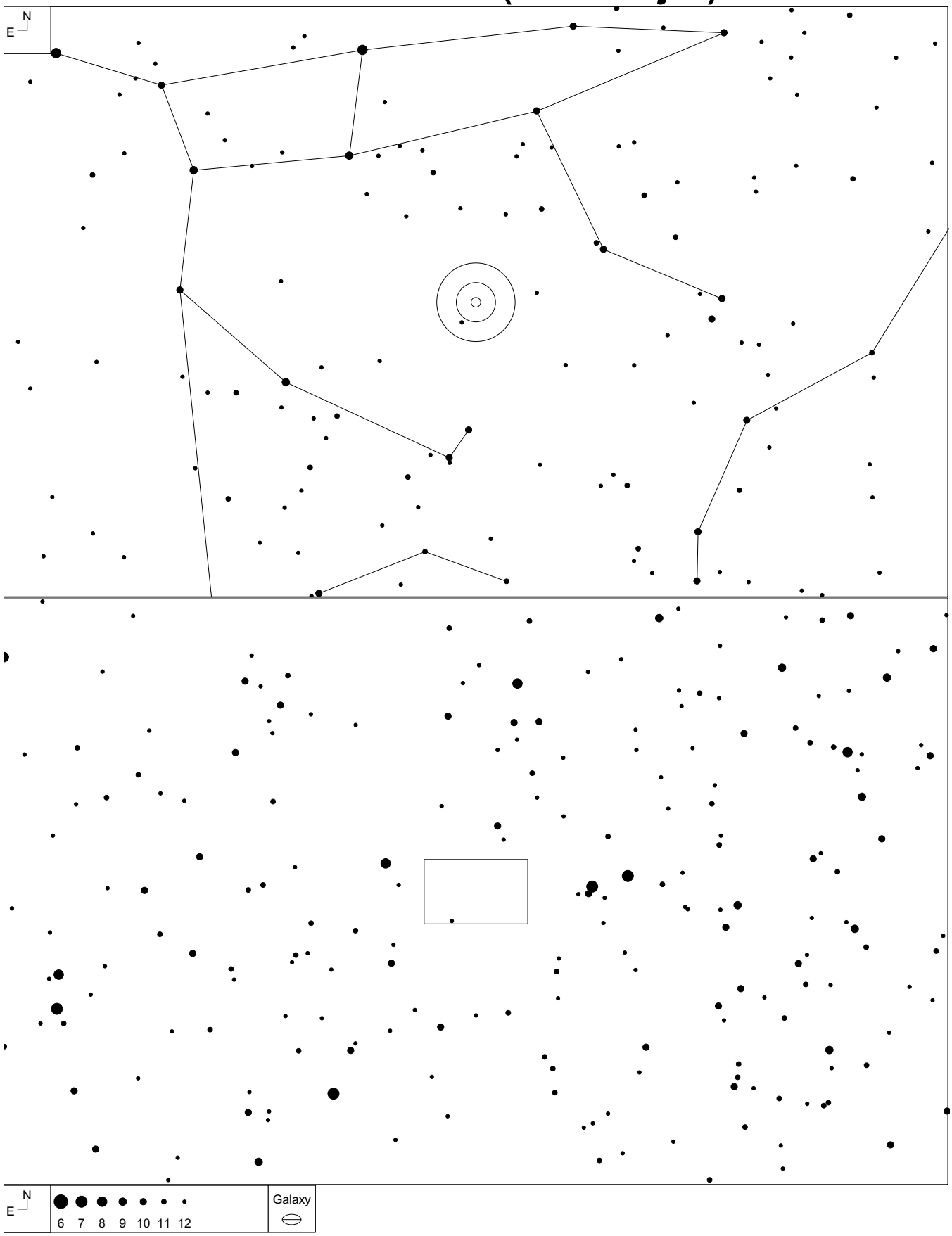
1ES 0954+658 (Ursa Major)





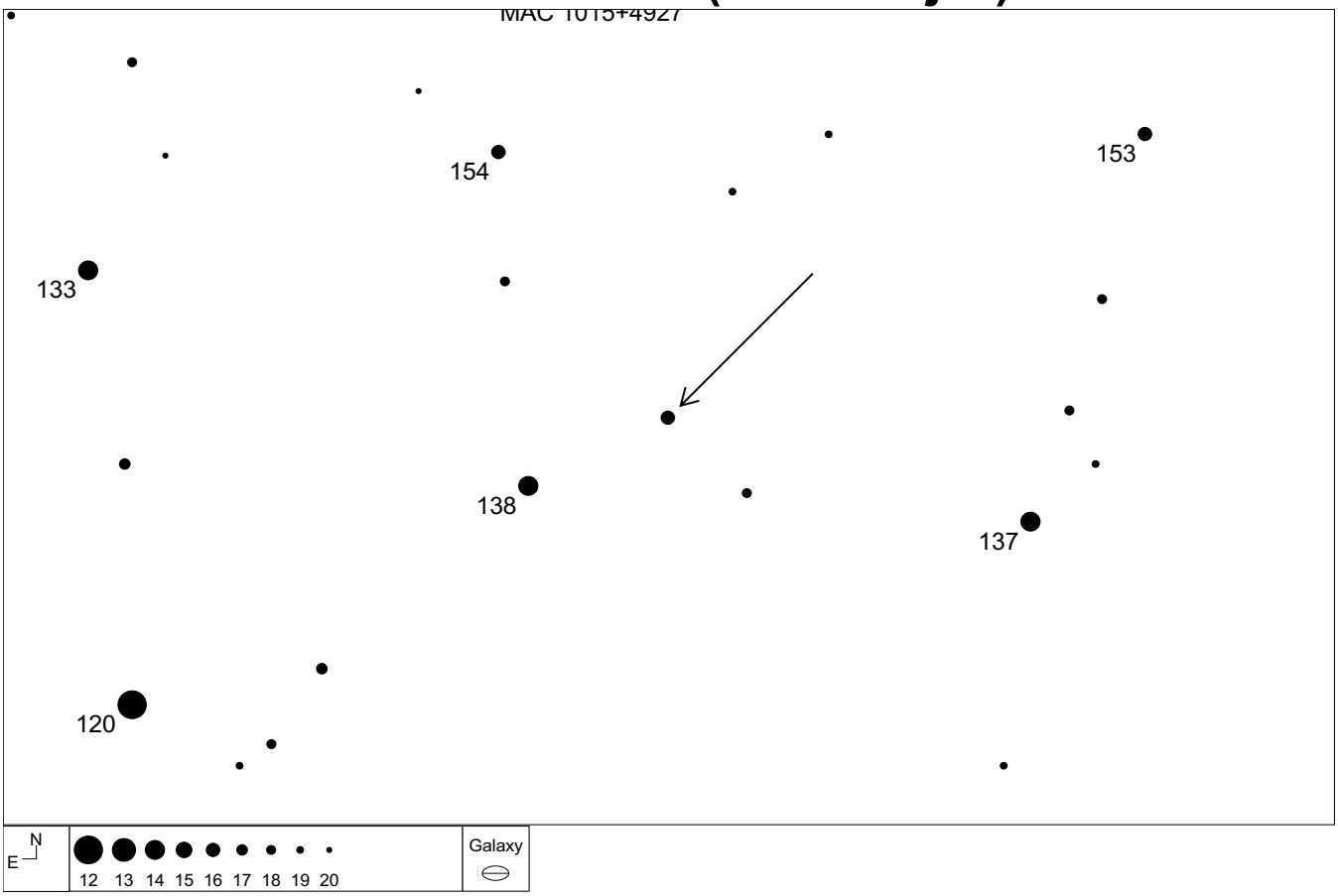
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	09 58 47.2	+65 33 55	15.8 - 16.7	stellar	0.368	

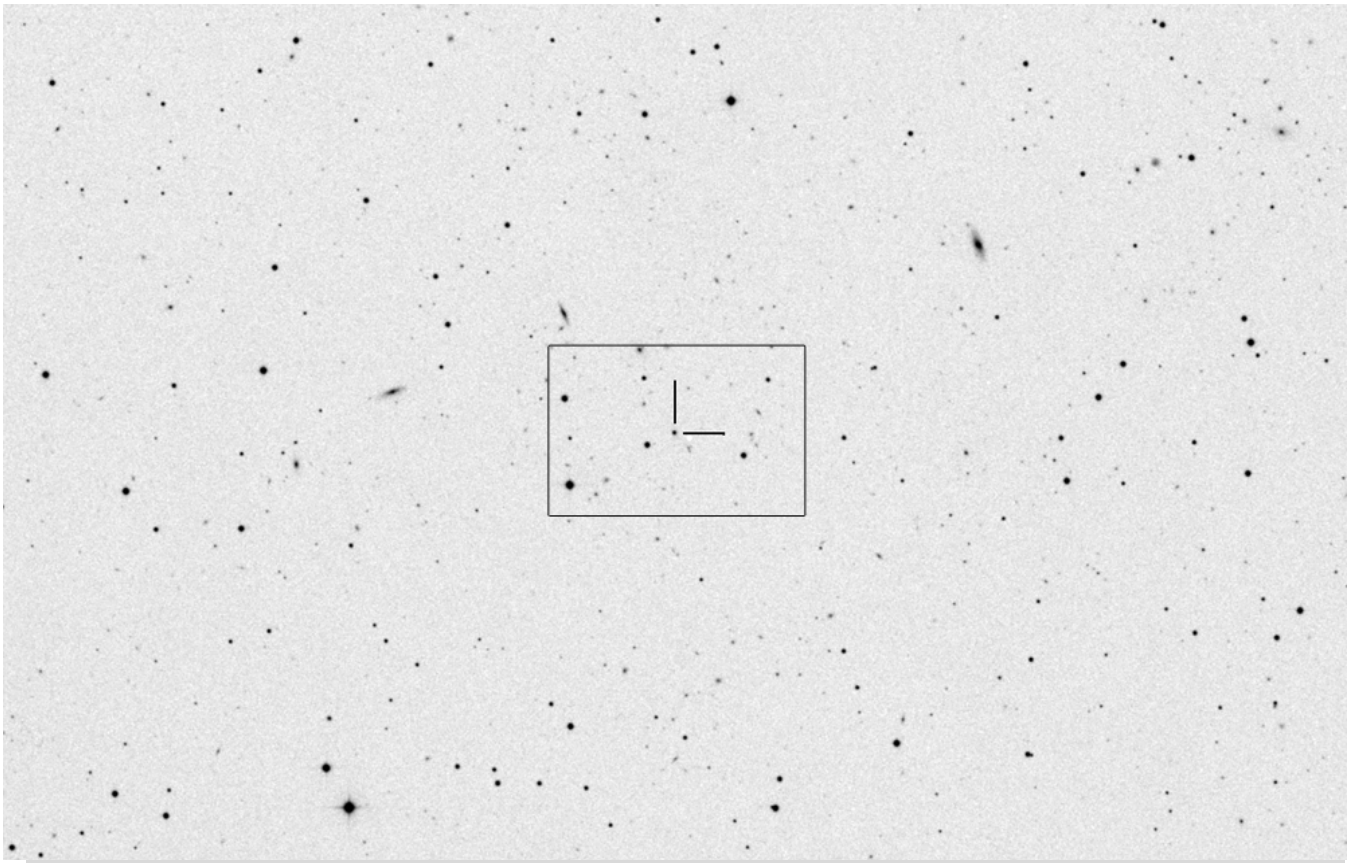
1ES 1011+496 (Ursa Major)



Albert, J. et al "Discovery of Very High Energy γ-Rays from 1ES 1011+496 at z = 0.212" *Astrophysical Journal*, Vol 667 (2007): L21-L24

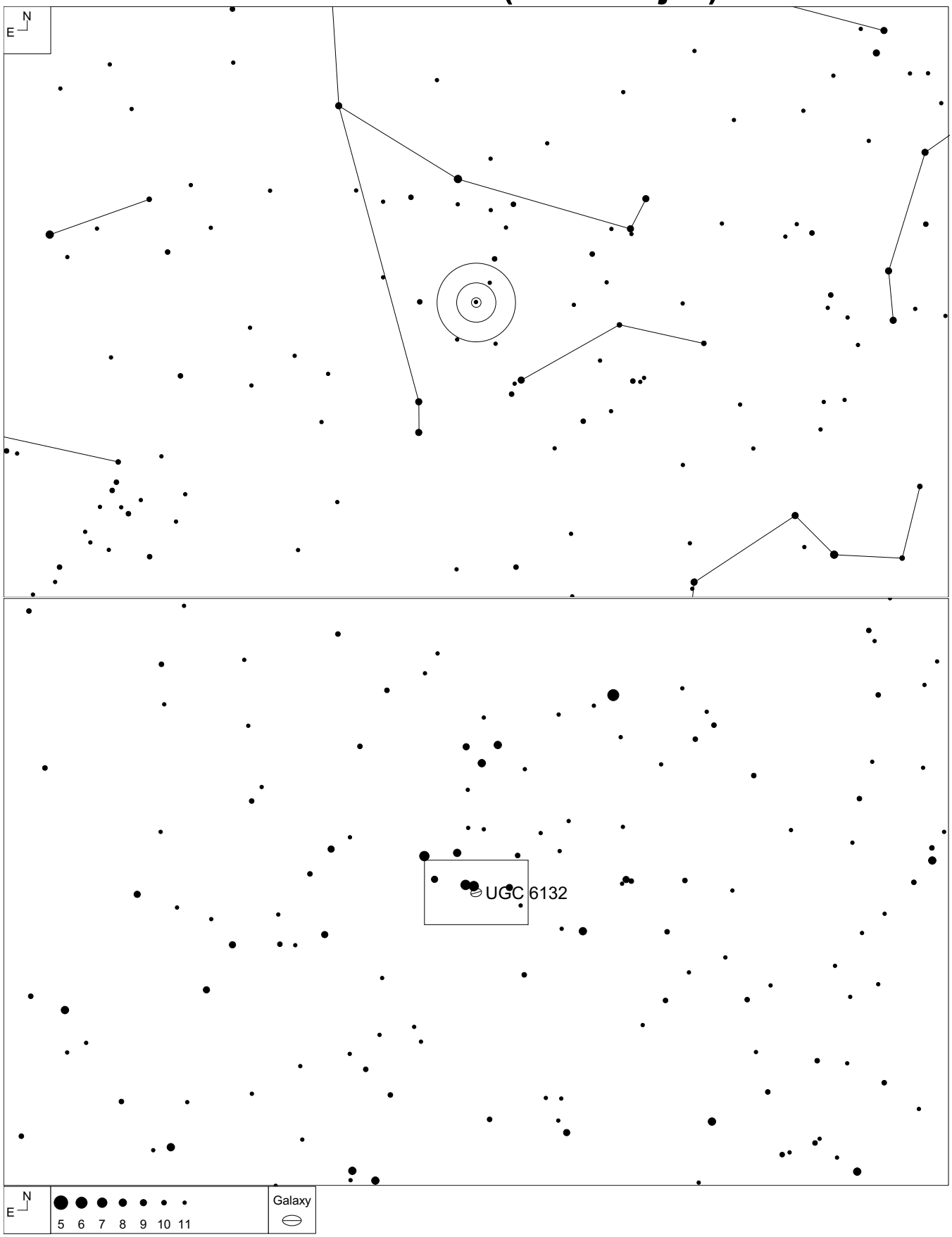
1ES 1011+496 (Ursa Major)





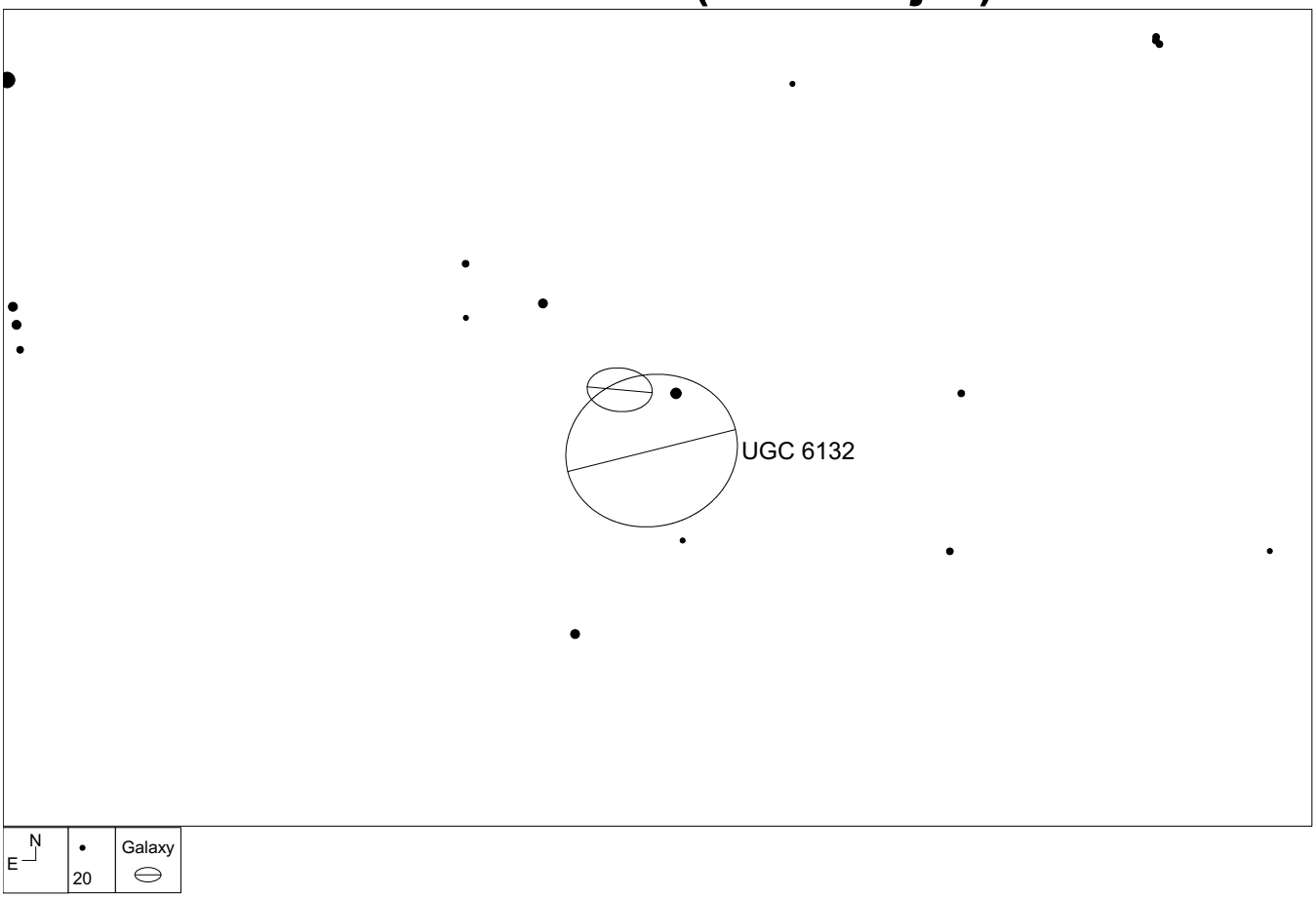
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	10 15 04.1	+49 26 01	14.3 - 15.4	stellar	0.200	

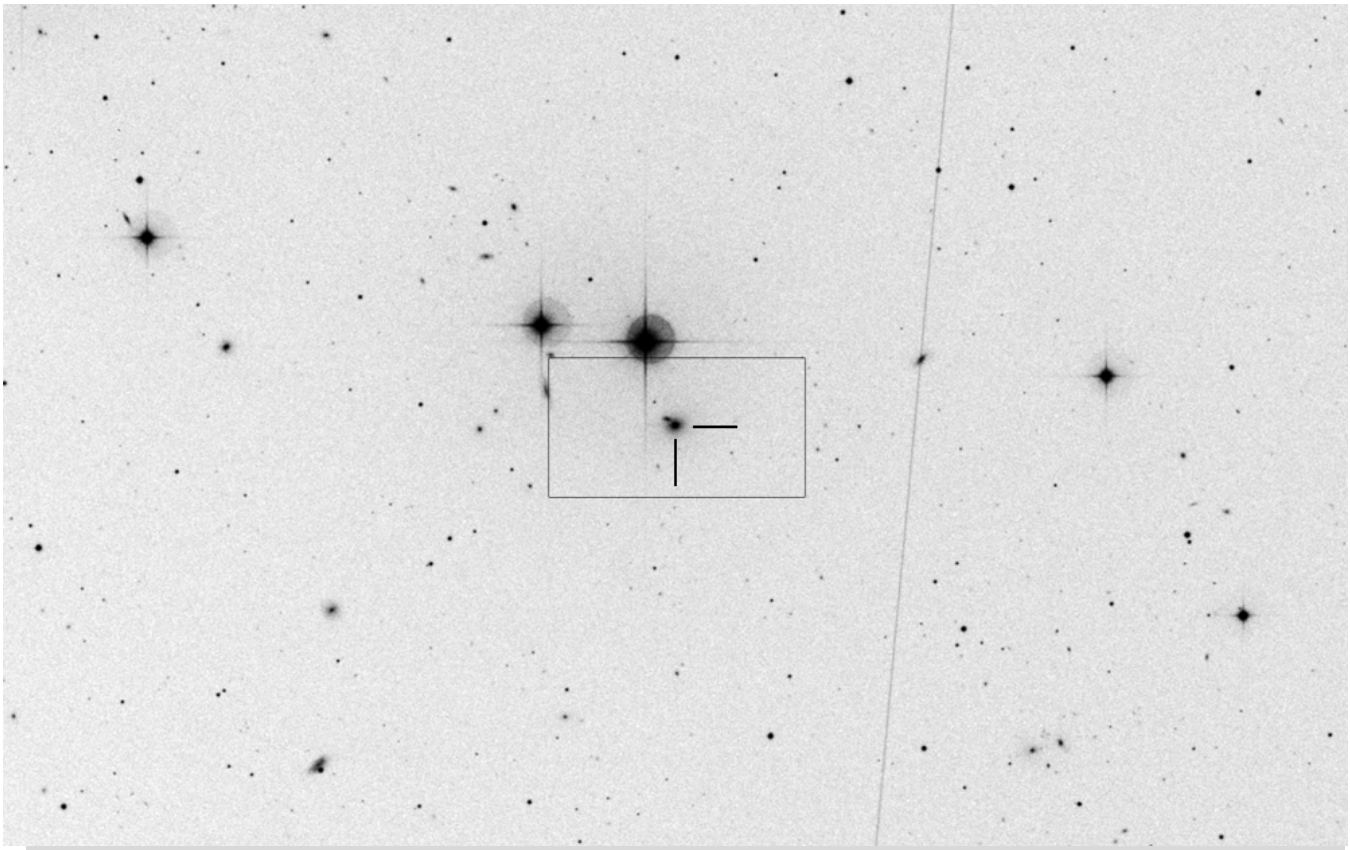
Markarian 421 (Ursa Major)



http://www.theskyscrapers.org/markarian-421-the-brightest-blazar

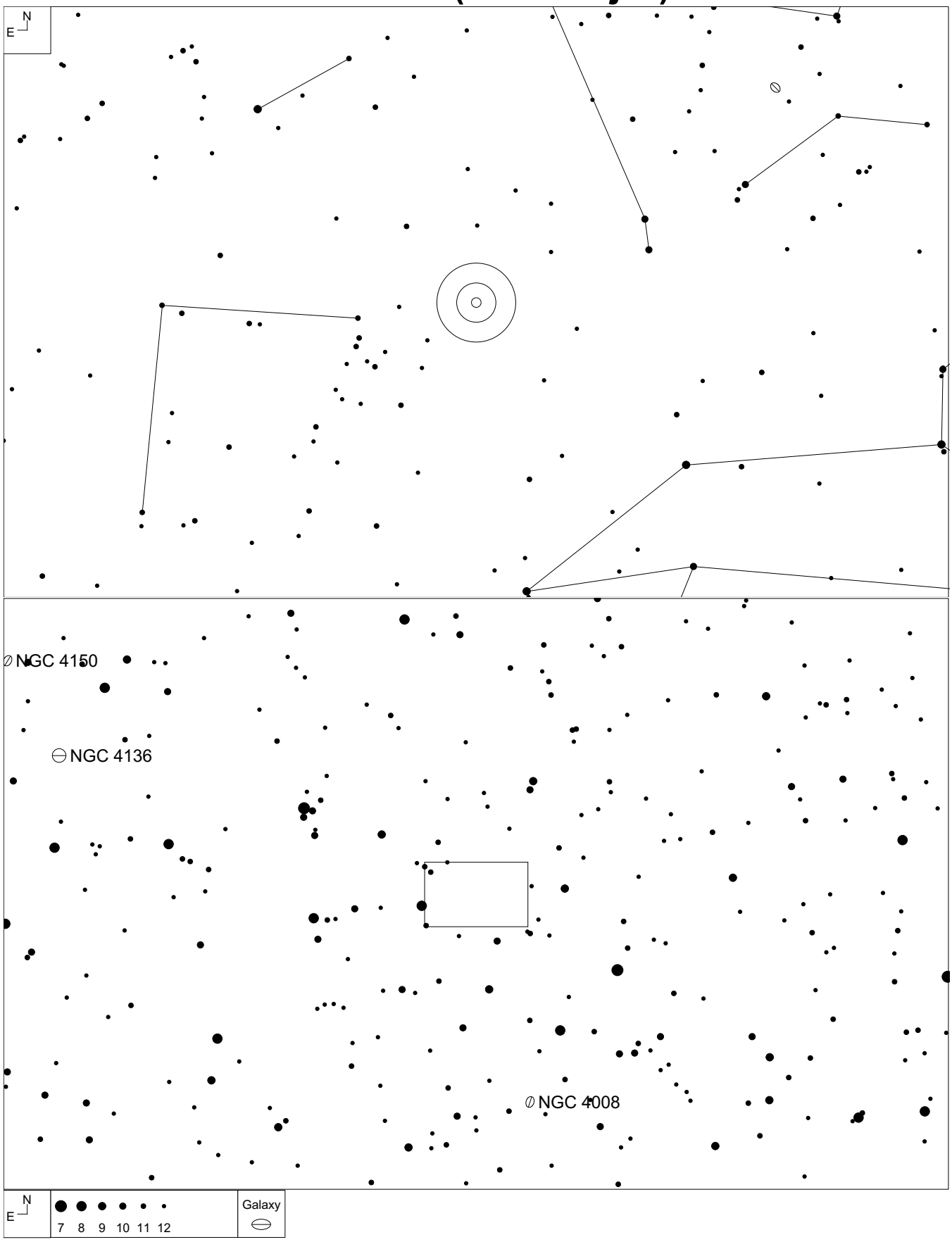
Markarian 421 (Ursa Major)





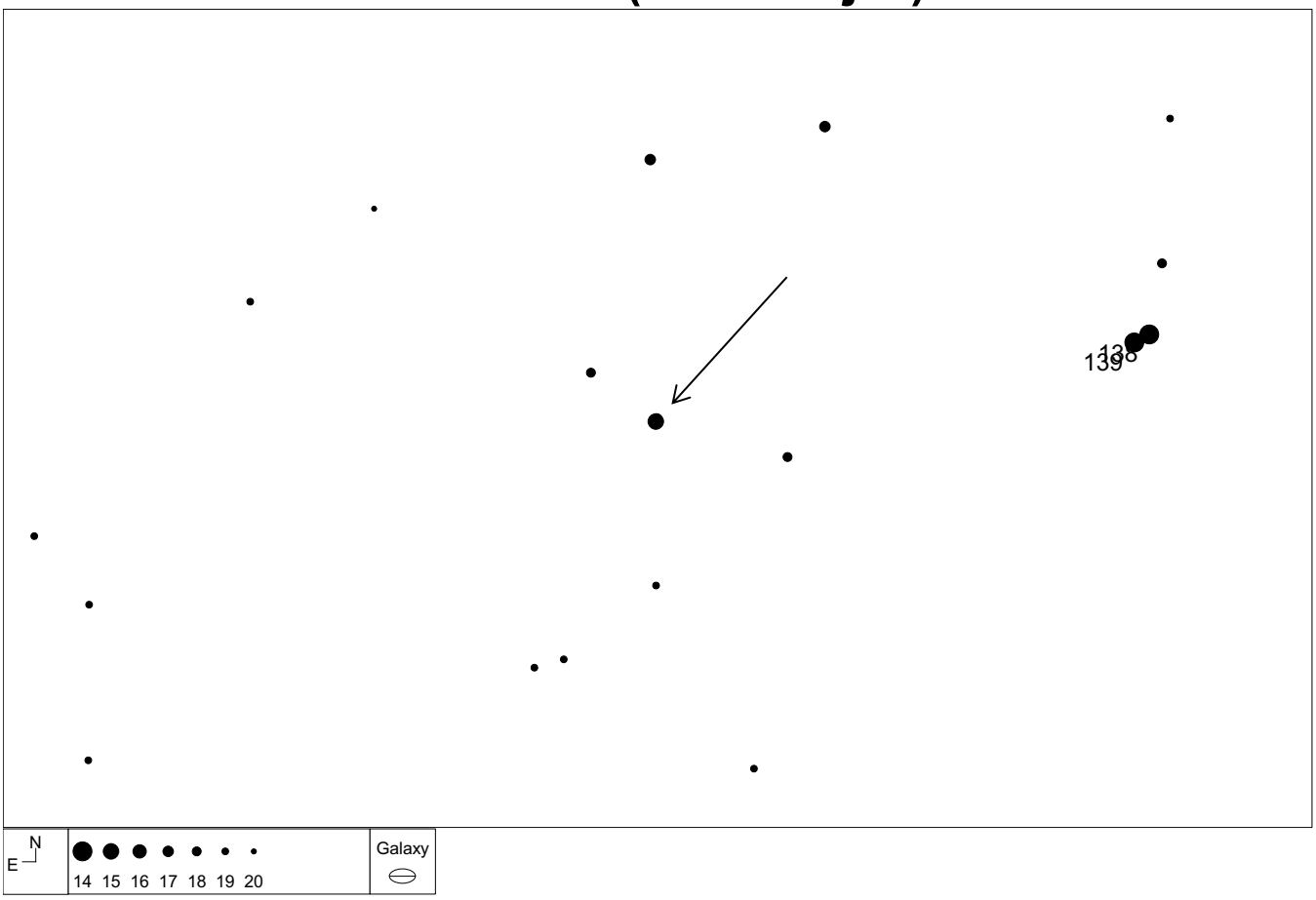
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	11 04 27.3	+38 12 32	12.0 - 14.4	0.8 x 0.6'	0.03002	UGC 6132

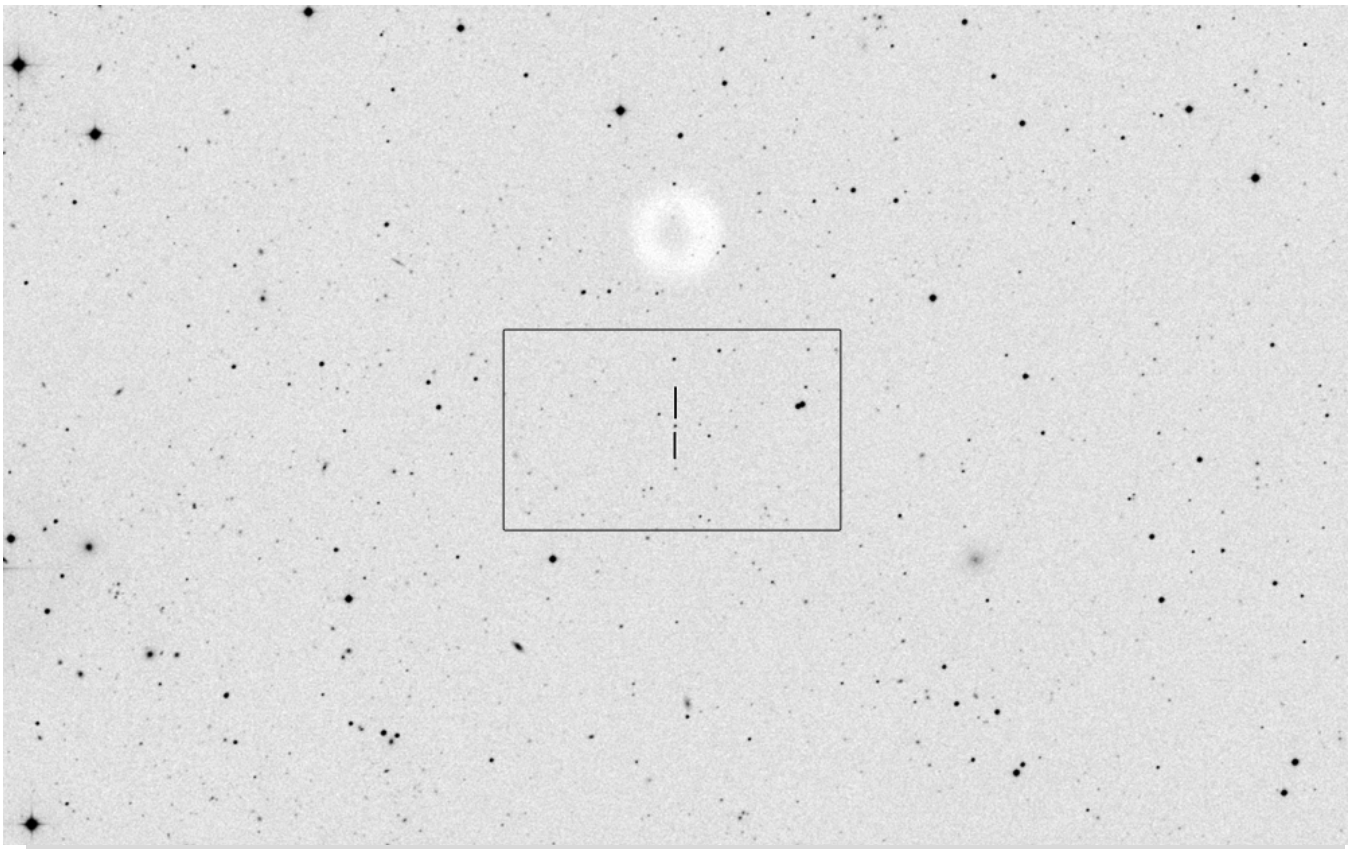
4C 29.45 (Ursa Major)



Fan, J.H. et al. "Optical Photometrical Observations and Variability for Quasar 4C 29.45." *Publications of the Astronomical Society of Japan*, Vol 5813 (2006): 797-808

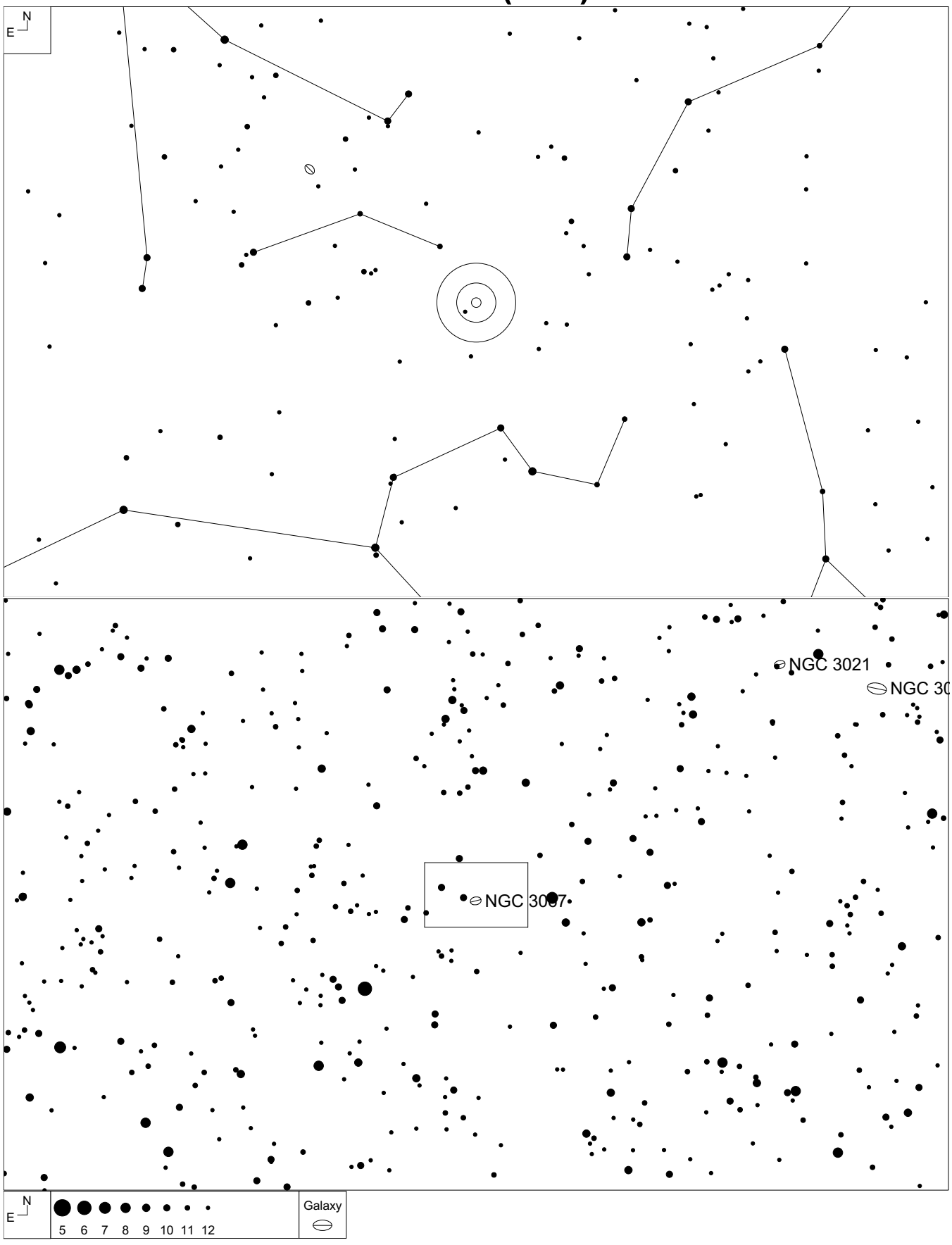
4C 29.45 (Ursa Major)



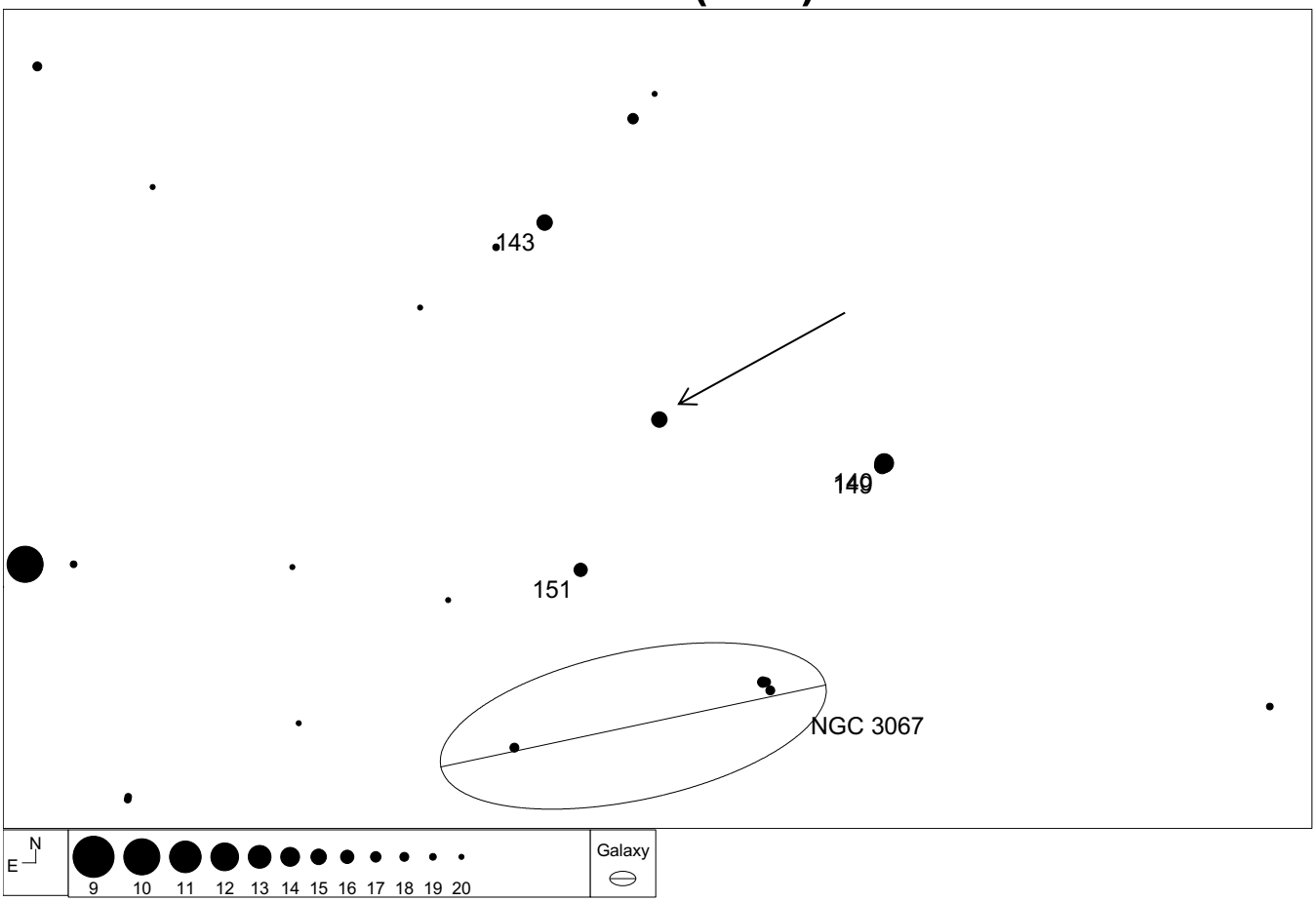


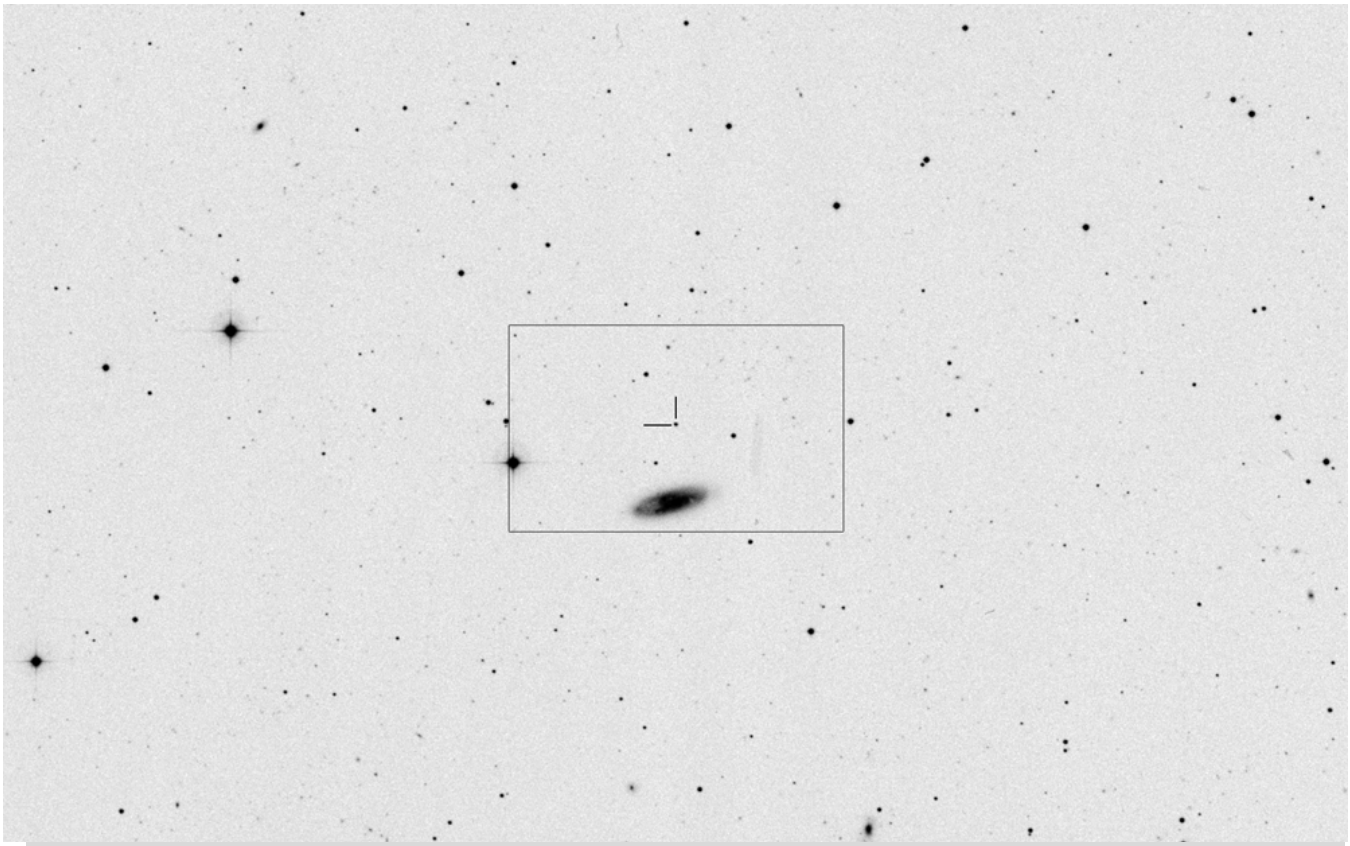
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	11 59 31.8	+29 14 44	13.0 - 18.1	stellar	0.729	

3C 232 (Leo)



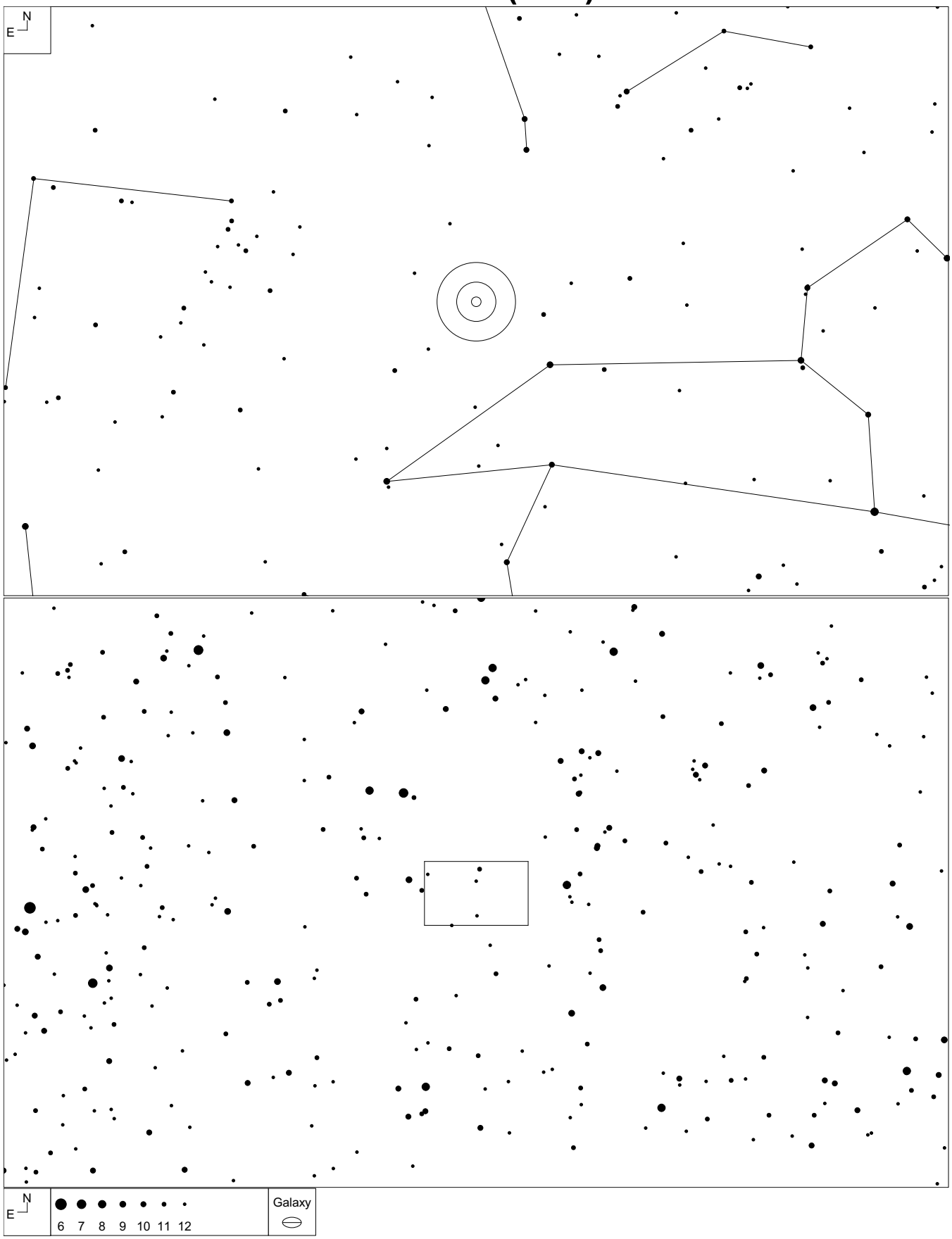
3C 232 (Leo)



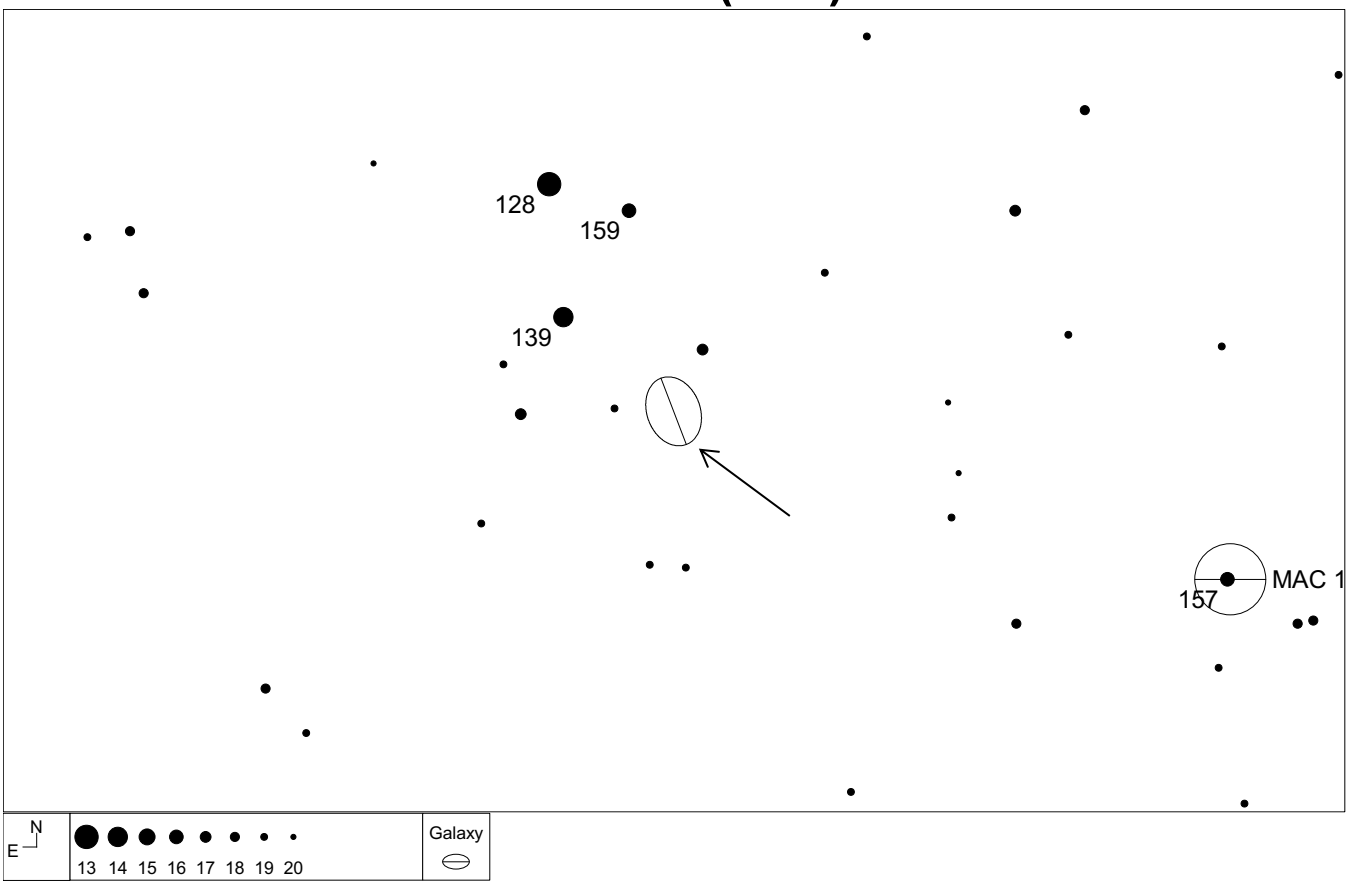


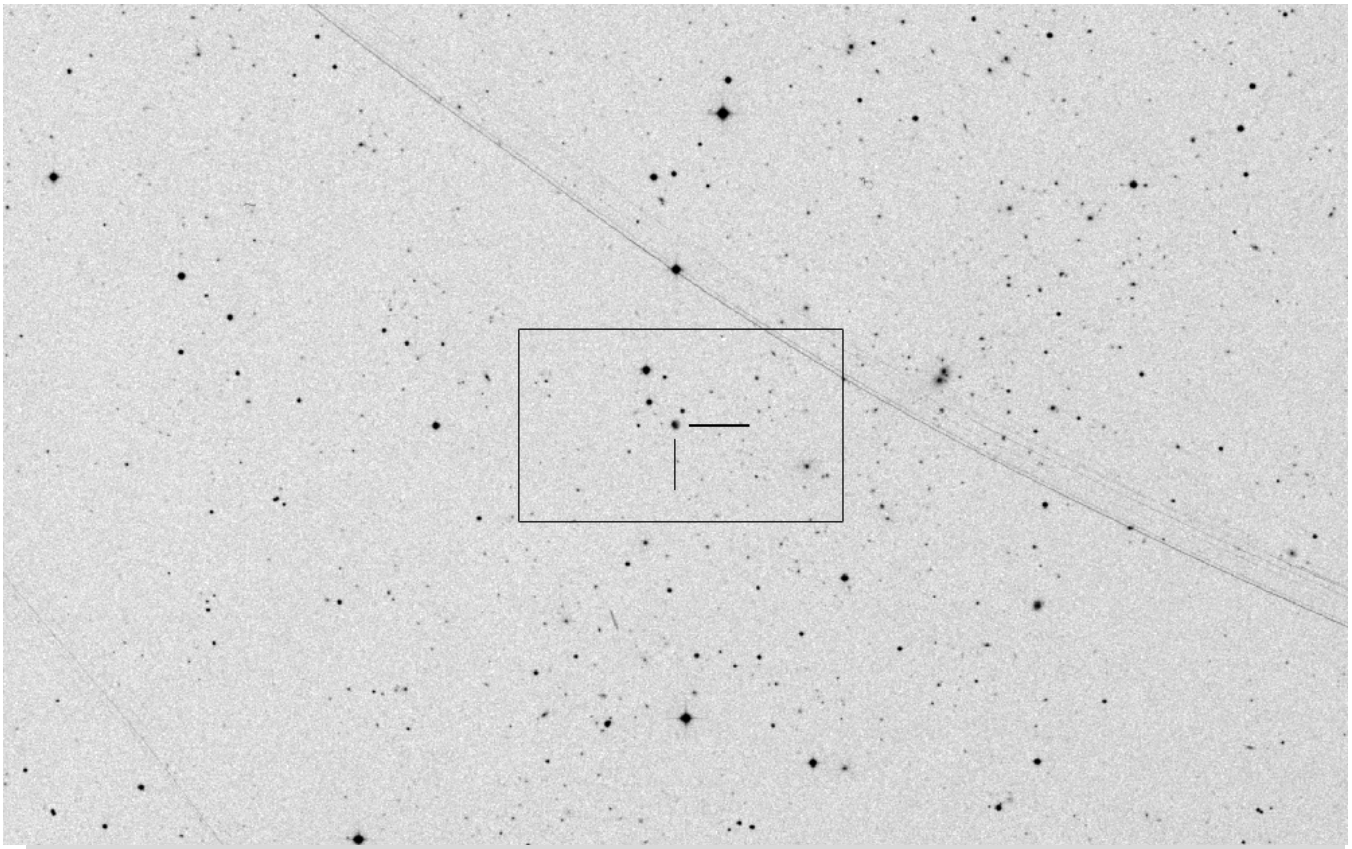
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	09 58 21.0	+32 24 02	15.3 - 16.2	stellar	0.53	

AU Leo (Leo)



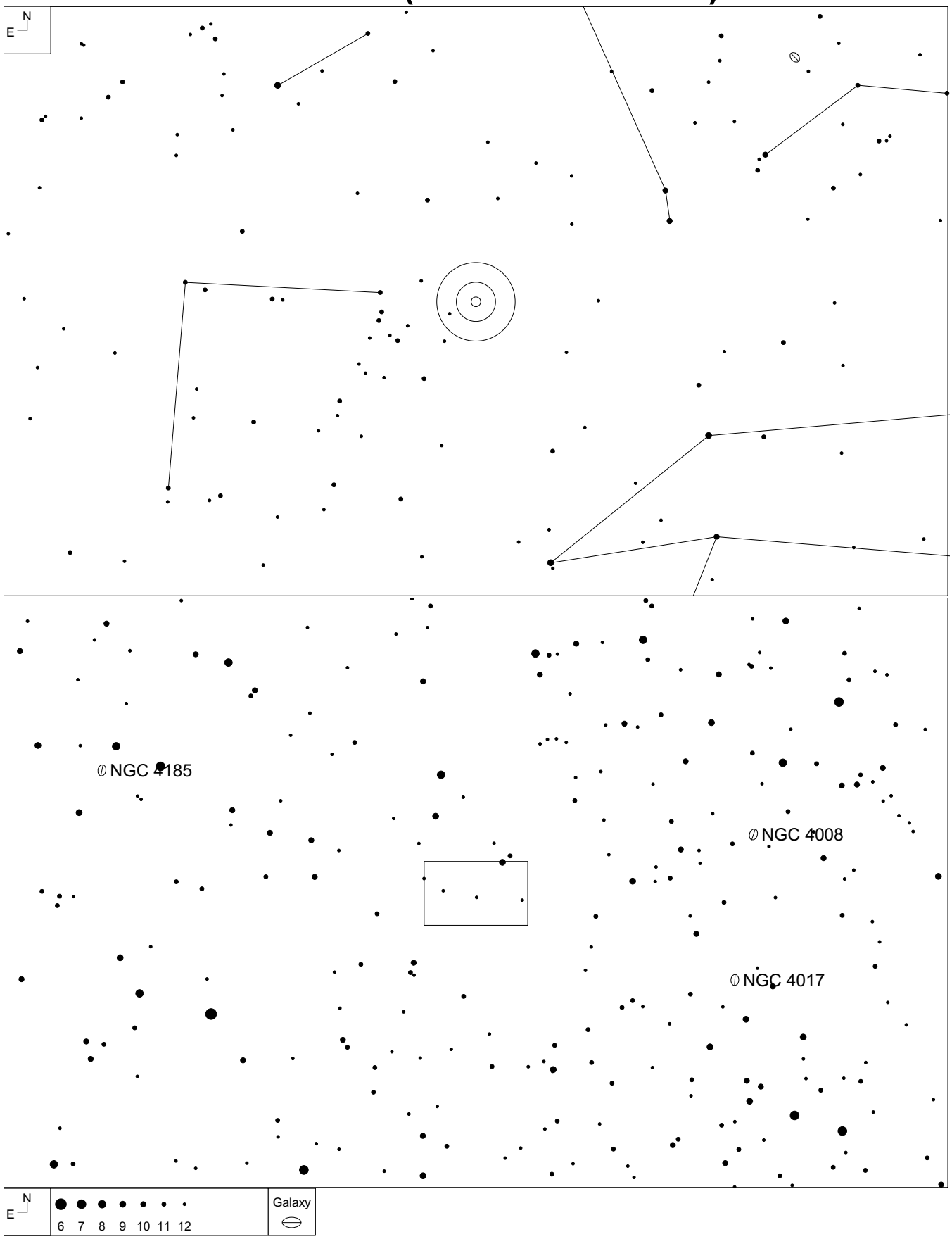
AU Leo (Leo)





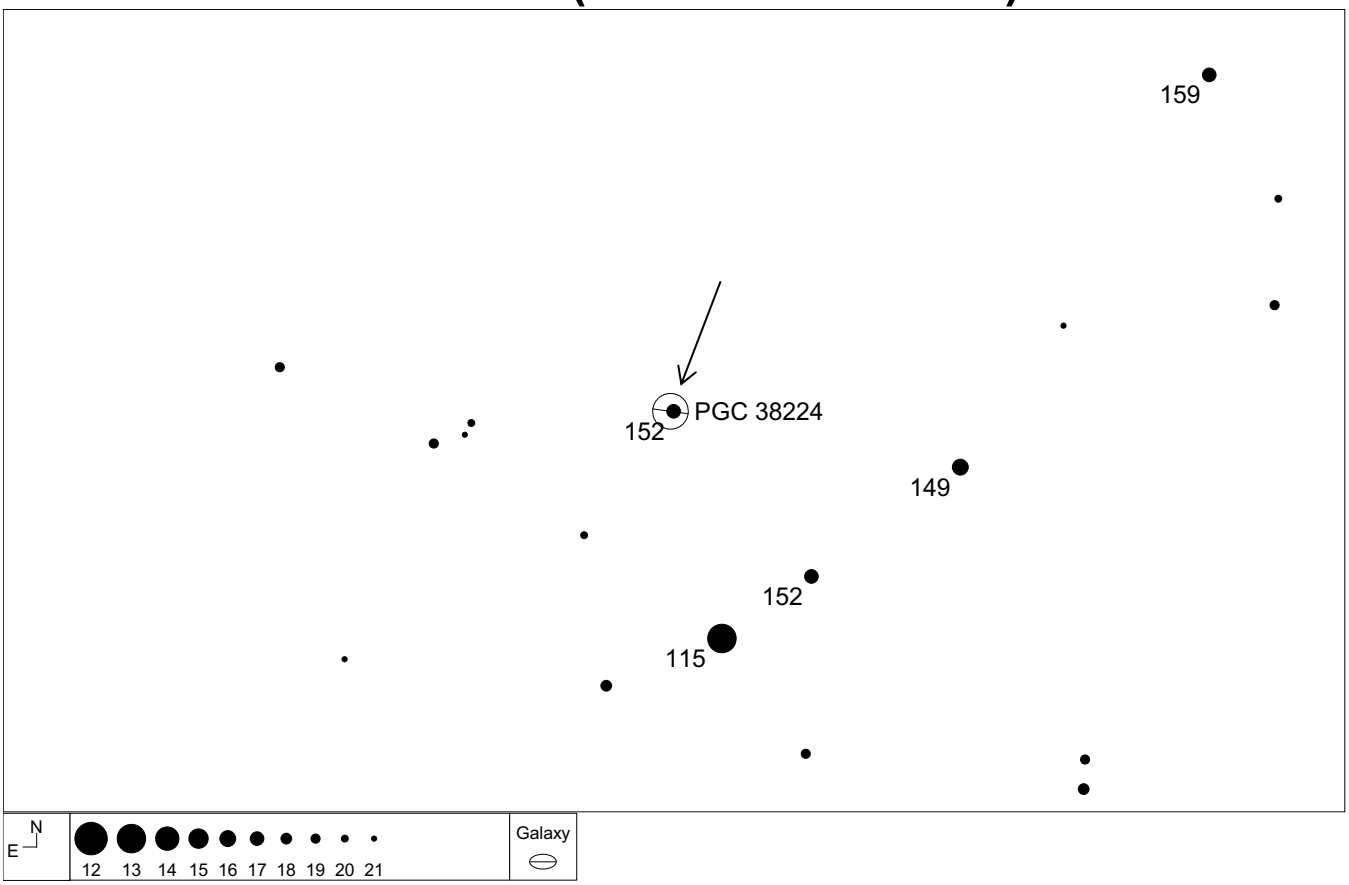
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	11 30 14.3	+23 48 09	17.0	20”	0.025	A 1127+24

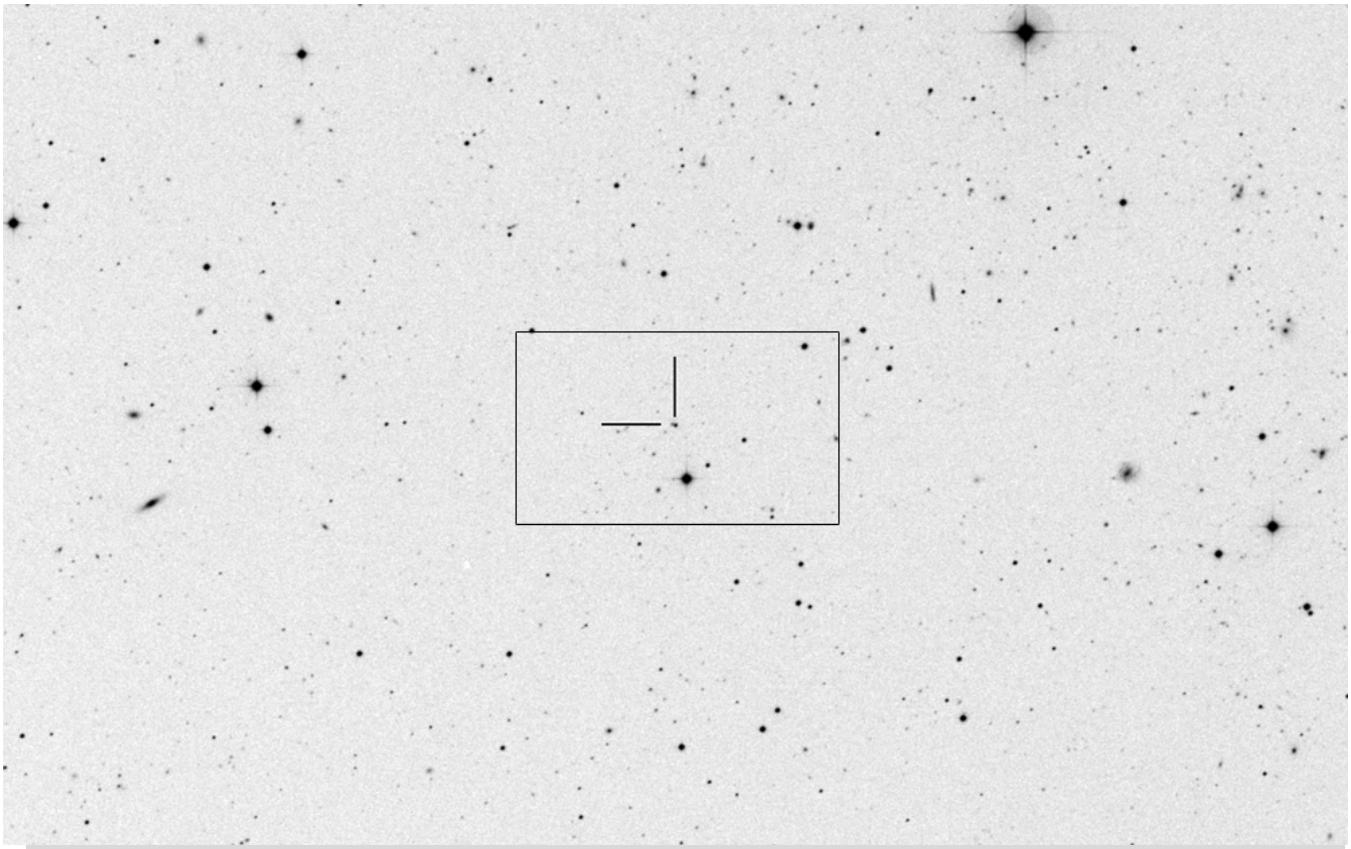
GQ Com (Coma Berenices)



Bond, H.E., et al "GQ Comae and V396 Herculis - Two Low-Redshift, Optically Variable QSOs" *Astrophysical Journal*, Vol 213 (1977):1-7

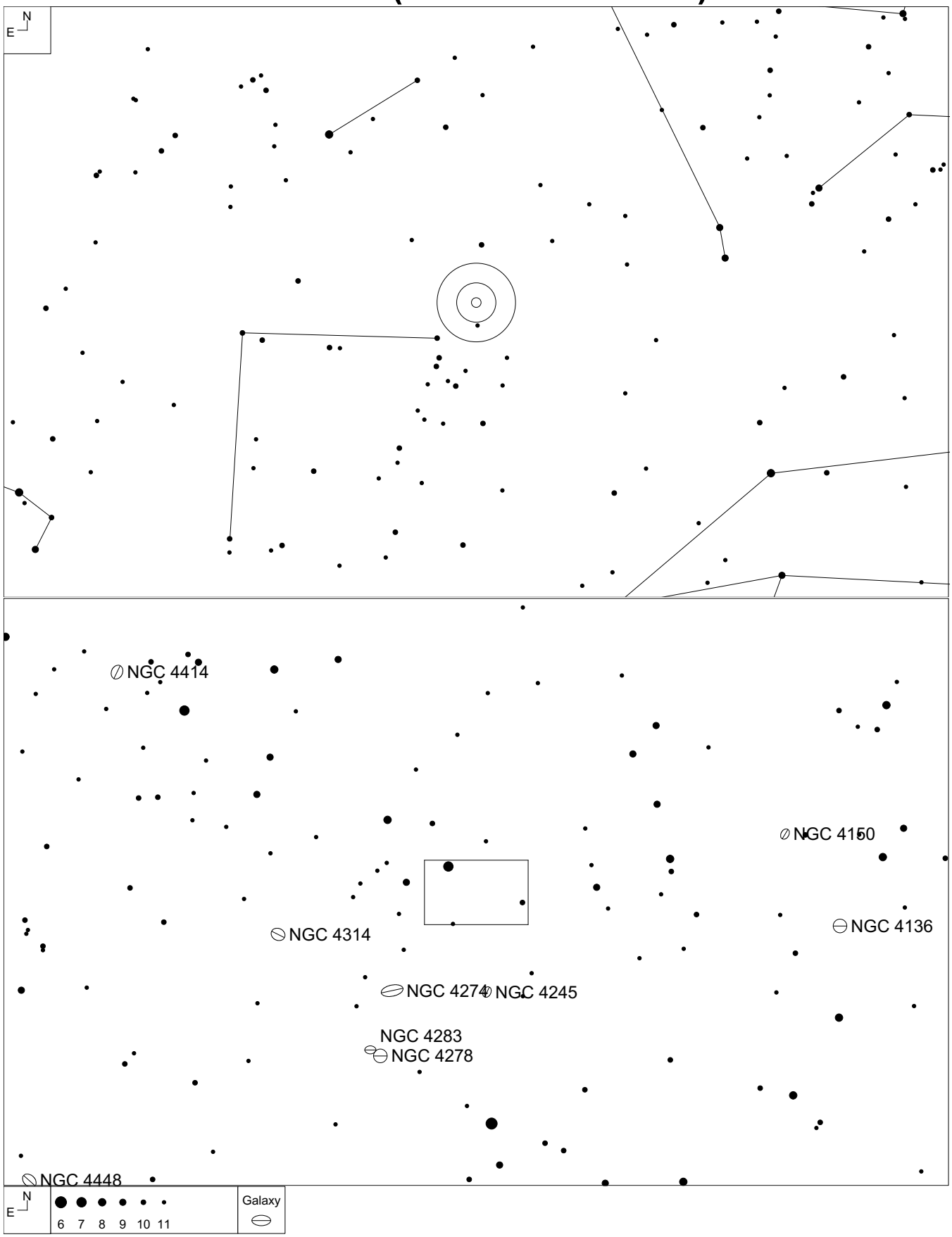
GQ Com (Coma Berenices)





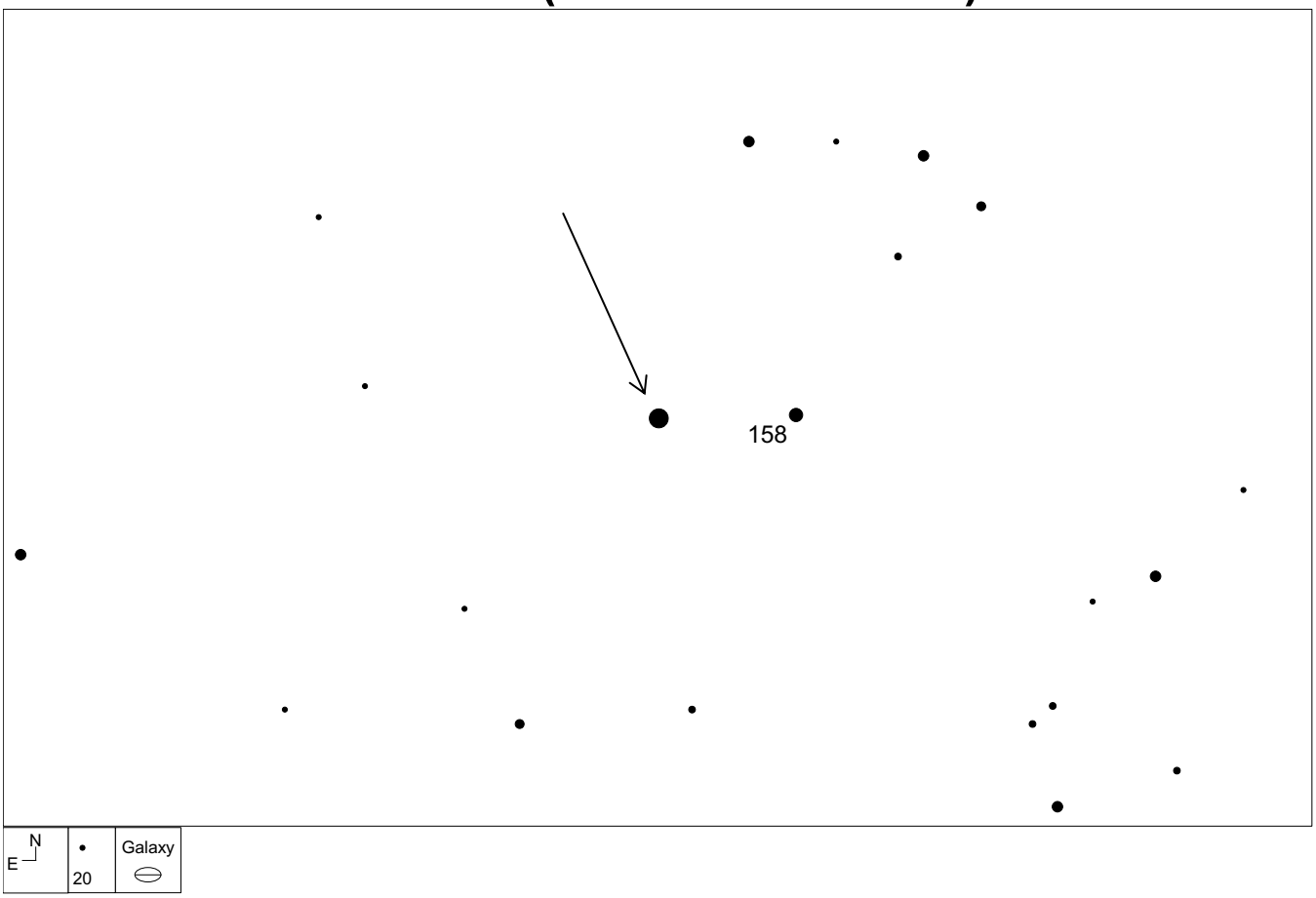
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	12 04 42.1	+27 54 12	14.7 – 16.1	18”	0.165	PG 1202+281

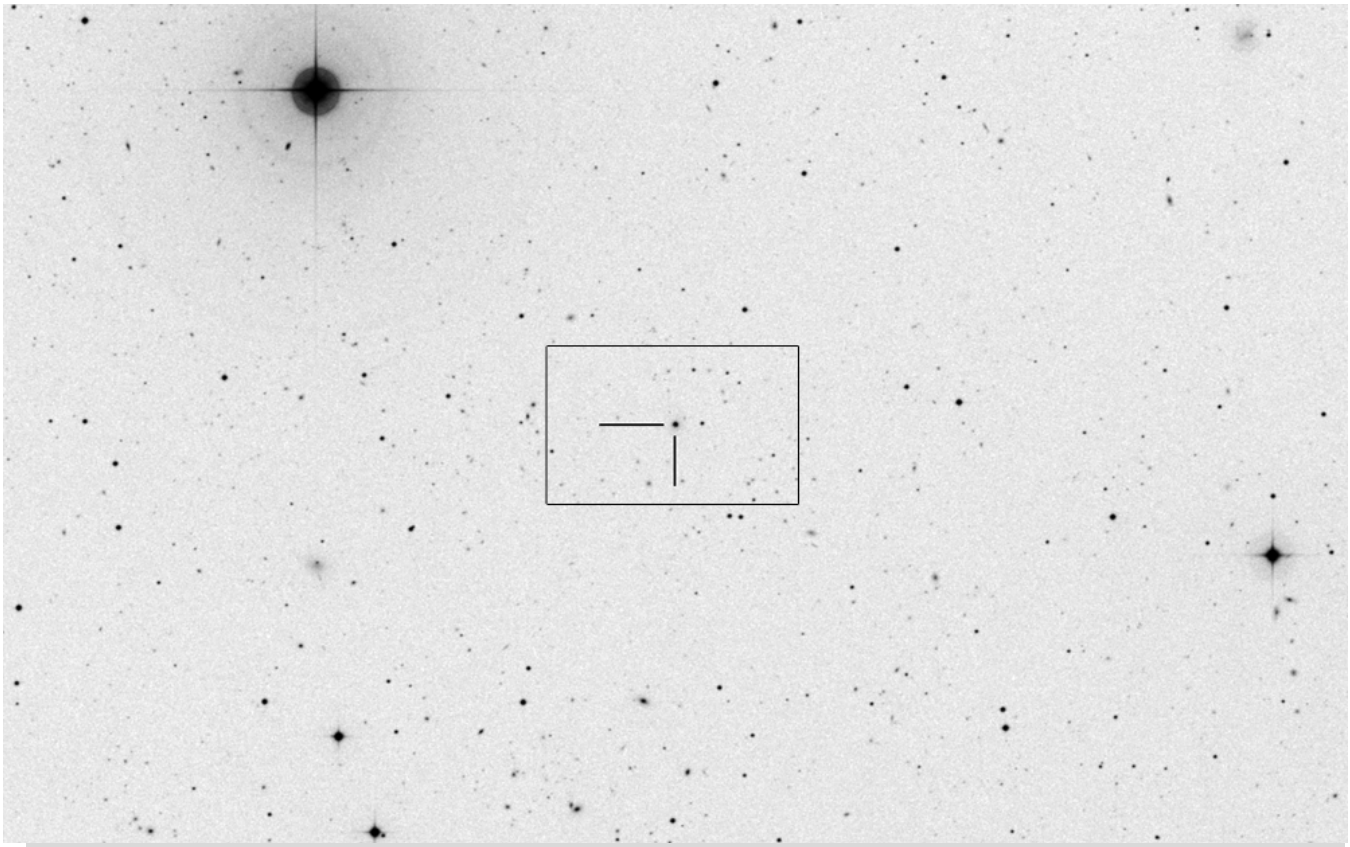
ON 325 (Coma Berenices)



Worrall, D.M. et al "Multifrequency observations of the BL Lacertae objects OQ 530 and ON 325" *Astrophysical Journal*, Vol 284 (1984): 512-518

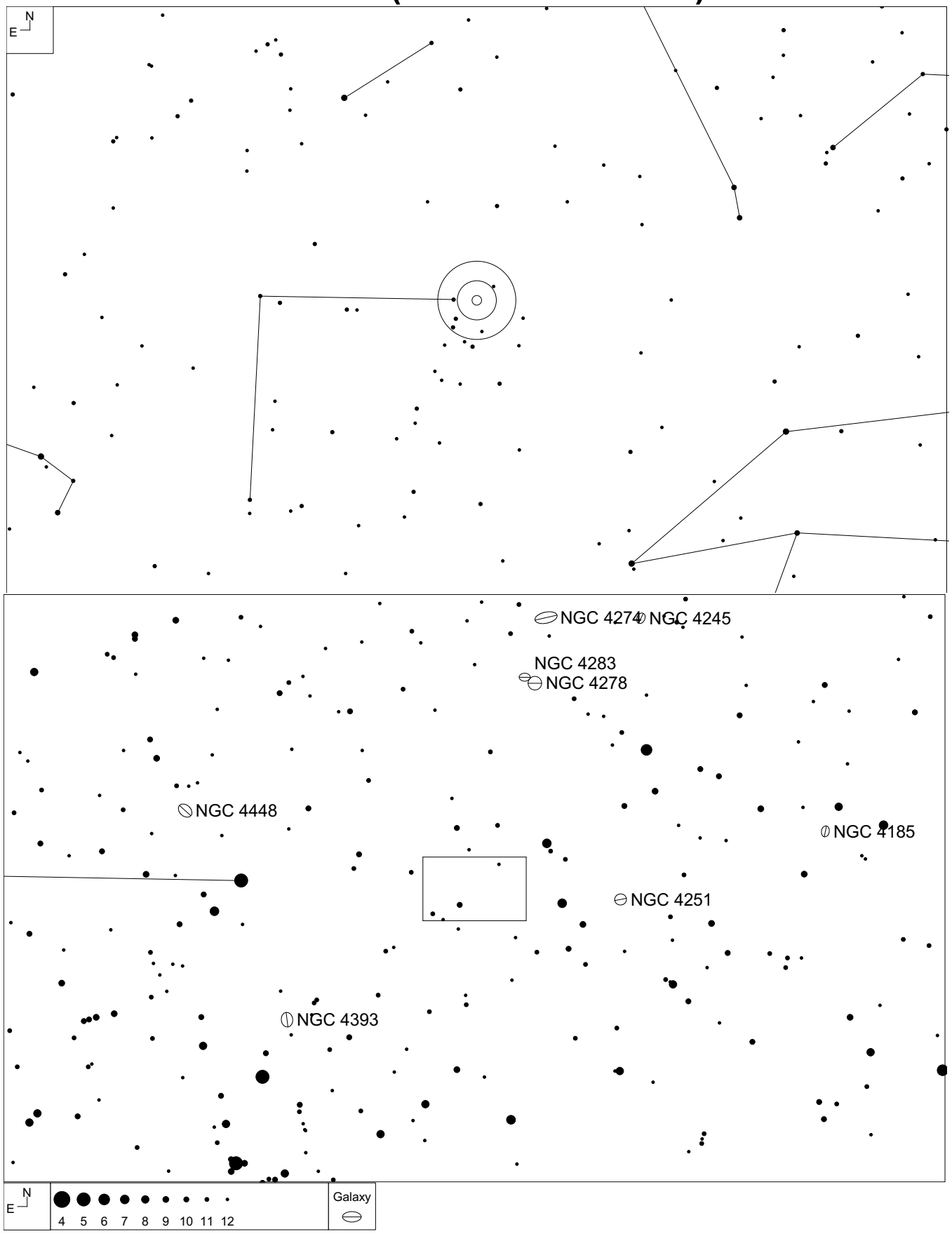
ON 325 (Coma Berenices)





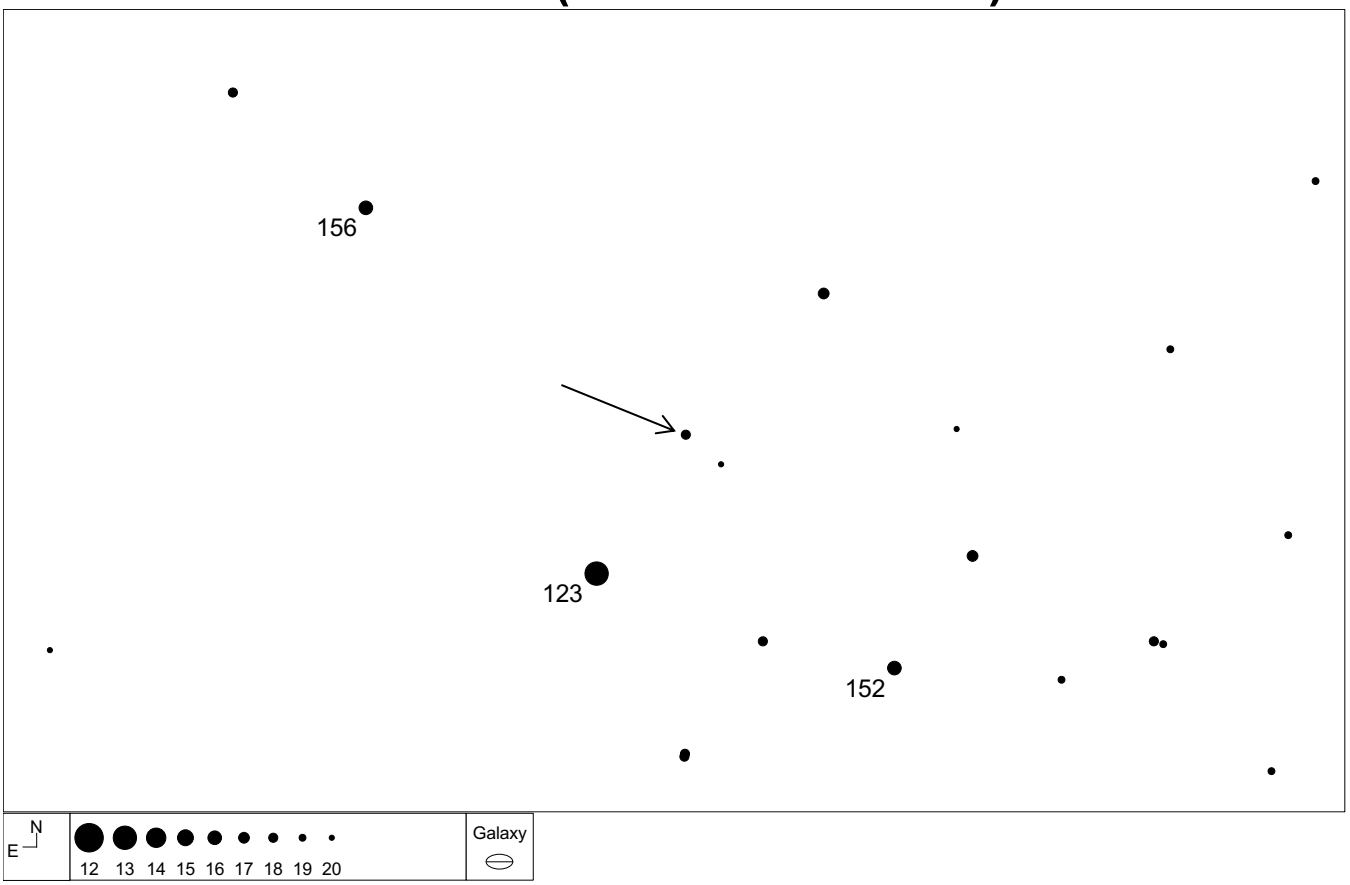
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	12 17 52.1	+30 07 01	14.4 - 16.8	stellar	0.237	

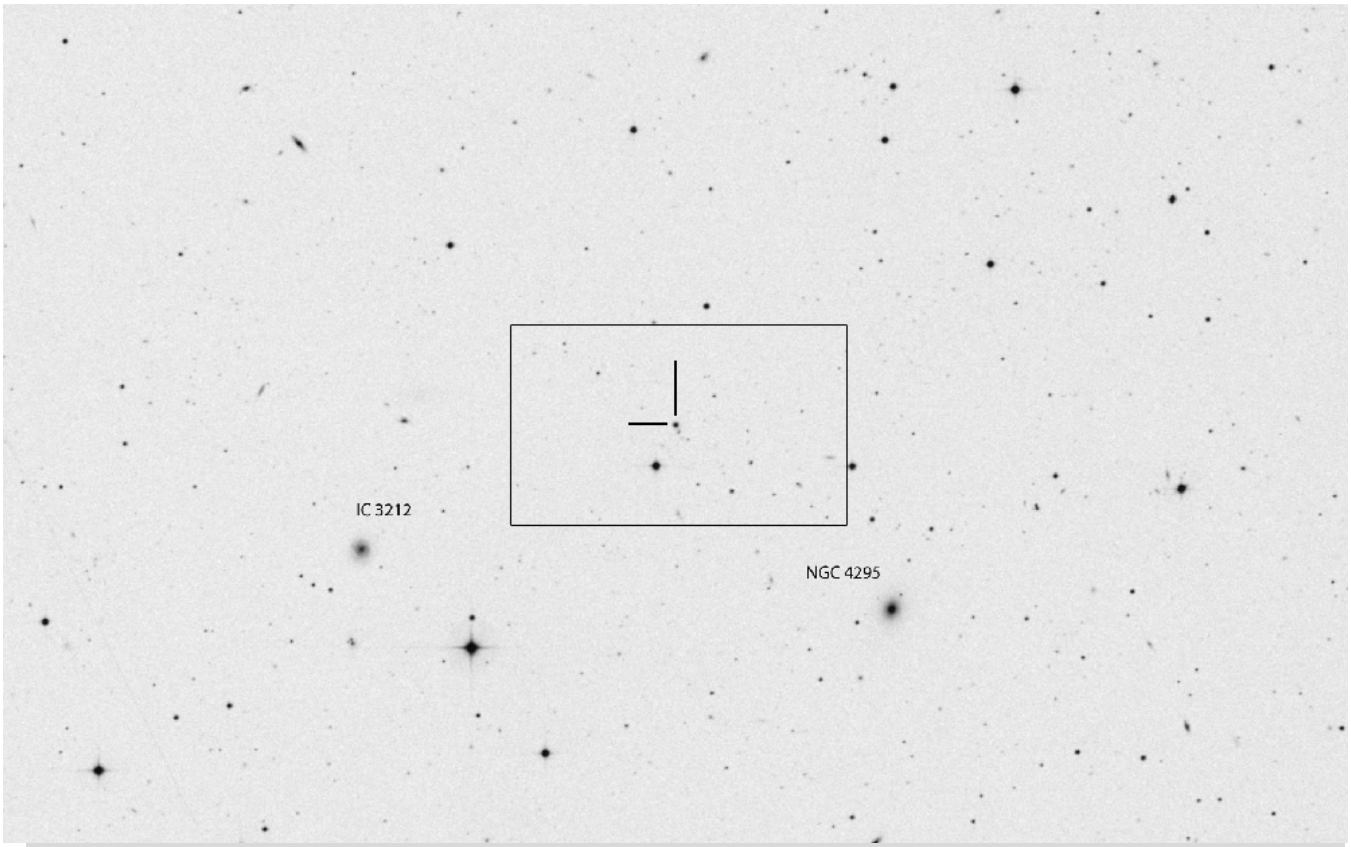
W Com (Coma Berenices)



Cheng, X.L. et al "Optical Observations of BL Lac Object ON 231 (W Comae) During 2010 March–April" *Monthly Notices of the Royal Astronomical Society*, Vol 429 (2013): 2773-2779

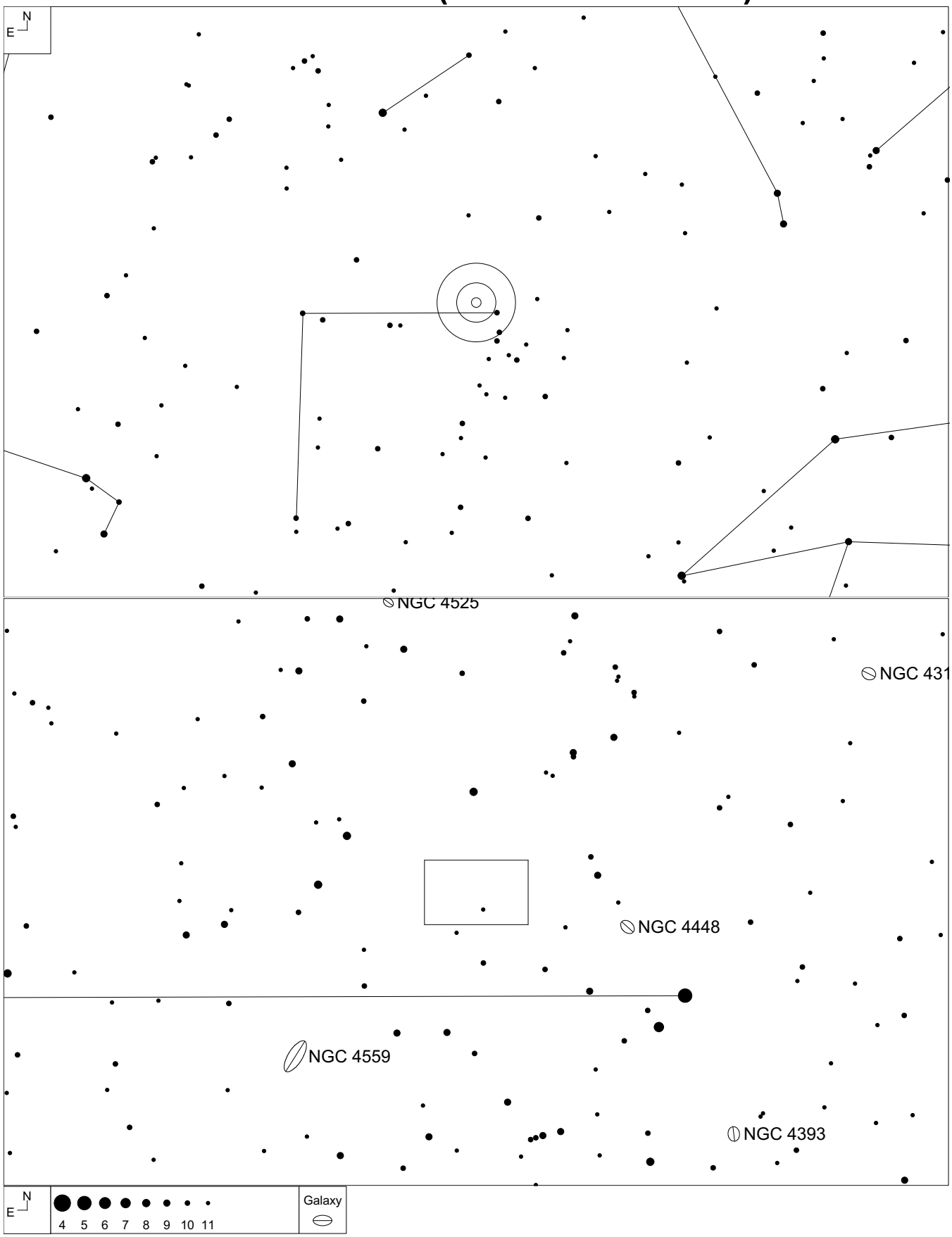
W Com (Coma Berenices)



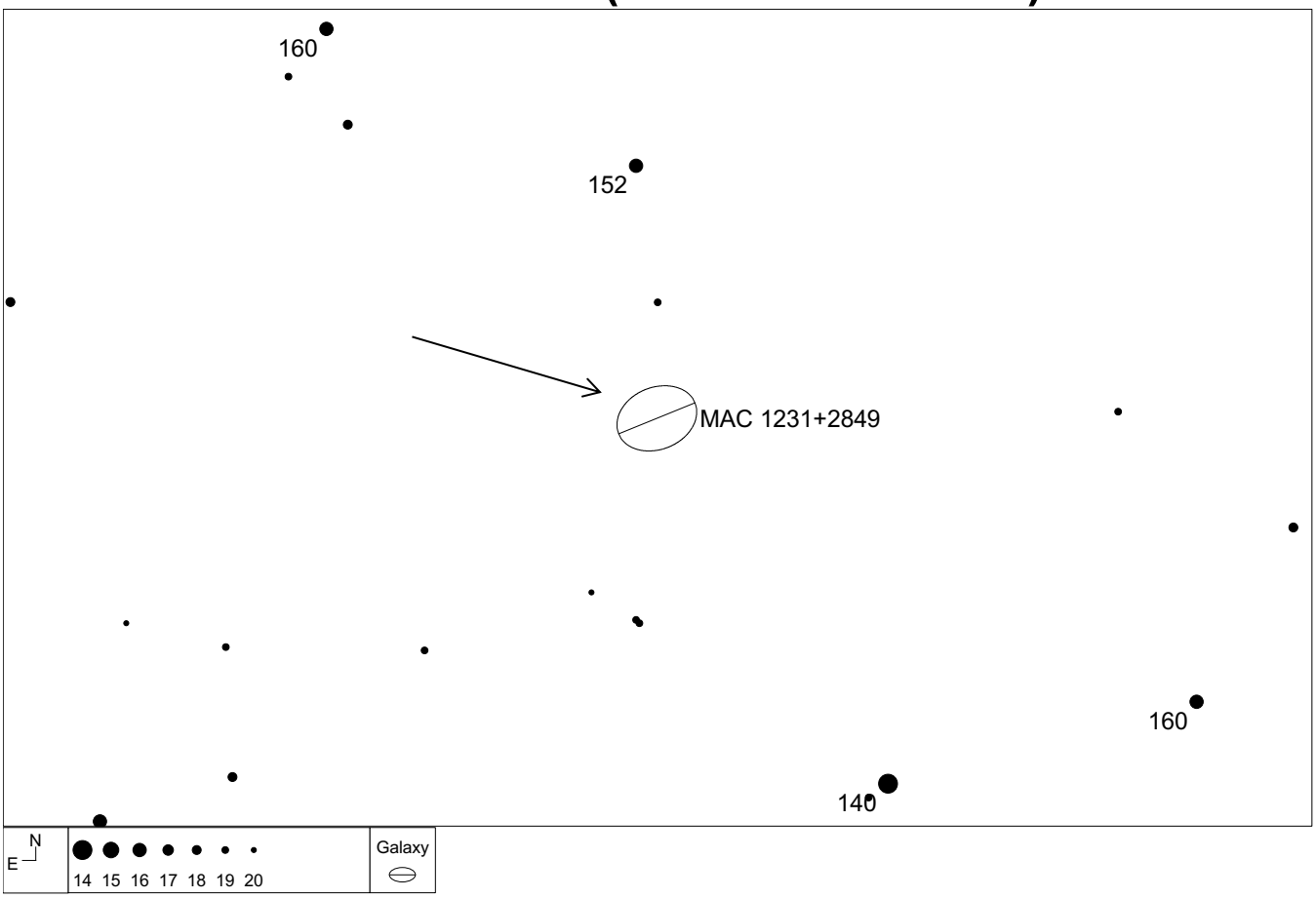


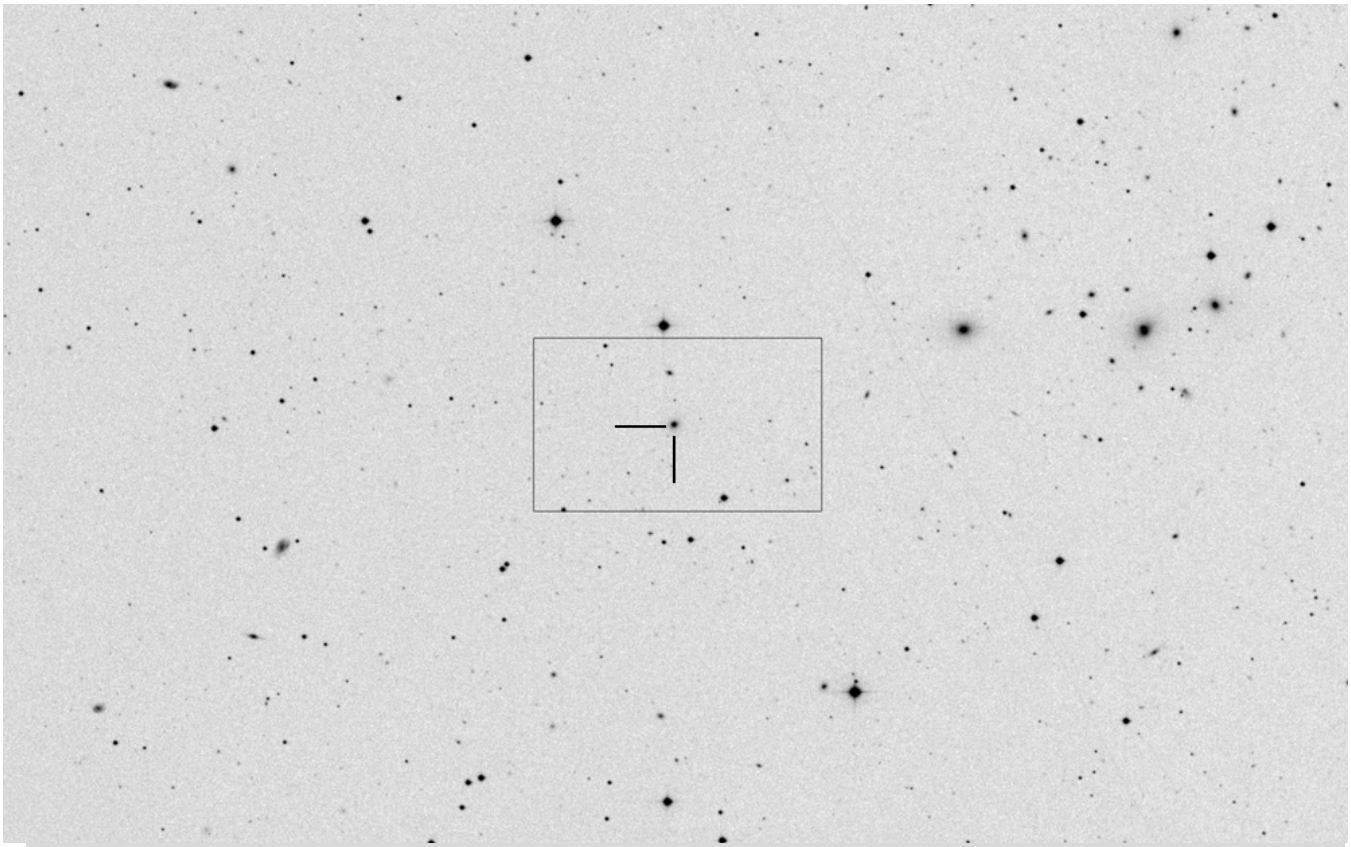
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	12 21 31.7	+28 13 58	11.5 – 17.5	18”	0.102	ON 231

1231.7+2848 (Coma Berenices)



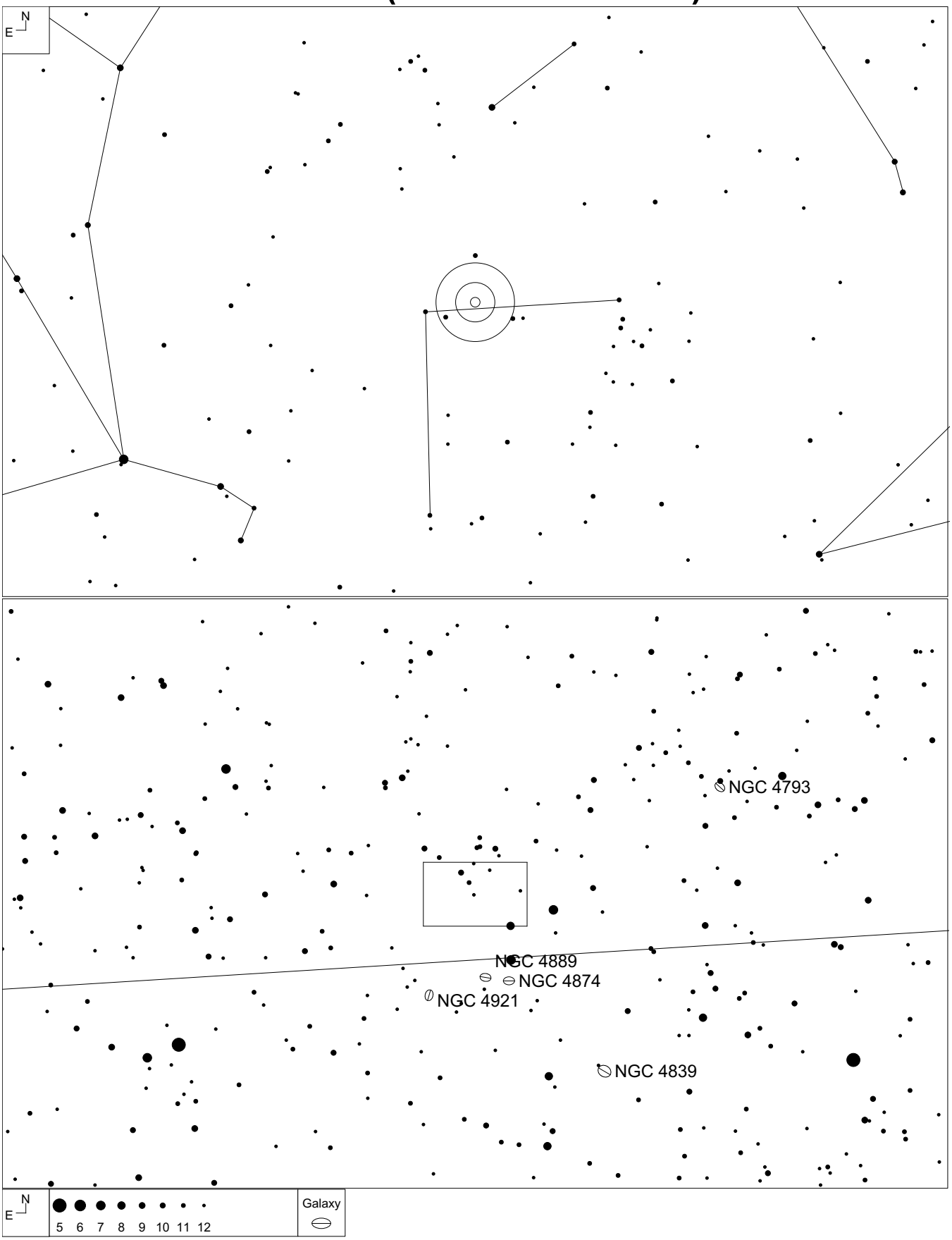
1231.7+2848 (Coma Berenices)



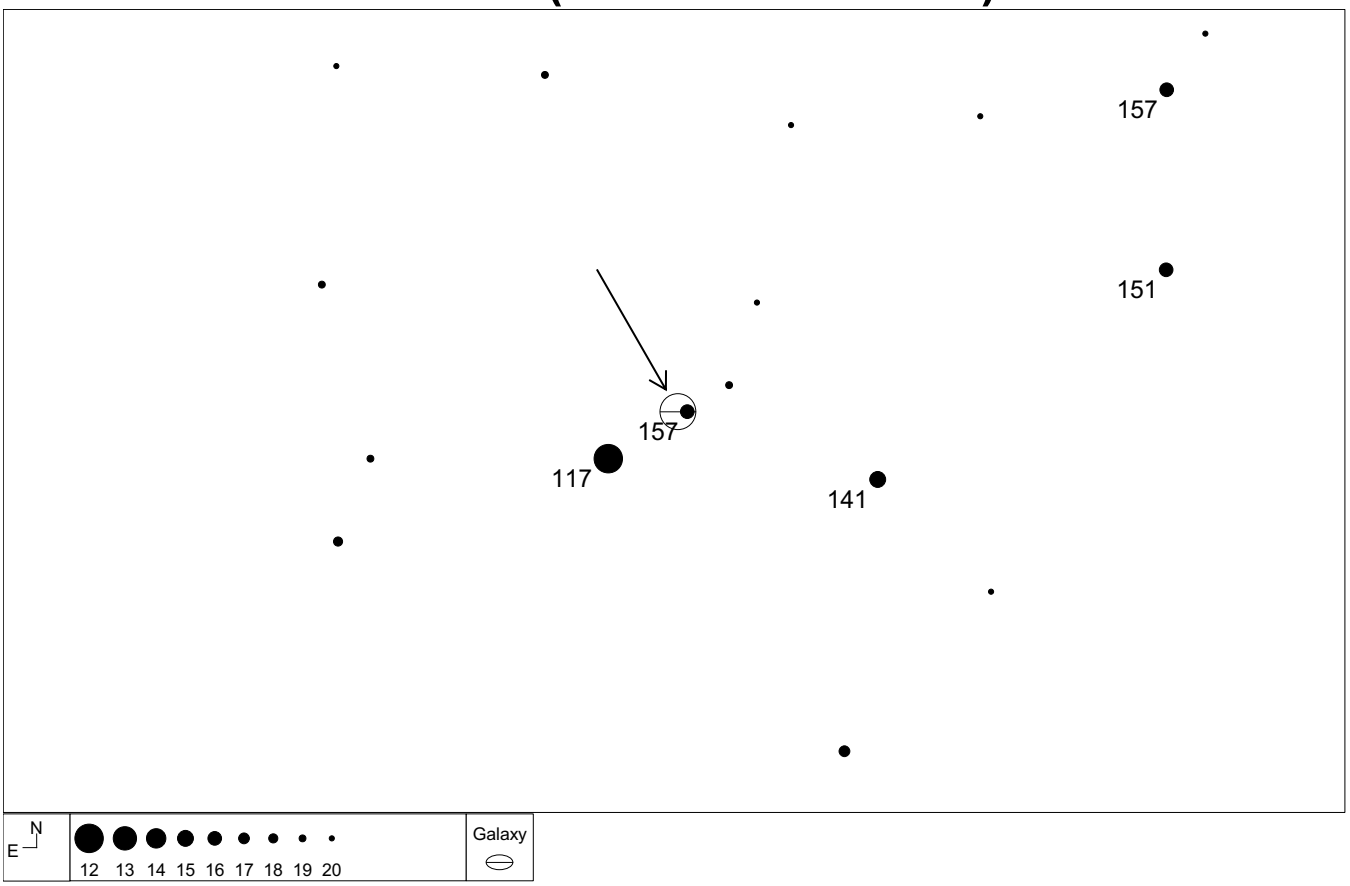


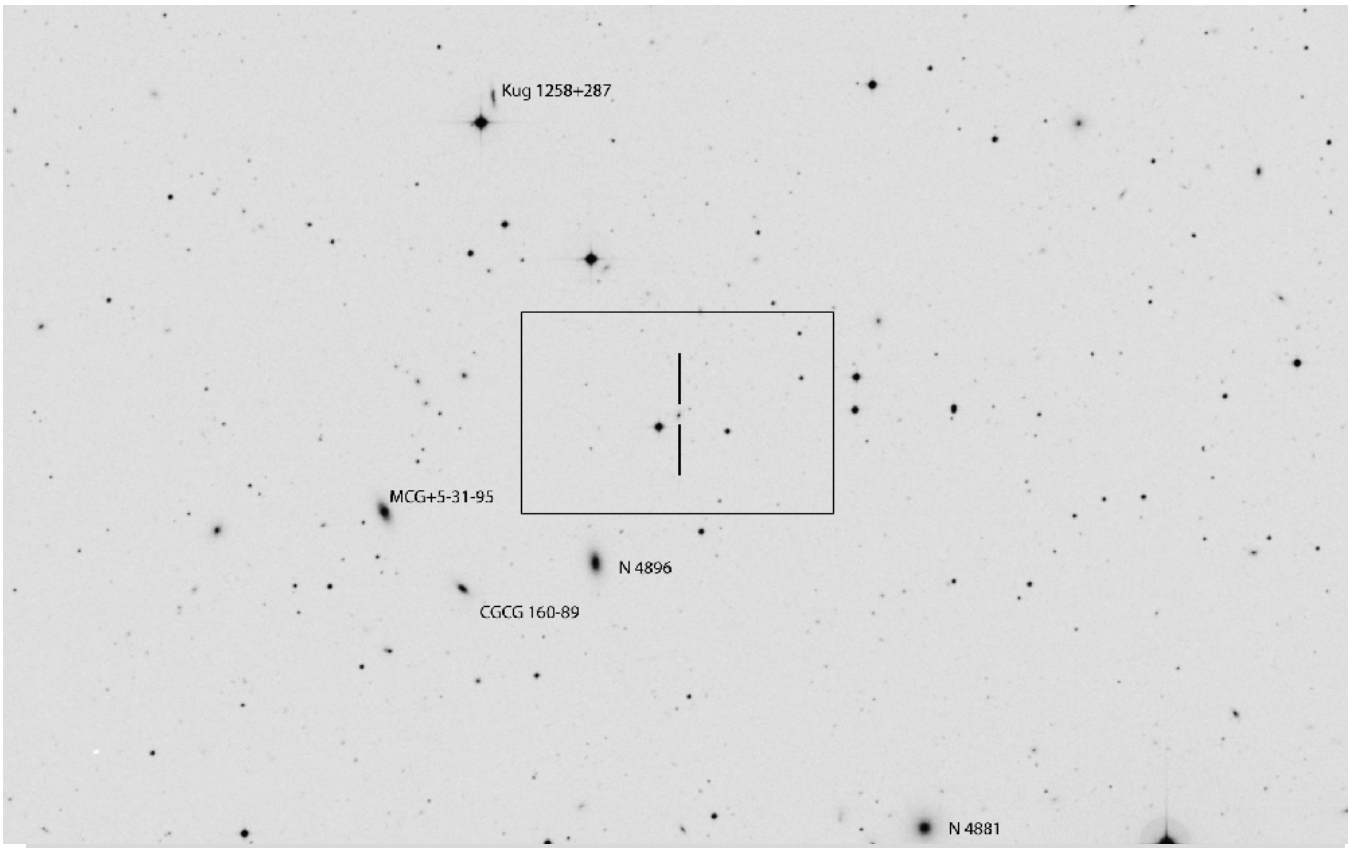
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	12 31 55.6	+28 49 13	17.0	0.4 x 0.3’	1.0	

X Com (Coma Berenices)



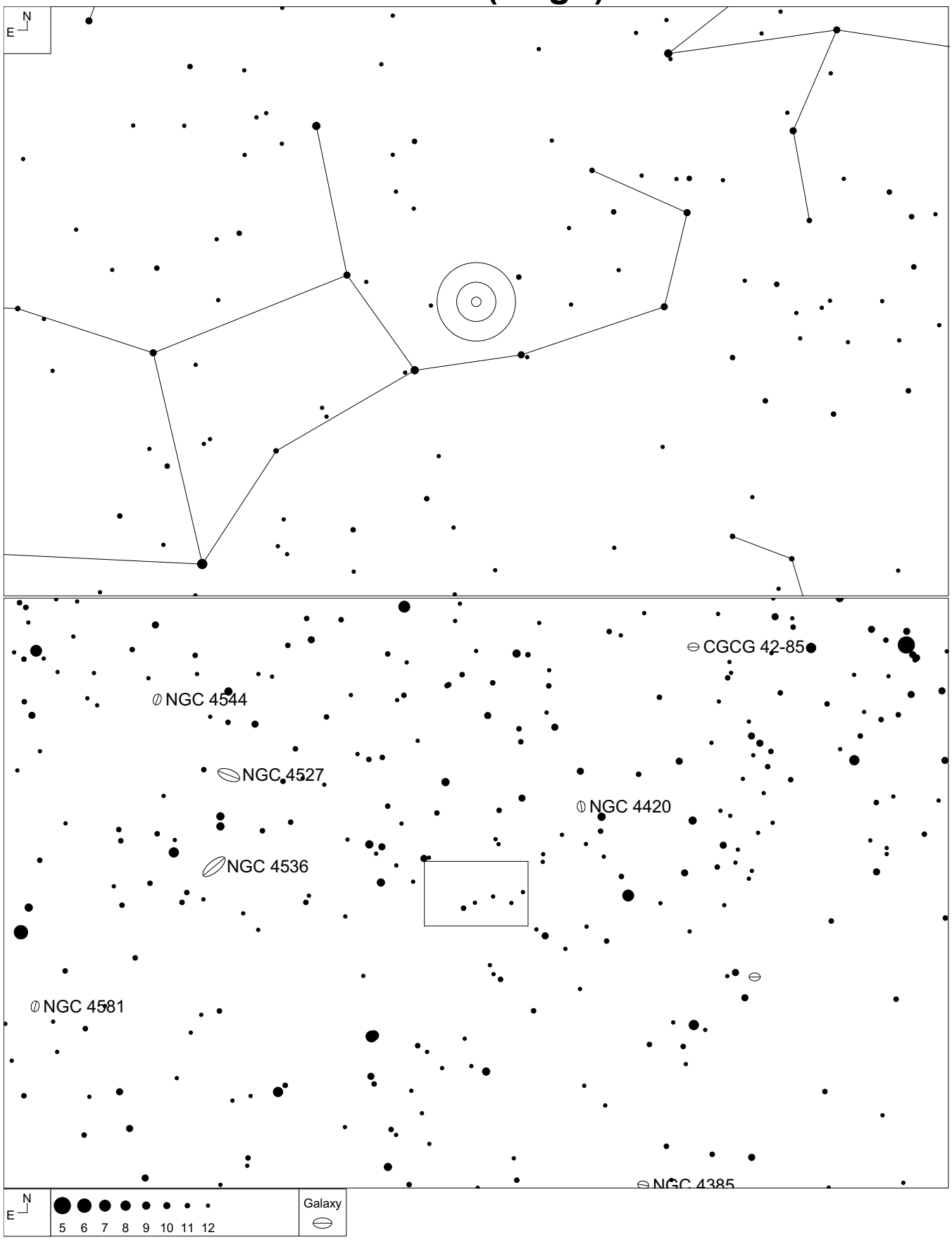
X Com (Coma Berenices)





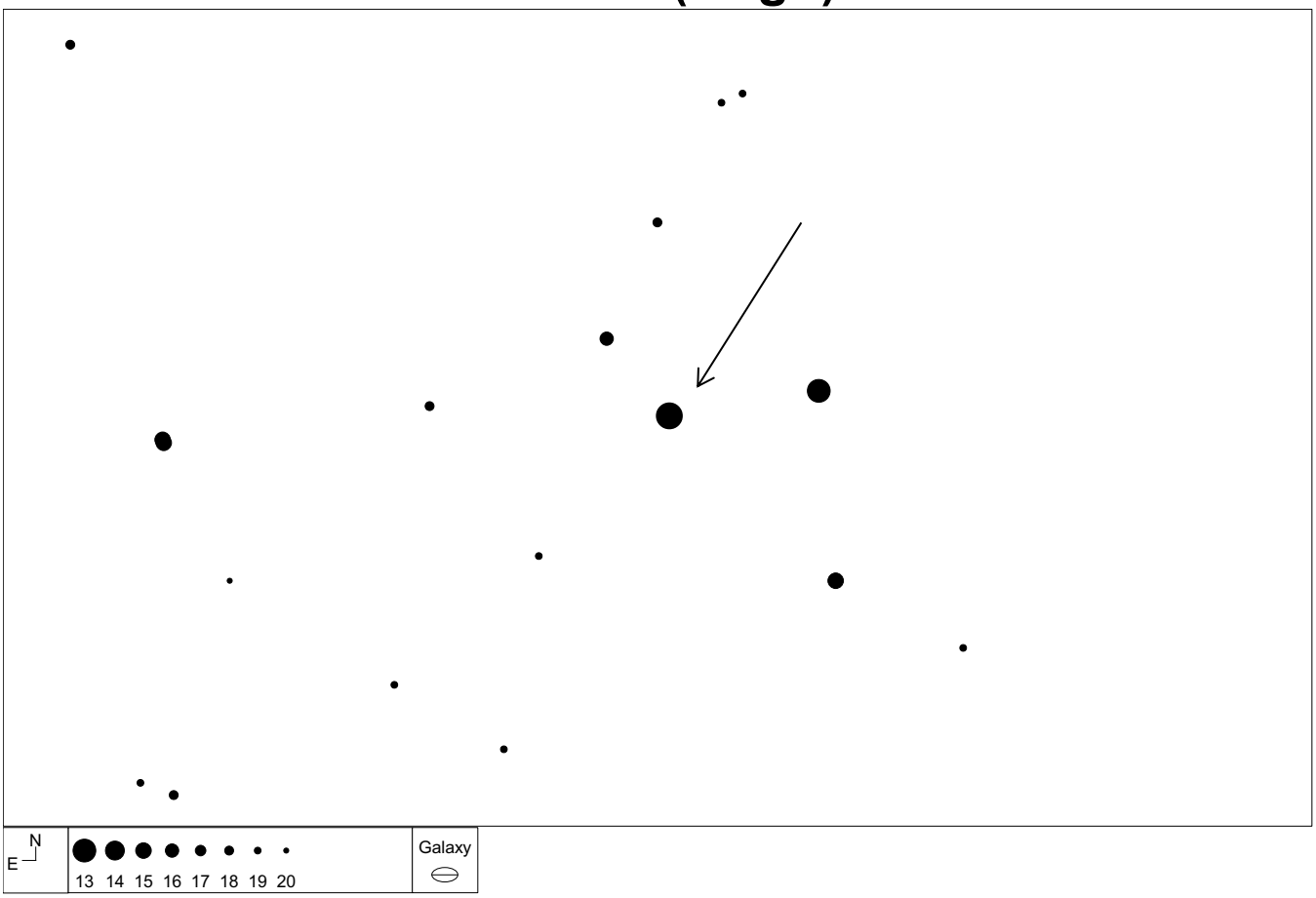
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	13 00 22.5	+28 24 03	12.5 – 17.9	20 x 12”	0.092	PGC 44750

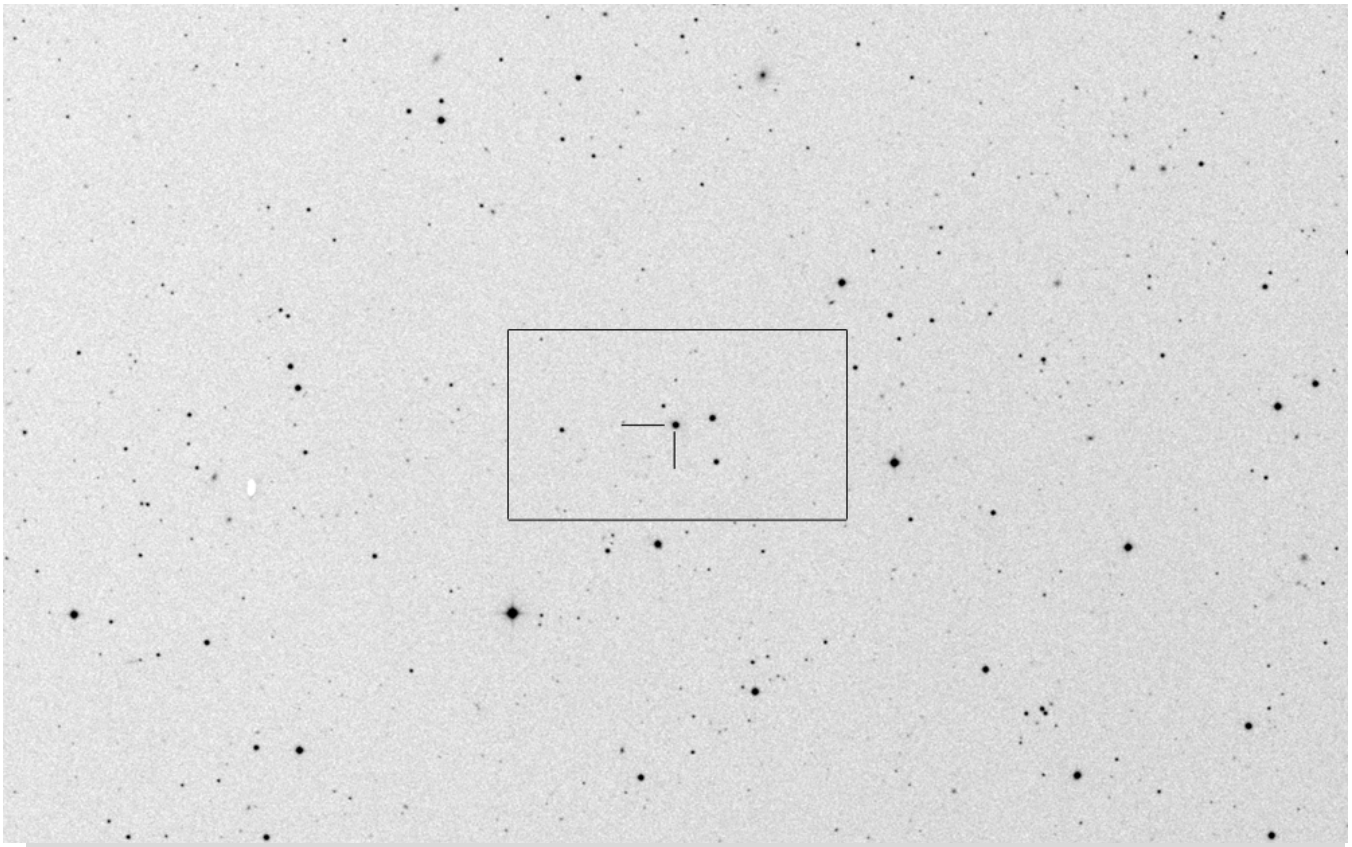
3C 273 (Virgo)



Uchiyama, Y. et al Shedding "New Light on the 3C 273 Jet with the Spitzer Space Telescope " *Astrophysical Journal*, Vol 648 (2006): 910-921

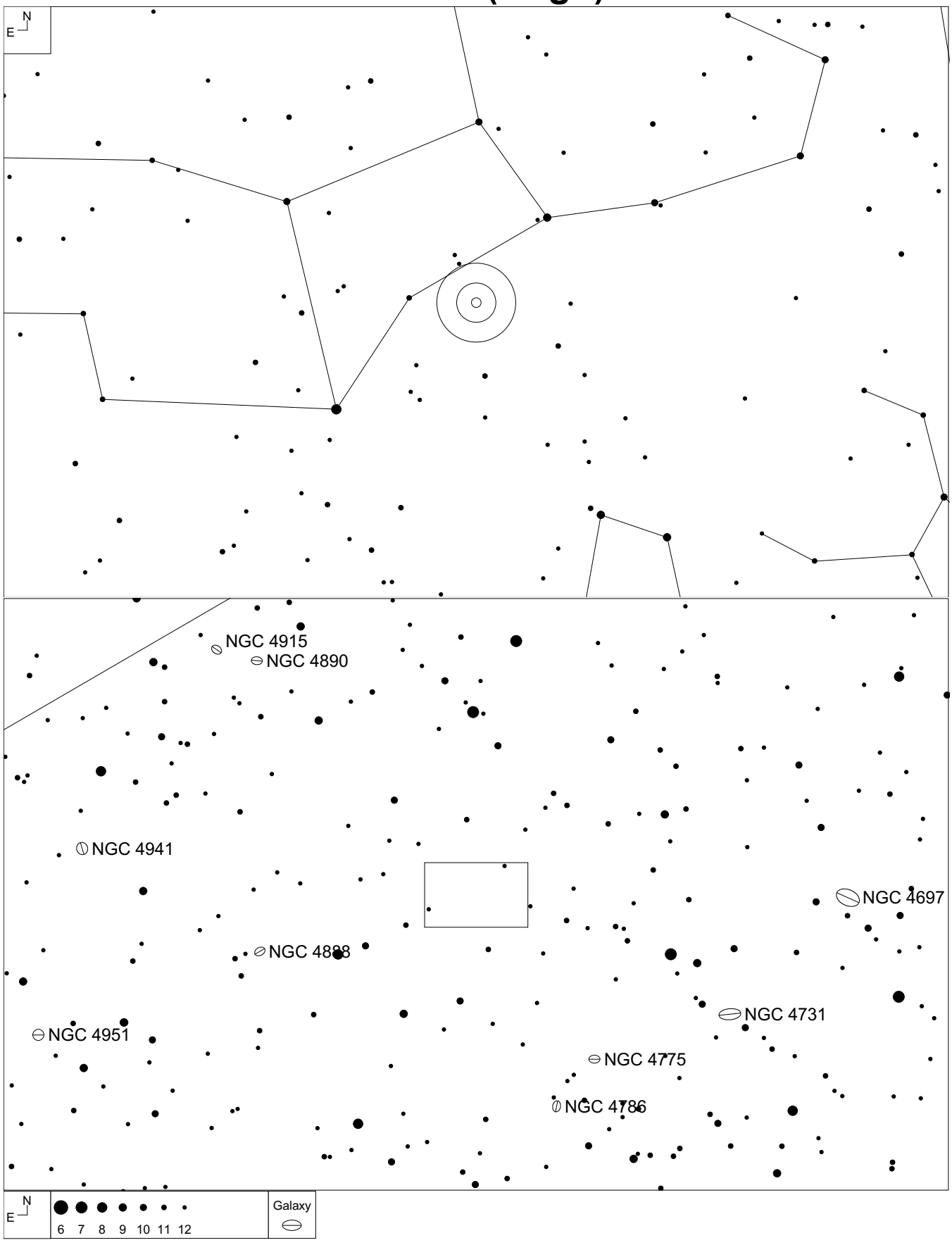
3C 273 (Virgo)



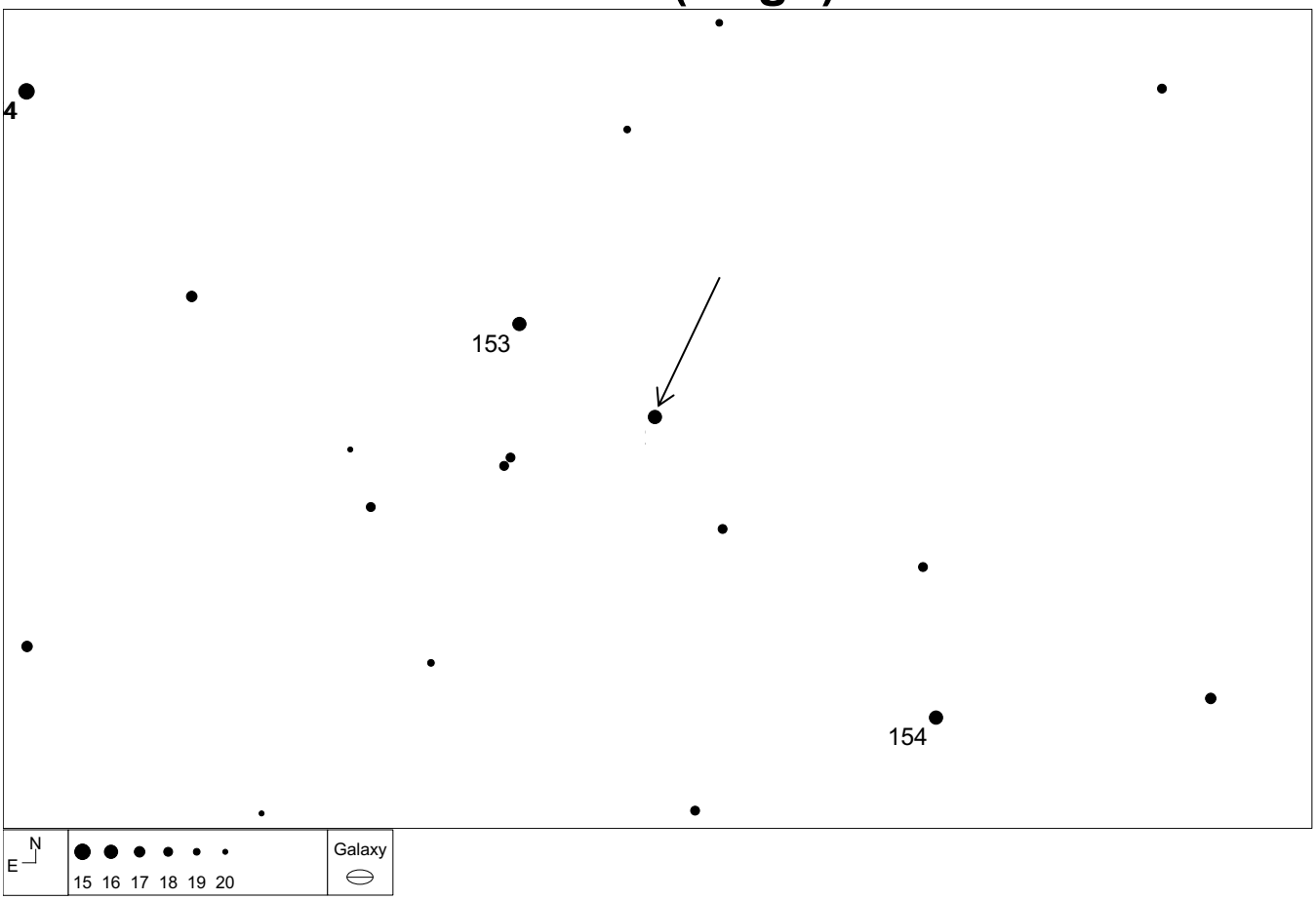


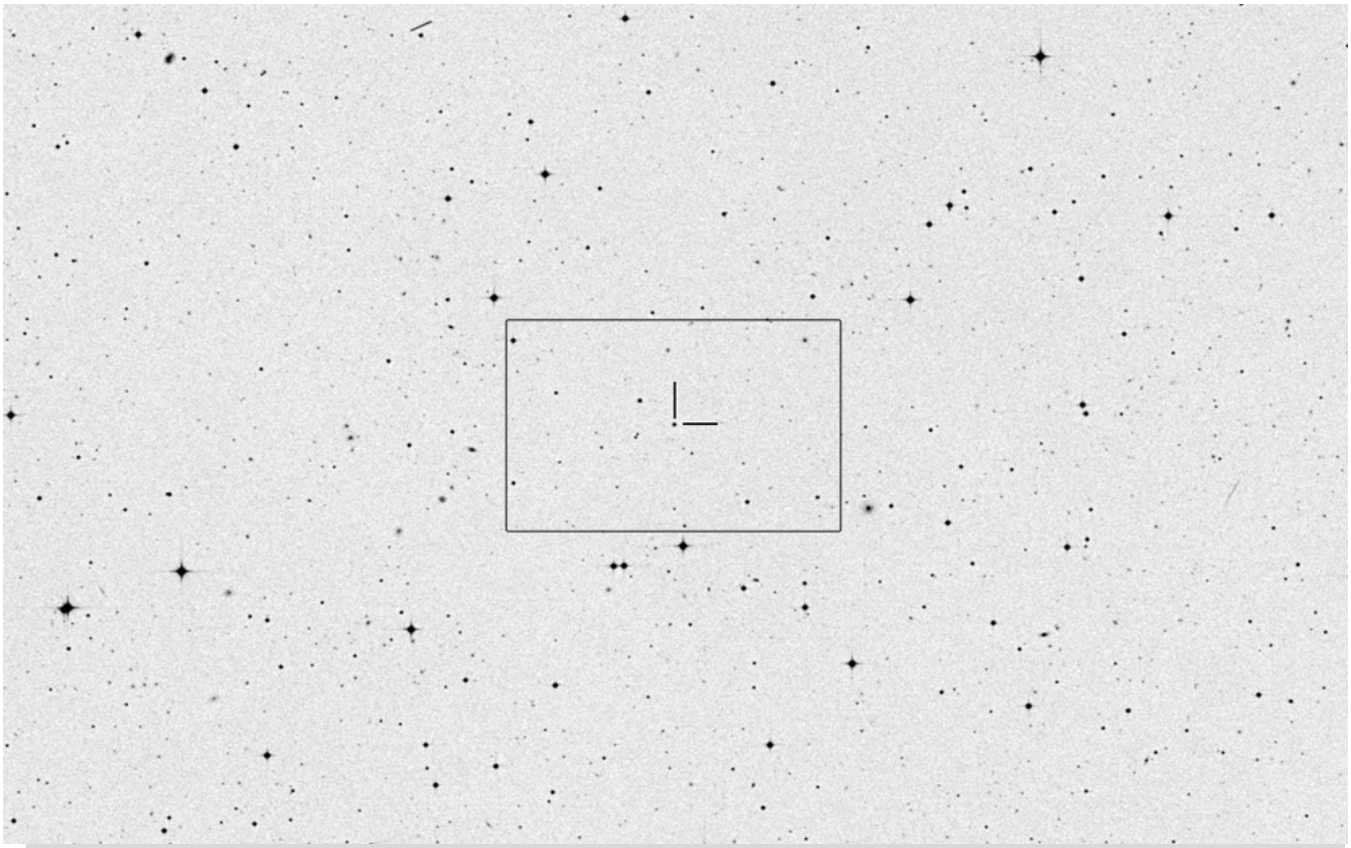
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	12 29 06.7	+02 03 09	11.7 - 13.2	stellar	0.158	

3C 279 (Virgo)


N
E
NGC 4915
NGC 4890
NGC 4941
NGC 4697
NGC 4888
NGC 4731
NGC 4951
NGC 4775
NGC 4786
N
E
6 7 8 9 10 11 12
Galaxy

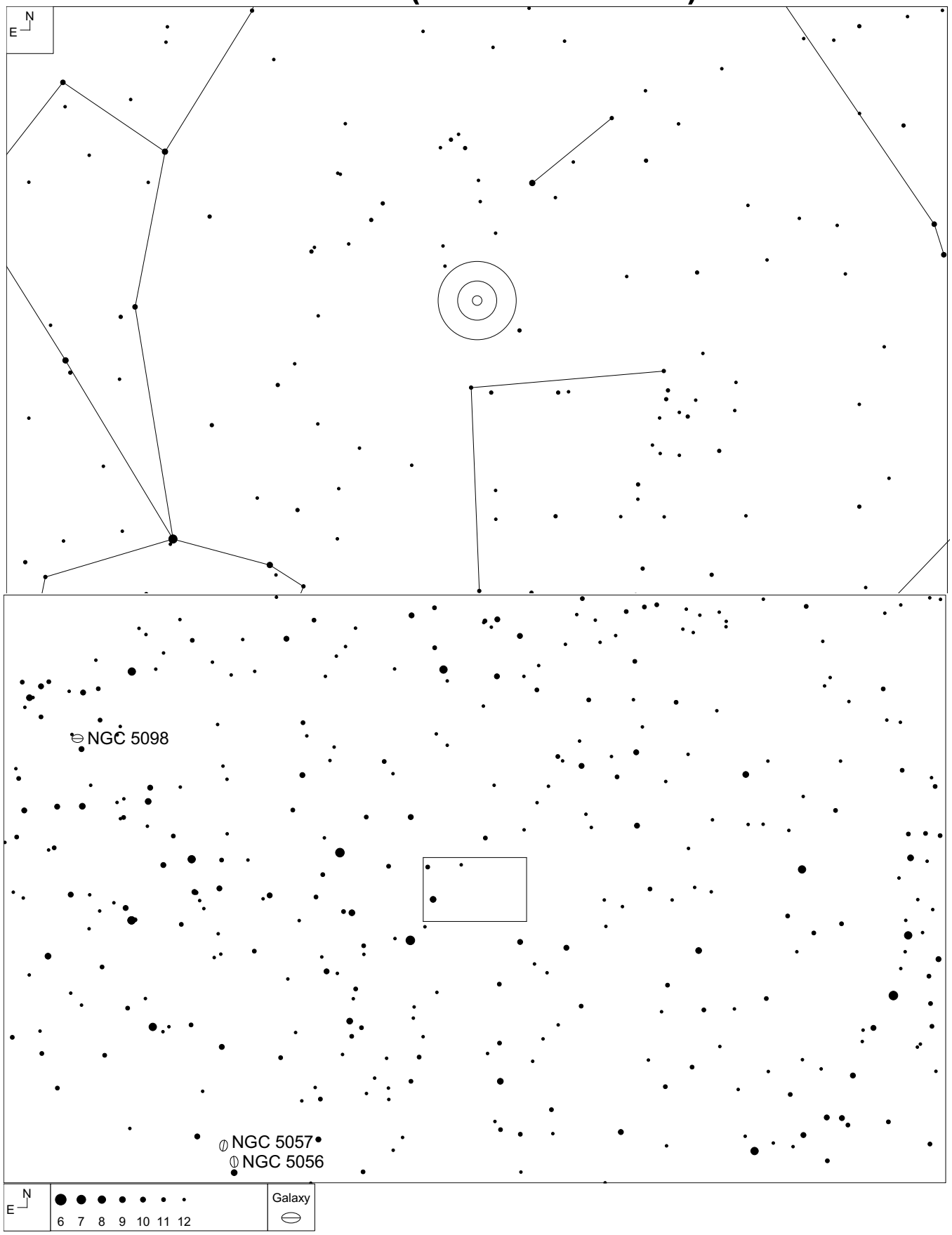
3C 279 (Virgo)





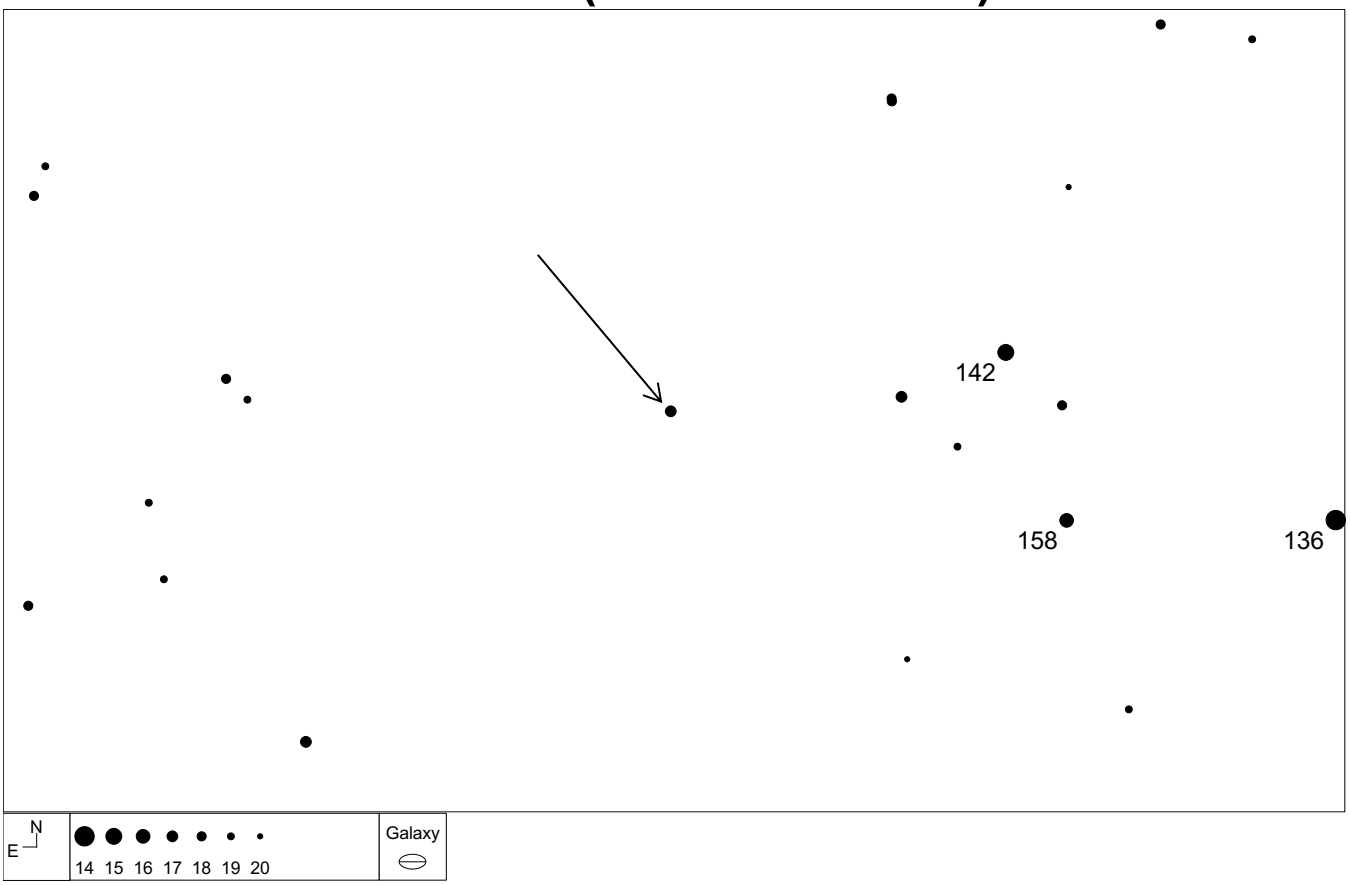
Type	RA	Dec	Mag	Size	Redshift	Other Name
OVV	12 56 11.1	-05 47 22	13.3 - 16.3	stellar	0.540	

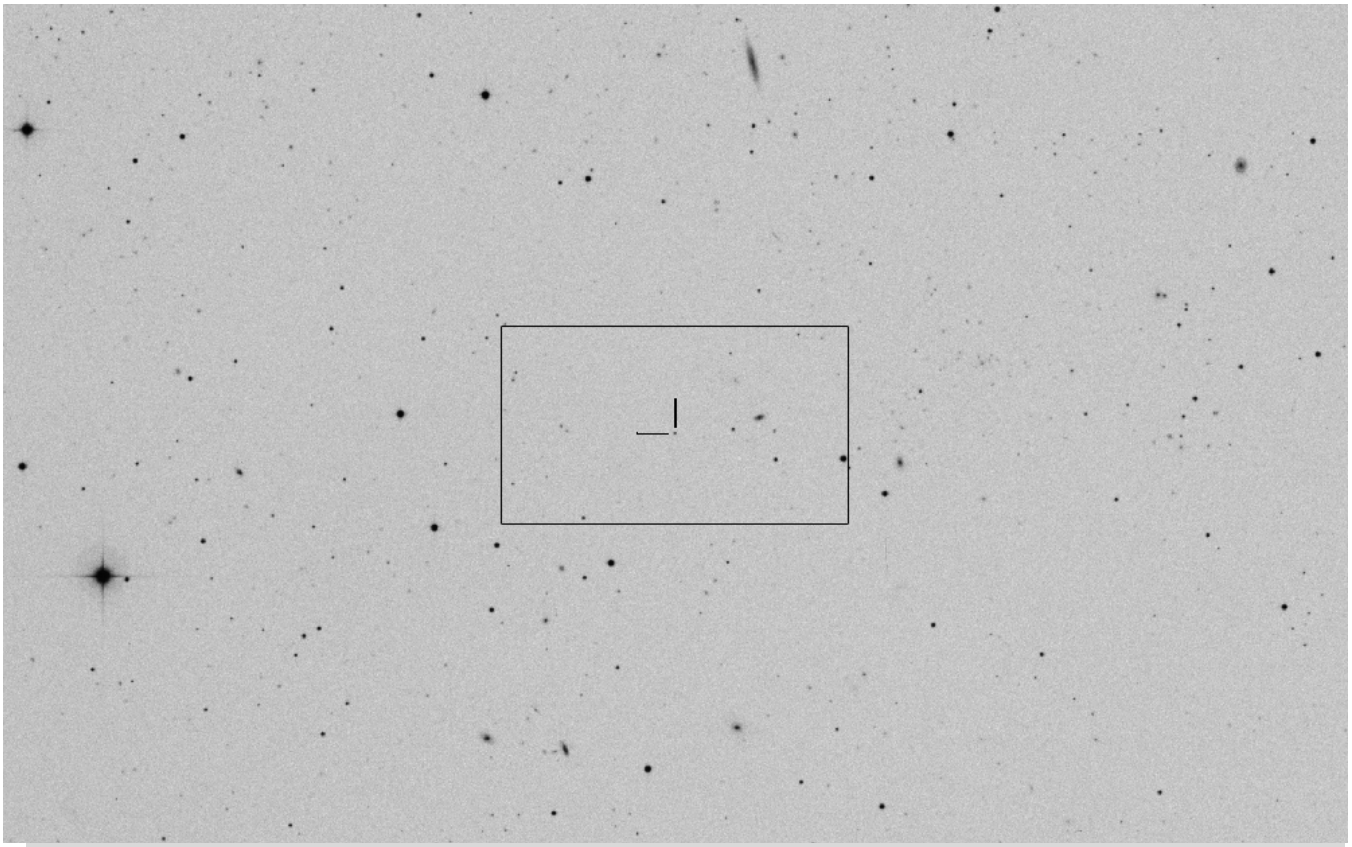
AU CVn (Canes Venatici)



http://quasar.square7.ch/fqm/1308+326.html

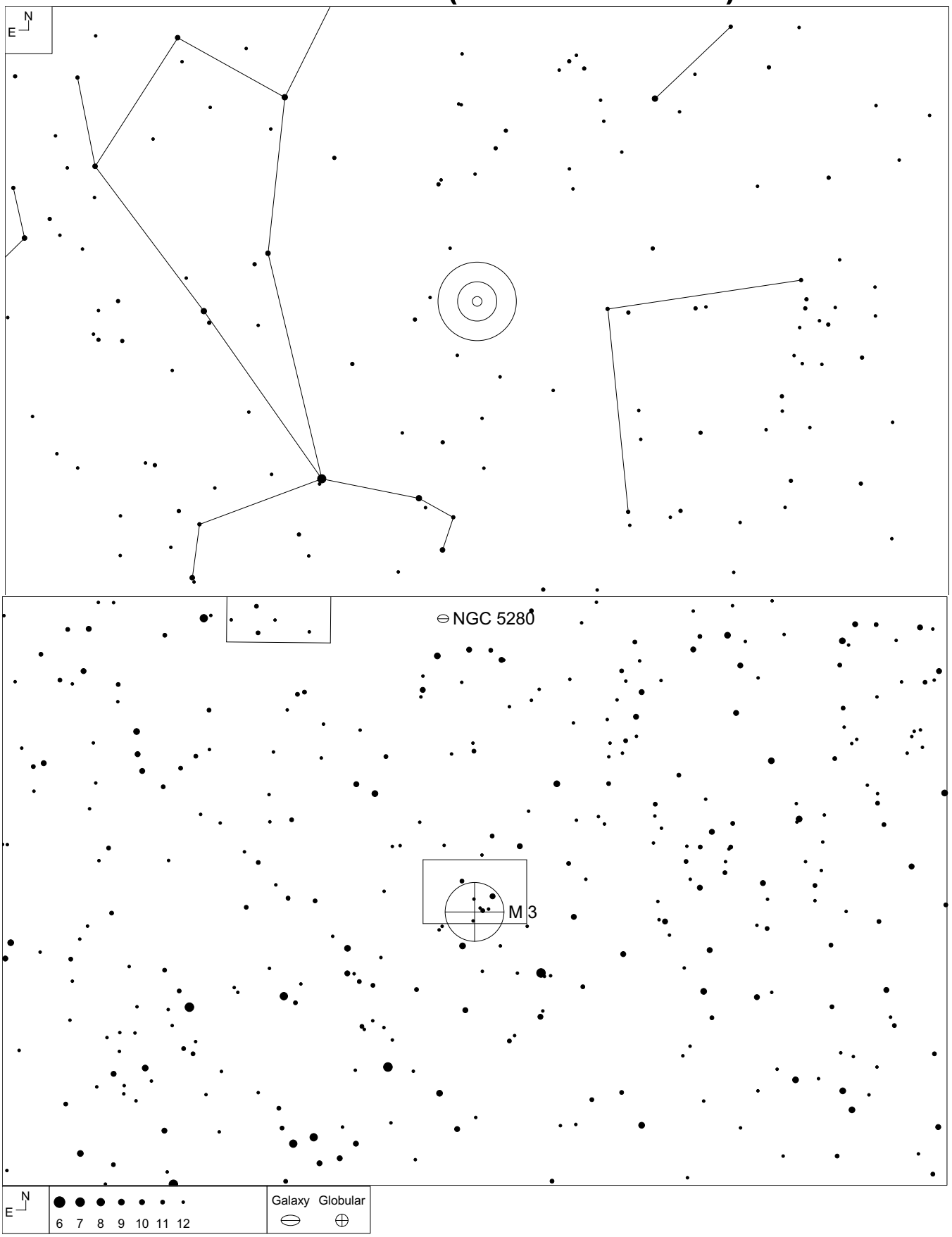
AU CVn (Canes Venatici)



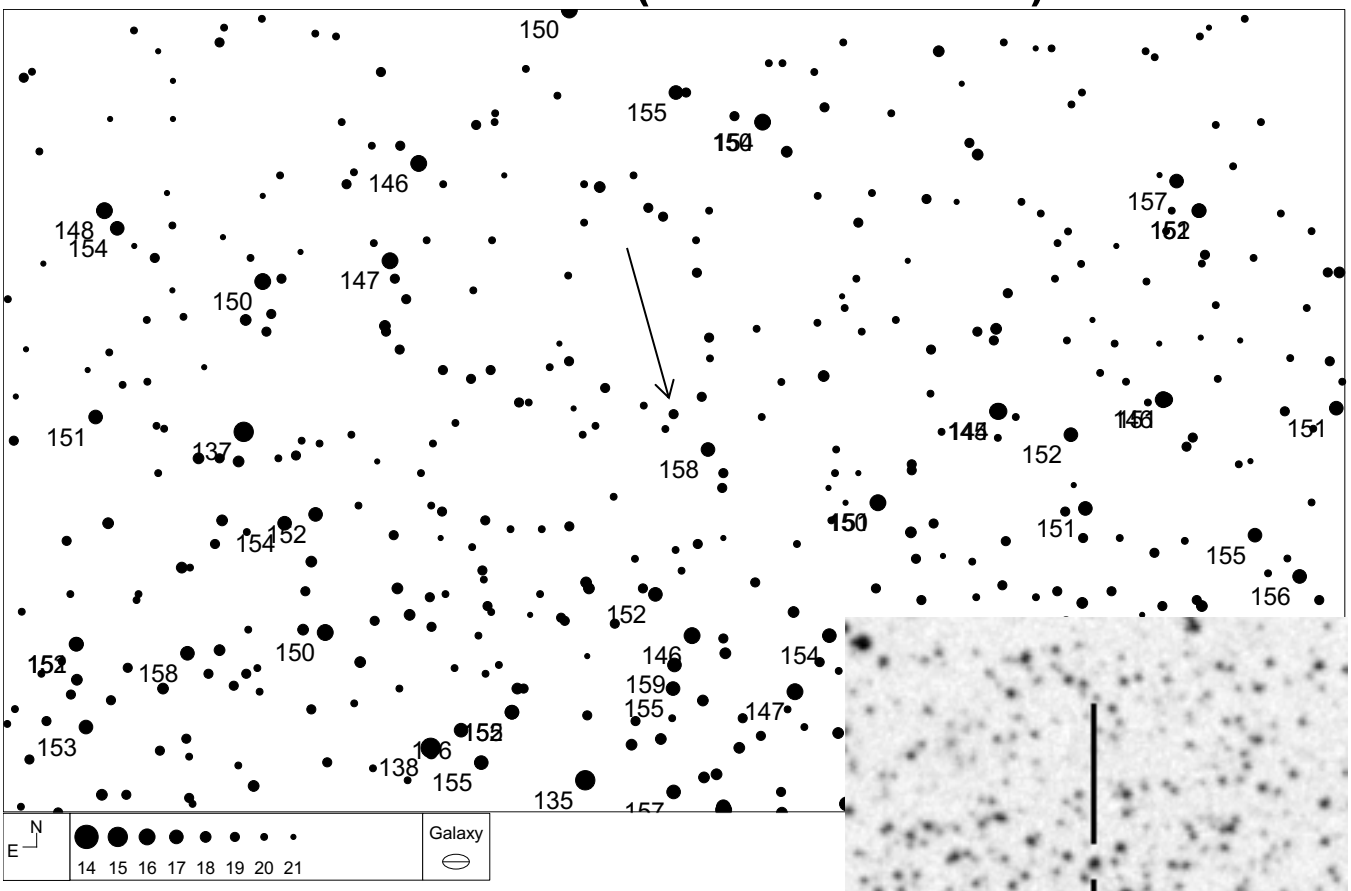


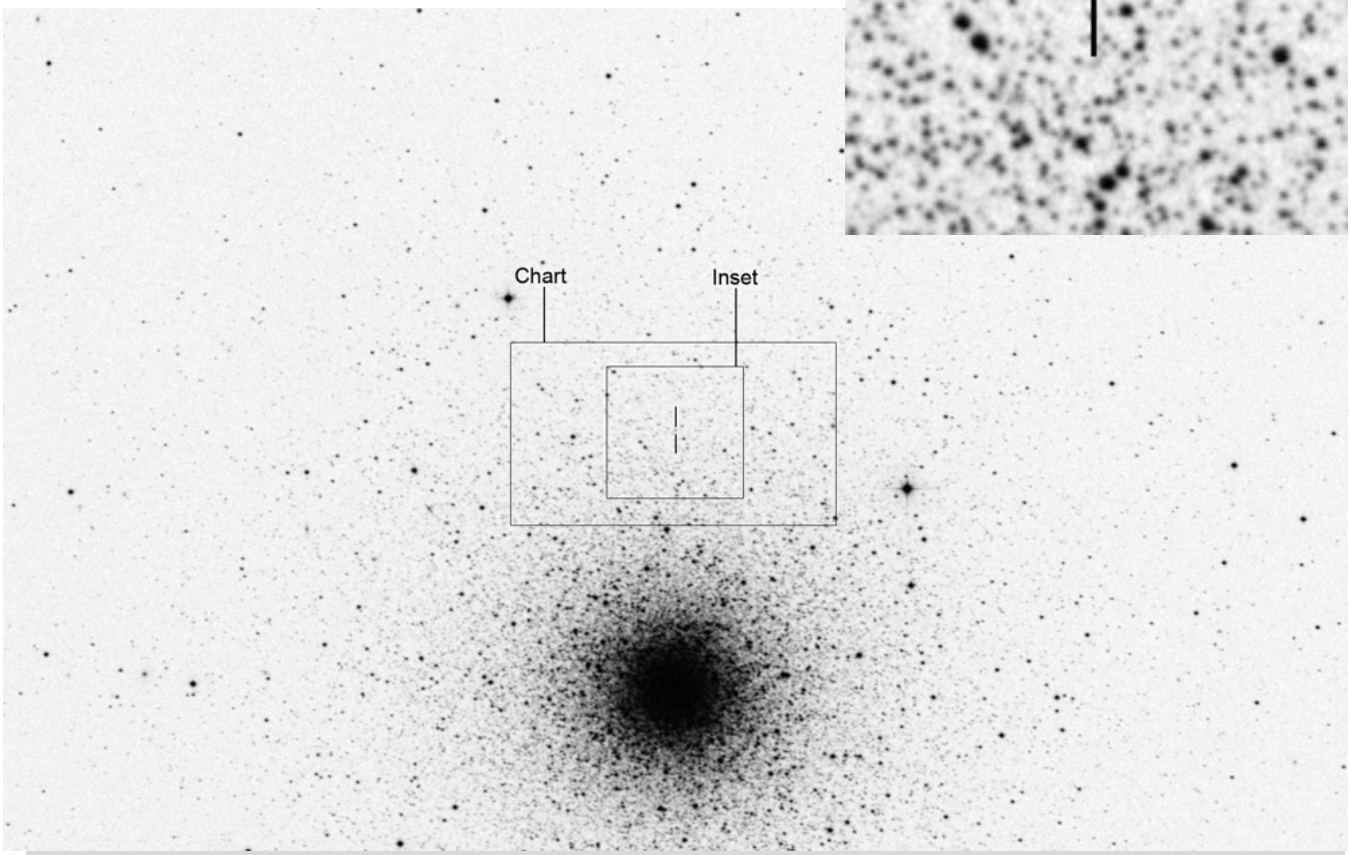
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	13 10 28.6	+32 20 44	13.9 – 19.6	stellar	0.996	B2 1308+32

S10764 CVn (Canes Venatici)



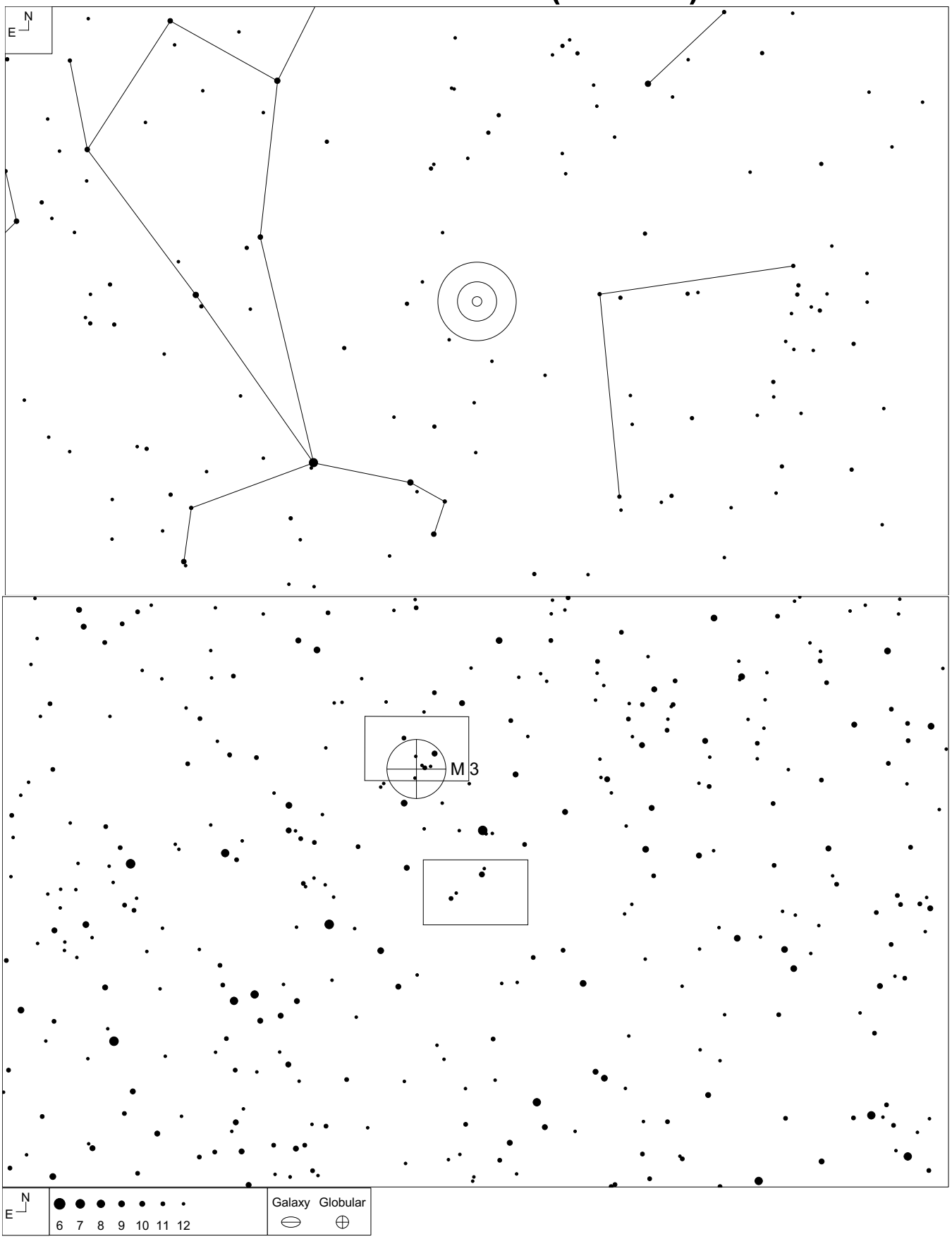
S10764 CVn (Canes Venatici)



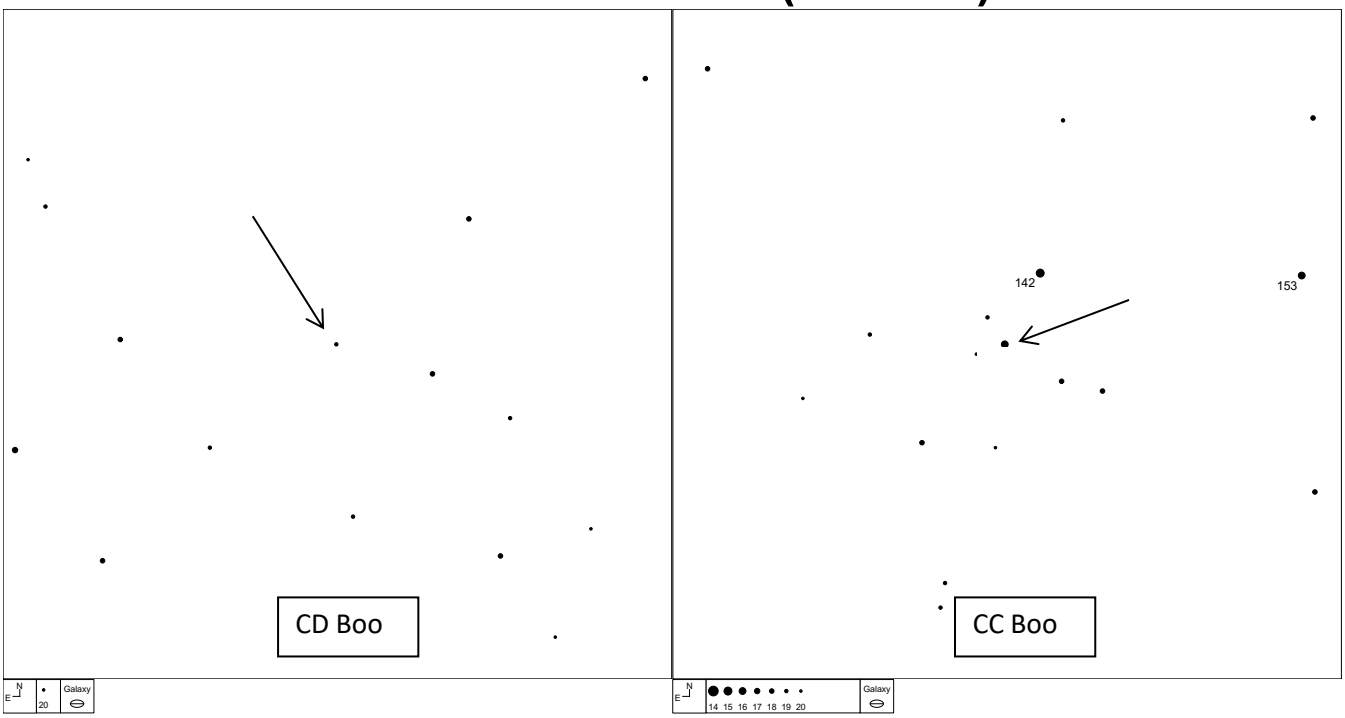


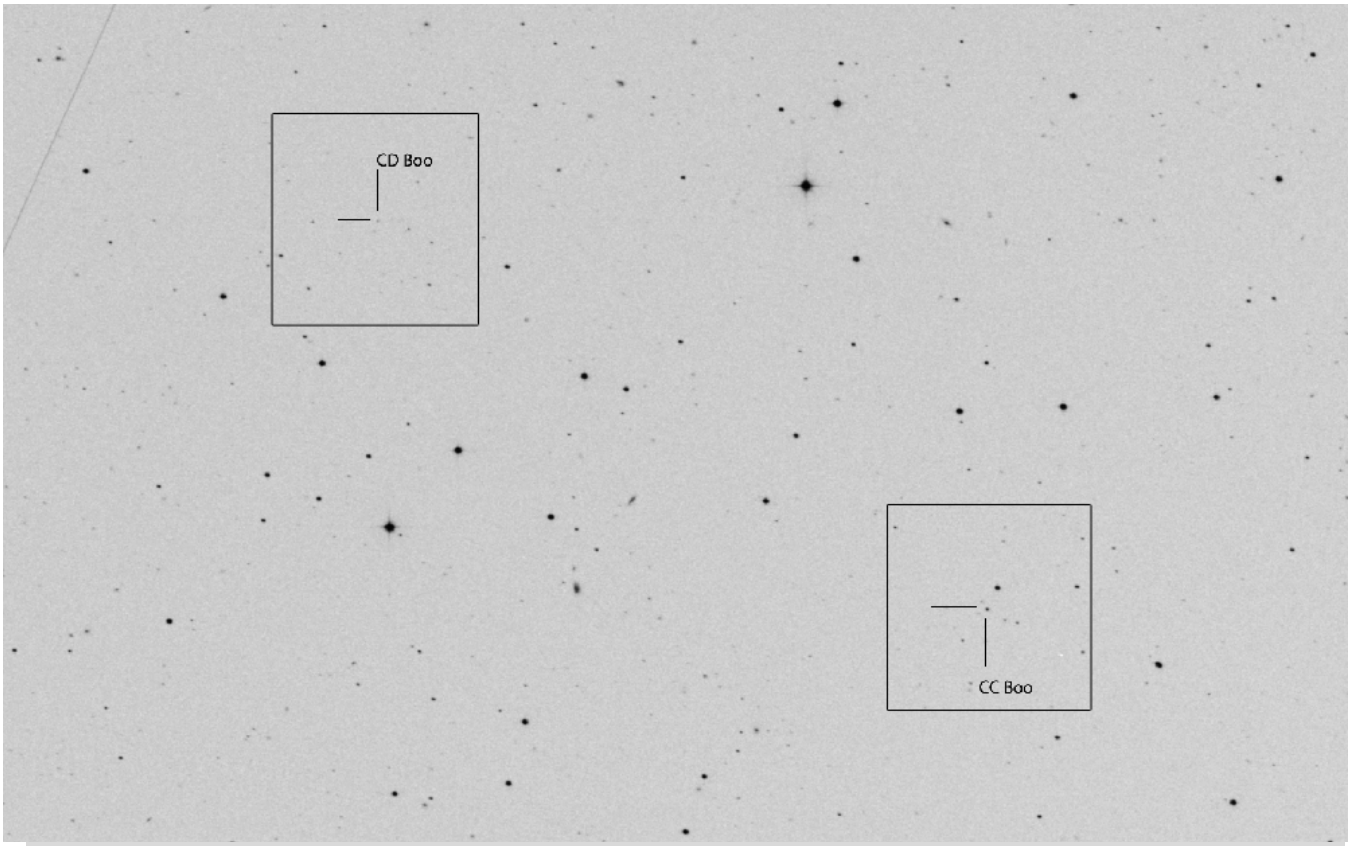
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	13 42 10.9	+28 28 48	18.3 - 19.8	stellar	0.063	B2 1339+28

CC and CD Boo (Bootes)



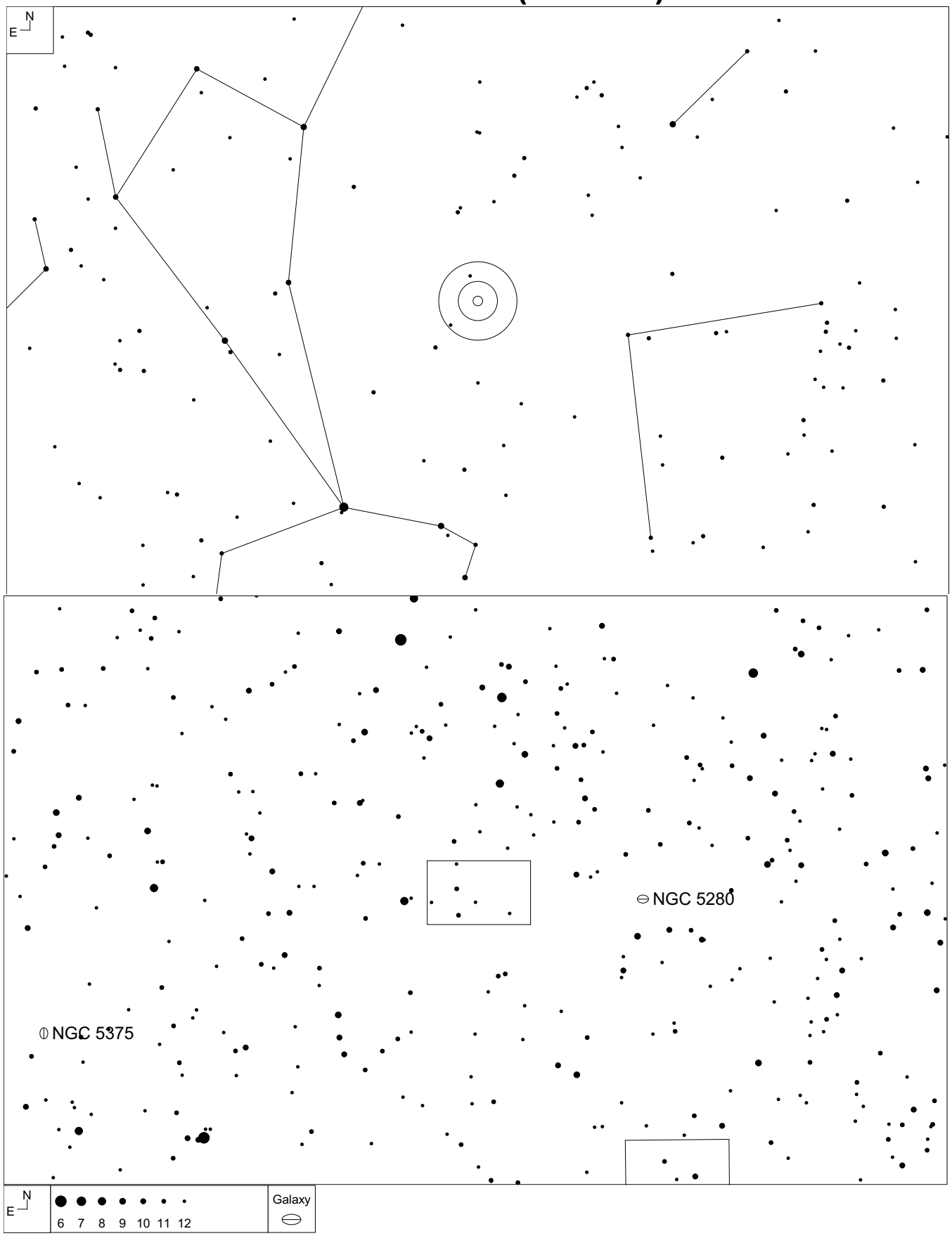
CC and CD Boo (Bootes)



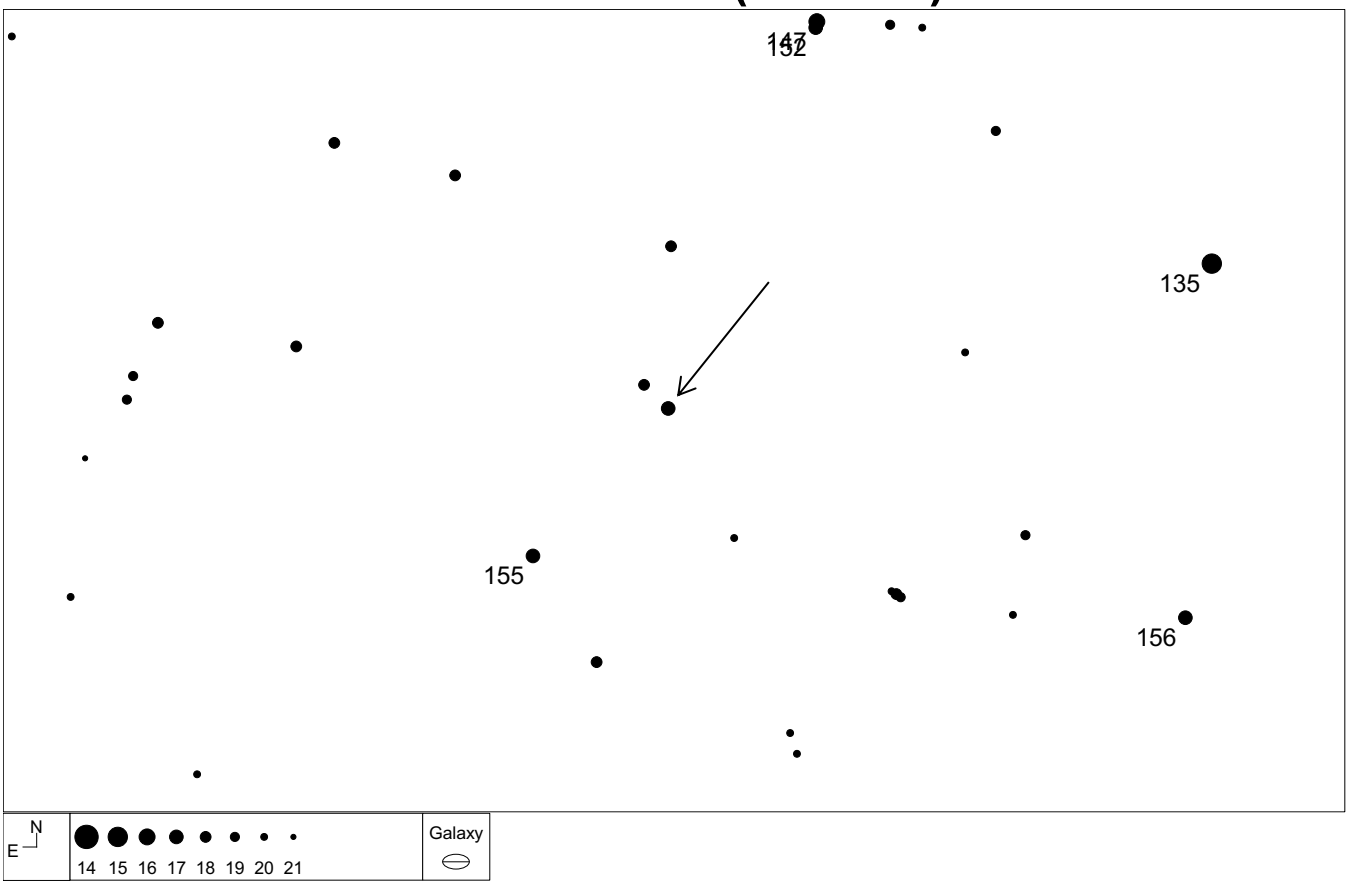


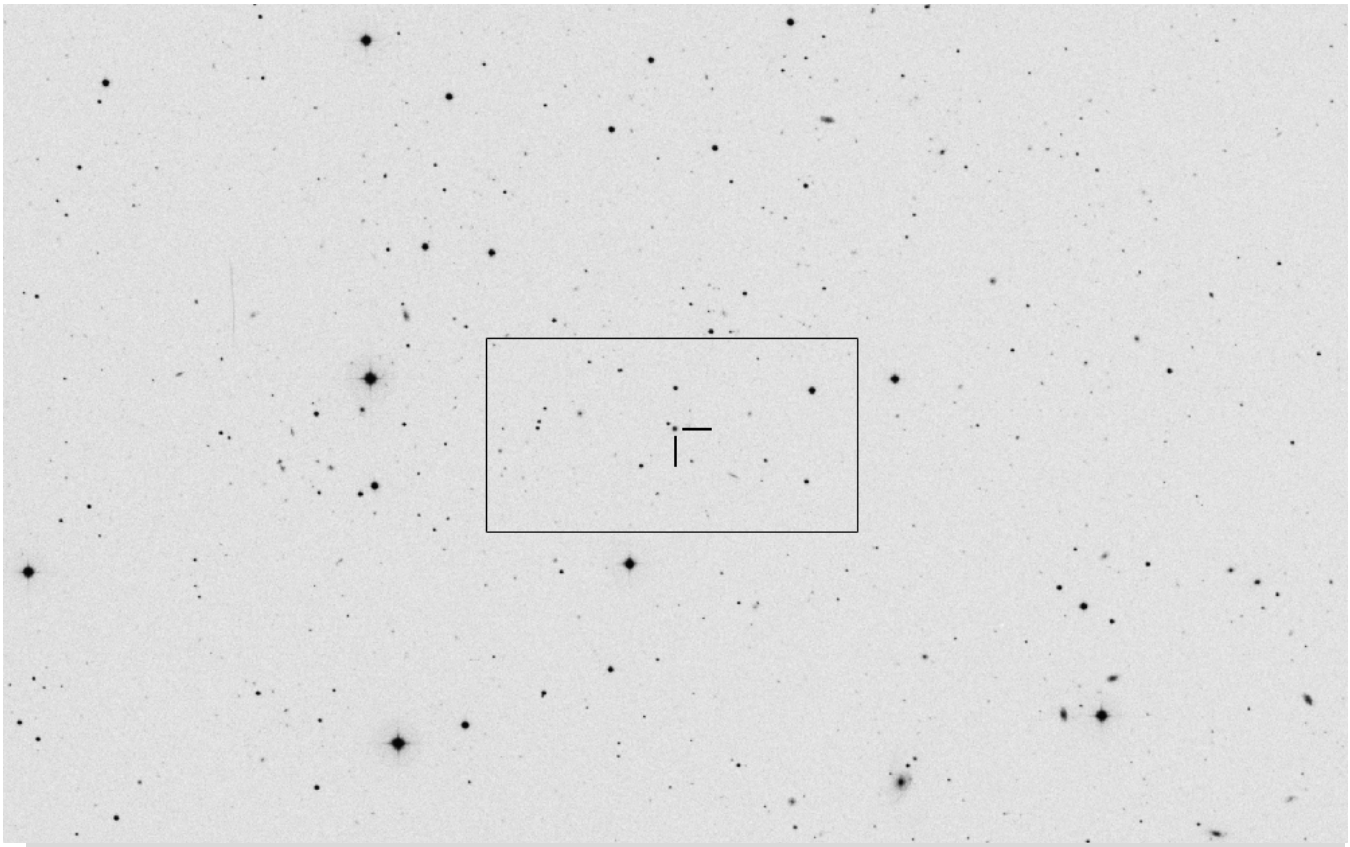
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	13 40 22.8	+27 40 58	17.8 – 19.5	stellar	0.172	S10762 (CC Boo)
QSO	13 41 23.3	+27 49 55	18.9 – 19.7	stellar	1.045	S10763 (CD Boo)

S10765 Boo (Bootes)



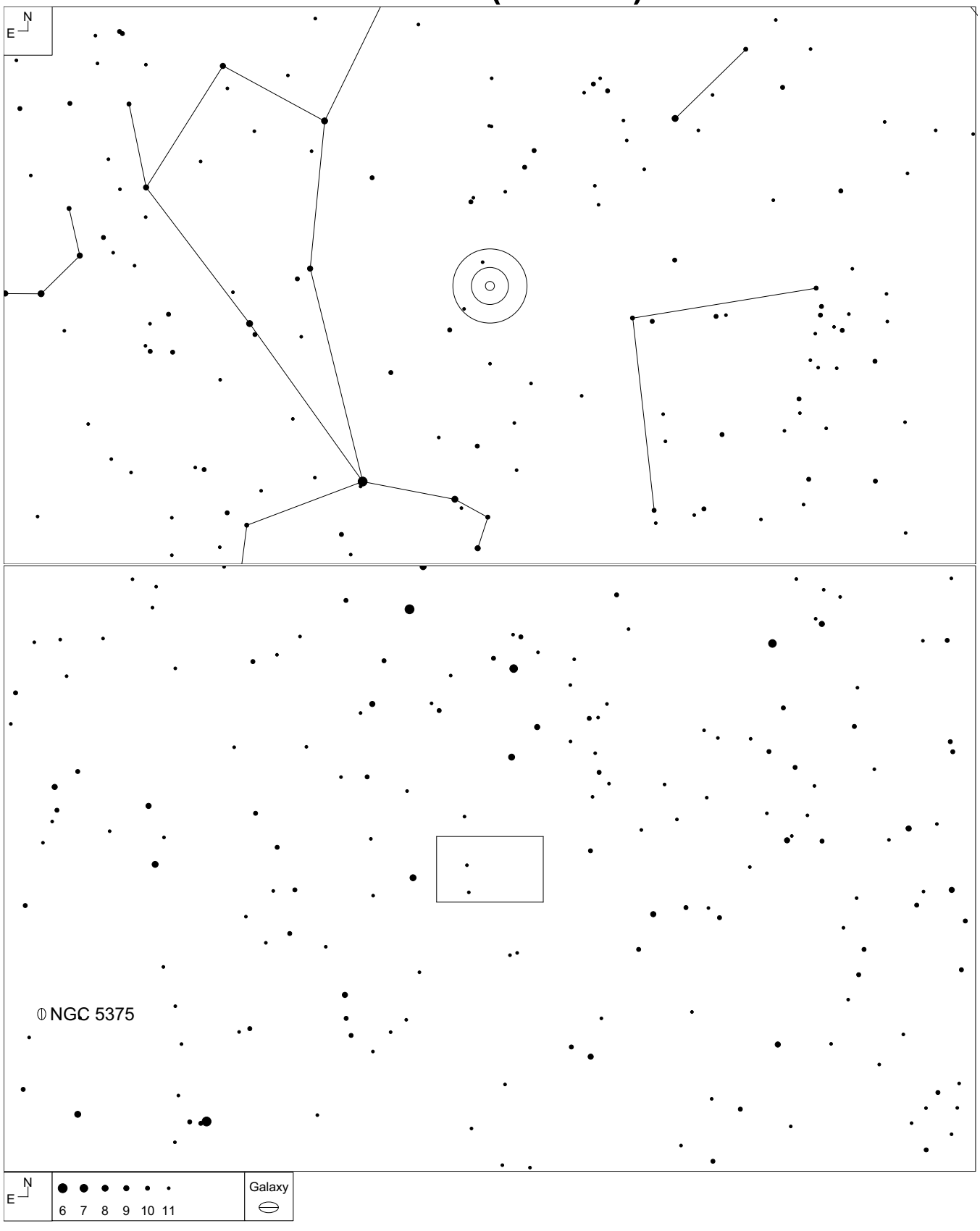
S10765 Boo (Bootes)





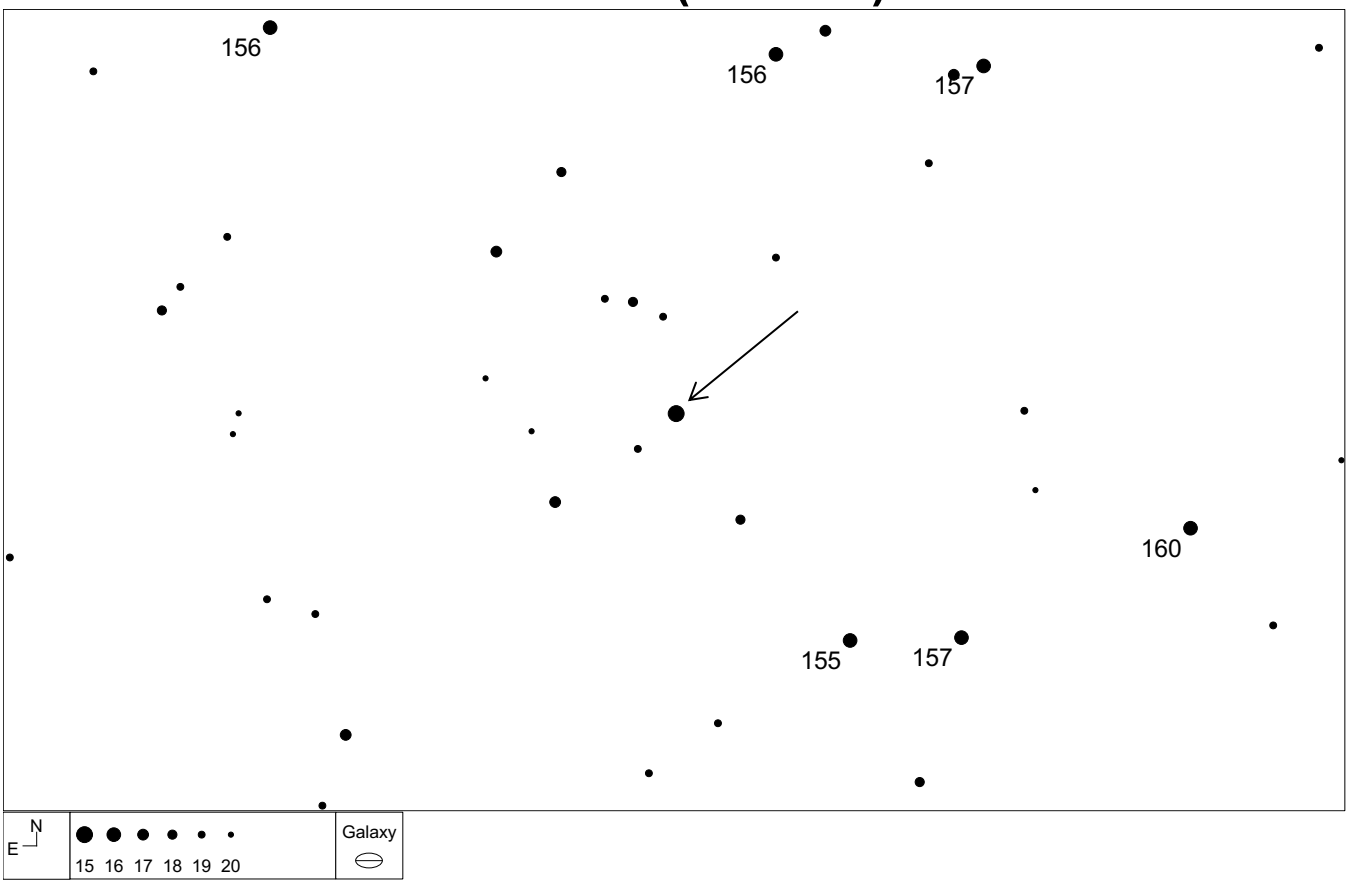
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	13 46 47.2	+29 54 20	17.0 – 18.8	10”	0.63	NGP9 F324-276706

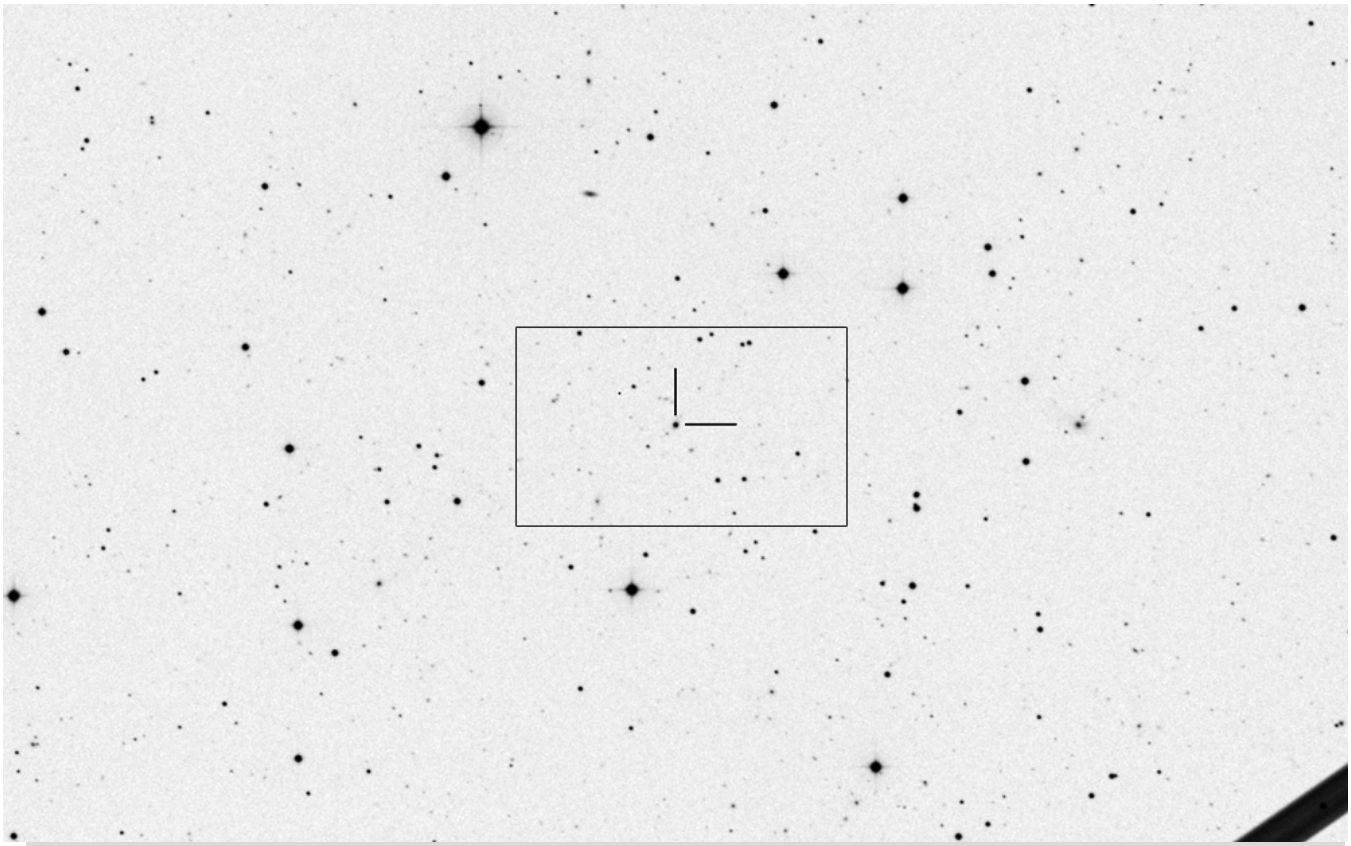
OQ 530 (Bootes)



Worrall, D.M. et al "Multifrequency observations of the BL Lacertae objects OQ 530 and ON 325" *Astrophysical Journal*, Vol 284 (1984): 512-518

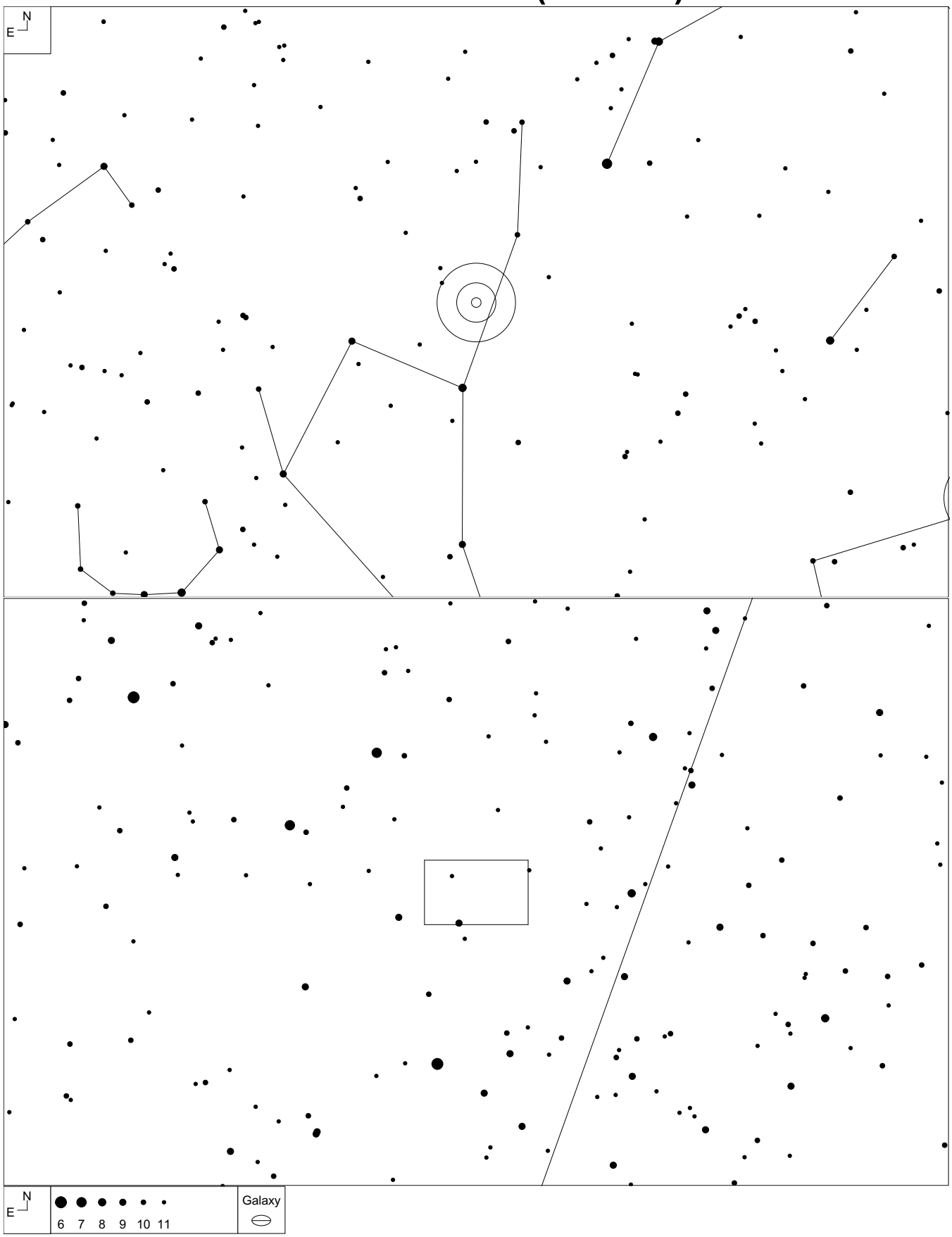
OQ 530 (Bootes)



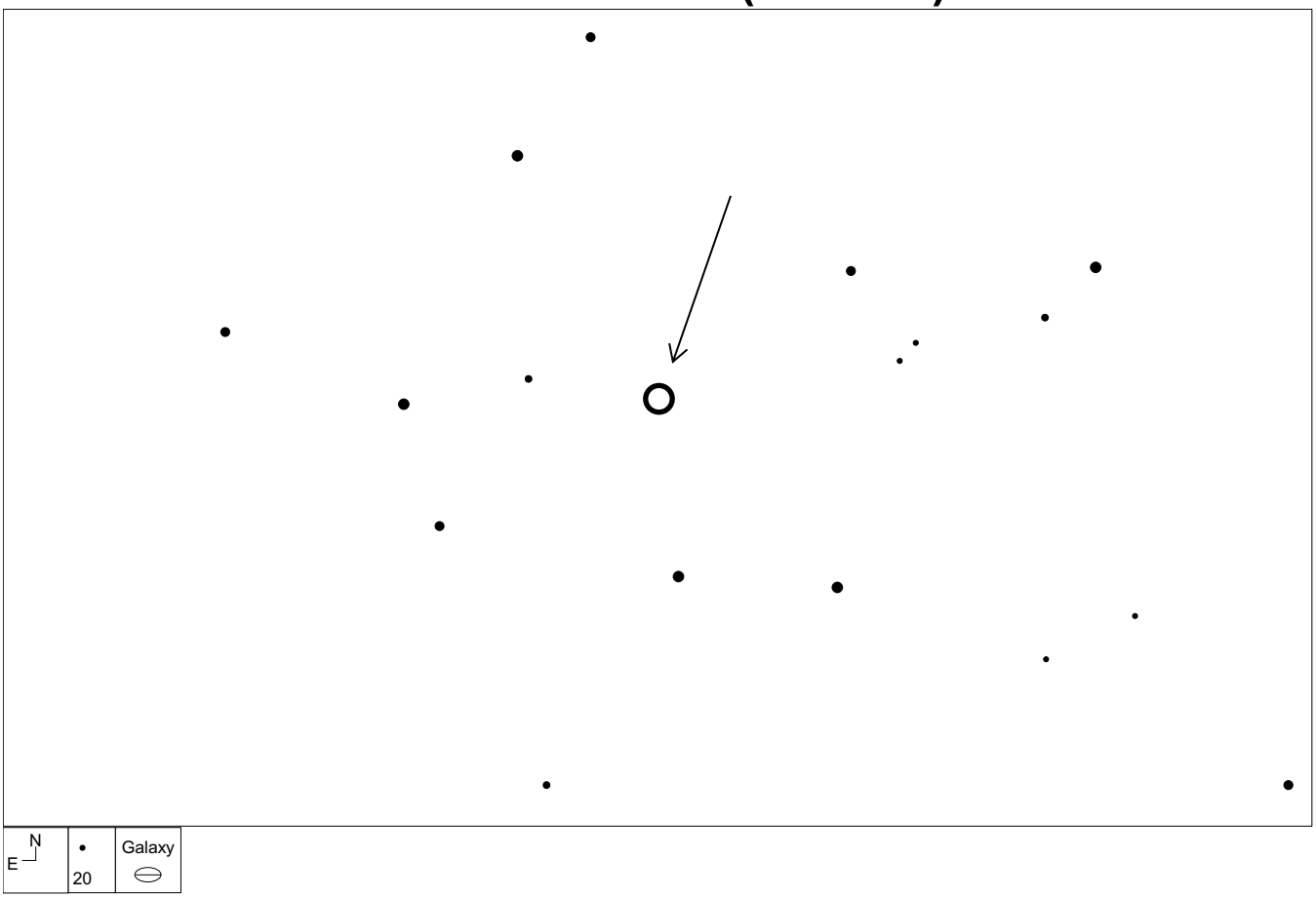


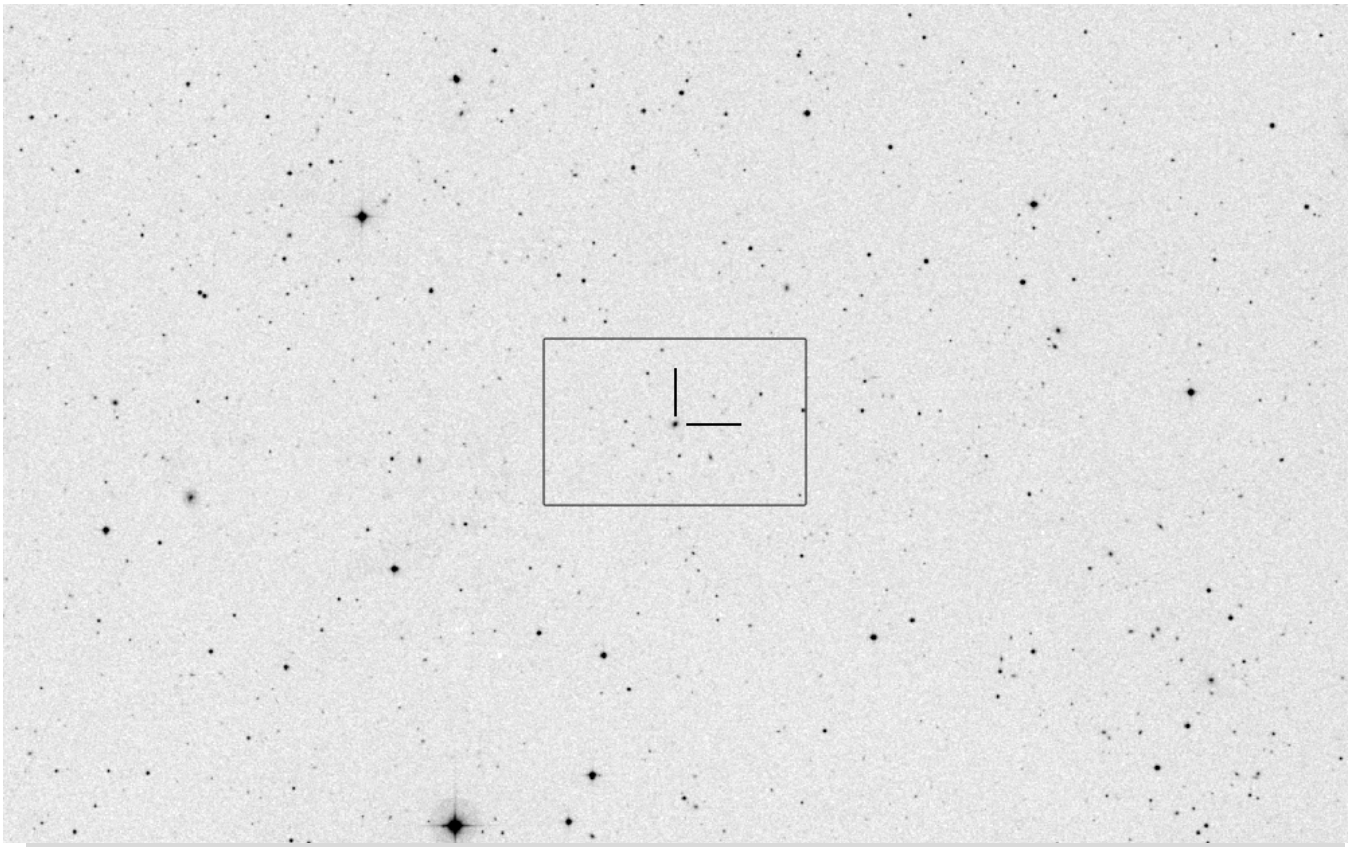
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	14 19 46.6	+54 23 15	14.6 - 15.9	10”	0.151	PG 1418+546

1ES 1426+428 (Bootes)



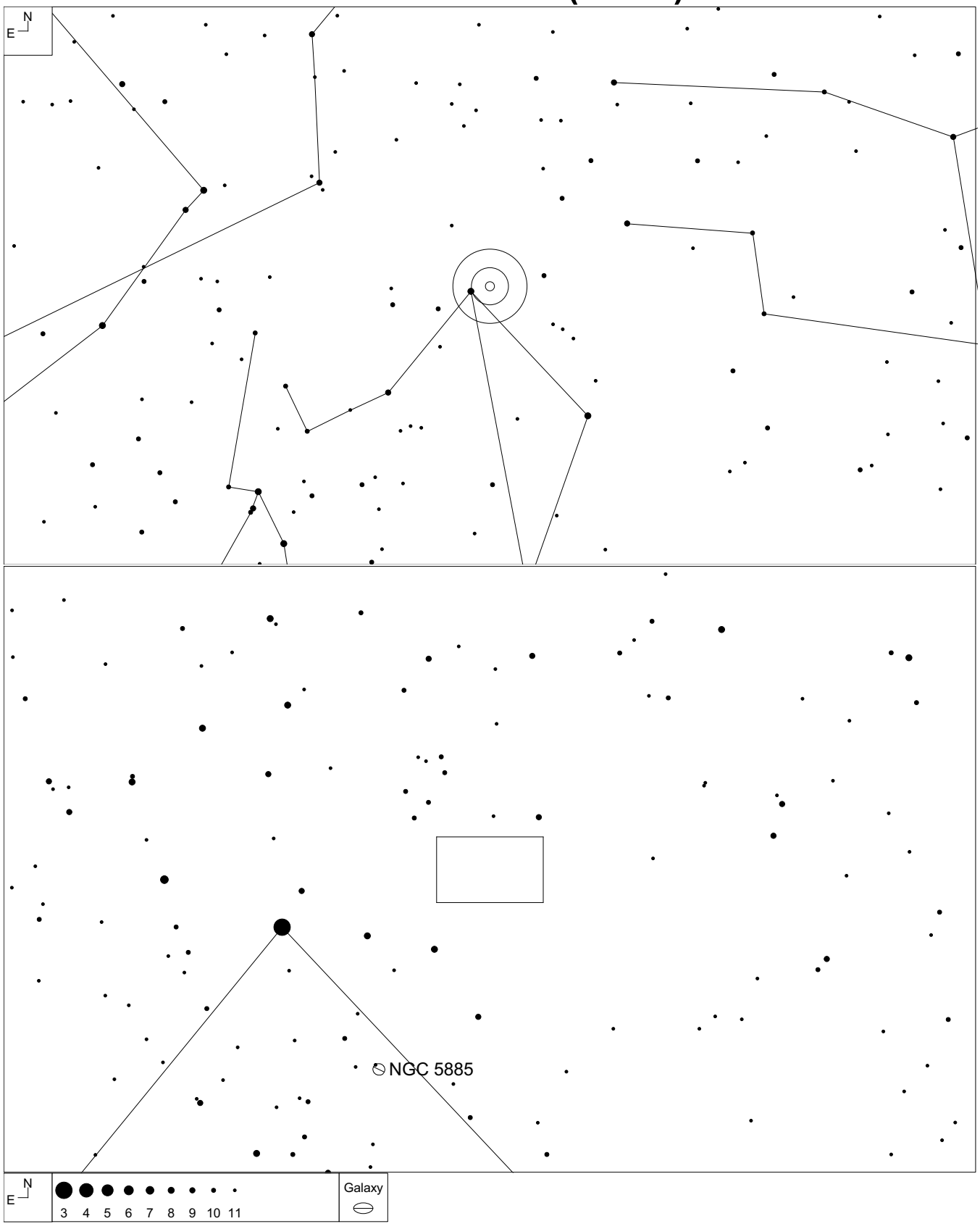
1ES 1426+428 (Bootes)



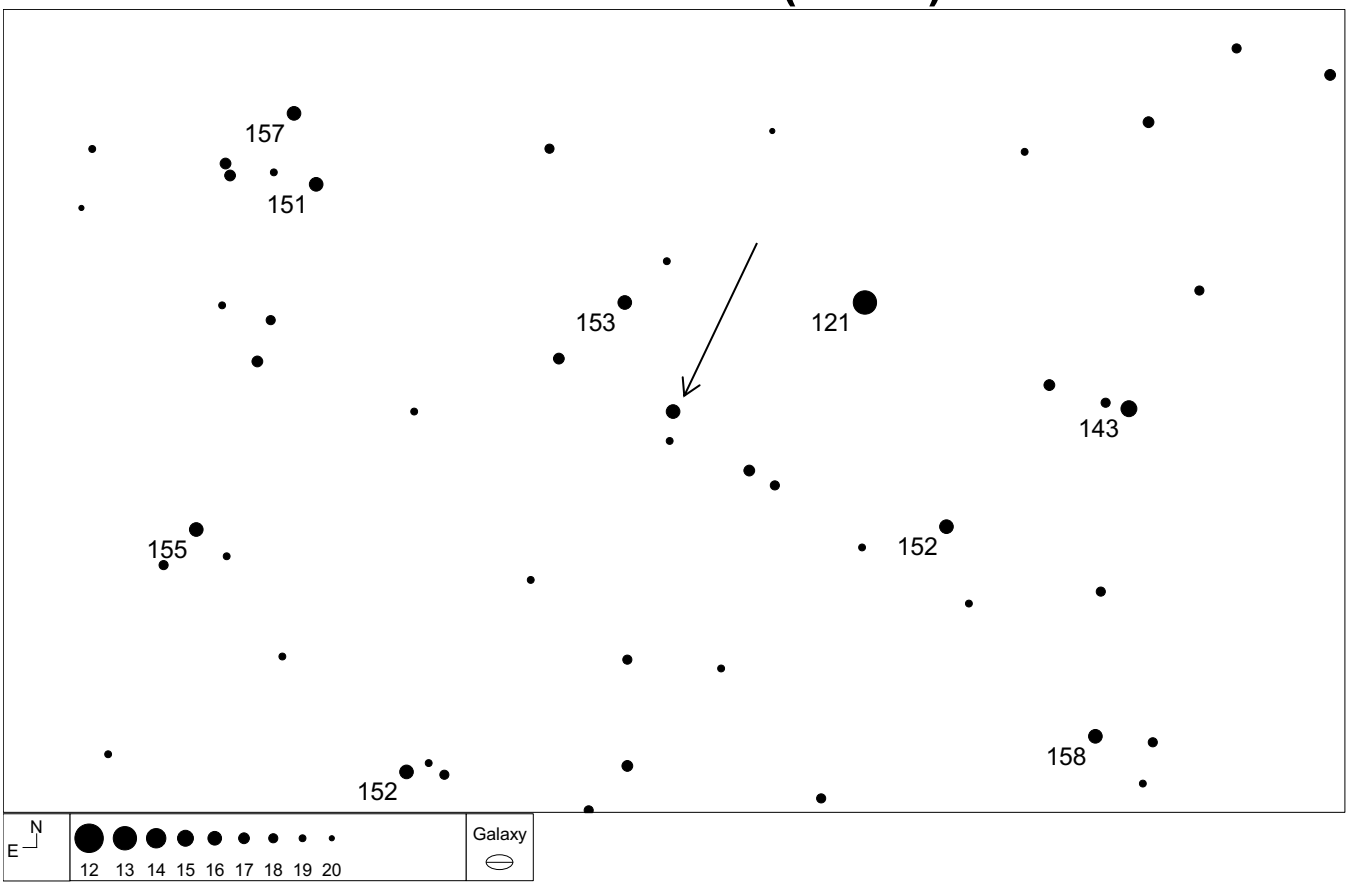


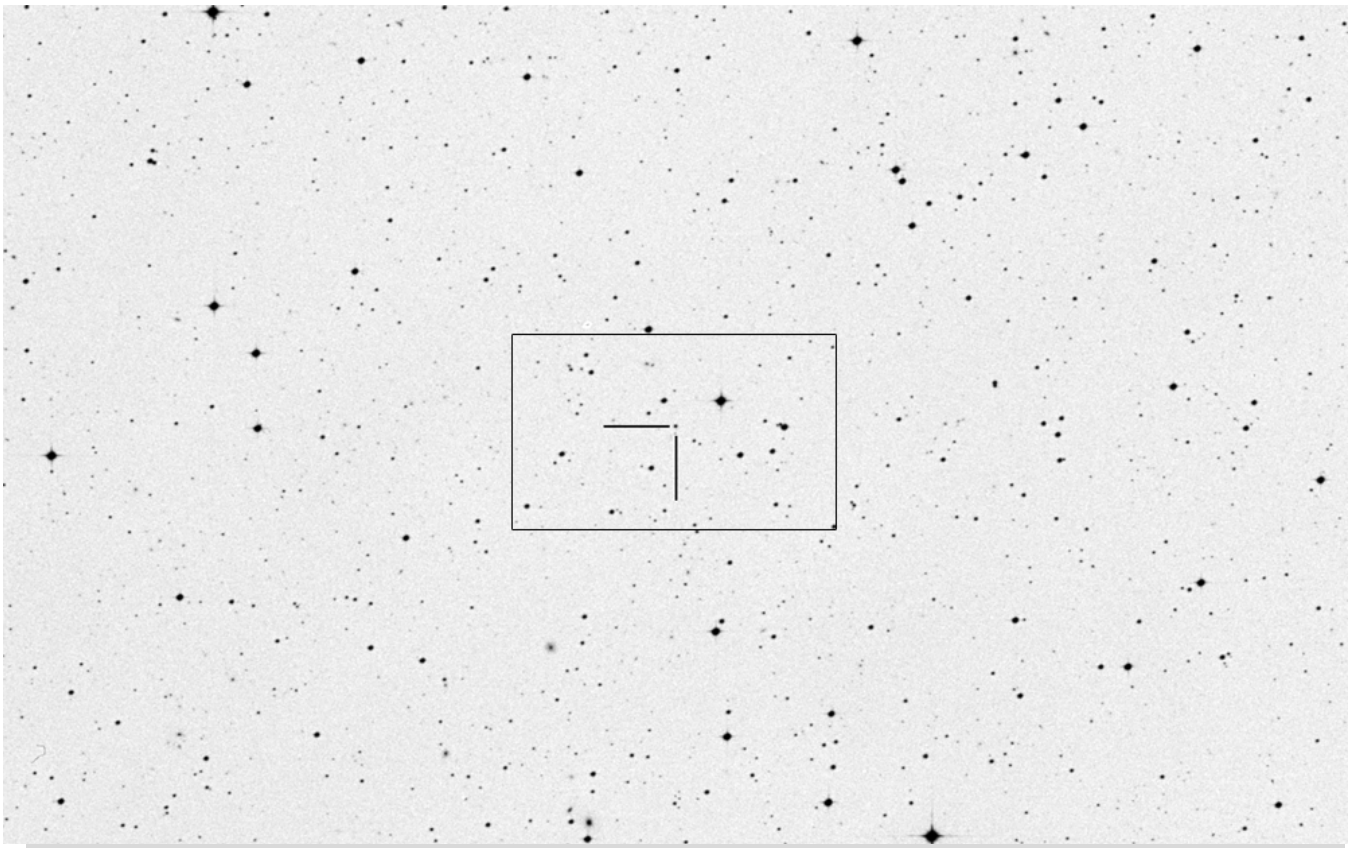
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	14 28 32.6	+42 40 21	13.8 - 16.4	0.2’	0.129	

PKS 1510-089 (Libra)



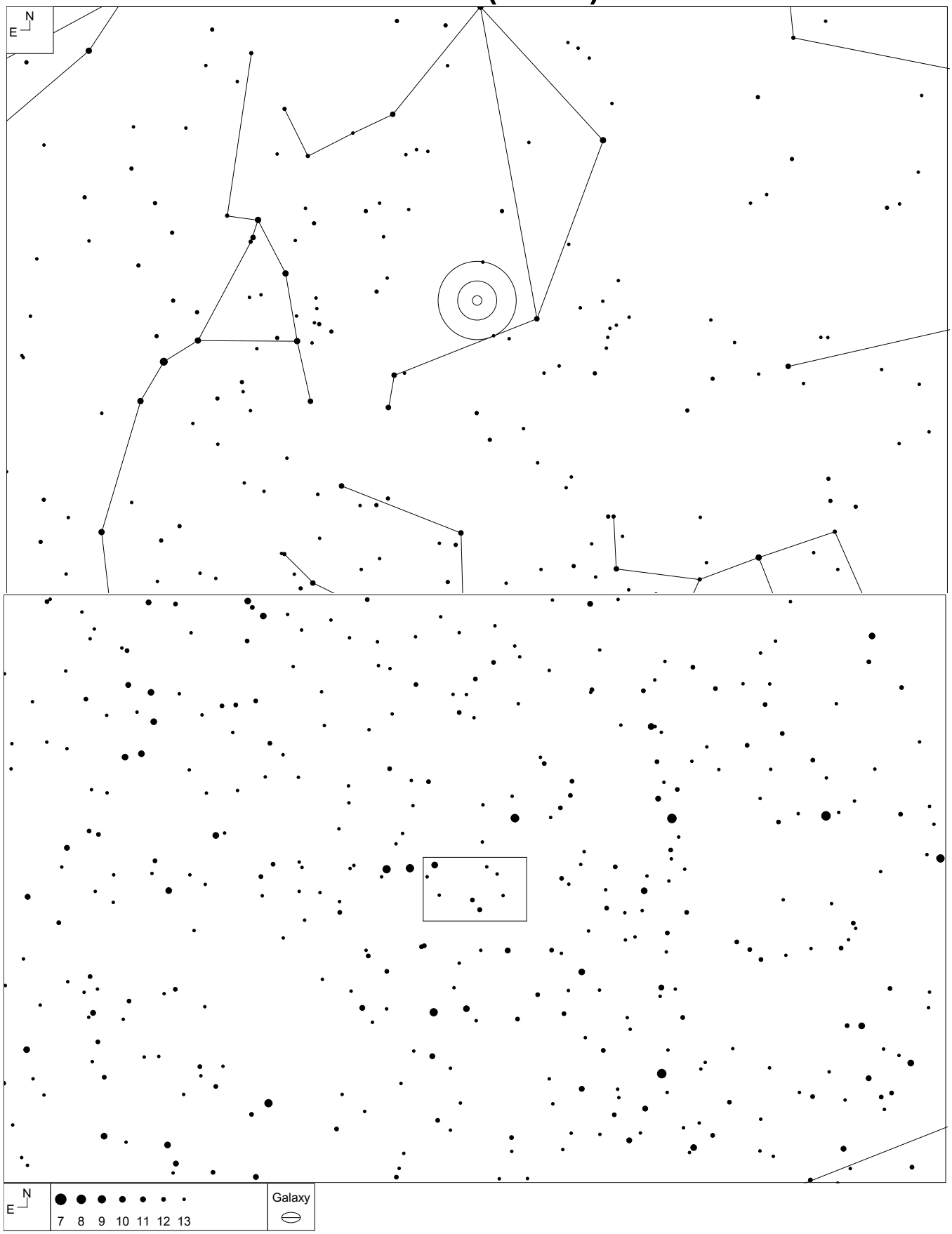
PKS 1510-089 (Libra)



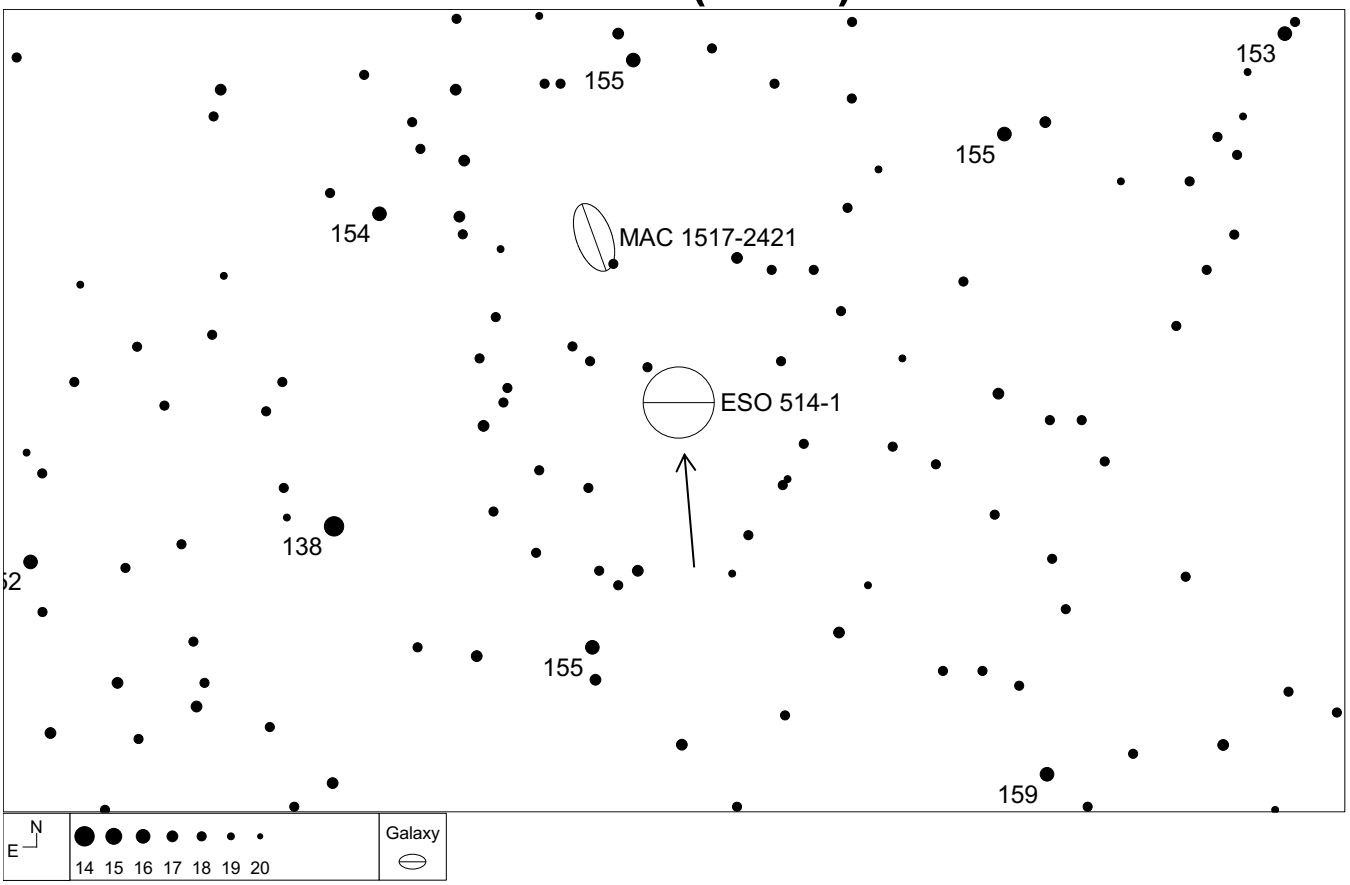


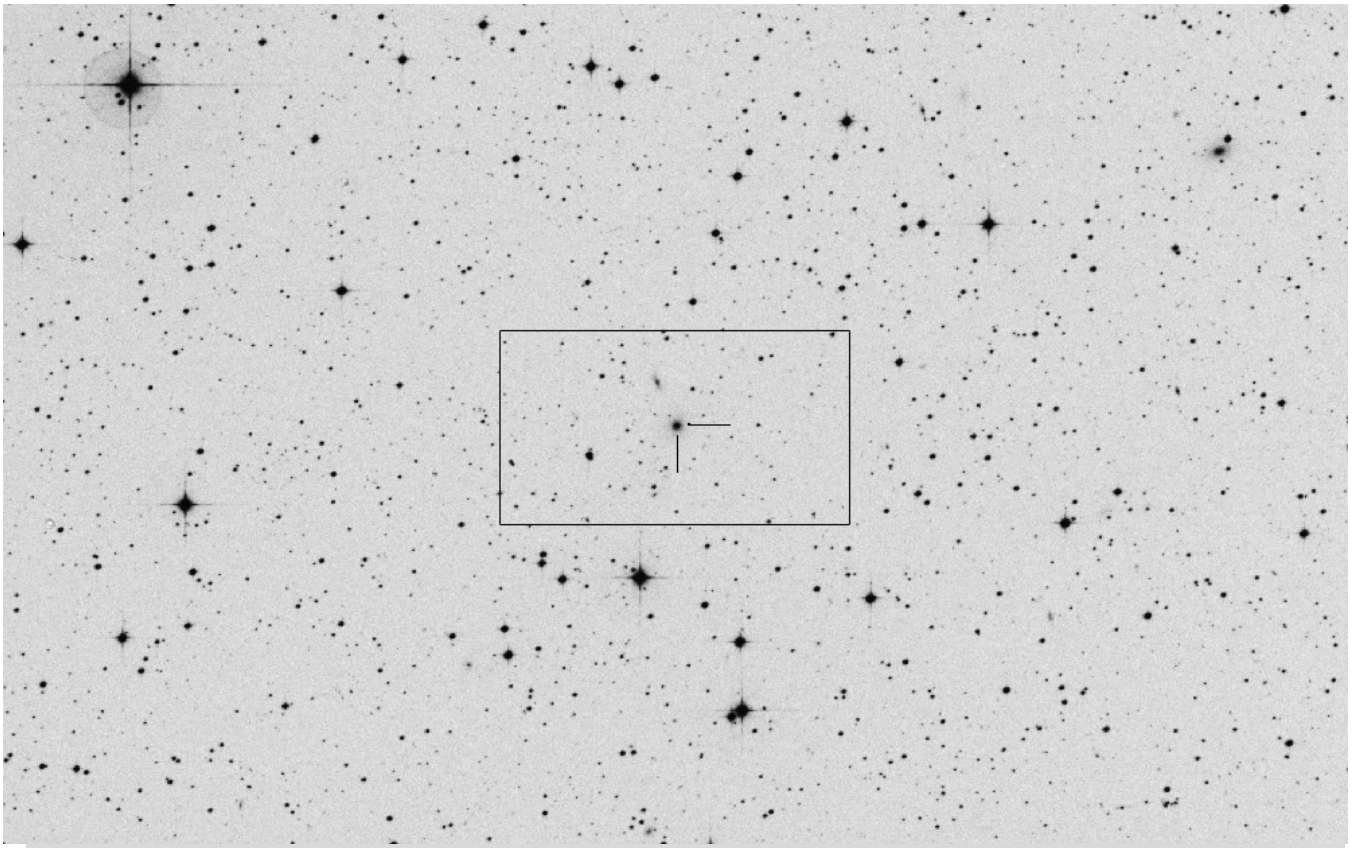
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	15 12 50.5	-09 06 00	11.8 - 17.8	stellar	0.36	OR-017

AP Lib (Libra)



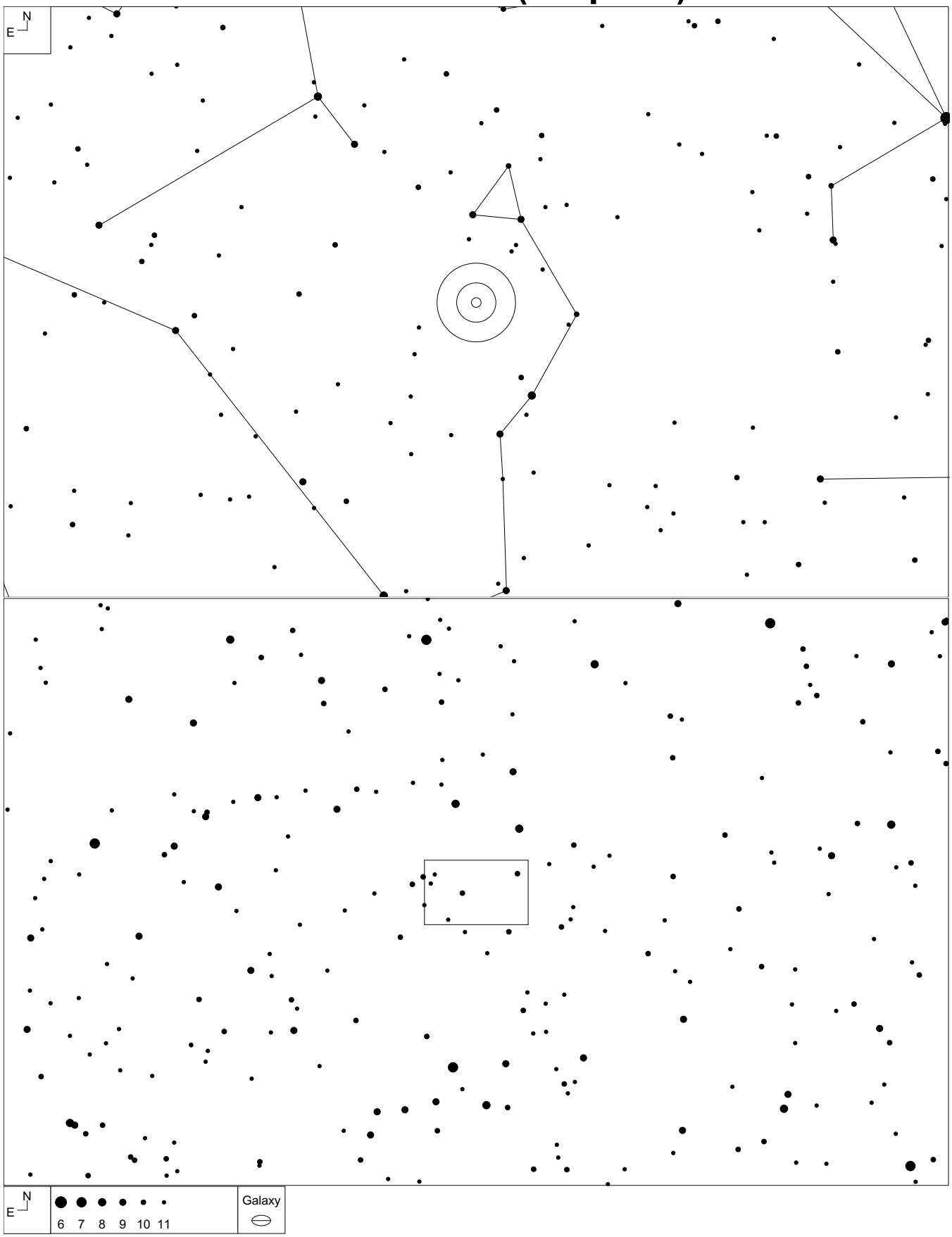
AP Lib (Libra)





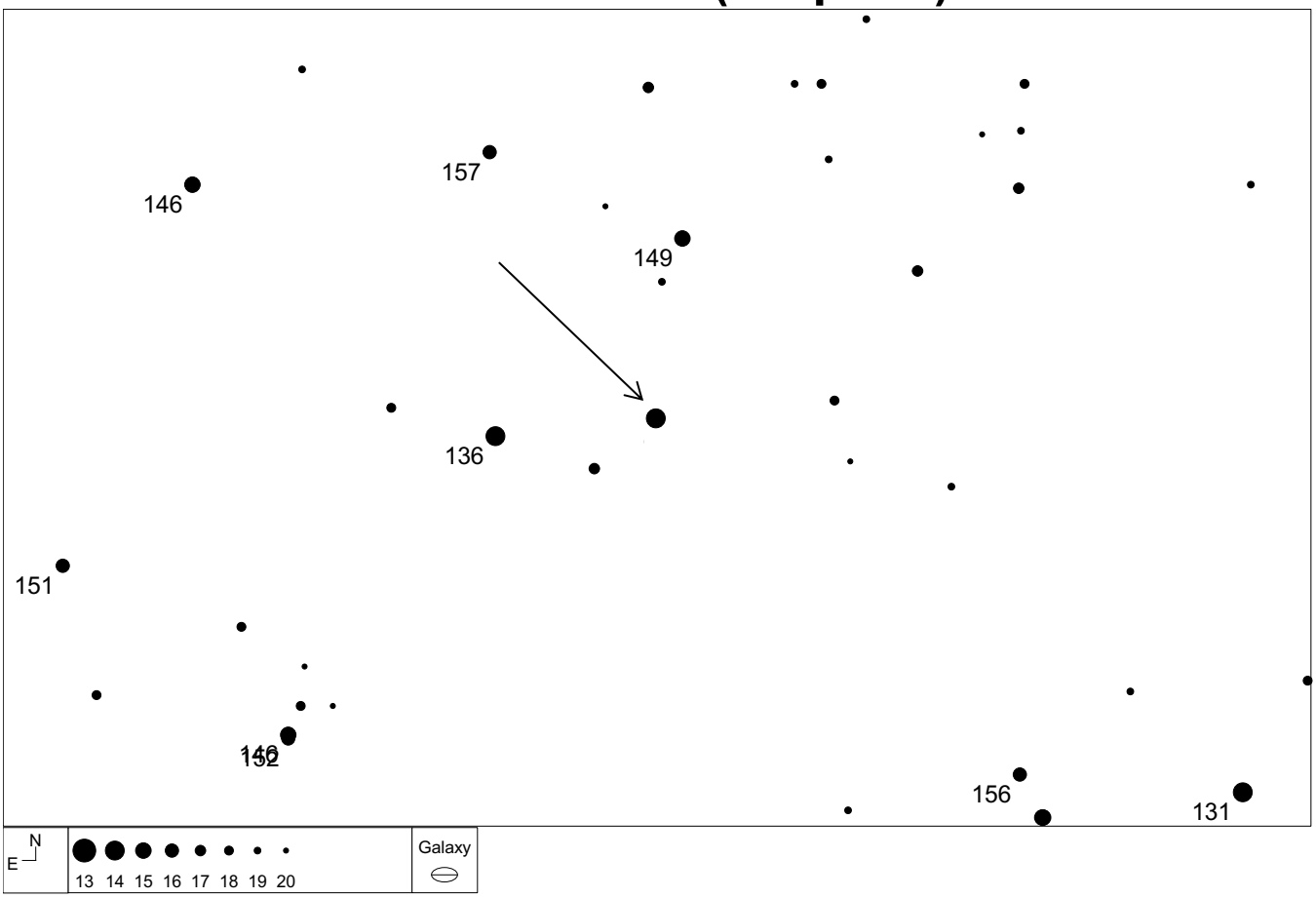
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	15 17 41.9	-24 22 22	14.0 – 16.7	25”	0.042	PKS 1514-04

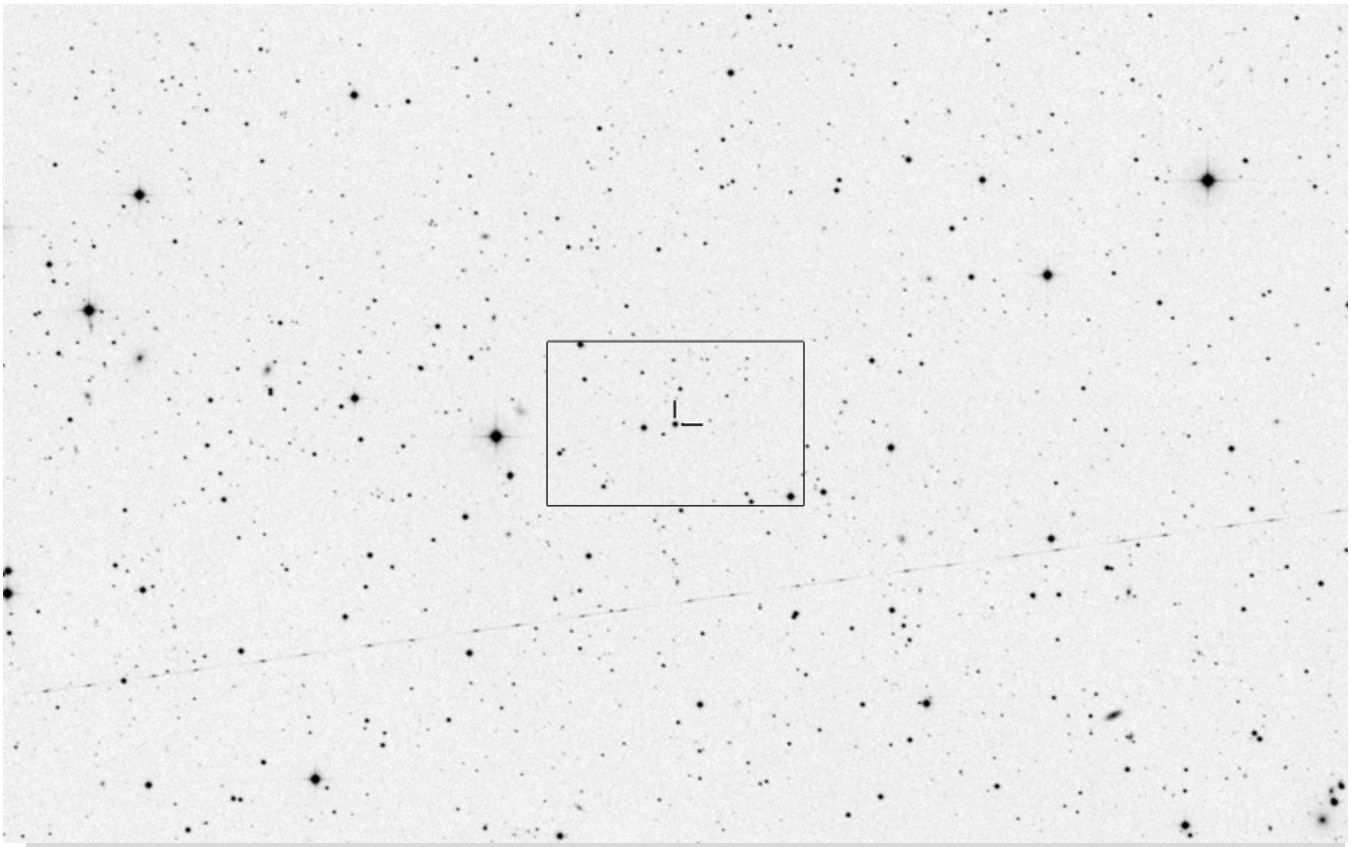
PG 1553+113 (Serpens)



Aleksic, J. et al "PG 1553+113: Five Years of Observations with MAGIC". *Astrophysical Journal*, Vol 748 (2012): 46-55

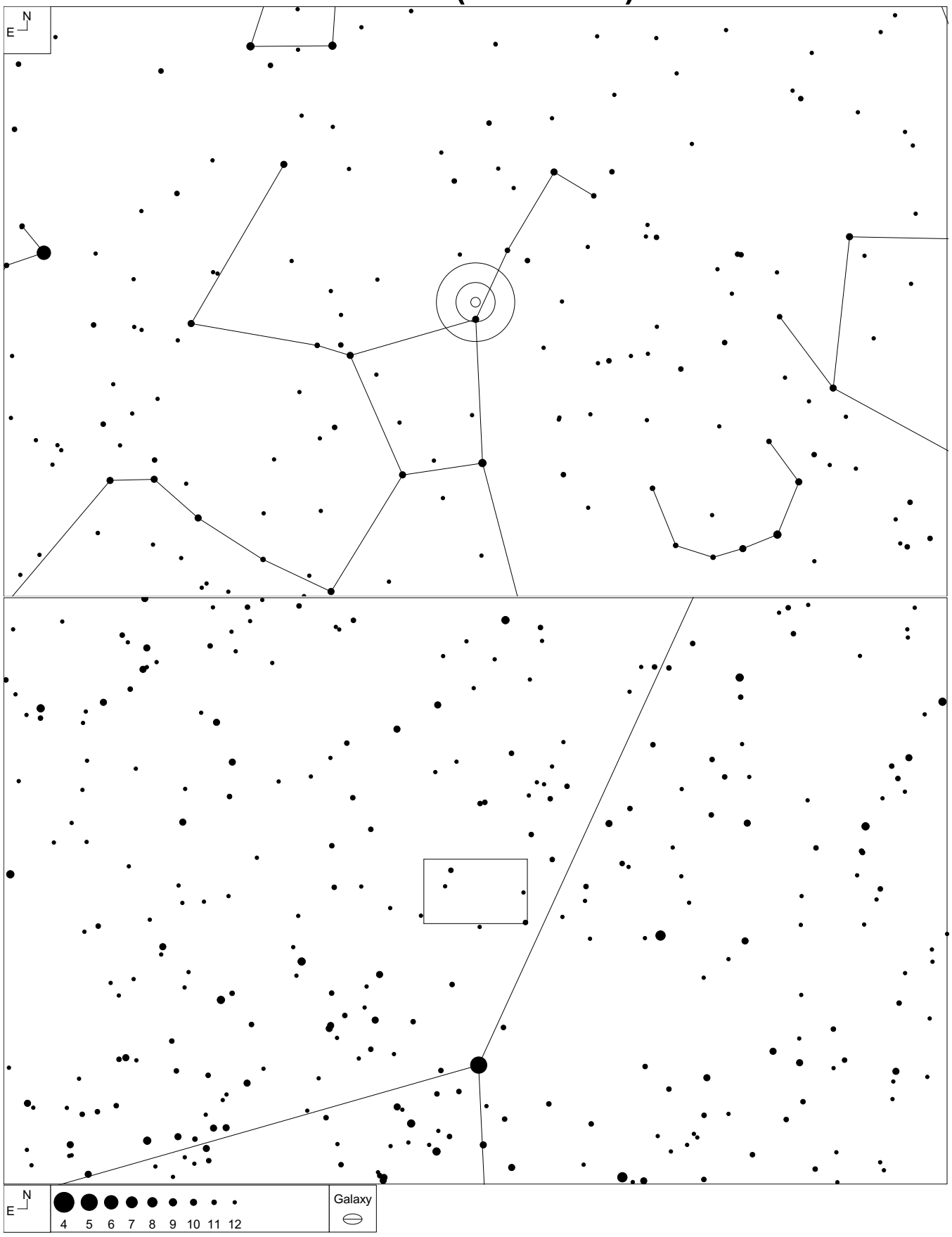
PG 1553+113 (Serpens)





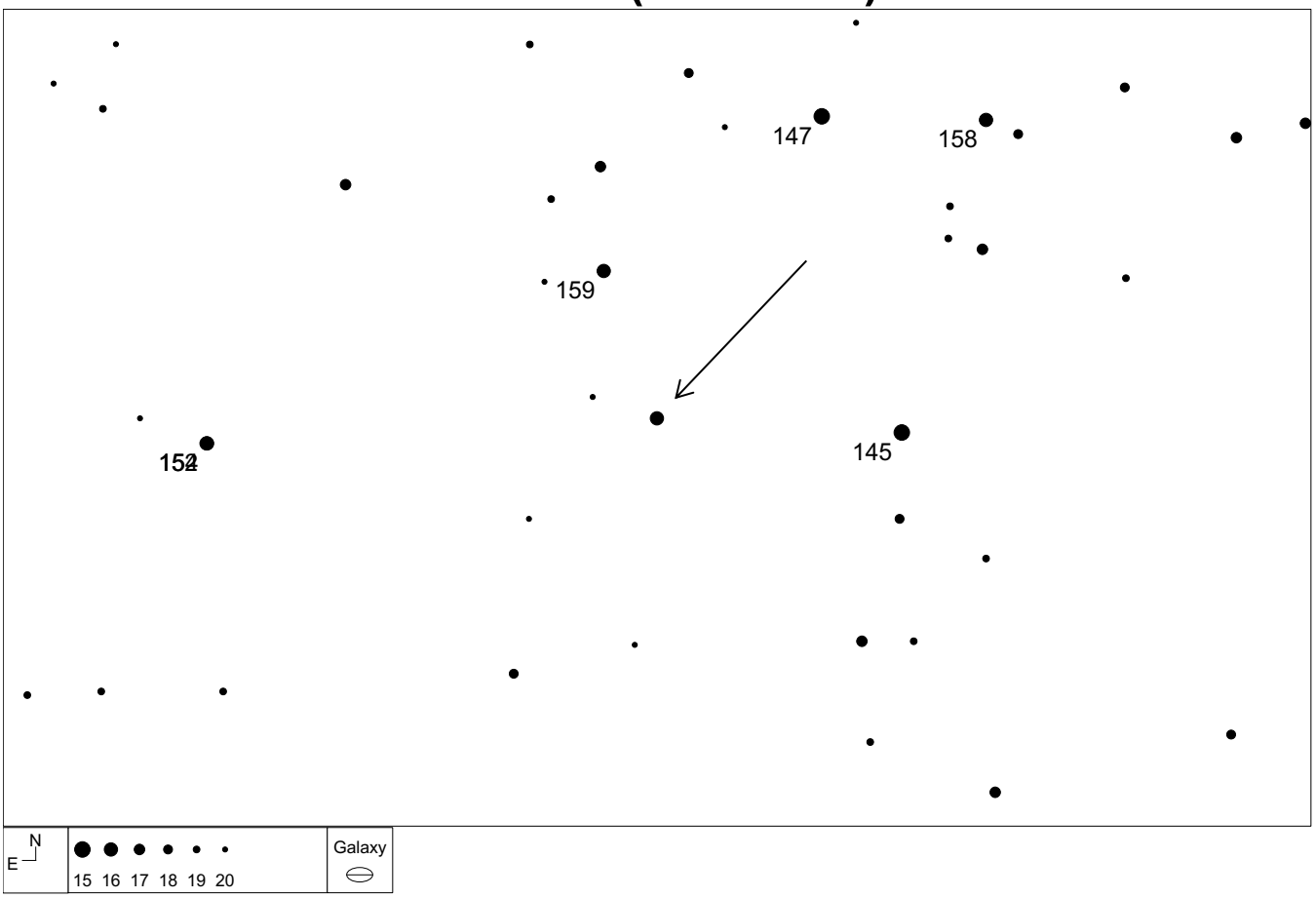
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	15 55 43.0	+11 11 24	13.1 - 13.9	stellar	0.36	

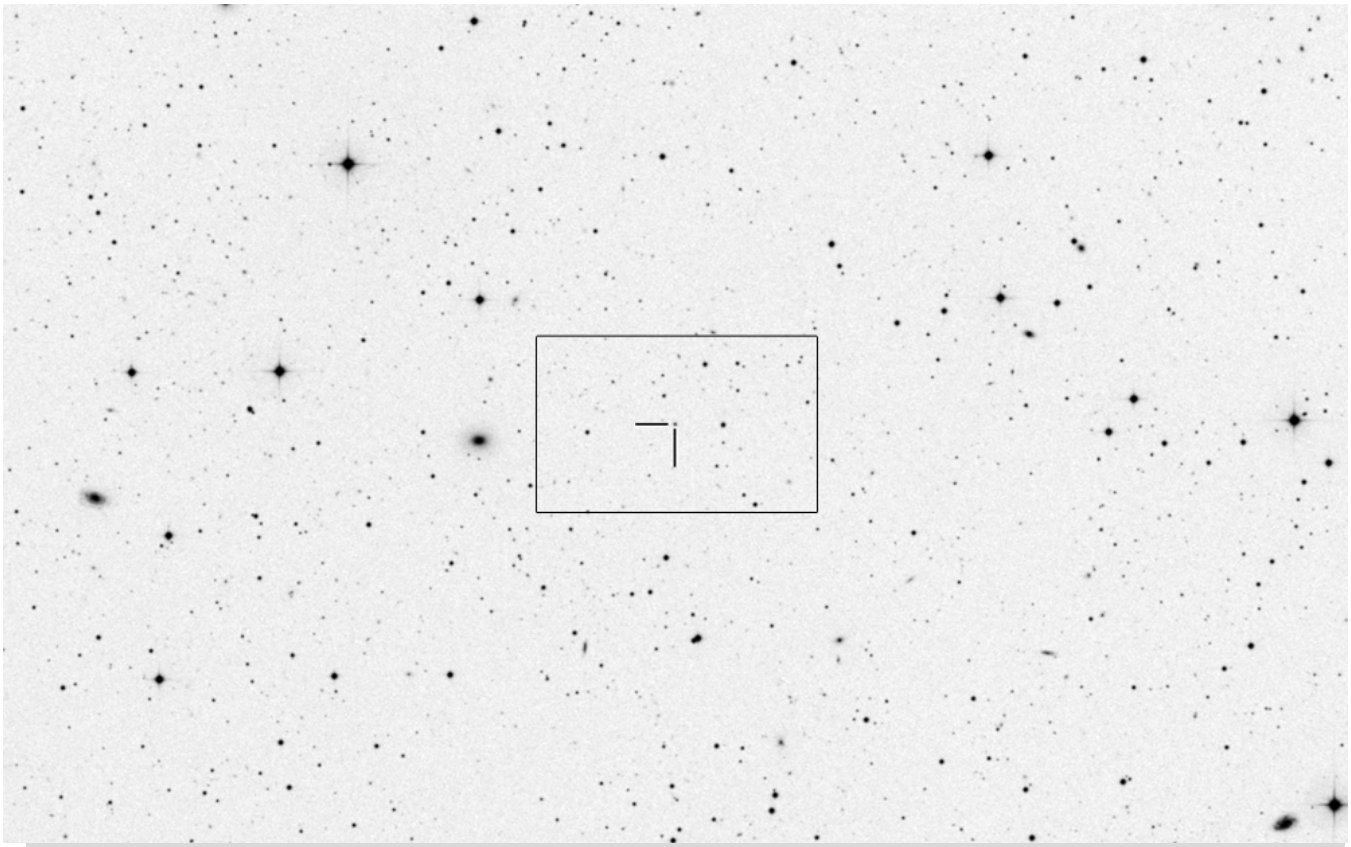
3C 345 (Hercules)



Quasar Jet Exceeds 7 times the Speed of Light (http://laserstars.org/news/3C345.html)
Moore, R.L. et al "Superluminal Acceleration in 3C 345" *Nature*, Vol 306 (1983): 44-46

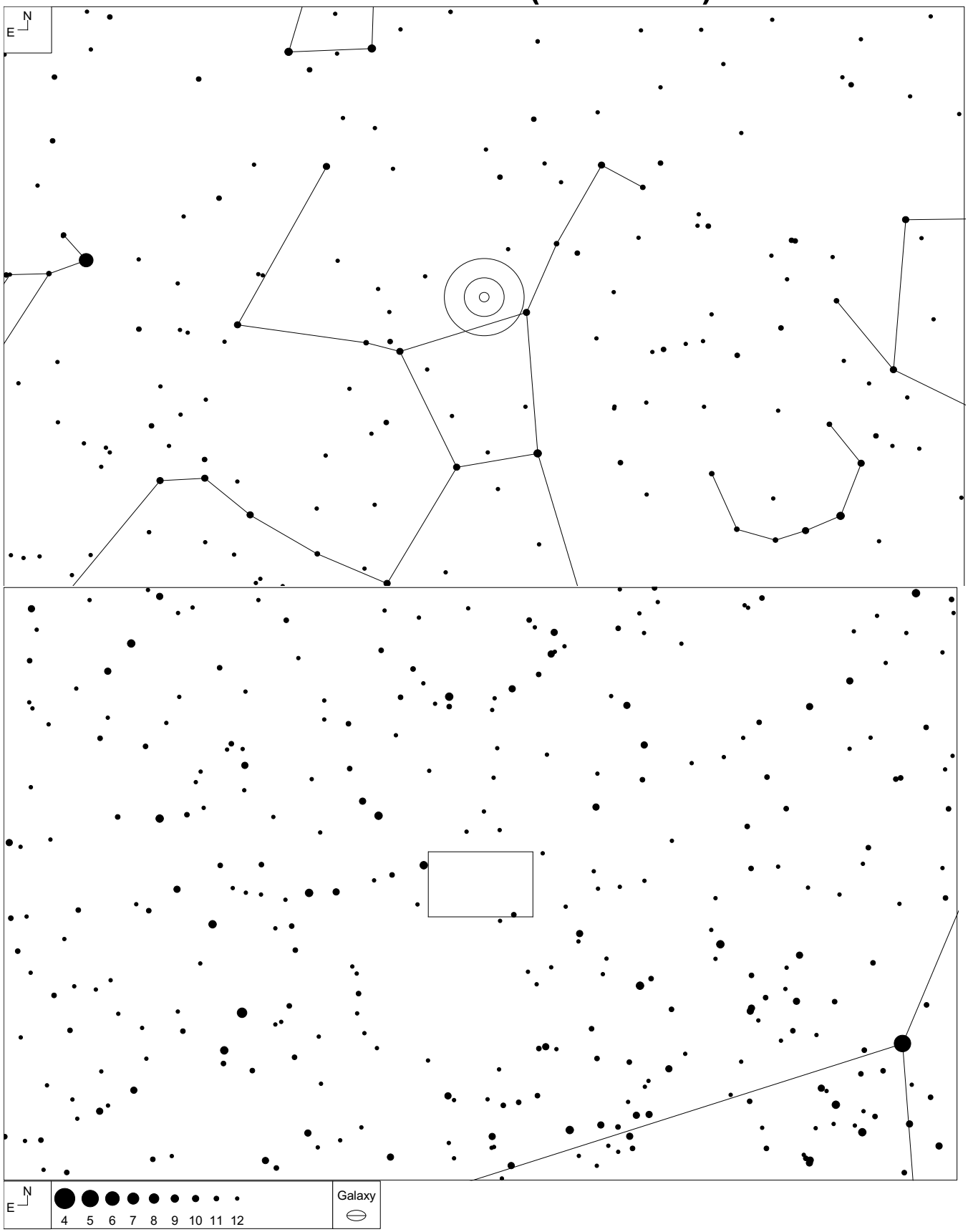
3C 345 (Hercules)





Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	16 42 58.8	+39 48 37	14.3 - 17.3	stellar	0.5928	

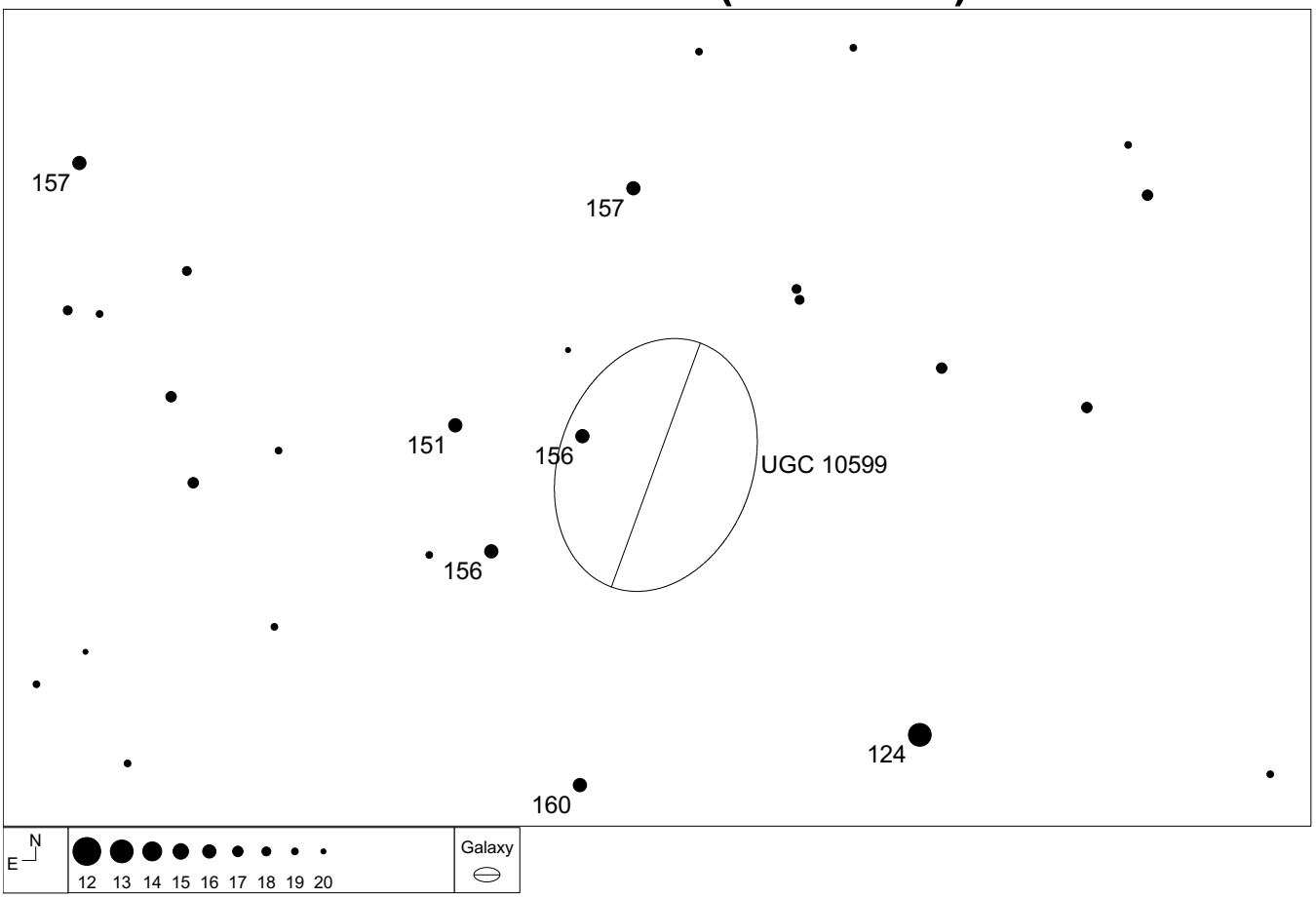
Markarian 501 (Hercules)

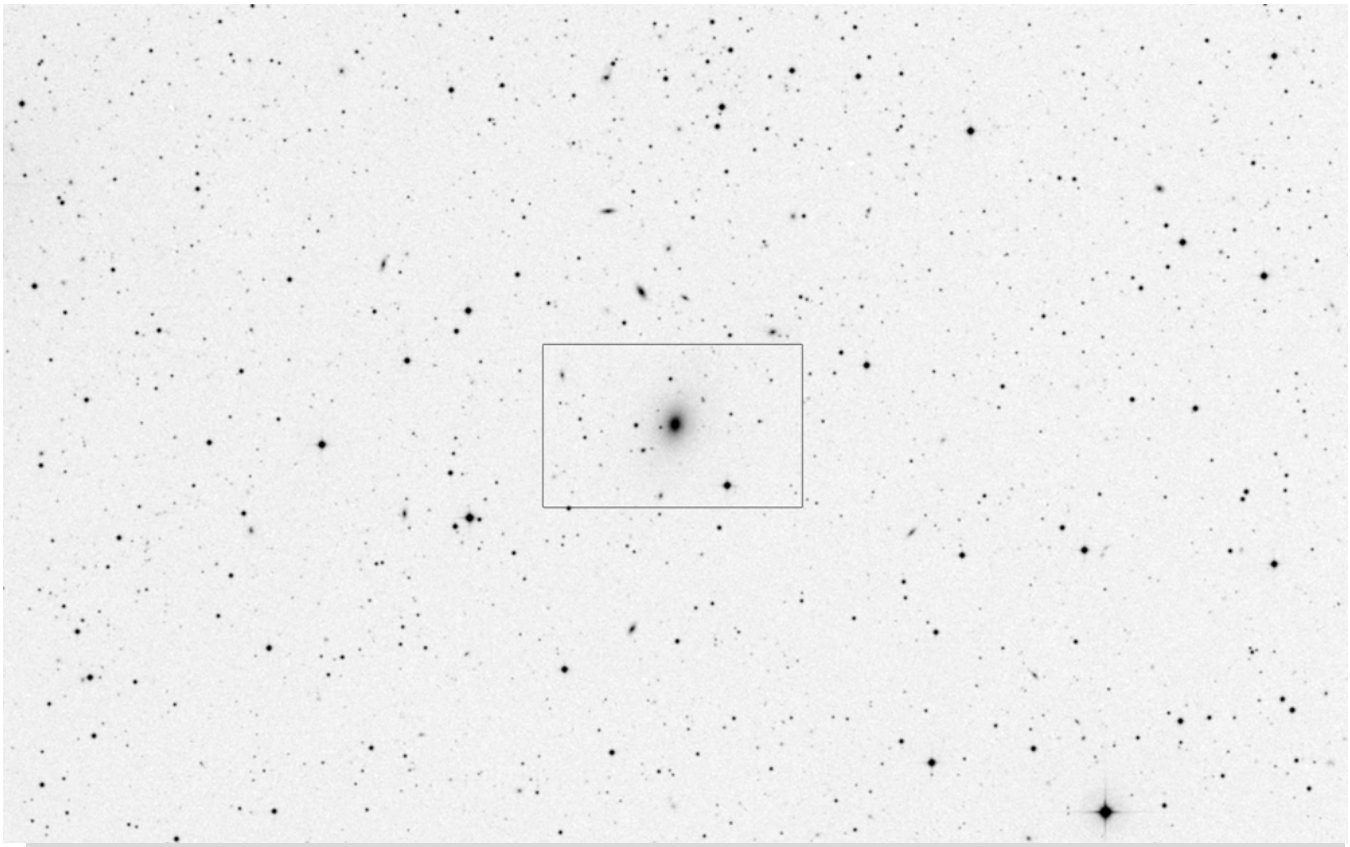


During remarkable flaring activity in 1997 Markarian 501 was the brightest source in the sky at TeV energies, outshining the Crab Nebula by a factor of up to 10

Protheroe, R.J. et al "Very High Energy Gamma Rays from Markarian 501" *25 Int. Cosmic Ray Conf., Durban 1997, Highlight Session*

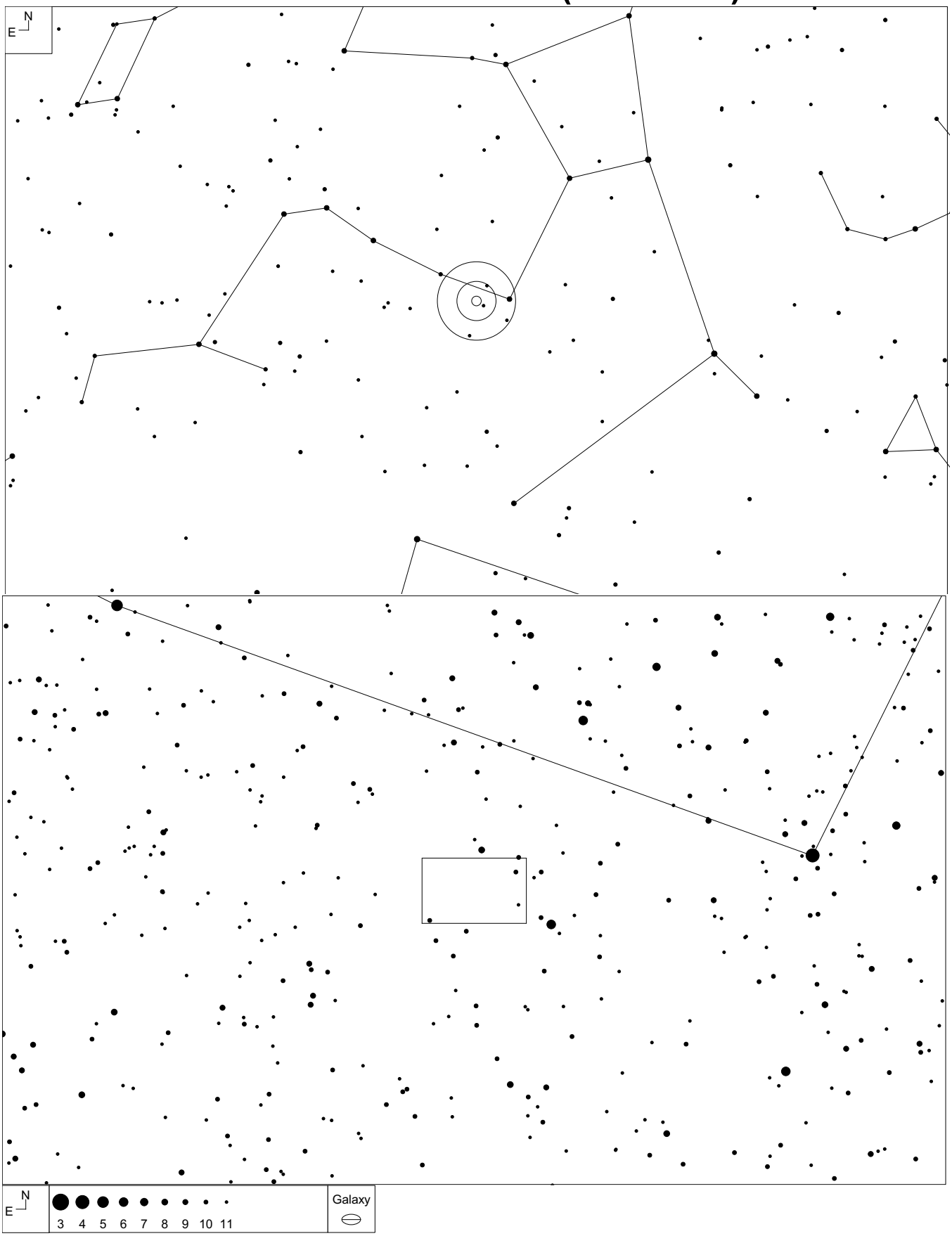
Markarian 501 (Hercules)





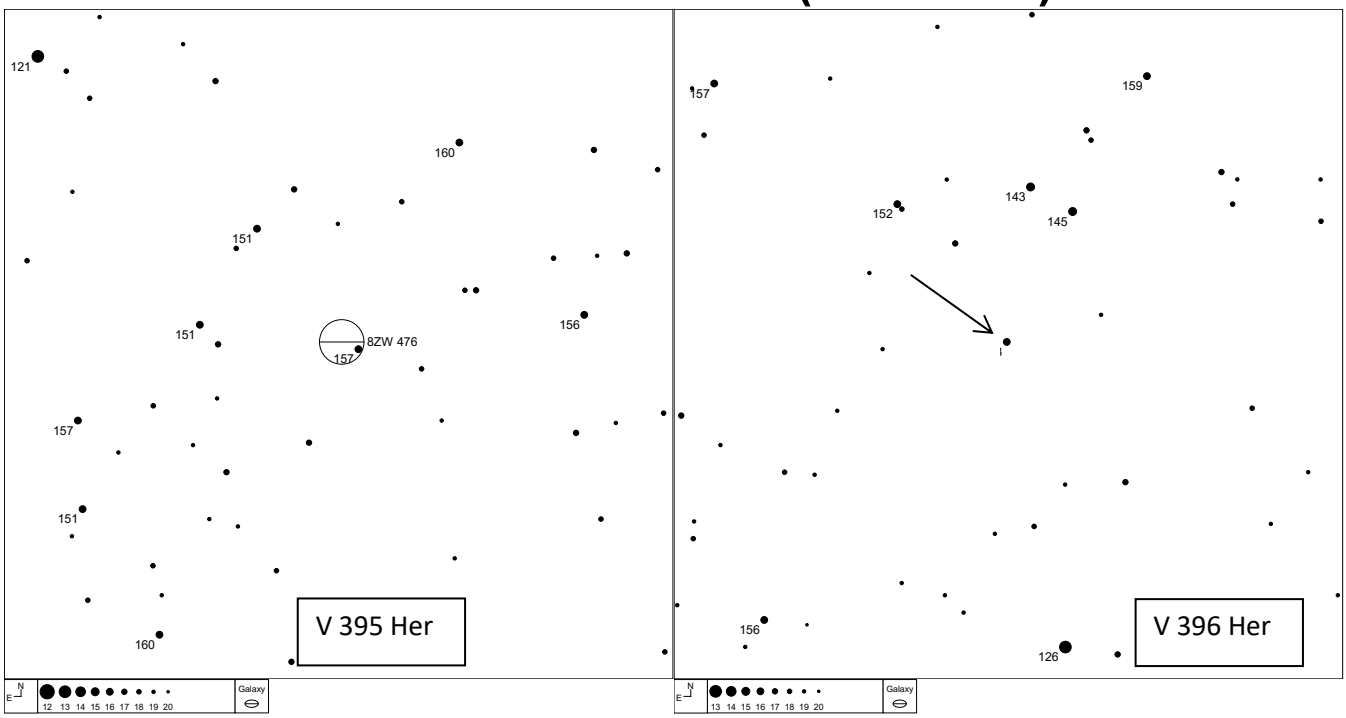
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	16 53 52.2	+39 45 37	13.3 – 13.9	1.2 x 0.9’	0.0337	UGC 10599

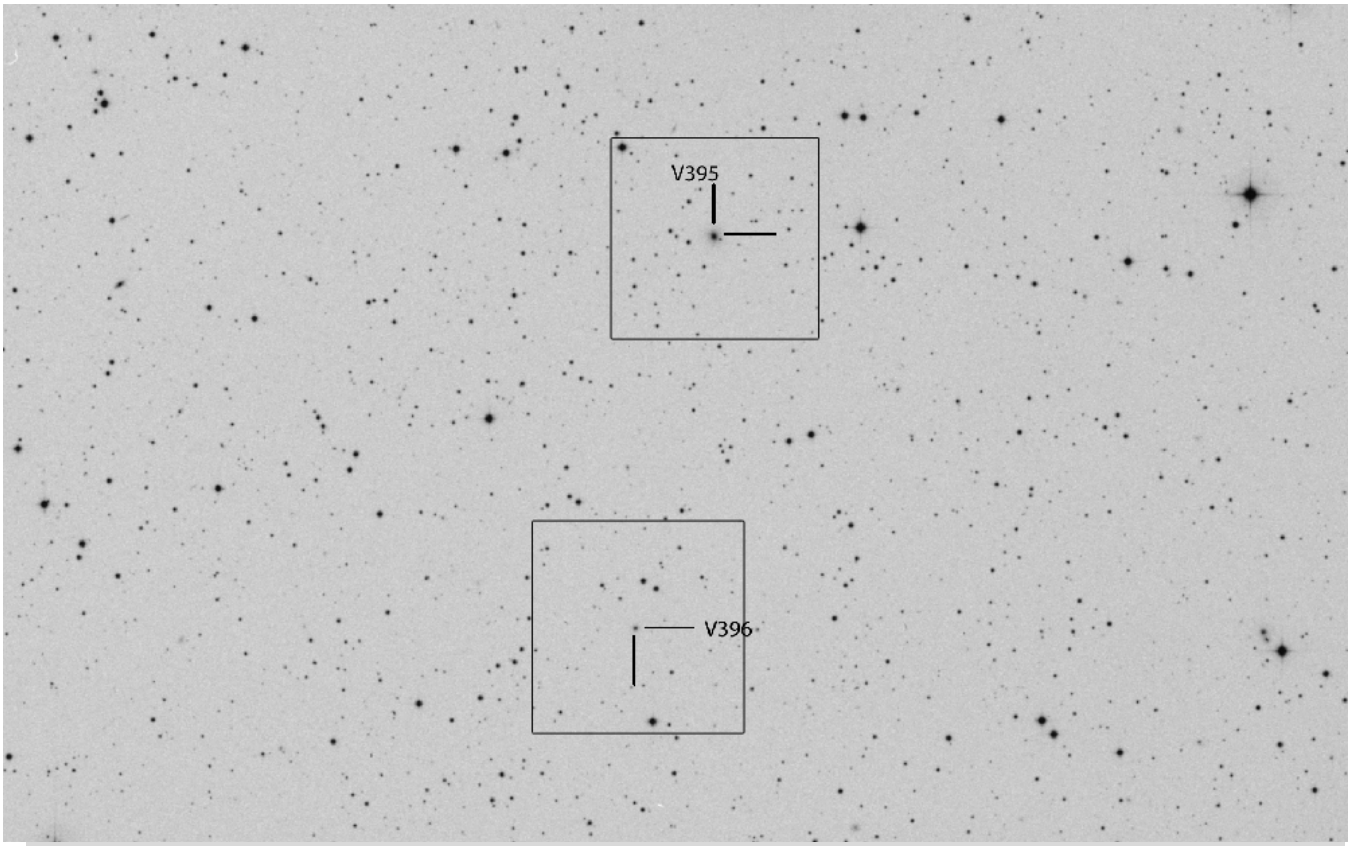
V395 and V396 Her (Hercules)



Bond, H.E. “The Optically Variable Galaxy V395 Herculis” *Astrophysical Journal*, Vol 174 (1972): L163
Bond, H.E., et al “GQ Comae and V396 Herculis - Two low-redshift, optically variable QSOs” *Astrophysical Journal*, Vol 212 (1977): 1-7

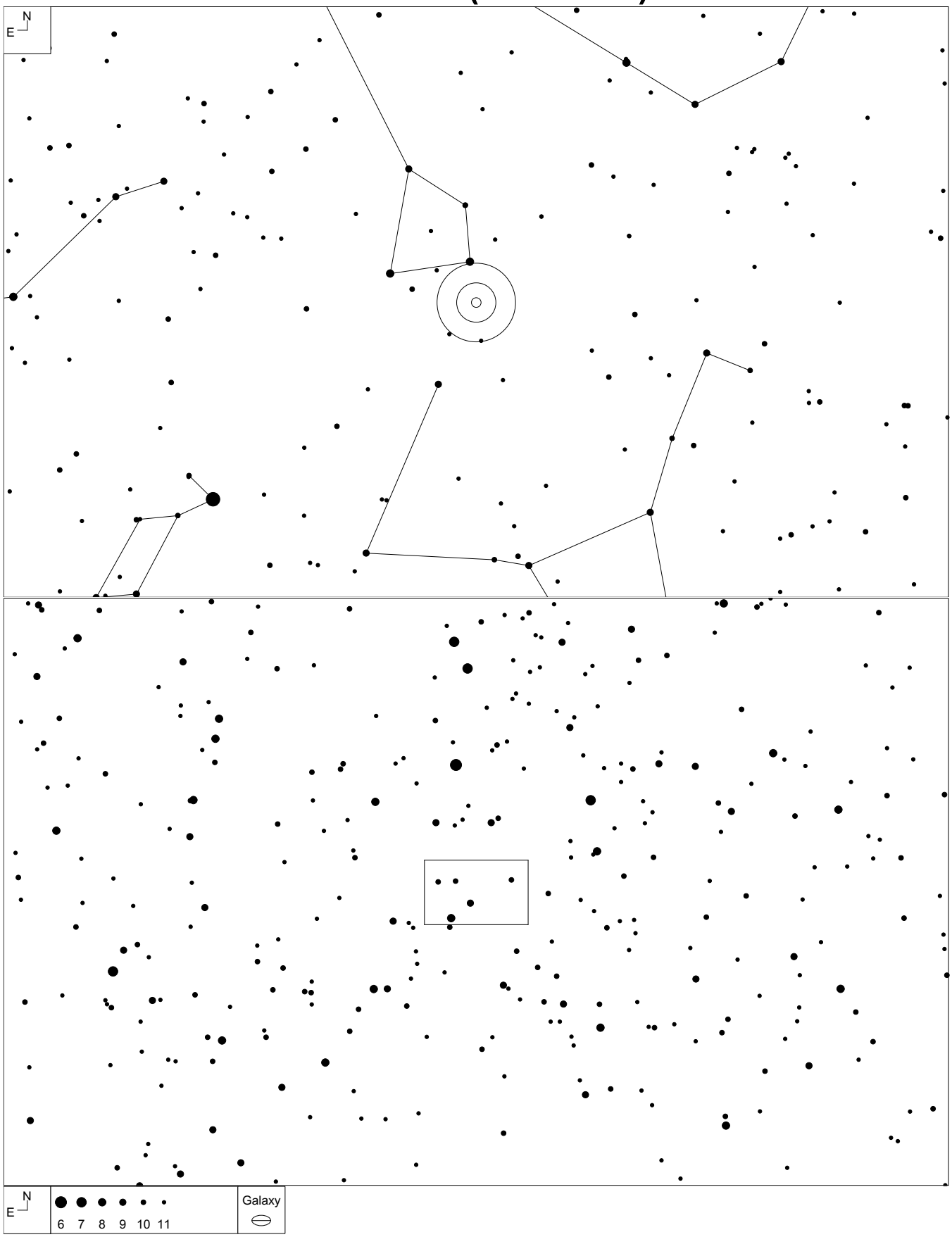
V395 and V396 Her (Hercules)





Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	17 22 34.1	+24 45 00	16.1 – 17.7	20 x 16”	0.0638	8 Zw 246 (V395)
QSO	17 22 41.2	+24 36 18	15.7 – 16.7	8”	0.175	Q1720+246 (V396)

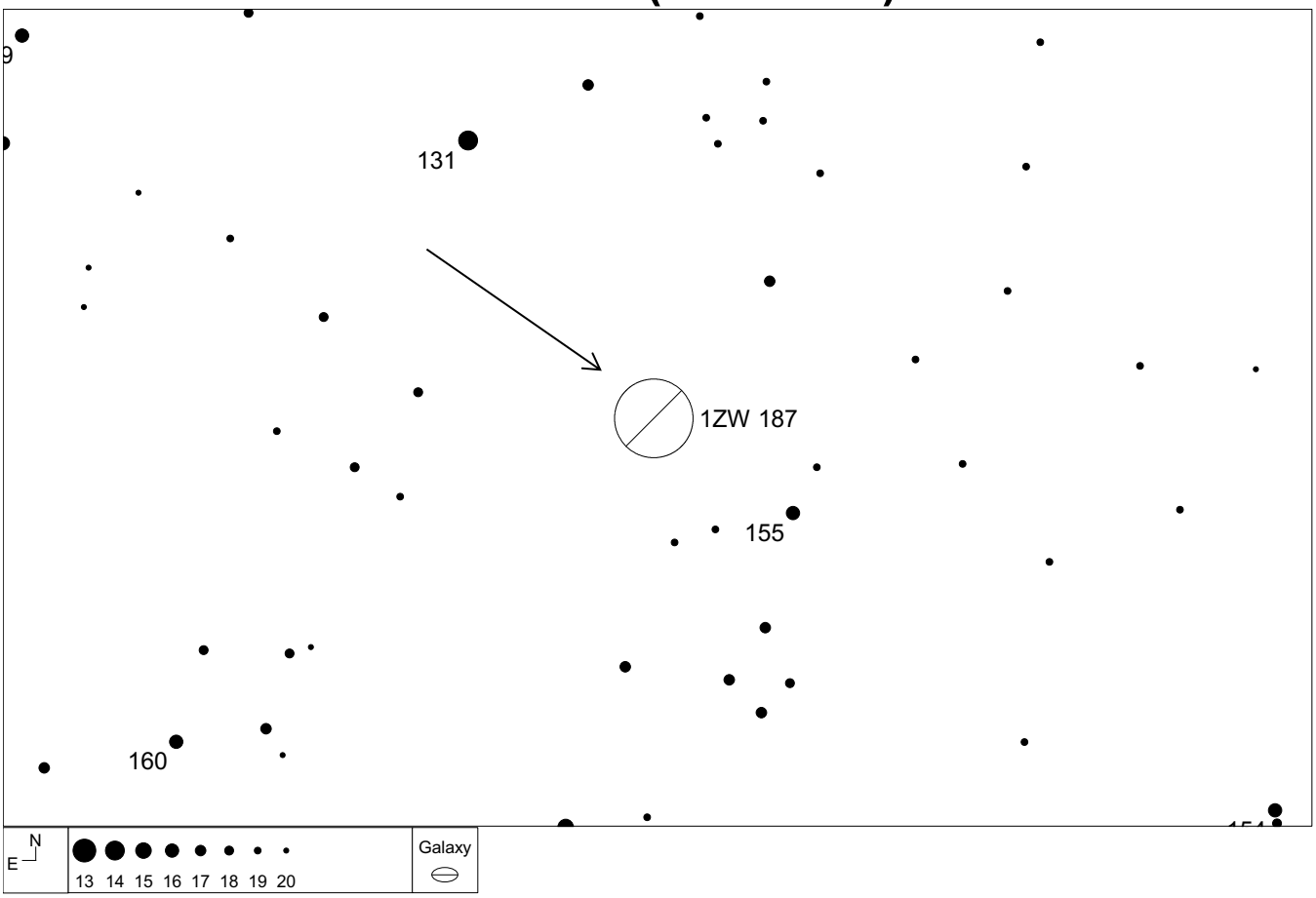
I Zw 187 (Hercules)

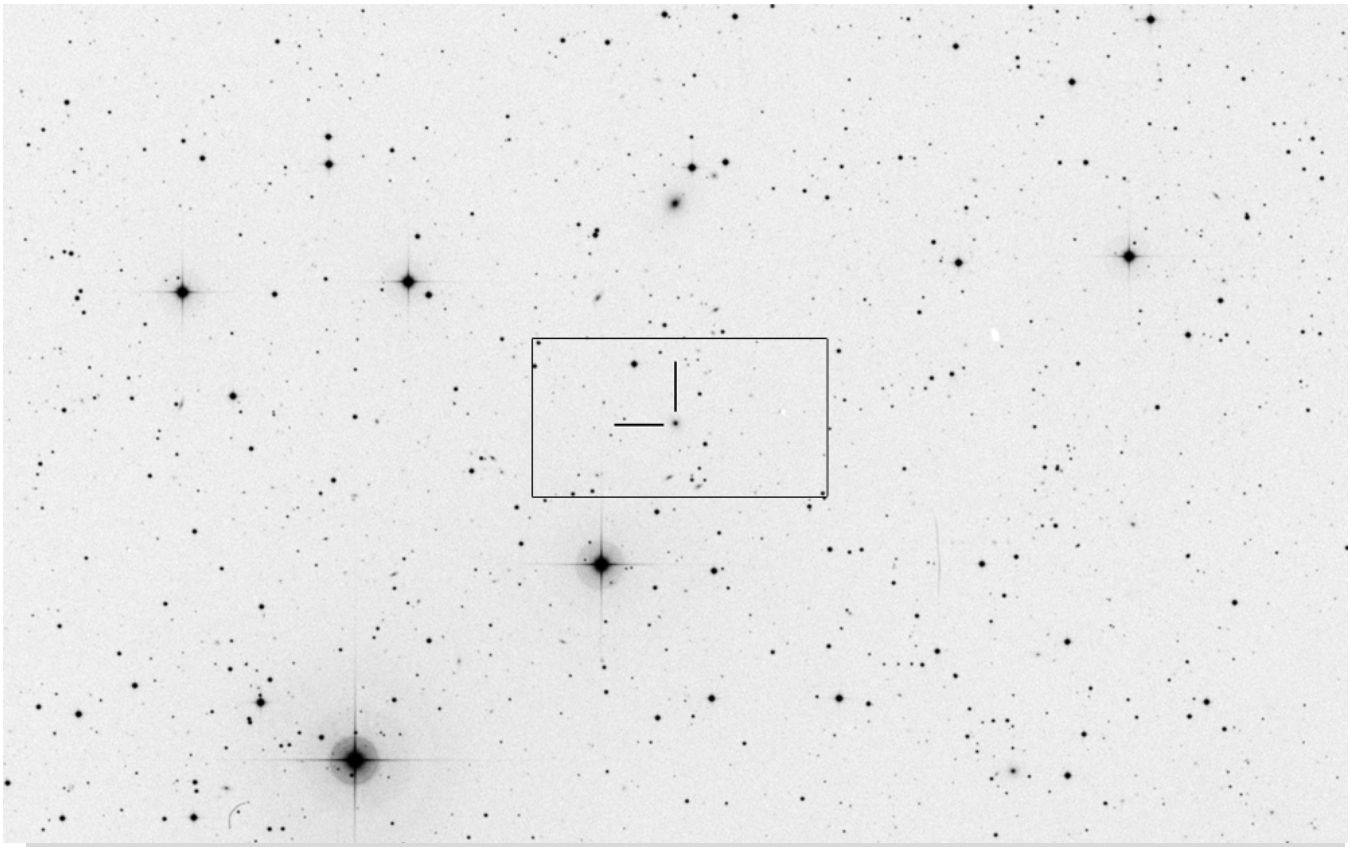


http://quasar.square7.ch/fqm/1727+502.html

Bregman, J.N. et al "Simultaneous observations of the BL Lacertae object I ZW 187" *Astrophysical Journal*, Vol 253 (1982): 19-2

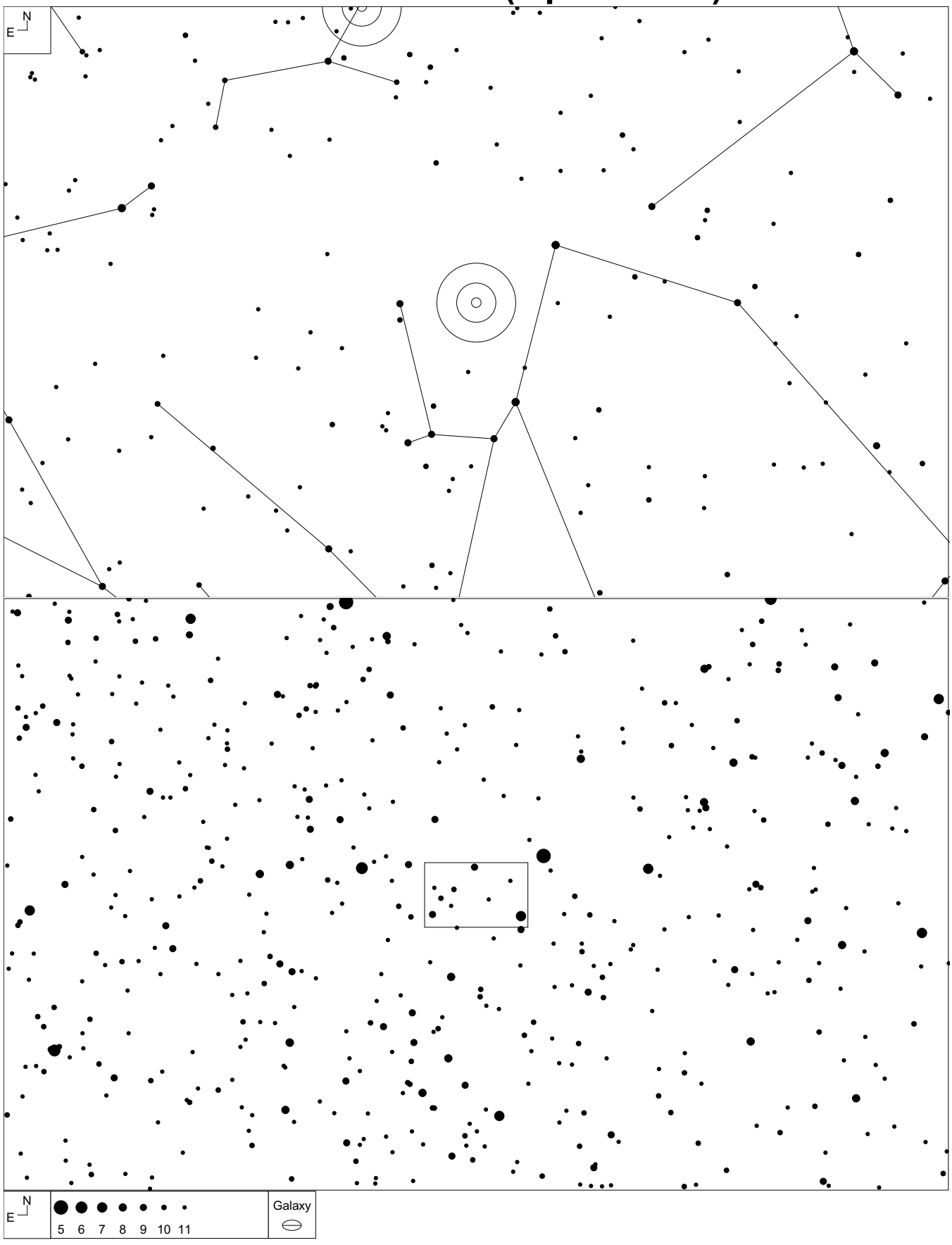
I Zw 187 (Hercules)





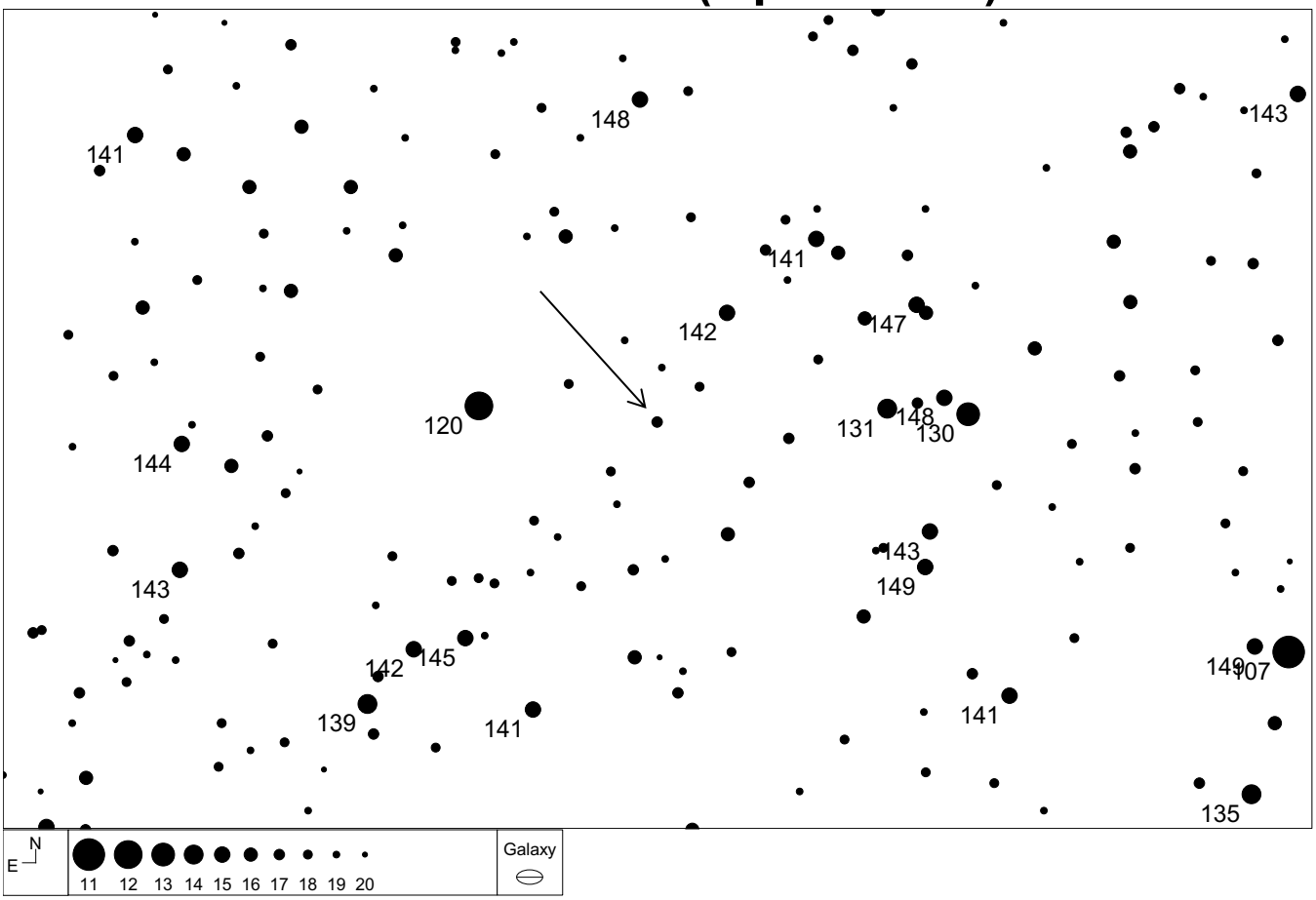
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	17 28 18.6	+50 13 10	14.2 – 16.8	0.4’	0.055	OT 546

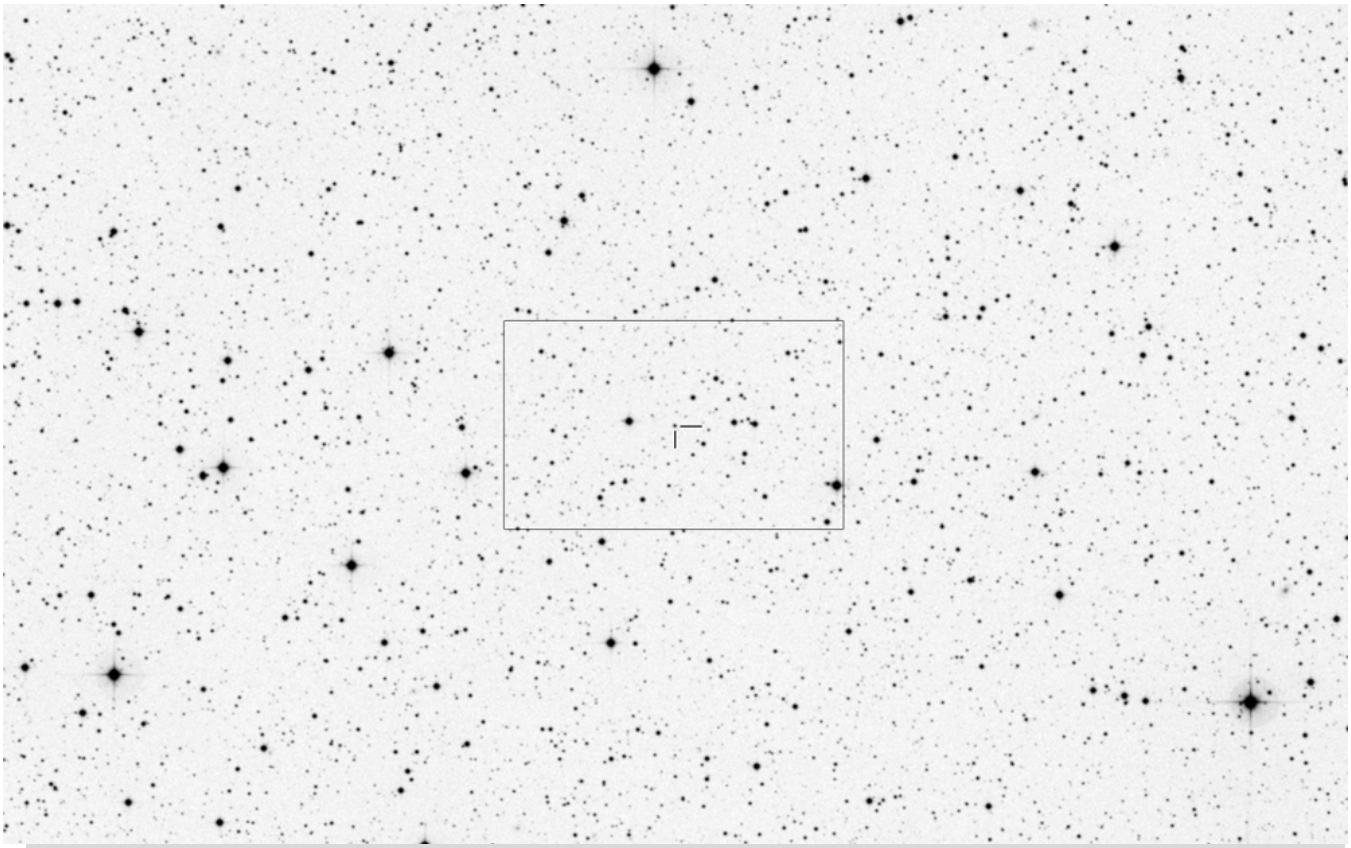
PKS 1749+096 (Ophiuchus)



Lu, R.S. et al. "The parsec-scale jet of PKS 1749+096." *Astronomy & Astrophysics*, manuscript no. OT081 (2012)

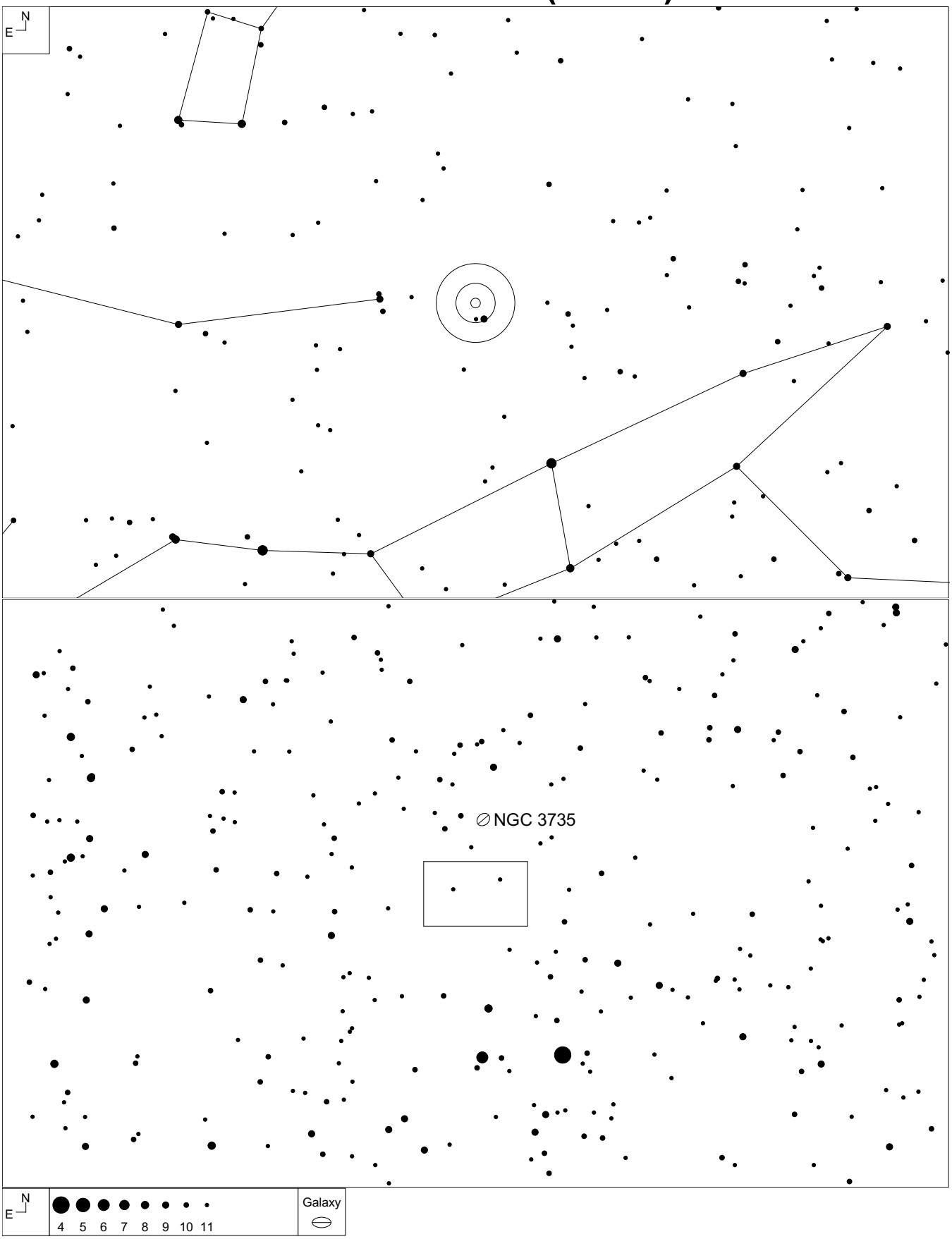
PKS 1749+096 (Ophiuchus)





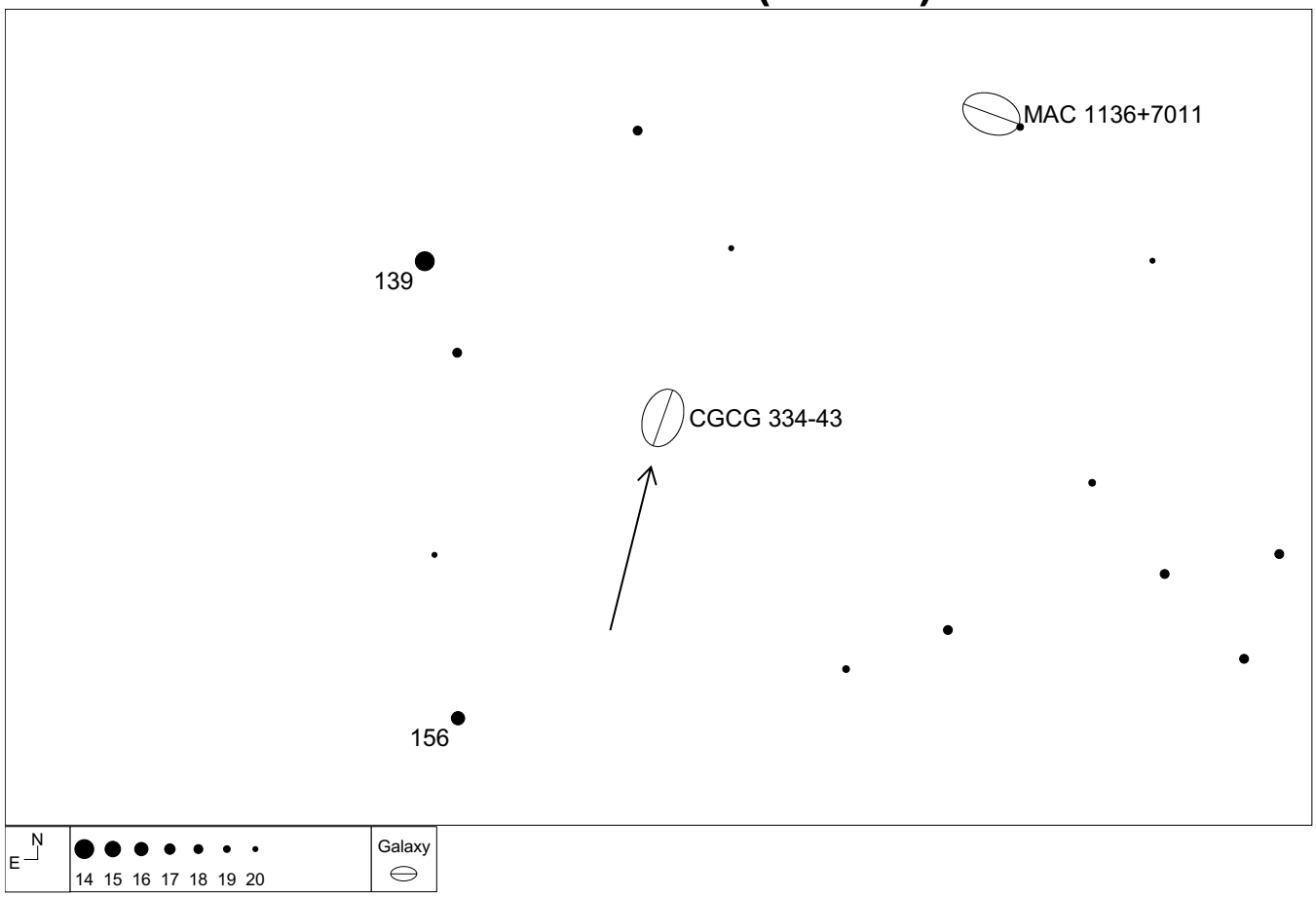
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	17 51 32.8	+09 39 02	14.1 - 18.4	stellar	0.322	OT 081

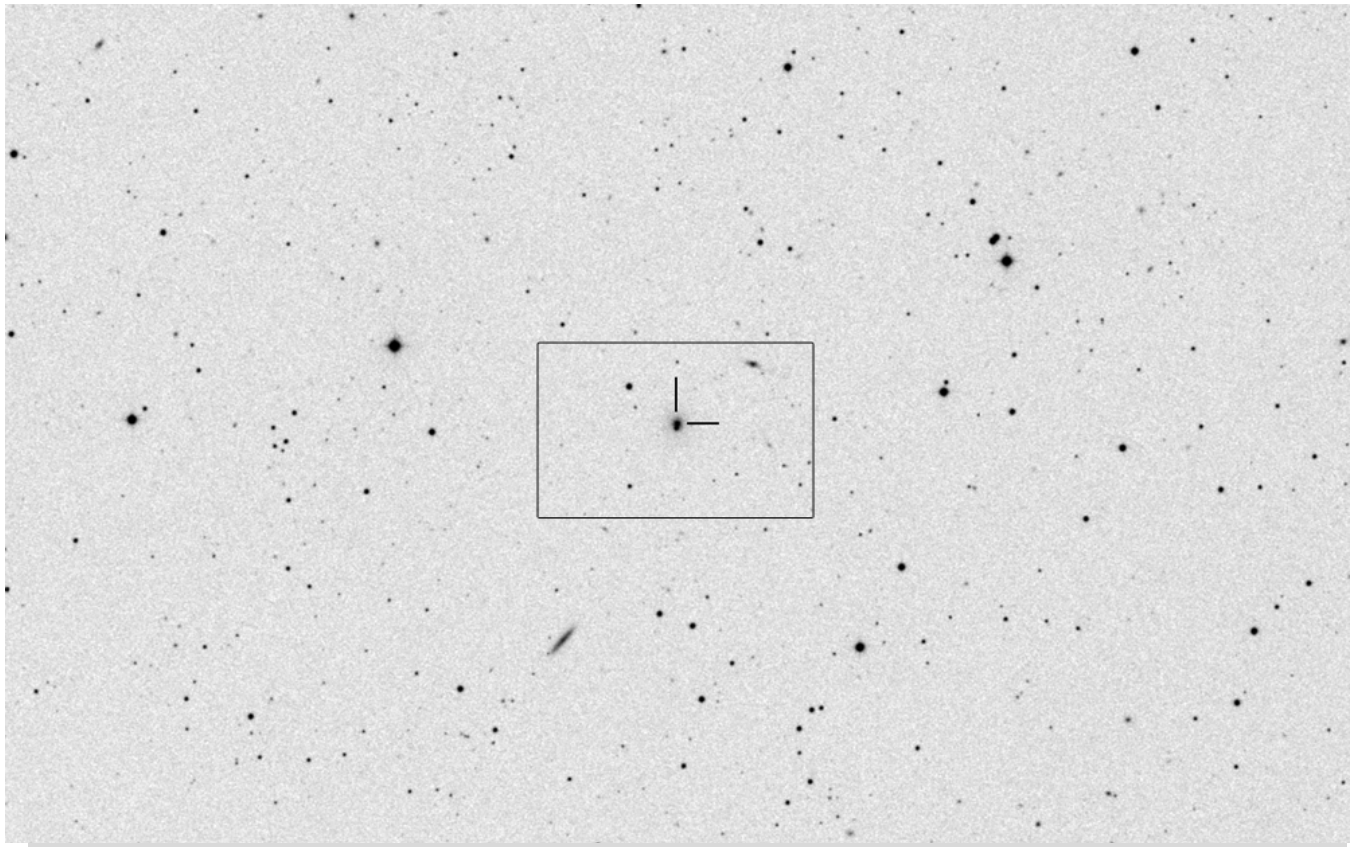
Markarian 180 (Draco)



Albert, J. "Discovery of Very High Energy γ-Rays from Markarian 180 Triggered by an Optical Outburst" *Astrophysical Journal,* Vol 648 (2006): L105-L108

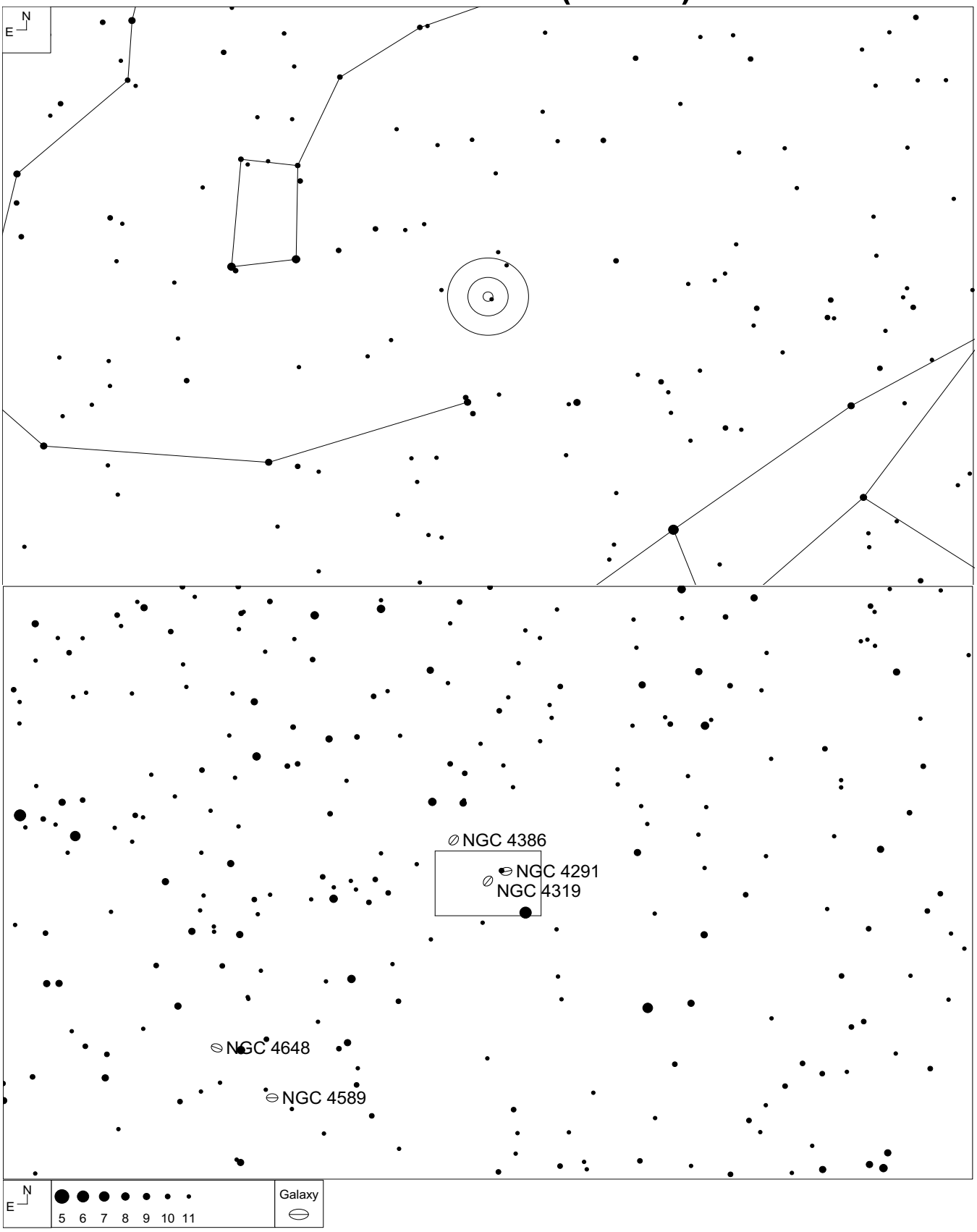
Markarian 180 (Draco)





Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	11 36 26.4	+70 09 27	14.0 - 15.1	0.3 x 0.2’	0.046	CGCG 334-43

Markarian 205 (Draco)

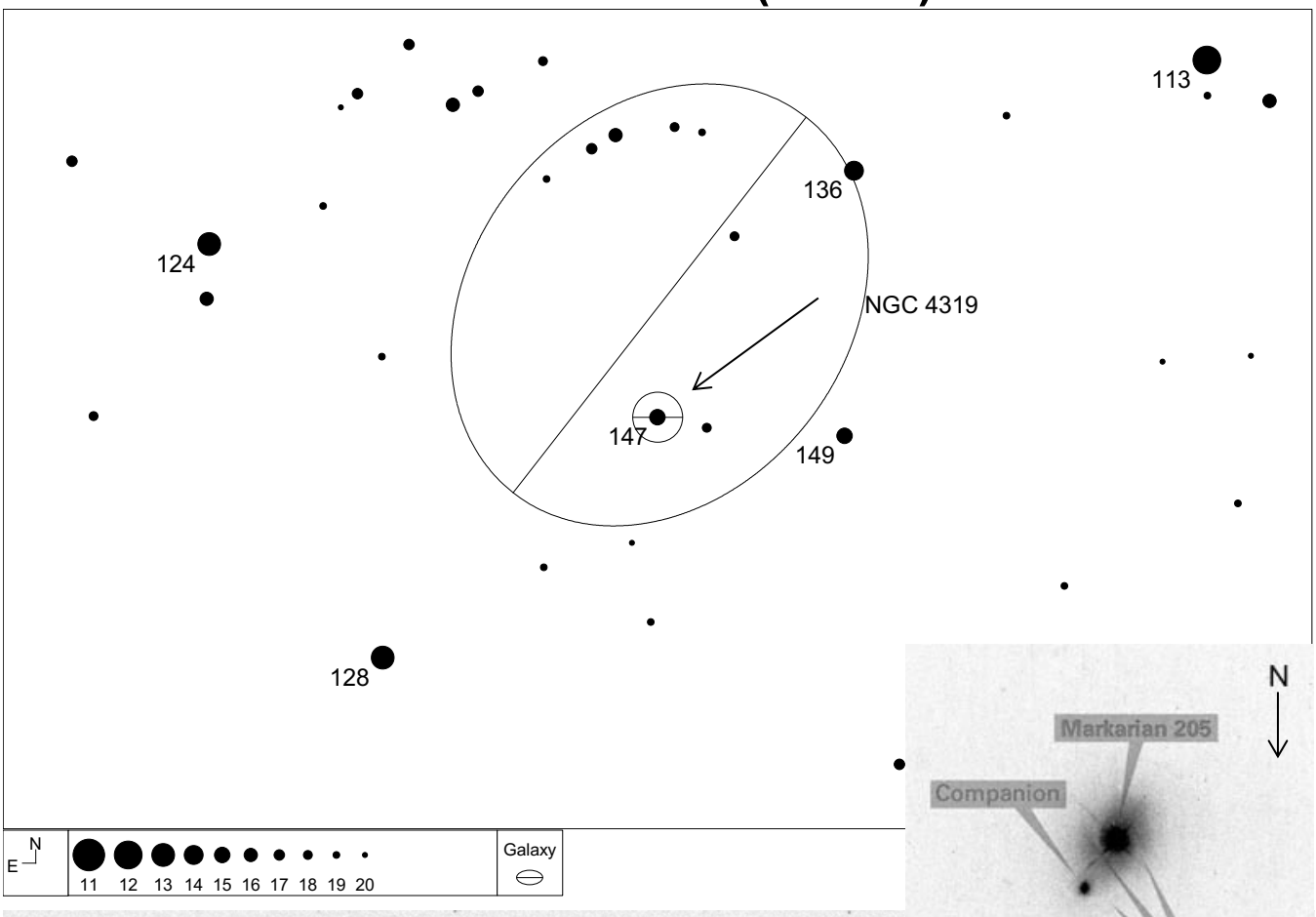


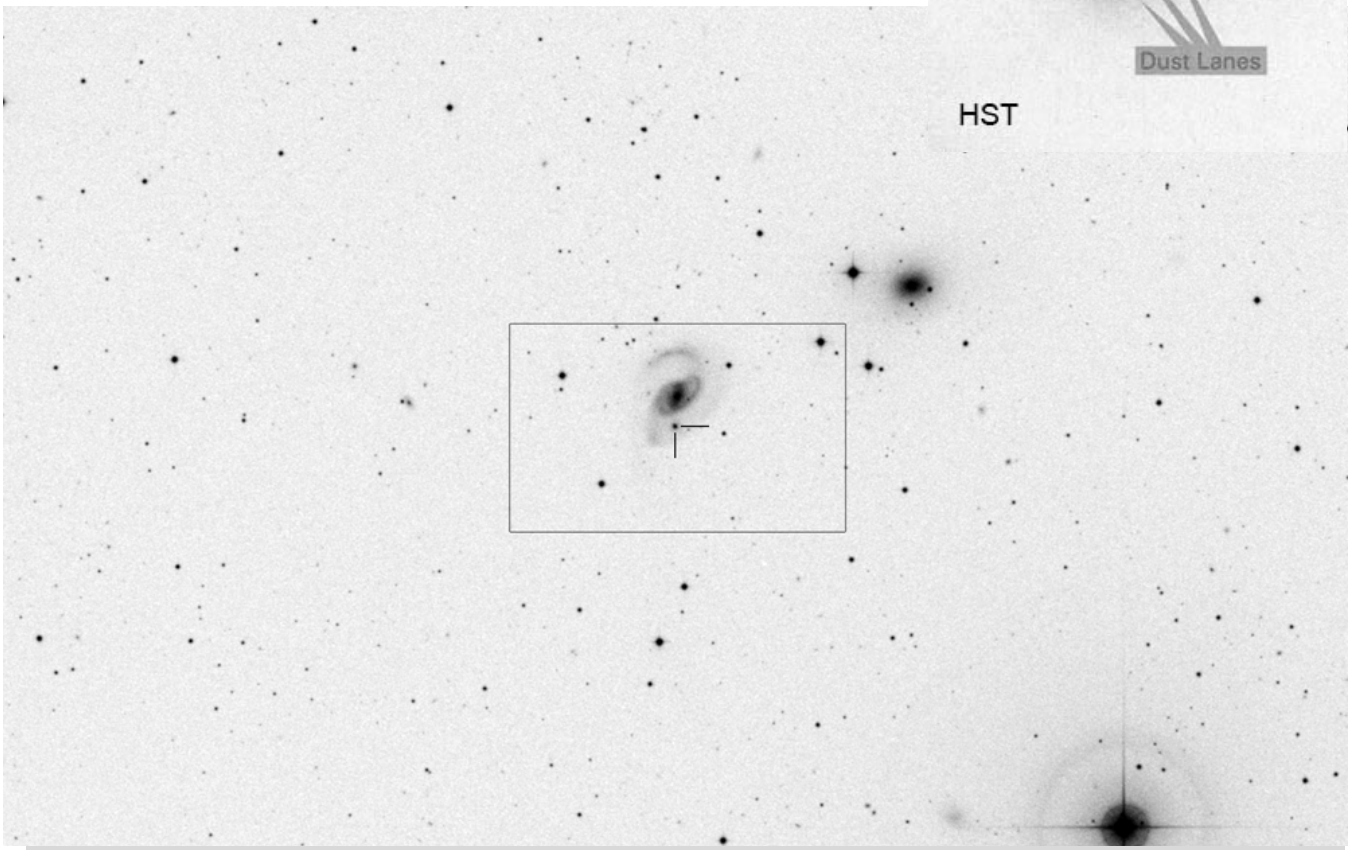
Sulentic, Jack and Arp, Halton. “The galaxy-quasar connection - NGC 4319 and Markarian 205. I - Direct imagery. II” *Spectroscopy Astrophyisical Journal*, Vol. 319 (1987)

Favre, P. et al. “BeppoSAX observations of the quasar Markarian 205” *Astronomy and Astrophysics*, Vol 421 (2004): 91-101

Knacke, Roger. *NGC 4319 and Markarian 205*. http://heritage.stsci.edu/2002/23/supplemental.html (see inset)

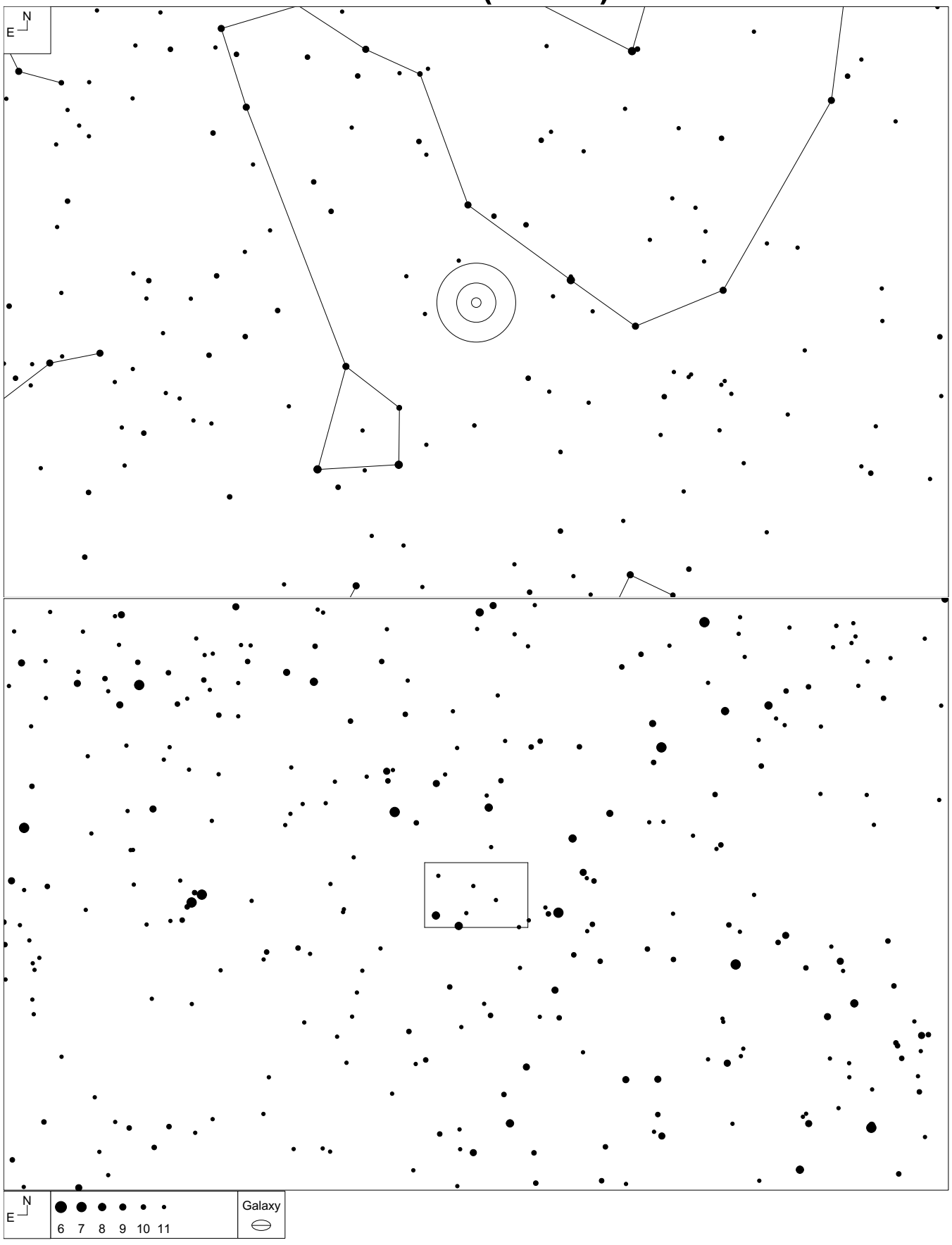
Markarian 205 (Draco)





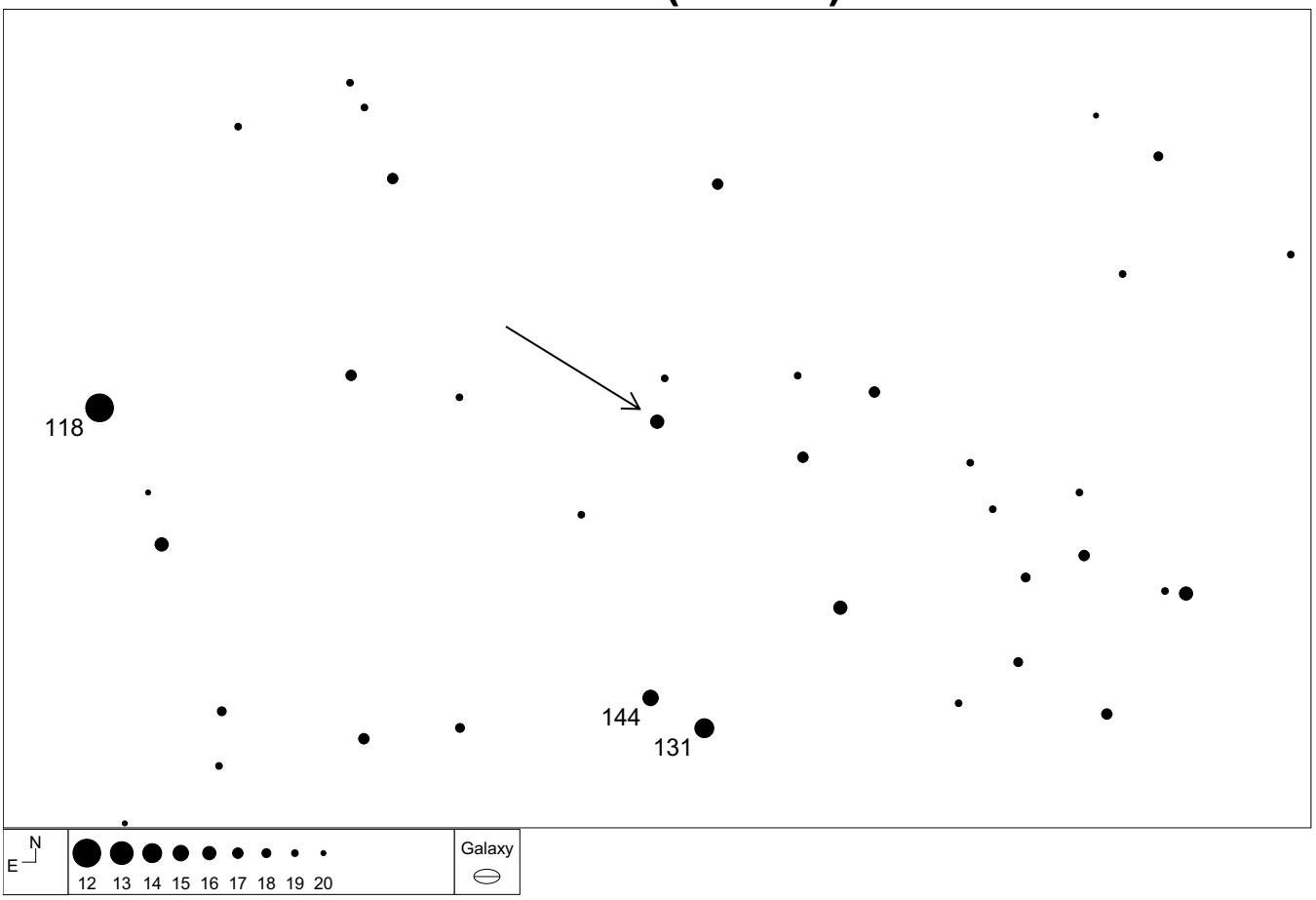
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	12 21 44.1	+75 18 38	13.9 - 15.2	0.3’	0.070	PGC 39975

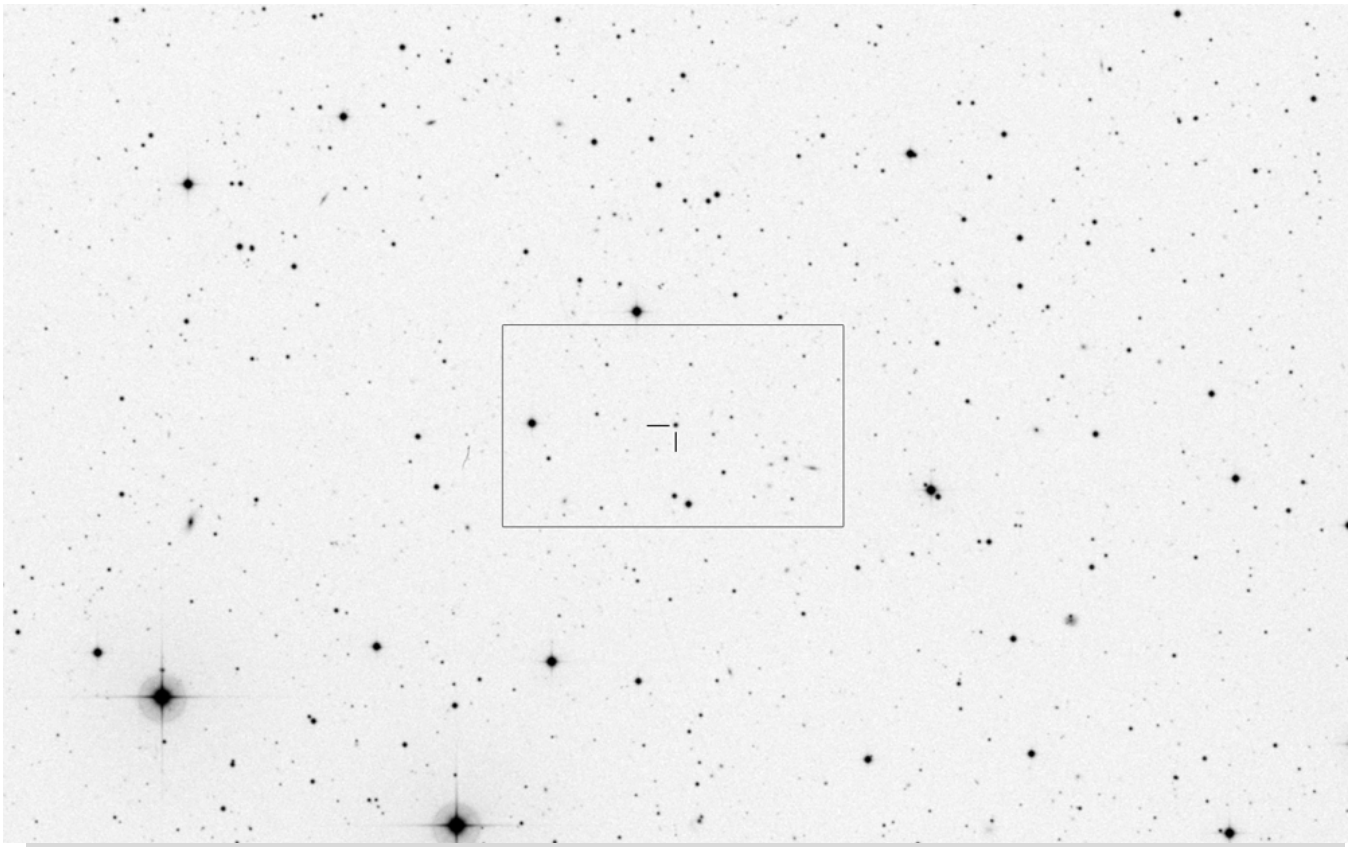
3C 351 (Draco)



Nesci, R. et al. “S5 1803+78 revisited.” *Proceedings of the IBWS 2011 conference. Karlovy Vary*, April 2011

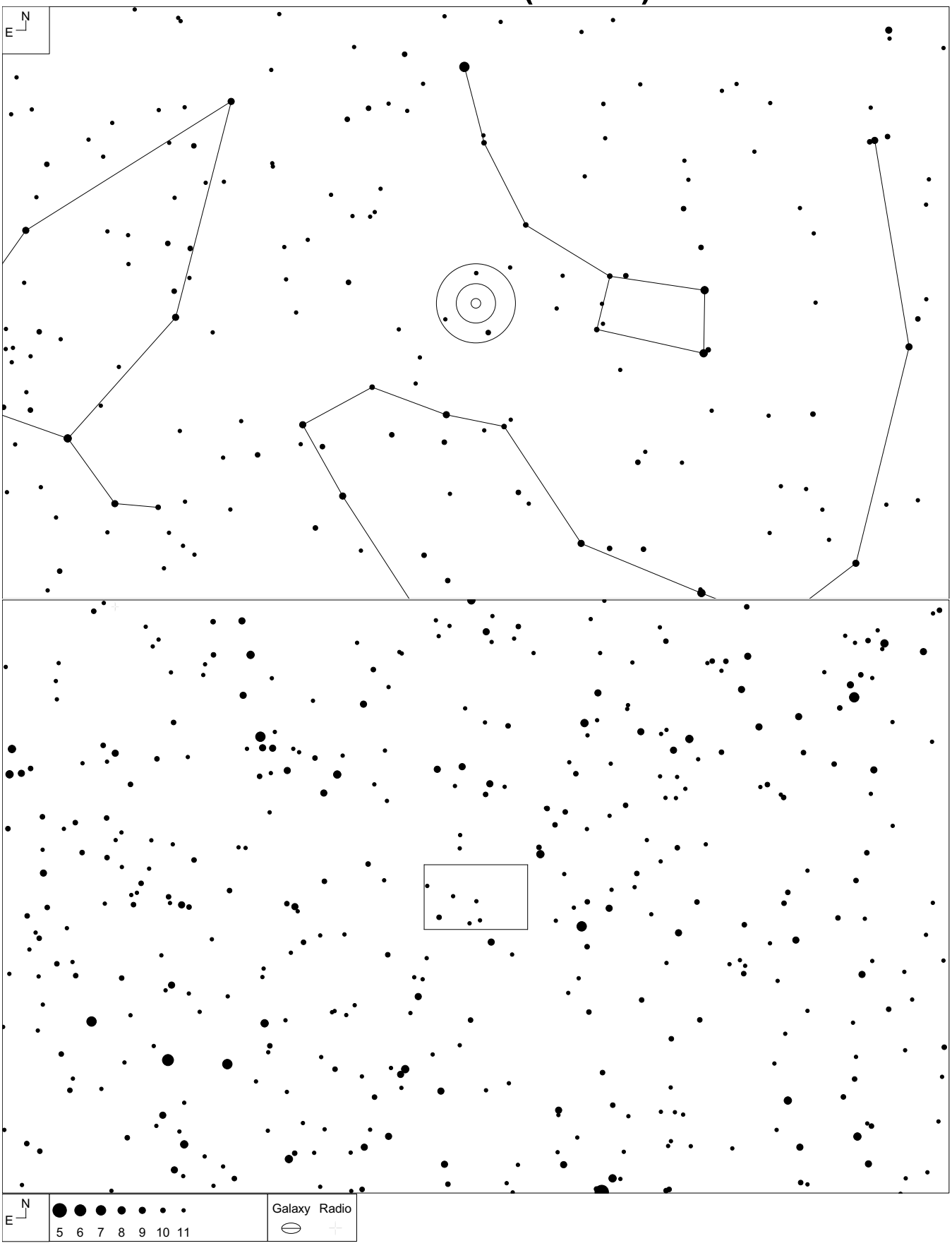
3C 351 (Draco)



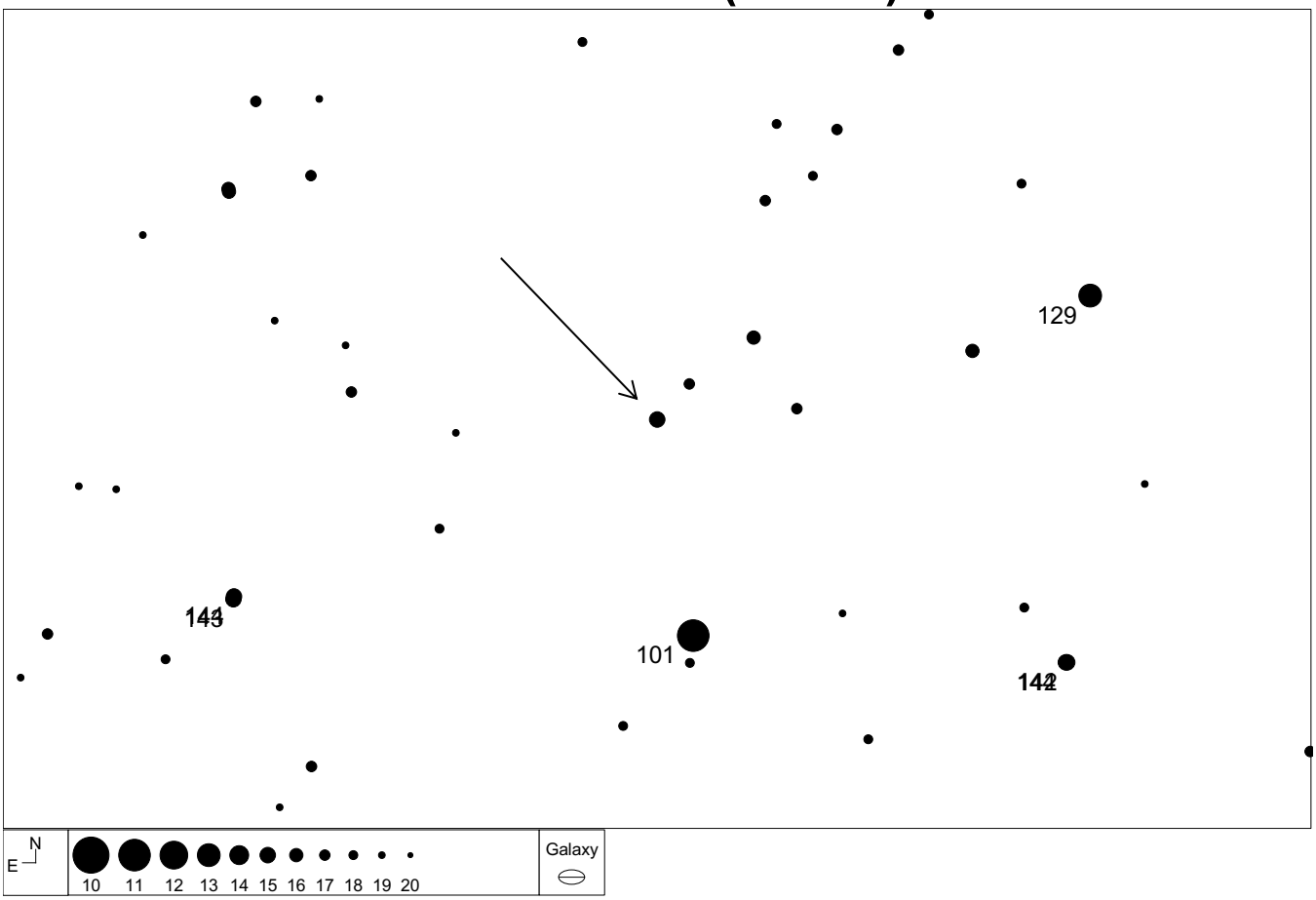


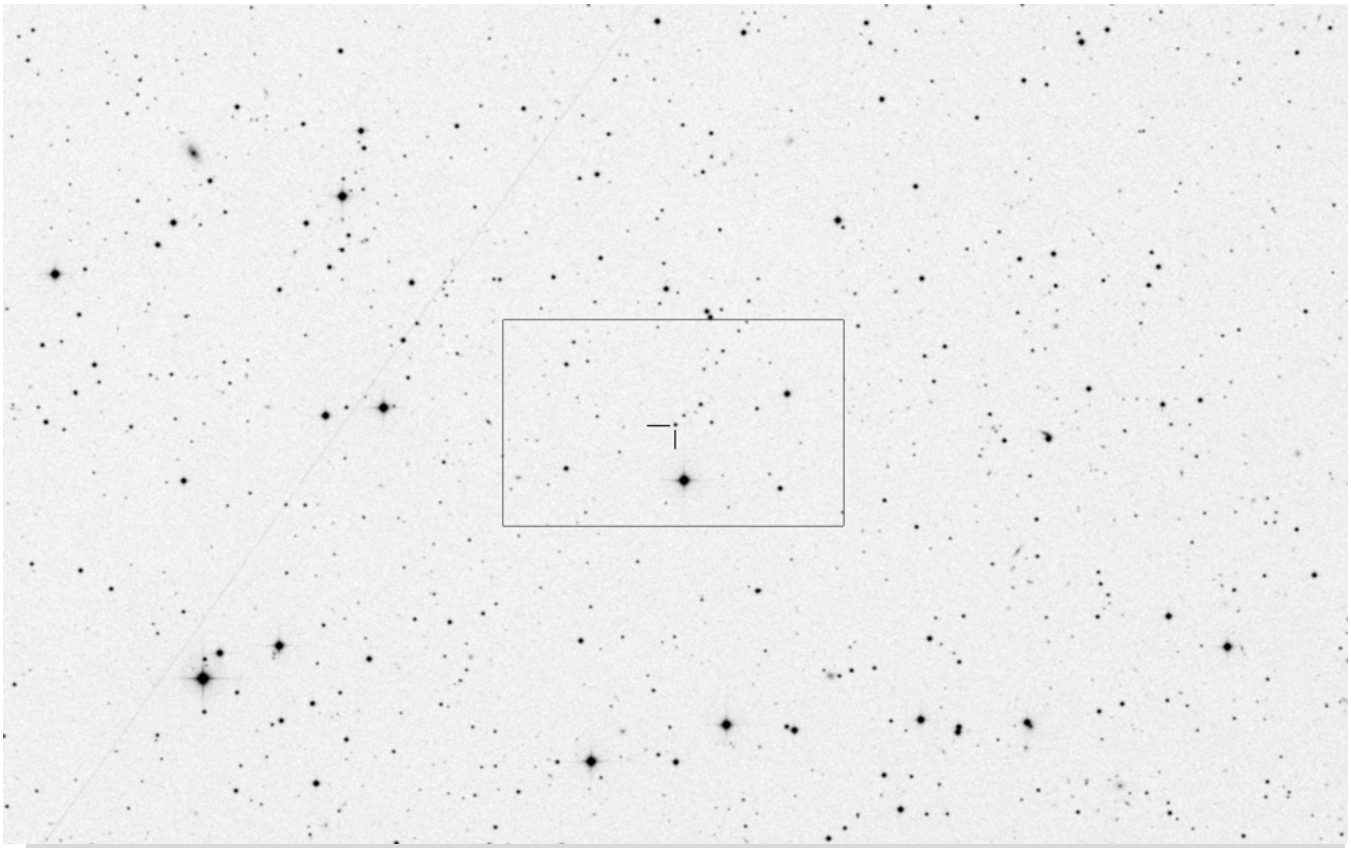
Type	RA	Dec	Mag	Size	Redshift	Other Name
QSO	17 04 41.4	+60 44 31	15 - 16	stellar	0.372	

S5 1803+78 (Draco)



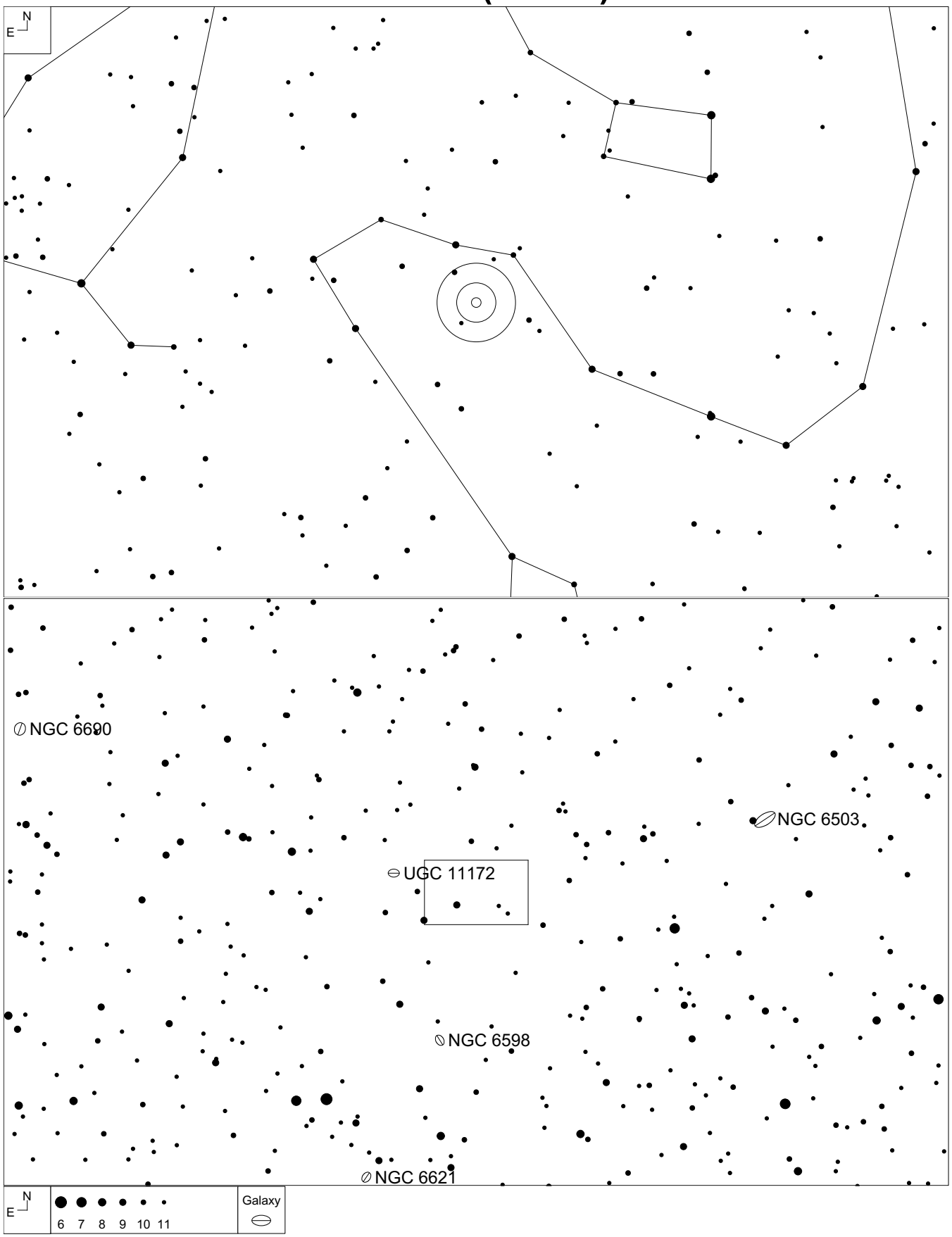
S5 1803+78 (Draco)





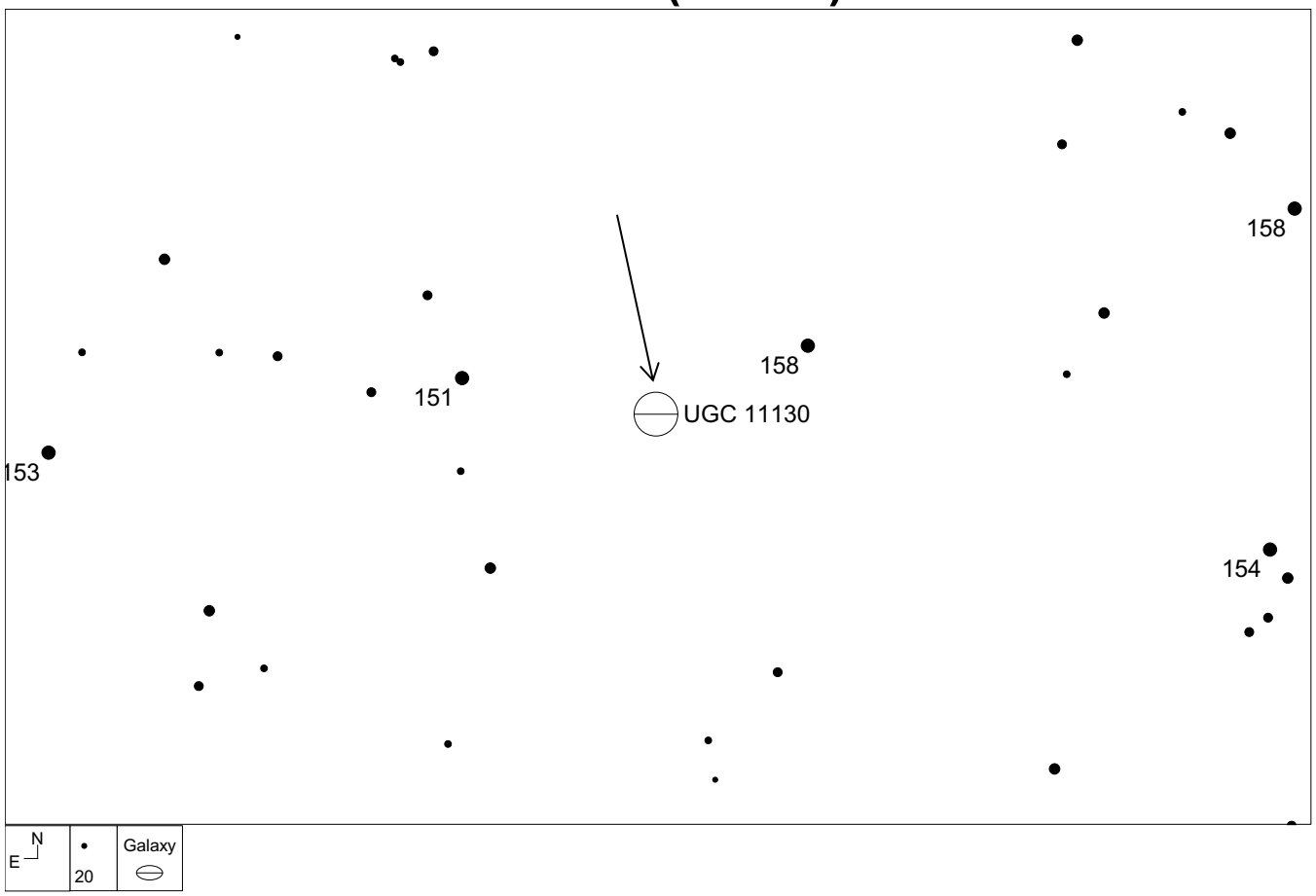
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	18 00 45.7	+78 28 04	14.0 - 16.5		0.684	

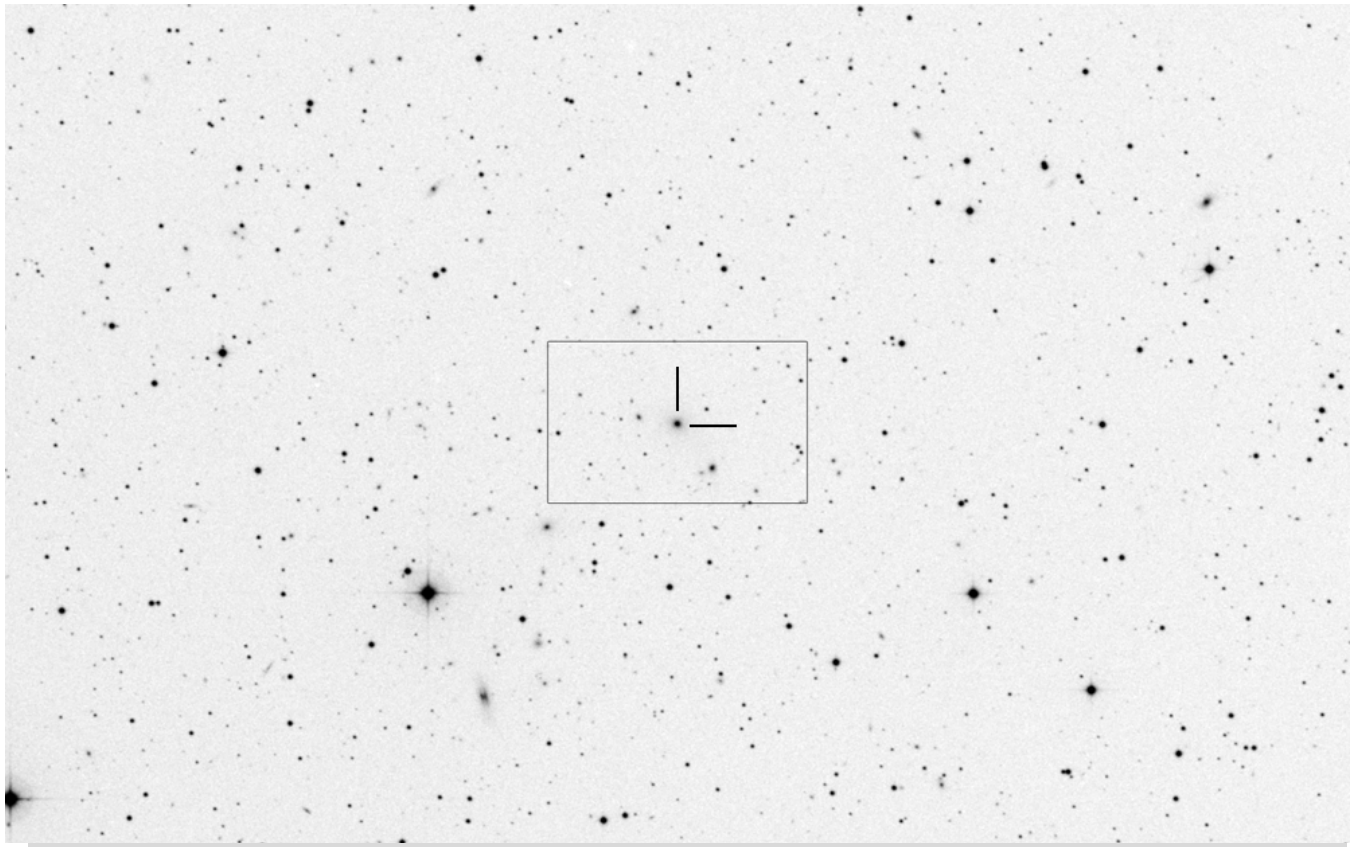
3C 371 (Draco)



Nilsson, K. et al "Discovery of an Optical Jet in the BL Lacertae Object 3C 371." *Astrophysical Journal*, Vol 484 (1997): L107-111

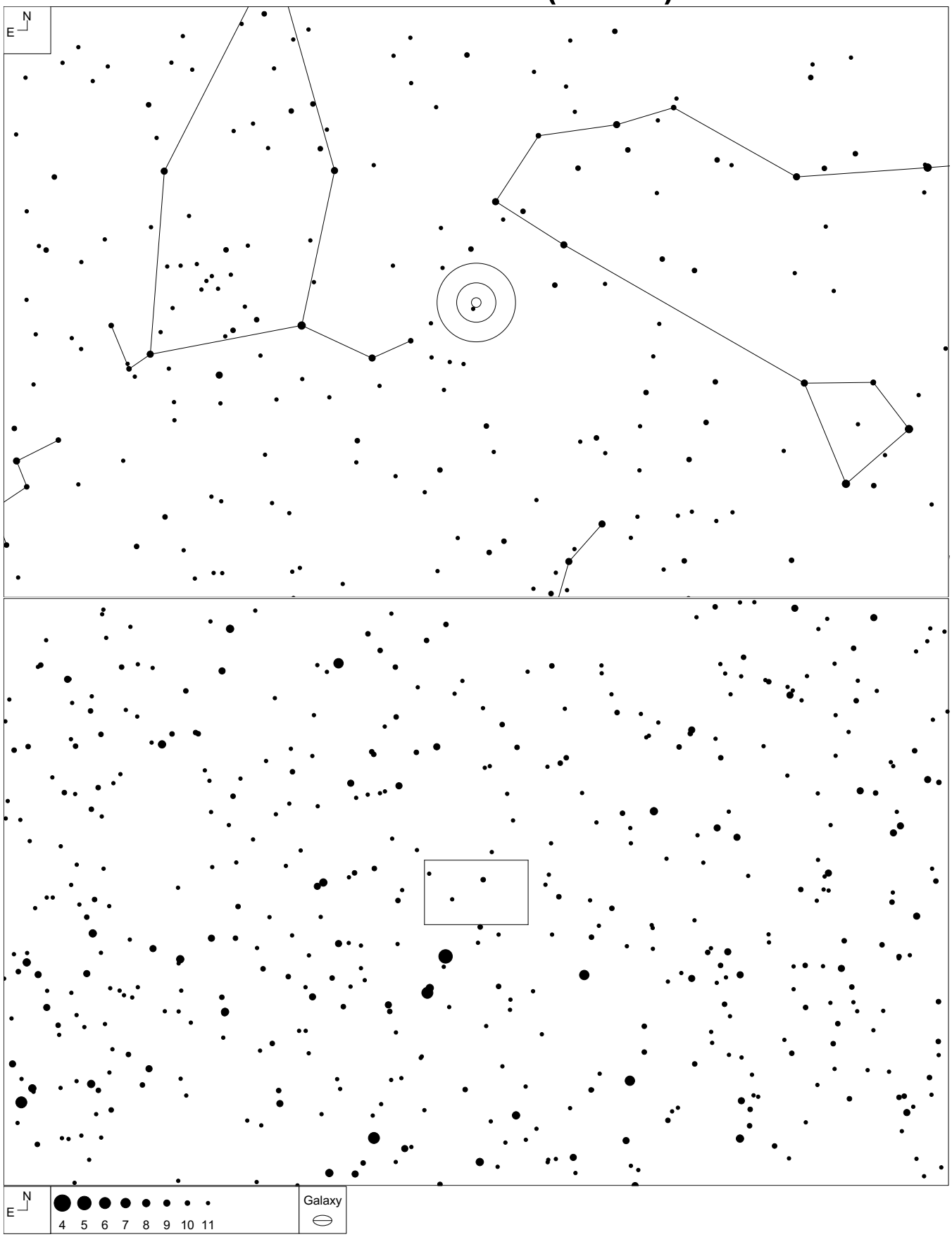
3C 371 (Draco)





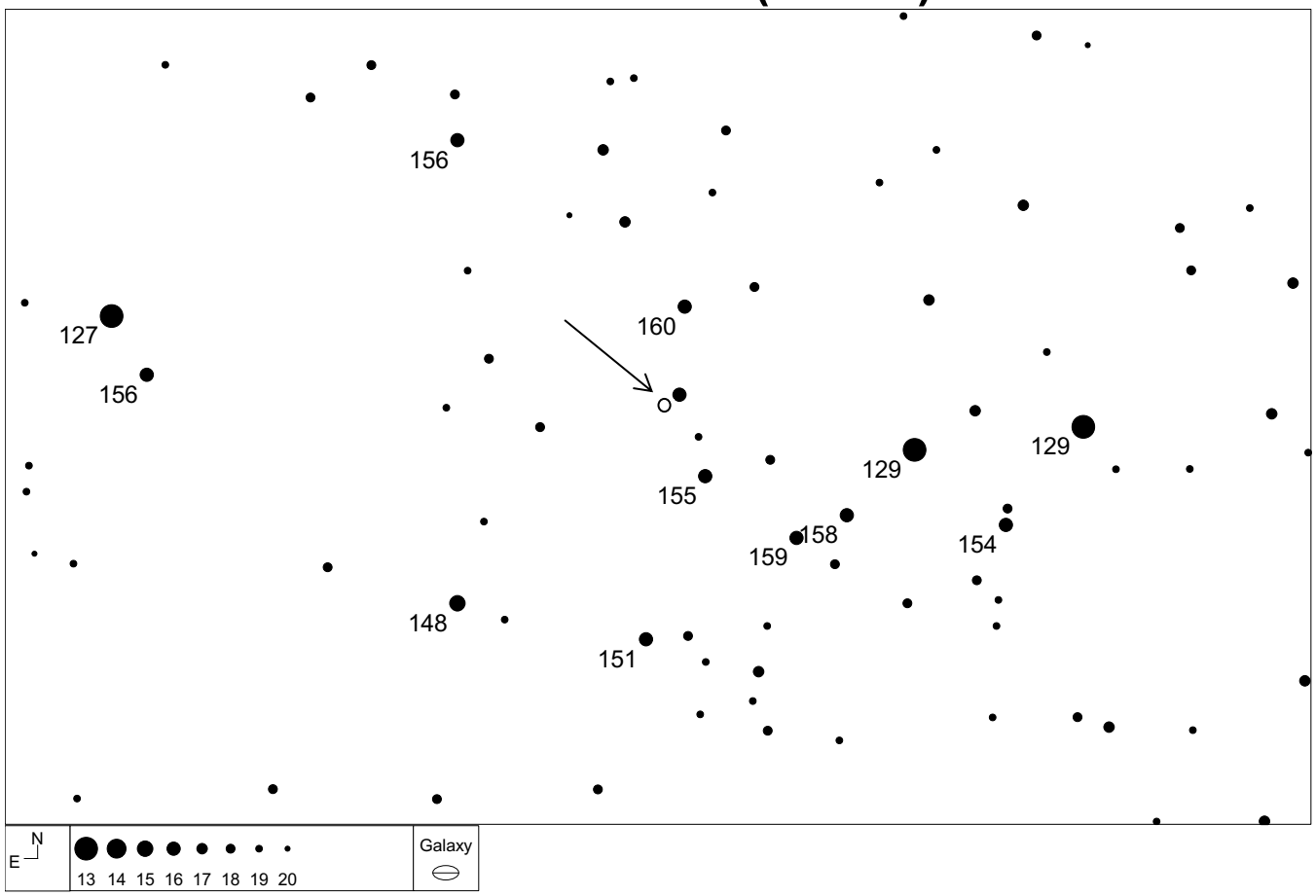
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	18 06 50.7	+69 49 28	13.5 - 15.0	0.2’	0.051	UGC 11130

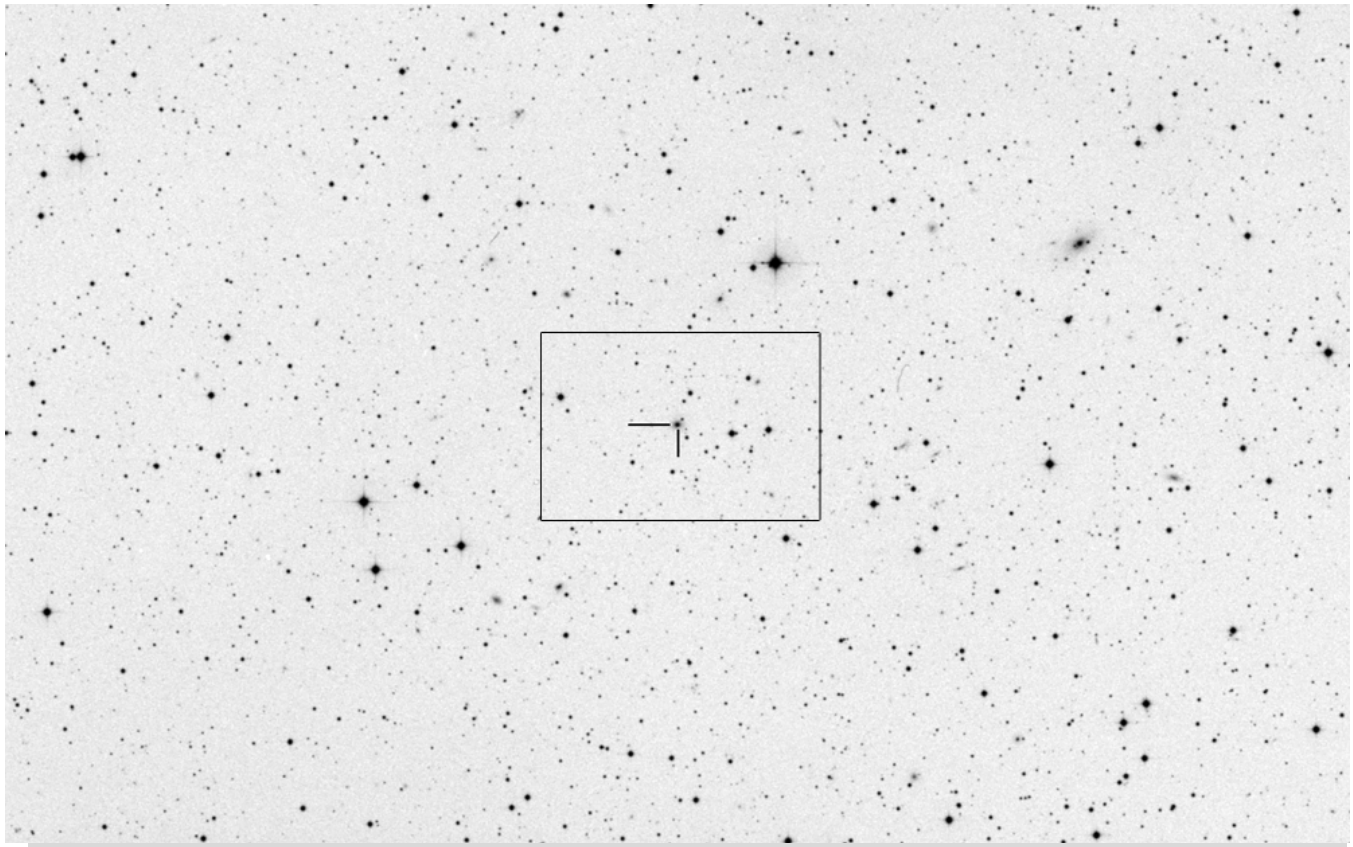
1ES 1959+650 (Draco)



Gutierrez, K. et al "Multiwavelength Observations of 1ES 1959+650, One Year After the Strong Outburst of 2002" *Astrophysical Journal*, Vol 644 (2006): 742-747

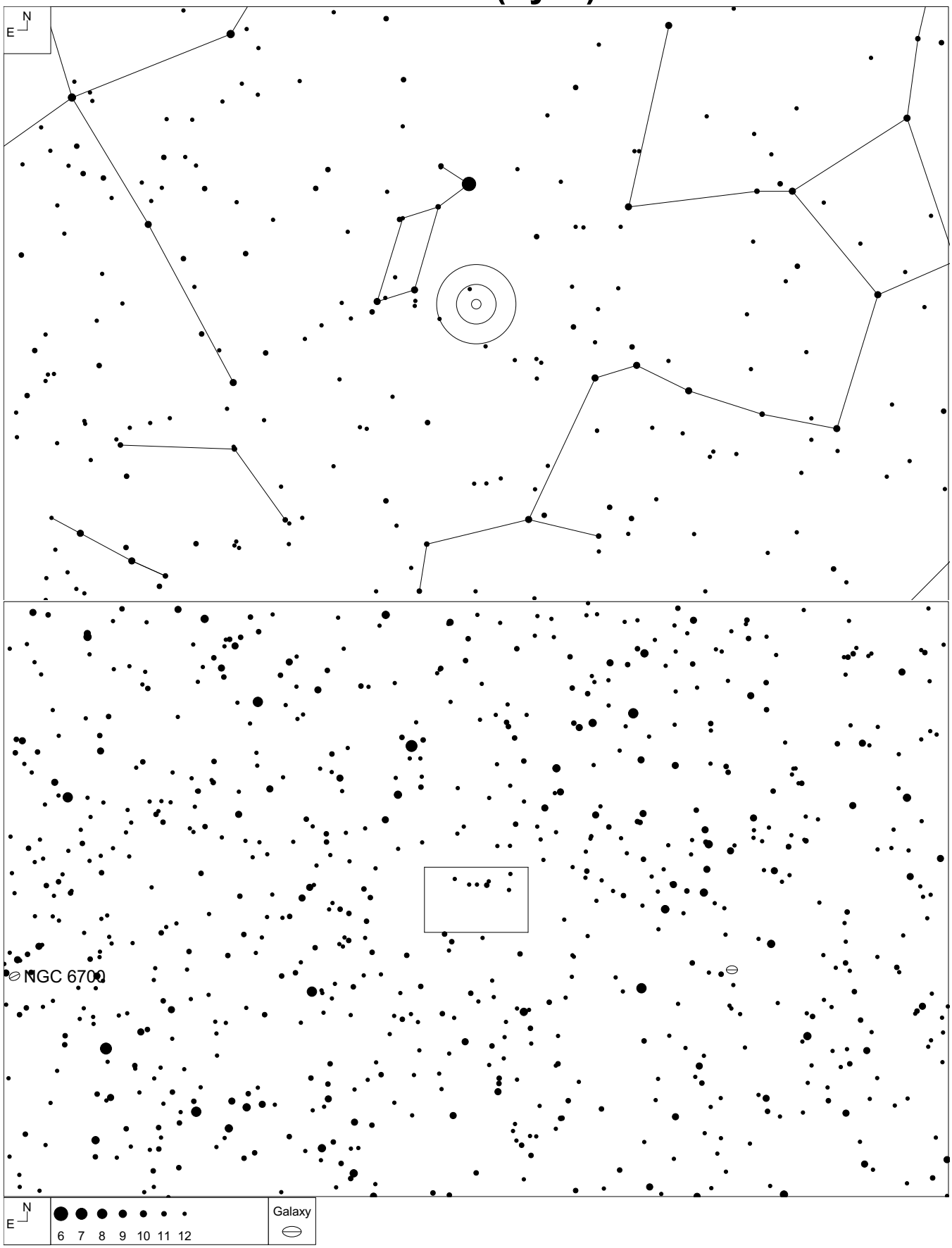
1ES 1959+650 (Draco)





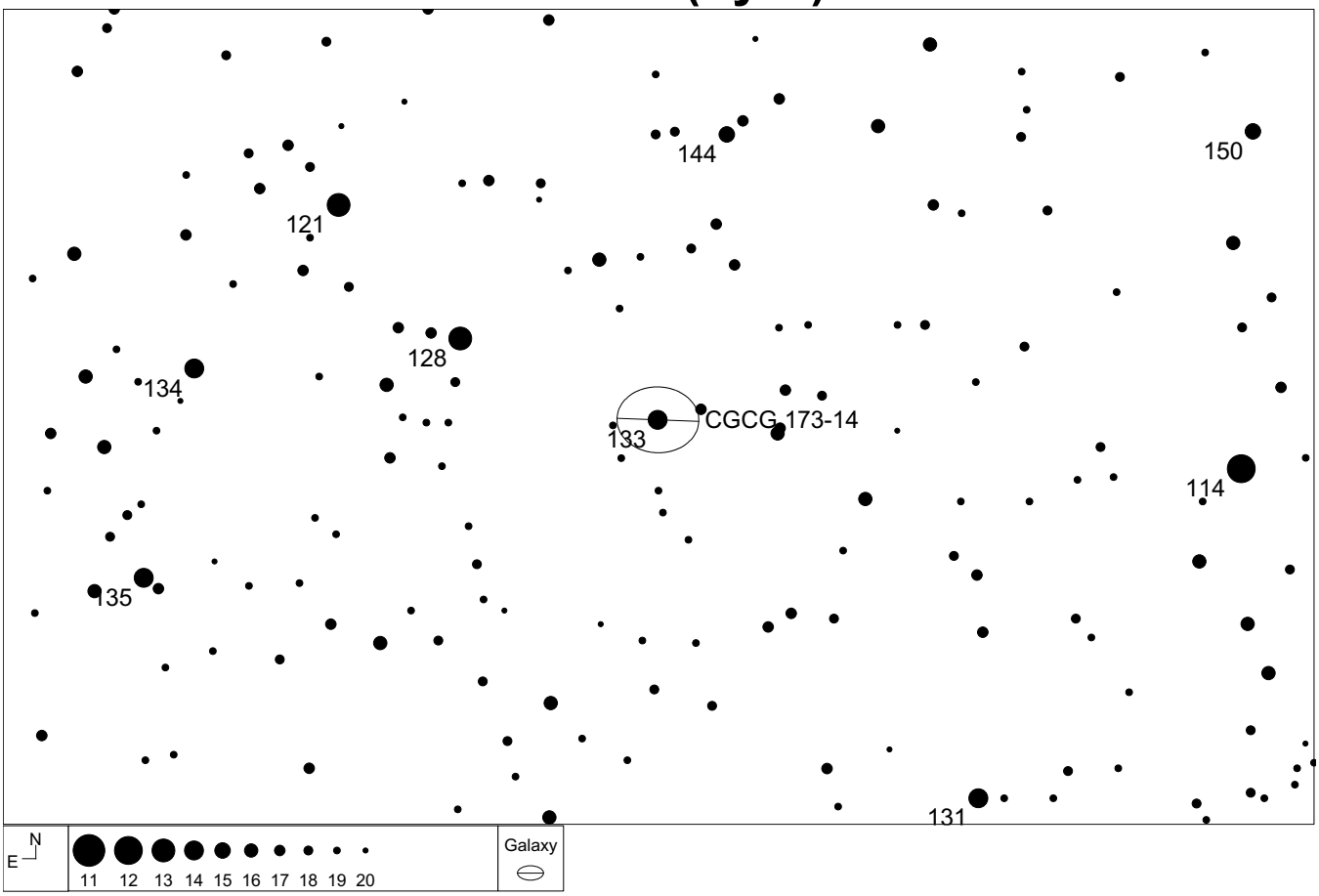
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	19 59 59.9	+65 08 55	14.1 - 15.2	stellar	0.047	

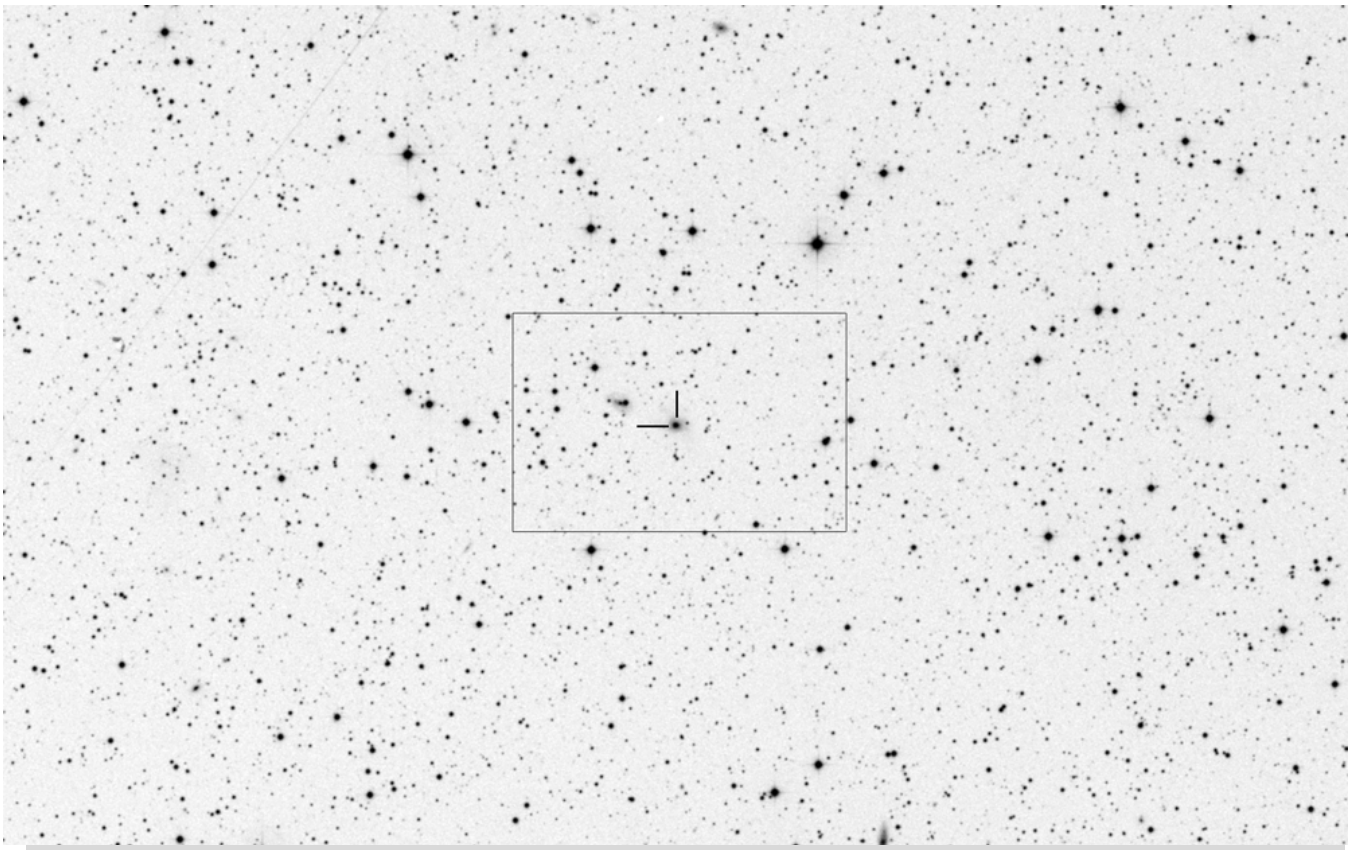
3C 382 (Lyra)



Gliozzi, M. et al "The Nature of a Broad-Line Radio Galaxy: Simultaneous RXTE and Chandra HETG Observations of 3C 382." *Astrophysical Journal*, Vol 664 (2007): 88-100

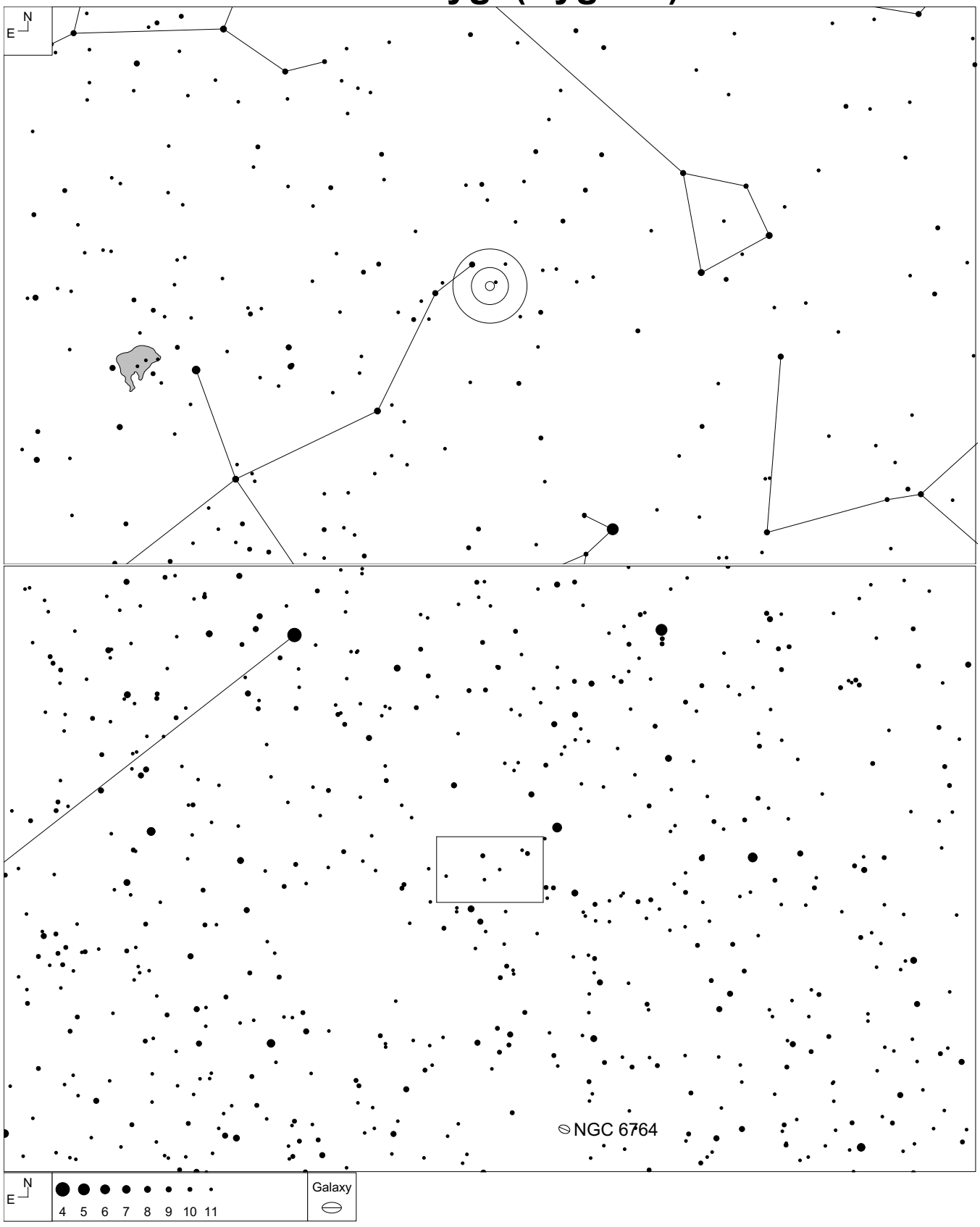
3C 382 (Lyra)



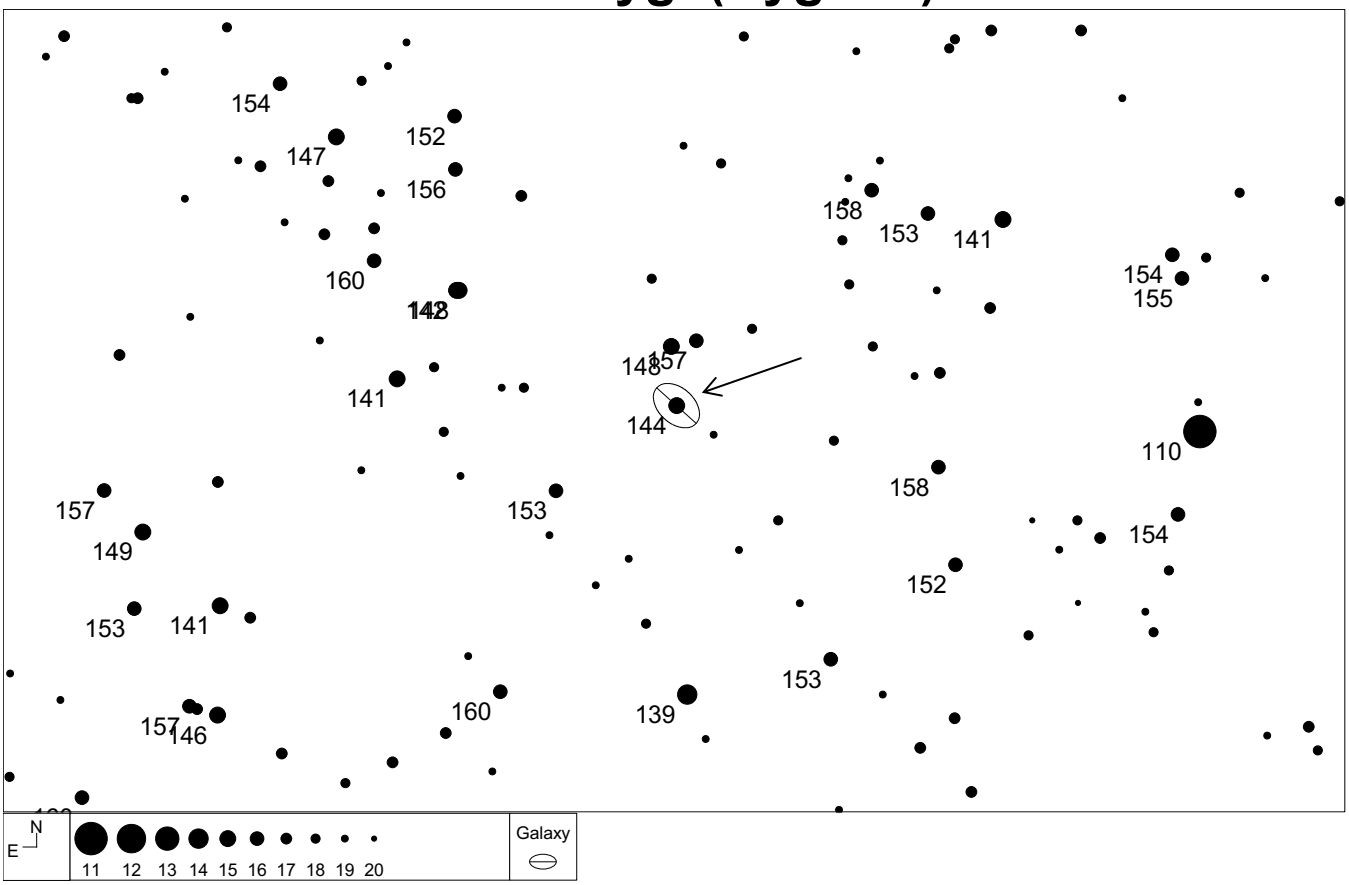


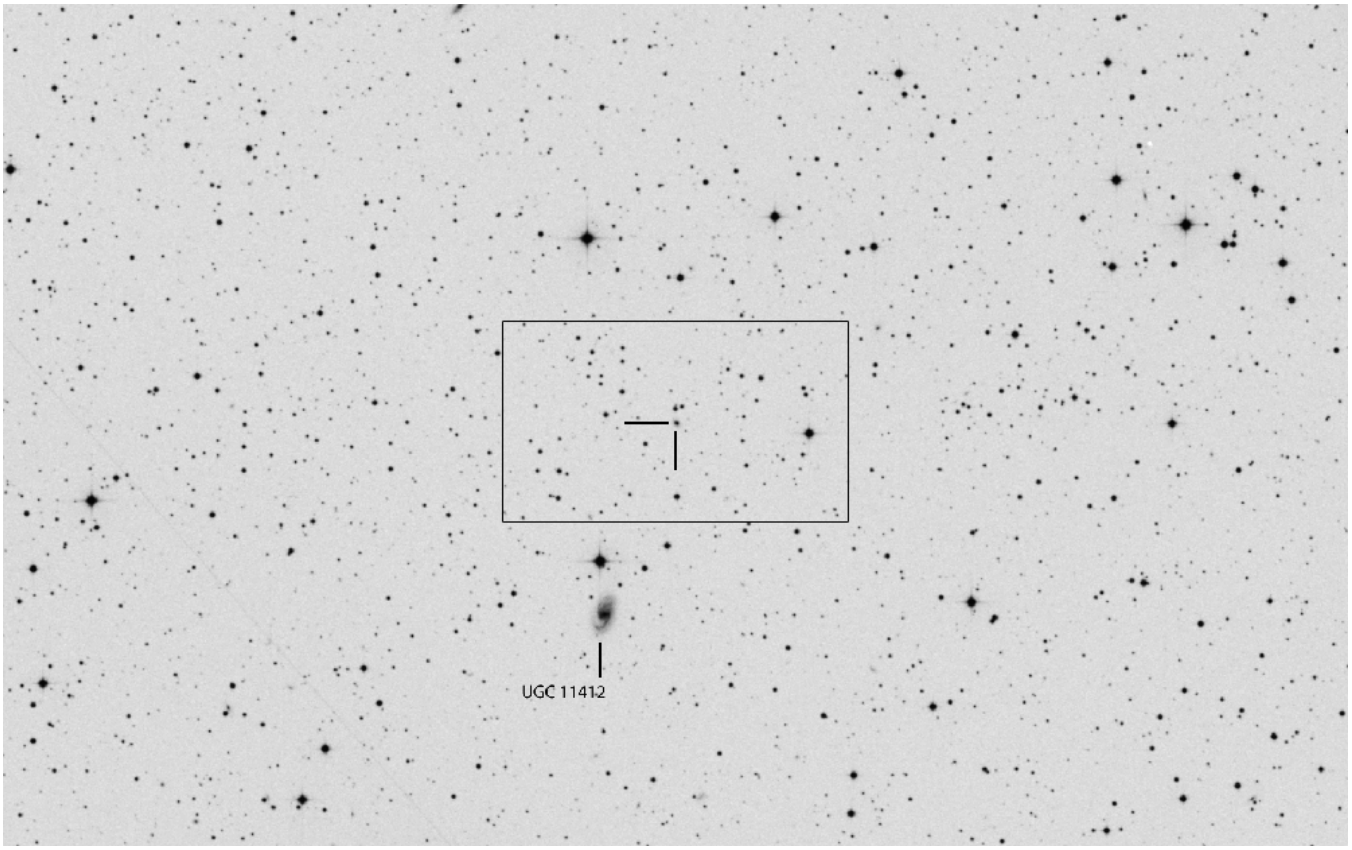
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	18 35 03.4	+32 41 47	12.5 - 14.5	0.5 x 0.4’	0.058	CGCG 173-14

V1102 Cyg (Cygnus)



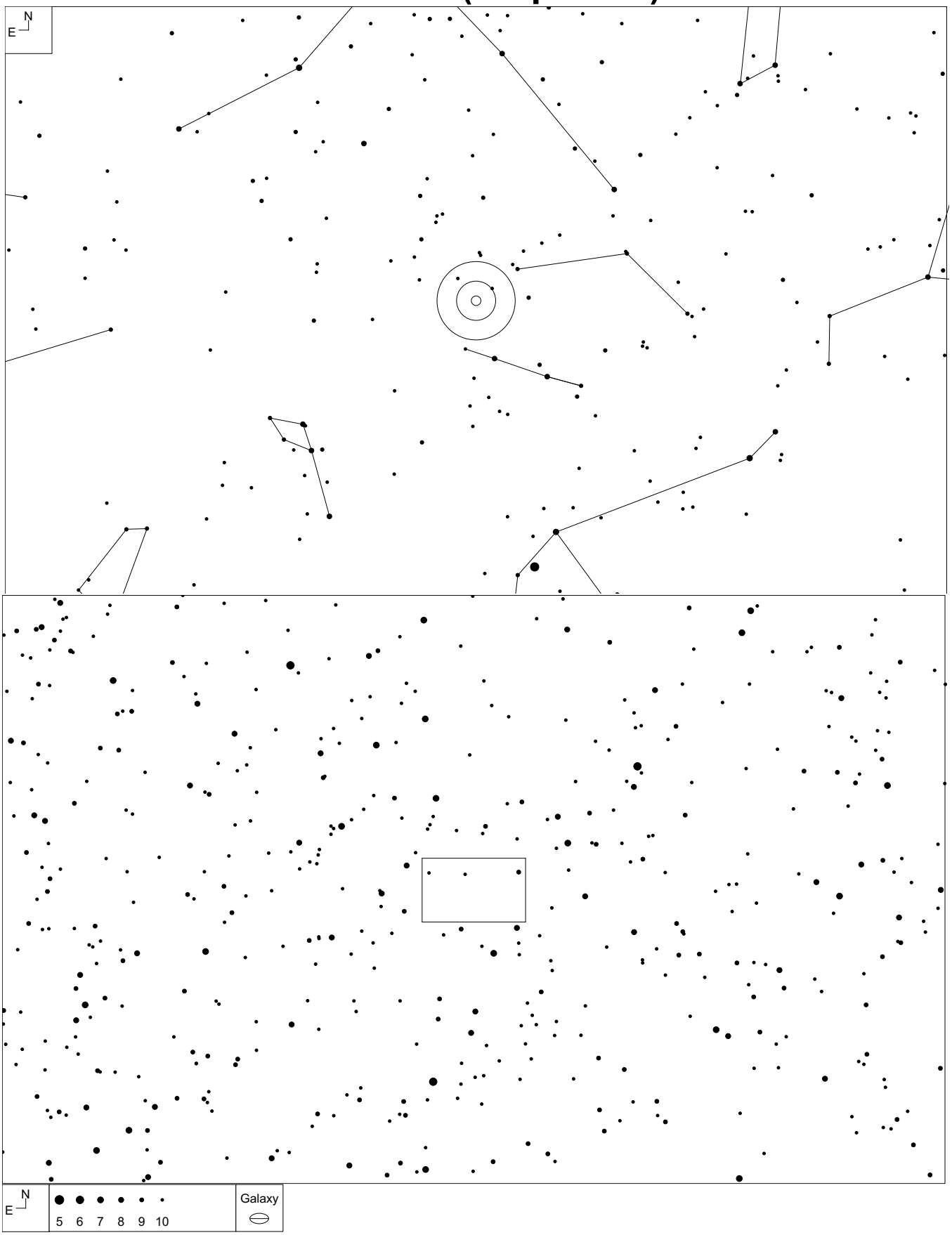
V1102 Cyg (Cygnus)



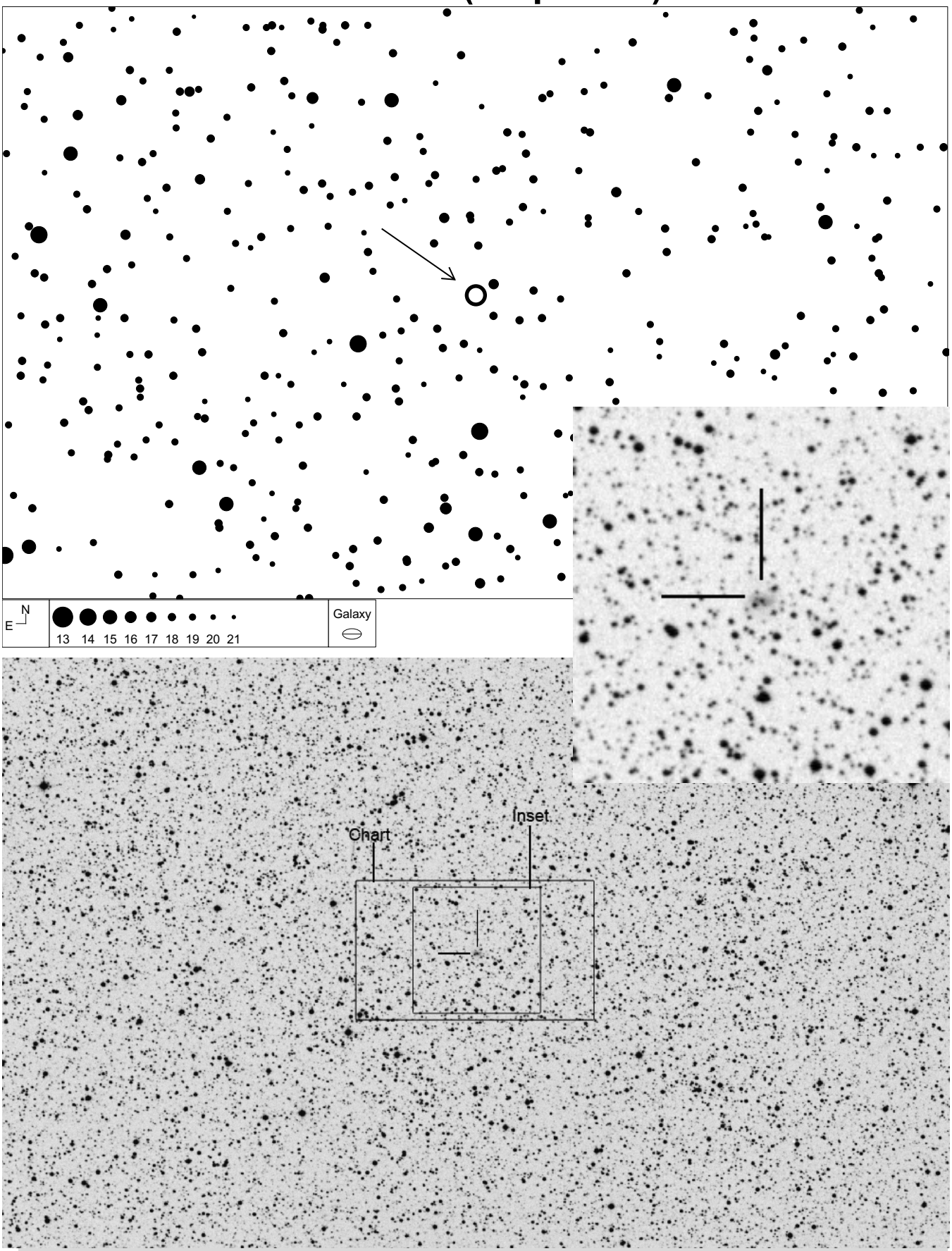


Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	19 10 37.2	+52 13 13	15.5 – 17.	18 x 10”	0.027	PGC 62859

V362 Vul (Vulpecula)

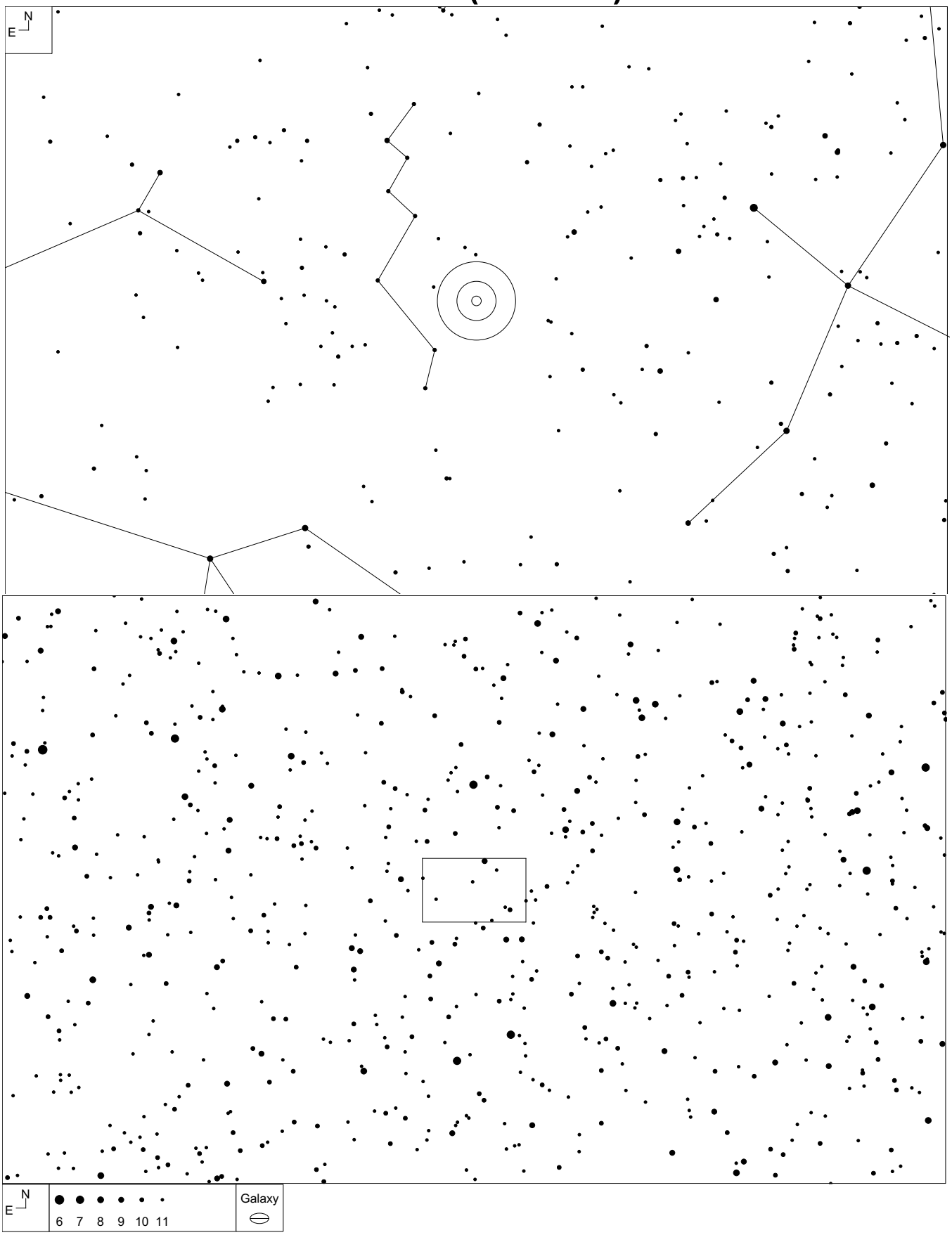


V362 Vul (Vulpecula)

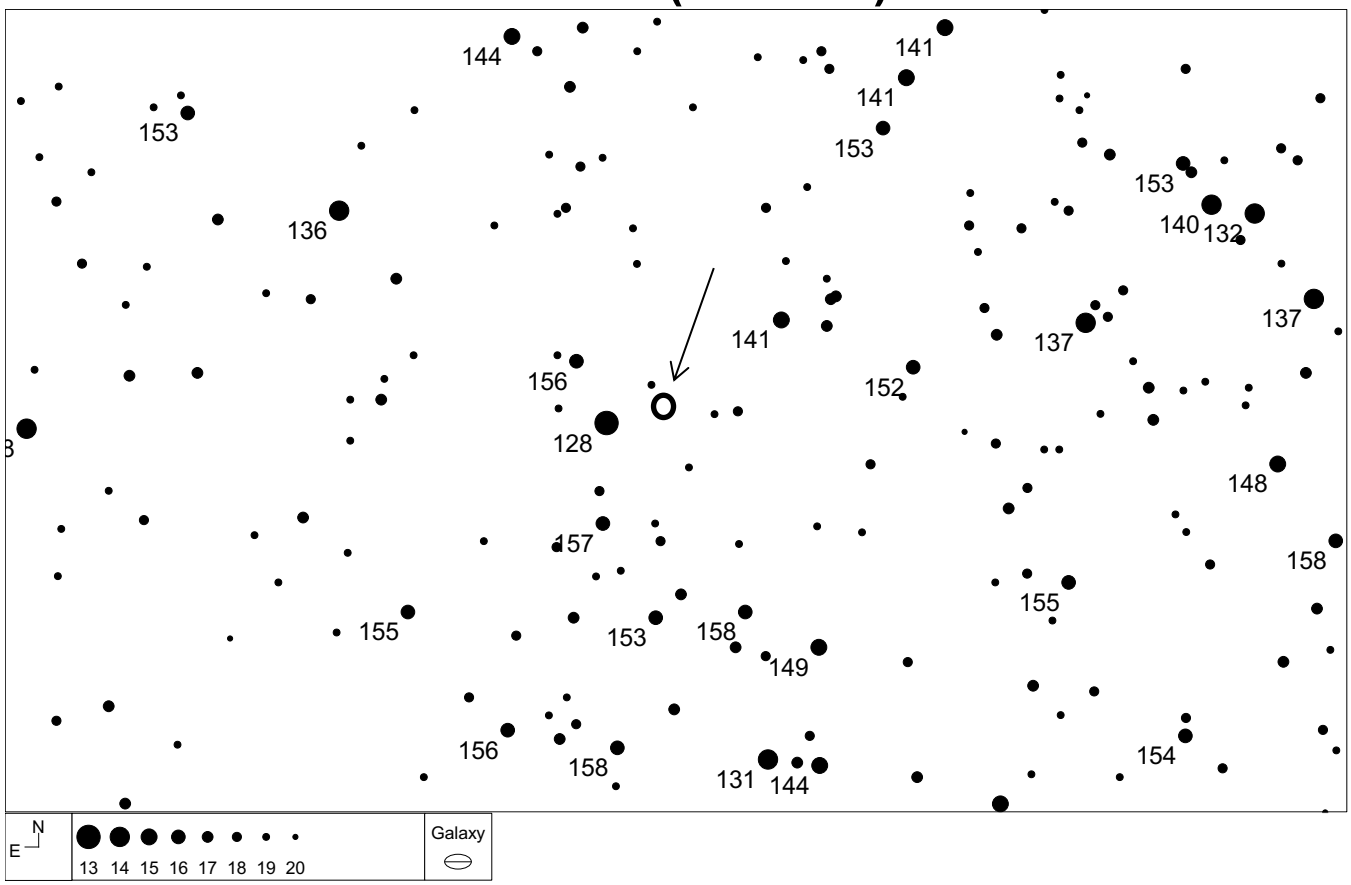


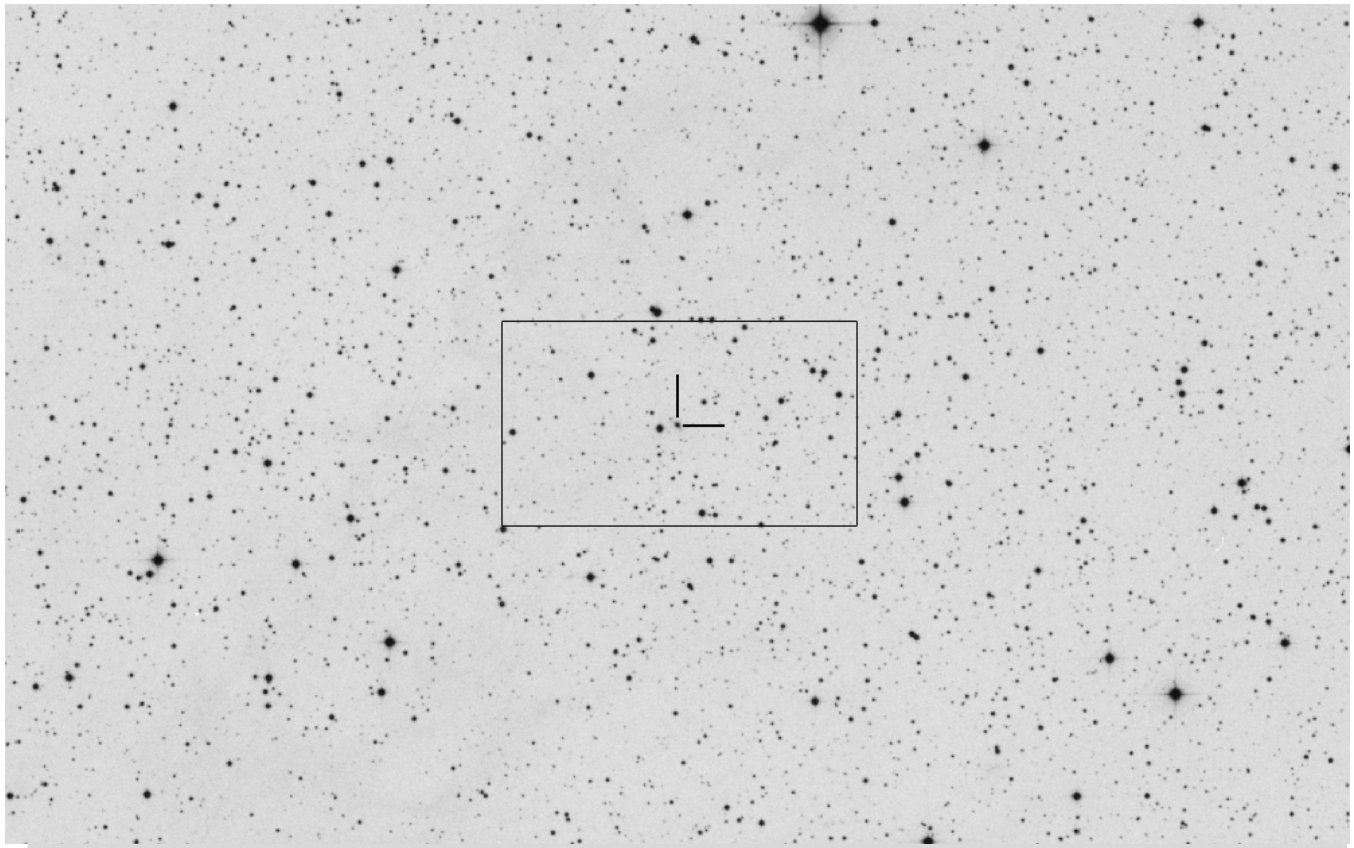
Type	RA	Dec	Mag	Size	Redshift	Other Name
AGN	20 02 48.6	+22 28 27	16.0 – 17.7	18 x 12”	0.029	E 2000+223

BL Lac (Lacerta)



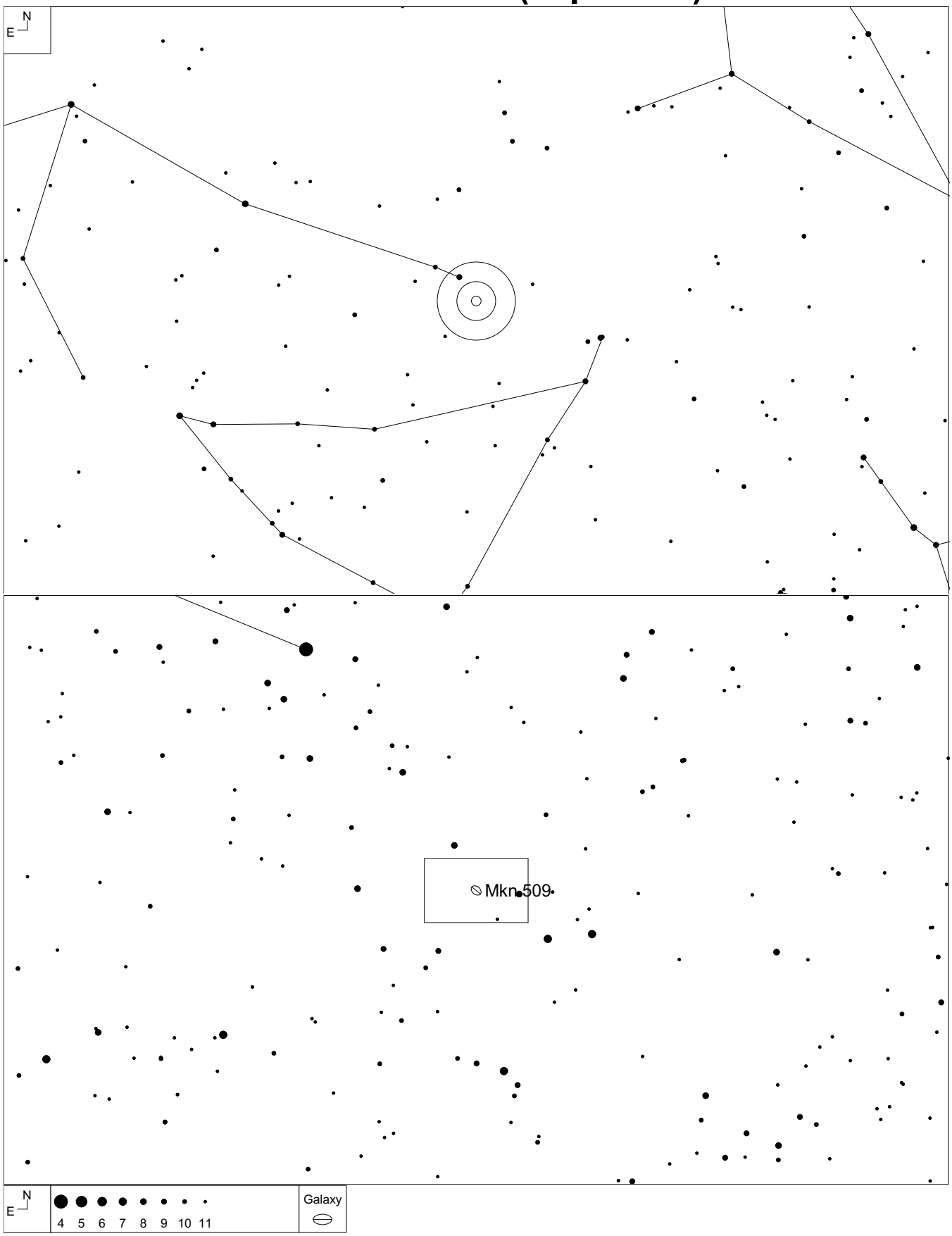
BL Lac (Lacerta)





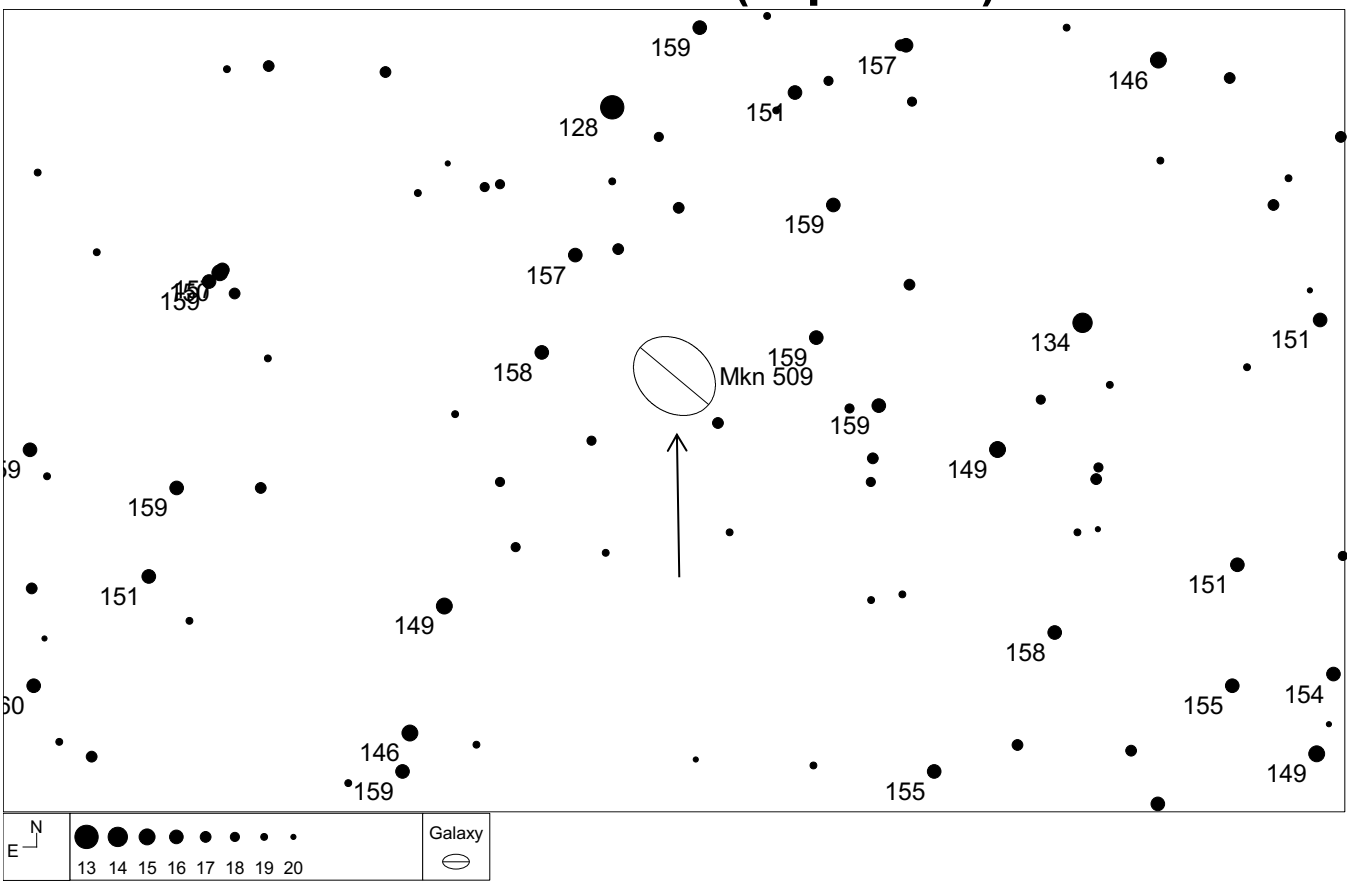
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	22 02 43.3	+42 16 39	12.4 – 17.2	30 x 15”	0.069	VRO 42.22.01

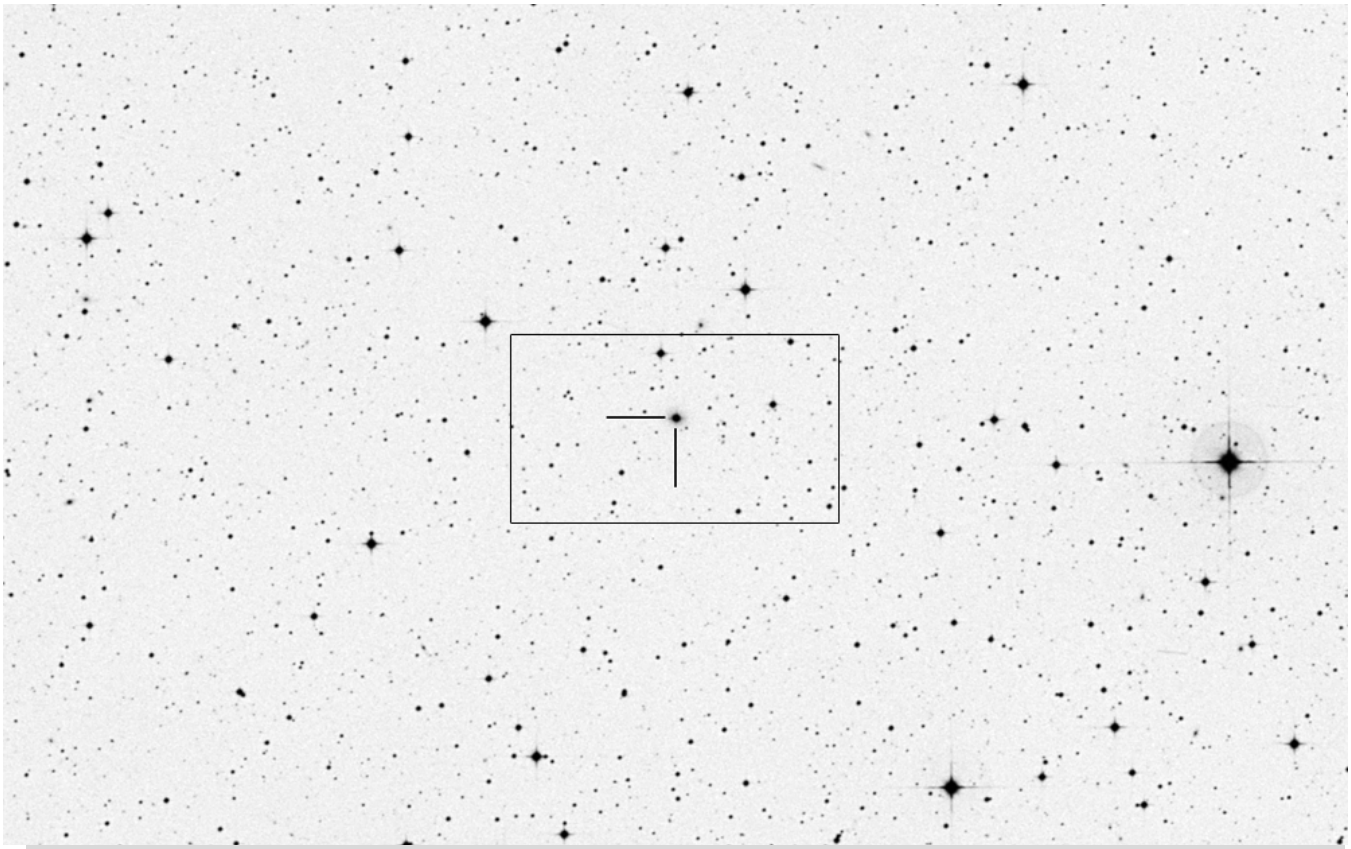
Markarian 509 (Aquarius)



Kaastra, J. et al "Accretion and outflow of gas in Markarian 509" *Proceedings IAU Symposium,* No 290 (2012)
"Astronomers delightful Horror: Active Galaxy Markarian 509" (http://tinyurl.com/co8a39l)

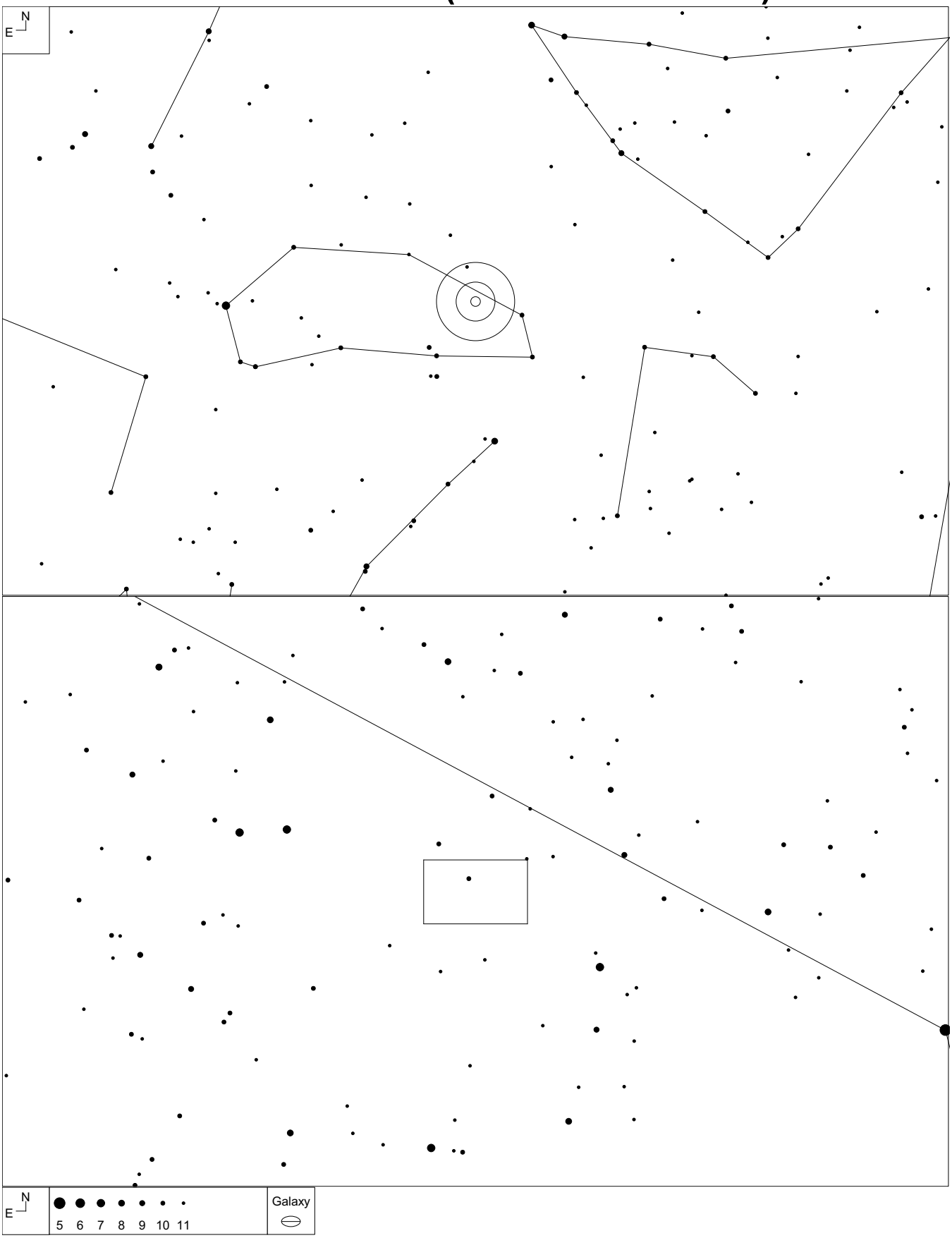
Markarian 509 (Aquarius)





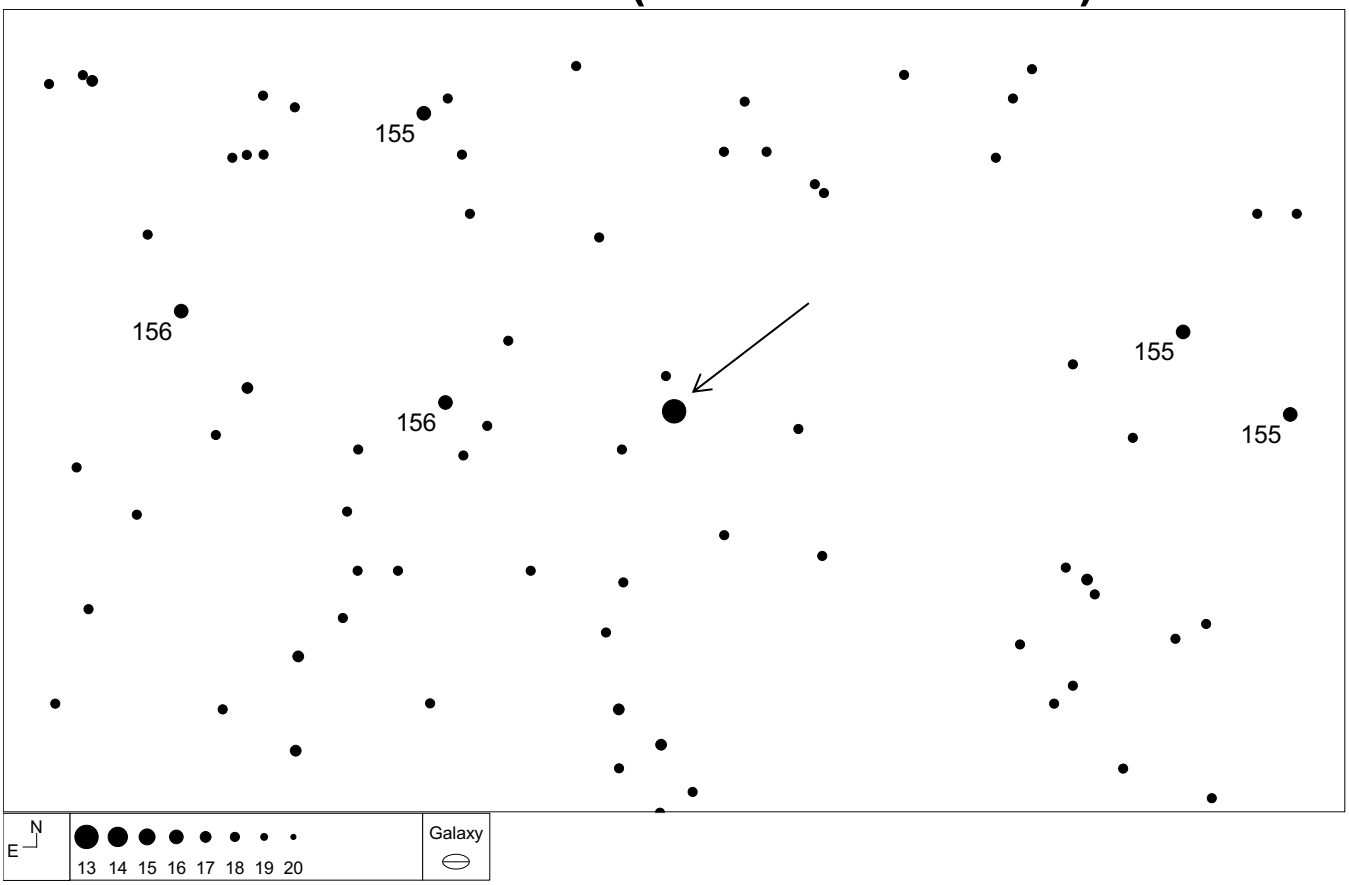
Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	20 44 09.8	‘-10 43 35	12.6 – 15.65	0.5 x 0.4’	0.033	PGC 65282

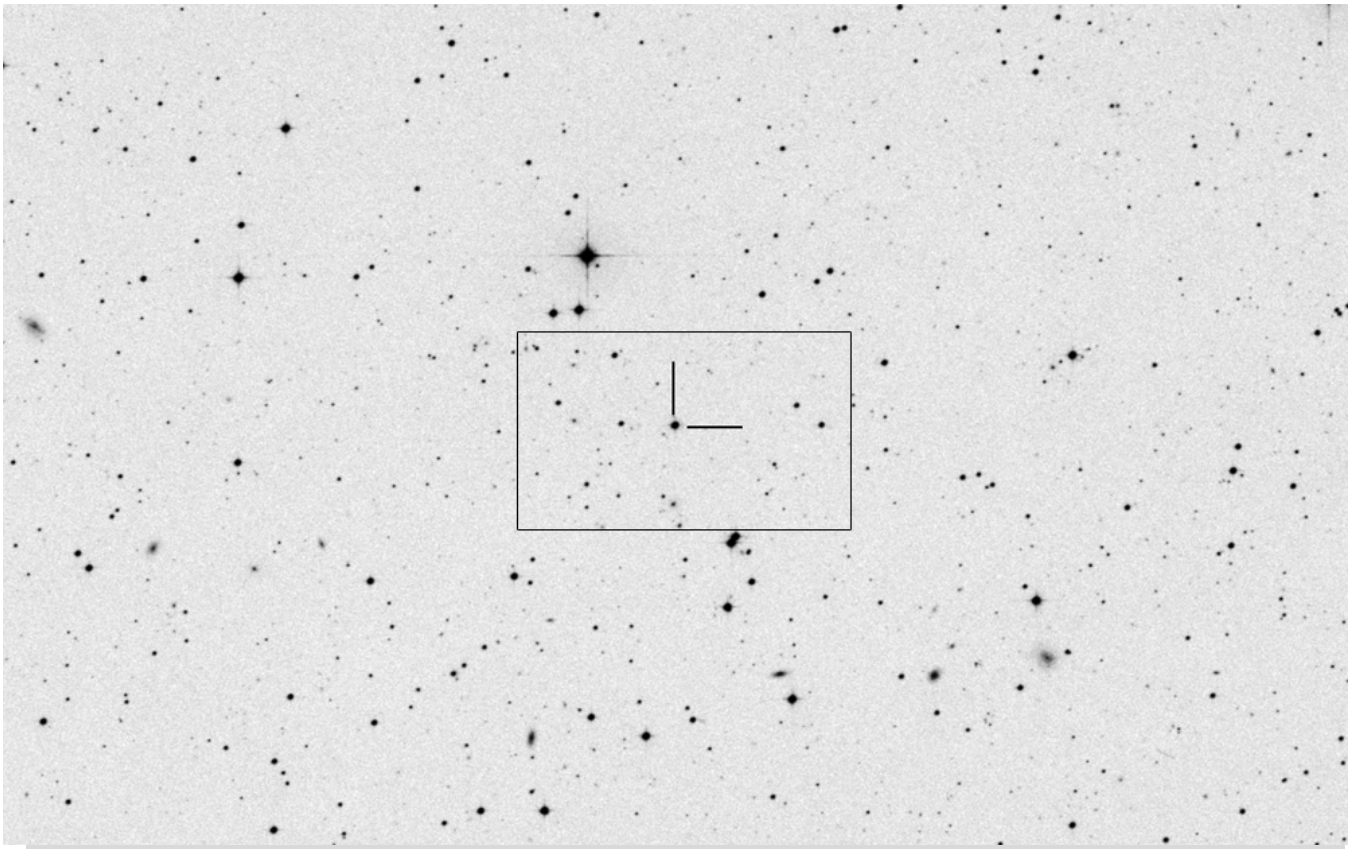
PKS 2155-304 (Pisces Austrinus)



The HESS Collaboration. “Simultaneous observations of PKS 2155-304 with H.E.S.S., Fermi, RXTE and ATOM: spectral energy distributions and variability in a low state” *Astrophysical Journal,* Vol 696 (2009): L150-L155

PKS 2155-304 (Pisces Austrinus)





Type	RA	Dec	Mag	Size	Redshift	Other Name
BL	21 58 52.0	-30 13 32	11.9 - 13.4	stellar	0.116	

Additional Resources

Journal and Amateur Articles

Bond, H.E. "A Search for Extragalactic Objects in the General Catalog of Variable Stars" *Astrophysical Journal*, Vol 181 (1973), L23-L24

Gottlieb, Steve. "Blazar, Blazar, Burning Light" *Sky and Telescope* (Apr 2010)

Hewitt, Nick. "Active Galactic Nuclei and the Amateur" *The Deep Sky Observer*, Vol 116 (Apr 1999)

Mattrox, J.R. "Observing Blazars with the WEB Telescope" *Precision CCD Photometry, ASP Conference Series*, Vol 189 (1995), 95-102

Porcas, R.W. "Observing Blazars with VLBI" *NATO Science Series II: Mathematics, Physics and Chemistry,* Vol 135 (2005), 93-106

Stein, W.A.; O'Dell, S.L.; Strittmatter, P.A. "The BL Lacertae Objects" *Annual Review of Astronomy and Astrophysics*, Vol 14 (1976), 173-195.

Steinicke, Wolfgang. *Extragalactic Objects Discovered as Variable Stars*. United Kingdom: Webb Deep Sky Society (2000)

Books

Craine, Eric R. *A Handbook of Quasistellar and BL Lacertae Objects*. Tucson, AZ: Pachart Publishing House, 1977

Mobberley, Martin. *Cataclysmic Cosmic Events and How to Observe Them*. London, UK: Springer-Verlag, 2009

Steinicke, Wolfgang and Jakiel, Richard. *Galaxies and How to Observe Them.* London, UK: Springer-Verlag, 2007

Websites

ned.ipac.caltech.edu/level5/Sept02/Zwicky/Zwicky_contents.html - Catalogue of Selected Compact Galaxies and of Post-Eruptive Galaxies by Dr. Fritz Zwicky

www.klima-luft.de/steinicke/AGN/vargal/vargal2000.htm - Extragalactic Objects Discovered as Variable Stars by Dr. Wolfgang Steinicke

www.aavso.org/ - American Association of Variable Star Observers

nedwww.ipac.caltech.edu/ - NASA-IPAC Extragalactic Database – NED

skyserver.sdss.org/dr10/en/tools/chart/navi.aspx - SkyServer DR10 Tools for Visual Exploration (SDSS)

www.deepskyforum.com - The premier Deep Sky forum where advanced deep sky observers converge and discuss various aspects of deep sky observing.

www.astronomy-mall.com/Adventures.In.Deep.Space - Great source of observing projects for all skill levels.

www.cloudynights.com – Great resource for like-minded amateurs discussing most aspects of the hobby.

Sources of Charts and Images

Charts by *Megastar version 5* Willmann-Bell Richmond, VA

archive.stsci.edu/dss/acknowledging.html - DSS images (Digital Sky Survey)

Revision History

Date	Revision
Apr 24, 2013	New document
Apr 26, 2013	Deleted IV Zw 49 Added IV Zw 29 and I Zw 1.
May 13, 2014	Turned the Index from landscape to portrait format to keep in line of publisher requirements.
March 2024	Minor edits. Reformatted footnotes and references and other minor edits. Note: No new objects.