

Fine Structure in the α - Decay of ^{215}Ac to ^{211}Fr

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The isotope ^{215}Ac was first identified by Valli *et al.* [1], who reported a half-life of $T_{1/2} = 0.17(1)$ s and an α - energy of $E_\alpha = 7602$ keV. In a recent study on decay properties of Ac - isotopes close to $N = 126$ indication for fine structure in the α -decay of ^{215}Ac was observed [2]. To confirm these results and to obtain further information on its decay properties a more detailed investigation was performed. ^{215}Ac was produced by the reaction $^{209}\text{Bi}(^{12}\text{C},6n)^{215}\text{Ac}$ at bombarding energies $E_{\text{lab}} = 85$ MeV and 109 MeV. It was separated from the projectile beam by SHIP and afterwards implanted into a 16-strip - Si-detector, which was used to measure the α -particle energies. γ -rays emitted in coincidence with α -particles were measured with a four-fold segmented Ge-Clover detector. The results are listed in table 1.

Our proposed spin and parity assignments for the daughter nucleus ^{211}Fr are based on comparisons with the $N = 124$ isotones ^{207}Bi and ^{209}At , α -decay hindrance factors, an observed (tentative) M1 transition and known $9/2^-$ -ground state, and $(11/2^-)$ - and $(13/2^-)$ -levels at 583.2(2) keV and 652.62(10) keV, respectively [3].

Hindrance factors (HF) in table 1 are calculated employing the equation $HF = \delta_{gs}^2 / \delta_{ex}^2$, where δ_{gs}^2 is the average reduced α -decay width of ^{214}Ra and ^{216}Th (data are taken from [3]) and δ_{ex}^2 is the reduced width for the decay of interest. Both reduced widths are calculated according to the method of Rasmussen [4].

In figure 1 we compare our proposed partial level scheme for the daughter nucleus ^{211}Fr with those of neighbouring $N = 124$ isotones. In the α -intensities losses due to summing α -particle and conversion electron signals were not

taken into account, since for the relatively large γ -energies for most of the transitions, one expects small internal conversion coefficients. This is also evidenced by a small number of Fr K X-rays associated with ^{215}Ac α -decay. The by far largest fraction of X-rays is associated with the 505.9 keV level and by some fraction also with the 633.1 keV and 739.2 keV levels. Therefore α -intensities feeding these levels are probably underestimated and thus their HF's overestimated.

Table 1: The data attributed to the α -decay of ^{215}Ac .

E_α / keV	E_γ / keV	i_{rel} / %	HF	transition
7602(5)	–	99.57(7)	1.3	–
7211(10)	395.8(1)	0.20(2)	30	$(7/2^-)^a \rightarrow 9/2^-$
7108(10)	505.9(2)	0.007(4) ^a	350	$(5/2^-)^a \rightarrow 9/2^-$
7108(10)	110.1(4)	–	–	$(5/2^-)^a \rightarrow (7/2^-)^a$
7029(10)	583.2(1)	0.12(1)	11	$(11/2^-) \rightarrow 9/2^-$
6978(10)	633.1(2)	0.007(4) ^a	120	$(5/2^-)^a \rightarrow 9/2^-$
6978(10)	237.2(4)	–	–	$(5/2^-)^a \rightarrow (7/2^-)^a$
6960(10)	652.6(2)	0.07(1)	11	$(13/2^-) \rightarrow 9/2^-$
6877(10)	739.2(4)	0.026(14) ^a	13	$(7/2^-)^a \rightarrow 9/2^-$
6877(10)	342.6(5)	–	–	$(7/2^-)^a \rightarrow (7/2^-)$

^a tentative.

References:

- [1] K. Valli *et al.* Phys. Rev. 167, 1094 (1968)
- [2] F.P. Heßberger *et al.* EPJ A8, 521 (2000)
- [3] R.B. Firestone *et al.*, *Table of Isotopes*, Wiley 1996
- [4] J.O. Rasmussen, Phys. Rev. 113, 1593 (1959)
- [5] F.P. Heßberger *et al.*, EPJ A15, 335 (2002)

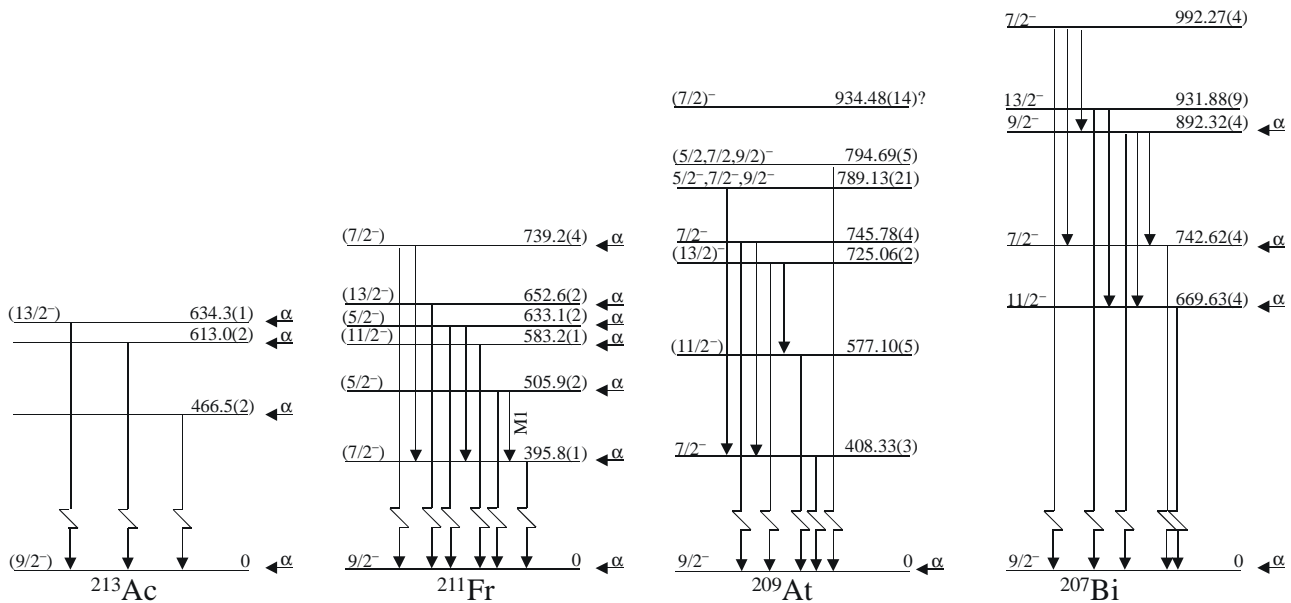


Figure 1: Level schemes of ^{213}Ac , ^{209}At , ^{207}Bi isotones with excitation energies below 1 MeV [3,5] and proposed level scheme of ^{211}Fr . Observed α -decays populating different levels are indicated by horizontal arrows.