

Shocking news - a polarizing study of a tidal disruption event

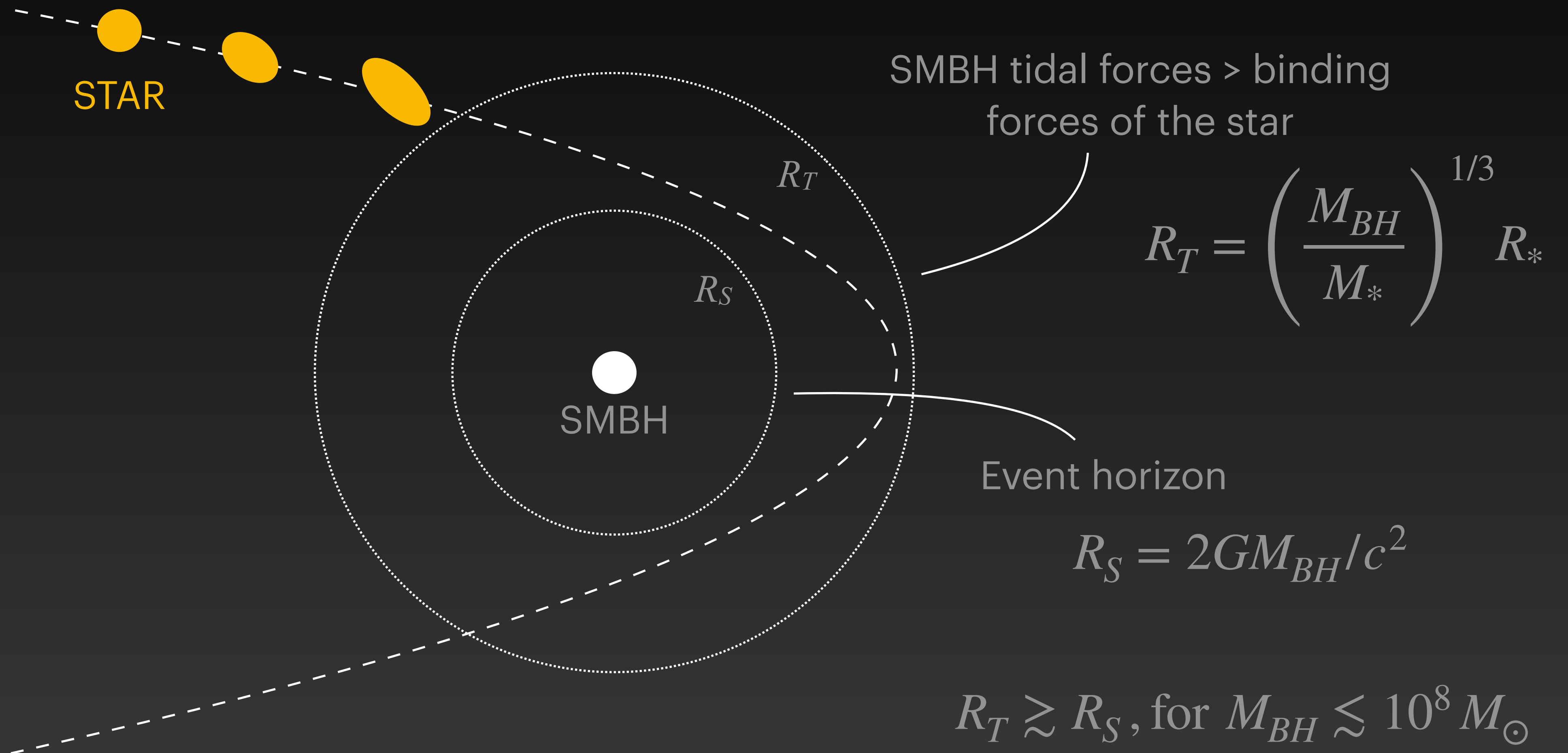
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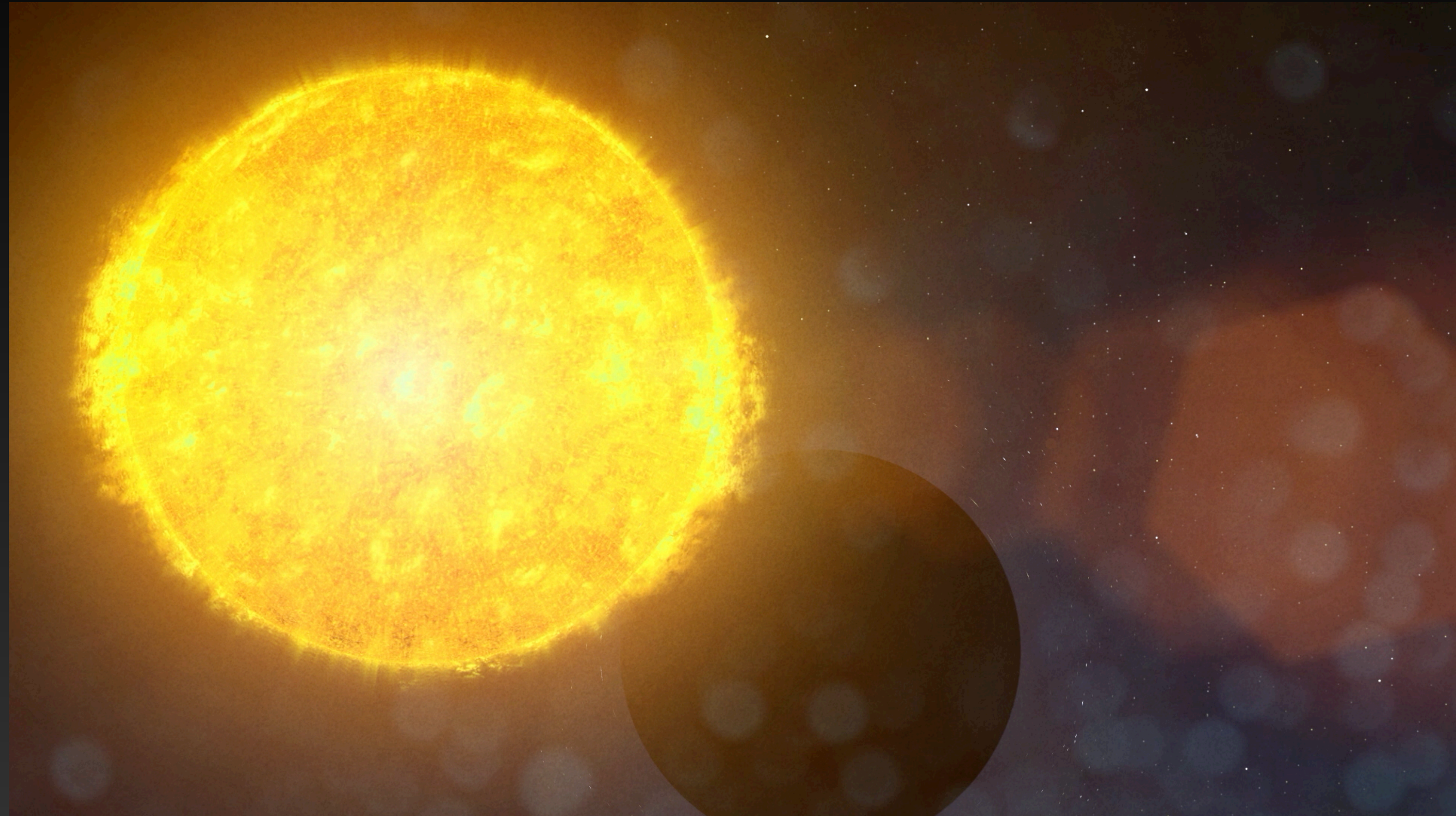
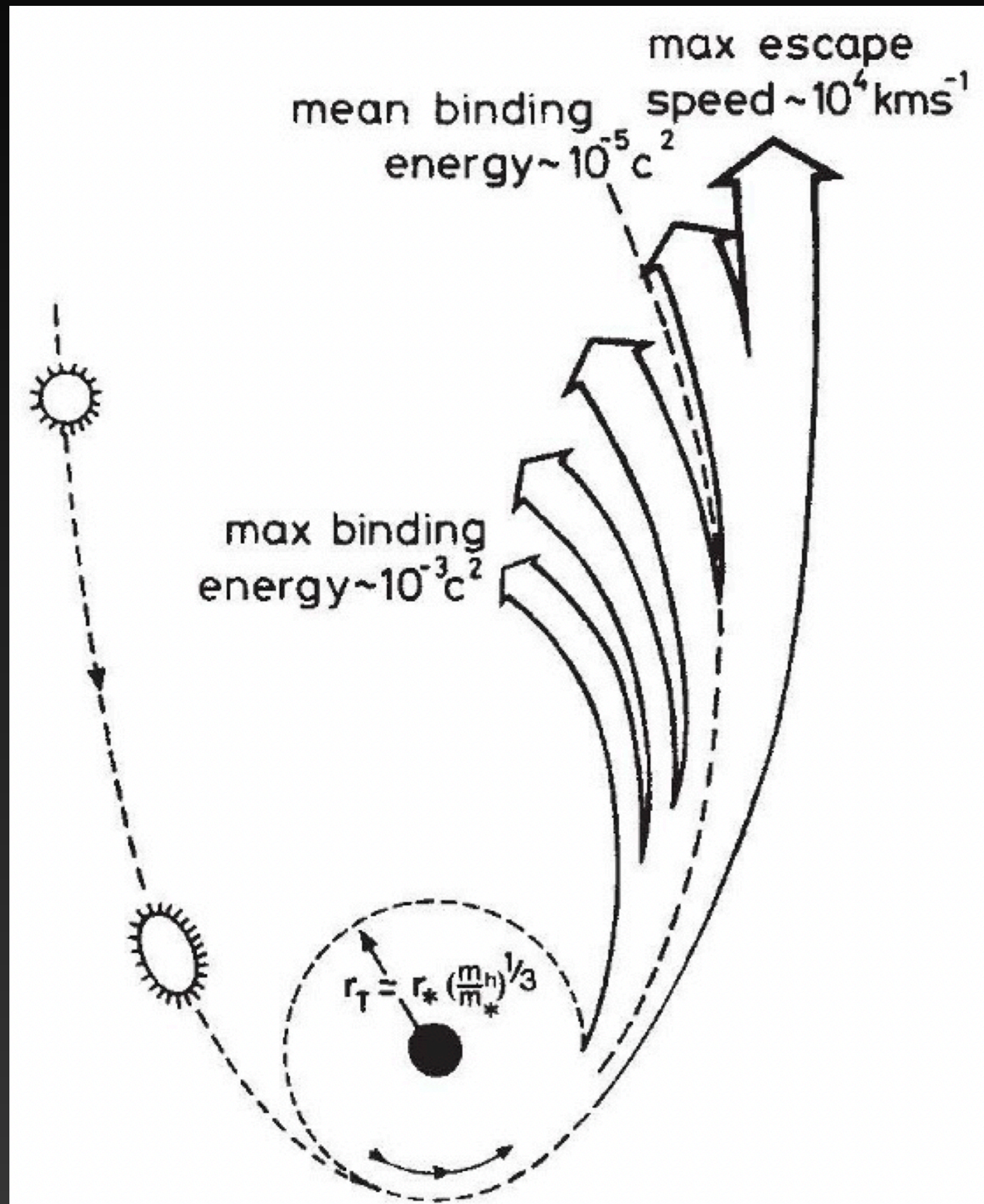
+ Yannis Liodakis (FINCA), Elina Lindfors (FINCA), Talvikki Hovatta (FINCA), Marco Berton (FINCA), Jenni Jormanainen (FINCA), Kari Nilsson (FINCA), Dmitry Blinov (FORTH/Heraklion), Kate Alexander (CIERA/Northwestern), K. Kouroumpatzakis (FORTH/Heraklion), N. Mandrakas (FORTH/Heraklion)

Liodakis, KK, et al.
Accepted for publication in Science

Tidal Disruption Event (TDE)



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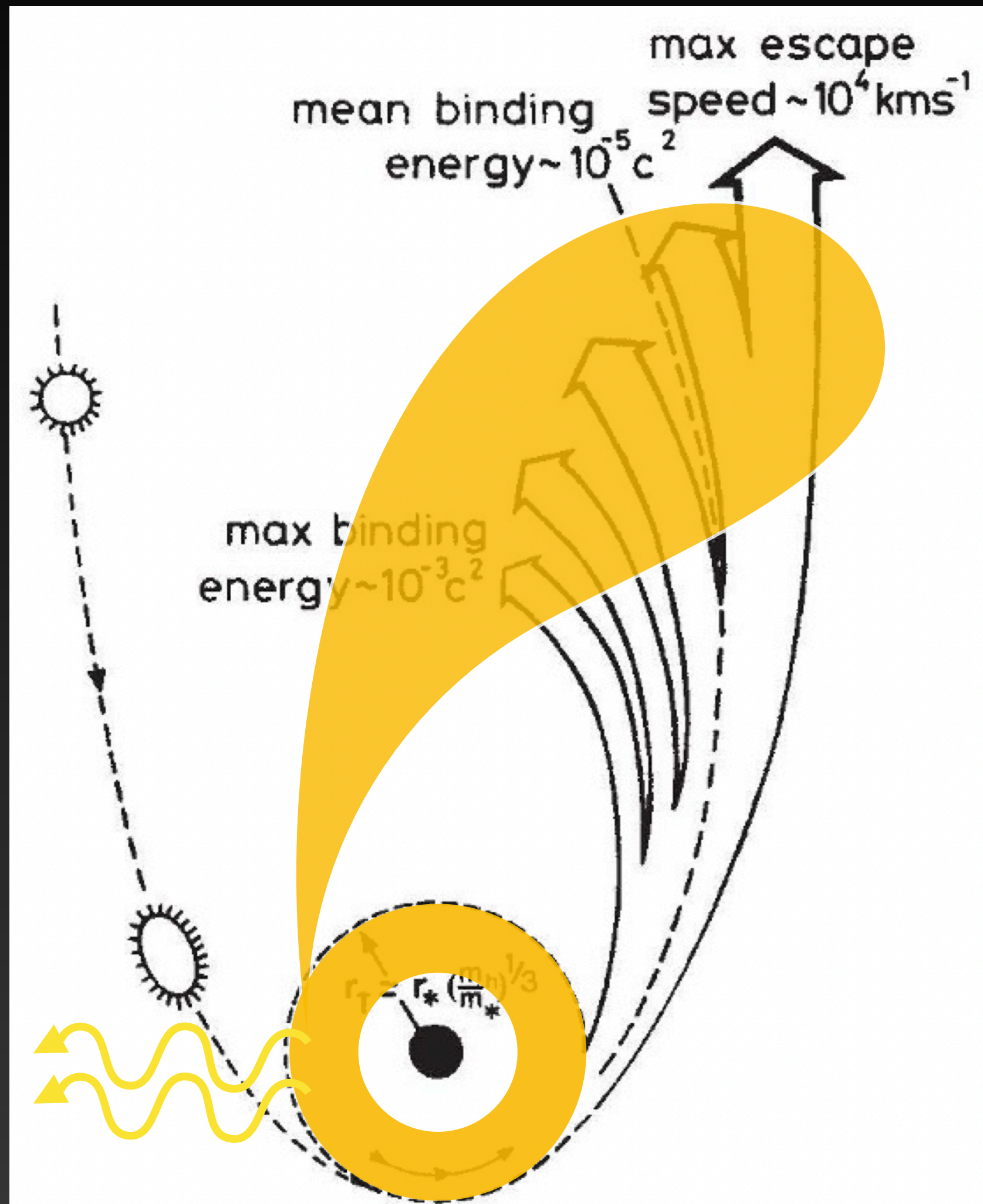


Credit: NASA's Goddard Space Flight Center/Chris Smith (USRA/GESTAR)

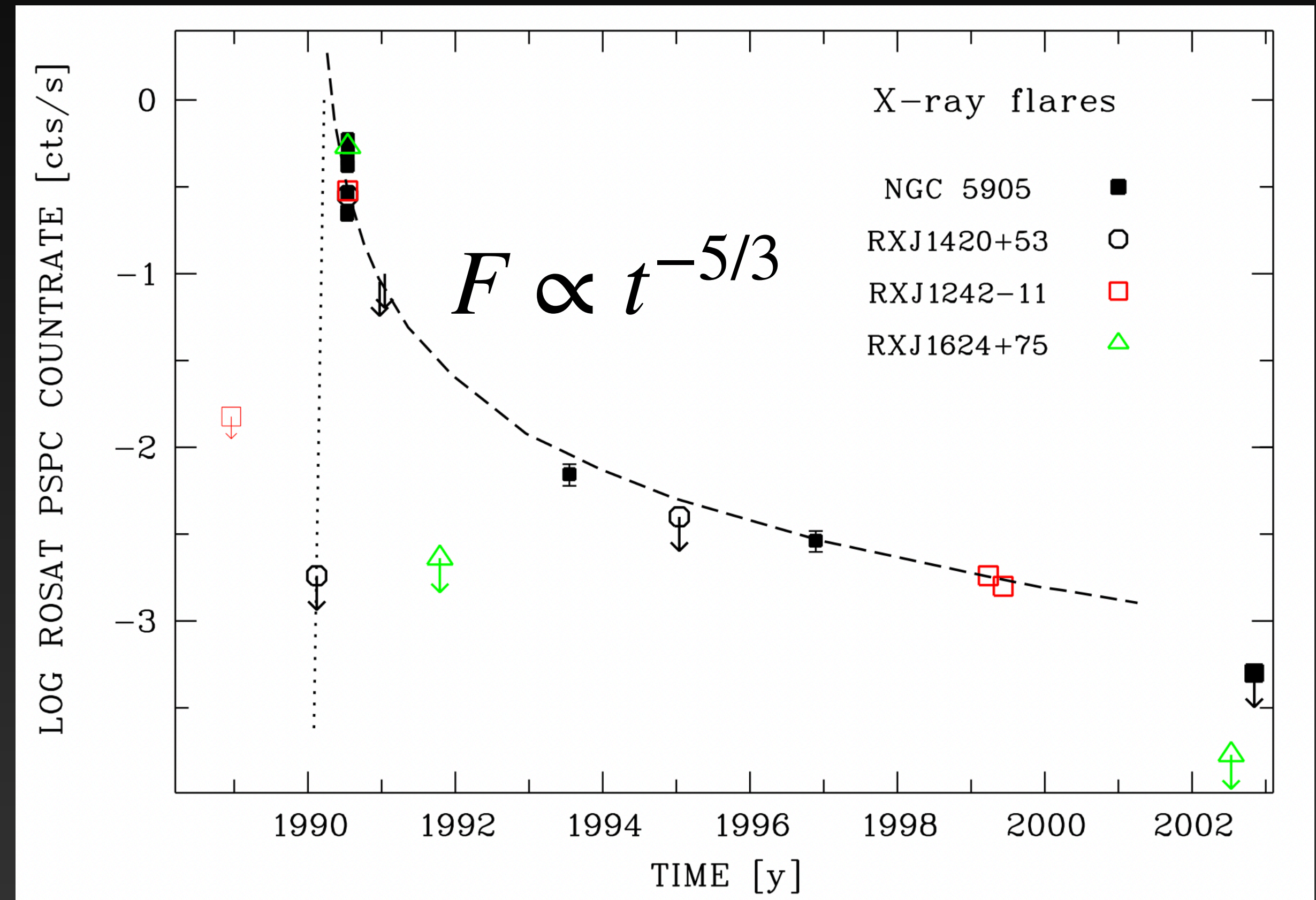
Rees 1988; Carter & Luminet 1982, 1983;
Luminet & Carter 1986

Origin of the emission in TDEs

Accretion disk



Rees 1988

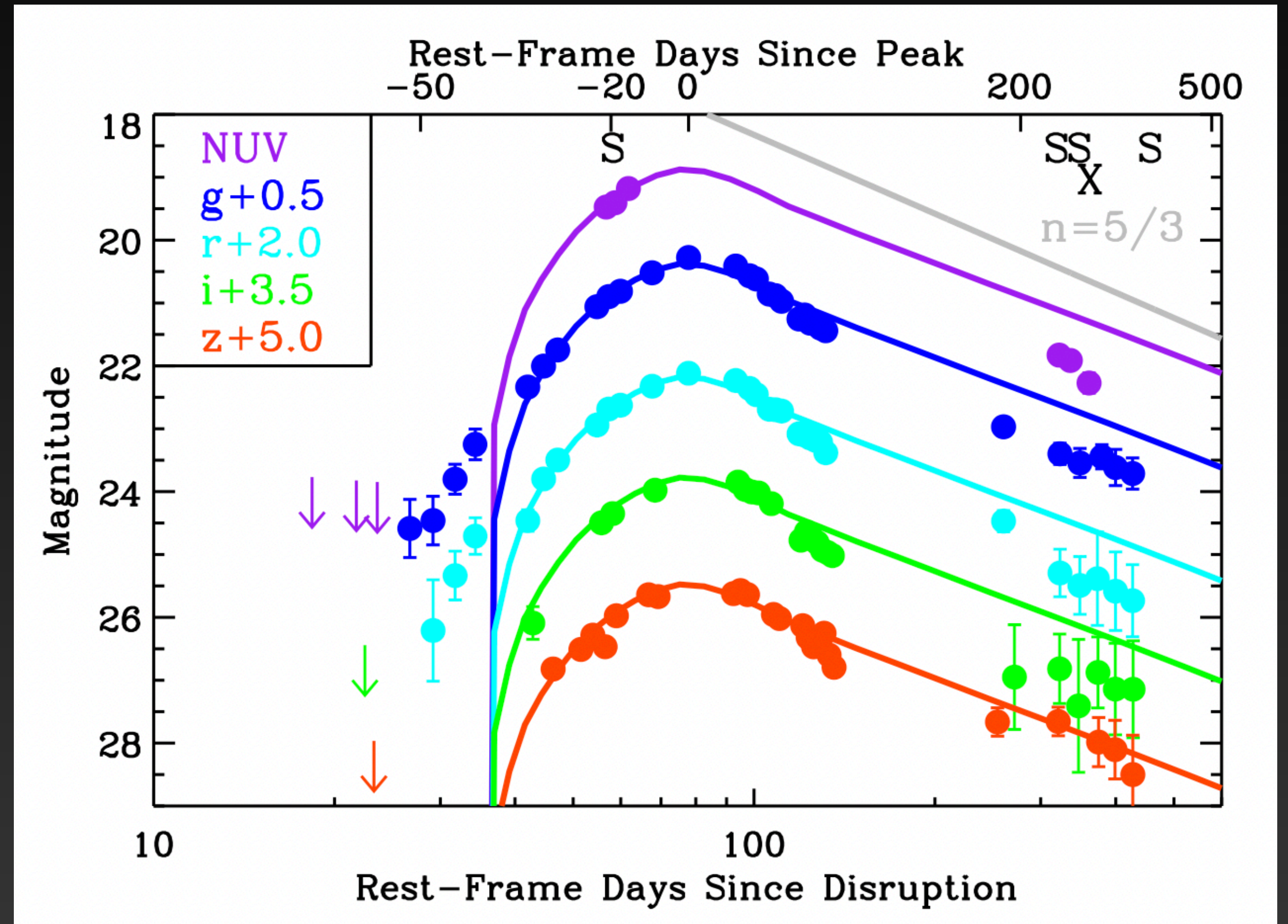


Komossa & Bade 1999; Komossa 2004

Origin of the emission in TDEs

Optical TDE

- Surprising “optical” TDE (Gezari+12)
- Located at galaxy centres
- Not as hot as accretion disk (~few 10^4 K)
- Two orders of magnitude larger radii ($\sim 10^{15}$ cm)



Gezari+12

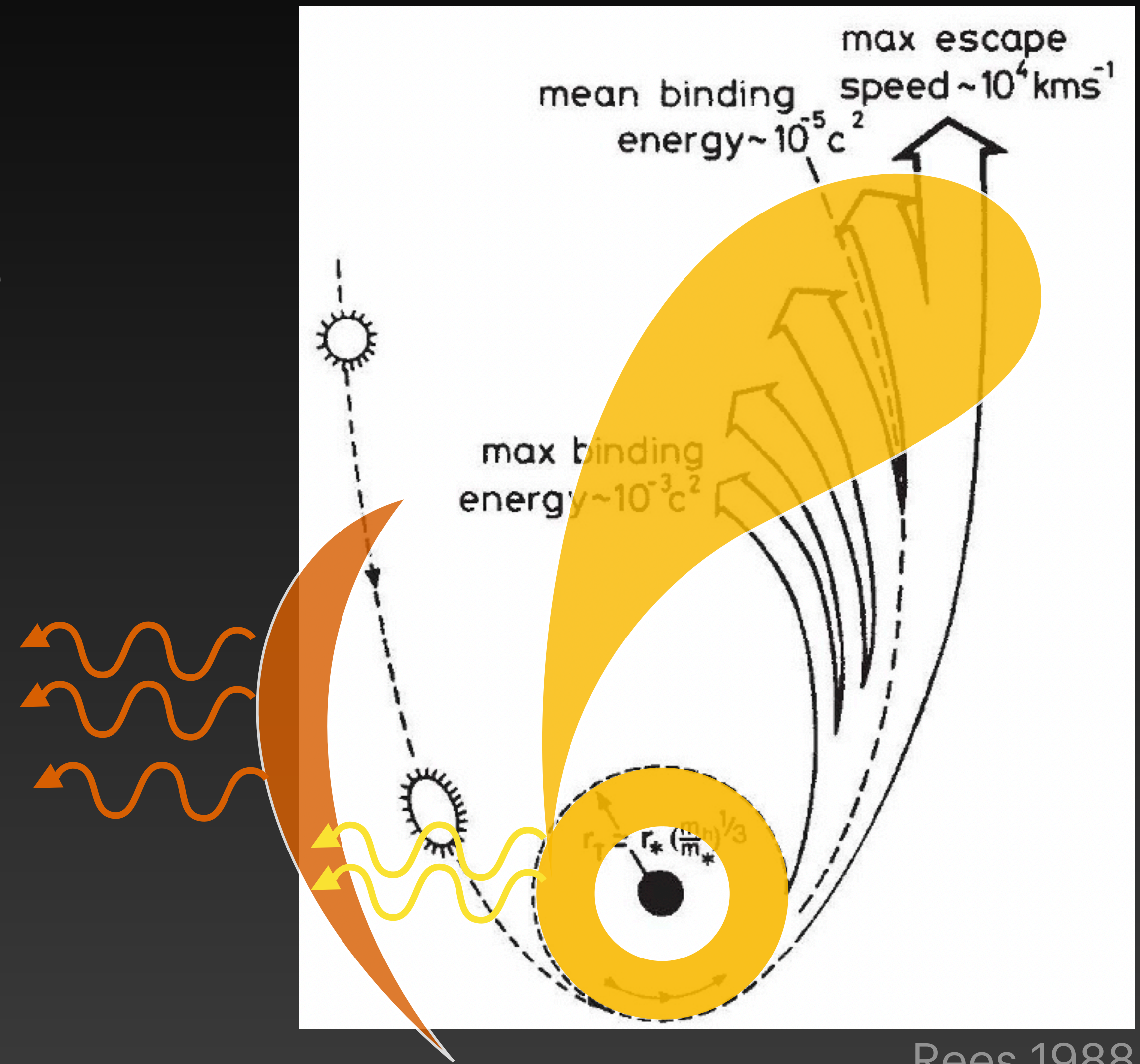
Origin of the emission in TDEs

Accretion disk + reprocessing

- An extended, optically thick envelope from stellar debris reprocessing the accretion disk emission can explain the optical behaviour (Roth+16)



Guillochon+14



Rees 1988

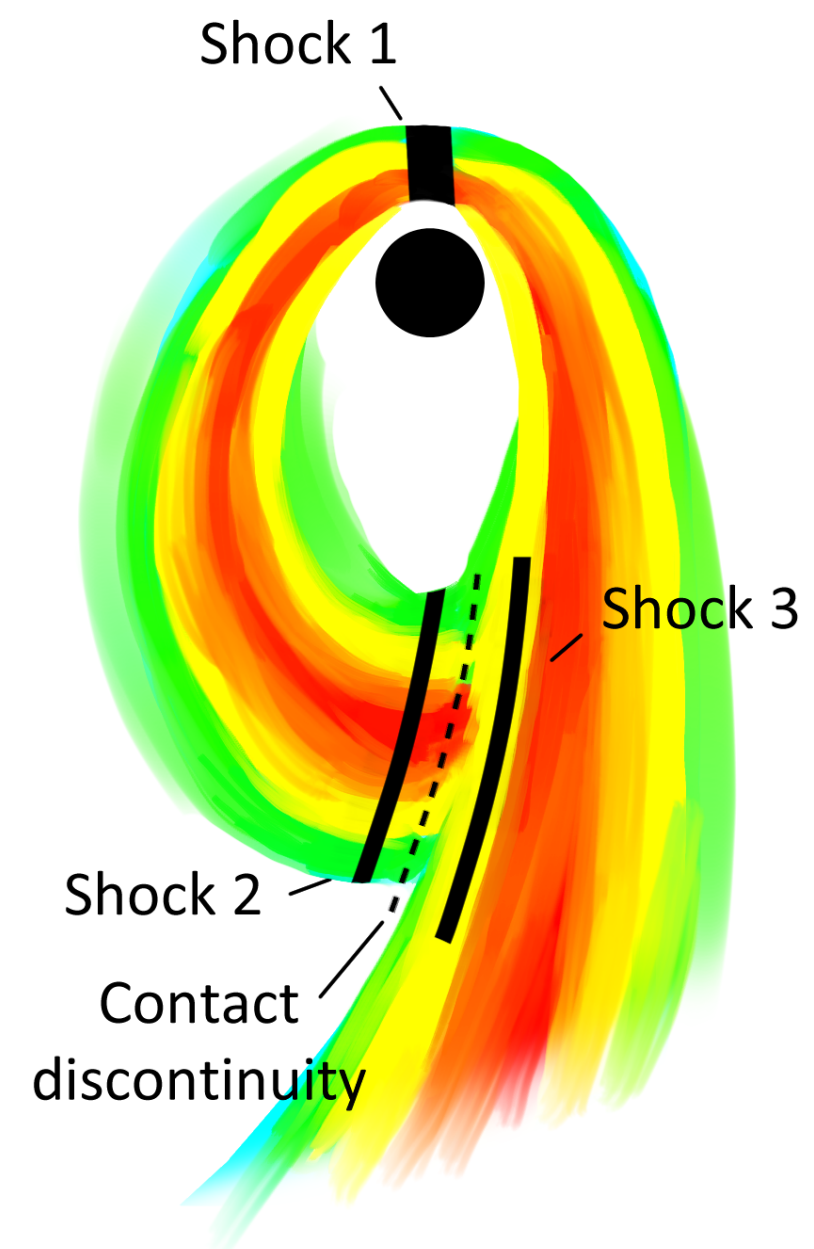
Origin of the emission in TDEs

Shocks from colliding stellar streams (Piran+15; Shiokawa+15)

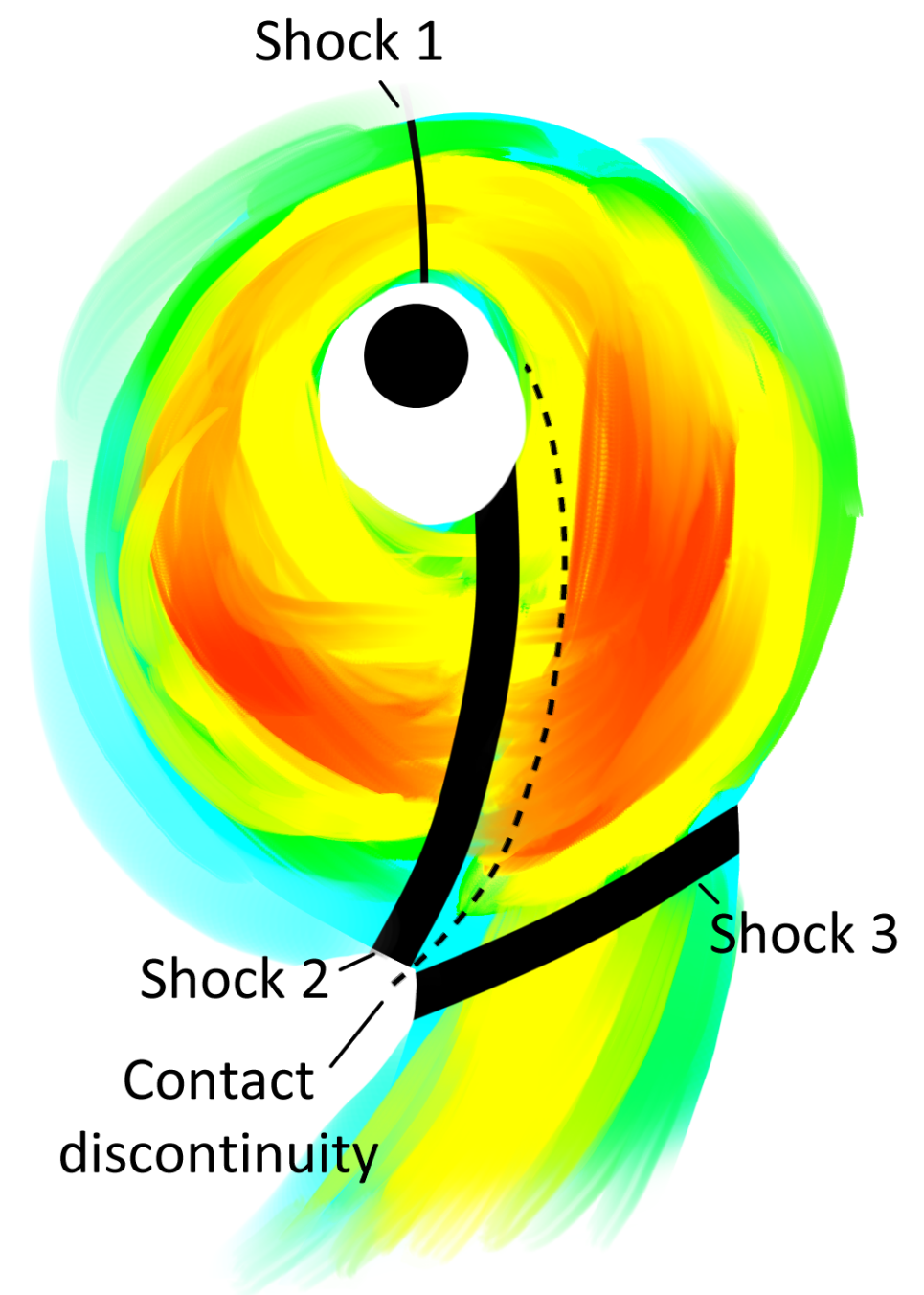
$t = 0$ Does not dissipate enough energy to circularize flow



$t = 1.5 \times t_0$

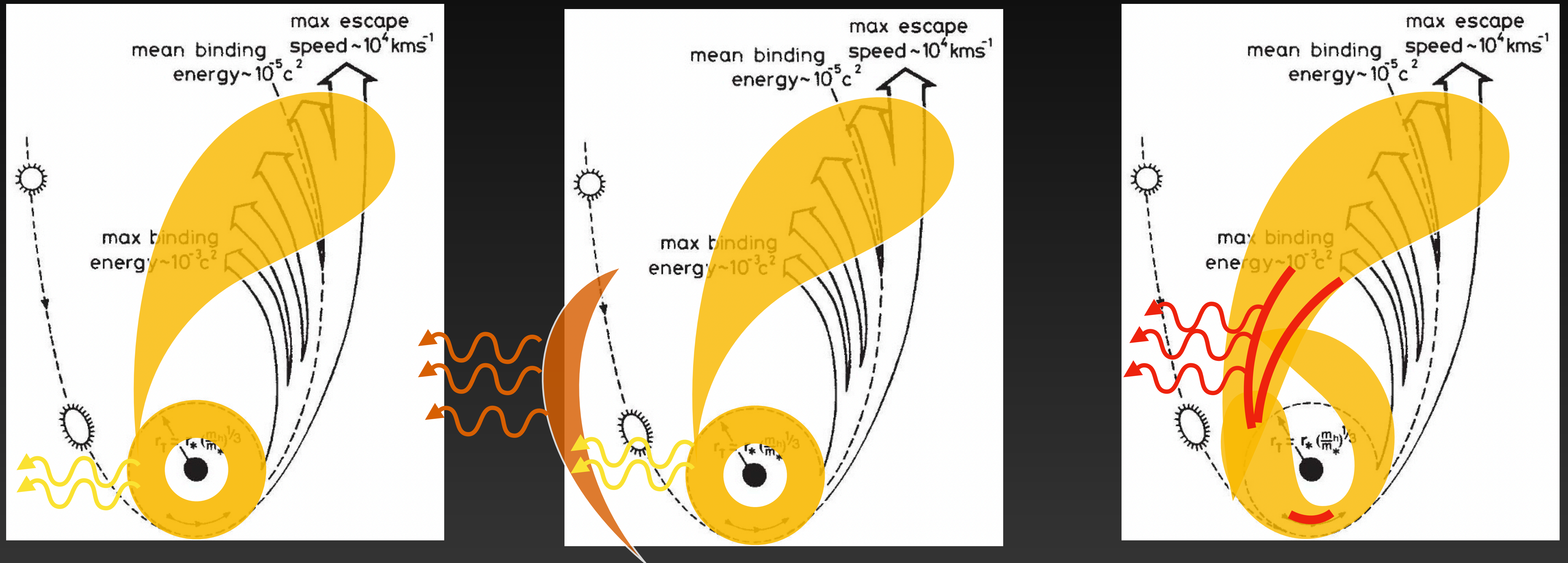


$t = 3 \times t_0$



Origin of the emission in TDEs

Accretion disk + reprocessing + shocks



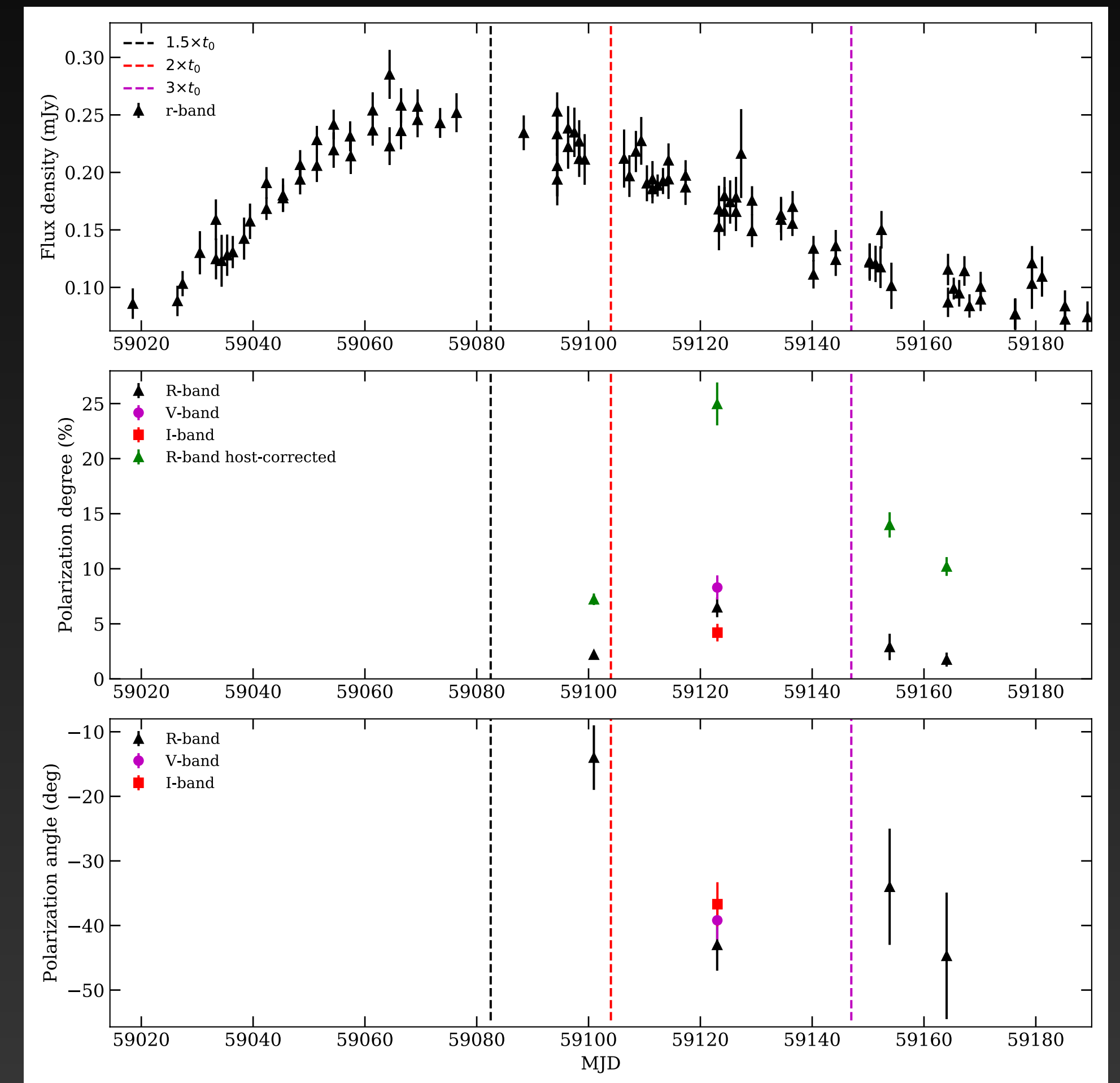
How to distinguish between different scenarios?

Optical polarization in AT 2020mot

- First significant measurements of high linear polarization from a TDE decay
- Three epochs observed with RoboPol (one with ALFOSC) with a peak **intrinsic polarization of $25 \pm 4\%$**
- Host & MW polarization $< 1\%$
- Evolution in PA of ~ 40 deg

$$\Pi_{corr} = \Pi_{obs} \times I / (I - I_{host})$$

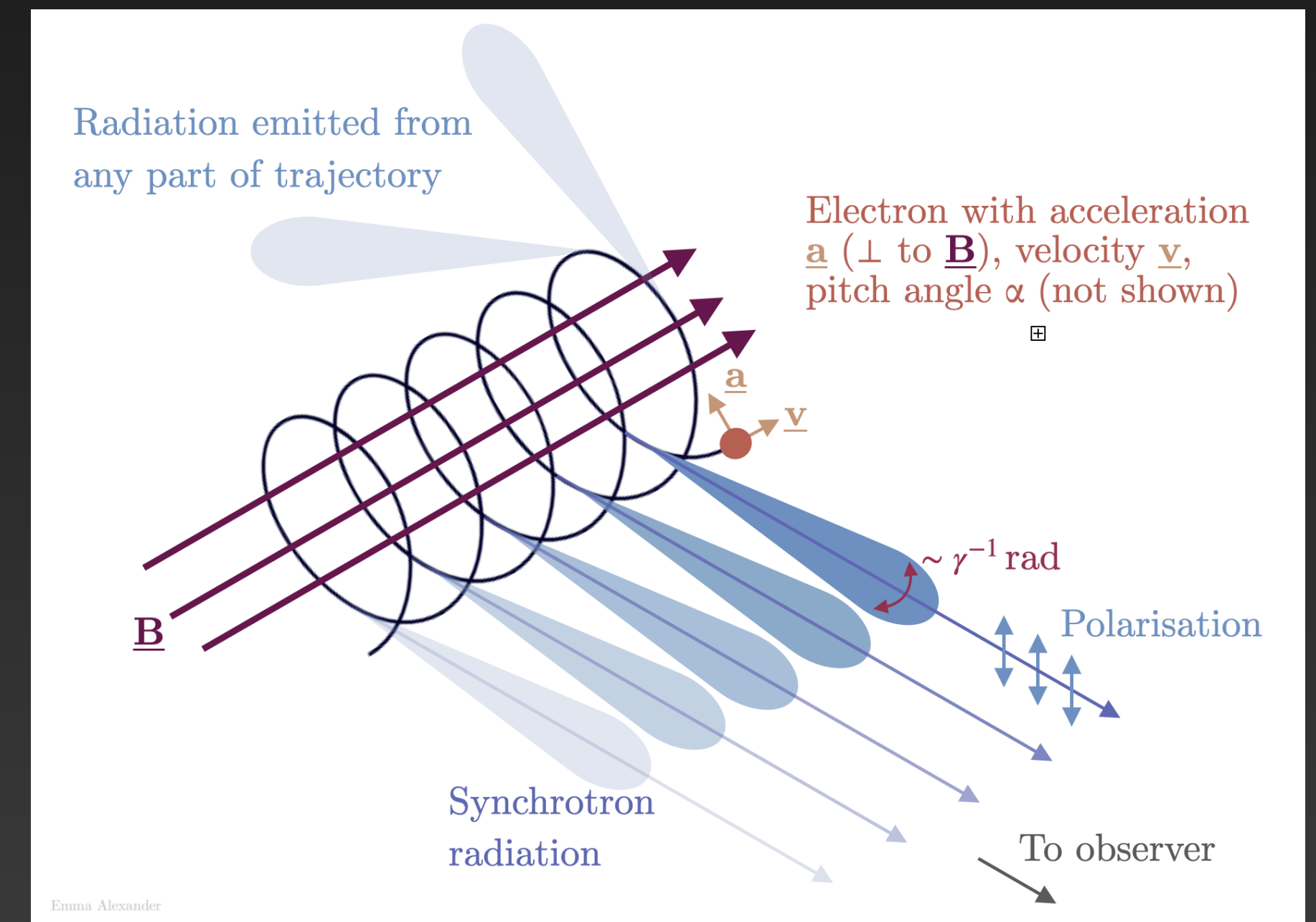
$$I = I_{TDE} + I_{host}$$



Optical polarization in AT 2020mot

Jet contribution?

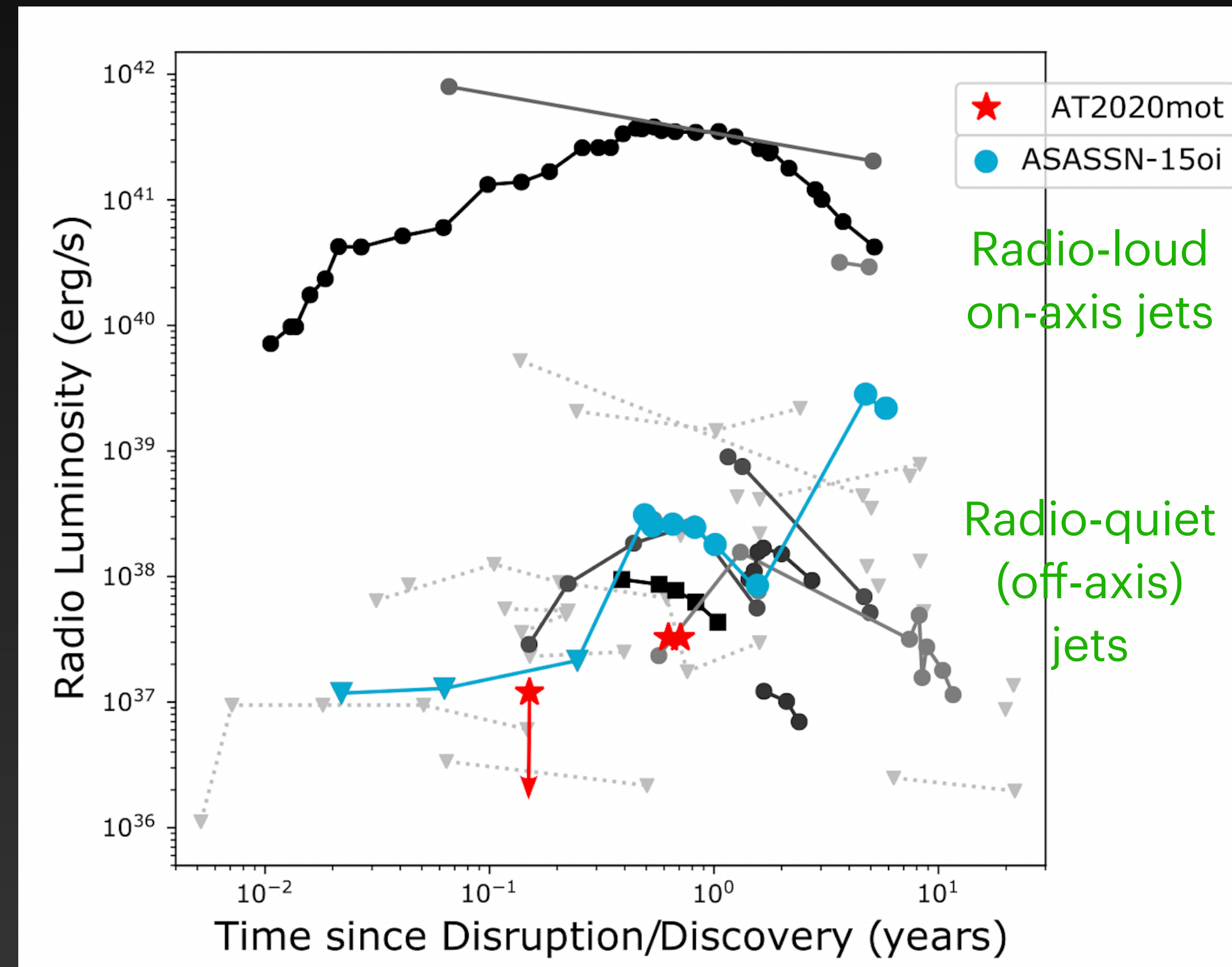
- The high degree of polarization is hard to produce with known astrophysical mechanisms apart from synchrotron radiation
- (On-axis) jets are observed in TDEs but rarely (~1%)
- Is there a jet in AT 2020mot?



Optical polarization in AT 2020mot

Jet contribution? Radio?

- VLA observations during three epochs
- Non-detection @ 15 GHz
- $\sim 85 \pm 25 \mu\text{Jy}$ @ 1.4 GHz and $\nu^{-0.7}$ spectrum consistent with star formation ($\text{SFR} \sim 0.27 \pm 0.08 M_{\odot}/\text{yr}$)
- CIGALE fit $0.11^{+0.21}_{-0.11} M_{\odot}/\text{yr}$

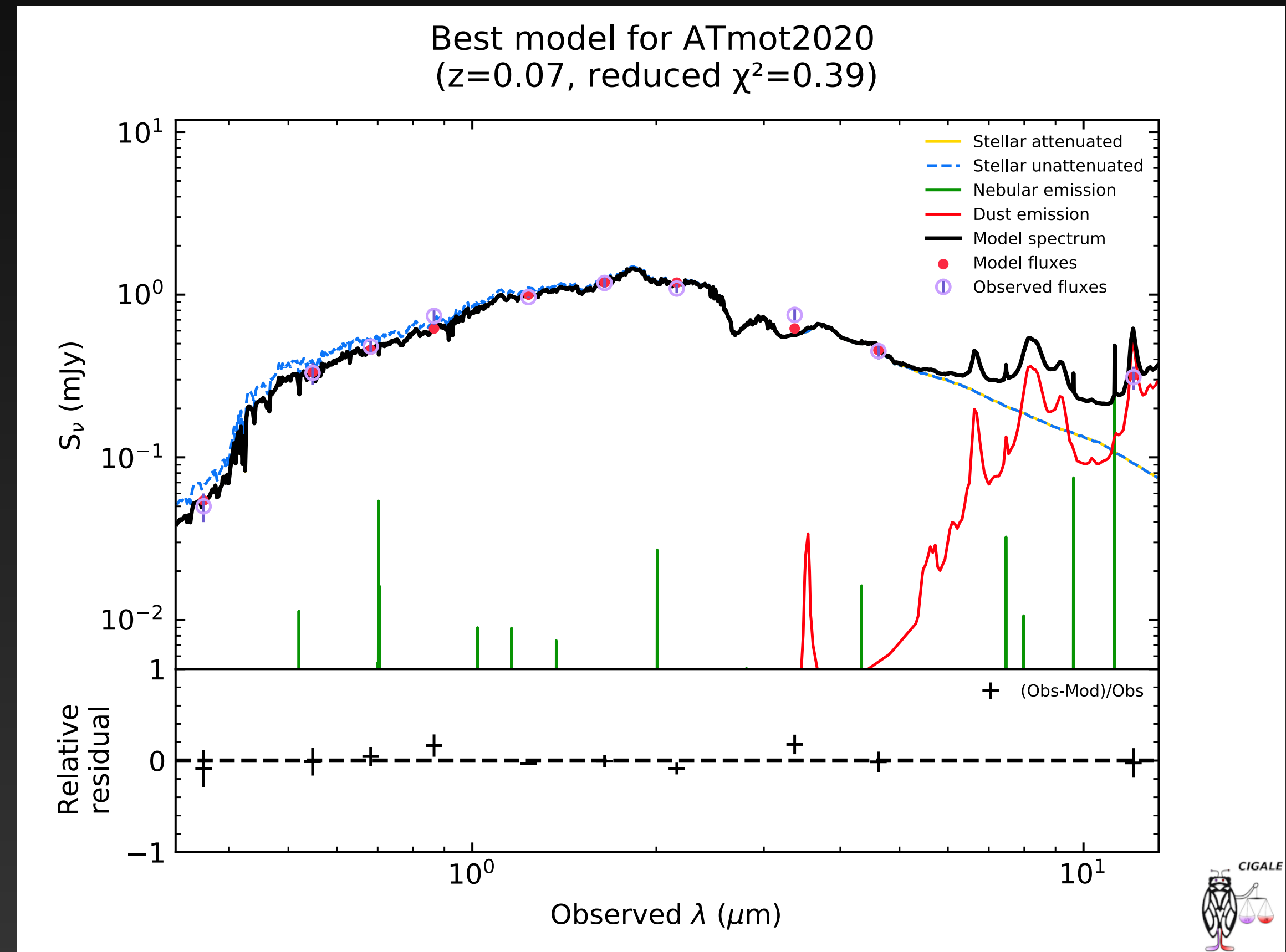


Courtesy of K. Alexander

Optical polarization in AT 2020mot

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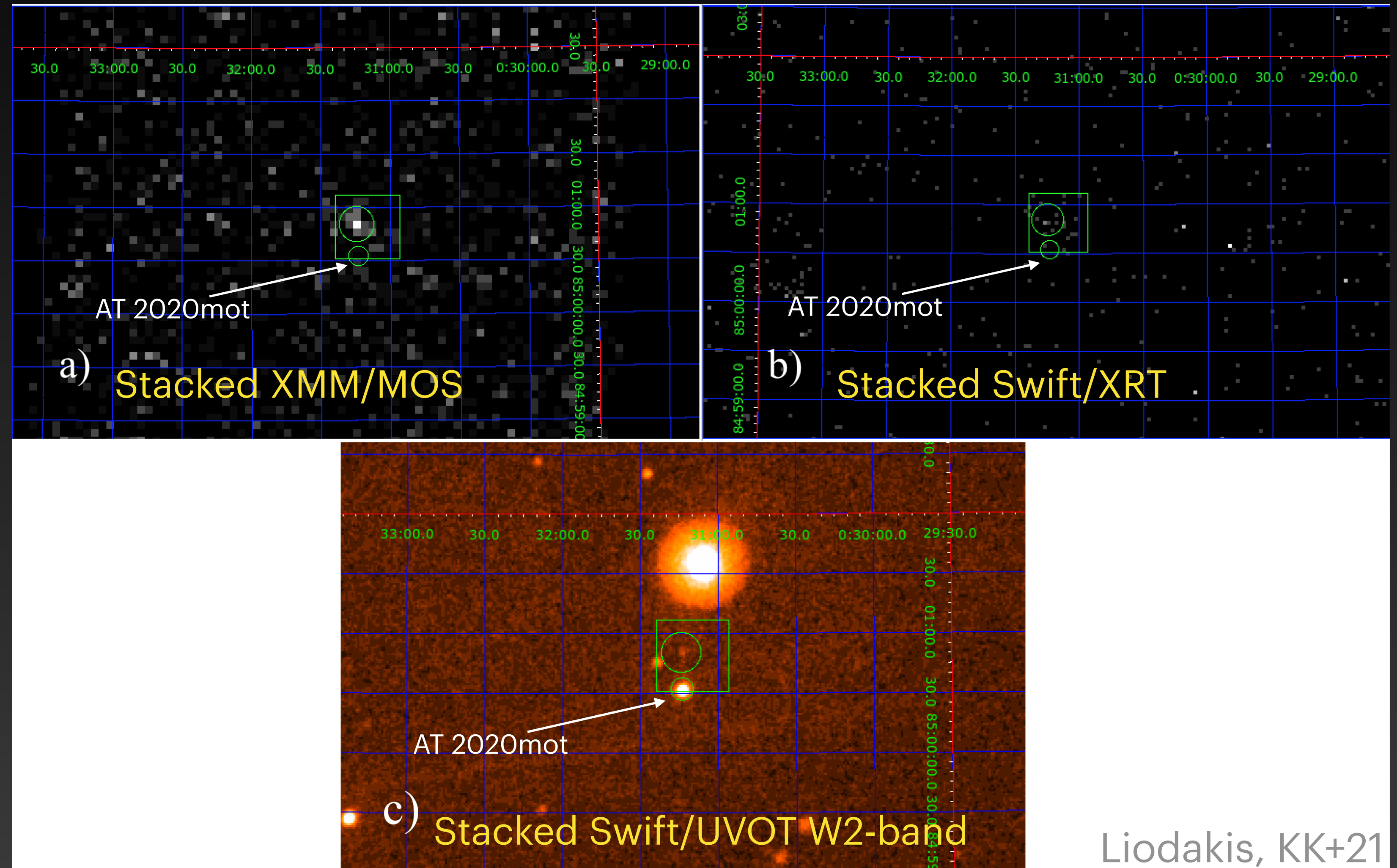


Courtesy of K. Kouroumpatzakis

Optical polarization in AT 2020mot

Jet contribution? X-rays from jet base (corona)?

- Swift & XMM observations throughout the TDE decay (>200 days)
- No X-ray detection even at late times (off-axis jet scenario)



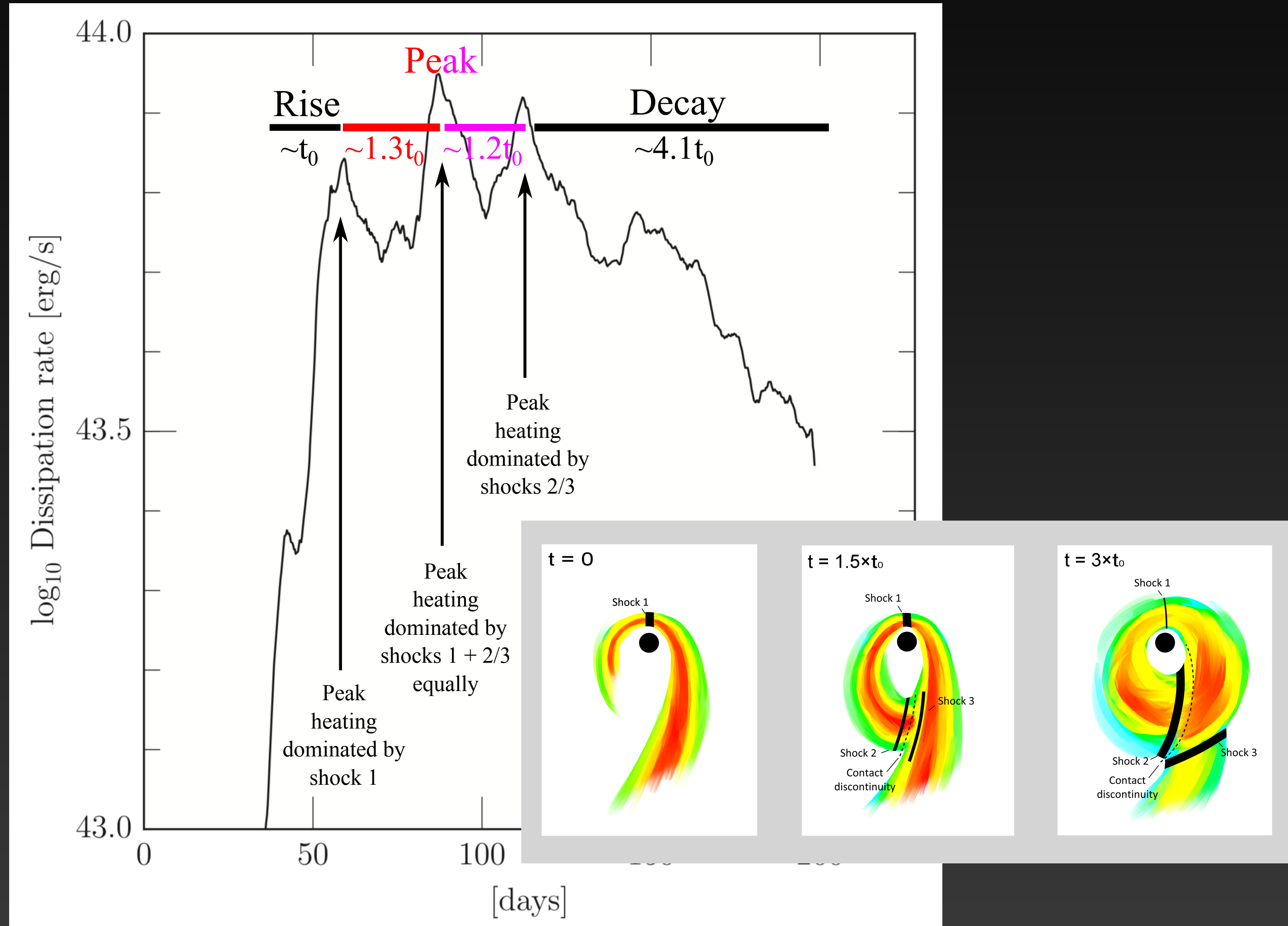
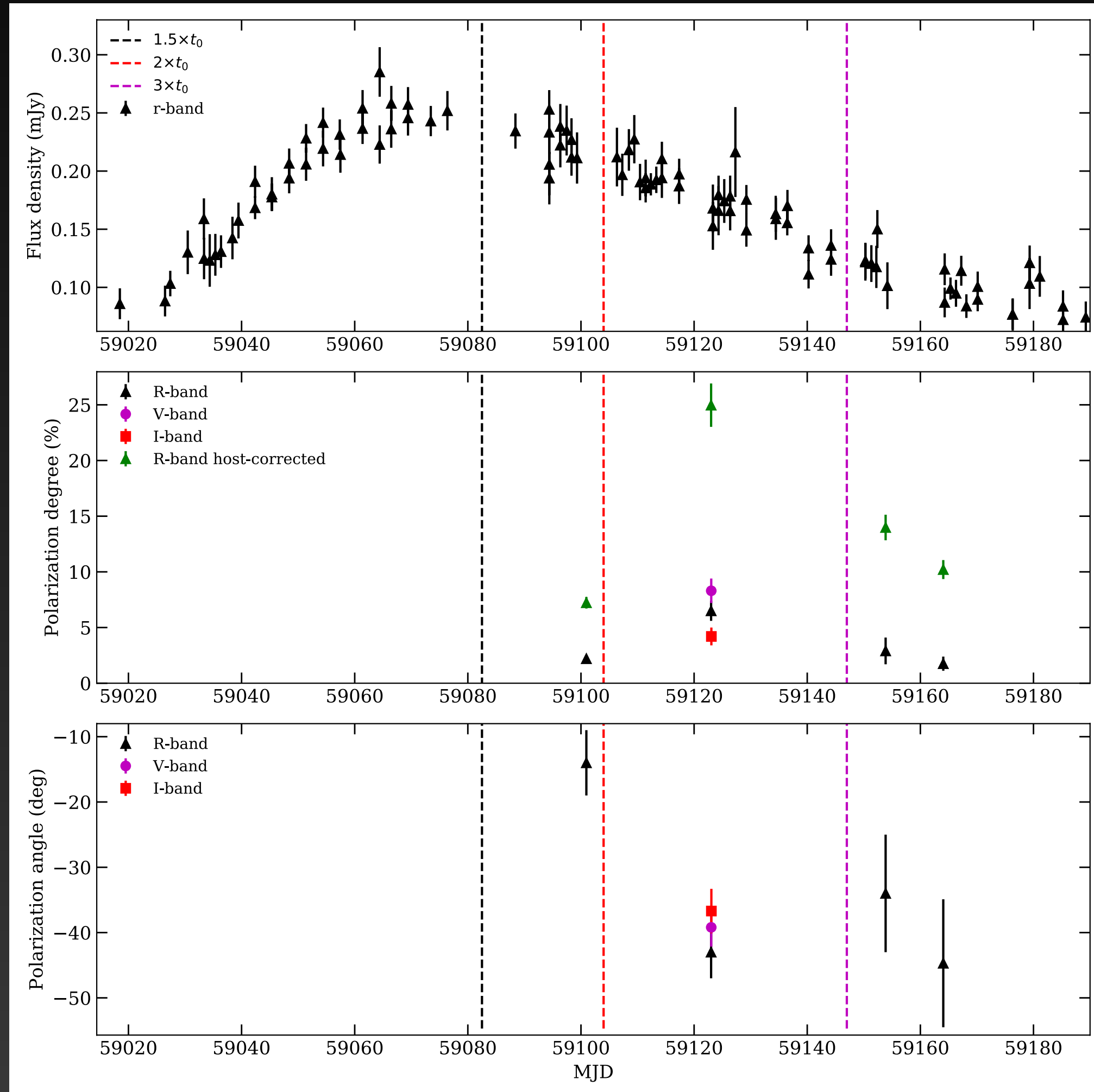
Optical polarization in AT 2020mot

Disk or reprocessing contribution?

- Scattering from accretion disk produces max. 11.7% linear polarization
- Scattering from stellar debris disk, if clumpy, can produce up to 10% linear polarization (Marin & Stalevski 2015; Marin & Schartmann 2017)
- TDE reprocessing models require quasi-spherical geometry that are low-polarized due to symmetry
 - Also produces optical spectral lines and late radio+X-ray emission which we didn't observe

Optical polarization in AT 2020mot

Colliding stellar stream shocks



Conclusions

- Colliding stellar stream shocks seems to be currently the only viable scenario for explaining the observations
- Polarized radiation (magnetic fields) not taken into account in the TDE simulations
 - Stellar magnetic field is expected to be amplified (Bonnerot+17)
- Statistics of one at the moment, so more observations are needed!

Thank you!

