ALMOST MEDIUM-FREE MEASUREMENT OF THE HOYLE STATE DIRECT-DECAY COMPONENT WITH A TPC

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The structure of the Hoyle state, a highly α-clustered state at 7.65 MeV in ^{12}C, has long been the subject of debate. Understanding if the system comprises of three weakly-interacting α-particles in the 0s orbital, known as an α-condensate state, is possible by studying the decay branches of the Hoyle state.

The direct decay of the Hoyle state into three α-particles, rather than through the ^{8}Be ground state, can be identified by studying the energy partition of the 3 α-particles arising from the decay. By using beta-delayed charged-particle spectroscopy of ^{12}N using the TexAT (Texas Active Target) TPC, a high-sensitivity measurement of this branching ratio can be performed without contributions from pile-up events.

A Bayesian approach to understanding the contribution of the direct components via a likelihood function shows that the direct component is $< 0.043\%$ at the 95% confidence level (C.L.). This value is in agreement with several other studies and here we can demonstrate that a small non-sequential component with a decay fraction of about 10^{-4} is most likely.

The measurement of the non-sequential component of the Hoyle state decay is performed in a medium-free reaction for the first time. The derived upper-limit is in agreement with previous studies and demonstrates sensitivity to the absolute branching ratio. Further experimental studies would need to be combined with robust microscopic theoretical understanding of the decay dynamics to provide additional insight into the idea of the Hoyle state as an α-condensate.

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