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Searching for new physics with neutrinoless double-beta decay

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Neutrinoless double-beta ($0\nu\beta\beta$) decay is a hypothetical nuclear process in which two neutrons turn into protons (or vice versa) but, unlike in the standard double-beta decay, no neutrinos are emitted. Several large-scale experiments worldwide are dedicated to observing it. When observed, the lepton-number-violating process would provide unique vistas beyond the Standard model of particle physics. It would not only shed light on the unknown mass-scale of neutrinos but also prove that neutrinos are their own antiparticles, hence explaining the matter-antimatter symmetry of the Universe. However, the half-life of the process depends on coupling constants whose effective values are under debate, and nuclear matrix elements (NMEs) that have to be extracted from nuclear theory. Unfortunately, at present different many-body calculations probe matrix elements whose values disagree by more than a factor of two. Hence, it is crucial to gain a better understanding on the NMEs in order to plan the future experiments and to extract the intriguing beyond-standard-model physics from the experiments.

I will discuss how these NMEs have recently been improved by the nuclear theory group of the UB. Furthermore, I will discuss how other nuclear processes – that have been or can be measured – can be utilized to constrain the values of the $0\nu\beta\beta$ NMEs.

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