Summer Reading

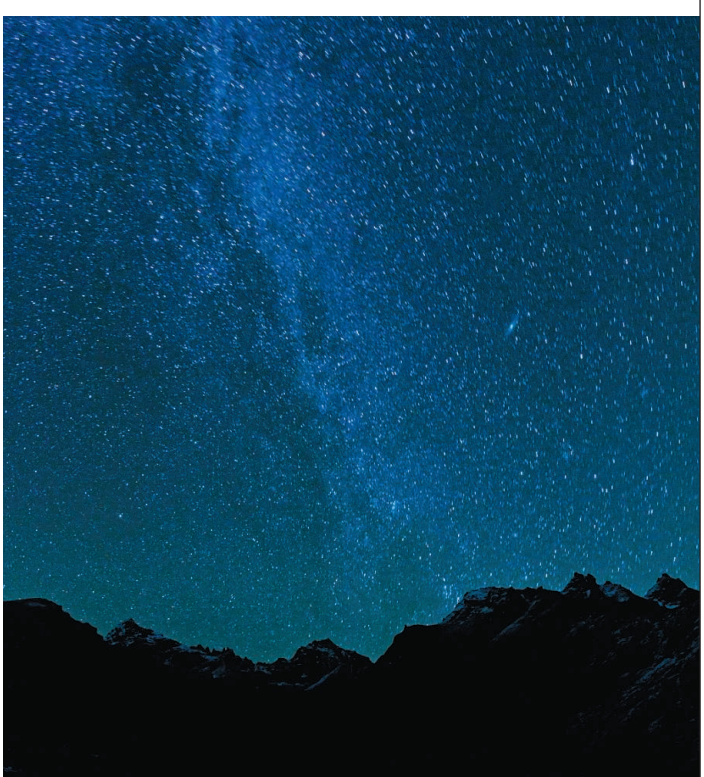
Looking for stimulation? Here are some suggestions and reviews from graduate students and postdocs.

Counterintuitive Solutions

Paradox: The Nine Greatest Enigmas in Science. Jim Al-Khalili. Bantam, London, 2012. 251 pp. £16.99. ISBN 9780593069295.

Paradoxes in physics have long been used to highlight knots in our understanding of how the world works. Jim Al-Khalili's *Paradox* examines nine celebrated examples and carefully disentangles them—demonstrating they are not logical paradoxes when cast in the right light. These run from the well known (Zeno's paradox, Maxwell's demon, and Schrödinger's half-immortal cat) to the less so (the pole in the barn paradox, Laplace's demon, and Olbers' paradox).

The paradox commonly attributed to Olbers provides the book's high point. The underlying question—why is the night sky dark?—is easy to state and equally easy to overlook. In explaining its resolution (a finite, expanding universe), Al-Khalili (a physicist at the University of Surrey) offers an enchanting portrait of our evolving understanding of the universe from Ptolemy through to Einstein. That the first correct solution was proposed by writer Edgar Allan Poe in his *Eureka: A Prose Poem*, an altogether fantastic and arguably unhinged intertwining of poetic and scientific passion (*1*), left me wondering whether this paradox held the seed of a more compelling book. The author's recollection of his first glimpse of the Andromeda galaxy through a telescope provides hints of his own passion and thrill of discovery. The thrill, unfortunately, is quickly dispelled by the aside that follows, "Physicists often tend to think in this strange way."



Dark despite all of the stars.

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The book's tone resembles the pleasant patter of a magician who carefully offers his hat up for inspection before pulling out the rabbit. In many instances, the revelation delights—such as Al-Khalili's untangling of the Monty Hall paradox and, as an example in miniature, his discussion of the claim that "every Scotsman who travels south to England raises the average IQ of both countries." In other cases, we are left wanting. The discussion of Maxwell's demon, a creature that can seemingly create order from randomness, ends with the exasperated decree: "We can never defeat the Second Law of Thermodynamics. Always remember that." Nonetheless, Al-Khalili clearly summarizes all of the paradoxes, and he attempts solutions from several different angles for completeness.

Paradox provides a serviceable and, at times, compelling field guide to some of the most important and fascinating conundrums in physics. Al-Khalili engagingly describes the tools necessary to disarm them and bits of lore that enrich them. If he doesn't convincingly convey the most luminous tint of a particular paradox, that is all the more reason to venture forth in search of your own answers in your own strange way.

–Michael R. Sprague[1]

References

1. http://xroads.virginia.edu/~hyper/poe/eureka.html.

The Mind Inside Our Skull

Neuromania: On the Limits of Brain Science. Paolo Legrenzi and Carlo Umiltà; translated by Frances Anderson. Oxford University Press, Oxford, 2011. 132 pp. $29.95, £14.99. ISBN 9780199591343.

It was noon, and church bells were ringing as a doctor carefully examined a patient who had traumatic lesions in the frontal cranial bone. He noticed that pulsations in the cerebral arteries had become stronger, but, curiously, that change was not linked to changes in pulse rate and blood pressure measured on the patient's arm. The patient then confirmed his doctor's somewhat weird suspicion: the ringing bells reminded him it was time to say a prayer. This experience led the Italian physiologist Angelo Mosso (1846–1910) to the first attempt to relate variations of blood flow in the brain to mental activity, a link that is at the core of modern neuroimaging techniques such as functional magnetic resonance imaging (fMRI). Such techniques have allowed scientists to shed some light on the neural substrates underlying ongoing mental processes.

Angelo Mosso.

Mosso's research is one of several important contributions that 19th-century neurologists made toward establishing the relationship between the mind and the brain and that are reviewed in *Neuromania*. In this brief book, neuropsychologists Paolo Legrenzi (Ca'Foscari University, Venice) and Carlo Umiltà (University of Padua) bring a welcome appraisal of brain research to a broad audience. They provide an insightful and comprehensible overview of methods and techniques from the origins of brain science to today's MRI scanners. However, rather than emphasizing state-of-the-art procedures and technologies, they focus on the limitations of the field, covering methodological aspects and controversial assumptions that are commonly unknown to the general public.

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Legrenzi and Umiltà put brain science in a broader perspective and discuss its sociopolitical implications, something scientists often neglect when presenting their own fields. The advent of neuroimaging opened many new lines of research. Because the question "what happens in the brain when … ?" fits practically any aspect of human activity, fMRI has been applied to a wide range of issues—from people's artistic or religious experiences to their preferences for specific products or political parties. As a consequence, many established concepts in the social sciences gained the prefix "neuro-" and a profusion of new disciplines emerged (neuroaesthetics, neurotheology, and neuropolitics, to mention a few). Putting these disciplines under scrutiny, Legrenzi and Umiltà highlight that old knowledge may have been presented as novel just by changing "mind" to "brain," without bringing actual scientific progress.

In the authors' reading, the brain has become the system of reference in explanations of human mind and behavior, relegating to the background an alternative approach that emphasized the social and cultural aspects of the human mind. A word of caution: The important issue is not a matter of which perspective should prevail but that many decisions regarding human life depend on how society defines the mind-body relationship. If only one aspect appears in the foreground, there may be drastic differences when dealing with thorny topics such as abortion and euthanasia. Answers to the complex questions raised by technological and scientific progress toward controlling life and death depend on ethical and ideological choices. To think about such issues from a strictly biological point of view may be misleading—after all, inside our skull there is more than just a brain. **– Ricardo Basso Garcia**[1]

Headed home. Rock pigeon (*Columba livia*).

Finding Their Place In the World

Nature's Compass: The Mystery of Animal Navigation. James L. Gould and Carol Grant Gould. Princeton University Press, Princeton, NJ, 2012. 310 pp. $29.95, £19.95. ISBN 9780691140452.

For most of human history, the clear understanding of the position of the Sun, the Moon, and stars and their movements across the sky was invaluable to human navigation. Sailing, especially on the open ocean without any visible landmarks, posed serious challenges to early civilizations. Nowadays, with the help of technologies such as Global Positioning Systems (GPS), navigation has become seemingly trivial. However, many nonhuman animals (including birds, turtles, and butterflies) can migrate thousands of kilometers and locate places with a precision we have only recently achieved. In *Nature's Compass*, evolutionary biologist James Gould (Princeton University) and science writer Carol Grant Gould discuss how animals carry out such extraordinary feats using only their senses.

While focusing mostly on honey bees and homing pigeons (which they have studied extensively in their own lab), the authors provide nonspecialists with a clear introduction to animal navigation. They warn that in analyzing animals' abilities to know locations and directions, we are prone to "imagining that animals see challenges" and "use the same strategies to solve the problems" as we do. In fact, the mechanisms used—the position of the sun and stars, polarized light and color gradients, endogenous timers, landmark memory and cognitive maps, magnetic fields, and more—vary both among taxa and within individuals (depending on context and age).

The Goulds guide readers through the multiple ways in which honey bees illuminate animals' navigation systems. In one intriguing example, forager bees were trained to a food location on a boat in a lake. Even though their dances back at the hive were vigorous, no recruits came to the boat. However, once the boat was moved close to the far shore, new bees began to appear. Bees do not usually fly over water, and the authors suggest that the bees at the hive decoded the direction and distance cues. But when positioning the food source in their mental maps located it in the middle of the lake, they decided not to act on the information.

Having been bred to return to their loft quickly and directly, homing pigeons provide a means for addressing essential questions that would be difficult to answer when working with "wide-ranging, twice-a-year migrants." The authors describe how the disruptive effects of solar storms on homing ability led Gould and others to propose that the pigeons have magnetic maps. Further testing revealed that the birds' location sense is greatly perturbed by magnetic-field anomalies. Using a magnetic map to return requires that the birds be able to sense small differences in field strength and direction. The Goulds mention the putative detector (a magnetite-rich organ in the beak), but they also note recent alternative findings. In addition to birds, sea turtles, spiny lobsters, and newts have been shown to use magnetic information to orient themselves.

The authors conclude with a short consideration of how understanding migration and its evolution may prove crucial for conservation in the face of habitat loss and changing climate.

Nature's Compass provides a wonderful account of efforts to unravel the mysteries of animal migration. Effectively drawing on their own experiences and the extensive scientific literature in the field, the Goulds explain what we currently know about how animals locate their positions. Their survey also offers an accessible starting point for those who might wish to improve our understanding of the topic. **–Homare Yamahachi**[2]

Evolution and Robots

Darwin's Devices: What Evolving Robots Can Teach Us About the History of Life and the Future of Technology. John Long. Basic Books, New York, 2012. 281 pp. $26.99, C$30, £17.99. ISBN 9780465021413.

I am envious of those who when asked what they work on can respond, "I study the evolution of robots." John Long (a vertebrate physiologist at Vassar College) is one such researcher, and reading *Darwin's Devices* is like listening, over drinks, to a voluble, engaging, and funny scientist tell you about his work. On occasion, his jargon gets a little heavy, he will toss in an unexplained concept, or he will digress about his youthful dreams to join the Navy. But for the most part, Long draws you into a compelling and wide-ranging conversation. This includes discussions of the mechanics of fish backbones, how we practice science, the nature of evolution, what it means to be intelligent, our dystopian

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