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E2/M1 MIXING RATIOS IN ^{196}Pt FROM THE $^{195}Pt(n,\gamma)^{196}Pt$ REACTION

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ABSTRACT

Angular correlations in ^{196}Pt have been measured using a new two detector correlation system at Brookhaven National Laboratory (BNL). The properties of ^{196}Pt can be well described in terms of the O(6) limit of the IBA-1 formalism[1] and the empirical determination of mixing ratios offers a further refinement to that comparison. The measured M1 components may provide information concerning the location of the isovector mode in the O(6) region. In addition, known correlations can provide a test of the new correlation system.

EXPERIMENT

A target of 6.3 gms enriched to 97.3% in ^{195}Pt was placed in the external thermal neutron beam at the monochromater beam facility of the High Flux Beam Reactor at BNL. Angular correlations were measured using a new two detector system which comprises one fixed detector and one moving. The latter is attached to a lead screw by a sliding rod and the screw is driven by a stepping motor. Microswitches at each end serve to reverse the direction of the motor and, in one case, to define the first counting position at 180°. For this experiment the two detectors were situated at 11.6 and 14.6 cm from the target position. Angles ranging between 90° and 180° can be chosen by setting a fixed number of motor steps and the resultant precision in defining the angle is better than 0.1°. The cycle can be repeated with the same degree of accuracy. At each position data is collected for a pre-determined interval before the detector moves the prescribed number of steps to the next counting position. Each time the motor stops, it increments a binary counter which is read by the data acquisition computer and 'tagged' onto the coincidence event to indicate the angle between the detectors. A singles spectrum is also taken at each of the angles and, in this case, the binary signal is used to route the counts into different parts of memory to create a 1K spectrum for each of the measuring stations. These spectra can then be used to normalize for different counting times, neutron beam fluxes, etc.

RESULTS

J^{π} assignments for the low lying levels in ^{196}Pt have been well established in an earlier study[1]. The present experiment can therefore be used not only to unambiguously determine mixing ratios but also to test the new correlation system using known decay

EHB

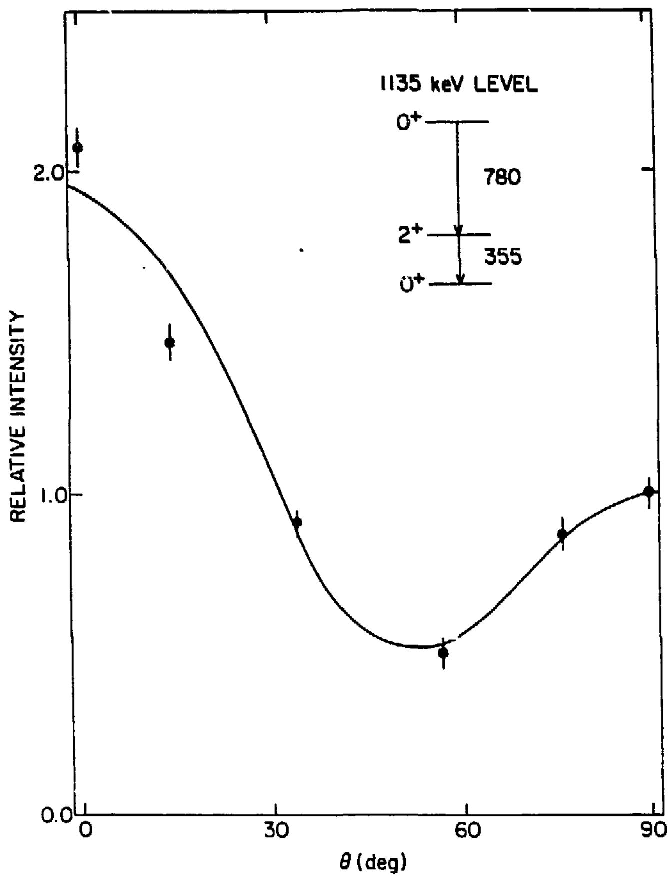

Fig. 1. Gamma-ray intensity as a function of angle for the 780→355 cascade. The solid line represents a theoretical $0^+ \to 2^+ \to 0^+$ correlation.

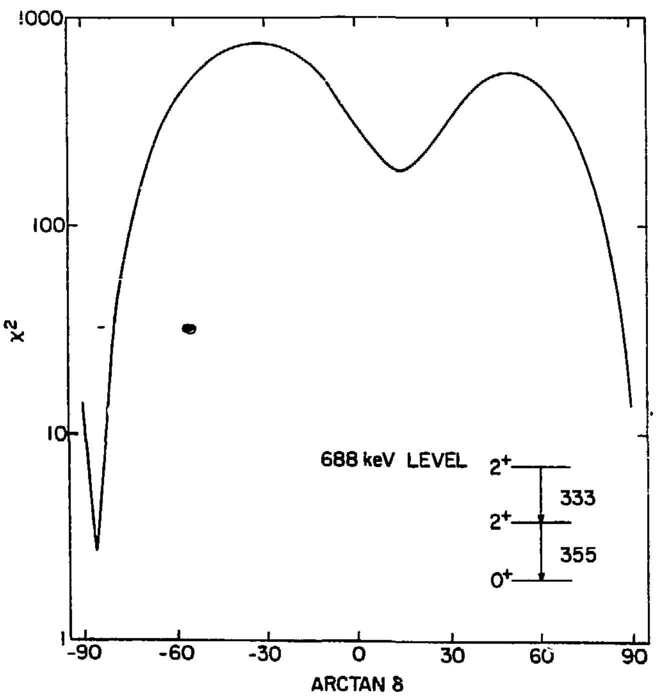

Fig. 2. Plot of χ^2 versus arctan δ for the 333→355 cascade.

Table of measured mixing ratios.

E_γ(keV)	Spin Sequence	O(6) Quantum Numbers (σ,τ,ν_Δ)	Mixing Ratio δ
326	$3^+\to 2^+$	$(6,3,0)\to(6,2,0)$	<-19.08 >7.12 or $-0.09^{-0.33}_{+0.14}$
333	$2^+\to 2^+$	$(6,2,0)\to(6,1,0)$	$-14.30^{-4.78}_{+2.87}$
673	$2^+\to 2^+$	$(6,4,1)\to(6,2,0)$	$-0.62^{-0.61}_{+0.41}$
1006	$2^+\to 2^+$	$(6,4,1)\to(6,1,0)$	<-19.08 >8.14
1091	$3^-\to 2^+$		$0.25^{+0.15}_{-0.13}$

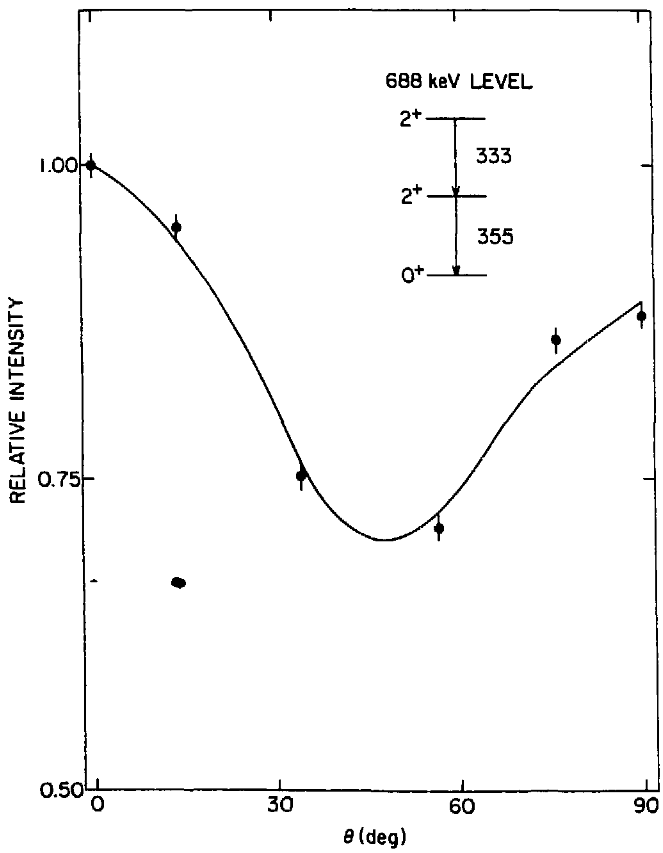

Fig. 3. Gamma-ray intensity as a function of angle for the 333→355 cascade. The solid line represents the fit for the assigned value of δ.

patterns. One such test is shown in Fig. 1 where the relative intensity of the 780-355 keV cascade is plotted against angle. The 1135 level has been identified as a 0^+ level and indeed the data shows the distinctive pattern of a $0^+\to 2^+\to 0^+$ correlation. In addition, values of E2/M1 mixing ratios (δ) for four transitions have been determined and are given in the table. The criteria for setting limits on δ was taken from ref. 2. Figure 2 shows a plot of χ^2 versus arctan δ for the 333-355 keV cascade and Fig. 3 shows the relevant fit to the data points as a function of angle.

DISCUSSION

A successful description of the properties of ^{196}Pt has been made in terms of the O(6) limit of the IBA-1 formalism[1]. In this limit, states are characterized by quantum numbers $(\sigma, \tau, \nu_\Delta)$ and the selection rules for E2 are $\Delta\sigma=0$, $\Delta\tau=\pm1$. The $\Delta\tau$ rule arises from the form of the E2 operator and is therefore strictly applied. However, the $\Delta\sigma=0$ rule arises from a numerical cancellation and is therefore more susceptible to a slight change in the wavefunction when the strict symmetry is broken. Both the 326 and 333 keV transitions obey these selection rules and the table shows that these are predominantly E2 transitions, although in the case of the 326 keV transition, the possibility of a large M1 component cannot be eliminated. The decay of the 1361 keV (6,4,1) level to the (6,1,0) level via the 1006 keV transition has been determined to be more than 98% E2 even though it breaks both E2 selection rules. This may arise because the strict O(6) symmetry is slightly broken, allowing mixing between states which have non-zero E2 matrix elements with the (6,1,0) state.

In the IBA-1, the M1 matrix element consists of two parts[3], one of which yields the same selection rules as for E2 transitions whilst the other gives $\Delta\sigma=2$, $\Delta\tau=0$. While the best test of these rules would involve transitions from the $\sigma=4$ states, the existence of M1 components in transitions between states with $\sigma=6$ cannot be explained by this approach. In IBA-2, where neutrons and protons are treated separately, M1 transitions result from admixtures of states which are not fully symmetric with respect to the n and p degrees of freedom. Therefore, the large M1 admixture in the 673 keV is a measure of the antisymmetric component in the 1361 keV level and could be used, in conjunction with a numerical IBA-2 calculation of ^{196}Pt, to provide an indication of the likely position of the lowest fully antisymmetric state, which is characterized by a large B(M1) strength to the ground state, and in this region should have $J^\pi=1^+$. Evidence for such an isovector mode has recently been obtained in the deformed region[4], via electron scattering.

ACKNOWLEDGEMENT

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