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P2.2019 Laser pulse propagation in a collisional plasma in weakly-relativistic regime

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We investigate the propagation of laser pulse in plasmas to estimate the pulse compression based on collisional absorption under weak-relativistic ponderomotive nonlinearity. The physical mechanism behind it is analyzed theoretically. Absorption of laser energy in plasma has been a curial issue, which has been, attracting continued interest ever since the invention of lasers. In the range of laser intensity around 10^15 W/cm^2, the laser absorption can be dominated by inverse bremsstrahlung or collisional absorption during the laser≠solid interaction, where the laser pulse compression is very important in determining the particle energy during acceleration. We have analyzed the longitudinal pulse compression in 1D geometry, assuming a uniform transverse distribution of the irradiance profile. An equation for the dimensionless pulse compression parameter has been derived and the effects of absorption on laser pulse compression have been studied. The laser pulse compression is reduced due to the collisional absorption in plasmas. Fast pulse dispersion is also observed due to pulse absorption, which is obviously associated with the strong energy attenuation in plasmas in this regime. A picosecond pump pulse compression is reduced to about 25% due to the collisional absorption. For large absorption coefficient, the nonlinearity associated with the laser absorption in plasmas is affected severely and the pulse compression is reduced. The present work is motivated by the need to gain understanding of laser pulse propagation in a collisional plasma and its implications on particle acceleration by high-intensity laser irradiation of targets. The results, in particular the compression of the laser pulse, have taken a further step towards a broad application of laser-plasma interaction in a large variety of fields such as accelerator physics and electromagnetic radiation generation.

References:
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