Isotopic distribution of fission fragments using multinucleon transfer reactions in inverse kinematics: From fission yields to scission properties

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Fission in inverse kinematics: kinematical boost for a direct identification of the fission fragments







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Isotopic distributions of fission fragments induced in 2 proton transfer





M. Caamaño et al., PRC 88, 024605 (2013)

Assets of the experimental set-up: **Reconstruction of kinematical properties**



M. Caamaño, F. Farget et al. PRC 92, 034606 (2015)

Neutron number N

Average velocity of fission fragments

$$\langle V \rangle (Z) = \frac{\sum_{A} Y(A,Z)V(Z,A)}{\sum_{A} Y(A,Z)}$$





$$A_{1}^{*}v_{1}^{*} = A_{2}^{*}v_{2}^{*}$$

$$A_{1}^{*} + A_{2}^{*} = A_{c}^{*}$$

$$< v_{1,2}^{*} > = < v_{1,2}^{*} >$$

$$< v_{1}^{*} > / < v_{2}^{*} = A_{2}^{*} / A_{1}^{*}$$

$$A_{1}^{*} = A_{c}^{*}(v_{1} / (v_{1} + v_{2}))$$

$$A_{2}^{*} = A_{c}^{*} - A_{1}^{*}$$

Momentum conservation Mass conservation Isotropic evaporation

Reconstruction of the scission fragment masses A*

$$\begin{array}{ll} < A^* >_1 = & A_{FS} \frac{< V_2 >}{< V_1 >} & \text{Cr} \\ < A^* >_2 = & A_{FS} - < A^* >_1 & \end{array}$$

Charge conservation $Z_2 = Z_{FS} - Z_1$

Neutron excess of the fragments at scission

$$\langle N^* \rangle / Z(Z) = \frac{\langle A^* \rangle (Z) - Z}{Z},$$



Average neutron excess @ scission



Average neutron multiplicities @ scission

10





Neutron multiplicity

Similar trend in direct neutron observation



Neutron multiplicity : →Excitation energy →Neutron excess of Scission fragments



Very complete information!!



Conclusions

- Fission experiments based on inverse kinematics at Coulomb energy allow for
 - A comprehensive measure of the fission product yields
 - A precise measure of the kinematic properties
 - An original and powerful insight into the fission process with the reconstruction of some scission point properties :
 - Deformation, TXE, charge polarization....
- As a perspective, the impact of excitation energy will be studied
- New actinides produced in other transfer reactions will be investigated