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SUPERCONDUCTIVITY OF GALLIUM ARSENIDE AT HIGH PRESSURES

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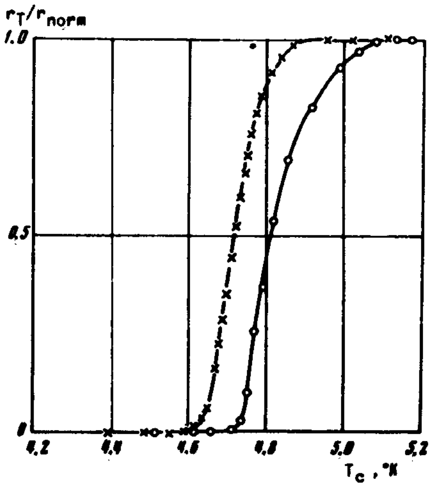
The semiconducting compound GaAs, which has a lattice of the type ZnS at a pressure p = 0, goes over into the metallic state at p = 250 kbar and room temperature [1]. A number of III - V compounds having a similar crystal structure (InSb, GaSb, and AlSb) go over into metallic modifications with the structure of white tin at respective pressures 22.5, 70, and 125 kbar. All these modifications are superconducting [2 - 4]. One might expect the metallic phase of GaAs to be likewise superconducting.

We report here observation of superconductivity in GaAs at pressures exceeding 250 kbar.

Pressures up to 300 kbar were produced at room temperature in a high-pressure chamber described in [5], using anvils of polycrystalline superhard materials of the SV type; the pressures were determined with a calibration curve based on the reference phase-transition points of Bi (p = 81 kbar), Fe (130 kbar), Pb (160 kbar), Fe + 8.4 wt.% Co (180 kbar), and GaAs (250 kbar). A force up to 4 tons was produced by a mechanical low-temperature press. The superconducting transitions were revealed by the change of the electric resistance. The sample temperature was measured with a semiconducting Allen-Bradley thermometer.

In the pressure region up to 250 kbar, the contact between the platinum electrodes and the sample produced a p-n junction with a resistance exceeding 10 megohm. The transition of the GaAs into the metallic state was revealed by the sharp decrease of the electric resistance to the value ∿3 ohm, which increased slightly with further increase of pressure. In the pressure region 250 - 300 kbar, the resistance of the samples upon cooling from 240 to 5°K decreased by approximately 4 times. With further lowering of the temperature, sharply pronounced transitions to the superconducting state were observed (see the figure). The temperature T_c of the transition into the superconducting state was 4.8°K at p = 260 kbar and decreased with further increase of pressure



Superconducting transitions of GaAs at different pressures: 1 - p ≈ 300 kbar, 2 - 300 kbar.

in the inverval 260 - 300 kbar, at an average rate $dT_c/dp = 0.2 \times 10^{-5}$ deg/bar.

It was suggested in [4] that T_c of the metallic modifications of III - V compounds should be close to T_c of the isostructural or metallic modifications of IV elements, which have an atomic mass close to the "average" mass of the atoms of the compound. However, the transition temperatures of AlSb II (2.8°K at p = 120 kbar) and Ge II (5.35°K at p = 115 kbar), which have close atomic masses, differed strongly. Apparently such a comparison is meaningful only for compounds in which the atomic weights of the elements differ little from one another. Indeed, the obtained value T_c = 4.8°K for the metallic modification of GaAs in quite close to T_c of Ge II.

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NARROW MOLECULAR RESONANCES UPON SATURATION OF ABSORPTION IN SEPARATED LIGHT BEAMS

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1. We report in this article the first observation of narrow molecular resonances within the Doppler line upon saturation of absorption in the field of two parallel spatially separated light waves. This effect is of considerable interest for the investigation of small-angle molecule scattering, the investigation of coherent interaction of molecules with a light field, and stabilization of the frequency of gas lasers.

2. Upon saturation of absorption on the Doppler-broadened transition of a coherent traveling wave, a "hole" is burned in the contour because of the saturation of the absorption of the molecules that are at resonance with the field, i.e., they have a definite projection of the velocity $\vec{v}$ on the direction of propagation of the wave $\vec{k}$:

$$|\omega_0 - \nu - \mathbf{kv}| \lesssim \Gamma << \Delta\omega_{\text{Доп}}, \tag{1}$$

where ω_0, Γ, and $\Delta\omega_{Dop}$ is the frequency of the center, the homogeneous width,