Combining equations (7) and (6) gives the expression obtained by combining equations (1) and (3).

The reason for the smallness of the gravitational coupling constant is the enormous amount of matter in the universe. This may not be a very satisfactory answer, and it cannot be completely satisfactory until the problem of mass creation is understood.

The statistical support for Dirac's cosmology is found to be missing. However, the existence of physicists now and the assumption of the validity of Mach's Principle are sufficient to demand that the order-of-magnitude relations between the three numbers, given by equations (1), (2) and (3), be satisfied.

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DICKE discusses the three cosmological numbers: (1) which determines the gravitational constant, (2) which determines the Hubble age of the universe, and (3) the number of particles in the universe. They are related in that: (1) is roughly the reciprocal of (2) and (3) is roughly the square of (2). I assumed that these relations correspond to something fundamental in Nature. With an evolutionary universe (2) varies with time, and then (1) and (3) would also have to vary with time.

Dicke considers that there is a fundamental relation between (1) and (3), following from Mach's Principle, but that (2) is independent, so that (1) and (3) may be constant while (2) varies with time. He then shows that (2) would have to have roughly its present value when habitable planets exist. On this assumption habitable planets could exist only for a limited period of time. With my assumption they could exist indefinitely in the future and life need never end.

There is no decisive argument for deciding between these assumptions. I prefer the one that allows the possibility of endless life. One may hope that some day the question will be decided by direct observation. One would have to measure (1) to an accuracy of 1 in 10^{10} and then repeat the measurement after a few years and see whether the result has altered.

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SPACE SCIENCE

Direct Measurement of Interplanetary Dust Particles in the Vicinity of Earth

ADDITIONAL knowledge about interplanetary dust particles has been obtained from the direct measurements made with rockets, satellites, and space probes. The results obtained with the microphone type of dust particle sensor carried by the U.S. satellites, *Explorer I* (1958 Alpha) and *Vanguard III* (1959 Eta); the U.S. space probe, *Pioneer I*; and the Soviet vehicles, *Sputnik III* (1958 Delta 2), Space Rockets I and II, and the Interplanetary Station (1959 Theta), have already been reported. In addition, a definitive set of data has recently been obtained with the U.S. satellite, *Explorer VIII* (1960 Xi). A series of corrections has been completed which allows our results from a series of seven successful high-altitude rockets instrumented at Oklahoma State University to be used in quantitative discussions of interplanetary dust particles. We would like to present the preliminary results (including a new and very interesting curve for the mass distribution and spatial density) from an analysis of the available direct measurements of interplanetary dust particles.

The best calibrations of the microphone system that are at present possible are performed with particles ranging from large glass beads elastically impacting at low speeds to small iron spheres inelastically impacting at speeds up to approximately 10 km. sec.$^{-1}$. Such calibrations indicate that the microphone system is sensitive to a quantity that is closely related to the momentum of an impacting dust particle. An average velocity, relative to a satellite, of 30 km. sec.$^{-1}$ has been assigned to the dust particles in order that the results may be used in a determination of the mass distribution of the interplanetary dust particles.

The three datum points obtained with *Explorer VIII* are plotted (together with those from *Vanguard III*, *Explorer I* and the series of rockets) as the distribution curve shown in Fig. 1. The equation of a straight line that approximately fits the datum points is:

$$\log I = -17{\cdot}0 - 1{\cdot}70 \log m$$

where I is the influx-rate of dust particles and m is the particle mass holding approximately for m in the range 10^{-10} gm. $\lesssim m \lesssim 10^{-6}$ gm. The data from *Vanguard III*, *Explorer I* and the rockets fit remarkably well on the curve defined by the data from *Explorer VIII*. In fact, all other available direct measurements also can be made to look fairly reasonable when plotted as in Fig. 1 if proper allowances are made for the type of experiment, the confidence that can be placed in any particular measurement, the shielding effect of Earth, and the actual fluctuations in the spatial density that have been observed with *Explorer I*, *Vanguard III*, and *Explorer VIII*.

The curves obtained from an extrapolation of the tabulation by Watson[1] and from the extrapolated tabulation by Whipple[2] of results from meteor observations are shown as reference curves in Fig. 1. Both the extrapolated curves follow the constant mass per unit visual magnitude relationship common to discussions of results from meteor observations and roughly serve as the limits of uncertainty encountered in placing such results on a mass distribution curve. This uncertainty arises because of the uncertainty in relating particle mass to photographic, visual, or radar magnitude, and the uncertainty in assigning a mass density of meteoroidal particles.

Either of the extrapolated curves can be forced to pass through any one of the given direct measurements datum points by adjusting the mass to magnitude relationships and the mass density for meteoroidal particles. The three datum points obtained with *Explorer VIII* define a slope for a limited portion of the distribution curve in addition to defining the influx-rates for dust particles in three different ranges of particle mass, showing that the curve determined by direct measurements departs significantly from the extrapolated curves.

Caution must be exercised in extrapolating the new distribution curve out of the range of particle mass for which direct measurements have actually been