THE EFFECT OF A GRAVITATIONAL WAVE AT THE CONTACT OF CONDUCTORS

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The possibility of the existence of a quite measurable current (10^{-14} A) induced by a gravitational wave (GW) at the contact of two conductors is shown.

According to the theory of detection of GWs the force affecting the crystal detector in the field of a GW is a tidal force which may be described in terms of a curvature tensor [1]. The acoustic waves arising under the influence of this force may induce the oscillations of the electron density resulting in electric phenomena [2]. However, a GW not only influences the particles directly but distorts the local electric field too. Variations of the latter perturb the basic state of the system of bounded ions in the crystal lattice slightly but, as is shown before, it may influence the free electrons considerably leading to the appearance of local currents.

In this paper the electric effects induced by a GW in a plasma with nonzero initial selfconsistent nonhomogeneous electric field are considered, the results differing essentially from the results of refs. [3,4] describing the effects in the initially isotropic plasma. The main difference is in the nonlocal character of the effect of a GW on the media in question resulting particularly in oscillations of the screening radius, in distortions of the configuration of the selfconsistent electric field and in the appearance of an electric current.

Analogous to the case described in refs. [3,4] the change of the electron-gas pressure under the influence of the GW's field plays the main role in the formation of the electric current. As an illustration we shall give the example of the conduction electrons in the contact of two metals which may be described by the general relativistic kinetic theory having a strict dynamic basis [5]. Thus, let us examine the effect of the plane GW described in the synchronic reference system by the Peres metric

$$ds^2 = du\, dv - L^2 [e^{2\beta}(dx^2)^2 + e^{-2\beta}(dx^3)^2] \quad (1)$$

[where $L(u)$, $\beta(u)$ are functions of the retarded time $u = ct - x^1$; they are related by the equation $L'' + \beta'^2 L = 0$] on the conduction electrons near the planar contact of two metals with different concentrations of free electrons n_-, n_+. The reverse influence of conductors on the GW may be neglected, because when $\omega = 10^4\ s^{-1}$ the WKB approximation for the GW [6] requires $\rho \ll 10^{14}$ g/cm^3 (where ρ is the metal density). In this case the conduction electrons may be described by the general relativistic Vlasov equations [5,6] [‡1]

$$[p^i \widetilde{\nabla}_i + (e/c) F^i_{,k} p^k \partial/\partial p^i] f_e = 0 , \quad (2)$$

$$L^{-2}(L^2 F^{ik})_{,k} = -(4\pi/c) j^i , \quad L^{-2}(L^2 F^{ik})_{,k} = 0 , \quad (3)$$

where

‡1 We assume that $\omega \gg \nu_{eff}$, where ν_{eff} is an effective collision frequency of electrons in metals. This approximation may be fulfilled for very pure metals only at low temperatures.

