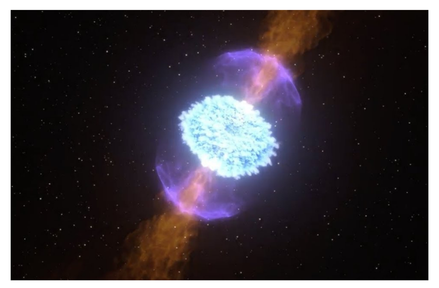
DESIGNING KILONOVAE OBSERVATIONS FOR THE JAMES WEBB SPACE TELESCOPE

DeOndre Kittrell[1], Rishap Lamichhane[2], Pradip Gatkine[3] , Dr. Leo P. Singer[3,4]

[1]Morgan State University, [2]Howard University, [3]UMD Astronomy, [4]NASA GSFC

Introduction

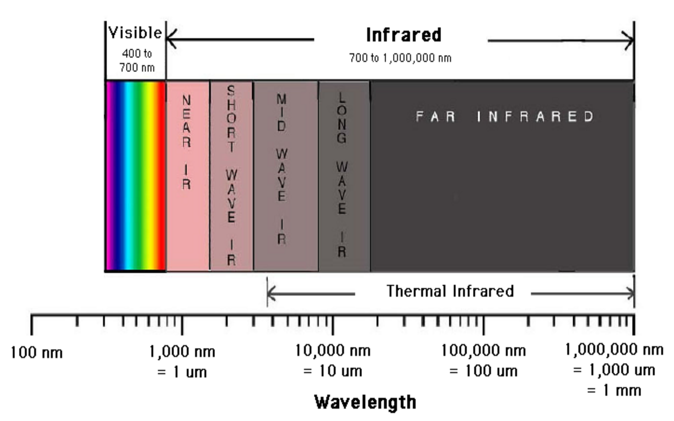
On August 17, 2017 the Laser Interferometer Gravitational-Wave Observatory (LIGO) detected a gravitational wave emitted from a binary neutron star merger, nearly 130 million light years away.



The merger caused an explosion known as a kilonova, which ejects tons of neutron-rich material into space at speeds a fraction of the speed of light.

It has long been speculated that these kilonovae explosions are the cosmological factories that produce heavy elements such as gold, silver and, platinum.

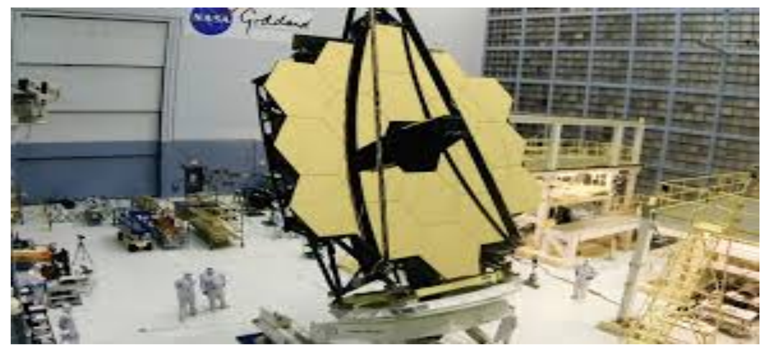
Observations of Kilonovae



Kilonovae have their peak emission in the near-infrared to mid-infrared part of the spectrum making them difficult to observe.

The James Webb Space Telescope (JWST) will be the first satellite to possess instruments designed specifically for these wavelengths.

Targeted configuration strategies can expand the kilonovae science by determining reasonable exposure times, helping to maximize the functionality of JWST.



Goals

- We seek to design observations for JWST that will utilize instruments such as NIRcam and MIRI to effectively study kilonovae.
- Utilize python based program MOSFIT to identify key parameters and model kilonovae events

MOSFIT

- The Modular Open Source Fitter for Transients (MOSFIT) is python-based program that is used to create models of high-energy events such as kilonovae and supernovae.
- Models can be run through MOSFIT to produce several outputs such as light curves and SED's

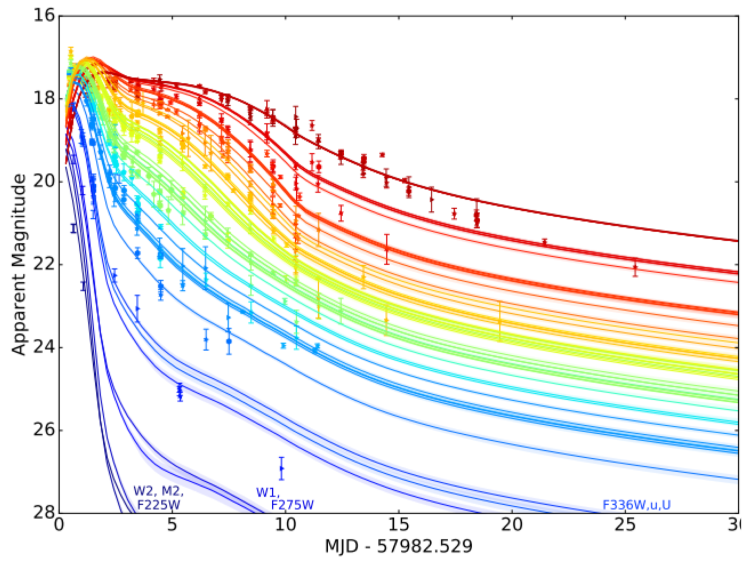


Figure I: Multi-band light curve for GW180817 (Villar et. Al 2017)

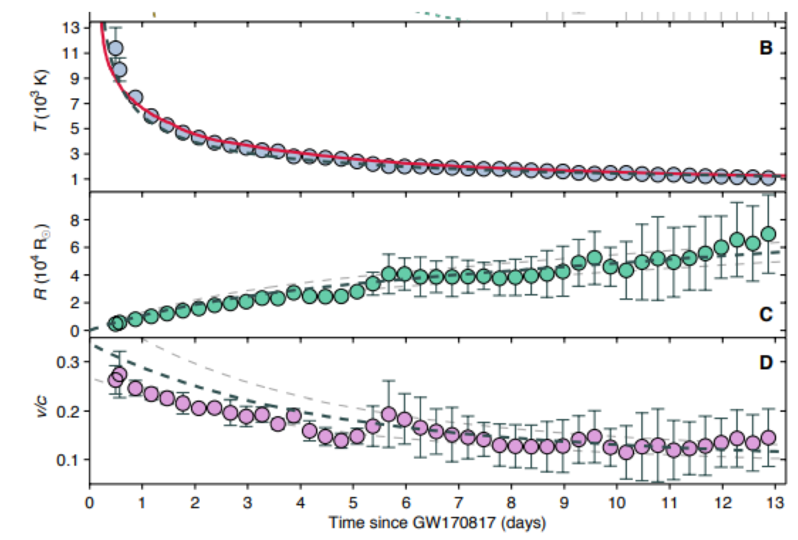


Figure II: Plots for kilovovae parameters of GW170817 (v,T,R) changing with time. (Kasliwal et. Al 2017)

Methods

Design kilonovae models using MOSFIT based on parameters of the ejecta (mass, velocity, and opacity).

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Design host galaxy models using Pandeia based on various properties (redshift, stellar age, star formation rate).

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Synthesize kilonovae and galaxy models into source scenes for the JWST Exposure Time Calculator

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Input synthesized scenes into the JWST Exposure Time Calculator

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Modify viewing configurations to obtain various exposure times and signal-noise ratios (SNR's)

Results

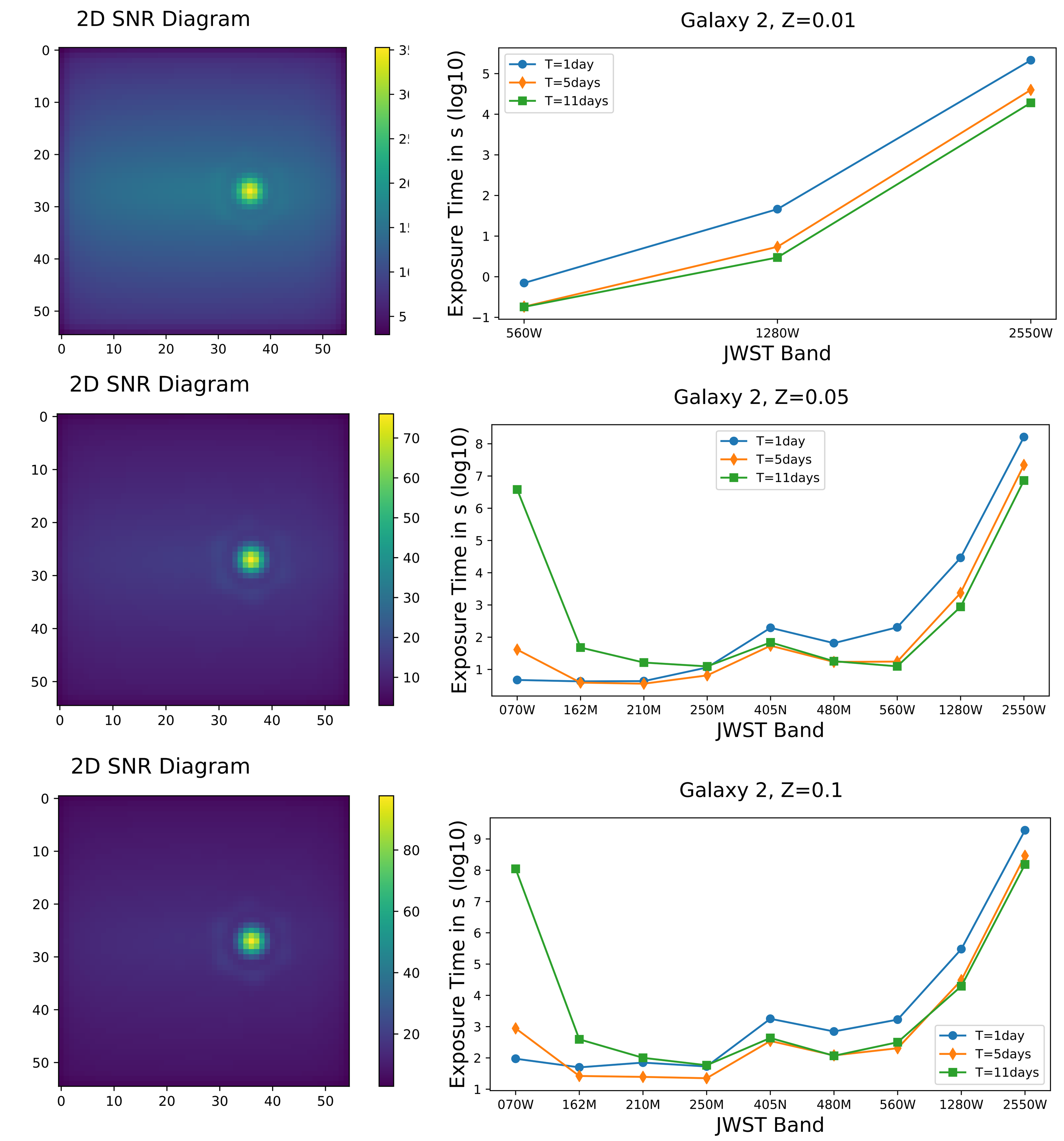

Figure III (left): MIRI SNR diagrams of host galaxies and kilonovae at redshifts z=0.01with temperature 5000K, 3500K 1500 K using filter 1280W

Figure IV (right): Plot showing the resulting exposure time across several filters in the near-infrared/mid-infrared bands. Calculated at redshift z=0.01,0.05,0.1

Conclusions

- **For the the closest source (z=0.01), MIRI exposure times at all epochs increases as the filter shifts further into the mid-infrared.**
- **NIRcam exposure times appear to be lower for sources at higher redshifts; MIRI exposure times increase exponentially.**
- **Further experimenting with configurations will allows us to be more proficient determining effective observing techniques.**

Acknowledgements & Contact

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References

1. W. Fong, E. Berger, D.B. FoxAstrophys. J., 708 (Jan. 2010), pp. 9-25
2. Villar, V. A., Guillochon, J., Berger, E., et al. 2017, arXiv:1710.11576
3. Fong, W. et al. Demographics of the Galaxies Hosting Short-duration Gamma-Ray Bursts. Astrophys. J. 769, 56 (2013).