

$^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ measurement for ^{19}F production in AGB stars

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$^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ is known to be one of the key formation mechanisms of ^{19}F in AGB stars [1]. ^{19}F may also be produced through this reaction in other stars such as Wolf-Rayet stars [2]. The ^{19}F abundance observed in the stellar spectra strongly depends on the conditions in the astrophysical site. Its nucleosynthetic origin has been debated for several decades, however the understanding of the $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ reaction rate within the Gamow window at 200 MK for AGB stars is incomplete. Discrepancies in strength and energy exist between previous measurements in one of the key resonances, at $E_{\text{c.m.}}=1.323$ MeV. Furthermore, the direct-capture, non-resonant cross-section has never been directly measured.

The DRAGON recoil separator at TRIUMF was utilised to perform an inverse kinematics measurement of the $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ reaction. Recoiling ^{19}F nuclei leaving the windowless helium gas target were separated using DRAGON's electromagnetic mass separator and detected in a DSSSD. Emitted gamma-rays from the de-excitation of the compound nucleus were detected in a BGO array surrounding the target and used for a coincidence analysis. We have measured the strength and energy of the $E_{\text{c.m.}}=1.323$ MeV resonance in the $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ reaction as well as the direct-capture cross section down to an energy of $E_{\text{c.m.}}=0.96$ MeV. The 2017 ERNA measurement by Di Leva et al. [3] was the first time $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ was measured in inverse kinematics; two strong reference resonances were measured. This measurement at DRAGON is the second inverse kinematics measurement. Our new measurement of the $E_{\text{c.m.}}=1.323$ MeV resonance will help in solving the existing discrepancies regarding its strength, and provides an independent measurement of its energy, as well as the first measurement of the direct-capture contribution in the low-energy regime. This measurement will reduce uncertainties in $^{15}\text{N}(\alpha,\gamma)^{19}\text{F}$ reaction rate, especially in the direct-capture component where no previous measurements exist, thus helping to refine our understanding of AGB models and ^{19}F production.

References

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- [2] G. Meynet and M. Arnould, *A&A*. 335 (2000) 176.
- [3] A. Di Leva et al., *Phys. Rev. C*. 95 (2017) 045803.

Primary authors: LENNARZ, Annika (TRIUMF); FROST-SCHENK, Joseph (University of York)

Co-authors: Dr LAIRD, Alison (University of York); Mr PSALTIS, Athanasios (McMaster University); DAVIDS, Barry (TRIUMF); Dr RUIZ, Chris (TRIUMF); Dr DIGET, Christian Aaen (University of York); Prof. BARDAYAN, Daniel (University of Notre Dame); Mr GOLTON, Daniel (University of York); HUTCHEON, Dave (TRIUMF); Dr CONNOLLY, Devin (TRIUMF); BLANKSTEIN, Drew (University of Notre Dame); KARPESKY, J (Colorado School of Mines); LIANG, Johnson (McMaster University); LOVELY, M (Colorado School of Mines); HALL, Matthew (University of Notre Dame); Mr WILLIAMS, Matthew (University of York); MACHULE, Peter (TRIUMF); Dr FOX, Simon (University of York); Dr GILLESPIE, Stephen (TRIUMF); GREIFE, Uwe (Colorado School of Mines)

Presenter: FROST-SCHENK, Joseph (University of York)

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