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 (Jlm.), 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 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]:

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

where [2]

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

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.

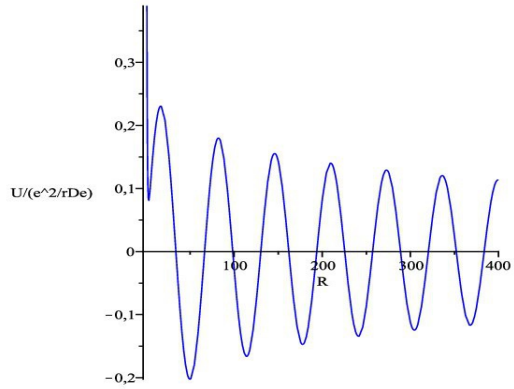

Figure1. The potential (1) where the integration till the $k\le 1/r_{Di}$ was performed, here $R=r/r_{De}$

REFERENCES

[1] E. M. Livshits , L.P. Pitaevskii , "*Physical Kinetics*", Pergamon Press, London, 452 pp. (1981).

[2] A.F. Alexandrov, L.S. Bogdankevich, A.A. Rukhadze, "*Principles of Plasma Electrodynamics",* Springer Verlag, Heidelberg, pp. 167-170 (1984).