the onward march of entropy, which simply expresses the tendency towards a state of greater probability independent of the scale of clock-graduation adopted.

Eddington has directed attention[6] to three time-direction sign-posts: (1) our consciousness of the temporal sequence; (2) the expansion of the universe; (3) the increase of entropy. We now see that by suitable choice of clock-graduation the second is abolished and replaced by a statement about the acceleration of 'atomic clocks'. The first is basic and given, and is so used in our analysis. The third is not therefore 'the barb on time's arrow'—time's arrow is already barbed in the statement of the before-and-after relation in the observer's experience; the increase of entropy must therefore be a theorem, or consequence of the existence of the temporal sequence.

It is perhaps scarcely necessary to add that when in the above we use the term "relatively stationary", we are not appealing either to material measuring rods or to the indefinable 'rigid' length-measure. We mean simply that the light-time difference for a to-and-fro signal, measured on the appropriately graduated clock, is a constant.

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[1] Milne, E. A., *Proc. Roy. Soc.*, A, **156**, 69 (1936) and *Quart. J. Math.* (*Oxford*), **8**, 22 (1937).

[2] Whitrow, G. J., *Quart. J. Math.* (*Oxford*), **6**, 249 (1935).

[3] Milne, E. A., *Proc. Roy. Soc.*, A, **158**, 327 (1937). There are certain departures from the Einstein mechanics for speeds v approaching c.

[4] Milne, E. A., *Proc. Roy. Soc.*, A, **165**, 343 (1938).

[5] Whitrow, G. J., *Quart. J. Math.* (*Oxford*), **7**, 271 (1936).

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A New Boundary Condition and the Geodesic Postulate

Einstein and Rosen[1] have admitted that the geodesic postulate is an extraneous one and that the field-equations of gravitation must give both matter and motion independently of such a postulate. It has not been rigorously proved yet that the geodesic postulate is implicit in the field-equations[2]. A new boundary condition is stated here, couched in invariant terms; it is found to be satisfied by the Schwarzschild solution, and the content of the geodesic postulate that a test-particle describes a geodesic is shown to be implied by this condition. No extraneous postulate is necessary to account for the motion if the new boundary condition is accepted.

The inner and outer fields of an isolated spherical mass are given by the line-elements,

$$ds^2 = -\sec^2 x dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) + (A - B\cos x)^2 dt^2, \quad . \quad . \quad . \quad (1)$$

where $R \sin x = r$ and

$$ds^2 = -\left(1 - \frac{2m}{r} - \frac{\lambda r^2}{3}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta d\varphi^2) + \left(1 - \frac{2m}{r} - \frac{\lambda r^2}{3}\right)dt^2 \quad . \quad . \quad . \quad (2)$$

The boundary conditions that are satisfied at the common surface, $r = r_0$, are two, as usually stated: (i) the pressure $p = 0$ and (ii) $g_{\mu\nu} = g'_{\mu\nu}$, the dash indicating the external field. The boundary conditions in the corresponding problem of Newtonian gravitation suggest that there is one more condition satisfied by (1) and (2) at $r = r_0$; and that is found to be that the laws of mechanics, namely,

$$(T^{\nu}_{\mu})_{\nu} = 0, \qquad (3)$$

hold good whether we use the three-index symbols for $g_{\mu\nu}$ or for $g'_{\mu\nu}$ at the common surface. In other words, this boundary condition is $(T^{\nu}_{\mu})_{\nu} = (T^{\nu}_{\mu})'_{\nu} = 0$. In the one-body problem considered above, this merely demands $\Gamma^4_{r4} = \Gamma'^4_{r4}$ $(r = 1, 2, 3, 4)$, which condition is found to be satisfied at the boundary.

For a perfect fluid for which the condition of continuity holds good in the form $[(p+\rho)v^i]_i = 0$, if, at the boundary, the pressure-gradient is supposed to be negligible compared to the density, (3) reduce to the equations of geodesics[4],

$$(v^{\mu})_{\nu}v^{\nu} = 0. \qquad (4)$$

By the new boundary condition, (4) become geodesics not only of the inner but of the outer field also. Thus at the surface a fluid runs in geodesics of the external field. A particular case of this general result for a finite fluid mass is provided by a test-particle which, if treated as of negligible dimensions, traces a geodesic.

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April 2.

[1] Einstein and Rosen, *Phys. Rev.*, (ii), **48**, 1, 73.

[2] Becquerel, "Le Principe de Relativité", pp. 209–214 (1922). The proofs given here are not rigorous. Evidently they are not accepted by Einstein and Rosen.

[3] Tolman, R. C., "Relativity, Thermodynamics and Cosmology" 247 (1934).

[4] Narlikar, V. V., and Singh, Jaipat, *Phil. Mag.*, 629 (April 1937).

Distortion of Mountain Strata, Isostasy, and Glacial Periods

THE connexion of the distorted mountain strata with isostasy has been examined in NATURE of April 2, p. 603. The foundation of the argument was that the strata were originally deposited horizontally at the bottom of the sea. It is, however, necessary to go further back, for they must have been lifted to a great height before isostatic influences could begin to operate. There is here a problem of flow in a medium of extremely viscous type, namely, the outer region of the earth beneath, which can scarcely be avoided. If anywhere the horizontal drift beneath is from both sides towards the same centre the lighter material above it will be pushed up as is required, and in part also pushed down, but the resulting displacement need not at first be isostatically distributed. So also at ocean deeps the underlying drift away from the centre may carry along the more solid upper strata, thinning them out: anyhow a problem presents itself there. Moreover, in all internal motions the drift relative to the surface is necessarily tangential. The analogy of the sideway shrinking up of a flat roll of cloth has been employed.

The process here described would be remote in time. It can scarcely be going on now to any sensible degree, *unless isostatic conditions prevail*; for it would gradually alter the period of the earth's rotation, which is known for astronomical reasons to have been extremely steady for some thousands of years. This consideration also excludes any hypothesis of great accumulation of ice in the Arctic regions; for it would lower the general level of the oceans and a change of level of more than a few centimetres is not permitted. So too the land must have not altered its