

provided in *Quantum Information*, which opens with chapters on the basics of probability, information, and quantum mechanics. Although self-contained, those chapters also introduce related concepts such as entropy and its relation to information, provide a workable knowledge of the density matrix, and set the stage for discussions on quantum aspects of measurement, communication, and computing. In addition to the traditional topics on quantum computing and quantum communication, the chapters contain nuggets that are usually not provided in texts. For example, the chapter on quantum processing has a section on cluster states, which are crucial to the novel notion of one-way computing. The chapter on generalized measurement includes a detailed discussion of probability operator measure. However, most of the details are saved for the appendices.

For an evolving subject like quantum information, it is natural that a text will contain topics that reflect the author's preference and omit others. Barnett's text is strong on formalism, but avoids any discussion of practical systems, whose inclusion would have required detailed discussions and a much longer book. But there are other topics whose absence I felt more acutely. A relatively detailed discussion of quantum decoherence, which Barnett does not provide, is necessary to understand the challenges in designing quantum computing devices. Also conspicuously absent is a treatment of concurrence, the most widely used measure of entanglement.

Those quibbles aside, *Quantum Information* is an impressive book. The engaging introductory chapters, extensive problem sets, and exhaustive appendices result in a textbook that I highly recommend for a one-semester course on quantum information at the advanced undergraduate or graduate level.

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The Edge of Physics

A Journey to Earth's Extremes to Unlock the Secrets of the Universe

Anil Ananthaswamy
Houghton Mifflin Harcourt,
New York, 2010. \$25.00 (322 pp.).
ISBN 978-0-618-88468-1

Unfortunately for journalist Anil Ananthaswamy, tropical island paradises do not seem to be conducive to comprehending the mysteries of the cosmos. In *The*

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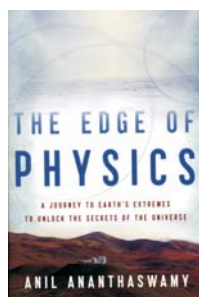
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Edge of Physics: A Journey to Earth's Extremes to Unlock the Secrets of the Universe, Ananthaswamy details his pilgrimage to some of the least hospitable places on the planet to see how physicists are expanding our understanding of the universe.

The Edge of Physics follows in the footsteps of Bill Bryson's *A Short History of Nearly Everything* (Broadway, 2003), putting faces and places to cutting-edge scientific endeavors. In addition to his firsthand reports of the latest research done in extreme places, Ananthaswamy digs deeper than Bryson into cosmology and particle astrophysics. This book is not a primer by any stretch; it focuses on introducing the armchair scientist to the amazing instruments and people that explore the night sky searching for clues to such mysteries as dark matter, dark energy, quantum gravity, and the Big Bang.

Each chapter revolves around one location and one research project. The author deftly weaves together a narrative that includes the history of the project and the people involved, the fundamental physics underlying the project, and the technology that makes the research possible. For example, while discussing the Mount Wilson Observatory near Pasadena, California, Ananthaswamy introduces dozens of key players who helped with the telescope's development and research, including George Ellery Hale, Edwin Hubble, and Fritz Zwicky, and lesser-known contributors such as Milton Humason and Henrietta Swan Leavitt. Limitations of earlier telescopes, such as the Yerkes Observatory's 40-inch refractor, inspired the design and construction of Mount Wilson's then state-of-the-art 100-inch reflector telescope, whose pieces were mule-hauled up the narrow path to the peak. Ananthaswamy explains numerous crucial technologies, including those used to manufacture and support the immense reflectors and the spectrographs that analyzed light and revealed that the Milky Way is not alone in the universe; eventually, such measurements led to the concept of the Big Bang.

I was especially curious to read the chapter on the IceCube Neutrino Observatory. In late 2009 I had the opportunity to work for a month on the IceCube project at the Amundsen–Scott South Pole Station. Ananthaswamy's spot-on depiction brought back fond memories of the -25°C working conditions and late nights in the “IceCube Lounge” in



the company of larger-than-life characters. He succinctly explains the complex workings of the 5000-plus IceCube detectors deep within the South Pole's ice cap, and without missing a beat he examines the mechanics of neutrino oscillation and shows how that phenomenon relates to quantum gravity.

Each chapter builds neatly on the foundations established in previous chapters. Once readers understand the functionality of a single-mirror reflector telescope, they are better poised to understand the complexities of the 50-square-meter multiple-mirror telescope atop Chile's Cerro Paranal and, from there, the Square Kilometer Array radio telescope, which will be constructed either in South Africa's Karoo region (the site that Ananthaswamy visited) or Western Australia's Boolardy plains. Physics concepts build on each other as well: The introduction of Cepheid variables is followed by a discussion of the expansion of the universe, which is followed by an explanation of inflation; a description of neutrinos leads to a summary of dark matter and quantum gravity, and a narrative on dark matter leads to a discussion of dark energy and the curvature of spacetime.

The scope of physics discussed in this book is immense and potentially intimidating, but the content is carefully managed to remain accessible. Ananthaswamy does not presume a deep understanding on the part of his readers; he adroitly explains the basics of each topic to a depth necessary to comprehend the technology, research, and discoveries of each project. As a reference for readers, Ananthaswamy includes appendices on the standard models of particle physics and cosmology.

Only in the final chapter, which describes the European Space Agency's *Planck* space telescope, does the narrative begin to overreach. That is perhaps due less to the author's writing than to the incredibly abstract nature of the topic—string theory, multiple dimensions, and alternate universes are not simple concepts, to say the least. Readers interested in the complexities of string theory might check out other sources to gain a stronger background after finishing this book.

Ananthaswamy could very well lay claim to the title of Indiana Jones of cosmology. But for general readers interested in an overview of cosmology with an adventurous twist, *The Edge of Physics* provides a taste of extreme envi-

ronments and cutting-edge science from the comfort of their own living rooms. Ananthaswamy demonstrates that science is above all a human pursuit, a string of challenges to overcome and successes to celebrate as we strive to better understand our existence.

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