Letters to the Editor.

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A Comparison of Whitehead's and Einstein's Formulæ.

IN Whitehead's theory of gravitation, as in Einstein's, the tracks of particles in a gravitational field are determined by the condition that a certain integral taken along the track is stationary. The integrand is denoted by dJ in Whitehead's theory and ds in Einstein's. Light-tracks are further conditioned by dJ or ds, respectively, being zero. Since both theories are known to give the observed results for the perihelion of Mercury and the deflexion of light, dJ cannot be widely different from ds in the field of a single particle (the sun); but I do not think it has hitherto been noticed that dJ is *exactly* equal to ds.

For a particle at rest at the origin the most familiar form of ds is that given by Schwarzschild,

$$ds^2 = -(1-2m/r)^{-1}dr^2 - r^2d\theta^2 - r^2\sin^2\theta d\phi^2 + (1-2m/r)dt_1^2, \quad (1)$$

where Schwarzschild's co-ordinate is denoted by t_1 to distinguish it from Whitehead's "time." If in (1) we introduce a new co-ordinate t, given by

$$t = t_1 - 2m\log(r-m), \quad . \quad . \quad . \quad (2)$$

the expression reduces to

$$ds^2 = (-dr^2 - r^2d\theta^2 - r^2\sin^2\theta d\phi^2 + dt^2) - (2m/r)(dt-dr)^2. \quad . \quad (3)$$

By setting $ds = 0$ in (3) it is found that for the co-ordinates (r, t) the outward velocity of light in a radial direction is unity; the inward velocity depends on r.

Corresponding to the element $(dr, d\theta, d\phi, dt)$ there is a "causally correlated" element of the world-line of the attracting particle—*i.e.* disturbances propagated with unit velocity from the two ends of the latter element reach respectively the two ends of the former. The components of the causally correlated element are easily seen to be $(0, 0, 0, dt-dr)$. Whitehead denotes the *Euclidean* lengths of the two elements by dG_M and dG_m, and the potential (propagated with unit velocity in Euclidean space) due to a simple source m on the latter element by ψ_m. Accordingly (3) can be written

$$ds^2 = dG_M^2 - 2\psi_m dG_m^2,$$

which is precisely Whitehead's expression for dJ^2 ("Principle of Relativity," p. 81, (13)).

Since then $dJ = ds$ the tracks of planets and of light are the same in Whitehead's theory as in Einstein's. Divergences can only arise in problems involving the exact metrical interpretation of the symbols—*e.g.* the shift of spectral lines. In Einstein's theory the time as measured by a clock is ds, and neither dt_1 nor dt have any fundamental metrical equivalent; in Whitehead's theory dt is pre-eminently the "time," but I must leave to adherents of his theory the elucidation of what this implies. It may be remarked that Schwarzschild's t_1 corresponds to a synchronisation of time, at different parts of the solar system, by the condition that the outward velocity of light is equal to the inward velocity; Whitehead's t corresponds to a synchronisation by the condition that the outward (but not the inward) velocity is constant throughout the system. The formulæ for dJ and ds no longer agree perfectly if more than one attracting particle is considered, because Whitehead calculates the resulting field by simple superposition, whereas Einstein's formulæ are non-linear.

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Observatory, Cambridge,
January 20.

The Mass-spectrum of Indium.

SINCE the last report on the results of the mass-spectrograph (NATURE, September 22) the work with that instrument has been very disappointing. Owing partly to the capricious behaviour of the apparatus for producing accelerated anode rays, with consequent difficulties in obtaining intense beams, and partly, no doubt, to the unfavourable properties of the elements remaining to be analysed, the only success worth recording is in the case of the element indium (At. No. 49, At. Wt. 114·8).

The mass rays of indium were obtained from an anode containing the fluoride which had been prepared from a sample of the metal kindly supplied to me by Prof. Richards of Harvard. The mass-spectrum of the element shows one line only at 115. This measured against I^{127} and Cs^{133} shows no deviation from the whole number rule. Its intensity was not sufficient to rule out the possibility of a small percentage of a second isotope, but in the absence of any evidence on this point indium is best regarded as a simple element of mass number 115 as predicted by Russell (NATURE, October 20, p. 588).

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Cavendish Laboratory,
Cambridge, January 23.

The Continuous Spectrum of Hydrogen.

IN the last few months we have been engaged in observations of electron discharges in hydrogen which appear to supplement those described by Prof. Harvey B. Lemon in NATURE of January 26. The region investigated by us is that of lower values of voltage, discharge current and gas pressure, our upper limits being 60 volts, 10 milliamperes, and 0·8 mm. of mercury respectively. Our source of electrons consisted of a filament either of tungsten or of baryta-coated platinum about 2 cm. from a flat circular nickel anode of 2·5 cm. diameter provided with a central rectangular slit, the whole being suitably enclosed in an evacuated transparent quartz tube.

Over the whole of this range except at the lowest pressures there are two well-marked stable types of luminous discharge. The low voltage type sets in at a voltage which increases with increasing pressure and varies between about 20 to 35 volts and is accompanied by a very sharp and extensive increase in the discharge current passing through the tube. The luminosity present in this discharge consists of a bell-shaped blue glow of great intensity with an extremely sharp boundary and is located on the side of the anode towards the cathode. We have not been able to ascertain with certainty that there is any luminosity in any other part of the discharge at this stage. Most of the energy of this radiation consists of the continuous spectrum extending into the extreme ultra-violet as described by Lemon, but the Balmer lines and some secondary spectrum lines are also discernible. We have evidence that as the temperature of the filaments is increased and the gas pressure is reduced, the striking voltage for this discharge tends to a limit which is very close to the ionisation potential of hydrogen (15·9 volts, $H_2 \rightarrow H + H_+ + e$).

The current carried by the discharge described