# Nuclear transitions to search for physics beyond the standard model

Nathal Severijns
Instituut voor Kern- en Stralingsfysica, Department of Physics and Astronomy, KU Leuven, Leuven, Belgium

Nuclear transitions have the advantage that nature provides many isotopes with many different beta-transition spin sequences, so that a proper choice can maximize the sensitivity to the physics aimed at. Typical observables are beta-transition ft-values, (angular) correlations between the spin and momentum vectors of the different particles involved in the beta decay, and the beta spectrum shape.

For many years the corrected Ft-values of the $0^+ \rightarrow 0^+$ superallowed pure Fermi transitions have been the major source leading to the value of the $V_{ud}$ quark-mixing matrix element. Combined with the other matrix elements on the first row of this matrix (i.e. $V_{us}$ and $V_{ub}$), the unitarity of the matrix can be tested, allowing to check on possible physics beyond. Recently the Ft-values from neutron decay and the beta transitions between the so-called mirror nuclei have become sufficiently precise that they start contributing to the value of $V_{ud}$ as well. Apart from spectroscopic quantities characterizing the respective beta transitions, a correlation measurement to determine the Gamow-Teller/Fermi mixing ratio is required for the neutron and mirror beta decays as well. Making further progress on the precision of $V_{ud}$ requires both improved experimental data for the neutron and mirror beta decays, but also improved theoretical calculations for several small corrections included in the Ft-values.

Correlation measurements with different beta transitions (including the neutron and mirror beta decays) allow addressing possible types of new physics beyond the standard model, such as right-handed currents, but also scalar or tensor type weak currents, the latter usually via the Fierz interference term. Traditionally, the beta-neutrino angular correlation and the beta-asymmetry parameter, but recently also the beta-spectrum shape, are used for this. At the present level of precision of 0.5% and better, small corrections induced by the strong interaction (often called recoil corrections, the larger of which being weak magnetism) are to be included as well. Recent beta-spectrum shape measurements provide useful additional information on the weak magnetism term, while global analysis of existing experimental data allow setting limits on the possible presence of scalar and tensor types of weak interactions.