Evidence for non-termination of rotational bands in ^{74}Kr

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The atomic nucleus reveals a number of features of a finite many-fermion quantum mechanical system which either do not exist or cannot be experimentally measured in other systems. One of these unique features is smooth band termination, namely a continuous transition within the same configuration from collective rotation at low spin to a non-collective single-particle (terminating) state at maximum spin I_{max} [1]. Such terminating bands have been studied in detail during the last decade [1]. However for a long time it has been predicted that not all the bands terminate in a non-collective state, i.e. some bands show strong collectivity even at $I = I_{max}$ [1]. Recently we have observed experimentally the first strong indication in ^{74}Kr that this process takes place in nuclei [2].

High-spin states in ^{74}Kr were studied via the ^{40}Ca(^{40}Ca, α2p)^{74}Kr fusion-evaporation reaction using two different setups. The experiments were performed at Legnaro and Argonne using ^{40}Ca beams delivered by the XTU Tandem accelerator and the ATLAS accelerator, respectively. In the first setup EUROBALL and ISIS were used for γ-ray detection and charged-particle channel selection, while GAMMASPHERE and MICROBALL were used in the second setup.

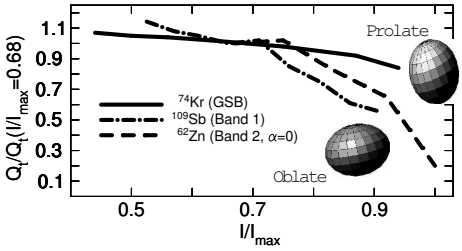

Figure 1: Transition quadrupole moments of the bands in ^{62}Zn, ^{74}Kr and ^{109}Sb, normalized at $I/I_{max} = 0.68$, as a function of I/I_{max}.

In order to study the shape evolution of rotational bands up to I_{max}, we have measured the lifetimes (or, equivalently, the transition quadrupole moments, Q_t) using the thin-target Doppler-shift attenuation method (DSAM). Figure 1 illustrates how the classical examples of smooth band termination, ^{62}Zn and ^{109}Sb, show pronounced drops of Q_t close to band termination, in contrast to ^{74}Kr. The stability of Q_t in ^{74}Kr indicates the persistance of collectivity up to I_{max}. This result is supported by theoretical calculations. It represents the first strong evidence for "non-termination" of rotational bands at I_{max}.

[1] A.V. Afanasjev *et al.*, Phys. Rep. **322**, 1 (1999).
[2] J.J. Valiente-Dobón *et al.*, Phys. Rev. Lett. (to be submitted).