Microscopic description of proton emitters

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Theory to interpret proton emission, and predict nuclear structure at the extremes of stability

- Relativistic mean field with density functionals

Relativistic Hartree-Fock-Bogoliubov theory, provides a unified framework to describe relativistic mean-field and pairing correlations. Covariant energy density functionals **CDF** can predict nuclear structure properties and spectrocospic factors for proton and neutron rich nuclei, and also proton radioctivity. Non-linear meson exchange **NL3** and density dependent point coupling **DD-PC1**, and **PC-PK1** used to interpret proton emission

- Non-relativistic models: non adiabatic quasi-paticle model NAQP

The proton is in a single particle Nilsson resonance with the deformed core, and the excitation spectrum of the daughter nucleus is taken into account. The pairing residual interaction is included in a natural way. **NAQP** was applied to

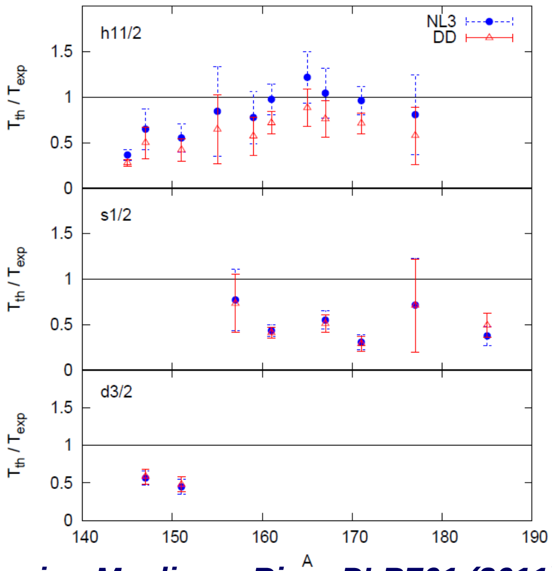
→ nuclei with axial and non axial deformations

→ odd-even and odd-odd nuclei

Examples of applications:

CDF calculation spherical :

Observe correlations

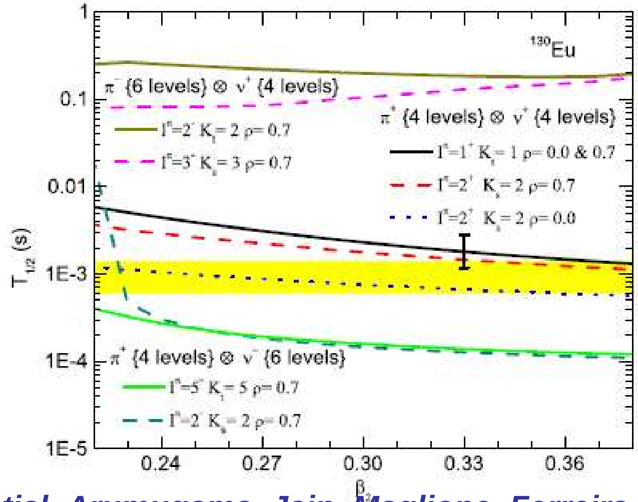


Ferreira, Maglione, Ring. PLB701 (2011)508

Ferreira, Maglione, Ring, PLB753(2016)237

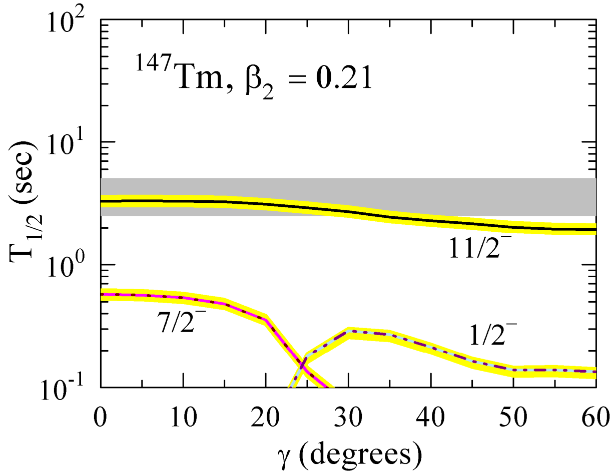
NAQP decay for odd-odd nuclei

130Eu Identify decay state and shape

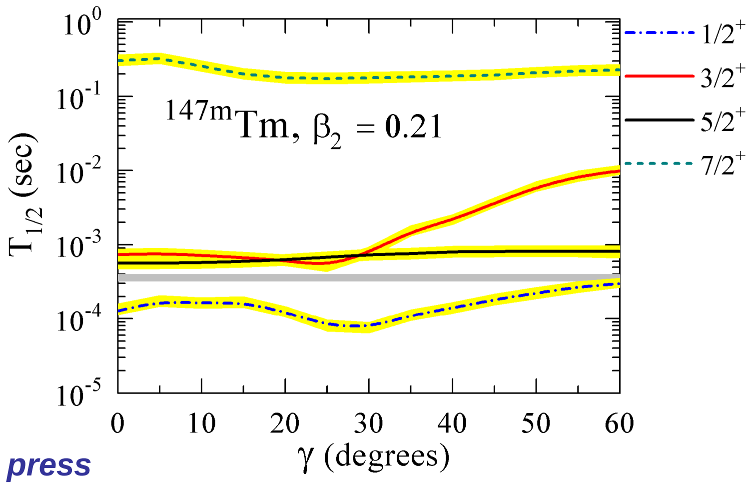


Patial, Arumugama, Jain, Maglione, Ferreira, PRC88 (2013)054302

NAQP for nuclei with γ deformation



PRC (2017) in press



Finding decaying state and deformation of 151Lu with NAQP model

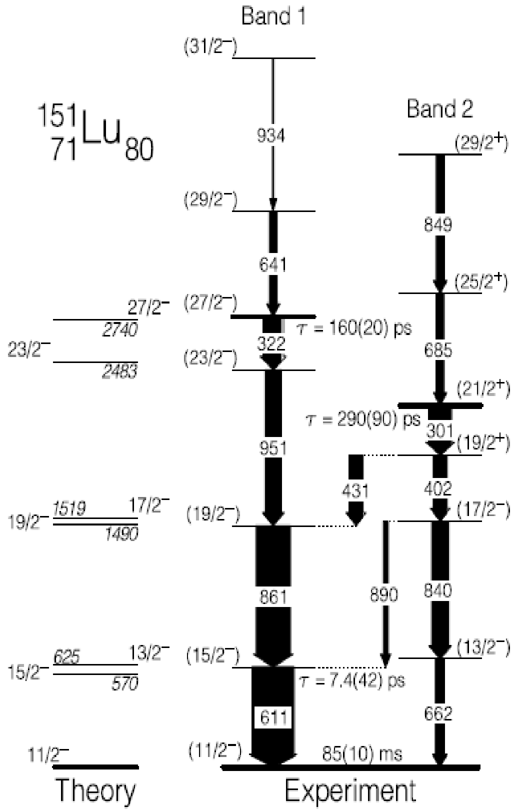
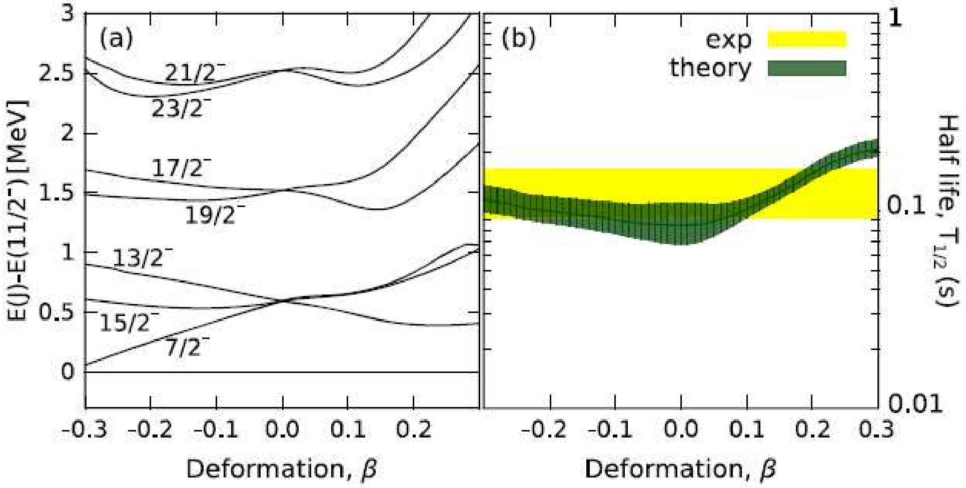


Fig. 1. (Right) Excited levels in ^{151}Lu assigned in this work. The widths of the arrows correspond to the intensities of each transition, with the white component of each arrow indicating the calculated internal conversion component. The lifetimes of the states measured in this work are also shown. (Left) Theoretical level scheme calculated at an oblate deformation of $\beta = -0.03$, where the theoretical and experimental energy separations of the $(17/2^-)$ and $(19/2^-)$ states are equal to 30 keV (see later).



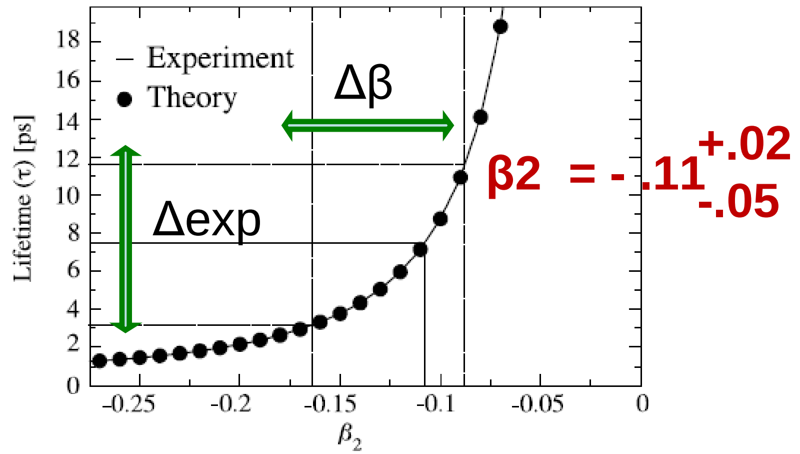
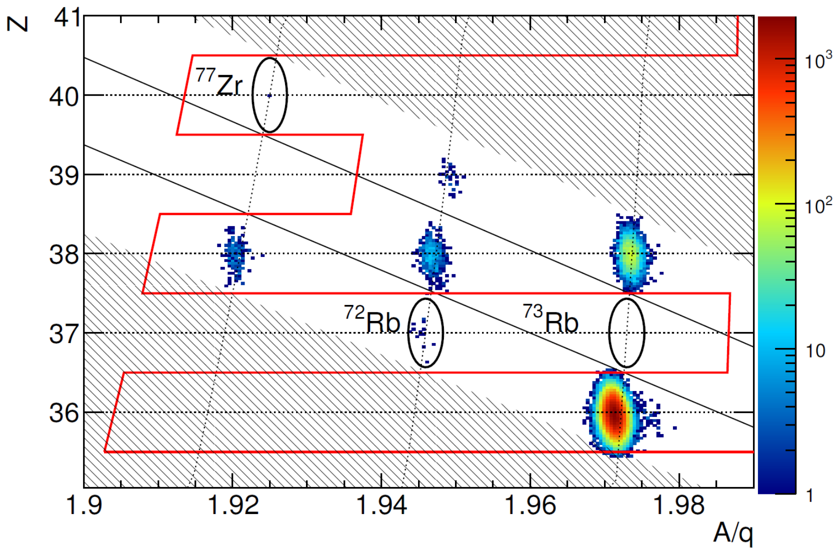
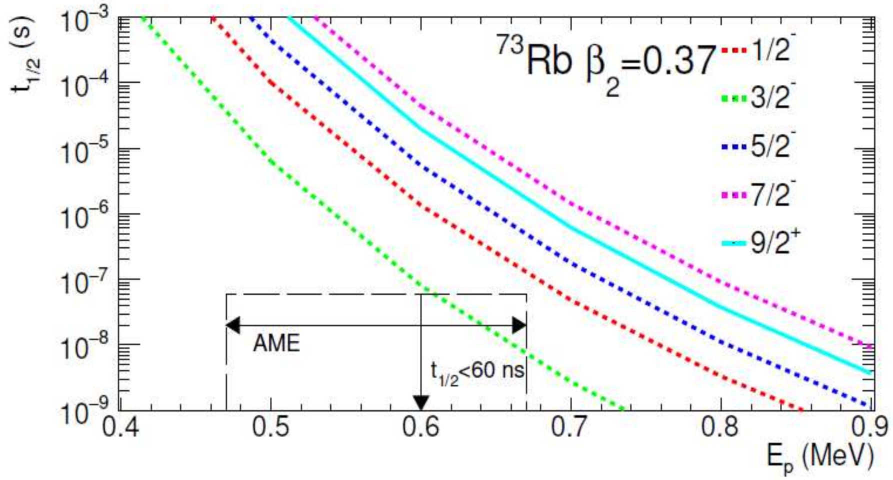


Fig. 6. Theoretical non-adiabatic calculations (circles) of the change in the deformation parameter, β as a function of the lifetime of the $(15/2^-)$ state in ^{151}Lu. The region bound by the dashed lines corresponds to the limits on β from the experimental RDDS lifetime measurement of 7.4(42) ps made in this work.

Cullen, Ferreira, Maglione, et al. PLB725(2013)79.
Cullen,Ferreira, Maglione, et al.PRC91(2015)044322

Discovery of ^{72}Rb and limit for $t_{1/2}$ of ^{73}Rb   NAQP calculation





Suzuki, Sinclair, Söderström, Lorusso, Davies, Ferreira, Maglione et al,
Phys. Rev. Lett 119 (2017)192503

Conclusions:

a solid theory exist to interpret experimental data of decay of drip-line nuclei, and get nuclear structure information at the extremes of stability, impossible to obtain otherwise.