	Experiment title:	Experiment number:
	Low temperature electrical switching and CDW commensurability in $NbSe_3$	HS-2649
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Shifts:	**Local contact(s)**: Dr. Andrei FLUERASU	*Received at ESRF:*

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Report:

A number of quasi-one-dimensional metals, such as $NbSe_3$, are known to undergo a so-called Peierls transition into a low-temperature state with modulated electron density, the charge density wave (CDW) state. The periodic lattice distortion accompanying the CDW gives rise to satellite reflections observable with, e.g., X-ray diffraction techniques. Application of an electric field above a threshold value, E_T , depins the CDW from impurities and induces a collective electron transport due to the coherent incommensurate CDW motion.

$NbSe_3$ is the prototype of a class of CDW systems exhibiting collective transport. Two CDWs appear in $NbSe_3$: a upper one below T_{P1} = 145K with a wavevector Q_1 = (0, 0.241, 0) and a lower one below T_{P2} = 59K with Q_2 =(0.5, 0.260, 0.5). While no coupling between the two CDWs has ever been detected, we have recently reported a dynamical interaction between Q_1 and Q_2 (see report HS1919 and [1]).
The onset of CDW conductivity at E_T is generally smooth, but in the temperature range below 2/3 T_{P2}, typically below 35K, an abrupt discontinuity in the current-voltage curves occurs. It was proposed that this switching effect may be due to ultra strong pinning centers, breaking the phase continuity of the moving CDW**.**

The aim of the experiment was to monitor the local deviations from joint commensurability in $NbSe_3$ at low temperatures (T below 40K) to correlate the occurrence of switching in conductivity with the presence of jointly commensurate regions

For this purpose, we proposed to look at second order satellites from Q_1 and Q_2 which will or will not superpose depending whether the commensurability condition is fulfilled or not. Up to now, only second order satellites of Q_1 have been measured; no information on those of Q_2 were available.

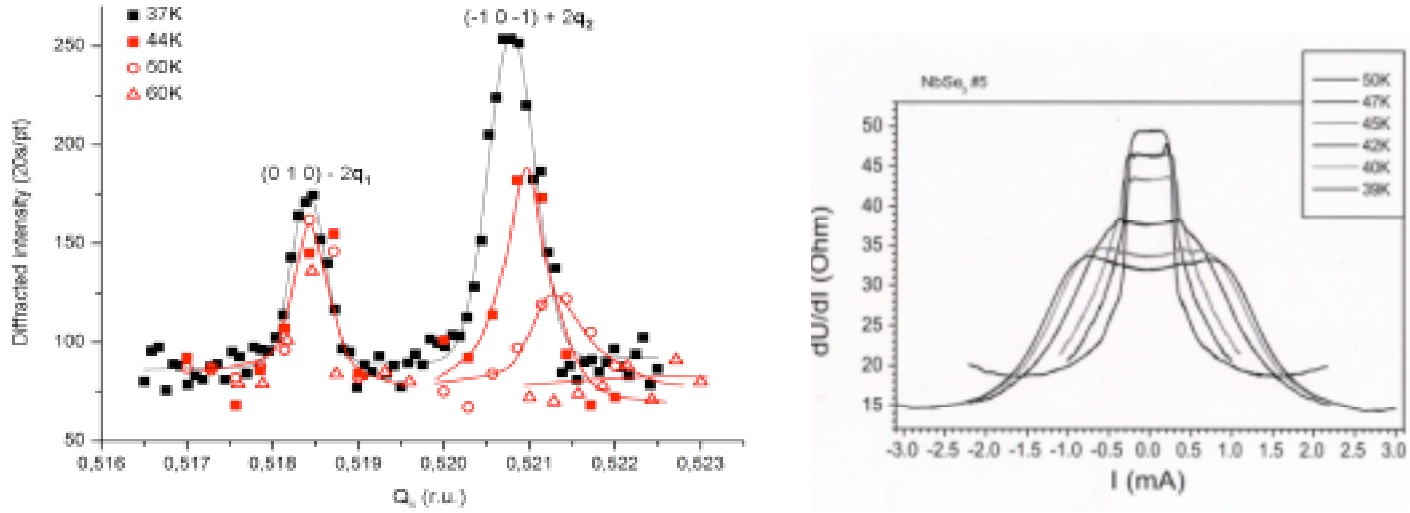

Fig.1 left: temperature dependence of second harmonic satellites corresponding to the Q_1 and Q_2 CDWs in $NbSe_3$; right: Differential resistance of $NbSe_3$ measured in situ at different temperatures. The onset of CDW conductivity is smooth; switching will appear at lower temperatures.

Thus the first part of the experiment has consisted in the search of second harmonic satellites of Q_2. We have scanned the portion of reciprocal space along b^* around 0.5, 1.5 and 2.5 using the very high resolution available at ID10a. Fig.1 left shows the second order satellites corresponding to Q_1 and Q_2 which appears between 0.518 b^* and 0.521 b^*. The T-dependence of this scattering reveals that, as expected, the Q_2 satellite disappeared above T_{P2}, while the position of the Q_1 is T-independent. It can also be seen that when cooling below T_{P2} the wavevector of Q_2 is driven towards joint commensurability with Q_1 [2]. This is not achieved within the temperature that we could explore in the experiment. Intensity of the Q_2 satellites is well above the experimental background already at 50K and shows that further measurements below 37K will not suffer from intensity limitations.

During the experiment, we faced time consuming experimental problems that prevented us from completing our measuring plan :
- the unexpected switching-off of the displex compressor due to a short circuit in the temperature control plug
- while the displex came directly from maintenance in UK just before the experiment, it was not functioning according to specifications and we were unable to reach a temperature below 37K.
- the OEM750 driver module, which works n conjunction with the DPAP7 controllers, was broken. As a consequence, we broke several DPAP7's and the system was behaving erratically. This occurred during a long 4 days week-end and proper working conditions demanded to realign the instrument at each motor change.

We have measured *in situ* the non linear current-voltage curves at different temperatures, as shown in Fig.1 right, but only above 37K. We were thus unable to detect switching effects which occur at lower temperatures and which was the aim of the proposal.
The experiment was, however, successful in the sense that we show that we can now study the change of satellite positions by exploring a very small q-space and search for a possible joint commensurability effects between the two CDWs. That will be the aim of a new proposal, continuation of this one.

References :
[1].A.Ayari et al. : Phys. Rev. Lett. 93 (2004) 106404
[2].A.H. Moudden et al. Phys. Rev. Lett. 65 (1990) 223