On the other hand we have from equations (4) and (5):

$$\frac{u_1 + u_2}{1 + \frac{u_1 u_2}{c^2}} = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}} = v_0 \qquad (6)$$

but such an addition of velocities u_i ($i = 1,2$) would be nonsensical from the physical point of view—unlike the equations 5*a* and *b*.

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[2] Mohorovičić, S., *Phys. Z.*, **14**, 988 (1913).
[3] Broglie, Louis de, *Einfuhrung in die Wellenmechanik*, 34 (Leipzig, 1929). Mohorovičić, S., in *Kritik Fortbildung Relativitatstheorie*, **1**, 207, 238 (Graz, 1958).

Does Matter have a Half-Life?

IN a recent book Prof. R. O. Kapp[1] has suggested that atoms of matter disappear spontaneously in a statistically random manner with a half-life of about 4×10^8 years and that it is this extinction of matter which causes gravitational attraction. It is the purpose of this communication to point out that there is no reason why the confirmation or disproof of this suggestion should not be established by means of existing techniques.

The gravitational constant G is usually reported[2] as $(6{\cdot}670 \pm 0{\cdot}005) \times 10^{-8}$ dyne. cm.^{2}gm.$^{-2}$ and it is not unreasonable to assume that the sensitivity of the apparatus used for the determination of G can be made somewhat better than the stated error of 5 parts in 6,000 and may well be 0·04 per cent or even less. It is difficult to estimate the speed with which such an apparatus would respond to a change of this magnitude, but it is not unlikely that a change of half-sec. duration or possibly even less would be detectable.

Assuming that G is determined by a Cavendish–Boys type of apparatus and that the weight of the attracting lead spheres is about 1,000 gm., the number of lead atoms involved would be $(1{,}000 \times 6{\cdot}023 \times 10^{23})/207{\cdot}2$ or about 3×10^{24}. Now, if the half-life of matter is taken as 4×10^8 years, the number of lead atoms which would cease to exist in every half-sec. interval must be about $(3 \times 10^{24} \times 0{\cdot}693)/(4 \times 10^8 \times 6 \times 10^7)$ or 1×10^8.

Assuming a normal Gaussian distribution it follows that there is 1 chance in every $1{\cdot}6 \times 10^4$ that the actual number of atoms which disappear in any given half-sec. interval will differ from this value by a detectable 0·04 per cent (which is 4 times the standard deviation)[3].

In other words, provided the deflexion of the beam is monitored continuously for a month at a time, the apparatus should spontaneously record a value of G which is either high or low for about 300 of the half-sec. intervals during such a one month period (which involves 5×10^6 half-sec. intervals). A control experiment would, of course, have to be carried out with an otherwise identical beam in the absence of lead weights.

The feasibility of monitoring the apparatus for a month on end may seem somewhat far-fetched, but R. H. Dicke *et al.* have successfully monitored their apparatus in a repeat of the Eötvös experiment for a period of several months[4].

Moreover, only a slight increase in the assumed sensitivity or the speed of response of the apparatus would produce a marked increase in the frequency of detectable deviations of G from the average value. It is even conceivable that the half-life of matter may be somewhat greater than the value suggested by Kapp and that the uncertainty in the currently accepted value of G may be partly due to statistical variations in the rate of disappearance of matter and not wholly the result of extraneous causes.

Provided an apparatus with sufficient sensitivity and speed of response can be constructed, it should thus be possible, by an analysis of the frequency and magnitude of such apparent variations in G, not only to verify that matter does have a half-life (if it in fact does disappear spontaneously) but to estimate the magnitude of such a half-life as well. The importance of a positive result for such an experiment on our understanding of gravitational attraction can scarcely be over-emphasized.

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[2] Birge, Raymond T., *Rev. Mod. Phys.*, **13**, 233 (1941).
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DR. SWART makes an interesting suggestion which is theoretically sound. He shows himself aware of the three main practical difficulties, and it may be worth while to emphasize these for the benefit of anyone who might wish to translate the proposal into an experiment.

The first difficulty is that the Cavendish–Boys type of apparatus is at present not quite sensitive enough. One could perhaps hope to increase its sensitivity by the requisite factor of about 3; but this would only add to the second difficulty, which is that of securing a sufficiently quick response. Apparatus of this type measures in effect the time-integral of power; hence the well-known inverse ratio between sensitivity and speed of response. However, the technique of measurement has improved enormously since the year when Boys determined the value of G. It is not unreasonable to hope that Dr. Swart's proposal may soon become feasible, if it is not so already. Perhaps a technique using a differential method would be more promising than that used by Cavendish and Boys.

The third difficulty is the effect of Earth tremors which would shake the apparatus. Adequate isolation from these may not be possible; but Dr. Swart's proposed control experiment with an otherwise identical beam in the absence of lead weights might provide means of distinguishing between the effect of shaking the apparatus (noise) and the effect of fluctuations in the gravitational field.

The suggested test mass, namely, 1,000 gm. serves to illustrate the magnitudes entering into the problem. For an actual experiment, however, the optimum mass would have to be determined. This would, of course, be a function of the constants of the experimental apparatus.

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