Spin-polarized exotic nuclei: from fundamental interactions, via nuclear structure, to biology and medicine.

Magdalena Kowalska, CERN EP-Dept.

This talk is devoted to versatile studies, whose common point is the fact that beta or gamma decay from polarized radioactive nuclei is anisotropic in space.

Our experimental setup devoted to laser polarization of short-lived nuclei is located at the CERN-ISOLDE facility. We have already used it to polarize 35Ar beam with the aim to determine more precisely the Vud matrix element of the CKM quark mixing matrix. Soon, we plan to perform nuclear structure studies by measuring angular beta-gamma coincidences in order to assign spins and parities of nuclear excited states around 30Na, where observations are especially challenging for nuclear theory.

The main part of our present activities concerns beta-detected NMR, which is up to 10 orders of magnitude more sensitive than conventional NMR, due to a much higher degree of spin polarization and a much more efficient resonance detection via beta-decay asymmetry. We aim at using it for the studies of the interaction of proteins and DNA with metal ions, such as Na, Cu, Zn, which are crucial in many biological processes, including Alzheimer's and Parkinson's diseases. A further development concerns gamma-detected MRI, which can combine the strengths of the high sensitivity of PET and SPECT techniques with high spatial resolution of MRI by using polarized beams of longer-lived gamma-decaying nuclei.

In this talk I will introduce asymmetry of beta and gamma decay, will mention principles of laser polarization and the experimental setup, and will concentrate on selected aspects of the versatile research avenues mentioned above.