particles in, for example, aqueous solutions. The electric force in those equations is usually described by a steady function. Fluctuations in number density of charged particles are allowed in Einstein's treatment but fluctuations in net charge and electric potential are not. Traditional Langevin equations of Brownian motion seem inconsistent with the idea that charge creates electric force and so are unlikely to be helpful, at least in my view. It is hard to imagine systems in which the number density of ions can fluctuate while the number density of charge does not.

I believe Einstein's description of Brownian motion must be coupled to equations describing the electric field when the diffusing particles have significant charge. An equation is needed to show how the charge on one particle creates force on another. The ink particles studied by Robert Brown were surely charged. The fluctuating electric field and stochastic flow can be computed from the density of ink particles, ions, and solvent molecules by solving Poisson's or Maxwell's equations together with flow equations. (Spatially inhomogeneous boundary conditions are needed to force the macroscopic flow described by Fick's law.)

This so-called self-consistent treatment of diffusion and the electric field is used in computational electronics to design the transistors and integrated circuits of our electronic technology.[1] Diffusion and the electric field have not been treated self-consistently in most of computational chemistry and biology—for example, in simulations of molecular dynamics of ions or proteins—although such treatments are found in analyses of ionic motion through protein channels.[2–5]

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**Bob Eisenberg**
*(beisenbe@rush.edu)*
*Rush Medical Center*
*Chicago, Illinois*


The fascinating article recounting Einstein's mistakes at different stages of his career goes beyond the usual focus on the cosmological constant and quantum mechanics. In particular, the discussion of Kaluza–Klein theory examines Einstein's later attempts at a unification theory. But in the course of developing general relativity, Einstein made another assumption, which he later tried to revisit—one that future generations may come to regard as Einstein's greatest "mistake."

Curvature of spacetime is, of course, related by general relativity to the presence of mass-energy. This curvature, though it plays out in the arena of four-dimensional spacetime, corresponds to our intuitive understanding of geometric curvature in three dimensions. General relativity also makes a crucial assumption that another geometric object, called the torsion, vanishes. That is not the only assumption that could have been made, however, and as Einstein explored extensions of general relativity after 1915, he reevaluated his initial assumption.

In the 1920s and 1930s, Einstein collaborated[1] with the eminent French mathematician Elie Cartan, who was responsible for much of the foundation of 20th-century differential geometry. As early as 1922, Cartan tried to explain to Einstein that a different type of curvature, which could be called a total curvature and which contains the traditional curvature as a piece, vanishes. With this condition, called teleparallelism (TP), the torsion need not vanish. Einstein and Cartan explored the implications of TP for generalizing general relativity beyond the gravitational field, but ultimately abandoned that route. Unfortunately, the tools Cartan himself offered to differential geometry were insufficiently mature at that stage to be exploited by Einstein even if the physicist had been able to fully understand them.[1]

Teleparallelism does offer advantages, including a greater mathematical richness than general relativity and a potential resolution of mathematical issues related to the nature of conservation laws in general relativity.[2,3] Wielding the methods of modern differential geometry that Cartan first introduced, physicists in the past couple of decades have elaborated unified theories with TP as an important component.[3,4] For instance, TP and another geometric ingredient[5] lead to the "natural" incorporation of electromagnetism in one such theory, fully within the tradition of the geometrical paradigm of Einstein.[3]

TP may ultimately prove to be a better assumption for a geometric theory. If so, it would still be an extreme excess of Whiggery, to use Weinberg's wonderful phrase, for those future generations to fault Einstein for his choice in general relativity. The very mathematical concepts, let alone the tools, behind TP did not even exist in 1915 when general relativity was unveiled to the world.

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**Robert E. Becker**
*(roberte.becker@prodigy.net)*
*York, Pennsylvania*


**Weinberg replies:** I thank the writers of these letters for their thoughtful remarks. Alfred Goldhaber offers a fascinating speculation, that Einstein might have developed modern quantum mechanics by building on his 1905 introduction of the quantum of light. However, there would have been an obstacle in his path: a shortage of relevant data. By concentrating on atoms rather than photons, de Broglie, Bohr, Heisenberg, and Schrödinger were able to find guidance and confirmation from the huge amount of spectroscopic data already available to them. I can't think of any way that the quantum theory of light itself could have found similar quantitative support from experimental data in the 1900s or 1910s.

Tom Cornsweet wisely reminds us that the published literature gives only a limited insight into the work of scientists. Real historians, unlike me, try to go deeper by studying diaries, letters, and personal reminiscences, but some aspects of the past can never be recovered.

As far as I have thought about the matter, I agree with Hans Ohanian about the synchronization of clocks. I have not emphasized this point when I have taught relativity theory, preferring instead to take Lorentz invariance as a starting point.

I do not know of any evidence that Einstein would have been content for God to play dice all the way, as suggested by Ravi Gomatam. Einstein did acknowledge the many successes of quantum mechanics, but as far as I know he always hoped that those successes could be explained on the basis of a thoroughly deterministic theory.

Ron Larson takes me to task for my "not-so-subtle knock on religion." I certainly never intended my remark to be subtle. The reason that I did not mention religion is that I intended to knock reliance on *any* supposedly infallible authority—in other words, not only the attribution of infallibility to the Bible or Koran, but also to *Das Kapital*, *Mein Kampf*, or Mao's little red book. I did not say that science gave Einstein guidance on public issues. The reason I said Einstein made no mistake on the issues I mentioned is not that I thought he was infallible, but that I thought he was right.

It is of course true, as Brian Hall says, that Einstein's fallibility does