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Open questions in neutrino physics

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In this presentation, after a brief historical introduction, I will review the progress made in the last few years in theoretical approaches to the open questions of 1\ . What is the absolute mass scale of neutrinos 2\ . Are neutrinos Dirac or Majorana particles [1] 3\ . How many neutrino species are there After briefly discussing single beta decay and single electron capture as a way to determine the neutrino mass [2], I will concentrate my attention to neutrinoless double beta decay (DBD). Here, I will first discuss the standard mass mechanism and the associated phase space factors (PSF), $G_{0\nu}$, and nuclear matrix elements (NME), $M_{0\nu}$, appearing in the expression for the inverse half-life showing the current limits on the average neutrino mass, $\langle m\nu \rangle$, obtained with the free value of the axial vector coupling constant, $g_A=1.269$. I will then discuss the present situation for the quenching of the axial vector coupling constant in heavy nuclei, indicating the impact that this quenching may have on experiments and showing results for three scenarios, free value $g_A=1.269$, quark value $g_A=1.0$, and maximal quenching $g_A=1.269 A^{-0.18}$. In the final part of the presentation, I will discuss current work on contributions to neutrinoless DBD of 1\ . (Hypothetical) sterile neutrinos [3], light and heavy 2\ . (Hypothetical) non-standard mechanisms, short-range and long-range In the concluding remarks, and in light of the part of the presentation dealing with sterile neutrino and non-standard mechanisms, I will strengthen the argument for continuing experimental work of neutrinoless DBD. [1] E. Majorana, Nuovo Cimento 14, 171 (1937) [2] E. Fermi, Z. Phys. 88, 161 (1934) [3] B. Pontecorvo, Sov. Phys. JETP 26, 984 (1968)

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