The Pair Conversion Decay of the Hoyle state

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The triple-alpha process leading to the formation of stable carbon in the Universe is one of the most important nuclear astrophysical processes. The radiative width of the so-called Hoyle state, involving the 7.654 MeV E0 and the 3.2148 MeV E2 transitions, is known with 10-12% accuracy. A novel, more direct, approach to determining the width was proposed recently [1], which is based on the measurement of the E0 and the E2 internal pair conversion intensities. The Hoyle state in ^{12}C was populated using the (p, p') reaction with 10.5 MeV proton beams from the ANU 14UD Heavy Ion Accelerator. Electrons and positrons from the pair conversion decay were recorded with a new magnetic pair spectrometer, which combines the ANU superconduction solenoid, Super-e [2], with an array of six 9 mm thick Si(Li) detectors [3]. Here we report on our first successful experimental observation of the pair conversion decay of the 7.654 MeV E0 transition of the Hoyle state, which carries approximately 1.5% of the electromagnetic decay intensity.

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