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Proton-neutron pairing in the fp-shell via the 48Cr(p,3He)46V transfer reaction

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Unlike standard like-particle pairing (neutron-neutron, proton-proton) that exists only in the T=1 channel, proton-neutron pairing can exist in both the T=1 and T=0 channels. This coexistence could explain phenomena such as the overbinding of self-conjugate nuclei.

Proton-neutron pairing can be studied by spectroscopy as in ref. [1], or by transfer reactions, as in ref. [2], since the two-nucleon transfer reaction cross section is expected to be enhanced by pairing. The relative proton-neutron T=1 and T=0 pairing strengths can be accessed by measuring transfer cross sections to the low-lying (J=0^+, T=1) and (J=1^+, T=0) states in odd-odd N=Z nuclei. The (p,^{3}He) reaction can be used, as its selection rules allow to populate both states at once.

As pairing is a collective effect, it is expected to be stronger in the middle of high j orbitals. The $f_{7/2}$ shell is the highest j shell currently accessible with sufficient beam intensity for two-nucleon transfer reactions in N=Z nuclei. The nucleus ^{48}Cr, lying at the middle of this shell, has been selected for study and will be compared with previous experiments in the same region [2]. Moreover, ^{48}Cr is a good candidate for exploring the interplay between pairing correlations and deformation, as it is known to be a good rotor up to spin 10^+ [3].

The experiment to measure the two-nucleon transfer reaction ^{48}Cr(p,^{3}He)^{46}V was performed in 2023 at GANIL. A radioactive ^{48}Cr beam at 30 MeV/u was produced by fragmentation of a primary ^{50}Cr beam and selected by the LISE spectrometer, before impinging on a CH_2 target. A forward array of DSSD-CsI telescopes (MUGAST) was used to identify light charged particles and reconstruct the excitation energy, and was coupled to 12 EXOGAM Germanium clovers around the target, a Zero Degree Detection (ZDD) and MWPC detectors to reconstruct event by event the beam position on the target.

I will present preliminary absolute cross sections and cross section ratios, and angular distributions for the low-lying states of ^{46}V. They will be compared with second-order distorted wave Born Approximation (DWBA) calculations for two-nucleon transfer performed with both realistic and single particle two-nucleon amplitudes (TNA). The results will be put in perspective with theoretical models and the systematics in the f-shell : ^{56}Ni(p,^{3}He), ^{52}Fe(p,^{3}He) and ^{40}Ca(p,^{3}He).

[1] Cederwall, B., Moradi, F., Bäck, T. et al. Evidence for a spin-aligned neutron-proton paired phase from the level structure of ^{92}Pd. Nature 469, 68-71 (2011). https://doi.org/10.103/nature09644

[2] Le Crom, B., Assié, M., et al. Neutron-proton pairing in the N=Z radioactive fp-shell nuclei ^{56}Ni and ^{52}Fe probed by pair transfer, Physics Letters B 829 (2022), 137057. https://doi.org/10.1016/j.physletb.2022.137057

[3] Robinson, S. J. Q. and Hoang, T. and Zamick, L. and Escuderos, A. and Sharon, Y. Y. Shell model calculations of $B(E2)$ values, static quadrupole moments, and g factors for a number of $N = Z$ nuclei. Phys. Rev. C 89 (2014), 014316. https://link.aps.org/doi/10.1103/PhysRevC.89.014316

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