X-ray counterparts of gravitational waves

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Ninth International Fermi Symposium
NS-NS(BH) channels to produce short GRB jets

from Ascenzi, Oganesyan et al. 2020
NS-NS(BH) channels to produce short GRB jets

on-axis view

off-axis view

on axis transients GWs, GRB, afterglow, kilonova

off axis transients GWs, ?, afterglow, kilonova

Ascenzi, Oganesyan et al. 2020
GW 170817/GRB 170817A

Kasliwal et al. 2017
Ioka & Nakamura 2018
Salafia et al. 2018
Lazzati 2018
Bromberg et al. 2018
Matsumoto et al. 2018
D’Avanzo et al. 2018
Dobie et al. 2018
Alexander et al. 2018
Troja et al. 2018
Mooley et al. 2018
Ghirlanda et al. 2019

Abbott et al. 2017
the future
BNS horizon 2030s

Einstein Telescope

S. Grimm, J. Harms, M. Branchesi
ET

ET+LIGO/Virgo/KAGRA/LIGOindia

S. Grimm, J. Harms, M. Branchesi
how to hunt for the prompt joint detections?

BUT we need to look inside of the JET (compactness problem, see e.g. Matsumoto et al. 2019)

wide field telescope - not in γ-rays - early bright off-axis counterparts
Early off-axis emission

- γ-ray burst
- keV-MeV
- forward shock
- X-ray optical
- kilonova
- optical NIR
Bright X-ray counterparts of GRBs

Swift/XRT data of GRB 061121

Flux (0.3-10 keV) (erg/cm²/s)

Time since BAT trigger (s)

expected from forward shock
Wide Field X-ray instruments

mission concept (~2030s)

**the ECLAIRs instrument (4-250 keV)**
FOV of ~2sr with source location accuracy < 10’

**the Wide Field Monitor (2-50 keV)**
FOV of ~3.7sr

planned launch date is 2027

to be launched by the end 2021

**Wide Field Imager (0.3-5 keV)**
FOV of ~0.5 sr

**Soft X-ray Imager (SXI, 0.3 – 5 keV)**
FOV of ~0.5sr with source location accuracy < 1-2’

**Transit AstroPhysics Probe (TAP)**
Bright X-ray counterparts of GRBs

Swift/XRT data of GRB 061121

Flux (0.3-10 keV) (erg/cm²/s)

Time since BAT trigger (s)
The mystery of X-ray afterglows observed by Swift

- plateau phase is observed at least in 1/3 of GRBs
- energy injection is the most discussed model (has chromaticity problem)
  Rees & Mészáros 1998
  Zhang et al. 2006
  Granot & Kumar 2006
  Nousek et al. 2006
  would require a stable NS
  Dai & Lu 1998
  Zhang & Mészáros 2001
  Yu et al. 2010
  Metzger et al. 2011
  Dall’Osso et al. 2011
- recently proposed jet structure models
  Oganesyan et al. 2020; Beniamini et al. 2020; Panaitescu 2020; Ascenzi et al. 2020

figures from Kumar et al. 2008
New way to look at X-ray afterglows

- based on the structure jet
- explains all the phases
- no NS needed, BH is fine
- chromatic lightcurves

Oganesyan et al. 2020
Steep Decay Plateau

Oganesyan et al. 2020
movie by Ascenzi
Off-axis X-ray emission from GRBs

Ascenzi, Oganesyan et al. 2020
mission concept (~2030s)

Soft X-ray Imager (SXI, 0.3 – 5 keV)
FOV of ~0.5sr with source location accuracy < 1-2°

by Samuele Ronchini
Early off-axis emission

$\gamma$-ray burst
keV-MeV

forward shock
X-ray optical

kilonova
optical NIR
by Samuele Ronchini