Observation of the Radiative Decay Mode of the Free Neutron

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The theory of quantum electrodynamics (QED) predicts that betadecay of the neutron into a proton, electron and antineutrinoshould be accompanied by a continuous spectrum of soft photons.While this inner bremsstrahlung branch has been previously measured in nuclear beta and electron capture decay, it had never beenobserved in free neutron decay. The photon energy spectrum and branching ratio for neutron radiative decay have beencalculated using two approaches: a standard QED frameworkand heavy baryon chiral perturbation theory. The radiative decay modeof free neutrons was recently observed by measuring photons in coincidence with both the emitted electron and proton. The branching ratio was determined to be (3.13 +/- 0.34) x 10-3 (68 per cent level of confidence) in the energy region between 15 keV and 340 keV, where the uncertainty is dominated by systematic effects. The value is consistent with the predictions of both theoretical approaches; the characteristic energyspectrum of the radiated photons, which differs from the uncorrelated background spectrum, is also consistent with the calculated spectrum. This result provides opportunities for moredetailed investigations of the weak interaction processes involvedin neutron beta decay. A second experiment is planned to perform a precision measurement of the radiative photon energy spectrum and the branching ratio.