should deflect eastward if Earth rotates. Decades later Isaac Newton, in proposing the same test to Robert Hooke, wrote that "the advance of the body from the perpendicular eastward will . . . be very small and yet I am apt to think it may be enough to determine the matter." Hooke attempted it unsuccessfully. That delicate but apparently straightforward experiment is bedeviled by all sorts of effects that may spring to the mind of the modern physicist but were then unknown; it wouldn't be successfully performed until the 19th century.[2]

Clarage comments that Riccioli's work bears on significant historical matters and that his vocation as a Jesuit priest should be noted. Indeed, Riccioli was a prominent defender of Tycho Brahe's brand of geocentrism; he opposed the heliocentric theory with scientifically robust challenges—including an astronomical anti-Copernican argument he developed with Grimaldi[3]—that would not be fully answered for almost two centuries. His work suggests that opposition to the ideas of Copernicus was more scientific in nature than has generally been acknowledged. Certainly, more study of the scientific work of Riccioli, Tycho, and other anti-Copernicans is called for, and it will probably yield more surprises. As Manuel López-Mariscal points out above, no aspect of the history of physics ever seems to be as simple as the versions presented in the physics textbooks.

References

1. See, for example, E. Gregersen, ed., *The Britannica Guide to Heat, Force, and Motion*, Britannica Educational in assoc. with Rosen Educational Services, New York (2011), p. 121.
2. See C. M. Graney, *Phys. Perspect.* **13**, 387 (2011).
3. C. M. Graney, *J. Hist. Astron.* **41**, 453 (2010).

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Archaeology terminology confusion

Anna Frebel and Volker Bromm's article "Precious fossils of the infant universe" (PHYSICS TODAY, April 2012, page 49) was both intriguing and confusing to me. As a geologist who also holds a degree in archaeology, I found the use of the terms "fossil" and "archaeology" in the article inappropriate. In the fields of geology and paleontology, the term "fossil" means evidence of past life preserved in the geologic record. Likewise, in anthropology, "archaeology" is a specific term related to the study of past human activity through examination of material culture and environmental evidence of humans. As I read the article, I was sorely disappointed to discover that it had nothing to do with life or past human existence.

The terms in the Frebel and Bromm article might seem appropriate to astronomers and physicists. However, consistency in the use of scientific terms, especially by scientists, would help avoid misunderstanding and improve interdisciplinary communication. The misappropriation of the above terms is akin to the frequent misuse of the term "theory" in the news media when they really mean idea or hypothesis. Surely, scientists in physics and astronomy can devise accurate and descriptive terms to communicate their discoveries rather than hijacking existing scientific terms that are widely accepted to mean something completely different. Otherwise, the article was excellent.

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Randomness of the tossed coin

The Quick Study "Probability, physics, and the coin toss" (PHYSICS TODAY, July 2011, page 66) by L. Mahadevan and Ee Hou Yong discusses the dynamics of a fair, thick coin. In particular, the authors try to determine how thick a coin should be to have a one-in-three chance of landing on edge. The authors do not consider coin bounces but note that adding bounces leads to "more physical realism and fun." Their main result—illustrated in the boundary plot, figure 2c, which presents initial conditions leading respectively to heads, tails, and edges—is stated as follows: "As ω [angular velocity] and u/g [vertical speed scaled by the gravitational acceleration g] become large, any disk representing a probability distribution of initial conditions is tiled finely and equally, now by regions associated with heads, tails, and sides." That statement is correct.

Note, however, that the boundaries separating the regions of heads, tails, and sides are smooth. Thus if one takes finite initial values for the angular and vertical velocities and takes care to avoid the boundaries, then a small enough initial error will yield a predictable, fixed outcome for the coin toss. In that scenario, bounces are essential for randomness in the coin toss (see reference 1, which considers an infinitesimally thin coin). As the number of bounces increases, the boundaries of the heads and tails regions become more complex; in the limit of an infinite number of bounces, they become fractal (see reference 1, figures 3 and 4). In that limit only, it is impossible to predict the outcome of the coin toss no matter how well the initial conditions are determined. We obtained similar results for the dynamics of dice,[2] which can be viewed as a generalization of the thick coin considered in the Quick Study.

References

1. J. Strzalko, J. Grabski, A. Stefanski, P. Perlikowski, T. Kapitaniak, *Math. Intell.* **32**(4), 54 (2010).
2. J. Strzalko, J. Grabski, A. Stefanski, T. Kapitaniak, *IJBC* **20**, 1175 (2010).

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Fusion could fuel particle physicists' future

In response to Persis Drell's commentary on the present state of the US particle-physics program (PHYSICS TODAY, June 2012, page 8), I would like to suggest that one possibility for its future direction may be found just a few pages later in the same issue (page 25). The US fusion program has stalled, partly because funding is now going to ITER, but also because of a lack of new ideas for how to get the job done.

Having worked a bit in both fusion and particle physics, I can appreciate how the programs relate. A fusion reactor, by any fundamental description, requires expertise in almost every area covered by high-energy physics: Confining the plasma is a problem for quantum electrodynamicists, getting the nuclei to fuse is a problem for quantum chromodynamicists, and I'm sure there would be something for the weak-force folks to do. By focusing its efforts on the design, construction, and operation of a working fusion reactor, the particle-physics community can make itself beneficial to humanity and relevant to the American

taxpayer, thus ensuring a healthy level of funding for years to come.

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Did Lomonosov see the Venusian atmosphere?

Vladimir Shiltsev (PHYSICS TODAY, February 2012, page 40) properly credits Mikhail Lomonosov with a wide range of scientific achievements. But we have been corresponding with Shiltsev for some months about our realization[1] that Lomonosov did not discover the atmosphere of Venus. One of us (Pasachoff) analyzed spacecraft observations of the Cytherean atmosphere at the 2004 transit of Venus,[2] and we realized that what Lomonosov reported did not match actual atmospheric observations. NASA's *Transition Region and Coronal Explorer* spacecraft detected Venus's atmosphere for about 20 minutes as Venus's silhouette entered the Sun's limb, and again for the first 20 minutes of its exit from the solar disk. Lomonosov saw only a bulge of light—shown in figure 4a of Shiltsev's article—and a brief flash of light. We think that what he saw was an artifact of his relatively primitive and small telescope rather than the aureole that is sunlight refracted toward Earth by Venus's atmosphere. Our conclusions were reinforced by observations made during the 2012 transit of Venus.

Lomonosov wrote, quoted here from a translation made for us, "I watched with keen attention for the ingress of the trailing limb of Venus, which, it seemed, had not yet taken place, for there seemed to be a small segment not yet entered upon the Sun. However, there suddenly appeared between the trailing limb of Venus and the following [solar] limb a hair-thin luminous sliver. The time that separated the two appearances was not more than a second" (reference 1, page 5). But the actual aureole is produced by the refraction of sunlight in the Venusian atmosphere, and it is much too thin and faint for 18th-century observers to have seen it with the instruments available to them and from their low-altitude locations. Further, the bulge Lomonosov reported was probably an artifact that resulted from the blurring of the edge between Venus's dark disk and the bright solar limb on either side of it.