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EDITORIAL

High-Energy Astrophysics

The New Year begins auspiciously for astronomers. The shuttle mission to repair the Hubble Space Telescope (HST) could not have gone better, and that success is as valuable to NASA as a whole as it is to the astronomical community in particular. It will be some weeks before tests of the revamped HST are complete, but there have been no problems so far, and the instrument should at last offer the celestial view its designers originally intended.

The omens are good in optical astronomy generally: the multi-mirror Keck Telescope in Hawaii is coming along well, and innovative designs for large ground-based optical telescopes are emerging from Japan, Europe, and the United States. But perhaps the most significant expansion of astronomers' view of the heavens has come, over the last two decades or so, from observations at wavelengths shorter than optical. Improvements in detector technology, along with the routine availability of satellite launches, have produced maps of the sky in ultraviolet radiation, x-rays, and gamma rays. ROSAT, the German-British-U.S. x-ray astronomy satellite, and the Compton Gamma Ray Observatory, a U.S. project comparable to HST in size, complexity, and cost, are less well known to the public but have been undoubted scientific successes. The Extreme Ultraviolet Explorer, whose history and first results are described by Bowyer in this special issue of *Science* on high-energy astrophysics, has filled in the last gap in the astronomical electromagnetic spectrum, and in the x-ray waveband there is plenty more to come (see the Perspective by Tanaka).

This recitation of successes is not meant to discount the day-to-day problems of astronomers, who like all researchers these days have to scrimp and save. A perennial complaint is the difficulty of obtaining enough money to maintain observatories and ground-support facilities once the telescope is built or the satellite launched, but this is not a difficulty unique to astronomy or even to science; it reflects, on a national scale, the fact that it is easier to borrow $25,000 from the bank for a new car than it is to get $1,000 to fix your old one.

In these straitened times, nevertheless, astronomers have an enviable number of new projects in hand, and when most scientists feel increasingly obliged to play up their work for its social relevance and technological benefits, it is worth remarking that astronomy remains, in these pragmatic terms, a singularly useless endeavor; it saves no lives and generates no improved mousetraps. What it possesses, however, is an enduring fascination. This derives not from the fact that astronomers tackle fundamental problems—they can make no special claim to fundamentality, against the similar claims of particle physicists or human geneticists—but from simple awe. High-energy astrophysics offers physics on the grand scale: neutron stars and black holes, million-degree plasmas, and teragauss magnetic fields.

Early observational efforts in high-energy astrophysics yielded a sparse selection of objects, often with no obvious counterpart in the visual sky, but as the field has matured its results have been more fully integrated into the overall astronomical picture. Bignami's Perspective describing the identification of the mysterious gamma ray source Geminga as an unusual pulsar rests on detective work at many wavelengths that would have been technically impossible less than a decade ago. The Perspectives by Bailyn, discussing hot stars in the centers of old globular clusters, and by Kinney, on the nature of active galaxies, also show how observational evidence across the electromagnetic spectrum combines to give a picture greater than the sum of its parts. A corollary is that sources detected exclusively in one energy band are hard to fathom: as Hartmann explains, short bursts of gamma rays are seen randomly and frequently across the whole sky, but still have not been linked to any known phenomenon at any other wavelength, and remain mysterious.

The expanding horizons of astronomy constantly bring in new physics. Rogers tells how recent progress in understanding the opacity of highly ionized atoms has resolved some old problems in the interior structure of stars, while Taubes' news story on neutrino "telescopes" describes how astronomers may be able to see directly into the cores of stars and supernovae. Now that the extreme ultraviolet waveband has been explored, and if an explanation for the gamma ray bursts is found, it is possible that the repertoire of cosmic phenomena across the whole electromagnetic spectrum will soon be essentially complete—but then neutrino astronomy is just beginning, cosmic rays remain poorly understood, and there is dark matter to be found. The edge of the universe is still a long way off.

David Lindley