pressure produces no tendency to transverse motion. But the water immediately in contact with the rough bottom and sides of the channel is retarded, and its centrifugal force is insufficient to balance the pressure due to the greater depth at the outside of the bend. It, therefore, flows inwards towards the inner side of the bend, carrying with it detritus which is deposited at the inner bank."

This explanation of Prof. Thomson's, which he completely verified by experiment, has long been known to, and accepted by, river engineers, and it is unfortunate that, through unawareness of it, an incorrect, though admittedly plausible, view of the action of rivers at bends should still be entertained and disseminated.

BRYSSON CUNNINGHAM.

141 Copers Cope Road,
Beckenham, Kent.
Oct. 2.

Gravitational Statics in Three Dimensions

THE commonly accepted case for three-dimensional gravitational statics is far from complete. On the Faraday tube hypothesis, a diagram shows that gravitational tubes of force attract laterally and exhibit a thrust longitudinally. Each pressure is $g^2/8\pi G$ dyne.-cm.$^{-2}$, where g is the field intensity and G Newton's constant. The field has energy $-g^2/8\pi G$ erg.-cm.$^{-3}$, the negative sign holding because if work is done against, that is, *added* to the field, for example, by expanding a sphere, the numerical value of the field's energy-volume integral is *diminished*, positive and negative energy being annihilated in the process, which naturally is reversible.

By the mass-energy relation, which, of course, need not be taken as proceeding from four-dimensional theory, we are forced to ascribe to the field a mass-density, $-g^2/8\pi G c^2$ gm.-cm.$^{-3}$, and we have

$$\operatorname{div} g = -4\pi G\rho + \frac{g^2}{2c^2}, \quad . \quad . \quad . \quad (1)$$

where ρ is the positive mass-density at the point. Corresponding to electricity, the conceptions of negative mass and energy are gravitational only; inertially, they are absurd.

Applying (1) to a sphere of mass M, uniform density ρ, and radius R, the internal field is given by

$$g = k\,c \tanh \frac{kr}{2\,c} \quad . \quad . \quad . \quad (2)$$

where $0 < r < R$ and $k = (8\pi G\rho/3)^{1/2}$. Now, keeping $r < R$ let both tend to infinity. g tends to the constant value g, equal to kc, so that $-\mathbf{g}^2/8\pi G c^2 = -\rho/3$. If these arguments are sound, they dispose of Einstein's objection[1] to an infinite Newton-Faraday universe. Again, if $g = g_0$ when $r = R$, we get

$$4\pi R^2 g_0 = 4\pi G M\sqrt{\frac{2}{\gamma}}\tanh\sqrt{\frac{\gamma}{2}} \quad . \quad . \quad . \quad (3)$$

where $\gamma = GM/c^2R$. That is, the number of unit tubes threading the surface varies even with M constant.

The external field is given by

$$g = \frac{G\Delta}{\left(1 + \frac{1}{2}\frac{G\Delta}{c^2R}\right)r^2 - \frac{1}{2}\frac{G\Delta}{c^2}\,r} \quad . \quad . \quad . \quad . \quad (4)$$

where $R < r < \infty$, and Δ is defined by $g_0 R^2 = G\Delta$, being related to M by (3). If $\gamma \ll 1$ and $r \gg R$, then in (4) we may replace Δ by M and reject the second term in the denominator on the right hand side. Differentiating, we get

$$\frac{\partial g}{\partial M} = \frac{G}{r^2}\left(1 - \frac{5}{6}\gamma\right),$$

which is simply the relativistic claim that a particle apparently loses mass when lowered slowly into a gravitational field.

Finally, since the field is not a true inverse square, it is not in equilibrium, the resultant force being clearly directed towards expansion. To approximate the conditions in our own universe, treated as a huge sphere the constituent particles of which are free to move, if we exclude all sources of energy-supply for this force but the field itself, spontaneous expansion will begin only if the total field energy can become more negative in the process so as to allow the further creation of positive energy. Actually, our universe cannot be infinite for its observed expansion would then be meaningless. This is impossible if $\gamma \ll 1$, but when γ compares with unity, it has a range of values satisfying this condition. Thus the recession of the spiral nebulæ is due, not to real repulsion, but to the field's intrinsic instability, and, *ceteris paribus*, such an expansion, once started, would become oscillatory. These high values of γ for a sphere make the total field energy comparable with the total positive energy, and exact evaluation (which for one of the two necessary integrals does not appear to be simple) would probably reveal that the algebraic sum of the quantities of all forms of energy is zero under these conditions. Applied to our universe, such a result is manifestly philosophically necessary and conclusive.

STANLEY G. EMSLIE.

c/o New Zealand House,
415, The Strand,
London, W.C.2.
Sept. 20.

[1] Einstein, A., "Relativity. The Special and the General Theory", pp. 105–106.

Snow Crystal or Snowflake

IN the introduction to his useful summary in NATURE of August 28, p. 345, of Prof. U. Nakaya's physical investigation on falling snow, Mr. G. Seligman writes: "he [Prof. Nakaya] proposes to continue to call a particle of falling snow a 'snow crystal' in preference to my 'snowflake'. As all snow, whether falling or having lain on the ground for months, is crystalline, the word 'snow crystal' is likely to lead to ambiguity. I admit that 'snowflake' ('simple' for a single crystal; 'compound' for an assemblage) is not perfect, but until a better word is devised it must, I fear, remain."

I regret to have to disagree with Mr. Seligman, who is doing so much to revive the study of snow and glaciology in Great Britain, but I cannot accept his use of the word snowflake to describe the single ice crystals of which snow is composed. In the choice of scientific words great care must be taken not to extend the meaning of words in common use beyond their ordinary significance. Now the compound word 'snowflake' has a very definite meaning in the English language and is applied only to that variety of atmospheric precipitation which occurs in the form of loosely cohering masses of ice crystals. To quote