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Standard Model and Beyond with Neutron Beta Decay Experiments

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The underlying charge-current weak interaction of the neutron beta decay connects together the Fermi constant G_F, CKM matrix element V_{ud}, the nucleon axial weak coupling constant g_A, and the free neutron life time τ_n. Consequently, the combination of direct measurements of these provides stringent constraints to the Standard Model. At present, G_F and V_{ud} have been measured to a precision of 5 ppm and 225 ppm, respectively, whereas the data in g_A and τ_n are less precise, and both exhibit significant inconsistency among measurements. With polarized neutrons, g_A can be determined by measuring the angular correlation of the decay electrons with the neutron spin (so-called β-asymmetry). In the past, β-asymmetry have been measured in the cold neutron beam experiments, yielding a range of results much wider than the reported uncertainties. A new β-asymmetry measurement, UCNA (Ultracold Neutron Asymmetry), has been developed using the solid deuterium pulse spallation ultracold neutron (UCN) source at the Los Alamos Neutron Science Center, where UCN are transported in a guide system, fully polarized, then loaded into a decay trap within a solenoidal beta spectrometer. Utilizing UCN give this experiment very different systematics compared to cold neutron experiments. In this talk, I will give a brief review of the neutron beta decay measurements on the angular correlations as well as the life time. The main focus of this talk will be on the UCNA experiment. I will discuss the experimental techniques, and present the new results from the data in 2008 and 2009. The implication of the new results, combined with the world data on β-asymmetry, V_{ud}, and τ_n, will also be discussed.