Radio Emission from Tidal Disruption Events

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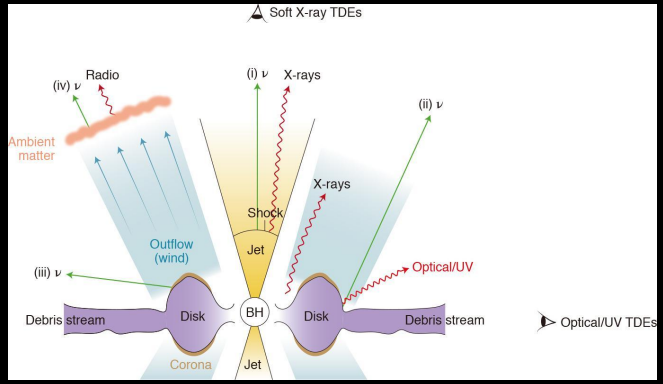
on behalf of the VAST collaboration

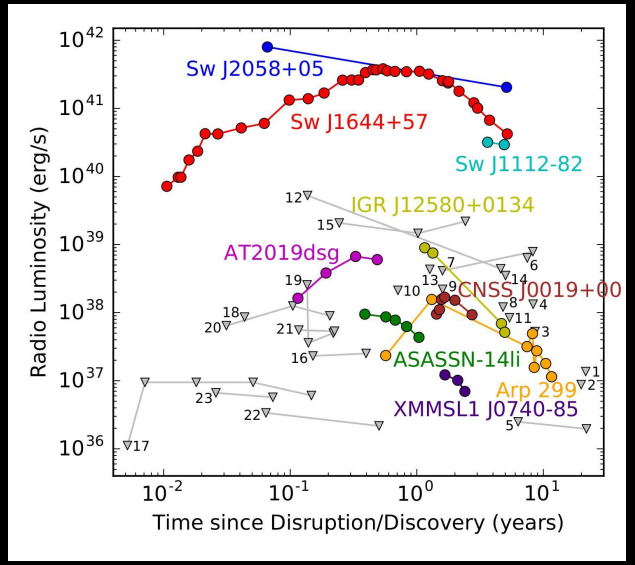
The Transient and Variable Universe 2023

21 June 2023

TDE Emission (Radio PoV)



Picture credits: Hayasaki K., 2021, NatAs, *5*, 436



Picture credits: Alexander K.D., et al., 2020, SSRv, 216, 81

- Emission from relativistic jets vs outflows
- Unique probe to study the circumnuclear medium (Alexander K.D., et al., 2020, SSRv, 216, 81, Goodwin A.J, et al., 2023, MNRAS, 518, 847; MNRAS, 522, 5084)
- Evolve on ~ year long timescales
- Not common in all thermal TDEs (Alexander K.D., et al., 2020, SSRv, 216, 81)

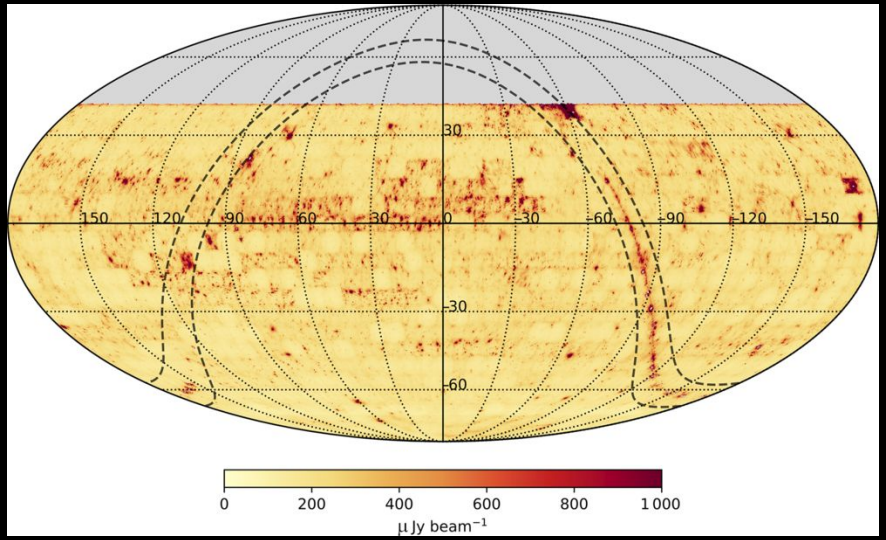
Australian SKA Pathfinder (ASKAP)

- Interferometric array of 36 dishes
- Spectral range of 700 - 1800 MHz
- 31 deg^2 field of view
- ~12-20” resolution (at 1 GHz)
- ~2” positional uncertainty

Pic. credits: https://www.atnf.csiro.au/projects/askap/images/2012_Aerial-view-of-MRO.jpg

Rapid ASKAP Continuum Survey (RACS)

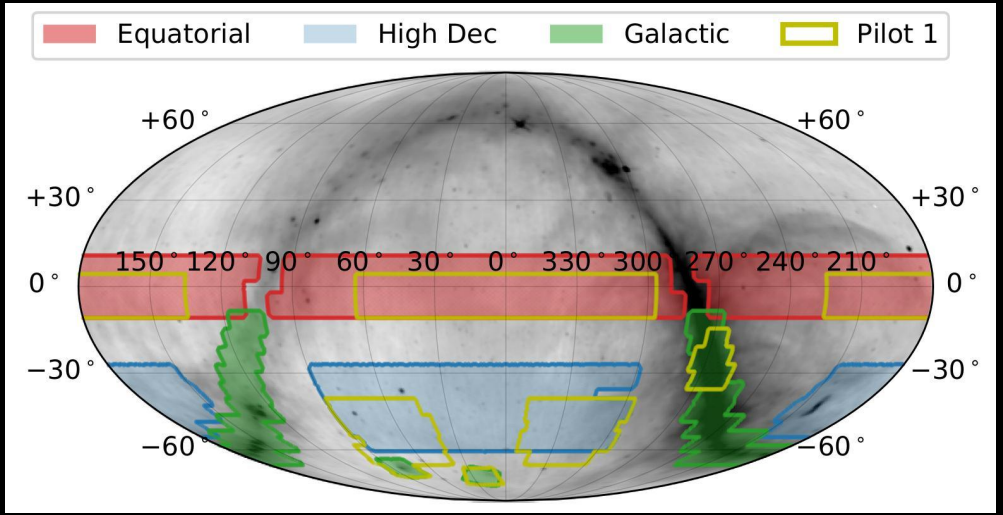
- +41° declination limit (sky area 36000 deg^2)
- Sensitivity of 0.25 mJy/beam (~10 min)
- Three spectral bands
  - RACS-low (887.5 MHz); 2 epoch survey
  - RACS-mid (1367.5 MHz); single epoch
  - RACS-high (1655.5 MHz); single epoch
- Survey time ~230hrs (vs 1800hrs per epoch for VLASS)



Picture credits: McConnell et al., 2020, PASA, 37, e048

Variable and Slow transients (VAST)

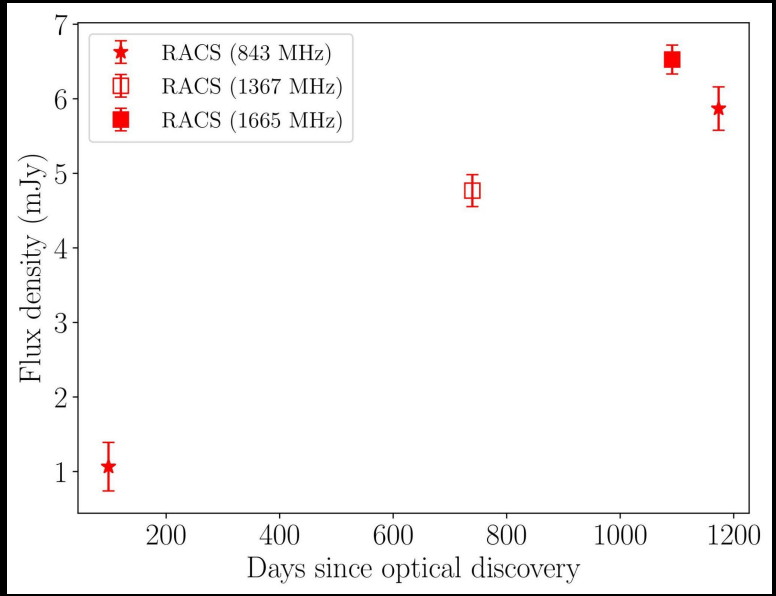
- Total survey time is 2200 hrs
- High galactic latitude observations
  - 4800 deg^2 equatorial fields $|\delta|<10^o$
  - 3450 deg^2 $-60<\delta<-30$ fields
  - Two month cadence
  - Repeated for 4 years



Picture credits: VAST collaboration

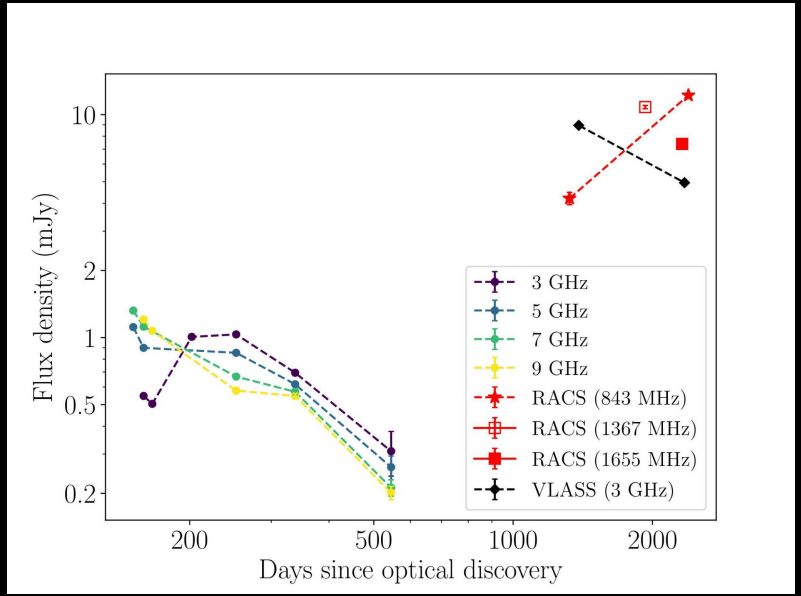
AT 2019ahk - first detection in radio

- Search for a radio source with $5''$ of optical position
- Discovered on 29 January 2019 (z=0.0262; d=115 Mpc)
- No reported radio detection for this event
- RACS detected a rising transient over a 3 year period
- Detected at low, mid and high frequencies.



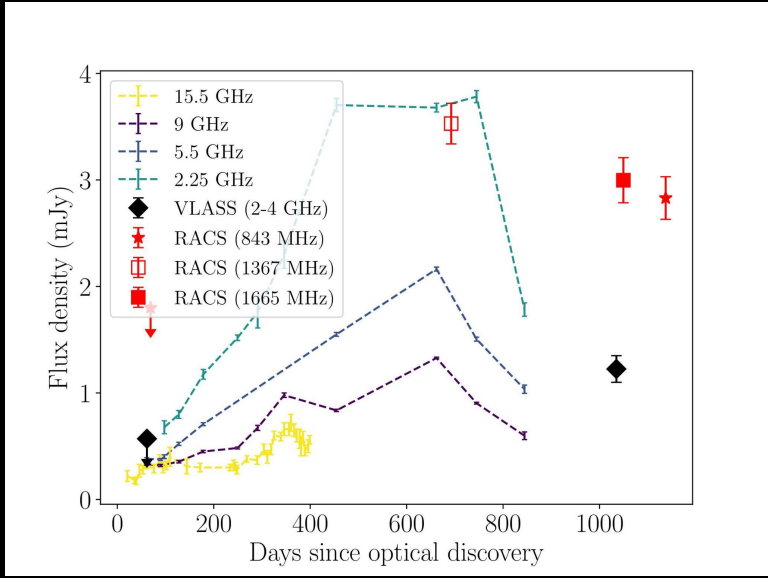
ASASSN-15oi - late time activity

- Discovered on 2015 August 14 (z=0.0484; d=216 Mpc)
- First radio detection ~ 6 months later (Horesh et al. 2021 Astronomy, *5*, 491)
- Observed to be fading rapidly
- Rebritening detected in VLASS epoch 1.1, but fading
- RACS detected a rising transient at the lowest frequency with detections at mid and high frequencies.



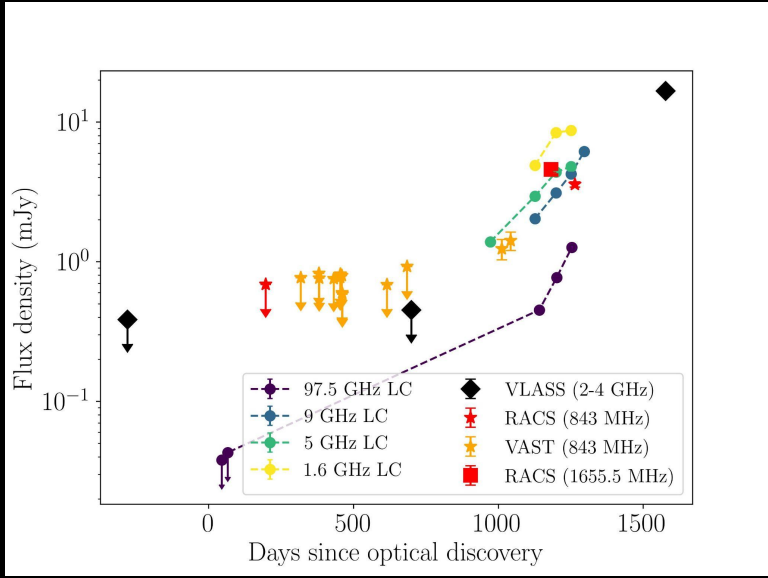
AT 2019azh - late time activity

- Discovered on 22 February 2019 (z=0.022; d=100 Mpc)
- Extensive radio follow up (Sfaradi et al. 2022, ApJ, 933, 176 and Goodwin, A. J 2022, MNRAS, 511, 5328)
- RACS detections > 3 years later in all bands
- VLASS detects in the second epoch
- Optically thin at later times or re-brightening (??)



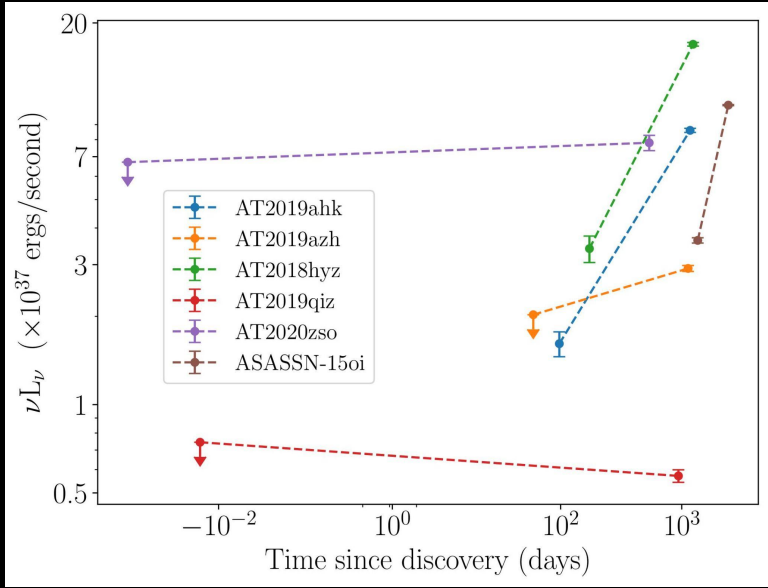
AT 2018hyz - contemporary low frequency coverage

- Discovered on 14 October 2018 (z=0.045; d=206 Mpc)
- Radio follow up (Cendes, Y 2022, ApJ, 938, 28)
- RACS and VAST pilot detections
- Reliable serendipitous observations
- Ability of VAST full survey



In a nutshell

- Sample of 6 clear TDE detections
- Late time (~ 3 year) evolution
- Need for late time radio follow-up
- ~15 % of the optical TDEs (in a 3 year period)
- Capability of high cadence VAST survey



Expectations for VAST survey

- Bias (from RACS cadence) against fast evolving TDEs
- ~15 % of the optical TDEs from RACS (in a 3 year period)
- Translates to ~10 TDE detections in the VAST survey given optical rate (lower limit)
- 2 month cadence of VAST for 4 years aids detecting fast/slow evolving radio emission from TDEs
- VAST has access to commensal data from ASKAP projects.

Future steps

- Independent sample selection from radio (Hannah Dykaar, University of Toronto, VAST collaboration)
- Prospects of radio first detection from highly dust obscured regions
- Modeling AGN + TDE activity
- Can be used as a reference for ~20% of the radio sky to check for pre-outburst activity.

If you are interested in joining the VAST collaboration, please contact Prof. David Kaplan (kaplan@uwm.edu)

https://www.vast-survey.org/