Numerical Simulations of Laser Wakefield in Inhomogeneous Plasmas

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It is predicted that an accelerating mirror moving at a relativistic speed is able to mimic the physics of black hole evaporation[1]. Therefore, creating an object having such a property in a laboratory may provide a practical method to study the physics related to the black hole. Wakefield formed in a plasma caused by a relativistic intensity laser pulse is a possible candidate for the moving mirror, as they consist of the over-critical density spikes moving at a relativistic speed.

As the phase speed of wakefield depends on the background electron density, it is considered that the acceleration of the moving mirror can be controlled by using an inhomogeneous density profile, however, due to the nonlinear nature of the wakefields, It is difficult to obtain the dependence of the speed of the wakefields on the background electron density by analytical methods. Therefore, we performed the numerical simulations to study the dependence of the speed of the wakes to the background electron density to search the condition for the accelerating mirror.

We performed the simulations with a 2D Particle-In-Cell code EPOCH2D[2]. Laser pulse with the 10^{19} W/cm^2 intensity is injected into the under-dense plasma which have an inhomogeneous density profile. The moving frame is used to track the travelling wakefields excited by the laser.The detail will be presented in the session.

[1] P. Chen and G. Mourou, Phys. Rev. Lett., 118, 045001 (2017).
[2] T. D. Arber, et al., Plasma. Phys. Control. Fusion., 57, 113001 (2015).