Book Review

Helge S. Kragh, *Conceptions of the Cosmos: From Myths to the Accelerating Universe: A History of Cosmology.* Oxford: Oxford University Press, 2007, viii + 276 pages. $85.00 (cloth).

Kragh, an experienced historian of science who has been writing about the development of cosmological ideas more or less since the time of his 1981 doctorate, has produced a book that contains "the wealth of the Indies" in the Johnsonian sense. Boswell's entry for April 17, 1778, quotes:

> As the Spanish proverb says, "He who would bring home the wealth of the Indies must carry the wealth of the Indies with him." So it is in travel, a man must carry knowledge with him if he would bring home knowledge.

And if you protest that reading is not travel, Emily Dickinson and I will fire back with "There is no frigate like a book, / To take us lands away," and hope you have sense enough not to quote her in front of school boys.

Conceptions of the Cosmos (the word used interchangeably with universe and world) in other words provides much data, and a good deal of information and even wisdom, but I think these can be appreciated and safely incorporated into a personal knowledge store only by readers whose store is already fairly large. The book covers the full sweep from Egypt and Babylon to inflation and string theory, and you will probably find, as I did, that the sections that most often tempt you to scrawl comments like "a ha" and "wow" in the margins are the same ones you will decorate with "oops," "no," and less polite synonyms. I ended up with 40-some of each class, and a comparable number of "reference please,""hoo hee," "Did Einstein really say that in French?" and other wishes for more information in sections to which I brought a smaller knowledge store.

The main sections are (1) myths to Copernicus, (2) Newtonian era, (3) foundations of modern cosmology (the cut between 2 and 3 occurring with publications of general relativity and demonstration of existence of external galaxies), (4) hot big bang, and (5) new horizons. My comments lie thickest in the middle sections. The last could have collected many question marks, but another recent book, Universe or Multiverse? (Bernard Carr, editor), answers most of them. Concerning the first section, I feel a certain ambivalence. Greek ideas from Thales to Ptolemy (neither of whom lived in Greece) are traced with care, and the 12 medieval pages are a feast in comparison with what one usually gets. But the Egyptians and Babylonians, whose cultures endured something like twice as long as any of the others and whose ideas must have changed, each get only a snapshot, relying on some quite old sources, and the Egyptian illustration not attributed to any particular epoch (but it is not the one from Tut's tomb that you see most often or the late dynastic one that has the most writing).

Possibly the most important underlying idea is that of the realists versus the instrumentalists, otherwise known as finding out the truth versus saving the phenomena, or in the most aggressive form over the years, "cosmology is not science." Or the big bang or steady state or inflation or the multiverse concept or whichever idea you don't like this week. Kragh's view is that cosmology is science and has been at least since the

time of Aristotle onward, in the sense of comparing ideas with observations. Moving from less to more controversial, I think one can say about black holes, dark matter, the standard hot big bang, and inflation that each can be regarded as shorthand language for a very large number of wellconfirmed observations. In addition the shorthand makes it possible to organize the observations so they are easy to remember (increasing mass-to-luminosity ratio with increasing length scale for dark matter, for instance) and to fit in with other parts of astronomy, physics, and all. Notice that exactly the same case can be made for phlogiston, and it too was, I think, a scientific idea, as shown by its replacement by oxidation when observations required, helped of course by Stahl being dead well before Lavoisier wrote.

And now as many detailed items as the editors will allow, since G.d., the devil, and the fun have all been said to be in the details, though the first two rarely use NASA bullets.

A ha! Cosmology and cosmetology do share a common root in the Greek for order and beauty.

The Stigler-Merton Principle. Just about every important cosmological idea (scale-dependent gravity, non-Euclidiean geometry, fractals, the Milky Way as a spiral, mass-energy equivalence, cosmological nucleosynthesis…) can be traced back further and to someone more obscure than you might have supposed, and Kragh is, in general, very good about attempting to identify firsts, 20 or more in my lists.

Units. Parsecs and light-years oscillate with no conversation factor given and occasional confusion, for instance, the placement of the solar system in a "Kapteyn universe" at distances from the galactic center that are inconsistent between text and illustration.

Units again. The cosmological constant is generally given as (length)–2, though once as (time)–2 and once again as (grams cm–3) with no conversion factors or explanations of how to carry out comparisons. The modern units are either dimensionless (so that Λ contributes about 0.7 toward a closure density of 1.0) or GeV–4 (somewhere around $2 \times 10–47$) for easy comparison with the masses and energy scales of particle physics generally given in GeV.

Missing persons. Einstein's equations have lost their Hilbert. Eddington and Dyson (Frank not Freeman) are bereft of their eclipse expedition co-leader Crommelin. And Occam has been shaved away from his fellow medieval discussants of multiple worlds, Bradwardine, Buridan, and Oresme.

Found persons. Very brief but useful introductions to John Nicolson (stellar nucleosynthesis beginning in 1913), Orest Chwolson (1924 paper on relativistic gravitational lensing), and John James Waterston (gravitational contraction energy for the sun, before Kelvin and Helmholtz).

Unforgivable? The fine-structure constant said to be $4\pi2e2/h2c$ rather than $2\pi e2/hc$, and an estimate for the size of the universe said to be 10 parsecs rather than 10 million in a context where it could have been either.

Aw shucks. Gauss quite possibly did not try to use three mountain tops to look for non-Euclidean geometry. Laplace may well never have told Napoleon that he had no need for the hypothesis of a creator.We are not assailed with the "greatest blunder" Einstein quote but rather given a proper reference to the 1931 paper where he declared he

no longer found a need for that hypothesis (he had called it an integration constant in an earlier letter to Besso). To which one can only say, *eppur se muove*.

Oops. One that I think goes to the admissibility of the evidence and not just the weight. The author suggests that Huggins in the late 1860s might have worried that his measurements of Doppler shifts for stars would contradict "the generally held view of a static universe." But proper motions for stars had been known for more than a generation before and the approximate direction of motion of our sun relative to the other stars established from them by astronomers from Halley to Argelander, the latter in 1837.

Conflicts of interest. I cannot claim discrimination, having been cited three times, quoted once, and allowed to contribute a diagram (of the trends with time in measured values of the Hubble constant). But I think accurate measurements of gravitational redshifts of white dwarfs came a good deal earlier than the 1980s mentioned by Kragh, and this counts as a conflict because the first large set was published by Greenstein and Trimble in 1967. Others who might complain include Slipher (whose radial velocities are given to Stromberg at one point), Wirtz (odd description of his attempt to determine the solar motion relative to nebulae), Arrhenius (said to have had trouble thinking of processes that would increase entropy), and the Australian Journal of Physics, described as not widely read, though in the period when counts of radio sources were in bitter dispute, it published two of the dozen most-cited papers in all of observational astronomy. Undoubtedly too polite to complain is Professor Fang Lizhi, whose 1991 book appears in the alphabetized references between papers by Linde and Lodge.

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