the material density is about a hundred times greater than the smoothed-out average density of the nebulæ themselves. He goes on to dismiss this requirement on the grounds that it finds no favour with observational astronomers. Now I stated explicitly that on my theory the inter-nebular medium consists effectively of hydrogen, which has negligible scattering effect on the light received from even the most distant nebulæ observed. Moreover, a uniform inter-nebular medium has no effect on the peculiar motions of the nebulæ. Thus there is no way in which such a medium can be directly observed, and, accordingly, one is left wondering under what canon of logic Prof. Jordan refers the issue to observational astronomy for a decision.

I also find it difficult to understand why Prof. Born raised the question of the conservation of energy, for one of the most striking results of my work, and also of the work of Bondi and Gold, is that the large-scale features of the universe are independent of time. The conservation of energy is a trivial consequence of this result.

It remains to consider objections to the suggestions made by Prof. Jordan and Prof. Kapp. If the matter of the universe originates in large explosive lumps, identified by Prof. Jordan as supernovæ, it is difficult to understand why the diffused matter is observed to be concentrated in nebulæ instead of being more or less uniformly distributed, and also why the supernovæ are apparently confined to the nebulæ instead of being uniformly distributed throughout space. There is also the serious difficulty that the observed rate of supply of material by the novæ and supernovæ is far too small to be cosmologically significant, amounting as it does to only about one-thousandth of the masses of the nebulæ in a time equal to one Hubble unit ($1 \cdot 8 \times 10^9$ years). Also the material emitted from supernovæ almost certainly has a very different chemical composition from the material comprising the nebulæ (which are largely composed of hydrogen). The temperatures and densities in supernovæ are so high that nuclear reactions take place very rapidly, and it is to be expected that their effect is to leave the material far poorer in hydrogen content than normal interstellar material.

Turning now to Prof. Kapp's interesting suggestion, if the disappearance of matter in dense condensations were at all comparable with the required rate of appearance of matter in inter-nebular space (this rate being fixed so as to get the observed rate of expansion of the universe), then, as can be shown, every dense body, such as a planet or a star, must lose half its mass in less than 10^9 years. A rapid decrease of mass of this order can scarcely be reconciled with astronomical and geophysical data.

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A High-Efficiency Neutron Detector

The recent development of scintillation counters as high-efficiency detectors of gamma-radiation makes attractive the possibility of detecting neutrons by means of the γ-rays produced in many neutron-induced reactions. Particularly interesting is the detection of the 480-keV. γ-ray given off by the excited lithium-7 in the reaction:

$$B^{10} + n \rightarrow Li^{7*} + He^{4}$$
$$Li^{7*} \rightarrow Li^{7} + \gamma \text{ (480 keV.).}$$

Ninety-three per cent[1] of the intermediate boron-11 nuclei decay via this excited state of lithium-7. We have detected the γ-rays from this reaction and also from the (n,γ) reactions in cadmium, indium and samarium.

The Harwell crystal spectrometer was used for providing a source of mono-energetic neutrons with a comparatively low proportion of accompanying γ-rays. The sample was placed in the beam of neutrons diffracted from a calcium fluoride crystal. The scintillations produced by the resultant γ-rays in an anthracene crystal were detected by an R.C.A. 931A. photo-multiplier tube. The counter was protected from the intense background of neutrons and γ-rays from the pile by successive shields of lead, cadmium and paraffin wax.

The efficiency of the counter remained constant with all samples, except the indium, for neutrons with energies lying between 0·04 and 0·2 eV. The indium sample was the only one which was not 'black' over this range. The detection efficiency for boron was approximately 1 per cent, and for the other samples about 4 per cent. The comparatively low efficiency of boron is largely due to the fact that only one γ-ray is produced for every neutron captured, while several γ-rays are given off in the (n,γ) reactions in cadmium, indium and samarium. However, in the energy region above a few hundred electron volts, where this detector is likely to be of most value, the boron cross-section is well known.

The scintillation detector described above should provide a counter which is more efficient than a boron trifluoride counter for neutrons with energies lying between 100 and 100,000 eV. A practicable thickness of boron-10 (2–2½ cm.) is effectively 'black' to neutrons of up to 10,000 eV., so that the efficiency should remain constant up to this energy. It will best be employed with sources relatively free from γ-rays, such as the pulsed time-of-flight spectrometer suggested by Cockcroft[2]. Work on these applications is proceeding.

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[1] Bøggild, J. K., *Kgl. Danske Vid. Sels., Math.-Fys. Medd.*, **23**, 4, 26 (1945).

[2] *Nature*, **163**, 869 (1949).

Photo-electric Disintegration of the Deuteron at 6·13 and 17·6 MeV.

We have measured the cross-section of the deuteron for disintegration by γ-rays of effective energy 6·13 and 17·6 MeV. The results are:

$$\sigma_{6 \cdot 13} = (21 \cdot 5 \pm 1 \cdot 2) \times 10^{-28} \text{ cm.}^2$$
$$\sigma_{17 \cdot 6} = (\ 8 \cdot 5 \pm 1 \cdot 2) \times 10^{-28} \text{ cm.}^2$$

(both these uncertainties are probable errors). The γ-rays were obtained, in the first case, by bombarding thick targets of calcium fluoride with protons of energy 890 keV., and, in the second, by bombarding thick targets of lithium hydroxide with protons of energy 500 keV. The disintegrations were produced in an ionization chamber of volume 475 c.c. containing deuterium at a pressure of 38 atmospheres; the