ON THE MECHANISM OF FISSION AT VERY HIGH ENERGY *, §

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The main features of fission of heavy nuclei at energies of incoming particles of the order of a few hundred Mev have been established in works by O'Connor and Seaborg[1], Jungerman and Wright[2], Goeckermann and Perlman[3], and others. Goechermann and Perlman also proposed a model to explain the fission of Bi with 190 Mev deuterons in which they assume that some twelve neutrons were evaporated in a raw after the nucleonic cascade until the residual nucleus reached the proper Z^2/A calculated from the liquid drop model and then it underwent fission.

There is experimental evidence [4,5] that the fission process is much faster than it was thought earlier. These two works proved that there are more fission fragments emitted in the direction of the incoming proton or neutron than at right angle. This indicated that at this

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excitation energy which is about 30 Mev, the fission process can take place before the formation of the compound nucleus.

There is also experimental evidence from the work of W. E. Bennet[6] showing that when Bi is irradiated with 450 Mev protons, the yields of Po isotopes are from ten to twenty times smaller than the yields of Bi isotopes of the same mass number, showing that the probability of the incoming proton to stay in the nucleus is small. Unfortunately his cross-sections are not corrected for efficiency of the counter, but assuming plausible correction factors for his corss-sections it seems that the yield of Bi^{200} plus Po^{200} is not more than one percent of the reaction cross-section compared with about ten percent for the fission cross-section of Bi in the same conditions.

It seems therefore likely that other mechanisms operate at high energy fission. It is possible that the fission takes place shortly after the nucleonic cascade produced in the heavy nucleus by the incoming particle, and then the excited fission fragments emit six neutrons each in a process describable by the evaporation theory.

A way to distinguish if the neutrons are emitted before fission or after fission is the measurement of the angular distribution of the neutrons emitted in coincidence with the fission fragments. This experiment could be done in a similar way to the experiment of J. S. Frazer[7] but using neutrons of a few hundred Mev. The angular distribution should be spherically symmetric if the neutrons are emitted before fission, but asymmetric if the neutrons are emitted after fission. In this last case we have calculated that the ratio of the intensity at zero degree to the ratio of the intensity at ninety degrees is equal or greater than 1.8 for incoming neutrons of 100 Mev, and equal or greater than 1.32 for incoming neutrons of 400 Mev. For this calculation we have assumed ten neutrons evaporated and the thermal excitation energy was estimated from the works of Goldberger[8] and Bernardini[9].

It is possible that high energy fission occurs by a mechansim intermediate between these two, namely, after the initial cascade a few neutrons are emitted, fission takes place and a few more neutrons are emitted from the fission fragments. In this case the angular distribution would still be asymmetric, but less than in the case where all the neutrons are emitted after fission.

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