W35a Monte Carlo simulations of fast Newtonian and mildly relativistic shock breakout from a stellar wind

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A strong explosion of a compact star surrounded by a thick stellar wind drives a fast ($> 0.1c$) radiation mediated shock (RMS) that propagates in the wind and ultimately breaks out gradually once photons start escaping from the shock transition layer. The shock velocity may even be relativistic in exceptionally strong or aspherical explosions. The properties of the breakout signal depend on the dynamics and structure of the shock during the breakout phase.

In this talk, I will present spectra and light curves of the breakout emission of fast Newtonian ($v_s/c = 0.1, 0.25$) and mildly relativistic ($v_s/c = 0.5$) shocks that are computed based on self-consistent Monte Carlo simulations of RMS which take into account the effect of radiative losses. A strong dependence of the νf_ν peak on shock velocity is found, ranging from ~ 1 keV for $v_s/c = 0.1$ to ~ 100 keV for $v_s/c = 0.5$, with a shift to lower energies as radiative losses increase. For all cases studied, the spectrum below the peak shows a nearly flat component ($F_\nu \propto \nu^0$) that extends down to the break frequency below which free-free absorption becomes important. The result implies much bright optical/ultraviolet emission than hitherto expected. For representative conditions, the light curves exhibit a gradual rise over tens to hundreds of seconds. The application to SN 2008D/XRT 080109 and the detectability limits are also discussed. We predict a detection rate of about one per year with eROSITA.