ASYMMETRIC SUPERNOVA EXPLOSIONS : THE MISSING LINK BETWEEN WOLF-RAYET BINARIES, RUN-AWAY OB STARS AND PULSARS

Jean-Pierre De Cuyper
Astrofysisch Instituut, Vrije Universiteit Brussel, Belgium.

The WR binary systems, consisting of a WR star and an O or B star companion, are supposed to be the progenitors of the massive X-ray binaries. The missing link is generally accepted to be the SN explosion of the WR star which leaves a pulsar remnant. As most pulsars originate from single stars, observations of their proper motions indicate that they receive at their birth a "kick" velocity of about 100 km s^{-1}. We assume this velocity to be due to the asymmetry of the SN explosion. This asymmetry, together with the loss of the SN shell and its impact on the OB star, may cause to disrupt the remaining system.
For the ten best known WR binaries we evaluated the survival probability P after an instantaneous SN explosion, leaving a 1.5 $M_\odot$ collapsar with a random orientated kick velocity of 75 kms^{-1} (case a) and 150 kms^{-1} (case b) respectively. The influence of the impact is found to be marginal. The run-away velocity of the remaining system $\bar{v}_g$ and of the disrupted OB star $\bar{v}^{\infty}_{OB}$ are comparable and of the same order of magnitude, but smaller than the initial orbital velocity of the OB companion; which decreases for increasing values of the initial orbital period. They are found to be independent of the kick velocity.

Systems with an initial period of less than a few weeks stay together for case a and have $.85 > P > .7$ for case b. Indicating that most of the high velocity OB stars ($v_g > 60$ kms^{-1} have a collapsed companion. For systems having an initial period of the order of months : $.9 > P > .7$ (case a) and $.6 > P > .4$ (case b). Hence single run-away OB stars are less nummerous and most of them have a low runaway velocity ($\bar{v}^{\infty}_{OB} < 40 kms^{-1}$). These results are in agreement with the observed bimodal run-away velocity distribution of OB stars and the observed properties of massive X-ray binaries.In case of disruption a single pulsar is formed with a runaway velocity up to 100 kms^{-1} (case a) and 200 kms^{-1} (case b) resp; independent of the initial orbital period. Few of them have negligable runaway velocity. High velocity pulsars (such as PSR0450-18 : $\bar{6}50 kms^{-1}$) are found to originate from systems consisting of a "single" WR star and an old pulsar companion, which are disrupted by the second SN explosion. In the opposite case a binary pulsar (such as PSR 1913+16) is formed. Here the survival probability is low depending also on the previous mass loss and the asymmetry of the SN explosion.

D. Sugimoto, D. Q. Lamb, and D. N. Schramm (eds.), Fundamental Problems in the Theory of Stellar Evolution, 184.