



Contribution ID: 76

Type: Invited talk

Measurements of the $^{20}\text{Ne}+^4\text{He}$ resonant elastic scattering for characterization of the ^{24}Mg states at relevant excitations for carbon - carbon burning process

Thursday, 22 June 2017 17:20 (30 minutes)

Detailed knowledge on complex spectroscopy of the ^{24}Mg nucleus at excitation energies between 14 and 19 MeV has large impact on understanding of clustering in nuclei and on carbon - carbon burning, the $^{12}\text{C}+^{12}\text{C}$ fusion, in massive stars. The $^{12}\text{C}+^{12}\text{C}$ and $^{16}\text{O}+^8\text{Be}$ cluster structures (threshold energies are 13.9 and 14.1 MeV respectively) become active in this energy region mixing with already strong $^{20}\text{Ne}+^4\text{He}$ clustering (threshold energy is 9.3 MeV). Their interplay and effects of strong α -clustering in ^{12}C and ^{20}Ne lead to unique structural properties and very complex spectroscopy of the ^{24}Mg . In this energy region are expected to exist the band heads of a number of rotational bands associated with the $^{12}\text{C}+^{12}\text{C}$ cluster structure whose high spin members are identified at higher excitations. It is crucial to identify low spin members of these rotational bands to improve understanding of their origin. The $^{12}\text{C}+^{12}\text{C}$ clustering has a strong effect on the C-C burning which play an essential role in many astrophysical phenomena, both quiescent and explosive. Existing data in astrophysically relevant energy range show large discrepancies in the S-factors and substantial improvements in future direct measurements are required to make further progress.

Indirect experimental approach through measurements of the $^{20}\text{Ne}+^4\text{He}$ resonant elastic scattering was used to search for ^{24}Mg states which may increase C-C burning rate. Observation of the 0^+ (or 1^-) resonance at excitations between 15 and 18 MeV would strongly indicate enhanced reaction rate of the $^{12}\text{C}+^{12}\text{C}$ fusion while its non-observation would imply non-resonant nature of the C-C burning, and hence its reduced contribution in many stellar phenomena. Measurements of the $^{20}\text{Ne}+^4\text{He}$ excitation functions by use of the 36.07, 45.45 and 53.17 MeV ^{20}Ne beams delivered by the PIAVE-ALPI facility of Laboratori Nazionali di Legnaro INFN and a thick ^4He gas target which stops the beam in front of the detector were performed. This beam energy range corresponds to the $^{12}\text{C}+^{12}\text{C}$ relative energy range of prime importance for astrophysics. Scattered α -particles were detected in large area highly segmented silicon strip detector telescope built of 20 μm thick ΔE SSSD and 1000 μm thick E DSSSD. Telescope was positioned at 0° . Detailed measurements of the beam energy loss and beam intensity, needed for an accurate data analysis, were performed.

Elastic scattering excitation functions were extracted for data between -5° and 5° and normalized to previously taken data. Large number of overlapping resonances is detected in the excitation functions. Strong contribution of the inelastic scattering to the first excited ^{20}Ne state was observed and further analysis was performed for data free of inelastic scattering events. Using all available results on ^{24}Mg states at these excitations, attempts to fully characterize the observed resonances in the excitation functions in terms of spin, parity, width and partial widths were done using R-matrix calculations. No clear evidence for the 0^+ or 1^- state was found. Obtained results show the limitations of performed experiment and give clue for improved experiment. Complementary measurements using resonant scattering technique with the ^{20}Ne beam and low density ^4He gas target which will provide high resolution data for larger angular range were recently performed at LNL INFN and obtained data are being analysed.

Primary authors: Dr SOIC, Neven (Rudjer Boskovic Institute Zagreb Croatia); Dr TOKIC, Vedrana (Rudjer Boskovic Institute Zagreb Croatia)

Co-authors: Dr MARQUINEZ DURAN, Gloria (Department of Applied Physics, University of Huelva, Spain); Prof. MARTEL, Ismael (Department of Applied Physics, University of Huelva, Spain); Dr WALSH, Joe (School of Physics and Astronomy, University of Birmingham, United Kingdom); FERNANDEZ GARCIA, Juan Pablo (Laboratori Nazionali del Sud INFN, Catania, Italy); Dr PREPOLEC, Lovro (Rudjer Boskovic Institute, Zagreb, Croatia); Dr ACOSTA, Luis (Department of Applied Physics, University of Huelva, Spain); LATTUADA, Marcello (LNS); Mrs FISICHELLA, Maria (LNS); Prof. MILIN, Matko (Department of Physics, Faculty of Science, University of Zagreb, Croatia); Dr UROIC, Milivoj (Rudjer Boskovic Institute Zagreb Croatia); Mr SKUKAN, Natko (Rudjer Boskovic Institute, Zagreb, Croatia); FIGUERA, Pierpaolo (LNS); Mr SMITH, Rob (School of Physics and Astronomy, University of Birmingham, United Kingdom); BAILEY, Sam (School of Physics and Astronomy, University of Birmingham, United Kingdom); Dr SZILNER, Suzana (Ruder Boskovic Institute); Dr MIJATOVIC, Tea (Rudjer Boskovic Institute, Zagreb, Croatia)

Presenter: Dr SOIC, Neven (Rudjer Boskovic Institute Zagreb Croatia)

Session Classification: Indirect methods 2

Track Classification: Indirect methods in nuclear astrophysics