



CAMPUS ASTRONOMY: A CATALOGUE

Jesus Rodrigo F. Torres

Chairman, Department of Astronomy,
Graduate School, Rizal Technological
University;
Mandaluyong City, Philippines

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I. Introduction

Eight years after introduction of the Astronomy programs of the Rizal Technological University (MS in Astronomy, Graduate Diploma in Astronomy, and BS in Astronomy Technology), I have felt a real need for an observing catalogue which students can use, especially if they are observing in the school campus. An observing catalogue that would contain the most interesting objects in the night sky and which would be within the capability of binoculars or small telescopes now available in dealers' shops in malls has been imperative in the last few years. These binoculars and telescopes are now within the reach of the budgets of students, as they are even cheaper than cell phones.

The observing catalogue should be useful under the stars; it should contain

usable maps that give enough detail to be useful in locating objects. The majority of the objects in the guide should be observable even in severely light-polluted campuses. It should contain enough useful information to satisfy the intellectual needs of the astronomer; such information should create a hunger for more information which the astronomer will search for himself or herself later.

The observing catalogue should contain objects a fairly new astronomer with a working knowledge of the most important constellations which he or she can identify easily. The constellations themselves should be the more prominent ones. Almost all of them should have easily identifiable patterns.

The observing catalogue should have pictures of most of the included objects, with a fair representation of the objects which can be studied, such as galaxies, open clusters, globular clusters, nebulae, single, double and multiple stars, and even supernova remnants. The pictures shall be those which would give a better understanding of the object, or which should

For Correspondence:

jrftorres2002ATyahoo.com

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more or less be similar to what the astronomer would see in the eyepiece.

With these things in mind, this observing catalogue for campus astronomy is hereby presented.

II. Research Objectives:

This research shall have the following objectives:

1. To produce an observing catalogue which will be useful in campus astronomy especially in educating students in astronomy in the field setting? The observing site shall be in a campus. As benchmark, all the objects in the catalogue should be observable in the RTU Pasig Campus.
2. The catalogue should be useful to both new and advanced campus astronomers, and should have enough information for field lectures or while observing activities are in progress.
3. The catalogue should contain just enough of the most interesting astronomical objects which can be easily or moderately observed through small-aperture telescopes or even binoculars of good quality.
4. The catalogue should be useful in the manual search for the objects described.

III. Research Problems:

This research shall have as its major problem the production of an observing catalogue for campus astronomy. Specifically, it shall have the following sub-problems:

1. What astronomical objects should be included which would serve the objectives of the research?
2. What information should be included in describing the objects?
3. What methods shall be used to describe the objects and to validate their inclusion in the catalogue?

4. What type of telescopes or binoculars shall be recommended based on the researcher's own field observations of the objects in the catalogue?

IV. Research Methods:

The research shall rely on the following methods to answer the three problems above-specified:

1. Expert consultation. I have consulted with the advanced astronomers in the country for suggestions on the objects to be included. These astronomers are characterized by their experience in holding observational activities with students of various client schools; they are those who have many years of observing experience; some also engage in astrophotography or sketching; they have years of experience as lecturers in the astronomical clubs in the country; some have work directly related to astronomy, such as lecturers in schools or astronomy entrepreneurs.
2. Field Observation. I have observed and re-observed the objects included in the catalogue. The type of telescopes which would be effective in observing the different types of objects have been determined through these observations.
3. Data gathering. Known data on the objects are taken from Internet sources and from books. The astronomer who happens to be using this book should try to confirm the data by himself or herself, as research in this field is very dynamic and continuing.

V. Observing Sites:

The objects included in the catalogue should be observable in the campuses of the Rizal Technological University. Objects which can be seen and observed in the Mandaluyong Campus while the Quadrangle floodlights are open while the athletes and

cheer dance groups are practicing are indeed good and bright objects for observation, as there can be no more worse observing site than this campus in this situation.

The Pasig Campus is light-polluted as it is in the middle of greater Manila. It is adjacent to the Pasig City General Hospital which opens its bright halogen floodlights which trespass to RTU property.

Students and faculty in schools, colleges and universities which have campuses in dark locations will surely be able to observe all the objects in this catalogue even with smaller telescopes. I purportedly observed all objects in the Mandaluyong and Pasig campuses as these are possibly some of the worst places to do astronomical observing. If these objects can be observed in these campuses, surely they can be observed in dark campuses.

VI. Telescopes and Other Equipment:

For this research, the following equipments have been used, without going

into the technical details about them; an astronomer will sooner or later learn about those details. I will discuss here the value of the telescopes relative to the observation of the objects in this catalogue.

I have used the following telescopes Celestron 8-inch Schmidt-Cassegrain telescope or C-8, Celestron 4-inch achromatic refractor or C-102, Orion XT-10 Newtonian Reflector, Binoculars and Astroscan described in my paper entitled "Messier objects as a tool in teaching astronomy".

VII. Objects in the Catalogue:

After the consultations with the experts have been done, the list of objects to be included in the catalogue have been finalized, with suggestions to include additional objects or delete some which may, in practice, be decided as necessary adjustments.

Table 1. List and Types of Objects in the Catalogue

Object	Type	Magnitude	Minimum Equipment
Andromeda			
M31	galaxy	3.50	60-mm Telescope
Gamma Andromedae (Almaak)	multiple star	2.15	60-mm Telescope
Ara			
Caldwell 86 (NGC 6397)	globular cluster	5.70	60-mm telescope
Caldwell 82 (NGC 6193)	Open cluster + bright nebula	5.20	60-mm telescope
Aries			
Gamma Arietis	double star	4.50	60-mm Telescope
Auriga			
Alpha Aurigae (Capella)	multiple star	0.1	Naked eye, Binoculars
Three Kids	asterism		Naked eye
Epsilon Aurigae	giant variable star	4.7	Naked eye, binoculars
M36	open cluster	6.00	binoculars
M37	open cluster	5.60	binoculars
M38	open cluster	6.40	binoculars
Aquarius			

M2	globular cluster	4.00	60-mm Telescope
Zeta Aquarii	double star	3.7	60-mm Telescope
Aquila			
Alpha Aquilae (Altair)	single star	0.8	Naked eye
Bootes			
Alpha Bootis (Arcturus)	giant single star	-0.1	Naked eye
Cancer			
M44 (beehive)	open cluster	3.10	Binoculars
M67	open cluster	6.90	60-mm telescope
Canis Major			
h 3945	double star		60-mm telescope
M41	open cluster	4.50	60-mm Telescope
Canes Venatici			
Cor Caroli	double star	2.9	60-mm Telescope
M3	globular cluster	6.40	60-mm telescope
Capricornus			
Alpha Capricorni 1/2	double star	4.40/3.55	60-mm Telescope
Carina			
Canopus	giant single star	-0.6	Naked eye
Caldwell 92 (NGC 3372)	giant star + nebula	1.0	60-mm telescope
Caldwell 91 (NGC 3532)	open cluster	3.0	60-mm telescope
Cassiopeia			
Caldwell 13 (NGC457)	open cluster	6.4	60-mm telescope
M52	open cluster	6.90	60-mm telescope
Eta Cassiopeiae	double star	3.45	60-mm telescope
M103	open cluster	7.40	60-mm telescope
Centaurus			
Alpha Centauri	double star	4.40	60-mm Telescope
Beta Centauri (Hadar)	multiple star	0.55	60-mm telescope
Omega Centauri	globular cluster	4.65	Binoculars
Cepheus			
Mu Cephei (The Garnet Star)	super red giant star	4.20	Naked eye, 60-mm telescope
Coma Berenices			
Melotte 111	open cluster	10.5	Naked eye
Corona Borealis			
R Coronae Borealis	variable star		binoculars
Crux			
Alpha Crucis	double star	0.8	60-mm telescope
Caldwell 94 (NGC 4755)	open cluster	4.20	Binoculars, 60-mm telescope
Cygnus			
Alpha Cygni (Deneb)	giant single star	1.2	Naked eye, Binoculars
Beta Cygni (Albireo)	double star	3.0	60-mm telescope

M29	open cluster	6.60	Binoculars, 60-mm telescope
Delphinus			
Job's Coffin	asterism		Naked eye
Gamma Delphini	double star	5.1/4.3	60-mm Telescope
Hercules			
M13	globular cluster	5.90	Binoculars, 60-mm Telescope
M92	globular cluster	6.50	60-mm telescope
Hydra			
M48	open cluster	5.80	60-mm telescope
M68	globular cluster	8.20	60-mm telescope
Alpha Hydrae (Alfard)	single star	2	Naked eye,
Gemini			
Alpha Geminorum (Castor)	multiple star	1.6	60-mm telescope
M35	open cluster	5.10	Binoculars, 60-mm telescope
Leo			
The Sickle	asterism		Naked eye
Alpha Leonis (Regulus)	single star	1.4	Naked eye
Gamma Leonis (Algieba)	double star	2.0	60-mm telescope
M65	galaxy	9.30	100-mm telescope
M66	galaxy	9.00	100-mm telescope
Lepus			
M79	globular cluster	8.00	Binoculars, 60 mm telescope
Libra			
Alpha Librae (Zubenelgenubi)	multiple star	5.2	binoculars
Beta Librae (Zubeneschamali)	single star	2.6	Naked eye, binoculars
Lyra			
Alpha Lyrae (Vega)	single star	0.0	Naked eye
Epsilon Lyrae 1/2	two double stars	4.7/4.6	60-mm telescope, 100-mm telescope
M57	planetary nebula	9.00	100-mm telescope
Monoceros			
Beta Monocerotis	multiple star	3.8	60-mm Telescope
NGC 2244	open cluster + nebula	4.80	60-mm Telescope
M50	open cluster	5.90	60-mm Telescope
Ophiuchus			
M12	globular cluster	6.60	100-mm telescope
M10	globular cluster	6.60	100-mm telescope

IC 4665	open cluster	4.20	Binoculars, 60-mm telescope
Orion			
M42	emission nebula	4.00	binoculars
Betelgeuse	super red giant star	0.4	Naked eye
Rigel	Single star	0.2	60-mm telescope
Collinder 7	open cluster		60-mm telescope
Sigma Orionis	multiple star	4.00	100-mm telescope
NGC 1981	open cluster	4.60	binoculars
Pegasus			
51 Pegasi	single star	5.45	Naked eye
M15	globular cluster	6.40	60-mm telescope
The Great Square of Pegasus	asterism		Naked eye
Perseus			
Alpha Persei (Mirphak)	single star	1.8	Naked eye,
M34	open cluster	5.20	60-mm telescope
NGC 869	open cluster	4.00	binoculars
NGC 884	open cluster	4.00	binoculars
Pisces			
TX Piscium	single star	4.95	60-mm telescope
Puppis			
M46	open cluster	6.10	60-mm telescope
M47	open cluster	4.40	60-mm telescope
NGC 2451	open cluster	2.80	binoculars
Sagittarius			
M24	star cloud	11.00	binoculars
M8 (Lagoon Nebula)	nebula	6.00	60-mm telescope
M22	globular cluster	5.10	60-mm telescope
Serpens			
M5	globular cluster	5.80	60-mm telescope
Scorpius			
Alpha Scorpii (Antares)	super red giant star/double star	1.1	100-mm telescope
M4	globular cluster	5.90	60-mm telescope
M6	open cluster	4.20	60-mm telescope
M7	open cluster	3.30	binoculars
NGC 6231	open cluster	2.60	60-mm telescope
Scutum			
M11	open cluster	5.80	60-mm telescope
Taurus			
M45 (Pleiades)	open cluster	1.6	Binoculars, Naked eye
The Hyades	asterism		Naked eye
Aldebaran	single star	0.9	Binoculars, Naked eye
M1	supernova remnant	8.40	100-mm telescope

Ursa Major			
The Big Dipper	asterism		Naked eye
Alcor and Mizar	two double stars	2.2/ 4.2	60-mm telescope
M81	galaxy	6.90	binoculars
M82	galaxy	8.40	binoculars
Ursa Minor			
Alpha Ursae Minoris (Polaris)	double star	2	60-mm telescope
Vela			
Gamma Velorum (Regor)	multiple star	1.75	60-mm -Telescope
Caldwell 85 (IC 2391)	open cluster	2.5	60-mm Telescope
Virgo			
M104	galaxy	8.30	60-mm telescope
Alpha Virginis (Spica)	double star	1.0	Binoculars, Naked eye

Table 2. Number of Objects Per Type

Type	N
1. Globular clusters	14
2. Open clusters	31
3. Open clusters + bright nebula	2
4. Single stars	9
5. Giant single star	1
6. Giant single star + nebula	1
7. Emission nebulae	2
8. Double stars	14
9. Double-double stars	1
10. Giant variable star	1
11. Variable star	1
12. Super red giant stars	3
13. Multiple stars	8
14. Galaxies	6
15. Planetary nebula	1
16. Asterisms	5
17. Star cloud	1
18. Supernova remnant	1
TOTAL	102

Definition of Terms

Globular clusters- A tight, spherical grouping of hundreds of thousands of stars. Globular clusters are composed of older stars, and are usually found around the central regions of a galaxy. ^[1]

Open clusters- A collection of young stars that formed together. They may or

may not be still bound by gravity. Some of the youngest open clusters are still embedded in the gas and dust from which they formed. ^[2]

Single stars- A self-luminous object that shines through the release of energy

produced by nuclear reactions at its core.^[3]

Emission nebulae- An emission nebula is a nebula that glows; it emits light energy. The reddish light is produced when electrons and protons combine, forming hydrogen atoms. Emission nebulae are formed when energetic ultraviolet light from a very hot star excites a cloud of hydrogen gas; the UV radiation ionizes the hydrogen (it strips electrons from the hydrogen atoms). The free electrons combine with protons, forming hydrogen and red light. The Horse head Nebula is in front of an emission nebula which illuminates the outline of the "horse head."^[4]

Double stars- A grouping of two stars. This grouping can be apparent, where the stars seem close together, or physical, such as a binary system.^[5]

Variable star- A star that fluctuates in brightness. These include eclipsing binaries.^[6]

Super red giant stars- The stage in a star's evolution where the core contracts and the star swells to about five hundreds times its original size. The star's temperature drops, giving it a red color.^[7]

Multiple stars- A **multiple star system**, where in some have tri-nary, quarternary, quintuple, sextuple, septuple stars, depending of the number of stars the system contains. Binary star systems are the most common, and follow elliptical orbits, under the influence of each other's gravity.^[8]

Galaxies- A large grouping of stars. Galaxies are found in a variety of sizes and shapes. Our own Milky Way galaxy is spiral in shape and contains several billion stars. Some galaxies are so distant that their light takes millions of years to reach the Earth.^[9]

Planetary nebula - A planetary nebula is a nebula formed from by a shell of gas

which was ejected from a certain kind of extremely hot star. As the giant star explodes, the core of the star is exposed. Planetary nebulae have nothing to do with planets. The Hourglass Nebula is a planetary nebula.^[10]

Asterisms- A collection of stars (within a constellation) that forms an apparent pattern from Earth. Some familiar asterisms include the Big Dipper, the Little Dipper, Pleiades, Trapezium, and the Summer Triangle.^[11]

Star cloud- A dense grouping of unrelated stars which looks nebulous, such as the Sagittarius Star Cloud.

Supernova remnant- An expanding shell of gas ejected at high speeds by a supernova explosion. Supernova remnants are often visible as diffuse gaseous nebulae usually with a shell-like structure. Many resemble "bubbles" in space.^[12]

VIII. Conclusions and Recommendations:

The following conclusions are derived from the study.

1. It is possible to prepare an observing guide for Campus Astronomy through consultations with advanced Filipino astronomers.
2. The preparation of catalogues such as this one can only be done if the researcher actually observes all the objects he or she will include in the said catalogue, with various available telescopes.
3. The objects listed in this Campus Astronomy observing catalogue are those which can be seen or observed by means of the naked eyes, binoculars and telescopes as small as refractor telescopes of 60-mm objective lenses. The biggest telescopes for Campus Astronomy should be limited to 200-mm apertures.

IX. The following recommendations are hereby proposed:

4. Observing guides in Campus Astronomy for more advanced observers should be prepared which would include more advanced objects such as dimmer galaxies, open clusters, globular cluster, planetary nebulae, and emission nebulae. The objects would require the use of more advanced telescopes such as 4-inch refractors or bigger, and 6-inch reflectors or bigger.
5. More specialized observing guides such as Planetary Nebulae for Campus Astronomy, Globular Clusters for Campus Astronomy, Galaxies for Campus Astronomy, Open Clusters for Campus Astronomy, Double and Multiple Stars for Campus Astronomy, and others like these can be developed by advanced astronomers.
6. Actual observing in relatively dark campuses in the State Universities and Colleges outside Metro Manila can be done to determine the potential of such campuses for doing dark-sky astronomy.

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