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# GYROMAGNETIC RATIOS OF LOW-LYING EXCITED STATES IN THE EVEN $^{192-198}$Pt ISOTOPES; EXPERIMENTAL MEASUREMENTS AND THEORETICAL PREDICTIONS

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HHB:mc

April 28, 1981.

Dear Colleague:

You will note on page 8 of the enclosed preprint that we have reported agreement of our measurements with the Rutgers parameterization15) of the enhanced transient field. In an earlier preprint1) on the g-factors in $^{198}$Pt we reported similar agreement.

This agreement was, however, illusory. We assumed for both sets of measurements that the Fe foil thickness was 5 μm, as listed on the foil packet obtained from Goodfellow Metals. We have since measured these foils via Rutherford scattering to be 6.4±0.3 μm (or 5.0 mg cm$^{-2}$).

The thickness of the Fe foil is immaterial for relative g-factor measurements using identical foils. However, from the point of view of the parameterization of the transient field, a knowledge of the foil thickness is of great importance.

Using this, now, 6.4 μm Fe foil, the $(\Delta\theta/g)$ measurements for $^{196}$Pt and $^{198}$Pt are not compatible with the prediction of the Rutgers parameterization. However, our $(\Delta\theta/g)$ measurements are wholely consistent with those of other authors who have measured the precession of the $2_1^+ \to 0_1^+$ transition in $^{196}$Pt in the transient field.

H.H. Bolotin.

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# GYROMAGNETIC RATIOS OF LOW-LYING EXCITED STATES IN THE EVEN $^{192-198}$Pt ISOTOPES, EXPERIMENTAL MEASUREMENTS AND THEORETICAL PREDICTIONS

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**Abstract**: The gyromagnetic ratios of the $2_2^+$ and $4_1^+$ states in $^{196}$Pt were measured relative to that of its $2_1^+$ level. The thin-foil IMPAC technique was employed utilizing the enhanced transient hyperfine magnetic field present at the nuclei of swiftly recoiling ions traversing magnetized ferromagnetic materials. The states of interest were populated by Coulomb excitation using beams of 220-MeV $^{58}$Ni ions. For $g(2_1^+)$ taken as 0.326±0.014, the present measurements yielded $g(2_2^+) = 0.3$[illegible] and $g(4_1^+) = 0.30 \pm 0.05$. These results and those reported by prior workers for the g-factors of corresponding levels in $^{192}$Pt, $^{194}$Pt, and $^{198}$Pt are used to trace the systematics of the magnetic moments of these low-lying levels in the even $^{192-198}$Pt isotopes. We have also carried out Interacting Boson Approximation (IBA) model-based calculations of the g-factors of these states. The experimental and theoretical results are compared in detail.

NUCLEAR REACTIONS $^{196}$Pt(Ni,Ni') $^{196}$Pt($2_1^+$, $2_2^+$, $4_1^+$), E = 220 MeV, enriched target; measured $W(\theta,H,t)$ in enhanced transient field polarized Fe, particle-γ coin. Deduced gyromagnetic ratios $2_2^+$, $4_1^+$ $^{196}$Pt. IBA calculations; predicted static dipole moments of corresponding states in even $^{192-198}$Pt isotopes Experimental-theoretical comparison.

## 1. Introduction

In an earlier paper,[1] both our experimental measurements and Interacting Boson Approximation (IBA)[2-4] model-based calculations of the gyromagnetic ratios of the $2_1^+$, $2_2^+$, and $4_1^+$ levels in $^{198}$Pt were reported. In it, we demonstrated that in the near-O(6)[5] limiting IBA symmetry, with the inclusion of a small symmetry-breaking $\underline{Q}\cdot\underline{Q}$ force, the gyromagnetic ratios of these levels were predicted to depart from constancy to a small extent; our experimental results were not inconsistent with these predictions. The parameters of the interactions used in these calculations were the same as had been shown by Bolotin *et al.*[6] to account well for both the measured absolute and relative B(E2) transition rates and the $Q(2_1^+)$ of the even $^{194-198}$Pt isotopes. Within the context of these theoretical considerations, Stuchbery *et al.*[1] showed that in the lighter Pt isotopes (where the degree of symmetry breaking is expected to be greater[7,8] than in $^{198}$Pt) the predicted departure from constancy of the g-factors might be expected to be somewhat larger.

In order to examine the extension of these considerations specific to some of the lighter even Pt isotopes, this paper presents the results of our experimental measurements of the gyromagnetic ratios of the $2_1^+$, $2_2^+$, and $4_1^+$ states in $^{196}$Pt. These findings are combined with the earlier measurements[1] of the g-factors of the corresponding levels in $^{198}$Pt and those reported[9,10] for $^{192,194}$Pt in order to trace the systematics of the g-factors of these levels in the even $^{192-198}$Pt isotopes; these results are compared with our theoretical predictions.

## 2. Experimental procedures

The g-factors of $2_2^+$ and $4_1^+$ states relative to that of the $2_1^+$ level in $^{196}$Pt were determined experimentally utilizing the enhanced transient hyperfine magnetic field observed to be present at nuclei of ions swiftly recoiling through magnetized ferromagnetic foils.$^{11-16)}$

The nuclear states of interest were populated by multiple Coulomb excitation using 220-MeV $^{58}$Ni$^{15+}$ ion beams from the 14UD Pelletron tandem accelerator at the Australian National University. Virtually the same experimental particulars pertained in these measurements as in our earlier investigation of the g-factors of the corresponding states in $^{198}$Pt.$^{1)}$ We employed a triple-layered target composed of an 1.1±0.1 mg cm$^{-2}$ layer of Pt (enriched to 97.5% in $^{196}$Pt) electrodeposited on a 5 μm thick annealed Fe foil which was backed with an evaporated layer of Cu ∼15 μm thick.

To provide both good heat conduction away from the beam spot and added mechanical support, an additional 20 μm thickness of Cu was placed in intimate contact with the downstream side of the target sandwich.

The thin Fe foil, triple-layered target technique employed in this work to measure the g-factors of the states of interest has been described in detail elsewhere[17,18]. As utilized, the excited Pt ions recoiled through the thin Fe foil to stop in the evaporated Cu stratum which also served as a beam dump. Since the Pt ions traversed the Fe foil and came to rest in the perturbation-free Cu backing, they were not subject to the static field in the ferromagnetic foil.

Four ∿ 60 $cm^3$ Ge(Li) detectors were employed; two placed 5.7 cm from the target at ±110° to the direction of the beam and two at 7.5 cm from it at ±25°. Each detector recorded the $2_1^+ \to 0_1^+$ (355 keV), $2_2^+ \to 2_1^+$ (333 keV), and $4_1^+ \to 2_1^+$ (521 keV) decay γ rays in $^{196}Pt$ in coincidence with beam projectiles backscattered into a common annular surface-barrier particle detector that subtended the angular range 147-166° at the target. In this arrangement, events were recorded for $^{196}Pt$ ions which recoiled in a forward cone of half-angle ∿ 7° with an average velocity $v/c = 3.$[illegible]%.

A polarizing field of 500 Oe was applied to the Fe foil (in the plane of the foil, normal to the beam direction) which was more than adequate to fully saturate it. By reversing the field at frequent intervals, systematic errors were minimized, and the recorded field-up (↑) and field-down (↓) data were appropriately normalized; the field direction was flipped after a preset number of backscattered ions from the target were registered in the singles spectrum of the annular detector. As related in our earlier publication[1], beam-bending effects were negligible (i.e. ≤ 0.09 mrad).

The unperturbed angular distributions of the transitions of interest in $^{196}$Pt were not measured directly, but were calculated for our geometry in a straightforward manner using the Winther-de Boer[19)] multiple Coulomb excitation code with the matrix elements obtained by Bolotin _et al._[6)] and the previously reported[20)] measured E2/M1 multipolarity mixing ratio, $\delta = -5.2 \pm 0.5$. [A similar calculation employing the matrix elements provided by these same workers[6)] gave predicted γ-ray angular distributions in $^{198}$Pt in excellent agreement with experiment[1,6)] for the same geometry.]

For a given unperturbed γ-ray angular distribution, $W(\theta)$, it can be readily shown that the counting rate, $N$, recorded by a gamma-ray detector at a specified distance from the target is most sensitive to the transient field-induced angular precession, $\Delta\theta$, of that distribution when located at that angle $\theta_\gamma$ to the beam such that $S^2N$ is a maximum [$S$ is the logarithmic derivative of $W(\theta)$]. For the target-to-detector distances of the Ge(Li) detectors employed in the present investigation, $\theta_\gamma$ was approximately $\pm72^\circ(\mp108^\circ)$, $\pm20^\circ(\mp160^\circ)$, and $\pm67^\circ(\mp113^\circ)$ for the $2_1^+\to0_1^+$, $2_2^+\to2_1^+$, and $4_1^+\to2_1^+$ transitions, respectively. Consequently, one pair of detectors was positioned at $\pm110^\circ$ to the beam direction where the sensitivity for the $2_1^+\to0_1^+$ and $4_1^+\to2_1^+$ transitions was very close to maximal. Geometrical constraints caused us to place the other two detectors at $\pm25^\circ$ to the beam axis where, nevertheless, near maximum sensitivity for the $2_2^+\to2_1^+$ transition precession measurement pertained.

Coincidences between each γ-ray detector and the annular particle detector were recorded in an event-by-event, multi-parameter mode on magnetic tape (γ-ray, particle, and time-analogue converted pulse-heights, plus a field-up/field-down tag bit). The coincidence spectrum associated with each field direction was obtained separately in off-line tape play-back sorts. Although chance coincidence rates were small throughout the experiment, they were duly subtracted in the analysis. Gates set on the detected projectiles backscattered from the Pt target, together with random coincidences subtracted, eliminated all Fe and Cu γ rays from the sorted spectra.

## 3. Analysis of data and other experimental features

Corrections for decay in flight while in Fe were either negligible or relatively small, as all three excited states of interest have mean lives long compared to the transit time of the Pt ions through the 5 μm Fe foil, i.e., the shortest mean life is that of the $4_1^+$ level ($\tau = 5.1 \pm 0.4$ psec)[6]; the transit time, $\tau_{Fe}$, of the ions through Fe in the present experiment (∼ 0.7 psec) was calculated from the known kinematics on the basis of the stopping powers of Zeigler[21].

The extraction of the gyromagnetic ratios of the states of interest from the data followed the prescription detailed by Stuchbery et al.,[1,16] and requires no amplification here. As was the case in our earlier measurements[1] of the g-factors of levels in $^{198}$Pt, a relatively high sensitivity to the precession of the angular distribution of the $2_1^+ \rightarrow 0_1^+$ transition also pertained at ±25° to the beam direction. Thus, the data recorded by the detectors placed at these angles, as well as that registered by those at ±110° to the beam, provided independent determinations of the precession angle of rotation of the $2_1^+ \rightarrow 0_1^+$ angular distribution; these were combined appropriately. Such was not the case for the other two transitions studied, as the slopes of the $2_2^+ \rightarrow 2_1^+$ and $4_1^+ \rightarrow 2_1^+$ γ-ray angular distributions were close to zero at ±110° and ±25°, respectively.

## 4. Experimental results

The relevant portions of the coincidence γ-ray spectra recorded at 25° and 110° are presented in fig. 1, where the differences in the relative strengths of the transitions recorded at these two angles reflect the dissimilarities in the angular distribution of these gamma rays. Table 1 lists the particulars of the experimental measurements and the values of the g-factors of the $2_1^+$, $2_2^+$, and $4_1^+$ states. In these results, the g-factor of the $2_1^+$ level in $^{196}$Pt was taken as known [$g(2_1^+;{}^{196}\mathrm{Pt}) = 0.326 \pm 0.014$] from the weighted average of all previously reported[10)] determinations, and the gyromagnetic ratios of the $2_2^+$ and $4_1^+$ states were measured relative to it. Thus, that value of $g(2_1^+;{}^{196}\mathrm{Pt})$ and the present measured precessional shift, $\Delta\theta$, of the $2_1^+\rightarrow0_1^+$ transition distribution served as the transient field normalization for the precession measurements of the two higher levels, since the $^{196}$Pt ions in all three excited states of interest recoiled through the iron foil with the same velocity and experienced the same transient field during the same transit time, $T_{Fe}$, through the 5 μm foil. Population of states higher in excitation energy than that of the $4_1^+$ level was too weak to allow their gyromagnetic ratios to be determined sufficiently well.

As the transient field normalization in the present work was provided by the observed precession, $\Delta\theta/g$, of the $2_1^+$ level, it was unnecessary to rely upon any form of velocity- and mass-dependent parameterization. Nevertheless, we find that the present measurements are consistent with the "universal" parameter fit of the transient field proposed by the Rutgers group$^{15)}$, as were our previous measurements for $^{196}$Pt ions$^{1)}$ recoiling through Fe foils; while the previous body of transient field data for Pt ions available at the time of their fit was found to be singularly inconsistent with it. The results of our recently completed experimental investigations to more definitively establish the velocity dependence of the transient field present at Pt ions which recoiled through thin (1 μm) Fe foils with velocities spanning the range $0.019\leq v/c\leq0.039$ will be reported shortly elsewhere$^{24)}$.

These results, and those previously reported for the gyromagnetic ratios of the $2_1^+$ and $2_2^+$ states in $^{192,194}$Pt[9,10] and the $2_1^+$, $2_2^+$, and $4_1^+$ levels in $^{198}$Pt[1)], are presented in table 2.

## 5. IBA calculations of g-factors

Within the context of the IBA model, although M1 transitions are forbidden on the basis of the first-order M1 operator, M1 decays can be accommodated within the model when the second-order expansion M1 operator is employed[1)]. In the latter case, Stuchbery *et al.*[1)] also showed that the gyromagnetic ratio of any given level, g(L), can be expressed as

$$g(L) = g \pm g_c \frac{1}{10} \left[\frac{(2L-1)(2L+3)}{L(L+1)(2L+1)}\right]^{\frac{1}{2}} \langle \alpha L \| (d^{\dagger}s)_2 + (s^{\dagger}d)_2 \| \alpha L \rangle, \qquad (1)$$

where the subscripts denote angular momentum couplings, $\alpha$ represents all relevant quantum numbers other than L of the specific state, and the magnitude of the coefficient $g_c$ reflects the M1 decay strength of an L→L transition. As $[(d^{\dagger}s)_2+(s^{\dagger}d)_2]$ is a generator of the IBA limiting symmetry O(6) group, the reduced matrix element on the right of eq. 1 vanishes in the strict O(6) limit and the g-factors of all states are equal to g in this limit, even though M1 transitions (using the second-order M1 operator) are allowed via $g_c$; in this case, the L→L M1 transition follows[1)] the O(6) E2 selection rule $\Delta\sigma = 0$, $\Delta\tau = \pm 1$.

However, when, as by way of incorporation of a relatively small $\underline{Q}\cdot\underline{Q}$ force, the strict O(6) limiting symmetry is broken, the reduced matrix element in eq. 1 is non-vanishing, and equality of the g-factors of levels in a given nucleus no longer pertains; for a given $g_c$, the degree of departure from constancy of the gyromagnetic ratios scales as the strength of the symmetry breaking.1)

For the calculations of the g-factors of the low-lying excited states in the even $^{192-198}$Pt isotopes, the boson wavefunctions were generated using the boson interaction

$$H_B = H[O(6)] + D\underline{Q}\cdot\underline{Q} \,, \qquad (2)$$

where H[O(6)] is the boson Hamiltonian in the O(6) limit of the IBA5), and $\underline{Q}\cdot\underline{Q}$ is the perturbing symmetry-breaking quadrupole force3) of strength D. The closest geometrical analogue of the O(6) limit is the γ-unstable vibrator25) and, in eq. 2,

$$H[O(6)] = AP_6 + BC_5 + CL(L+1) \,,$$

where A, B, and C are, respectively the strengths of the boson pairing operator, $P_6$, in the O(6) group5), the phonon energy [Casimir operator, $C_5$, in the subgroup O(5)5)], and the angular momentum shift. The parameters A, B, C, and D for each of the nuclei of interest were determined by a fit to the experimental level spectrum of that nuclide. However, for the purpose at hand, these interaction parameters were so nearly the same as that obtained earlier by Bolotin et al.$^{6)}$ in their overall fit to the composite level spectra of $^{194,196,198}$Pt [which yielded detailed agreement for the level spectra, B(E2) rates, and $Q_{2_1^+}$ values across a range of Pt isotopes$^{6)}$] that we have chosen, without loss of specificity, to employ the latter in the present calculations of all of the even Pt isotopes under consideration. These parameters are: A=160.1 keV, B=270.1 keV, C=15.91 keV, and D= -0.9 keV.

Table 3 lists the requisite experimental findings reported for the $2_2^+ \rightarrow 2_1^+$ (L→L) transitions in each nuclide from which the parameter $g_c$ (eq. 1) can be evaluated. The values of $g_c$ so obtained and the overall corrections to g(L) induced by the symmetry breaking are presented in table 4; while the g-factors calculated for these states are shown in table 5 where they are compared with the experimentally determined values.

The apriori ambiguity in the sign of the correction factor (eq. 1) cannot be fully resolved in these calculations; yet, the relative signs of the $2_1^+$ and $4_1^+$ corrections in any given nuclide are identical, while the signs of the correction terms for the $2_1^+$ and $2_2^+$ levels are opposite and lead to a larger predicted relative departure of the ratio $g(2_1^+)/g(2_2^+)$ from unity than that of the ratio $g(2_1^+)/g(4_1^+)$.

## 6. Comparison of calculated and measured gyromagnetic ratios

The experimentally determined g-factors of the $2_1^+$ and $2_2^+$ levels and, where available, that of the $4_1^+$ state in each one of the four even Pt isotopes under consideration do not, within empirical uncertainty, display any discernible departure from constancy. Indeed, the measured gyromagnetic ratios presented in tables 2 and 5 for all levels of interest in all the even Pt nuclides are consistent with being the same within error.

The calculated g-factors of levels in any given nuclide (table 5) do depart from constancy; in particular, that of the $2_2^+$ states in these nuclides differ by from ~5 - ~10% from those of the $2_1^+$ and $4_1^+$ levels in the same isotope, with the latter two states predicted to have more nearly identical g-factors in each nuclide. The degree of symmetry breaking increases with decreasing mass in the Pt isotopes and would, by and of itself, lead to a greater departure from equality of the g-factors of the levels in the lighter Pt nuclides. However, the calculated gyromagnetic ratios do not follow this trend monotonically, as the measured M1 strengths of the $2_2^+ \to 2_1^+$ (L=1) transitions display (table 3) considerable variation which, through the parameter $g_c$, mitigate this mass-dependent tendency of the correction terms of the g(L)s. For this reason, the overall effect on the g-factors of these levels is not as great as might otherwise be anticipated; and although, in general, the experimentally measured gyromagnetic ratios are reasonably precise, the empirical errors associated with these determinations are, unfortunately, somewhat too large to expose the relatively small departures from constancy calculated for the g-factors of these states. Nevertheless, the present and prior[6)] IBA-based calculations which include the same degree of symmetry-breaking force not only provide good agreement with the absolute and relative B(E2) rates, $Q_{2_1^+}$, and level spectra over the span of even Pt isotopes but, at the same time, display overall consistency with the measured gyromagnetic ratios of the $2_1^+$, $2_2^+$, and $4_1^+$ levels of these same nuclides.

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Table 1. Experimental particulars and results of present g-factor measurements of designated states in $^{196}$Pt.

| Level ($J^{\pi}$) | $T^{a}_{Pt}$ (psec) | $T^{a}_{Fe}$ (psec) | $E^{a}_{i}$ (MeV) | $E^{a}_{o}$ (MeV) | $\epsilon(25^{o})^{b}$ ($\times 10^3$) | $S(25^{o})^{c}$ | $\epsilon(110^{o})^{b}$ ($\times 10^3$) | $S(110^{o})^{c}$ | $\langle\Delta\theta\rangle^{d}$ (mrad) | Experimental g-factors: Present work[e] | Experimental g-factors: Previous work |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $2^+_1$ | 0.022 | 0.68 | 137 | 20 | -54.8± 1.5 | 1.59 | -94.6±1.7 | 2.58 | -35.5±1.4 | - | 0.326±0.014[f] |
| $2^+_2$ | 0.022 | 0.68 | 137 | 20 | -60 ±11 | 1.86 | - 7 ±5 | 0.20 | -32 ±6 | 0.30±0.06 | - |
| $4^+_1$ | 0.022 | 0.68 | 137 | 20 | + 2 ± 4 | 0.14 | -33 ±5 | 1.07 | -33 ±5 | 0.30±0.05 | - |

[a] Transit time of recoiling Pt ions through Pt target, ($T_{Pt}$), and through the Fe foil, ($T_{Fe}$), as well as the energies of the ions incident, ($E_i$), and leaving, ($E_o$), the Fe foil were obtained using the known target and Fe foil thicknesses, the known kinematics of the reaction, and the stopping powers of ref. 21.

[b] The experimental ratio $\epsilon = (1-\rho)/(1+\rho)$ multiplied by $10^3$, where $\rho = \{[N\uparrow(+)N\downarrow(-)]/[N\downarrow(+)N\uparrow(-)]\}^{\frac{1}{2}}$ measured with the detectors positioned at (±) the specified angle, and $N\uparrow(N\downarrow)$ are the normalized counting rates recorded for polarizing field up (down).

[c] The values of S [the logarithmic derivative of $W(\theta)$] for the transitions at the designated angles were calculated for the present experimental geometry(see text). These S values are presumed to have a 5% uncertainty.

[d] Weighted average of experimentally determined $\Delta\theta = \epsilon/S$ values at 25° and 110° for each level.

[e] The g-factors obtained in the present work are relative to the weighted average of previous determinations of the gyromagnetic ratio of the $2^+_1$ level in $^{196}$Pt (presented in the last column). The value listed for $g(4_1)$ incorporates a small correction for decay in flight while in Fe (see text).

[f] Weighted average of prior values reported in the literature (summary of previous measured values are presented in ref. 10).

Table 2. Summary of experimentally determined g-factors reported for the designated levels in the even $^{192-198}$Pt nuclides.

| Level ($J^\pi$;isotope) | Experimental gyromagnetic ratio | $g(2_1^+)/g(2_2^+)$ | $g(2_1^+)/g(4_1^+)$ |
|---|---|---|---|
| $2_1^+;^{192}$Pt | 0.329±0.019[a] | 1.02±0.16 | 0.8 ±0.6 |
| $2_2^+;^{192}$Pt | 0.324±0.046[a] | | |
| $4_1^+;^{192}$Pt | 0.4 ±0.3[b] | | |
| $2_1^+;^{194}$Pt | 0.320±0.016[a] | 0.99±0.09 | |
| $2_2^+;^{194}$Pt | 0.324±0.026[a] | | |
| $2_1^+;^{196}$Pt | 0.326±0.014[a] | 1.09±0.22 | 1.09±0.19 |
| $2_2^+;^{196}$Pt | 0.30 ±0.06[c] | | |
| $4_1^+;^{196}$Pt | 0.30 ±0.05[c] | | |
| $2_1^+;^{198}$Pt | 0.324±0.026[d] | 0.95±0.18 | 0.95±0.18 |
| $2_2^+;^{198}$Pt | 0.34 ±0.06[d] | | |
| $4_1^+;^{198}$Pt | 0.34 ±0.06[d] | | |

[a] Weighted average of prior determinations presented in ref. 10.

[b] Ref. 23.

[c] Present results; measured relative to $g(2_1^+;^{196}$Pt).

[d] Reported in ref. 1; measured relative to $g(2_1^+;^{196}$Pt).

Table 3. Experimental particulars of the $2_2^+ \rightarrow 2_1^+$ transitions in the even $^{192-194}$Pt isotopes.

| Nuclide | $B(E2;2_2^+ \rightarrow 2_1^+)\,e^2fm^4$ | E2/M1 multipolarity mixing, $\delta(2_2^+ \rightarrow 2_1^+)$[a] |
|---|---|---|
| $^{192}$Pt | $190 \pm 30$[b] | $5.4 \pm 0.2$[c] |
| $^{194}$Pt | $4230 \pm 150$[d] | $4 \pm 2$[e] |
| $^{196}$Pt | $3500 \pm 310$[f] | $-5.2 \pm 0.5$[g] |
| $^{198}$Pt | $2600 \pm 380$[h] | $-2.9^{+0.4}_{-0.6}$[h] |

[a] The sign of the multipolarity mixing parameter, $\delta$, follows the convention of ref. 26.

[b] Ref. 27.

[c] Ref. 28.

[d] Ref. 29.

[e] Ref. 30.

[f] Ref. 6.

[g] Ref. 20.

[h] Ref. 1.

Table 4. Corrections to the gyromagnetic ratios of the designated states in the even Pt isotopes.

| Nuclide | $g_c^a$ | Correction to gyromagnetic ratio for $J^\pi$ level | | |
|---|---|---|---|---|
| | | $2_1^+$ | $2_2^+$ | $4_1^+$ |
| $^{192}$Pt | 0.004 | ±0.004 | ∓0.003 | ±0.002 |
| $^{194}$Pt | 0.025 | ±0.014 | ∓0.014 | ±0.011 |
| $^{196}$Pt | 0.022 | ±0.010 | ∓0.010 | ±0.007 |
| $^{198}$Pt | 0.026 | ±0.008 | ∓0.008 | ±0.006 |

[a] See text for discussion of this parameter.

Table 5. Calculated and measured g-factors of designated states in the even Pt isotopes.

| Nuclide | $J^{\pi}$ of level | Calculated[a] g-factors $g(2_1^+)$ correction sign[b] |  | Experimental g-factor | Calculated[a] $g(2_1^+)/g(2_2^+)$ $g(2_1^+)$ correction sign[b] |  | Experimental $g(2_1^+)/g(2_2^+)$ | Calculated[a] $g(2_1^+)/g(4_1^+)$ $g(2_1^+)$ correction sign[b] |  | Experimental $g(2_1^+)/g(4_1^+)$ |
|---|---|---|---|---|---|---|---|---|---|---|
|  |  | + | - |  | + | - |  | + | - |  |
| $^{192}$Pt | $2_1^+$ | 0.329 | 0.329 | 0.329±0.019[c] |  |  |  |  |  |  |
| $^{192}$Pt | $2_2^+$ | 0.322 | 0.336 | 0.324±0.046[c] | 1.022 | 0.979 | 1.02±0.16 | 1.006 | 0.994 | 0.8 ±0.6 |
| $^{192}$Pt | $4_1^+$ | 0.327 | 0.331 | 0.4 ±0.3[d] |  |  |  |  |  |  |
| $^{194}$Pt | $2_1^+$ | 0.320 | 0.320 | 0.320±0.016[c] |  |  |  |  |  |  |
| $^{194}$Pt | $2_2^+$ | 0.292 | 0.348 | 0.324±0.026[c] | 1.096 | 0.920 | 0.99±0.09 | 1.010 | 0.991 | - |
| $^{194}$Pt | $4_1^+$ | 0.317 | 0.323 | - |  |  |  |  |  |  |
| $^{196}$Pt | $2_1^+$ | 0.326 | 0.326 | 0.326±0.014[c] |  |  |  |  |  |  |
| $^{196}$Pt | $2_2^+$ | 0.306 | 0.346 | 0.30 ±0.06[e] | 1.065 | 0.942 | 1.09±0.22 | 1.009 | 0.991 | 1.09±0.19 |
| $^{196}$Pt | $4_1^+$ | 0.323 | 0.329 | 0.30 ±0.05[e] |  |  |  |  |  |  |
| $^{198}$Pt | $2_1^+$ | 0.324 | 0.324 | 0.324±0.026[f] |  |  |  |  |  |  |
| $^{198}$Pt | $2_2^+$ | 0.308 | 0.340 | 0.34 ±0.06[f] | 1.052 | 0.953 | 0.95±0.19 | 1.006 | 0.994 | 0.95±0.19 |
| $^{198}$Pt | $4_1^+$ | 0.322 | 0.326 | 0.34 ±0.06[f] |  |  |  |  |  |  |

[a] As the calculated predictions for the gyromagnetic ratios depend on the specification of the common value of the parameter g (eq. 1) for all states in a given nuclide, the values listed for the g-factors and g-factor ratios of states in each nuclide are based upon taking $g(2_1^+)$ equal to the experimental value for this level in that nuclide.

Table 5. (continued)

[b] See text for discussion of sign ambiguity. The calculated g-factors presented in each column headed by the alternative algebraic signs constitute alternative sets of normalized predicted values and are not to be considered as sets of upper and lower limits of these calculations.

[c] Weighted average of prior measurements presented in ref. 10.

[d] Ref. 23.

[e] Present results; measured relative to $g(2_1^+;{}^{196}\mathrm{Pt})$.

[f] Reported in ref. 1; measured relative to $g(2_1^+;{}^{196}\mathrm{Pt})$.

## Figure Caption

Figure 1: Relevant portion of gamma-ray spectra recorded in coincidence with projectiles backscattered from the $^{196}$Pt target registered in the Ge(Li) detectors located at 25 degrees, A(upper), and 110 degrees, B(lower), to the incident beam direction. The full-energy peaks of the transitions are labelled by $J_i^{\pi} \to J_f^{\pi}$ and isotope; those of most direct interest in this study are the $2_1^+ \to 0_1^+$ (355 keV), $2_2^+ \to 2_1^+$ (333 keV), and $4_1^+ \to 2_1^+$ (521 keV) in $^{196}$Pt. The small (note ordinate log scale) high- and low-energy shoulders on the $4_1^+ \to 2_1^+$ and some other transitions in both spectra arise from the decay in flight of the relatively short-lived parent states while the Pt ions slow and come to rest. [The narrower breadths of these shoulders in the lower (110$^{\circ}$) spectrum are due to the greater obliqueness of the detector angle to the ion recoil direction than pertains in the upper (25$^{\circ}$) spectrum.] The differences in the relative intensities of the $\gamma$ rays exhibited in these two spectra reflect the disparities in the angular distributions of the various transitions.

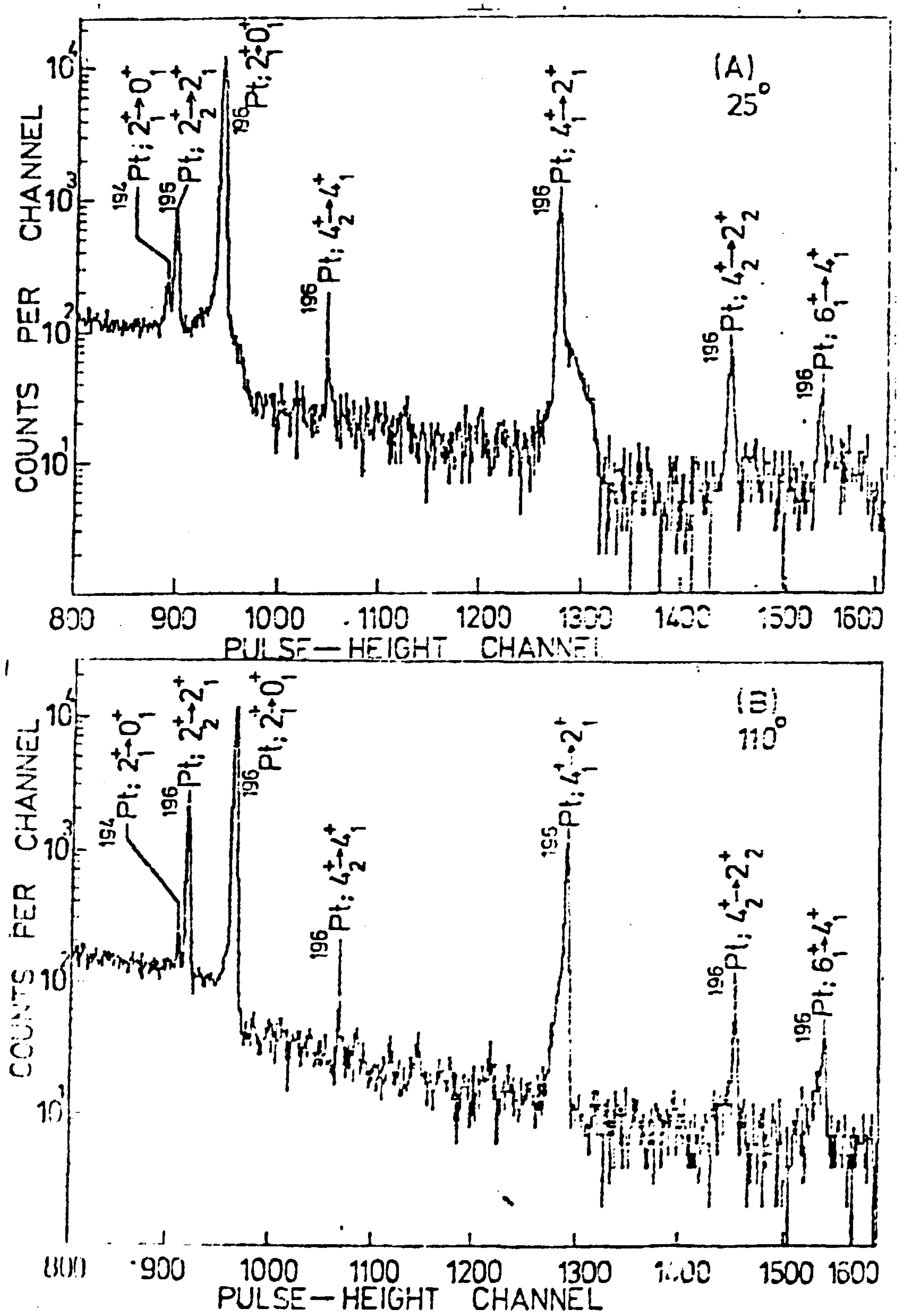
(A)
25°
COUNTS PER CHANNEL
$10^4$
$10^3$
$10^2$
$10^1$
$^{194}$Pt; $2^+_1 \to 0^+_1$
$^{195}$Pt; $2^+_2 \to 2^+_1$
$^{196}$Pt; $2^+_1 \to 0^+_1$
$^{196}$Pt; $4^+_2 \to 4^+_1$
$^{196}$Pt; $4^+_1 \to 2^+_1$
$^{196}$Pt; $4^+_2 \to 2^+_2$
$^{196}$Pt; $6^+_1 \to 4^+_1$
800
900
1000
1100
1200
1300
1400
1500
1600
PULSE—HEIGHT CHANNEL
(B)
110°
COUNTS PER CHANNEL
$10^4$
$10^3$
$10^2$
$10^1$
$^{194}$Pt; $2^+_1 \to 0^+_1$
$^{196}$Pt; $2^+_2 \to 2^+_1$
$^{196}$Pt; $2^+_1 \to 0^+_1$
$^{196}$Pt; $4^+_2 \to 4^+_1$
$^{195}$Pt; $4^+_1 \to 2^+_1$
$^{196}$Pt; $4^+_2 \to 2^+_2$
$^{196}$Pt; $6^+_1 \to 4^+_1$
800
900
1000
1100
1200
1300
1400
1500
1600
PULSE—HEIGHT CHANNEL

Figure 1.