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Filamentation instability fluctuations of proton fast ignitor due to temperature anisotropy in pre-compressed fuel

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Abstract
Filamentation instability is an electromagnetic wave that grows normal to the proton-driven direction in fast ignition scenario that can reduce beam quality or dissipate it due to pinching force before this beam reaches the dense core. On the other hand, producing an isotropic pre-compressed fuel is almost impossible in this process. Therefore, Weibel instability may cumulate with filamentation instability. Consequently, the instability growth rate can increase or decrease. In this study, first, the growth rate of this instability is obtained due to variations of beam density and energy in the cold model. Then the dispersion equation of this system is derived with saddle-point approximation of Maxwell-Jüttner distribution and Vlasov equation. Numerical results show that if the parallel temperature ($T_{\parallel}$) is selected more than the perpendicular temperature ($T_{\perp}$) of the background (positive anisotropy), the cumulative effect can increase the instability growth rate compared to isotropic fuel. In addition, instability decreases in negative anisotropy. For instance, if medium temperature anisotropy is selected 50%, the growth rate increases 2.59 times relative to the isotropic state for a proton beam with a density ratio of 0.1. Also, the growth rate can be reduced by half in -50% anisotropy for this medium. Furthermore, fluctuations in the growth rate due to temperature anisotropy are severe for dilute beams. However, this instability may quench for density ratios less than 0.1

Keywords: filamentation instability, dispersion equation, temperature anisotropy, proton fast ignition, instability growth rate

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