News on ^{12}C from the β-decays of ^{12}B and ^{12}N*

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^{12}C is the fourth most abundant nuclear species observed in the universe, but in the energy region just above the 3α-threshold broad overlapping resonances make spectroscopy very challenging, and so despite numerous experimental studies significant uncertainties still remain on the low energy nuclear spectroscopic properties of this isotope.

There is a long and continuing interest in the nuclear structure of ^{12}C. The low energy region is characterized by a fascinating interplay between mean-field and cluster type properties, and it stands as a challenge to theory to capture both these features in one approach. Besides nuclear structure interest the spectroscopic properties of the states in ^{12}C just above the 3α-threshold are of great importance for the understanding of the triple-α reaction in stars.

The main experimental uncertainty on the low energy nuclear structure of ^{12}C concerns the properties of 0^+, and 2^+ states above the famous 7.654 MeV 0^+ state. Also the breakup mechanism of the 1^+ states at 12.71 MeV and 15.11 MeV have been an old problem of nuclear physics, which has received new attention in the context of the recent discussion of two-proton radioactivity. The β-decays of ^{12}N and ^{12}B populate selectively 0,1,2^+ states and so are ideally suited for elucidating the main open questions. We have carried out a series of experiments which, by taking advantage of new techniques in beam handling and charged particle detection developed for Rare Isotope studies, have led to a breakthrough in the study of these β-decays.

The main objectives of our experiments, which will be discussed in this contribution, are to determine :

1. The Spin-parity of the 10.3 MeV state and its possible interference with the 7.654 MeV state.
2. The breakup mechanism of the 10.3 MeV state.
3. Where is the second 2^+ state in ^{12}C, and how does it influence the triple-α process.
4. What is the breakup mechanism of the 12.71 MeV state?

The experiments have been carried out at the On-line Isotope Separation facilities IGISOL at Jyväskylä, Finland, and ISOLDE at CERN in the period 2001-2004. First results from our experiments are published in [1-4],

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[1] H.O.U. Fynbo *et al.*, Phys. Rev. Lett. **91**, 82502 (2003).
[2] H.O.U. Fynbo *et al.*, Nucl. Phys. **A 738**, 59 (2004).
[3] H.O.U. Fynbo *et al.*, Nature **433**, 136 (2005).
[4] C.Aa. Diget *et al.*, Nucl. Phys. **A**, In press.