

# Powder Zeeman NQR Study on the Absorption Forms for Nuclear Spin 5/2\*

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For nuclei which have a nuclear spin of 5/2 and exhibit a small asymmetry parameter of the electric field gradient ( $\eta$ ) at the nuclear site, line shapes of the Powder Zeeman NQR (PZMNQR) spectra based on the transition between the energy levels  $m_I = \pm 1/2$  and  $\pm 3/2$  (the lower frequency line) were studied by means of computer simulations and experiments. (i) When an  $\eta$  value is very small (type 1;  $\eta = 0$ ), the line shape exhibits two shoulders like the style of the American football player. (ii) While an  $\eta$  value is small (type 2;  $0 < \eta < \text{around } 0.01$ ) but not zero, the line shape has two small peaks which are symmetrically located on the shoulders, as in the case of the small  $\eta$  type of spin 3/2. (iii) When an  $\eta$  value is not small (type 3; around  $0.01 < \eta$ ), the line shape has two symmetrical dips in stead of the peaks, which are also similar to the case of not small  $\eta$  type of spin 3/2. As the  $\eta$  value increases from around 0.01, the two dips grow and reach the maximum at the  $\eta$  value of 0.349, and then become smaller and obscure in the range of  $\eta$  larger than 0.349.

The observations of PZMNQR spectra were performed for several compounds including the  $^{127}\text{I}$  and/or  $^{121}\text{Sb}$  nuclei to estimate the  $\eta$  values, and gave the results as follows: very small for  $^{127}\text{I}$  (207.683 and 209.133 MHz, at 77 K) in  $\text{SnI}_4$ ; very small for  $^{127}\text{I}$  (176.496 and 177.438 MHz, at 77 K) in  $\text{GaI}_3$ ; small for  $^{127}\text{I}$  (265.102 MHz, at 77 K) in  $\text{CH}_3\text{I}$ ; 0.33 for  $^{127}\text{I}$  (247.69 MHz, at 77 K) in  $\text{C}_2\text{H}_5\text{I}$ ; 0.27 for  $^{121}\text{Sb}$  (58.23 MHz, at 290 K) in  $\text{SbCl}_3$ . The estimated  $\eta$  values were compared to those obtained from the frequencies of two NQR lines for spin 5/2. They were in good agreement with each other for the small region of  $\eta$ , though somewhat large disagreements were seen in the cases of not small  $\eta$  values.

*Key words:* NQR; Nuclear Quadrupole Resonance; Zeeman effect; Powder Zeeman NQR; Spin 5/2.

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