

Evidence of an Electrostatic Mach's Principle?

by

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ABSTRACT. In January, 1995 this author posted on the internet, and in 1999 published in an archival journal [1], a simple formula [derivable in one line of elementary integral calculus] demonstrating, in connection with the Fényes-Nelson Stochastic Mechanics (as an alternative to the Copenhagen Interpretation of Quantum Mechanics), that *Planck's constant* h is proportional to the mean number density of charged particles in the visible universe at any given epoch of cosmological time. Here it is demonstrated by two additional lines of equally elementary differential calculus that this formula for h constitutes *direct evidence* for the *expansion* of the universe, provides a more logical *alternative interpretation* of anomalous observations claimed in evidence of *alleged* "acceleration" of this expansion, and in fact *predicts* four recent astrophysical discoveries so surprising that they have appeared on the front pages of national newspapers during 1999-2001, including the cosmological *increase* in the *Fine Structure constant* α and the *equinoctial fluctuation* of h itself when measured in a laboratory on this earth.

INTRODUCTION. In [1] a formula was derived demonstrating that *Planck's constant* h is directly proportional to the *mean number-density* \bar{n} in *particles/m³* of electrons or protons in the visible universe at any given epoch. Specifically, h as measured in a laboratory on Earth should be given by

$$h = \sqrt{8\pi/3} \cdot \left(\frac{e^2}{4\pi\epsilon} \right) \cdot \frac{\bar{n}}{R_0^{1/2}} \cdot \iota,$$

where $R_0 = 1$ *Astronomical Unit* (AU) in m and where e denotes the electron charge and ϵ the permittivity of free space and ι a unit-intensity scale-factor of dimensions $(m^{5/2} \cdot sec)$. Now $\bar{n} = 5.51 \cdot \Omega \cdot (H_0/70)^2$ per m^3 from standard physical cosmology, where $\Omega \equiv (\rho_o/\rho_c)$ denotes the usual *critical density* ratio, and where H_0 denotes the value, at the present epoch, in $(km/sec)/Mpc$, of *Hubble's constant*.

Hence *Planck's constant* h is *proportional to the square of Hubble's constant* H_0 .

An alternative way to display the cited result is to use the standard definition of the *Fine Structure Constant* α , in terms of which the preceding formula becomes

$$\alpha = \sqrt{3\pi/2} \cdot R_0^{1/2} / [c \cdot \bar{n} \cdot \iota]$$

where c denotes the speed of light.

It is immediate that there are at least **4 independent astrophysical tests** of either of the two preceding formulae, all of which are *confirmatory* in terms of the most recently published data. Simply take logarithms of both sides of each formula and regard e and c as constants (at least to first order); then upon differentiating one finds that at any epoch at which \bar{n} may be regarded as constant

$$dh / h = -(1/2) \cdot dR_0 / R_0 ,$$

where the physical necessity of regarding R_0 as a variable parameter will be explained shortly, while if R_0 is taken to be constant but the mean number-density \bar{n} is allowed to vary as the epoch in cosmological time varies, then

$$d\alpha/\alpha = -d\bar{n}/\bar{n} .$$

FIRST TEST. It is easy to verify that identifying h with *Planck's constant* yields

$$\Omega \cdot (H_0/70)^2 = 0.0693, \quad (1)$$

in relatively excellent agreement with the latest observational data. Indeed, in order to test the validity of the previous expression for h , we require an estimate of the mean particle-density of the universe. Furthermore, according to Peebles [2], the mean number-density \bar{n} is related to Hubble's constant as follows. Assume that the universe is composed entirely of protons and neglect the mass of the electrons in comparison to the nearly 2,000 times greater mass of the protons. Then

$$\begin{aligned} \bar{n} &= \rho_0/M_p = (9.23 \times 10^{-27} \cdot \Omega \cdot (H_0/70)^2 \text{ kg/m}^3) / (1.67 \times 10^{-27} \text{ kg}) = \\ &= 5.53 \cdot \Omega \cdot (H_0/70)^2 \text{ per } m^3 , \end{aligned} \quad (2)$$

where H_0 denotes the present epoch's value of the *Hubble constant*, measured in *km/sec* per *Mpc*. Inserting (2) into my 1995 formula and solving for the least well-known factor gives, after use of the well-known values $h = 6.625 \times 10^{-34} \text{ J-sec}$; $e = 1.6021 \times 10^{-19} \text{ C}$; $\epsilon = 8.854 \times 10^{-12} \text{ F/m}$; $R_0 = 1.485985 \times 10^{11} \text{ m}$, the claimed result (1). According to recent news reports [*Washington Post*, 5/26/99; *The Economist*, 5/29/99], $H_0 \cong 70$ and so the factor $(H_0/70)^2 \cong 1.0$ is of order unity. In a discussion of the product on the left side of (1), Peebles quotes the *cosmic background radiation* (CBR) results as supporting a value of 0.013 ± 0.005 , which means that since the second factor is not certainly well-known, the density ratio Ω could be within an order of magnitude of the range [0.01, 0.02] according to the CBR. Peebles also discusses *five dynamical approaches* to estimation of Ω , arriving at the range [0.004, 0.200] for the 4 shorter-scale methods and [0.01, 1.0] for the more controversial longer-scale method. In conclusion Peebles [2] states that "it seems prudent to bear in mind ... that what is securely detected on smaller scales, $\Omega \sim 0.1$, is all there is." If one rounds off (1) to a single decimal place, namely $\Omega \cdot (H_0/70)^2 = 0.1$, and keeps in mind that $(H_0/70)^2 \sim 1$, then in the light of the most "**securely detected**" results, the new formula for h has predicted that $\Omega \sim 0.1$, *i.e.* empirical **confirmation** of its validity is presently as **good as could be hoped for!**

SECOND TEST. What is the physical meaning of the appearance of R_0 in the formula for h ? In [1] it was shown that in order to derive Schrödinger's Equation via the Fényes (1952) & Nelson (1967, 1985) *Stochastic Mechanics* (SM) as a neo-classical alternative ([3]-[4],[8]-[13]) to the Copenhagen interpretation of Quantum Mechanics (QM), one must integrate over the spherical annulus centered upon a terrestrial laboratory and having an inner radius R_0 and outer radius $R \gg R_0$, after which R is allowed to increase without limit and the integral is proved to converge. The reason for choosing the

inner radius $R_0 = 1$ AU is that the Sun is the largest mass of fully ionized matter closest to the Earth and so relevant to the theory used in [1]. However, the preliminary result cited above is actually a slight over-simplification. From celestial mechanics the distance from the Earth to the Sun varies sinusoidally throughout a calendar year and as the epoch approaches the vernal and autumnal equinoxes then the durations of night and day become equal so that the Earth is exactly midway between its extremes in terms of the physically effective R_0 that is appropriate for the cited integration. Since now we have $dR_0 / R_0 \sim 2 \times 10^{-6}$, the formula for h requires that $|dh| / h \sim 10^{-6}$, i.e. that Planck's "constant" must have a slight annual *sinusoidal* variation related to the *equinoxes*. Is this measured to be the case? The standard method for the most accurate determination of h in the laboratory is to use a *Josephson Junction Analyzer* (JJA) to calibrate *Josephson's constant* $2e/h$ in terms of voltage metrology compared with use of a Zener diode. It is well known in all voltage metrology labs throughout the world that this procedure seems to produce an annual variation that has usually been dismissed as a terrestrial weather effect; however, Russell Fleming of the Army metrology lab at Redstone Arsenal in Huntsville, AL has since 1997 been making public slideshow presentations [5] pointing out that in his lab some *three years* of recorded values of h showed an annual *sinusoidal* variation of about *one ppm* which consistently has its *maxima* and *minima* EXACTLY at the *vernal* and *autumnal equinoxes*.

THIRD TEST. As the universe expands in cosmological time, the mean number-density \bar{n} decreases so that according to the present theory [1] the fine structure constant α must increase. According to [6], four independent samples of absorption systems in the spectra of *distant quasars*, spanning 23% to 78% of the age of the visible universe, have provided a *4 sigma* confidence-level in the claim that as cosmic time increased

$$d\alpha/\alpha = (0.72 \pm 0.18) \times 10^{-5} ,$$

whence the question of whether or not the present theory passes this test devolves upon whether or not the reader believes that a reasonable average of $d\bar{n}/\bar{n}$ over the redshift range $0.5 < z < 3.5$ is consistent with the presently required deduction that as cosmic time increased

$$d\bar{n}/\bar{n} \approx -10^{-5} .$$

This is a complicated question (how to average the decrease properly over the optical data sets used), and the present author will defer to the authors of [6] as to whether or not his theory passes this test with lesser or greater plausibility; suffice it to say, that the present theory [1] clearly *does not fail* this test!

FOURTH TEST. This is simply a conceptually independent variant of the preceding test, based upon observations of the spectral characteristics of distant Type Ia *supernovae* rather than quasars. In recent years two independent teams have used the Hubble Space Telescope (HST) to [7] "analyze a few tens of supernovae, at a range of distances spanning a corresponding time interval of about one-half the age of the universe. The results of these analyses came as a shock to the two teams ... Distant objects appeared to recede slower than expected from the normal Hubble expansion law. ... When I first saw

these results I must admit that I did not believe them. Since then, however, both teams have done a truly marvelous job in eliminating other possible interpretations.” Unfortunately however the present theory [1] was not considered as a candidate explanation for the anomalous observations, and now it is widely accepted that some mysterious “dark energy” must be present to account for a hitherto unsuspected “acceleration” in the expansion of the universe! But true scientists shave daily with Occam’s Razor according to which “entities are not to be multiplied unnecessarily.” On the basis that the present theory has not been falsified by the preceding three tests, one may assume that standard Hubble cosmology [2] remains [tentatively!] correct and that the anomalous supernovae spectra have precisely the same explanation as that provided by the immediately preceding test regarding evolution in cosmological time of the fine structure constant α .

CONCLUSION. The present theory is offered as a *complement* to the important and valid theory of de la Peña & Cetto [8a,b], which though conceptually profound is inherently incapable of appraising h more accurately than within a few orders of magnitude because of uncertainties in the truly enormous numbers used in “coincidences” of the type first noted by Dirac (although it should be noted that Dirac’s ‘coincidences’ are actually a proved theorem in the neo-classical TOE of Puthoff *et al* [9]-[11]!). While philosophers of science have pointed out defects in Sir Karl Popper’s dictum that a proposition is not “scientific” unless in principle it is capable of being falsified if false there is considerable merit in this criterion. It has been demonstrated above that the present formula [1] for Planck’s constant h as proportional to the mean number-density \bar{n} of charged particles in the visible universe at each epoch of cosmological time is clearly *capable* of being falsified if false. Moreover at this time the evidence is quite clear that the formula has NOT been falsified and therefore it must be accepted as a viable contender for the best explanation of why QM is not truly weird until someone can demonstrate that any one of the preceding four tests was not truly passed.

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