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Large-amplitude electron oscillations with spatially inhomogeneous ion densities? BARBARA ABRAHAM-SHRAUNER, Washington University — No analytic solutions for large-amplitude electron oscillations in a cold plasma with immobile ions have been found for spatially inhomogeneous ion densities. The one-dimensional (spatial) electrons obey two fluid equations and two Maxwell equations for the electric field. The Eulerian variables are transformed to Lagrangian variables. The problem is then reduced to the equation of motion of an equivalent particle in one dimension and the Lagrangian time (orbital) given as an integral over the position. The expressions for the electron oscillations with immobile and spatially homogeneous ion densities are recovered. Several possible spatially inhomogeneous ion densities are explicitly solved but the electron density vanishes, an unphysical result. A particular generic solution for the electron position as a function of the Lagrangian position and time is shown by Lie symmetry methods to require spatially homogeneous ion densities. More general forms of spatially varying ion densities give a simple condition for a nonzero electron density. However, for the Jacobian elliptic functions secular terms that destroy the oscillation occur if either the modulus of the elliptic function or a coefficient of the Lagranian time depends on the Lagrangian position. The key restriction is Gauss' law. These results restrict perturbation solutions.

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