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# Tunneling Spectra in NbSe<sub>3</sub>/I/Pb junctions

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NbSe<sub>3</sub> goes through two phase transition inducing SDW states for  $T_1 = 149$  K and  $T_2 = 59$  K. These two transitions bring a partial condensation at Fermi level, the low temperature conductivity being always of metallic type. The evaluation of the width of the "gap" cannot be done simply. We employed this word "gap" although it is incorrect here. Tunneling effect has permitted us to obtain an estimation of this "gap" for  $P = 1$  bar and  $P = 1$  Kbar. We have kept tunneling spectra only for  $T < T_2$ . For  $T_1 > T > T_2$ , the width of the "gap" and thermal broadening are such that a measure is too imprecise. We have used the lead superconductivity as a test of good tunneling devices.

The presence on our curves (figure 1, 2 and 3) of phonon-electron interactions shows that we have good tunneling spectra. It is clear that lead tunneling spectra is not modified which indicates that the  $N(E)$  variation around Fermi level is slow and covers a wide domain. This is shown by a calculation from the classical expression

$$I(V) = I_0 \int_{-\infty}^{+\infty} N(E)_{Pb} \cdot N_2(E + eV) [f(E) - f(E + eV)] dE$$

in which  $N_2(E)$  have the shape indicated by the figure 4.

The inserts in figures 2 and 3 show the evolution of  $R(T) = dV/dI (V=0)$  versus temperature. It is clear that  $R(T)$  increases from  $T_2 = 58$  K at  $P = 1$  Kbar and  $T'_2 = 54$  K at  $P = 1$  Kbar. If we take for the gap value the width between the points where

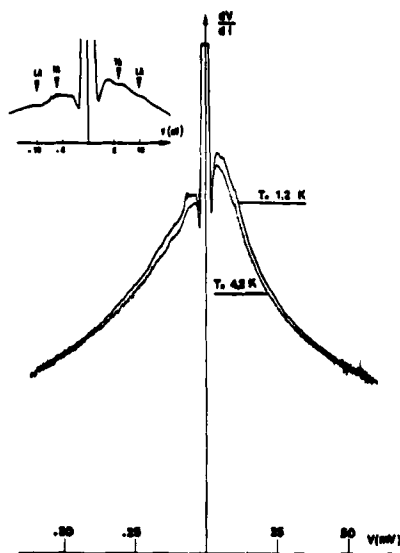


Figure 1 : Classical tunneling spectra at ambient pression and at low temperature obtained with  $\text{NbSe}_3/\text{I}/\text{Pb}$  junction. In insert the phonon-electron interactions are clearly seen.

$R(T)$  increases significantly we obtain :

$$\frac{2 \Delta (1 \text{ bar})}{kT_2} \simeq \frac{2 \Delta (1 \text{ Kbar})}{kT'_2} \simeq 14$$

This value is of the same order as those obtained for same type of conductors (1). We can see that for  $P = 1 \text{ Kbar}$  (figure 3)  $R(T)$  is higher than for  $P = 1 \text{ bar}$  (figure 2). On the other hand the curves  $dV/dI (V)$  cover a wider surface at  $P = 1 \text{ bar}$  than at  $P = 1 \text{ Kbar}$ . That is to say that for a moderate pressure, CDW and superconductivity don't coexist ;  $N(E_F)$  and the global

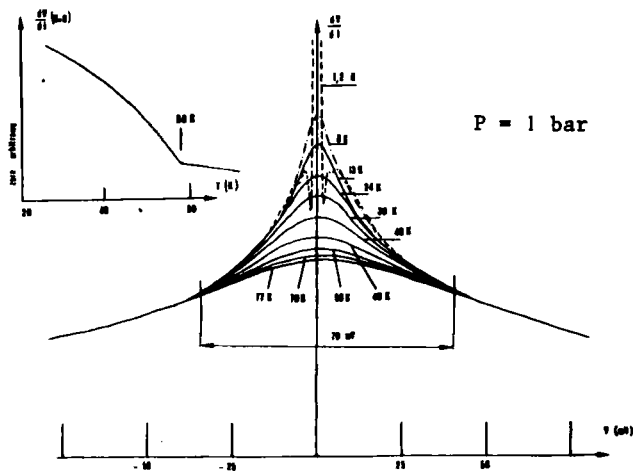


Figure 2 : Evolution with temperature of  $dV/dI$  versus bias voltage at ambient pressure. The insert shows the temperature dependance of  $dV/dI$  ( $V=0$ ).

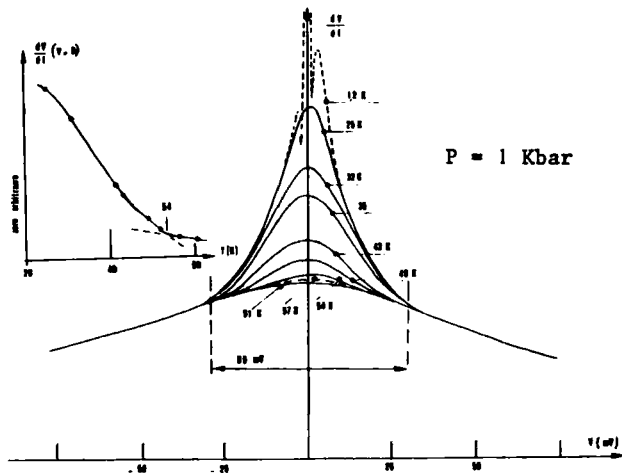


Figure 3 : Evolution with temperature of  $dV/dI$  versus bias voltage at  $P = 1$  Kbar. It is interesting to compare the inserts of figure 2 and 3.

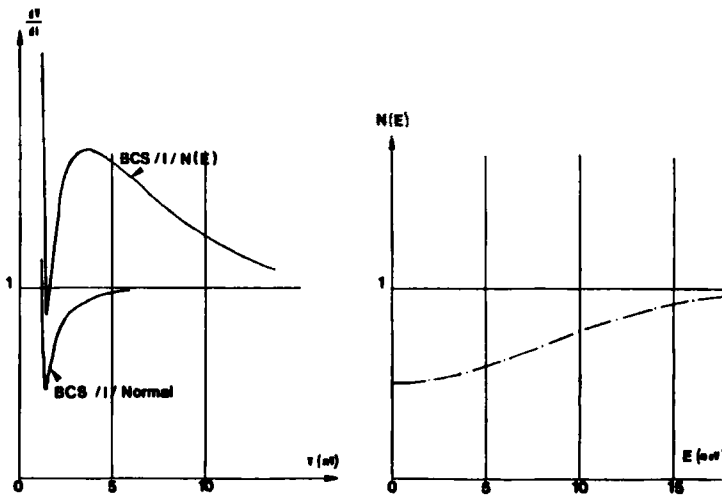


Figure 4 : This figure BCS/I/N(E) shows the theoretical modification induced by the presence of density of states  $N(E)$  (right curve) and we have compared this curve to another when  $N(E)$  is metallic or normal.

condensation are weaker (i.e. the "gap" becomes deeper and thinner). The observation of tunneling spectra at higher pressure should permit a verification if the hypothesis advanced by FRIEDEL (2) to explain the evolution with temperature of super-conductive transition of  $\text{NbSe}_3$  are correct.

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(1) C. SAINT LAGER Thesis, Grenoble (1983)

(2) J. FRIEDEL J. Physique Lettres 36, 279 (1975)