

# Hunting Gravitational Wave Mergers with Cosmic Surveys

Mohit Dighamber and Antonella Palmese – FERMILAB-POSTER-21-100-E

## INTRODUCTION

Nearly 60 gravitational wave (GW) events from merging compact object binaries (binary black holes, binary neutron stars and neutron star-black hole systems) have been detected by the LIGO and Virgo gravitational wave detectors. The first gravitational wave multi-messenger detection of GW170817, associated to the kilonova AT2017gfo which was discovered by the Dark Energy Survey (DES) amongst other teams in 2017, has also been the last GW event with an associated counterpart.

The DES-GW team is now hunting down new associations of GW detections with optical emission visible with the Dark Energy Camera, a massive camera built at Fermilab for the DES, and now mounted on the Blanco telescope in Chile.

## OBJECTIVES

- Search for the optical emission expected from binary neutron stars or binary black holes emitting gravitational waves in active galactic nuclei (AGN) disks.
- Fit flare models to light curve data
- Work towards finding a constraint on  $\lambda$ : the fraction of Binary Black Holes that occur in AGNs
- Handle analyses of big data in astrophysics

## METHODS

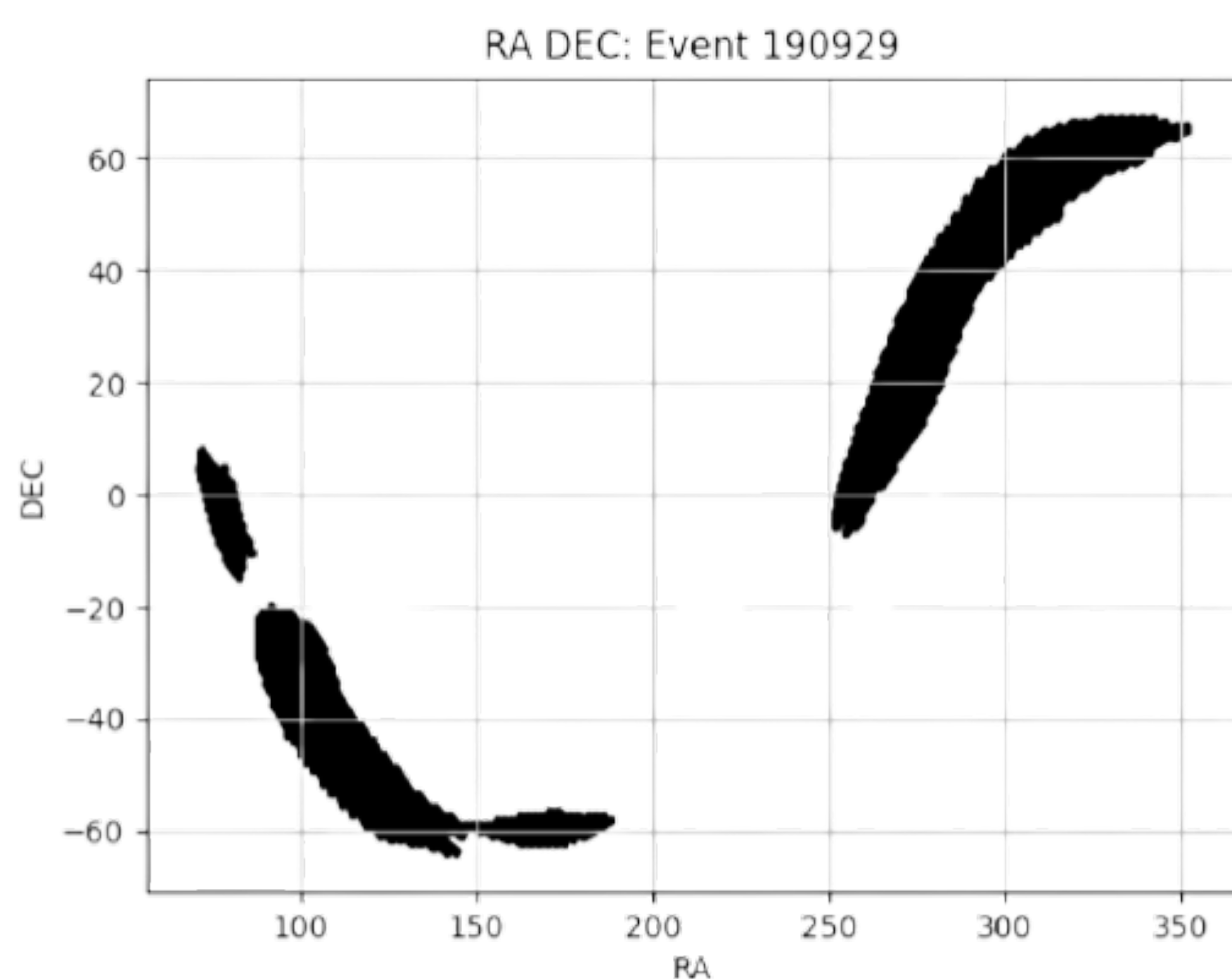


Figure 1 – Skymap showing the 90% probability location range for GW event 190929.

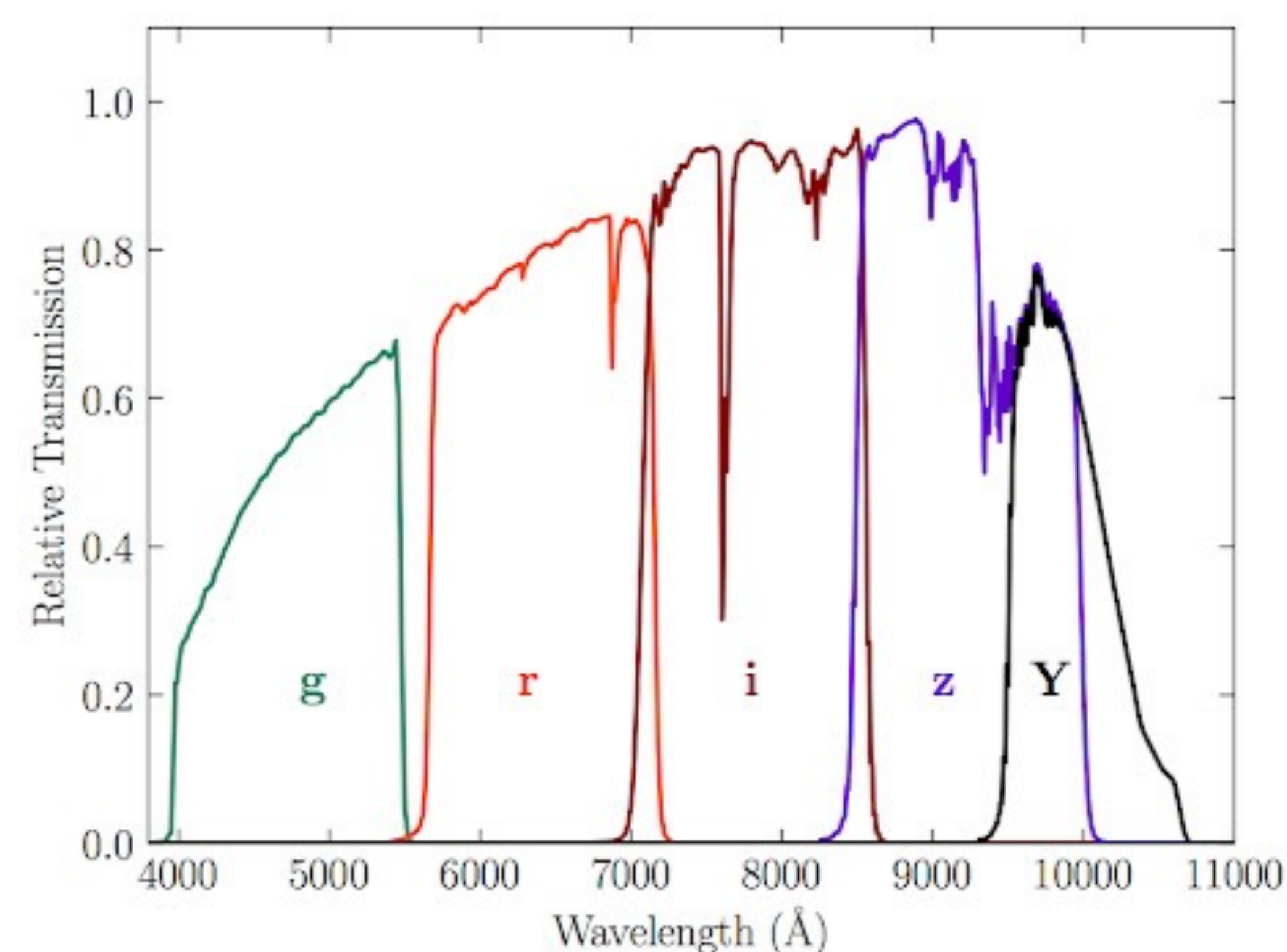


Figure 2. DES DR1 Standard Bandpasses for the DECam g, r, i, z, and y filters.

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## RESULTS

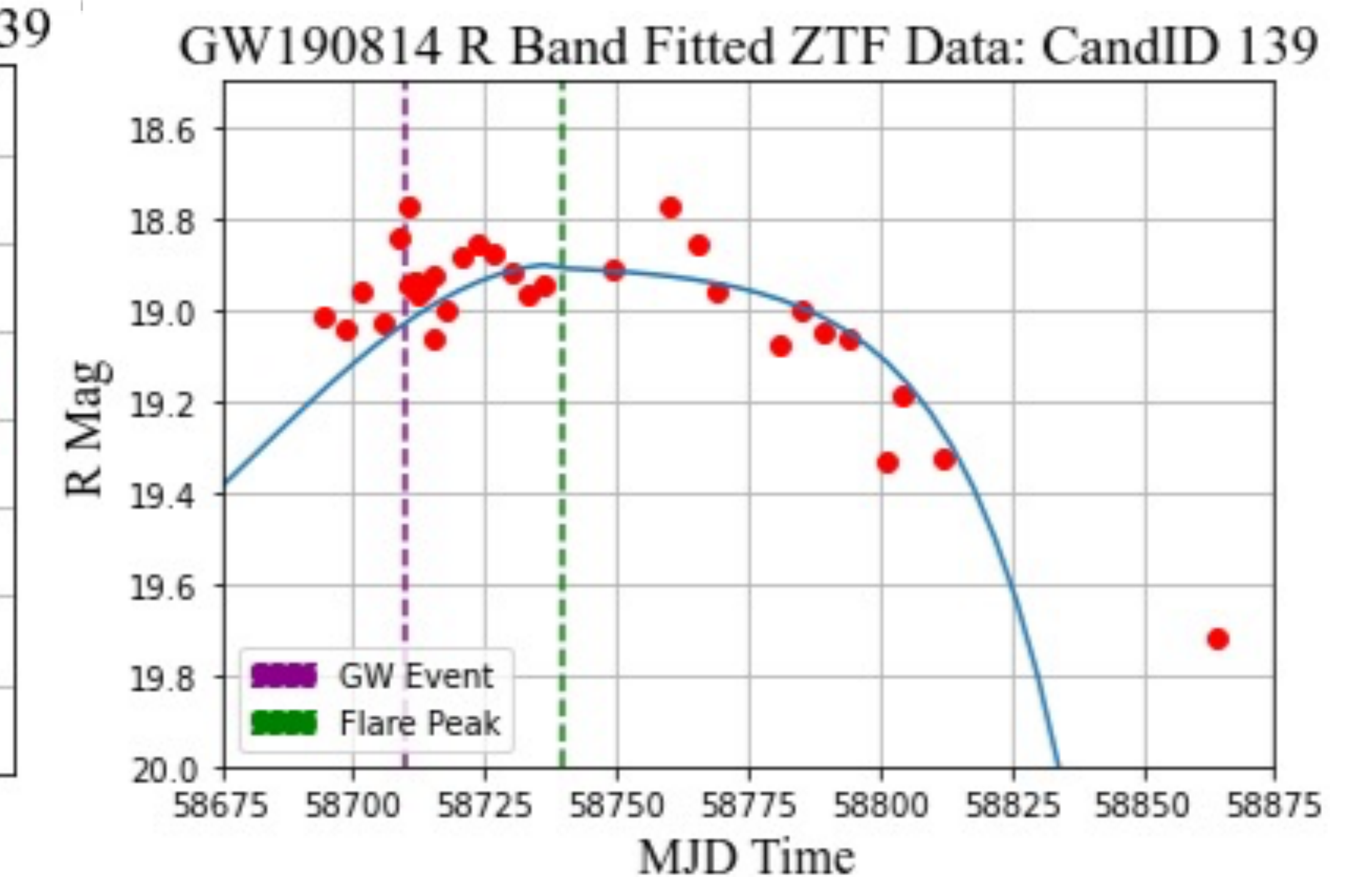
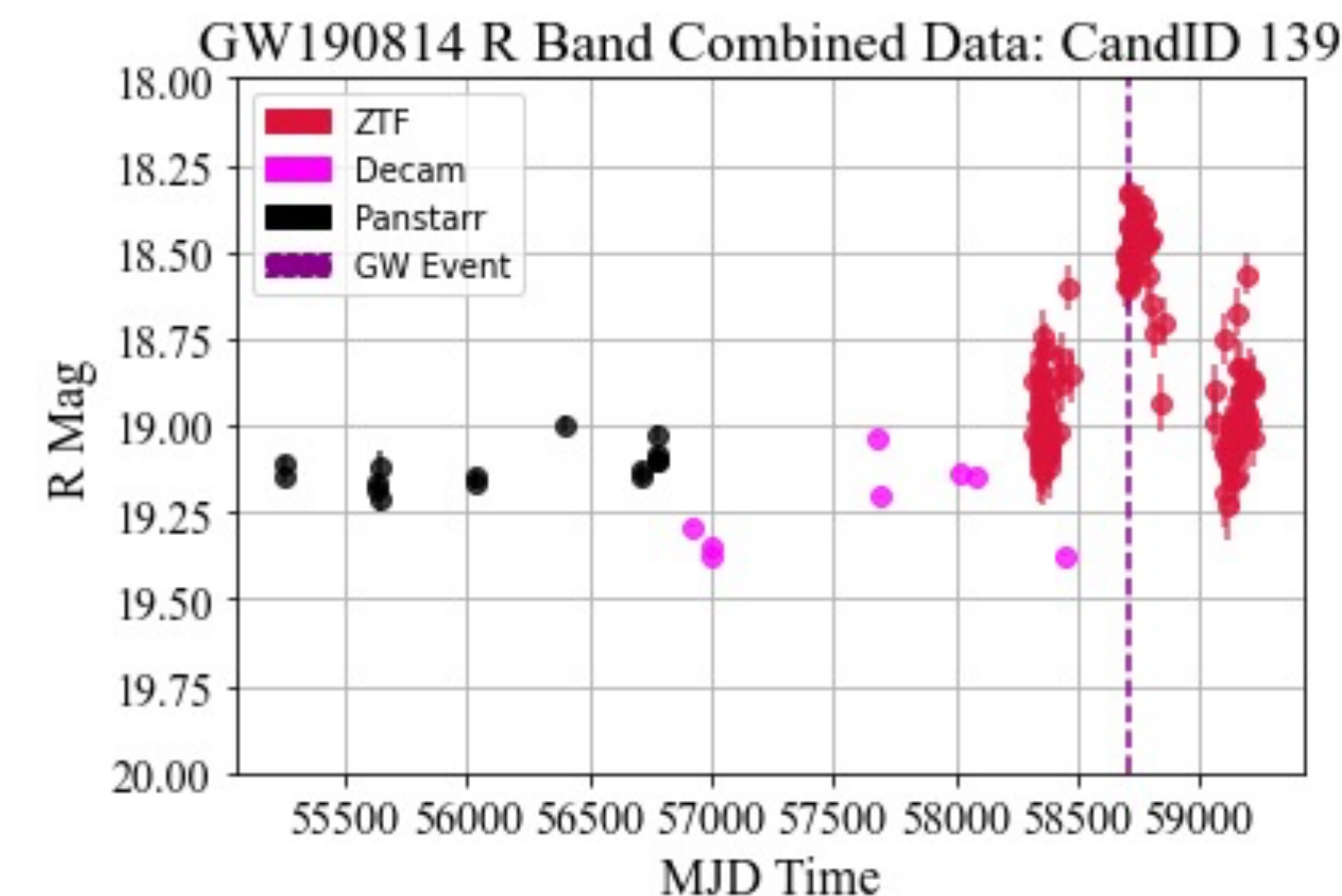


Figure 3 (Top Left). R Band Data sourced from ZTF, DECam, and PanSTARRS databases.

Figure 4 (Top Right). Curve with a Gaussian rise/exponential decline fitted to R Band flare data. Fit is optimized for the locus of the GW Event, up to  $\pm 200$  MJD away from the event.

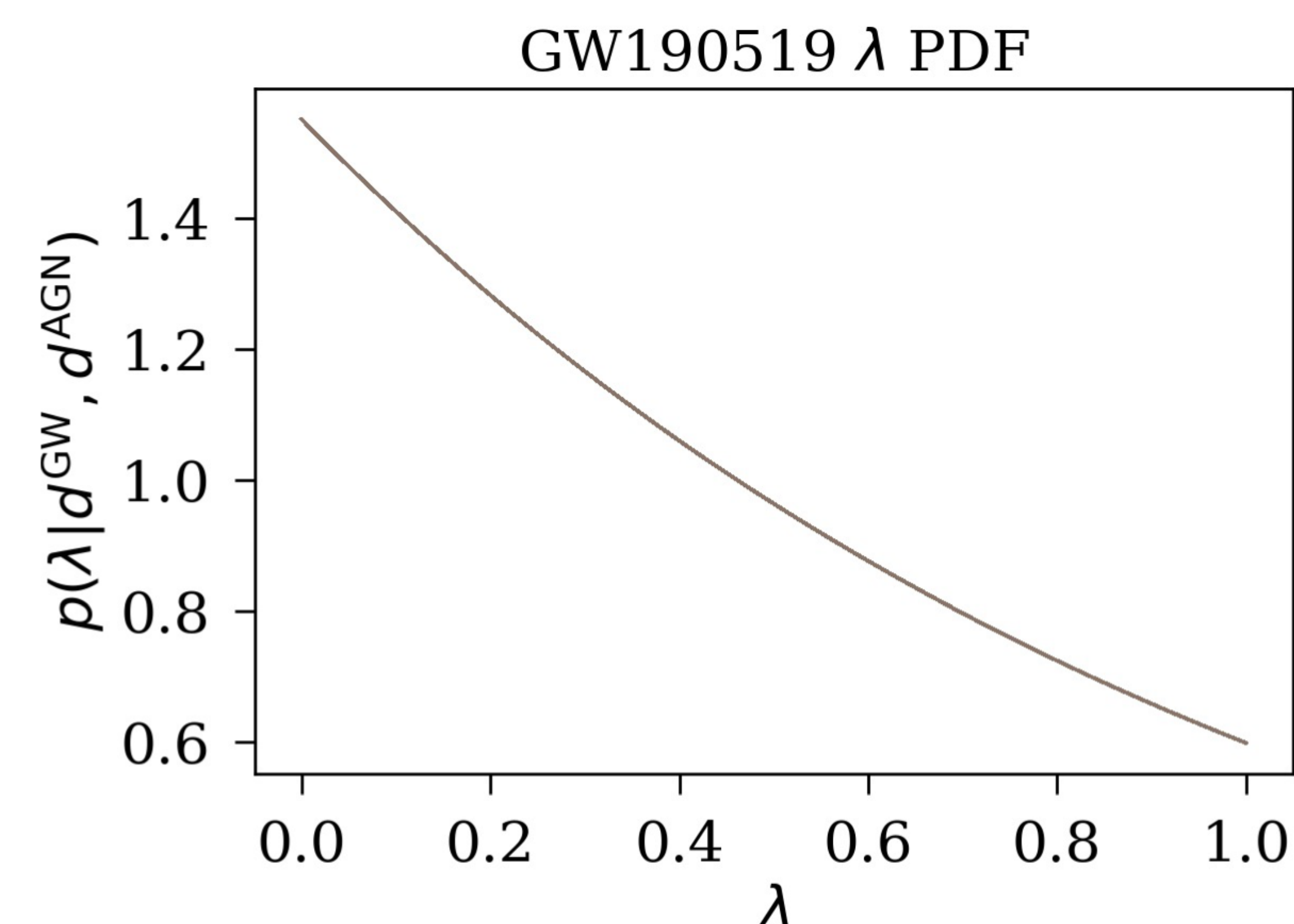


Figure 5 (Bottom Left). Probability distribution for the lambda parameter derived from GW 190519 using a Bayesian framework.

## CONCLUSIONS

- Specific flare for GW190814 (candID 139) not consistent with gravitational wave event
- Analysis ongoing for currently available GW data
- Gaussian rise/exponential decline fit found for general locus of the GW event
- Lambda upper 2-sigma: 0.929

## FUTURE WORK

New discoveries of GW counterparts using DECam will help shed light on some of the unknowns related to these systems, including their origin and the production of the heaviest elements in the Universe, and they will enable measurements of the expansion of the Universe. Future work will involve searching for flares like candID 139 and exploring the constraints on  $\lambda$  using future events.