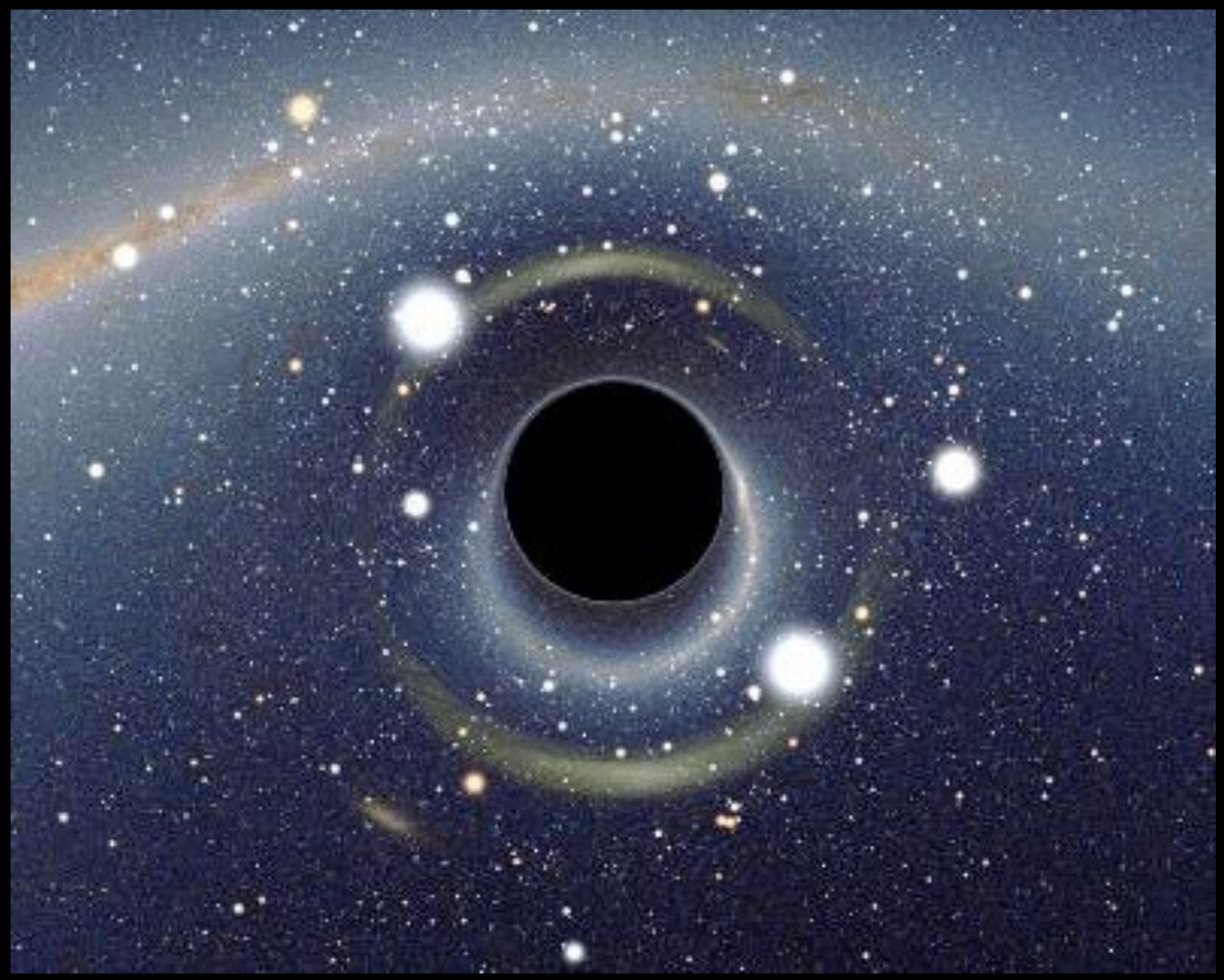
Massive black holes & tidal disruptions of stars

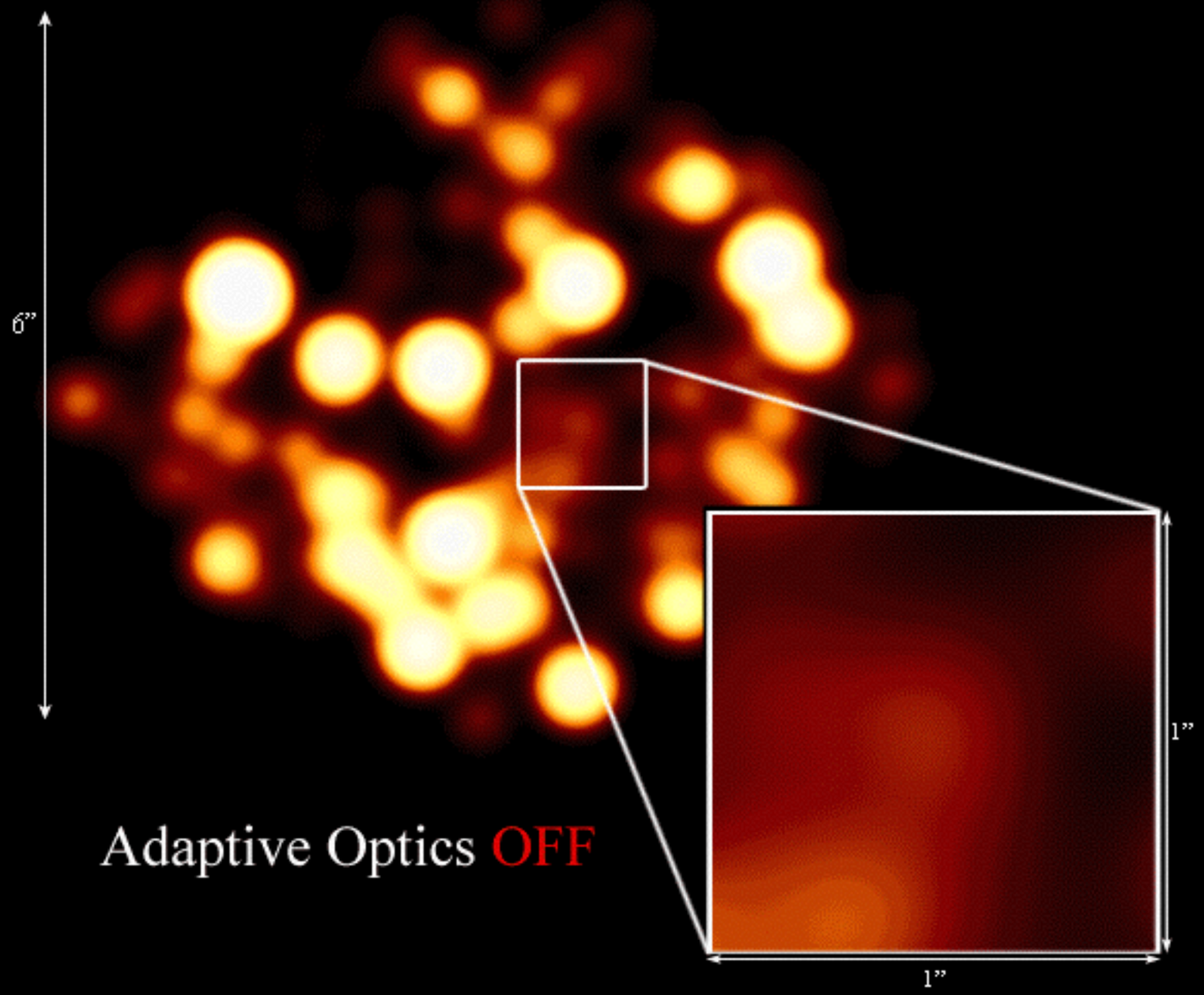
Ilya Mandel
University of Birmingham

Black Holes

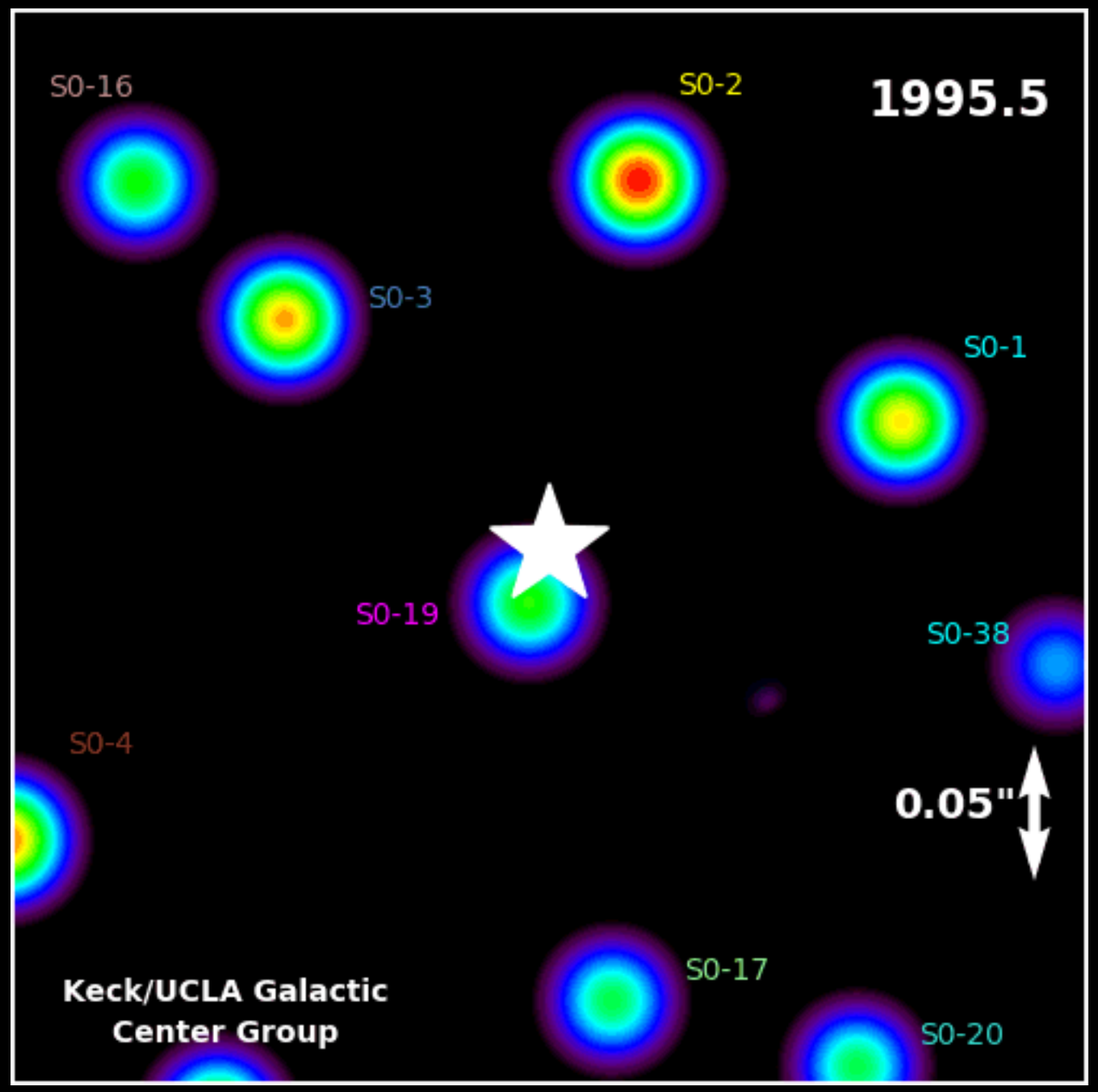


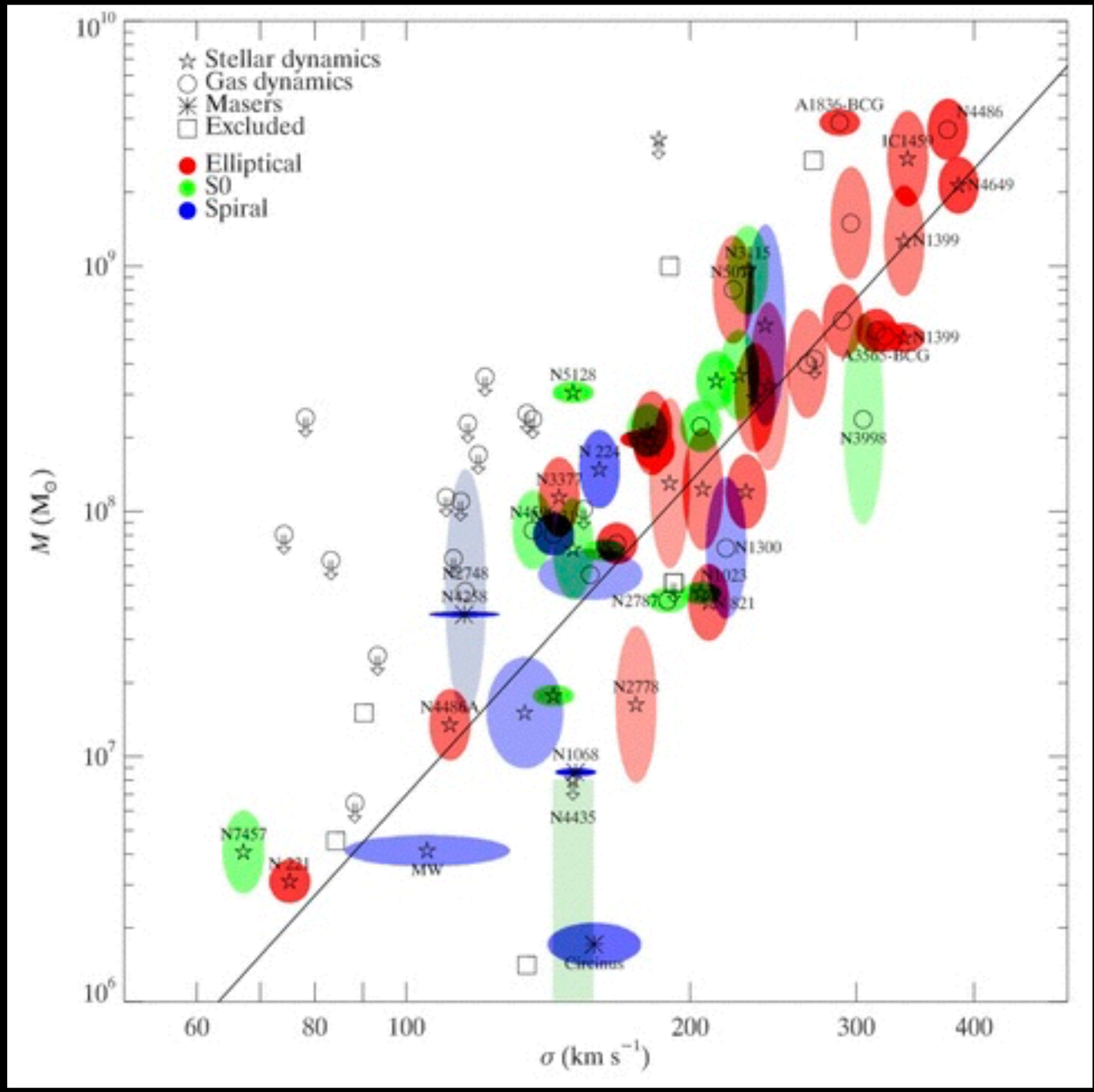
- Very dense collapsed matter
- Gravitational force so strong that not even light can escape

The Galactic Center at 2.2 microns



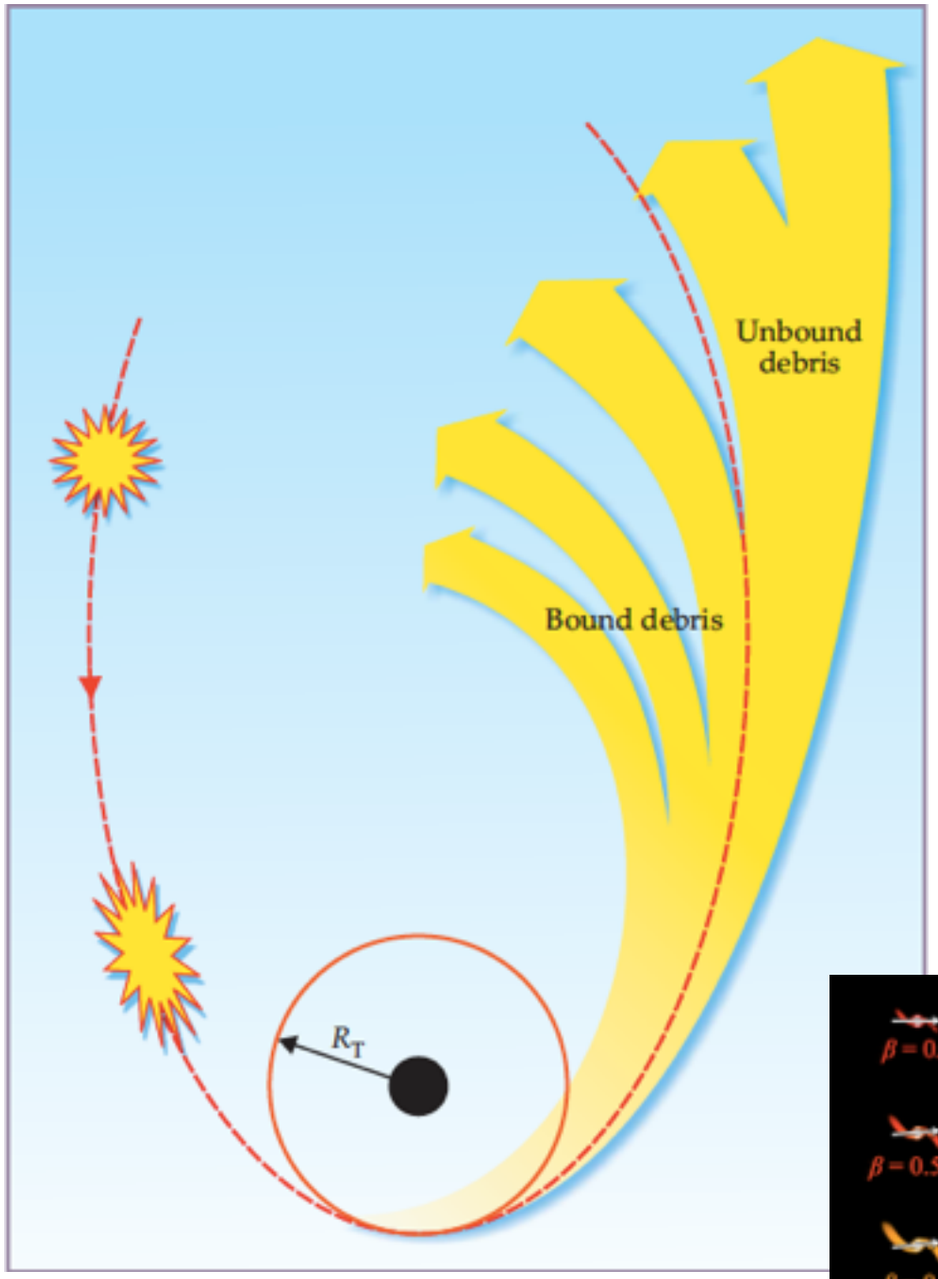
Adaptive Optics OFF

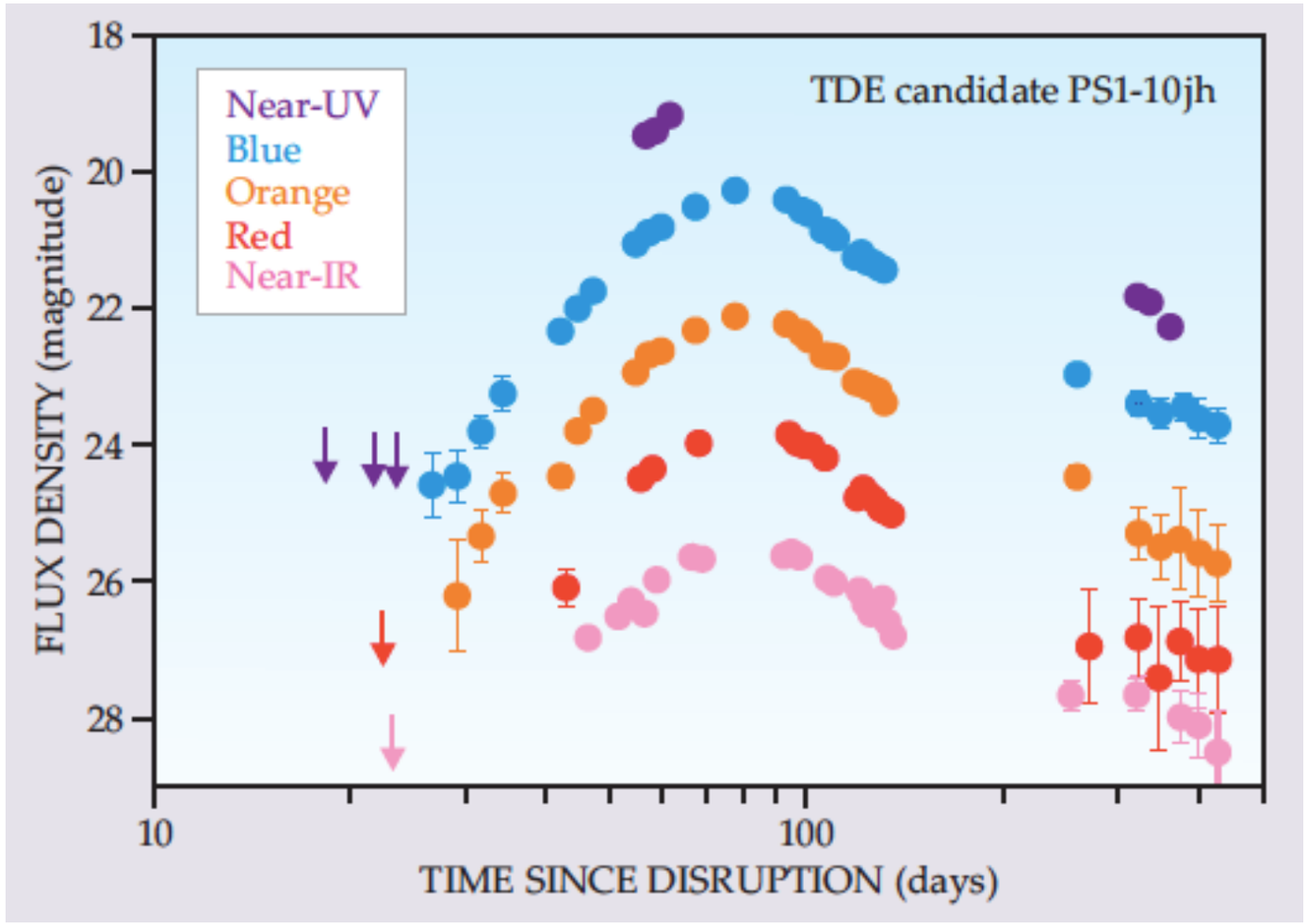

S0-16
S0-2
1995.5
S0-3
S0-1
S0-19
S0-38
S0-4
0.05"
S0-17
Keck/UCLA Galactic
Center Group
S0-20



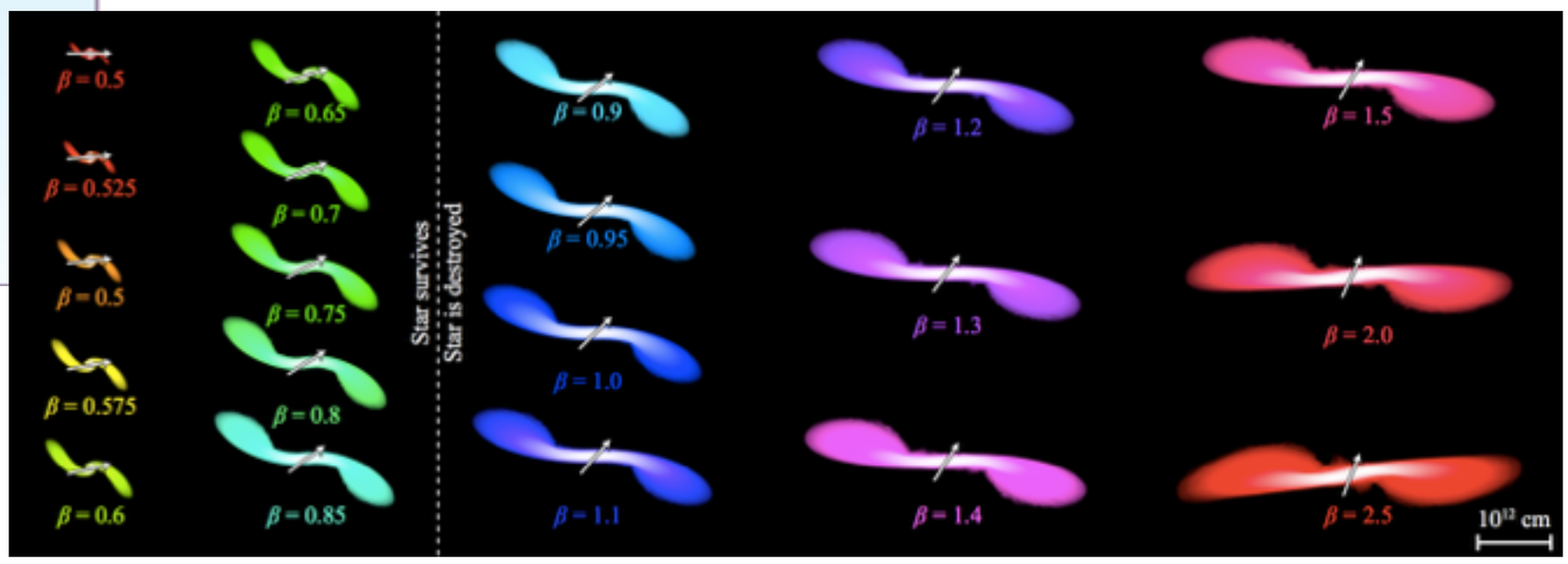
Gultekin et al., 2009

Tidal disruption

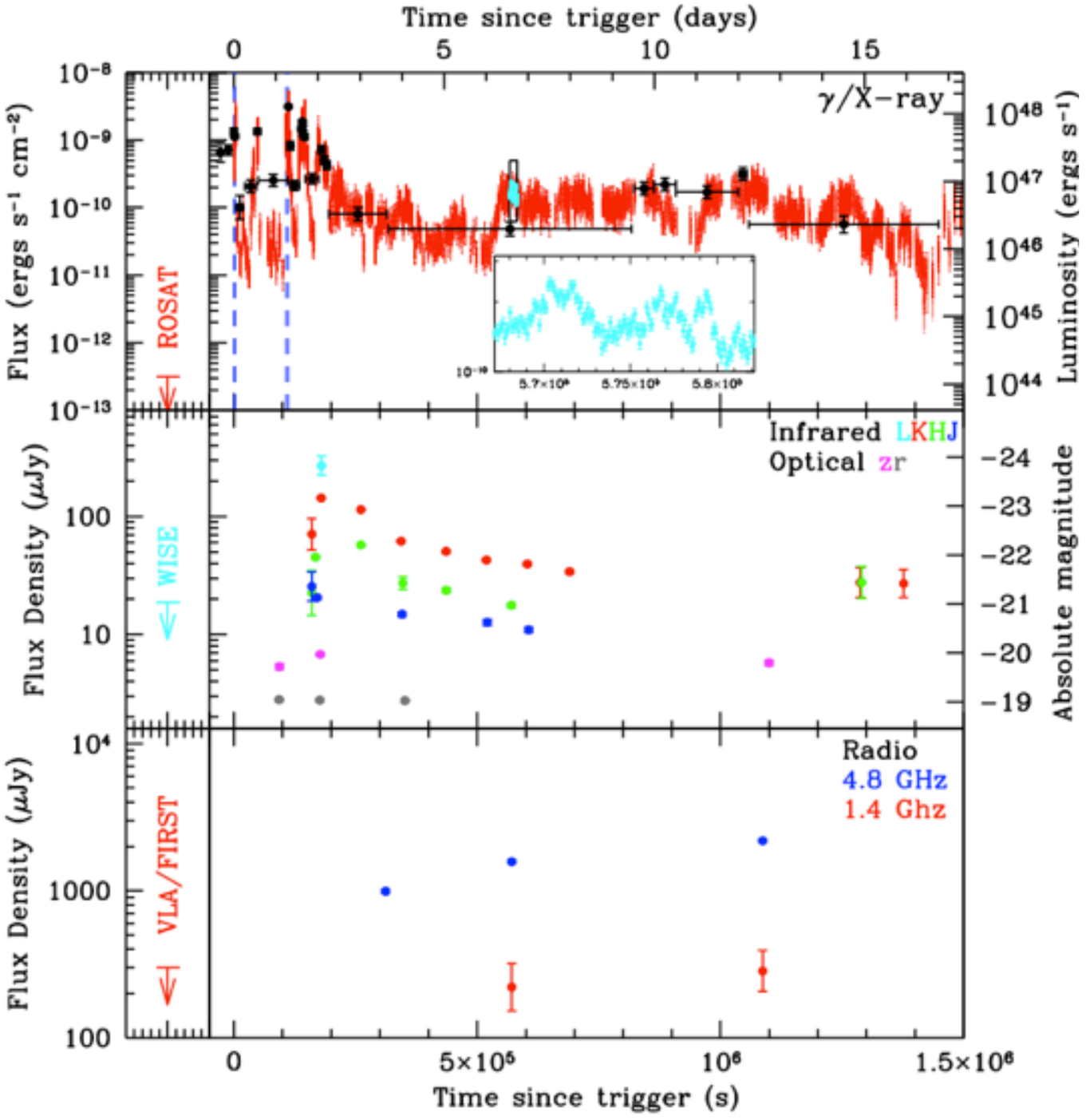


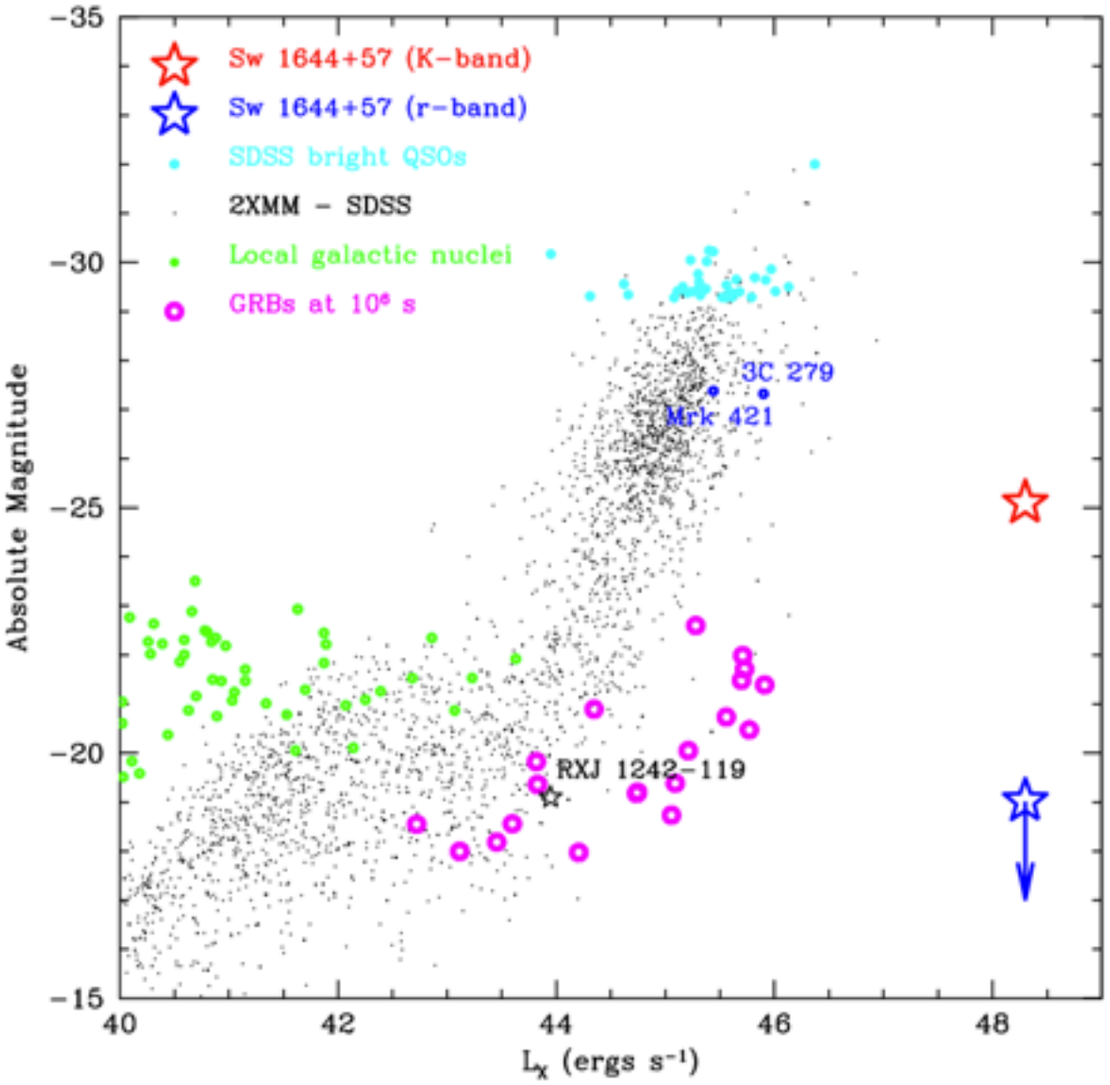


[Rees, 1988; Gezari, 2014; Guillochon & Ramirez-Ruiz, 2013]



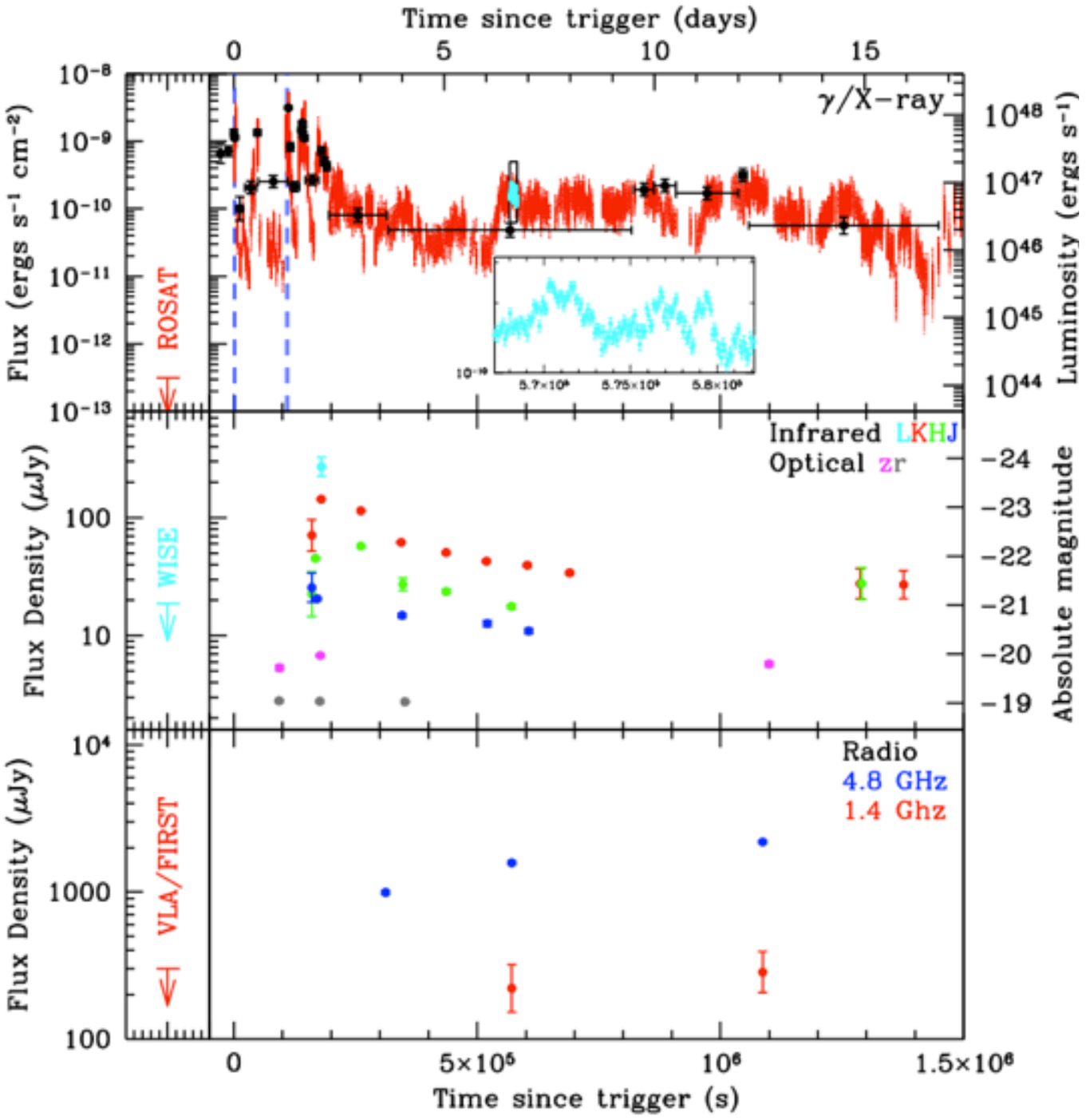
Tidal disruption + jets



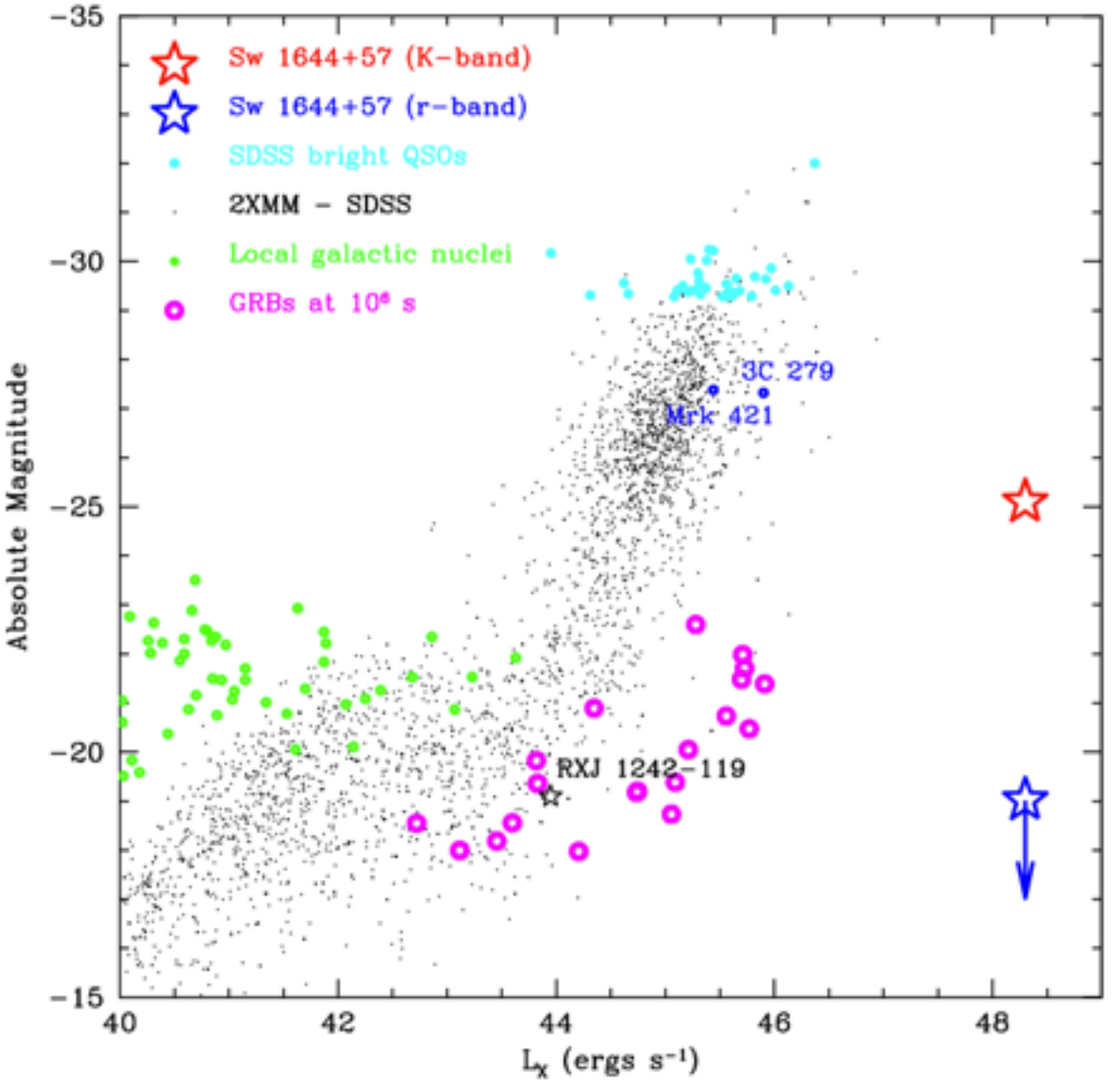


[Bloom et al., 2011, Science, 333, 203; Levan et al., 2011, Science, 333, 199;
also Burrows et al., 2011, Nature; Zauderer et al., 2011, Nature]

Tidal disruption + jets

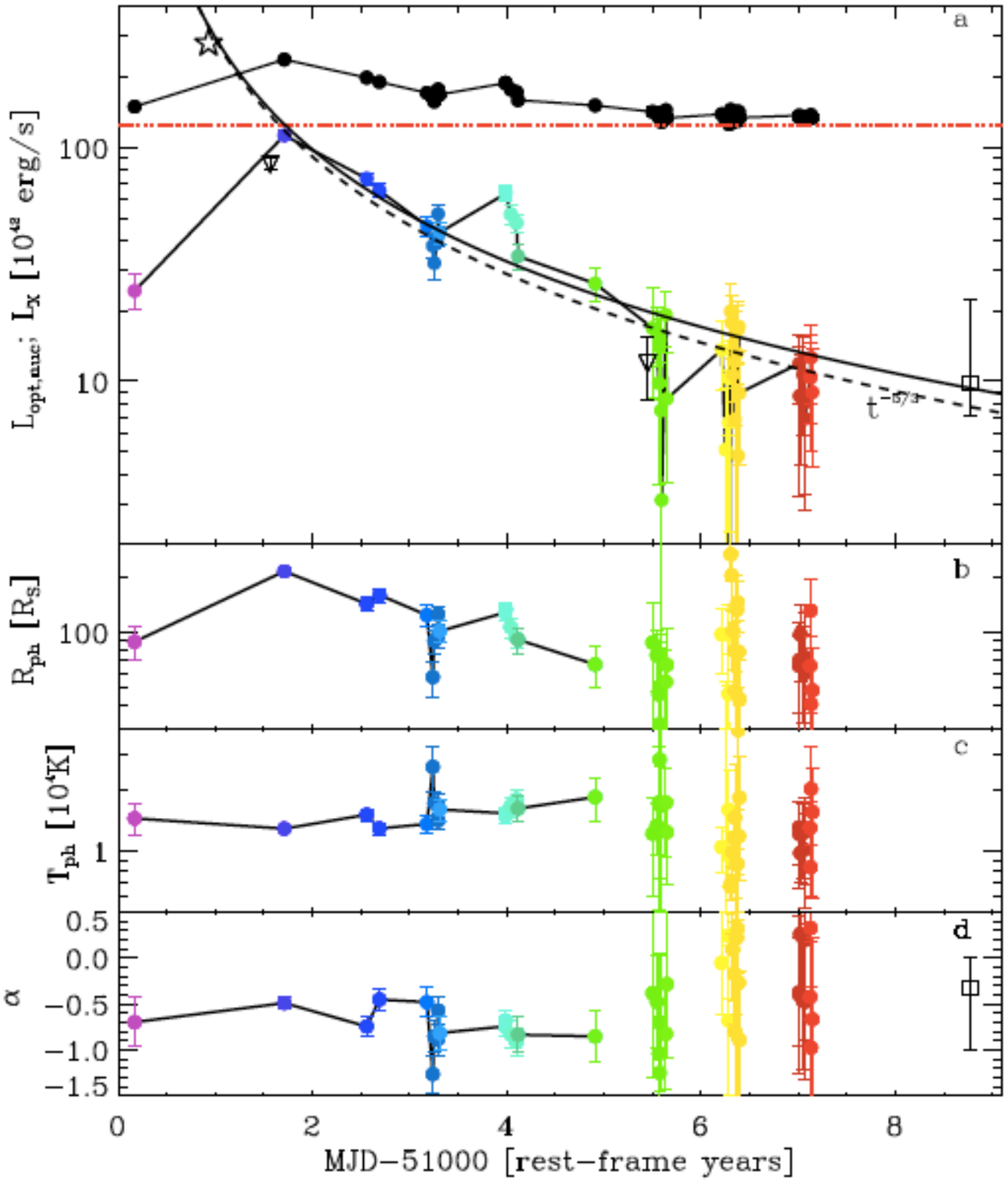


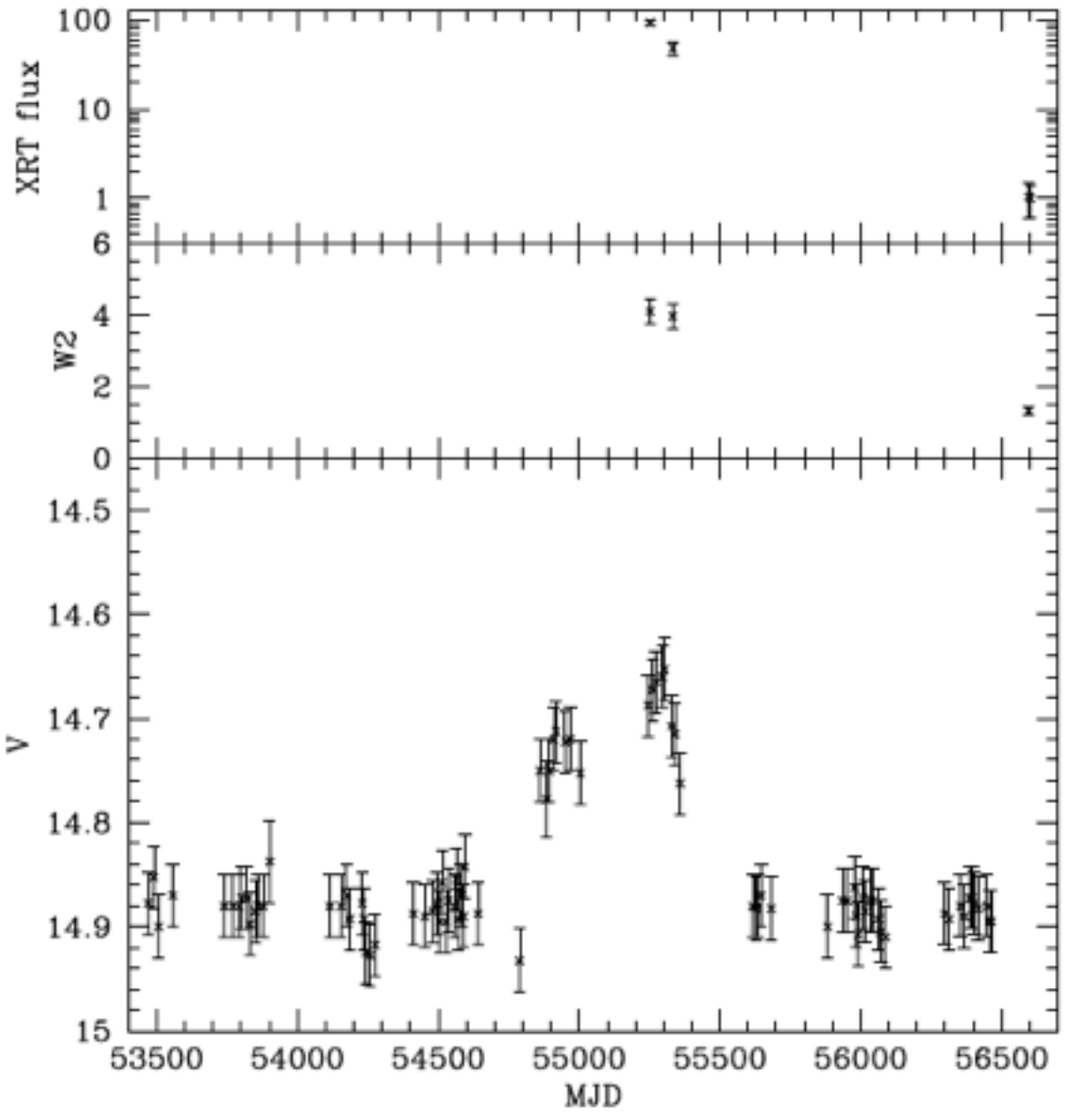
[Tchekhovskoy et al., 2014, MNRAS, 437, 2744: prompt jet requires magnetic flux > 10^{29} G cm^2]



[Bloom et al., 2011, Science, 333, 203; Levan et al., 2011, Science, 333, 199;
also Burrows et al., 2011, Nature; Zauderer et al., 2011, Nature]

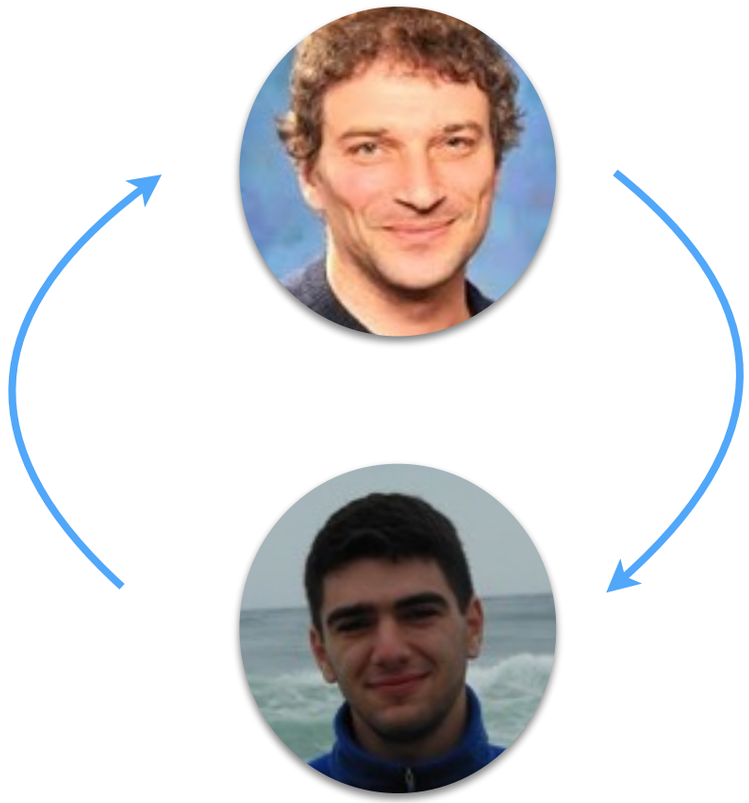
More unusual tidal disruptions?





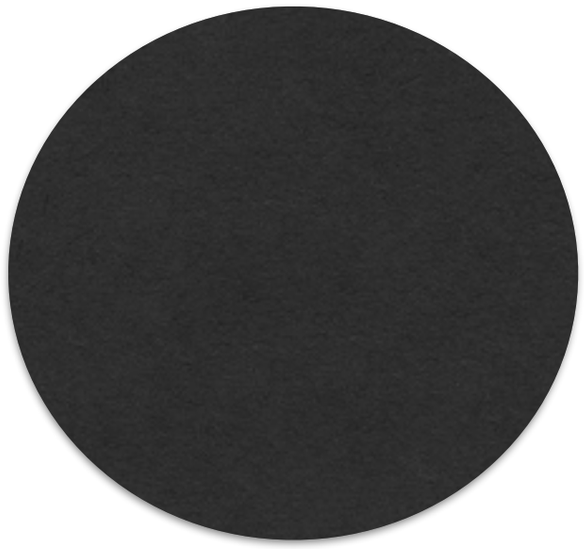
[Merloni et al., 2015, ArXiv: 1503.04870
Grupe et al., 2015, ArXiv: 1504.01389]

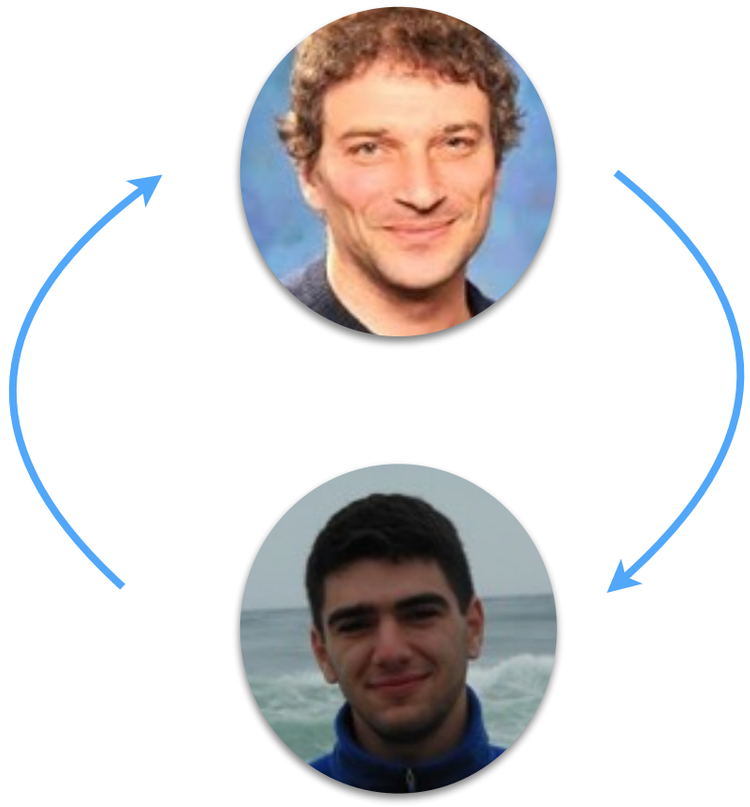
Binary tidal disruptions



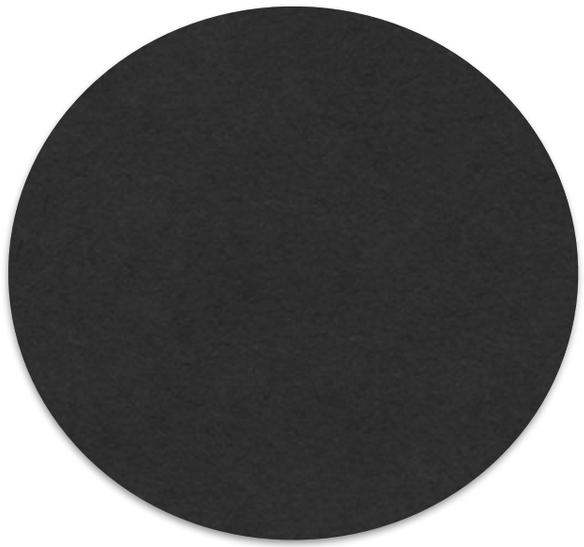
[Mandel and Levin, 2015, ArXiv:1504.02787]

Binary tidal disruptions

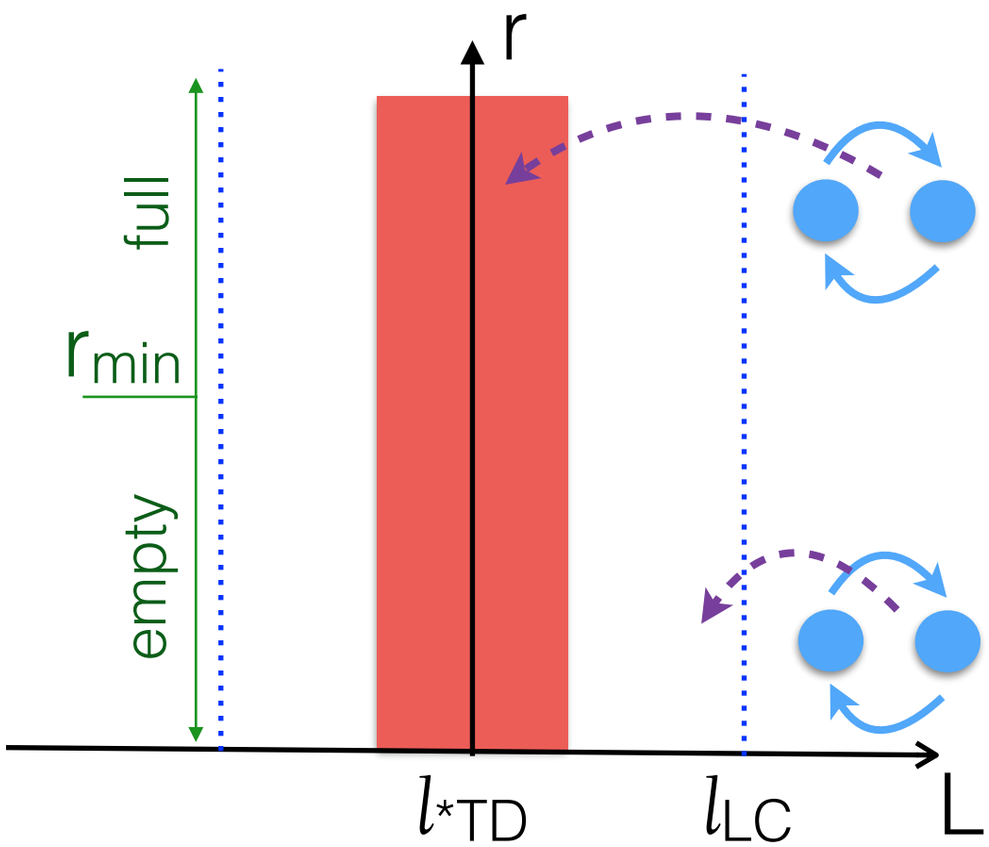


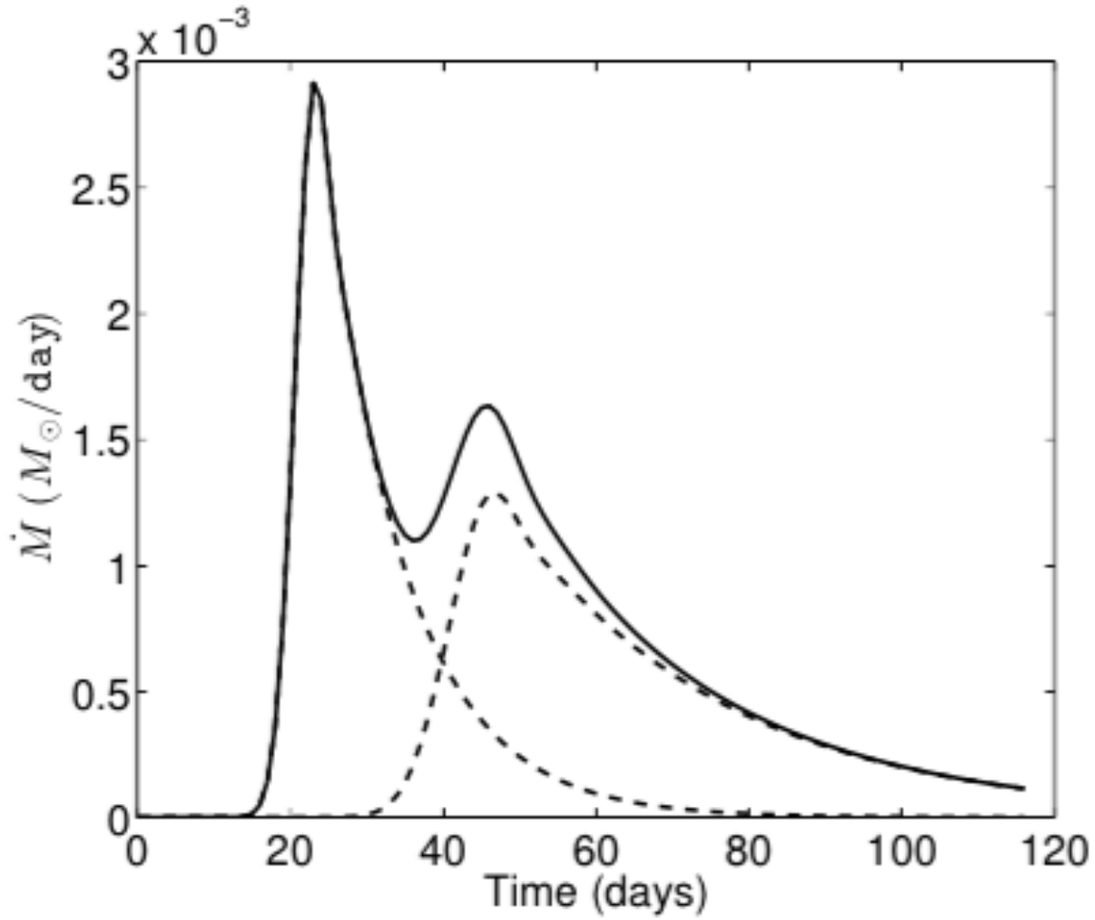


Binary tidal disruptions



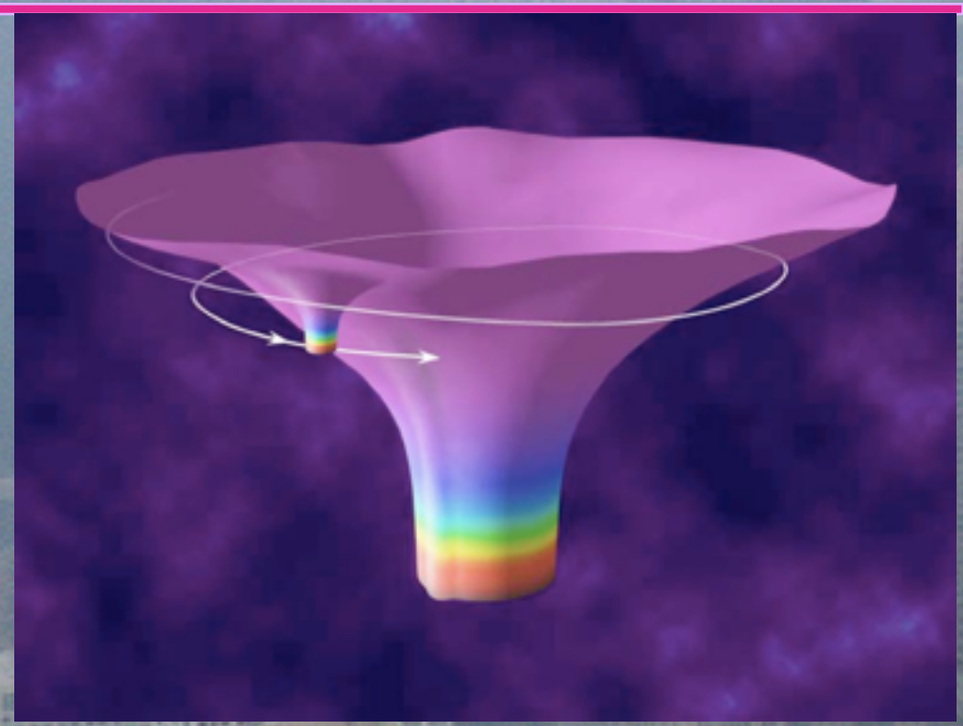
Double tidal disruptions



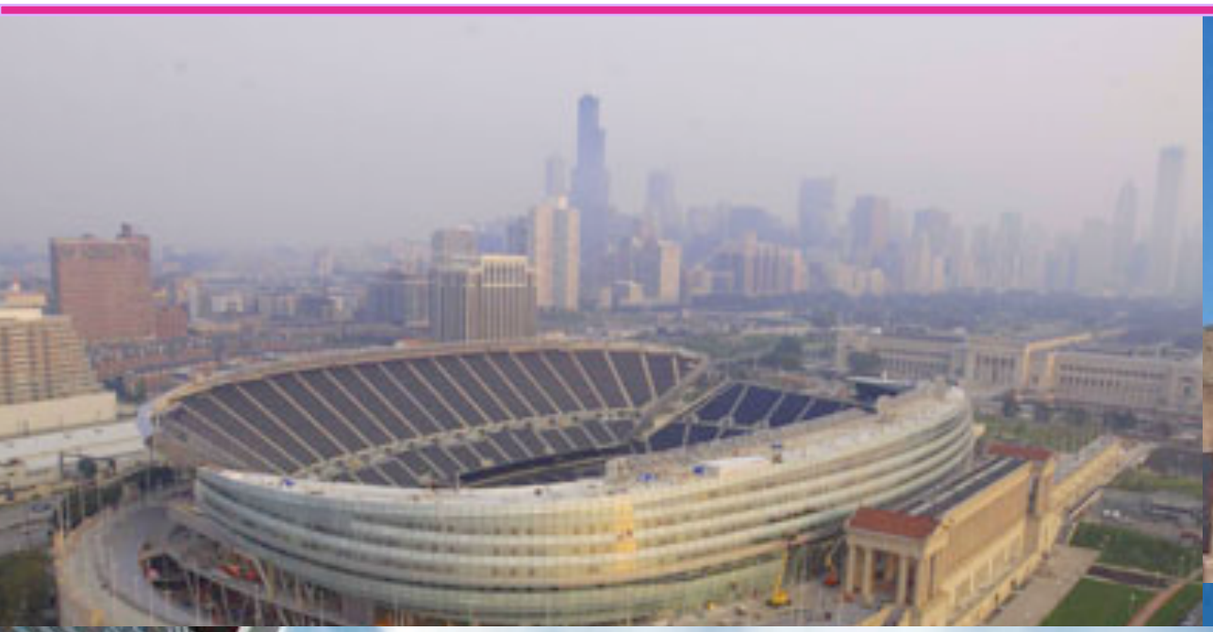


LISA: Looking for massive black holes with gravitational waves

Exploring the spacetime...



… taking lots of pictures



Mapping black holes