

# Precise characterization of the $\beta$ -decay of ${}^8\text{B}$ to ${}^8\text{Be}$

*D. Fernandez Ruiz<sup>1</sup>, O. Tengblad<sup>1</sup>, M.J.G. Borge<sup>1</sup> for the IS633 collaboration*

*1. IEM -CSIC (Madrid/Spain).*

${}^8\text{B}$  is a 1-proton halo nucleus that undergoes  $\beta^+$ /EC decay feeding the excited states of  ${}^8\text{Be}$ . The study of this EC/ $\beta^+$  decay is of interest to both astrophysics and nuclear structure. In nuclear astrophysics, the decay of  ${}^8\text{B}$  is the main source of high-energy solar neutrinos above 2 MeV and thus a key component of the “solar neutrino problem” [1]. In nuclear structure, this decay offers a unique probe to explore the structure of  ${}^8\text{Be}$  including the best predicted case of full isospin mixing between nuclear states [2]: a  $2^+$  isospin doublet formed by two narrow excitation levels at 16.6 and 16.9 MeV excitation energy in  ${}^8\text{Be}$ , with respectively dominant configurations of  ${}^7\text{Li}+p$  and  ${}^7\text{Be}+n$ . This work is mainly focused on this doublet.

Within the  $Q_{\text{EC}}$  window ( $Q_{\text{EC}} = 17,9798(1)$  MeV), there are three  $2^+$  states in  ${}^8\text{Be}$  that are fed through allowed beta transitions and a  $1^+$  state. The decay through a board  $2^+$  state at 3 MeV [2], is the dominant (>88%) one and the primary source of high-energy solar neutrinos [1]. The  $\beta^+$ /EC decay through the  $2^+$  isospin doublet formed by the 16.6 and 16.9 MeV resonances is modelled assuming that Fermi strength only goes to the  $T=1$  component and Gamow-Teller strength only to  $T=0$ . A possible EC- feeding to a high  $1^+$  level at 17,640 MeV is energetically possible and will be followed by a 337 keV proton and the recoiling  ${}^7\text{Li}$  ion. Assuming that the wave function of a halo nuclei can be factorised [3] into a core and a halo (in this case  ${}^8\text{Be} = {}^7\text{Li} + p$ ), one could model this EC-decay as occurring in the core with the halo proton as a spectator. The strength of this branch is estimated [4] from the decay of  ${}^7\text{Li}$  giving a  $\Gamma=2,3\cdot 10^{-8}$ .

Since  ${}^8\text{Be}$  is unbound, the feeding to the  $2^+$   ${}^8\text{Be}$  states is followed by break up into two  $\alpha$  particles, giving rise to a  $\alpha + \alpha$  continuum spectrum extending up to 17 MeV. Theoretically this spectrum is dominated by the Gamow Teller contribution up to 15 MeV, however, experimentally this has only been proven up to 8 MeV. The decay of  ${}^8\text{B}$  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 hinted by 5 events in a previous JYFL experiment [5].

The MAGISOL (Madrid-Aarhus-Goteborg-ISOLDE) collaboration, has conducted multiple experiments to study the structure of the  ${}^8\text{Be}$  nucleus in different facilities [5,6], the most recent one is experiment IS633, which took place at the ISOLDE facility at CERN in Switzerland aiming to resolve the  $\beta$ -feeding to the doublet and determine the level of isospin mixing. The experimental setup consisted of four compact particle telescopes, with each telescope comprising a Double-Sided Silicon Strip Detector (DSSD) with a thickness of 40 resp. 60  $\mu\text{m}$  stacked with a 1500  $\mu\text{m}$  thick Si-PAD detector. At the centre of the setup, a 30  $\text{mg}/\text{cm}^2$  carbon foil catcher was placed to stop the mass-separated 50 keV  ${}^8\text{BF}_2$  beam. An additional 500  $\mu\text{m}$  thick DSSD was placed below the implantation foil to maximize  $\beta$ -detection. The implanted  ${}^8\text{B}$  nucleus decays via an EC/ $\beta^+$  process, feeding the previously mentioned states of  ${}^8\text{Be}$ , which in turn breaks up into two  $\alpha$  particles that were detected in the setup, allowing for reconstruction of the excitation spectra.

The high statistics obtained during the experiment allowed for an accurate characterization of the  ${}^8\text{B}$  to  ${}^8\text{Be}$  decay. The two orders of magnitude higher statistics compared to the previous JYFL experiment, allowed for the observation of the separated feeding to the two members of the doublet for the first time in a beta-decay work. The feeding to the  $2^+$  states in  ${}^8\text{Be}$  was studied through an R-Matrix analysis of the  $\alpha + \alpha$  spectrum. Additionally, the effect of the  $\beta$ -recoil in the  ${}^8\text{B}$  decay was studied employing a prescription given in [7] to fit the  $\alpha - \alpha$  spectrum at different total energy values. This study has allowed us to for the first time experimentally confirm the dominance of the Gamow-Teller contribution in the decay up to 14 MeV. In this contribution, we will discuss this precise investigation in detail.

## References

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