supported by its accord with the pendulum anomalies. The conclusions drawn are as follows : [5]

(*a*) That in peninsular India in general, isostatic compensation definitely does not prevail. An area of 100,000 sq. miles in the Gangetic Plain shows an anomaly ranging from 1000 to 6700 feet equivalent surface rock; while north of Nagpur is an area of 50,000 sq. miles with anomaly ranging from − 1000 to − 3700 feet of rock.

(*b*) That in Himalayan regions there is some measure of compensation; but the total area in which adequate observations have been made is small.

It is entirely wrong then to quote India as a region supporting the hypothesis of Hayford isostasy. Isostasy *may* prevail in the Himalaya, as Pratt suggested; but it does not prevail over the remaining portion of India.

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[1] "Isostasy and the Figure of the Earth", *American Journal of Science*, vol. 21, No. 121, January 1931.
[2] Survey of India, *Professional Paper*, No. 5.
[3] Survey of India, *Professional Paper*, No. 17.
[4] Survey of India, *Professional Paper*, No. 13.
[5] Details of all the work are given in *Geodetic Reports*, vol. 1, 1-5.

Origin of Cosmic Radiation.

THE frequency ν of radiation can be deduced from its absorption μ by means of the well-known formula of Klein and Nishina,[1] which can be put in the form

$$\mu = \frac{2\pi Ne^4}{m^2c^4} f\left(\frac{h\nu}{mc^2}\right).$$

This gives frequencies which agree well with experiment up to the frequencies of the hardest γ-rays; beyond this it is impossible to test it.

The formula supposes absorption to result entirely from scattering by free electrons (N per cubic cm.). In dealing with γ-radiation, all extra-nuclear electrons are treated as free, since (in the language of classical theory) their period of oscillation is long compared with the period of the incident radiation. The nuclear electrons and protons have 'periods of oscillation' comparable with those of γ-radiation, and so must not be treated as free, except when the incident radiation is of far shorter period than γ-radiation. Cosmic radiation comes within this latter category, whence it appears probable that in deducing the wave-length of cosmic radiation by the Klein-Nishina formula, N ought to refer to all electrons, nuclear as well as extra-nuclear, and not merely to the latter. A second term ought also to be added to represent scattering by protons, but calculation shows that this is entirely insignificant. The effect of taking the nuclear electrons into account is to double, or more than double, the absorbing power of all atoms except hydrogen. It increases the absorbing power of water for cosmic radiation to eighty per cent above the value usually calculated.

The following table shows the absorption (per metre of water) calculated for the radiation produced by the synthesis of iron, and by the annihilation of 1, 2, and 4 protons and their accompanying electrons:

Process.	$\frac{h\nu}{mc^2}$.	Calculated μ.		Observed μ (Regener).
		Extra-nuclear electrons.	All electrons.	
26 H → Fe	876	0·076	0·136	..
+ − → O	1845	0·039	0·071	0·073
+ + − − → O	3690	0·021	0·038	..
+ + + + / − − − − → O	7380	0·011	0·020	0·020

The last column gives the true absorption of the two most penetrating constituents of cosmic radiation, as analysed by Regener.[2] The agreement with the figures in the preceding column is probably well within errors of observation. Although the problem is beset by every kind of uncertainty, this agreement at least suggests that the most penetrating constituent so far observed in cosmic radiation may originate in the annihilation of an α-particle and its two neutralising electrons (the components of a helium atom), while the next softer constituent may originate in the annihilation of a proton and its one neutralising electron (the components of a hydrogen atom). Such an interpretation leaves no room for radiation originating in the simultaneous annihilation of two protons and two electrons, which would result in a unit decrease in atomic number. Although this may seem surprising at first, it accords well with the marked differentiation between elements of odd and even atomic numbers, with the fact that radioactive atoms eject α-particles but never protons, with the fact that no atom of atomic weight 2 is known, and also, I think, with the general spirit of nuclear physics.

These two constituents appear to be far too hard to be produced by the synthesis of iron, while the synthesis of heavier elements would seem to be ruled out by their rarity in the universe. If the annihilation of matter is the true origin of the two hardest constituents of the cosmic radiation, it would seem likely that these and these alone form the fundamental radiation, and that all other constituents represent mere softened or degraded forms of these. No calculation I have ever been able to make seems at all friendly to Millikan's suggestion [3] that the hardest radiation of all has its origin in the synthesis of iron.

J. H. JEANS.
Dorking, April 9.

[1] NATURE, **122**, p. 398, Sept. 15, 1928.
[2] NATURE, **127**, p. 233, Feb. 14, 1931.
[3] *Physical Review*, Feb. 1931, p. 250.

Chemistry of Vitamin B_2.

A CHEMICAL study of vitamin B_2 in a cold aqueous extract of commercial liver extract (Eli Lilly, No. 343) has been made. This solution is very rich in vitamin B_2, being effective in producing good growth in young rats on a B_2 deficient diet, in a daily dose representing 40-60 mgm. of the original liver extract.

Picric acid and benzoyl chloride do not precipitate the vitamin, nor is it precipitated or destroyed by nitrous acid. It is not precipitated by flavianic acid. Neutral lead acetate partially precipitates the active material both at pH 4·6 and 7, while litharge does not precipitate it at all. Silver nitrate precipitates the bulk of the vitamin. Baryta does not precipitate it either in an aqueous solution or in a medium of 50 per cent alcohol. 'Norite' charcoal adsorbs the factor at the natural pH of the aqueous liver extract (pH 4·6), which, however, could not be eluted by acid, alkaline or neutral water-alcohol mixtures, or by a dilute solution of saponin. Three extractions with 30 per cent propyl alcohol appeared to extract it partially with a considerable loss of activity. Treatment with phosphotungstic acid gives an inactive precipitate and a filtrate with a small degree of activity. A combination of the two is equally unsatisfactory. Esterification with ethyl alcohol leaves the bulk of the activity in the non-esterified portion, the ester itself being almost wholly devoid of activity. Trypsin has no effect on the vitamin.

On the basis of the present evidence it appears that, if the vitamin is a single chemical entity, it is probably not a base, an acid, or a peptide, but a neutral