

## O3.403 Long-term nonlinear dynamics of electron-ion Weibel instability in laser plasmas and stellar winds

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See the full abstract here <http://ocs.ciemat.es/EPS2019ABS/pdf/O3.403.pdf>

In laser plasmas, as well as in solar and stellar winds, ions and electrons can have comparable energies and strongly anisotropic velocity distributions. Under those conditions both fractions of a collisionless plasma can make a significant contribution to the development of the Weibel-type instability and the subsequent formation of self-consistent current structures and magnetic fields, i.e. the evolution of the spectral properties of quasi-magnetostatic turbulence.

In the report we consider, for the first time to our knowledge, the nonlinear stage of the Weibel instability in a two-component plasma with strong temperature anisotropy and equal initial energies of electrons and ions [1] on the basis of numerical simulation with the 2D3V PIC-code DARWIN [2]. The Maxwellian distributions of particles by each velocity projection were initially set, but with different temperatures along and across the  $z$  axis of the Cartesian coordinates, with the longitudinal temperature being the greater, so that the development of the instability led to the formation of current filaments along this axis.

The simulations, carried out in the plane orthogonal to the  $z$  axis, made possible to investigate the long-term evolution of a quasi-stationary magnetic field and current filaments created first by the electrons and then jointly by the electron and ion fractions. In the process of saturation and non-linear power-law decay, the small-scale magnetic fields, created by the electron currents of the Weibel instability, induce an electric field that generate ion currents, which determine the long-term slow evolution of large-scale magnetic field perturbations. Over time the electrons become isotropic and a significant part of them becomes magnetized. It “freezes” the evolution of magnetic fields, eliminating or significantly delaying the ion Weibel instability, which could otherwise develop due to remaining for a long time anisotropy of ion temperatures.

We discuss the possibility of implementing this scenario in laser plasma, solar and stellar winds and estimate the expected parameters of the resulting self-consistent current filaments and their evolution rates. The influence of the large-scale (external) magnetic field on the rate of formation and spectral characteristics of the magnetostatic turbulence is also discussed.

### References

- [1] L. V. Borodachev et al., *Radiophys. Quantum El.*, 59 (12), 991 (2017)
- [2] L. V. Borodachev and D. O. Kolomiets, *J. Plasma Phys.*, 77 (2), 277 (2011)

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