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LETTER TO THE EDITOR

Zirconium-91 NQR in zircon

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Abstract. Pure ^{91}Zr NQR in mineral zircon has been observed at room temperature. The $\frac{3}{2}$–$\frac{5}{2}$ transition is centred at 6.142 MHz with a linewidth of approximately 70 kHz and a T_1 of 0.57 ± 0.07 s.

A study of the NMR of ^{91}Zr (spin $\frac{5}{2}$) in zircon, $ZrSiO_4$, was reported recently [1] in which the nuclear quadrupole coupling was determined from single-crystal rotation patterns. With a quadrupole coupling of 20.47 MHz and zero η, which is imposed by the crystal symmetry [2, 3], the two pure NQR transitions should be found at 6.141 MHz and 3.070 MHz. We have located the upper resonance and measured the spin–lattice relaxation time at room temperature.

The sample consisted of ten chunks of clear light brown alluvial zircon about 5–10 mm in size, which were packed at random into a glass container. The sample coil consisted of 25 turns with an inside diameter of 15 mm and a length of 38 mm. Pure NQR spin echos were observed with a pulse spectrometer based on a Novex system. The spin echo was initially observed at spectrometer frequencies near 6.142 MHz, with a sequence of two 15 μs pulses separated by 250 μs at a transmitter power of approximately 200 W;

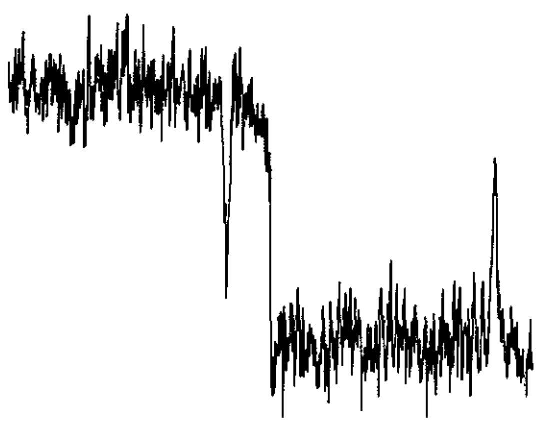

Figure 1. Spin echo obtained with 6000 transients at a frequency of 6.142 MHz.

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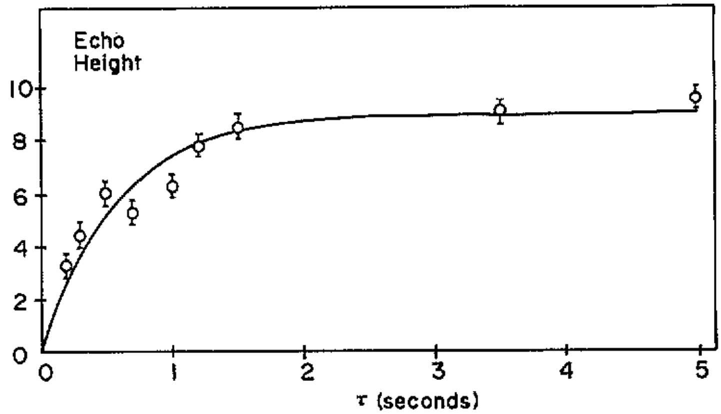

Figure 2. Recovery of the echo height following a saturating comb of twelve pulses.

a delay time between pulse pairs of at least one second was needed to get a good signal-to-noise ratio. With approximately 11 000 transients, a signal-to-noise ratio of about 10 was achieved; a typical echo taken with 6000 transients is shown in figure 1. The authenticity of the echo was confirmed by removal of the sample, by variation of the time between pulses, and by application of an inhomogeneous magnetic field.

The echo was featureless, and appeared in various phases depending in part on the tuning of the matching circuit and the preamplifier, and the transmitter power. When the echo height was plotted as a function of spectrometer frequency with constant spectrometer settings, the apparent linewidth was 70 kHz.

The spin–lattice relaxation time was determined by saturation recovery with a saturating comb, since this method does not depend on achieving exact 90° pulses [4]. A chain of 12 pulses, 1 ms apart, was used to saturate the resonance, followed by a recovery period of up to 5 s, and the spin-echo sequence. For this experiment, 6000 transients were accumulated for each recovery time value, and the echo height, taken to be the root mean square of the echo heights in the two quadrature channels, was plotted versus recovery time as shown in figure 2. The value of T_1 was 0.57 ± 0.07 s.

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