Intermediate-mass black holes
&
Gaia science alerts' unique potential

Peter Jonker (SRON & RU)
Thomas Wevers (RU & SRON)
Francesca Onori (SRON & RU)
Marianne Heida (SRON & RU)

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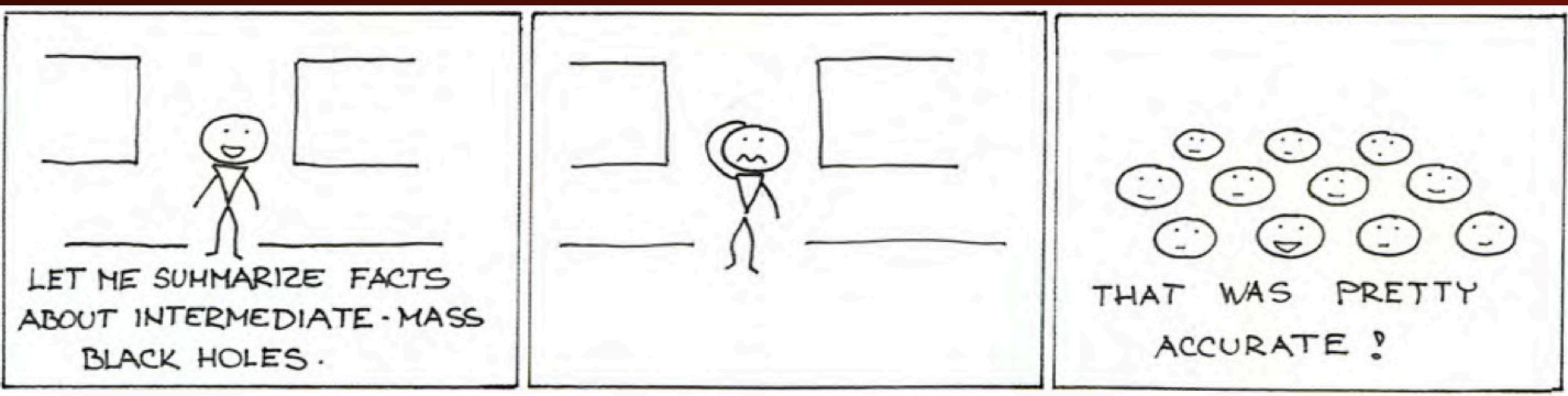
Netherlands Institute for Space Research

European Research Council
Established by the European Commission

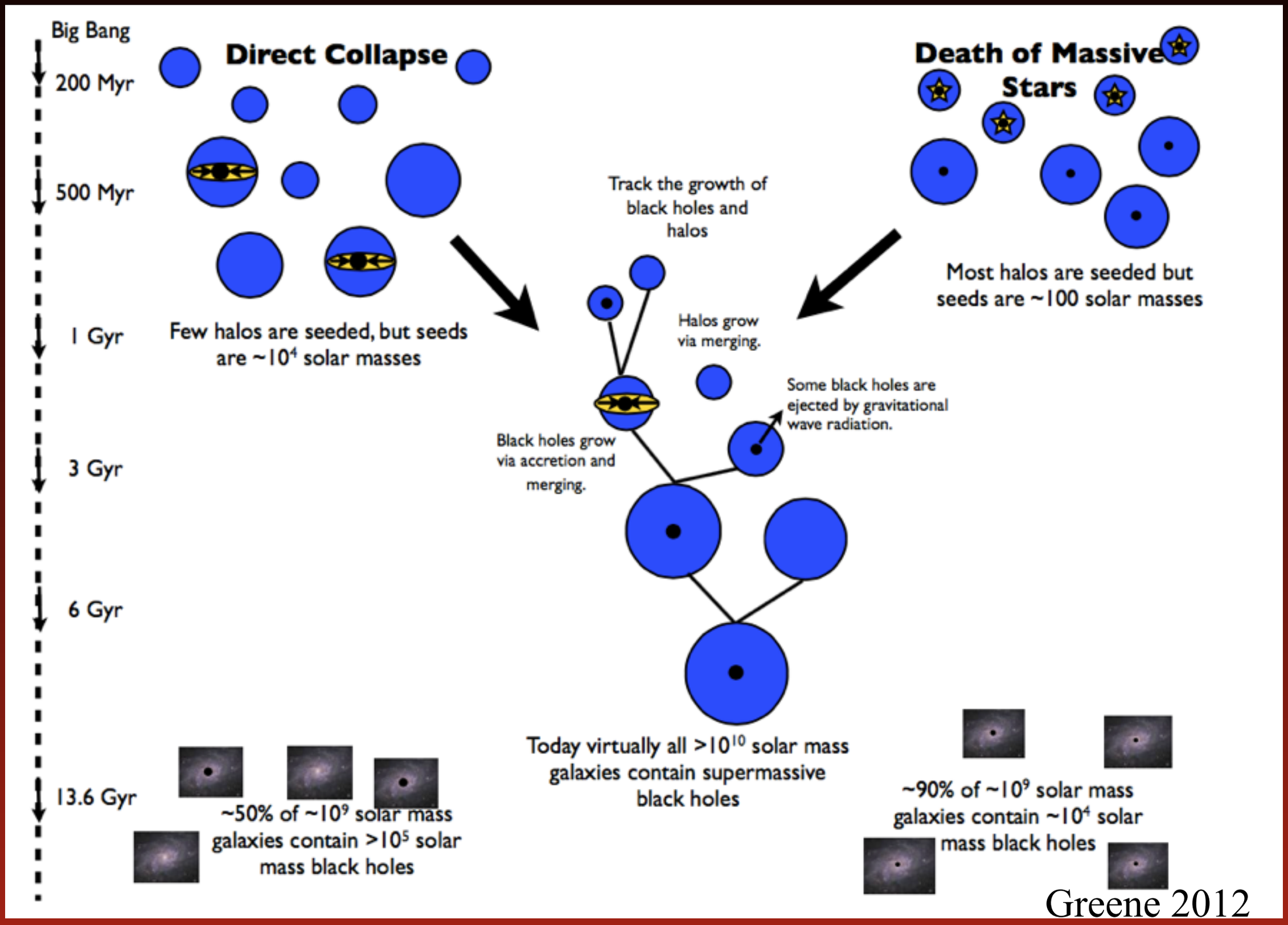
Department of Astrophysics · Radboud University Nijmegen

Gaia Science Alerts Workshop, Liverpool Nov 10-14, 2015

Do IMBHs exist?



Occupation fraction depends on the nature of the seed BH



Greene 2012

Ultra-luminous X-ray sources

Cartwheel galaxy

HST

(Credit: NASA/STScI)

Chandra

(Credit: NASA/CXC/A.Wolter & G.Trinchieri et al.)

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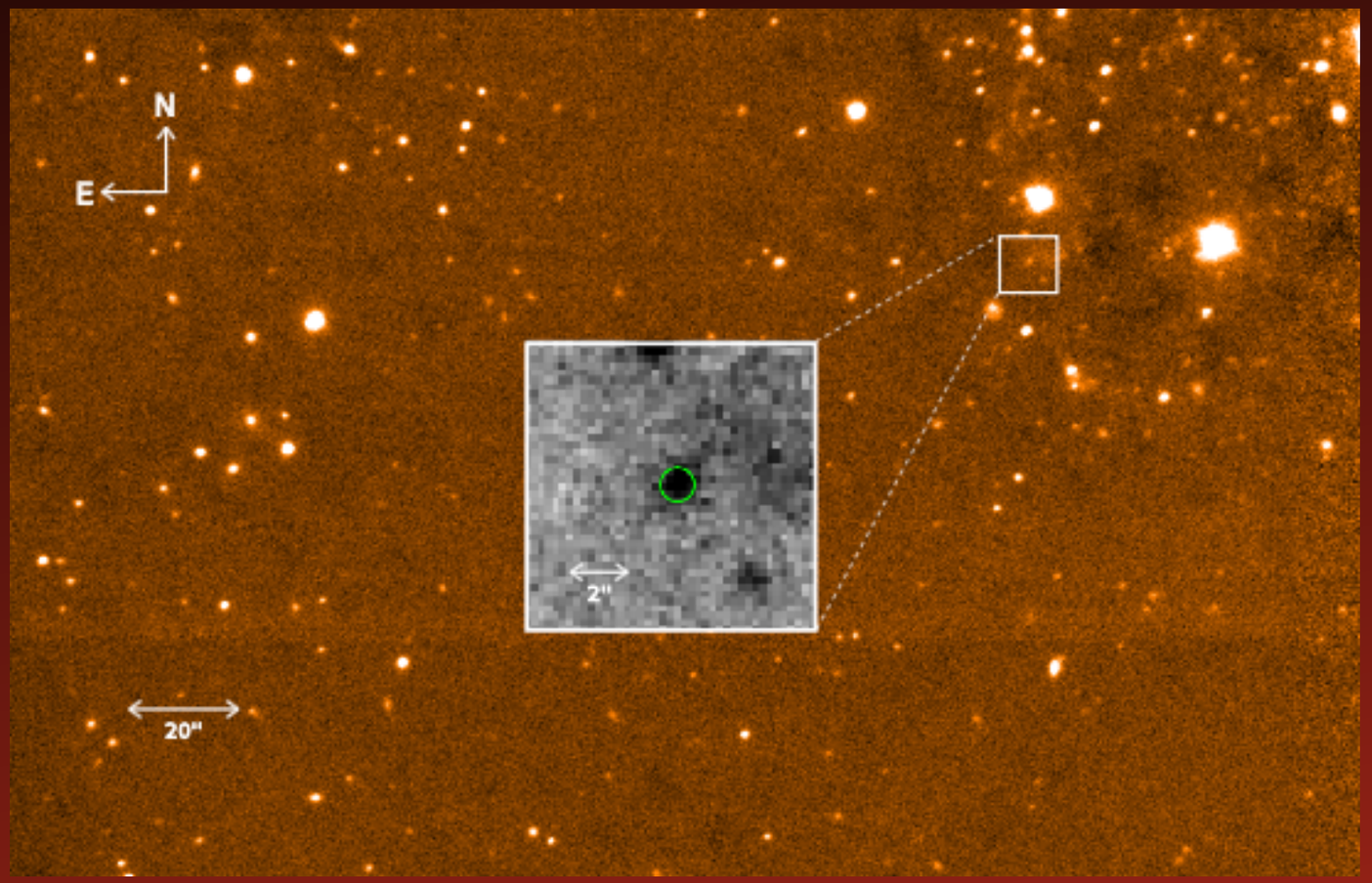
ULXs: BH-red supergiant binaries?



Imaging survey: 4m class telescopes WHT
Spectroscopic follow-up: VLT, Keck, Gemini

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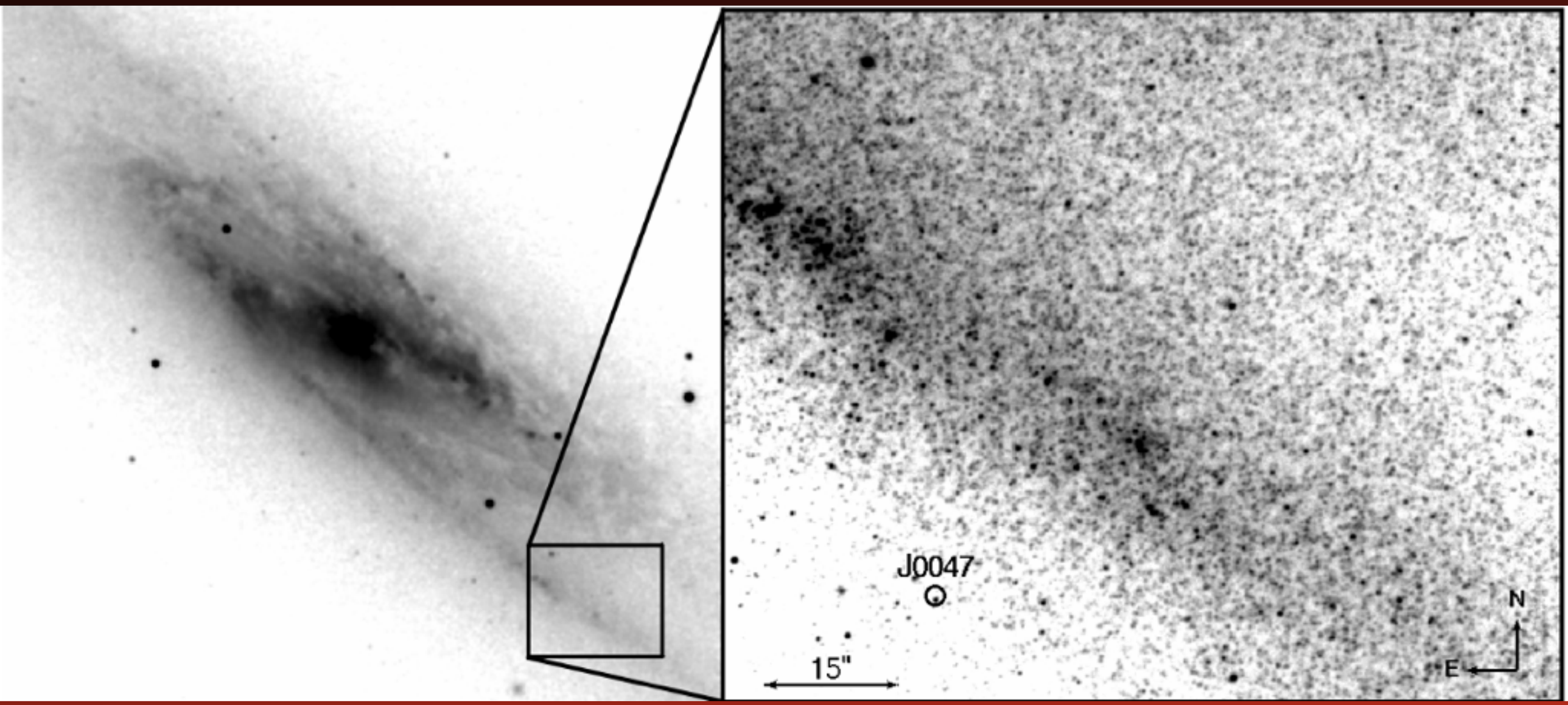
Heida, Jonker, et al. 2014

ULXs: BH-red supergiant binaries

ULX in NGC253

VLT/X-shooter

ULX in NGC253



2MASS K_s

ESO ISAAC K_s

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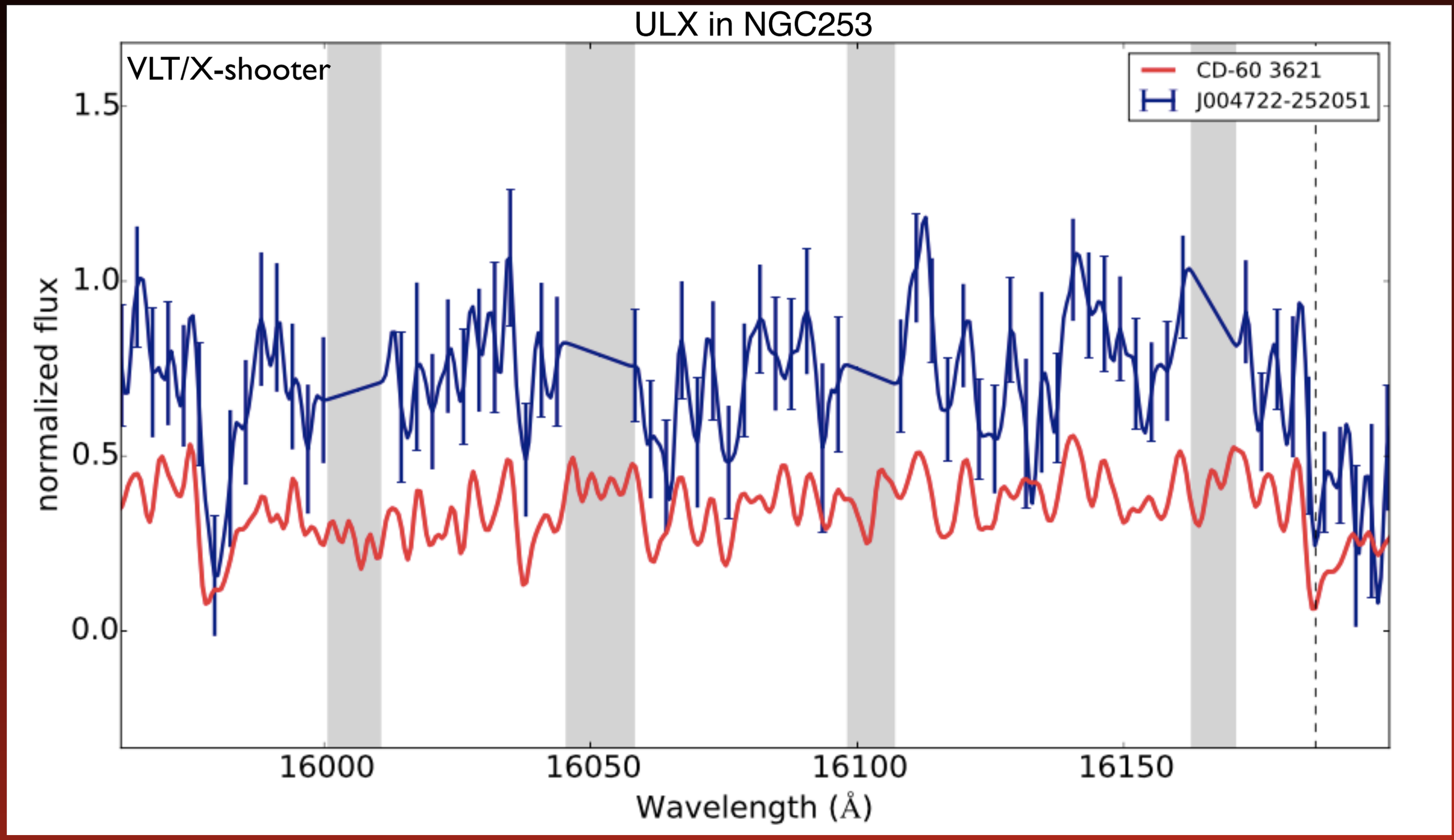
Heida, Torres, Jonker, et al. 2015

ULXs: BH-red supergiant binaries



V_{radial}=66±6 km/s

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Heida, Torres, Jonker, et al. 2015

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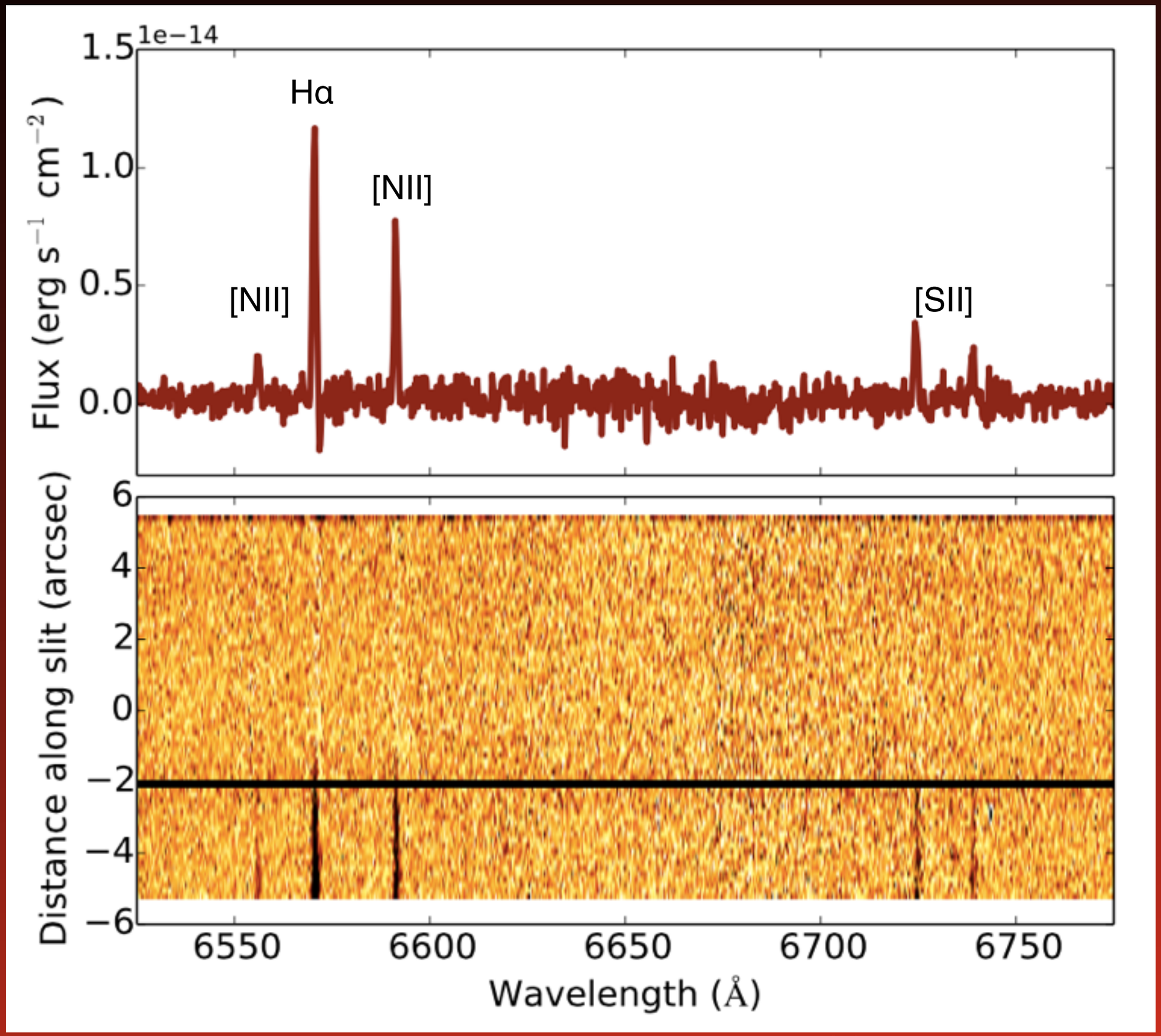

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Heida, Torres, Jonker et al. 2015

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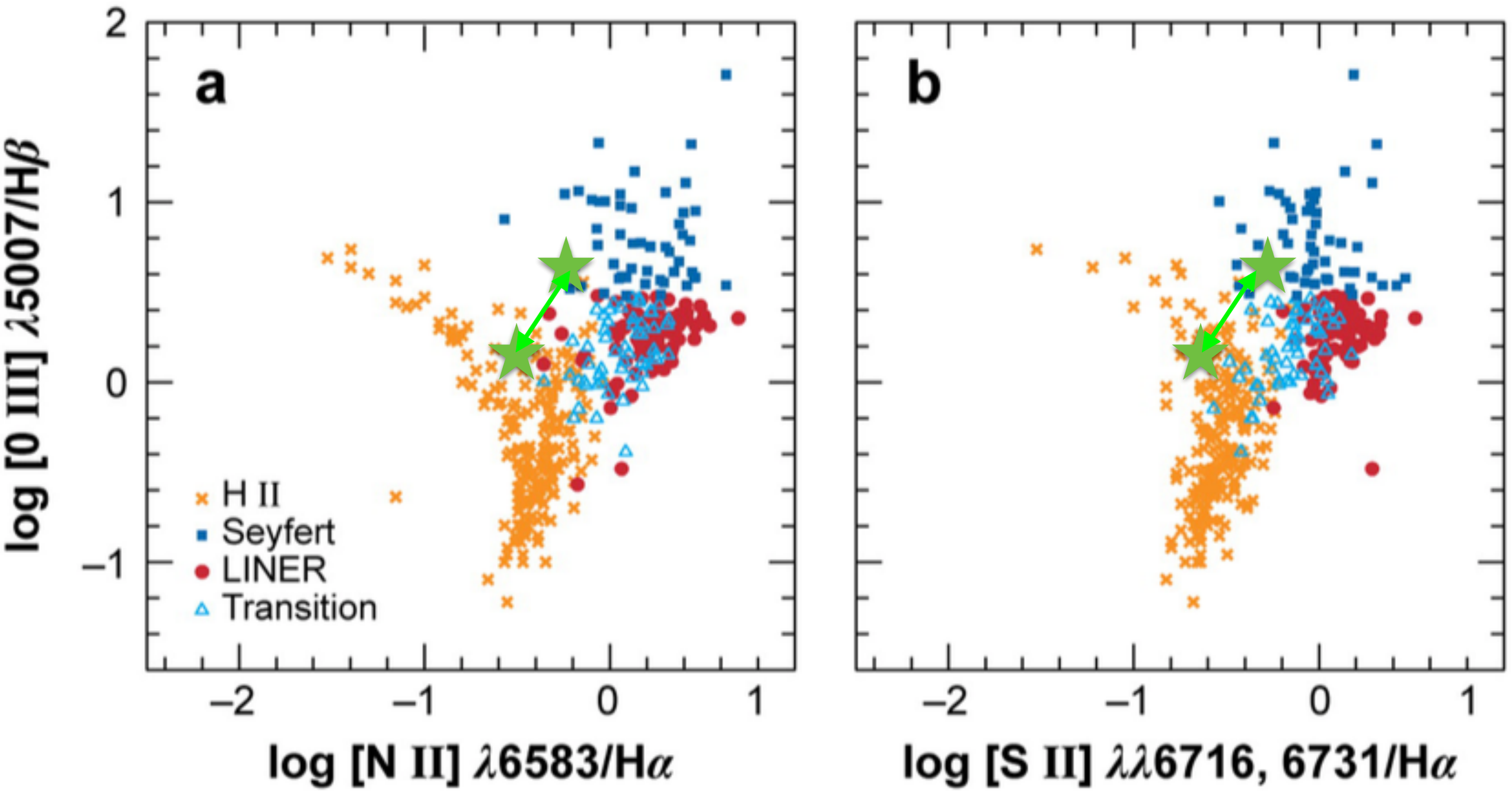

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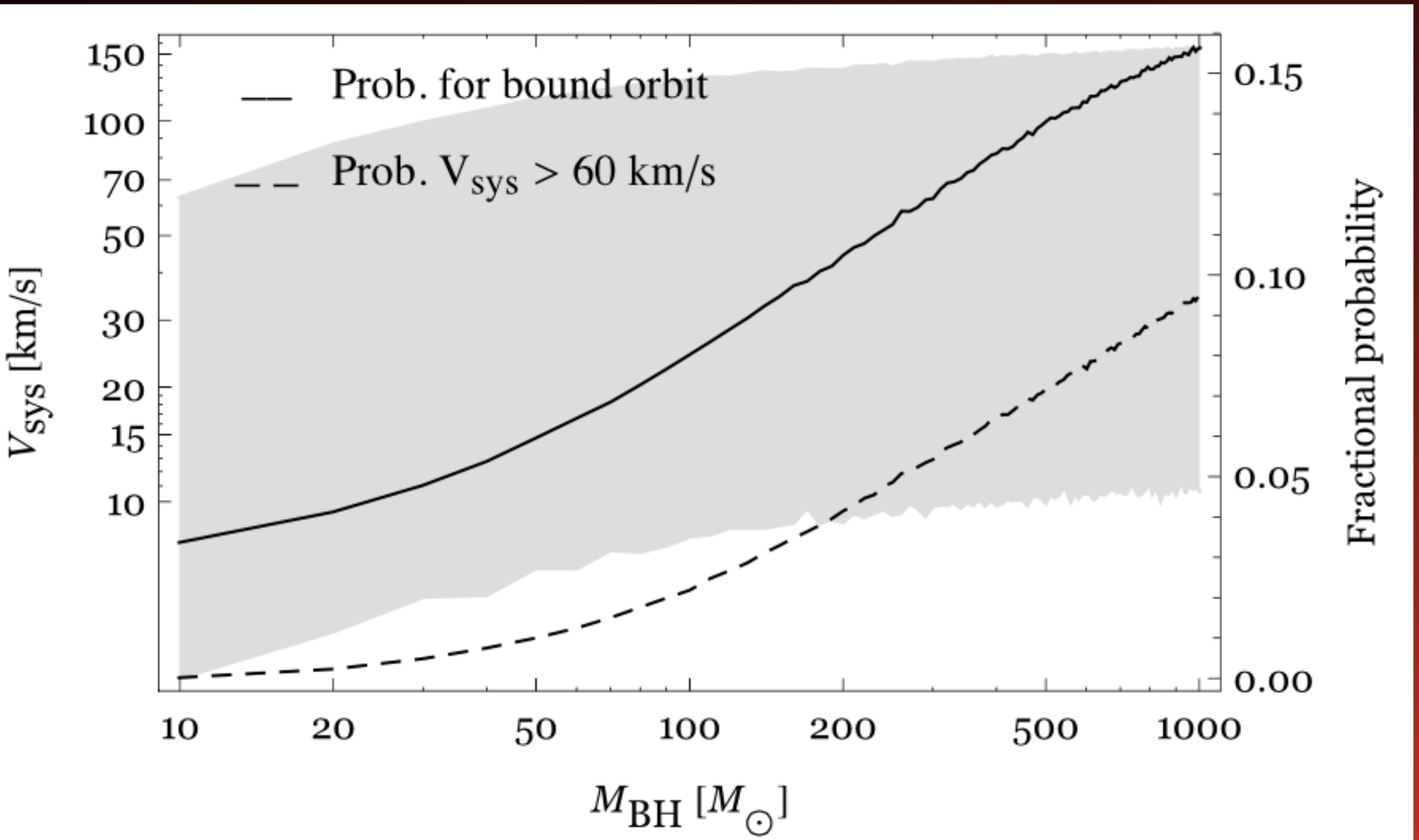
Heida, Torres, Jonker et al. 2015

ULXs: BH-red supergiant binaries



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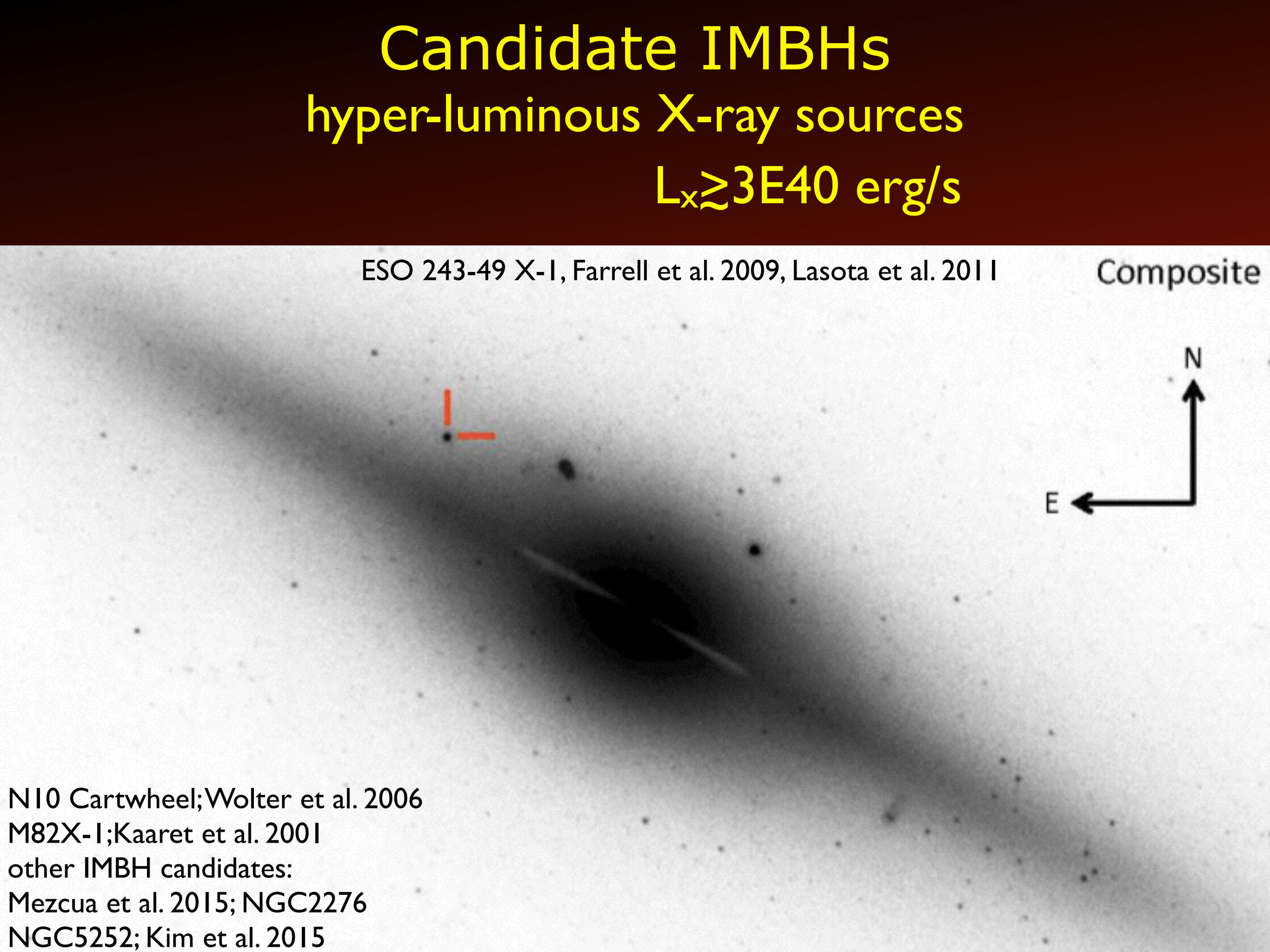
Heida, Torres, Jonker et al. 2015

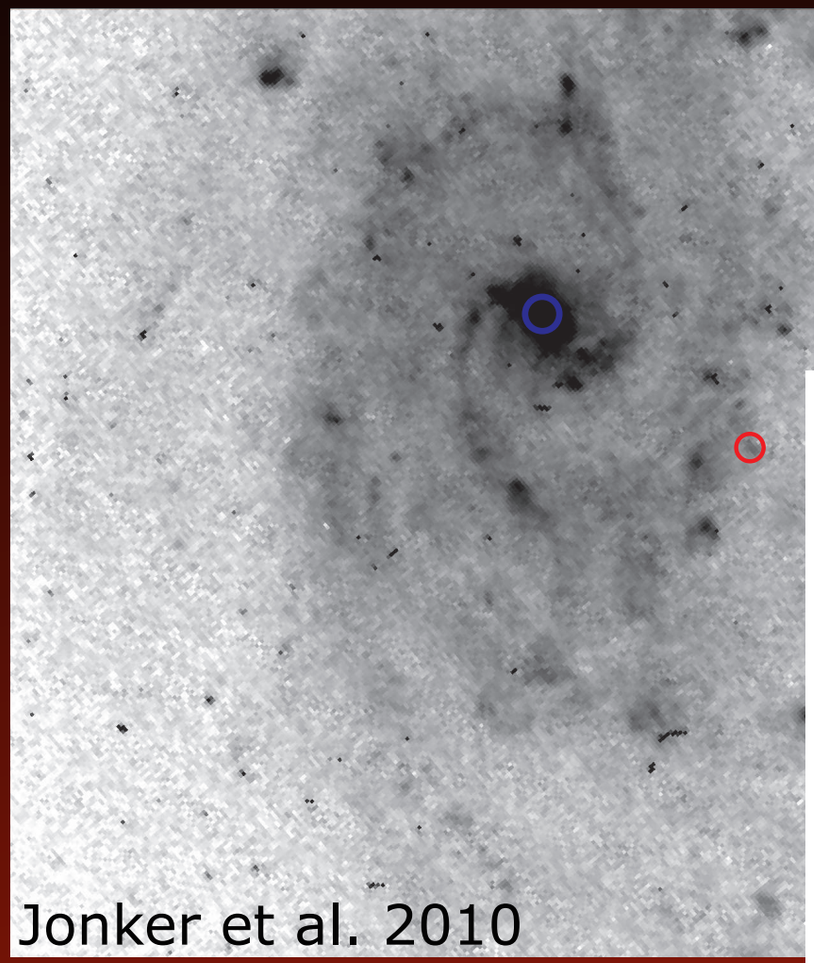
Candidate IMBHs
hyper-luminous X-ray sources
$L_x \gtrsim 3E40$ erg/s

ESO 243-49 X-1, Farrell et al. 2009, Lasota et al. 2011



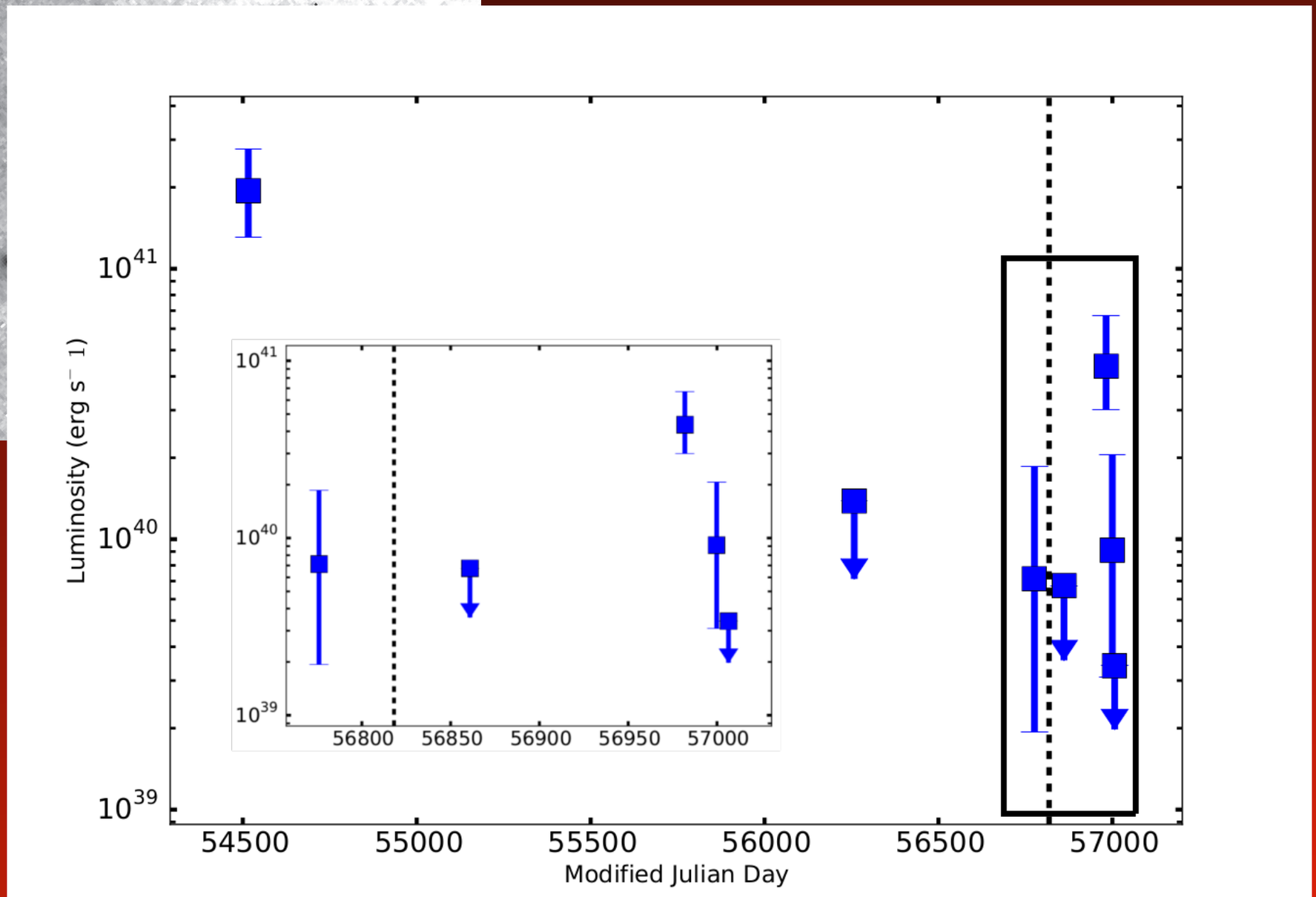
N10 Cartwheel; Wolter et al. 2006
M82X-1; Kaaret et al. 2001
other IMBH candidates:
Mezcua et al. 2015; NGC2276
NGC5252; Kim et al. 2015

HLX2



Jonker et al. 2010

$L_{x,peak}$=2E41 erg s^{-1}



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Heida, Jonker, & Torres 2015, MNRAS, ArXiv 1509.00329

IMBHs & tidal disruption events?

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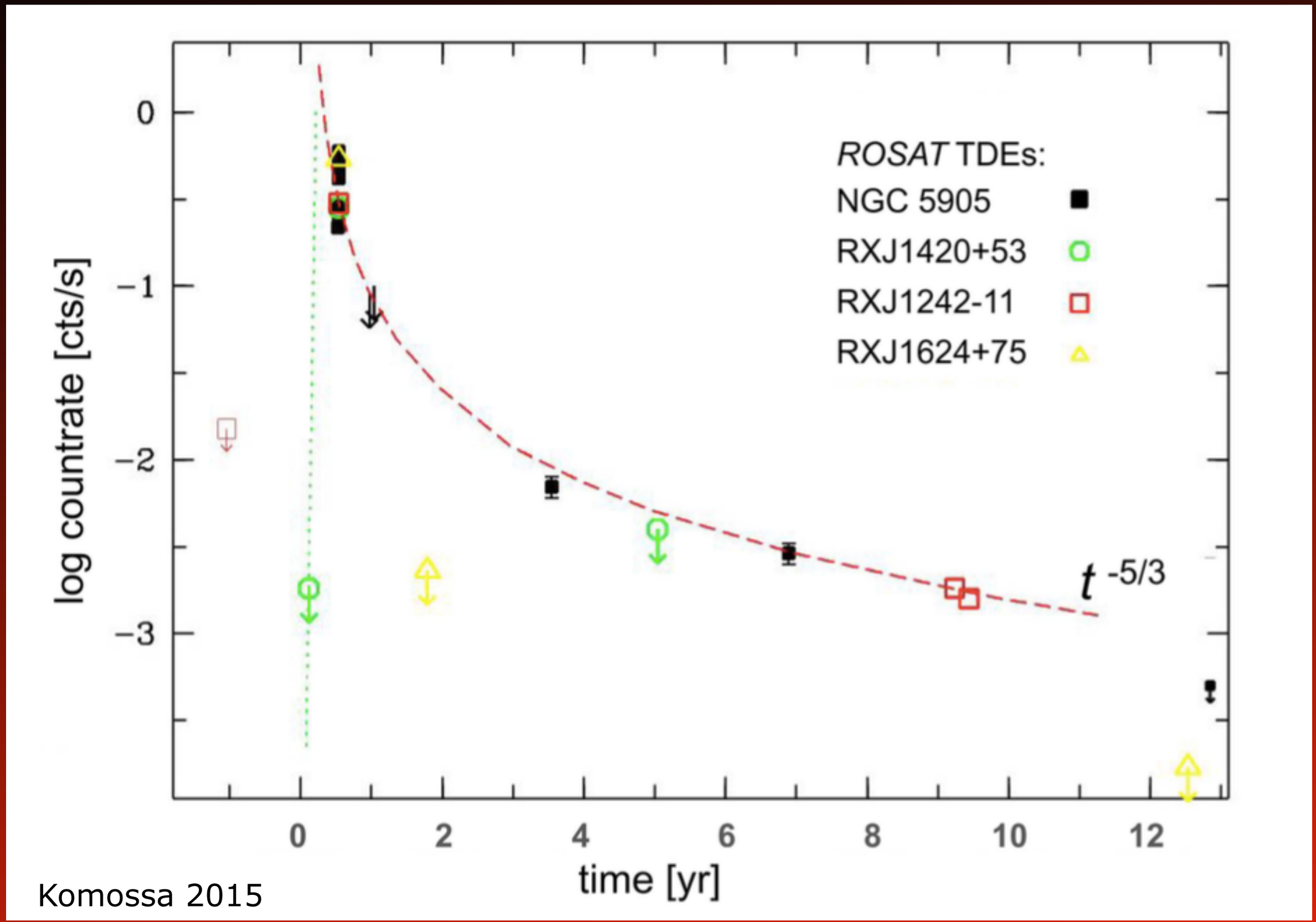
Tidal disruption events; X-ray



Komossa 2015

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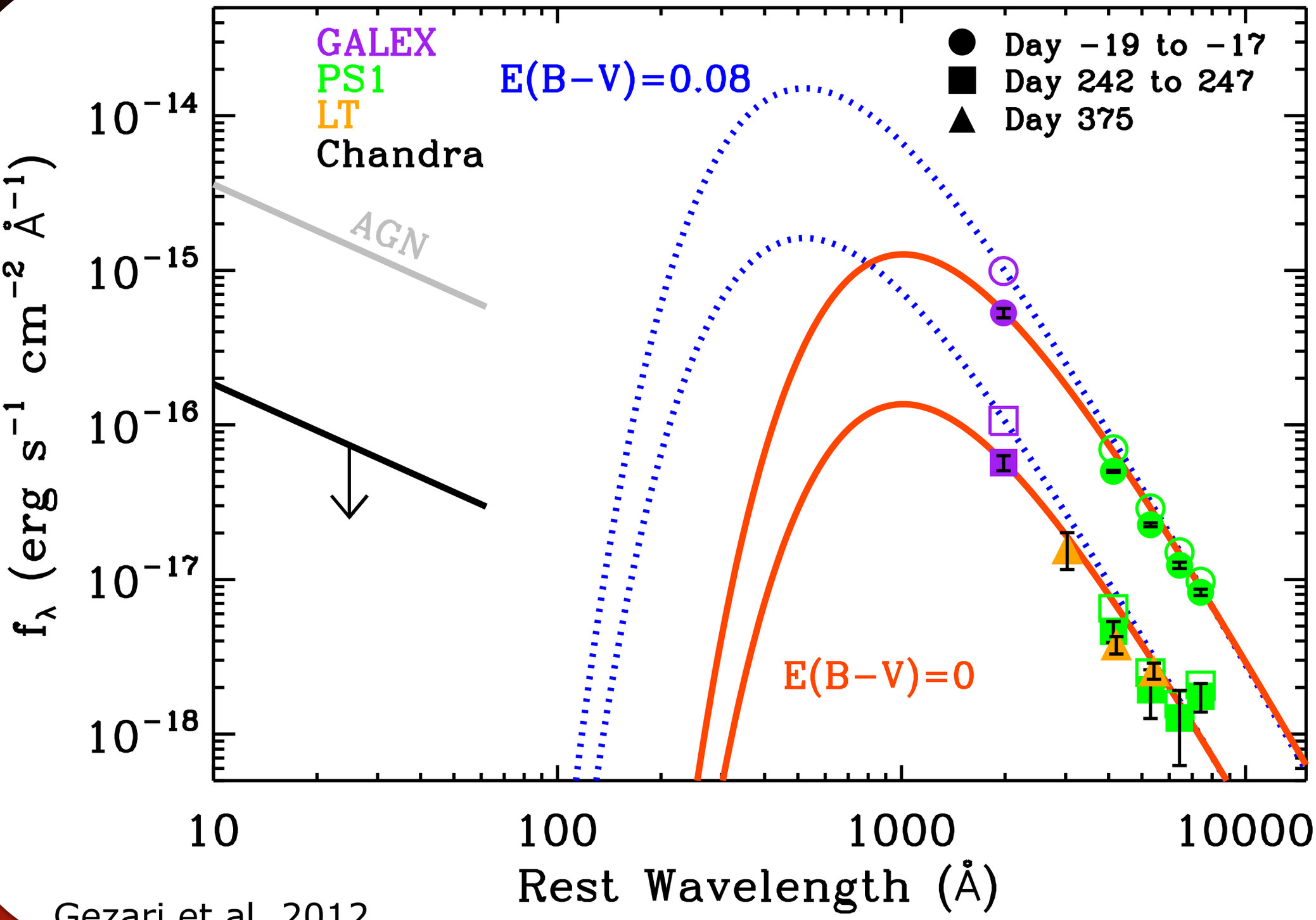
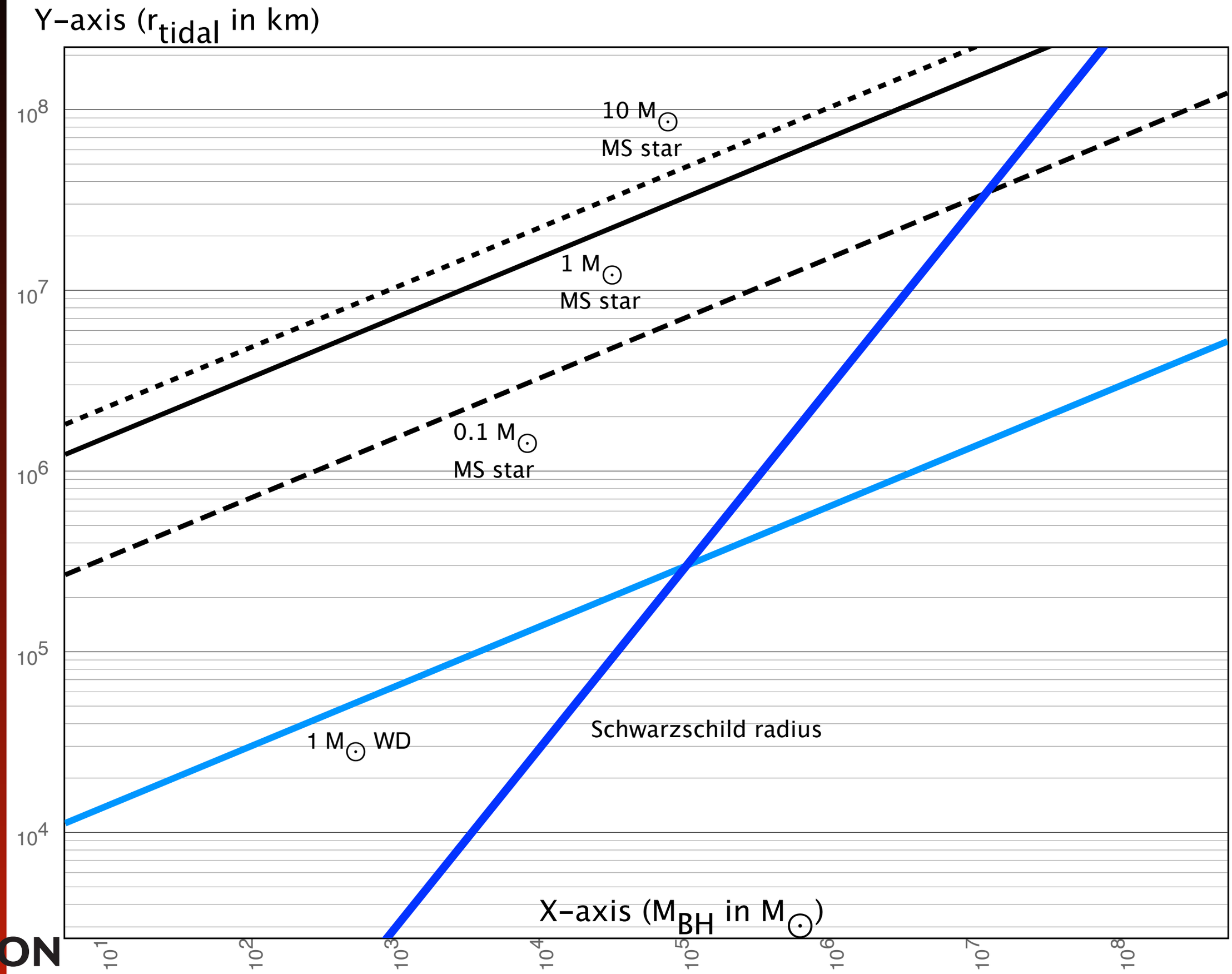
XMM: e.g. Esquej+08; Maksym+10, 13, 14; Saxton+14; Feng+15; Lin+11, 15

Tidal disruption events; optical



Gezari et al. 2012

Tidal disruption events & IMBHs



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Tidal disruption of a WD by an IMBH

WD-BH encounter

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masses (sol.)	0.2 (WD) & 1000 (BH)
in. separation	50 (in 1.E9 cm)
hydrodynamics	SPH (4 030 000 particles)
EOS, gravity	Helmholtz, N
nucl. burning	red. QSE-network (Hix 98)
simul. time	5.4 min
color coded	column density
penet. factor	12

coding, simulation, visualisation: S. Rosswog

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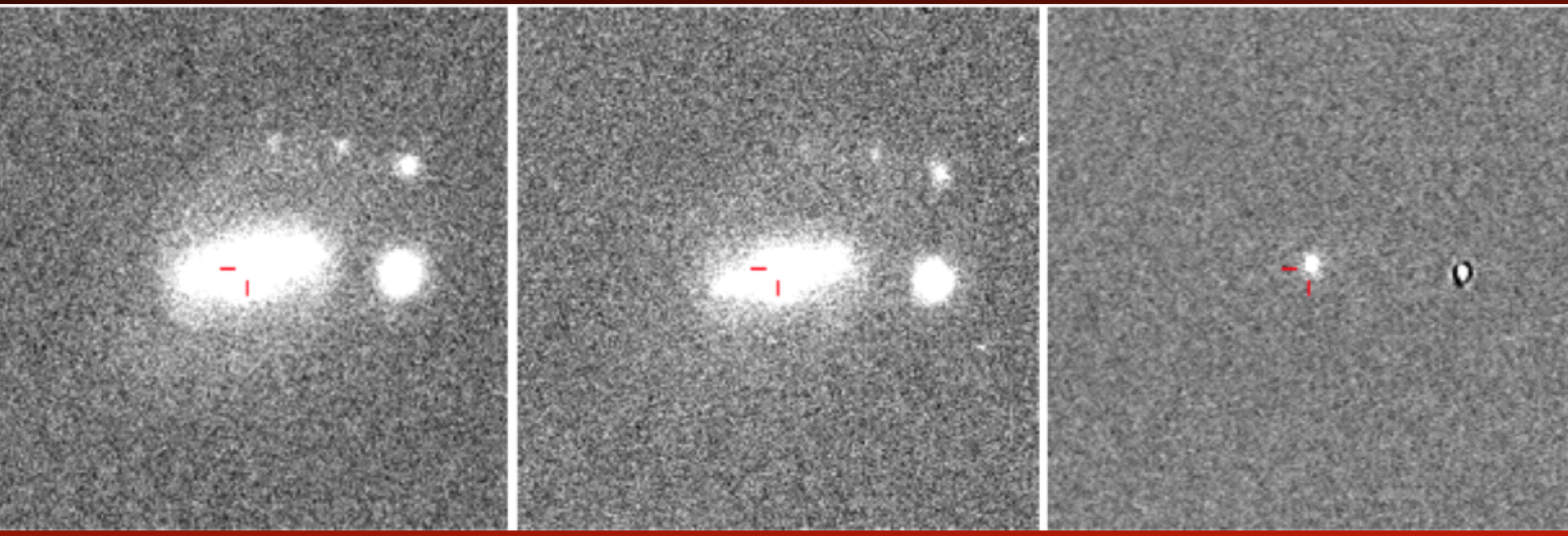
Rosswog, Ramirez-Ruiz, Hix 2009

Nuclear (?) event



Data courtesy Lukasz Wyrzykowski

Tidal disruption events & IMBHs

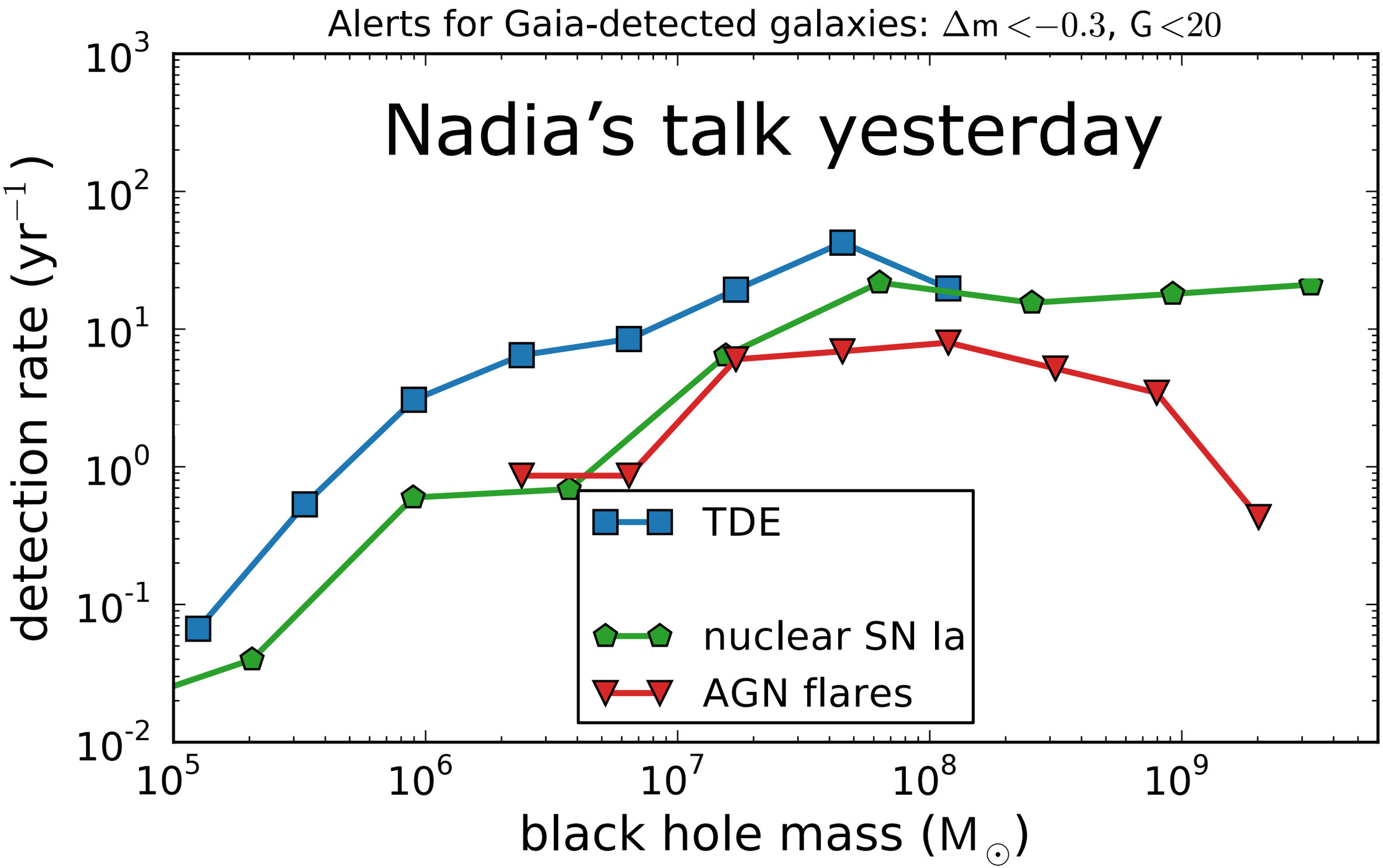


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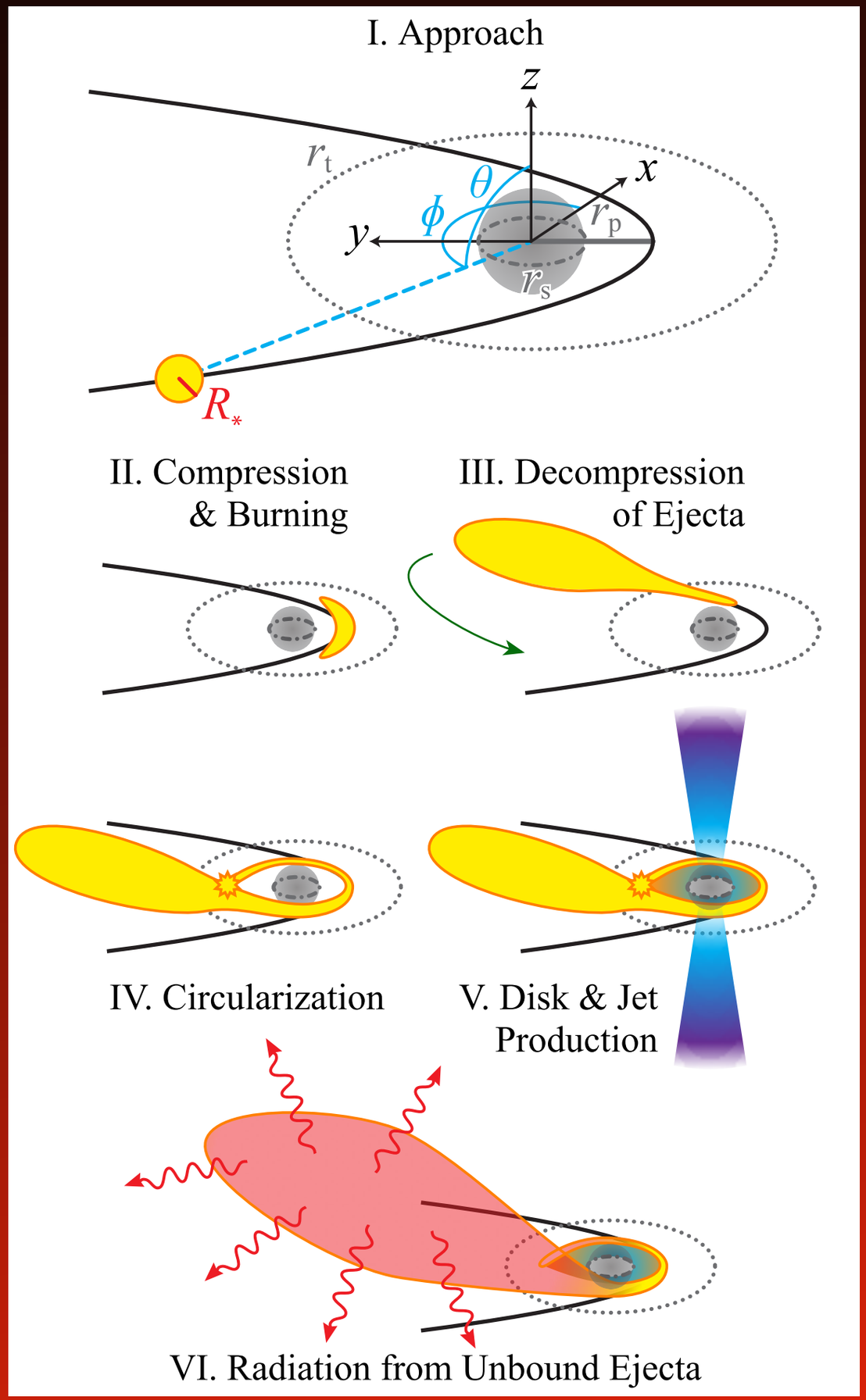
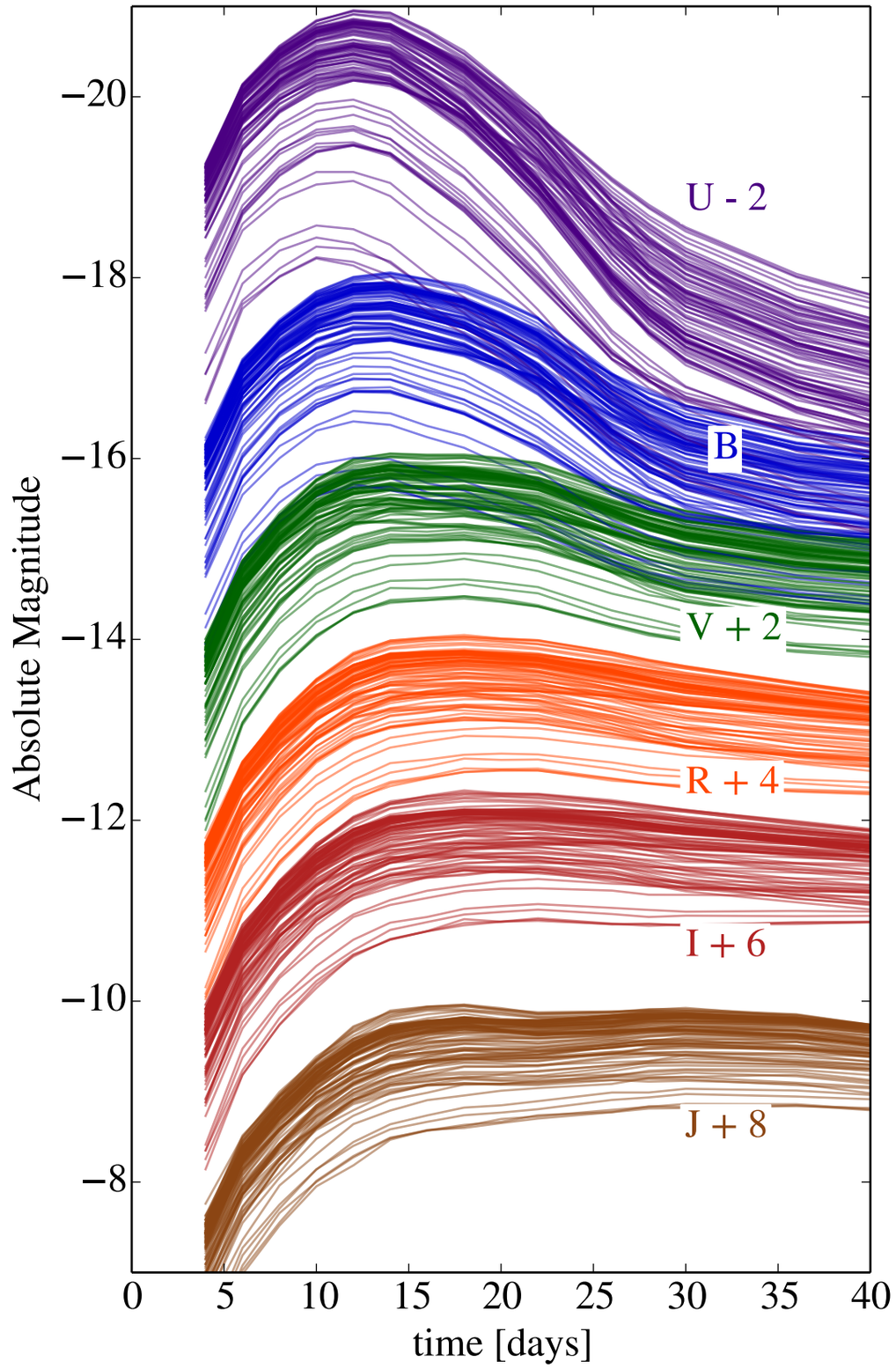
Figure courtesy Sjoert van Velzen

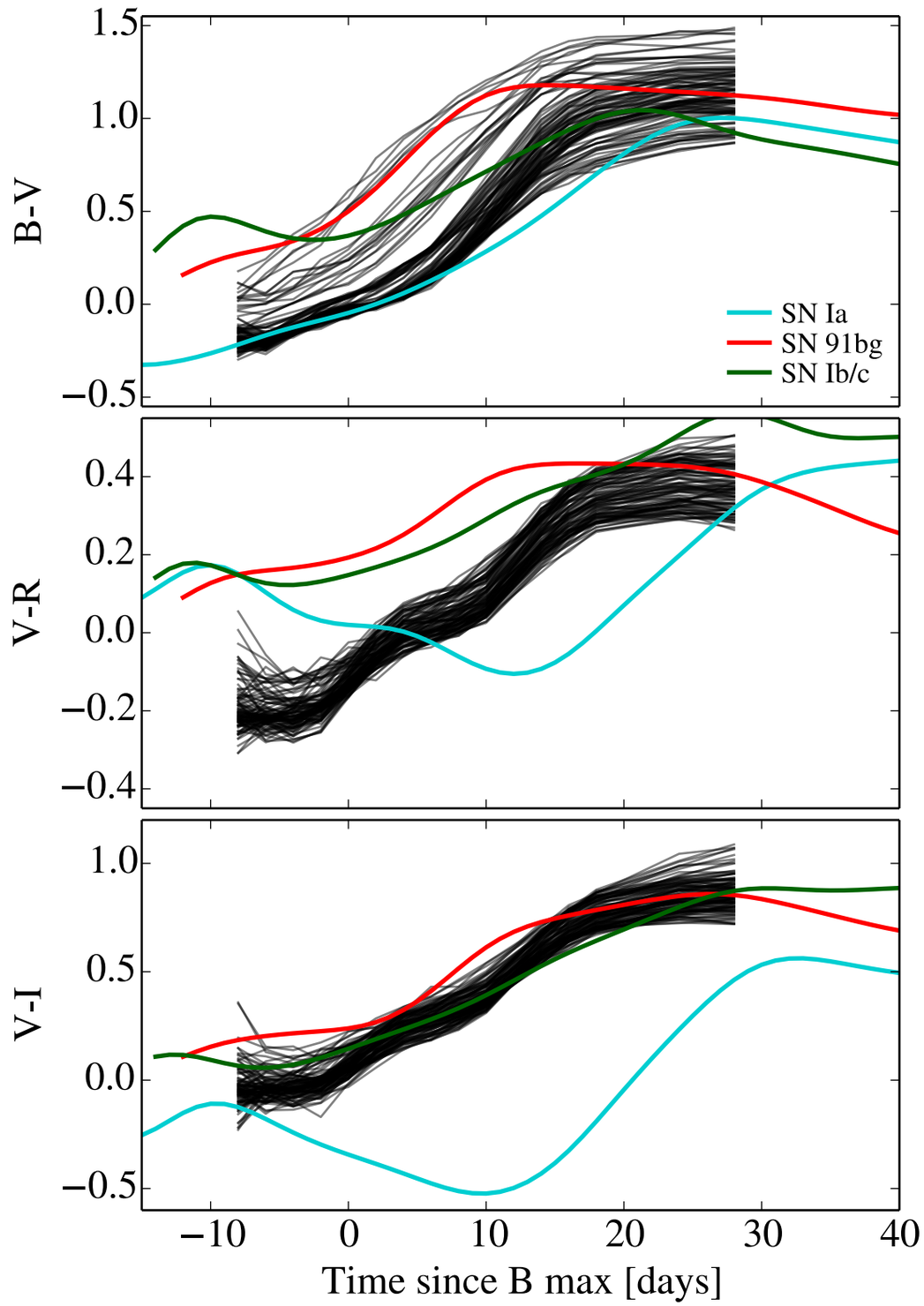
Tidal disruption events & IMBHs



MacLeod et al. (2015)

Nuclear Type ~Ia





MacLeod et al. 15

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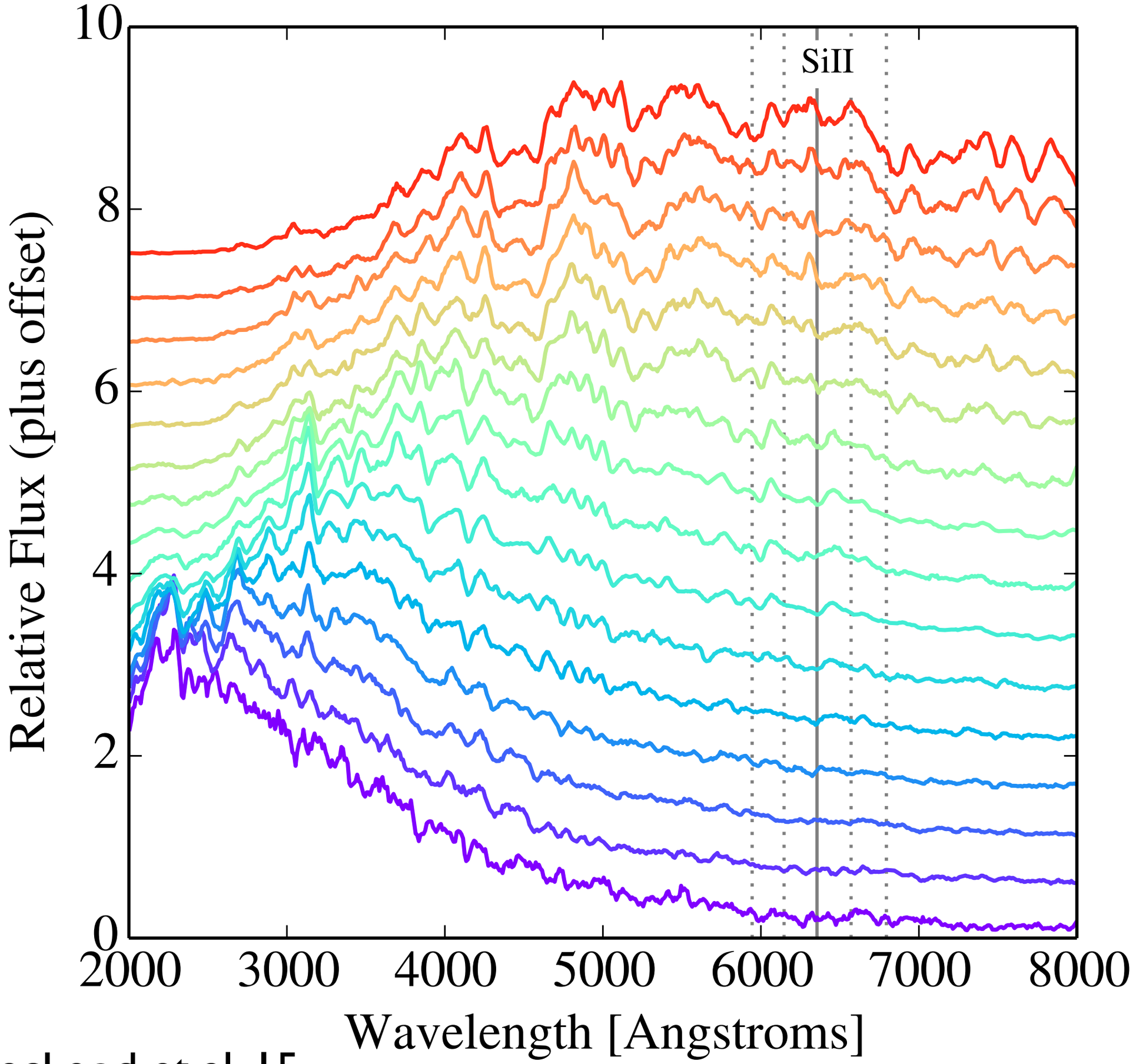
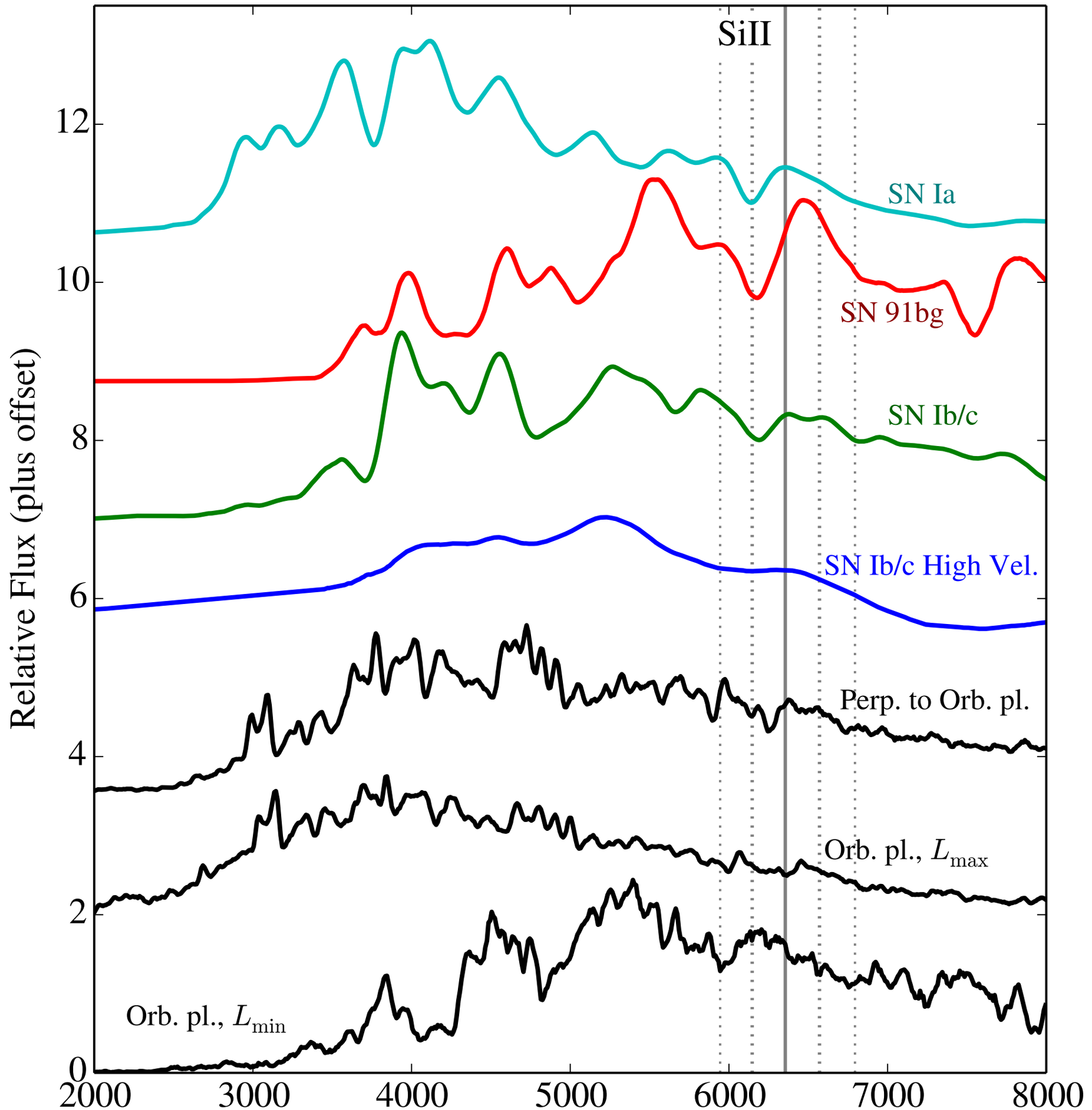
a.o. Luminet & Pichon 89; Rosswog et al. 08 & 09

Nuclear Type ~Ia



MacLeod et al. 15

Nuclear Type ~Ia



MacLeod et al. 15

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Are there WD TDEs?

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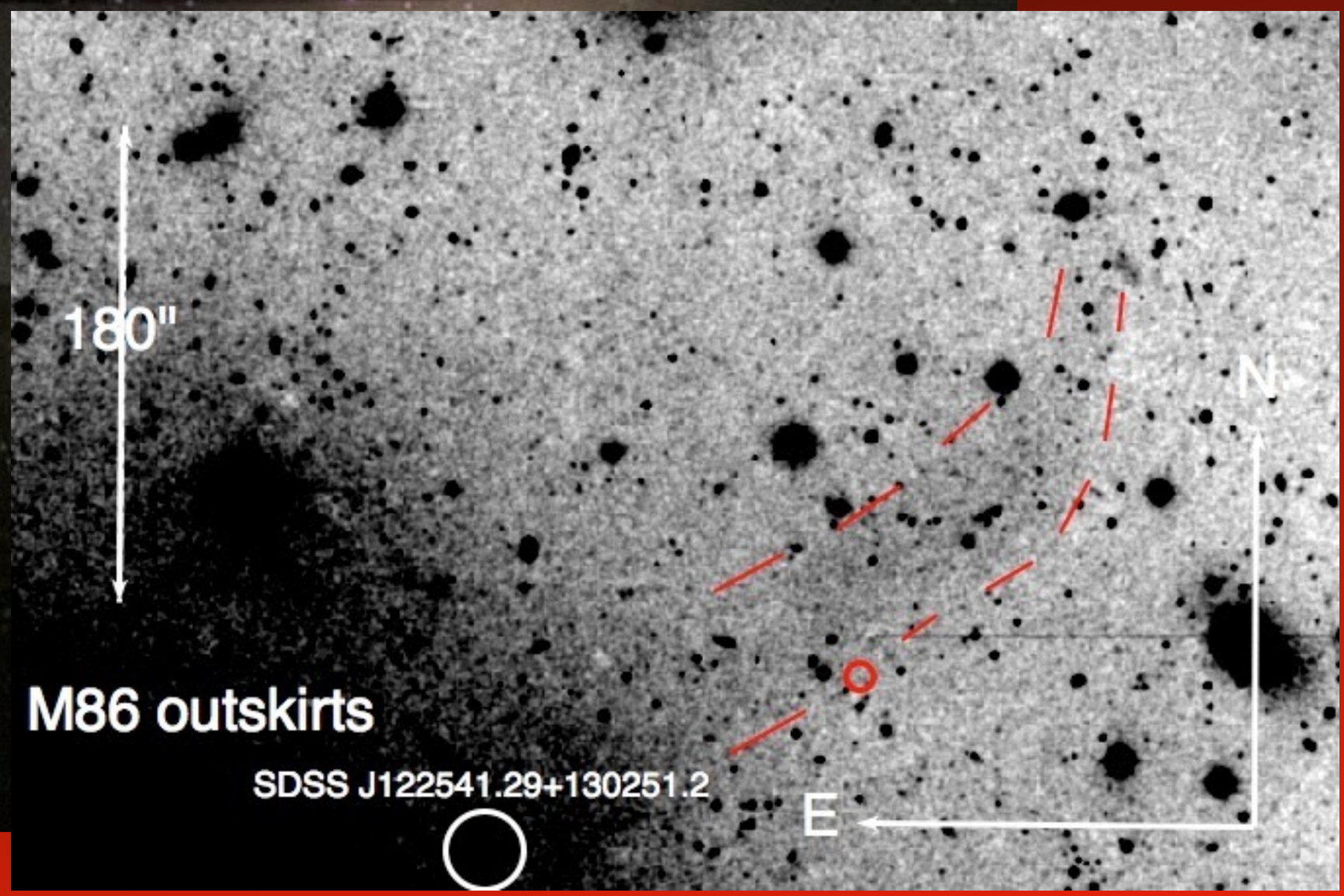
M86

SDSS



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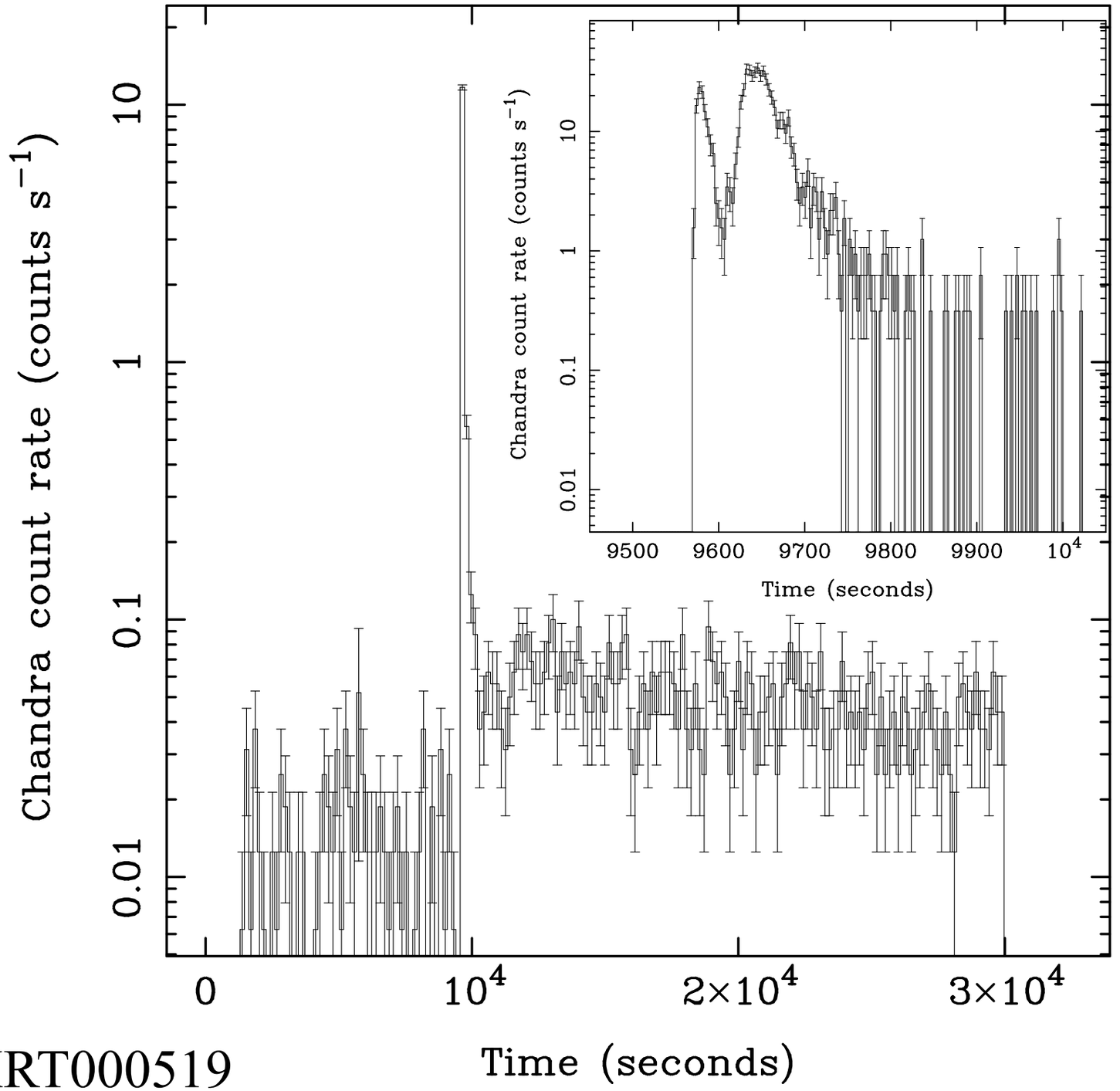
Detection of a fast X-ray transient



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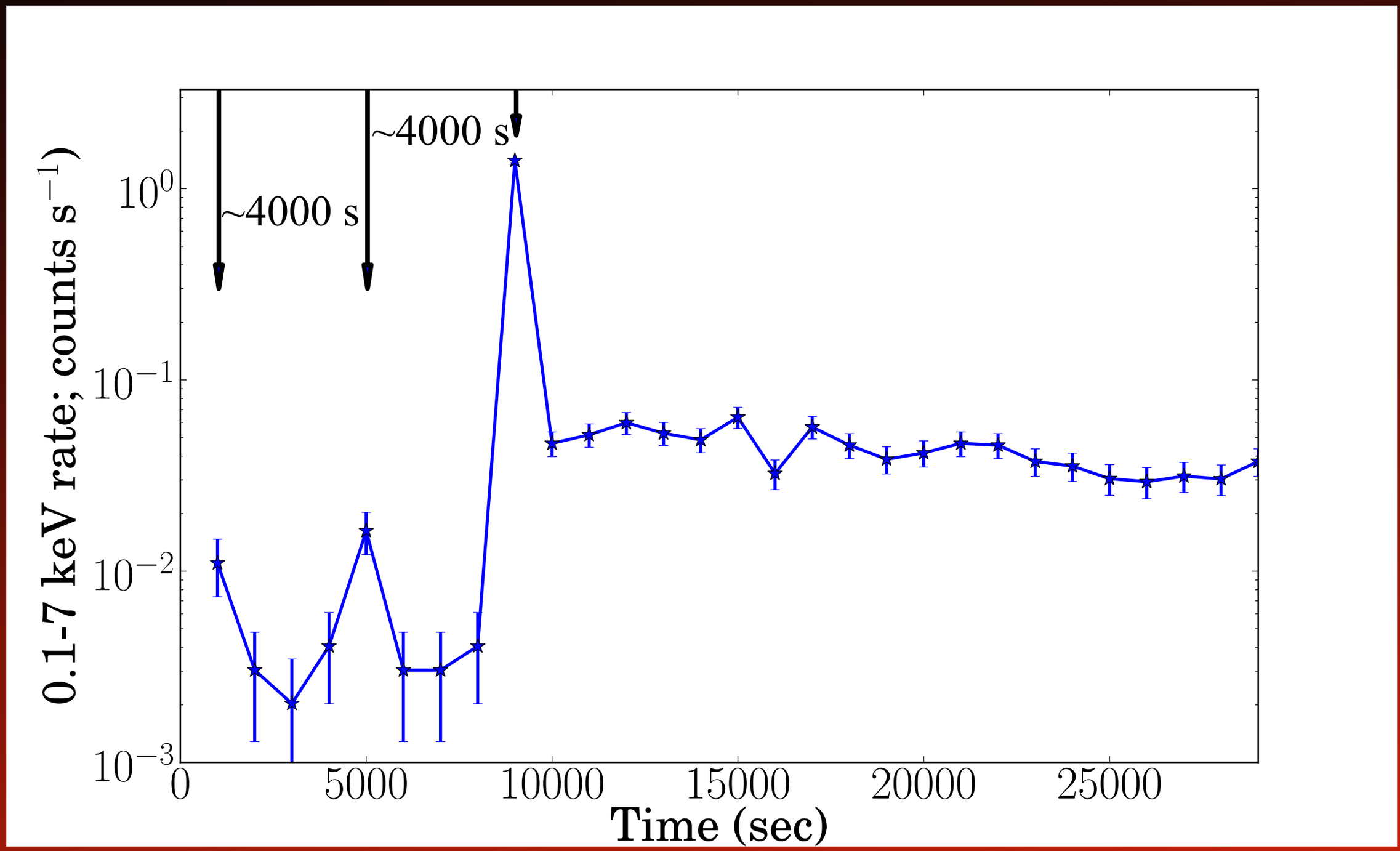
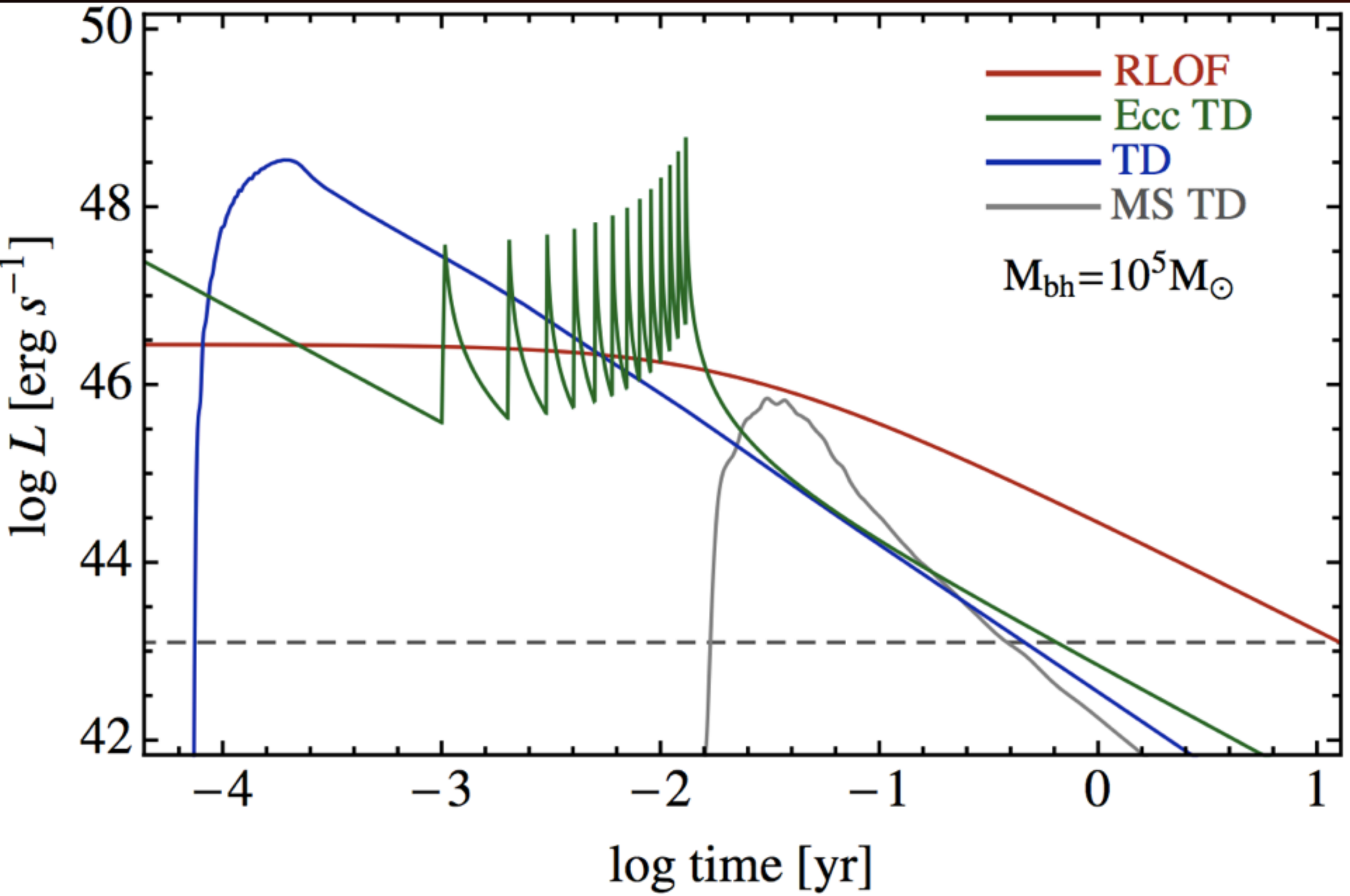
$F_{peak\ (0.5\text{-}10\ keV)}=2\times10^{-10}$ erg cm^{-2} s^{-1} Jonker et al. 2013, ApJ

Precursors to the transient



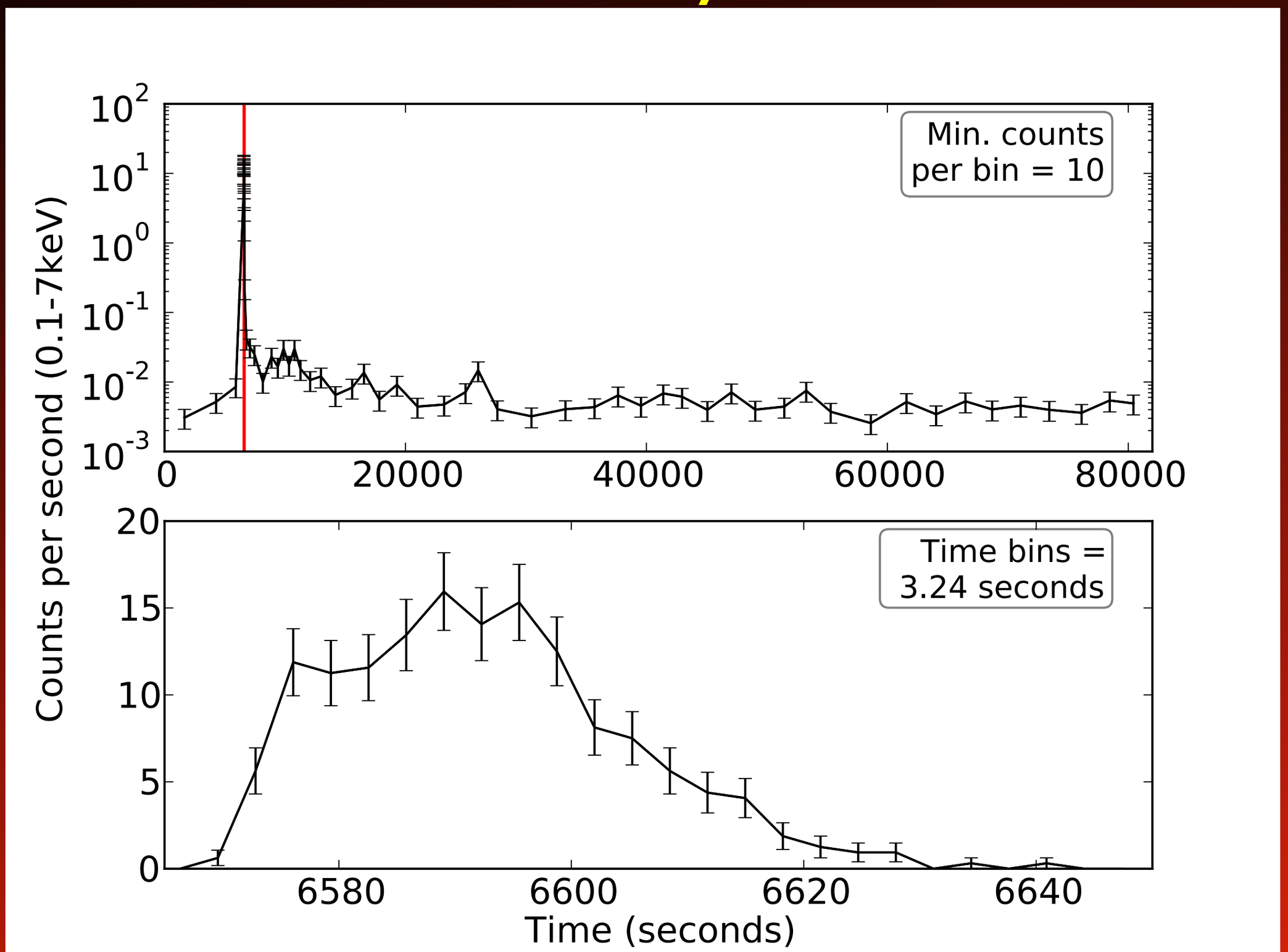
Jonker et al. 2013, ApJ

WD orbits IMBH



Macleod et al. 2014 (and refs therein)

More fast X-ray flashes:



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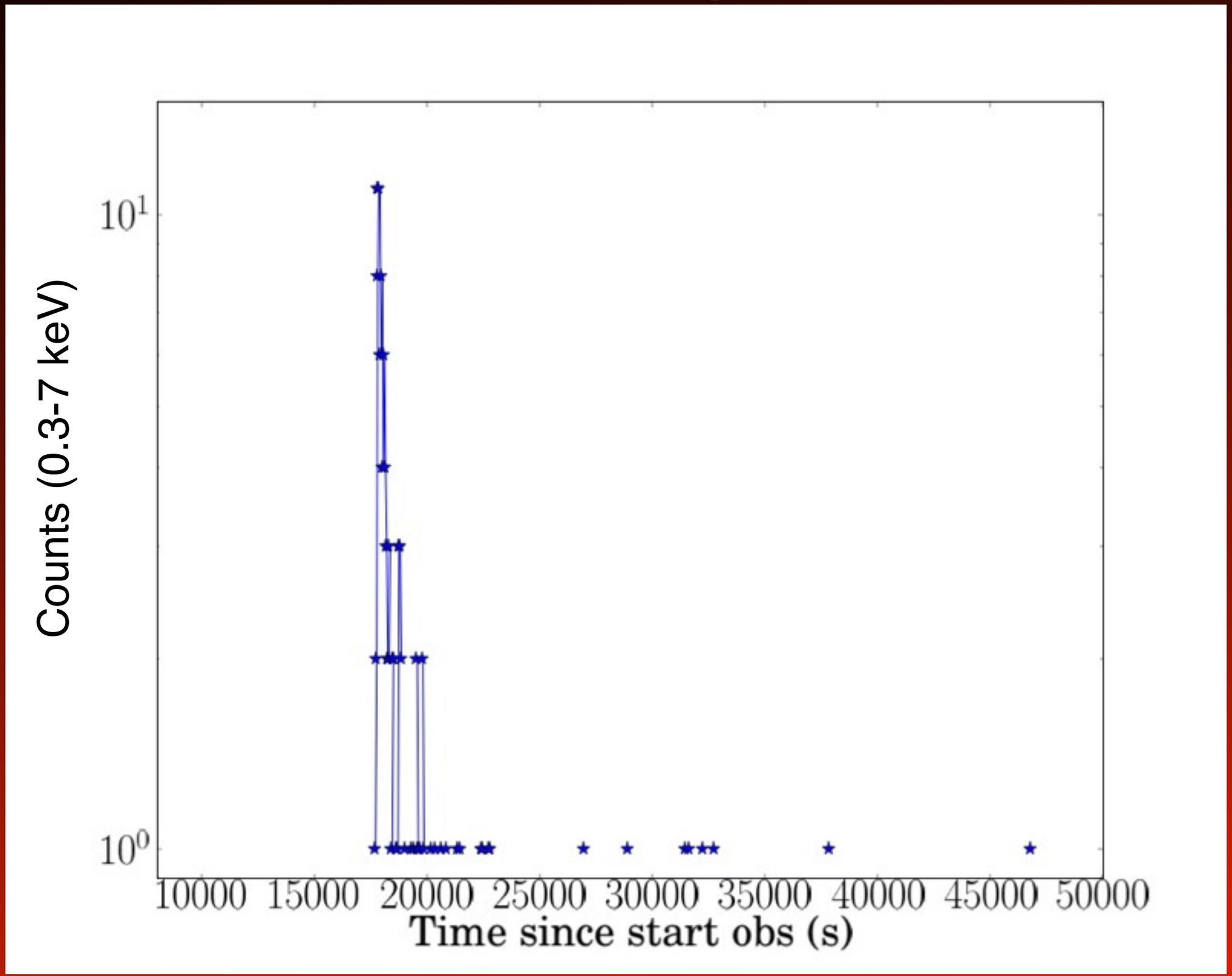
Glennie, Jonker, et al. 2015, MNRAS

More fast X-ray flashes:



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reported in ATel #6541:Luo et al. 2014

Conclusion:

Capitalize on Gaia strenghts:
fast, virtually simultaneous spectroscopy &
diffraction limited imaging

Gaia-discovered tidal disruption events will be a great tool to search for intermediate-mass black holes

OGLE found some peculiar (nuclear) Type Ia's
what are they?

Second the call for a "watch list"