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Shell evolution in Sc isotopes

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Shell evolution [1,2] is one of the most discussed topics in the last two-decades in nuclear structure physics. It reveals that the traditional shell structure known for stable nuclei changes when we go towards the neutron-drip line. Recently, the low-energy states of neutron-rich ^{55}Sc has been populated in an experiment [3], in which the first excited state $(3/2)^-$ has been found near 0.5 MeV. Since the structure of ^{55}Sc includes one proton above the closed Z = 20 core, the low-excitation energy of this state points to the disappearance of the traditionally large proton $1p_{3/2}$-$0f_{7/2}$ energy gap in the neutron-rich region. In order to into look this point in detail, we have performed theoretical calculations within the shell-model framework [4]. We have found out that the proton $1p_{3/2}$-$0f_{7/2}$ energy gap reduces at ^{55}Sc but the $(3/2)^-$ state does not gain its excitation energy from this gap. In fact, this state mainly originates from the transition of a neutron across the N = 34 semi-magic shell gap. Thus, its low-excitation energy indicates the weakening of this gap above Ca.

References:
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Primary author: Dr KUMAR, Pawan (Technische Universität Darmstadt, Darmstadt and GSI Helmholtzzentrum für Schwerionenforschun, Darmstadt)

Co-authors: Prof. MARTÍNEZ-PINEDO, Gabriel (GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, and Technische Universität Darmstadt, Darmstadt); Dr MANCINO, Riccardo (Technische Universität Darmstadt, Darmstadt and GSI Helmholtzzentrum für Schwerionenforschun, Darmstadt)

Presenter: Dr KUMAR, Pawan (Technische Universität Darmstadt, Darmstadt and GSI Helmholtzzentrum für Schwerionenforschun, Darmstadt)

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