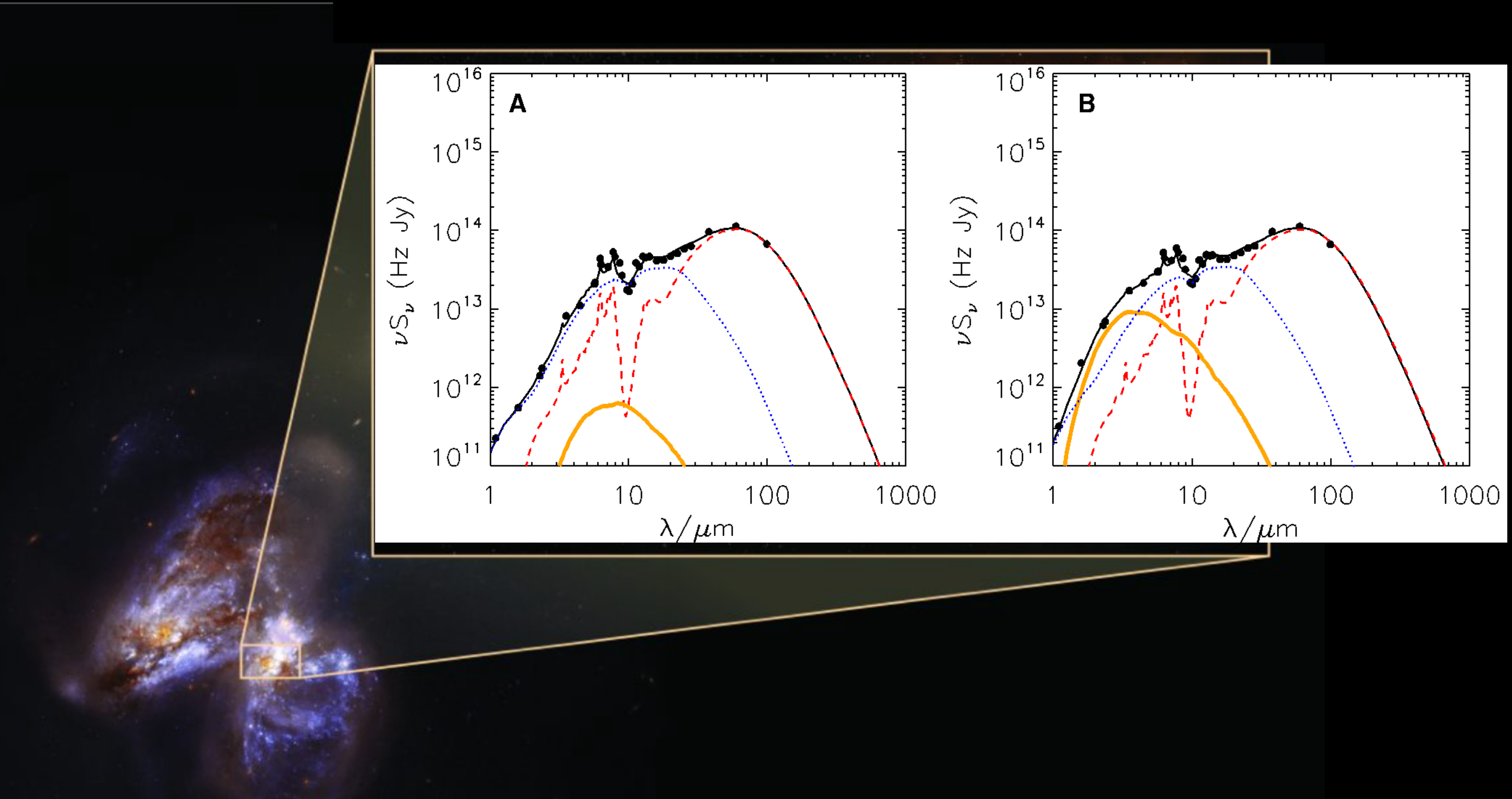
Exploring the obscured transient universe

Seppo Mattila *(University of Turku, Finland)*



Roman CCS White Paper

Exploring the obscured transient universe

Roman Core Community Survey: *High Latitude Wide Area Survey*

Scientific Categories: *stellar physics and stellar types; stellar populations and the interstellar medium; galaxies; supermassive black holes and active galaxies*

Additional scientific keywords: Galaxy mergers; Interacting galaxies; Luminous infrared galaxies; Starburst galaxies; Ultraluminous infrared galaxies; Interstellar dust; Massive stars; Supernovae; Star formation; AGN host galaxies; Supermassive black holes

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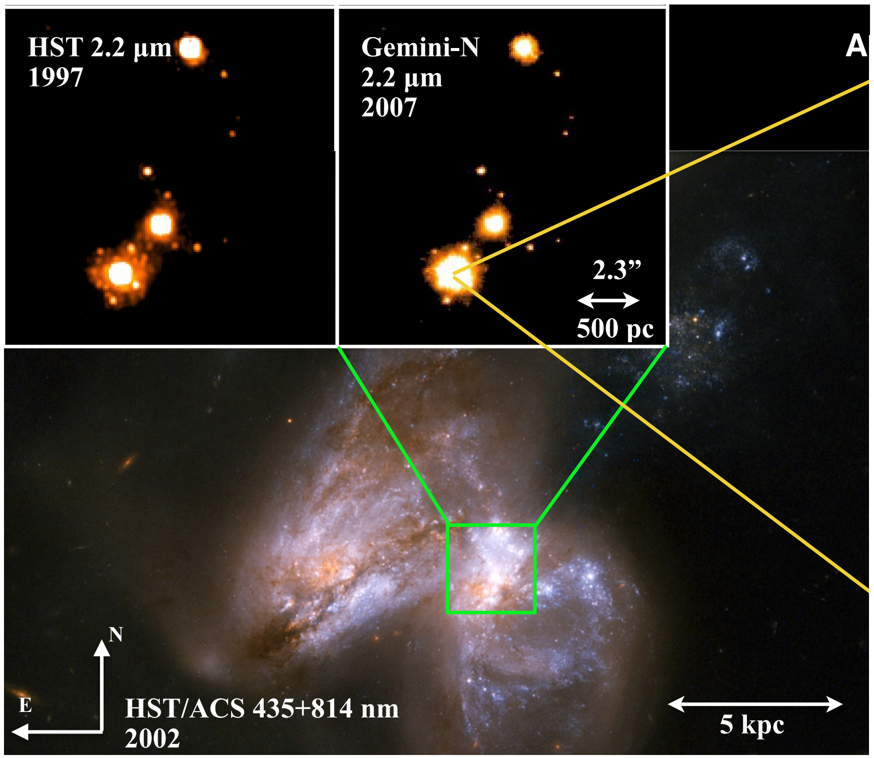
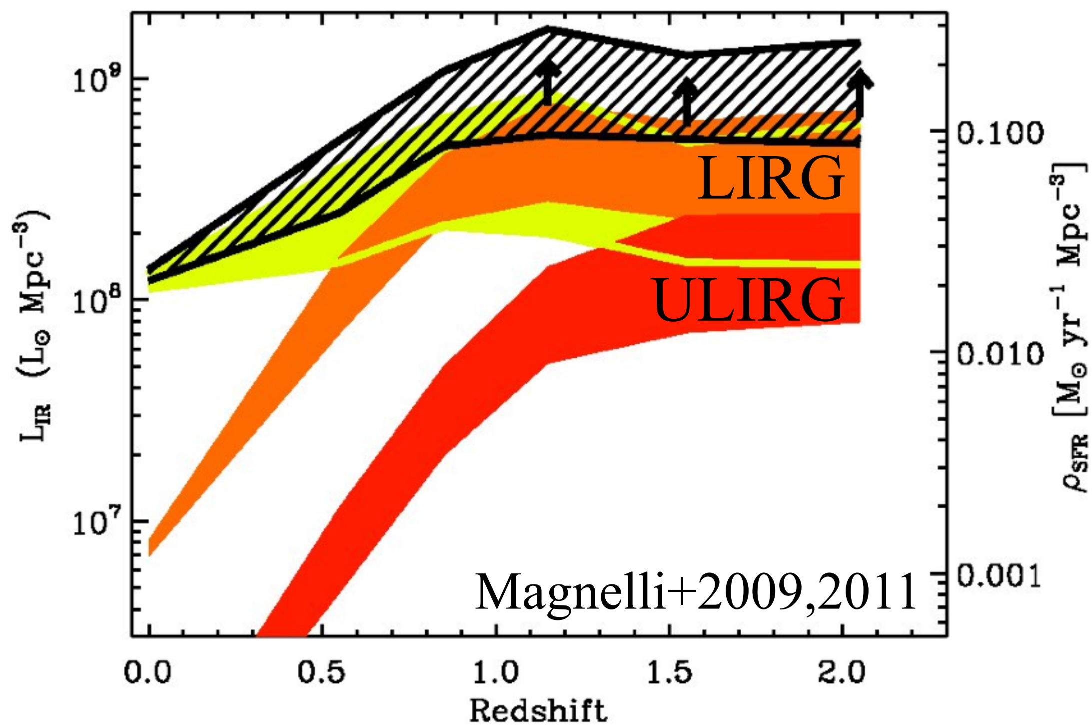
Dust-obscured transients in (U)LIRGs

- Luminous and ultraluminous ($L_{IR} > 10^{11} L_{\odot}$) IR galaxies radiate the bulk of their energy in the IR as re-radiation by warm dust, heated by a starburst and/or AGN



Arp 299, LIRG at ~45 Mpc



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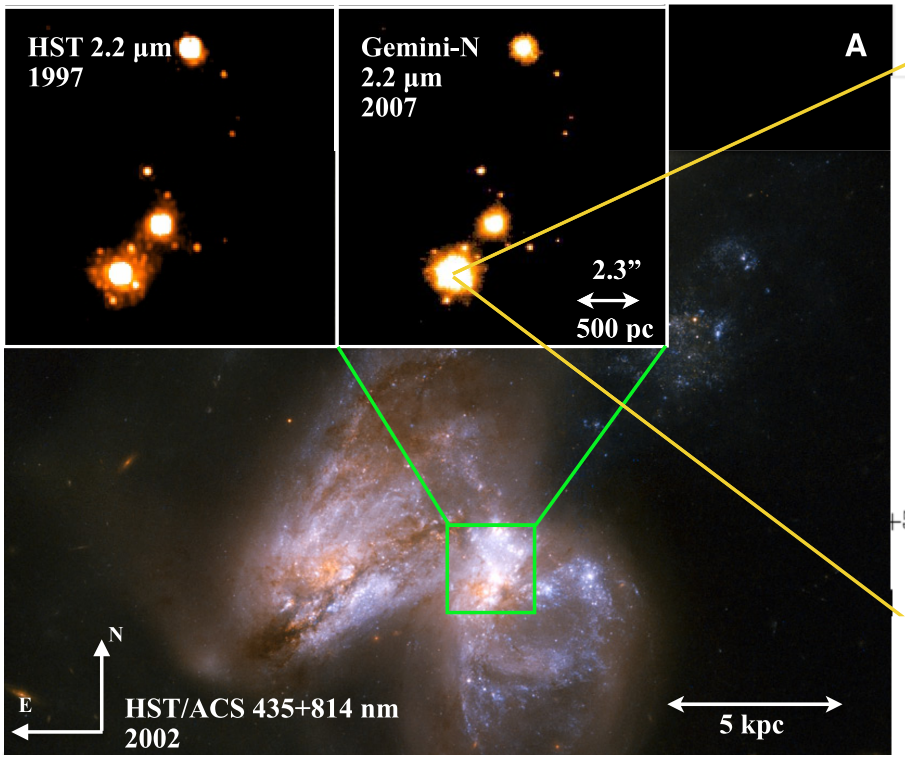

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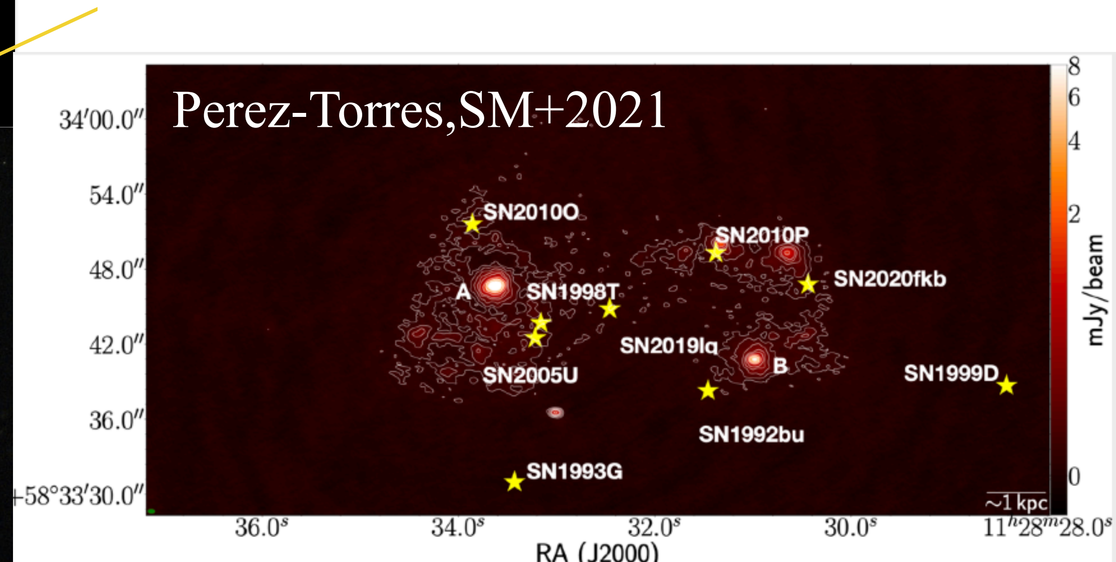

IR searches: Fox+2021; Kankare+2021; Jencson+2019; Kool+2018 + many more

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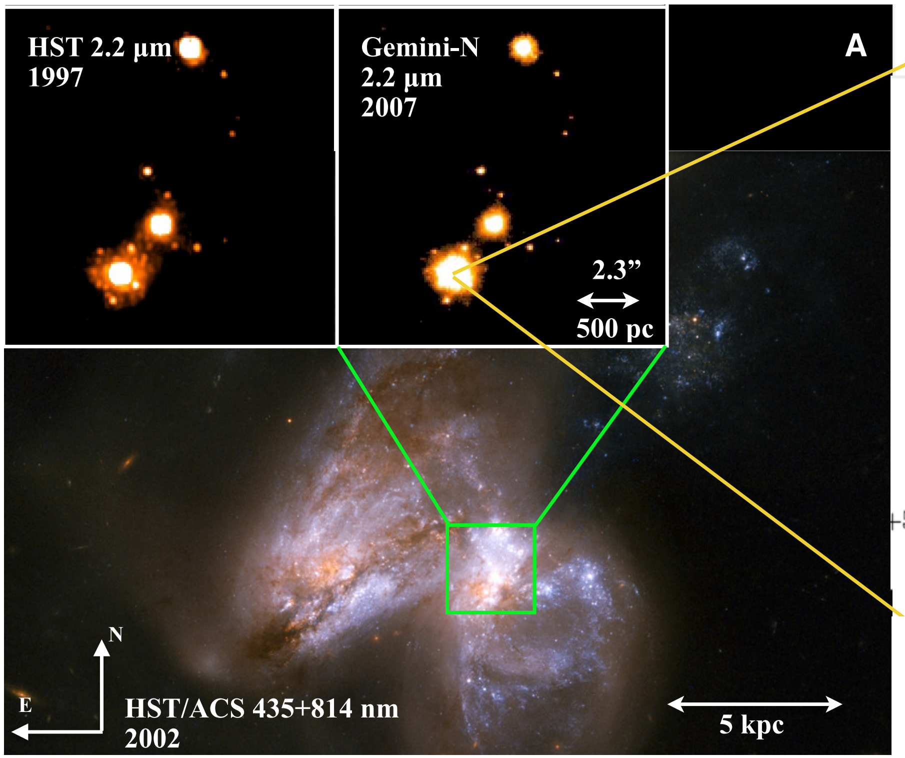

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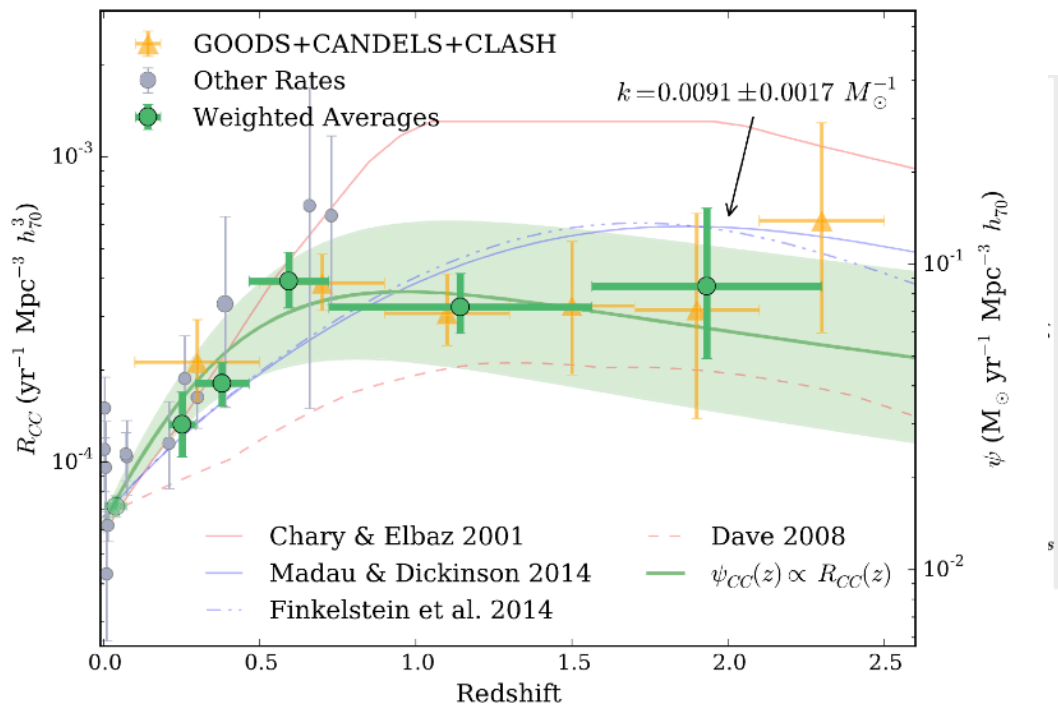

Strolger+2015; Mattila+2012

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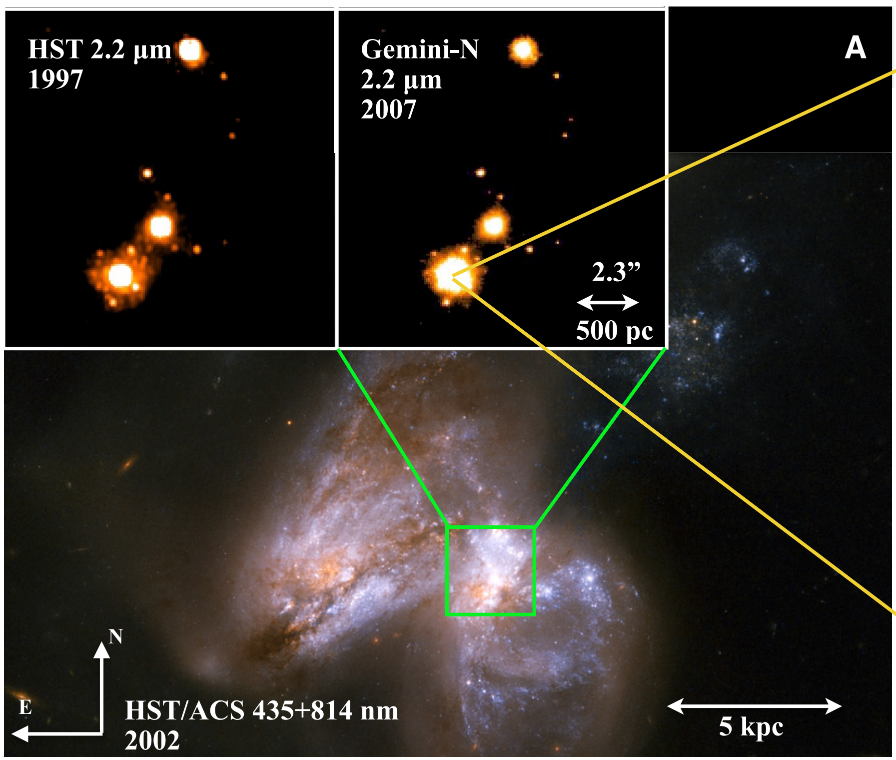

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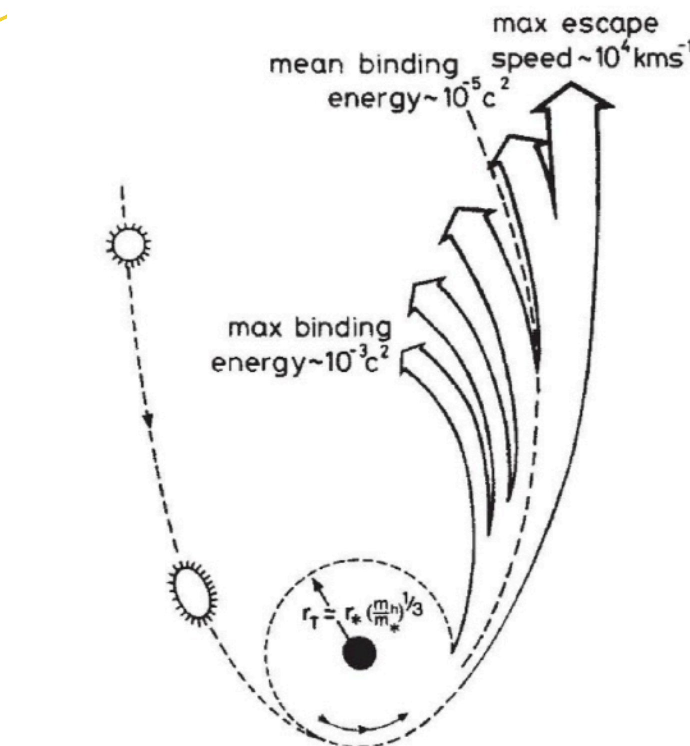

Rees 1988

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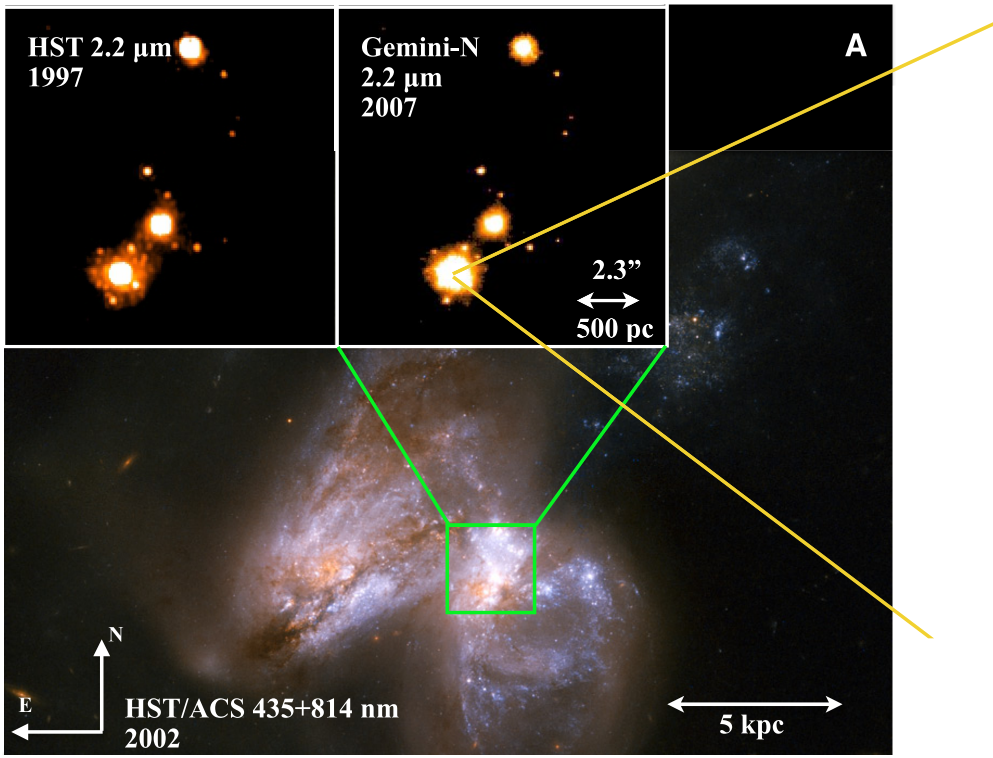

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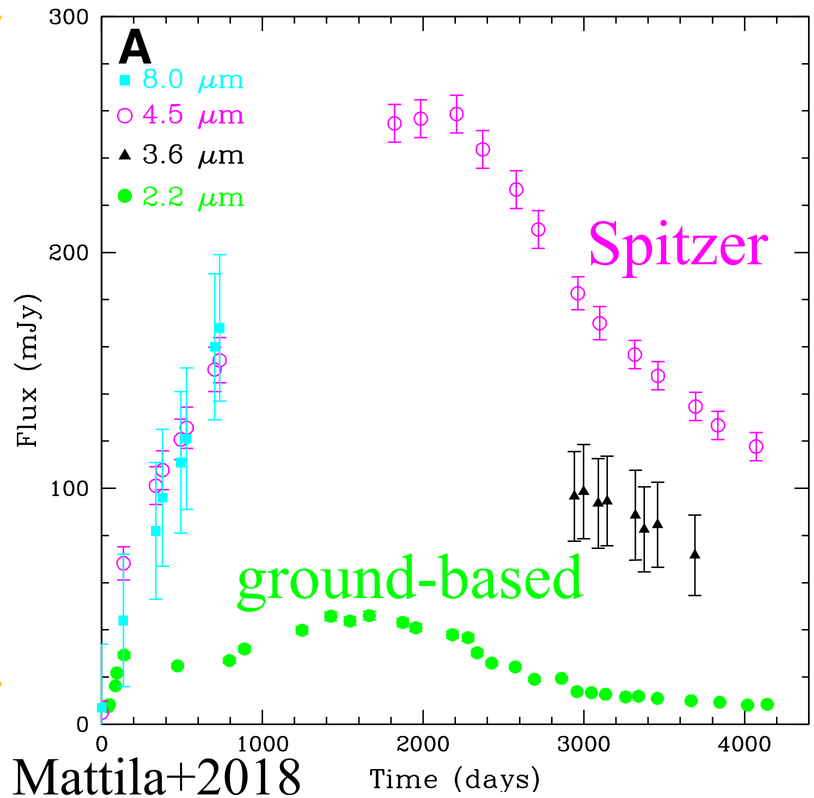
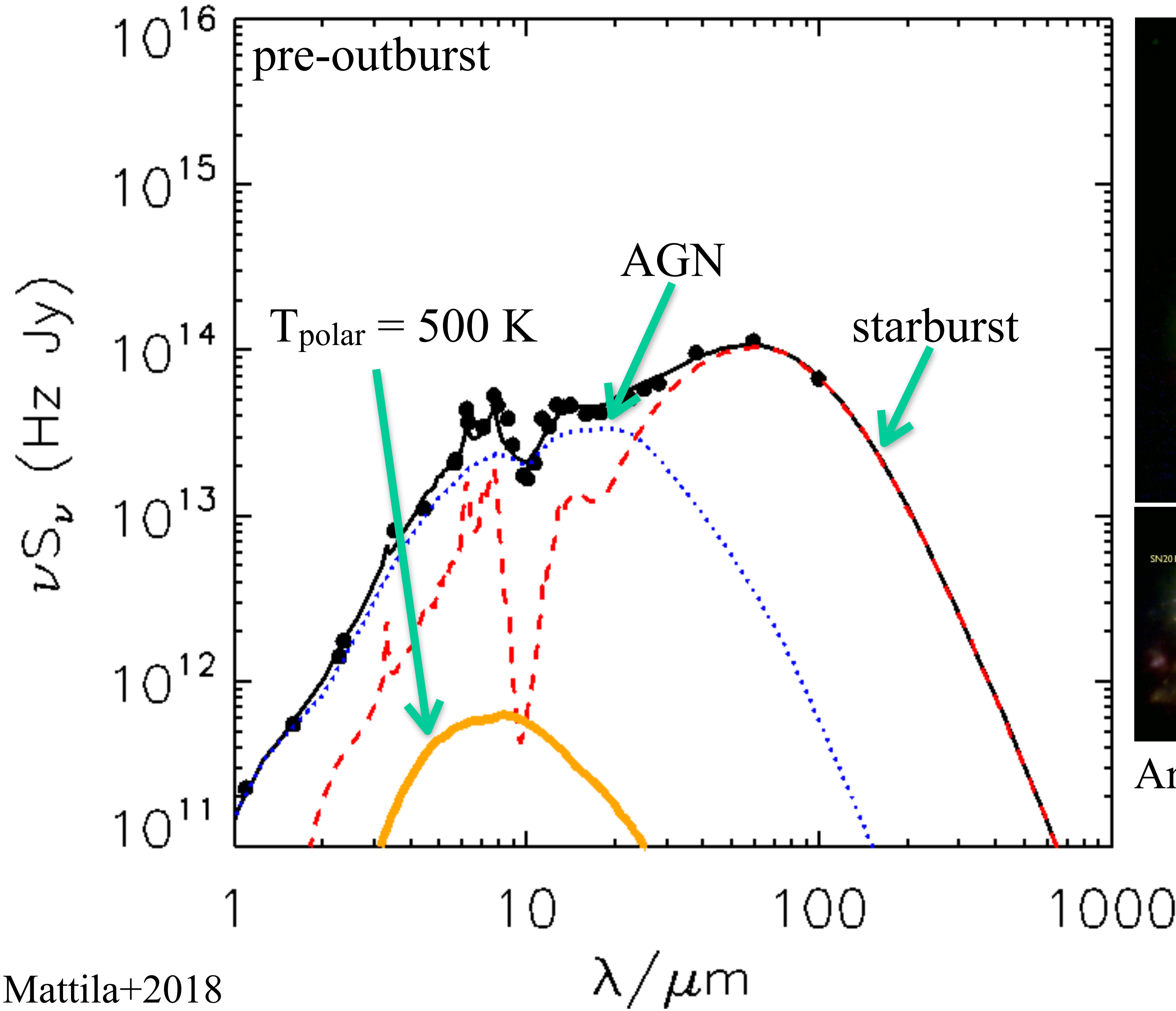
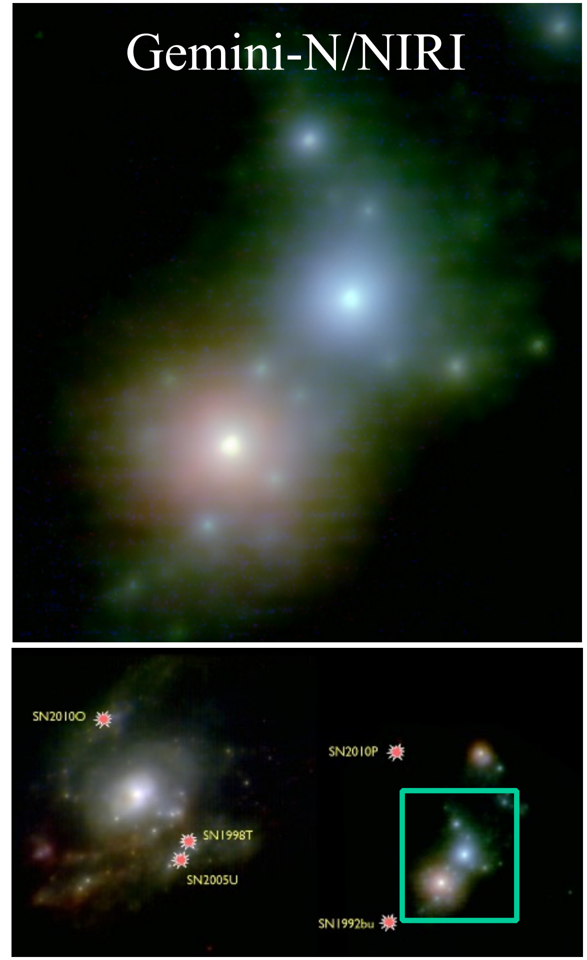


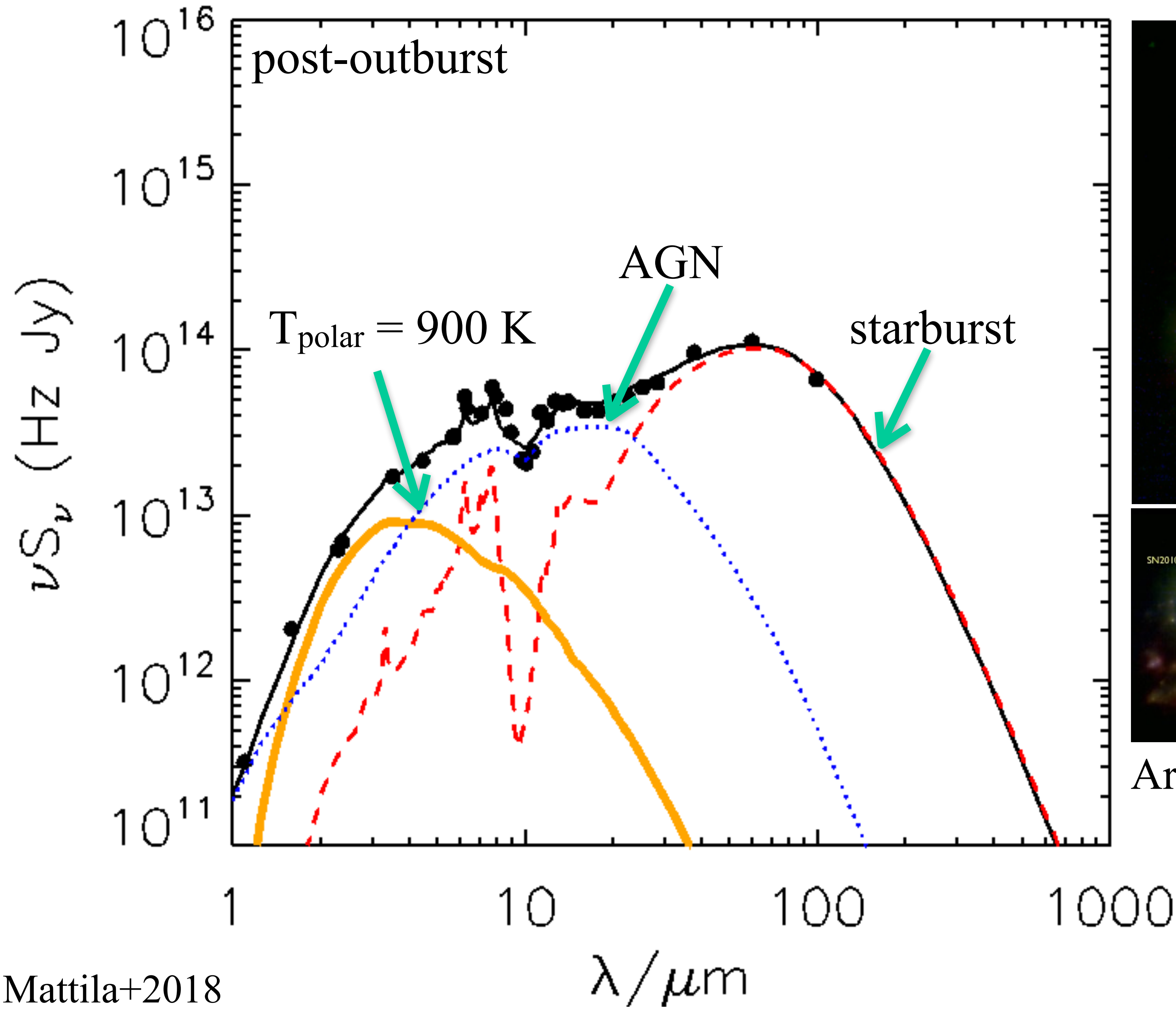
Mattila+2018





Arp 299-B

Mattila+2018



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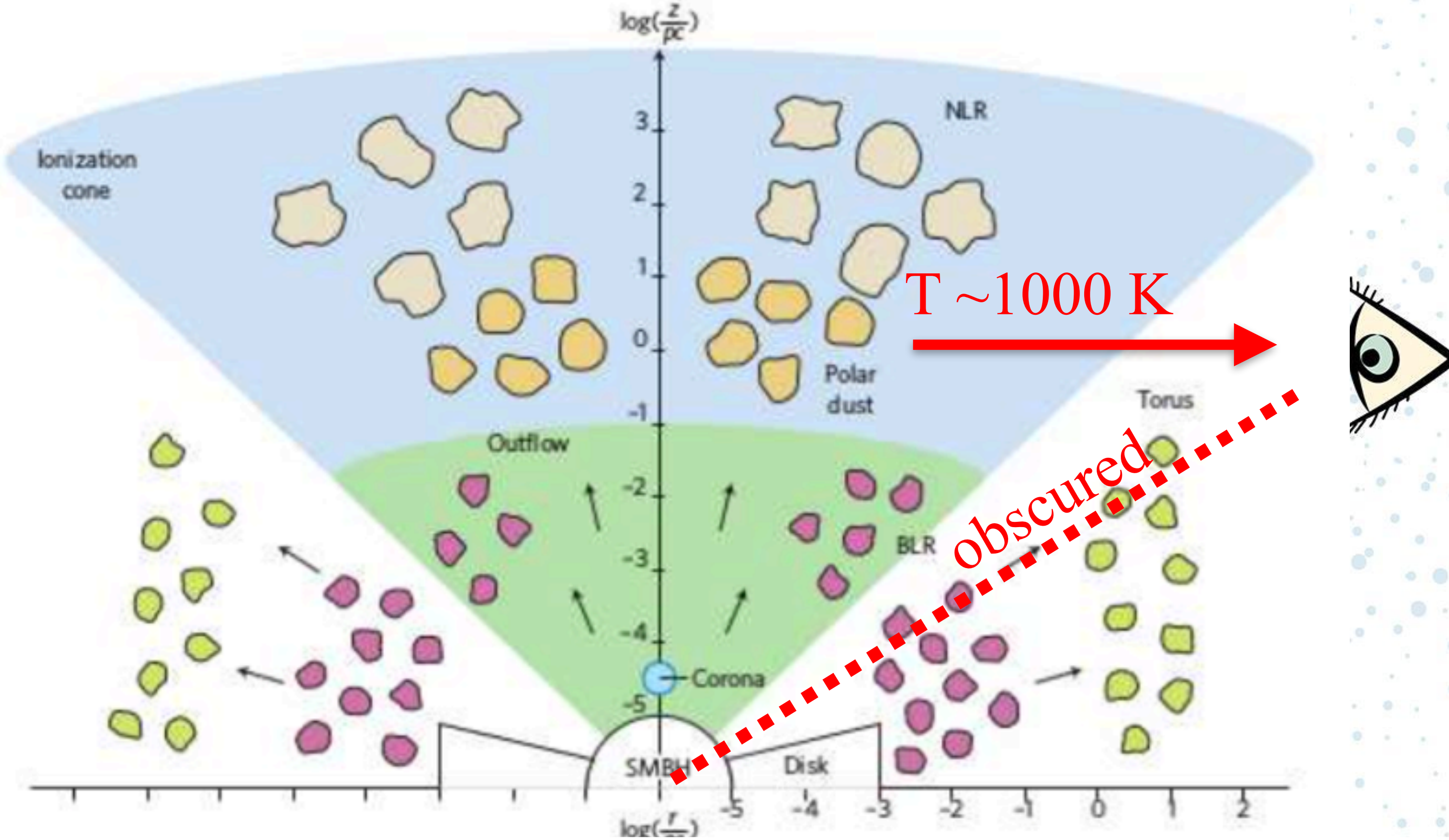
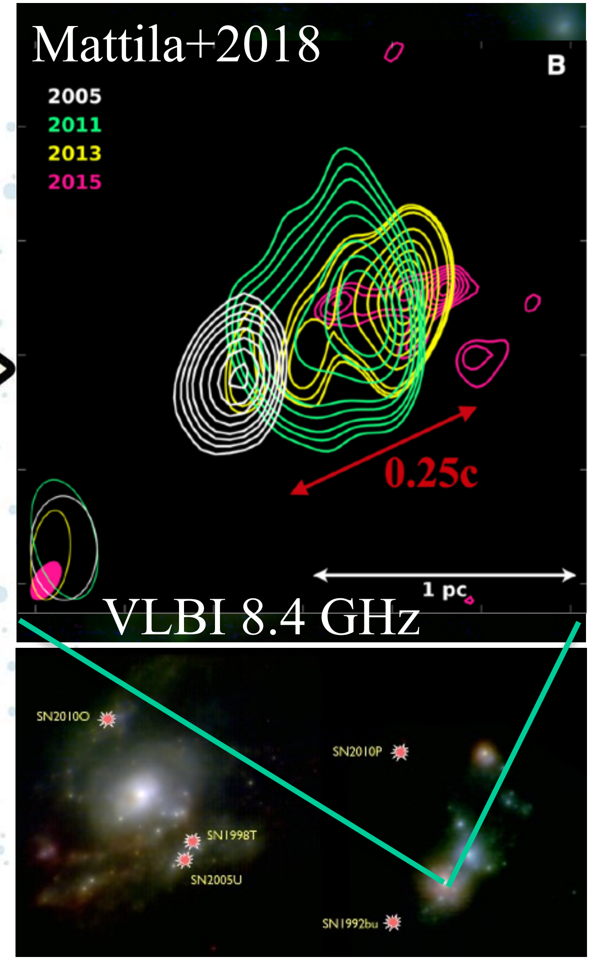


Ramos Almeida & Ricci (2017)

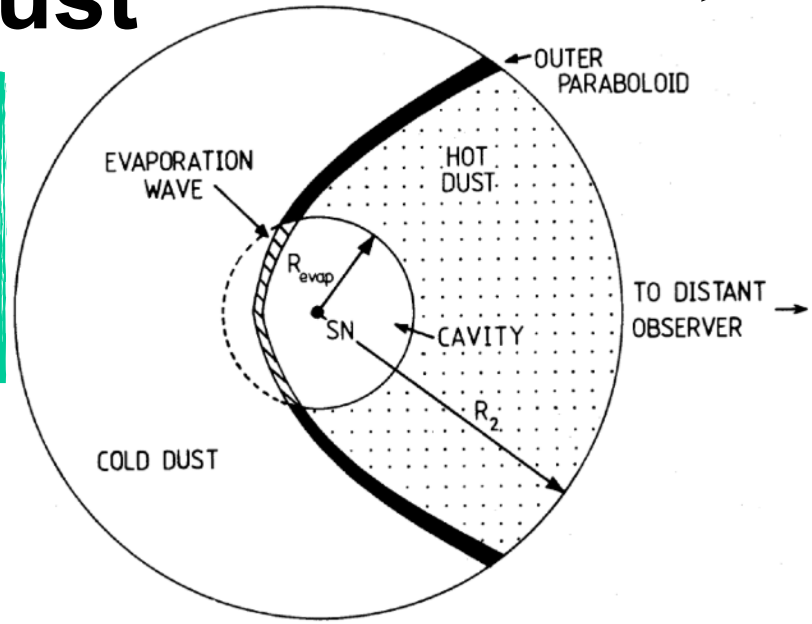


Arp 299-B

- Observed IR emission re-radiation by optically thick dust clouds in the polar regions of the AGN, which suffer from a relatively low dust extinction in the foreground
- Radio VLBI revealed a resolved, expanding jet with a viewing angle not consistent with the pre-existing AGN but likely powered by a tidally disrupted star by the SMBH

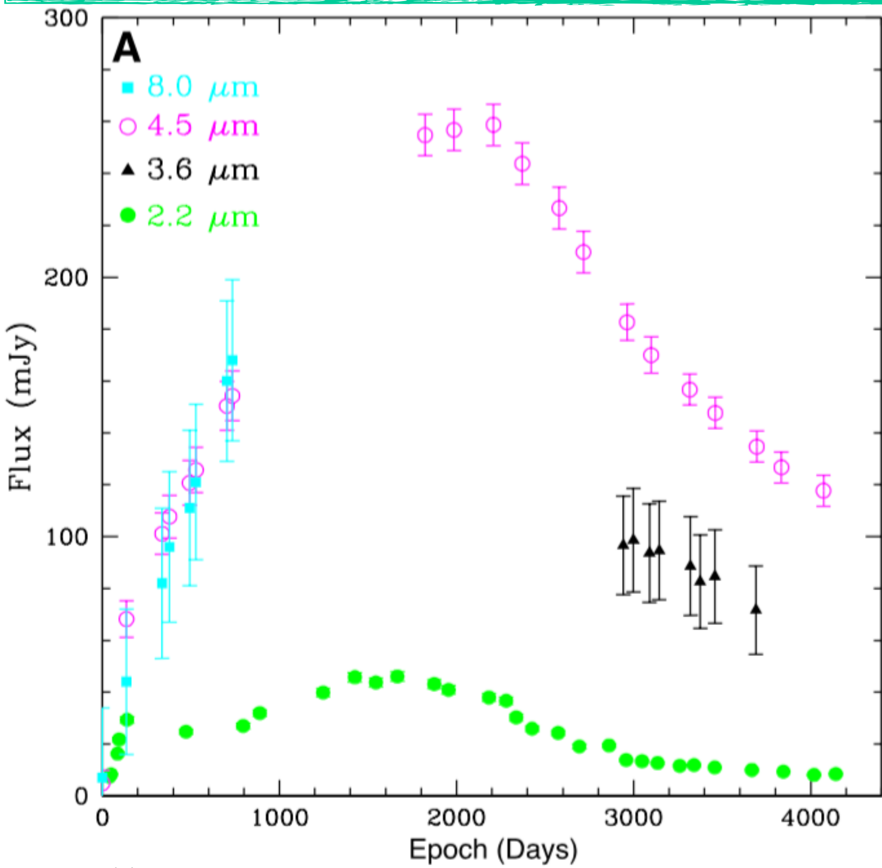
IR echo from surrounding dust

Graham & Meikle (1986)

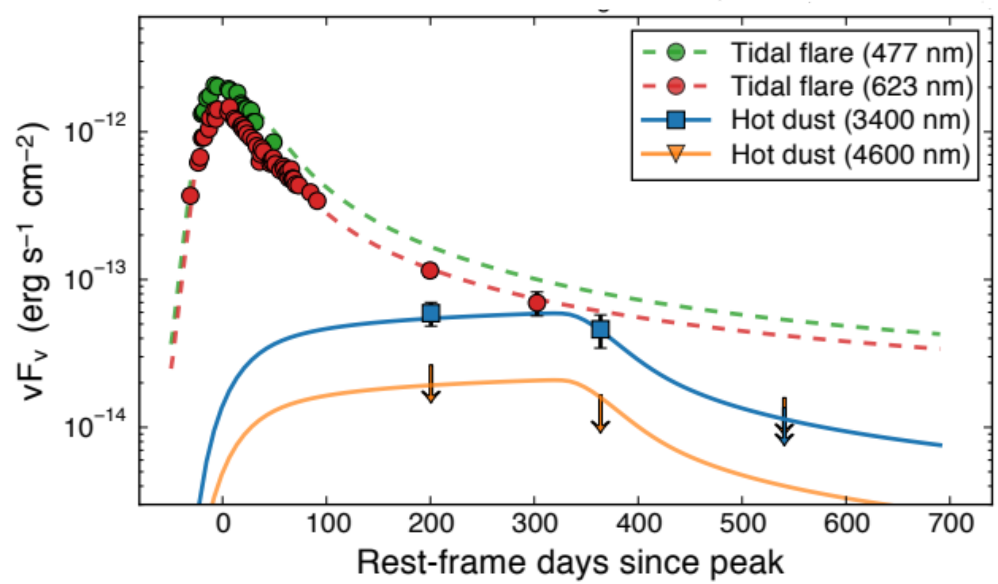


Transient's UV/optical radiation evaporates dust up to a radius determined by its luminosity and SED

Dust outside this radius absorbs and re-radiates the energy in the IR, opt-IR delay from light travel time



Mattila+2018

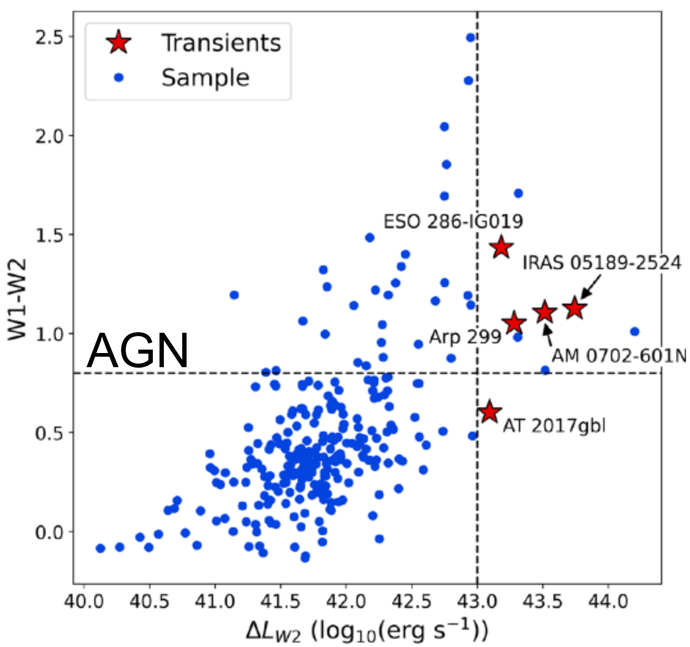


Van Velzen+2016; Lu+2016

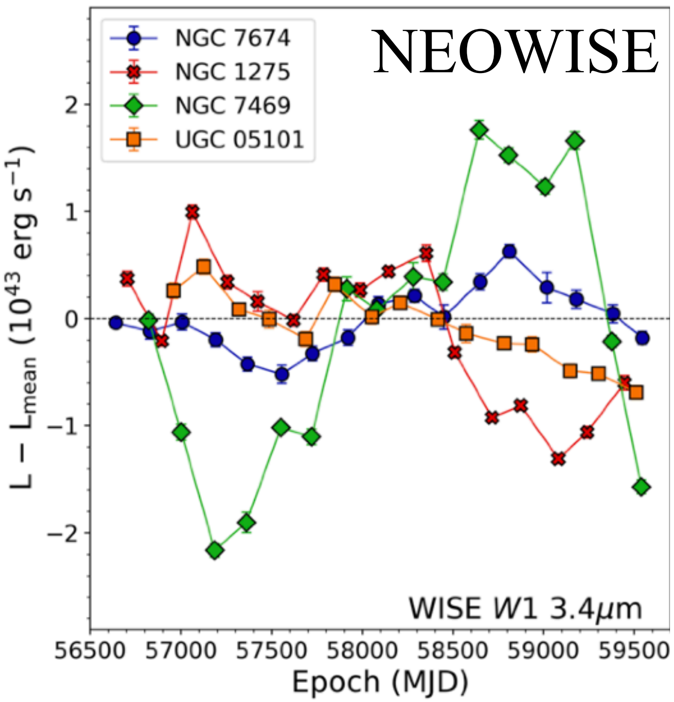
Population of dust-obscured TDEs

- Survey with NEOWISE: 6 month cadence at 3.4 and 4.6 μm from 2013 to 2020
- 215 (U)LIRGs from the IRAS revised bright galaxy catalog of Sanders
- Select nuclear transients with $\Delta L > 10^{43}$ erg s^{-1} and filter out sources showing stochastic IR variability

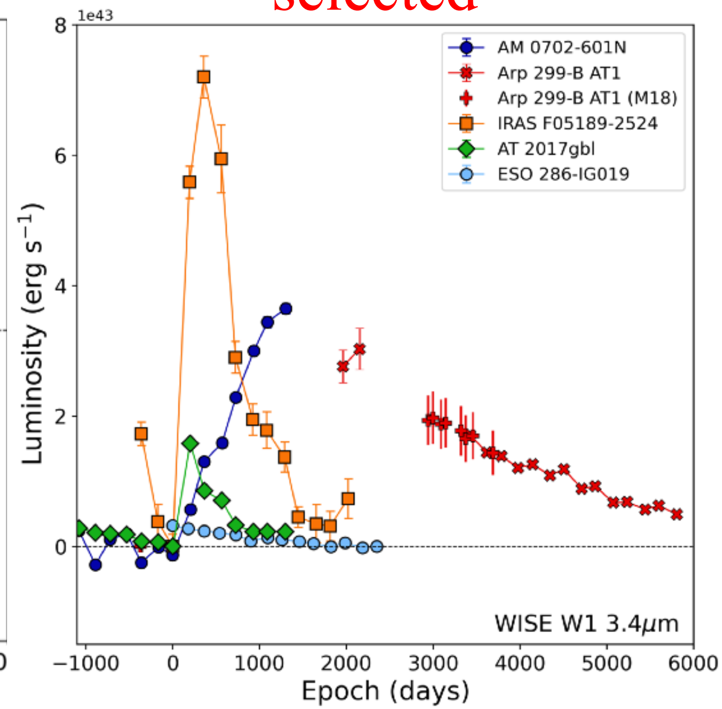
=> 5 smoothly evolving luminous transients incl. the dust-obscured Arp 299 TDE



filtered out



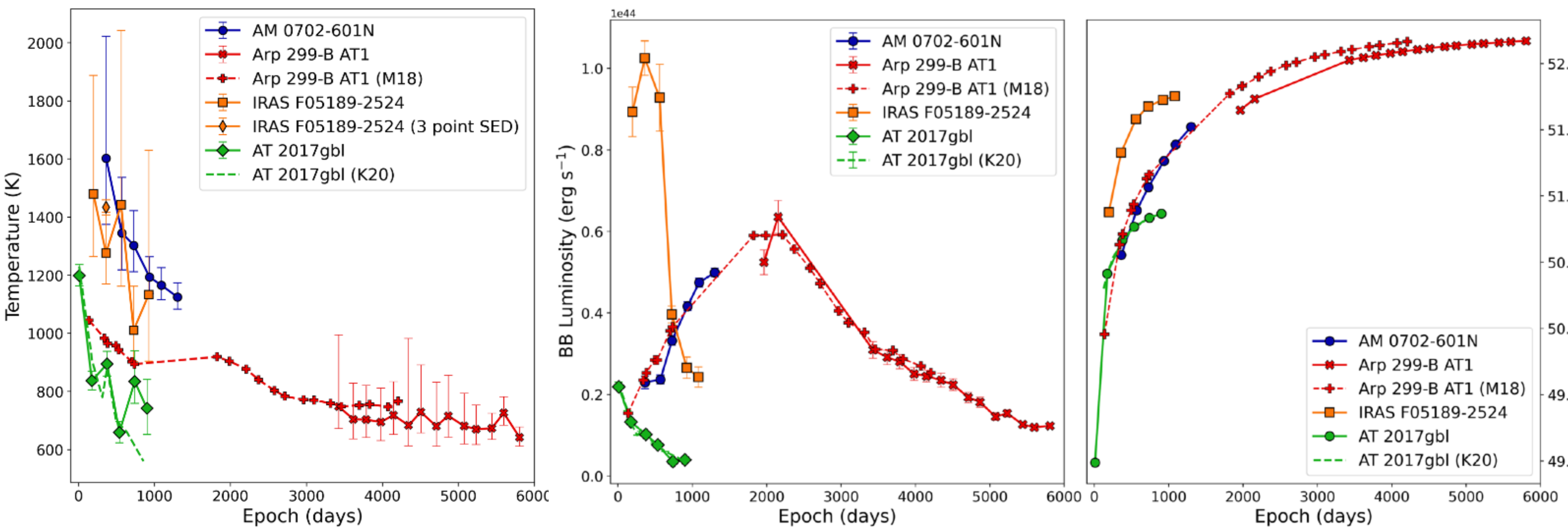
selected



Reynolds,SM+2022

Population of dust-obscured TDEs

- Blackbody temperatures consistent with transient IR echoes but more energetic than SNe or optical TDEs, also different from changing-look AGN
- Rate $10^{-(2.3\text{-}2.8)}$ LIRG^{-1} year^{-1} over order of magnitude higher than the rates of optical TDEs or extremely variable AGN - population of dust obscured TDEs in (U)LIRGs?



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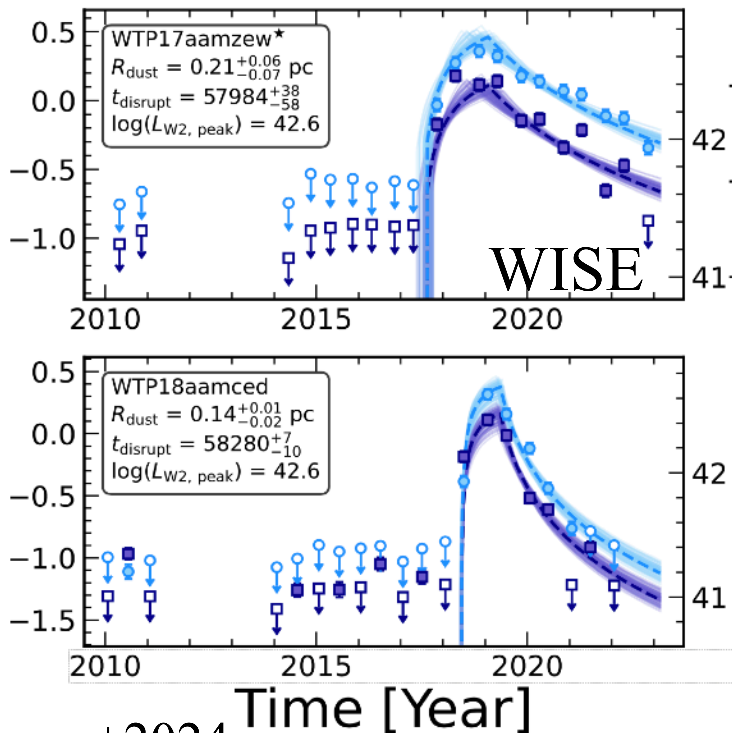
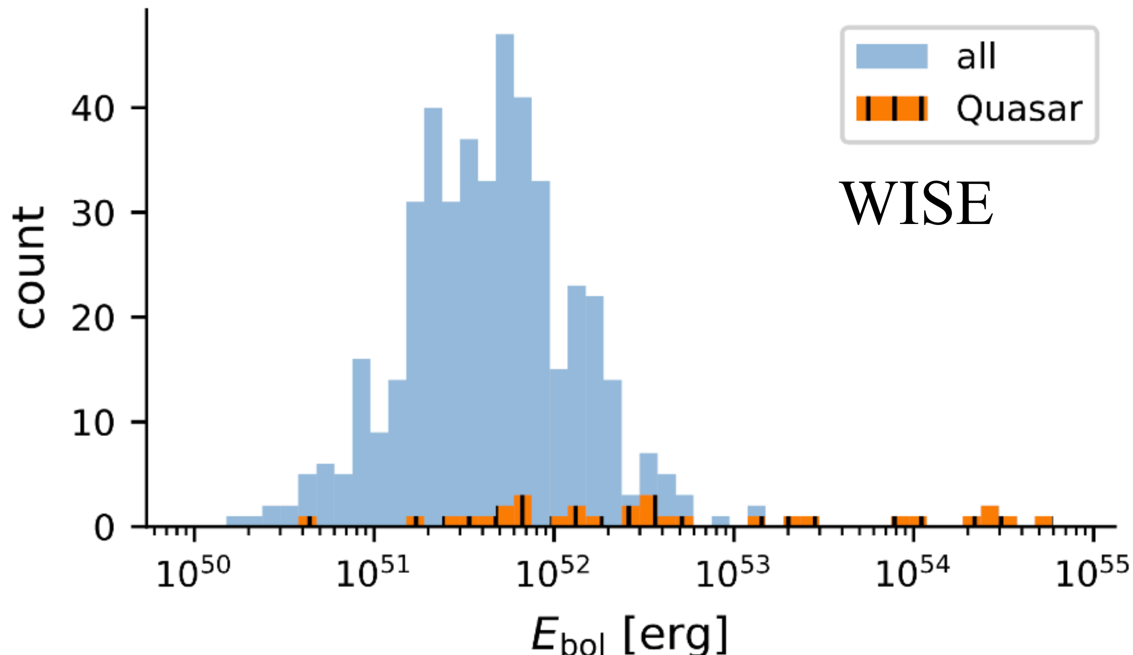
- Rate $10^{-(2.3-2.8)}$ LIRG^{-1} year^{-1} over order of magnitude higher than the rates of optical TDEs or extremely variable AGN - population of dust obscured TDEs in (U)LIRGs?
- Recent searches in NEOWISE data have identified large samples of candidate TDE IR echoes over the whole sky with rates comparable to the optical TDE rates



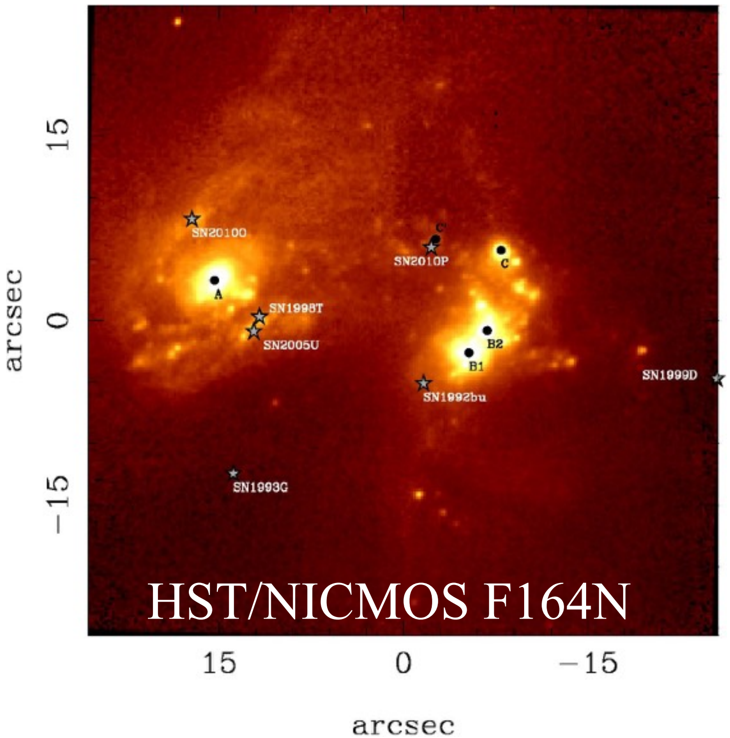
Masterson+2024

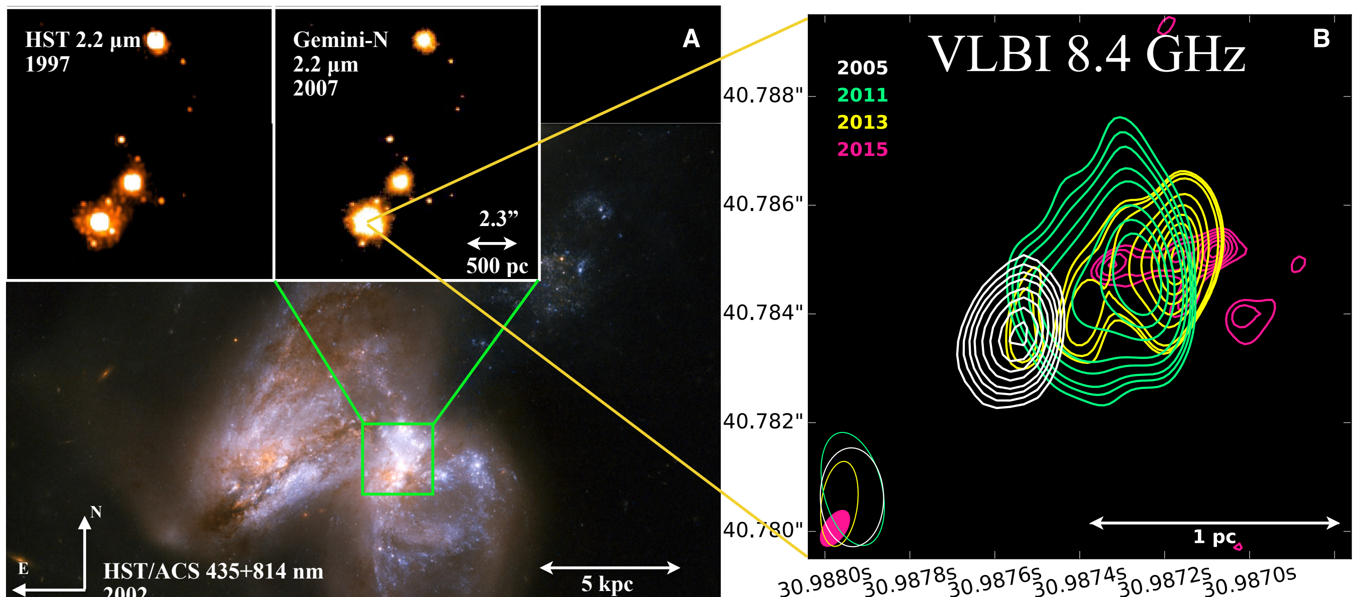


Necker+2024

Detectability of dust-obscured transients in HLWAS

- In Mattila+ White Paper we propose turning RST into an efficient discovery machine of dust-obscured transients thanks to wide FOV in the IR, spatial resolution, depth
- **Dividing High Latitude Wide Area Survey into separate epochs ~6-12 months apart** in time would allow the detection of slowly evolving transients over 1700 deg^2
- **Including the F213 filter** in the survey would allow more efficient characterisation of the detected transients using additional color information

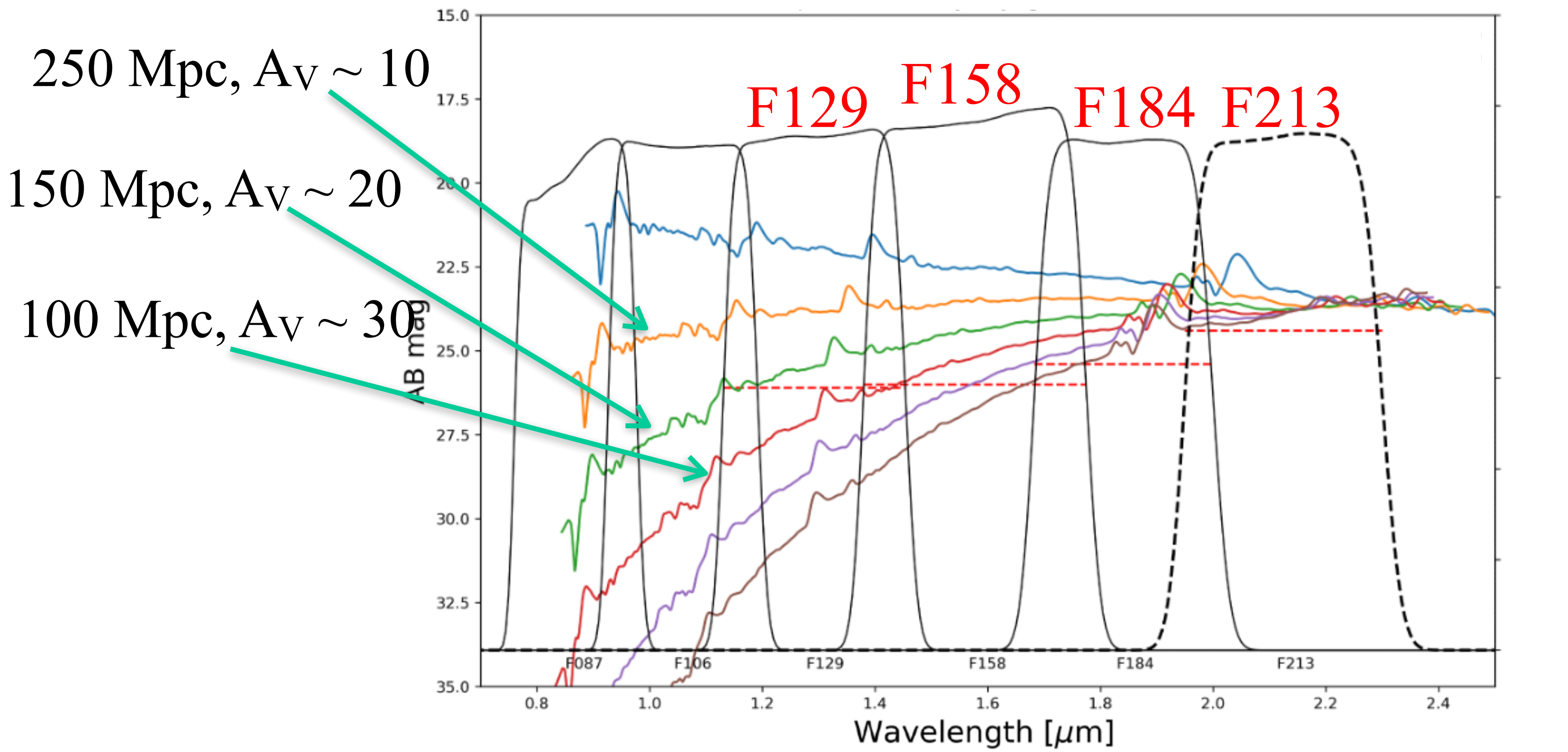




Mattila+2018

Detectability of dust-obscured transients in HLWAS

- RST can detect in several filters large numbers of dust-obscured (A_V < 10 mag) core-collapse SNe up to 250 Mpc and some SNe with A_V ~ 30 mag up to 100 Mpc



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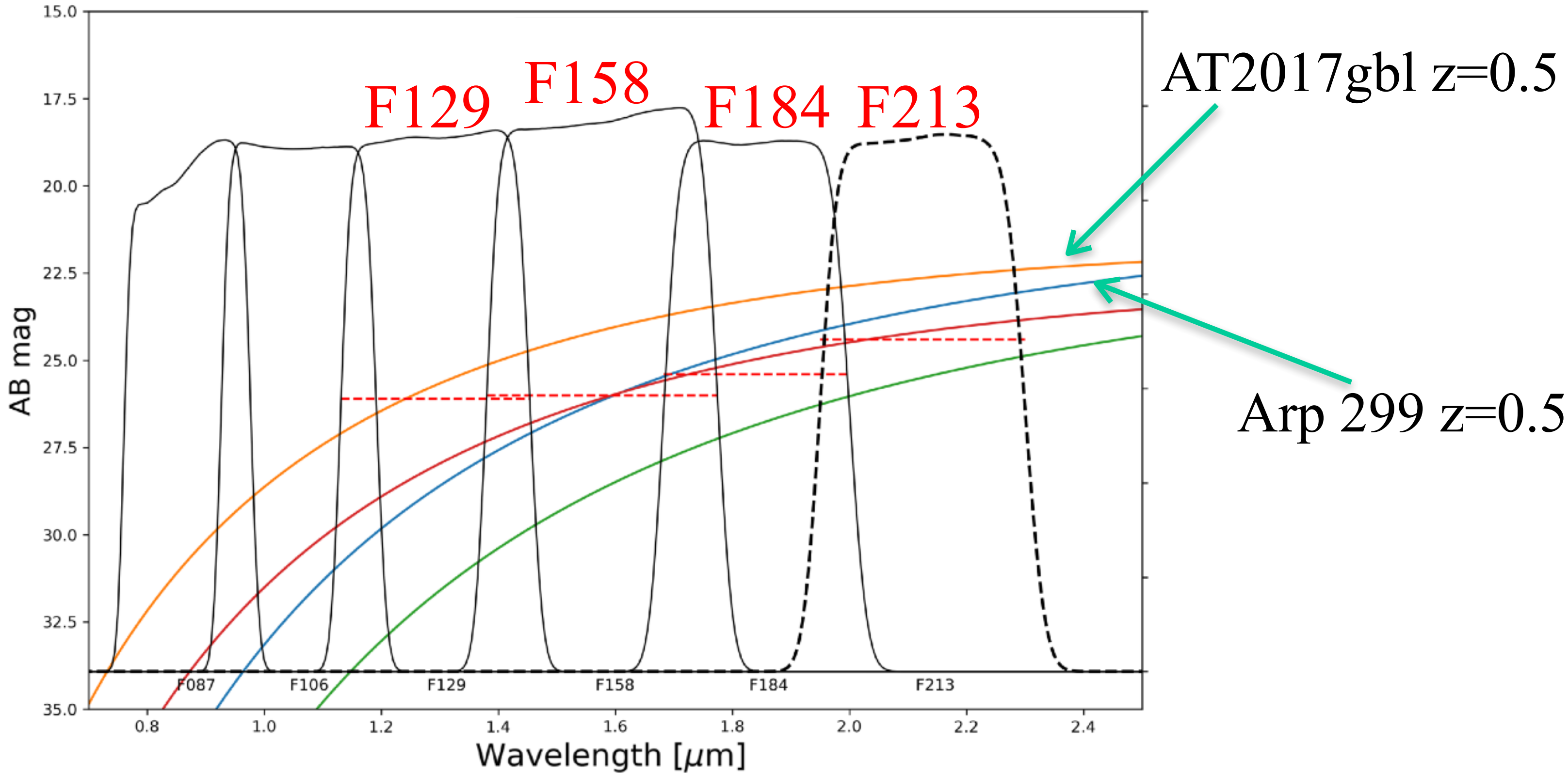
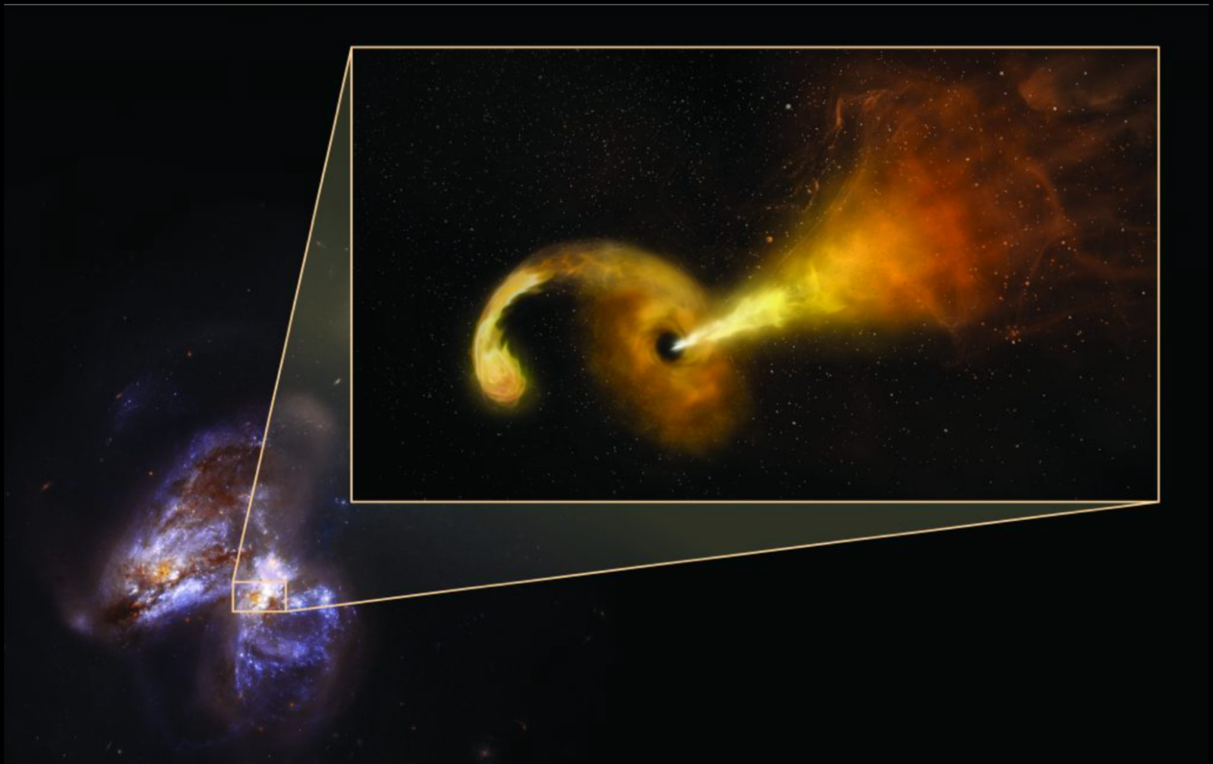
- IR luminous TDE candidates are detectable in several filters up to z ~ 0.5; HLWAS could allow the characterisation of several 100s if divided into >2 epochs



Summary

- Ground-based near-IR observations, Spitzer and WISE have revealed dust-obscured SNe and TDE candidates within the nuclear regions of nearby galaxies
- Dividing the High Latitude Wide Area Survey into >2 epochs can allow characterisation of dust-obscured transients at a level not possible in any previous surveys
- Important implications, e.g., for SNe as probes of the cosmic star formation history and via characterisation of the dust-obscured TDE population for feedings of the SMBHs



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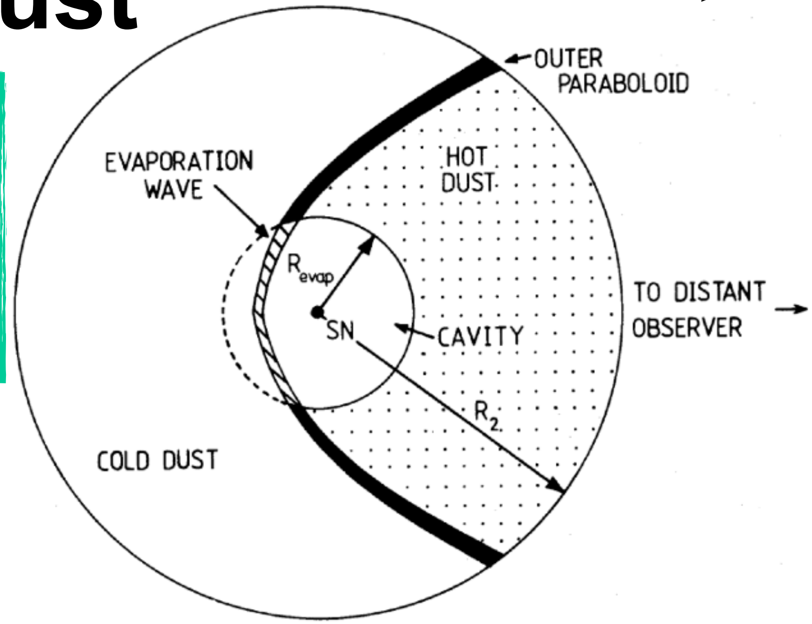

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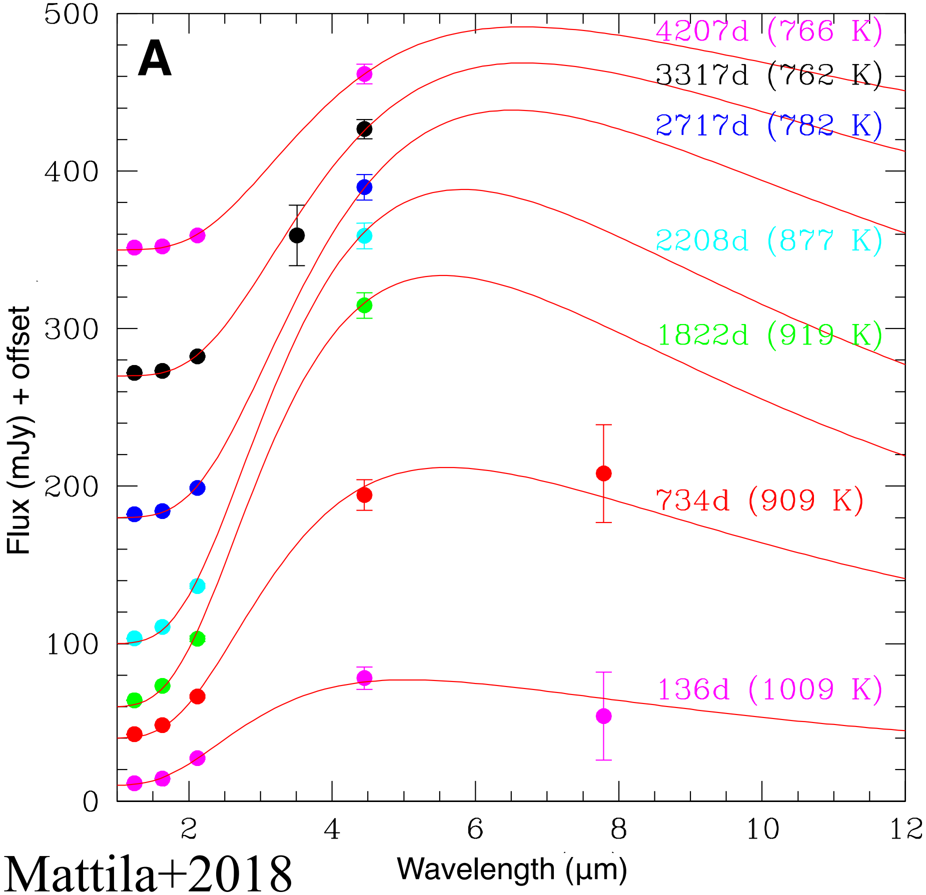
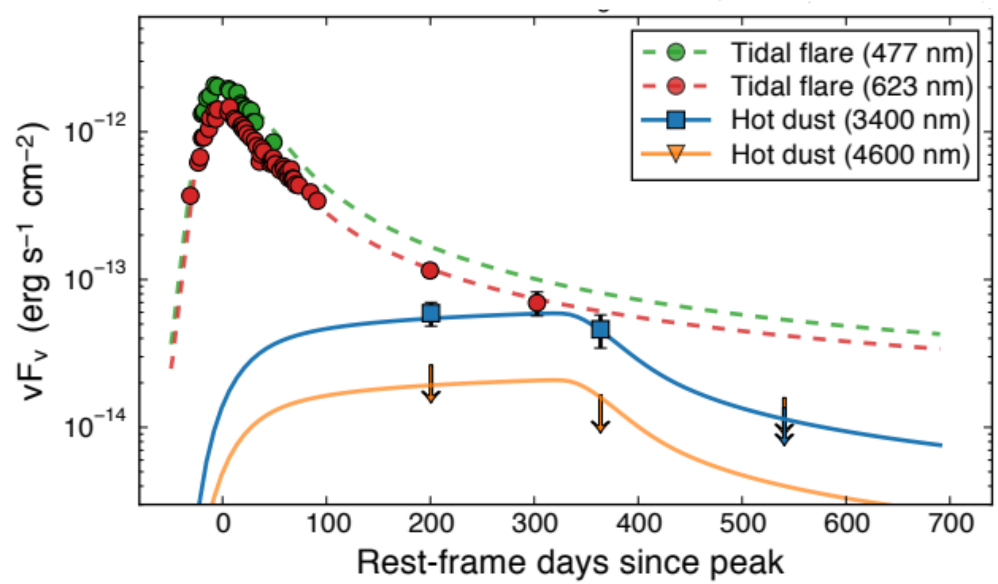


Mattila+2018



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