*Proc. Natl. Acad. Sci. USA*
Vol. 96, p. 5337, May 1999
Editorial

# Setting our sights on the stars

Astronomy is in a remarkable boom period, largely driven by new facilities and steady increases in computing power. Telescopes on spacecraft and in large new ground-based facilities have provided substantial increases in angular resolution, sensitivity, and wavelength coverage, each of which allows deeper investigations of the Universe. The upshot continues to be that each increase is matched by new and often unexpected discoveries.

As part of the National Academy of Sciences' initiative to promote the physical sciences, social sciences, and mathematics in its house journal, the *Proceedings of the National Academy of Sciences* (PNAS), we have put together the first in a series of special features on some of the latest developments in astronomy. This first feature, spanning three issues of the journal, consists of 10 Perspectives from researchers at the forefront of the field. In addition to the Perspectives, we are encouraging submission of original research that will also be included in the Web-based version of the astronomy feature (see www.pnas.org/misc/special.shtml).

The first set of astronomy Perspectives (which appeared in issue 8, April 13, 1999) deals with various facets of cosmology—the study, broadly speaking, of evolution of the Universe. The first three cosmology articles involve observations of very distant objects. Robert Kirshner (1) describes recent developments in using supernovae as standard candles to study the geometry of space. The astonishing result—contrary to all earlier expectations—is that the expansion of the Universe appears to be accelerating, rather than decelerating. This has profound implications for cosmology and for the ultimate fate of the Universe. The geometry of the Universe is also under investigation with gravitational lenses, as reported by Steven Myers (2), where, by studying differential time delays in the multiple images of a distant quasar, it is possible to find the scale of the Universe. A satisfying aspect is that the result, the numerical value of the Hubble constant, agrees well with that obtained from other methods, even though the lens technique operates directly on the distant objects and does not build up a "ladder" of calibrations, starting with nearby objects. This type of agreement lends weight to the astronomers' claim that they are in fact measuring and weighing the Universe with some precision.

August Evrard (3), in the fourth cosmology article, gives us a view into the world of numerical simulation somewhere between theory and observation, in which an educated "guess" is made for the condition of the early Universe, and its evolution under gravity is then calculated. The result is a map of the virtual sky which can be compared with the actual, observed distribution. To the extent that they agree, the simulations have been successful, and a more-or-less plausible model of the early Universe has been found.

Understanding the actual processes involved in the formation of galaxies and stars is a major goal of astronomy. Charles Steidel (4) describes current work in finding and measuring the characteristics of very distant galaxies. "Very distant" is equivalent to very young, and thus researchers are working with galaxies that were born when the Universe was only 10% of its current age. At that early epoch there were stars much like those that exist around us today, and it is clear that galaxies and stars began to form early in the life of the Universe.

The high-energy Universe—both in terms of individual particles (x-rays and gamma rays) and total luminosity (quasars)—continues to amaze and baffle astronomers and physicists. The second set of three astronomy Perspectives (which appeared in issue 9, April 27, 1999) report on different aspects of this work. James Condon (5) describes the large radio surveys now being made at several observatories, surveys that are cataloging millions of powerful radio galaxies, quasars, and other objects. Large optical surveys are also being made and the combination of the two will provide generations of astronomers with the raw material for further detailed studies of a great variety of astronomical objects. Andrew Fabian (6) presents the current picture of active galaxies, each of which contains a bright central region producing enormous amounts of energy powered by a massive black hole. The third article of this set, by Dieter Hartmann (7), describes gamma ray bursters. Some of these bursts are truly extraordinary. A recent burst, for a brief period of time (a little more than a minute) had a luminosity (assuming isotropic radiation) much greater than that of a supernova and far exceeding that of all the stars in its host galaxy: these truly are the "largest explosions in the Universe."

The third set of Perspectives (appearing in this issue and wrapping up the special feature) deals with much closer regions of space, all the way in to our own Sun. Pierre Demarque and David Guenther (8) describe helioseismology, a field that studies the Sun through its internal vibrations. Each of the 10 million modes of oscillation of the solar interior produces a characteristic pattern of velocity on the surface, and many modes can be measured with spacecraft and with a global network of telescopes. The chief result is good verification of the standard solar model, which in turn has many implications for physics and astronomy, including the demonstration that the measured deficit of solar neutrinos is probably a matter for neutrino physics rather than for solar physics. Chryssa Kouveliotou (9) describes the recently discovered magnetars—neutron stars with exceptionally strong magnetic fields, above $10^{14}$ Gauss. Unlike the more common pulsars, which radiate at radio wavelengths, magnetars radiate x-rays and gamma rays and so may only be studied using satellites (because of the absorption of these frequencies by the Earth's atmosphere). These are high-energy objects but of much lower luminosity than the powerful extragalactic gamma-ray burst sources. Finally, Jonathan Lunine (10) gives the current picture of the search for planets around nearby stars and a discussion of the possibilities for finding life on them. This is especially timely in view of the recent discovery of a star, Upsilon Andromedae, orbited by three Jupiter-size planets. This implies that planets, even some like the Earth, should be common in the Milky Way.

Broad though this sweep of subjects is, it provides only the beginning of a survey of the most exciting work being done in astronomy—future special issues are planned that will expand and extend the scope of our coverage of this area of research. As before, as well as commissioning Perspectives, we will continue to actively encourage the submission of original astronomy research for possible publication in PNAS. The electronic versions of the published research papers will be folded into the Web-based astronomy special features, all of which will be made available though the home page of PNAS. In this way, we plan to build a useful resource for astronomy readers.

All areas of the physical and social sciences and mathematics are being considered for special features in the journal. The next special issue, in social sciences and economics, is planned for June/July (see www.pnas.org/misc/special.shtml). At the same time PNAS is encouraging submission of original research in all these areas. The goal—beyond generating a set of useful resources for researchers—is to produce a truly international multidisciplinary journal, a journal that is run by scientists, for scientists. All are invited to become involved in this effort.

Marshall Cohen
Editorial Board Member

Guy Riddihough
Associate Recruiting Editor

1. Kirshner, R. P. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4224–4227.
2. Myers, S. T. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4236–4239
3. Evrard, A. E. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4228–4231.
4. Steidel, C. C. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4232–4235.
5. Condon, J. J. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4756–4758.
6. Fabian, A. C. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4749–4751.
7. Hartmann, D. H. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 4752–4755.
8. Demarque, P. & Guenther, D. B. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 5356–5359.
9. Kouveliotou, C. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 5351–5352.
10. Lunine. J. I. (1999) *Proc. Natl. Acad. Sci. USA* **96,** 5353–5355.