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g-FACTOR OF THE 53 keV $5/2^-$ STATE IN ^{197}Pt MEASURED BY THE TDPAC METHOD*

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The g-factor of the 53 keV state in ^{197}Pt has been measured using the gamma-gamma TDPAC method in an external magnetic field of 25.1 kG. The measurements were performed by utilizing the 346 - 53 keV gamma cascade in the decay of 95.4 min ^{197}Pt. The value of the g-factor was obtained to be $+0.335 \pm 0.010$. This result is compared with the g-factors of similar states in ^{195}Pt and ^{197,199}Hg. The measurements demonstrate the possibility of using ^{197}Pt in future TDPAC studies.

INTRODUCTION

The platinum isotopes are situated in a most interesting transitional region where the stable shape of the nucleus changes suddenly from a sphere to a highly deformed spheroid. These nuclei therefore offer an excellent opportunity to observe changes between the spherical and spheroidal shapes. Although considerable experimental data on the low-lying levels in odd-A Pt isotopes have been reported our understanding of the structure of these nuclei is still unsatisfactory. The $p_{1/2,3/2}$ $f_{5/2}$ and $i_{13/2}$ single neutron states in odd-A Pt isotopes are expected to be fairly low in energy[1], however they have not been identified conclusively except in the case of ^{195}Pt. Several theoretical calculations have been carried out in the past to explain the observed properties of these nuclei. In the case of ^{195}Pt Gal[2] made calculations using the core-excitation model where energies of the levels, the multipolarities of the transitions and the transition rates between the ground state $1/2^-$ and the two low lying doubletes $3/2^-$ and $5/2^-$ are reproduced rather well. However the agreement with the measured magnetic moments of these states was poor with the exception of the first $5/2^-$ state at 130 keV[3].

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The present measurement of the g-factor of the 53 keV 5/2$^-$ state in ^{197}Pt was undertaken with the twofold interest: a) to provide an experimental value of the magnetic moment to further elucidate the nature of this 5/2$^-$ state in terms of collective (core-excitation model) or the quasi particle model; b) to demonstrate the possibility of using the 346-53 keV gamma-cascade in ^{197}Pt in TDPAC studies. To our knowledge so far all the magnetic hyperfine interaction studies on platinum have been performed using the ^{195}Pt as the probe nucleus. The 95.4 min 13/2$^+$ state of ^{197}Pt almost exclusively depopulates by the cascade with 346 keV and 53 keV gamma-rays and the large theoretical angular correlation coefficient, A_{22}^{theo}=0.2207, of this cascade makes it quite attractive for the time differential investigation of hyperfine interactions. The measured half-life of the 53 keV level $T_{1/2}$ = 16.58 $\pm$ 0.17 nsec[4] also seems to be quite suitable for this purpose. However it is essential to know the precise value of the nuclear moment of the state before it can be used in the TDPAC studies. We have measured the g-factor of the 53 keV state in ^{197}Pt using the gamma-gamma TDPAC method in an external magnetic field of 25.1 kG. The measurements were performed by utilizing the constant angle reverse field method and the 346-53 keV gamma cascade in the decay of 95.4 min ^{197m}Pt.

EXPERIMENTAL

The radioactive sources of 95.4 min ^{197m}Pt were produced by the neutron irradiation of thin platinum foils ($\approx$10mg/cm^2) containing $\approx$98% ^{196}Pt. The neutron irradiations were carried out in the IEA-RI reactor with the neutron flux of $\approx 10^{13}$ n/cm^2. sec. Since repeated irradiations were necessary for the experiment a number of foils were prepared and any given foil was again irradiated only after a cooling period of 4-5 days in order to reduce the contributions from the decay of 18 h ^{197}Pt. Only other impurity in the sample was that of 30 min ^{199}Pt present in small quantity. A total of 80 irradiations were carried out for the entire experiment.

For our time differential experiment we utilized two 2" x 2" NaI(Tl) detectors coupled to RCA 8850 and RCA 8575 phototubes through the 30 cm lucite light guides to detect the 53 keV and 346 keV gamma radiations respectively. A conventional fast slow coincidence system utilizing the differential discriminators and a time to pulse height converter in connection with a multichannel analyser was used for recording the delayed coincidence spectrum. The timing resolution of the equipment was determined by using the 343 keV gamma - 53 keV X-ray cascade in the decay of ^{175}Hf. Typical time resolution of the set up was 5.5 nsec FWHM. The use of the long light guides was probably responsible for this rather large time resolution. A FWHM of 2.9 nsec was obtained in our experiment[4] for the lifetime measurement of the 53 keV state in ^{197}Pt where no light guides were used. A magnetic field of 25.1 kG was supplied by an electromagnet. The delayed coincidence spectra for each direction of the magnetic field were stored in two different subgroups of the multichannel analyser memory. The field direction was changed every 10 min with the detectors maintained at 135^o. In this manner each source was measured for 180 min before replacing it with a fresh source.

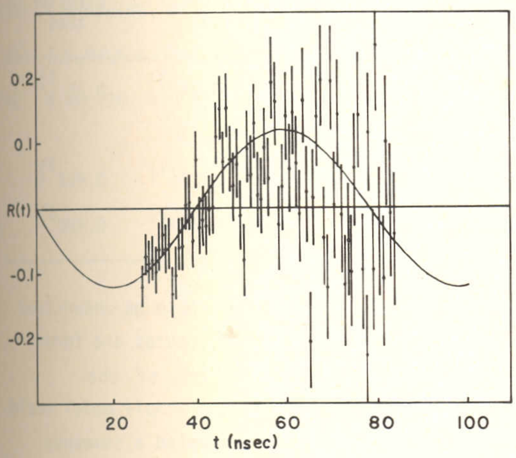

Fig. 1 - Spin precession of the magnetic moment of the 53 keV state in ^{197}Pt in the external magnetic field of 25.1 kG.

RESULTS AND DISCUSSION

The assymetry ratio $R(t) = N\uparrow - N\downarrow / N\uparrow + N\downarrow$ calculated from the measured time spectra are plotted in fig(1). The solid curve is the least square fit of the experimental data to the function $R(t) = A \sin 2\omega_L t$. The data corresponding to the initial approximately 25 nsec were not considered in the least squares fit as they have some prompt contribution coming from the decay of ^{199}Pt. The resulting value of the Larmor precession frequency ω_L is 40.3 ± 1.2 MHz and the calculated g-factor is $+0.335 \pm 0.010$. In addition to yielding the frequency, the fit also gives information on the amplitude or the effective anisotropy observed which must be satisfactorly accounted for. The theoretical angular correlation coefficient for the cascade, $A_{22}(theo) = 0.2207$, after appropriate solid angle corrections reduces to a value 0.170 and this is approximately equal to the observed $A_{22}(exp) = 0.166 \pm 0.015$. The above result is in agreement with the expectations since Pt metal has a cubic structure and no quadrupole interactions should be present to influence the A_{22}. In addition the results show that there is no significant radiation damage caused by the neutron irradiation of the samples.

One can observe in table 1 a resemblence in some of the properties of the first $5/2^-$ state in ^{195}Pt, ^{197}Pt, ^{197}Hg and ^{199}Hg. In particular the g-factors of these states are strickingly similar. The enhancement factor for the $5/2^- - 1/2^-$ E2 - transition is approximately ten or more in all the nuclei and should indicate a predominantly collective character of the state. It was pointed out by de-Shalit[5]

TABLE 1

Some properties of the first $5/2^-$ state in ^{195}Pt, ^{197}Pt, ^{197}Hg and ^{199}Hg

	Energy (keV)	$T_{1/2}$(n.sec)	$B(E2)_{Exp}/B(E2)_{SP}$	g-factor exp	g-factor theo
^{195}Pt	130	0.67 ± 0.03 [8]	10 [10]	0.35 ± 0.04 [3]	0.35 [1]
^{197}Pt	53	16.58 ± 0.17 [4]	10 [11]	0.335 ± 0.010	
^{197}Hg	134	8.066 ± 0.008 [9]	8 [3]	0.342 ± 0.006 [9]	0.468 [7]
^{199}Hg	158	2.45 ± 0.05 [9]	18.5 [2]	0.352 ± 0.013 [9]	0.480 [6]

that the properties of the first two excited states in ^{199}Hg could be understood in terms of the core-excitation model where the $5/2^-$ and $3/2^-$ states are formed by the coupling of the $p_{1/2}$ neutron to the first 2^+ excitation of the even-even core. It was later pointed out by Gal[2] that such a simple model could not explain the properties of the states in ^{195}Pt and he suggested a somewhat different model where an admixture of the first two 2_1^+ and 2_2^+ states in ^{194}Pt and ^{196}Pt contribute to the formation of the $3/2^-$ - $5/2^-$ doublet.Gal obtained a fairly good agreement in the case of ^{195}Pt for the energies, multipolarities and transition rates. However with the exception of $5/2^-$ state at 130 keV theory could not explain the observed g-factors of these states. Kalish and Gal[6] and Vianden and Krien[7] have used the similar approach to predict the magnetic moment of the 158keV and 134 keV $5/2^-$ states in ^{199}Hg and ^{197}Hg,respectively,with some sucess.However as pointed out by Gal himself the magnetic moments are extremely sensitive to the admixture of higher configurations and even to small single particle contributions. There are no specific calculations available for the magnetic moment of the 53 keV state in ^{197}Pt, from any of the theories. From the observed resemblence with $5/2^-$ state in ^{195}Pt, ^{197}Hg and ^{199}Hg it may not be too unreasonable to assume a somewhat similar structure for this state in ^{197}Pt.

REFERENCES

|1| L.S.KISSLINGER and R.A.SORENSEN, Rev. Mod. Phys. 35(1963) 853.

|2| A.GAL, Phys. lett. 20(1966) 414.

|3| B.WOLBECK and K.ZIOUTAS, Nucl. Phys. A181 (1972) 289.

|4| J.C.SOARES, A.MELO, F.B.GIL and R.N.SAXENA, to be published.

|5| A. de -SHALIT Phys. Rev. 122 (1961) 1530.

|6| R.KALISH and A.GAL, Nucl. Phys. A175 (1971) 652.

|7| R.VIANDEN and

|8| B.HERMATZ, Nuc

|9| K.KRIEN, K.KRO

|10| L.GRODZINS, R.

|11| S.G.MALMSKOG,

|12| R.KALISH, R.R.

|7| R.VIANDEN and K.KRIEN, Nucl. Phys. A277 (1977) 442.

|8| B.HERMATZ, Nucl. data Sheets vol. 14 (1978).

|9| K.KRIEN, K.KROTH, H.SAITOVITCH and W. THOMAS, Z.Physik A283 (1977) 337.

|10| L.GRODZINS, R.R.BORCHER and G.B.HAGEMANN, Nucl. Phys. 88 (1966) 474.

|11| S.G.MALMSKOG, Arik Fysik 34 (1967) 195.

|12| R.KALISH, R.R.BORCHER and H.W.KUGEL, Nucl. Phys. A161 (1971) 637.