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extract water from a shrinking Lake Mead, drawing on the "dead pool" that will be left below the intakes for generating electricity. She doesn't have the money to build that straw right now, but she is working hard to keep her improbable city from drying up and becoming a casualty like ancient Mesopotamia. Similarly, Phoenix continues to issue building permits helter-skelter and counts on "augmenting the supply" of water sometime in the future. But where will the state and city go for more supply, and how will they bring it cheaply over mountains and plains to keep Phoenix sprawling into the sunset?

DeBuys gathers enough scientific evidence to make a convincing case against that growth mentality. A similar case could be made against growth in the rest of the United States, although in the East the threat may be too much water, not too little, and too many storms, not too much smoke and dust. The past warns us that ancient peoples once failed to adapt and survive. Will theirs be America's fate? Perhaps. But past human behavior may not be a reliable indicator of how people will behave in the future. If the environment is becoming nonlinear and unpredictable, as deBuys argues, then human cultures may also become nonlinear and unpredictable. No other people have had as much scientific knowledge to illuminate their condition. What we will do with that knowledge is the biggest imponderable of all.

Donald Worster is the Hall Distinguished Professor of American History at the University of Kansas. His current research focuses on the shift in America from a culture of abundance to one of scarcity. He is the author of a number of books, including Rivers of Empire: Water, Aridity, and the Growth of the American West *(Pantheon Books, 1985) and* The Wealth of Nature: Environmental History and the Ecological Imagination *(Oxford University Press, 1993).*

PHYSICS AND ASTRONOMY

Exploring the Dark Universe

Jonathan L. Feng

THE 4% UNIVERSE: Dark Matter, Dark Energy, and the Race to Discover the Rest of Reality. Richard Panek. xvi + 297 pp. Houghton Mifflin Harcourt, 2011. $26.

A college classmate of mine went to work for a prestigious management-consulting firm right after we graduated. Every month or so he would head out to advise a different Fortune 500 company. When I ran into him a year after he took the job, I asked him how he could possibly provide insights to top business executives when these same people had often spent entire careers immersed in their company's work. His response? "I usually have no idea how to improve these companies, but they do. And when I come into their office and close the door, they'll say things to me that they would never tell their colleagues."

In *The 4% Universe,* Richard Panek has done something similar, not with business executives, but with physicists and astronomers who are confronting some of the biggest questions in science today. Want to hear a codiscoverer of dark matter say what she truly thinks of her legendary mentor? Want to be a fly on the wall as scientific history is shaped by the backroom dealings of a good-old-boy network? Want to read the e-mails scientists send as they jockey for position in the Nobel Prize queue? Scientists usually share such information only with their closest colleagues, but it's all in Panek's book, and it's placed in enough historical and scientific context to be both intelligible and riveting.

The topic of *The 4% Universe* is nothing less than the search for an understanding of the contents, history and future of the cosmos. Until recently, the field of cosmology had little theoretical foundation, and its observational uncertainties made it the butt of jokes from those in more established fields. Over the past few decades, though, and especially in the past 15 years, cosmology has been transformed into cutting-edge science by a host of breakthroughs, including those recognized by the 2011 Nobel Prize in Physics. We now know that the elements of the periodic table make up only 4 percent of the universe, with another 23 percent composed of dark matter, and the remaining 73 percent made of dark energy. The properties of dark matter and dark energy are becoming increasingly constrained, but what exactly they are remains an open question, and Panek's book takes the reader through the period of transformation and up to the current frontiers of the field.

The book begins with portraits of some of cosmology's pioneers, going all the way back to Isaac Newton. Panek reminds us that Newton tried valiantly to describe the state of the universe, eventually worrying over the fact that his law of universal gravitation required "that all the particles in an infinite space should be so accurately poised one among another as to stand still in a perfect equilibrium," something he said was as difficult as making an "infinite number" of needles stand "poised upon their points." This same concern (often accompanied by the same analogy) continues to worry modern researchers (who decry the "fine-tuning" and "unnaturalness" of modern theories), and it motivates some of the leading speculations in cosmology and particle physics today.

Moving to the modern era, Panek tells the story of how Jim Peebles, a founding father of theoretical cosmology, used a "supercomputer" at Los Alamos National Laboratory in 1969 to simulate the motion of 300 galaxies to see how clusters of galaxies form. Such "N-body" simulations remain a staple of the field, but today's supercomputers now track not hundreds but billions of bodies. Later, Panek describes Brian Schmidt (one of the 2011 Nobel laureates) in 1995 downloading images of supernovae, which would soon provide evidence for dark energy, at a rate of 100 bytes per second. The hurdles he and his colleagues confronted back then seem almost ludicrous as we download our YouTube videos over the Web just a decade and a half later. Panek's historical anecdotes provide an interesting perspective both on how far we've come and on how the same basic questions have perplexed leading scientists throughout history.

Panek has a talent for elucidating difficult concepts. For example, his account of the history of dark energy, including Einstein's famous blunder of

removing the cosmological constant, is explained beautifully and in some detail. Panek also does a good job of explaining the difference between hot and cold dark matter. And he knows how to turn a phrase. After mentioning that in high school Saul Perlmutter (another of the 2011 Nobel Prize winners) had wanted "to learn how to think like a writer" but in college had majored in physics and ultimately chose to study supernovae, Panek makes this observation: "Instead of the nature of narrative, Perlmutter would be exploring the narrative of nature." These and many other little gems make for fun reading.

The book is not completely error-free. On page 192, for example, *gauge boson* and *gaugino* are misspelled, we read that the supersymmetric partner of the neutrino is the neutralino (it's actually the sneutrino), and Panek appears to imply that the neutralino was proposed as dark matter before the axion (in fact, the possibility of axion dark matter was noted by three independent research groups just before neutralino dark matter was proposed in 1983 by Haim Goldberg). Such mistakes are very few and far between, however, and do little to diminish Panek's significant accomplishment of explaining complicated concepts in new and enlightening ways.

Spectacular progress has been made on dark matter and dark energy in recent years, and as a result, the genre of popular books on cosmology is becoming a crowded field. Some recent offerings have violated Einstein's edict to make everything as simple as possible, but not simpler. In *The 4% Universe*, however, the ideas are explained clearly for an intelligent nonexpert audience; little previous knowledge is required, and the science has not been distorted beyond recognition by the use of poetic license. Along the way, the book sheds light not only on our current understanding of the universe, but also on the people studying it. The result is a fascinating picture of humankind's never-ending journey to comprehend the cosmos.

Jonathan L. Feng is professor of physics and astronomy at the University of California, Irvine, working at the interface of theoretical particle physics and cosmology. He is coauthor, with Mark Trodden, of the November 2010 Scientific American *cover story on cosmology, and he recently narrated, with Daniel Whiteson, an animated* PhD Comics *strip by Jorge Cham on the topic of dark matter.*

PSYCHOLOGY

The Battle Between Intuition and Deliberation

Steven Sloman

THINKING, FAST AND SLOW. Daniel Kahneman. x + 499 pp. Farrar, Straus and Giroux, 2011. $30.

Did you know that highly intelligent women tend to marry men who are less intelligent than they are? This fact may appear to be a fascinating piece of information that reveals something about the socialization of women in our society, but it is actually a necessary consequence of statistics; it must be true. As long as the correlation between the intelligence scores of spouses is less than perfect, then if you have a very high IQ score, your partner is more likely than not to have a lower one, because most people have a lower one. No alternative explanation is needed.

Daniel Kahneman's new book, *Thinking, Fast and Slow,* isn't about marriage, IQ or the battle of the sexes. It's about the battle that goes on inside us between a self that reacts quickly and automatically to fascinating facts, angry faces, tempting food and simple problems (what is 5 + 4?) versus a self that thinks more slowly, effortfully, and deliberately, explains facts by appealing to such things as the implications of random variation, tells us why people are angry and why we should resist temptation, and solves complex problems (what is 287 + 736?). These two selves make it possible for us to come to conclusions quickly when the need arises (should I hit the brakes or the accelerator?) and to slowly think through difficult decisions when many competing considerations must be weighed (should I buy an SUV or a minivan?).

For psychologists who want to understand how the mind works, slow thinking tends to be easier to explain. People generally have some insight into their slow thought processes. They can to some extent introspect and articulate what they were thinking.

We are less conscious of what goes on under the hood when we are thinking fast. What is the process you used to conclude that 5 + 4 = 9? It must have something to do with memory, but presumably you didn't appeal to any specific memory. You recognized an abstract pattern and completed it. Psychologists have only vague ideas about how we represent such abstract patterns and reason about them so quickly and effectively. We do know that the mind brings a lot to the table. The conclusions we come to with such speed and automaticity meet our needs the vast majority of the time, yet they are not consistently optimal. The mind produces systematic errors. One reason for this is that fast thinking is shaped not only by the world being thought about, but also by the way the mind goes about its business.

The focus of Kahneman's book is characterization of this process of rapid thought. In a masterly fashion he has woven several strands of insight into a finely detailed tapestry. Much of what he reports is an updated version of the work he did with Amos Tversky in the 1970s and 1980s—work that constitutes one of the great intellectual achievements of the 20th century—and the work for which he was awarded the Nobel Prize in Economic Sciences in 2002. The names Kahneman and Tversky are almost synonymous with the study of judgment and decision making—the study of how human psychology operates under conditions of uncertainty and the biases that result, biases that cause us to get less of what we want, be it love, money, health or merely accuracy. Their work is important because of what it teaches us about how the mind works and also because it offers numerous hints about how we can do better, both as individuals and as a society. It challenges the idea, pervasive in economics, that people have consistent preferences that guide their choices. Rather, Kahneman says, "inconsistency is built into the design of our

This is the game about universe exploration and interstellar conquest. It is also the first NFT Dapp in the Wanchain ecosystem. Here, we are particularly grateful to the Ethereum-based Dark Forest team for all their efforts on this game, and also thank the developers from Wanchain for introducing such a high-quality Dapp from Ethereum to Wanchain, making great contribution to the prosperity of the Wanchain ecosystem.Â Seek artifact NFTs by exploring the universe. Performance improvements. It is worth noting that the playersâ€™ data and records in the old version of Dark Forest cannot be inherited to the new version of Dark Forest. Players must re-create the game account to start a new journey. Advantages of Developing Dapps on Wanchain. The Dark Universe is a series of monster films that are being developed and distributed by Universal Pictures. The Dark Universe serves as rebooted versions of past monster films that take place in a shared universe. The Mummy (2017). The Invisible Man (2020). Bride of Frankenstein (TBA) (unreleased; pre-production/currently shelved). Dark Army (TBA) (unreleased; pre-production). Renfield (TBA) (unreleased; pre-production). The Invisible Woman (TBA) (unreleased; pre-production). what's in the universe, the age of the universe, and sometimes why there is a universe.â€ However, said Kolb, the field of cosmology is relatively new to science.â€œWhen I was in graduate school in the late 1970s, cosmology was something that was considered a bit wacky, because there were no experiments and there weren't observations, and it was just pure speculation,â€ Kolb said. â€œBut in the past 30 years or so, there have been such advances in what can be measured and advances in our understanding of basic physics particularly at high energies, that now [cosmology] is considered a scie