Fine structure in the alpha decay of neutron-deficient polonium isotopes

K. Van de Vel[1], A.N. Andreyev[2], D. Ackermann[3], S. Antalic[4], H.J. Boardman[2], P. Cagarda[3], J. Gerl[3], F.P. Heßberger[3], S. Hofmann[3], M. Huyse[1], D. Karlgren[1,5], B. Kindler[3], I. Kozhoukharov[3], M. Leino[6], B. Lommel[3], G. Münzenberg[3], C. Moore[2], R.D. Page[2], C. Schlegel[3], P. Van Duppen[1]

[1]Instituut voor Kern- en Stralingsfysica, University of Leuven, Belgium; [2]Oliver Lodge Laboratory, University of Liverpool, UK; [3]GSI Darmstadt; [4]Comenius University of Bratislava, Slovakia; [5]Royal Institute of Technology, Stockholm, Sweden; [6]JYFL, University of Jyväskylä, Finland

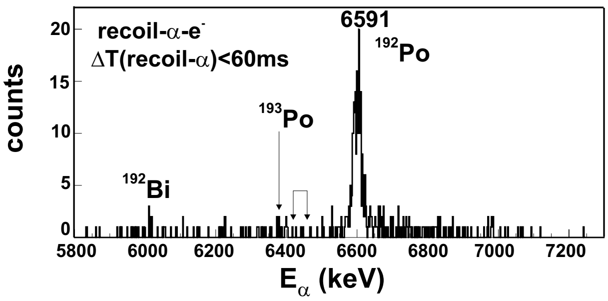

Figure 1: Spectum of α particles, correlated with evaporation residues within 60 ms, and in prompt coincidence with conversion electrons.

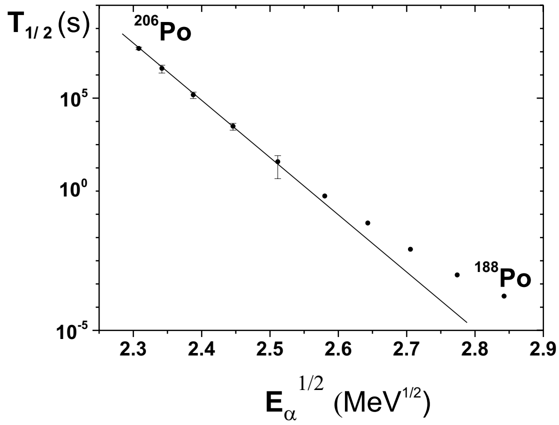

Figure 2: Geiger-Nuttall plot of the even-mass Po isotopes below A=206. The half-life is given in seconds, the energy in MeV.

Shape coexistence is a well-studied phenomenon in nuclei around the closed Z=82 proton shell [1]. One of the best studied cases to date is ^{186}Pb, where three differently shaped (spherical-oblate-prolate) 0^+ states were observed in a recent experiment at the SHIP [2]. In ^{188}Pb an oblate 0^+ state was earlier observed in three experiments [3, 4, 5], while two different candidates for the position of a prolate 0^+ state were suggested: at 767(12) keV [4] or at 725(2) keV [5]. In the present experiment at the SHIP, the α decay of light $^{188-192}$Po and $^{186-190}$Bi nuclei was re-studied. The experimental set-up used was described in [2]. We present preliminary results for fine structure (f.s.) in the α decay of ^{192}Po, to clarify the data on the prolate 0^+ state in ^{188}Pb. The nuclei of interest were produced in the ^{142}Nd(^{52}Cr,2n)^{192}Po reaction. Fig 1. shows an α-particle spectrum, recorded in the silicon stop detector within 60 ms after implantation of the evaporation residue, and in prompt coincidence with conversion electrons, detected in the backward silicon detector array. The peak at 6591(20) keV (after correction for α-electron summing in the stop detector) corresponds to the α decay of ^{192}Po to the oblate 0^+ state at 588 keV in ^{188}Pb, in agreement with the results of [3, 4, 5]. The α decay to the prolate 0^+ state in ^{188}Pb, either at 767 keV or at 725 keV from [4, 5], respectively, corresponds to α-particle energies of 6416 keV and 6457 keV, respectively (indicated with arrows in Fig. 1). An upper limit of 3 % for the intensity of the α decay to the suggested prolate 0^+ states in ^{188}Pb, relative to the decay to the oblate state has been deduced. This brings into question the presence of the prolate state at 767 keV, identified in [4] as the intensity of the decay to the prolate state obtained in their work was 51 %, relative to the intensity of the decay to the oblate state. The population of the prolate state at 725 keV, suggested in [5], might be smaller in the present reaction.

By using the ^{142}Nd(^{50}Cr,4n)^{188}Po reaction, improved data for the ground state→ground state (g.s.) decay of ^{188}Po were obtained: E_α=7908(15) keV, $T_{1/2}$=300(50)μs, in agreement with [6]. In Fig. 2 a Geiger-Nuttall plot is shown for the g.s.→g.s. decay of the even-mass Po nuclei with A≤206. From mass 196 onwards the log($T_{1/2}$) values start to deviate from the linear behaviour described by the Geiger-Nuttall law, the half-life of the α decay to the g.s. in the Pb daughter nucleus being considerably longer than expected. This can be explained by the gradual change in the g.s. configuration of Po from a spherical one close to N=126, to a mixed spherical-oblate configuration for A≤196. In ^{188}Po the prolate configuration probably becomes lowest in energy [6]. As the ground state of the daughter Pb isotopes remains mainly spherical, the strength of the α decay from the g.s. of Po to the spherical ground state of the corresponding Pb isotopes decreases, while the α decay to the deformed excited 0^+ states in Pb is enhanced when moving towards N=104, the neutron mid-shell.

References

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