HYPERFINE STRUCTURE AND ISOTOPE SHIFT INVESTIGATIONS OF ^{145}Pm AND ^{147}Pm

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Here we report on our ^{145}Pm and ^{147}Pm measurements performed at the IRIS mass separator at the LNPI using the laser facility of the group for atomic physics of the Philipps University of Marburg. Promethium is an artificial element and its optical spectra are studied very poorly. In this work hyperfine structures and isotope shifts of the two transitions $4f^5\,(^6H)\,5d\,^7K_{j=4} \rightarrow 23261.30_{j=4}\,cm^{-1}$ at $\lambda = 557.6\,nm$ and $4f^5\,(^6H)\,5d^7\,K_{j=4} \rightarrow 23761.98_{j=3}\,cm^{-1}$ at $\lambda = 542.5\,nm$ in the Promethium II spectrum of the radioactive

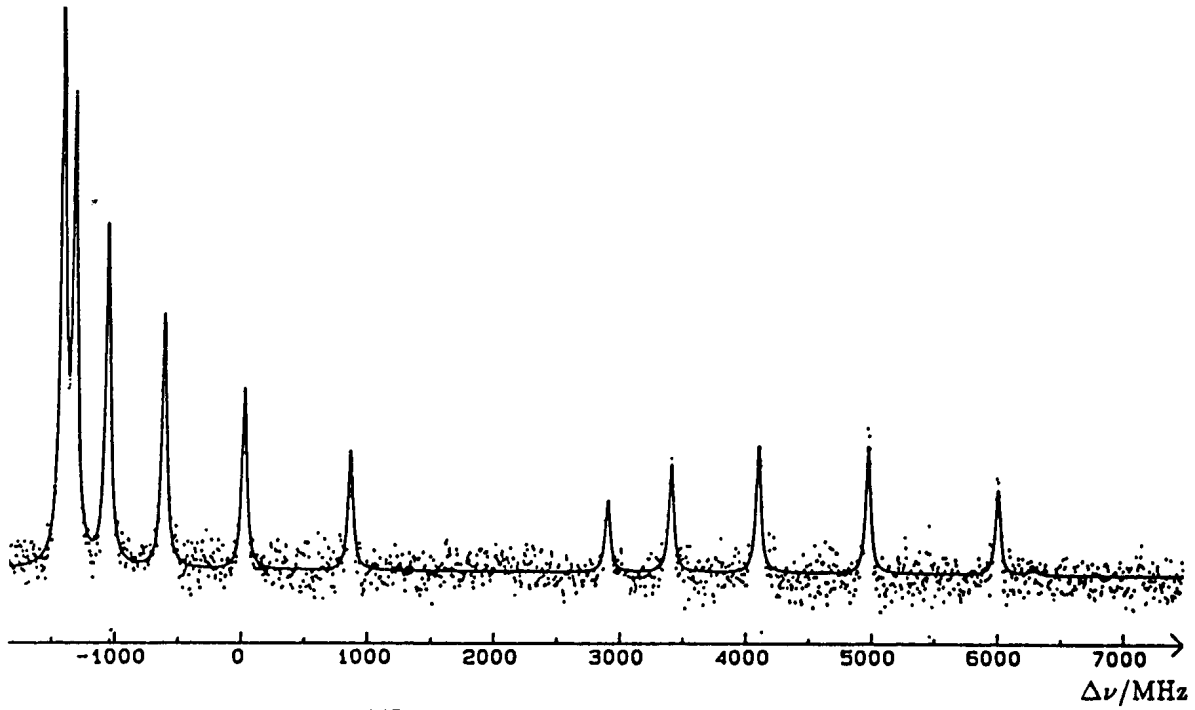

Fig. Measured hyperfine structure of ^{145}Pm line at $\lambda = 557.6\,nm$

isotopes ^{145}Pm and ^{147}Pm have been studied by collinear laser ion beam spectroscopy [1]. Fig. presents an experimental hyperfine structure of ^{145}Pm line at $\lambda = 557.6\,mn$. From the number of its components the nuclear spin of ^{145}Pm and ^{147}Pm could be determined as ^{145}I = 5/2 and ^{147}I = 7/2. These values are in agreement with the results of other previous investigations. Note that the spin for ^{145}Pm is determined for the first time by the optical method. From the analysis of the measured spectra, the hyperfine structure splitting factors A and B of the lower and the two upper states and the center of gravity of the hyperfine structures were determined (see table). From the ratios of the A and B-values one can calculate the magnetic dipole moment and the electric quadrupole moment of ^{145}Pm as the nuclear moments of ^{147}Pm are known. With $\mu(^{147}\mathrm{Pm})=2.63(7)\,\mu_n$ and $Q(^{147}\mathrm{Pm})=0.66(15)\,b$ [2] (without Sternheimer-corrections) we obtain $\mu(^{145}\mathrm{Pm})=3.80(16)\,\mu_n$, $Q(^{145}\mathrm{Pm})=0.21(8)\,b$ and the Sternheimer-corrected value of the quadrupole moment $Q_{sth}(^{up}145\mathrm{Pm})=0.27(14)\,b$. These values may be compared with the calculations performed in the

frame of deformed Hartree-Fock approximation [3]: $\mu_{calc}(^{145}Pm) = 2.8\,\mu_n$ and $Q_{sth,calc}(^{145}Pm) = 0.39\ b$. The measured value of the isotope shift in the line $\lambda = 557.6\ nm$ is $\Delta\nu(^{147}Pm - {}^{145}Pm) = 993(4)\ MHz$.

Table

Isotope	$A(^7K_4)/MHz$	$A(23761.98_{j=3}\ cm^{-1})/MHz$	$A(23261.30_{j=3}\ cm^{-1})/MHz$
^{145}Pm	1141.8(21)	1087(3)	
	1144.5(5)		1340.2(7)
^{147}Pm	569.8(9)	542(2)	
	566.0(7)		662.6(9)

Isotope	$B(^7K_4)/MHz$	$B(23761.98_{j=3}\ cm^{-1})/MHz$	$B(2326.30_{j=3}\ cm^{-1})/MHz$
^{145}Pm	—130(54)	—80(73)	
	—67(15)		—104(14)
^{147}Pm	—228(26)	—122(29)	
	—207(7)		—346(9)

Determined *A*- and *B*-values of the three investigated states.

References

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2. Reader J., Davis S.P. //Jour.Opt.Soc. Am.53. 1963. 431.
3. Alkhazov G.D. et al. //Nucl.Phys., A477. 1988. 37.