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On the possibility of generating ultra-dense fireball pair beams at CERN CHARLES ARROWSMITH, University of Oxford, ROBERT BINGHAM, STFC RAL, University of Strathclyde, TRISTAN DAVENNE, STFC RAL, NITIN SHUKLA, IST Lisbon, NIKOS CHARITONIDIS, YACINE KADI, CERN, TODD HUFFMAN, University of Oxford, BRIAN REVILLE, MPIK, SCOTT RICHARDSON, AWE, HUI CHEN, LLNL, LUIS SILVA, IST Lisbon, SUBIR SARKAR, GIANLUCA GREGORI, University of Oxford — Several extreme astrophysical phenomena are observed on Earth as ultra-high energy radiation and cosmic rays, of which the specific generation mechanisms remain an open question. In the case of the fireball model of gamma ray bursts (GRBs), relativistic jets with an arbitrary mixture of electrons-positrons-hadrons are unstable to plasma instabilities in the background medium. Particle-in-cell (PIC) simulations of pair beams propagating in plasmas have confirmed the role of such instabilities in generating strong microscopic magnetic fields relevant to explaining radiation signatures of GRBs. It remains beyond the reach of simulation to explore the long-term evolution of these magnetic fields and address questions surrounding the emergence of coherent macroscopic structures which are key for modelling emission from collisionless shocks. Creating ultra-dense relativistic pair beams is an ongoing experimental challenge. However, recent Monte-Carlo simulations with the FLUKA code modelling 440 GeV protons at the CERN HiRadMat facility show promising results, giving rise to the possibility of generating pair beams with high enough densities for experimental observation of plasma instabilities relevant to GRB fireballs and related afterglow evolution.

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