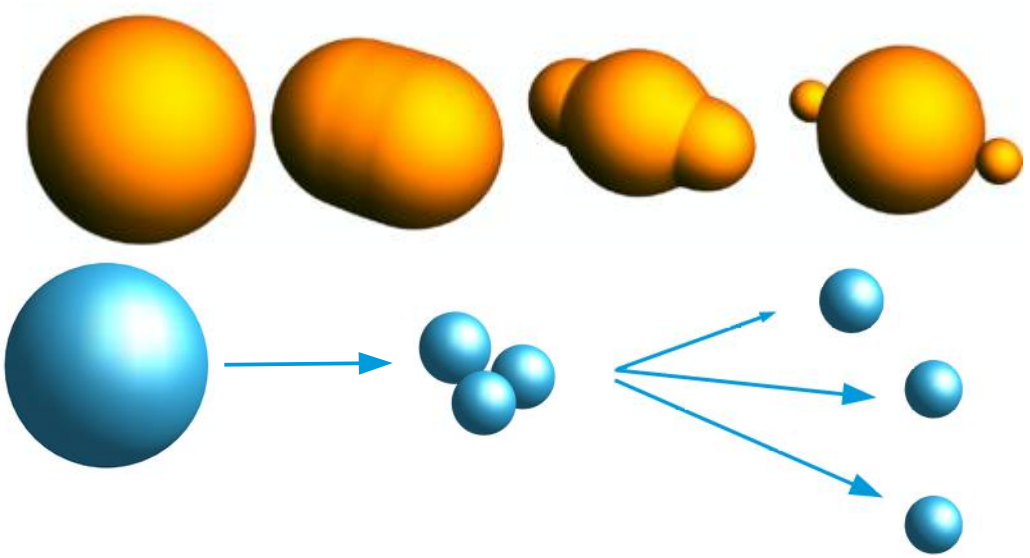
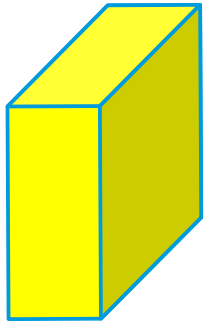
Explore the three-fragment decay of relatively heavy QP in the Fermi domain

Related to very deformed configurations produced at high spin and/or to the role of alpha-clusters in deformed nuclei





FAZIA + INDRA

A few references (warning, not all specific of this channel but somehow related)

* THEORY Wong Phys. Lett. B 41, 446 (1972).

Wong proposed that toroidal exotic shapes can be favoured by shell effects or cluster-structures for medium-light nuclei and by the strong Coulomb field for heavy nuclei especially at high spin.

* EXP Hannamann PHYSICAL REVIEW C 109, 054615 (2024)

In this case associated to N=Z system (cluster structures) very low upper limit for cross section (tens of microbarns) has been deduced for these structures.

***** THEORY Karthikraj et al PHYSICAL REVIEW C 102, 024607 (2020)

Ternary fission of α-structured nuclei with 12 A 60: A three-body decay approach

* THEORY Tian PHYSICAL REVIEW C 82, 054608 (2010)

Au Au at 15MeV/u in iQMD to investigate the ternary events (sequential vs. direct)

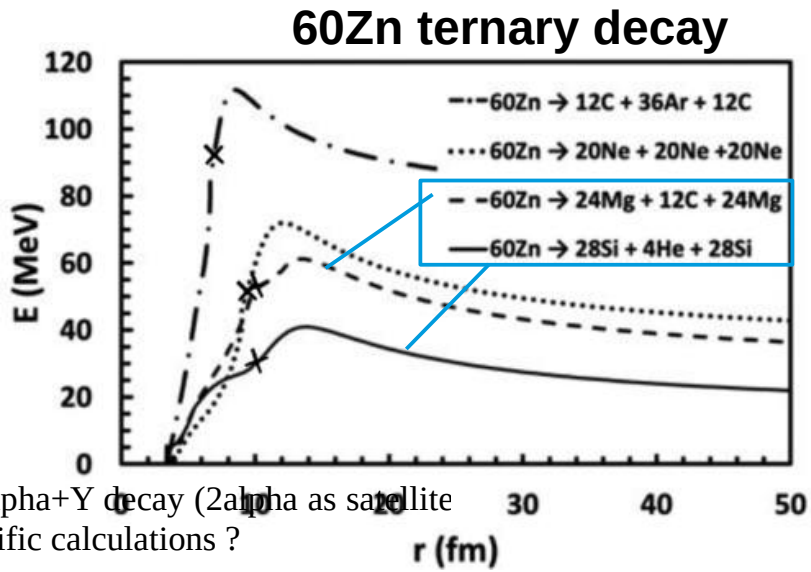
*EXP CHIMERA Swira-Shalot PRL 101, 262701 (2008); also a paper on same subject and system at 23MeV/u

A few references

* THEORY

Royer et al PRC Phys. Rev. C 109, L041604, 2024

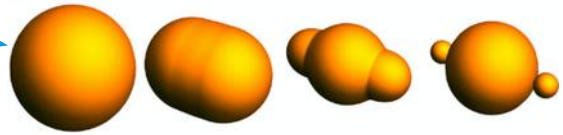
FRAME: liquid drop model



Calculations within the LDM. Main focus on 2alpha+Y decay (2alpha as satellite for medium-mass nuclei. Can we ask Royer specific calculations ?

Most Calculations within the LDM devoted to Heavy nuclei.
Main focus on 2alpha+Y decay (2alpha as satellites)
However there are also hints for medium-mass nuclei.

Can we ask Royer specific calculations ?



Possible reactions

Possible feasible systems (beams found in the GANIL web as available)

$^{158}Gd_{64}$ at 34MeV/u on X X=C,Mg,S
$^{181}Ta_{73}$ at 35MeV/u on X X=C,Mg,S
$^{56}Ni_{28}+^{12}C_{6}$ at 30-40MeV/u more related to alpha cluster structures (N=Z)
$^{112\text{-}124}Sn_{50}$ +C at 35MeV/u on X X=C isospin d.o.f. exploration?

Ta+S at 35

vcb== 135.32 Ecm== 951.73

b grazing= 11.5113468 11.5113468

proj and targ graz.lab angle= 1.315 85.6 proj and targ graz.cm angle= 8.778 171.2

ellegrazing= 405.5 R12= 12.4288149 vcm,massa ridotta= 6.99 27.192

EkinCNLAB (0deg)=, E/A_CN= 5383.26270 25.2735329 Static Fissility for full CN= 0.767804742

Ecm/Atot= 4.46824932

Xfusfev/Xtot(Eudes)= 0.146170184 XfusCF/Xtot(Eudes)= 8.57505947E-02

Possible feasible systems (beams found in the GANIL web as available)

$^{158}Gd_{64}$ at 34MeV/u on X X=C,Mg,S some possibilitiy also for isospin dof?

$^{181}Ta_{73}$ at 35MeV/u on X X=C,Mg,S

Gd+Mg

vcb== 93.8366013 ecm== 708.39

b grazing= 10.97 proj and targ graz.lab angle= **1.070** 85.93

proj and targ graz.cm angle= 8.134 171.86 ellegrazing= 292.062561

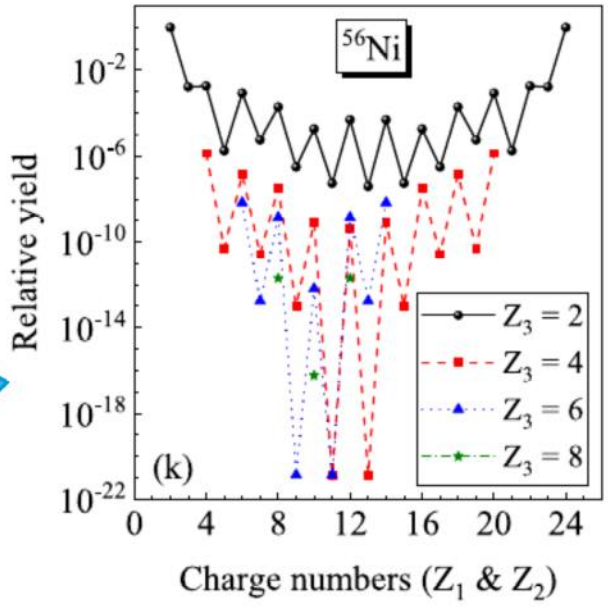
R12= 11.7855940 vcm,massa ridotta= 7.038 20.83

56Ni+C

vcb== 26MeV ecm== 346

b grazing= 8.8 proj and targ graz.lab angle= **0.8** 88

ellegrazing= 113 R12= 9.2 vcm,massa ridotta= 6.8 cm/ns 9.8



PHYSICAL REVIEW C 102, 024607 (2020)

Exotic breakup channels in QP decay

...in particular producing 3Body (elongated ? toroidal?) exotic configurations
– Role of high spins available in the entrance channel
– Role of a-clusters, if N=Z reactions used
– Role of isospin dof, if isotopic chain of beam ions used

Experimental and general comments

- Topics not much studied so far
- feasible at GANIL (not possible with a Spectrometer)
- Grazing below the acceptance of FAZIA. No risk of projectile implantation and elastic huge rates
- no fission from the QT
- QT decay/remnants should be clearly separated (vrel,thetarel and N/Z) and scarcely accepted anyhow
- -possible (rare) fusion residues should be almost along beam line (not detected and very big)
- -BR assessment for this channel (3B breakup vs. others)
- -if 3 fragments detected we could attempt N/Z balance (for Ta 72/3=24 at the limit of A-ident in Fazia, of course this is for a breakup in 3 similar fragments; for Ni+C broader range of accepted split asymmetry, 34/3=11 easy)
- sequential vs. Prompt decay in 3B : 2 2b steps vs. 1 3b steps
- 2b (normal fission) decay included if M>1 trigger in FAZIA
- max E densities (<4MeV) generally below the known MF threshold (5-6MeV/u)