The electric field of an electron in a electron-hole plasma with degenerate electrons. Formation of a superconductivity state.

S. P. Sadykova\(^1\), A. A. Rukhadze\(^2\)

\(^1\)Forschungszentrum Julich (Jül.), Juelich, GERMANY
\(^2\)Prokhorov General Physics Institute, RAS, Vavilov Str. 38., Moscow, 119991, RUSSIA

We consider the conditions for formation of a superconductivity state either in a semiconductor or in an 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 \(\alpha\) and \(\beta\) in an electron-hole plasma can be described by the following equation [1]:

\[
U(r) = \int e^{i\vec{k}\cdot\vec{r}} U(k) d\vec{k}, \quad U(k) = \frac{e_\alpha e_\beta}{2\pi^2 k^2} \frac{1}{k^2 \varepsilon'(kV_\alpha, k)},
\]

where [2]

\[
k^2 \varepsilon'(kV_\alpha, k) = k^2 \pm \frac{3\omega_{L-}^2}{V_{F-}^2} - \frac{\omega_{L+}^2}{V_\alpha^2} + \imath \beta, \quad \beta = 3\pi \frac{V_\alpha \omega_{L-}^2}{V_{F-}^2},
\]

here \(V_\alpha\) is the speed of a test electron with the charge \(e_\alpha\) producing the potential \(\phi_\alpha\) at a point \(r=0\) where the charge \(e_\beta\) is located; \(V_{F-}\) - the speed of a weakly damped electron-hole sound wave, \(\omega_{L+, L-}\) - the hole and electron Langmuir frequencies.

![Figure 1. The potential (1) where the integration till the \(k \leq 1/r_{Di}\) was performed, here \(R=r/r_{De}\)](image)

REFERENCES
