	Experiment title: **Magnetic-field induced transition in $NbSe_3$**	**Experiment number**: HE- 2420
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Shifts:	**Local contact(s)**: Dr. Claudio MAZZOLI	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

CURRAT* Roland, ILL, Grenoble
FLUERASU* Andrei, ESRF, Grenoble
LEMÉE-CAILLEAU* Marie-Hélène, ILL, Grenoble
LORENZO* J. Emilio, Institut Néel/CNRS, Grenoble
MONCEAU* Pierre, Institut Néel/CNRS, Grenoble
ORTEGA* Luc, Institut Néel/CNRS, Grenoble

Report:

Low dimensional electronic systems characterized by a quasi-one-dimensional (Q1D) Fermi surface (FS) tend to form a density wave (DW), either a charge-density-wave (CDW) or a spin-density-wave (SDW) ground state at low temperatures as a consequence of the nesting instability of the FS [1,2]. The electronic structure of Q1D conductors can be considerably modified by a high magnetic field which effectively suppress the interchain orbital motion, thereby driving the system more one-dimensional. In addition to this orbital effect, Pauli effects can affect the CDW ordering [3,4]. This latter effect can be formulated as a breaking of degeneracy of two density waves, those with parallel and antiparallel spin with respect to H. This is reminiscent of the treatment of two coexisting CDW's with overlapping electronic bands. The coupling of two CDW's with different wave vectors may stabilize a soliton lattice in the relative phase of two waves [3].

$NbSe_3$ is one of the prototype of Q1D materials. It undergoes two successive Peierls transitions at T_{P1}= 145K and T_{P2}=59K with modulation wavevectors Q_1 = (0, 0.241, 0) and Q_2 = (0.5, 0.260, 0.5), respectively, remaining however semi-metallic below T_{P2}. This behaviour indicates that the Fermi surface (FS) has not been totally destroyed by both CDW's, probably because of the lack of perfect nesting between portions of the FS connected by distortion wave vectors Q_1 and Q_2, respectively.

The aim of the present proposal *was to measure the position and the shape of the Q_2 CDW satellite of $NbSe_3$ under a magnetic field (up to 10T) at low temperature (4.2K to 30K) in the hope of determining the effect of an applied magnetic field on the CDW superstructure.*

The $NbSe_3$ crystal measured has the form of a whisker, 4mm long with a width of 30 μm and a thickness of 5 μm mounted such a way that Q_2 is in the diffraction plane (Fig.1). The magnetic field was applied perpendicular to the chain direction (b axis) with an angle of 26° with the (b,c) plane. The position of the Q_2 satellite along b* measured at 2.5K when a magnetic field of 8T is applied.

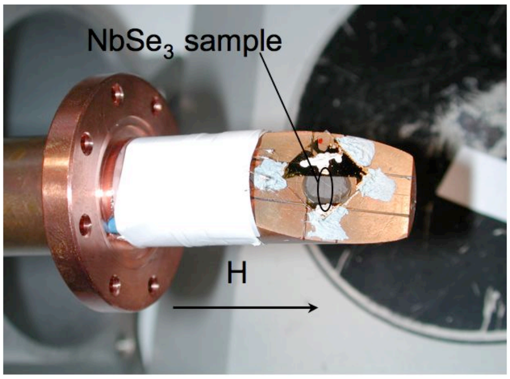

Figure 1: sample set-up

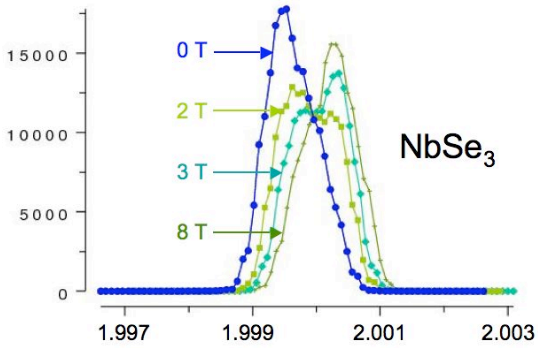

Figure 2: Magnetic field effect on the (1 2 1) Bragg peak

However the main Bragg peaks are also affected by H. Fig.2 shows the (121) reflection at different magnetic fields. The peak splits above 2-3T. In Fig.3 we have drawn the position of the maximum of the main Bragg (020) peak and of the Q_2 satellite at 2.5K as a fuction of H. The relative effect of the change of the position of Q_2 with respect of that of the (020) peak is of the order of 1.5-2 10^{-4}, slightly above the resolution of the measurements.

During the experiment, we faced difficulties which were time consuming. For low temperature measurements we first surrounded the sample holder with a beryllium cap with a diameter of 2cm. This beryllium revealed not to be totally amorphous but formed of small crystallites with micron size of the same order of that of our whisker. Unfortunately, 3 days were lost before we took away this beryllium, then allowing us to perform experiments. This loss of time has prevented us to perform measurements with magnetic field at different T

Before asking for the continuation of the present experiment (field dependence of the Q_2 satellite at different temperature till 30K), we have to explain the effect of H on the average Bragg peaks : a trivial effect would be a displacement of the sample due to some magnetic forces on the sample holder around 2-3T; a crude estimation indicates that a displacement of 100 microns might explain the results. The second explanation would be a magneto-elastic effect which appears around 2-3T, unexpected till now. To disentagle between these two possibilities, a diffraction experiment on a powdered sample under magnetic field is important and will be the topic of a new proposal.

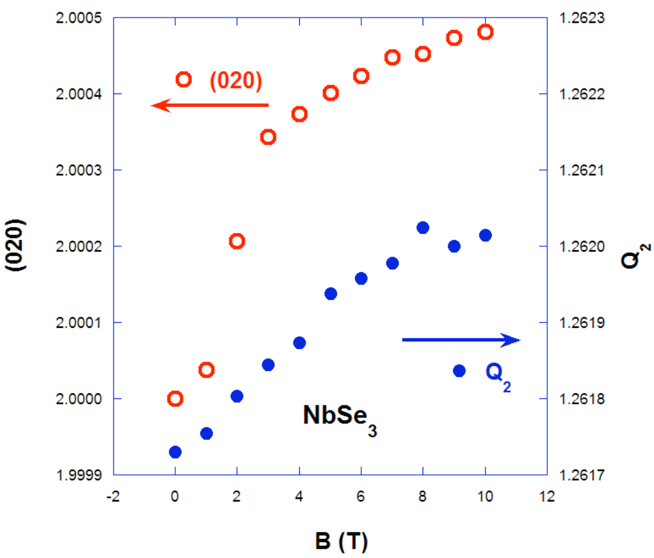

Fig.3 Position of the (020) Bragg and of the Q_2 satellite as a function of the magnetic field

[1] G. Grüner, Density Waves in Solids, Addison Wesley 1994

[2] Proceedings of the International Workshop on Electronic Crystals (ECRYS) edited by S. Brazovskii, P. Monceau and N. Kirova , J. Phys. IV **12** (2002) ; **131** (2005).

[3] D. Zanchi, A. Bjelis and G. Montambaux, Phys. Rev. **B53** (1996) 1240

[4] R.D. McDonald et al. Phys. Rev. Lett. **94** (2005) 106404