Electromagnetically Induced Transparency in the Strongly Relativistic Regime

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Stable transport of laser beams in highly overdense plasmas is of significance in the fast ignition of inertial confinement fusion, relativistic electron generation, and powerful electromagnetic emission, but hard to realize. Early in 1996, Harris proposed an electromagnetically induced transparency (EIT) mechanism, analogous to the concept in atomic physics, to transport a low-frequency (LF) laser in overdense plasmas aided by a high-frequency pump laser. However, subsequent investigations show that EIT cannot occur in real plasmas with boundaries. Here, our particle-in-cell simulations show that EIT can occur in the strongly relativistic regime and result in stable propagation of a LF laser in bounded plasmas with tens of its critical density [1]. A relativistic three-wave coupling model is developed, and the criteria and frequency passband for EIT occurrence are presented. The passband is sufficiently wide in the strongly relativistic regime, allowing EIT to work sustainably. Nevertheless, it is narrowed to nearly an isolated point in the weakly relativistic regime, which can explain the quenching of EIT in bounded plasmas found in previous investigations.

References

[1] T-H Zhang, W-M Wang, Y-T Li and J Zhang, Phys. Rev. Lett. **132**, 065105 (2024)