

Astronomers and NASA: Not an easy relationship

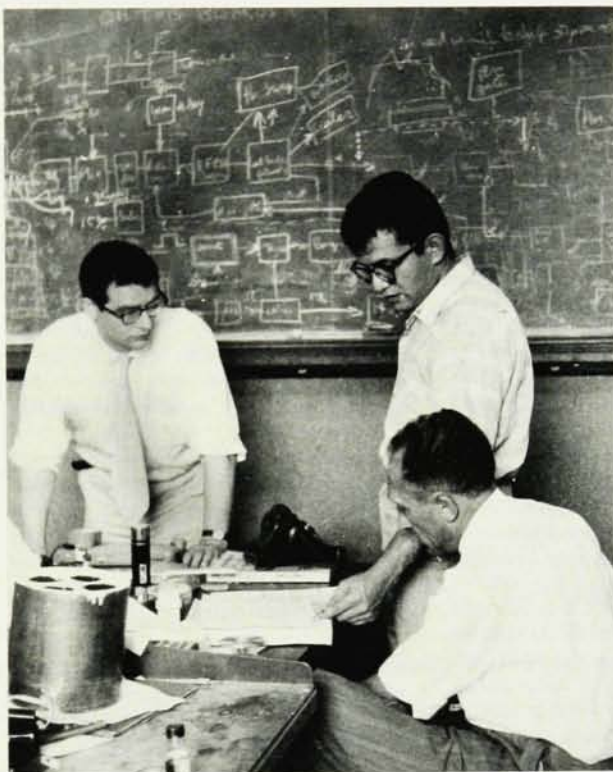
The X-Ray Universe

Wallace Tucker and Riccardo Giacconi
201 pp. Harvard U.P., Cambridge, Mass.,
1985. \$19.95.

The privilege of learning about the origin of a new field of science from the inventors of the field is a rare one, but one in store for readers of *The X-Ray Universe*, a new volume in the series of *Harvard Books on Astronomy*. Riccardo Giacconi and Wallace Tucker tell, from a personal point of view (albeit in the third person), the exciting story of the beginnings of x-ray astronomy and its progress through the present. They explain that because today's x-ray astronomy is too wide ranging and too much a part of the mainstream to be treated as a separate field, they could not give a survey the way other books in the series do.

In clear, incisive language, Tucker and Giacconi describe the earliest attempts to find x rays from space with rockets and make clear how much faith and persistence were necessary to carry the work forward. They relate the successes and the failures of early rockets, and place in perspective the roles of various scientists, both individuals and groups. They describe such heart-stopping moments as when the first testing of the Einstein Observatory's mirror yielded no signal, leading them to fear that the concept of grazing-incidence mirrors didn't work after all. (Actually, a test ribbon had been left in place, blocking the image.) Later, when the telescope, newly in orbit, apparently wasn't working, staff scientists ordered the star trackers turned off. "This brought a howl of protests from Mission Control. Turning the star trackers off meant delaying the activation schedule, which meant keeping a large staff standing by with nothing to do." NASA seemed more interested in the schedule than in the experiment. The scientists held firm.

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Riccardo Giacconi (left), Herbert Gursky (right) and Fred Hendel (foreground), photographed in 1958 at the Palmer Physics Laboratory in Princeton. The photo appears in *The X-Ray Universe*, reviewed here.

Later analysis showed that the star trackers had been picking up the reflection of the Moon from the ocean.

The book develops some important themes, for example, that "x-ray astronomy developed because creative scientists ignored the predictions of theorists that a search for cosmic sources of x rays would be futile or of little interest." Indeed, the authors hold that the widespread belief that the nature of science and scientific progress is straightforward leads to a "stifling of the independent spirit" and to unimaginative funding that does not advance science as much as government support should.

It is particularly interesting to read *The X-Ray Universe* in the aftermath of the tragedy of the Challenger explosion: The book makes clear that NASA's interests were often not those of science or scientists. We see how

NASA pushed to get the Einstein Observatory (which it was bureaucratically too difficult to name officially, so unofficial naming had to do) launched "on schedule and on budget" even as the scientists were pressing for "the necessary time and money to maintain the integrity of the experiment in the face of increasingly strict budgetary and scheduling difficulties. In the heat of these conflicts," the authors relate, "some scientists expressed the viewpoint that NASA managers would fly a bag of sand, if only it was launched on budget and on schedule." To save money NASA adopted the cost-cutting procedure of "'prototyping,' meaning prototype plus flight," that is, building only one of a device. With hindsight we can see that taking the prototyping approach to parts of the space shuttle design may have led to tragedy.

When NASA shortened the testing

time for the Einstein Observatory to one month, instead of the six months originally allotted, "Giacconi protested loudly." In one particular instance NASA, worried about the schedule, overruled the scientists and engineers by directing a contractor to stop polishing the mirror one day early. "This decision eventually caused a substantial loss of efficiency at high energies, where it was needed most because the mirrors naturally become less efficient at high energies." Perhaps worst of all, NASA disregarded Giacconi's argument that the satellite could be controlled with magnetic torquing instead of with booster jets that would be dependent on a finite supply of gas. NASA had its way, even though the extra cost would have been less than half a percent of the total cost of the mission, and providing computer management of the postlaunch to save gas was more expensive than a magnetic-torquing system would have been. The organization saved only in a bookkeeping sense, as it "did not object because the money came not from the hardware budget but from postlaunch operations funds," and so wound up diminishing money for data analysis. "This does not take into account the incalculable loss of scientific data due to the premature demise of the observatory," Giacconi and Tucker conclude.

The final part of the book is devoted to various aspects of science that were aided by or developed as a result of data gained with the Einstein Observatory and other x-ray satellites; these include studies of neutron stars, black holes, active galaxies, quasars and cosmology.

The X-Ray Universe is illustrated with occasional black-and-white photographs of scientists, rockets and data, and with five color photographs. The book contains a useful list of additional readings and a good index. It is a pleasure to see such a sturdy book with a sewn binding.

Every student of astronomy, on whatever level, should surely read this book. And all scientists would find it a fascinating survey of a new field, with important lessons to teach about the nature of science in general and big science as it is today. I hope that Giacconi can bring to the Hubble Space Telescope the same success that he brought to the Einstein Observatory, and that his jousting with bureaucracy works.

Computational Physics

Steven E. Koonin

403 pp. Benjamin/Cummings, Menlo Park, Calif., 1985. \$32.50

Computer software usually suffers from one of two defects: It is either too simple to do anything exciting or

too complex to do anything understandable. To solve the problem of complexity, software authors have tried to develop user-friendly presentations of the material or supplied manuals to explain what may not be user friendly. Both of these approaches often fail. The user-friendly presentation is seen as a block to actually running the software—it is a textual presentation in a computer environment. The manual is seen as subservient to the software and is ignored or lost—it is a textual presentation competing with a computer environment. In *Computational Physics*, a textbook with accompanying disk for IBM PCs and compatibles, Steven E. Koonin has solved these problems by turning the computer manual into a textbook that explains, chapter by chapter, both the physics and the algorithms behind some of the most impressive physics software I have ever seen. Unlike software manuals, Koonin's textbook concentrates on the theoretical aspects of each particular problem and includes the programs as part of the exercises and projects at the end of each chapter. This approach makes the text and software synergistic rather than competitive.

Computational Physics covers a variety of numerical techniques in areas such as differential equations, matrix operations, boundary-value problems and Monte Carlo methods. These numerical techniques are applied to an even wider variety of computa-

tional physics problems. Examples include using the fourth-order Runge-Kutta algorithm to determine the structure of white dwarf stars, applying Gauss-Seidel iteration to Laplace's equation in two dimensions, using the Numerov algorithm to find bound solutions to the Schrödinger equation and solving the hydrogen molecule with the path-integral Monte Carlo method. The book is also filled with helpful computer techniques, among them a method for generating normally distributed random values from uniformly distributed random values.

Unfortunately, because of the breadth of coverage, neither the numerical techniques nor the physics problems are presented with sufficient explanation or motivation for this book to stand alone as a text. It could be used in a computational-physics course following advanced undergraduate courses in quantum mechanics. It could also be used as supplementary material in other physics courses to demonstrate the application of computational techniques to their topics. The computer programs that accompany the text, used in conjunction with the text, would make excellent classroom demonstrations or computer laboratory "experiments" in a wide variety of courses.

Sixteen computer programs on the disk, written in BASIC, demonstrate the application of numerical techniques to physics problems. The appendix includes a listing of each program.

Gaussian wave packet with an energy of 0.422 units tunneling through a barrier with an energy of 0.500 units. The three graphs show the packet before, during and after making contact with the barrier. They were obtained with one of the programs included with *Computational Physics*, reviewed here.

