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Proton hole states in ^{19}N from the d(^{20}O, ^{3}He): Study of the Z=6 shell gap

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The Z=6 shell gap in neutron-rich carbon isotopes has been a subject of debate, with recent studies claiming its prevalence in this region of the nuclear chart [1], in contradiction with recent measurements [2] and shell model predictions [3].
In order to shed more light into this subject, the structure of ^{19}N was investigated through the proton-removal d(^{20}O, ^{3}He) reaction using the active target ACTAR TPC [4].

In 2022, the GANIL facility provided a pure ^{20}O beam which was selected by the LISE3 spectrometer at 35A MeV with an intensity of $2{\cdot}10^4$ pps. The beam was delivered to the ACTAR TPC setup, filled with a 90/10 mixture of D_2 and C_4H_{10} at 1 bar. The energy of the particles leaving the volume was measured in the Si pad detectors while the angle was obtained from the reconstruction of the tracks in the gas. The E_x spectrum was built with the missing mass technique. The obtained results demonstrate the potential of the ACTAR TPC setup for future transfer reaction experiments.

The low-lying structure of ^{19}N revealed multiple p-hole states with l=1 determined from the differential cross section. The location of the states that carry the largest $0p_{1/2}$ and $0p_{3/2}$ strength allowed for the determination of the ($\pi 0p_{1/2}$-$\pi 0p_{3/2}$) spin-orbit splitting in ^{20}O. Our results support a reduction of the Z=6 shell gap due to the tensor force in agreement with theoretical predictions from [3] using state-of-the art interactions in this region such as YSOX and SFO-tls.

References:

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[4] B. Maus et al. Nucl. Instrum. Meth. Phys. Res. A 940, (2019), 01689002.

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