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Penning-trap mass measurements of 45-47Cl

Studying the evolution of shell closures approaching the drip-lines is a powerful way to probe nuclear forces and refine the theoretical description of nuclear structure. The particular case of the spin-orbit N=28 magic number has been intensively investigated in various types of experiments. It has been suggested that the loss of magicity below 48Ca arises from a subtle interplay between proton- and neutron- induced collectivity. Indeed, at N=28, the proton d3/2 and s1/2 orbitals become degenerate, enabling quadrupole excitations for nuclei with Z<20. Moreover, when removing protons from the d3/2 orbital, the attractive residual interaction $(\pi d_{3/2}-\nu f_{7/2})$ being stronger than $(\pi d_{3/2}-\nu d_{3/2})$ leads to a weakening of the N=28 shell gap, again favouring quadrupole excitations. However, other effects such as three-body forces or the coupling to the continuum have also been suggested to play a role. Nuclear structure changes in this region remain not fully understood.
Mass spectrometry offers an alternative way to probe shell closures, by examining trends in one- and two-neutron separation energies (S_n and S_{2n}) along isotopic chains. In particular, the strength of a closure is directly related to a sudden drop in S_n and S_{2n} values, when crossing a magic number, making the masses at N=29 and N=30 especially critical. Along these isotonic chains, only the masses of K (Z=19) and Ar (Z=18) have been measured. Neutron-rich Cl have recently been measured at the LEBIT Penning Trap at MSU, but only up to N=28. The mass of 46Cl (N=29) has been measured, but the uncertainty remains large, whereas the 47Cl mass remains unmeasured.
Therefore, we propose to measure the masses of 45-47Cl, and thus probe the N=28 shell gap for Z<18 through binding energy trends, providing critical insights into the evolution of shell structure far from stability.

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