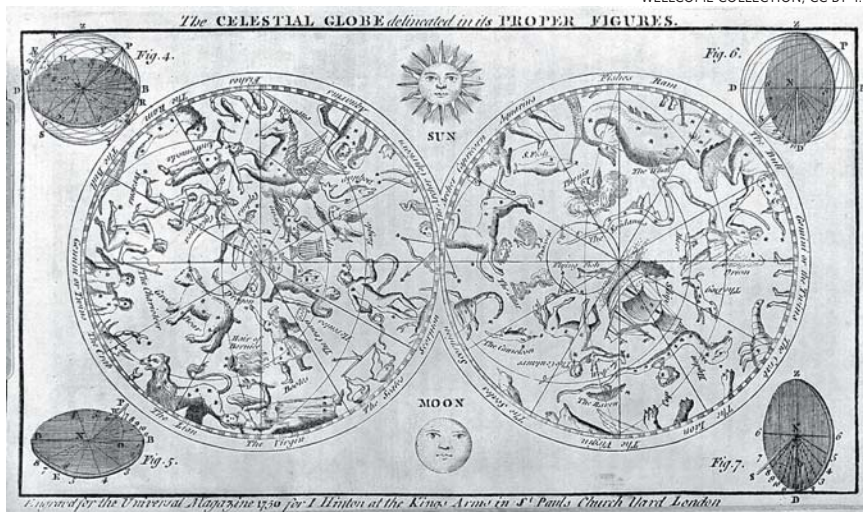




Connecting the micro- and macroverses

Our understanding of the universe is in the midst of a revolution that rivals the one brought on 100 years ago by the birth of quantum mechanics and the discovery of the expansion of the universe. The standard model of particle physics provides a well-tested mathematical description of the basic forces and particles of nature and a springboard for speculation about a grander unification of all forces, and the lambda-cold dark matter (Λ CDM) cosmology describes the universe from quantum fluctuations and quark soup to the formation of galaxies and today's accelerated expansion.

Profound puzzles lie at the frontiers of inner and outer space and link them: the identity of the mysterious dark matter that binds galaxies and clusters, the nature of the dark energy whose repulsive gravity drives accelerated expansion, and the cause of the putative early inflationary epoch whose quantum fluctuations became the seeds for cosmic structure. Few books have attempted to tell the full story of the microverse and macroverse and their deep, unexpected connections. Alvaro De Rújula's *Enjoy Our Universe: You Have No Other Choice* has done so with success.

De Rújula is a brilliant and opinionated Spanish particle theorist who spent most of his career at CERN. There he par-

Enjoy Our Universe
You Have No Other Choice

Alvaro De Rújula
Oxford U. Press, 2018.
\$25.95



ticipated in the current revolution of our understanding of the universe. He is also known for his dazzling illustrations drawn on transparencies. Fifty or so are reproduced in the book in full color, capturing the reader's attention and getting the author's points across. His unique voice comes through loud and clear in the text, just as Stephen Hawking's does in *A Brief History of Time: From the Big Bang to Black Holes* (1988).

De Rújula tells us that his book is "intended for anyone—independently of the education (s)he has suffered—who is interested in our basic current scientific understanding of the Universe." You won't find the multiverse or superstring theory here; he sticks to what we really know—which is already amazing enough—and eschews speculation.

The book is organized into 37 bite-sized chapters, each in essence a mini-lecture. (Oops, I have revealed the big secret, De Rújula is teaching the reader a lot of physics.) Some of the chapters are

as short as one page—for example, chapter 8, which sums up the standard model. Others cover more technical detail or asides to the main narrative, such as chapter 15, "Is Basic Science Useful?"

The author also has a star system for flagging the more challenging material; like the Michelin guide, he awards each chapter from one to three stars. Brace yourself: Chapter 13, on renormalizable relativistic quantum field theories, rates only two stars. In the same spirit, *Enjoy Our Universe* features 104 footnotes, some of which are quite entertaining, and a useful glossary of terms and acronyms. De Rújula revels in acronyms, including ones of his own creation such as WEAHM (With Exactly All His Might), so the glossary is essential.

The first four short chapters are a warm-up on the basics of science. De Rújula does a wonderful job of covering the scientific method and conveying that science is a human activity. He even makes a discussion of units interesting. From there, he moves on to explain the standard model of particle physics. This is where *Enjoy Our Universe* really shines. Particle theory is De Rújula's specialty, and he participated in many of the field's most important events, including the discoveries of the charm quark in 1974 and the Higgs boson in 2012. On the other hand, although it is important to understand the twin paradox, and the pedagogy is great, two chapters on the twins is a bit much.

The last third of the book is devoted to modern cosmology and the Λ CDM model, the cosmological counterpart to the standard model. It is all there and clearly explained, but with less passion and a few errors. For instance, De Rújula includes a picture of Edwin Hubble with his 1909 championship University of Chicago basketball team, but in the text refers to Hubble as an outstanding football player and law major. Neither is true. De Rújula also doesn't do justice to the tortured path to recognizing the expansion of the universe for what it is—the expansion of space—and he muddles the fascinating history of the cosmic microwave background. However, none of these are major flaws.

The biggest surprise is what De Rújula doesn't cover or comment on: supersym-

metry, superstrings, particle dark matter, or other big mysteries. The author is not a fan of supersymmetry or superstrings, which have so dominated particle theory for 30 years, and I was hoping to hear him opine as he did in his 1986 *Nature* essay "Theoretical physics: Superstrings and supersymmetry" or in his 1985 workshop talk entitled "Supersymmetry or Superstition?" The title of his final chapter, "In Spite of Our Admitted Igno-

rance," had me ready for his thoughts on dark matter and dark energy. I was eager to learn where he thinks the two now-intertwined fields are going. But I was disappointed when the book ended abruptly and with a whimper rather than a bang.

There is much to recommend in this book: the beautiful drawings that chronicle, teach, and entertain; the passionate recollection of the 1974 "Charm Revolu-

tion," in which De Rújula was instrumental; the story of Michael Faraday, the first scientist with a vision to unify physics; and the art and history sprinkled throughout. As you will learn if you read *Enjoy Our Universe*, De Rújula is an engaging tour guide of this remarkable revolution in physics.

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The life of a physicist in Victorian Britain

THEODORE BLAKE WIRGMAN, C. 1876; WELLCOME COLLECTION, CC BY 4.0



VISIT OF THE QUEEN TO THE LOAN COLLECTION OF SCIENTIFIC APPARATUS AT SOUTH KENSINGTON
PROFESSOR TYNDALL EXPLAINING THE ACTION OF THE FOG-HORN

JOHN TYNDALL demonstrates a foghorn to Queen Victoria and her entourage.

John Tyndall's death was nearly as remarkable as his life. The celebrated Irish physicist was known for his popular lectures on science, his daring climbs in the Swiss Alps, and his discovery of the phenomenon that we now know as the greenhouse effect. By the time he was in his early seventies, Tyndall suffered from severe insomnia and took a pair of medications to combat it: chloral and magnesia. But on 4 December 1893, his wife, Louisa, unfortunately confused the two bottles, which resulted in his death from chloral overdose 10 hours later.

The grief-stricken Louisa set out to complete a "life and letters" volume in her husband's honor, the usual way to commemorate a great thinker in Victorian Britain. Books such as *Life and Letters of Thomas Henry Huxley* (1900) and *The Life and Letters of Faraday* (1870) helped secure the legacies of other men of science. But Louisa was unable to complete the massive task of transcribing her husband's correspondence before her own death in 1940. Despite fame during his lifetime, Tyndall faded into near-obscure during the 20th century.

Now historian Roland Jackson has given Tyndall a weighty biography, *The Ascent of John Tyndall: Victorian Scientist, Mountaineer, and Public Intellectual*, that explores both Tyndall as a person and his place in Victorian science. *The Ascent of John Tyndall* chronicles the man's varied and fascinating life using quotes from his journals and from his extensive correspondence. From those sources, Jackson provides a fine-grained account of Tyndall's day-to-day life—his social circles, his financial situation, his romantic hopes and disappointments. Here is a typical passage: "Tyndall now terminated his employment with [Richard] Carter.... [He] believed that Carter owed him £257, but offered to settle for £200, of which £180 was left on account. Carter hosted a farewell dinner on 16th August, inviting [Thomas] Hirst and their colleague Jemmy Craven too. A few days later, Tyndall left for Manchester and from thence the south."

Many readers will welcome the chance to immerse themselves in Tyndall's world this way, but others may find themselves bogged down and skimming passages on topics that interest them less.

Tyndall came from humble origins. Born around 1820 in the Irish town of Leighlinbridge, he began his working life as a land surveyor. His interest in science blossomed in early adulthood,

**The Ascent of
John Tyndall**
Victorian Scientist,
Mountaineer, and
Public Intellectual

Roland Jackson
Oxford U. Press, 2018.
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