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

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OUTLINE

1) Experiment: $^{238}U \rightarrow Ti$ at 1 A·GeV at the FRS (GSI)

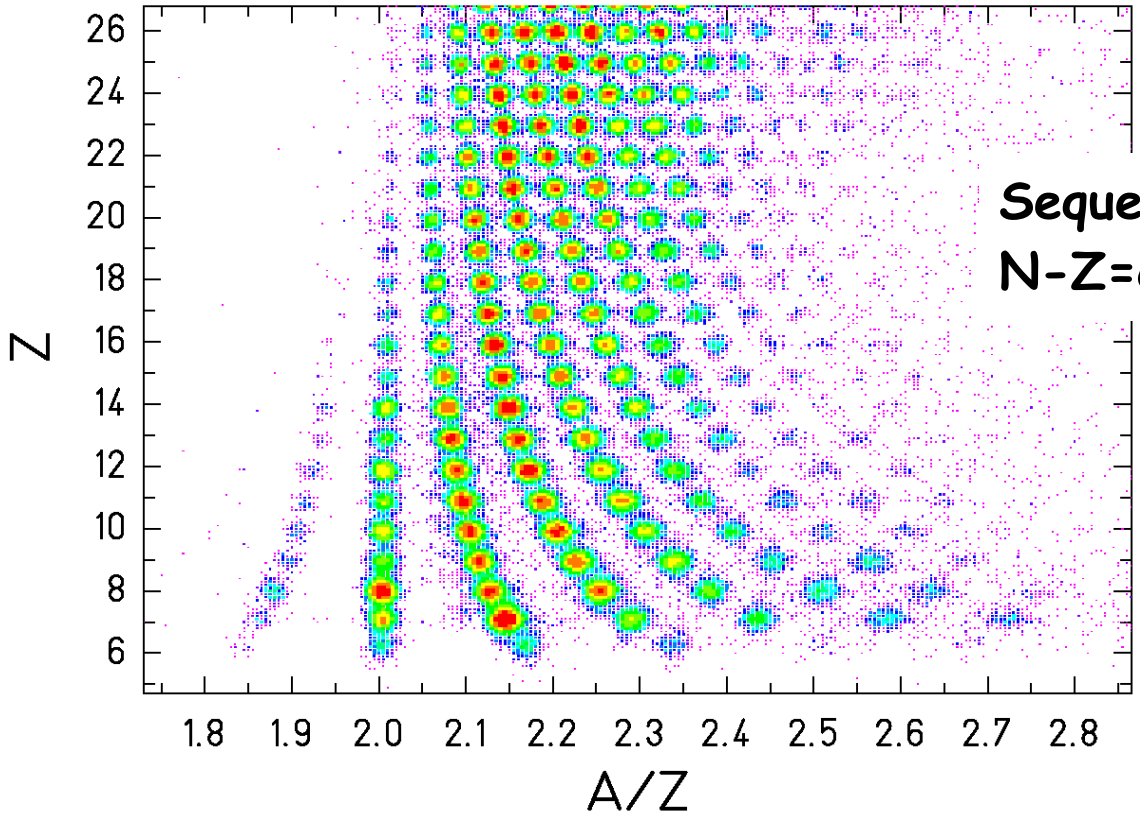
2) Results: production cross sections of residual nuclides

3) Data reveal complex structural effects

4) Analysis of the results by the light of the statistical model

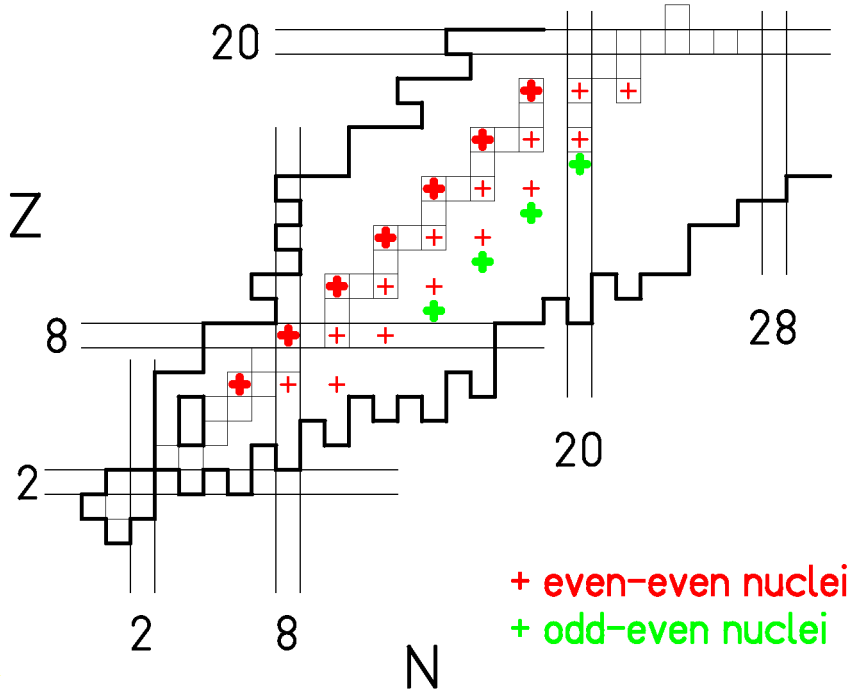
5) Conclusions

1 A GeV ^{238}U on titanium

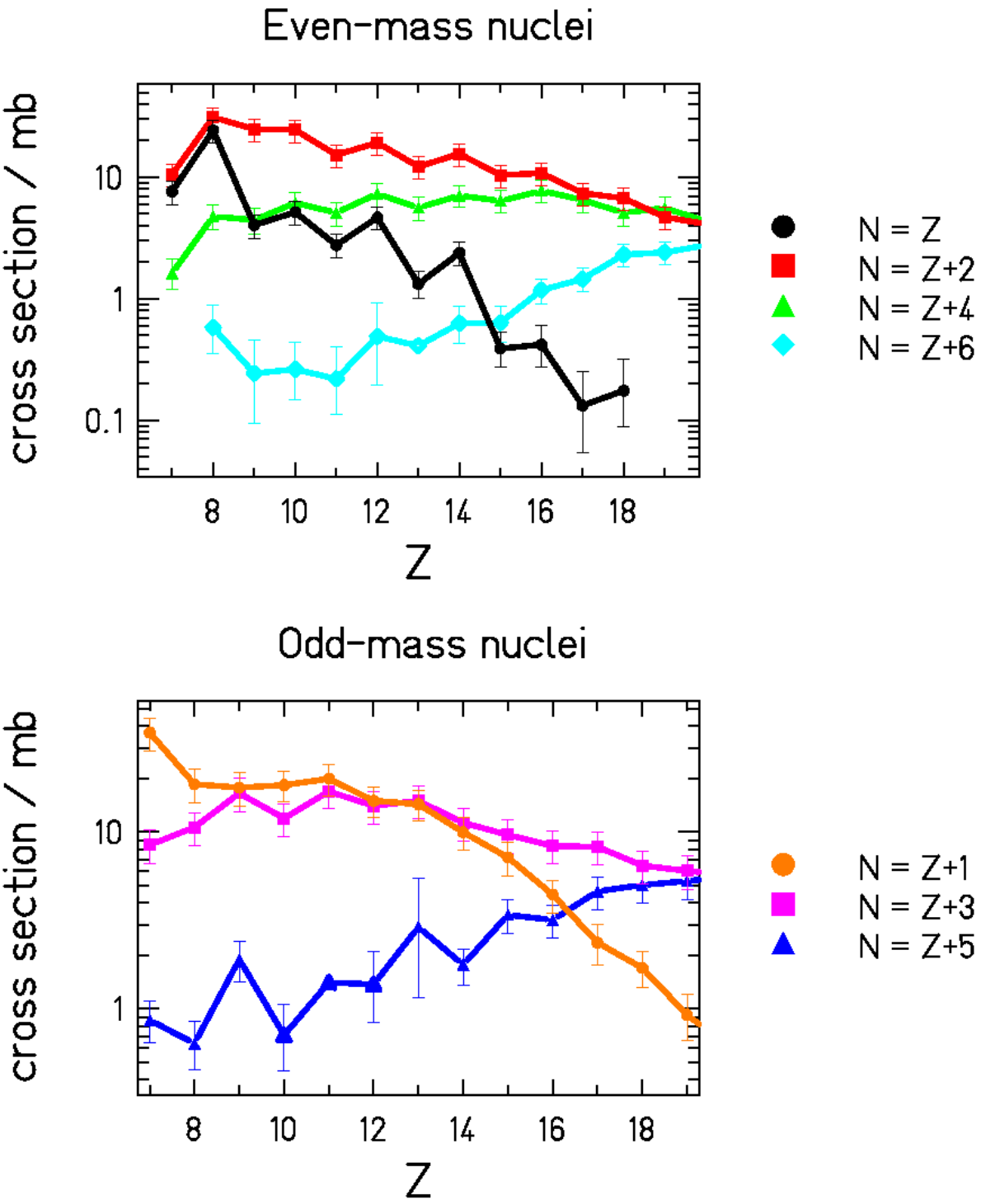


Sequence:
N-Z=constant

Nuclei with enhanced production



EXPERIMENT

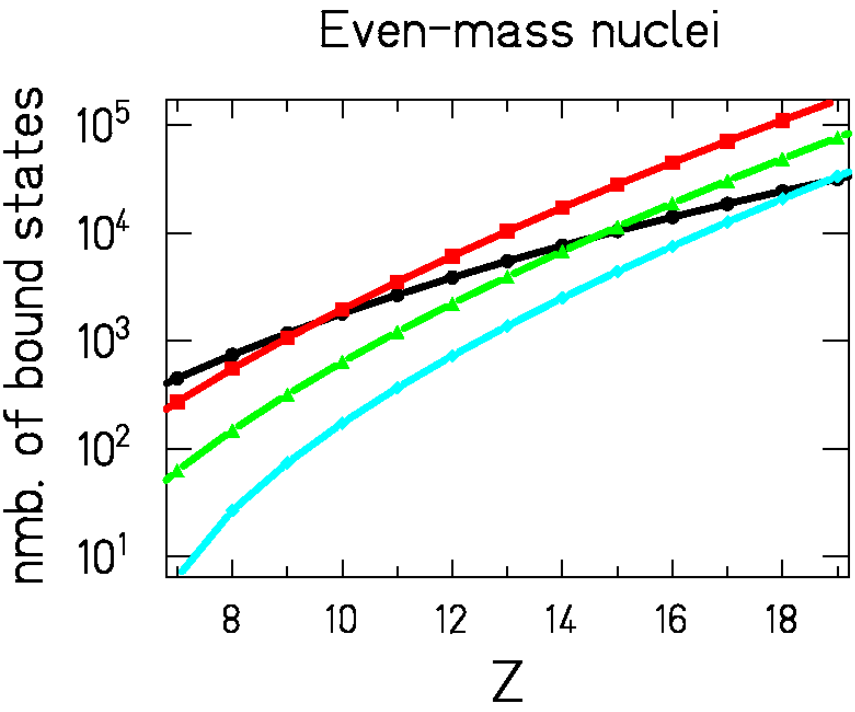

Even-mass nuclei
cross section / mb
10
1
0.1
8
10
12
14
16
18
Z
N = Z
N = Z+2
N = Z+4
N = Z+6
Odd-mass nuclei
cross section / mb
10
1
8
10
12
14
16
18
Z
N = Z+1
N = Z+3
N = Z+5

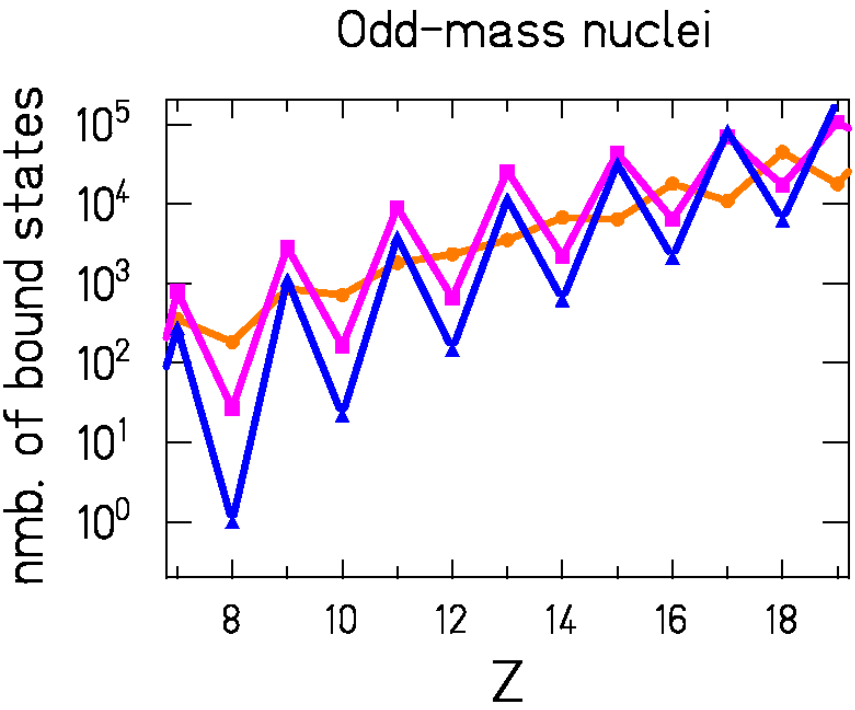
CALCULATION

$$M = M_{LD} - \delta$$

$$\rho \sim \exp\left(2\sqrt{a(E-\delta)}\right)$$

$$\begin{cases} \delta_{oo} = 0 \\ \delta_{oe} = \delta_{eo} = \Delta \\ \delta_{ee} = 2\Delta \end{cases}$$



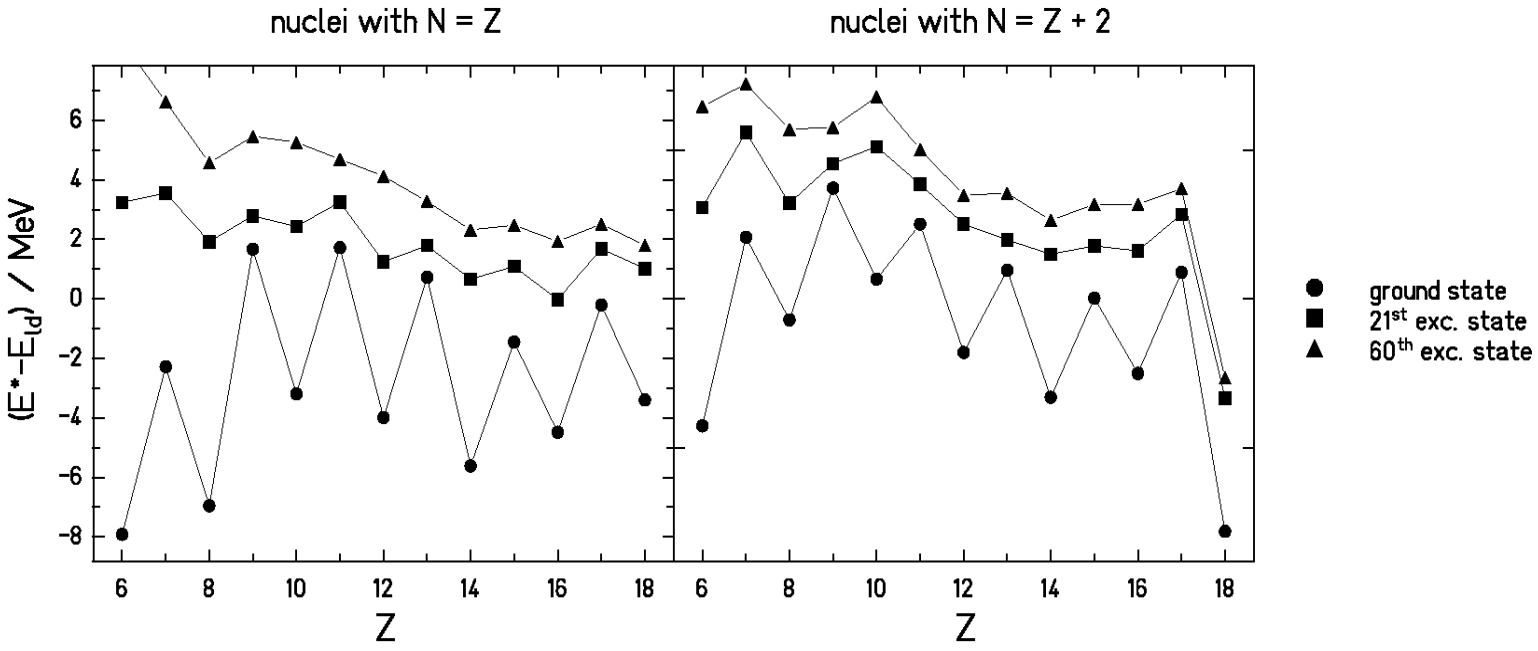


INDICATION FOR EFFECTS BEYOND BLOCKING

In the experimental masses:

even-odd staggering in N=Z nuclei stronger than in other even-A nuclei

In the experimental level density:



POSSIBLE EXPLANATION

- mean-field contribution to pairing effect
- alpha clustering
- neutron-proton pairing

Conclusions

Experiment: light nuclides of 1A·GeV ^{238}U+Ti

FRS allows full (A, Z) identification

→ **formation cross section for every isotope**

Results:

complex structure of nuclei produced in rather violent collisions

Explanation:

1) the statistical model explains the structure of odd-mass nuclei as the most prominent manifestation of pairing

→ **independence of the reaction mechanisms**

2) even-odd structure of even-mass nuclei could be related to higher-order structural effects in the level density

→ **yields from highly excited nuclei are a rich source of information on nuclear structure.**