Possible Origin of the "Anomalous" Interference Terms in ^{192,194}Pt

F. Todd Baker

Department of Physics and Astronomy, The University of Georgia, Athens, Georgia 30602

(Received 5 April 1979)

It is noted that, if β_4 deformations are included in the rigid asymmetric-rotor model of Davydov and Filippov, previously measured values of $M_{02}{}^2$, $M_{02'}{}^2$, $M_{22'}{}^2$, $M_{22}{}^2$, and $M_{04}{}^4$ $[M_{rs}{}^{\lambda} = i^{\lambda}\langle s \| M(E\lambda) \| r\rangle]$, including their relative signs, may be simultaneously predicted for ^{194}Pt.

Experimental determinations[1-3] of the sign of the interference term $P_3 = M_{02}{}^2 M_{02'}{}^2 M_{22'}{}^2$ $[M_{rs}{}^{\lambda} = i^{\lambda}\langle s | | M(E\lambda) | | r\rangle]$ have shown that $P_3 < 0$ for the nuclei ^{192,194}Pt. Measurements[4-6] of the quadrupole moments of the first 2^+ states (2) have shown that $M_{22}{}^2 < 0$ (i.e., these nuclei may be qualitatively described as having an oblate intrinsic shape). These signs of P_3 are therefore anomalous since Kumar[7] has pointed out that for either a rotational model or a vibrational model one expects $P_4 = P_3 M_{22}{}^2$ to be negative if the second 2^+ state ($2'$) is a predominantly $K=2$ state. Isakov and Lemberg[8] have shown that $P_4 < 0$ also for the rigid asymmetric-rotor model (ARM) of Davydov and Filippov.[9]

Lee *et al.*[10] have recently shown that the results of Coulomb excitation of ^{192,194}Pt are consistent with an ARM description of these nuclei. Their results, however, are insensitive to the reduced matrix element $M_{02'}{}^2$ and are therefore insensitive to the sign of P_3.

Baker and co-workers[2,3] have shown that $M_{04}{}^4 < 0$ (relative to $M_{02}{}^2 M_{24}{}^2$) for all stable even-A Pt isotopes. The origin of a strong $B(E4, 0^+ \to 4^+)$ is customarily interpreted as evidence for static β_4 deformations.

The preceding discussion provides the motivation for this Letter: It is of interest to incorporate β_4 deformations into the ARM and to examine the effects on the predicted $E2$ properties of transitional nuclei. Surprisingly, this straightforward extension of the ARM has not previously been done. The moments of inertia for a nucleus with a shape given by

$$R(\theta, \varphi) = R_0[1 + \beta_2 \cos\gamma Y_{20} + \tfrac{1}{2}\sqrt{2}\,\beta_2 \sin\gamma (Y_{22} + Y_{2-2}) + \beta_4 Y_{40}] \quad (1)$$

may be shown to be

$$I_x = 4\beta_2{}^2 B_2 \sin^2(\gamma - \tfrac{2}{3}\pi) + 10\beta_4{}^2 B_4, \quad (2a)$$

$$I_y = 4\beta_2{}^2 B_2 \sin^2(\gamma - \tfrac{4}{3}\pi) + 10\beta_4{}^2 B_4, \quad (2b)$$

$$I_z = 4\beta_2{}^2 B_2 \sin^2(\gamma). \quad (2c)$$

The irrotational relation between the inertial parameters, $B_4 = \frac{1}{2}B_2$, has been assumed. With these moments of inertia, the Hamiltonian may be diagonalized in the $|JMK\rangle$ basis where

$$|JMK\rangle = \frac{2J+1}{[16\pi^2(1+\delta_{K0})]^{1/2}}[D_{MK}{}^J + (-1)^J D_{M-K}{}^J]. \quad (3)$$

The reduced matrix elements are then easily evaluated; a uniform charge distribution with radius given by Eq. (1) has been assumed.

The results of such a calculation for ^{194}Pt are shown in Tables I and II. Table I shows the parameters β_2, β_4, and γ determined by fitting the E_2 matrix elements $M_{02}{}^2$, $M_{02'}{}^2$, $M_{22'}{}^2$, and $M_{22}{}^2$ for ^{194}Pt. All three parameters of the model were treated as free parameters. The value of β_4 is in good agreement with the previously measured value.[2]

The computed reduced matrix elements are compared to the experimental values in Table II. The agreement is very good; in particular, the "anomalous" sign of P_4 is correctly predicted even though $M_{22}{}^2 < 0$.

It is therefore concluded that if the existence of large values of $B(E4, 0^+ \to 4^+)$ for transitional nuclei is interpreted as resulting from static hexadexapole deformations, the finding that $P_4 > 0$ is not anomalous *within the rigid asymmetric-rotor model.* It should be noted, however, that this finding does not rule out other current models of the transitional nuclei. Indeed, the microscopically obtained γ-soft model of Kumar and

TABLE I. Parameters determined by fitting $M_{02}{}^2$, $M_{02'}{}^2$, $M_{22'}{}^2$, and $M_{22}{}^2$ for ^{194}Pt. The parameters are those of Eq. (1) of the text.

R_0 (fm)	β_2	β_4	γ (deg)
6.947	0.151	−0.070	41.71

TABLE II. Experimental and predicted values of reduced matrix elements $M_{rs}{}^{\lambda} = i^{\lambda} \langle s \| M(E\lambda) \| r \rangle$ for ^{194}Pt. The parameters of Table I have been used. The units are $e \cdot \mathrm{fm}^{\lambda}$.

	$M_{02'}{}^2$	$M_{02'}{}^2$	$M_{22'}{}^2$	$M_{22}{}^2$	$M_{04}{}^4$
Data	$-127.3(6)$ [a]	9.0(2) [a]	145.5(25) [a]	$-83.(8)$ [b]	<-964 [c]
Theory	-127	8.44	139	-61.2	-1486

[a]Ref. 11. [b]Ref. 4. [c]Ref. 2.

Baranger[12,13] (which fails to predict correctly the sign of P_4 for ^{194}Pt) might also be improved by including the β_4 degree of freedom; investigation of this is outside the scope of the present work. The calculations described here merely provide a simple example of the ways in which $E2$ and $E4$ nuclear properties can have important influences on each other.

A complete description of this model and its application to W, Os, Pt, and Hg nuclei will be published elsewhere. This work has been supported by National Science Foundation Grant No. PHY 76-08788.

[1]F. T. Baker, A. Scott, T. H. Kruse, W. Hartwig, E. Ventura, and W. Savin, Phys. Rev. Lett. 37, 193 (1976).

[2]F. T. Baker, A. Scott, T. H. Kruse, W. Hartwig, E. Ventura, and W. Savin, Nucl. Phys. A266, 337 (1976).

[3]F. T. Baker, A. Scott, R. M. Ronningen, T. H. Kruse, R. Suchannek, and W. Savin, Phys. Rev. C 17, 1559 (1978).

[4]J. E. Glenn and J. X. Saladin, Phys. Rev. Lett. 20, 1298 (1968).

[5]L. Grodzins, B. Herskind, D. R. S. Somayjulu, and B. Skaali, Phys. Rev. Lett. 30, 453 (1978).

[6]J. Sprinkle, D. Cline, P. Russo, R. Scharenberg, and P. Vold, Bull. Am. Phys. Soc. 22, 545 (1977).

[7]K. Kumar, Phys. Lett. 29B, 25 (1969).

[8]V. I. Isakov and K. Kh. Lemberg, Pis'ma Zh. Eksp. Teor. Fiz. 9, 698 (1969) [JETP Lett. 9, 438 (1969)].

[9]A. S. Davydov and G. F. Filippov, Nucl. Phys. 8, 237 (1958).

[10]I. Y. Lee, D. Cline, P. A. Butler, R. M. Diamond, J. A. Newton, R. S. Simon, and F. S. Stephens, Phys. Rev. Lett. 39, 684 (1977).

[11]C. Baktash, J. X. Saladin, J. J. O'Brien, and J. G. Alessi, Phys. Rev. C 18, 131 (1978).

[12]K. Kumar and M. Baranger, Nucl. Phys. A122, 273 (1968).

[13]K. Kumar, Phys. Lett. 29B, 25 (1969).

Observation of the Simultaneous Additive Effect of Several Xenon Perturbers on the Cs 6s-9p Doublet

J. F. Kielkopf

Department of Physics, University of Louisville, Louisville, Kentucky 40208

and

N. F. Allard

Section d'Astrophysique, Observatoire de Paris, 92190 Meudon, France

(Received 11 April 1979)

Multiple satellites appear in absorption spectra on both components of the Cs $6s$–$9p$ doublet perturbed by xenon at densities of the order of 10^{19} atoms/cm^3. The profiles of these perturbed lines computed with the Anderson-Talman theory, and the density dependence of the absorption at the multiple satellite frequencies, definitely identify the origin of the satellites as the combined additive effect of one to four perturbers.

The appearance of satellites on atomic spectral lines perturbed by foreign gases, known for many years, is of considerable interest because it provides significant evidence from which realistic poetntials for the interactions of excited atomic states may be inferred.[1-3] In the nearest-

