New directions in study of ternary decays

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CCT progress from ISINN to ISINN





Collinear Cluster Tripartition



0. Short review of the previous results

CCT gross-structure (bump) in ²⁵²Cf (sf)



Structures symmetric to the arms



 LF_1

HF

LF₂

Confirmation of CCT gross-structure in ²³⁵U (n_{th},f)



Z evidence: it is really Ni-bump



COMETA data: Ni-bump & Ge-bump without any gating









1. Confirmation of the shape isomeric states in FF

Recent Experiments at the IBR-2 reactor









2. Searching for new long-lived shape isomers

Theoretical predictions



Figure 1. Evolution of nuclear shapes during the deformation process from one parent nucleus 252Cf to three separated fragments 146Ba, 10Be, and 96Sr.



J. Phys. G: Nucl. Part. Phys. **26** (2000) L97–L102 Nuclear qusi-molecular states in ternary fission

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The half-lives of some quasimolecular states which could be formed in the 10Be and 12C accompanied fission of 252Cf are roughly estimated to be the order of 1 ns, and 1 ms, respectively.

> The liquid drop model deformation energy versus separation distance for the 10Be accompanied cold fission of 252Cf with 132Sn and 100Zr heavy fragments. The new minimum appears in the shaded area from *Rov*3 to *Rt*.



Figure 3. The liquid drop model, *E*LD, the shell correction, δE , and the total deformation energies, *E*, for the 10Be accompanied cold fission of 252Cf with 146Ba and 96Sr heavy fragments. The new minimum appears in the shaded area from *Rov*3 to *Rt*.

Theoretical predictions

Table 1. Calculated half lives of some quasi-molecular states ²⁵²Cf.

Particle	Fragments		Q _{exp} (MeV)	K	$\log T(s)$
¹⁰ Be	132Sn	110Ru	220.183	19.96	-11.87
	138Te	104 Mo	209.682	25.23	-9.59
	138Xe	104Zr	209.882	26.04	-9.23
	¹⁴⁶ Ba	⁹⁶ Sr	201.486	22.98	-10.56
¹² C	147La	⁹³ Br	196.268	39.80	-3.26
	142Ba	⁹⁸ Kr	199.896	42.71	-1.99
	140Te	100Zr	209.728	38.21	-3.95
	132Sn	¹⁰⁸ Mo	223.839	31.46	-6.88

In red: ¹²C accompanied ternary decay with half lives ~ 1ms & 10ms

Preliminary result



3. New short lived shape isomers ?

Mass-mass distribution from235U(n, f) reaction. Strange lines M1=M2+const





"Unphysical" prolongation of the lines into the region far above of the mass of the mother system...?!

Hypothesis: LCP delayed fission isomers (Lcp delayed Fission Isomers - LFI)







The same in the larger scale

The same origin of all tilted lines M1~=M2+const ? No...

Also tilted line



M2 (amu)

The same in detail...





Also symmetrical initial configuration



Evidently, it is not LFI, but with out any doubt, 3 last examples are also bright manifestations of clustering.



M₂ (amu)





One more example for the collection...

COMETA, Cu foil, n=1 mass-mass plot



Conclusions

1. Our CCT dedicated experiments apparently opened new field for investigation of new shape isomers based on at least ternary prescission configurations namely:

- shape isomers in conventional FF (expected life time $\tau^{\sim}\,\mu s)$
- long lived shape isomers (Poenary prediction)

τ~ **ms**

- LCP delayed fission isomers (LFI)
- τ~ < <mark>ns</mark>
- 2 We observe as well linear trajectories in the correlation mass plots differ from those linked with LFI, nevertheless, all of them are very bright and original manifestations of clustering in cold nuclei.
- 3. We treat the results behind these conclusions as the indications of interesting physics . To be sure more convincing methodics based on the flash-ADC technique is in progress.



C12_r5, mos1&2 only