

moving bodies,” “On the movement of small particles suspended in stationary liquids required by the molecular-kinetic theory of heat,” and “Does the inertia of a body depend upon its energy content?” These four papers, with the help of Kennedy’s book, could be very well understood by undergraduates. Einstein’s PhD thesis, “A new determination of molecular dimensions,” would, in my opinion, be too cumbersome for most undergraduates.

Of the several good ways to teach general relativity to undergraduates (see my article with Thomas Moore in *PHYSICS TODAY*, June 2012, page 41), I would not consider giving them Einstein’s original 1916 paper to be one. But for students who already have experience with general relativity, reading the original paper along with Kennedy’s explanations would be a wonderful experience. I look forward to presenting some of Einstein’s papers to my students next year, and I will definitely use *A Student’s Guide to Einstein’s Major Papers* as a resource.

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The God Problem

How a Godless Cosmos Creates

Howard Bloom
Prometheus Books, Amherst, NY, 2012.
\$28.00 (575 pp.).
ISBN 978-1-61614-551-4

What is the problem that science writer Howard Bloom aims to address in *The God Problem: How a Godless Cosmos Creates*? The subtitle gives an indication. Basically, it is to give a naturalistic account of the world we see around us, a world abounding with intricate structure. In short: Is God necessary?

That problem has a long and distinguished history. The poem *De rerum natura* (*On the Nature of Things*), written in the first century BC by Lucretius, is a classical statement that anticipates several modern scientific ideas, promotes atomism, and accounts for creation without a creator. The following excerpt (translated by Martin Ferguson Smith) illustrates his ideas:

But because throughout the universe from time everlasting countless numbers of [atoms], buffeted and impelled by blows, have shifted in countless ways, experimentation with every kind of movement and combination has

at last resulted in arrangements such as those that created and compose our world.

As the sciences of physics and biology developed, weighty objections to that point of view arose that were only (perhaps) adequately addressed in the 20th century.

Isaac Newton argued that the regular system of planets requires finely tuned initial conditions. Writing in 1692 to scholar and theologian Richard Bentley, his University of Cambridge colleague, Newton concluded, “this must have been the effect of counsel.”

James Clerk Maxwell marveled at the uniformity of atoms and molecules. In his 1875 *Encyclopaedia Britannica* article on atoms, he hinted at a similar conclusion:

The various processes of nature to which these molecules have been subjected since the world began have not been able in all that time to produce any appreciable difference between the constants of one molecule and those of another. . . .

The formation of the molecule is therefore an event not belonging to that order of nature under which we live. . . . It must be referred to the epoch, not of the formation of the earth or of the solar system, but of the establishment of the existing order of nature.

In an 1802 article in *Natural Theology*, distinguished theologian and churchman William Paley eloquently expressed a then widely held (and still influential) argument that the marvelous order we find in the biological world indicates design:

Suppose I had found a watch upon the ground, and it should be inquired how the watch happened to be in that place. . . . There must have existed, at some time, and at some place or other, an artificer or artificers . . . who comprehended its construction, and designed its use. . . .

. . . every manifestation of design, which existed in the watch, exists in the works of nature; with the difference, on the side of nature, of being greater or more, and that in a degree which exceeds all computation.

Science can now propose meaningful answers to all those objections. Big Bang cosmology tracks down the origin of the universe to a simple, remarkably uniform condition early in its history. Small inhomogeneities grew in amplitude through gravitational instability and eventually collapsed and fragmented to produce the galaxies, stars, and planets we see today. Dissipation through radiation allows the formation of stable systems, without the need for fine adjustment. The standard model of particle physics, which embodies quantum field theory, accounts for the uniformity of molecules in rich detail and for the structure of matter in general. And the Darwin–Wallace theory of evolution by natural selection, conceptually grounded in Mendelian genetics and explained physically by Francis Crick and James Watson, answers Paley.

Nor is mind (or consciousness, free will, or the soul) a safe refuge for the supernatural. It has come to seem quite plausible, at least since the works of Alan Hodgkin, Andrew Huxley, and Alan Turing, that human thought is grounded in electrochemical processes that manipulate patterns of activation in the brain.

Of course, none of that prevents one from asking why or from interpreting the consensus in a God-friendly manner. Heroes of physics, including Galileo Galilei, Johannes Kepler, Newton, Michael Faraday, Maxwell, and Max Planck, sincerely considered their endeavor as an exploration of God’s handiwork or of God’s mind. Albert Einstein and Stephen Hawking expressed that sentiment too, though perhaps with tongue in cheek.

There are great and serious stories to be told here, both historical and intellectual. Unfortunately, Bloom’s book does not focus on the central thread but wanders far off course and follows several bizarre tangents. I will mention two.

Throughout the book, many pages are devoted to passionate denials of “*A = A*.” All those denials, needless to say, are based on silly misunderstandings of that logical principle. (They’re almost as silly as Ayn Rand’s manic affirmations of it!)

And according to Bloom, the ultimate basis of physical behavior is sociality: “Each quark comes with an etiquette book built into it that tells it who to rush forward and embrace.” Headings in the book include “How Gossip Grows the Universe,” “The Case of the Obsessive-Compulsive Cosmos,”

and the concluding “The Big Bang Tango—Quarking in the Social Cosmos.” This is metaphor run amok.

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