RevMexAA (Serie de Conferencias), **49**, 83–83 (2017)

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

HYPERCRITICAL ACCRETION IN THE INDUCED GRAVITATIONAL COLLAPSE

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We presented the induced gravitational collapse (IGC) paradigm that have been applied to explain the long gamma ray burst (GRB) associated with type Ic supernova, and recently the X-ray flashes (XRFs)

The progenitor of the IGC scenario is a tight binary system formed by a carbon-oxygen core (CO) and a neutron star (NS). The CO core collapses and undergoes a supernova explosion (SN) which triggers the hypercritical accretion onto the NS companion. At this point, the fate of the system will depend crucially on the initial binary parameters (Becerra et al. 2016; Ruffini et al. 2016):

- In a first scenario, also referred as binary-driven hypernova (BdHNe), the CO-NS binary is enough bound ($a < 10^{11}$ cm), so the accretion rate on the NS grows up to $\gtrsim 10^{-2}\,\mathrm{M}_\odot\,s^{-1}$, this allows to the NS reach its critical mass, and collapse to a black hole (BH) with a GRB emission. The emission is characterized by an isotropic energy $E_{\rm iso} \gtrsim 10^{52}$ erg, a rest-frame spectral peak energy, $E_{p,i} \gtrsim 2\,$MeV and a prompt emission of about 100 s.

- A second scenario can happen for binary systems with larger binary separations. The hypercritical accretion ($\lesssim 10^{-2}\,\mathrm{M}_\odot\,\mathrm{s}^{-1}$) onto the NS is not sufficient to induced its gravitational collapse. Instead of a GRB emission, a X-ray flash (XRF) is produced with $E_{\rm iso} \lesssim 10^{52}$ erg, $E_{p,i} \lesssim 200\,$keV, and prompt emission phases of about $10^2 - 10^4$ s.

Then, the interaction between the SN and the NS can lead to two possible out-states : in the case of the BdHNe, a binary of a new form neutron star (ν-NS) of $1.4 - 1.5 M_\odot$ born in the SN and BH that comes from the collapse of NS companion is formed.

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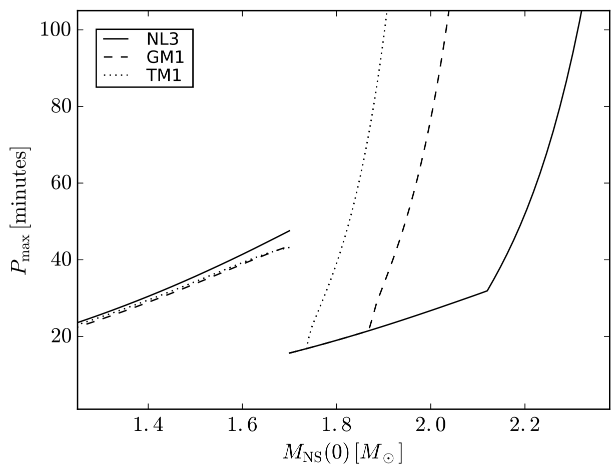

Fig. 1. Maximun orbital period at which the accretion rate onto the NS companion with initial mass $M_{\rm NS}(0)$, is enough to induced its gravitational collapse to a BH.

While for the XRF we have a neutron star binary: the ν-NS and a more massive NS which has accreted mass form the SN.

In figure 1 is shown the maximum orbital period at which the NS can collapse in function of its initial mass. This was calculated following the evolution of the NS mass and angular mometum, simulating the accretion with the Bondi-Hoyle-Lytleton formalism and assuming a power-law density profile and an homologous expansion for the SN with an outermost layer velocity of 2×10^9 cm/s. For the CO core was assumed a progenitor of $30\,M_\odot$, that at the moment of the explosion has about $9\,M_\odot$ and a radius of 7.65×10^9 cm (see Becerra et al. (2016) for details). For systems with $P < P_{\rm max}$, the NS will accrete enough mass, reaching its critical mass and collapse to a black hole.

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