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Understanding the Universe: An Inquiry Approach to Astronomy and the Nature of Scientific Research

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Asian Space Race is a useful (albeit very expensive) primer for those interested in an introduction to the panoply of actors in the Asian space programs. Its analysis of whether or not Asia is in the middle of a space race raises some interesting issues. For example, does the new competitive spirit between the big three Asian nations constitute an analog to the older Cold War space race? (In my view, the analogy only partially fits.)

Such questions are interesting, but the effectiveness of Lele's answers is compromised by the organization of the book, which often reads like a list of details in lieu of analysis, and by the lack of engagement with a deeper source base, such as interviews and archival documents. We also do not hear of any of the principal people behind these programs. Because few personalities are featured, Lele's conclusions about national imperatives suggest that all national programs are monolithic and devoid of internal discussion, debate, and dissent. Finally, a more rigorous copyeditor would have addressed the many typos and problems in syntax, which occasionally make for difficult reading. But those are relatively minor shortcomings in what is otherwise a useful contribution to the growing literature on Asian space efforts.

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Understanding the Universe

An Inquiry Approach to Astronomy and the Nature of Scientific Research

George Greenstein
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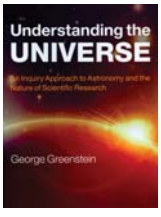

George Greenstein has been a professor of astronomy at Amherst College in Massachusetts for more than 40 years. For a good part of his career, he has advocated for an inquiry-based approach to the teaching of science. *Understanding the Universe: An Inquiry Approach to Astronomy and the Nature of Scientific Research* is the result of that long-time commitment.

Understanding the Universe is an introductory textbook to be used in an astronomy course for nonscience majors, and I would definitely recommend it for that purpose. Greenstein writes that his goal is to expose students to the "nuanced treatments of the process of science." He is not principally interested in having his students simply memorize facts; rather, he invites them to be part of the discovery process, argue hypotheses and theories, and explore implications. He includes numerous discussions about the nature of science that nicely complement his treatment of scientific theories.

I was pleased to read in Greenstein's accompanying essay posted on the book's website (under the "Resources" tab at http://www.cambridge.org/greenstein) that instructors "cannot cover everything: if we spend a lot of time on one issue, many other issues will be left out." Most astronomy textbooks are plagued with an encyclopedic quest to cover the entire subject in a one- or two-semester course. Such an approach is doomed to failure. I agree with Greenstein that the main goal of introductory science courses is not merely to prepare scientists but also to open the minds of college students to the inquisitive and

wondrous nature of science. And there is no better way to do that than to guide students to think and inquire about the nature of physical phenomena the way scientists do. In that regard, this book, in my opinion, succeeds to a great extent.

Sections that reappear throughout the book—"Now you do it," "Detectives on the case," and "You must decide"—entice students to examine critically what was covered and to elaborate and examine hypotheses by themselves. A nice example of Greenstein's method is how he constructs a Hertzsprung–Russell diagram (relating the absolute luminosity of stars to their effective temperatures) by making an analogy to a plot of vehicle horsepower versus weight.

One shortcoming in this book is its lack of coverage of gravitational-wave astronomy. (There is also no discussion of neutrino astronomy or cosmic rays.) Although gravitational waves have not yet been detected, I feel an opportunity was missed. The feeling does not stem only from my personal involvement in the field; indeed, the quest to detect gravitational waves and the progress in the field so far are ideal subjects for Greenstein's approach of teaching science by inquiry.

Even now, scientists on the Laser Interferometer Gravitational-Wave Observatory project and other astronomers are rushing to find an optical counterpart to the first gravitational wave, whenever it is detected. The hypothesis that this first event could originate in the collapse of a binary neutron star system could have illuminated Greenstein's discussions of the nature of science and the changing of paradigms. Furthermore, the relationship between binary collapse and gamma-ray bursts—the brightest explosions in the universe—is a true mystery, full of suspense and thrill, whose final chapter is yet unknown.

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