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Nucleon tranfer reactions induced by A < 50 projectiles

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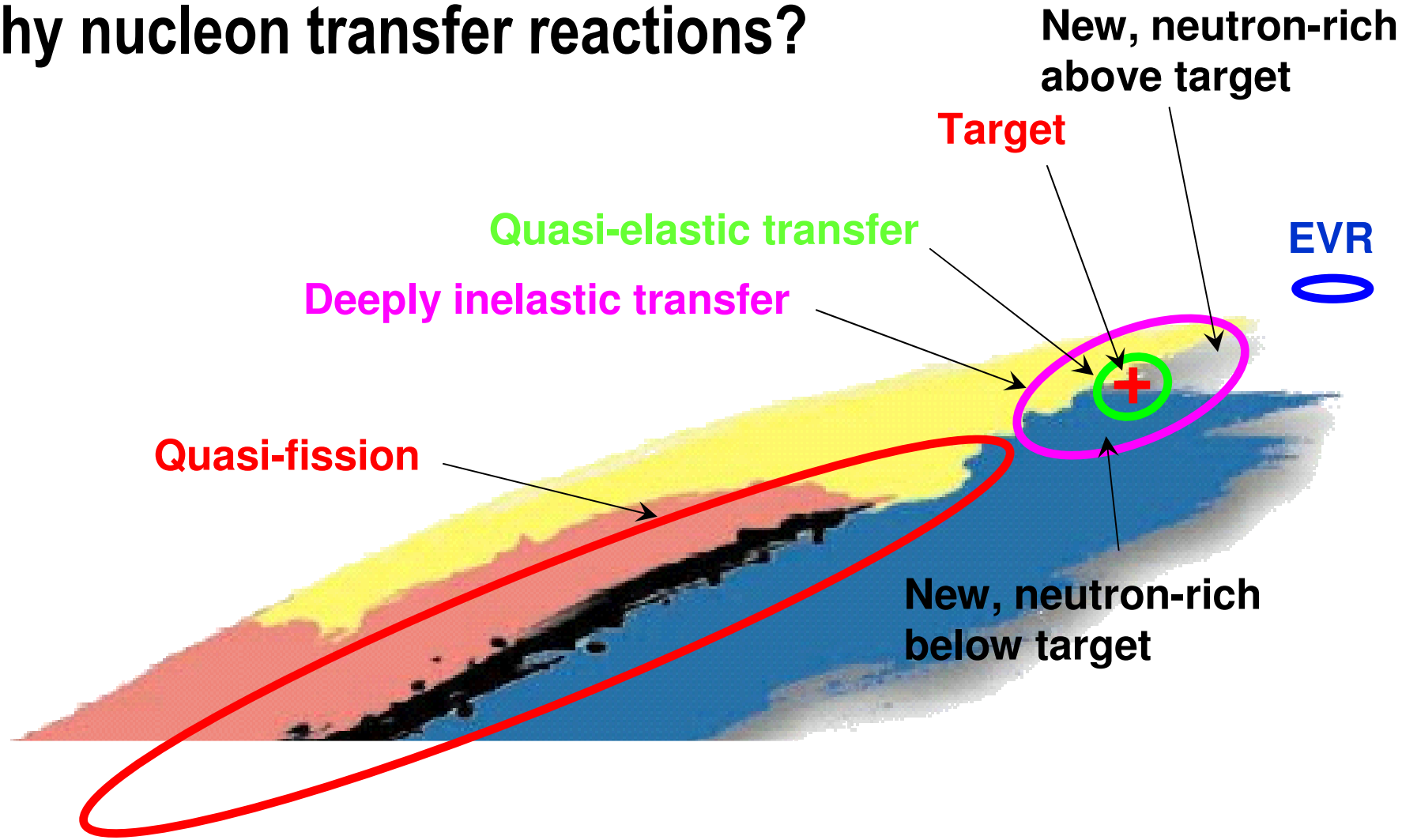
Why nucleon transfer reactions?



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Transfer reactions with A < 50 projectiles and ^{248}Cm as a target

Studied systems:

^{16}O + ^{248}Cm → above target yields up to ^{256}Md

^{18}O + ^{248}Cm → above target yields up to ^{259}No, below target to Pu

^{20}Ne + ^{248}Cm → above target yields up to ^{256}Md,

^{22}Ne+ ^{248}Cm → above target yields up to ^{256}Fm

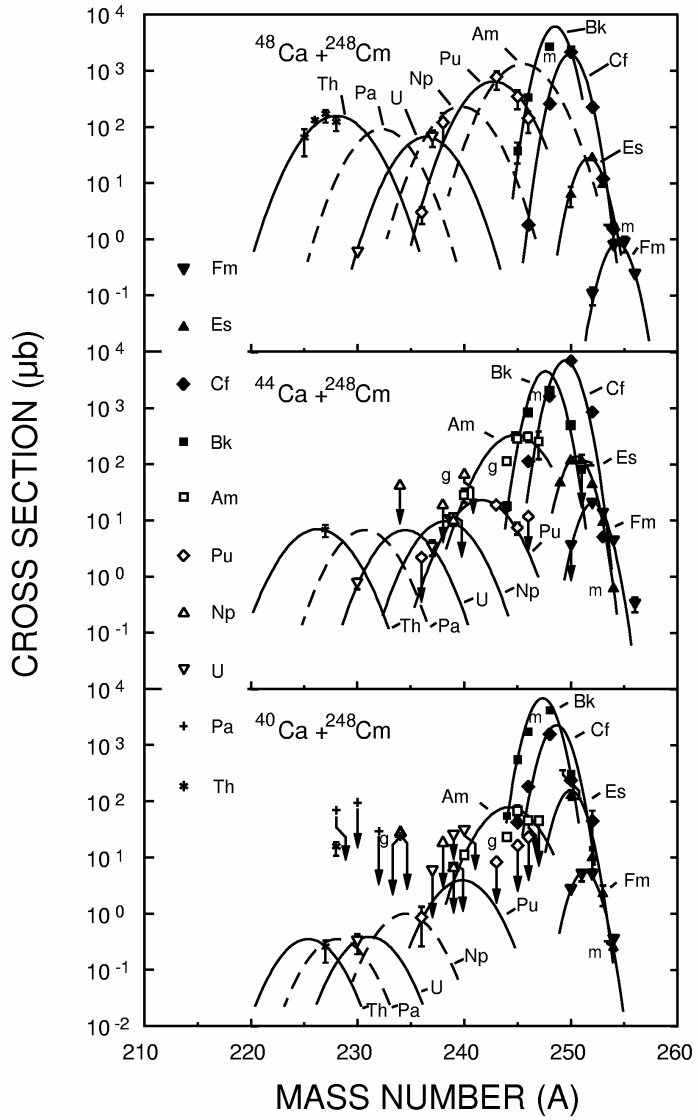
^{31}P + ^{248}Cm → above target yields up to ^{256}Fm, excitation functions

^{40}Ar + ^{248}Cm → above target yields up to ^{256}Fm, excitation functions

^{40}Ca + ^{248}Cm → above target yields up to ^{256}Fm, below target to Th, excit. functions

^{44}Ca + ^{248}Cm → above target yields up to ^{256}Fm, below target to Th, excit. functions

^{48}Ca + ^{248}Cm → above target yields up to ^{256}Fm, below target to Rn, excit. functions

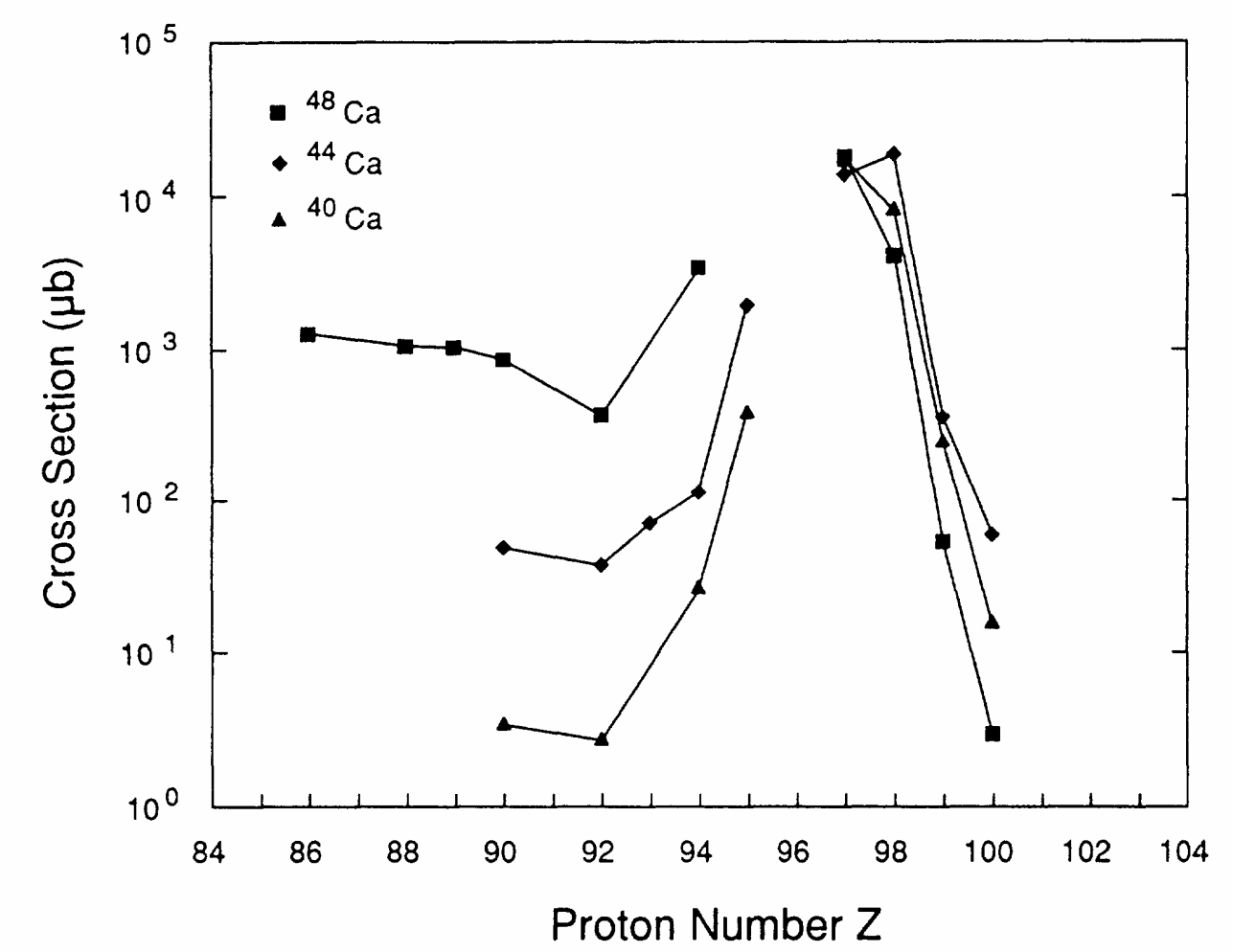


Common features

- Yields are highest for transfers of 1 and 2 protons from projectile to target
- FWHM of Gaussian distributions are 2,5 to 3 amu for above target yields
  ⇒quasi elastic reactions!
- FWHM of Gaussian distributions are 5 to 5,5 amu for below target yields
  ⇒deeply inelastic reactions!
- pronounced even-odd staggering of above target yields
- Orders of magnitude different cross sections for below target yields

A. Türler et al., Phys. Rev. C46, 1364 (1992)

Elemental yields $^{40,44,48}Ca + ^{248}Cm$



A. Türler et al., Phys. Rev. C46, 1364 (1992)

Production of Fm-isotopes in various HI transfer reactions

(additional data is available for ^{22}Ne, ^{31}P, ^{40}Ar, $^{40,44}Ca$ projectiles)

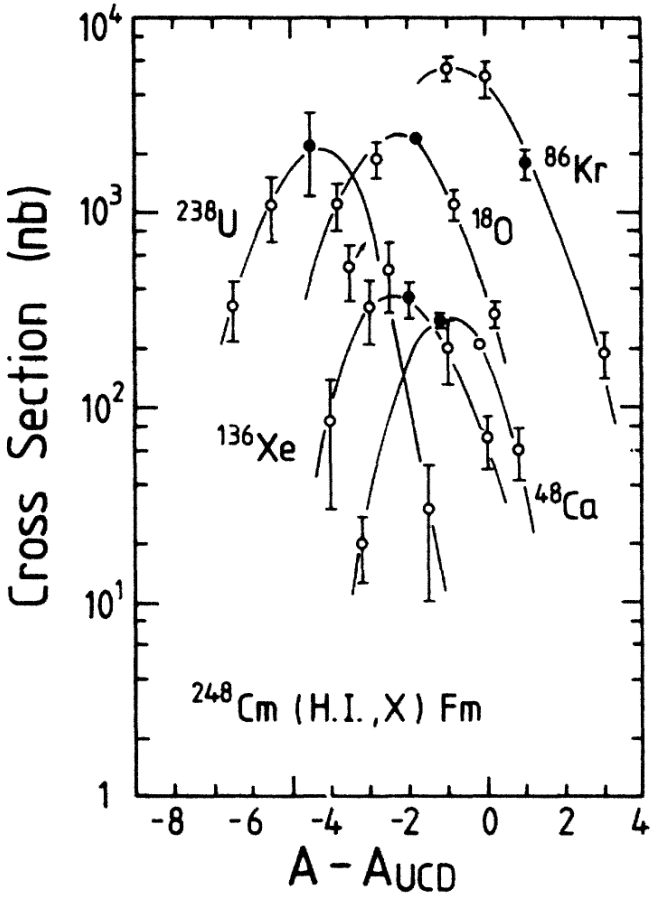
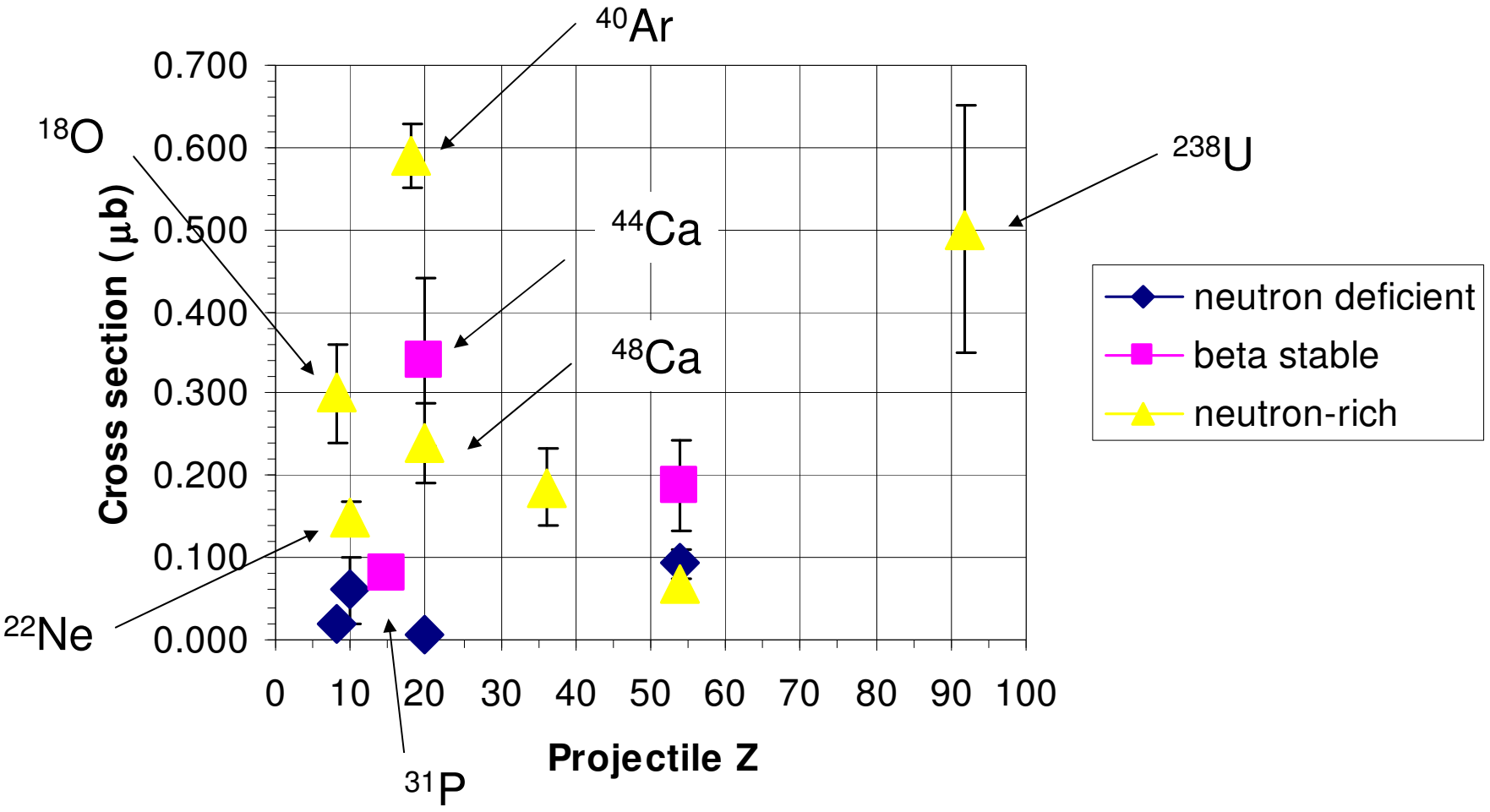


FIG. 8. Production of fermium isotopes from several heavy ion reactions with ^{248}Cm at energies near the nominal Coulomb barrier. The data are plotted against the difference of the nuclide mass number and the mass expected for a $Z=100$ species arising from a uniform charge density intermediate. The ^{254}Fm data points are filled in.

K.J. Moody et al., Phys. Rev. C33, 1315 (1986)

Analysis of the production of ^{256}Fm

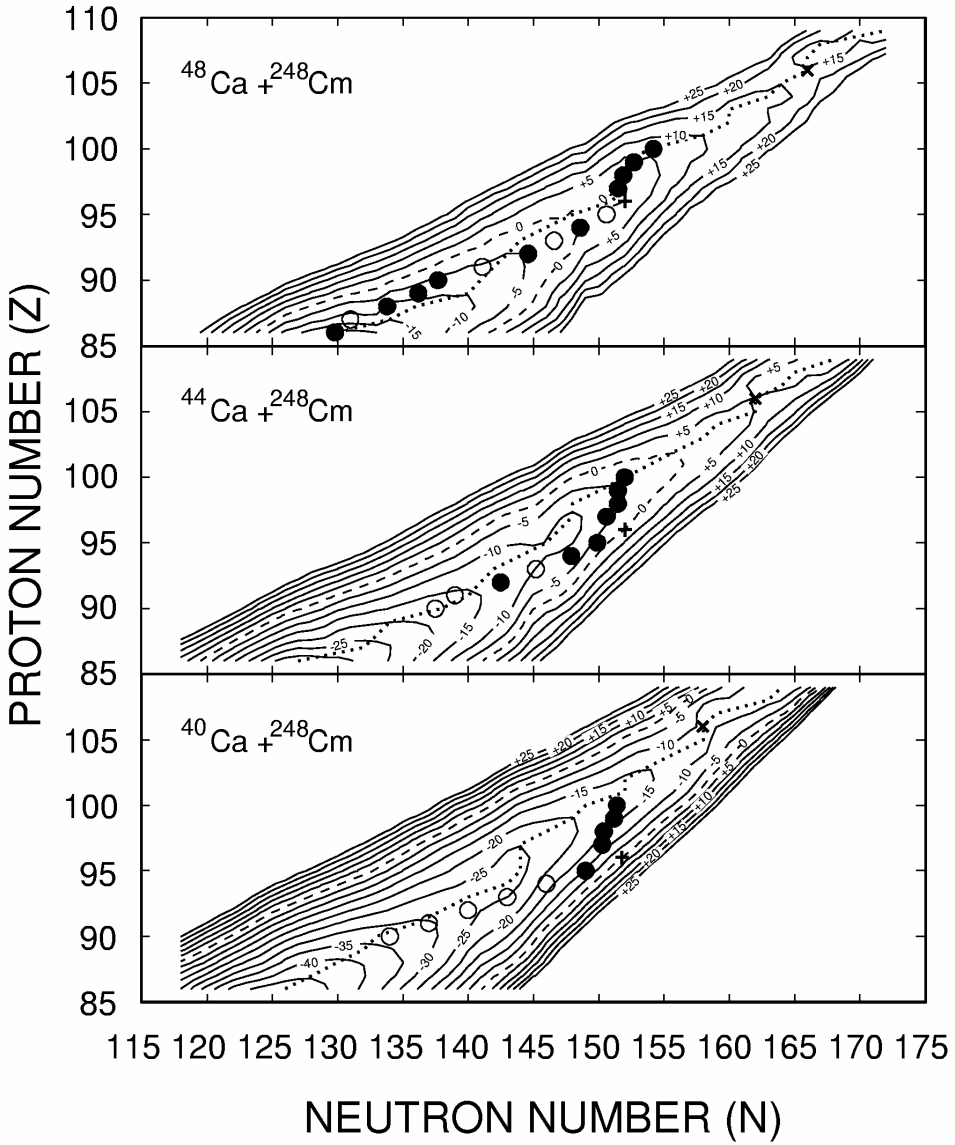


A qualitative interpretation of the results with the aid of potential Energy Surfaces

$$PES = V_{Prod} - V_{React} - Q_{gg}$$

$V_{Prod}(Z,N) - M_{TL} - M_{PL} = V_{Coul} + V_{Nucl} + V_{Cent}$

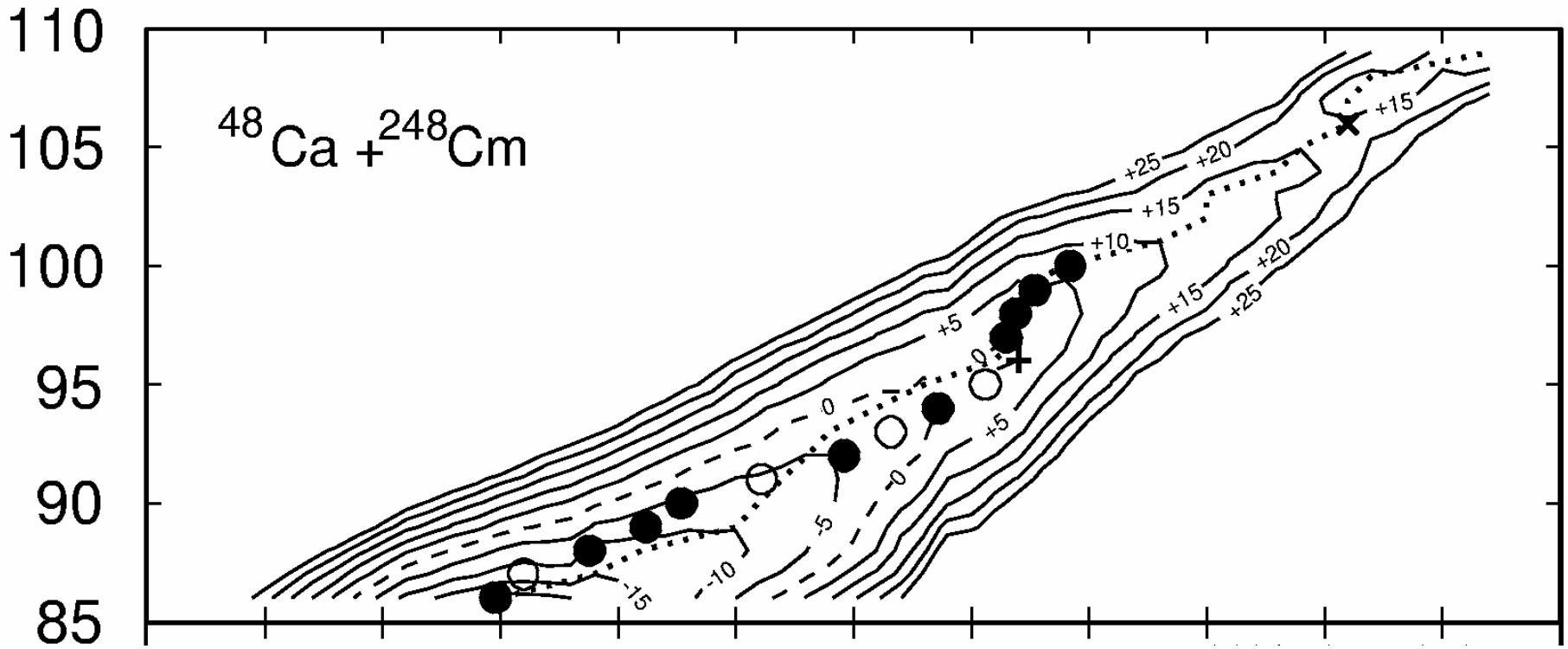
M_{TL}: mass target-like fragment
M_{PL}: mass projectile-like fragment
V_{Coul}: Coulomb potential at R_{int}
V_{Nucl}: nuclear potential at R_{int}
V_{Cent}: centrifugal potential at R_{int}



PES for the system
^{40,44,48}Ca + ^{248}Cm

A. Türler et al., Phys. Rev. C46, 1364 (1992)

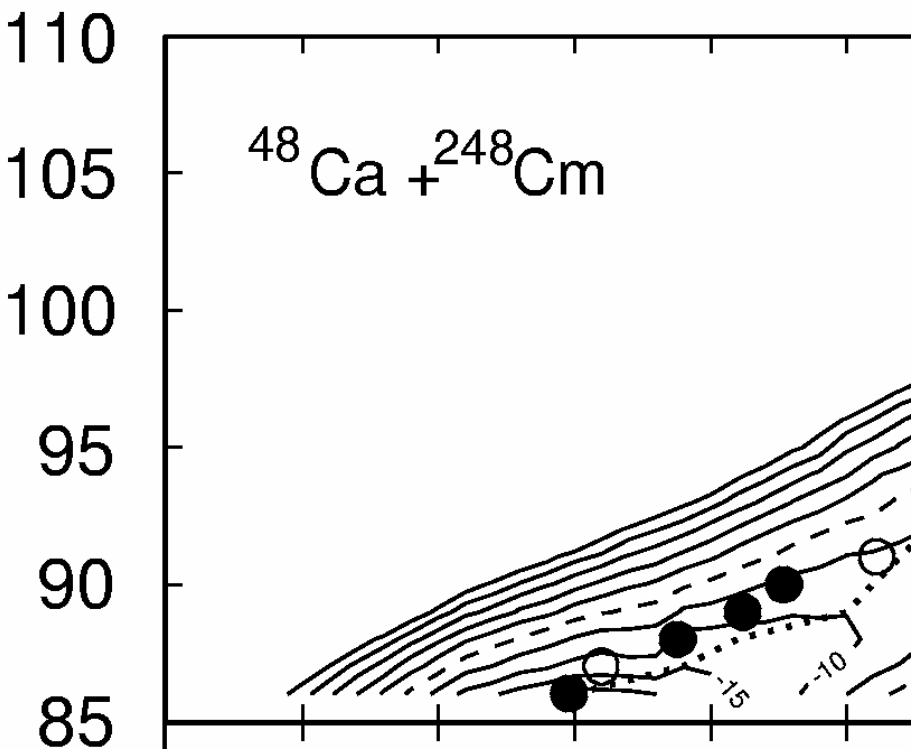
PES in detail: $^{48}Ca + ^{248}Cm$



Above target yields have unfavorable Q-values!
Below target yields have favorable Q-values!
Centroids of the distributions closely follow the valley of the PES

A. Türler et al., Phys. Rev. C46, 1364 (1992), D.C. Hoffman et al., Phys. Rev. C31, 1763 (1985)

PES in detail: $^{48}Ca + ^{248}Cm$



Above target yields have unfavorable
Below target yields have favorable Q
Centroids of the distributions closely

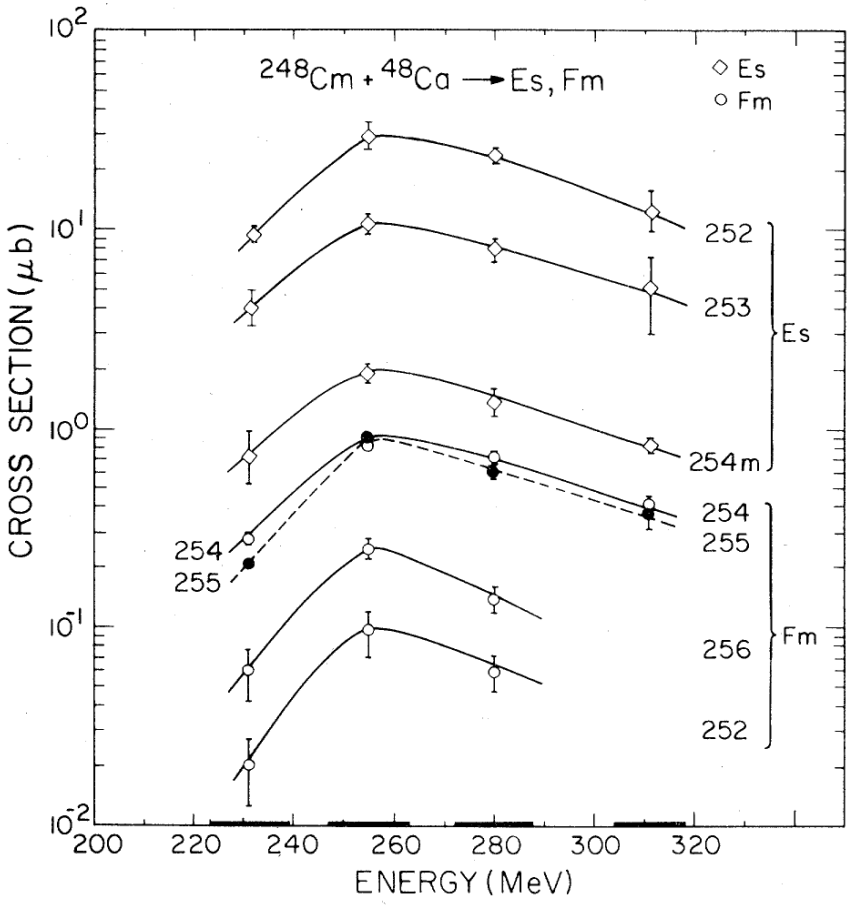
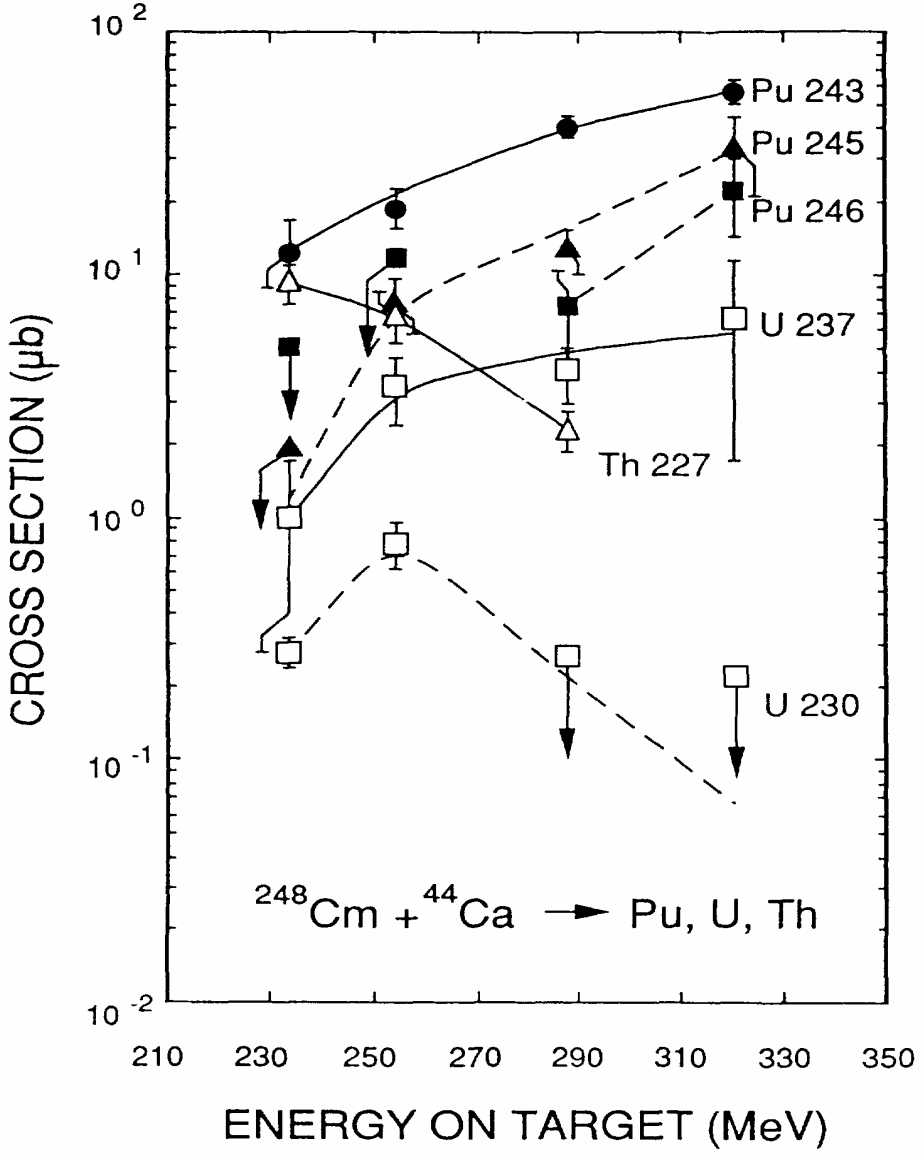
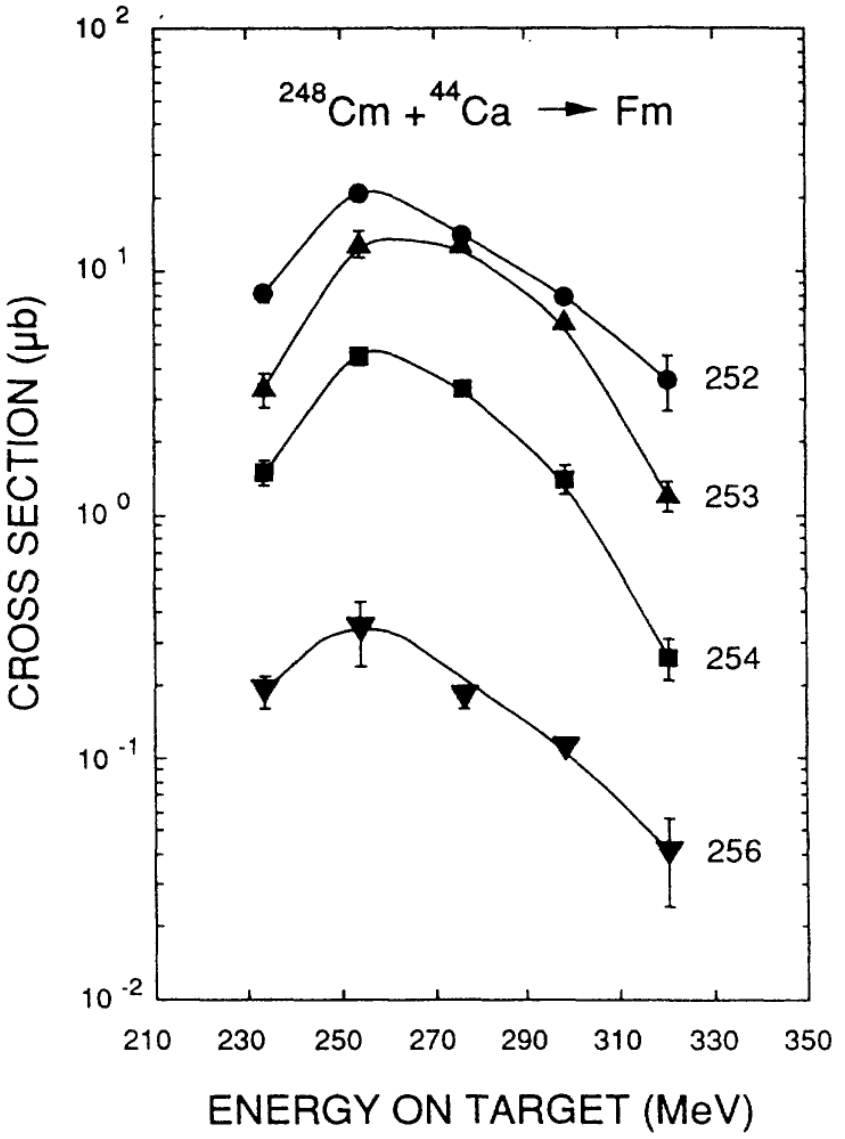


FIG. 8. Excitation functions for Es and Fm isotopes produced in the bombardment of ^{248}Cm with ^{48}Ca.

A. Türler et al., Phys. Rev. C46, 1364 (1992), D.C. Hoffman et al., Phys. Rev. C31, 1763 (1985)





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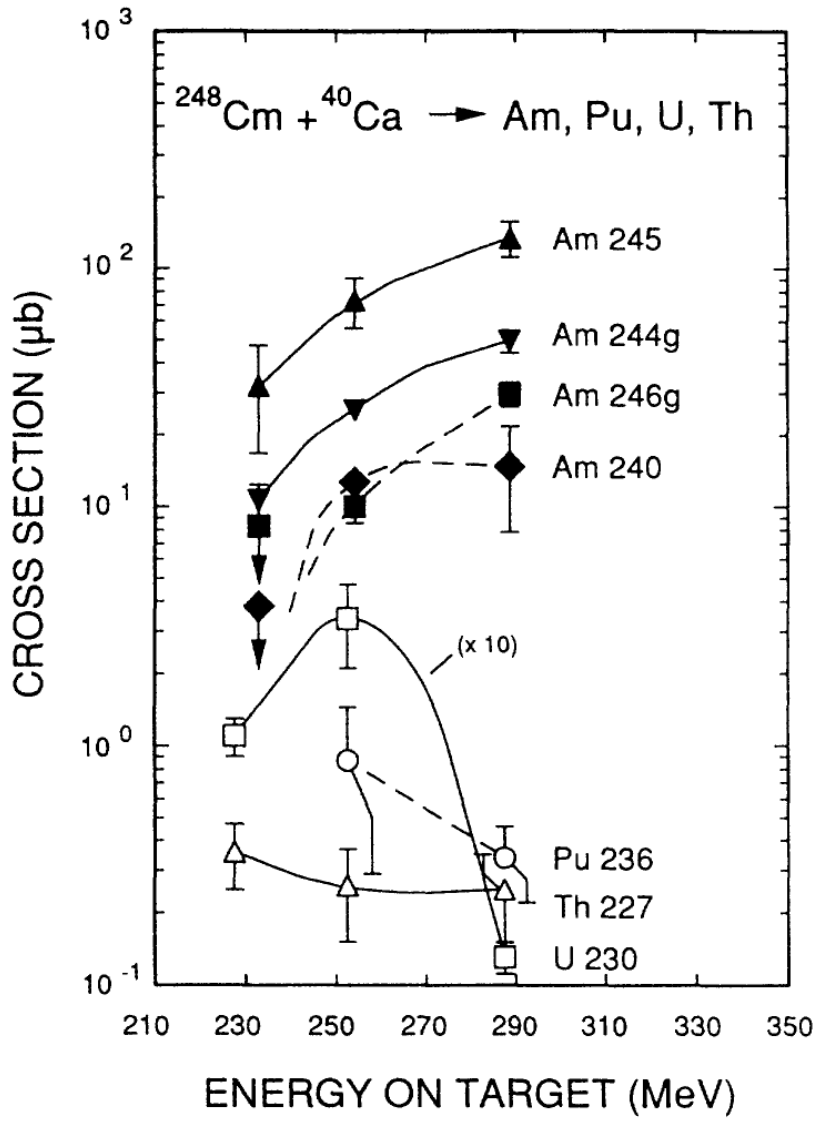

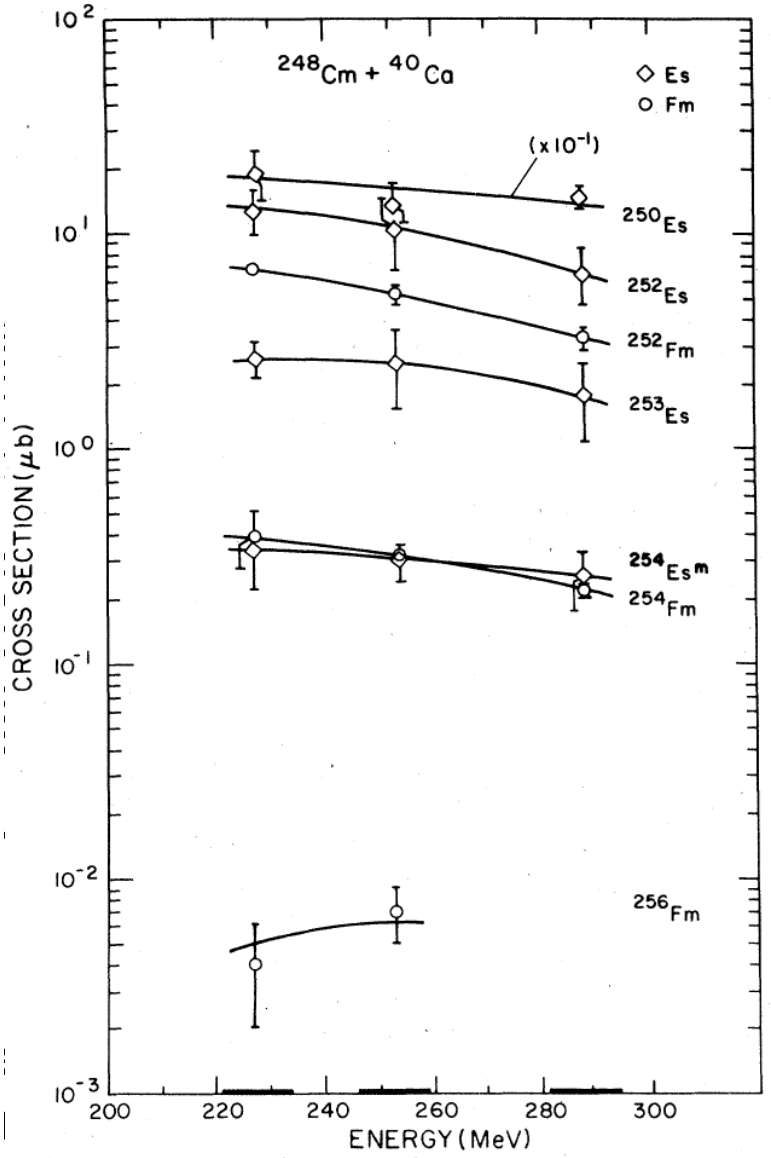

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Summary and Outlook

- ✓ There is quite a large body of data that needs to be analyzed with new quantitative models (we need a „HIVAP“ for transfer reactions)
- ✓ Transfer of pairs is obviously enhanced!
- ✓ Most neutron-rich does not mean highest prodcuction of neutron-rich target-like fragments, the PE is important!

Proposal: Are there Q-value effects in transfer reactions (i.e. as with ^{48}Ca in fusion)?

- ➢ Let us investigate reactions where the projectile-like fragment is magic or doubly magic (investigated was i.e. ^{40}Ar(-2p,-2n)^{36}S,
- ➢ i.e. ^{50}Ti(-2p)^{48}Ca, ^{54}Cr(-4p,-2n)^{48}Ca, ^{58}Fe(-6p,-4n)^{48}Ca, …