A coherent flash from a neutron star merger: The birth of a magnetar

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Rowlinson, de Ruiter, Starling, Rajwade, Hennessy, Wijers, Anderson, Mevius, Ruhe, Gourdji, van der Horst, ter Veen, Wiersema, 2023, Submitted





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Merging neutron stars

What is the central engine?

Credit: NASA's Goddard Space Flight Center/CI Lab

Antonia Rowlinson

Coherent radio emission models



Rowlinson & Anderson (2019)

Chasing compact binary mergers



Short gamma-ray burst jet



Swift GRB satellite

Gravitational waves



Virgo GW detector



GRB 201006A

Detected by Swift

Duration ~0.5 seconds

 2 hour LOFAR observation started
4.75 minutes after GRB



LOFAR 2 hour observation



Detection of candidate source

- Sky model subtracted from visibilities
- Imaged in 10 second snapshots
- 5.2σ detection at 76.5 minutes after GRB
- Flux density of 35 ± 12 mJy
- Note slight offset from X-ray position



Search for a dispersed signal

- Image plane dedispersion of detected source
- 2.5σ tentative detection
- DM 770 pc cm⁻³
- Corresponds to z ~0.6 using Macquart correlation (James et al. 2022)





Collapsing a magnetar to black hole

- Magnetic reconnection event at collapse time
- Magnetar parameters obtained from fitting X-ray data
- (Falcke & Rezolla 2014, Zhang 2014)



Conclusions

- 5.2σ detection of a faint radio transient 76.5 minutes after a compact binary merger
 - Caveat: slight offset from X-ray position
- Tentative detection (2.5 σ) of dispersion
 - Caveat: signal needs to be narrow-band (though not inconsistent with FRBs) and not very short (>1 second intrinsic duration)
- Consistent with predictions from coherent radio emission models

Spare Slides

Coherent radio transient population



Restframe lightcurve







SGRB properties - duration



SGRB properties – Fermi relation



LST matched images

Transient

(a) b) Declination (degrees) Declination (degrees) 007 00 05 05 0 00 05 0 00 65.100 65.100 62.000 61.900 61.800 62.000 61.900 61.800 Right Ascension (degrees) Right Ascension (degrees)

1 month later

Offsets of sources



Pixel distribution in search area



Constraining duration



DM histogram

