

TDPAC STUDIES OF ELECTRIC QUADRUPOLE INTERACTION OF ^{133}Cs IN COMPOUNDS OF BARIUM (BaCr_2O_7 AND BaCrO_4)

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ABSTRACT

The Electric Field Gradients (EFG) in BaCr_2O_7 and BaCrO_4 compounds were studied using time differential perturbed angular correlation technique. The observed interaction frequencies are found to be 678 ± 7 MHz and 79 ± 1.3 MHz giving the EFG in the two compounds to be $(14 \pm 1.4) \times 10^{17}$ V/cm² and $(1.6 \pm 0.03) \times 10^{17}$ V/cm² respectively.

1. INTRODUCTION

In recent years, there has been increased interest in the study of the electric field gradients in ionic compounds¹⁻⁷. Weiss⁸ has discussed various factors affecting the EFG in compounds. In the case of barium compounds like BaSO_4 , BaCO_3 and $\text{Ba}(\text{NO}_3)_2$,

where the 6s electrons of the barium atom contribute in bonding, the major contribution to the EFG is due to ligand ions⁹. Using ^{133}Cs as probe Sharma *et al.*⁹ have measured interaction frequencies in BaCO_3 and BaSO_4 as 17×10^7 rad/sec and 11×10^7 rad/sec respectively and almost no interaction in $\text{Ba}(\text{NO}_3)_2$.

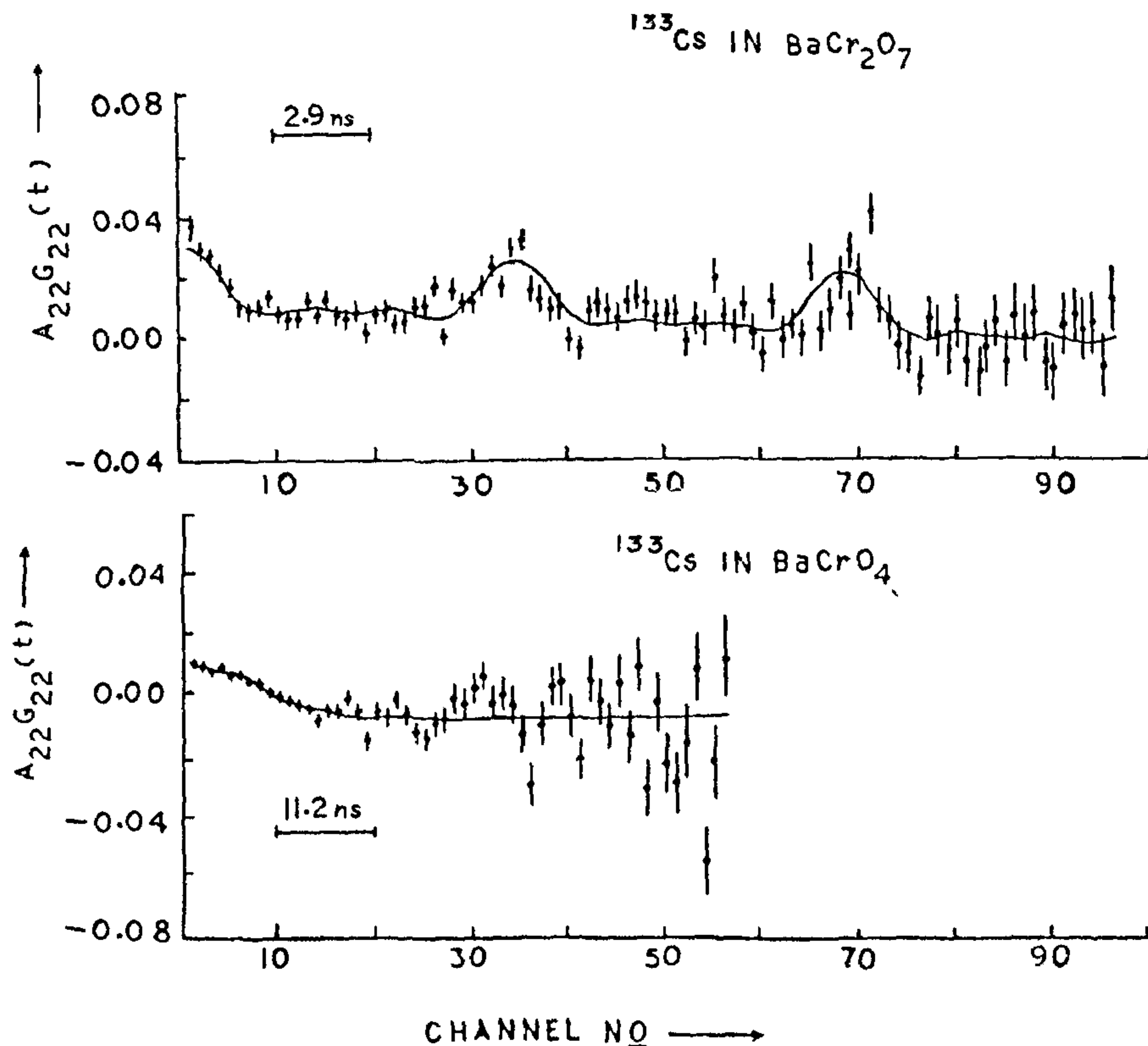


FIG. 1. TDPAC spectrum of barium dichromate and barium chromate at room temperature.

In the present work the quadrupole interaction of the 81 keV ($5/2^+$) level of ^{133}Cs in monoclinic barium-dichromate (BaCr_2O_7) and rhombohedral barium chromate (BaCrO_4) is studied using time differential perturbed angular correlation (TDPAC) technique. The radioactive ^{131}Ba decays to ^{133}Cs via the 356–81 keV gamma ray cascade with intermediate state having half life of 6.35 ns; electric quadrupole moment 2.0 barns as an upper limit⁹⁻¹⁰. The Sternheimer anti-shielding factor γ_∞ for ^{133}Cs is reported to be -157^{11} .

2. EXPERIMENTAL

The compounds BaCr_2O_7 and BaCrO_4 were prepared by chemical processing of radioactive BaCl_2 with potassium-dichromate and potassium chromate in acidic solutions respectively.

The TDPAC measurements were carried out with powder samples at room temperature using a four counter set up with ORTEC TAC and ND 1100 MCA. The time resolution of the system was found to be 2.3 ns (FWHM). After subtracting the chance coincidences, the ratio $A_{22}G_{22}(t)$ was calculated as defined below :

$$A_{22}G_{22}(t) = \frac{2 [W(180^\circ, t) - W(90^\circ, t)]}{[W(180^\circ, t) + 2W(90^\circ, t)]}$$

where $W(180^\circ, t)$ and $W(90^\circ, t)$ are counting rates of coincidences at 180° and 90° respectively and 't' is the time delay between two gamma-ray photons. The data shown in Fig. 1 were computer analysed using standard function for randomly oriented EFG for spin $(5/2)^{12}$, keeping the asymmetry parameter η as floating.

3. RESULTS AND DISCUSSION

The computer fit of the data gave the interaction frequency ν_q in barium dichromate to be 678 ± 7 MHz with a spread of 3% and the asymmetry parameter $\eta = 0$. Combining this with the reported quadrupole moment of the ^{133}Cs excited state, the EFG was obtained to be $(14 \pm 1.4) \times 10^{17}$ V/cm². In the

case of barium chromate the interaction frequency was found to be 79 ± 1.3 MHz but with a large spread of 61%, a fact which does not allow us to derive any meaningful result for the EFG in this case. The value of A_2^{eff} at time $t = 0$ was found to be less than that expected for the cascade and could perhaps be explained by the time dependant electric quadrupole interactions during the charge neutralisation process of the ion ($\tau_{\text{ion}} \approx 10^{-8}$ sec).

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