

NS-NS versus BH-NS Binaries as short GRB Progenitors

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- Modeling
- Merger times
- Merger locations
- Afterglow characteristics
- Conclusions

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Modeling: StarTrack population synthesis code

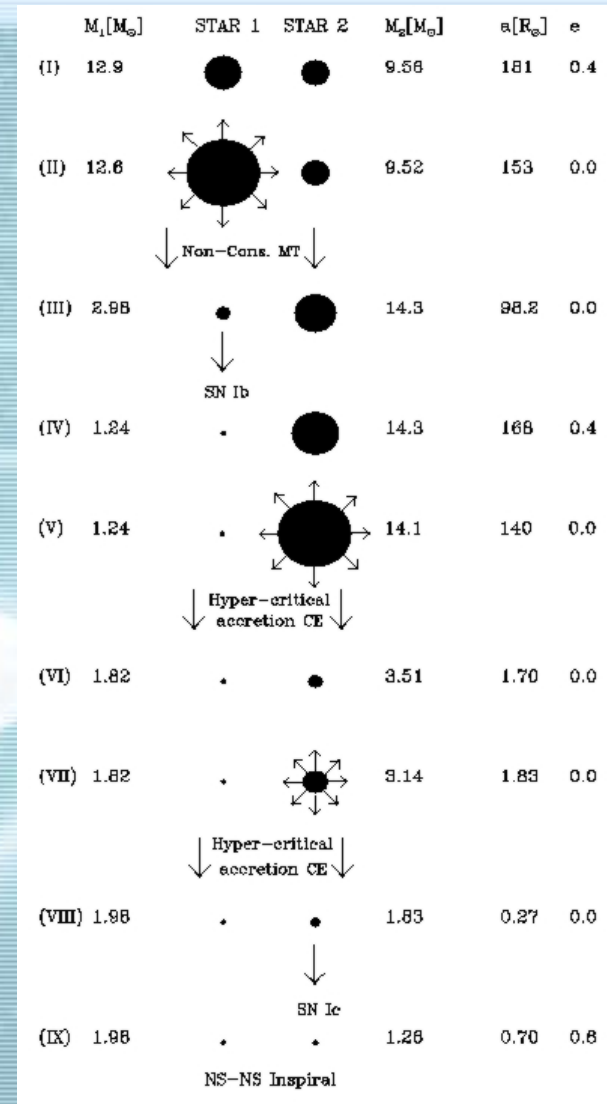
Input physics:

- detailed single stellar models
- wind-, metallicity-dependent evolution
- binary component tidal interactions
- ang. momentum loss: GR, MB, mass loss
- calibrated Mass Transfer phases
- evolution into Common Envelope
- full eccentric approach to SNe
- latest natal kicks
- mass spectrum for NS / BH formation
- motion in galactic potentials

Belczynski & Kalogera 2001

Belczynski, Bulik & Kalogera 2002

Ivanova, Belczynski et al. 2003



Ultracompact NS-NS: $T_{merger} \sim 1-100$ Myr

What are the predictions for NS-NS and BH-NS mergers?

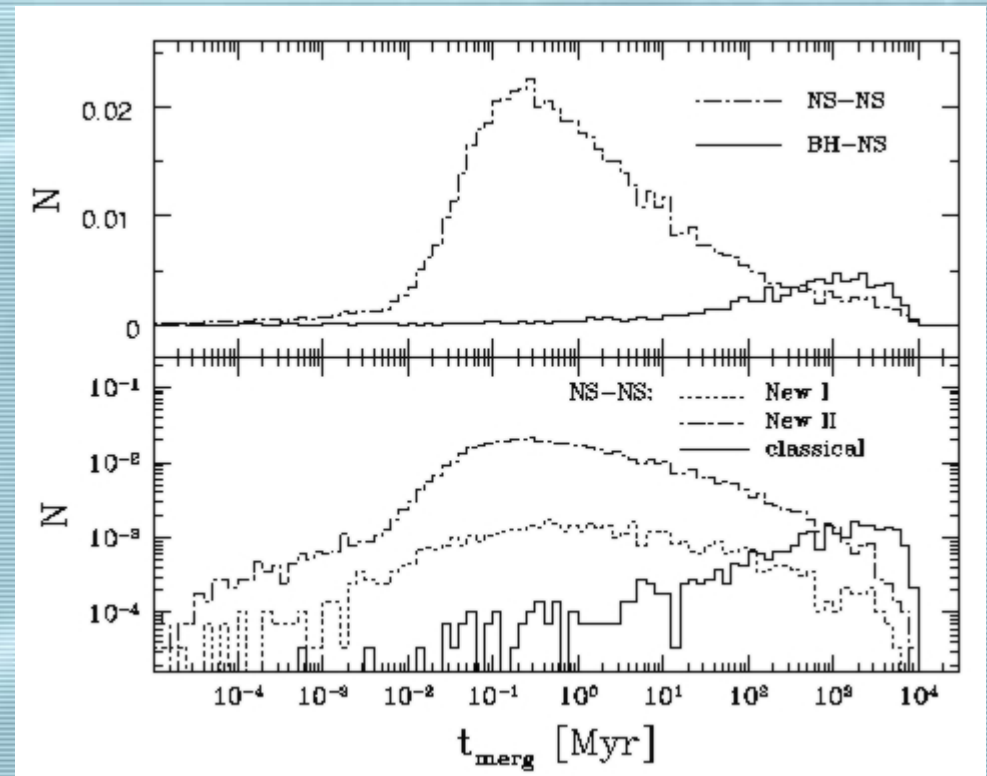
Modeling: populations / merger times

Population content [rates]:

- *new (short-lived) NS-NS* [$\sim 3\text{-}300 \text{ Myr}^{-1}$]
- *classical (long-lived) NS-NS* [$\sim 1\text{-}30 \text{ Myr}^{-1}$]
- *BH-NS* [$\sim 1\text{-}40 \text{ Myr}^{-1}$]

Merger times:

- *new NS-NS*: $\sim \text{Myr}$
- *classical NS-NS*: $\sim 1\text{-}10 \text{ Gyr}$
- *BH-NS*: $\sim 0.1\text{-}10 \text{ Gyr}$



Belczynski, Kalogera & Bulik 2002

Merger times combined with birth speeds set merger locations

Modeling: merger locations with respect to host galaxy

Ultracompact NS-NS mergers:

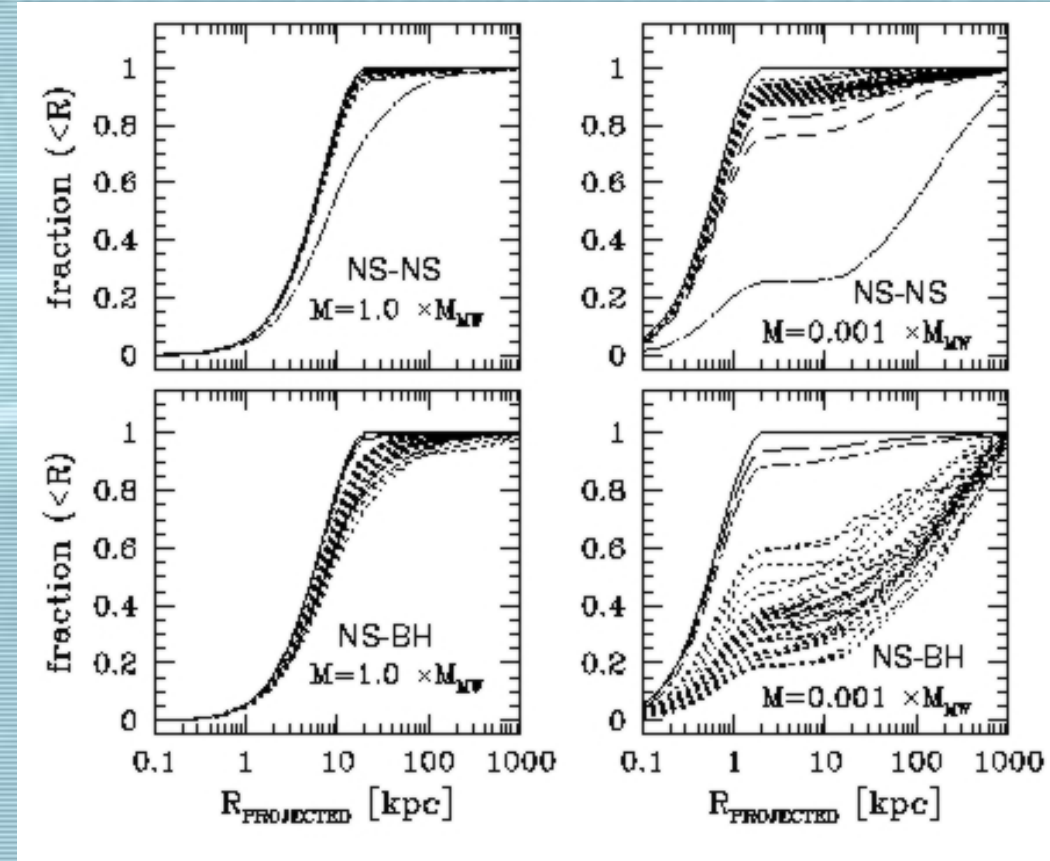
- merge within (or outskirts of) hosts
- prompt mergers
- expected in starburst / spirals

GRB050709: outskirts of small starburst

BH-NS mergers and classical NS-NS mergers:

- merge outskirts / outside hosts
- delayed mergers
- expected in spirals / ellipticals

GRB050509B: outskirts of large elliptical

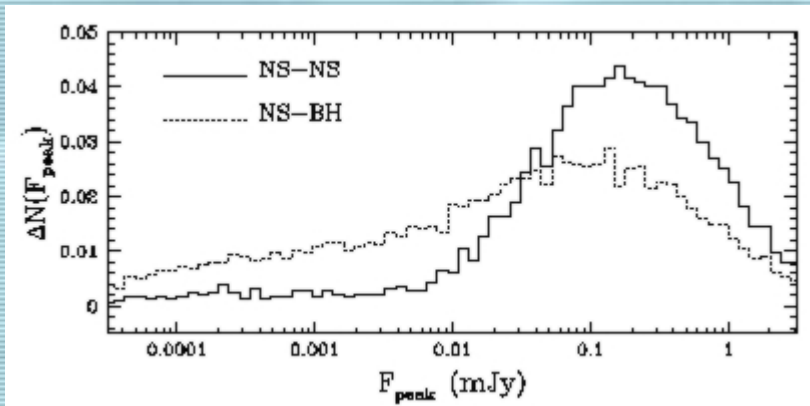
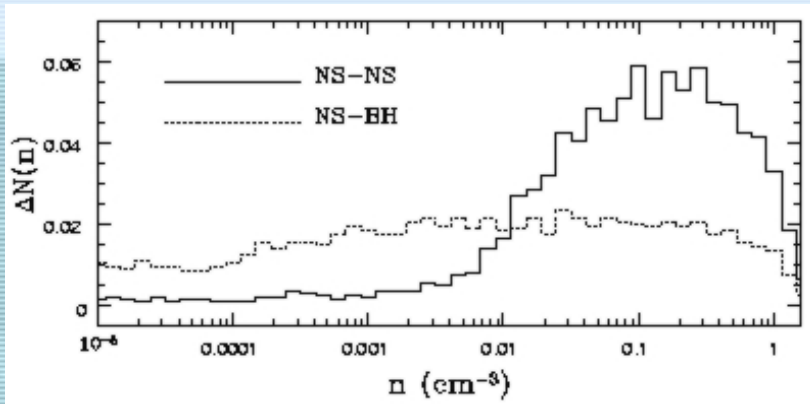


Belczynski, Bulik & Rudak 2002

but GRB050724 was found inside small elliptical.....

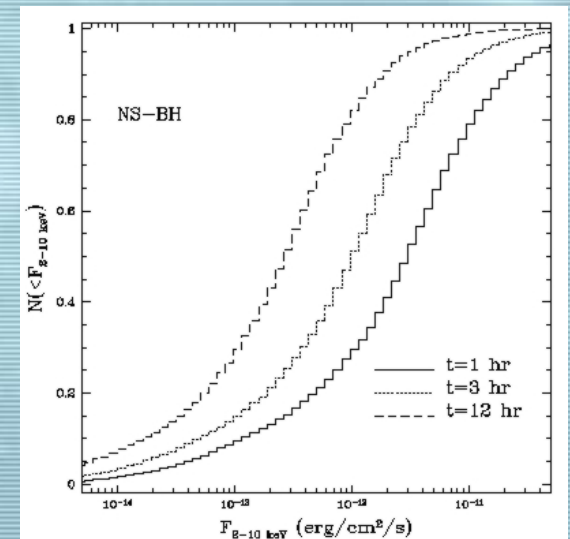
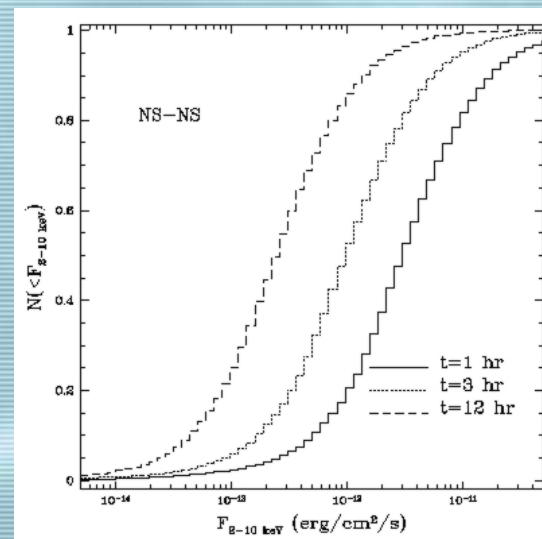
Mergers sites are different for various comp. object populations

Modeling: afterglow characteristics



Denser environments for NS-NS as compared with BH-NS mergers lead to a higher peak flux for a given host

X-ray afterglows should be observable, although strongly dependent on the power-law index of electron density distribution ($p=2$ assumed)



Perna & Belczynski 2002

Different afterglows expected for NS-NS and BH-NS mergers

Conclusions & Current work

- *Different environments produce different types of mergers:*
 - *Starbursts: ultrashort NS-NS systems (prompt GRBs within host)*
 - *Ellipticals: BH-NS and classical NS-NS systems (long-delayed GRBs on outskirts / outside host)*
 - *Spirals: mixed population*
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- *Both observations (Galactic NS-NS) and theoretical predictions favor short-lived NS-NS binaries. That is in clear contradiction with long delay times and association of short GRBs with old elliptical galaxies.*
- It is important to realize that long delays / elliptical hosts do not rule out the existence of short-lived NS-NS systems (since we observe them) and only may indicate that NS-NS mergers are not responsible for majority of short GRBs.*
- *Are then BH-NS alone short GRB progenitors? (or rather some combination of BH-NS and NS-NS makes short GRBs?) (pop. synth. re-analysis underway)*