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Observation of the Radiative Decay Mode of the Free Neutron

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Despite decades of detailed study, the radiative decay mode of the neutron has never been definitively observed. We report observation of this process, in which a photon is emitted along with the proton, electron and antineutrino. Photons with energies between 15 keV and 340 keV were detected by a scintillating crystal coupled to an avalanche photodiode and were distinguished from uncorrelated background photons by coincidence with both the decay electron and proton. Correlated background from external bremsstrahlung generated in the electron detector has been estimated to be minor, due to the physical separation and limited line-of-sight between the particle and photon detectors. Measurement of the dependence of the radiative decay rate on the available phase space of the decay is consistent with the expected behavior for radiative decay. The energy spectrum of the radiated photons, which differs from the uncorrelated background spectrum, is also consistent with the calculated spectrum. The measured branching ratio is consistent with theoretical predictions. We discuss the results of this first experiment, and the design of an improved apparatus to perform a precision measurement of the branching ratio and spectrum.

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