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Plasma-induced modification of β-decay rates relevant for the s-process

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The s-process nucleosynthesis pathway is governed by the competition between neutron capture rates and β-decay lifetimes of radioisotopes. The latter are susceptible to changes in atomic configuration of the parent and daughter ions and are consequently modified inside stellar plasmas due to the ion charge state distribution and level excitation. PANDORA is an upcoming facility at INFN-LNS which aims to use an electron cyclotron resonance ion source (ECRIS) as a compact magnetoplasma to measure plasma-induced variation of β-decay rates. We report here on upgrades in the theoretical modelling of in-plasma β-decay under different thermodynamic conditions, through the examples of orbital electron capture in 7Be and bound/continuum decay in 134Cs. The
results reaffirm the impact of the electronic configuration on the decay rate and improve upon the methodology of Takahashi-Yokoi by including finer atomic effects. Using a Particle-in-Cell Monte Carlo (PIC-MC) code to model ECRIS dynamics, we extend the analysis to a realistic laboratory plasma and demonstrate expected spatial gradients of isotope decay rates in the plasma chamber.

Author: MISHRA, Bharat

Presenter: MISHRA, Bharat