any extended distribution of matter, that is, $F(R, P; R', P') = F(R', P'; R, P)$, where $F(R, P; R', P')$ is the probability that a particle going in the direction R at the point P will emerge in the direction R' at the point P'. This is because the probability of following any route is equal to the probability of following the reverse route, through the same elements of volume. Thus the probability of a certain end result from a number of possible routes will equal the probability of the reversal of the result occurring through the reverse routes.

In our case the scatterer (star) is to a large extent nonabsorbing and noncapturing. The former is true except for particles colliding with the star, which can only happen when their energy is sufficiently great, and the latter is true except for particles which follow asymptotic or periodic orbits in the magnetic field of any one of the N stars. These orbits, however, almost certainly form a set of zero measure in the manifold of all possible orbits,[2] that is, they occur only exceptionally. Thus, while a dipole magnetic field can imprison charged particles starting from a point within it and can also keep them away if starting from infinity, depending on their energy and angular momentum, it can only exceptionally capture such particles starting from infinity. In our case, therefore, all particles starting in a direction R at a point P, sufficiently far from all neighboring stars, have only a small chance of being either absorbed or captured in a periodic orbit (of finite or infinite period), so that the great majority of them will emerge at infinity. For almost all particles, therefore, the probability of emerging at infinity must be unity, or

$$\int_{R'} F(R, P; R', \infty)dR' = 1 \qquad (1)$$

almost always.

Now consider a beam of particles at infinity whose intensity in a direction R' is $I_\infty(R')$. The intensity at P observed in the direction R will be

$$I_p(R) = \int_{R'} F(R', \infty; R, P)I_\infty(R')dR'. \qquad (2)$$

Using (1) and assuming an isotropic distribution at infinity such that $I_\infty(R')$ is a constant (independent of R'), we find that Eq. (2) becomes

$$I_p(R) = I_\infty \int_{R'} F(R, P; R', \infty)dR' = I_\infty \qquad (3)$$

by (1). Therefore the intensity in any direction at P is the same and the distribution is isotropic at P if it is isotropic at infinity.

From the remark made previously, it is clear that if the distribution of positive and negative particles at infinity is isotropic, it will also be isotropic at any point P, except for small irregularities due to absorption by collision and by capture into periodic orbits. We conclude that particle scattering by magnetic fields of the stars is unable to contribute anything to the solution of the problem whether or not cosmic particles come from beyond our galaxy. The considerations developed in this note clearly hold so long as the scattering centers satisfy the conditions of being nonabsorbing and noncapturing, irrespective of the law of force which is responsible for the scattering. It need hardly be emphasized that they apply only to the case in which there is no resultant magnetic field for the whole galaxy, such as would exist if the dipoles were oriented along preferential directions. In this case particles would either be imprisoned if born within the galaxy, or kept out, if coming from outside, depending on their energy and angular momentum. The reciprocal property of paths would then break down in general, but would still hold for any allowed direction at any point within the galaxy.

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[1] A. H. Compton and I. A. Getting, Phys. Rev. **47**, 817 (1935). M. S. Vallarta, C. Graef and S. Kusaka, Phys. Rev. **55**, 1 (1939).
[2] See the discussion by E. J. Schremp, Phys. Rev. **54**, 153 (1938); and forthcoming papers by O. Godart and by A. Banõs, Jr.

Nuclear Excitation of Indium by X-Rays

It has been shown recently[1, 2] that the stable nucleus In^{115}, when excited by fast neutrons or protons, may be left in a metastable excited state, designated by In^{115*}, from which it decays, emitting negative electrons, with a half-life time of 4.1 hours.

We have now observed that the same metastable state can be excited when indium is irradiated by x-rays. The x-rays were produced by bombarding a 2-mm thick lead target with electrons from an electrostatic generator. A thick indium foil, 1 inch in diameter, was placed directly behind the lead target. After 30 minutes irradiation at an electron energy of 1.73 Mev and a current of 10 μa, the indium foil showed an initial activity, recorded on a Geiger-Müller counter, of 45 counts per minute. The activity decayed with a period of approximately 4 hours. The walls of the counter reduced the intensity of the rather soft β-rays to about one-half. Until more is known about the effective x-rays, no well-defined cross section can be deduced from these data.

By varying the bombarding voltage it was established that the effect has a threshold at 1.35 ± 0.1 Mev. This result might be interpreted by assuming that In^{115} has at that energy an excited state which combines both with the ground state and the metastable excited state.

In a note which has just become known to us Pontecorvo and Lazar[3] also report the excitation of indium by x-rays. In their experiments the x-rays were produced with an impulse generator working at a peak voltage of 1850 kv.

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[1] Goldhaber, Hill and Szilard, Phys. Rev. **55**, 47 (1939).
[2] Barnes and Aradine, Phys. Rev. **55**, 50 (1939).
[3] Pontecorvo and Lazar, Compte rendus **208**, 99 (1939).