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Quest of octupole deformation in very light Te isotopes

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Excited states of ^{31}S and ^{31}P mirror nuclei were recently studied using the same fusion evaporation reaction ^{24}Mg(^{12}C, 1α1p) and ^{24}Mg(^{12}C, 1α1n). The 45~MeV beam was delivered by the XTU-Tandem accelerator at LNL Legnaro. The detection system was composed of GALILEO γ-ray spectrometer coupled to 4π Si ball Euclides and to Neutron Wall. Previous studies of A=31 mirror nuclei showed the oscillation behaviour of Mirror Energy Difference values (MED) values for the negative-parity sequence as a function of spin. These oscillation may be explained including in the wave function excitations to the fp shell considering thus the electromagnetic spin-orbit effect. Description of the MED in sd shell nuclei for negative parity and high spin states involving the electromagnetic spin orbit term is up to now only qualitative (because it involves interactions in two main shells). Additionally, shell-model calculations performed using the USD residual interaction and the Monte Carlo shell model with the SDPF-M interaction reproduce well the excitation energies and the reduced transition probabilities for positive-parity states up to the spin $\frac{13}{2}^-$. An interesting feature revealed by these calculations is that the yrast negative-parity states show an alternating structure: the $\frac{7}{2}^-$, $\frac{11}{2}^-$, and $\frac{15}{2}^-$ states are described by almost equal contributions of the proton and neutron excitation to the fp shell, whereas the $\frac{9}{2}^-$ and $\frac{13}{2}^-$ states have only a neutron excitation to the $f_{7/2}$ shell. Because experimental MED values are available up to spin J=$\frac{13}{2}$ for both negative and positive parity in our experiment we tried to identify high-spin states if ^{31}S in order to disentangle the theoretical puzzle. The results of our investigations will be presented.

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