Classical and quantum framing of the Now

David Mermin's musings about that elusive Now (PHYSICS TODAY, March 2014, page 8) are a welcome indication that physicists are beginning to ask questions about time. Physics treats time as a coordinate in spacetime in which a point can represent an event. But a person's Now doesn't figure in that scheme—it has no special status, yet it is what each of us directly experiences.

The disjunction between directly experienced time and abstract physics time was first and famously pointed out by French philosopher Henri Bergson.[1] On 6 April 1922, Bergson and Albert Einstein both attended a meeting of the Philosophical Society of Paris, convened to honor Einstein's work. There, the distinction between what Einstein called psychological time and physicist's time was discussed.[2] Mermin's note reminds us that 92 years on, there is still no accommodation.

Mermin's Now, however, is not Bergson's. Mermin's Now can be depicted as a point in his world line, and that sort of depiction is exactly what Bergson objected to. Treating time like space, he thought, was a deep error. What one was conscious of was not a point-like Now but rather a duration, in which the Now was a multiplicity; it was not a single thing that could be recorded as a point on a world line but a mutual penetration of past and present and a hint of the future.

Nor could one person's Now be exactly the same as another's. Different memories, perceptions, temperament, and so on make one's Now unique. Physics cannot deal with the unique and has yet to understand consciousness, so a meaningful accommodation between Bergson's duration and the point-like Now of physics is still some way off.

I'm grateful to Mermin for telling us what he thinks about Now. He alludes to deep issues.

References

1. H. Bergson, *Time and Free Will: An Essay on the Immediate Data of Consciousness*, Dover, Mineola, NY (2001).
2. H. Bergson, *Duration and Simultaneity: Bergson and the Einsteinian Universe*, 2nd ed., Clinamen Press, Manchester, UK (1999).

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■ **The trouble David Mermin** is having with the concept of Now is similar to the problem that Plato, Aristotle, and Martin Heidegger had with the concept of being. Both have no meaning when considered as individual points; they are continuous entities and can only be understood as such. Heidegger pointed out that for most people, being and Now are self-evident. Apparently, it's only physicists and philosophers who are embarrassed by their lack of understanding of such obvious concepts. According to Ockham's razor, the simplest explanation is usually the best one. And Albert Einstein, who venerated simplicity, once said that the only reason time exists is "so that everything doesn't happen all at once." That statement may seem facetious, but it is a corollary of his equating of space and time.

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■ **David Mermin says** correctly that the spacetime of special relativity does not by itself describe our experience of Now. He also notes that we are "complex, extended entities." A natural conclusion is that a notion of Now is not built into the fundamental laws of physics. Rather, it arises from the particular way our brains are organized to process temporal information—a way that is consistent with the fundamental laws but not an inevitable consequence of them. Reference 1 provides simple models of how that works within familiar classical physics, including special relativity.

That conclusion is supported by models of observing systems that do not have a past, present, and future way of organizing temporal information and that are also consistent with the fundamental laws.

Reference

1. J. B. Hartle, *Am. J. Phys.* **73**, 101 (2005), http://arxiv.org/abs/gr-qc/0403001.

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■ **Mermin replies:** Understanding the Now was not the main purpose of my March 2014 commentary. My primary point was that a new way of resolving the puzzles and paradoxes of quantum mechanics, called QBism by Christopher Fuchs and Rüdiger Schack, was also able to settle that longstanding problem in classical physics. After my earlier commentary on QBism (PHYSICS TODAY, July 2012, page 8), I was concerned that many of the letters about it (December 2012, page 8) had sounded the same theme: that the letter writer's own way of looking at quantum mechanics was already perfectly satisfactory. I hoped that by applying QBist thinking to a strictly classical problem, I could disengage those readers from their favorite interpretation of quantum mechanics and help them think about QBism on its own merits. I recently emphasized in *Nature*[1] that QBism sheds light on classical physics, too, but there I discussed quantum applications of QBism as well as classical applications ("CBism").

The letters here all address only the problem of the Now but not the fact that I deal with it through a classical application of QBism. While I'm disappointed that they say nothing about QBism or CBism, I'm pleased that they all agree that the problem of the Now is indeed a problem. Not everybody does.

Berge Tatian and B. K. Ridley both criticize me for taking the Now to be a point. But I don't. I call the Now an event "whose duration and location are restricted enough that it can usefully be represented as a point in space and time." I say that "the events we experience are complex, extended entities" and that "to represent our actual experiences as a collection of mathematical points . . . is a brilliant strategic simplification, but we ought not to confuse a cartoon . . . with the experience itself."

Ridley's comment "Nor could one person's Now be exactly the same as another's" suggests that I say it could be.

Letters and commentary are encouraged and should be sent by email to ptletters@aip.org (using your surname as the Subject line), or by standard mail to Letters, PHYSICS TODAY, American Center for Physics, One Physics Ellipse, College Park, MD 20740-3842. Please include your name, work affiliation, mailing address, email address, and daytime phone number on your letter and attachments. You can also contact us online at http://contact.physicstoday.org. We reserve the right to edit submissions.

What I do say is "The commonality of my Now and your Now whenever we are together requires that our Nows must coincide at each of two consecutive meetings." "Commonality" or "coincide" mean only that our two private Now experiences happen at a common place and time, not that they are identical. Indeed, the personal experiences of different people are incomparable, except through the imperfect medium of language.

I agree with James Hartle on much in the paper he cites, but we have important differences. He takes spacetime to be objective and fundamental; I take it to be an abstract tool used by an agent to organize her experience. He uses the notion of a point in spacetime uncritically; I regard it as an approximate representation of an agent's spatially and temporally extended experience. He takes an agent's experience to be an objective property of the agent, like the contents of a register. I take an agent's experience to be private and self-evident to that agent and to be the fundamental basis for her inference of an external world; the experience of each agent plays a special role for that—and only that—agent, analogous to the special role played by "the classical domain" in the quantum mechanics of Lev Landau and Evgeny Lifshitz.

Rudolf Peierls wrote to John Bell in 1980, "In my view, a description of the laws of physics consists in giving us a set of correlations between successive observations. By observations I mean . . . what our senses can experience. That we have senses and can experience such sensations is an empirical fact, which has not been deduced (and in my opinion cannot be deduced) from current physics."[2] If "us" is expanded to "each of us," then nobody has ever put QBism and CBism more concisely than that.

References

1. N. D. Mermin, *Nature* **507**, 421 (2014).
2. S. Lee, ed., *Sir Rudolf Peierls: Selected Private and Scientific Correspondence*, vol. 2, World Scientific, River Edge, NJ (2009), p. 807.

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Out of Ehrenfest's closet

The article by Dirk van Delft on Paul Ehrenfest's final years (PHYSICS TODAY, January 2014, page 41) offers fascinating insights into the life of a remarkable man. It also offers a speculation as to why Martin Klein never wrote the second volume he had originally planned for his Ehrenfest biography. As Marty told me many years ago, he took a sabbatical in Leiden, the Netherlands, when he began his research for the biography, and he visited Ehrenfest's widow, Tatiana, fairly often during that time.

At some point—after volume 1 had been written, I believe—Marty visited Tatiana again. During that visit she inadvertently opened a closet, and papers that she had kept hidden came tumbling out. It was my understanding that Marty abandoned the second volume because he did not have access to those papers, which he considered essential and which I assume are the letters acquired by the Boerhaave Museum. The article by van Delft offers abundant clues as to why Tatiana wanted to keep them secret.

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UN's Basic Space Science Initiative: A follow-up report

Almost 20 years after I first wrote about the United Nations and European Space Agency workshops on space science (PHYSICS TODAY, July 1996, page 90), I feel obliged to provide an update on the continuing initiative, which seems to be unique and is raising interesting and uncommon questions. The United Nations Basic Space Science Initiative (BSSI) is a long-term effort to develop astronomy and space science through regional and international cooperation, particularly in developing nations. In addition to the UN and ESA, NASA and the Japan Aerospace Exploration Agency have also cosponsored workshops.

The idea for the BSSI was first discussed in 1986 in New York. Among the participants in that discussion were I. I. Rabi and Dorothy Michelson Livingston.

From 1991 to 2004, the workshops on basic space science addressed the status of astronomy in Asia, Latin America, and Africa. As a result of those workshops and with leadership from the National Astronomical Observatory of Japan, telescope facilities were inaugurated in 7 developing nations and planetariums were established in 20, with equipment donated by Japan.