Nuclear Structure C

Neutron Skin Effects in Mirror Energy Differences: The Case of ^{23}Mg-^{23}Na

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Energy differences between analogue states in the T=1/2 ^{23}Mg-^{23}Ma mirror nuclei have been measured along the rotational yrast bands with the EXOGAM + Neutron Wall + DIAMANT setup at GANIL. The nuclei of interest have been populated via the ^{12}C+^{16}O fusion evaporation reaction.

This allows us to search for effects arising from isospin-symmetry breaking interactions (ISB) and/or shape changes. Data are interpreted in the shell model framework following the method successfully applied to nuclei in the $f_{1/2}$ shell.

The introduction of a schematic ISB interaction of the same type of that used in the $f_{1/2}$shell will be shown as needed in order to reproduce the data.

An alternative novel description, applied here for the first time, will be presented. It relies on the use of an effective interaction deduced from a realistic charge-dependent chiral nucleon-nucleon potential.

This analysis provides two important results: (i) The mirror energy differences give direct insight into the nuclear skin; (ii) the skin changes along the rotational bands are strongly correlated with the difference between the neutron and proton occupations of the $s_{1/2}$"halo" orbit.

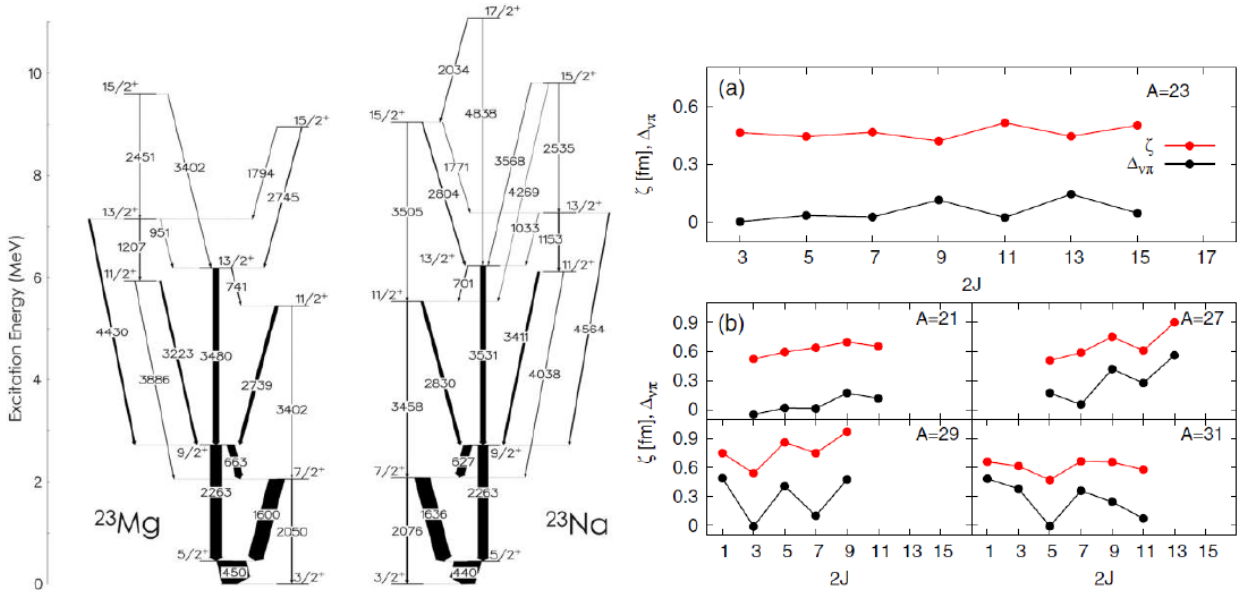

Fig. 1: (a) ^{23}Mg-^{23}Na level schemes deduced in this work; (b) The parameter ζ (proportional to the neutron skin) and the difference in the occupation number of the $s_{1/2}$orbital between neutrons and protons.

[1] A. Boso *et al.*, Phys. Rev. Lett. 121, 032502 (2018)

Electron Capture of ^{8}B into highly excited states of ^{8}Be

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There is surprisingly little known experimentally about the beta strength distribution of the proton halo nucleus ^{8}B. The main experimental efforts have been dedicated to establish the shape of the α-α spectrum arising from the β+ decay via the 3.03 MeV state in ^{8}Be due to its astrophysics interest, as this decay is the unique source of energetic solar neutrinos above 2 MeV.

From the nuclear structure point of view, the main interest lies in the decay to the highly excited states in ^{8}Be that can give information on the halo structure of ^{8}B. Especially the indication for strong isospin mixing in the 2^{+} doublet at 16.6 - 16.9 MeV having dominant configurations integrated by ^{7}Li+p and ^{7}Be+n, respectively [1].

The β+/EC decay feeding to this doublet mainly proceed via the 16.6 MeV state, that has been observed by several groups, however, the electron capture process feeding the 16.9 MeV state was first hinted by Kirsebom et al. [2]. In a recent experiment performed at the ISOLDE Decay Station at CERN we confirm the latter decay branch with much better statistics. We present in this contribution the results obtained from this experiment, in particular, the R-matrix analysis of the full α-decay spectrum. This analysis allows for a proper characterization of the 2+ doublet and a discussion of the resulting isospin mixing will be presented.

[1] P. von Brentano, Phys. Rep. 264, 57 (1996)
[2] O. Kirsebom et al., Phys. Rev. C 83, 065802 (2011)

The structure of ^{25}Na measured using (d,p) transfer: relevance to the ^{24}Al(p.g)^{25}Si reaction rate in astrophysical environments

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Recently, results have been reported for states in ^{25}Si as studied via gamma-ray spectroscopy in nucleon-removal reactions at intermediate energy [1]. The measurements were interpreted together with experimental results [2,3] for the mirror nucleus ^{25}Na and with new shell model calculations and it was found [1] that the astrophysical reaction rate was likely to be up to a factor of 100 larger than previously thought [4].

Using a radioactive beam of 10^{4} pps ^{24}Na at 8 MeV/nucleon, produced using ISAC2 at TRIUMF, the d(^{24}Na,pg)^{25}Na reaction has been studied [3]. Differential cross sections were measured for 12 states in ^{25}Na including the astrophysically relevant 3.995 MeV $9/2^{+}$ state. Definitive spin assignments were obtained, taking into account the observed gamma-ray decay patterns, and spectroscopic factors were deduced showing striking agreement with new shell model calculations (fig. 1). The experimental details, the complete structure results for ^{25}Na and the connection to the astrophysical reaction will be presented. The measured value of the s-wave transfer to the 3.995 MeV state implies an even more significant role for the mirror state in ^{25}Si than previously [1] inferred.