Scission deformation of ^{120}Cd/^{132}Sn neutronless fragmentation in ^{252}Cf(sf)

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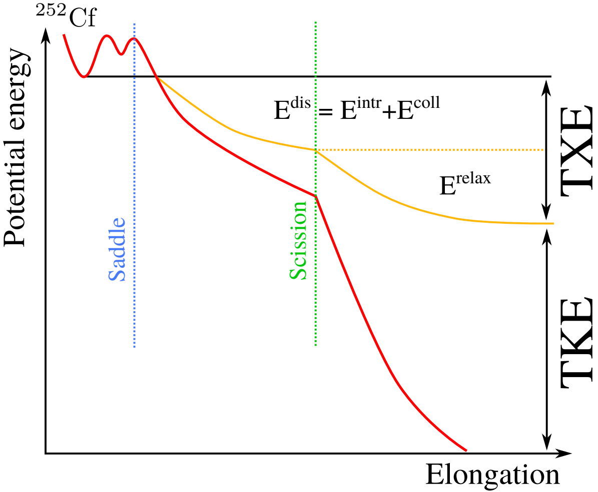
22nd August 2024

Fission

Energy & excitation energy repartition



$\langle Q \rangle \simeq 218$ MeV

$\langle TXE \rangle \simeq 34$ MeV

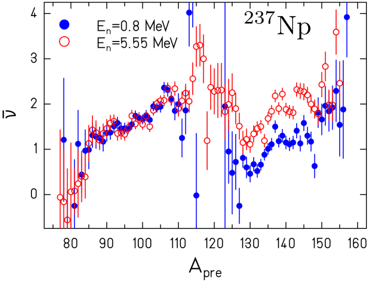
$\langle TKE \rangle \simeq 184$ MeV

J. Milton *et al*, PR **111** (1958)

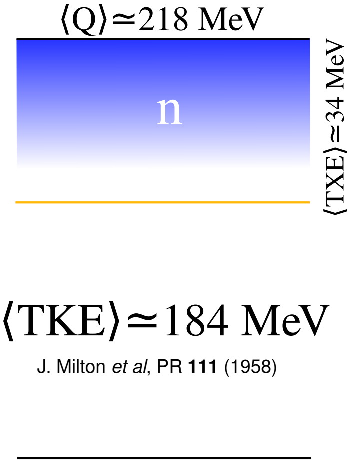
Fission

Energy & excitation energy repartition

K.H. Schmidt *et al*, PRL **104** (2010),
data from A. Naqvi *et al*, PRC **34** (1986)



- Neutrons major conveyors of the excitation energy,
- Heavy fragment appear to get more EE than the light one.



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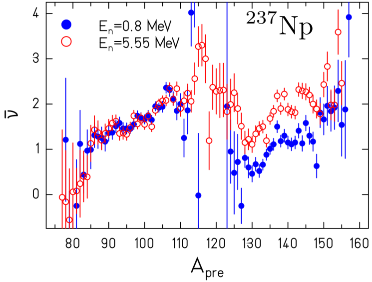

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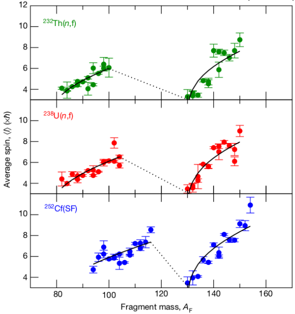
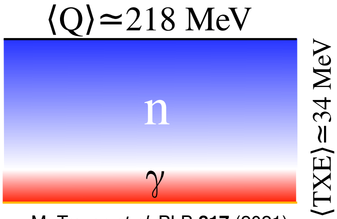
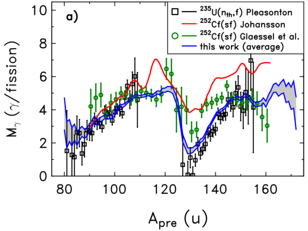
J. Wilson *et al*, Nature **590** (2021)



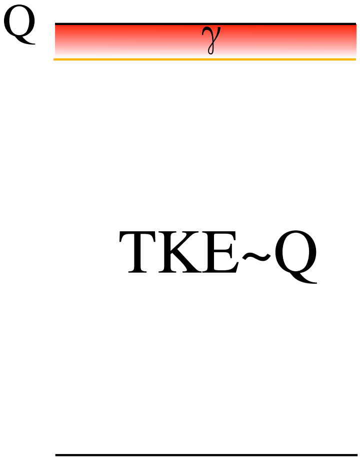


M. Travar *et al*, PLB **817** (2021)



Recent measurements of M_γ and $\langle J \rangle^{post}$ shed new light to the AM generation mechanism

Neutronless fission as an access to the primary fragments

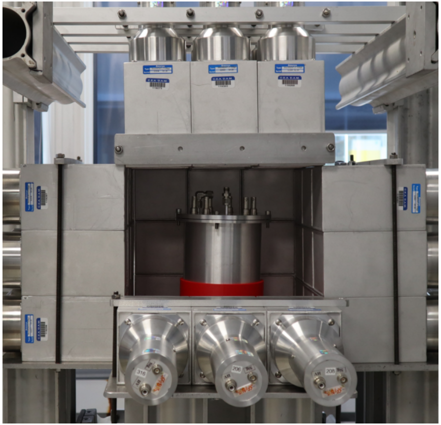


- Neutronless fission give access to the primary fragments, experimentally challenging [1,2].
- Excitation energy and angular momentum are both exhausted by the γ emission.

[1] C. Signarbieux *et al*, J. Physique Lettres **42** (1981)
[2] H.-H. Knitter *et al*, Nucl. Phys. A **536** (1992)

Experimental Setup

- 54 NaI: Prompt spectrum measurement and isomers identification.
- Twin Frisch-Gridded Ionization Chamber:
  - Fragments identification
    $\overrightarrow{p_L} = \overrightarrow{p_L} \Rightarrow A_L/A_H = E_H/E_L,$
  - excellent intrinsic resolution ($\sim$ 0.3 MeV),



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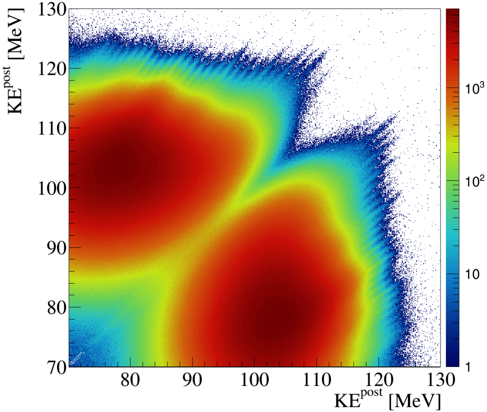
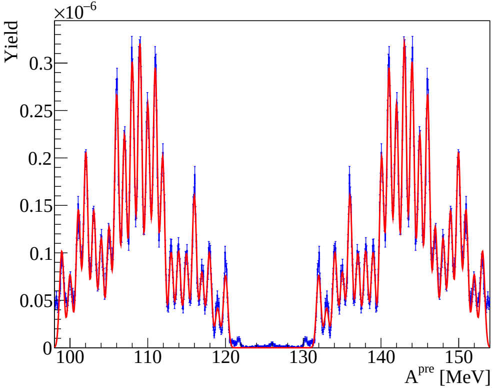
  - Fragments identification $\overrightarrow{p_L} = \overrightarrow{p_L} \Rightarrow A_L/A_H = E_H/E_L$,
  - excellent intrinsic resolution ($\sim$ 0.3 MeV),
  - ultra-thin backing (5 μg.cm^{-2}): identification of neutronless fission.



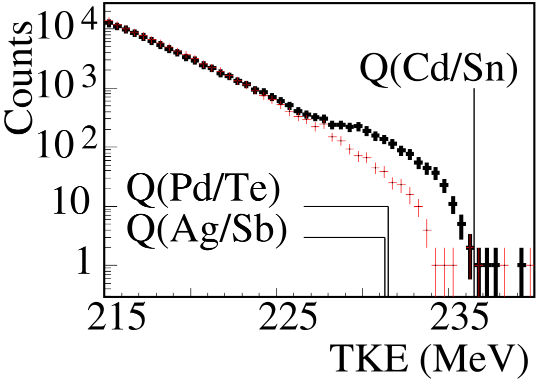
Neutronless fission

- Resolved masses (0.7 a.m.u.) for high TKE events: without neutron emission, $\sigma(A) = \sigma(E)$



Angular momentum and scission deformation of ^{120}Cd

- ^{120}Cd/^{132}Sn fragmentation extracted by TKE selection,



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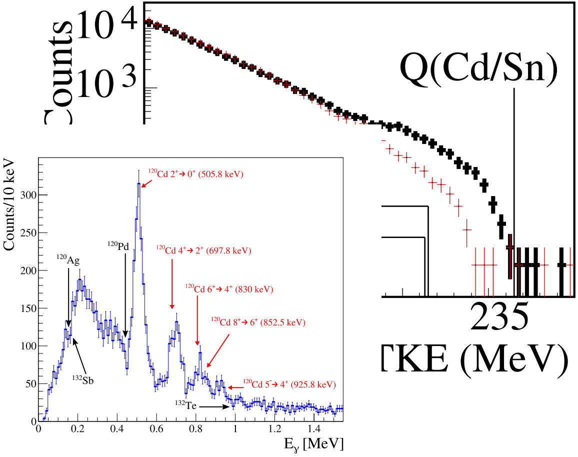
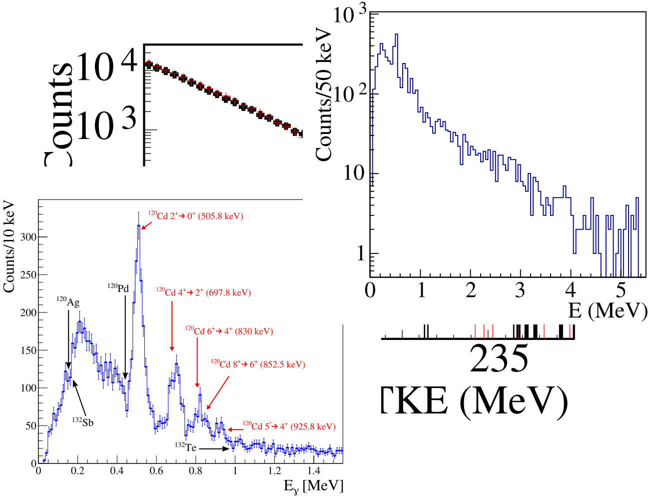


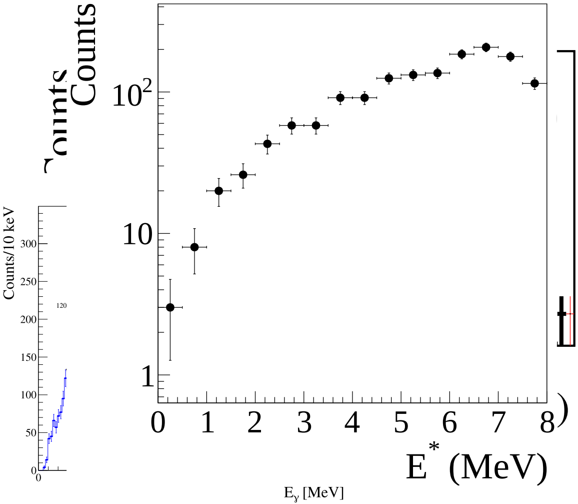
Angular momentum and scission deformation of ^{120}Cd

- ^{120}Cd/^{132}Sn fragmentation extracted by TKE selection,
- ^{132}Sn observed in its ground state in at least 98% of the Cd/Sn events.



Angular momentum and scission deformation of ^{120}Cd

- ^{120}Cd/^{132}Sn fragmentation extracted by TKE selection,
- ^{132}Sn observed in its ground state in at least 98% of the Cd/Sn events.
- **Measurement of ^{120}Cd excitation energy distribution.**



Angular momentum and scission deformation of ^{120}Cd

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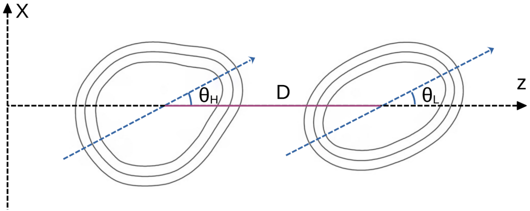
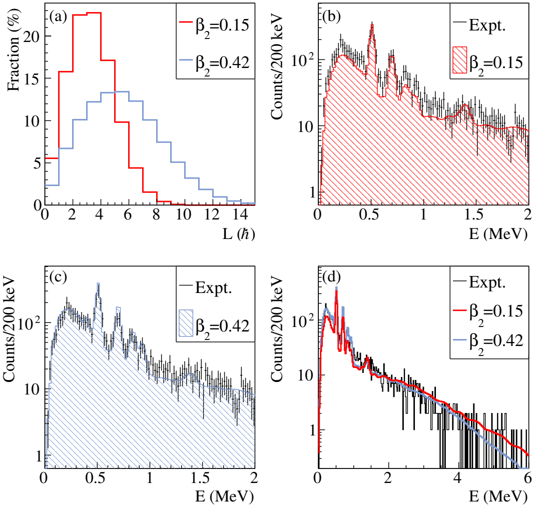
- Angular momentum is the most constraining observable to reproduce the experimental spectrum:
  - AM generated from collective quantum DoF and its dynamics [3],



[3] G. Scamps *et al*, Phys. Rev. C **108**, 034616 (2023)

Angular momentum and scission deformation of ^{120}Cd

- Angular momentum is the most constraining observable to reproduce the experimental spectrum:
  - AM generated from collective quantum DoF and its dynamics [3],
  - Constraint the scission deformation of ^{120}Cd ($\beta_2 \sim 0.4$) [4].

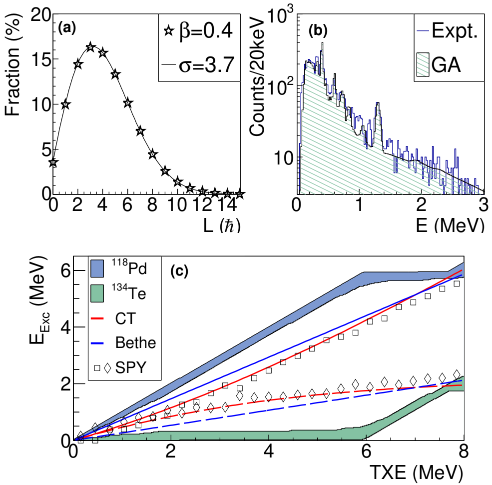


[3] G. Scamps *et al*, Phys. Rev. C **108**, 034616 (2023)
[4] A. Francheteau *et al*, Phys. Rev. Letters **132**, 142501 (2024)

^{118}Pd/^{134}Te neutronless fragmentation

Excitatio0n energy repartition

- ^{118}Pd/^{134}Te identified in the same way,
- AM constrained by G. Scamps calculations,
- then the EE repartition between the two fragments is the key quantity to reproduce th experimental γ-spectrum,
- determined through a genetic algorithm.
- The present work validates the current understanding of the EE sharing.
- Submitted to Phys. Rev. Letters.



Summary

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- First study of the γ-spectra in cold fission.
- Cold fission seen thanks to an excellent energy resolution.
- $^{120}\mathrm{Cd}/^{132}\mathrm{Sn}$ (published in PRL):
  - $^{132}\mathrm{Sn}$ measured in its ground state,
  - First measurement of the $^{120}\mathrm{Cd}$ excitation energy,
  - Determination of its angular momentum distribution using the orientation-pumping mechanism,
  - Constrain the scission deformation of $^{120}\mathrm{Cd}$, different from its ground state.
- $^{118}\mathrm{Pd}/^{134}\mathrm{Te}$ (submitted to PRL):
  - First determination of the energy repartition with a genetic algorithm,

Collaborators

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Thank you for your attention

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