

in the Magnetic Fusion Energy Engineering Act of 1980.

While ITER is now aimed at many of the original EPR goals as an international venture, a timetable for a demonstration power plant remains obscure.

In 1988, the ITER venture began. Originally, at the 1985 Reagan-Gorbachev Summit Meeting, it appeared that the two had agreed on a relatively rapid process leading to construction. As it turned out, how-

ever, construction did not begin in earnest until 2009, more than 20 years later.

Stacey's history ends in 1988, with the handoff of the INTOR design work to the new ITER team. Many of the INTOR participants joined the ITER design team, including Ken Tomabechi (Japan), who became the first ITER design team director. The 20-year history of ITER preparations (1988-2009) appears in secondhand reports in the trade press and elsewhere,

but a candid insider's history, such as the one Stacey has provided for INTOR, remains to be written.

I highly recommend this book to all those involved in fusion research, administration, and policy. It is well written, in an engaging style, while also being unusually candid and thorough. Well-done and thanks, Bill Stacey.

Stephen O. Dean is the president of Fusion Power Associates.

The Story of the Sloan Digital Sky Survey

by Laurence Hecht

A Grand and Bold Thing: An Extraordinary New Map of the Universe Ushering in a New Era of Discovery

Ann Finkbeiner

New York: Free Press, 2010

Hardcover, 223 pp., \$27.00

The author devoted three or more years to interviewing the participants and doing the research to document this great achievement in observational astronomy, which is now accessible to all on the Internet. Some of the nation's leading astronomers and an army of code writers, many of them graduate and undergraduate students in the field, put together the system for utilizing a 2.5 meter (98-inch) telescope at Apache Point, N.M. to make the largest sky survey ever assembled, including more than a million galaxies.

My disappointment was not in the description of how the project came to be, but in the interpretation of its results, which sticks a bit too obediently to standard cosmological assumptions. The modern, zipped-up style of science writing also proves a distraction. Is this really what it takes to sell books these days, or are the writers merely degrading themselves in pursuit of a will-o'-the-wisp of public approval?

The Sloan survey was the brainchild of James Gunn, an accomplished astronomer, cosmologist, and master instrument designer, who conceived it in the 1970s and spent most of the 1990s helping to bring it to fruition. Fermilab, Princeton, the University of Chicago, and a number of other leading universities participated, with initial funding from the Sloan Foundation.

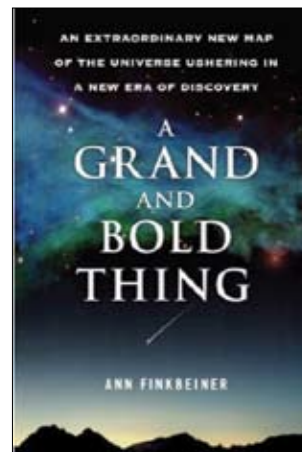
A Network of Superclusters

The photographs and spectrographic data have contributed to our understanding of the structure of the universe, at least in the visual spectrum. When combined with a smaller visual survey, 2dF, run out Cambridge University, the maps showed an ordering to the galaxies that had not been known before.

Galaxies form in clusters which are part of superclusters. These superclusters, in turn, are "hot isolated in clumps but are parts of a universal network, filaments of lights that are denser or thinner and sprawl over sheets that fold themselves around dark voids.... It looks like solidified lava, or a sponge, or medically imaged tissue.... It is biological, geological, natural—just the way you would expect the universe to look."

Google Sky and WikiSky utilize the Sloan maps for the approximately one-quarter of the celestial sphere that they cover, and fill in the rest of the sky with other less intensive surveys. WikiSky attempts to integrate the view of the sky in different wavelengths, including the ultraviolet and infrared. An International Virtual Observatory Alliance is attempting to oversee the production of detailed multi-wavelength archives, including the gamma ray, X-ray, ultraviolet, visual, and infrared spectra.

I found Chapter 7, The Virtual Observatory, to be the most fun. Part of the unusual agreement in the project had been that after a year, all data would go into the public domain, via the Internet. That decision has already revolutionized the field, in which access to telescopes and proprietary nature of data had heretofore



been a severe restriction. Today, anyone can access the Sloan digital archive, simply by searching for SkyServer on the Internet. Once there, a huge wealth of information is available to any who wish to learn how to use it.

There have been 713 million hits on the Sloan archive since the first public release of data in June 2001; currently it has 60,000 to 70,000 different users a month, many times more than the number of professional astronomers in the world. Some of these are volunteers who are using the Sloan archive to participate in a project known as the Galaxy Zoo, to help classify the millions of galaxies photographed by the Sloan Survey. Computers are not as good as humans at the complex shape recognition and interpretation required for this. There are 272,000 "zooites," as the participants in the Galaxy Zoo project call themselves.

Dusty Beginnings

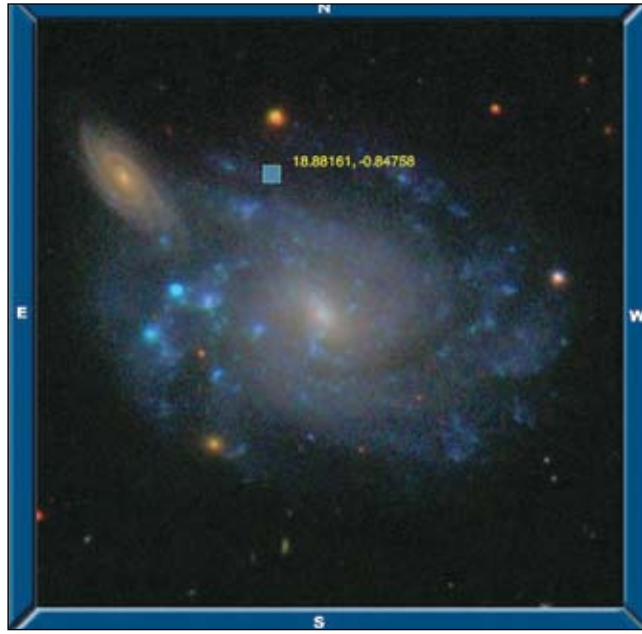
The idea of enlisting the public in such programs originated with a NASA project called Stardust@Home, which drew in 24,000 people to examine Internet images of 40 million dust grains collected from a comet's tail and brought back to Earth. The idea was to see if any of the grains looked unusual and might have come from outside the Solar System.

In 2007, two Oxford University astronomers needed help in examining a sample of blue elliptical galaxies to determine their shape. They guessed that if 24,000 people, “dusties” as they were known, would look at grains of comet dust, it should be possible to find some Internet users to look at the beautiful galaxy photographs in the Sloan archive.

Combining with a small group of astronomers who needed shape classification of galaxies, they created the website Galaxy Zoo, expecting that in three years they might get 10 classifications per galaxy. Within a few hours of a July 2007 3-minute appearance on BBC Today, Galaxy Zoo had received 10,000 emails, most from people complaining that they couldn’t get to the website. The server had of course crashed. After assigning the site to a new computer, by the end of the week, the 50-million classifications which had been projected to take 3 years, had been completed by 150,000 volunteers.

Completely Conventional

The disappointing aspect of the book is the complete acceptance of the conventional view of cosmology. For example, if red shift is not simply a measure of recession velocity, but as Halton Arp’s work indicates, may be an intrinsic feature of certain formations which lie at various dis-



Sloan Digital Sky Survey/Sky Server

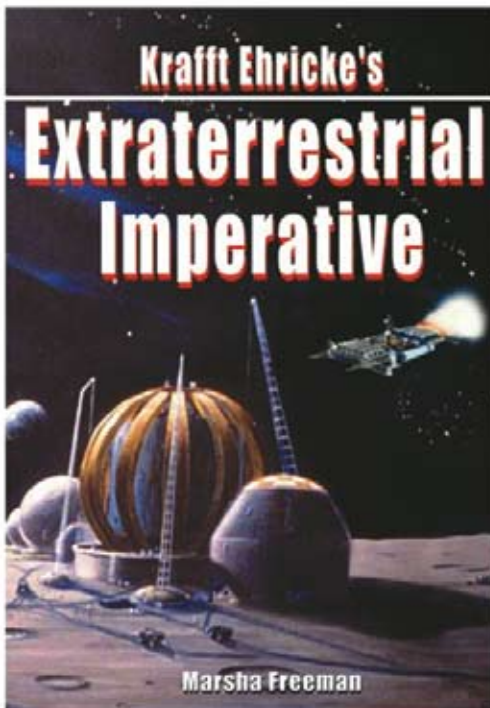
NGC 450 and a companion, two of the many galaxies available for exploration on the Sky Survey. Although these two galaxies appear to form a pair, they are actually at different distances; the smaller, fainter object is 7 times farther away.

tances from us, then the entire map is off.

The same is true if expansion theory, which supposes that higher velocities mean greater distance, is mistaken. And there is the problematic “Big Bang.”

Reprising the standard accepted theory in any field, no matter how popularly, does not really serve to educate the public, but only to indoctrinate it. What is

interesting, and truly instructive, is what contradicts it, for there the new discoveries lie. In this regard, the recounting of Jim Gunn’s thoughts is provocative. Ann Finkbeiner is well-versed in the conclusions of modern cosmology, but more attention to the underlying assumptions which determine how we know what we think we know, would be welcome.



Krafft Ehricke's Extraterrestrial Imperative by Marsha Freeman

ISBN 978-1-894959-91-9, Apogee Books, 2009, 302pp, \$27.95

From this new book the reader will gain an insight into one of the most creative minds in the history of space exploration.

Krafft Ehricke's contribution to space exploration encompasses details of new, innovative ideas, but also how to think about the importance and value of space exploration for society.

The reader will gain an understanding of the early history of the space pioneers, what they have helped accomplish, and how Ehricke's vision of where we should be going can shape the future.

At this time, when there are questions about the path of the space program for the next decades, Krafft Ehricke has laid out the philosophical framework for why space exploration must be pursued, through his concept of the "Extraterrestrial Imperative," and the fight that he waged, over many years, for a long-range vision for the program.

Readers will find it a very imaginative work, and a very up-lifting story.

Krafft Ehricke's *Extraterrestrial Imperative* is the summation of his work on encouraging the exploration and development of space. The book contains all of his reasons why we need to get off the planet and explore space.

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