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Indirect Experimental Methods and $^{12}\text{C}+^{12}\text{C}$ Fusion

C-burning plays a pivotal role in astrophysics, from the nucleosynthesis of massive stars, to explosive scenarios in carbon-rich environments such as superbursts from accreting neutron stars and type Ia Supernovae [1-4]. Carbon burning occurs at temperatures greater than 0.4 GK, corresponding to center-of-mass energies exceeding 1 MeV. The dominant evaporation channels below 2 MeV are α and proton, leading to ^{20}Ne and ^{23}Na , respectively. In spite of the considerable efforts devoted to measure the $^{12}\text{C}(^{12}\text{C},\alpha)^{20}\text{Ne}$ and $^{12}\text{C}(^{12}\text{C},p)^{23}\text{Na}$ cross sections at astrophysical energies, they have been measured only down to 2.14 MeV, still at the beginning of the astrophysical region [5]. As known, direct measurements at lower energies are extremely difficult. Moreover, in the present case the extrapolation procedure from current data to the ultra-low energies is complicated by the presence of possible resonant structures even in the low-energy part of the excitation function. For these reasons, indirect approaches can represent a unique way for an accurate investigation at the relevant energies. In particular indirect information on the energy trend plus ^{24}Mg levels that may play a role in the $^{12}\text{C}+^{12}\text{C}$ low-energy fusion has been obtained through the $^{12}\text{C}+^{13}\text{C}$ and $^{13}\text{C}+^{13}\text{C}$ fusion [6]. Recently, the Trojan Horse Method [7] has been applied in the measurement of the $^{12}\text{C}(^{14}\text{N},\alpha)^{20}\text{Ne}+2\text{H}$ and $^{12}\text{C}(^{14}\text{N},p)^{23}\text{Na}+2\text{H}$ three-body processes [8]. The measurement was performed at 30 MeV of ^{14}N beam energy in the quasi-free (QF) kinematics

regime, where 2H from the ^{14}N Trojan Horse nucleus is spectator to the $^{12}\text{C}+^{12}\text{C}$ two-body processes. The cross section experiences a strong resonant behaviour with resonances associated to ^{24}Mg levels. As a consequence, the reaction rate is strongly enhanced at the relevant temperatures.

Results from indirect experiments will be presented and discussed.

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