This Week's Citation Classic

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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. [North American Aviation Science Center, Thousand Oaks, CA and California Institute of Technology, Pasadena, CA]

The analysis of measurements at the highest possible levels of precision are significant in bringing together phenomena in various branches of physics and in verifying the adequacy of fundamental theory, as well as providing a consistent set of numerical values of the fundamental physical constants. [The SC/® indicates that this paper has been cited over 310 times since 1965.]

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"A review paper is more likely to be cited than an original research paper might be: a review that provides a recommended set of numerical values of fundamental physical constants, even more so; and a paper that points out a serious discrepancy between two basic experimental measurements is bound to engender discussion. Our paper followed earlier similar reviews of the numerical data on the physical constants[1,2] such as the speed of light, the mass of the electron, the Avogadro constant, and the Faraday constant. At that time, a measurement of the fine structure of the optical spectrum of hydrogen, using the then relatively new microwave techniques which had led to the discovery *of* the Lamb shift, yielded a numerical value of the fine-structure constant which differed by 22 parts per million from a value of the same constant derived from a measurement of the microwave hyperf ine separation (hydrogen maser radiation). This difference, although small, was well outside the expected uncertainties of the measurements. If it were correct, it

would have implied either that the accepted theory of the structure of the proton was in error or that the theory of quantum electrodynamics was inadequate. In spite of this uncertainty, the numerical values of the physical constants had been endorsed by the International Union of Pure and Applied Physics and recommended for general use by the International Union of Pure and Applied Chemistry. It would be difficult to determine how many citations to the paper were by those who merely used a convenient table as a source of useful numerical values and how many citations were concerned with the more fundamental problem of the discrepancy.

"In 1969, Taylor, Parker, and Langenberg[3] published a completely independent review that included their recent measurements of the Josephson effect in superconductors. This gave a very precise measurement of the ratio of the electron charge to the Planck constant and showed clearly that the fine structure data were in error. (The actual source of that error was not, and has not yet been, identified but the fine structure measurements were extremely difficult to carry out and to analyze, and several possible factors could have been responsible for the small distortions of the spectroscopic line shapes necessary to account for the misleading result.) Many of the citations of our paper were certainly related to a comparison with this review.

"In 1973, Taylor and I updated the analysis to include more recent measurements, and a new revision (as of 1981) is presently in process. It is perhaps ironic that the numerical values of the fundamental physical constants should change as often as they have over the past three decades, but it is the seeking for ultimate truth, rather than the attainment of the goal, that is important. The periodic reviews are of most significance if they stimulate new measurements and the development of new techniques; the utility of the recommended numerical values is also important but, in my mind, secondary."

1. **DuMond J** W M & **Coben E R.** Our knowledge of the atomic constants *F, N, m* and *h* in 1947, and of other constants derivable therefrom. *Rev. Mod. Phys.* 20:82-108, 1948.
2. **Cohen E R, Crowe K M DuMond J W M.** *Fundamental constants of physics.* New York: Interscience Publishers, 1957. 287 p.
3. **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.
4. **Coben E R & Taylor B N.** The 1973 least squares adjustment of the fundamental constants. *J. Phys. Chem. Ref. Data* 2:663-734, 1973.