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Nuclear Excitation by Electronic Transition of U-235[1]

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Nuclear excitation by electronic transition (NEET) is a rare nuclear excitation that is theorized to exist in numerous isotopes. NEET is the inverse of bound internal conversion and occurs when an electronic transition couples to a nuclear transition causing the nucleus to enter an excited state. This process can only occur for isotopes with low-lying nuclear levels due to the requirement that the electronic and nuclear transitions have similar energies. One of the candidate isotopes for NEET, ^{235}U, has been studied several times over the past 40 years and NEET of ^{235}U has never been conclusively observed. These past experiments generated conflicting results with some experiments claiming to observe NEET of ^{235}U and others setting limits for the NEET rate. If NEET of ^{235}U were to occur, the uranium would be excited to its first excited nuclear state. The first excited nuclear state in ^{235}U is only 76 eV, the second lowest known nuclear state. Additionally, the 76 eV state is a nuclear isomer that decays by internal conversion with a half-life of 26 minutes. In order to measure whether NEET occurs in ^{235}U and at what rate, a uranium plasma was required. The plasma was generated using a Q-switched Nd:YAG laser outputting 789 mJ pulses of 1064 nm light. The laser light was focused onto uranium targets generating an intensity on target of order 10^{12} W/cm^2. The resulting plasma was captured on a catcher plate and electrons emitted from the catcher plate were accelerated and focused onto a microchannel plate detector. Measurements performed using a variety of uranium targets spanning depleted uranium up to 99.4% enriched uranium did not observe a 26 minute decay. An upper limit for the NEET rate of ^{235}U was determined.

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