Asymmetric quasifission in reactions with heavy ions

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Flerov Laboratory of Nuclear Reactions

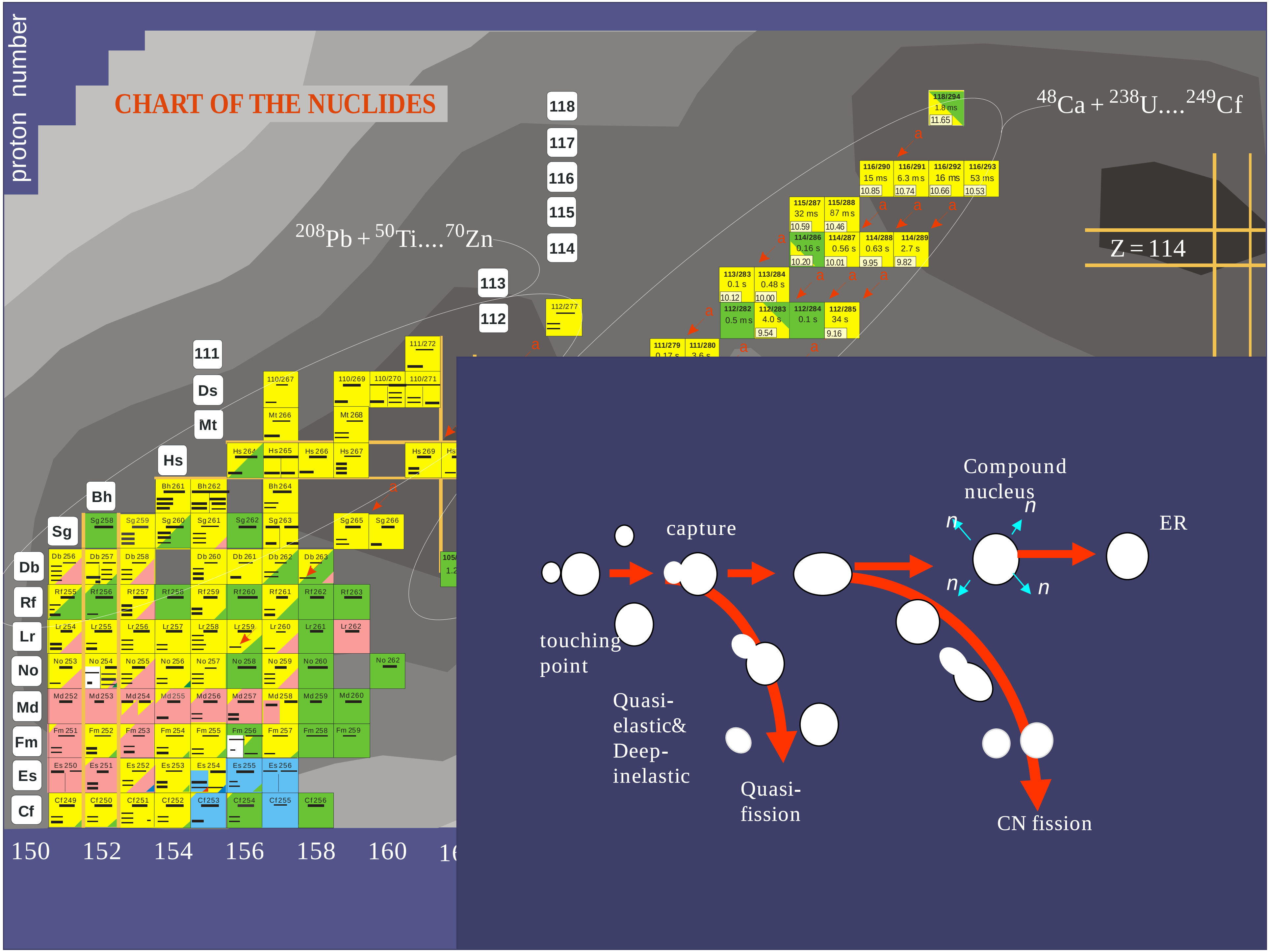
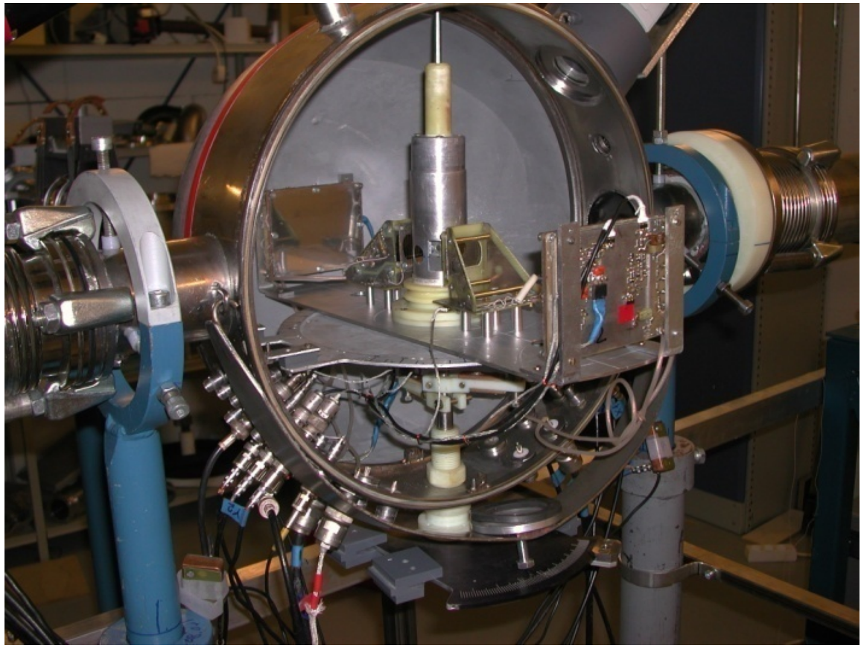
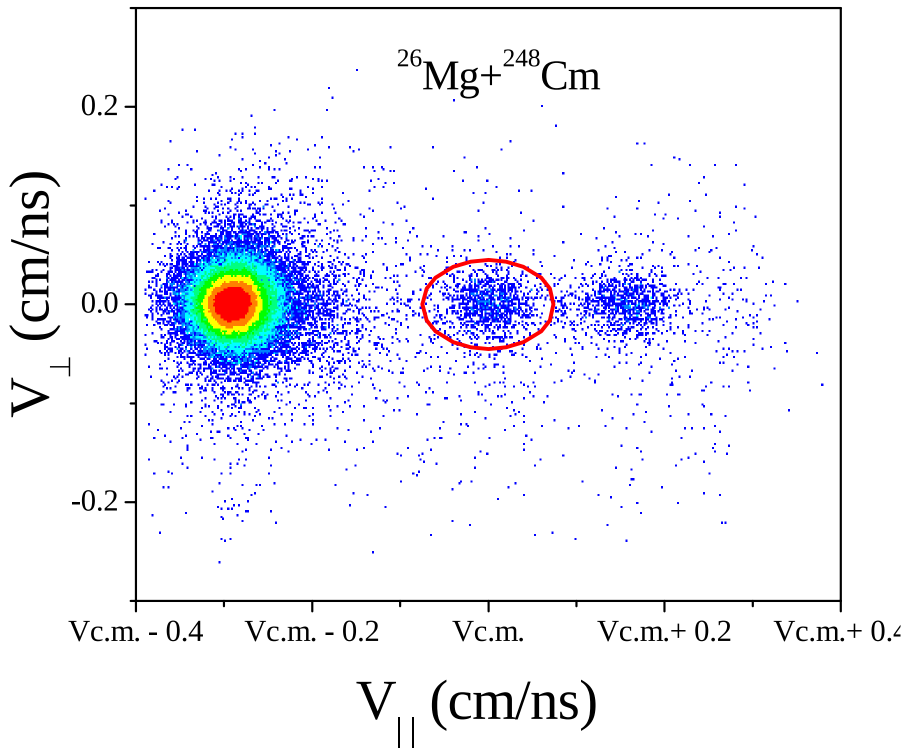


CHART OF THE NUCLIDES
proton number
208Pb + 50Ti....70Zn
48Ca + 238U....249Cf
Z = 114
118
117
116
115
114
113
112
111
Ds
Mt
Hs
Bh
Sg
Db
Rf
Lr
No
Md
Fm
Es
Cf
150
152
154
156
158
160
touching
point
capture
Compound
nucleus
ER
n
Quasi-
elastic&
Deep-
inelastic
Quasi-
fission
CN fission

CORSET: correlation set-up for the measurements of the velocities of binary fragments



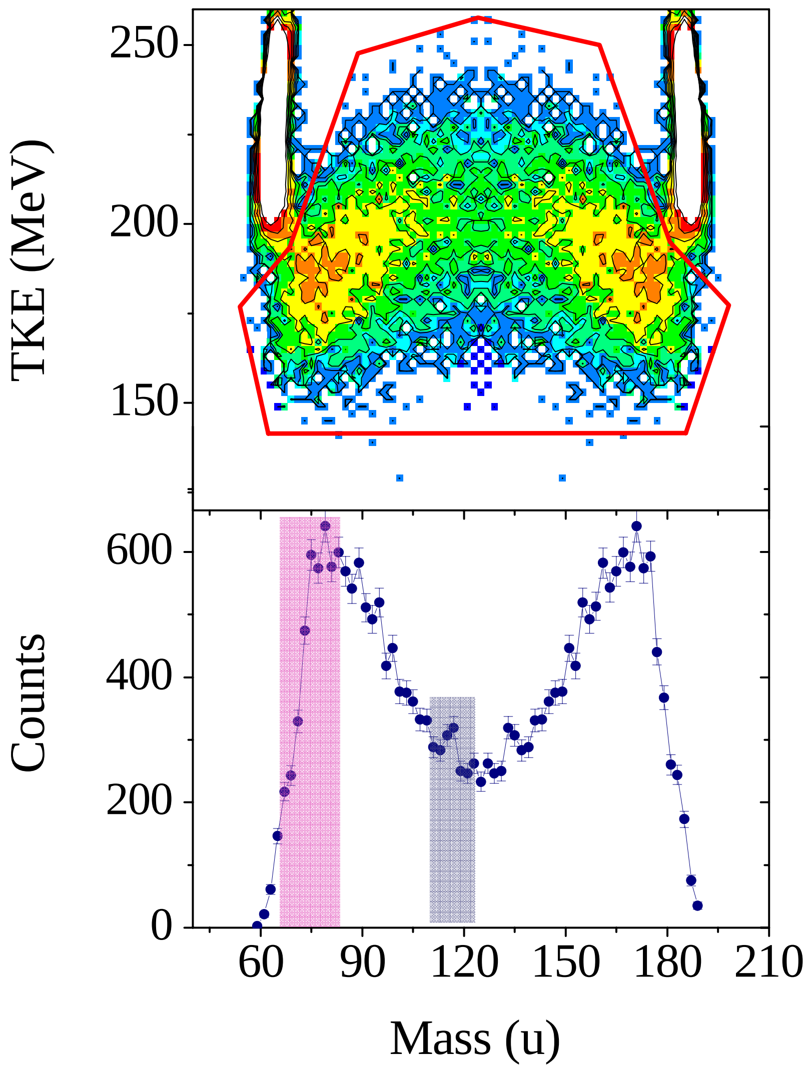


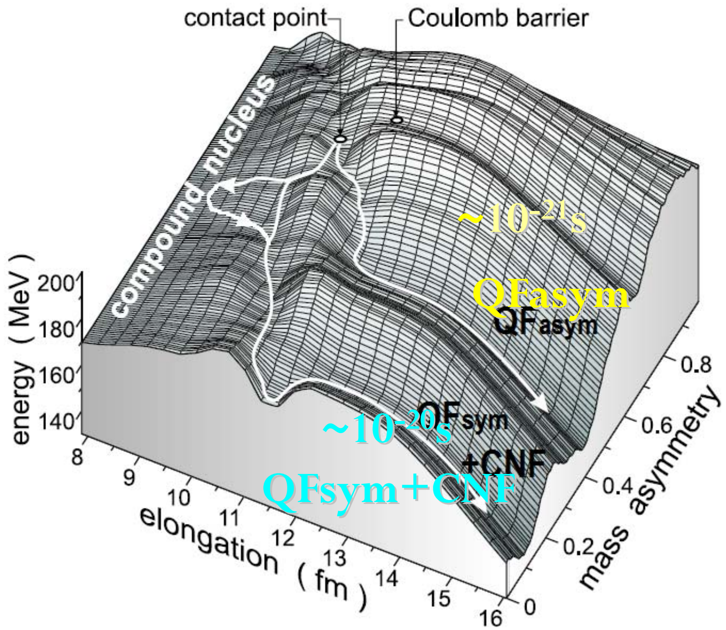
- **Measured values:**

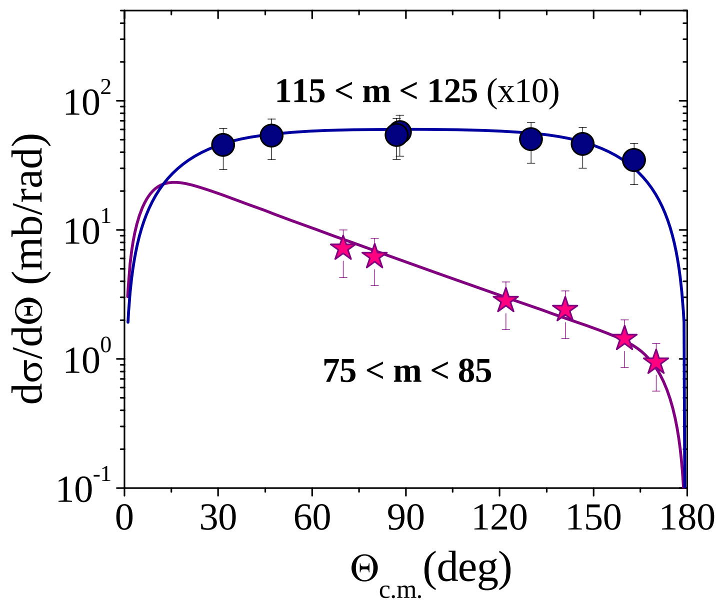
  V1lab, V2lab, θ1lab, θ2lab
- **Extracted values:** Mass, Energy, TKE, θcm for the both fragments

Heavy ion-induced reactions: binary channel

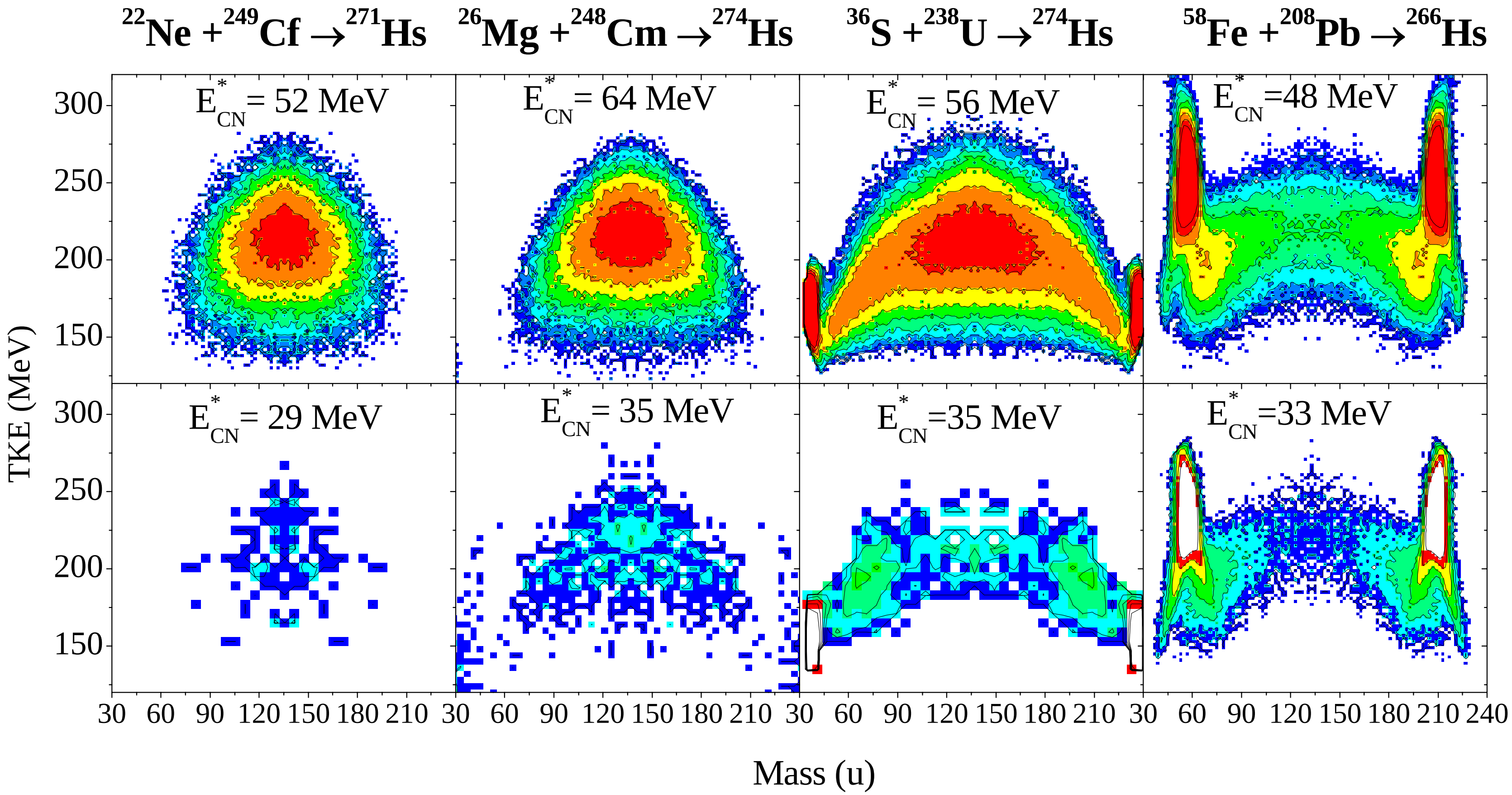
$^{64}Ni + ^{186}W \rightarrow ^{250}No^{*}$ $\boldsymbol{E^{*} \cong 40\ MeV}$





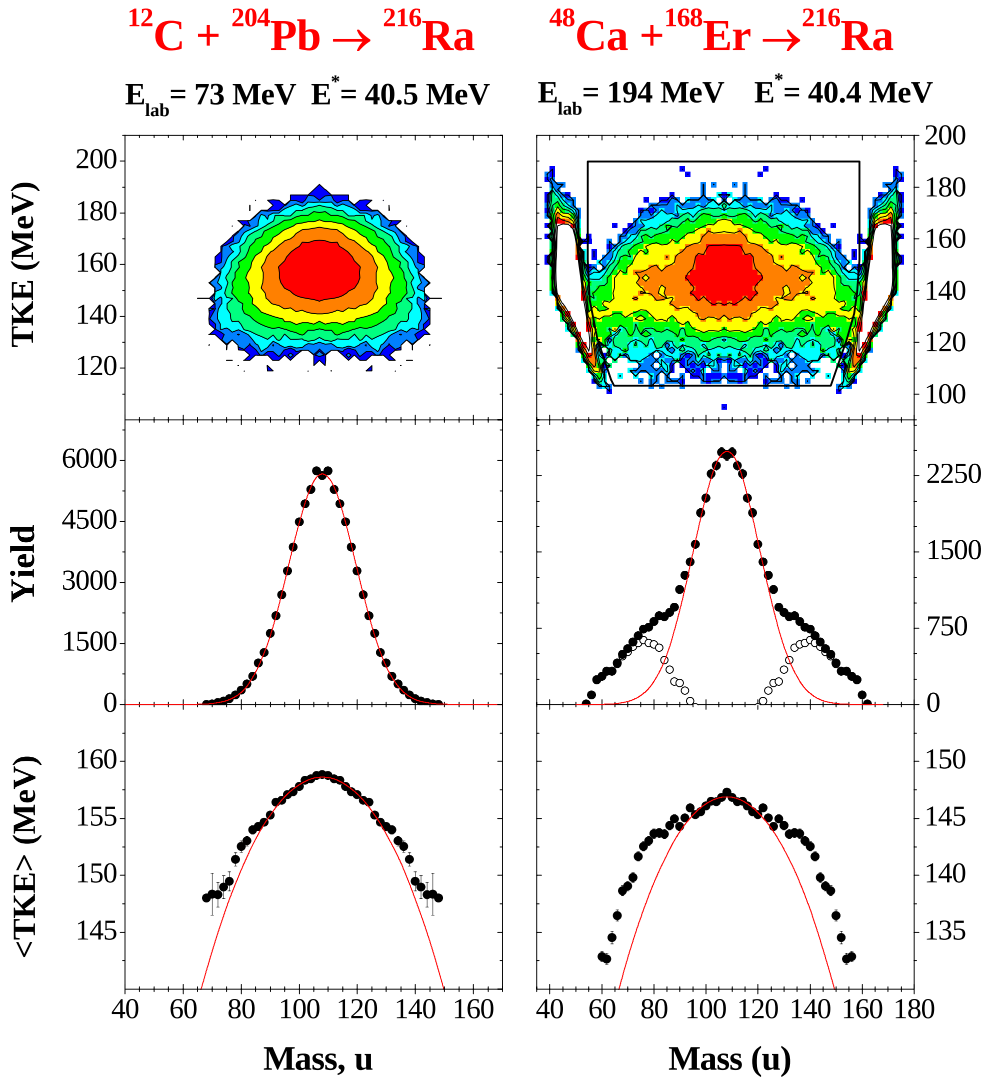


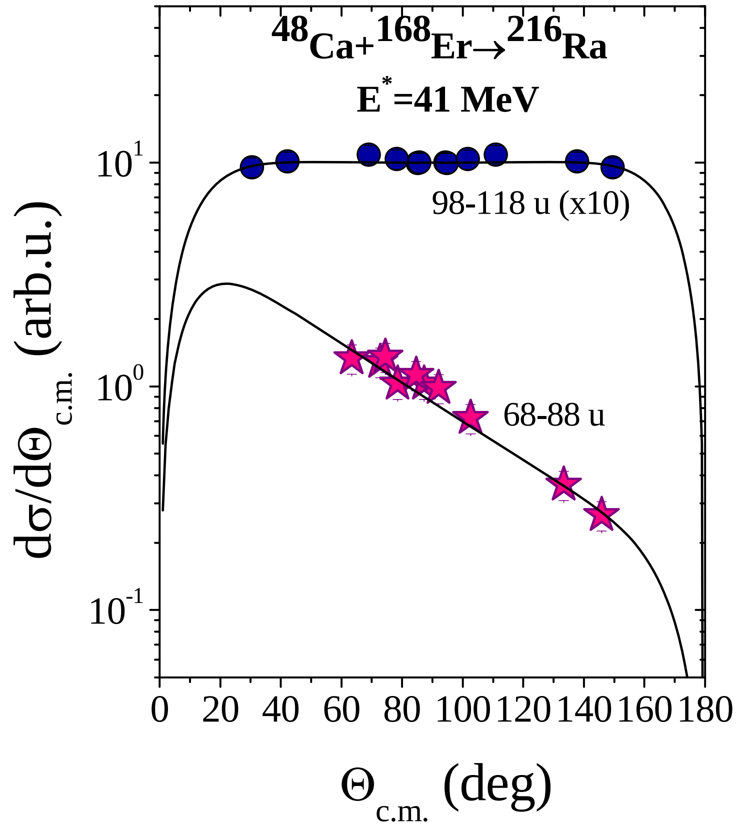
Competition between fusion and QF processes: Hs (Z=108) composite systems



Z_1Z_2=980 1152 1472 2132

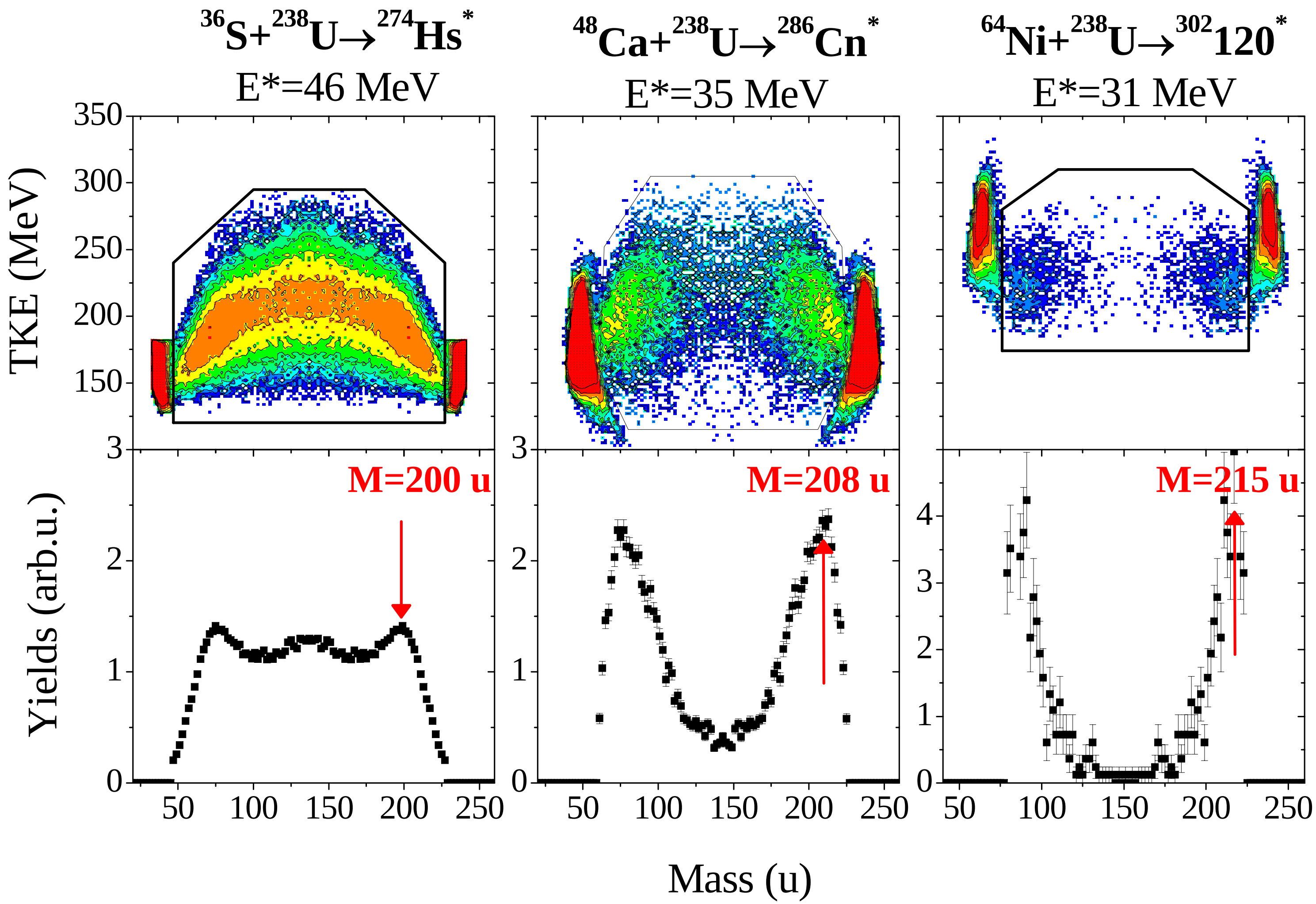
Presence of asymmetric QF in the medium composite systems (A~190-230u)





Z_1Z_2=492 1360

Asymmetric QF in the syperheavy composite systems

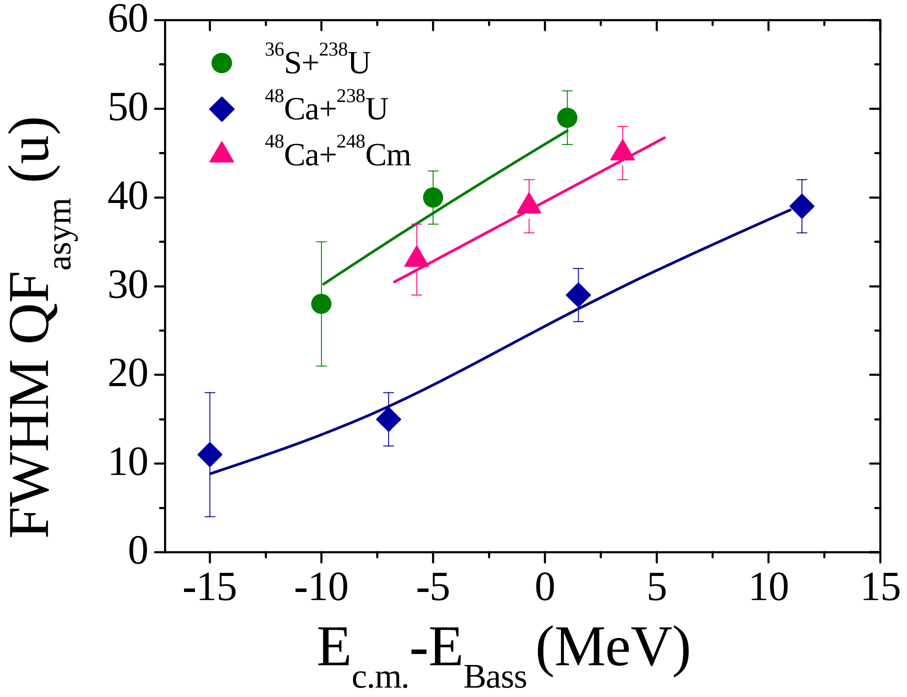


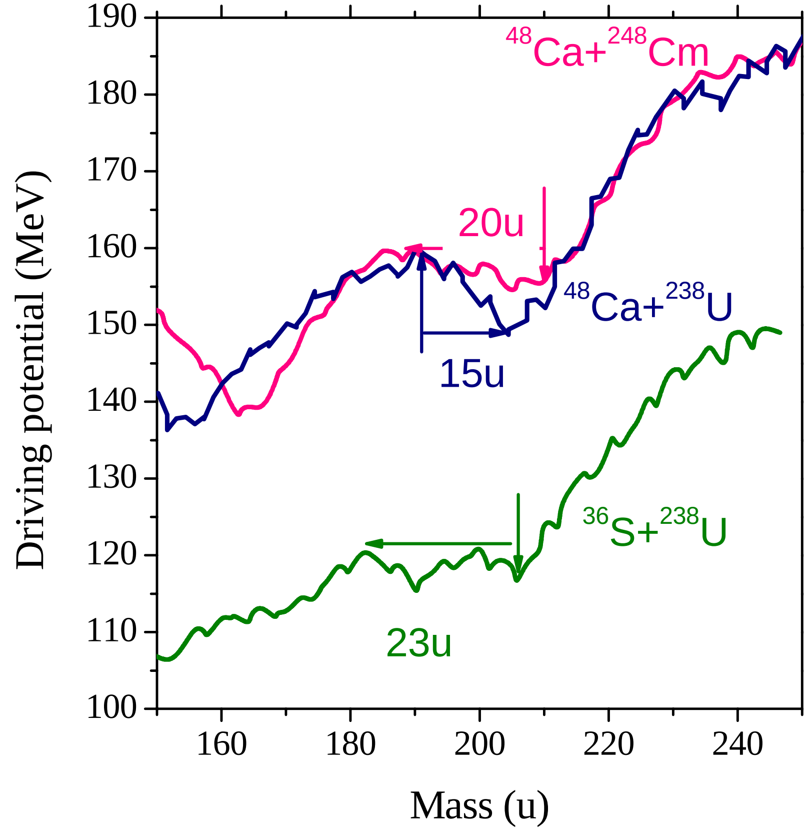
The positions of heavy peaks in the primary mass distributions of asymmetric QF fragments in reactions with heavy ions

Reactions	Z_1Z_2	<M_H>	<$M_H$shells>	Reference
$^{30}Si+^{238}U$	1288	178	199,3	Nishio et al. (EXON09)
$^{36}S+^{238}U$	1472	200±3	202,5	Nishio, Itkis(PRC83)
$^{40}Ar+^{238}U$	1656	204	204,5	Nishio et al. (EXON09)
$^{48}Ca+^{238}U$	1840	208±3	208,5	Kozulin et al.(PLB683)
$^{48}Ca+^{244}Pu$	1880	210±3	211,8	Itkis et al. (NPA787)
$^{48}Ca+^{248}Cm$	1920	211±3	213,8	Itkis et al. (NPA787)
$^{64}Ni+^{238}U$	2576	215±3	216,5	Kozulin et al.(PLB686)

$$< M_H shells>=((M_{CN}-M_{Z=28})+(M_{CN}-M_{N=50})+M_{Z=82}+M_{N=126})/4$$

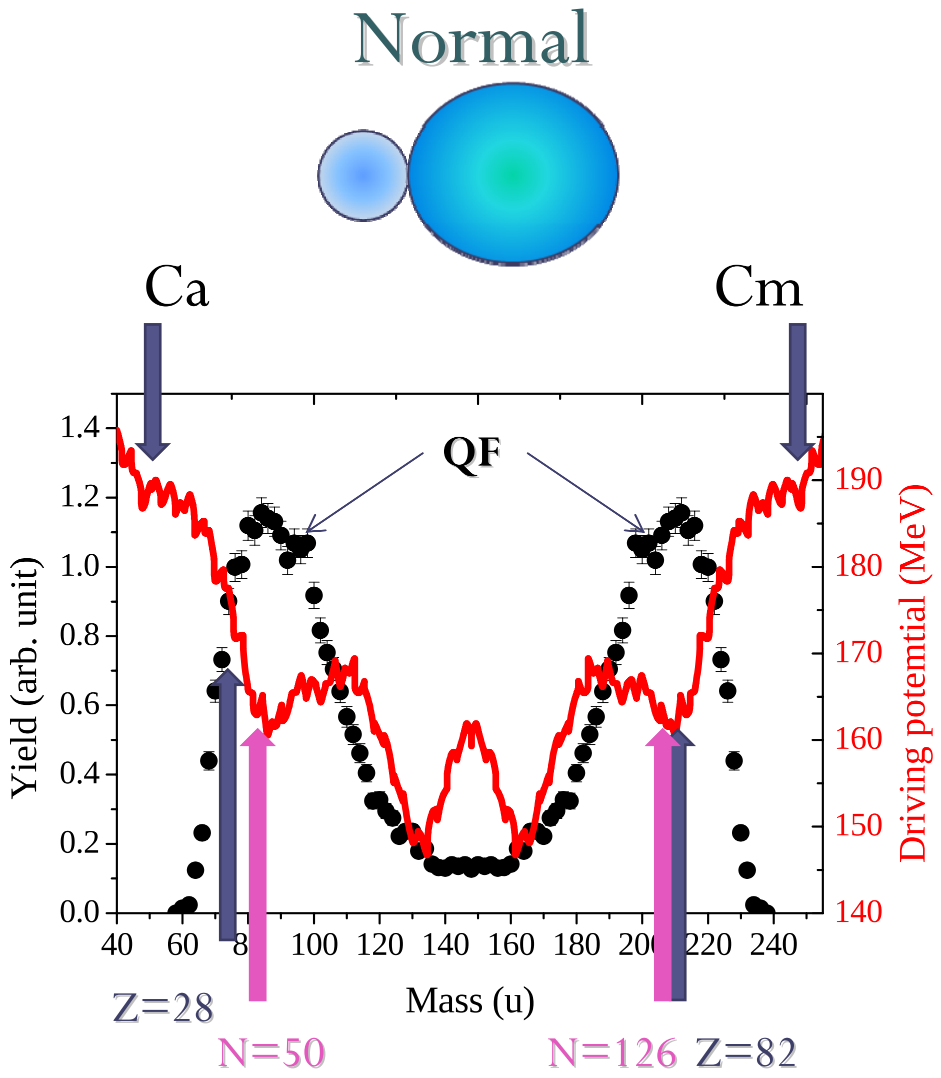
The widths of Qfasym mass distributions

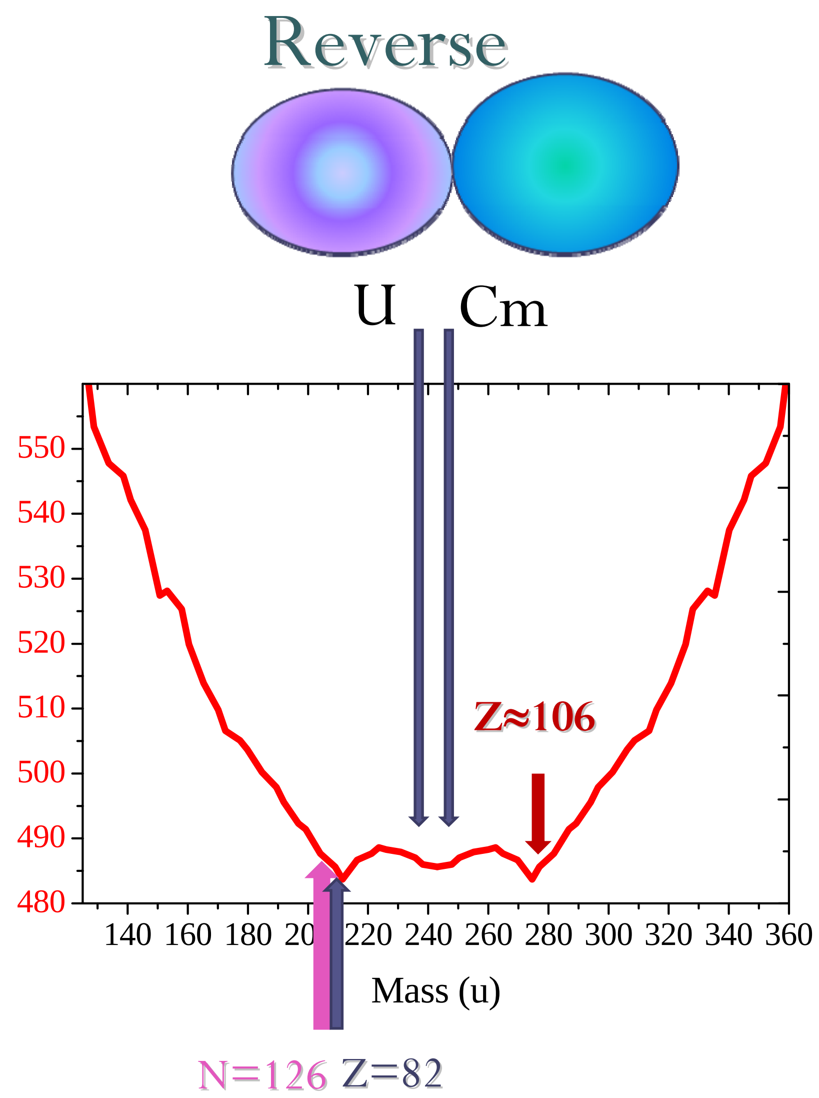




While the relative contribution of QF to the capture cross section mainly depends on the reaction entrance channel properties, such as mass-asymmetry, collision energy, deformation of interacting nuclei and the Coulomb factor Z_1Z_2, the features of asymmetric QF are determined essentially by the driving potential of composite system.

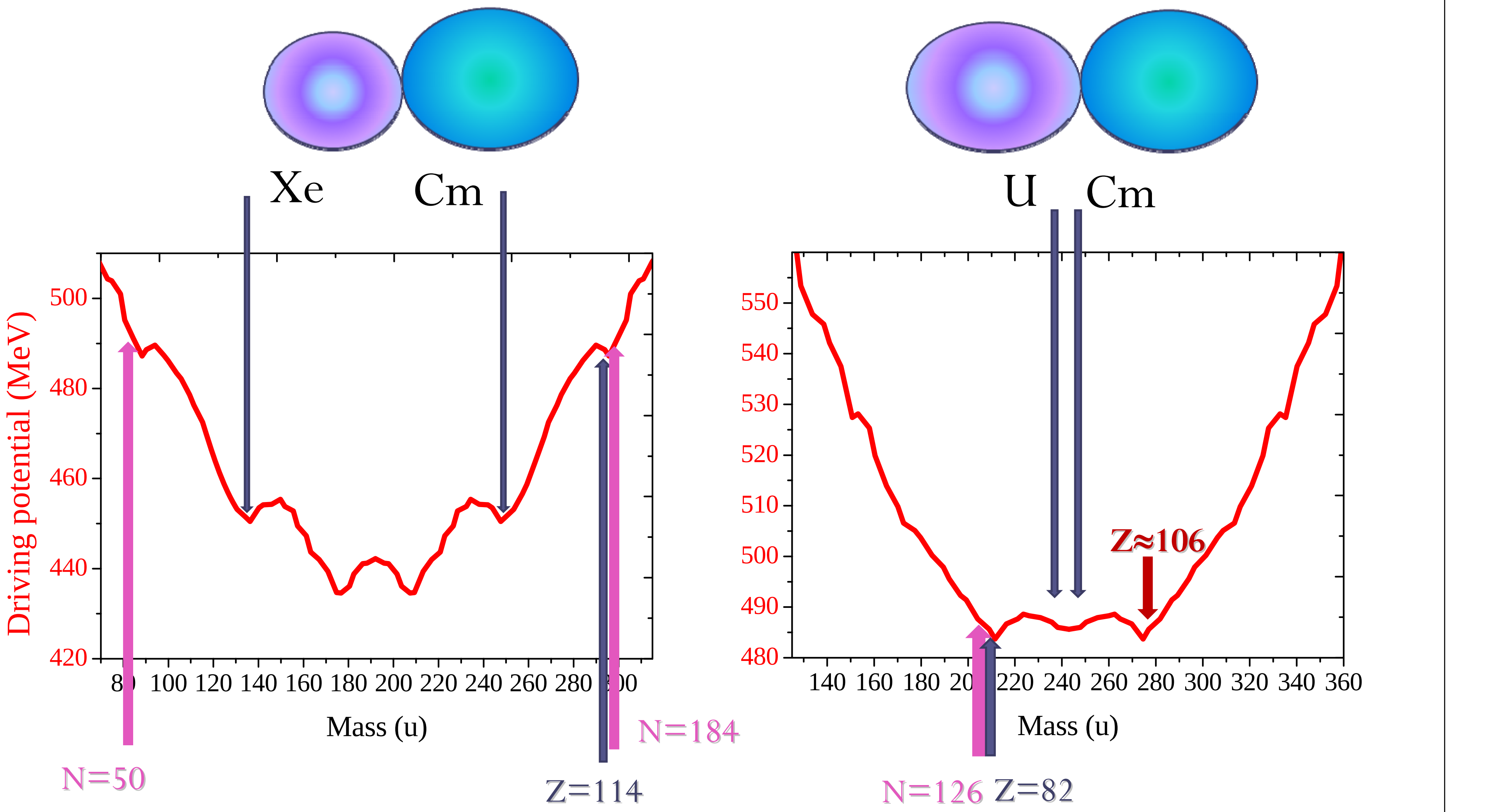
Asymmetric QF





Asymmetric QF

Reverse



Summary

- While the relative contribution of QF to the capture cross section mainly depends on the reaction entrance channel properties, the features of asymmetric QF are determined essentially by the driving potential of a composite system.
- The major part of the asymmetric QF fragments peaks around the region of the Z=82 and N=126 (double magic lead) and (Z=28 and N=50) shells, and the maximum of the yield of the QF component is a mixing between all these shells. Hence, shell effects are everywhere present and determine the basic characteristics of fragment mass distributions.
- An alternative way for further progress in SHE can be achieved using the deep-inelastic or QF reactions. To estimate the formation probabilities of SHE in these reactions the additional investigations are needed.

Collaboration

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Thank you for your attention!