Two Decay Paths for Calculating Nuclear Matrix Element of Neutrinoless Double-Beta Decay

J. Terasaki

IEAP, Czech Technical University in Prague, Horská 3a/22, 128 00 Prague 2, Czech Republic

Neutrinoless double-beta decay is a weak decay of nucleus possible if the neutrino is a Majorana particle, and this decay supplies us, if it occurs, with a precious tool for determining the effective neutrino mass. The effective neutrino mass is determined by measuring the decay probability and calculating the nuclear matrix element and phase-space factor. It is necessary for calculating the nuclear matrix element to obtain accurate nuclear wave functions, however this task is not trivial at all because none of the wave functions of those nuclei used for the experiment can be obtained without approximations. A problem is known that several methods for calculating the nuclear wave functions yield values of nuclear matrix elements differing by a factor of $2-3$.

I have so far calculated the nuclear matrix element of ^{150}Nd$\to$^{150}Sm by using the quasiparticle random-phase approximation (QRPA) [1]. The nuclear matrix element of the neutrinoless double-beta decay is given by a trace of product of four matrices, and one of them is an overlap matrix of the QRPA states obatined based on the initial and final states. I have improved the calculation of the overlap by using the QRPA ground states defined as the vacuum to the quasibosons.

In this paper, I discuss a further development of the method to calculate the nuclear matrix elements of the double-beta decay [2]. It is possible to employ virtual decay paths, including two-particle transfer, to calculate the nuclear matrix element of neutrinoless double-beta decay under the closure approximation, in addition to the true double-beta path. I propose introduction of the proton-neutron pairing interaction with an adequate strength in the double-beta-path calculation for obtaining the NME equivalent to that of the two-particle-transfer-path calculation.

References

[1] J. Terasaki, *Phys. Rev. C* **86** (2012) 021301(R); **87** (2013) 024316; **91** (2015) 034318.

[2] J. Terasaki, *Phys. Rev. C* **83** (2016) 024317.