eminence in some field who has decided that something is rotten in that field's fundamentals. In essence, they have decided that their hole is a false claim or has been mined out, even though it may be capacious and well populated.

Importantly, good crazy ideas do not have to be true to be valuable. Distinguished astrophysicist Fred Hoyle and colleagues had the crazy idea that influenza came from space.[2] The more general concept of panspermia—of which Hoyle's idea is a special case—is, however, of considerable interest.

Perhaps an even better example of that line of thinking is Hoyle's wonderful science fiction novel *The Black Cloud* (Harper, ca. 1957), wherein an intelligent life-form exists as a dispersed but organized globule that wanders into our solar system. That is a truly engaging though crazy idea: Could life take the form of something that we normally think of as having high entropy? Indeed, some fluid dynamical systems display order—consider Jupiter's Great Red Spot—and the question of what form life could take remains an open one.

Another distinguished astrophysicist, Thomas Gold, had the crazy idea that natural gas was part of Earth's starting material rather than arising from biological processes much later in Earth history.[3] Geochemists might laugh (some did), and yet the possible delivery of large amounts of reduced carbon to Earth at formation is not such a ridiculous idea. We still do not know Earth's total reservoir of carbon, since some of it may be very deep. Gold was wrong about natural gas, but the idea is provocative, and that's good.

More famously, Lord Kelvin had the crazy idea that you could figure out the age of Earth by solving the diffusion equation for heat conduction in a half-space. He knew that Earth is a sphere, but the diffusion time for the whole Earth is so large that a half-space suffices. (For more on Lord Kelvin's mistake, see my letter, PHYSICS TODAY, November 2010, page 8.)

Kelvin's idea is a particularly interesting example because it was not regarded as crazy at the time but would be viewed as crazy now, for reasons that could have been explained to him back then. He was ignoring the geological evidence for the great expanses of time that must have passed, but there were as yet no good clocks for geologic time. He was also ignoring the possibility of convection, and that should not have been acceptable. Crazy ideas are often ephemeral: What was crazy then can be "natural" now and vice versa.

As for Crazy Ideas of the Third Kind, opinions will vary, but perhaps one is the idea that gravity is an emergent phenomenon, an idea often attributed to Andrei Sakharov. The extension of a rubber band, which roughly obeys Hooke's law, is purely entropic and has nothing to do with the forces between the atoms that make up the material, so one could say that in that case a force law emerges from Boltzmann's definition of entropy. Or perhaps Roger Penrose and his fundamental discretization of spacetime would be one of the Third Kind. Many great developments in physics began encumbered with ideas that we have now shed—for example, Maxwell's molecular vortices.

My thesis adviser, Ed Salpeter, would occasionally say to me, "Is it crazy enough to be true?" I think what he meant is that when you're attempting to explain something important and it has resisted solution for a significant time, then the mundane explanation is unlikely to work, so you should be seeking the "crazy" answer. Although Salpeter almost invariably wrote papers of great solidity and impact, he did coauthor a paper with Carl Sagan on life in the atmosphere of Jupiter.[4] It was a good crazy paper, I think. Life in the atmosphere of Jupiter figures prominently in a science fiction novel, *The Algebraist* (Orbit, 2004), by Iain Banks.

In a somewhat similar spirit, Niels Bohr, responding to a lecture by Wolfgang Pauli, said, "We are all agreed that your theory is crazy. The question which divides us is whether it is crazy enough to have a chance of being correct." The hard part lies in figuring out what is crazy enough.

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LETTERS

Meghnad Saha and the contemporary scene

I much enjoyed Soma Banerjee's article "Meghnad Saha: Physicist and nationalist" (PHYSICS TODAY, August 2016, page 38), particularly for its bringing attention to Saha's English translation, with Satyendra Nath Bose, of Albert Einstein's and Hermann Minkowski's papers. Their translation was published by the University of Calcutta in 1920.

Many English-language readers of the papers found them in a later translation, first published in 1923 by Methuen in London. A paperback edition of that translation, *The Principle of Relativity* (Dover Publications), is still in print today.

In a letter to Einstein posted from Dacca University on 4 June 1924, Bose, then unknown internationally, introduced himself:

> I do not know whether you still remember that somebody from Calcutta asked your permission to translate your papers on Relativity in English. You acceded to the request. The book has since been published. I was the one who translated your paper on Generalised Relativity.

That letter also contained a copy of Bose's own English-language manuscript on the statistics of photons, which had been rejected for publication by the *Philosophical Magazine*. As aficionados of Bose–Einstein condensation know, Einstein, then already a world-famous scientist, soon arranged for Bose's paper to be translated into German and published in *Zeitschrift für Physik*.

The rest is history—though seemingly lost in its mists is the English original of Bose's famous paper. I've sought it for some time. Do any readers know its location?

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