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Exploring the limits: From halo nuclei to super heavy elements - basic research and new medical applications

Exploring the limits of the existence of elementary matter is a primary goal of nuclear physics. New species such as halo nuclei and super heavy elements have been discovered. Experimental methods have been further developed for medical applications including cancer therapy with heavy ion beams and time-of-flight mass spectrometry for medical diagnostics. This work has been largely carried out at the GSI Helmholzzentrum für Schwerionenforscheung. Light neutron rich nuclei at the limits of nuclear binding develop neutron halos. The nuclear core is surrounded by a halo of dilute neutron matter, heavier species develop a neutron skin. Reaction studies give new insights in nuclear structure. The key instrument for these experiments is the GSI projectile fragment separator (FRS). With the FRS basic research for cancer therapy with heavy ion beams such as the choice of the therapy beam and a special PET diagnostics have been made. Super heavy elements (SHE) at the upper end of the periodic table exist only by shell stabilization. At GSI the new species of deformed shell stabilized SHE has been discovered. The spherical super heavy nuclei predicted for Z=114 are still waiting for discovery though this proton number has already been surpassed with heaviest element observed, oganesson, with 118 protons. To reach this goal the new generation of SHE factories is under way. Drawbacks of the existing experiments are the insufficient sensitivity and the identification by decay characteristics. The new SHE factories will provide more beam intensity for higher sensitivity and direct A, Z identification by isobaric mass measurement with high-resolving multi-reflection time-of-flight mass spectrometers (MRTOF-MS). These spectrometers have a resolving power of 600,000 and are also suitable for the analysis of macro molecules or even cell fragments. Such spectrometers are developed at Giessen University. Experiments for the identification of exotic nuclei created in transfer reactions are under way.

Biography

Gottfried Münzenberg completed his PhD at Giessen University. He was the Leader of the GSI Department: Nuclear Structure and Nuclear Chemistry and University Professor at Mainz University. Among his awards are the Röngten Preis of Giessen University, the Otto Hahn Preis der Stadt Frankfurt, and the Lise Meitner Prize of EPS. He was awarded Hononrary Doctor of JINR Dubna and University of Jyväskylä.

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