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Mixing between single particle and intruder states towards the N=20 island of inversion: lifetimes in 37S

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The disappearance of the N=20 shell closure in the so-called "island of inversion"around 32Mg is one of the most striking examples of the strength of nucleon-nucleon correlations. In this region, the quadrupole-deformed intruder configuration (based on a multi-particle multi-hole configuration) becomes the ground state, subverting the expected shell ordering predicted by a harmonic oscillator plus spin-orbit term. The odd N=21 isotonic chain provides the possibility to study the single-particle and intruder states as a function of decreasing Z. Available spectroscopic evidence points out the appearance of strong branching ratios among the single-particle and collective intruder configurations in 37S [1], suggesting that they mix significantly, contrary to the notion of 37S being well out the island of inversion. However, a precise quantification of this phenomenon in terms of transition strength is still lacking. The first excited state (3/2− state at 646 keV) is the only one with a measured lifetime [2], but no transition probability has been firmly determined for the intruder states, in particular those decaying to the a priori spherical single-particle states. A combined DSAM+RDDS measurement has been performed to measure such transition probabilities, in particular for the 2p-1h 3/2+ state at 1397 keV and the 3p-2h 7/2− at 2023 keV, exploiting the performance of the AGATA spectrometer in terms of energy and angular resolutions. The 37S nucleus has been produced via the 36S(d,p) reaction in inverse kinematics, detecting the recoiling protons in the silicon array SPIDER to obtain an accurate reconstruction of the excitation energy of 37S. The short lifetimes measured point to large M1 and/or E2 strengths connecting the intruder and spherical states. This would imply a significant mixing between the configurations, arising questions about the determination of the neutron p3/2-p1/2 single-particle strength distribution in 37S.

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