NON-LINEAR ISOTHERMAL WAVES IN DEGENERATE ELECTRON PLASMA

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A non-linear differential equation of oscillations of chemical potential of 1D stationary wave in a degenerate neutralized electron gas is derived, analyzed and solved exactly. It is found that a phase velocity of wave is bounded below by a critical value V_{crit}. Exact formula of the V_{crit} is

$$V_{\text{crit}} = \sqrt{\frac{kT}{m}\frac{\text{Li}_{3/2}\left(-\exp\frac{\mu_0}{kT}\right)}{\text{Li}_{1/2}\left(-\exp\frac{\mu_0}{kT}\right)}}, \qquad (1)$$

where $\text{Li}_{\nu}(x)$ is the polylogarithm. The V_{crit} runs to known value for a cold electron Fermi-gas $V_{\text{crit}} = \sqrt{2\mu_0/3m}$ at $\mu_0/kT \to \infty$. It would seem that the V_{crit} runs to the $V_{\text{crit}} = \sqrt{kT/m}$ for an isothermal classic gas at $\mu_0/kT \to 0$. But we have found another limit:

$$V_{\text{crit}} = \sqrt{\frac{kT}{m}}\sqrt{-\frac{1}{\sqrt{2}}\frac{\zeta(3/2)}{\zeta(1/2)}} \approx 1.1246856\sqrt{\frac{kT}{m}}, \qquad (2)$$

where $\zeta(x)$ is the Riemann zeta-function. Obtained 12% difference from classic plasma is explained very easy: there is not a limiting transfer which transforms the Fermi-Dirac distribution to the Maxwell one if the Pauli principle is kept in action.

Profiles of the wave are calculated. They are different from harmonic waves.

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1. *Kuzelev M.V., Rukhadze A.A.* Methods of wave theory in media with dispersion. M.: Fizmatlit. 2007.