Complex nuclear-structure phenomena revealed from the nuclide production in fragmentation reactions

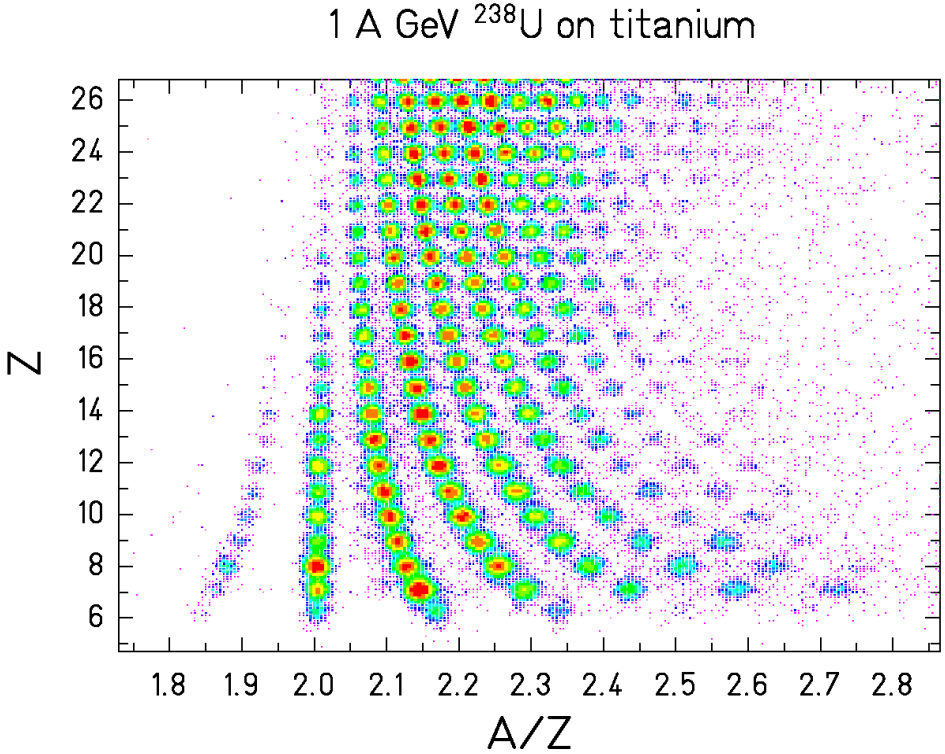
M. V. Ricciardi[1], A.V. Ignatyuk[2], A. Kelić[1], P. Napolitani[1], F. Rejmund[3], K.-H. Schmidt[1], O. Yordanov[1]

[1]GSI, Darmstadt, [2]IPPE, Obninsk, Russia, [3]IPN, Orsay, France

Nuclear Physic A 733 (2004) 299-318

OUTLINE

- Experimental data from 1 A·GeV $^{238}U \rightarrow$ Ti at the FRS (GSI) reveal complex structural effects
- Analysis of the results with statistical evaporation model
- The role of pairing and other possible effects
- Conclusions



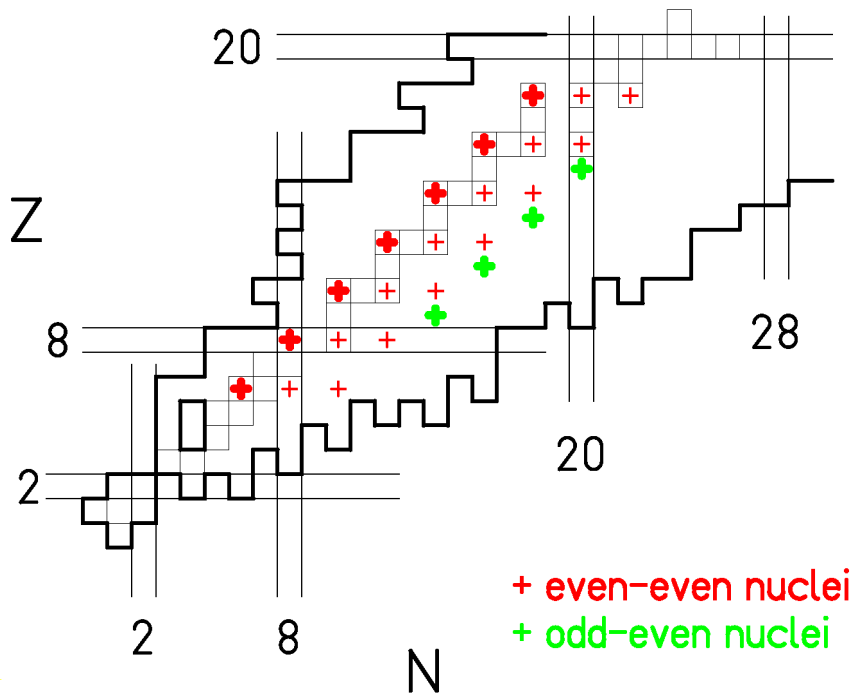
Sequences:
N-Z=constant

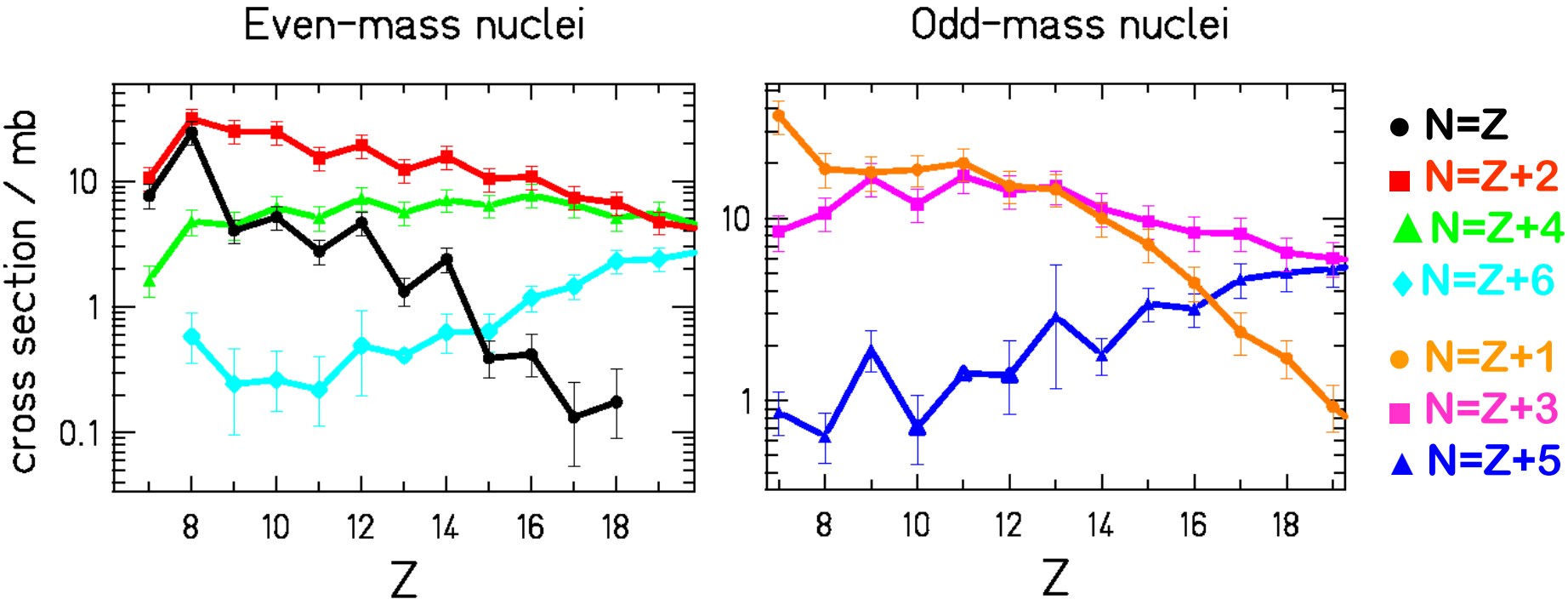
Experimental data (measured at FRS)

Production cross sections of residues

1 A·GeV $^{238}U \rightarrow$ Ti

Nuclei with enhanced production





Enhanced production of even-Z nuclei
Staggering of same strength (~10%) for N=Z+2, N=Z+4, N=Z+6 chains
Staggering particularly strong (~50%) for the N=Z chain
Staggering gradually disappears as Z increases

Enhanced production of odd-Z nuclei
The strength of the staggering increases for n-rich chains
In the N=Z+1 chain the staggering turns from odd-even to even-odd as Z increases
Staggering gradually disappears as Z increases

IS THIS OBVIOUS?

Experimentally

First time that the even-odd staggering of the residual nuclei from high-energy reactions is observed in all its complexity

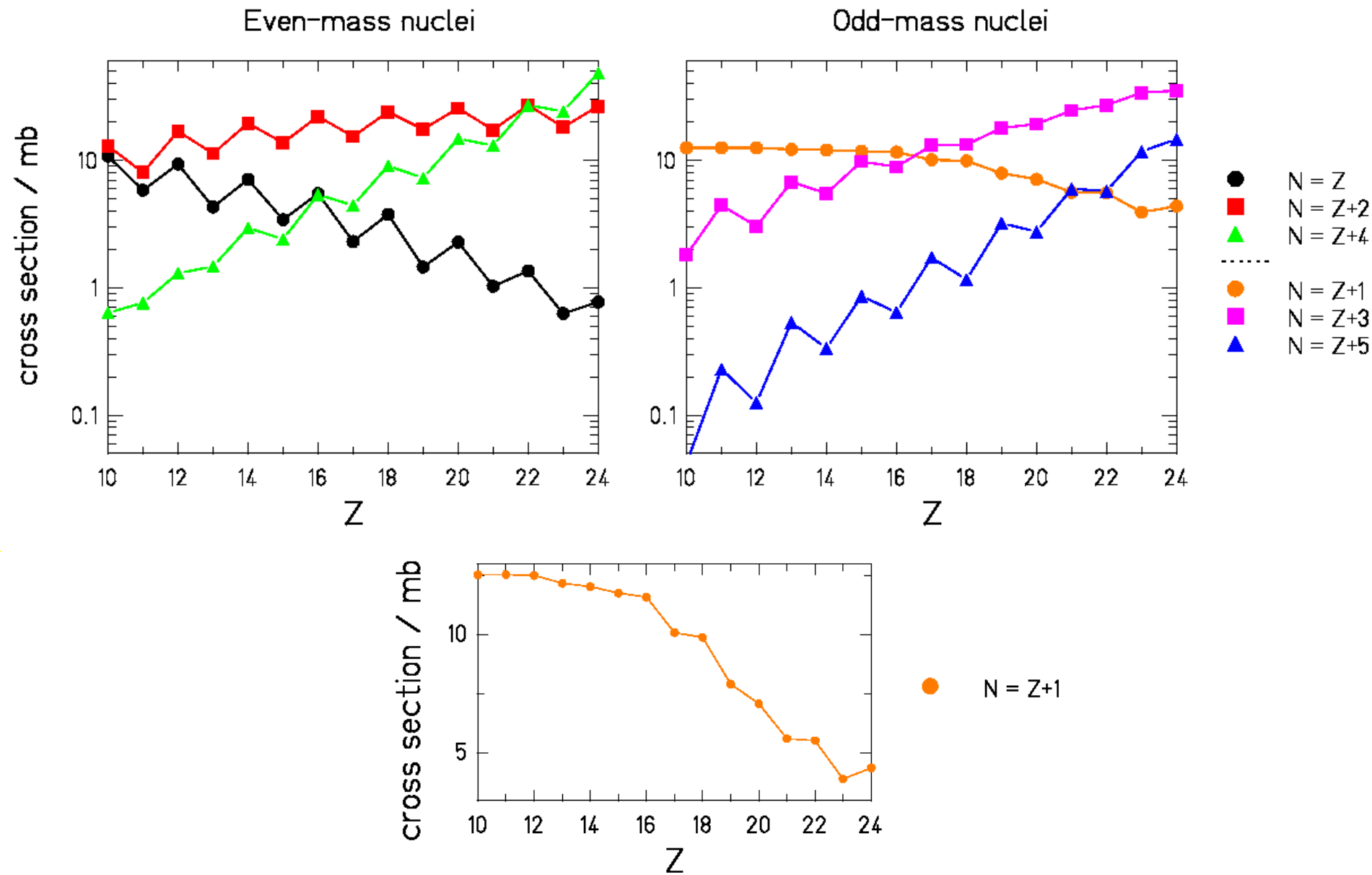
Theoretically

Nuclear superfluidity: it vanishes at about E*~10 MeV
→ valid only for low-energy-reaction residues

Our proposition: even-odd fluctuations are produced at the end of the evaporation cascade

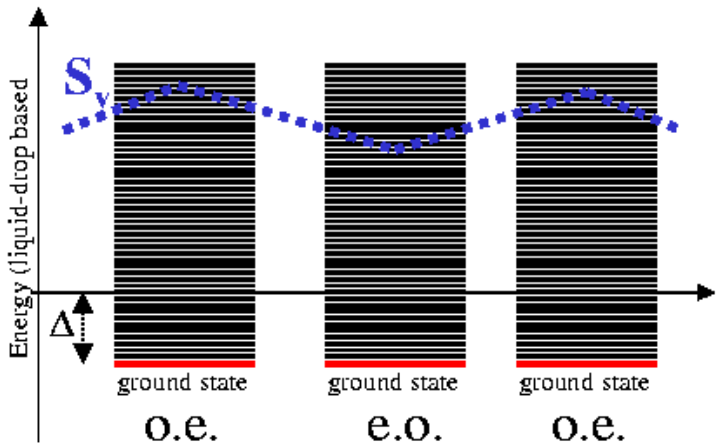
→ Structural effects are restored in the end products of hot decaying nuclei

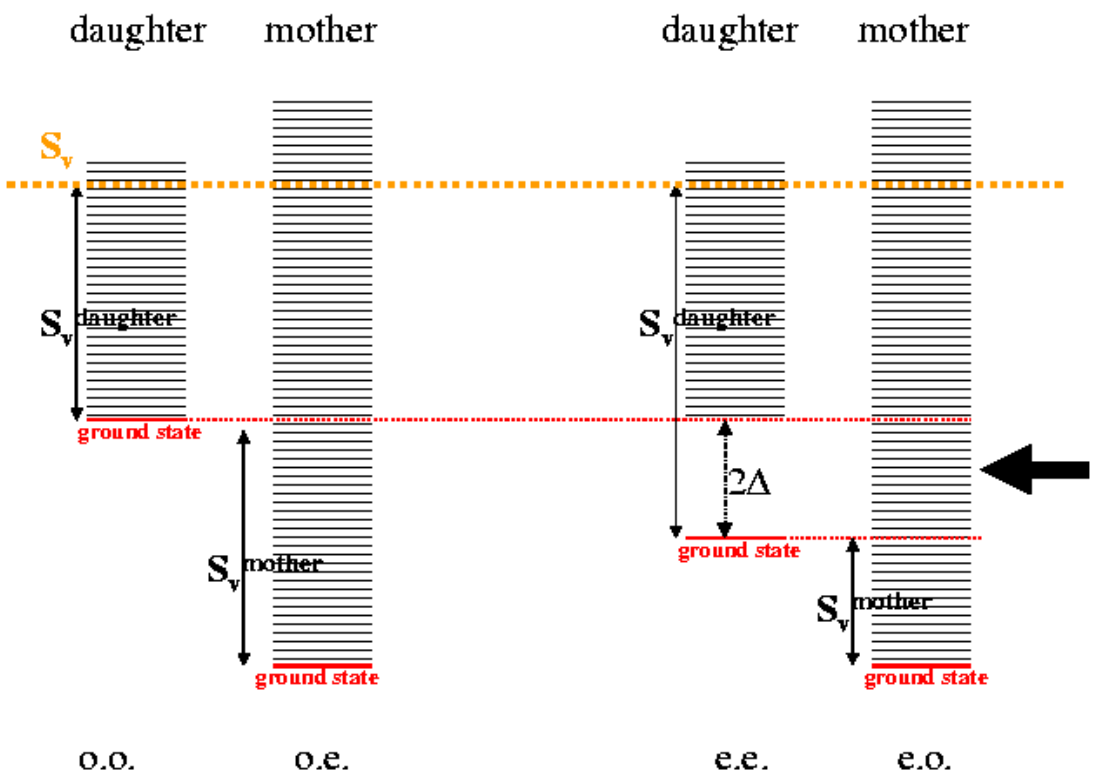
ANALYSIS WITH AN EVAPORATION CODE (ABRABLA)



WHAT IS BEHIND THE EVAPORATION CODE

Two essential ingredients:
binding energies and level densities





CONCLUSIONS

Enhanced production of even-Z nuclei	Enhanced production of odd-Z nuclei
Staggering of same strength (~10%) for N=Z+2, N=Z+4, N=Z+6 chains	The strength of the staggering increases for n-rich chains
Staggering particularly strong (~50%) for the N=Z chain	In the N=Z+1 chain the staggering turns from odd-even to even-odd as Z increases
Staggering gradually disappears as Z increases	Staggering gradually disappears as Z increases

- Structural effects are restored in the end products of hot decaying nuclei, regardless of the first-stage of the reaction mechanism
- A statistical evaporation code can reproduce the main characteristics of the staggering
- The main characteristics of the staggering are a manifestation of the blocking effect of pairing
- more complex phenomena could be responsible for the strong even-odd structure observed in the yields of the N=Z residues

Yields from highly excited nuclei are a rich source of information on nuclear structure