GAMMA-RAY BURSTS AND COLLISIONLESS SHOCKS

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Observations of gamma-ray burst (GRB) "afterglows," delayed low energy emission following the prompt burst of gamma-rays, suggest that the afterglow is produced by a relativistic, collisionless shock wave driven by the GRB energy release into the surrounding plasma. Afterglow observations provide us with a unique probe of relativistic collisionless shocks. Combined with phenomenological considerations, they imply that (i) The pre-shock magnetic field is amplified at the shock by ~ 5 orders of magnitude to near equipartition; (ii) The field does not decay over $\sim 10^7$ plasma skin depths; (iii) Electrons are efficiently accelerated to a power-law energy distribution, $d\log n/d\log E \approx 2.2$, with energy density similar to that of the protons (and of the magnetic field). I will briefly review the observations and the phenomenological arguments that lead to these conclusions, the challenges these conclusions pose to the theory of collisionless shocks, and our current understanding of the relevant physics.