CC/NUMBER 38
SEPTEMBER 21, 1987

This Week's Citation Classic®

Taylor B N, Parker W H & Langenberg D N. Determination of *e/h*, using macroscopic quantum phase coherence in superconductors: implications for quantum electrodynamics and the fundamental physical constants. *Rev. Mod. Phys.* 41:375-496, 1969. (Also published as *The fundamental constants and quantum electrodynamics*. New York: Academic Press, 1969. 353 p.) [RCA Labs., Princeton, NJ; Dept. Physics, Univ. California, Irvine, CA; and Dept. Physics and Lab. for Research on the Structure of Matter, Univ. Pennsylvania, Philadelphia, PA]

The fundamental constants of nature play a key role in the basic theories that connect all the diverse fields of physics. Consequently, careful comparisons of their numerical values as obtained from various experiments in these different fields can critically test the validity of the basic theories themselves. [The *SCI*® indicates that this paper has been cited in over 565 publications.]

Barry N. Taylor
Electricity Division
National Bureau of Standards
Gaithersburg, MD 20899

June 16, 1987

This paper was a direct outgrowth of our highly accurate experimental determination of the Josephson frequency-voltage ratio $2e/h$ using the ac Josephson effect in superconductors.[1,2] By combining our value of $2e/h$ with the thoroughly reexamined, experimentally measured values of other constants and related conversion factors, we derived a highly reliable value of the fine-structure constant α, which was independent of quantum electrodynamic (QED) theory. We then used this value of α to evaluate the theoretical expressions for a number of QED-dependent quantities, for example, the Lamb shift, hyperfine splitting in hydrogen, and the anomalous magnetic moment of the electron. Finally, these theoretical values were compared with carefully reevaluated experimental values, thereby providing critical and unambiguous tests of QED. We also derived a new set of "best" values of the fundamental constants from a carefully selected subset of all the available data.

This paper required nearly two years to complete and was made all the more difficult by our different locations. I still recall the many Saturdays that Don Langenberg and I spent in the library of the RCA Laboratories working on the paper and arguing over various points of writing style, among other things! Another difficulty was that we were all low-temperature, solid-state physicists who knew comparatively little about the fundamental constants. We had become enamored of the field through our experimental determination of $2e/h$, which evolved from earlier work that Langenberg and I had done on the physics of the ac Josephson effect and from reading various articles relating to the fundamental constants such as that of E. Richard Cohen and Jesse W.M. DuMond.[3]

On the basis of the work reported in this paper and two others,[1,2] we received the 1975 John Price Wetherill Medal of the Franklin Institute, Philadelphia, Pennsylvania.

I believe this paper has been highly cited (it was even translated into Russian) because it provides a thoughtful review and summary of a large amount of experimental and theoretical work of interest to a broad range of scientists; critical and unambiguous tests of QED, one of physics' most important theories; and significantly more reliable numerical values for many of the fundamental physical constants.

Shortly after the publication of this paper, I left RCA to take a position with the National Bureau of Standards (NBS). I have continued my fundamental constants data-analysis efforts at NBS, and, in collaboration with Cohen and under the auspices of the Committee on Data for Science and Technology, I published in 1973 the results of a new evaluation of the constants with a new set of recommended values.[4] This has just recently been replaced by our 1986 effort.[5] Writing the 1969 paper clearly had a profound effect on me—it is now nearly 20 years later and I am still at it!

1. **Parker W H, Taylor B N & Langenberg D N.** Measurement of $2e/h$ using the ac Josephson effect and its implications for quantum electrodynamics. *Phys. Rev. Lett.* 18:287-91, 1967. (Cited 105 times.)
2. **Parker W H, Langenberg D N, Denenstein A & Taylor B N.** Determination of e/h, using macroscopic phase coherence in superconductors. I. Experiment. *Phys. Rev.* 177:639-64, 1969. (Cited 60 times.)
3. **Cohen E R & DuMond J W M.** Our knowledge of the fundamental constants of physics and chemistry in 1965. *Rev. Mod. Phys.* 37:537-94, 1965. (Cited 320 times.)
4. **Cohen E R & Taylor B N.** The 1973 least-squares adjustment of the fundamental physical constants. *J. Phys. Chem. Ref. Data* 2:663-734, 1973. (Cited 420 times.)
5. ———. The 1986 adjustment of the fundamental physical constants. *CODATA Bull.* 63:1-36, 1986.