

# Multi-messenger Astronomy Observations Via Alert Stream Filtering

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In this work we show advancements in follow-up methods for detection of electromagnetic counterparts to gravitational wave signals. These multi-messenger observations are important targets for their ability to unlock science including measurement of the Hubble constant, which is a current major effort in cosmology. In this work we include a data-driven heuristic to select anomalous flares which are candidate electromagnetic counterparts to the gravitational wave signals of merging black holes. This work also includes a systematic analysis of filtering done on telescope alert streams in order to identify astronomical transients, including these binary black hole merger flares. This analysis takes advantage of the six year history of observation and filtering on data from the Zwicky Transient Facility (ZTF). This work targets improvement of filter efficiency and interpretability, and also searches for interesting objects in the gaps between the range of filters operating on the ZTF alert stream. All of this work is done with the goal of minimizing followup latency for quickly evolving and fading signals. It is motivated by the upcoming Rubin Observatory, which will produce an alert stream that is magnitudes larger than that of ZTF.

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