LETTERS TO THE EDITOR

	PAGE
The External Field of a Radiating Star in General Relativity. BY P. C. VAIDYA	183
Permeability and Hydrolysis of Sodium Soils. BY M. R. NAYAR AND K. P. SHUKLA	183
The Nature of the Tea Oxidase System. BY H. B. SREERANGACHAR ..	185
Catalysis of Dichromate-Hydrobromic Acid Reaction by the Oxalate Ion. BY C. R. VISWANATHAM AND G. GOPALA RAO ..	186
Description of an Egg-Laying Female of the Indian Glow-worm, Lamprophorus tenebrosus *Walker.* BY J. SAMUEL RAJ	186
Fluctuation in the Weight of a Plant. BY C. V. KRISHNA IYENGAR ..	188
The Blood Groups of the Doms. BY S. S. SARKAR	189
BY D. N. MAJUMDAR	189

THE EXTERNAL FIELD OF A RADIATING STAR IN GENERAL RELATIVITY

IT is well known that the generalization of Schwarzschild's solution corresponding to the external field of a radiating star has not yet been obtained. The internal field describes a mixture of matter and radiation. In the outer field there is the expanding inner zone of pure radiation, with radius r_1 at time t_1 beyond which the empty space is described by Schwarzschild's static solution. The zone of pure radiation is given by

$$ds^2 = -\left(1 - \frac{2m}{r}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta d\phi^2) + \frac{\dot{m}^2}{f^2}\left(1 - \frac{2m}{r}\right) dt^2, \quad (1)$$

$$f(m) = m'\left(1 - \frac{2m}{r}\right). \quad (2)$$

[As usual an overhead dot denotes a differentiation with regard to t and an overhead dash a differentiation with regard to r. $f(m)$ is an arbitrary function of m.]

Since the lines of flow of radiation must be null geodesics the radiation tensor has to be

$$T^{\mu\nu} = \rho v^\mu v^\nu \quad (3)$$

with

$$g_{\mu\nu} v^\mu v^\nu = 0 \quad (4)$$

so that

$$(\rho v^\mu)_{;\mu} = 0 \text{ and } (v^\mu)_{;\nu} v^\nu = 0. \quad (5)$$

The surviving components of the tensor are given by

$$-T_1^1 = T_4^4 = \frac{m'}{4\pi r^2}, \; T_1^4 = -\frac{m'^2}{4\pi \dot{m} r^2}, \; T_4^1 = \frac{\dot{m}}{4\pi r^2} \quad (6)$$

For differentiation along a line of flow we have the operator

$$\frac{d}{d\tau} = e^{-\lambda/2}\frac{\partial}{\partial r} + e^{-\nu/2}\frac{\partial}{\partial t}. \quad (7)$$

It is found that the field equations amount to

$$\text{(i) } \frac{dm}{d\tau} = 0, \text{ (ii) } \frac{d}{d\tau}(r^2 e^{\lambda} T_1^1) = 0,$$

$$\text{(iii) } \frac{d}{d\tau}(r^2 \rho) = 0, \text{ (iv) } \frac{dv^1}{d\tau} = 0. \quad (8)$$

The equation that is most difficult to handle corresponds to $T_{;\nu}^{\nu} = 0$. But it can be shown to be equivalent to (ii). The equation of continuity then leads to (iii) and (iv) readily. Thus, along the lines of flow of radiation m, v^1 and $r^2\rho$ are all conserved. It is worthy of notice that m' is positive while $\dot{m}$ is negative. This as well as the results (6) and (8) are suggested by the Newtonian analogue.

The total energy of matter and radiation is conserved. m is the affective mass of the whole system at a point. The value of m at the boundary $r = r_1$ at $t = t_1$ is a constant, M. At time t_1, for all values of r exceeding r_1, the field is given by Schwarzschild's line-element corresponding to the value M. Also $\dot{m} = f(\text{M})$ when $r \geq r_1$ and $t = t_1$.

The new results are (1), (2), (6), (8). Further details and astronomical applications are considered in a paper to be published elsewhere.

My thanks are due to Prof. V. V. Narlikar under whose guidance this work was done and who showed me the result 8 (i).

Benares Hindu University,
March 22, 1943. P. C. VAIDYA.

Einstein, Infeld and Hoffmann, *Annals of Mathematics*, 1938, p. 65; Narlikar, V. V., *Bombay Univ. J.*, 1939, **8**, 37.

PERMEABILITY AND HYDROLYSIS OF SODIUM SOILS*

FOR many purposes a correct idea of the effectiveness of leaching an alkali soil is necessary. For instance, in reclamation work leaching is often practised though we do not know how long it will take to remove the evil influences

* This work was carried out under the auspices of the Irrigation Research Section, P.W.D., U.P. Government.