

The mass of hydrogen accreted by the Earth in time T is then $Q = \pi x_0^2 R_{\oplus}^2 m_H n_1 v_1 T$ and using these new values of x_0 , n_1 and v_1 and the more plausible figure $T = 1.5 \times 10^{17}$ sec. for the age of the Earth, the revised rate of accretion is 1.37×10^{23} gm., which is not very different from the previous value. Oxidation would yield 1.23×10^{24} gm. of water, but this is only a rough estimate. During magnetic storms, the rate of hydrogen capture may be greatly increased, and there are other complicating factors which indicate that the present simple treatment can only be accepted as a first approximation.

In particular, the question of the efficiency of capture and retention of particles from the solar wind is bound to be mathematically very complex, as it involves not only the combination of a radial solar magnetic field and a rotating terrestrial dipole field, but also the interaction of the incoming particles with the local plasma and the dissipation of electron energy by bremsstrahlung radiation. But if we are to judge by the recent findings discussed by Dr. Frith, the observational evidence afforded by high-altitude meteorology does suggest that the capture process is in fact fairly efficient. Thus the proposed account of the origin of the oceans remains eminently defensible, though much further work will be needed before it can be considered as established.

C. M. DE TURVILLE

35 Regent Street,
Clifton,
Bristol, 8.

¹ Parker, *Astrophys. J.*, **132**, 821 (1960).

² van Allen, *Proc. Moscow Cosmic Ray Conf.*, **3**, 7 (1960).

³ Parker, E. N., *Astrophys. J.*, **128**, 677 (1958); **132**, 821 (1960).

PHYSICS

Theory of the Red Shift and the Nature of Planck's Constant

SINCE the Mössbauer experiment, the definition of the frequency of light requires further attention. In the theory of General Relativity the following definitions are possible:

(1) *Based on Maxwell's Theory.* Let us call A_a (A_0, A_1, A_2, A_3) the four potential. Let us assume $A_a = a_{\alpha\beta} x^\beta$ as the solution of Maxwell's equations. The transition to geometrical optics follows from the

assumption that $\left| \frac{\partial \phi}{\partial x^a} \right| = \varphi_{/a}$ is very great. Maxwell's

equations are then reduced to:

$$g^{\alpha\beta} \varphi_{/a} \varphi_{/\beta} = 0$$

We call $\varphi_{/0} = \nu_0$ the frequency, and then we can prove the following statements: (a) ν_0 is constant along the light ray in every static field and in every static co-ordinate system; (b) ν_0 depends on the gravitational field at the point of emission (red shift)¹.

(2) *Based on Quantum Theory.* We can just as well define $\nu_0 = \nu$ in a natural way as the frequency. Let us define the inertial mass μ by:

$$\mu^2 \left(g_{\alpha\beta} \frac{dx^\alpha}{dt} \frac{dx^\beta}{dt} \right) = m^2 = \text{constant}$$

$\mu \xi_{/0}^\alpha$ is a vector with $\xi_{/0}^0 = 1$. Einstein's fundamental assumption for light rays and de Broglie's for the waves of matter is:

$$\mu \xi_{/0}^\alpha = h \nu \xi_{/0}^\alpha$$

where $\xi_{/0}^\alpha$ is the velocity of light or that of the wave packet. It is natural to identify ν with the frequency, but to do so and also in order that (a) and (b) should be valid for ν , we must assume that h is a scalar density, and a quasi-Cartesian co-ordinate system has been chosen².

L. INFELD

University of Warsaw and
Polish Academy of Sciences.

¹ Laue, M., *Die Relativitätstheorie* (Vieweg Braunschweig, 1921).

² Białynicki, I., *Bull. Pol. Acad. Sci.*, Cl. III, **5**, 805 (1957).

Measurements of Heats of Adsorption of Organic Vapours on Adsorbents of High Surface Area using a Continuous Flow Calorimeter

AN apparatus for the measurement of heats of preferential sorption from liquid carriers by means of a continuous-flow system has already been described¹. It was felt that this technique might also be applied to adsorption processes taking place from the vapour phase. A later model of the apparatus originally described was therefore modified to investigate the adsorption of organic vapours on to surfaces of high specific area.

Fig. 1 shows the calorimeter, in which the temperature-sensing elements comprise four thermistors, two reference thermistors situated in the body of the apparatus to ensure that they remain at constant temperature and a further pair of thermistors embedded in the surface of the adsorbent under investigation. Nitrogen is passed through the calorimeter at a rate of 50 ml./min., and a sample of gas, saturated with the vapour being used, is injected into the nitrogen stream by means of a long hypodermic needle. When the vapour reaches the adsorbent it is adsorbed and the rise in temperature measured and recorded by the thermistors, which are connected in a Wheatstone bridge network which feeds a 10-mV. potentiometric recorder via a 'Vibron' electrometer.

In order to obtain values for the heats of adsorption of the materials used the calorimeter was calibrated

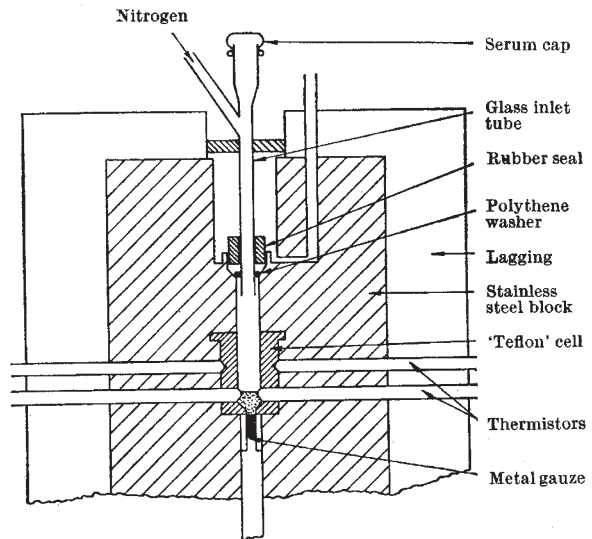


Fig. 1. Calorimeter for the determination of heats of adsorption from gases