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To cite this version:

HAL Id: jpa-00225780
https://hal.archives-ouvertes.fr/jpa-00225780
Submitted on 1 Jan 1986

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INVESTIGATION OF PERIPHERAL FISSION PROCESSES AT 30 MeV/u WITH $^{40}$Ar


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Abstract - Using targets of Th, Au, and Ta and an $^{40}$Ar-beam of 30MeV/u binary fission events have been measured in coincidence with an outgoing projectile fragment. For peripheral collisions the linear momentum and the azimuthal anisotropy have been determined. The correlation between the linear momentum transfer and the velocity of the projectile gives indications for two reaction mechanisms.

The mechanisms of heavy ion reactions change from deep inelastic collisions or complete fusion at low bombarding energies to a hydrodynamical behaviour at relativistic energies. In the intermediate energy region between 20 and 100 MeV/u the different processes are however not yet well known.

At the cyclosynchrotron SARA in Grenoble heavy targets, such as Ta, Au and Th were used to measure the transfer of energy, linear and angular momentum by $^{40}$Ar projectiles in peripheral fission processes. Peripheral collisions were selected requiring a projectile fragment with $A>=12$, which were identified with an ionisation chamber (IC) at angles between 6°- 13°. The direction of the projectile fragment together with the beam axis determined the reaction plane. A set of 10 large area parallel plate detectors (20°<θ<160°), measured the time of flight, the energy and the position of heavy target fragments.

Because of the small solid angle of the IC (Ω = 6 msr) we tried to obtain better statistics using an annular IC and PPD (each of them consisting of 12 elements) and a set of 6 quadratic PPD's to measure most of the projectile fragments with a ΔE - time of flight technique. Furthermore 6 tele-
scopes were used to measure the charge and the energy of light particles at angles between 13° and 120°.

In order to determine the angular momentum transferred to the target, we measured the azimuthal anisotropy (ratio of the yield at 180° and 90°) of the fission fragments in relation to the reaction plane. Fig.1 shows that this anisotropy is twice higher for Au than for Th.

![Fig.1](attachment:image1.png)

The azimuthal anisotropy for Th and Au

In addition the linear momentum $p_{||}$ transferred to the target was determined by measuring the folding angle of the two fission fragments, which were detected in coincidence with the projectile fragments. In Fig.2 the dependence of the azimuthal anisotropy on the linear momentum of the target is shown. Because of the lower fission barrier of Th in relation to Au the anisotropy at low $p_{||}$ is higher for Au than for Th.

![Fig.2](attachment:image2.png)

The anisotropy in dependence of the linear momentum transferred to the target for Th and Au
In Fig. 3 the correlation between the energy per nucleon of the projectile fragment and the folding angle of the fission fragments is shown. The arrow indicates $p_{||}=0$. The folding angle of $120^\circ$ corresponds to about $4$ GeV/c. Projectile fragments with $Z=17$ remain at their initial velocity ($30$ MeV/u) and therefore only small linear momenta can be transferred to the target. This reaction mechanism can be understood in the framework of fragmentation processes$^1$. With decreasing charge of the projectile fragment the linear momentum of the target increases and at the same time the energy per nucleon of the projectile is reduced. For $Z=8$ this second process dominates, but there also remains a contribution of fragmentation.

REFERENCES