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Eigenmodes of Langmuir waves trapped into the density holes

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Recently Ergun with co-authors [1] have published an interesting observation by WAVES experiment onboard STEREO (S/WAVES) satellite: Langmuir wave eigenmodes trapped into the density holes in the solar wind. We present the theoretical study of such eigenmodes trapped into the density holes in the framework of the first Zakharov equation, where the prescribed density profile is supposed to be moving but static. We assign different 2 and 3 dimensional density holes, in the last case we consider the profiles having cylindrical symmetry and we analyze the eigenmode type solutions. We compare electric field envelope profiles with the observations of the S/WAVES experiment. We obtain the condition that relates the density hole depth with its characteristic spatial scales for the trapped wave mode to exist. It is similar to the Zakharov's condition that defines the threshold for nonlinearity to dominate over dispersion. The major consequence of this study consists in the conclusion that the role these wave modes can play in the process of the beam-plasma interaction is determined by the characteristics of the density fluctuations in the solar wind. They can be important if the probability of the occurrence of density fluctuations satisfying the condition for the wave trapping is large enough.
[1] Ergun, R. et al., PRL, 2007