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# R-Matrix study of the beta decay of 8B to the highly excited states of 8Be

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The β$^{+}$/Ec-decay of the proton halo nucleus $^{8}B$ into $^{8}Be$ is interesting for astrophysics and nuclear structure. From the astrophysical point of view, β-decay is the main source of high-energy solar neutrinos above 2 MeV and thus, the main contributor to what was known as the "solar neutrino problem"[1]. On the nuclear structure side, this decay can be used to probe the structure of $^{8}B$ and populate the excited states of $^{8}Be$. We are interested in learning about the nature of the 16.6 and 16.9 MeV excited states of $^{8}Be$, previously only resolved in reaction experiments [2]. The totally isospin mixed character of the doublet has never been determined experimentally. The β$^{+}$/EC feeding to the doublet gives an opportunity to test this hypothesis, until the present work the individual feeding to the doublet could not be resolved.

Within the Q-value window, the following states in $^{8}Be$ are available: the broad $2^{+}$ state at 3 MeV [3], which is the dominant state and the primary source of high-energy solar neutrinos. A $2^{+}$ isospin doublet consists of two narrow levels at 16.6 and 16.9 MeV, with dominant configurations of $^{7}Li$+p and $^{7}Be$+n respectively. This doublet is the only case known of almost equal isospin mixing between nuclear states [2]. The decay through the doublet will have a Fermi part that will only go to the T=1 component, and a Gamow-Teller strength only to T= 0.

There is also a highly excited $1^{+}$ level at 17,640 MeV that decays by low energy (330 keV) proton emission into $^{7}Li$. The EC-feeding to this state has not yet been observed. Assuming that the wave function of a halo nucleus can be factorised [4] into a core and a halo (in this case, a proton), one could model the $^{+}$/EC-decay as occurring in the core with the halo proton as a spectator. The strength of this branch has been estimated from the decay of the $^{7}Be$ nucleus resulting in a value of the order of $10^{-8}$, see [5] for details.

The β$^{+}$/EC of 8B to $2^{+}$ states in $^{8}Be$ break up into two α particles, due to the broad nature of the 3 MeV $2^{+}$ state, it results in an α-continuum spectrum. The decay of 8B into the 16.626(3) MeV state has been observed by several groups, but the (mainly EC) decay into the 16.922(3) MeV state was first hinted at the previous JYFL08 experiment [6], where 5 events were attributed to the breakup of this state.

To study the nature of the doublet and other highly excited states in $^{8}$Be, the IS633 was performed at the ISOLDE facility at CERN. The experimental setup consisted of 4 particle-telescopes formed by a Double-Sided Silicon strip Detector (DSSD) of 40-60 $\mu$m thickness and stacked with a 1000 $\mu$m thick Si-PAD detector. Additionally, a thick 500 $\mu$m DSSD was placed below the implantation foil to maximize the angular coverage. At the centre of the setup, a carbon foil catcher of 30 $\mu$m/cm2 was placed to stop a 50 keV $^{8}B$ beam, more details in [7]. The high statistics of our experiment allowed us to resolve the feeding to the doublet for the first time in a $^{8}$B beta decay study.

The alpha-alpha coincidence spectrum was unfolded with the response function of the detector setup and the convoluted spectrum was analysed using the R-Matrix formalism to extract the feeding to the $2^{+}$ states in $^{8}$Be. In this formalism, the spectrum can be decomposed into the contributions of individual resonant levels. R-Matrix offers a way of analysing complex data that cannot be fitted with simple analytic functions (Gauss, Landau, etc). The spectrum is factorized in terms of a series of nuclear resonances, each characterized by a series of parameters (energy, decay width, and beta feeding), the values of these parameters are incrementally modified until the R-matrix calculation fits the experimental data, the fitted parameters will give us the physical observables of our system.

In this contribution, we discuss the current results and comment on possible additional analysis of this data. We have tested the consistency of the results through a series of cross-checks, in each test the R-matrix fits were repeated with a series of constraints applied to the data, in addition, we also compared the obtained results to previous experimental results [6]. We will present the observables deduced, the limitations of the R-Matrix fit and the isospin mixing found for the doublet.

References
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