Mapping of the $^{12}C^*$ and $^{9}B^*$ states of astrophysical interest via the $^{10}B(^{3}He, p\alpha\alpha\alpha)$ Reaction

M. Alcorta[1], H.B. Jeppesen[1,2], M.J.G. Borge[1], H.O.U. Fynbo[3], G. Garcia[4], O. Kirsebom[3], M. Madurga[1], G. Nyman[5], D. Obradors[1,4], O. Tengblad[1]

[1] Inst. Estructura de la Materia, CSIC, Serrano 113bis, E-28006 Madrid, Spain.
[2] CERN, ISOLDE, PH Department, CH-1211 Genève 23, Switzerland.
[3] Inst. for fysik og astronomi, Aarhus Universitet, DK-8000 Aarhus C, Denmark.
[4] CMAM, Universidad Autónoma de Madrid, Cantoblanco, 28049 Madrid, Spain.
[5] Fundamental Fysik, Chalmers Tekniska Högskola, S-412 96 Göteborg, Sweden.

The $^{3}He + ^{10}B$ reaction can give us information that is of relevance to nuclear astrophysics. In the $^{12}C^*$+ p channel we study resonances in ^{12}C which are important for determining the rate of the triple-alpha process responsible for helium burning in stars. In addition, studying the $^{9}B^*$ + α channel can give us information on the states in $^{9}Be^*$, its mirror nucleus, which influences the alpha-alpha-n reaction and therefore also contributes to helium burning.

In the past decade there have been a series of experiments performed using beta-decays of short lived isotopes (^{9}C, ^{9}Li, ^{12}N, ^{12}B) with the goal of studying resonances in ^{9}B[1], ^{9}Be[2] and ^{12}C[3]. The $^{3}He + ^{10}B$ reaction allows us to gain complementary information on both the ^{9}B and ^{12}C resonances compared to what is known from beta-decay experiments because we can populate states non-accessible to beta-decay studies due to energetic limitations and selection rules. As an example we can therefore study resonances with negative parity in ^{12}C and positive parity in ^{9}B, as well as gain information on energy levels situated above the Q-beta values.

This reaction has been studied once before in the 60's, but with very limited technology. Both the p + $^{12}C^*$ and α + $^{9}B^*$ channels were identified on-line from the image on an oscilloscope with two particles pre-selected in hardware coincidence at given angles.[4] With the development of segmented detectors and faster electronics, we have detected 4-particle coincidences in our setup at the 5 MV tandetron in Madrid with a much better resolution.

The experimental setup consisted of two 60 μm thick DSSSDs, backed with a 1.5 mm Si-detector and 2.5 mm Si-detectors. The DSSSDs give a granularity of 256 3 x 3 mm pixels. With a solid angle covered of about $1/9^{th}$ of 4π, we had a 2-particle detection efficiency of about 1%, and a 4-particle detection efficiency of approximately 0.015%. The reaction took place with a beam of ^{3}He at 2.45 MeV on a target of ^{10}B with a thickness of 20 $\mu g/cm^2$.

In our data we identified states in ^{12}C from the ground state up to about 18 MeV, with spins ranging from 0 to 4. Due to our very good resolution, we are able to determine properties of these ^{12}C resonances, such as their energy, width, and spin-parity. The ground state as well as the 2.34 MeV excited state in ^{9}B has also been observed. In this contribution preliminary results from the ongoing analysis will be presented.

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