Tidal Disruption Event Host Galaxies

K. Decker French (Hubble Fellow, Carnegie Obs)
with: Iair Arcavi, Ann Zabludoff, Or Graur
Tidal Disruption Event Host Galaxies

- What kinds of galaxies host TDEs?
- What galaxy properties influence the TDE rate?

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What kinds of galaxies host TDEs?

- Only answerable with sample of TDEs
- Sample of 8 UV/optical bright TDEs from ASASSN, PTF, Pan-Starrs, SDSS

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What kinds of galaxies host TDEs?

Arcavi+ 2014

Large # of E+A galaxies!
What kinds of galaxies host TDEs?

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French+2016
What kinds of galaxies host TDEs?

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What kinds of galaxies host TDEs?

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TDEs Occur at Higher Rates in Post-Starburst Galaxies

Hα EW Emission [Å] (Current SFR)

Lick HδA Absorption [Å] (SFR over past Gyr)

100 Myr burst
200 Myr burst
3 Gyr decline
0.2%
2.3%
SDSS Galaxies
Optical TDE hosts
Swift J1644

33x rate enhancement
190x rate enhancement

French+2016

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X-ray TDEs from Auchettl+17a may have lower post-starburst rate enhancement ~20-40x

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(Graur, KDF, et al. 2017; Law-Smith+17)
What galaxy properties influence the TDE rate? Why is the TDE Rate High in Post-Starburst Galaxies?

Why do the pc-scale stellar dynamics care about the kpc-scale star formation history?

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What galaxy properties influence the TDE rate?
Why is the TDE Rate High in Post-Starburst Galaxies?

Most post-starburst galaxies appear to have had a recent major merger.

Yang+2008: ubiquitous tidal features

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What galaxy properties influence the TDE rate? Why is the TDE Rate High in Post-Starburst Galaxies?

Most post-starburst galaxies have concentrated young stellar populations

Yang+2008

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Merger -> starburst:

- Central concentration of stars? (Stone+16 Law-Smith+17, Graur+17)
- Unusual central dynamics:
  - Eccentric disk? (Madigan+17) Radial anisotropies? (Stone+17)
- SMBH binary? (e.g., Chen+09,11; Li+15)
- Related to circumnuclear gas? (Kennedy+16)
What galaxy properties influence the TDE rate?

Central concentration of stars?

TDE rate $\sim 1e^{-3}/yr$

Stone & Van Velzen 2016
(see later talk!)

Decker French (Carnegie)
What galaxy properties influence the TDE rate?

Central concentration of stars?

Stellar Surface Density

Graur, KDF, et al. 2017

Decker French (Carnegie)
What galaxy properties influence the TDE rate?

Central concentration of stars?

Law-Smith+ 2017 (see later talk!)

Decker French (Carnegie)
What galaxy properties influence the TDE rate?

Decker French (Carnegie)

French+2016

33x rate enhancement
190x rate enhancement

Older post-starburst
Weaker starburst
Longer duration starburst

SDSS Galaxies
Optical TDE hosts
Swift J1644

Hα EW Emission [Å] (Current SFR)

Lick H\(\delta\)A Absorption [Å] (SFR over past Gyr)

100 Myr burst
200 Myr burst
3 Gyr decline
0.2%
2.3%

French+2016
What galaxy properties influence the TDE rate?

- 0.5-10% of current stellar mass from burst for most
- Most (6/8) have short (<200 Myr) starbursts
  - (not long >1 Gyr decline)
- Post-burst ages range from ~1 Gyr (except for one star-forming galaxy)

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What galaxy properties influence the TDE rate?

- SMBH binaries can substantially increase TDE rate for a short time (e.g., Chen+09,11; Li+15)
- Expect SMBH after merger

Decker French (Carnegie)
What galaxy properties influence the TDE rate?

- SMBH binary?
- Only most equal-mass mergers have had time to coalesce
- Timescales too short for SMBHB enhancement (Stone+17)

Decker French (Carnegie)
What galaxy properties influence the TDE rate?

BPT

\[
\log([\text{N II}] \lambda 6583)/([\text{H} \alpha \lambda 6563])
\]

\[\log W_{\text{H} \alpha} [\text{Å}]\]

- Circumnuclear gas? Kennedy+16: Can increase TDE rate by ~10x (not enough)

- But, what is the relation between TDEs and LINER-like emission from hosts?

Decker French (U. Arizona)
What galaxy properties influence the TDE rate? Why is the TDE Rate High in Post-Starburst Galaxies?

- **Central concentration of stars?** *(Stone+16, Law-Smith+17, Graur+17)*
  
  Possible in at least one case (pc scale), hints at kpc-scale over densities

- **Unusual central dynamics: Eccentric disk?** *(Madigan+17)*
  
  Radial anisotropies? *(Stone+17)*
  
  Possible, evidence from timing after starburst (see talks by Stone & Madigan)

- **SMBH binary?** *(e.g., Chen+09,11; Li+15)*
  
  Unlikely, if TDE rate scales weakly with SMBH mass ratio

- **Related to circumnuclear gas?** *(Kennedy+16)*
  
  Not enough to explain TDE rate in PSBs, other connections unknown

Decker French (Carnegie)
What galaxy properties influence the TDE rate?

- Any of these mechanisms would also increase TDE rate in starburst galaxies
- But, heavy extinction

Engel+2011
Arp 220
Extinction map
What galaxy properties influence the TDE rate?

- Any of these mechanisms would also increase TDE rate in starburst galaxies.
- But, heavy extinction.
- Nonetheless, one TDE candidate in ULIRG discovered (Tadhunter+17).
- Implies rate ~0.01-0.1/yr.

Decker French (Carnegie)
Conclusions

- TDEs occur at a high rate in post-starburst galaxies
- Central stellar concentration and/or dynamics likely influence the TDE rate
- Future surveys will enable better analysis of host galaxies of full TDE population

Decker French (Carnegie)