Self-modulation of a strong electromagnetic wave in a positron-electron plasma induced by relativistic temperatures and phonon damping

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The modulational instability of a linearly polarized, strong, electromagnetic wave in a (unmagnetized) positron-electron plasma is analyzed using relativistic two-fluid hydrodynamics to properly account for physical regimes of very high temperatures. The effect of phonon damping is also included in the treatment. The theory can be reduced to a pair of extended Zakharov equations. The envelope modulation is then studied by deriving the corresponding nonlinear Schrödinger (NLS) equation, using multiscale perturbation analysis. According to the intensity of the damping three different types of NLS are obtained. The main results are (a) that relativistic temperatures modify the stability result found in the literature for low temperature, zero damping, [formula presented] -[formula presented] plasmas, and (b) that phonon damping also produces substantial changes in the NLS, which then predict unstable envelopes. This work extends previous analyses, showing that if the phonon damping is O([