ERC Starting Grant No. 279369

The Gamma Ray Burst – Supernova Connection
and shock breakout physics

PI: Ehud Nakar
Tel Aviv University
Proposal duration: 60 month

Long gamma ray burst (long GRBs) and core-collapse supernovae (CCSNe) are two of the most spectacular explosions in the Universe. They offer a unique opportunity to study extreme physical environments and they proved to be both useful (as tools) and important (as ingredients) for many areas in astrophysics. We know that long GRBs and CCSNe are both an outcome of a massive star collapse, and in some cases, such collapse produces simultaneously a GRB and a SN. However, despite of a decade of research, we cannot describe the chain of events that leads from the collapse to the simultaneous generation of these two, apparently very different, types of explosions. Interestingly, the GRB-SN connection is based mostly on a spectroscopic association of a peculiar type of CCSNe – broad line Ic SNe– with a peculiar type of GRBs – low-luminosity GRBs.

In this proposal, I explain why low-luminosity GRBs are most likely relativistic shock breakouts of choked GRBs and why this is the best place to look for a breakthrough in the understanding of the GRB-SN connection. Hence, I propose a set of projects that will focus on three topics that carefully combines analytic calculation and numerical simulation. The combination of these projects is aimed at resolving the nature of the GRB-SN connection in particular and at getting a much better understanding of cosmic explosions in general. The three topics are: (i) Theory of shock breakout. (ii) Propagation of relativistic jets inside a star. (iii) The effect of jet propagation and GRB engine on the emerging SN.