

## $^{12}\text{C}$ formation: A classical quest in new Light \*

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Hans Bethe was the first to establish the concept of nucleon synthesis in stars [1] proposing the CNO cycle and the PP chain, but was unsuccessful in solving the  $^{12}\text{C}$  formation mechanism. Not until the introduction of the Hoyle state [2] in 1953 one was getting close to a solution. However, still 50 years later the  $^{12}\text{C}$  break-up is still not fully solved and the quest for learning more about the reaction rates in stars by studying the triple-alpha process is continuing.

In this work we have studied the break-up of  $^{12}\text{C}$  following the reactions  $^{10}\text{B}(^3\text{He},p\alpha\alpha\alpha)$  and  $^{11}\text{B}(^3\text{He},d\alpha\alpha\alpha)$ . The study was performed at the 5MV tandem accelerator at the *Centro de Micro Analisis de Materiales* (CMAM) [3] at the *Universidad de Aut3noma de Madrid*.

The break-up give us information on excited states in  $^{12}\text{C}$  from the famous Hoyle state up to an energy of almost 18 MeV.

Using a highly segmented experimental set-up the simultaneous detection of the three alpha particles in coincidence with a proton or deuteron respectively made possible a full kinematic reconstruction of the break-up. On the basis of the energies of the three alpha particles and their angular correlations it has been possible to separate the branching of the break-up through the *ground state* and the first excited  $2^+$  state in  $^8\text{Be}$ , as well as to determine the spin and parity of states for cases in which the assignment has been doubtful.

Some of these levels will also de-excite via electromagnetic emission. The comparison between the energy of proton that populate a state of  $^{12}\text{C}$  and the sum of the energies of the  $3\alpha$  emitted from the same state makes possible to determine the presence of electromagnetic disintegration ( $\gamma$ ) to lower states within  $^{12}\text{C}$  followed by the  $3\alpha$  break-up. This technique permits to identify g-emissions between states where the gamma radiation emitted does not correspond to a peak [4]. In this contribution we will discuss the experimental set-up followed by a detailed description of the analysis method to reach the results obtained.

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