

LETTERS

Walking the Planck Length through History

Frank Wilczek's Reference Frame article in the June 2001 issue of PHYSICS TODAY (page 12) shows how simple dimensional analysis, together with a few elementary facts, can lead to profound conclusions.

I would like to comment from personal experience on one historical point. Speaking of Planck's proposal that the Planck mass (M), length (L), and time (T) should form a fundamental system of units, Wilczek notes that the proposal was at first merely formally correct, but that "over the course of the 20th century, however, his proposal became compelling." But I can testify that it was still considered heretical well into the 1960s.

In 1959, I submitted a paper proposing that the Planck length L and time T should play a fundamental role in physics. In the case of L , the idea was based on an analysis of Werner Heisenberg's microscope experiment, taking account of the gravitational field of the photon used to measure the position of the particle. For T , the analysis involved the problem of keeping clocks synchronized in view of both the uncertainty relation between the reading of a clock and its energy, and the influence of gravitational energy on the rate of the clock. In both cases, I found that one runs into trouble when trying to obtain a position measurement (clock synchronization) with error less than $L(T)$. At the time, I knew nothing of Planck's proposal. Eventually this paper, and a follow-up, were published.¹ While my paper was suffering referee trouble, a similar idea was proposed by Asher Peres and Nathan Rosen.²

I don't claim that my papers deserved any better fate than they received: years of referee trouble,

eventual publication, a cold shoulder from the physics community. But some of the reasons for this cold shoulder are worth noting. At the time, I read many referee reports on my papers and discussed the matter with every theoretical physicist who was willing to listen; nobody that I contacted recognized the connection with the Planck proposal, and few took seriously the idea of L as a possible fundamental length. The view was nearly unanimous, not just that I had failed to prove my result, but that the Planck length could never play a fundamental role in physics. A minority held that there could be no fundamental length at all, but most were then convinced that a fundamental length L' , of the order of the proton Compton wavelength, was the wave of the future. Moreover, the people I contacted seemed to treat this much longer fundamental length as established fact, not speculation, despite the lack of actual evidence for it. Of the people I contacted, the only ones I can recall who had a positive attitude to the idea of L as a fundamental length were Henry Primakoff, David Bohm, and Roger Penrose.

I don't know when or how the transition of the Planck proposal from heresy to conventional wisdom took place, but I can attest that it had not even begun in the mid-1960s. I suspect that it did not really begin to take hold until at least the mid-1970s, but perhaps others can enlighten me on this.

References

1. C. A. Mead, *Phys. Rev.* **135**, B849 (1964); *Phys. Rev.* **143**, 990 (1966).
2. A. Peres, N. Rosen, *Phys. Rev.* **118**, 335 (1960).

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WILCZEK REPLIES: It is true and significant that the Planck length arises naturally when one considers the ultimate limits to measurement. Crudely, it happens because refined length measurement requires large momentum, according to Heisenberg's uncertainty principle, but when the momentum becomes too large, its gravitational effect becomes strong, curving space-time and distorting the interval one seeks to measure. Thus a fundamen-

continued on page 81

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