ANGULAR AND TEMPERATURE-DEPENDENT $^{77}$Se NMR IN THE METALLIC AND FIELD-INDUCED SPIN DENSITY WAVE STATE IN (TMTSF)$_2$ClO$_4$

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Introduction
A spin density wave (SDW) is a magnetic ground state characterized by the periodic modulation of the electronic spin density in quasi-one-dimensional (Q1D) conductors [1]. Due to the hyperfine interaction between the nuclear and electronic spins, nuclear magnetic resonance (NMR) is able to probe the dynamics of the SDW condensate. We present an exploratory investigation of the NMR pulsepower and magnetic field direction dependence of the $^{77}$Se NMR line shapes and relaxation rates in the metallic and field-induced spin density wave (FISDW) state of the Q1D organic conductor (TMTSF)$_2$ClO$_4$.

Experiment, Results, and Discussion
A single crystal of (TMTSF)$_2$ClO$_4$ with dimensions 0.5mm x 0.7mm x 3mm was inserted inside a coil just enough to fit it for better filling factor, and 0.5 mil gold wires were attached at the edges on the c-axis for the four-probe resistivity measurement. The sample was mounted on a G-10 holder of the goniometer and cooled at 10mK/min from 30K to 18K. Angular NMR and transport measurements were carried out in a sweepable 15 Tesla magnet.

The sharp upturn of the $^{77}$Se spin-lattice relaxation rate $1/T_1$ near 4K in Fig. 1a indicates the presence of strong local magnetic field in the FISDW state. Fig. 1b corroborates the magnetic character of this transition as depicted in the inhomogeneous broadening of the NMR spectra below $T_{SDW}$~4K. As the sample is cooled deep in the FISDW state, the nuclear relaxation rate decreases because of the slowing down of the magnetic fluctuations [2] and obeys a temperature power law dependence of about 2.3. The anisotropic nature of $1/T_1$ is established in Fig. 1c. Fig. 1d shows the coexistence of the metallic (central peak) and FISDW (two side peaks) states by adjusting the NMR pulse power. The main results of this preliminary study are that: 1) by reducing the pulse power, the FISDW state below the transition can be explored; 2) that by doing this we have identified a possible second phase below the transition where the $1/T_1$ vs. T curve changes slope; and 3) we now have the capability to study both the NMR signal and the electrical transport in this material simultaneously vs. angle, temperature, and magnetic field. Work is now in progress on FISDW systems to take advantage of these new capabilities.

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References