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Probing octupole deformation limits in neutron-deficient actinides at DESIR

The study of octupole deformation in atomic nuclei provides crucial insight into nuclear structure at the limits of stability. While the octupole deformation region centered at Z~88, N~136 has been well established experimentally, the question of its extent remains open, especially at higher Z. Experimental measurements in this region would help establish the boundaries of octupole collectivity as proton number increases.

The DESIR facility, coupled with the opportunities offered by S3 beams, offers a unique opportunity to investigate neutron-deficient actinides through complementary measurement techniques. The combination of high-precision mass measurements (PIPERADE), laser spectroscopy (S3-LEB or LASAGN), and decay spectroscopy (SEASON) will provide a comprehensive characterization of nuclear structure in this unexplored region.

For californium isotopes, fusion-evaporation reactions using ^{36}S beams on natural lead targets can access $^{239-243}$Cf, with production rates of several ions per second expected after S3-LEB. These isotopes lie in the predicted octupole-deformed region (N=136-140), where theory suggests significant gains in binding energy (~1-1.5 MeV) due to octupole correlations. Signatures of octupole deformation have already been found in neutron-deficient actinides through charge radii measurements compared with theoretical predictions. Similarly, alpha-decay spectroscopy has been used to study fine structure transitions populating low-lying octupole states, providing signatures of reflection-asymmetric shapes. The combination of those three techniques can thus provide key information to theoretical models and help pinpoint the precise extent of the region of deformation.

This experimental program will map the extent of octupole deformation in the neutron-deficient actinides, testing theoretical predictions and advancing our understanding of exotic nuclear shapes far from stability.

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