Spectroscopy of very heavy elements

P.T.Greenlees[1] on behalf of the **JUROGAM** and **GREAT** Collaborations
[1] Department of Physics, University of Jyväskylä, P.O.Box 35, 40014 Jyväskylä, Finland.

A stringent test for predictive power of current nuclear structure theories is provided by the study of deformed nuclei in the region of ^{254}No. These nuclei are the heaviest for which detailed in-beam and decay spectroscopy can be performed.

Initial in-beam measurements in the region focussed on γ-ray spectroscopy of even-even nuclei (e.g. ^{252,254}No, ^{250}Fm), studying the ground-state yrast bands and allowing extraction of parameters such as the moments of inertia, and proving the deformed nature of these nuclei [1-4]. More recently, attention has switched to odd-mass nuclei such as ^{253}No, ^{251}Md and ^{255}Lr, the latter being the heaviest nucleus so far studied in-beam [5-7]. Rotational bands have been observed in all these nuclei. The success of such in-beam γ-ray spectroscopic studies is strongly dependent on the g_K value of the odd particle, as the $M1/E2$ branching ratio is determined by $(g_K\text{-}g_R/Q_0)$. If the configuration is such that M1 transitions dominate, strong internal conversion precludes the observation of γ-rays.

Non-yrast and K-isomeric states have recently been observed in ^{252,254}No and ^{250}Fm through the use of both in-beam and focal plane decay spectroscopy [8-11]. The studies employed a calorimetric technique suggested by Jones, whereby the summed energy from a cascade of conversion electrons is detected in a DSSSD detector and used as a "tag" for γ-rays detected in the various germanium detectors [12]. These experiments have yielded data which can be used to determine the excitation energies and configurations of two-quasiparticle states in the region, and compared to the predictions of various theories. These comparisons show that reasonable agreement is obtained with Woods-Saxon approaches but discrepancies are observed with the predictions of HFB calculations with SLy4 or Gogny interactions [10,13]. Such observations highlight the need for such detailed spectroscopic data in order to improve the interactions used in these modern approaches.

An overview of the most recent results and the experimental techniques used will be presented. Perspectives for the development of new devices for further studies in this region will also be discussed.

[1] R.-D. Herzberg, J. Phys. G. **30**, R123 (2004).

[2] R.-D. Herzberg *et al.*, Phys. Rev. **C65**, 014303 (2002).

[2] P. Reiter *et al.*, Phys. Rev. Lett. **82**, 509 (1999).

[3] J.E. Bastin *et al.*, Phys. Rev. C. **73**, 024308 (2006).

[4] P. Reiter *et al.*, Phys. Rev. Lett. **95**, 032501 (2005).

[5] A. Chatillon *et al.*, Phys. Rev. Lett. **98**, 132503 (2007).

[6] P.T. Greenlees *et al.*, *To be published.*

[7] F.-P. Heßberger *et al.*, *To be published.*

[8] T.L. Khoo *et al.*,et al., *To be published.*

[9] R.-D. Herzberg *et al.*, *Nature (London)* **442**, 896 (2006).

[10] S.K. Tandel *et al.*, Phys. Rev. Lett. **97**, 082502 (2006).

[11] P.T. Greenlees *et al.*, *To be published.*

[12] G.D. Jones, Nucl. Instrum. Meth. Phys. Res. **A488**, 471 (2002).

[13] J.-P. Delaroche, M. Girod, H. Goutte and J. Libert, Nucl. Phys. **A771**, 103 (2006).