

single-minded focus on love as universal guide to human behavior.

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PHYSICS TODAY's celebration of the World Year of Physics, marking the centenary of Albert Einstein's 1905 papers, got off on the wrong foot with your publication of "God's Rays" by Bryce DeWitt in the January issue. The essay's only mention of Einstein is his "The Lord God is subtle but He is not malicious" quote, but for Einstein, "God" was a poetic metaphor for Nature. Einstein wrote, "I have repeatedly said that in my opinion the idea of a personal God is a childlike one," and "From the viewpoint of a Jesuit priest I am, of course, and have always been an atheist."¹

DeWitt claims that "it is common knowledge that theoretical physicists often start out as amateur theologians," but it is certainly not common knowledge, and is very likely untrue. His fellow religionists should express themselves in a journal other than PHYSICS TODAY.

Reference

1. M. R. Gilmore, *Skeptic* 5, 62 (1997).

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Thoughts on Starting the Hydrogen Economy

In their article "The Hydrogen Economy" (PHYSICS TODAY, December 2004, page 39), George Crabtree, Mildred Dresselhaus, and Michelle Buchanan say that "basic research must provide breakthroughs . . . to make a hydrogen-based energy system . . . vibrant and competitive." This statement overlooks the near-term feasibility of an ammonia-mediated hydrogen-based system.¹ A research breakthrough might reduce the cost of ammonia production, by emulating its biosynthesis,² for example. But we have known how to make NH_3 economically for almost a century. Nowadays, between 1% and 2% of the world's energy is devoted to synthesizing ammonia from air

and hydrocarbons, notably natural gas, via the Haber-Bosch process.³

Because ammonia forms hydrogen bonds, unlike H_2 or methane, it liquefies at about 8 atmospheres and room temperature, or ambient pressure and -33°C . Indeed, because of this favorably situated phase transition, anhydrous ammonia was used as a household refrigerant for much of the 20th century.

Pipelines are in place to distribute anhydrous ammonia. To fertilize their fields, farmers routinely pull tank trucks up to ammonia "filling stations." An ammonia-fueled automobile with an internal-combustion engine was reported in the 1970s.⁴ Commercial catalytic cells are available to break ammonia into nitrogen and hydrogen and thus produce feedstock for a hydrogen fuel cell. Solid-electrolyte ammonia fuel cells have been demonstrated.⁵

Because Bosch synthesis is performed in large industrial plants, the carbon dioxide byproduct can be captured and sequestered relatively easily—for example, by pumping it back into the wells that supplied the natural-gas feedstock. Any means of producing hydrogen based on a renewable energy source could

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