Preserving the Astronomical “Windows” by/for Education and Culture

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Abstract. The preservation of the astronomical environment is intimately connected to society's understanding and appreciation of astronomy. This requires effective education. We know how this can be done. It remains for us to become education-active, and to convince our colleagues and students to do likewise.

1. Introduction

One could argue that light pollution has no impact on education or culture, because so few people are interested in real science. This was presented in a particularly interesting and dramatic way by the organizer of this conference (Isobe 1990): he divided the people of Japan into seven categories, depending on their interest and involvement in astronomy and other sciences, ranging from $10^2$ serious amateur astronomers who produced useful astronomical data, to $10^8$ people who had no interest in science. Most people may prefer to look at billboards, and other artificial lighting—even space art such as the “star of tolerance.” The word education, however, comes from the Latin word to lead. We have an obligation to inform and educate students and the general public about the scientific, technical, and societal aspects of light pollution. See Pasachoff & Percy (1990), Percy (1996a), and McNally et al. (1997) for comprehensive reviews of astronomy education. Sperling (1991) has published an eloquent discussion of some of the same issues as in this paper, including an historical overview.

Almost everyone can relate, first-hand, to the issue of light pollution. Most can also relate to the issue of space debris; even though they do not encounter it first-hand, they are familiar with reports on the safety of satellites, space shuttles, and space stations. It is more difficult for people to relate to the preservation of the astronomical windows in the electromagnetic spectrum. Somehow, people believe that scientists can overcome every such problem with new technology, and/or with ingenuity. Education is absolutely essential in this case.

I recently published an article on the future of astronomy education (Percy 1996b). I pointed out that we had the knowledge to improve astronomy education at every level. But did we have the political will and “savvy”? Educating the world about light pollution and related issues is also a challenge. With a small expenditure of time and money, we could succeed—especially if we work in partnership with like-minded organizations. For over a decade, there has been
a “science education initiative” in the US, with generous funding from NSF, NASA and other agencies. I hope that other countries, including other space agencies, will recognize the need for such initiatives. These initiatives provide both a rationale and a possible source of funding for public education about the preservation of the astronomical environment.

The case of the developing countries is particularly interesting. Presently, such countries do not use large amounts of energy for lighting, but one might expect that, as they develop, they will. Perhaps they can be persuaded to use efficient and effective lighting from the start, rather than to make the same mistakes which the industrialized countries have made in the past. Since the International Astronomical Union is deeply involved in astronomical development, IAU Commission 50 should take this on as a project.

2. Why Is Astronomy Useful and Important?

People will not be sympathetic to light pollution unless they recognize the importance of astronomy. In fact, astronomy is deeply rooted in history and culture, as a result of its practical applications, and its religious and philosophical implications. It still governs the cycle of day and night, the seasons, and many aspects of long-term climate change. It contributes to the advancement of mathematics and computer science, and science and technology. It is a dynamic science in its own right, attracting much public attention. It deals with our place in time and space, and with our cosmic roots and environment. It also has aesthetic and emotional dimensions: it reveals a universe which is vast and beautiful; it harnesses curiosity, imagination, and a sense of shared exploration and discovery. In school, it can be used to teach concepts of light and gravitation, and to illustrate the observational approach to the scientific method. It attracts young people to science and technology; it increases public awareness and interest in science; and it is an enjoyable hobby for millions of people worldwide.

3. Light Pollution and Education

We know many things about effective science teaching and learning: young people (and adults) have deep-seated misconceptions about scientific topics, which teachers must identify and deal with; scientific concepts must be introduced in a logical sequence, and at an age at which students can absorb them; and science teaching is most effective when an inquiry-based or activity-based approach is taken (see various papers in Percy 1996a). This suggests that sky-watching should be an important part of astronomy education. Even though day-time astronomy is more convenient than night-time astronomy (“the stars come out at night, the students don’t”), the planets, stars, and constellations should be part of every astronomy course. This can be achieved, for instance, by allowing every student to make their own planisphere from a template (Schatz and Cooper 1994). They can be taught how to use this in the classroom, so that they can use it in the evening at their convenience.

Unfortunately, there are many barriers to the effective teaching of astronomy: lack of appreciation of its value; lack of understanding of astronomy, and astronomy education, by teachers; and the ingrained “classical” methods
of teaching by memorization and regurgitation. Astronomers must work with teachers to improve this situation, as has been done very effectively in France for over 20 years.

Ironically, the study of light pollution makes a very good "cloudy night activity" for students, because it requires them to understand scientific, technological, and societal issues. At the very least, they can use simple transmission diffraction gratings to observe the spectra of various natural and artificial light sources in their local environment. Class sets of gratings can be obtained from various science supply companies. Several interesting activities and projects on light pollution have been developed over the years. One of them (Maciolek 1996) was Internet-based; students used a simple device to measure light pollution, and sent their observations to a central database, which could then be used for analysis. Other activities include "Count the Stars," an activity for Grades 4–6 (International Dark-Sky Association publication #113), and an activity in "Science Projects in Astronomy," 1584 Caudor Street, Encinitas CA 92024, USA. Metaxa (1997), in Greece, is beginning a two-year Internet-based project to measure and discuss light pollution on a national and international basis; this approach is already widely used to study other environmental issues.

4. Light Pollution and Amateur Astronomy

There are various definitions of amateur astronomer. The simplest is "someone who enjoys astronomy, and cultivates it as a hobby." Large numbers of people fit this definition. They may be content to read about astronomy, attend lectures, or watch TV documentaries. They may enjoy sky-gazing, and be adept in using star charts and telescopes. Williams (1988) has proposed a more stringent definition: "someone who does astronomy with a high degree of skill, but not for pay." Such individuals can make important contributions to astronomical research, through the measurement of variable stars, for instance, or the discovery of comets, asteroids, novae, and supernovae. They can also make important contributions to astronomical education (Percy 1997): they produce radio and TV programs; they write newspaper and magazine articles, and books; they give astronomy courses and lectures; they volunteer in planetaria, science centres, and public observatories; they organize star parties; they are the driving force behind International Astronomy Day. They can even contribute to astronomy education in the schools, through programs such as the Astronomical Society of the Pacific's Project ASTRO (Bennett 1997).

Light pollution definitely hinders the recruitment and training of amateur astronomers—at least those who have an interest in studying or measuring the night sky, or showing it to others. As Sperling (1991) pointed out, this is partly due to a change in the interests of these sky observers: whereas they were once more interested in observing the sun, moon, and planets (which can still be seen from city skies), they are now more interested in "deep-sky objects" which require clear, dark skies for optimal viewing. Nebular filters, and CCD cameras can help to alleviate the problem and, as Scagell (1994) has pointed out, there is still much to observe from towns and suburbs. Nevertheless, amateur astronomers in large cities are now often content to read about astronomy, attend lectures, or prowl the Internet. During a visit to China in 1995, I was struck by
the differences between amateur astronomy there, and in North America. Urban amateur astronomers in China are much less able to escape from city lights than their counterparts in North America.

Amateur astronomers can be our strong allies in our battle against light pollution, as a result of their special skills and motivation. Indeed, an initiative by the Astronomical League (the “umbrella organization” of astronomy clubs in the US) in 1974 played a very important role in developing interest and activity in this topic. Amateur astronomers carried out a comprehensive study of light pollution in the Toronto area (Berry 1976), and Japanese amateur and professional astronomers have published several papers on this topic (e.g. Kosai et al. 1993). The British Astronomical Association’s campaign for dark skies is described in International Dark-Sky Association publication #72.

5. Electromagnetic Pollution and Space Debris

Most people can relate to the hazard of space debris, especially in this year (1997) when the accidental puncture of the Mir space station by a space shuttle received so much publicity. The risk is obvious, and is a concern to everyone involved in the space program. Until now, the prevailing attitude has been based on the fact that the risk of an impact is small—probably much smaller than the risk that the spacecraft would malfunction. But the risk is present, and increasing—like many other risks caused by modern technology.

Pollution of the electromagnetic spectrum is a more complex and difficult problem, because it is largely invisible. Most people (at least in the industrialized world) benefit from the sources of electromagnetic pollution. There is always a widespread assumption that science and technology can fix (or at least tolerate) any problem. Radio astronomy could certainly move into space, or to the moon, but the cost would be enormous.

6. Non-Solutions to the Light Pollution Problem

• *The Night Sky on a Planetarium Dome, or Computer Screen*. While planetaria and computers are important tools for astronomy education, they do not replace the real sky. In fact, planetaria are under threat as governments cut their budgets; the McLaughlin Planetarium in Toronto was recently closed (at least temporarily) for this reason. The night sky is free; as the song says, “the stars belong to everyone.” Likewise, images and charts on a computer screen are useful, but are ultimately artificial. We must not let nature evolve into an elaborate video game.

• *Dark Sites as Remote “Nature Reserves.”* Amateur (and professional) astronomers in the more affluent countries are fortunate in that many of them can travel to remote dark sites for star parties, or individual viewing. Unfortunately, this is not possible for most people, in most countries. It would be unfortunate if skystaring was restricted to the elite.

• *Astronomy with Remote Telescopes.* Already, professional and amateur astronomers, and students have access to robotic telescopes in remote sites,
for making measurements and images, and such facilities will have an increasing impact on astronomical research and education. They enable students to do real science, with real data. But these images, like other images on a screen, do not replace the experience of looking through the window of the universe, and seeing a sky full of stars.

- **Astronomy from Space.** Many people already believe that all modern astronomy is done with space facilities such as the *Hubble Space Telescope*. In future, amateurs and the general public may be able to obtain images from space with imaginative facilities such as the proposed UK *Humble Space Telescope*. But this will remain a costly, inconvenient, and elitist activity.

### 7. Solutions to the Light Pollution Problem

It would be unrealistic to believe that there is an effective, permanent solution to the light pollution problem. Still, there is much that can be done.

- **Promote astronomy education and culture.** If every astronomer and astronomy student spent 2 per cent more time on education and outreach, the effect could be profound. We must remember that, as Fraknoi (1996) has so eloquently pointed out, astronomy education happens in many places besides the classroom: on TV and radio, in newspapers and magazines, in planetariums and science centers, in astronomy clubs and their star parties, in youth groups, and on the Internet. The tools of “informal education” are as effective with students as they are with the general public.

- An efficient and effective approach is to **work in partnership with other organizations.** The Astronomical Society of the Pacific, for instance, publishes a quarterly teachers’ newsletter which reaches tens of thousands of teachers directly, and is available on the WWW ([http://www.aspsky.org](http://www.aspsky.org)) for downloading. Volunteers translate the newsletter into many different languages, so its impact is great. A newsletter on light pollution, including background information and activities, would meet the needs of both the education and the light pollution communities.

- **Become knowledgeable about both education and light pollution issues.** The case for more effective lighting is a strong one, and most people understand and support it when they know the facts. It would not be unreasonable to expect every astronomy department, and every major astronomy association (professional or amateur) to join the International Dark-Sky Association.

- **Make skygazing a part of the formal and informal education system, including the courses which you teach at every level.** While it is tempting to teach with lectures, textbooks, and pretty pictures, it is only part of the story. There are also many opportunities to introduce astronomy in parks and camps, and in evening programs of continuing studies.
• Support those organizations and individuals who are working to protect the astronomical windows. This includes IAU Commission 50, the International Dark-Sky Association, and the many professional and amateur astronomical societies which have recognized the problem.

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