連星中性子星合体の
電磁波カウンターパート

樫山和己
京大（天体核）
博士課程2年
THE ERA OF GW ASTRONOMY

• Advanced LIGO, Advanced VIRGO and LCGT
• The detection of 10Hz-kHz GWs is promising in the next 10yr (?).
  – Compact merger (NS-NS or NS-BH or BH-BH)
  – Supernovae
  – Neutron star rotation (glitches, giant flares)
  – ... and more
• Compact mergers are the most interesting one.
  – Event rate
  – Development of numerical relativity
  – Something radical must happen! - counterpart study
THE COUNTERPART

• Compact mergers, and what will happen?
  – Different glasses
  – Position determination
  – Feedback to the observation policy

• SGRB? Jet?
  – Disk formation
  – Neutrino annihilation
  – Magnetically driven wind
  – BZ like processes

• Eyes other than GW
  – γ or X or UV or optical or radio?
  – CRs?
  – Neutrinos?
  – Off-axis signals
Can we see them?

- Mass ejection before the merger
  - Outflow $\sim 10^{-3} M_\odot$/sec? (Dessart+ 09)
  - envelops formation $\sim 10^{-5} M_\odot$?

- Could be highly optically thick!

$$\tau = n\sigma_T R_i \sim 10^9 \left( \frac{M_{\text{env}}}{10^{-5} M_\odot} \right) \left( \frac{R_i}{10^{10} \text{cm}} \right)^{-2}$$

$$R_i \sim \beta c \Delta t \sim 10^{10} \left( \frac{\beta}{0.1} \right) \left( \frac{\Delta t}{10 \text{sec}} \right) \text{ cm.}$$

- Then a jet will be launched....
THE CARTOON

- jet
- cocoon
- central engine
  - disk + BH or NS
- Baryon-rich envelop
- ISM
Penetrate or not?

- Penetrate condition
  \[ E_{\text{jet}} \gtrsim M_{\text{env}} c^2 \cdot \frac{\theta^2}{4\pi} \]

- \(\bigcirc\) → relativistic jet come out
  → SGRB ?

- \(\times\) → shock heating
  → “re-heated fire ball ????”
  → Visible from off axis
REHEATED FIRE BALL : A POSSIBLE SMOKING GUN?

Concerns

SUMMARY AND FUTURE PROSPECTS

• EM counterpart of compact mergers.
  – Confirmation of the GW discovery
  – Different glasses
  – Feedback to the observation policy
• Ejected matters form the optically thick envelop.
• Reheated fire ball?
  – Time evolution and associated signals?