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Further Remarks on a Theory of Extended Quantization

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Abstract

The quantity of mass-energy in the universe is expressed in terms of some of its basic parameters. The methods of derivation involve the minimum possible unit of energy and the minimum possible non-zero force, introduced in a previous paper (in this journal) by the author (Crocker, 1970).

At the end of the author's paper (Crocker, 1970), it was mentioned that it should eventually be possible to express the total mass of the universe in terms of $\hbar$, τ, and U. The following is an attempt to solve this problem.

It will be assumed that the reader is familiar with the contents of Crocker (1970). G denotes the Newtonian constant of gravitation. The quantities U, τ, $\hbar$, and c are defined as in Crocker (1970). The Newtonian laws for gravitational potential *and* force (between two bodies whose dimensions are negligible compared to the distance between them) are used; geodesic distances are used in these formulae.

To remove any possible misunderstanding, in Section 3 of Crocker (1970), **F** and **p** are assumed to be constantly along the same geodesic; hence the simplified formulas given there for scalar F. (The author has also noticed that on line 1, page 285 of Crocker (1970), the words 'measurement on' should be replaced by 'calculation for', in order to remove any possible misinterpretation. Also, it should be clear on p. 285 that $(\Delta t)_{\max}$ is used to denote the largest Δt possible in the optimal case of the uncertainty principle (the case used on p. 285 and stated at the bottom of p. 284). Similarly for $(\Delta X)_{\max}$.) Potential is hereinafter taken to mean the absolute magnitude of the potential energy; similarly for force.

If the universe is closed, its entire mass, call it M, must be sufficient to exert a non-zero gravitational potential and force on even the smallest possible test mass $m_t = \hbar/c^2$; this must indeed be the case for any mathematically or geometrically possible distribution of the mass M. Consider, for instance, the entire mass M to be concentrated into a single ball whose dimensions are negligible compared with the maximum possible distance between M and m_t; M may then be regarded as a point. Then, *geometrico more*, the maximum possible distance between M and m_t (measured on a spacelike geodesic, along the hypersurface of a hypersphere, along which the gravitational force is presumed to act) is $U/2$, half the maximum attainable circumference of the universe.

Now one has for the two masses at this distance (ignoring the sign)

$$V_{\text{grav}} = G\frac{Mm_t}{U/2}$$

This is the smallest possible potential that can be created by this M for m_t (since each element of M is at the maximum possible distance from m_t), and hence for any mass. But

$$V_{\text{grav}} \geqslant V_{\text{min}}$$

where V_{min} is the ultimate, minimum non-zero potential. Now $V_{\text{min}} = \hbar$ as is easily surmised from Crocker (1970), since $\hbar$ is the smallest possible unit or quantity of energy. Thus $V_{\text{grav}} \geqslant \hbar$, so that (remembering $m_t = \hbar/c^2$), one has

$$M \geqslant \frac{1}{2}\frac{Uc^2}{G}$$

But it seems likely U is large enough to make $V_{\text{grav}} = V_{\text{min}}$ for then (and also because there may be an *extremum* principle operating)

$$M = \frac{1}{2}\frac{Uc^2}{G} \tag{1}$$

and with $U = 1{\cdot}5 \times 10^{27}$ m, a commonly accepted value, one finds $M = 1{\cdot}01 \times 10^{54}$ kg, a value in close agreement with present estimates from other sources.†

There is yet another way of deriving an expression for M in terms of U, c, G, and τ, using the gravitational force between M and m_t at the above maximum possible distance $U/2$ (with any motion entirely along a geodesic joining the masses). Then

$$F_{\text{grav}} = G\frac{Mm_t}{(U/2)^2}$$

this is the smallest possible force that M can exert on any mass. But

$$F_{\text{grav}} \geqslant F_{\text{min}}$$

† Although $\hbar$ cancels out, this derivation is conceptually (if not numerically) dependent on $\hbar$. (Moreover, M can be expressed in terms of $\hbar$, using (1) above in combination with the formula in Crocker (1970) relating $\hbar$ and U.) This microcosmic approach leads to results similar to those obtained from conventional cosmological considerations, a fact which may indicate the correctness of this approach and its basic assumptions.

where F_{min} is the minimum possible force discussed in Section 3 of Crocker (1970), where it was shown that $F_{min} = \hbar/c\tau$. Thus $F_{grav} \geqslant \hbar/c\tau$ so that

$$M \geqslant \frac{1}{4}\frac{U^2 c}{G\tau}$$

By the same reasoning as before, equality may well be expected to hold so that

$$M = \frac{1}{4}\frac{U^2 c}{G\tau} \tag{2}$$

Now the expressions obtained in (1) and (2) should be equivalent; they are so if and only if

$$U = 2c\tau$$

But this is precisely the expression obtained for an expanding and contracting universe with cosmological constant 0. This in itself constitutes evidence for the validity of the above derivations.

Reference

Crocker, R. (1970). *International Journal of Theoretical Physics*, Vol. 3, No. 4, p. 283.