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Study of the N=34 subshell gap (and abstract Ids 12,13,16)

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Shell closures are a fundamental concept in nuclear physics
and most of our knowledge of effective nucleon-nucleon interactions comes from the
study of nuclei with few valence particles around doubly-magic cores. There are by now a wealth of data coming from the study of exotic nuclei showing that the relative energies of the shell-model orbitals are not immutable but can change and evolve as a function of neutron number. This leads to the disappearance of well established magic numbers or to the appearance of new ones. For example, the presence of a $N = 32$ subshell closure has been recently derived from various experiments on neutron-rich nuclei from Ca to Cr. The existence of this energy gap at N=32 around Z=20 arises from a large energy spacing between the neutron p3/2 orbital and the higher lying p1/2 and f5/2 orbitals.

Otsuka and collaborators have also predicted that the N=34 isotones around Z=20 could exhibit characteristics of a shell closure due to the proton f7/2 - neutron f5/2
monopole tensor interaction. This effect could be revealed by measuring the first excited states involving the f5/2 neutron single particle orbital in the 55Sc nucleus.
The most direct evidence of the subshell at N=34 would be the high
energy of the first $+ state in 54Ca, not accessible today. However, the low-lying excited states of 55Sc, populated via the beta decay of 55Ca (g.s. 5/2-), involving the
f5/2 neutron single particle orbital will help to elucidate the gap
at N=34 and this will represent a crucial test for theoretical calculations
predicting a new shell clousure at N=34 around Z=20.

This nucleus will be produced in a fragmentation reaction at relativistic energies,
using a 86Kr primary beam at 350MeV.A. The BigRIPS fragment separator in combination with some of the Euroball Cluster detectors will be used for this study.
Probably a total of 7 days of beam time would be enough to
perform this experiment with final relevant results.

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