GW170817 - An overview

Arvind Balasubramanian[1] **(on behalf of a larger collaboration)**

[1]Department of Physics and Astronomy, Texas Tech University

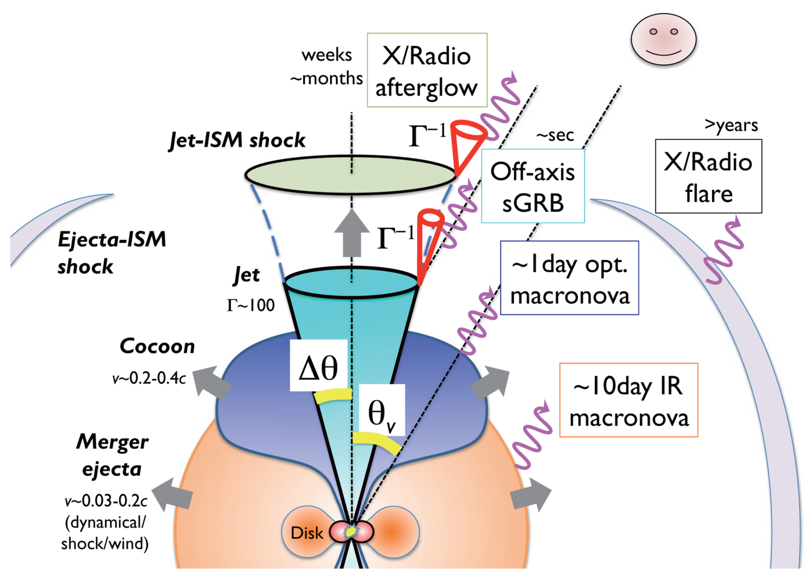
TEXAS TECH UNIVERSITY SYSTEM™

Abstract

GW170817 has been instrumental in providing important clues into the physics involved in neutron star mergers. Observations at different wavelengths of the electromagnetic spectrum have provided evidence for formation of heavier elements, insights into jet physics, circum-merger environment etc. and accompanied with gravitational wave measurements, have changed the way we look at such transients. In particular, radio observations track the fastest moving ejecta and helped to zero in on possible models that could explain the observed radiation. Continued observations can constrain the parameter space, allowing for better modelling of the inherent physics. I will present a brief overview of all observations of GW170817 done till date and will also hint upon what we expect to observe from the source in near future.

Background

GW170817 is the first binary-neutron star merger to have been observed in gravitational waves and in all bands of the electromagnetic spectrum. The spectrum is the same at any epoch ($F_\nu \propto \nu^{-0.569\pm0.002}$)!



Multi-wavelength observations helped to narrow down the model to a **structured jet** model (narrow highly relativistic jet surrounded by slower moving ejecta), where we have a successful jet which has bored through the cocoon.

Multi-wavelength observations

- Kilonova afterglow : Dynamical ejecta interacting with the circumstellar medium. (UV, optical, IR)
- Jet afterglow : Jet interaction with the circumstellar medium. (Non-thermal : X-rays and radio.

Radio monitoring helped rule out top-hat (uniform jet speeds), confirmed that the emission seen in other bands were from the slower moving ejecta and showed that the jet was successful in boring through the cocoon and that we were observing off-axis.

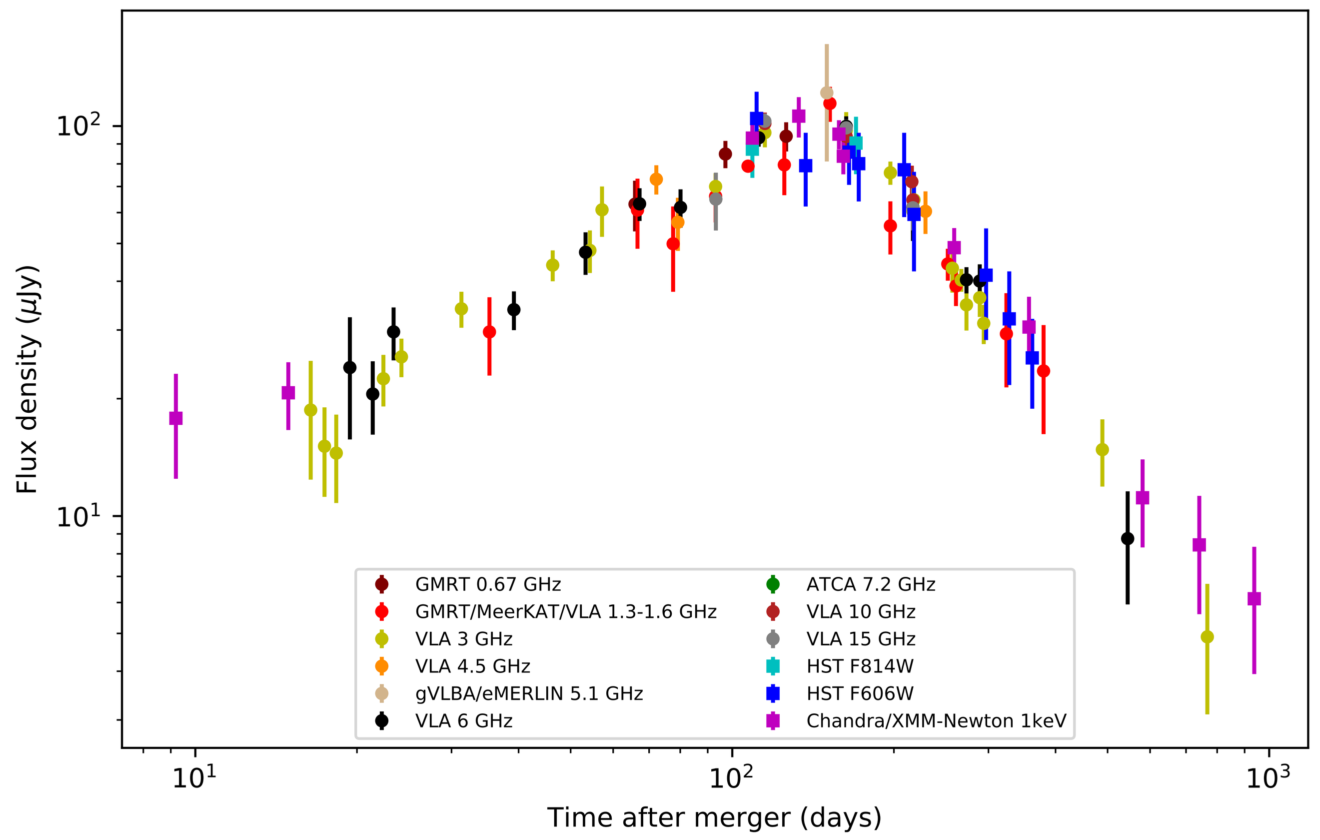
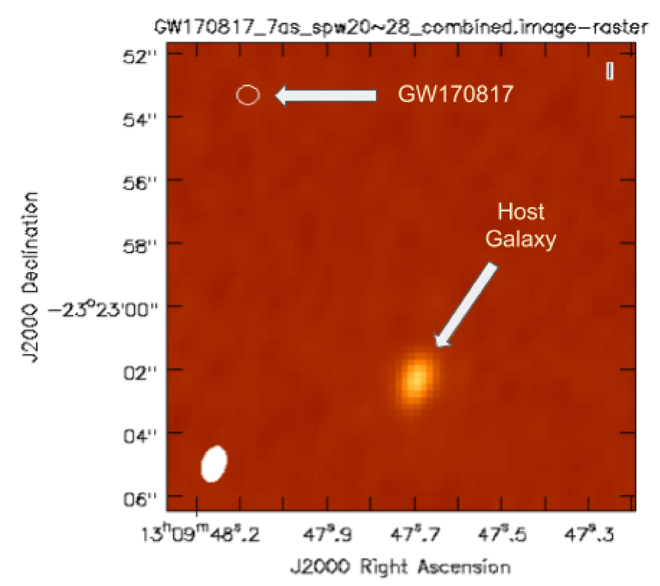


Figure 1: Panchromatic afterglow lightcurve



These recent observations have helped constrain the parameter space and continued observations will provide more insight into the physics of such mergers.

Future work

We have recently made radio observations to look for reminiscent emission due to jet afterglow or the expected brightening due to the **kilonova** afterglow.

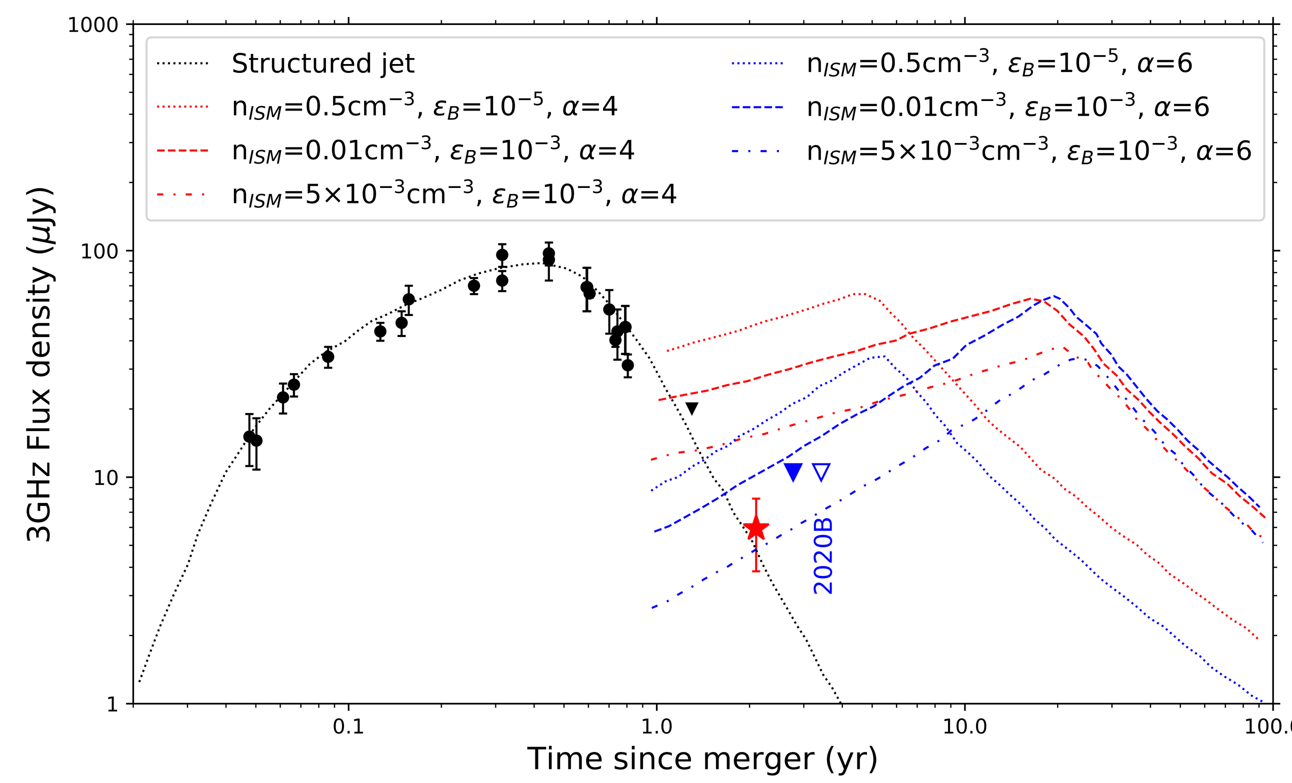


Figure 2: 3 GHz lightcurve for GW170817 showing the best fit structured jet model along with various models for the expected kilonova afterglow. The red star is a partial detection from our Sep 2019 observations. The blue filled triangle is the preliminary upper-limit from our recent Sep 2020 data. The open blue triangle is the sensitivity we expect from our approved 2020B VLA observation cycle.

Electromagnetic observations have also helped to confirm that speed of gravitational wave propagation is the same as that of light in vacuum, improved constraints on the hubble constant etc.

References

• Makhathini et al. 2020, arXiv, arXiv:2006.02382 • Corsi et al. 2018, ApJL, 861, L10 • Hallinan et al. 2017, Science, 358, 1579 • Ioka & Nakamura 2018, PTEP, 2018, 043E02 • Kasliwal et al. 2017, Science, 358, 1559 • Kathirgamaraju et al. 2019, MNRAS, 487, 3914 • Lazzati et al. 2018, PRL, 120, 241103 • Mooley et al. 2018a, Nature, 554, 7691• Mooley et al. 2018c, Nature, 561, 355