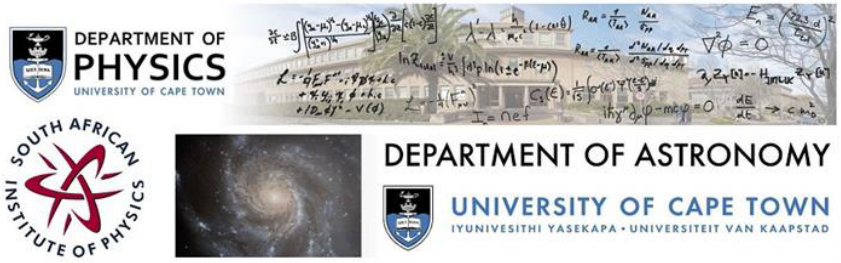

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Test for traditional vibrational wisdom in 110,112Cd by two proton stripping

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Abstract content
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The cadmium nuclei have traditionally been regarded as best examples of spherical vibrational nuclei. However, advances in nuclear spectroscopy have begun to detail the properties of these nuclei at the two and three vibrational phonon levels, casting doubts on the vibrational assumptions. In particular the properties of the excited 0n+ (i.e. for n ≥ 2) levels are key to vibrational models. Excited 0+ states can arise in nuclei in association with the nucleon pairing degrees of freedom, and in model spaces with collective shape degrees of freedom.

Historically, the Cd isotopes, especially 110,112Cd [J. Kern et al., Nucl. Phys. A593, 21 (1995)] have been favoured examples of near-harmonic quadrupole vibrational behaviour, with a two-phonon triplet of levels having I⊠ = 0+, 2+ and 4+ at approximately twice the energy of the one-phonon 21+ state. A further quintuplet of three-phonon levels with I⊠ = 0+, 2+, 3+, 4+ and 6+ is then expected close to three times the energy of the one-phonon state. This simple picture is complicated in cadmium isotopes by the presence of low-lying intruder states (caused by elevation of two protons across the Z = 50 shell gap). Extensive investigations of 110,112,114Cd [P. E. Garrett et al., Phys. Rev. C 75, 054310 (2007) & P. E. Garrett et al., Phys. Rev. C 78, 044307 (2008)] have revealed that these nuclei, far from being “textbook” cases of near-harmonic spherical vibrators, show serious disagreement with expected multi-phonon patterns of low energy excitation.

Details of the population of the excited 0n+ levels have been investigated at high resolution using 108,110Pd(3He, n-gamma)110,112Cd the two proton stripping direct reactions at 25 MeV. The experimental technique involves operating AFRODITE in-coincidence with a wall containing 12 large plastic scintillators to detect the fast neutrons from the direct reaction.

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Pete Jones, pete@tlabs.ac.za

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Primary author: Mr MAQABUKA, Bongani (iThemba LABS/University of the Western Cape)

Co-authors: Prof. SHARPEY-SCHAFER, John (University of Western Cape); Prof. PAPKA, Paul (University of Stellenbosch); Dr JONES, Pete (iThemba LABS)

Presenter: Mr MAQABUKA, Bongani (iThemba LABS/University of the Western Cape)

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