LNGS SEMINAR SERIES

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Filamentation instability in counter-streaming pair plasmas

Electron-positron pair plasmas are believed to play an important role in cosmology, in astrophysical sources of high energy electromagnetic radiation such as such as GRBs, AGNs and in pulsar wind nebulae. They are presently investigated analytically and numerically in the context of laser pulses with ultra-relativistic intensities and of their interaction with matter in view of the possibility of producing and studying such plasmas in the laboratory. Plasma instabilities take different forms in e^+ - e^- plasmas with respect to ordinary electron-ion plasmas because of their charge symmetry. In this presentation I will focus my attention on the filamentation instability that, in an ordinary plasma, is thought to be responsible for the formation of current channels and for the generation of multi MGauss magnetic fields in the interaction of ultra-high intensity laser pulses with plasmas. I will present the results of 1D3P and 2D3P relativistic PIC simulations that were carried out to study the filamentation instability in a e^+ - e^- plasma. Counter-propagating charge neutral beams with gamma factor in the range 1,1000 were simulated in a symmetric configuration. Long-runs were performed in order to explore the non-linear saturation phase far beyond the well understood linear growth phase. In both 1D and 2D simulations, during the final stage of the linear phase, a small fraction of the particles was accelerated up to twice their initial momentum. These particles are only partly confined by the filamentary structures of the magnetic field. The particle energy spectrum shows a broad distribution with a bump on the high energy tail. Radiation Reaction effects due to Radiative losses were included in the simulations. Significant energy losses were observed for gamma > 100 and pair plasma density > 10^{20} cm^{-3}. While the magnetic field structures were only mildly affected by these losses, particles in the high energy tail of the distribution were significantly decelerated.

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