Asymmetric supernova remnants generated by Galactic, massive runaway stars

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After the death of a runaway massive star, its supernova shock wave interacts with the bow shocks produced by its defunct progenitor, and may lose its spherical symmetry before expanding into the local interstellar medium (ISM). We investigate whether the initial mass and space velocity of these progenitors can be associated with asymmetric supernova remnants. We run hydrodynamical models of supernovae exploding in the pre-shaped medium of moving Galactic core-collapse progenitors. We find that bow shocks that accumulate more than about 1.5 Mo generate asymmetric remnants. The shock wave collides 160-750 yr up to 830-4900 yr after the supernova with these bow shocks then located at about 1.35-5 pc from the center of the explosion. It expands freely into the ISM whereas it is channelled into the region of undisturbed wind material moving in the opposite direction. This applies to an initially 20 Mo progenitor moving with velocity 20 km/s and to our initially 40 Mo progenitor. These remnants generate mixing of ISM gas, stellar wind and supernova ejecta that is particularly important upstream from the center of the explosion. Their lightcurves are dominated by emission from optically-thin cooling and by X-ray emission of the shocked ISM gas. We find that these remnants are likely to be observed in the [OIII] 5007 spectral line emission or in the soft energy-band of X-rays. Finally, we discuss our results in the context of observed Galactic supernova remnants such as 3C391 and the Cygnus Loop.

Reference: Meyer D. et al., MNRAS (450) 2015
Status: Manuscript has been accepted

Weblink: http://cdsads.u-strasbg.fr/abs/2015MNRAS.450.3080M

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