A New Island of Superdeformation in the A=80 Region

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Medium-mass nuclei in the A=80 region manifest a remarkable diversity of shapes and rapid changes of collectivity with particle number and angular momentum. As such, they provide a strong challenge to the microscopic models. For example, although both cranked Nilsson-Strutinsky and Hartree-Fock calculations predict coexistence of non-collective spherical shapes with collective prolate, triaxial, oblate and superdeformed shapes in the light Sr isotopes, they differ significantly in details. Therefore, experimental studies of these novel shapes may provide information about the nuclear force (e.g., the spin-orbit potential), or the delicate balance between the microscopic and macroscopic forces which governs the emergence of superdeformation in certain mass regions.

In an experiment using the EUROGAM spectrometer at the Daresbury Laboratory, we have succeeded in establishing an extensive set of band structures in ^{82}Sr that includes a discrete superdeformed band. The observed superdeformed band consists of about ten discrete transitions, with energies in the range of ~1300-2650 keV. The top transition in this cascade corresponds to the largest collective rotational frequency yet observed. The separation energies of the gamma rays are nearly constant and about 150 keV, which corresponds to a deformation parameter of $\beta\sim0.5$ and an axis ratio of 2:1. Using the early implementation of the GAMMASPHERE, a ridge-valley structure with a similar gamma ray separation energy was recently observed in an experiment which populated mostly ^{83}Y and ^{80}Sr nuclei. It, thus, appears that there exists a new island of superdeformation which is centered around nuclei with particle numbers Z~38 and N~44. The experimental dynamical moments of inertia of these bands are in excellent agreement with the predictions of the microscopic-macroscopic cranking calculations, but are much smaller than the values obtained using the relativistic mean field approach.

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