singularity. Without entering into a more detailed discussion of this question, we note only that there exists a definite limitation on the possible increase of Δ: since the role of the high-frequency field reduces to a weakening of the temperature factor, it follows that $\Delta < \Delta(T = 0)$.

Let us list some of the singularities of the superconducting state, stimulated by an alternating field: 1) It can be readily seen from (3) and (4) that a plot of $T(\Delta)$ with $\omega > \omega_c$ and fixed field intensity has a maximum at $T > T_c$.[2] The question whether the state at $T > T_c$ will be stable or metastable remains open for the time being. 2) An analogous picture should be observed also when a constant magnetic field H is applied. As is well known, the transition of a thin film from the superconducting to the normal state under the influence of a magnetic field is a second-order transition. In the presence of an alternating field, the $H(\Delta)$ curve has a maximum at $H > H_c$ and the destruction of superconductivity occurs at a finite value of Δ. 3) The increase of the critical current in the presence of an alternating field also follows directly from (3) when $\omega > \omega_c$. In all probability, this is precisely the phenomenon observed by Dayem and Wiegand [8]. The existence of a critical point for the effect observed by them, and the order of magnitude of the latter, are in qualitative agreement with (5).

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INVESTIGATION OF THE PROCESS OF RESONANT CHARGE EXCHANGE IN THE He^4 - He SYSTEM

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1. The effective cross section for resonant charge exchange, in the approximation of two states, is given by the formula

$$\delta = 2\pi\int_0^\infty b\,\mathrm{Sin}^2(\eta_g - \eta_u)\,db, \tag{1}$$

where b is the impact parameter, and $\eta_g - \eta_u$ is the phase difference between the even and odd states. Smith [1] has shown that if the phase difference $\eta_g - \eta_u$ is stationary in a certain interval b, then the function (v) (v - velocity of relative motion) has an oscillating character. One of the reasons why the phases are stationary is the presence of a maximum

1) It must be borne in mind that A_ω is the field inside the film. The coefficient connecting A_ω with the external field is determined by the geometry of the experiment, and in general is dependent on Δ.

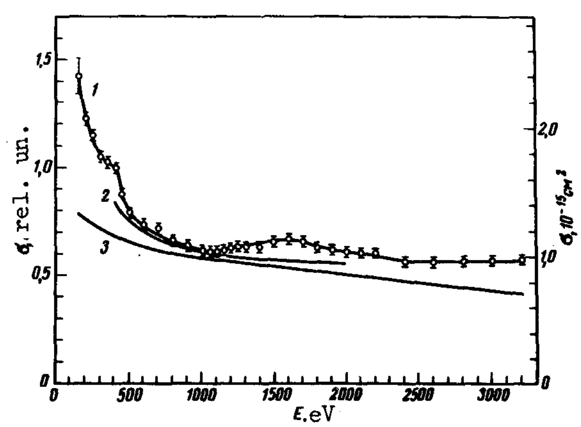
of the difference $V_g - V_u$ of the terms of the even (V_g) and odd (V_u) states as a function of the internuclear distance R. This explains, in particular, the oscillation of the total charge-exchange interaction cross section of alkali-metal ions and atoms, observed by Perel and co-workers [2]. Another cause of the stationary $\eta_g - \eta_u$ is the scattering of the incoming particle by the core of the atom [1]. To verify the validity of this theory, one can study experimentally the behavior of $\delta(v)$ for a system in which the difference $V_g - V_u$ has no maximum. A process convenient for this type of investigation is resonant charge exchange in the system

$$He^+ + He \rightarrow He + He^+, \quad (2)$$

which has been investigated many times and for which data are known on the terms of the quasi-molecule He_2^+ [3]. In addition, for this system the theory predicts the appearance of a noticeable effect.

2. The cross sections of the process (2) were measured in the present investigation with the instrument described in [4]. The He^{4+} ions were obtained from a source in which He was ionized by 60-eV electrons. To obtain a sufficiently exact dependence $\delta = f(E)$, the current intensity of the secondary ions in (2) was automatically recorded at two values of the energy E and E_0 (E - kinetic energy of the He^+ ions in the laboratory frame). The calculated value of δ at the energy E was then normalized to the value of the cross section measured at the reference point E_0, chosen to be $E_0 = 400$ eV. The cross section δ was measured in the energy interval $150 \leq E \leq 3200$ eV. The final results were determined as the arithmetic means of a number of measurements. The errors in the relative cross sections were defined as the arithmetic means of the deviations of the results of the individual measurements from the mean values. The absolute cross sections were determined by comparing them with the value $\delta = 1.05 \times 10^{-15}$ cm^2 measured at E = 400 eV in [5]. The accuracy of the absolute cross sections obtained in this manner is ± 25%.

3. The points with the error bars in Fig. 1 are the results of our measurements, and smooth curve 1 was drawn through them. The bars represent the errors in the relative cross sections. There are various published experimental and theoretical data on the cross sections of the process (2) [6]. For comparison, we show here the measured cross sections obtained in one of the latest investigations [5] (curve 2) and the cross sections calculated after Firsov [7] (curve 3). The measured cross sections can receive contributions also from the ionization processes $He^+ + He \rightarrow He^+ + He^+ + e$, but these contributions can be neglected, since their cross sections are small in the 150 - 3200 eV interval and range from 2×10^{-17} to 3.8×10^{-17} cm^2 [8].



Cross sections for charge exchange of He^+ ions with He atoms. 1 - present data, 2 - data from [5], 3 - data obtained on the basis of Firsov's theory.

4. The cross sections of the process (2), measured in many investigations, including [5], are characterized by a monotonic dependence on the ion energy. This agrees with the dependence predicted by the Firsov approximation, in which the quantity $\sin^2(\eta_g - \eta_u)$ is replaced in the calculation of the integral (1) by its mean value in a certain region of the parameter b. As seen from the figure, the curve 1 obtained by us is nonmonotonic, and the non-monotonicity exceeds the errors of the relative cross sections. These results apparently point to an oscillating character of the function $\delta = f(E)$ for the process (2).

From the electron energies of the principal levels of He_2^+ [3], we can conclude that the difference $V_g - V_u$ has no maximum, because to explain the oscillations of the cross section of the process (2) it must be assumed that the incident particle is scattered by the core of the target atom. Calculations [1] of the integral (1) for the H^+-H system reveal a weak oscillation of the cross section. There are no exact calculations of the integral (1) for the H^+-H system, but it follows from the theory that the oscillation of the cross section should increase with increasing atomic number of the particles.

In the He^+-He case, resonant charge exchange is connected between the odd and the adiabatic even terms. Resonant charge exchange with transition between the odd and adiabatic even terms is also possible. In both cases, oscillation of the cross section is possible and is due to scattering by the core, but in the latter case the conditions for the oscillation are more favorable because of the smallness of $V_g - V_u$ at $R = 0$ and the slo decrease of this difference with increasing R. According to Smith [1], the oscillating component of the charge-exchange cross section can be represented approximately in the form $Av^{1/4}\cos(\beta v^{-1} + \delta)$, ($\beta$ is the frequency and δ the phase of the oscillation), so that the distance between the extrema in the function $\delta = f(v^{-1})$ should be constant. In our experiment it is impossible to trace this function in a wide energy interval.

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AMPLIFICATION OF HELICONS IN InSb BY AN ELECTRON BEAM

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It is known that various magnetoplasma waves, particularly slow helical waves (helicons), can propagate in a magnetized electron plasma of semiconductors or metals. Whereas earlier principal attention was paid to the nature of these waves, at present greater interest is evinced in their amplification and in the development of microwave amplifiers and generators.