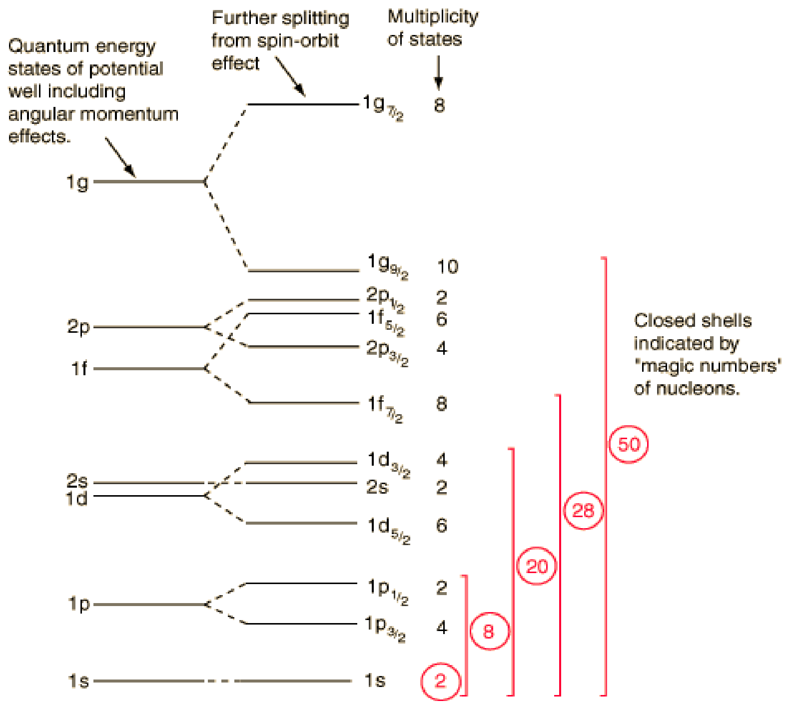
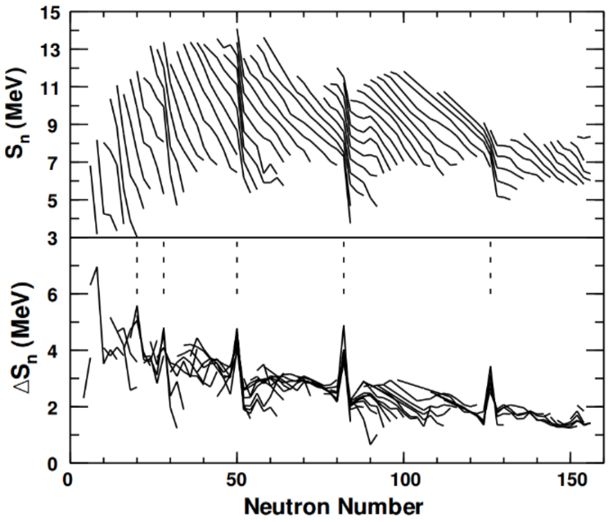
Quadrupole Collectivity beyond N = 28: Intermediate Energy Coulomb Excitation of $^{47,48}Ar$

The nuclear shell model has been successful in explaining nuclear structure for stable nuclei.

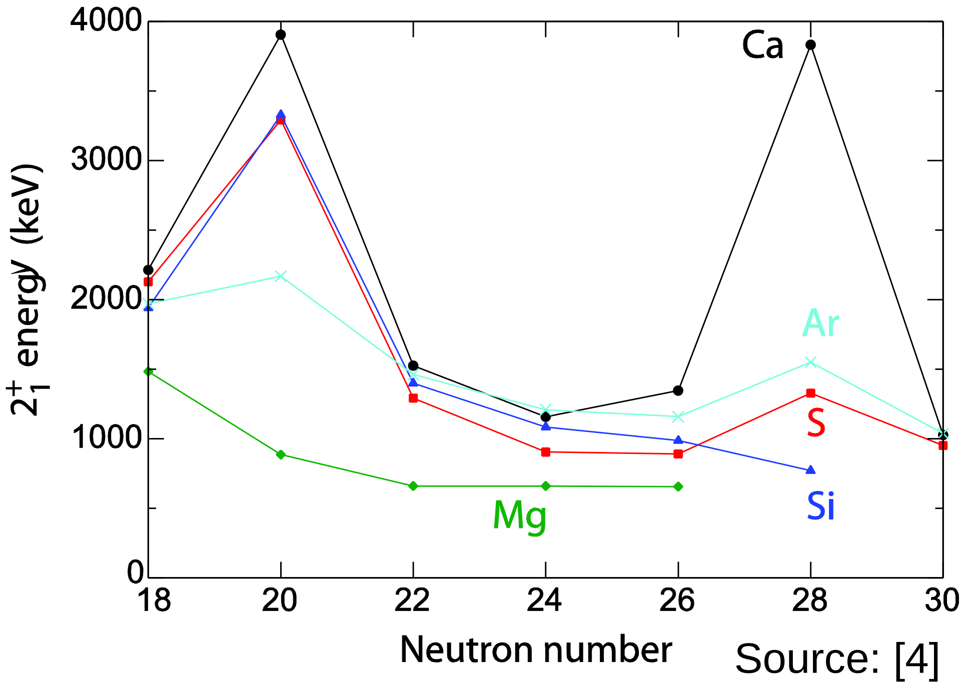
Away from stability, there is a breakdown of standard shell gaps and appearance of new magic numbers.



Source: [2]



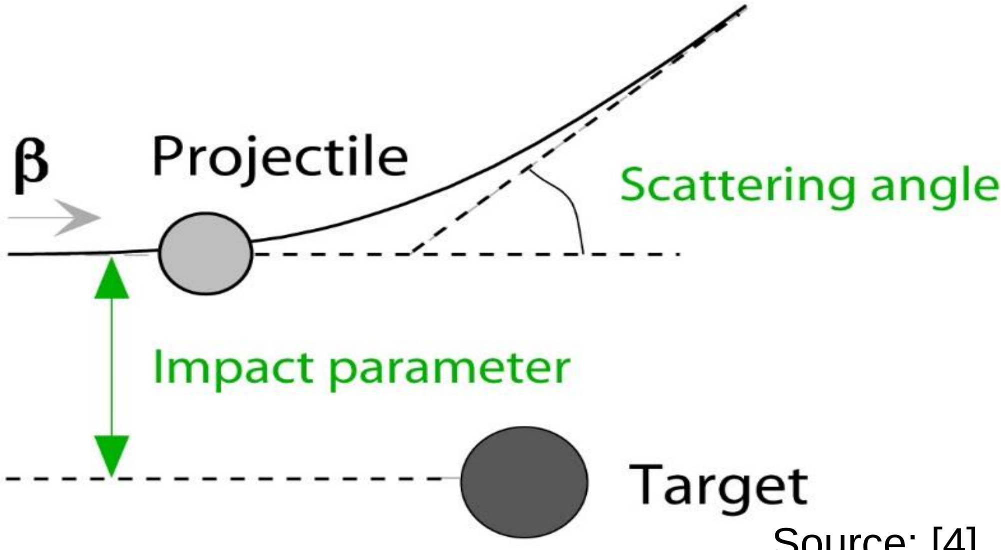
Source: [3]



Source: [4]

Do modern shell model interactions accurately predict nuclear structure away from stability?

Understanding Nuclear Structure Using Coulomb Excitation



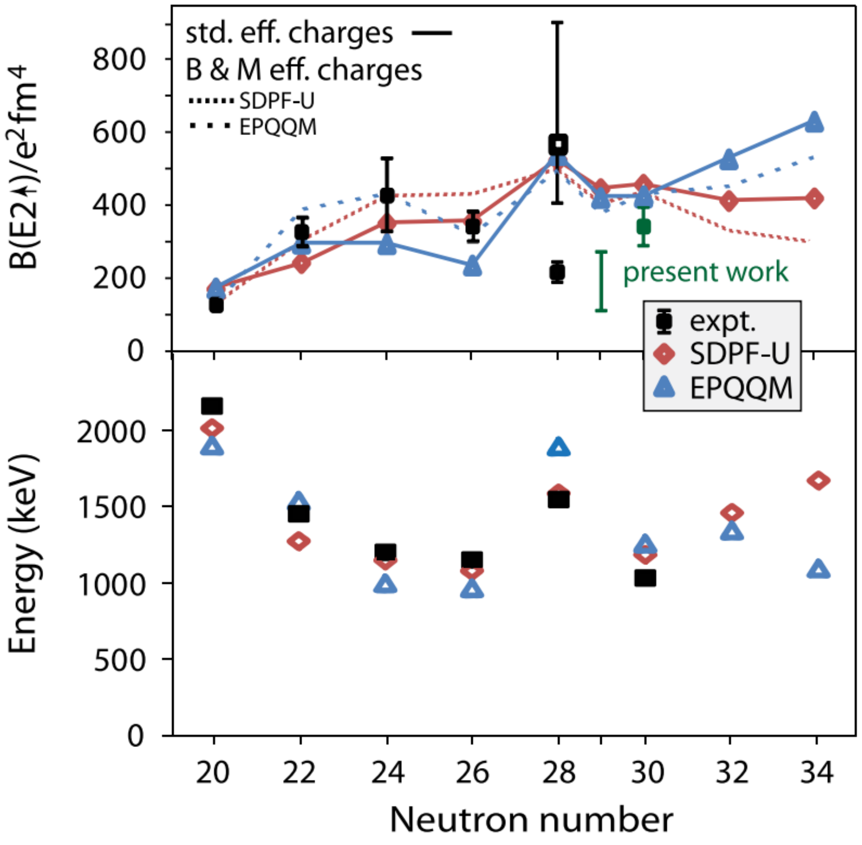
Source: [4]

Coulomb excitation measurements extract:

- Quadrupole Excitation Strength B(E2)
- Energy of 2^+ Level

This technique has been successful for experiments using low beam rates.

Low B(E2), High E2+ => Shell Gap
High B(E2), Low E2+ => Collective Motion (Deformation)



Source: [1]

These shell model calculations were unable to reproduce the expected B(E2) from the experiment.

Summary

- The shell model interactions used are state-of-the-art, as they involve both the f-shell and fp-shell.

- The experiment showed further evidence that Ar-46 behaves as the N = 28 closed-shell nucleus with the lowest Z.

- Current shell model interactions cannot reproduce the expected B(E2) for Ar-46.

There is still work to be done to understand why shell model calculations are unable to reproduce nuclear structure observables for all nuclei far from stability, and coulomb excitation experiments serve as important benchmarks for such models.

[1] Winkler et. al. "Quadrupole Collectivity Beyond N = 28: Intermediate Energy Coulomb Excitation of ^{47,48}Ar"
[2] http://hyperphysics.phy-astr.gsu.edu/hbase/nuclear/shell.html
[3] Vincent Bader's PhD Thesis
[4] A. Gade