The Radiative Width of The Hoyle State From Cascading γ-Ray Measurement

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The excited state of the ^{12}C nucleus known as the "Hoyle state", constitutes one of the most interesting, difficult and important challenges in nuclear physics, as it plays a key role in the production of carbon via fusion of three alpha particles in red giant stars. In this paper we report on a new measurement of the Γ_γ/Γ ratio of the 7.654 MeV 0^+ state, which together with the world data on $\Gamma_\pi(E0)/\Gamma$ and $\Gamma_\pi(E0)$ was used to determine the radiative width, Γ_{rad}, of the Hoyle state.

The experiment was carried out at the Oslo Cyclotron Laboratory. The Hoyle state was populated using the $^{12}C(p,p')^{12}C$ reaction at 10.7 MeV energy using a 180 $\mu g/cm^2$ thick natural carbon target. Cascade gamma-rays of E2 multipolarity and at energies of 3.215 MeV and 4.439 MeV were observed using the CACTUS array [1], consisting of twenty-six 5" by 5" NaI detectors. Scattered protons in singles and in coincidence with γ-ray cascades were recorded with the Silicon Ring (SiRi) array [2] consisting eight DE-E telescopes, where the front detector is segmented into eight strips. A total of 2.56×10^8 singles proton events leading to the excitation of the Hoyle state were observed in an 11 day run. The number of $p\gamma\gamma$ events involving the 3.215 MeV and 4.439 MeV γ-rays was 529(23). The observed angular correlation of the events is consistent with a 0-2-0 cascade.

This talk will focus on the analysis of the data and will compare our results with the only previous measurement performed by Obst and Braithwaite more than 35 years ago [3]. This study complements our project to determine the radiative width from pair conversion measurement of the E0 and E2 transitions de-exciting the Hoyle state [4].

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