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Stimulated Scattering of Strong Waves in Pair Plasmas

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Large-amplitude plasma waves are ubiquitous in the universe. They are subject to the non-linear wave–plasma interaction such as parametric instability, which plays a significant role for particle acceleration/heating and MHD turbulence. Recently, the non-linear wave–plasma interaction has attracted attention from astrophysics in the context of Fast Radio Bursts (FRBs). FRBs are millisecond-long bright flashes of radio waves, mostly from extragalactic distance [1]. Some FRBs are known to burst repeatedly, and such repeating FRBs often show the high degree of linear polarization [2]. Magnetars, which are neutron stars with extremely strong magnetic field, are the most likely progenitors of repeating FRBs [3]. The mechanism by which FRBs are generated in magnetars remains a topic of debate, and numerous theoretical models have been proposed, such as coherent emission from relativistic collisionless shocks via synchrotron maser instability [4]. In all models, FRBs must propagate through plasmas surrounding their sources and successfully escape. On the other hand, the effect of induced scattering on FRB propagation remains controversial, especially for strong electromagnetic waves.

In this study, we analytically derive the steady-state solution of the linearly polarized electromagnetic waves in cold pair plasmas for arbitrary wave amplitude and frequency. We will demonstrate the time evolution of the steady-state solution by using the particle-in-cell simulations and discuss the effect of the non-linear wave–plasma on the propagation of FRB radio pulses.

References

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