

## Book Review Physics Today Ostriker & Mitton

John Mather

Dec. 10, 2013

Can anyone explain to a general audience how astronomers converged on such an astonishing story as the Big Bang, with large doses of Dark Matter and Dark Energy that only astronomers can “see” and most astronomers didn’t want? Might the reader believe the answer? And can the story keep the attention of professional physicists? The answer is yes for “*Unraveling the Mysteries of the Invisible Universe*” by Jeremiah Ostriker and Simon Mitton (Princeton University Press, 2013). Ostriker, a theorist, is one of the modern pioneers of the subject, and Mitton, a physicist-journalist, is an excellent storyteller as well.

The book’s tale starts with Hipparchos and the methods of Greek astronomers, traces the beginnings of modern astronomy and physics, and quickly introduces Einstein’s quantum mechanics special and general and relativity, meanwhile banishing calculations to an appendix. Most of this is conceptually very clear, one of the best versions I’ve seen. (However, the retelling of Einstein’s thought experiment about lightning flashes and moving trains seems to me to be missing something essential.) Then comes the discovery of the expanding universe, which is much more interesting and complex than is generally appreciated. For instance, the book mentions the race of V. M. Slipher with a 24” refractor against William Campbell with a 36” telescope in 1912, both knowing that measuring spectra of galaxies was crucially important, even though it was not yet known that they were very distant, or that they contained stars. Slipher showed in 1915 that most galaxies had redshifts, and theorist Lemaitre predicted in 1927 that there would be a systematic linear relation between distance and velocity. So when we say that Hubble discovered the expanding universe, we’re simplifying a bit too much, and I’m glad to see the story in print here. Then we hear about evidence for dark matter as seen by Fritz Zwicky in the 1930’s, the fruitless hunt for the cosmic deceleration parameter, the history of Einstein’s  $\Lambda$  constant, and some of the many ways we now measure dark matter. And there are some delightful salvos against those who claim that the end of science is nigh, or that scientists don’t change their minds until the “paradigm shifts”.

The book is less enchanting in its stories of the recent past. The writing is more technical, with self-citations by Ostriker. The general reader might not care who did what in modern theory, while the physicist will keep right on going, since the participants are alive and well known today. The measurement and the implications of the cosmic microwave background fluctuations do not get the detail they need here, although they have astonished us all with their precision and (presumably) accuracy. There are no diagrams to illustrate how telescopes work, how spectrometers work, or how cosmic microwave background radiation is measured. As the Project Scientist and one of the three Principal Investigators for the COBE

(Cosmic Background Explorer) satellite, and now as senior Project Scientist for the James Webb Space Telescope, I'm very attuned to the question of "how could they possibly measure that?" or "why did they have to do it that way?" Well, the book really doesn't say, even though most of the recent progress in cosmology has come from improved technology and especially from space missions. With few exceptions, theory is driven by surprises in measurement, and most of those come from new equipment; see Martin Harwit's brilliant book "Cosmic Discovery", 1981, Basic Books, for convincing proof.

There are some bloopers about the release of the COBE results; the dates are misstated several times, and there's one pure invention, in which the book asserts that the COBE satellite spent four years in storage while waiting for launch; in fact, it was being rebuilt, with half of its mass, after the Challenger mission was lost, and was a more-than-full time project for many hundreds of people, including me. There are a few other facts that should have been checked: the age of the Earth is given as 3.7 Gyr, when it's 4.6; and there's a wrong calculation of escape velocity on page 207. And I would point out that Chuck Bennett was at NASA Goddard while he was leading the WMAP team.

Overall, *Unraveling the Mysteries of the Invisible Universe* is a cheerful and very accessible introduction to some of the most fascinating topics in astronomy today. It is clear about the concepts, it tells stories about the discoverers in remarkable detail, and it shows the logic leading to dark matter and dark energy. I would not hesitate to recommend it for both general readers and scientists.