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Urban Astronomy in the Philippines

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Abstract

Astronomy in the Philippines is among the most interesting fields of study according to Filipino students. The science, however, suffers from neglect because most Philippine institutions of higher learning have campuses in urban areas. Common understanding dictates that satisfactory astronomical observations and studies can only be done at dark sites away from urban lights. This study aims to prove that astronomical work can be done even in light-polluted urban settings, and to convince educational policymakers to consider establishing observatories in urban campuses and to offer astronomy as a subject or major.

1. INTRODUCTION

The study of astronomy is almost nonexistent in the Philippines. No school in the country offers astronomy as a major. Until very recently, it was not even included in any curriculum as a separate subject--only as part of a more general course in Earth science.

Among the thousands of higher education institutions here, very few have telescopes. In fact, although the largest universities are in the metropolitan Manila area, I could count only two institutions with telescopes: the University of the Philippines (UP) and the Ateneo de Manila University, which has the Manila Observatory in its compound. The UP has a 400-mm observatory-type telescope of the Cassegrain design, donated by the Japanese government. It is the second biggest telescope in the country in terms of aperture. The biggest telescope in the Philippines is the 450-mm Cassegrain, which is installed in the Astronomical Observatory of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) of the Department of Science and Technology. This telescope was also donated from the Japanese government. The 400-mm at the UP is often used by students during astronomy seminars, and the 450-mm at the PAGASA is used mostly for CCD imaging of variable stars. The Manila Observatory has an assortment of equipment used mainly for solar and atmospheric observing.

Other than the telescopes owned by the above universities, most telescopes in the Philippines are owned by the very few individuals who are members of the Philippine Astronomical Society and the Astronomical League of the Philippines. Most of these telescopes are small refractors, and some are small homemade reflectors. The biggest amateur telescopes here are Schmidt-Cassegrains with 8-inch and 14-inch apertures.

As mentioned, the biggest universities in the country are situated in the metropolitan Manila area, which sprawls to the provinces bordering it to the north, east, and south. Artificial lighting in those areas is so visible at night that an astronomer might wonder if any dark site remains that is satisfactory for conducting astronomical observations.

I am an amateur astronomer and a faculty member of the Rizal Technological University (RTU), and I discovered one day that an observing site is available at one of the university's campuses. This state-owned university has two campuses: the Mandaluyong City campus, right in the geographical center of metropolitan Manila, and the Pasig City campus a few kilometers to the east. The site I have chosen is on the roofdeck of the Pasig City campus building.

2. THE OBSERVING SITE: DESCRIPTION AND ANALYSIS

The RTU Pasig Campus is located in a thickly populated urban center about four kilometers east of the high-rise buildings of the Ortigas center. Adjacent to the south of the campus is a general hospital whose administrators have installed several thousand-watt halogen spotlights to illuminate the hospital's building. On the north side of the campus is a park and a church. The park is often well lit to allow sports aficionados to use its running track. Further north is the newly developing commercial center in Libis, Quezon City, where establishments attract customers by means of powerful search lights pointed skyward.

2.1 Seeing

These search lights and the general heavy light pollution in that direction limit observations of the three brightest stars of Ursa Minor, or a limiting magnitude of +3.0.

Fortunately, no commercial centers are located east and southeast of the campus, allowing observations to be made in those directions up to the zenith. The northern sky is still useful for observing, particularly if the targets are single, double, and multiple stars. Deep-sky objects, however, should be allowed to rise to at least 50 degrees before any satisfactory observations can be made.

In the south, many of the deep-sky objects of the major constellations such as Puppis, Lupus, Centaurus, Carina, Crux Australis, Sagittarius, and Scorpius can be observed in good detail. The southernmost object that we have observed so far is the Theta Carinae Cluster, which has a declination of -64º 24'. Any object below this declination cannot be seen from this urban site. However, many fine objects can be observed just above this declination, such as the Eta Carinae Nebula, the Lambda Centauri Cluster, and NGC 2516 (the Southern Beehive). This leaves out such fine objects as 47 Tucanae, the Magellanic Clouds, and the Tarantula Nebula. Although they are above the horizon, the area of sky where they are found is totally washed out by light pollution and atmospheric haze.

In addition to light pollution, there is major air pollution in the area. I often find the site heavy with the smell of burning garbage. Air pollution is an additional disadvantage because the suspended particulates reflect the urban lights.

Analyzing the seeing in the site through the Antoniadi Scale, it could be said that the site's seeing ranges from III (moderate seeing, with large air tremors) to IV (poor seeing, with constant troublesome undulations) to V (very bad seeing, scarcely allowing for a rough sketch). The Antoniadi Scale, however, may not provide adequate characterization of an urban observing site. Therefore, I have devised an Urban Astronomy Scale that categorizes the urban sky quality on any given night. The scale is as follows:

I. Best sky quality with the lights from the residential and commercial centers subdued; the air is satisfactorily transparent; a hint of the Milky Way can be glimpsed in the Scorpius-Sagittarius region; moonless and cloudless.
II. Good sky quality with the air being satisfactorily transparent, but lights in commercial and residential areas still on; moonless and cloudless.
III. Moderately poor sky quality with high or fast-moving clouds revealing patches of transparent sky, but light in commercial and residential centers is subdued; Moon in crescent phase.
IV. Poor sky quality with high or fast-moving clouds; lights in commercial and residential centers are still on; Moon in crescent phase.
V. Bad sky quality with haze; lights in commercial and residential centers still on; limiting magnitude is +3.0; Moon in quarter phase.
VI. Very bad sky quality with haze or clouds almost covering the entire sky; heavy air and light pollution; Moon first quarter or bigger; limiting magnitude ranging from +2 and +3.

After years of observing, I have found that different types of objects can be observed in all observing conditions in urban astronomy:

I. Galaxies down to magnitude 10, provided that they have high surface brightness; the brighter planetary nebulae such as the Blinking Planetary, M57, the Blue Snowball; bright nebulae; globular clusters to magnitude 10 to 11; open clusters; planets.
II. Bright galaxies to magnitude 9; bright globular clusters and open clusters; the brightest nebulae such as M42; planets.
III. Bright open and globular clusters; double and multiple stars; planets; crescent Moon.
IV. Moon and planets; bright open clusters.
V. Moon and planets; bright single and fainter double stars.
VI. Moon and planets; bright single and bright double stars.

2.2 Time of Observations

I cannot always schedule the time of observing. Many students trek to the observing site (the roofdeck) regardless of major. I oblige by showing them the "sky's greatest hits" for that particular night. Even when I do not feel like observing (e.g., when conditions match categories V or VI), the more dedicated students may ask me for even an hour of observing the planets or the Moon. Sky quality that falls under categories I, II, and III, however, is quite rare. When good conditions occur, I and the more dedicated student observers take the opportunity to conduct overnight observing sessions. Initially, the more dedicated student observers are usually those taking courses in education, regardless of major. They are the ones

who ask a lot of questions. Their enthusiasm is great, and it would not be good to discourage them by packing up early. I can sense that they are ready for an overnight observing session when they keep asking what objects can be seen next. Often, when the observing conditions are very good, I deliberately kindle their curiosity by telling them that some really good objects are about to rise, such as Jupiter and Saturn, or M57. They then talk among themselves and decide to stay the whole night. But then I have to pull out a few bills to let them buy some snacks. After a few phone calls and text messages to their parents, we are ready. These students are mostly boys; the girls' parents often do not allow them to stay out late, even for astronomy.

It is always better to plan these sessions several days in advance. Many times, students come into my office, ask astronomy questions, look at the frames of the beautiful astronomical objects hanging there, and ask if I have plans to observe. We then set the date for observing. We soon found a better way to prepare these observing sessions. A core group of students simply organized themselves into the RTU Astronomical Society, which has been growing in membership. If I have the time and energy, I join them in their observing, but sometimes I just lend them the Astroscan and the Celestron 4-inch refractor, plus a few observing books and the catalog that I have prepared. They prepare a list of targets for the night, take notes about the objects observed, and we share notes a few days later. It is all very enjoyable indeed. Many times, however, they just observe for two hours and go home. There is other homework to be done for the following day.

The Society now makes announcements for the more remarkable astronomical events and invites students to watch. I allow them to use my bulletin board to post astronomical pictures and information. Interest in astronomy is growing rapidly in the university. (We had several hundred students look at Mars during its 2003 approach, and several hundred more during the Venus transit. The telescope we used on both occasions was manually operated!) From this experience, it seems that the best way to develop an interest in astronomy is to let students see people observing with a telescope in an accessible place on campus (even during the day) as often as possible. In the beginning, everyone seems interested in looking through a telescope. When the observing program is sustained and regularly conducted, many students regularly join the observing, and when this happens, it is time to organize an astronomical society.

The key to success in finding and studying objects in urban astronomy is to observe as often as possible, even for short periods lasting up to two hours, and to have a lot of patience in waiting for those moments when faint objects will finally reveal themselves.

3. RESEARCH OBJECTIVES

The primary objective of our research has been to catalog the objects that can be seen and observed in the urban sprawl of metropolitan Manila. The catalog is a valuable addition to the RTU library, which had one book on astronomy. After the five volumes of the catalog were submitted, the number immediately grew to six. (As of this writing, the number has grown to 13 because I have finished seven more books in astronomy.) Now the students are encouraged to learn more about the objects that they have observed by referring to the catalog. Some make specific requests to include some objects in the observing list after coming across them in the catalog. The catalog therefore serves to satisfy the students' thirst for knowledge and to encourage more observations. The contents of some of the volumes can now be accessed at http://www.rtu.edu.ph. We are in the process of completing the online manuscript and the links to every object.

Copies of the catalog have been sent to the libraries of the National Research Council of the Philippines, the University of the Philippines, the Philippine Commission on Higher Education, the National Library, the PAGASA library, and some universities. The catalog is a very substantial contribution to the PAGASA library, which did not have even simple handbooks describing astronomical objects.

It is my hope that universities and colleges in the country will find the number of objects observed sufficient and convincing enough for them to consider the establishment of observatories on their campuses, even if they are in the cities. The observatories need not be equipped with expensive telescopes and equipment; modest telescopes will do. Domes may not be necessary either--just a nice open place on the roofdeck or in any vacant space might be enough. What is important is for the schools to start showing their students and faculty the wonders of the heavens, which will inspire them to pursue scientific studies. After small steps have been taken, some schools may begin offering astronomy courses. This will lead to further steps toward the development of astronomy education in the Philippines.

Last, it is my fervent hope that I am making some real contribution to the development of astronomy in the country and the resulting development of scientific consciousness among our people. I must admit that we--meaning I and the students--had to overcome substantial opposition and even hostility from some officials of my university who felt that I was wasting time and effort in pursuing what they thought was a nonpriority science. But perseverance, substantiated with real research output and evident enthusiasm among the students, has softened their hearts. Whenever the occasion arises, such as when we officials are on a trip, I bring a telescope to show them Saturn, the Moon, and a host of other objects. The sheer beauty and splendor of these objects have softened the hardest of administrative hearts.

4. METHODS

Most of the observations were done with students who were either curious to peek through the telescope or assist me by describing what they saw, or who would do actual sketches. Visual astronomy, it seems, is best done when the observer shares what he sees, especially if the observers are students. Their enthusiasm is infectious.

Plans are made before the observing sessions to list the targets for the night, which sometimes are not followed because clouds often cover the intended area of observation. If this happens, the researcher chooses whichever object may be observed depending on the sky conditions. When the most interesting objects are hidden from view, single stars still somehow satisfy the unquenchable curiosity of the students. Most important, other faculty members and school administrators are invited to participate in stargazing sessions. This strategy proved crucial in the formulation of university policies pertaining to astronomy.

4.1 Equipment

The RTU itself does not own any telescopes. I use my own telescopes and other equipment:

1. 8-inch Schmidt-Cassegrain in fork mount fitted with an 80-mm finder and bull’s eye target finder
2. 4.25-inch f/4.5 Newtonian reflector
3. 102-mm f/10 refractor
4. 10 x 50 and 7 x 50 binoculars

I also bring the catalog and several books containing data on astronomical objects for ready reference to answer questions by students. Most answers are already contained in the catalog, but I can always ask students to fetch additional books from the office if needed.

All of the equipment is noncomputerized. Through much practice, I have gained the skill of star-hopping to find obscure targets. I had to learn the constellations and identify their patterns using the more basic observing handbooks, such as Will Tirion's *Stars and Planets*, or the *Night Sky* from the Discovery Channel. As my skills improved, the *Sky Atlas 2000.0* came in handy. It shows stars down to magnitude 8.5, except that in the urban setting, the most that can be seen with the naked eye are magnitude 4 stars, but even the light pollution haze can be penetrated by a good pair of 10 x 50 binoculars, so star-hopping with the *Sky Atlas 2000.0* is still a cinch.

Often, I just calculate the position of an object by pointing the telescope to where the object should be. My 8-inch is equipped with a Teltrad and an 80-mm finder, both excellent devices specially suited to visual astronomy and star-hopping. When I have the telescope pointing properly at the object targeted, I look through the eyepiece. If the object is not there or cannot be seen after prolonged gazing, perhaps it is too faint to shine through the light pollution, so I list it among the "not-yet-seen" objects in my logbook for later attempts. The keys to this endeavor are patience--lots of it--and perseverance in learning the patterns in the night sky.

Contrary to common wisdom, I found out a long time ago that bigger telescope apertures show deep-sky objects better than smaller ones, even in a light-polluted location. We are now using a 10-inch Newtonian--acquired after the catalog was made--that can easily resolve some challenging objects (such as Epsilon Bootis and the components of Nu Scorpii) and that readily shows E and F of the Trapezium, even in the inner city. Many faint galaxies of magnitude 9 to 10 with relatively high surface brightnesses, which are hidden from the 4-inch refractor, are easily detected in the 8-inch, and even fainter ones of magnitude 11 with lower surface brightnesses are visible in the 10-inch. Globular and open clusters are more resolved in bigger apertures, and more details can be detected in planetary and bright nebulae. My advice is for urban astronomers to get the biggest aperture telescope they can afford and operate with relative ease.

4.2 Objects Cataloged

The following are the objects cataloged during the two years of urban astronomy observing (from January 2000 to March 2002). They are embodied in five volumes of work consisting of 300 observation reports:

a) *Supernova remnant.* Only one of this type was found, namely M1.
b) *Open clusters.* So far, I have cataloged 161 open clusters observable from the urban location. Some are the most famous, such as M45 (the Pleiades), M44 (Praesepe), M47, M6, and NGC 6231. However, my students and I have found many other obscure open clusters, such as Collinder, Pismis, and Ruprecht. Students delight in doing connect-the-dots on these objects.
c) *Galaxies.* These are some of the most difficult objects to see in urban astronomy. Type I or II conditions are needed before galaxies can even be glimpsed, and the urban astronomer should be pleased to have seen them at all. Very few galaxies show detail such as M64 (the Black Eye Galaxy) and M81. Most appear like ghostly patches of light, some have bright cores, and some can easily be mistaken for compact globular clusters or planetary nebulae. But the students are nevertheless delighted that they can see objects millions of light years away.
d) *Globular clusters.* I have cataloged 44 globular clusters in the first five volumes of this work. Some

are the best, such as Omega Centauri, M13, M22, M92, and M5, but many are pale and obscure, such as the globular clusters scattered in the Scorpius-Sagittarius and Ophiuchus regions. Students wonder if their stars do not touch each other until I explain their nature.

e) *Planetary nebulae.* I have so far cataloged 14 planetary nebulae. The best-known among them are the M57 (the Ring Nebula), M97 (the Owl Nebula), NGC 2392 (the Eskimo Nebula), and NGC 3132 (the Eight-Burst Nebula). Planetary nebulae always look bluish to the researcher, but many students see them as green! It seems that observers belong to two camps when it comes to planetary nebulae: the blue camp and the green camp.

f) *Bright nebulae.* I have cataloged only eight of this kind because of light pollution. The best moment to observe them in the urban area is when the lights from most establishments are subdued, but that means observing starting at 1:00 a.m. until about 3:00 a.m. M42 however, is the Great Orion Nebula and it fits its name. Students exclaim with admiration upon learning that it is an active star-forming region.

g) *Double and multiple stars.* To many students, these objects are some of the most fun to see. Some objects are very colorful, such as Beta Cygni (Albireo), Epsilon Bootis, and many others. Some students wonder if a bridge can be built between the two stars of a double system until their true distances are explained. They are delighted to learn that Alpha Geminorum, for example, is actually a six-star system.

h) *Variable stars.* These are the most difficult and frustrating objects to observe in urban astronomy. The observer really cannot visually follow the light variations of even the short-period variables because of the highly erratic Philippine weather, but light pollution does not seem to have much of an effect on the detection of variability of the bright variables, such as Algol. I have listed 20 of this type in the catalog, but we are not sure if their variations can really be observed.

i) *Asterisms.* Although these objects are said to have limited scientific value, students much prefer them because of the shapes that they present to the imagination. I have cataloged 12 of them. I explained to one curious student that asterisms are important in committing to memory the patterns in the sky, like those of constellations. Any apparent object that is not part of the pattern must be a supernova, a comet, or an asteroid.

j) *Single stars.* When all deep-sky objects are not observable, I show students the single stars. They pack enough marvels. Betelguese, Mu Cephei, Capella, Canopus, and even the most ordinary-looking single stars never fail to fascinate the students with their colors.

Once I explain the luminosity of these stars and their absolute magnitudes, distances, and possible diameters compared with our Sun, students look silently at them, trying to comprehend the information.

Compiling the objects listed in the catalog is a simple. We just list all of the objects that we can see or study, and record our own descriptions of them. We take careful notes on the number of stars that can be seen in a cluster with certain telescopes and their colors, and we estimate their magnitudes. We describe that night's sky conditions. Regarding double stars, we note the colors of the components and estimate their magnitudes. We sketch the nebulae seen and compare how various observers perceive their colors. We can only note the colors of stars because we do not have the equipment to study their spectra.

I allow students to make discoveries for themselves. With a telescope, for example, a group would point at a star. They would have to look at the maps to see what star it might be. The star is then added to the catalog. Students particularly enjoy this process. The more advanced observers among them are sometimes asked to look for the Messier objects and other deep-sky objects. If we have not yet recorded them, we put their discoveries in the catalog.

Our own observations are then supplemented by known data and by the observations of other astronomers. The texts are prepared for printing and distribution. I packed the catalog with as much information as I had access to--from my own books, from books borrowed from fellow amateur astronomers, and from the Web. Reading the text, an astronomer from India concluded that it could pass as the Philippine version of the Burnham's Celestial Handbook, only less extensive and organized. A heartwarming comment! But we have to pass the information on to our students who thirst for astronomical knowledge.

5. CONCLUSIONS AND RECOMMENDATIONS

Although the objects cataloged are still incomplete, they represent a good sample of astronomical objects that can be observed even in light-polluted urban areas. We plan to continue observing these objects and add others to the catalog over the next few years, so light pollution is really not a hindrance to a determined pursuit of astronomy.

In the field of education, I recommend that schools in the Philippines start acquiring simple telescopes designed to give students a general introduction to astronomy. Prospective teachers must first be trained to observe and to increase their knowledge in astronomy, because very few can teach beyond the most rudimentary aspects of the science. The Philippines is years behind in astronomy education, and if there is any good time to start, it is now.

I believe that more students and teachers will see the celestial sights, and a passion for astronomy and the sciences will be kindled if schools start acquiring telescopes and building modest observatories. A few determined students might pursue astronomy studies abroad. They would carry the torch, and I can only dream about what would be next. The catalog aims to motivate others to pursue similar observations and to create catalogs in their own cities through a cooperative endeavor between teachers and students, and through the assistance of amateur astronomers.

Government support for astronomy education is needed to provide funds for this purpose. The contribution of astronomy to the Philippines and the motivation for this investment would be astronomy's power to kindle scientific interest and consciousness among the students.

I have already felt such a surge of scientific interest in my students. In a political science class that I teach, discussions of Rousseau and Locke were rather drab, but I was surprised by the students' knowledge of the history of Galileo and the political implications of his trial. The discussion quickly turned to astronomy, and the class became very lively. These students have been joining me in observations. My history majors have borrowed my astronomy books and magazines after joining me in some observations. They have been reading them much faster than their history texts. Astronomy can ignite scientific interest among these students regardless of major. Some have asked me if they can enroll in any astronomy course, and I told them that no school in the country offers an astronomy major; it is sad to see their disappointment. When the time comes for education students to undergo their teaching demonstration as a culminating activity for their practice teaching, most of the science majors present astronomy topics, and the history majors present topics on the history of astronomy. This is evidence of how powerful astronomy is in developing scientific consciousness among our students.

I have found deep satisfaction in doing astronomy in the city, and most important, in sharing its wonders with young minds eager to learn. I feel that I am contributing to a better future. Several groups of students are already planning to conduct visual observations themselves for their undergraduate thesis projects.

Their topics are marvelous. Some would like to observe and sketch the planets over a period of time. Some like to survey the planetary nebulae and clusters. A few are toying with the idea of sketching the double stars. Some wish to study the Moon and the Sun. Others wish that they could take photos of the deep-sky objects or image them using CCD equipment, but we do not have such equipment at our university. These ideas are a far cry from the research projects that undergraduates conduct in advanced countries, but for the Philippines, it is a step toward a bright future. They are tiny steps, but we will take many of them.

Amateur astronomers can play a key role in astronomy education by conducting seminars and observations in schools, whatever the level, and training teachers in observing techniques. Amateur groups can also help schools to select equipment. School administrators do not know what equipment to buy, or where and how to buy it. Amateur astronomers know all of these things. The members of the Philippine Astronomical Society and the Astronomical League of the Philippines have conducted seminars and observing in some schools in the country, but these programs are few in number. Those who are invited to present occasional astronomy lectures bring their telescopes if they have them, but unfortunately, telescopes are expensive and only a few amateurs own them.

As a concrete step toward astronomy education in the Philippines, the Rizal Technological University has recently added Astronomy in its General Science Curriculum as a subject for students working toward a bachelor of science in education. This marks the first time that such a subject has been offered in any school in the Philippines. And most recently, the National Research Council of the Philippines, which is the premier collegiate body of researchers and scientists in the country and associated with the Department of Science and Technology, changed the name of the Division of Earth Sciences to the Division of Earth and Space Sciences, in recognition of the need to prioritize astronomy research. With these steps, astronomy education will reach far into the future.

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