High-spin isomer and the structure of the odd-odd nucleus ^{210}Fr

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It has been shown that the nuclear shell model depicts very well the structure of nuclei with mass A~208 (see [1] for example). This model describes the motion of nucleons outside an inert core (closed shells) that contains a magic number of protons and neutrons, more preferably both. In the region of interest here the doubly magic nucleus ^{208}Pb (Z=82, N=126) is initially taken as the core. The application of shell model calculations for nuclei with as many as eight quasiparticles outside the lead core, together with the search for high-spin isomeric states in the Fr isotopes, have motivated the present study.

The structure of ^{210}Fr has been investigated through the reaction ^{197}Au(^{18}O,5n)^{210}Fr using a 5.5mg/cm^2 gold target and a beam at an energy of 97 MeV. Such heavy ion reactions are a standard method populating high spin states in neutron-deficient nuclei. Chopped and pulsed beams from the 14UD Pelletron accelerator at the ANU Heavy Ion Facility were produced to initiate the reaction. The CAESAR array consisting of eleven high-purity germanium detectors was used to perform time-correlated γ-ray spectroscopy. A level scheme was deduced for ^{210}Fr with states up to J=25 and excitation energy around 5 MeV. Lifetimes from the ns range to the μs range were determined with a variety of techniques.

Structural features, common for nuclei near ^{208}Pb, have been discovered in ^{210}Fr. They include a 10^- isomer similar in structure to that in nearby odd-odd nuclei [2, 3, 4], and enhanced strengths for E3 transitions [5, 6] due to specific high-spin orbital rearrangements. The E3 transitions observed in ^{210}Fr decay from a 686 ns, J=24 isomer at an excitation energy of 4.4 MeV and are associated with changes in the proton wave function while the neutron holes do not contribute. This will be discussed with a focus on the transition probabilities involved with the proposed configuration changes.

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