

Practice Science Motivation (1 page)

A primary science goal of the 2023 Astronomy Decadal is the continued prompt multi-wavelength followup of transient events. These violent and explosive transient events provide a unique probe of high energy phenomenon and environments that are impossible to reproduce on the surface of the Earth. Of particular interest are tidal disruption events (TDEs; 2023 Decadal, Subsection B-Q2a). TDEs occur when a star approaches within the tidal radius of a supermassive black hole (SMBH) and is torn apart, releasing emission across the electromagnetic spectrum. Understanding the emission from TDEs on their own and how it relates to other transient emission is an open question in astronomy and a key focus of the 2023 Astronomy Decadal.

Studying TDEs will not only further our understanding of them but also many other areas of astronomy. For instance, studying TDE emission provides a probe the SMBH properties, the sub-parsec galactic nuclei environment, jet evolution and fundamental physics, and shock physics. For instance, using radio observations of TDEs we are able to study the density and particle makeup of the previously quiescent galactic nuclei at a sub-parsec scale(2023 Decadal, Section D-Q4d). Studying the density and structure of the galactic nuclei on such small scales will help us better understand both SMBH accretion and how it affects the evolution and structure of galaxies as a whole. Overall, this makes multiwavelength observations of TDEs necessary to further our fundamental understanding of high energy, dense astronomical environments.

In particular, prompt radio/millimeter observations of TDEs allow us to study the early evolution of jets (2023 Decadal, Subsections B-Q2a and B-Q3a). As the jets evolve outwards, they shock the previously quiescent circumnuclear medium, producing synchrotron emission visible in the radio and millimeter. Fitting a *complete* spectral energy distribution of TDEs allows us to extract properties of the jet, shock front, and ambient circumnuclear medium. Since this SED normally peaks around 1-10 GHz (depending on the time of the observation), observations with sensitive telescopes like the Very Large Array (VLA) and Atacama Large Millimeter Array (ALMA) necessary to study TDE radio/millimeter emission and further our understanding of jet evolution. A list of recently radio bright TDEs is given in Table 1 as examples of objects that require followup. Although, for a true study of this nature, we would need “Target of Opportunity” (ToO) observations within days after the initial optical or X-ray detection.

Table 1: Sample of Radio Bright TDEs for Observations

IAU Name	RA [hours]	Declination [degree]	Redshift	Approximate Flux Density at 6GHz [μ Jy]
AT2022dyt	10:00:08.008	+26:27:38.57	0.072	75
AT2022wtn	23:23:23.778	+10:41:07.99	0.049	300
AT2021sdu	01:11:23.924	+50:34:29.67	0.059	75
AT2020zso	22:22:17.130	-07:15:59.08	0.061	150

AT2018cqh	02:33:46.930	-01:01:28.38	— ¹	10 ⁵
AT2018hyz	10:06:50.871	+01:41:34.08	0.04573	10 ⁵

¹No redshift publicly available for AT2018cqh on the Transient Name Server (TNS).