Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Black-Hole Binaries As Relics Of Gamma-Ray Burst / Hypernova Explosions

By

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The Collapsar model, in which a fast-spinning massive star collapses into a Kerr black hole (BH), has become the standard model to explain long-soft gamma-ray bursts and hypernova explosions (GRB/HN), however, stars massive enough (those with $M_{ZAMS} \geq (18\text{-}20) M_{sun}$) to produce these events evolve through a path that loses too much angular momentum as to produce a central engine capable of delivering the necessary energy. In this work we study the soft X-ray transient sources as the remnants of GRBs/HNe; that is, binaries in which, as the massive primary star evolves a C-O burning core, it starts transferring material to the secondary star (Case C mass transfer), shrinking the orbit until a common-envelope evolution sets in and the secondary star spirals in, further narrowing the orbit of the binary and removing the hydrogen envelope of the primary star; eventually the primary star becomes tidally locked and gets spun up acquiring enough rotational energy to power up a GRB/HN explosion. The central engine producing the GRB/HN event being the Kerr BH through the Blandford-Znajek mechanism.

It turns out that our model can explain not only the long-soft GRBs, but also: The subluminous bursts, which comprise ~97% of the total, the GRBs of cosmological energy and the short-hard bursts (in a NS-BH merger). Because of our binary evolution through Case C mass transfer, it turns out that for the subluminous and cosmological bursts, the angular momentum is proportional to the 3/2 power of the mass of the secondary star. This gives the binary evolution a great advantage over the Woosley Collapsar model; namely, that one can "dial" the donor mass in order to achieve whatever angular momentum is needed to drive the explosion.

Population syntheses show that there are enough binaries to account for the progenitors of all classes of GRBs.

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