NUSTAR Seminar

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“Competition between allowed and first-forbidden beta decays in heavy neutron-rich nuclei”

Beta decay is classified as allowed (if the orbital angular momentum carried by the beta particle and neutrino is L =0), first-forbidden (L =1) and so on. The so-called forbidden transitions are hindered, but not completely suppressed. As the name suggests, the vast majority of beta decay is via allowed transitions. Nevertheless, there are regions on the nuclide chart where forbidden decays are expected to compete and even dominate. One of these is the region of heavy (A~200) neutron-rich nuclei. The decay properties of these nuclei affect the nucleosynthesis of heavy elements (A~195 abundance peak) produced in the rapid neutron capture process. Since these nuclei still cannot be produced on Earth, we have to rely on theoretical prediction. However, the calculation of first-forbidden beta decay is notoriously difficult and subject to debate.

In this talk I will concentrate on recent results obtained from the beta decay of 207,208Hg, nuclei close to the doubly-magic 208Pb.

208Hg provides a unique testing ground of the competition between allowed and first-forbidden beta decay. However it populates directly only negative parity states via first-forbidden decays. The strongest branch establishes a 0+ -> 0− decay to a core excited daughter state. The level scheme of the single proton-hole single neutron-particle 208Tl nucleus was established, providing the first direct test of the proton-neutron residual interaction in the N > 126, Z < 82 quadrant [1].

In addition, the Delta(n)=0 selection rule, where n is the number of nodes in the wave function, was tested in the beta decay of 207Hg [2]. This selection rule inhibits the decays from the N>126 neutron orbitals to Z<82 proton orbitals. Therefore, it forbids the otherwise "allowed" beta decays, contributing to the possible dominance of the first-forbidden transitions.

[1] R.J. Carroll et al, Phys. Rev. Lett. 125, 192501 (2020)

[2] T.A. Berry et al., Phys. Lett. B 793, 271 (2020) [2] T.A. Berry et al., Phys. Lett. B 793, 271 (2019)

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