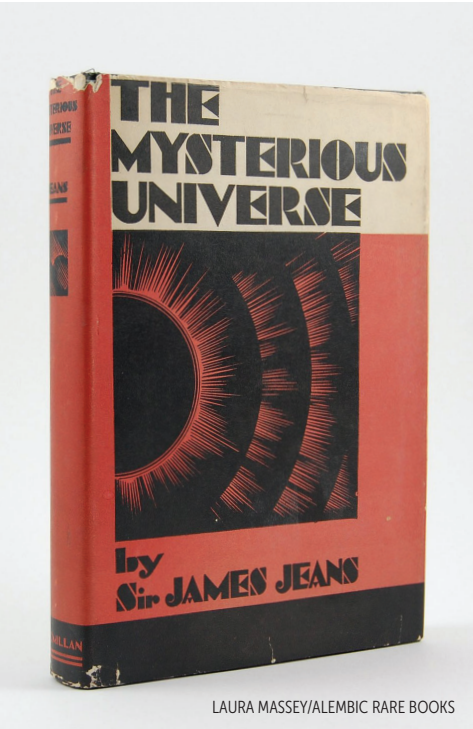
James Jeans's views on the nature of reality

Daniel Helsing's takedown of the views of James Jeans ("James Jeans and *The Mysterious Universe*," PHYSICS TODAY, November 2020, page 36) needs a rebuttal. The view that a real physical universe is "out there"—end of story—misses entirely the benefit of our huge and relatively recent mathematical insights into the nature of what seems to be reality, according to our evolved human senses.

We have achieved deeper insight only through our discovery of the immense power of often astonishingly simple mathematical equations that elucidate the nature of the so-called universe. That is profoundly yet almost trivially demonstrable! I offer an example: I expect Helsing would agree that the most mysterious thing about the universe is the nature not of matter or space but of time.

With Hermann Minkowski's 1908 insight into Einstein's 1905 special relativity, we humans achieved the almost unthinkable: a deep understanding of the utterly simple nature of time. For while $ds^2 = dx^2 + dy^2 + dz^2 + dt^2$ would describe a completely timeless Pythagorean universe having nothing but four space dimensions, Minkowski, bless him (*pace* Einstein), discerned that $ds^2 = dx^2 + dy^2 + dz^2 - dt^2$ actually describes the emptiest parts of *our* universe, which possesses three space dimensions but also has time. Yes, only a minus sign—but our greatest intellectual discovery ever.



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Such equations were created solely because of the existence of the human mind, and they demonstrate that the universe itself is intrinsically mental in its nature. In my 2005 essay "The mental universe," I assist Jeans and Arthur Eddington in the Sisyphean task of educating the public on that point.[1] I also try to assist young students in seeing how simple the math is; for example, I concisely present special relativity at https://henry.pha.jhu.edu/2-pager.pdf.

Reference

1. R. C. Henry, *Nature* **436**, 29 (2005).

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▶ **Helsing replies:** I did not intend a "takedown," as Richard Conn Henry claims, of James Jeans's idealistic interpretation of modern physics. Nor did I express the view that "a real physical universe is 'out there.' " Apart from exploring Jeans's inherently fascinating views and the reactions they provoked, I pointed to the historical dimensions of philosophical interpretations of physics, contemporary views included. I am agnostic on the question of the nature of ultimate reality—I do not know what is out there, and while I am certainly curious, I do not see how I will ever be in a position to know.

I respect and admire any scientist who works hard to advance our understanding of the universe and any popularizer who makes a genuine effort to interpret science philosophically—including James Jeans and the other popularizers I mention. Part of the process is cultivating an awareness of the historical embeddedness of our theories, interpretations, and worldviews, regardless of whether they tend toward idealism or naturalism.

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Nuclear is carbon-neutral

David Kramer stated in his news item "Hydrogen-powered aircraft may be getting a lift" (PHYSICS TODAY, December 2020, page 27) that "to be carbon-neutral, the hydrogen must be produced either with renewable energy or with natural gas equipped with carbon capture and storage." There is one other form of power production that is carbon-neutral and viable for use: nuclear.

I am curious whether Kramer omitted nuclear power by accident or by choice. Too often nuclear power is not considered for carbon-neutral power production, even though existing and advanced nuclear power technologies are widely accepted as carbon-neutral. Any serious discussion regarding either carbon-neutral energy production or hydrogen production should include nuclear power.

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▶ **Kramer replies:** The omission of nuclear power as a carbon-neutral power source was inadvertent, not deliberate.

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TV inspires future scientists

The article on *3-2-1 Contact* by Ingrid Ockert, in the January 2021 issue of PHYSICS TODAY (page 26), provided

an interesting background of the innovative show. As a child, I watched the show regularly, and I received a *3-2-1 Contact*–branded optics exploration kit as a gift one Christmas. I clearly remember aligning the mirrors of a periscope and exploring color combinations with a spinning wheel.

Working as an optical engineer a few decades later, with the opportunity to contribute to such historic efforts as the *James Webb Space Telescope* currently scheduled to launch on Halloween of this year, I frequently think back to that influential kit and show. My sincere hope is that organizations such as PBS and Sesame Workshop continue to receive the funding necessary to inspire our future engineers and scientists.

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A note on dielectrophoresis

A story about dipole molecules in liquid (PHYSICS TODAY, April 2020, page 17) has prompted me to share some of my own experiences.

When an electrically polarized object, like a dipole, is in a nonuniform electric field, it experiences a force. That phenomenon is known as dielectrophoresis. It is possible to create a field with constant, nonzero second derivative. A dipole particle in such a field would experience a constant force that can thus be made to move in a fixed direction under a constant force.

I created such a field in a shallow device I had made at glass manufacturer Owens-Illinois, my employer, and used yeast and blood cells to study it. The cells did not move unless the field had a frequency of at least 1 MHz. I did not try much higher frequencies. In 1975–76 I took my experiment to the hematology laboratory of Massachusetts General Hospital. Unfortunately, the hoped-for dispersion of velocities among cell types was not observed, and the study ended.

However, water molecules themselves have a dipole moment. When polarized light was passed vertically through the horizontal device, applying the 1 MHz field would switch the transparency on and off.

Apparently, the yeast or blood cells were passively carried along a current of water, driven by the nonuniform field. It is a mystery why there was no motion of the cells (yeast or blood) until the frequency was increased to 1 MHz. Perhaps clusters of water molecules, which are imagined to explain the high boiling point of water, are not dipoles, and the field at or above 1 MHz breaks up some of the aggregates, allowing the dipole moment of H_2O to be sensed.

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Chasing a power supply in Siberia

Arthur Liberman's Letter to the Editor on Cold War particle-physics collaborations (PHYSICS TODAY, October 2020, page 12) reminded me of a visit I made in 1969 to Akademgorodok, a small research town near Novosibirsk, Siberia. At that time our Northeastern University research group had theoretically postulated, and done an initial experiment on, ρ–ω interference in the leptonic decay mode.[1] There were several interesting features to be experimentally or theoretically studied, and a flurry of work followed. We sought to do definitive experiments at the well-suited colliding-beams accelerator in Gersh Budker's research facilities in Akademgorodok.

During discussions with the facility's director, Veniamin Siderov, concerning the proposed experiments, we compared the structure of the Novosibirsk research group with that of the Northeastern group. The numbers that emerged gave significant insight to the hurdles faced by physics researchers in the Soviet Union.

Northeastern's high-energy research group consisted of five PhDs and seven support technicians. When I requested that Siderov provide comparable information about his facility, he replied that he had 2000 technicians. I assumed that he had misunderstood my question, but he actually did have that many technicians working for him. To help me understand the staggering difference, he described the procedure he would follow when he needed, for example, a power supply.

In the US one would simply go out and buy a power supply, but such devices were not available on the Soviet market, and Siderov had no access to hard currencies. He would have to set up a production line in a subgroup of his 2000 technicians, and they would produce perhaps 100 power supplies. He would then act as a vendor of the devices—for several years if need be—to support his technicians and make purchases of his own from other similar manufacturing centers. The amount of organization, energy, and manpower required to obtain a power supply was staggering.

I had come prepared to discuss the details of the proposed experiment, but Budker was already expert in the details of ρ–ω interference. Instead he wanted to discuss the proposed experimental setup—in particular, the number of photomultiplier tubes and power supplies. He agreed to make the accelerator available for the proposed experiment on one condition—that after completion of the measurements, the equipment would be left at his lab.

I carried that proposition back to my supporting agency, which had previously supplied support for Soviet experiments in the US. However, the arrangement was not approved; it amounted to the US paying for Soviet beam time while Soviet researchers got US beam time for free.

Reference

1. R. G. Parsons, R. Weinstein, *Phys. Rev. Lett.* **20**, 1314 (1968).

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CONTACT PHYSICS TODAY

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