Tidal Disruption Events in OGLE and Gaia surveys

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Iair Arcavi, James Guillochon, Morgan Fraser, et al.

Gaia Science Alerts team in Cambridge
OGLE team in Warsaw
Unbiased OGLE and Gaia hunt for TDEs

OGLE
http://ogle.astrouw.edu.pl

Gaia Science Alerts
http://gsaweb.ast.cam.ac.uk/alerts

Polish 1.3m dedicated telescope in Las Campanas, Chile
Surveying continuously since 1992.

ESA space mission with 2x1.4m telescopes located in L2.
In operation since 2014.

Unbiased OGLE and Gaia hunt for TDEs

Gaia figure by Nadia Blagorodnova, OGLE fields by Jan Skowron
OGLE Nuclear Transients

Real-time and archive search. 
http://ogle.astrouw.edu.pl/ogle4/transients

Difference Imaging data for 6 million centres of galaxies.

Astrometric accuracy 130mas

Example AGN light curve
6 years of photometry

mysterious short nuclear transients:
- TDEs of low mass stars?
- low mass black-holes?

Candidate TDE
4 years long nuclear flare

Wyrzykowski+2014
OGLE16aaa - Hungry SMBH

- $z=0.167$, peak absolute mag $M=-20.5$
- slowly rising I-band light curve (~30d)
- very broad HeII and Hα emission
- hot black-body flare spectrum: 22,000K
- host shows weak narrow AGN lines (not E+A)
- no photometric activity in 3.5 yrs prior to the flare
- possible variability?

Wyrzykowski+2016, arxiv:1606.03125
TDE in a weakly active SMBH? left-overs from previous TDE?

Bias in optical-TDEs selection?

SDSSJ0748

SMBH: $10^{6.5}$ MSun, star: 0.3 MSun

Wyrzykowski+2016, arxiv:1606.03125
Nuclear transients in Gaia
Gaia’s advantage: superb astrometry
Nuclear transients in Gaia

Gaia’s advantage: instantaneous low-res spectra

even raw BPRP spectra indicate the detected flare is blue

single BPRP spectra at <19mag can recognise SN Ia from other types

Blagorodnova+2015,2016

raw public Gaia data!
Gaia16aax
Changing-Look QSO or Stripping (Partial) TDE

NUTS@NOT (Feb 2016)

Gaia alert light curve

Light curve and spectra consistent with $A_V=1$ mag change in extinction (hole in the dust?) but the time-scale way too short!

Follow-up: Gaia NOT, WHT (spec+grizJHK) XMM

work in progress
Gaia16apt
TDE? AGN Flare?

with: A.Hamanowicz, N.Britavsky

1mag flare, slow decline
WISE colours = AGN Flare?
broad Ha, Hb, HeII?
z=0.136
abs mag about -19.6 (no host)

work in progress
Stellar mass black holes
Stellar mass black holes

OGLE3-ULENS-PAR-02 - candidate ~9MSun BH

OGLE photometry from 2001-2008 and microlensing model

Mass, Distance (estimate)

Wyrzykowski+2016a
Stellar mass black holes

OGLE-III long microlensing events with parallax effect

single

binary systems

Wyrzykowski+2016a

Ozel+2010

GAP?
Stellar mass black holes

OGLE3-ULENS-PAR-02 - candidate ~9MSun BH

OGLE photometry from 2001-2008 and microlensing model

predicted Gaia astrometry for similar event

Mass, Distance
Stellar mass black holes

OGLE3-ULENS-PAR-02 - candidate ~9MSun BH

Combination of ground-based photometry and Gaia astrometry for long events will yield masses of black holes accurate to ~1% percent.

Rybicki in prep.
Summary

• OGLE and Gaia are well suited for finding transients in galaxy centres

• Superb astrometry (Gaia, OGLE)
  Instantaneous low-res spectra (Gaia)

• TDEs can be found also around active black holes (OGLE16aaa) - TDE rate bias?

• Future: spectral follow-up of candidates on VLT, SALT, NOT, WHT

• Gaia will help find galactic single/binary stellar mass BHs via microlensing
Thank you!