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## SUPERCONDUCTING RESPONSE IN BULK CdSb ALLOY NEAR THE LOCALIZATION THRESHOLD

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Experiments with metastable CdSb alloy demonstrate superconducting (S) response on the insulating side of the metal(M)-insulator(I) transition. This response dissappears with lowering the temperature.

Superconductivity behaves differently in disordered 2D and 3D electron systems. According to the scaling theory [1], disorder always leads to localization in 2D at T=0. As a result, S-I transition appears without intermediate M-state [2]. It has been observed and investigated experimentally [3,4]. The situation in 3D is complicated by M-state coming into play.

Those who make experiments near the localization threshold are always asked about the uniformity of their material. However, this may turn to be not very important when dealing with S-transition because S-interaction stimulates phase separation near the localization threshold even in an initially uniform material [5,6].

Our experiments were performed with $Cd_{43}Sb_{57}$ alloy [7,8]. Their advantage was that the whole sequence of states was obtained with one sample while its amorphization from a high-pressure metastable M-phase. Heating to room temperatures irreversibly transformed it into an amorphous I phase. Dosing the heating allows one to obtain a sequence of intermediate quasistable states. These states are labelled by the logarithm of the resistance ratio $R/R_{in}$ as measured at T=6K, $R_{in}$ is the resistance of the initial sample. The state q=4 separates M- and I-states [7].

Fig.1 displays the evolution of the S-response. When q>4, i.e. in I-states, the curves demonstrate the quasireentrant behavior. The magnetic field does not change the type of the curves: for q<4 minimum in R(T) does not appear (cf.[4] for 2D). The curves for the separating state q=4 are shown in Fig.2.

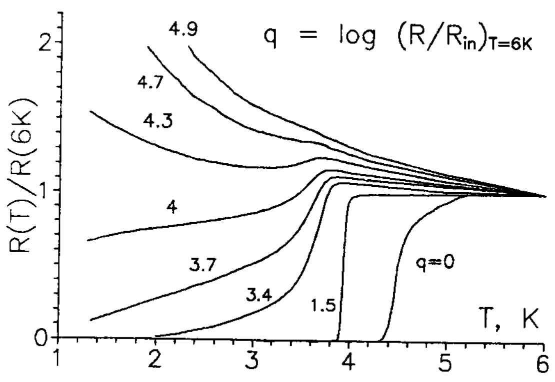


Fig.1. R(T) curves

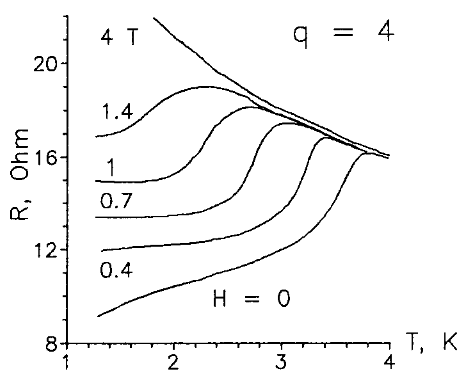


Fig.2. S-response at different H


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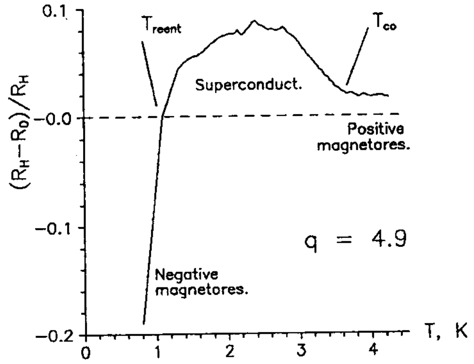


Fig.3. Magnetoresistance

The natural classical explanation of the curves R(T) with quasireentrant behavior would suppose that S- and I-regions of the material are connected in series, the quantum explanation suggests that one deals with partial formation of the S-condensate attributed to the whole sample. Some arguments in favour of the second assumption were obtained from measuring R(H) at different T [7]. Usual S-response at 3K (increase of R with H) gives way to negative magnetoresistance (NMR) at T<1K. One may conclude from the curves at intermediate temperatures that S-response is not simply masked by NMR but disappeares at low T. The competition between S-response and NMR is illustrated by Fig.3, $R_0$ and $R_H$ are resistances at the fields 0 and H=4T

We summarize by the diagram in Fig.4. The origin on the diagram corresponds to the M-I transition point, the quantity f along the x-axis is defined through the correlation length $\xi$ which tends to infinity from whichever side the transition is approached. Namely, $f=1/\xi$ on the I-side of the diagram (at right) and $f=-1/\xi$ on the M-side (at left). At the M-side, $\xi$ was deduced from the extrapolation of the conductance (1/R) to its value at T=0. The same procedure determines the state f=0.

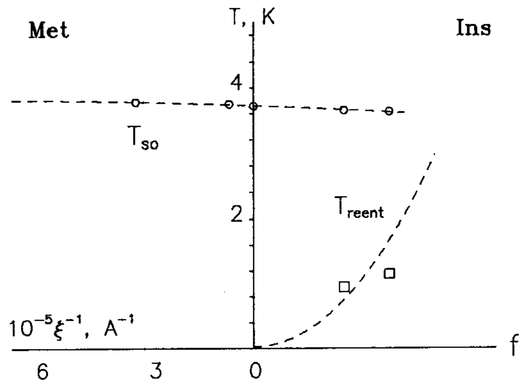


Fig.4. Vicinity of MI-transition

So the data concerning the superconductivity: onset and reentrant temperatures, are placed inside the frame established from the normal state. Fig.3 explains the way we extract the superconducting data.

When we reduce the temperature on the I-side we must reach a hopping regime. Apparently, this crossover coincides with the lower branch $T(f)= T_{reent}(f)$ on the diagram. So, if the whole approach is valid and we indeed deal with a single quantum state of the material, then it follows that crossover to hopping conduction destroys the superconducting response.

## REFERENCES

1. E.Abrahams et al., Phis.Rev.Lett. 42 (1979) 673
2. M.P.A.Fisher et al., Phis.Rev. Lett. 64 (1990) 587
3. D.B.Haviland et al. Physica B 169 (1991) 238
4. A. F. Hebard and M. A. Paalinen, Phys.Rev.Lett. 65 (1990) 927
5. L.Bulaevskii et al., Sov.Ph.-JETP 65 (1987) 380
6. A.A.Gorbatsevich et al., Sov.Ph.-JETP 74 (1992) 511
7. V.M.Teplinskii et al., Sov.Ph.-JETP 74 (1992) 905
8. V.F.Gantmakher et al., JETP Lett. 56 (1992) 309