Contribution ID: **34** Type: **Poster**

Determining the spectroscopic quadrupole moment of the first 2+ state in 36Ar

Wednesday, 7 December 2016 18:55 (10 minutes)

The work presented here pertains measuring the sign and magnitude of the spectroscopic quadrupole moment for the first excited 2+ state, Qs(2+), in 36Ar. This was done through a Coulomb excitation measurement using the reorientation effect at safe energies. The measurement was performed using a distance between nuclear surfaces of at least 6.5 fm as proposed by Spear in 1981 for light nuclei [1]. This distance ensures that there are no nuclear excitations taking place which could obscure the results. The Qs(2+) value was previously measured in 1971 by Nakai and collaborators [2] using a 206Pb target with a minimum safe distance between nuclear surfaces of 4.3 fm, and may be influenced by nuclear excitations. The additional assumption of a spherical shape for the first 2+ state in 206Pb was also unadequate [3]. The yielded Qs(2+) value by Nakai and collaborators is Qs(2+)=+11(6) efm2, with a large uncertainty. This is the only measurent of Qs(2+) in 36Ar and the one currently accepted in the NNDC.
A particle-gamma coincidence experiment was carried out at iThemba LABS last May 2016 to study the first 2+ state in 36Ar. A 1mg/cm2 194Pt target was bombarded with 36Ar beams at 134 MeV. The gamma rays were detected using 8 clover detectors whereas the scattered particles were detected using an S3 double-sided silicon detector at backward angles. A GEANT simulation of Rutherford scattered particles onto the S3 detector was implemented for calibration and testing purposes. An accurate measurement of Qs will help in understanding the shape evolution and deformation of nuclei in this region, in particular the zig zag of quadrupole shapes observed at the end of the sd shell. Other measurements aimed at determinining the Qs(2+) values in 20Ne, 32S and 40Ar were also carried out at iThemba LABS during a two-month Coulomb-excitation campaign and will be presented at the ISOLDE workshop.

[1] R. H. Spear, Phys. Rep. 73 (1981) 369.
[2] K. Nakai, F. S. Stephens and R. M. Diamond, Phys. Lett. 34B (1971) 389.
[3] A.M.R. Joye, A. M. Baxter, S. Hinds, D. C. Kean and R. H. Spear, Phys. Lett. 72B (1978) 307.

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Session Classification: Poster Session