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Measuring the Neutron Lifetime

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Neutron beta decay is the simplest example of nuclear beta decay and is crucial in our understanding of weak processes. The neutron lifetime, when combined with other neutron decay parameters, provides a test of the unitarity of the CKM matrix in the Standard Model. The value of the neutron lifetime is also an important input in Big Bang Nucleosynthesis models, as well as playing a role in other areas including solar physics and the detection of reactor antineutrinos. Two main methods have been utilized to measure the neutron lifetime: the bottle method and the beam method. In the bottle method, ultracold neutrons are confined in a material and/or magnetic trap. After varying lengths of storage time, the number of neutrons remaining in the trap are counted. In the beam method a cold neutron beam is passed through a fiducial volume. The absolute neutron beam flux is measured, as well as the absolute number of decay particles (protons or electrons) resulting from neutron decay inside the fiducial volume. While the most precise neutron lifetime experiments have reached uncertainties of less than 1 s, there remains significant scatter in the results, including a large discrepancy between the bottle average value and the beam average value for the neutron lifetime. An overview of the measurement methods and recent or ongoing experiments will be given, with an emphasis on current efforts to improve and check the results of the beam method.