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Nuclear physics in the N˜126 region relevant to the r process

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Half of the nuclei heavier than iron were synthetized in the r process. The r-process yield peak at A˜195 is linked to the N=126 closed neutron shell. In contrast to lighter mass regions, the r-process waiting point nuclei at N=126 still cannot be studied experimentally, and the yield calculations rely entirely on theoretical nuclear physics properties.
The most neutron rich N=126 nuclei for which basic observables such as the ground-state lifetime and mass were determined are 204Pt (Z=78) and 206Hg (Z=80), respectively. Therefore information on features which determine these values, single-particle energies and nucleon-nucleon interactions are crucial in order to increase the predictive power of nuclear theories. Nuclear structure information, like excited state energies, gamma-ray transition energies and transition strength are known "down"to 203Ir (Z=77).
In the case of the beta decay of N˜126 nuclei there is a strong competition between allowed and first-forbidden transitions. First-forbidden (FF) transitions can be dominant, with profound implications on their half-lives and therefore on the r-process [1]. And FF transitions are notoriously difficult to calculate. The beta decay of 208Hg into 208Tl was studied at ISOLDE Decay Station at CERN. Three negative parity excited states in 208Tl were populated directly in beta decay. In contrast none of the positive parity states were populated. This latter can be understood by considering the properties of the single proton and neutrons involved [2]. Similarly to 208Hg, 207Hg also decays predominantly via first-forbidden decays [3]. In addition, the validity of the less known Δn=0 selection rule in Gamow-Teller beta decay was investigated [4]. This selection rule has little importance for nuclei close to stability, but is essential for the Z<82, N>126 r-process waiting point nuclei, lengthening their lifetimes. Furthermore, accelerated radioactive beams at HIE-ISOLDE allowed for the first exploration of proton states beyond the N=126 closed shell [5], and the measurement of the transition strength B(E2; 2+->0+) transition strength in 206Hg [6].
In conclusion, the status of nuclear physics knowledge in the N˜126 region relevant to the r-process will be presented. Future opportunities will be also discussed.
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Field of work

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