

models and later to string theory.

In 1966 we had no idea what quarks really were or how they interacted. We had to wait until experiments had shown individual “partons” in elastic scattering, just as Jean Baptiste Perrin had to wait until 1926 to receive the Nobel Prize for his work on Brownian motion. We had to wait for the theoretical developments of asymptotic freedom and quantum chromodynamics. But it was already clear in 1966 that quarks were the real basic constituents of hadrons and not simply mathematical objects.

This letter was written when Dalitz and Ne’eman were still with us, and I had anticipated their reactions. Today I think it is appropriate to dedicate this letter to their memory.

## References

1. H. Lipkin, *Nature* **406**, 127 (2000).
2. A. Pais, “*Subtle Is the Lord . . .*”: *The Science and the Life of Albert Einstein*, Oxford U. Press, New York (1982).

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## A long history of peristaltic perturbations

Yves Pomeau and Emmanuel Villermanx, in their article “Two Hundred Years of Capillarity Research” (PHYSICS TODAY, March 2006, page 39), give a comprehensive overview. It is noteworthy, however, that the stability condition mentioned in the section on breakup and fragmentation was known decades before Joseph Antoine Ferdinand Plateau’s 1873 publication cited it. The condition that peristaltic perturbations are naturally unstable if their longitudinal wavelength is larger than the cylinder’s circumference was known to Plateau as early as 1850.<sup>1</sup> His analytical result was quoted by August Beer in 1855.<sup>2</sup> In correspondence with William Thomson (later Lord Kelvin), James Clerk Maxwell referred to this limiting condition in 1857.<sup>3</sup> Maxwell’s phrase “it is easy to show” suggests he had derived the result, though it is plausible he also read the earlier discussion by Plateau. Some of these references have been noted much more recently, in conjunction with an investigation of the nonlinear capillary response of liquid cylinders.<sup>4</sup>

## References

1. J. Plateau, *Ann. Phys. Chem.* **80**, 566 (1850).

2. A. Beer, *Ann. Phys. Chem.* **96**, 1 (1855); **96**, 210 (1855).
3. J. C. Maxwell to W. Thomson, letter dated 24 August 1857, reproduced in S. G. Brush, C. W. F. Everitt, E. Garber, eds., *Maxwell on Saturn’s Rings*, MIT Press, Cambridge, MA (1983), p. 44. See also P. M. Harman, ed., *The Scientific Letters and Papers of James Clerk Maxwell: Volume 1, 1846–1862*, Cambridge U. Press, New York (1990), p. 533.
4. W. Wei, D. B. Thiessen, P. L. Marston, *Phys. Rev. E* **72**, 067304 (2005).

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## Footnote on slippery ice

Here is an interesting footnote to the article “Why Is Ice Slippery?” by Robert Rosenberg (PHYSICS TODAY, December 2005, page 50). A wonderful out-of-print biography of Robert W. Wood,<sup>1</sup> who is especially famous for his research on physical optics and spectroscopy, relates that as an undergraduate at Harvard University in 1891, he heard of the “pressure-molten” theory of glacier sliding, and “totally disbelieved this.”

Wood had access to a powerful hydraulic press at a blower plant and decided to use it to disprove the theory. Water was frozen inside a cylindrical iron block, with a bullet accurately placed in the center of the ice cylinder. “The mighty ram of the hydraulic press” then pressed so strongly on the ice via a steel cylinder that ice needles “forced [their] way through imperfections in the casting” of the iron walls. And yet, when pressure was released and the ice removed, “the bullet was found at the center where it had originally been placed, thus clearly demonstrating that the ice within the cylinder had at no moment existed as *pressure-molten water*” (italics in the original). Wood, the inventive undergraduate student, published the results.<sup>2</sup> His experimental creativity later became legendary, and that early contribution to the “slippery ice” story looks like a harbinger of his future reputation.

## References

1. W. Seabrook, *Doctor Wood, Modern Wizard of the Laboratory: The Story of an American Small Boy Who Became the Most Daring and Original Experimental Physicist of Our Day – but Never Grew Up*, Harcourt Brace, New York (1941).
2. R. Wood, *Am. J. Sci.* **41**, 30 (1891).

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## Refuting evolution’s Cambrian controversy

In an item in the January 2006 issue of PHYSICS TODAY (page 32), Jim Dawson quoted National Academy of Sciences president Ralph J. Cicerone on “‘controversies’ (e.g. the Cambrian explosion) that evolutionary scientists have refuted many times using the available evidence.” I thought PHYSICS TODAY readers might like to know what some of the refutations are. How privileged we are today to know with more certainty than did Charles Darwin himself!

A true follower of Darwin knows that “the sudden appearance of animal fossils at the beginning of the Cambrian [period] was of particular concern to him.”<sup>1</sup> Darwin argued that the animals should have diverged gradually during a long prior period—“as long as, or probably far longer than, the whole interval from the Silurian [that is, the Cambrian period] to the present day.”<sup>2</sup> Because the required fossils were not found, he confessed, “The case at present must remain inexplicable; and may be truly urged as a valid argument against the views here entertained.”<sup>3</sup>

Only in 1954 were very early pre-Cambrian fossils convincingly found: bacteria and one-celled fungi, abundantly frozen in 2-billion-year-old black chert from North America.<sup>4</sup> This discovery quadrupled the known age of life on Earth. An investigative explosion into pre-Cambrian paleobiology was then inevitable. Since the 1960s, fossilized microbes up to 4 billion years old have been found in some of the oldest rocks on Earth.

We do not know the whole answer to Darwin’s concern, regarding the sudden appearance of animal fossils, with developed body plans in all the phyla. Nevertheless, that living things (at least one-celled microbes) flourished long before the Cambrian, just as claimed, is today indisputable.

## References

1. D. E. G. Briggs, D. H. Erwin, F. J. Collier, *The Fossils of the Burgess Shale*, Smithsonian Institution Press, Washington, DC (1994), p. 39.
2. C. Darwin, *Origin of Species*, facsimile of the first (1859) edition, Harvard U. Press, Cambridge, MA (1964), p. 307.
3. Ref. 2, p. 308.
4. S. A. Tyler, E. S. Barghoorn, *Science* **119**, 606 (1954).

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