Abstract

Three different aspects of low-lying electric dipole excitations in light and medium-mass spherical nuclei have been investigated in this thesis using complementary experimental methods. One focus was on the isospin character of dipole excitations in the doubly-magic nucleus $^{48}\text{Ca}$ probed in an $(\alpha,\alpha'\gamma)$ experiment at 34 MeV/u performed at the Kernfysisch Versneller Instituut (KVI) in Groningen, The Netherlands, along with a parity measurement performed at the High Intensity $\gamma$-ray Source (HI$\gamma$S) facility in Durham, USA, and a comparison with theoretical results from microscopic calculations. The coexistence of isoscalar, isovector, and isospin-mixed electric dipole excitations of diverse underlying structure, including a strong almost pure isoscalar oscillation, was revealed.

In addition, protons at intermediate energies (80 MeV/u) were used for the first time at KVI Groningen in a $(p,p'\gamma)$ coincidence experiment on $^{140}\text{Ce}$. In this way, access to the dipole response to a complementary hadronic probe with a dominant isoscalar character, but a higher penetration depth due to a higher energy per nucleon, is given. The deduced excitation pattern complements the picture previously obtained from $(\alpha,\alpha'\gamma)$ and $(\gamma,\gamma')$ experiments.

The last part of this thesis deals with the investigation of candidates for the two-phonon $(2^+_1 \otimes 3^-_1)_1^-$ state in $^{40}\text{Ca}$ and $^{140}\text{Ce}$. For this purpose, the $\gamma$-decay behavior of the candidates was studied using the newly installed and commissioned high-efficiency $\gamma$-$\gamma$ coincidence setup $\gamma^3$ for $(\vec{\gamma},\gamma')$ experiments at HI$\gamma$S. Besides the ground-state decay, a decay of the $1^-_1$ state to the $3^-_1$ state was observed for $^{40}\text{Ca}$, whereas for $^{140}\text{Ce}$ decays to the $2^+_1$ and to the $0^+_2$ state were detected.