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γ-ray spectroscopy of ^{213}Fr populated in the EC/β^+ decay of ^{213}Ra. Shell model interpretation.

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On behalf of IS608/IS650 IDS-Bucharest-York-Leuven Collaboration

The level structure of the semi-magic ^{213}Fr nucleus has been studied by means of EC/β^+ decay of the ^{213}Ra $1/2^-$ ground state up to an excitation energy of 3.6 MeV. It is the first observation of the low spin states, with J$\leq$7/2, above the previously known $(7/2^-)\rightarrow 9/2^-_{gs}$ sequence. This contribution represents a follow-up of the preliminary experimental results obtained during the IS608 campaign and partially from the IS650, both performed at the ISOLDE Decay Station. Being a mid-shell nucleus, with 5 protons above the doubly magic ^{208}Pb, ^{213}Fr exhibits interesting features like the l-forbidden M1 transition that proceeds between the $h_{9/2}$ and $f_{7/2}$ pseudo-spin partners ($7/2^- \rightarrow 9/2^-_{gs}$) and different decay patterns of the relatively low lying states, possibly given by the seniority conservation. It represents a challenging case to be interpreted theoretically, therefore shell model calculations became crucial to unraveling its intrinsic structure. Spin and parity assignments were made for the newly discovered levels on the basis of the systematics and the theory predictions within the KHPE valence space. Its ground state is expected to be of dominant $\pi h^5_{9/2}$ character if one compares it with its ^{209}Bi (Z=83) and ^{211}At (Z=85) isotones. Indeed, the calculations revealed that the $\pi(h^5_{9/2}; J)$ configurations have a dominant role (up to 90%) in the structure of the ground state and of the low energy states from the ground state band. A proton pair scattering was observed to be highly probable from the $h^3_{9/2}$ orbit to either $f^2_{7/2}$ or $i^2_{13/2}$, with $h^3_{9/2}f^2_{7/2}$ and $h^3_{9/2}i^2_{13/2}$ components also present in the structure of the states that belong to the $h^5_{9/2}$ multiplet. To extend the comparison with ^{211}At, the newly built level scheme of ^{213}Fr clearly manifests structural patterns. Apart from the first and the second excited states (both with J=$7/2^-$), the levels seem to group, as closely spaced levels, resembling multiplets. An interesting developed feature is given by their rather parallel cascades to the ground state. A multiplet of states only decays to one of the $7/2^-$ states and not to the other one.

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