LIFETIMES OF EXCITED STATES IN NEUTRON-RICH NUCLEI

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Lifetimes of low-lying excited states have been measured for a very wide range of neutron-rich nuclei in an experiment using the recoil-distance Doppler shift technique after fusion-fission reactions in inverse kinematics. In an experiment at GANIL a beam of ^{238}U was accelerated to an energy of 1475 MeV and directed onto a ^{9}Be target. The ^{247}Cm compound nucleus fissions while still inside the target foil. The fission fragments exit the target with high velocities and are strongly forward focused due to the inverse kinematics. The velocity of the fission fragments was slowed using a degrader foil, which was placed in a plunger device at micrometer distances from the target. After passing through the degrader, one of the two fission fragments was detected and identified in mass, atomic number, and charge state event by event using the VAMOS spectrometer, which was rotated to 20° with respect to the beam axis and equipped with a new, improved detection system at the focal plane. Gamma rays were detected around the target position with the segmented germanium clover detectors of the EXOGAM array and correlated with the fission fragment identified in VAMOS. The lifetime of excited states are extracted from the intensities of the fast and slow components of Doppler-shifted gamma rays as a function of the target-degrader distance. More than 200 nuclides with masses between $70<A<140$ were identified in VAMOS, allowing lifetimes to be measured for a wide range of nuclei under identical experimental conditions. The setting of the spectrometer was optimized for the transmission of neutron-rich isotopes of elements with Z=40-50, where lifetimes of excited states are only poorly known. Deformation and collectivity changes rapidly in this region of the nuclear chart, making the measurement of electromagnetic transition rates a stringent test and benchmark for nuclear structure models.

In a second experiment a similar technique was used to extract lifetimes of excited states in neutron-rich Zn isotopes populated in deep-inelastic collisions between ^{76}Ge projectiles and a ^{238}U target. The experiment was carried out at Legnaro National Laboratories and used the highly segmented germanium detectors of the AGATA Demonstrator array coupled to the PRISMA magnetic spectrometer. The experiment yielded an unexpectedly long lifetime for the 4^+ state in ^{74}Zn. The combination of *B(E2)* values from the lifetime measurement and excitation probabilities from a Coulomb excitation measurement at ISOLDE [1] gives information on the spectroscopic quadrupole moment for the 2^+ state in ^{74}Zn.

Results from both experiments will be presented and compared to theoretical predictions.

References

[1] J. Van de Walle *et al.*, Phys. Rev. C **79**, 014309 (2009)