Topic III - "Physics and astrophysics of neutron-deficient nuclei"

Talks by:

- David Joss – "Structure of heavy neutron-deficient nuclei near the proton drip line"
- David Jenkins – "Probing isospin non-conserving forces in nuclei through studies of isospin triplets"
- Emmanuel Clement – "Physics and astrophysics of neutron deficient nuclei"

EURISOL User Group

Report on the second EURISOL User Group Topical Meeting [1]

Neutron deficient exotic nuclei and the Physics of the *proton rich side* of the nuclear chart.

one-two -proton radioactivity
cluster radioactivity

✓Studies of the effects of nuclear shape and shell structure on quantum tunneling.

✓Direct measure of the proton separation energy.

✓Quantification of 2p-capture processes bridging bottlenecks at the rp-process waiting points.

❖Most of the one-proton radioactivity cases have been discovered using fusion evaporation reactions.

❖Pursue this approach but using secondary reactions with radioactive post-accelerated proton-rich beams such as ^{56}Ni and ^{72,74}Kr..

In-beam & decay spectroscopy below N=82
2p emission from heavy nuclei

Nuclear structure of N≈Z Nuclei

- The structure of these nuclei provides essential information *on isospin* symmetry of the nuclear force or proton-neutron correlations.

- Mirror Energy Differences between ^{67}Se and ^{67}As have been well reproduced theoretically.
- Discovery of excited states in the N = Z nucleus ^{92}Pd and the claiming of the presence of an isoscalar T = 0 pairing correlation at low-spins
- ^{92} Pd is today since 2011 the heaviest case studied experimentally.

- Use pn transfer reactions and compare the cross section to 0^+ and 1^+ spin-parity final states to measure the strength of T=1+ over the T=0 paring forces.
- The chain of Sn isotopes starting with ^{100}Sn special emphasis on Coulomb excitation and transfer reactions to locate single particle states (inverse (d,p) reaction at 10 MeV/u)

- Future in-beam studies of exotic neutron-deficient nuclei will mainly require the use of reactions induced by intense radioactive heavy-ion beams

- To map the rest of the N=Z cases up to ^{100}Sn or even above demands very intense beams

- Need of high performance, highly selectivity detectors such as the new generation of gamma-ray array detectors like AGATA and the neutron-detector array NEDA.

INC interactions, shape coexistence, collectivity ~^{100}Sn, octupole deformation

Nuclear Astrophysics

The rp-process is the main source of energy and determines the X-ray light curve in the X-ray bursts of thermonuclear explosions in the Galaxy.

The path is dominated by proton captures and -decays.

Observations have shown excellent agreement with theories but have also shown that the nuclear physics of the rp-process is not sufficiently well known to test the calculations at the level of precision provided by observations.

The key (p,γ) reactions happen on unstable nuclei while indirect methods do not reach the desired level of accuracy.

Present efforts are aimed at developing “ad hoc” instrumentation such as the Separator for Capture Reactions (SECAR).

In summary, direct measurement of reaction cross sections at low energy for astrophysics is an excellent physics case

Exotic excitations in proton rich nuclei and clusterisation

In contrast with neutron-rich nuclei, bound nuclei with an excess of protons can be found Only below Z=50, and even here the excess of protons is never very large
→ Do pygmy resonances, clearly observed in neutron-rich nuclei, still appear there?

The separation between the electric Pygmy Dipole Resonance (PDR) and the Giant Dipole Resonance increases as the nucleus becomes more proton-rich.

Clusterisation of light nuclei into alpha particles in N=Z nuclei is a well known phenomenon which is revealed in the binding energies of nuclei composed by alpha bonds

Should exist at the proton drip-line ?

Could be studied by fragmenting proton-rich nuclei previously accelerated to 30 MeV/u, or using alpha transfer reactions, at lower energy and measuring the associated spectroscopic factors.

Topic II - “Physics of Light Exotic Nuclei”

EURISOL User Group

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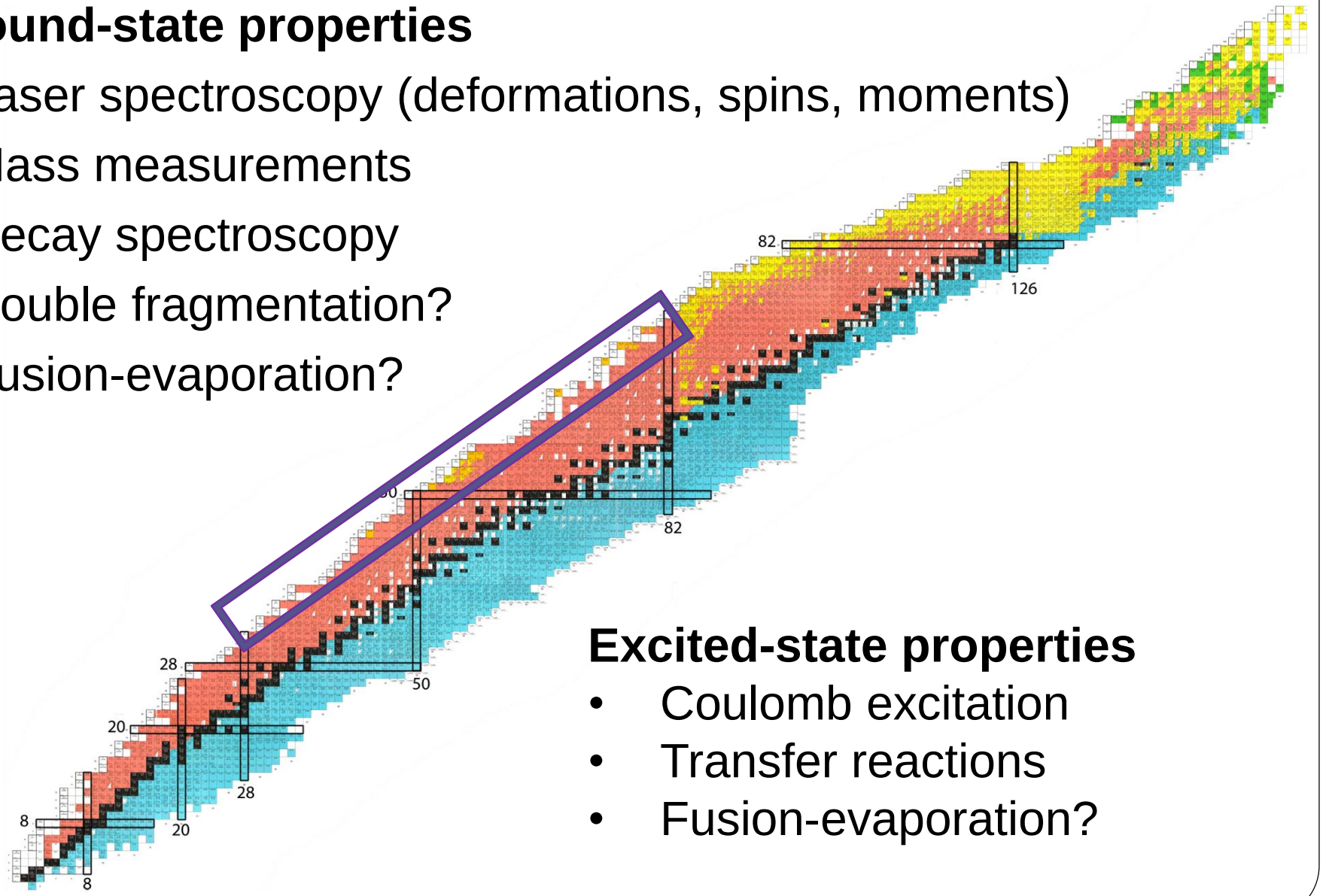
Neutron deficient exotic nuclei and the Physics of the *proton rich side* of the nuclear chart.

General physics case is still valid?

Summary: Future Prospects

Ground-state properties

- Laser spectroscopy (deformations, spins, moments)
- Mass measurements
- Decay spectroscopy
- Double fragmentation?
- Fusion-evaporation?



Excited-state properties

- Coulomb excitation
- Transfer reactions
- Fusion-evaporation?

Summary: Future Prospects