High-Energy Neutrinos from Non-Relativistic Shock-Powered Transients

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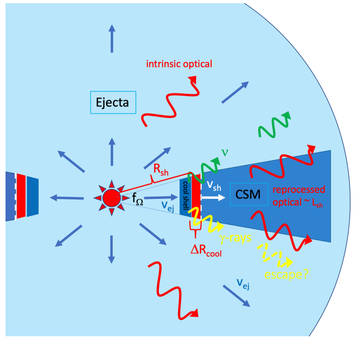
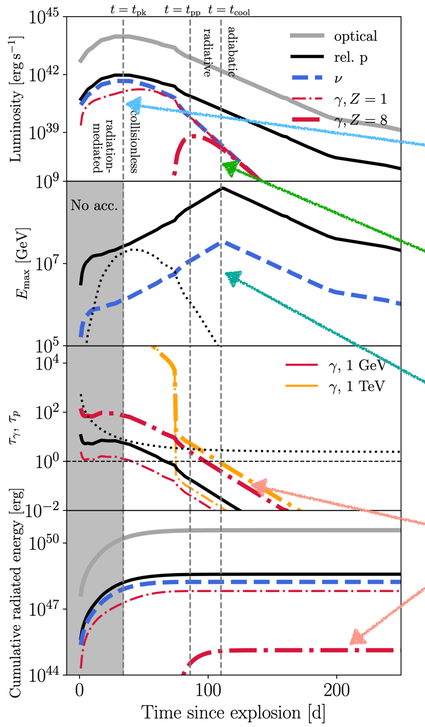


Schematic diagram illustrating shock-powered emission from explosive non-relativistic transients

- Shocks are generated when the explosion ejecta collides with a dense external medium.
- Shocks produce UV/X-ray emission, which is reprocessed into optical radiation. They also accelerate relativistic protons.
- At the epoch of peak emission, both thermal and nonthermal particles are radiative, such that the emitted γ-ray and neutrino energy is proportional to the shock-powered optically radiative energy.



Light Curves of Shock-powered Transients

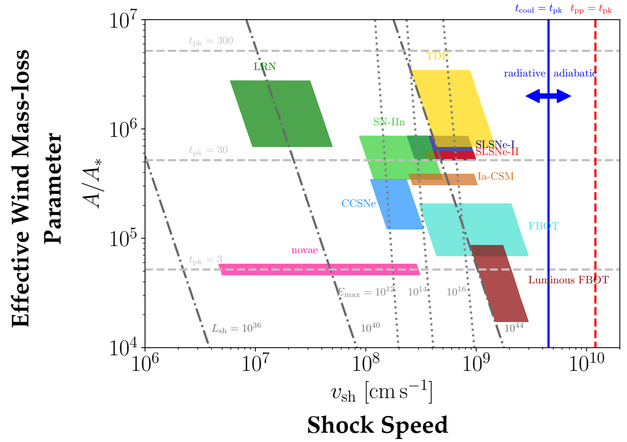
Collisionless shock condition can only be reached **after the peak** of the optical light curve

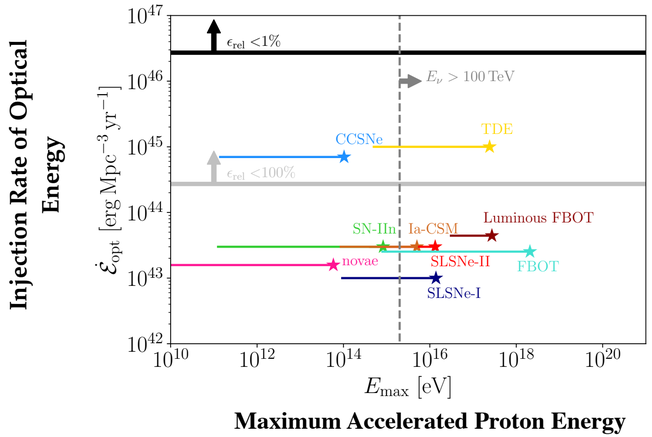
Shock is **radiative** in the first few months of the optical light curve

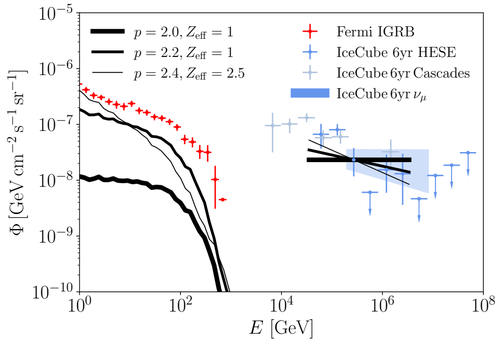
Emax depends on the size of the **ionized region** and the **evolution** of the shock velocity

Bethe-Heitler process in **ejecta with heavy nuclei** could attenuate GeV gamma rays

Observed Properties of Extragalactic Transients ``Zoo"







If the mass ejecta surrounding the shocks are nuclei-abundant, **shock-powered transients could be gamma-ray-hidden neutrino sources.**

Conclusions:

- Correlation in optical and GeV gamma-ray light curves of classical novae suggest that they both come from **radiation shocks with a particle acceleration efficiency < 1%.**
- The energy radiated by non-thermal ions in **high-energy neutrinos and gamma rays is directly proportional to the transient's shock-powered optical energy**.
- Based on observed and inferred energetics of various classes of optical transients, we find that transients powered by non-relativistic shocks **can barely explain the IceCube diffuse neutrinos**.
- Adiabatic shocks may have a cosmic-ray luminosity higher than the optical luminosity, but for most CSM density profiles, the total shock-dissipated energy is dominated by early times when the shock is radiative.

KF et al ApJ (2020) arXiv: 2007.15742