Fission Cross Section in Uranium and Thorium for Deuteron Impact

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As reported in a previous note,[1] experiments have been carried out with the cyclotron in this institute to investigate the cross section for fission in thorium and uranium produced by impact of deuterons with different energies. The fission outputs were determined by collecting the radioactive fragments on aluminum foils facing the targets and screened from the deuteron beam. Because of the difficulty of estimating the number of fission processes from the β-radioactivity of these foils, a considerable uncertainty, however, was involved in the determination of the absolute value of the fission cross section.

In continued experiments, this uncertainty has been reduced by a calibrating procedure in which two thin uranium targets were exposed to neutron impact. One of the targets was placed in a small ionization chamber and the number of fission particles emitted from this target counted by a linear amplifier. The fission particles from the second target were collected on a thin lead foil; the distance between the two targets was sufficiently small to ensure that the neutron intensity was very nearly the same. By measuring the activity of the collecting foil with the same counting arrangement as in the experiments with deuterons, the ratio between the foil activity and the number of fission particles emitted during the irradiation could thus be determined.

Instead of the preliminary value of $0.5\cdot 10^{-26}$ cm^2 given in the previous note, the measurements thus calibrated gave now the value $(2.2\pm 1)\cdot 10^{-26}$ cm^2 for the fission cross section in uranium at 9-Mev deuteron energy. The results found for the variation of the cross section with deuteron energy and the ratio between the cross sections in thorium and uranium given in the note remain, of course, unaltered. From the value 0.7 for the last ratio, which agrees with the independent determination by Krishnan and Banks,[2] we obtain in consequence, $(1.5\pm 0.7)\cdot 10^{-26}$ cm^2 for the fission cross section in thorium at 9-Mev deuteron energy.

Details of the experiments are described in a paper in print in the *Communications of the Copenhagen Academy of Sciences* where, also, a description of the cyclotron has just been published.[3]

[1] J. C. Jacobsen and N. O. Lassen, Phys. Rev. **58**, 867 (1940).
[2] R. S. Krishnan and T. E. Banks, Nature **145**, 860 (1940).
[3] J. C. Jacobsen, Det Kgl. Danske Vidensk. Selsk. Math.-fys. Medd. **19**, 2 (1941).

The Resistivity of Interstellar Space

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In a paper by Foster Evans on "Electric fields produced by cosmic rays,"[1] the conductivity of interstellar space has been computed on the assumption that electrons are scattered by neutral atoms with a collision radius of 10^{-8} cm. He assumes that there are two neutral atoms, one ion and one electron per cm^3 and that the electron temperature is 10,000°K. For these conditions the collision radius for a collision between an electron and a positive ion[2] is 50×10^{-8} cm so that the scattering by neutral atoms is entirely negligible. The mean free path is about 5×10^{12} cm and not 10^{15} cm as estimated by Evans.

The resistivity is given by the equation for an ionized gas[2]

$$R=\frac{1.48\times 10^4}{T_e^{\frac{3}{2}}}\log 0.72\times 10^6\,\frac{T_e^2}{N_+^{\frac{1}{3}}},$$

where R is resistivity in ohm-centimeters, T_e is electron temperature and N_+ is the number of ions per cm^3. The above numerical values give the resistivity of interstellar space as 0.2 ohm-centimeter; a value comparable with the resistivity of an intense low pressure discharge. The resistivity is extremely insensitive to variations in the number of ions or in the degree of ionization provided more than 1 percent of the atoms are ionized, and it remains of the same magnitude even within a stellar atmosphere. While this is a higher resistivity than assumed by Evans, it does not change the general conclusion of his paper that interstellar space is an equipotential region and that no conceivable energy source can change the potential of a star by more than a few volts.

[1] Foster Evans, Phys. Rev. **59**, 1 (1941).
[2] S. D. Gvosdover, Physik. Zeits. Sowjetunion **12**, 164 (1937).

Are There Spin One Mesotrons?

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The work of Christy and Kusaka[1] shows that the mesotrons which are mainly responsible for bursts at low altitudes cannot be particles of spin one, probably have spin zero, though possibly spin one-half. If mesotrons are responsible for nuclear forces, and if they do not have spin one-half, then the known spin dependence of nuclear forces demands that, in addition to mesotrons of spin zero, there must be particles of spin one. The experiments of Schein, Jesse and Wollan[2] indicate that the incident radiation is protonic and that the mesotrons are probably produced in multiple nuclear processes. If these things are true, it is extremely difficult to believe that mesotrons of spin one are not produced in addition to those of spin zero. Since such particles are not present in appreciable amounts at low altitudes, they must be highly absorbable. The radiative cross sections for particles of spin one are not adequate to account for so high an absorption. However, if spin one mesotrons disintegrate with a lifetime of about 10^{-8} second there is no contradiction with cosmic-ray evidence. This lifetime would be satisfactory for the mesotron theory of β-decay.

[1] R. F. Christy and S. Kusaka, Phys. Rev. **59**, 414 (1941).
[2] Learned in conversation with M. Schein.