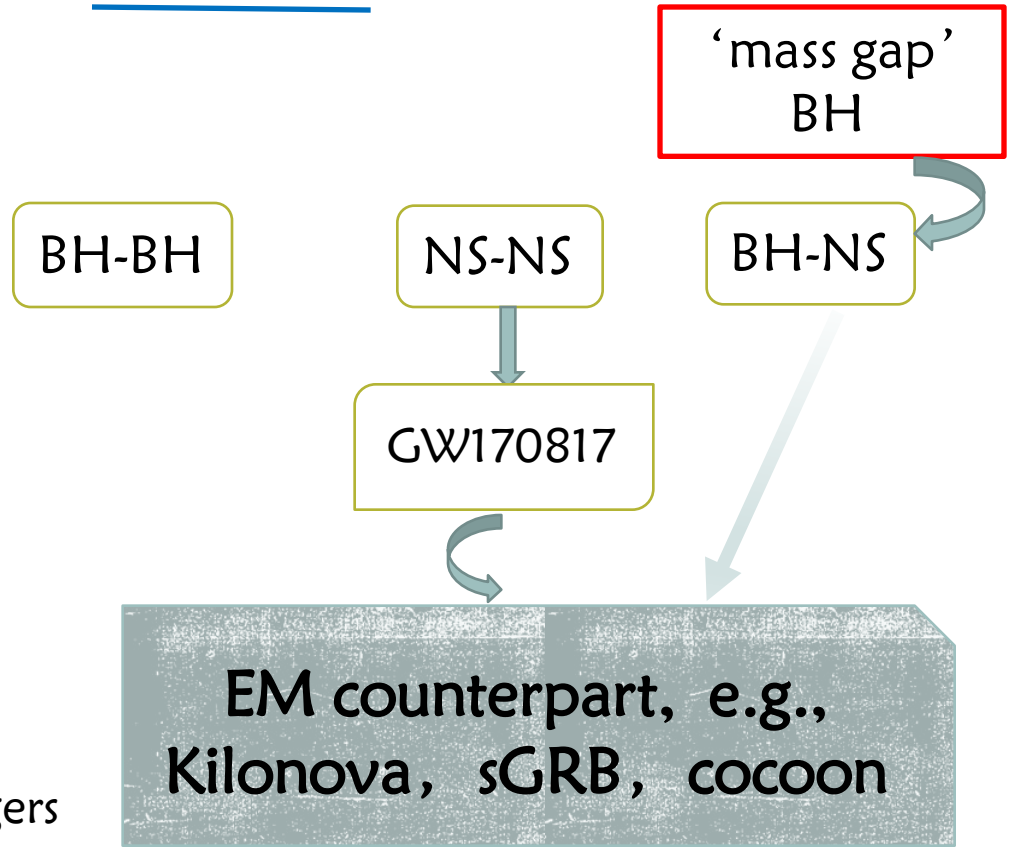
Estimates of the early EM emission from compact binary mergers

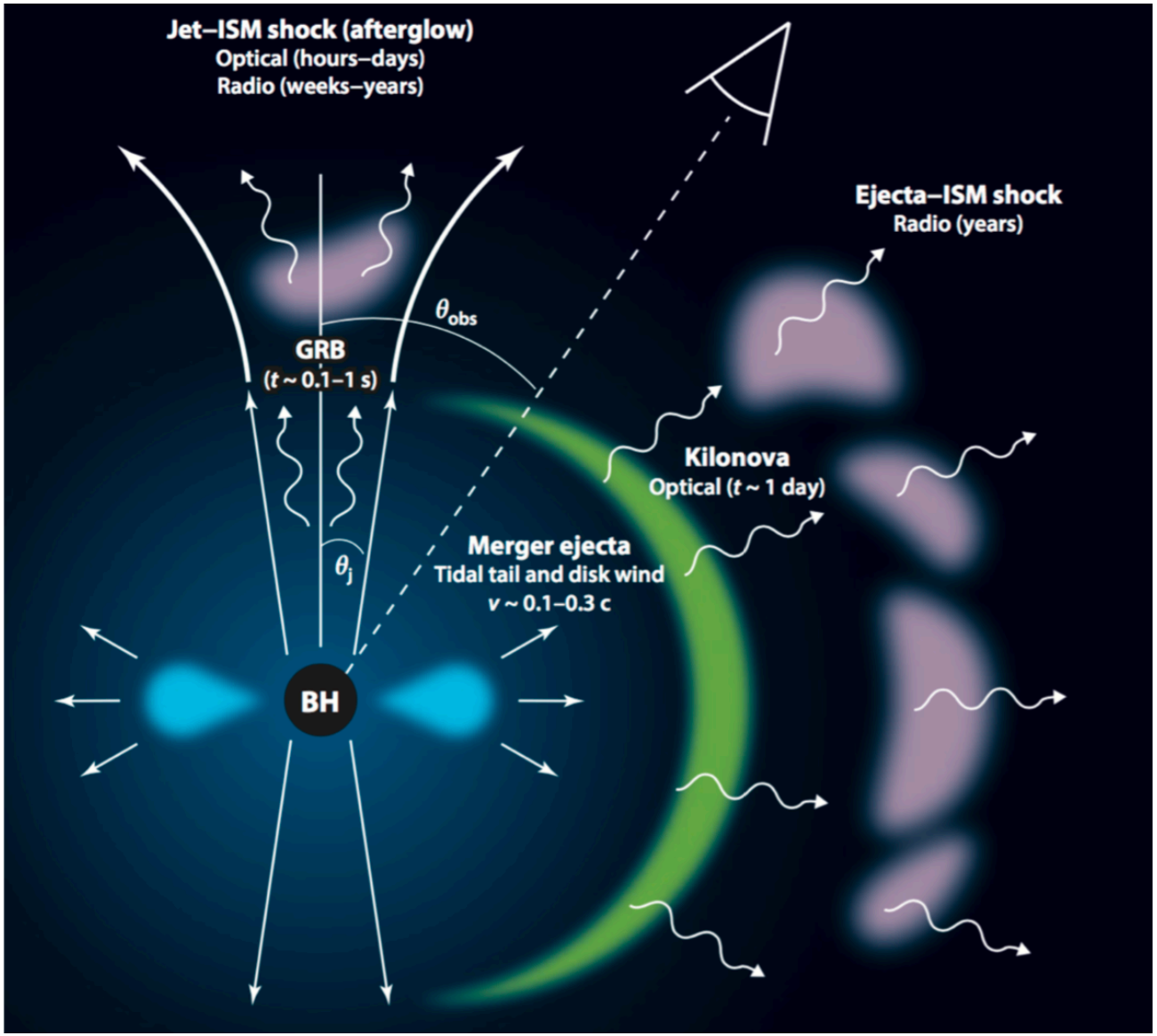
Yan Li（李彦）, Rong-Feng Shen（申荣锋）
Sun Yat-Sen University（中山大学）
October 31,2020,Beijing

Introduction

On August 17, 2017, LIGO&VIRGO firstly detected the gravitational wave (GW) signal of a merger of two neutron stars (GW170817). Subsequently, researchers had observed its electromagnetic (EM) counterpart -- kilonova/macronova(AT2017gfo).



In the third observing run of aLIGO & aVIRGO, there are at least 6 BNS mergers & 8 BHNS mergers.



1. kilonovae,
2. sGRBs,
3. cocoons.

Summary of the EM counterparts of NS-NS and BH-NS mergers.

Metzger (2019)

Introduction

The EM emissions (kilonova, sGRB, cocoon) depend on:

1. Chirp mass
2. Spin
3. Equation of state
4. BNS or BH-NS?

$$M_{\rm ch} = \frac{(M_1 M_2)^{3/5}}{(M_1 + M_2)^{1/5}}$$

Due to the large distance and the rapid decaying nature of those EM emissions, this work focuses on the above early EM emission (peak luminosity and timescale).

Method

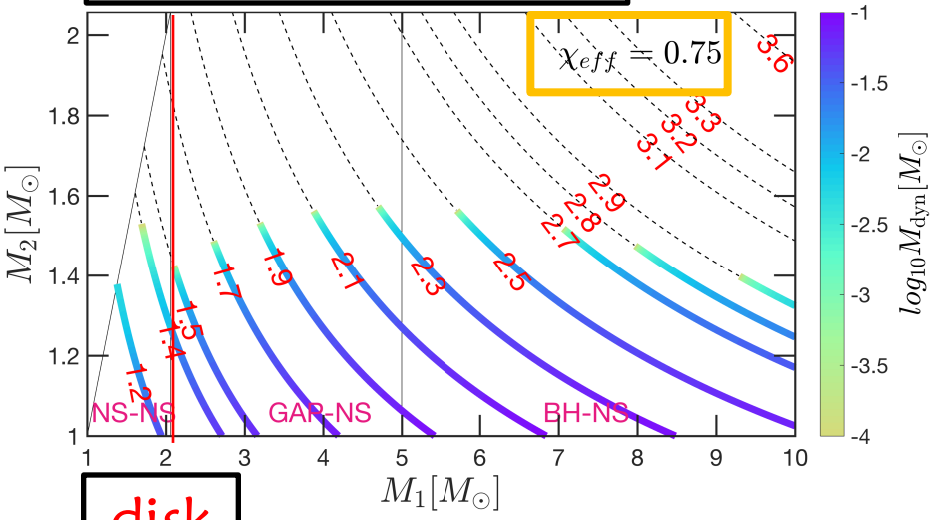
1. Chirp mass ($1.2M_\odot$-$2.7M_\odot$)
2. EOS (SFHo) $M_{\rm NS}^{\rm max} = 2.058M_\odot$
3. BH-NS (GAP-NS) or BNS?
4. Spin (0, 0.25, 0.5, 0.75)

Fitting Formulae
Krüger & Foucart (2020)
Foucart et al. (2018)

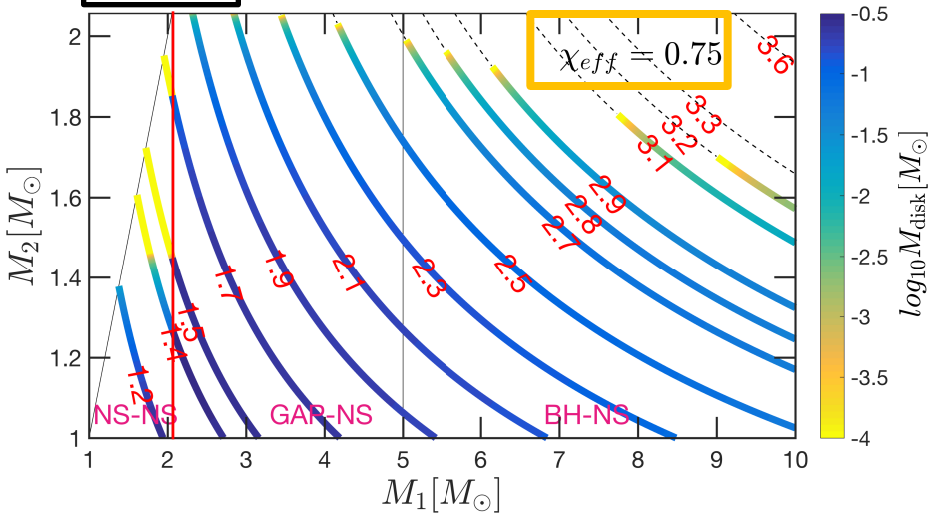
Masses of Dynamical Ejecta and Disk

The Early EM Emissions (KN, sGRBs, cocoons)

dynamical ejecta

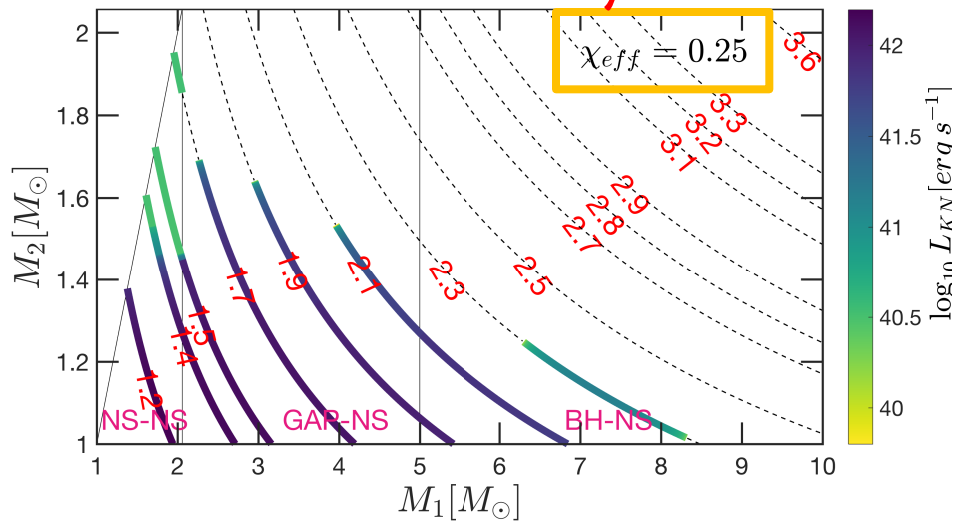


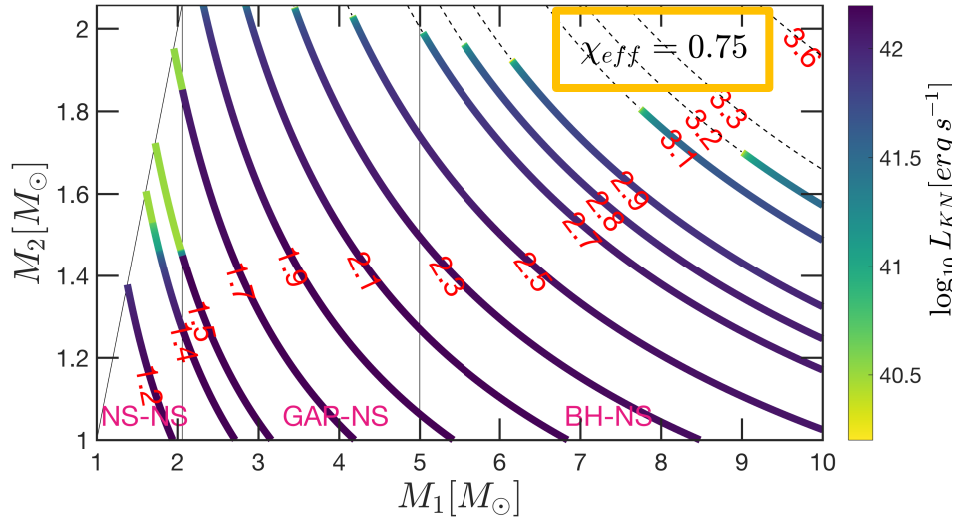
disk



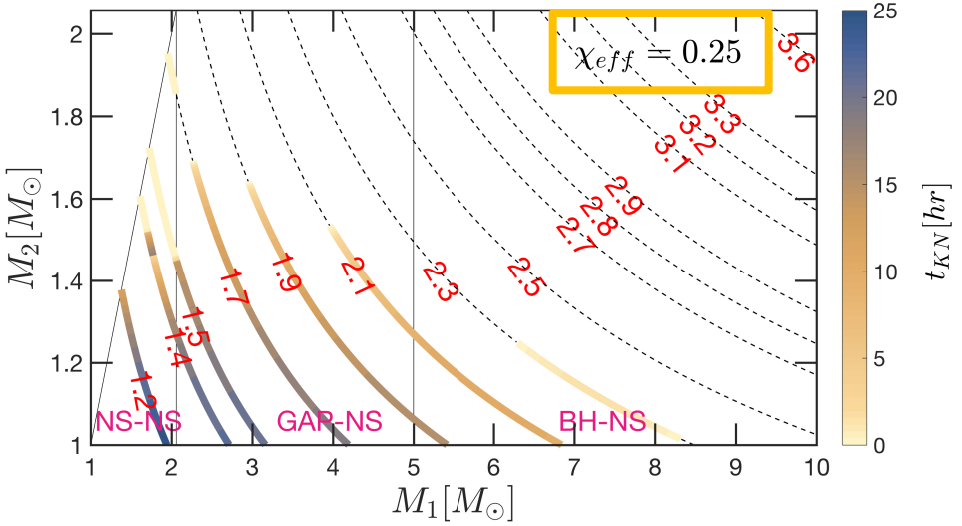
Result for kilonova

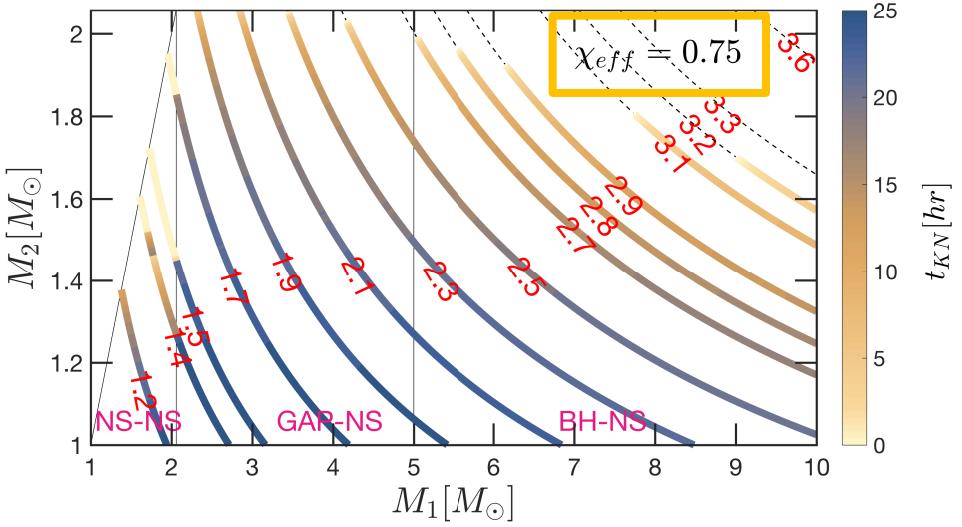
Peak luminosity



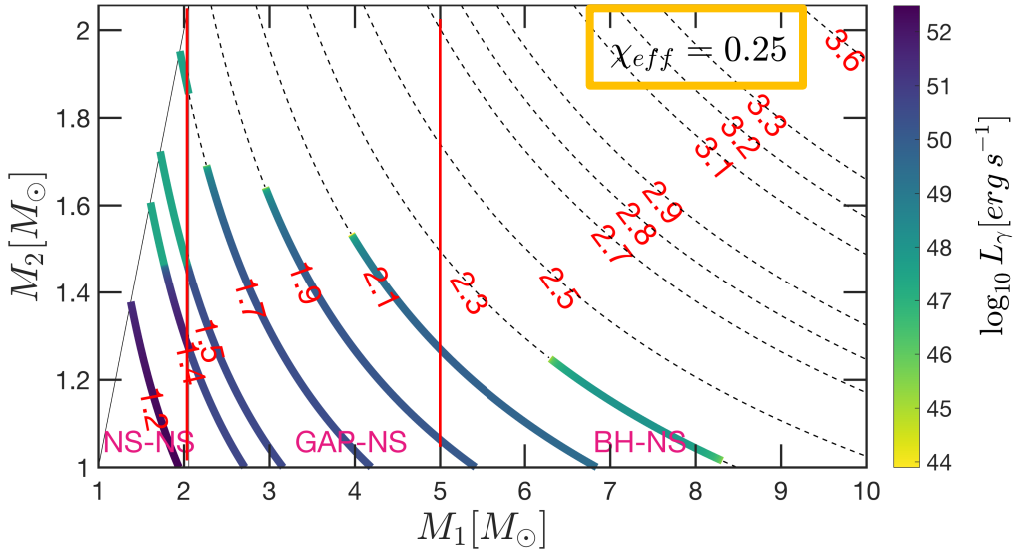


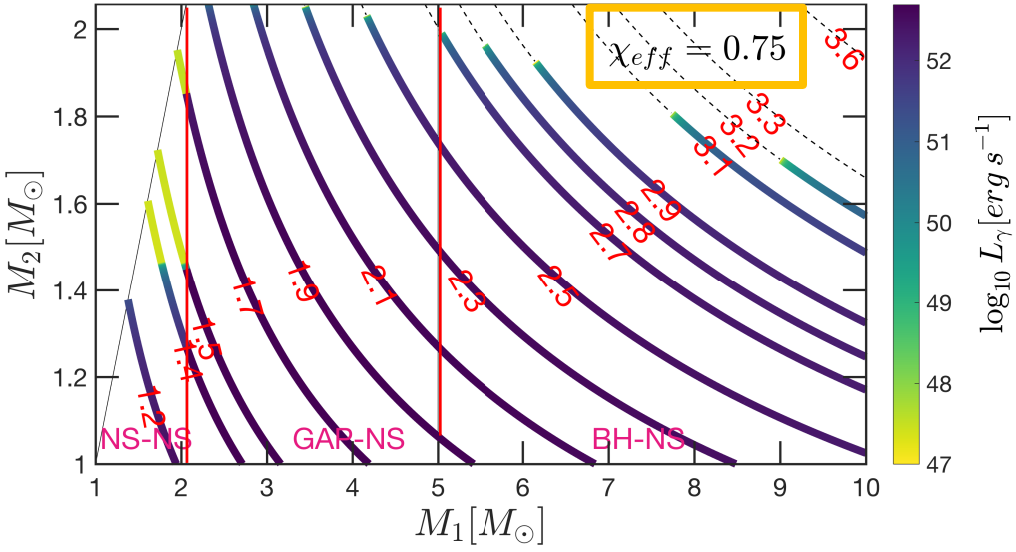
Peak timescale





Result for sGRB



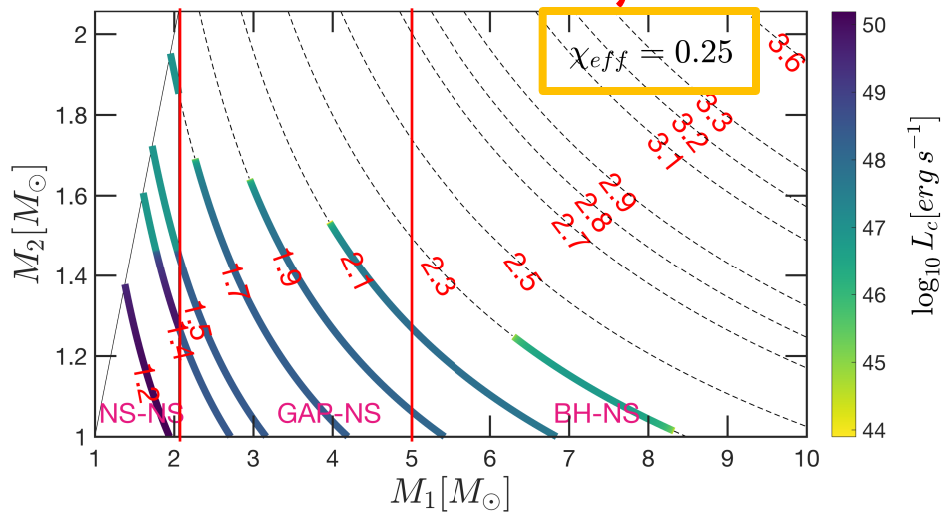


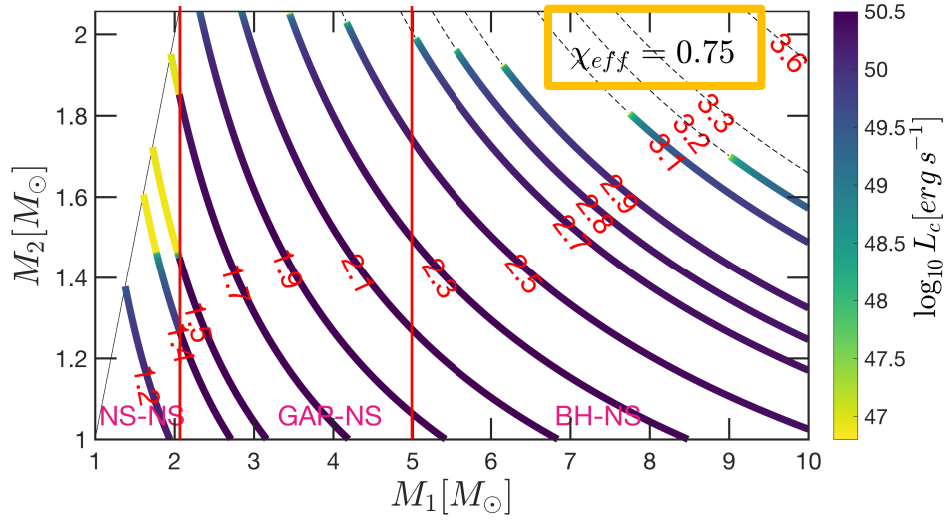
L_γ

Blandford-Znajeck (BZ) mechanism

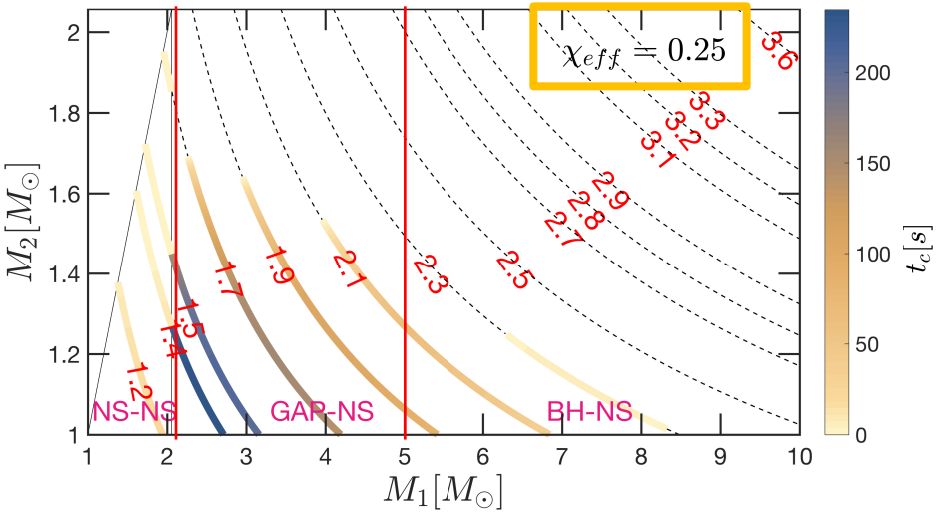
Result for cocoon prompt emission

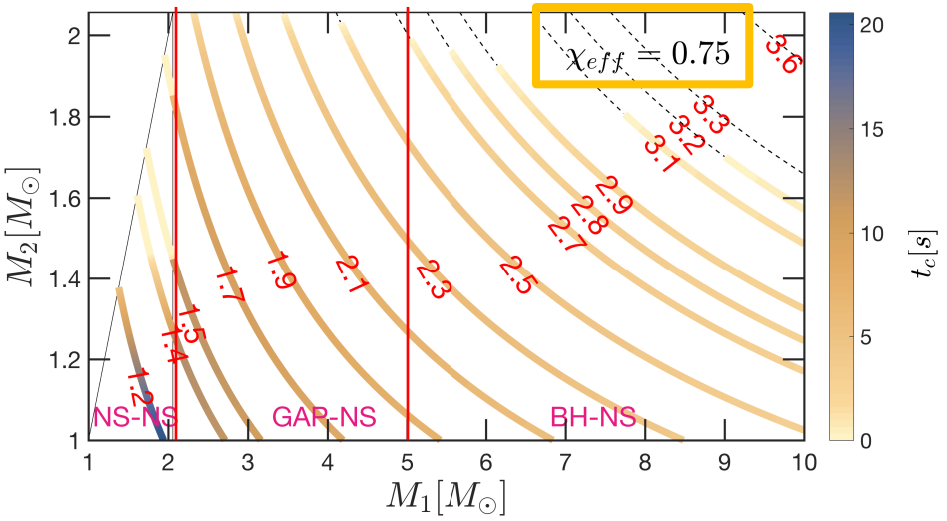
Peak luminosity





duration





Case study for GRB GBM-190816

1. Chirp mass ($\sim 2.9 M_\odot$)
2. BH-NS ($M_{NS} > 1.6 M_\odot$ $M_{BH} > 5.5 M_\odot$)
3. EOS (SFHo)
4. Spin (>0.5)

Fitting Formulae
Krüger & Foucart (2020)
Foucart et al. (2018)

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Masses of Dynamical Ejecta and Disk

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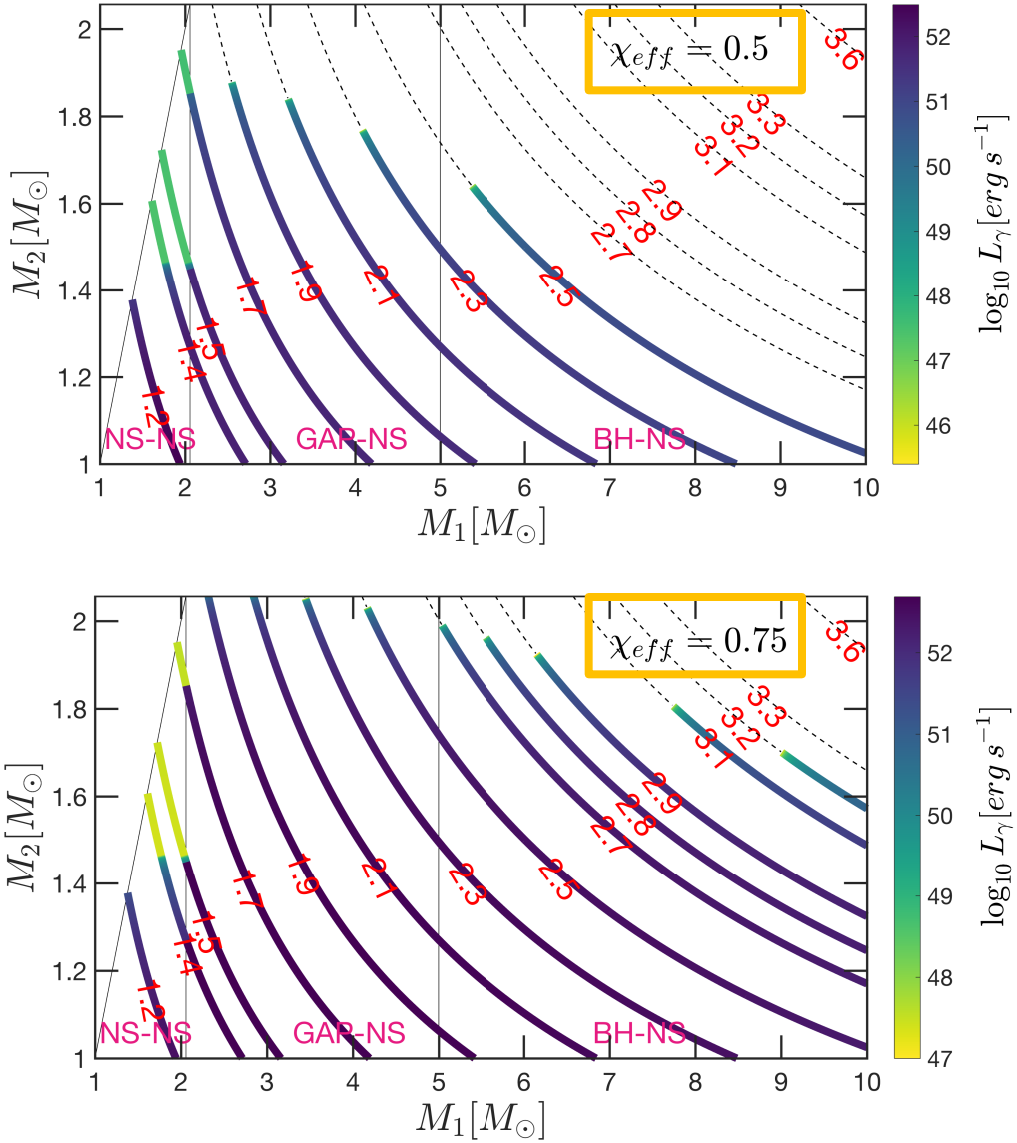
The Early EM Emissions
$L_{\gamma,iso} = 1.47 \times 10^{49} erg/s$



Summary and Conclusion

We estimate the luminosities and time scales of the emission from kilonova, sGRB and cocoon for compact binary mergers.

1. The observation of EM emission could be used to distinguish the types of the mergers (M_{ch} =1.5$M_{\odot}$ – 1.7$M_{\odot}$).

2. For GRB GBM-190816, the effective spin should be >0.5 and the mass of the lighter object should be >1.6$M_{\odot}$.

Thank you for your attention!