The electric field of an electron in a electron-hole plasma with degenerate electrons

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We consider the conditions for formation of a superconductivity state either in a semiconductor or in a electron-hole plasma with the degenerate electrons due to the attractive forces between the electrons as a result of the exchange effects through the electron-hole sound wave by analogy to the phonon waves in a solid state. One of the major unsolved problems of the superconductivity theory is determination of the static potential of a point electron. We have determined the view of an interaction potential between two electrons in a degenerate electron-hole plasma (1) with non-degenerate holes. The potential appears to be attractive at distances large than the Debye radius and decreases as $1/r^3$, See Fig.1. We discuss the conditions at which the bound electron state - Cooper Pair in a such field can be formed. The interaction potential of two electrons α and β in a electron-hole plasma can be described by the following equation [1]:

$$U(r) = \int e^{\imath \vec{k}\vec{r}} U(\vec{k}) d\vec{k}, \quad U(k) = \frac{e_\alpha e_\beta}{2\pi^2} \frac{1}{k^2 \varepsilon^l(kV_\alpha, k)}, \tag{1}$$

where [2]

$$k^2 \varepsilon^l(kV_\alpha, k) = k^2 + \frac{3\omega_{L-}^2}{V_{F-}^2} - \frac{\omega_{L+}^2}{V_\alpha^2} + \imath\beta, \quad \beta = \frac{3\pi V_\alpha \omega_{L-}^2}{V_{F-}^3}, \tag{2}$$

here V_α is the speed of a test electron with the charge e_α producing the potential ϕ_α at a point $r = 0$ where the charge e_β is located; V_{F-}- the speed of a weakly damped electron-hole sound wave, $\omega_{L+,L-}$ - the hole and electron Langmuir frequencies.

References

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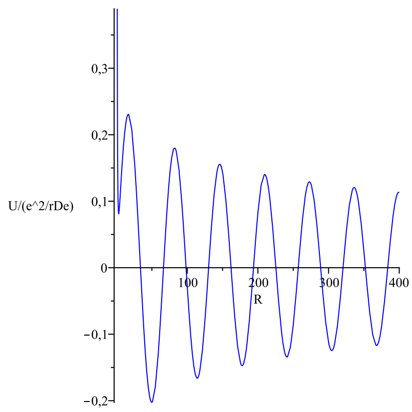

Figure 1: *The potential (1) where the integration till the $k \le \frac{1}{r_{Di}}$ was performed, here $R = \frac{r}{r_{De}}$*