Condensations in a Non-static Universe

Einstein and Straus[1] have recently considered the influence of the expansion of space on the gravitation fields surrounding the individual stars. The paper has attracted considerable attention, but an interesting new result implicit in their work does not seem to have been noted as yet[2]. The authors consider the cosmological model which, in the usual notation, is

$$ds^2 = -T^2(1 + zr^2/4)^{-2}\,\delta_{ij}\,dx^i dx^j + dt^2, \quad (1)$$

where $T = T(t)$, $z = 1, -1$ or 0.

The pressure vanishes everywhere if

$$2T\ddot{T} + \dot{T}^2 + z = 0 \text{ or } T\dot{T}^2 + zT = k, \quad (2)$$

k being a constant of integration. A consequence of the pressure being everywhere zero is that the density ρ is given by

$$\rho = 3k/8\pi T^3. \quad (3)$$

Hence

$$(4\pi\rho/3)T^3r^3\,(1 + zr^2/4)^{-3} = m(r), \quad (4)$$

is a function of r only. If r is fixed as r_0, m is also fixed and may be interpreted as the total mass contained within the boundary $r = r_0$. Einstein and Straus have shown that Schwarzschild's external line-element in an isotropic non-static form can be made to go over into the cosmological form (1) at $r = r_0$ by defining the constant k of (2) as

$$k = 2mr_0^{-3}\,(1 + zr_0^2/4)^3, \quad (5)$$

where m is the mass constant in Schwarzschild's solution. What we wish to point out is that (5) is precisely the relation that one gets from (3) and (4). This fact suggests that if the cosmic matter contained within the sphere $r = r_0$ condenses into a spherical body of the same mass m, there is no change in the external field beyond $r = r_0$. For a given cosmological model of type (1) (that is, for a given k) and for a given r_0 there is naturally a unique m.

V. V. Narlikar
K. R. Karmarkar

Benares Hindu University.
Sept. 7.

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An Observed Abnormal Increase in Cosmic-Ray Intensity at Lahore

During the course of an experimental study at Lahore on the directional total intensity of the cosmic radiation, with a triple coincidence counter system, we observed over a short period a very large increase (nearly 200 per cent) in the intensity.

The telescope consists of three internally quenched Geiger-Müller counters, 35 cm. long and 2·5 cm. in diameter, spaced 12·5 cm. from each other. These counters were prepared with copper oxide coated cylinders and filled with 9 cm. argon and 1·5 cm. pressure of ethyl alcohol vapour, all of them having very similar characteristics and with a plateau of 180 V. A stabilized high tension[1] is applied through a resistance of 0·1 megohm to the wires of the counters and the triple coincidence pulses are recorded by a circuit recommended by Johnson[2], which is an improvement on the original Rossi circuit. We can set the telescope at various angles to the zenith and also vary the azimuthal angle by a suitable mounting.

During July 31–August 3, with the telescope set vertically, and the axes of the counters in the magnetic meridian, we were getting an average of 23·8 coincidences per hour, and at an angle of 20° W. an average of 16 per hour. The readings were taken during the daytime between 11 a.m. and 5 p.m. in the Physics Laboratory, under a single roof of a few inches of concrete. This rate of counts was maintained until noon on August 3, but between noon and 1 p.m. and 1 and 2 p.m. with the telescope at 20° W., the counting rate increased to an average of 40 per hour, from a previous value of 16 per hour.

Considering it might be due to some fault in the apparatus or local causes, we checked all the voltages, which we found to be very constant. Then we checked and even changed a few valves, but the high rate was maintained. We then rotated the telescope, bringing it to the vertical position again, and between 2.30 and 4.30 p.m. took counts in this position, which were also much higher, namely, 60 per hour, as against 24 during previous measurements. It is to be noted that in both cases the total counts per hour increased to two and a half times.

On August 4 (Sunday) we took no observations. On August 5 about the same rate of coincidences as originally was restored, and the observations were normal.

The enhanced intensity lasted at least for five hours, probably longer, and checking up all the facts we are inclined to believe that it was a real increase in the intensity of the radiation. We shall be interested to learn if during the same interval the same abnormal increase was observed elsewhere; or whether it was shown only in a particular region of the earth.

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H. R. Sarna
O. P. Sharma

Physics Department,
Government College,
Lahore.
Aug. 10.

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Refraction Effects in Electron Diffraction

Observations by Sturkey and Frevel[1] and Hillier and Baker[2] indicate that some rings in electron diffraction patterns from magnesium oxide and cadmium oxide smokes are double, and in one case (the *220* ring) it was suspected that there were five components contributing to the ring contour. Sturkey and Frevel suggested that refraction by the regularly shaped particles gave rise to the two components, although their data were not conclusive. Using the high-resolution system of the R.C.A. type E.M.U. microscope as a diffraction camera, we have attempted to find some feature of the diffraction by oxides of this type attributable to stoichiometric excess of the metallic constituent. We have obtained patterns showing resolution of details of fine structure of the reflexions, from which a complete interpretation of the phenomenon is possible.

Patterns from magnesium oxide and cadmium oxide smokes, both of which occur as regular cubes of about 500 A. cube-edge, show rings to be double, triple, or, in the case of *h00* reflexions, single and sharp. In certain cases when orientation (cube faces normal to beam) was present, tilting of the plane of the specimen produced arc patterns from which information concerning the dependence of the multiplicity on the angle of tilt could be obtained. In patterns to which few individual crystals contributed, it was observed that spots were grouped about the position at which the normal reflexion was to be expected and that often groups of six were observed. Furthermore, the *h00* rings, although single, consisted of groups of two component spots displaced along the ring. Where larger deviations from the stoichiometric ratio existed, the spots were replaced by streaks radiating from the expected position of the reflexion. For example, yellow cadmium oxide gave spot patterns, whereas brown cadmium oxide, containing greater excess of cadmium, gave streaks. These effects are illustrated in enlargements (× 56) of small segments of certain rings (Fig. 1).

The angular deviation δ expected on the basis of refraction due to an inner potential P volts may be shown to be

$$\delta = \frac{P}{2E}\left(\pm\frac{\cos\psi_1}{\cos\varphi_1} \pm \frac{\cos\psi_2}{\cos\varphi_2}\right),$$

where φ_1 and φ_2 are the angles between the beam and the face normals, ψ_1 and ψ_2 are the angles between face normals and the diffraction plane normal, and E is the accelerating voltage of the electron beam. This reduces to

$$\delta = \frac{P}{2E}\,(\pm\tan\varphi_1 \pm \tan\varphi_2),$$

in the special case where the path of the beam lies in a plane perpendicular to the cube edge (see also ref. 1).

On the basis of this theory, it has been possible to interpret the features of the patterns obtained. The calculated variations in separation and relative intensity of the several components of the arcs with angle of tilt agreed with those observed. Agreement between the observed and calculated values for the angles between the individual streaks of one group and the radius of the ring was also obtained. Calculated inner potentials varying from 12 to 16 volts for the various planes lie in the range expected. Only a variation of inner potential, resulting, we suggest, from the presence of excess metal atoms in

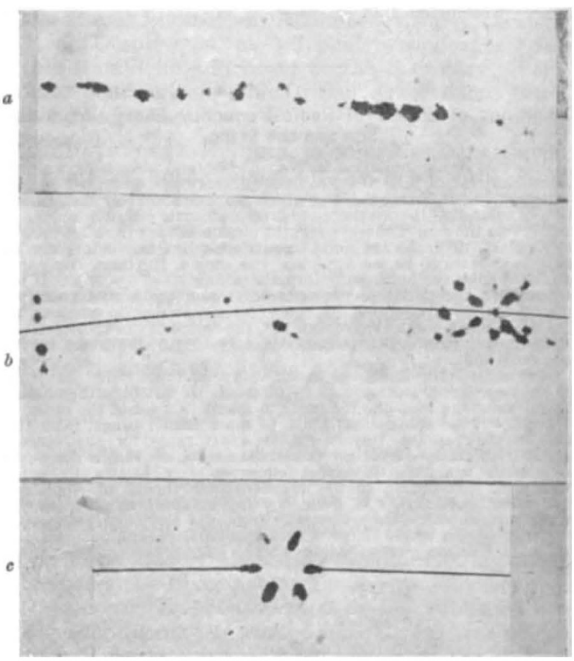

Fig. 1. Examples of groups of reflexions resulting from refraction by cubes of magnesium oxide for (*a*) (200), (*b*) (220) and (*c*) (422) planes. Undisplaced ring positions are indicated by the continuous line in (*b*) and (*c*). Enlargement from original pattern, 56 diameters