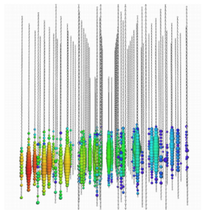
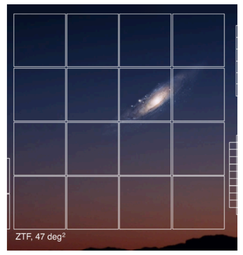
A high-energy neutrino coincident with a tidal disruption event.

ZWICKY TRANSIENT FACILITY Robert Stein, DESY

ZTF Follow-up Pipeline



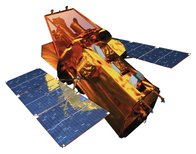
High-energy neutrino (IceCube)



Observe with ZTF

Rejects Stars/Planets/ Artefacts/Asteroids

Filter with AMPEL [1,2]



Rejects unrelated transients e.g Type-Ia supernovae

Trigger additional follow-up

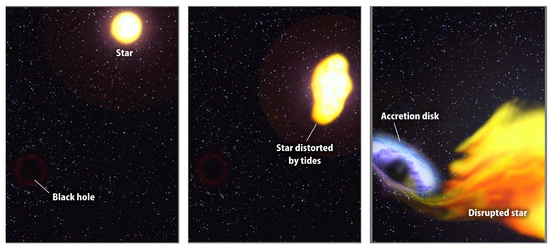
AT2019dsg and IC191001A

Follow-up of high-energy neutrino IC191001A identified tidal disruption event (TDE) AT2019dsg as likely neutrino source [1].

TDEs are rare. Accounting for all eight ZTF follow-up campaigns, probability of chance coincidence <0.5%

What is a TDE?

Credit: NASA/Goddard Space Flight Centre/Swift



Star approaches SMBH

Tidal Forces pull apart star

Stellar debris is partially accreted

Neutrinos from TDEs

TDEs have long been suggested as possible sources of cosmic rays and neutrinos

TDEs are too rare to explain the entire neutrino flux, but could produce a sub-dominant component.

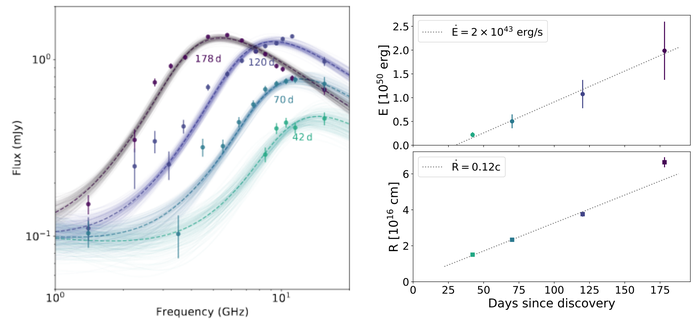
Conditions in AT2019dsg are consistent with requirements for PeV neutrino production [1, 4]

Coincidence suggests TDEs contribute to neutrino flux, compatible with previous search constraining contribution to <39% of total [5].

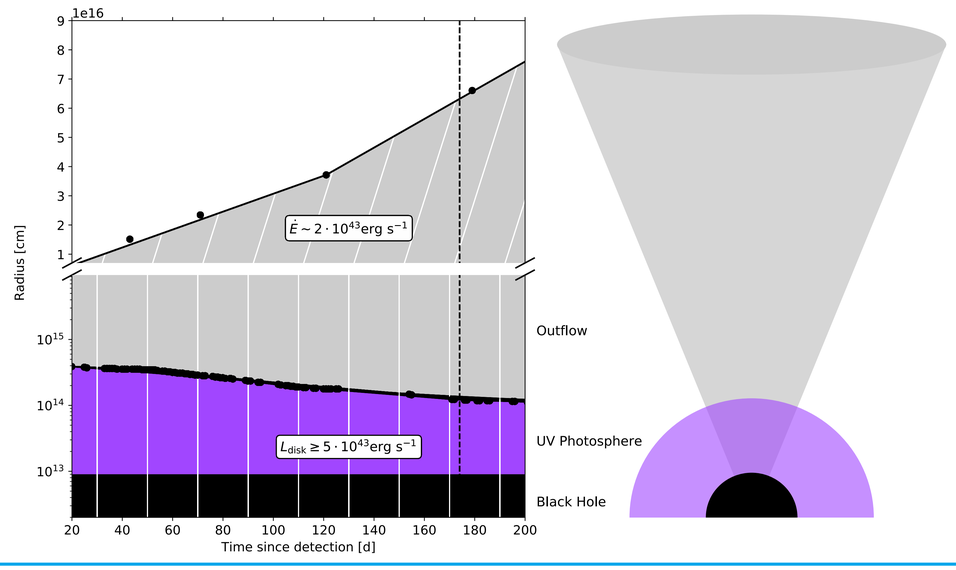
How many other TDEs have similar properties? Remains an open question.

Multi-Wavelength Observations and Modelling of AT2019dsg

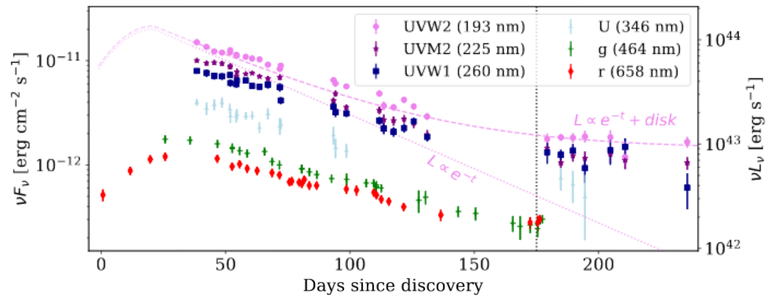
Radio



AT2019dsg one of handful of radio-emitting TDEs, confirming particle acceleration
Observations reveal synchrotron emission from mildly-relativistic outflow
First direct evidence of a central engine in a TDE, active until neutrino detection

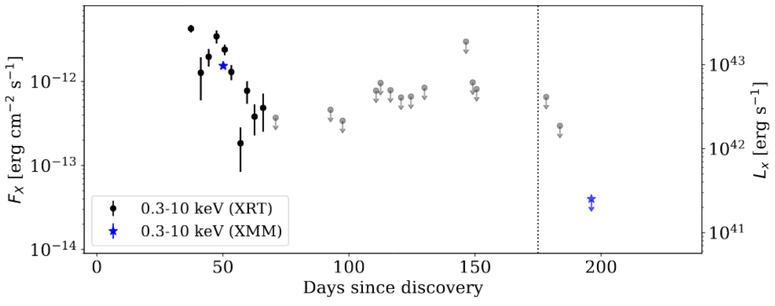


UV/Optical



UV/optical emission reveals a thermal photosphere
AT2019dsg in top 10% of brightest TDEs [3]
Evolution consistent with plateau from accretion disk formation

X-ray



AT2019dsg was one of the few TDEs detected in X-rays [3]
Initially bright but fades very quickly. Emitted close to black hole.
Rapid exponential decline due to to cooling or obscuration?

HELMHOLTZ Young Investigators

References:

- "A high-energy neutrino coincident with a tidal disruption event", R. Stein et al, submitted, (2020)
- "Transient processing and analysis using AMPEL", J. Nordin et al., A&A 631, (2019)
- "Seventeen Tidal Disruption Events from the First Half of ZTF Survey Observations: Entering a New Era of Population Studies", van Velzen et al., submitted (2020)
- "A concordance scenario for the observation of a neutrino from the Tidal Disruption Event AT2019dsg", W. Winter and C. Lunardini, submitted (2020)
- "Search for Neutrinos from Populations of Optical Transients", R. Stein for the IceCube Collaboration, 36th International Cosmic Ray Conference, (2019)

DESY.