DO FLUID WAVES PROPAGATE IN MILDLY RELATIVISTIC THERMAL PAIR PLASMAS?

P. PIETRINI
Dipartimento di Astronomia e Scienza dello Spazio, Universitá di Firenze, I-50125 Firenze, Italy

and

J.H. KROLIK
Department of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218, USA

Relativistic pair plasmas are implicated in the physics of the central regions of AGNs, and the observed variability of these sources can be related to the dynamics and changes in structure of these plasmas. To this respect a study of the behaviour of waves to which the pair plasma reacts as a fluid is quite relevant. We analyze the linear response to perturbations of a simple thermal mildly relativistic pair plasma system.

The equilibrium plasma is modeled as a spherical homogeneous cloud, where protons, electrons and pairs are at the same temperature, $\Theta \equiv kT/m_e c^2$, which is (trans-)relativistic for electrons and positrons; all the photons are generated within the cloud by bremsstrahlung and, possibly, Double Compton processes and subsequently they are Comptonized to form a Wien peak at the plasma temperature [3], [1], [2].

Differently from previous stability analysis [1], we allow for fluid motions in the perturbed state, to study the behavior of travelling waves as well. Therefore, we couple a momentum equation to proton continuity, pair balance and energy balance equations. Restricting the analysis to wavelengths λ, such that $\lambda << \lambda_{phot} \equiv 1/(n_p + 2n_+)\sigma_T$, the photon mean free path in the Thomson limit, no perturbation on the radiation field is to be considered.

Four distinct modes are sustained by the fluid-like plasma; two of them are isobaric modes, which turn out to be damped and basically non-propagating. The other two are sound waves, modified by pair and radiative effects. Their basic property is that they are generally strongly damped, on timescales shorter than the wave crossing time, and, under certain conditions, they do not propagate at all. This implies that it is difficult to propagate the information on pressure perturbations in the plasma and any pressure change which is created is smoothed out in a region whose dimension is of the order of a damping length around the origin of the pressure change itself.

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