LETTERS TO THE EDITORS

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IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 554. CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

The Mass of the Universe

I FIND certain difficulties in connexion with the mass of the universe considered as a finite sphere of radius $4 \cdot 9 \times 10^{23}$ miles and of volume $5 \cdot 2 \times 10^{71}$ cubic miles. Eddington gives the mass of the universe as 10^{22} stars averaging our sun in weight. Taking $2 \cdot 0 \times 10^{27}$ tons as the sun's weight, then the mass of the universe would be $2 \cdot 0 \times 10^{49}$ tons. There are, says Eddington, $1 \cdot 575 \times 10^{79}$ electrons and an equal number of protons in the universe. Assuming the mass of these units to be respectively $9 \cdot 038 \times 10^{-28}$ gm. and $1 \cdot 65 \times 10^{-24}$ gm., then the weight of the electrons must be $1 \cdot 4235 \times 10^{52}$ gm. and that of the protons $2 \cdot 598 \times 10^{55}$ gm.; their combined masses would amount to $2 \cdot 599 \times 10^{55}$ gm. or $2 \cdot 55 \times 10^{49}$ tons, which is a fairly close approximation to the weight of the universe calculated on the basis of stars.

But is not this mass, of the order of $2 \cdot 0 \times 10^{49}$ tons, too low? It would appear to leave out of account the mass of the radiations (photons) that are being poured out by luminous stars into practically every nook and corner of the $5 \cdot 2 \times 10^{71}$ cubic miles of space. Our own sun, we are told, is losing $4 \cdot 0 \times 10^{6}$ tons of matter every second while emitting in the same period of time an equivalent of energy, $3 \cdot 8 \times 10^{33}$ ergs. As the sun is an average representative of the stellar bodies, it follows that the totality of 10^{22} stars comprising the universe is losing $4 \cdot 0 \times 10^{28}$ tons of matter per second, and is emitting in the same time $3 \cdot 8 \times 10^{55}$ ergs.

Hubble, taking a shorter radius ($8 \cdot 23 \times 10^{23}$ miles) and a smaller volume ($1 \cdot 92 \times 10^{63}$ cubic miles) of the universe, gives his estimate of its mean density as $1 \cdot 5 \times 10^{-31}$ gm. of matter per cubic centimetre, that is, about a gram to every $6 \cdot 6 \times 10^{30}$ cm.^{3}, or in more homely weights and measures, about a pound mass in every $7 \cdot 2 \times 10^{17}$ cubic miles. Apart from the energy-equivalent of the matter in space (say $4 \cdot 08 \times 10^{23}$ ergs per pound), what is the mean quantity of the energy of radiations (photons) per unit volume—a cubic centimetre or a cubic mile—of space? Would not the mass of this, added to that of matter, afford a more trustworthy basis for calculating the total mass of the cosmos than a basis which takes into consideration matter alone?

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UNDOUBTEDLY, the mass of the radiation should be added to the mass of the stars and of the nebulous matter in computing the total mass of the universe. But the general belief is that its contribution is comparatively small—less than 1 per cent of the whole. This is not inconsistent with the figures cited by Admiral Beadnell. With radiation at the rate of 4×10^{28} tons per second, it would take 5×10^{18} seconds, or more than 10^{11} years, to accumulate to 1 per cent of the total mass 2×10^{49} tons. According to cosmological theory, the age of the stars can scarcely exceed 10^{10} years.

Perhaps Admiral Beadnell was thinking in terms of a former time-scale, based on the hypothesis of mutual annihilation of protons and electrons, which allowed an age of 10^{13} years or more. Owing to the discovery of the positron, neutron, etc., this hypothesis (always very dubious) has, I think, no adherents to-day. According to present theories, the source of a star's radiant energy is the transmutation of hydrogen into other elements. This means that less than 1 per cent of the mass of the universe has been, or ever can be converted into radiation. It may be noted that when the mass of the universe is computed from the total number of protons and electrons, no correction for the mass of the radiation is required, since it merely compensates the mass-defect of the nuclei formed by the transmutation.

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Turnover Rate of Nucleic Acid

CASPERSSON's work[1] on the nucleic acid metabolism suggests that an appreciable turnover of the nucleic acid present in the nuclei of tissue cells may take place. This fact induced us to determine the rate of turnover of nucleic acid extracted from various organs of rabbits by making use of the method of isotopic indicators applied previously to determine the turnover rate of various other phosphorus compounds.

The labelled sodium phosphate used as indicator was administered all through the experiment in order to keep the activity of the plasma inorganic phosphorus at a constant level. After the lapse of a few hours or days, the nucleic acid was extracted from some of the organs. A slightly modified form of Hammarsten's method[2] was used. The turnover figures, recorded in Tables 1 and 2, were obtained by comparing the specific activity (activity per mgm. phosphorus) of the nucleic acid phosphorus extracted at the end of the experiment with the average specific activity of the cellular inorganic phosphorus which prevailed during the experiment. The value of the activity of the cellular inorganic phosphorus is obtained from that of the tissue inorganic phosphorus after subtracting the share due to the extracellular space of the tissue. The specific activity of the inorganic phosphorus present in the interspaces is

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