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Nuclear astrophysics with stored and cooled highly-charged ions

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Storage of freshly produced secondary particles in a storage ring is a straightforward way to achieve the most efficient use of the rare species as it allows for using the same secondary ion multiple times. Employing storage rings for precision physics experiments with highly-charged ions (HCI) at the intersection of atomic, nuclear, plasma and astrophysics is a rapidly developing field of research. The number of physics cases is enormous. The focus in this presentation will be on the most recent results obtained at the Experimental Storage Ring ESR of GSI in Darmstadt and the Experimental Cooler-Storage Ring CSRe of IMP in Lanzhou.
Both the ESR and CSRe rings are coupled to in-flight fragment separators and are employed for precision mass spectrometry of short-lived rare nuclei. At CSRe, the enabled measurement of the velocity of every stored particle—in addition to its revolution frequency—has boosted the sensitivity and precision of mass measurements, which lead to accurate determination of the remaining masses constraining matter flow though 64Ge waiting point in the rp-process nucleosynthesis.
The ESR is presently the only instrument dedicatedly utilized for precision studies of decays of HCIs. Radioactive decays of HCIs can be very different as known in neutral atoms. Some decay channels can be blocked while new ones can become open. Such decays reflect atom-nucleus interactions and are relevant for atomic physics and nuclear structure as well as for nucleosynthesis in stellar objects. Especially the two-body weak decays of HCIs will be discussed.
The experiments performed at the ESR and CSRe will be put in the context of the present research programs in a worldwide context, where, thanks to fascinating results obtained at the presently operating storage rings, a number of projects is planned.

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