XV Latin American Regional IAU Meeting (Cartagena de Indias, Colombia, 3-7 October 2016)
Editors: Mario Armando Higuera Garzón & Santiago Vargas Domínguez

SUPERLUMINOUS SUPERNOVAE HYDRODYNAMIC MODELS

Mariana Orellana[1]

We use our radiation hydrodynamic code in order to simulate magnetar powered Superluminous Supernovae (SLSNe). It is assumed that a central rapidly rotating magnetar deposits all its rotational energy into the ejecta where is added to the usual power. The magnetar luminosity and spin-down timescale are adopted as the free parameters of the model. For the case of ASASSN-15lh, which has been claimed as the most luminous supernova ever discovered, we have found physically plausible magnetar parameters can reproduce the overall shape of the bolometric light curve (LC) provided the progenitor mass is $\approx 8M_\odot$. The ejecta dynamics of this event shows signs of the magnetar energy input which deviates the expansion from the usually assumed homologous behaviour. Our numerical experiments lead us to conclude that the hydrodynamical modeling is necessary in order to derive the properties of powerful magnetars driving SLSNe.

Magnetars are a natural explanation of long lasting extra-energy injection in SNe, explaining the factor 10 to 100 times brighter than normal. Spin down power can be assumed to be fully thermalized outside the neutron star at the innermost layers of the pre-supernova star. Chatzopoulos et al. (2016) examine some of the few viable interpretations for ASASSN-15lh. Magnetar models have been proposed for this extreme case. However, the analysis was based on simplistic assumptions that neglected the dynamic effects on the ejecta. In Bersten et al. (2016) we have presented hydrodynamic calculations of SLSNe within the magnetar scenario. The spin-down timescale, t_p, and magnetar energy loss rate, L_p, are the free parameters. They are afterwards translated to the magnetic field B and initial period P. We assumed that the SN exploded a week before the discovery. The magnetar parameters found are

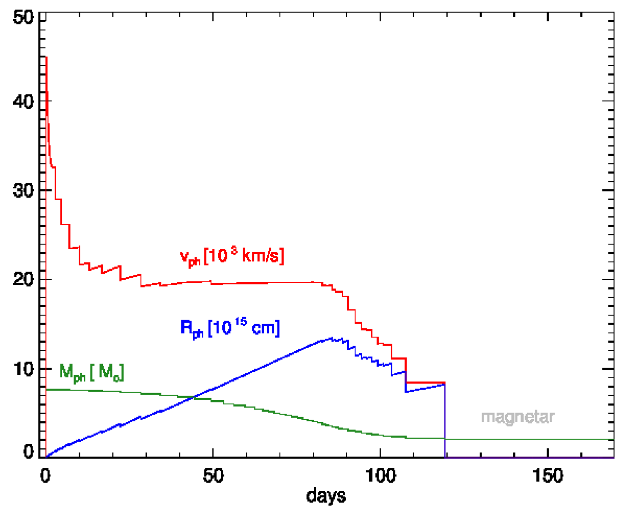

Fig. 1. Evolution of the photospheric properties: velocity, radius and mass enclosed, for our preferred model in the LC fit presented in Bersten et al. (2016)

$L_\mathrm{p} = 9 \times 10^{45}$ erg s^{-1} and $t_\mathrm{p} = 40$ days. At ~ 100 days, the photosphere reaches the inner regions where the magnetar energy is directly deposited.

The LC fit is sensible to the opacity κ, usually assumed as a gray one. We have incorporated OPAL tables with an opacity floor of 0.2 cm^{2}g^{-1} corresponding to the electron scattering opacity for hydrogen free material. Phostospheric velocities in Fig. 1 reproduce the observed spectroscopic velocities of ASASSN-15lh ≈ 20.000 km s^{-1} (Metzger et al. 2015).

REFERENCES

Bersten, M. C., Benvenuto, O. G., Orellana, M., & Nomoto, K. 2016, ApJ, 817, L8

Chatzopoulos, E., et al. 2016, ApJ, 828, 94

Metzger, B. D., et al., E. 2015, MNRAS, 454, 3311

[1]Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina & Sede Andina, Universidad Nacional de Río Negro, Mitre 630 (8400) Bariloche, Argentina (morellana@unrn.edu.ar).