Neutron β-decay and the Standard Model

H. Abele

Physikalisches Institut der Universität Heidelberg,
Philosophenweg 12, 69120 Heidelberg, Germany

Abstract

Neutrons study a number of hot topics from the field of particle physics and cosmology: Measurements of various mixed American-British-French-German-Hungarian-Japan-Russian groups of researchers determine the strength of the weak interaction of the neutron, which gives us unique information on the question of the so-called quark mixing. The experiments try to shed light on the origin of parity violation and the research is sensitive to a hypothetical violation of time reversal invariance in neutron decay. A nice example of particle physics with neutrons is cosmology. Starting at high temperature, the universe traverses quite different phase transitions into stages of lower symmetries. On all steps neutrons test these very early stages of the universe with a variety of observables.

The combination of neutron β-decay experiments at the Institut Laue-Langevin now challenge the Standard Model of elementary particle physics: A measurement of the β-asymmetry A_0 and the world average of the neutron lifetime τ determine the first element $|V_{ud}|$ of the quark-mixing-CKM-matrix. With this value and the particle data group values for $|V_{ud}|$ and $|V_{ub}|$, the unitarity condition for the first row of the CKM-matrix deviate from unity by $\Delta = 0.0083(28)$, which is 3.0 times the stated error and conflicts the prediction of the Standard Model of particle physics. We compare our result with other sources of information for V_{ud}, like nuclear β-decay experiments or W physics at LEP.