Magnetic field generation and gamma-ray bursts

Mikhail V. Medvedev\textsuperscript{1,2,3}

\textsuperscript{1}Institute for Advanced Study, School of Natural Sciences, Princeton, NJ 08540, mvm@ias.edu

\textsuperscript{2}Niels Bohr International Academy, Niels Bohr Institute, Copenhagen 2100, Denmark, medvedev@nbi.dk

\textsuperscript{3}University of Kansas, Department of Physics and Astronomy, Lawrence, KS 66045, medvedev@ku.edu

Gamma-ray bursts (GRBs) are likely related to relativistic outflows/jets produced in explosions of massive stars. Two physical ("non-progenitor") models of GRBs exist: the kinetic-energy-dominated (baryonic) ejecta and the magnetically-dominated (Poynting-flux-driven) ejecta. In the former model, energy dissipation and radiation emission occur at collisionless shocks, whose existence and high radiative efficiency implies rapid magnetic field generation, which does happen via the Weibel instability. The latter model (which can be relevant to pulsar winds as well) does not formally require any field generation: magnetic energy dissipation occurs via reconnection with subsequent synchrotron radiation emission. It has been discovered in simulations, however, that sub-Larmor-scale Weibel fields are generated in reconnection as well. In the talk, we discuss the physics and distinct observational signatures of such electromagnetic fields. The Weibel turbulence and magnetic reconnection in electron-positron pair plasma can be modeled in lab experiments with high-power lasers (NIF, Omega, etc). We outline how such experiments can advance our understanding of energetic astrophysical phenomena.