

# Unique Gaia science alerts potential for the discovery of intermediate-mass black holes

Peter Jonker (SRON & RU)  
Thomas Wevers (RU & SRON)

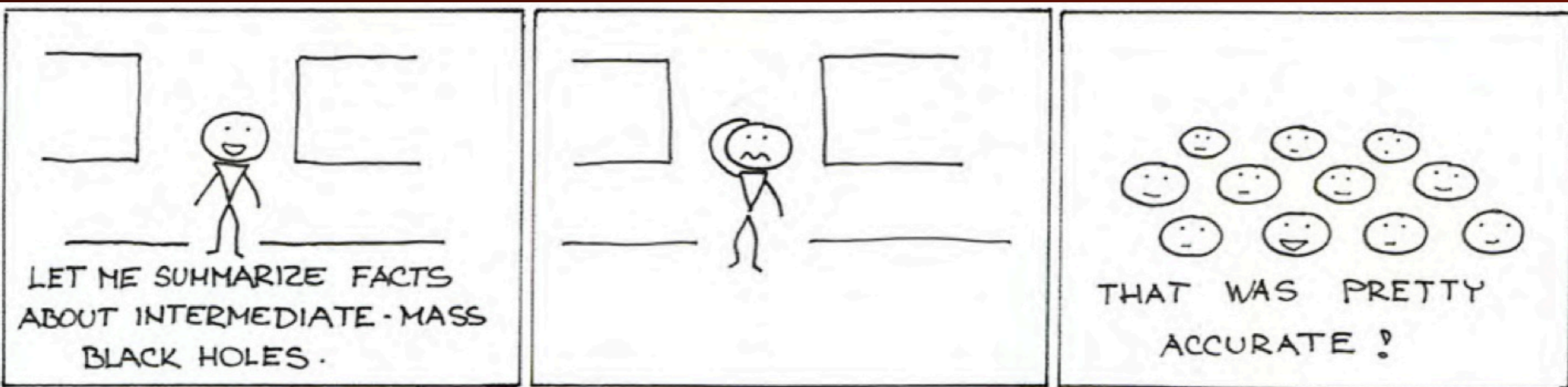


Netherlands Institute for Space Research

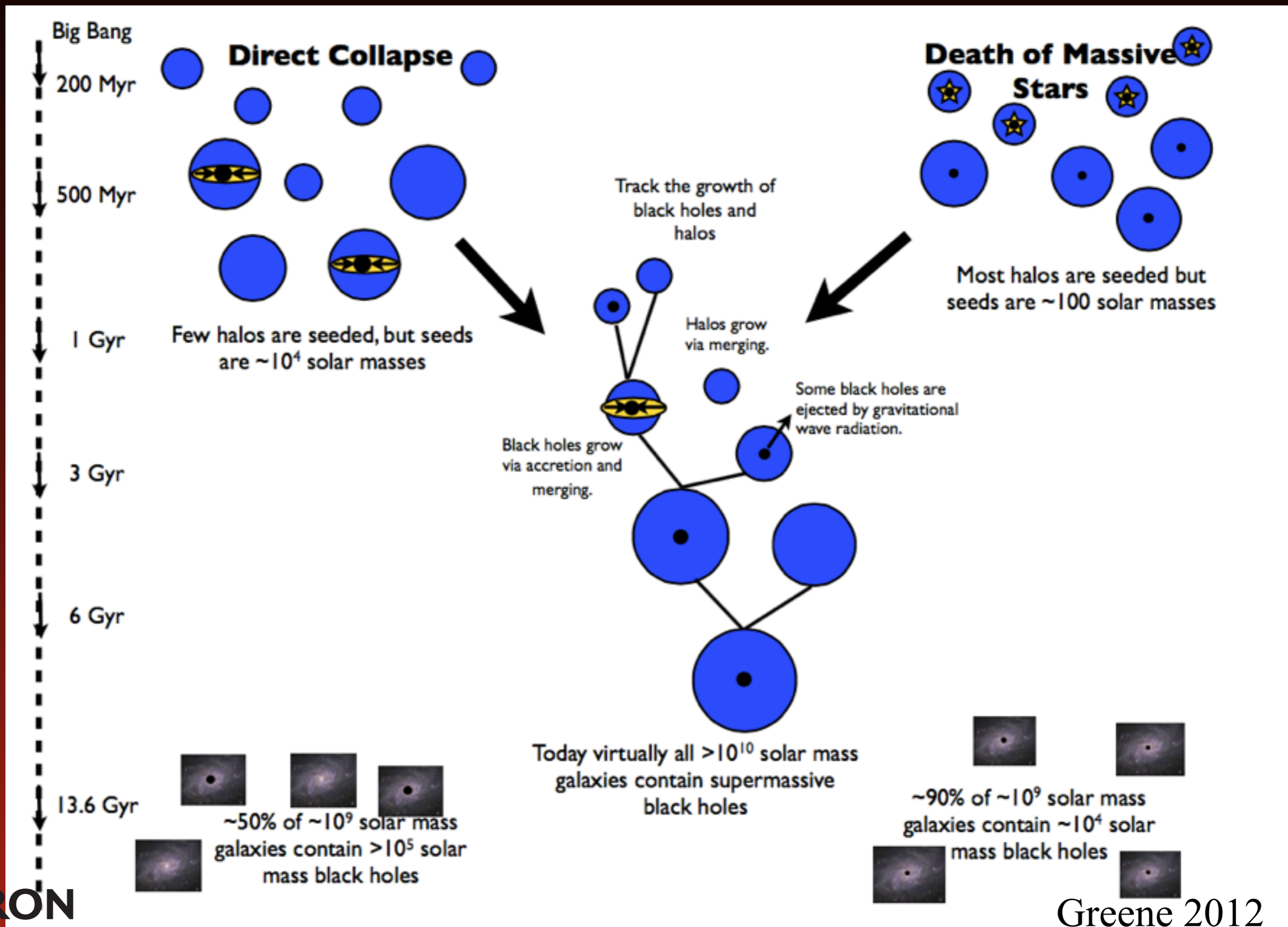


SEES, IoA Cambridge, 23-25 Sept 2015

# Do IMBHs exist?



# Occupation fraction depends on the nature of the seed BH



# Ultra-luminous X-ray sources



Cartwheel galaxy

HST

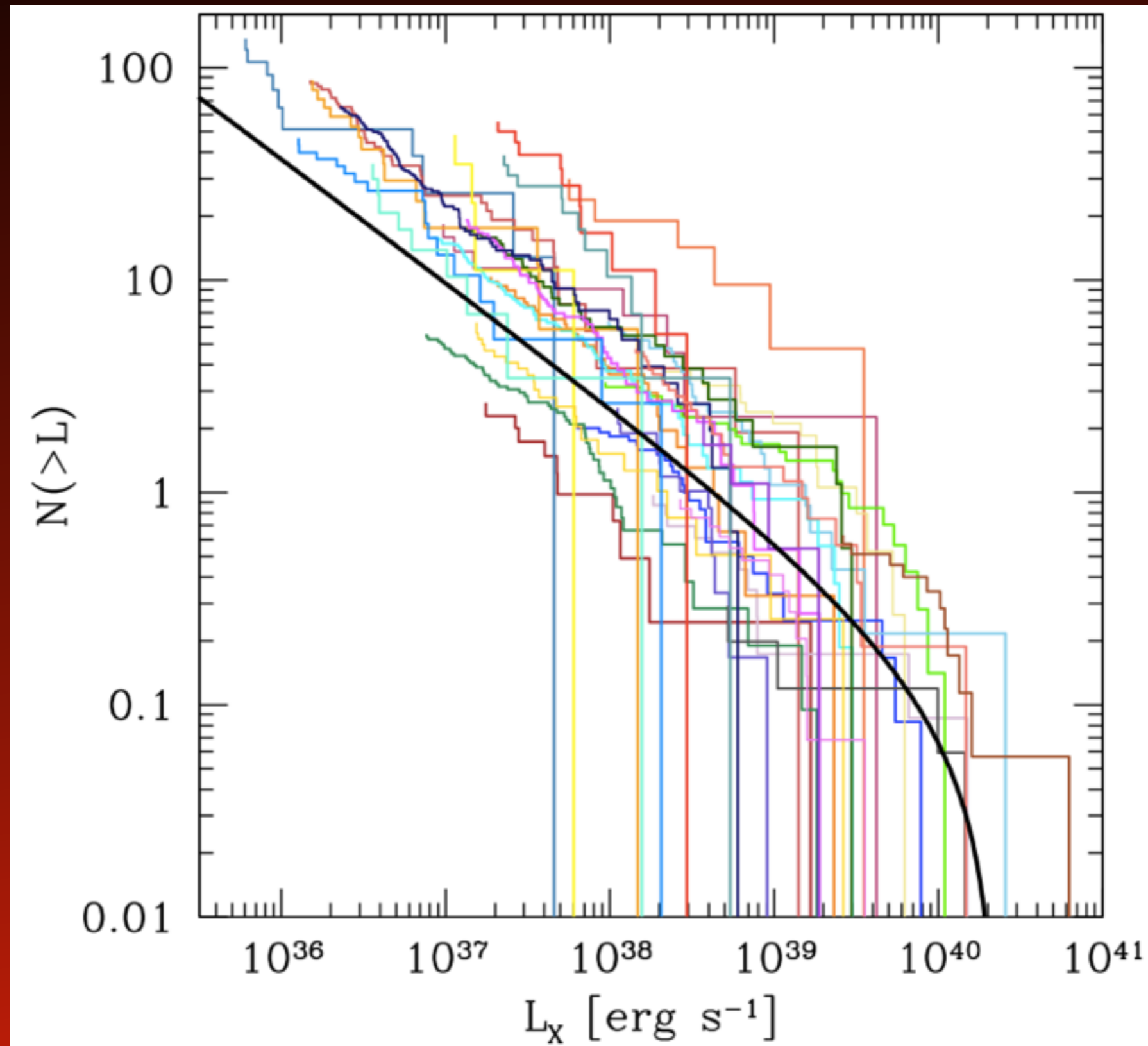
(Credit: NASA/STScI)



Chandra

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

# IMBHs in ultra-luminous X-ray sources?

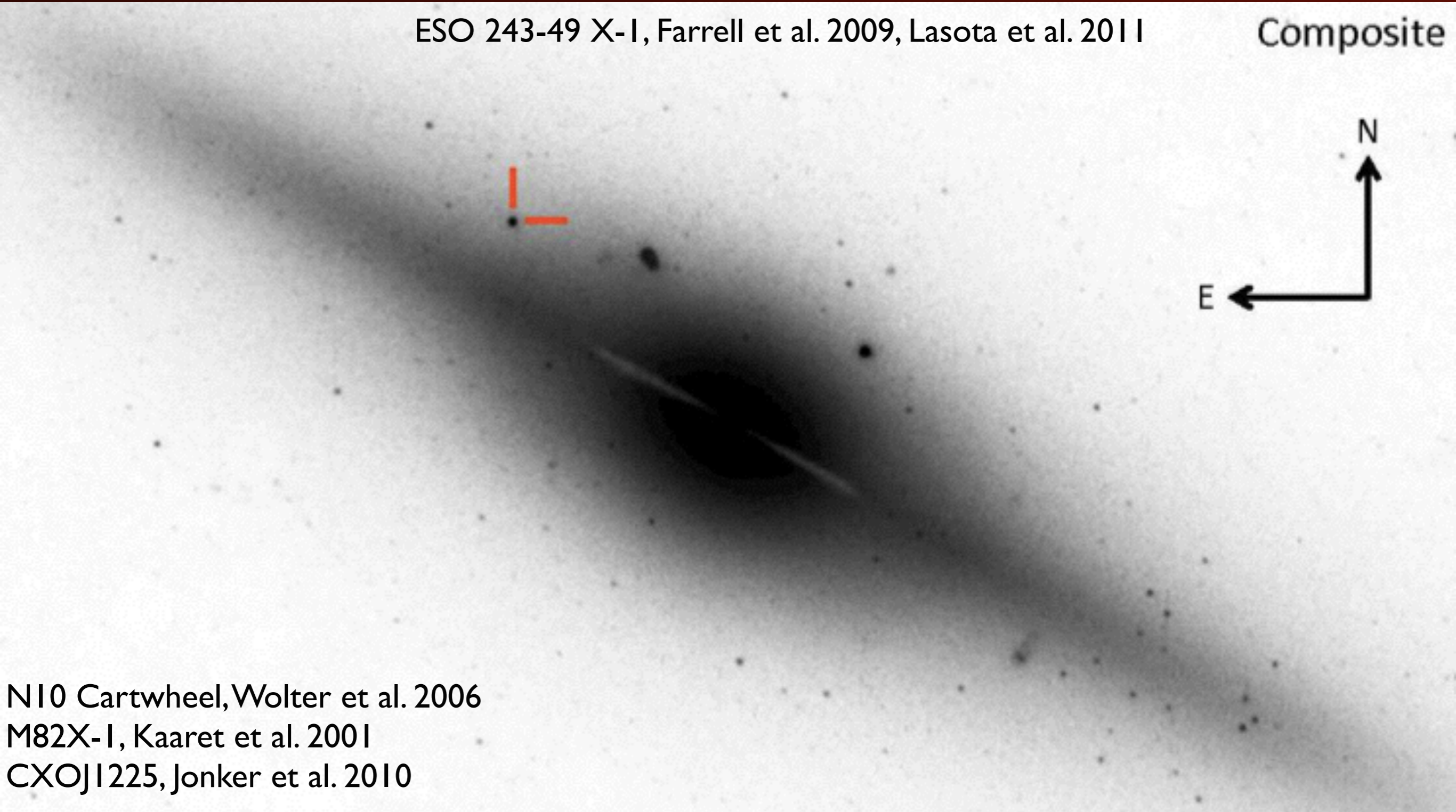


# Candidate IMBHs

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

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

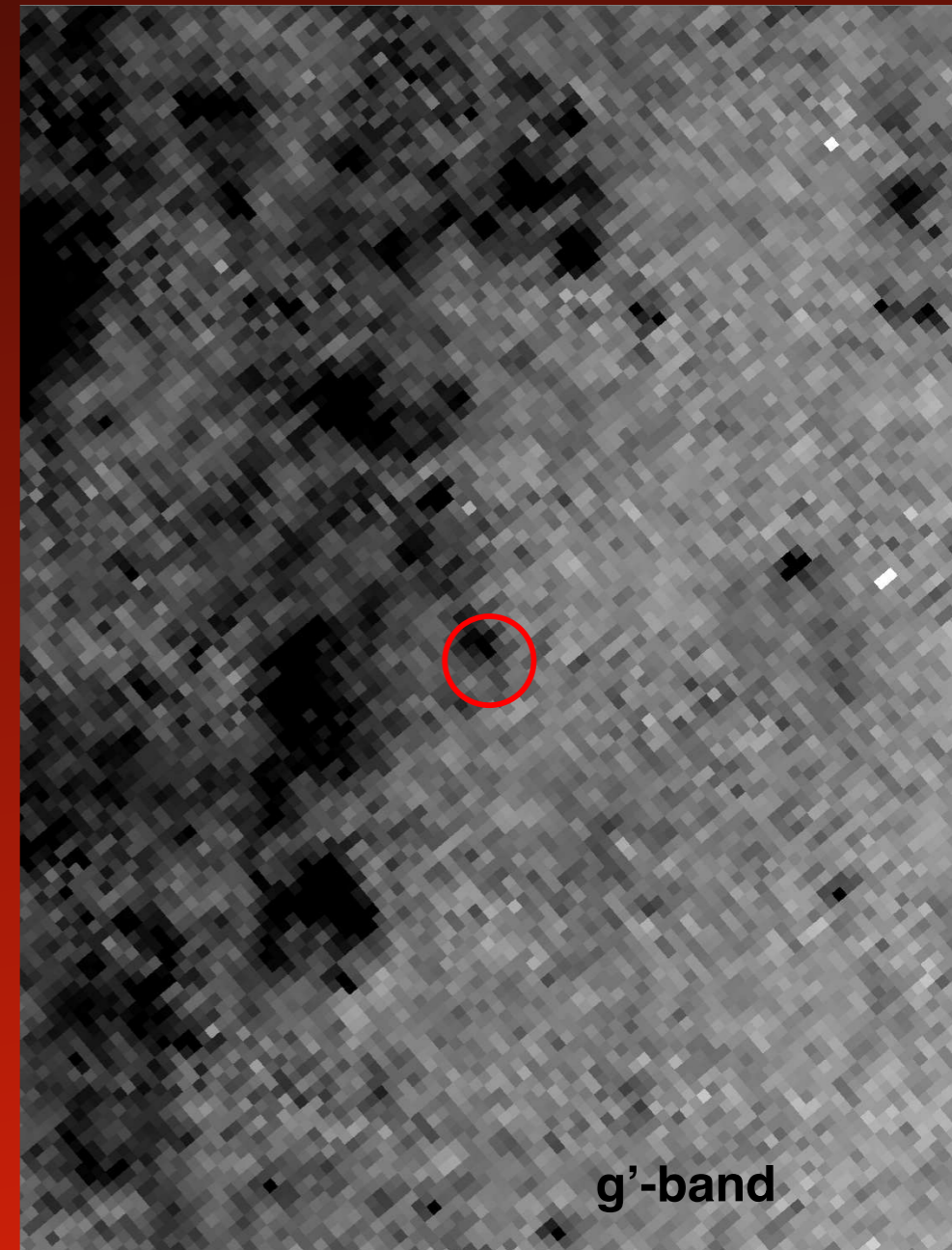
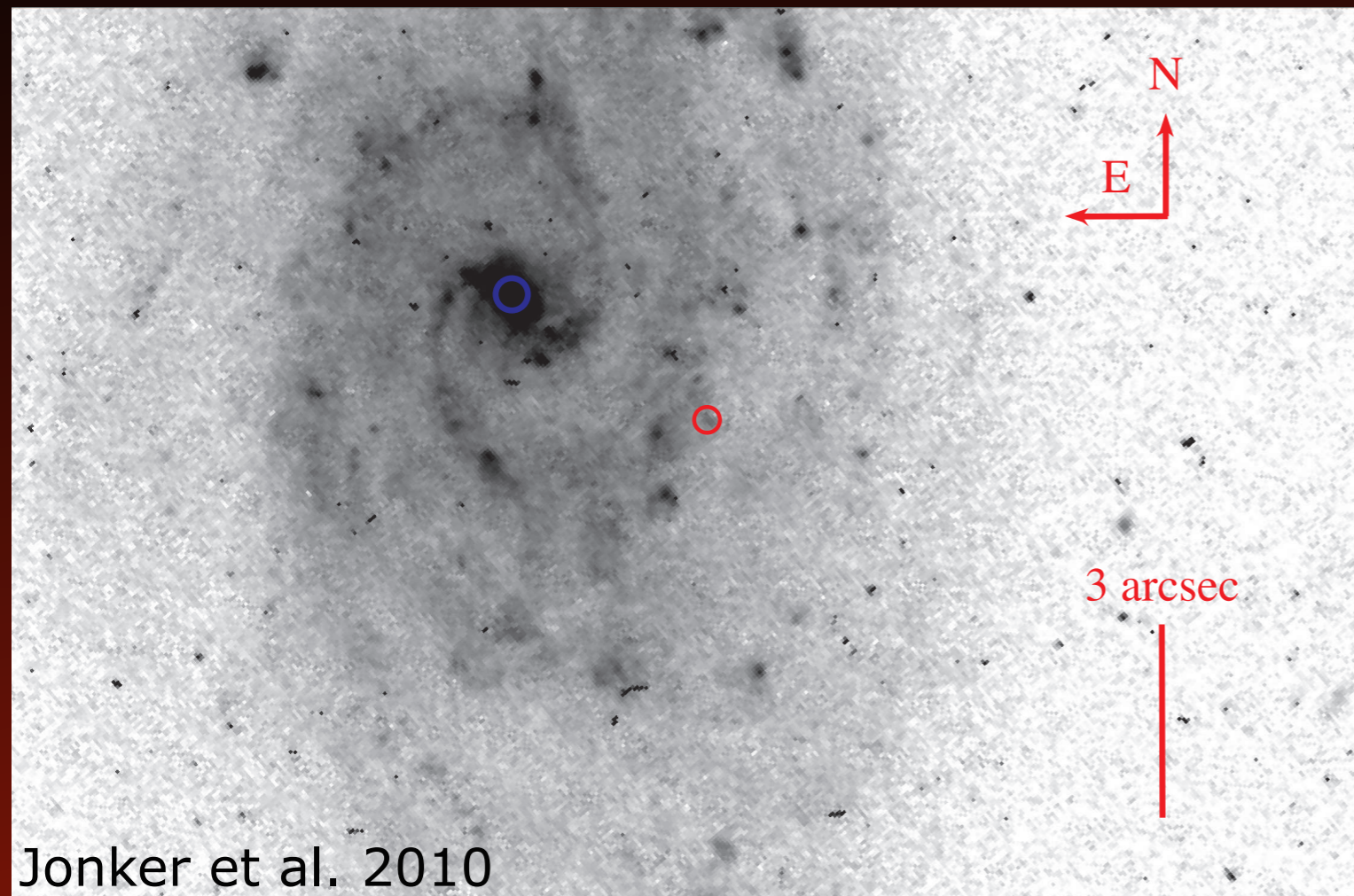
Composite



NI0 Cartwheel, Wolter et al. 2006  
M82X-1, Kaaret et al. 2001  
CXOJ1225, Jonker et al. 2010

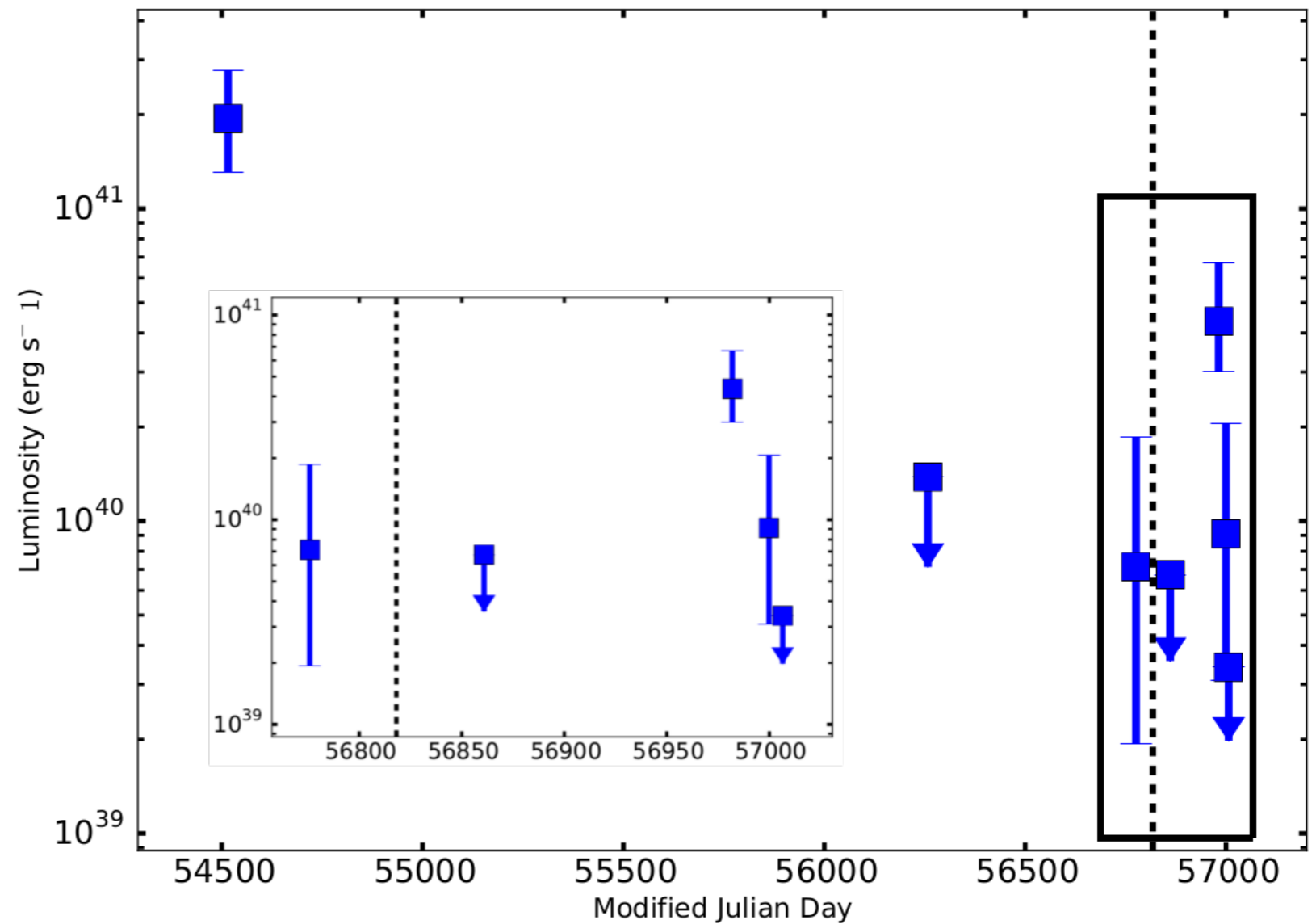
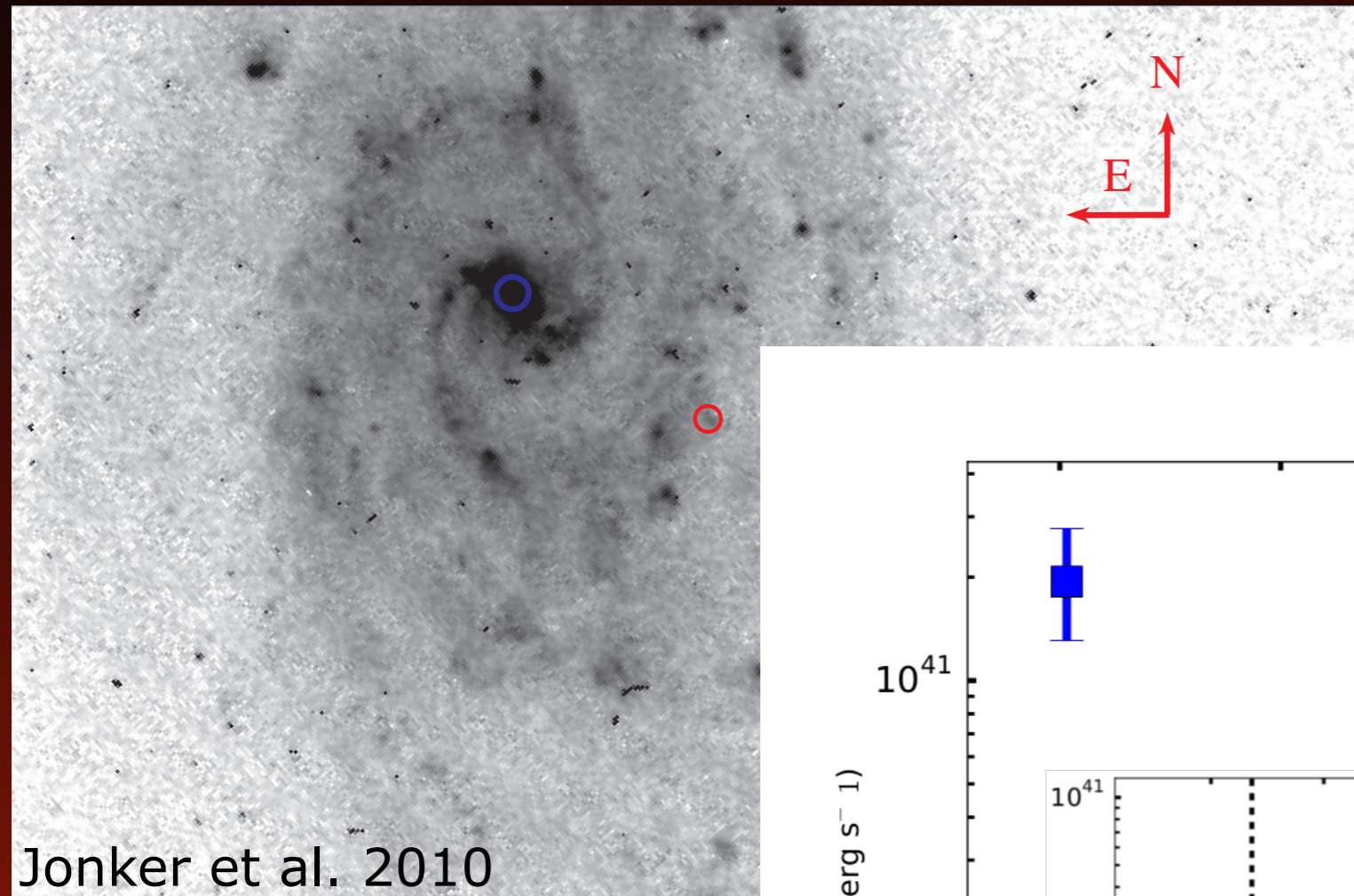
# HLX2

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



# HLX2

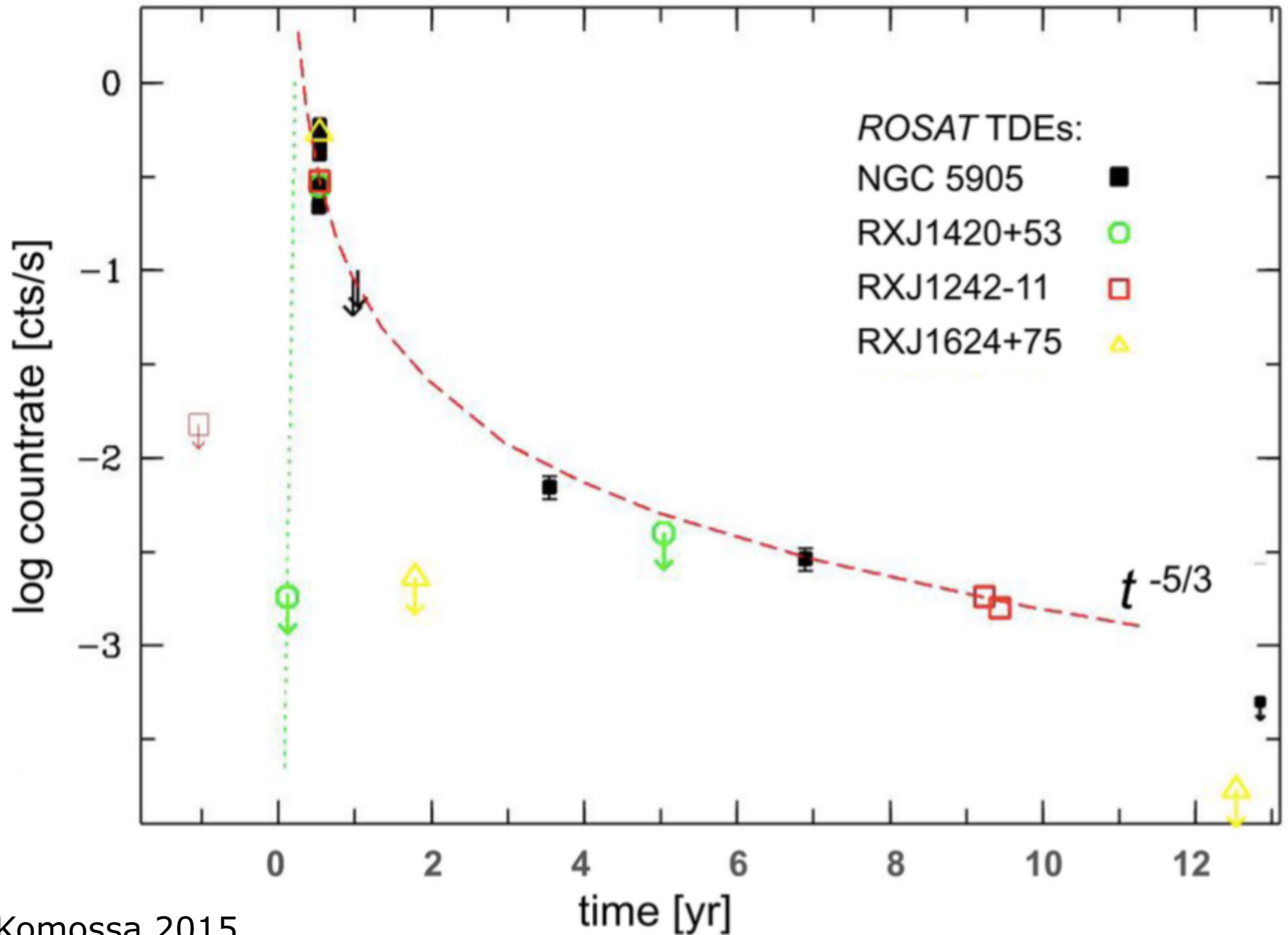
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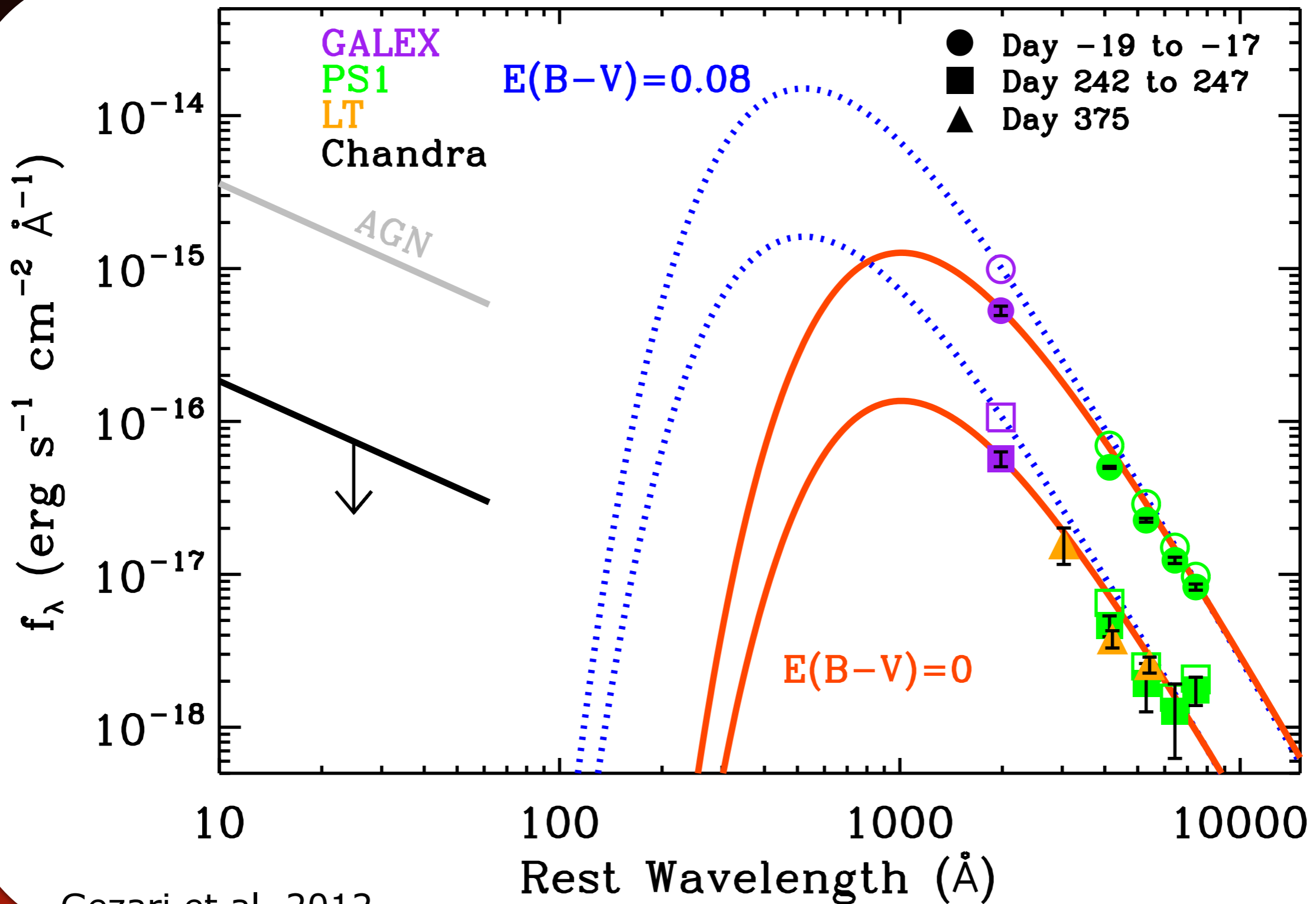
# IMBHs & tidal disruption events?

# Tidal disruption events; X-ray



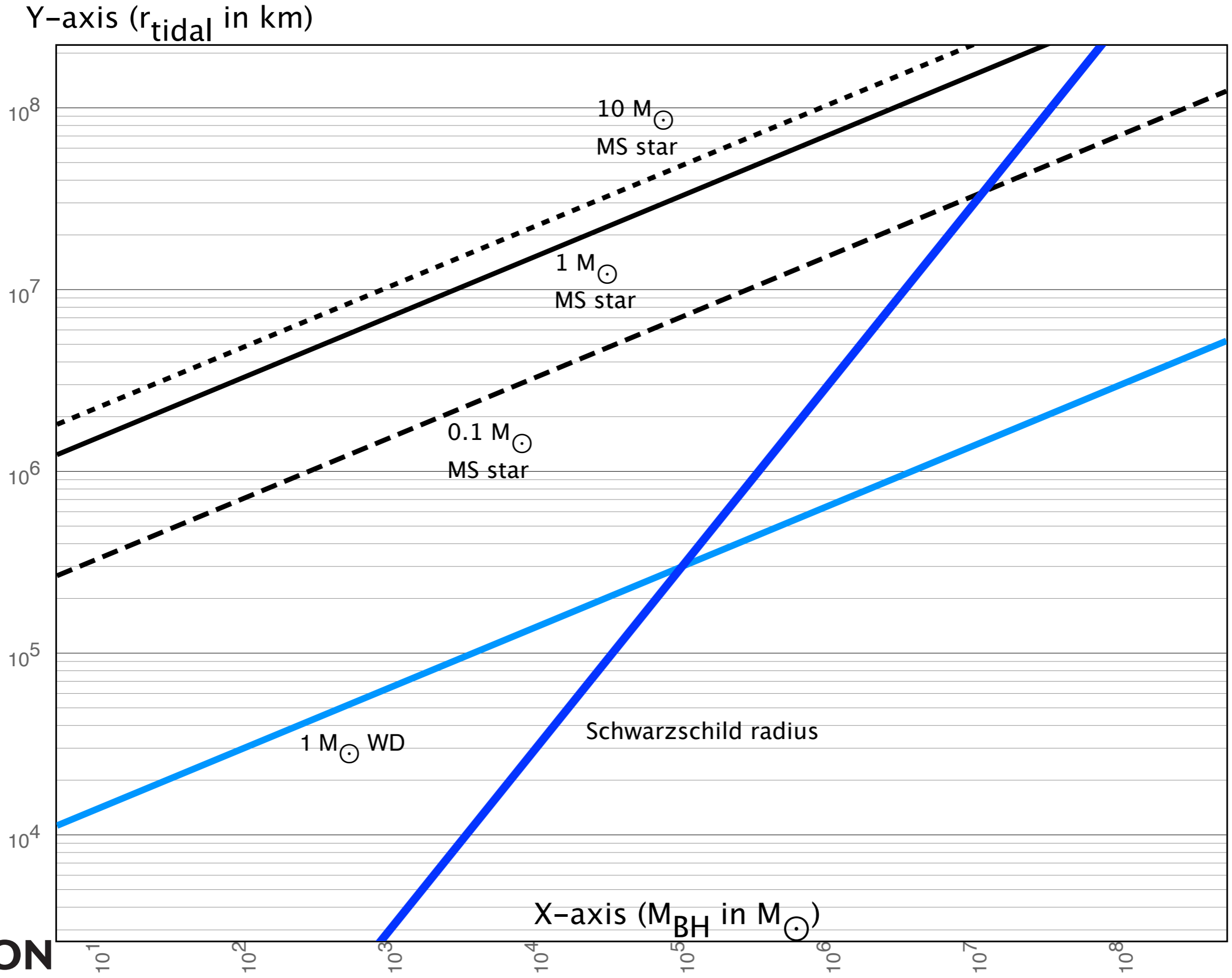
Komossa 2015

# Tidal disruption events; optical



Gezari et al. 2012

# Tidal disruption events & IMBHs



# Tidal disruption of a WD by an IMBH

## WD-BH encounter

\*\*\*\*\*

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

# Tidal disruption of a WD by an IMBH

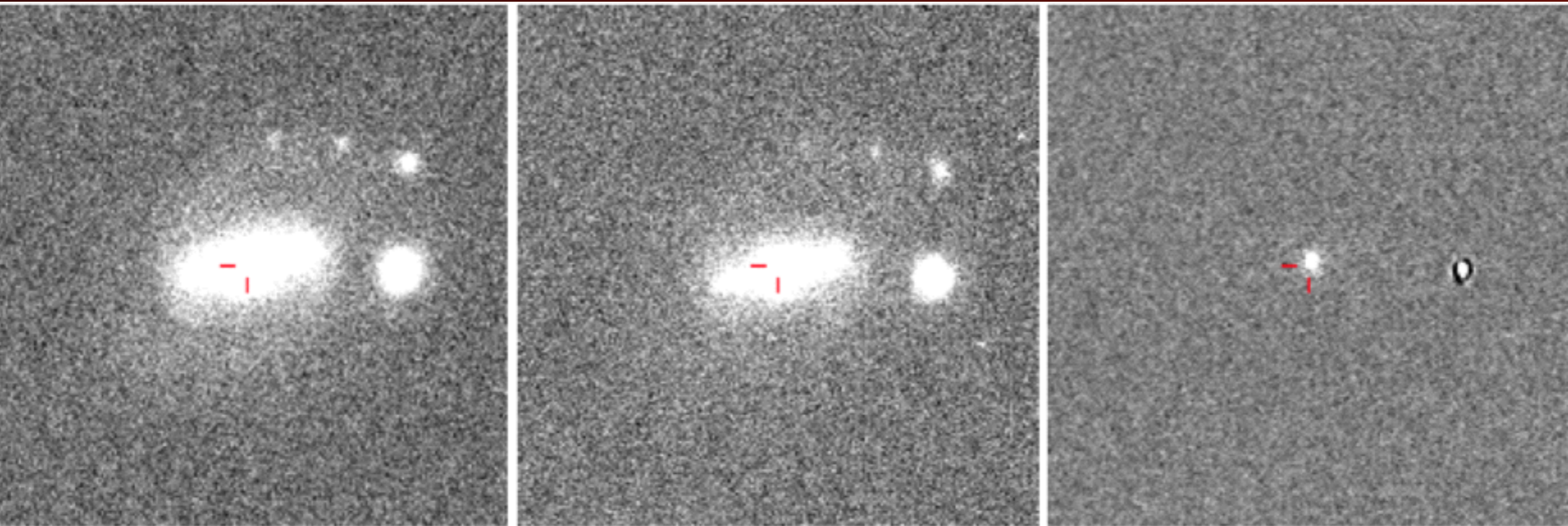
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# Nuclear (?) event



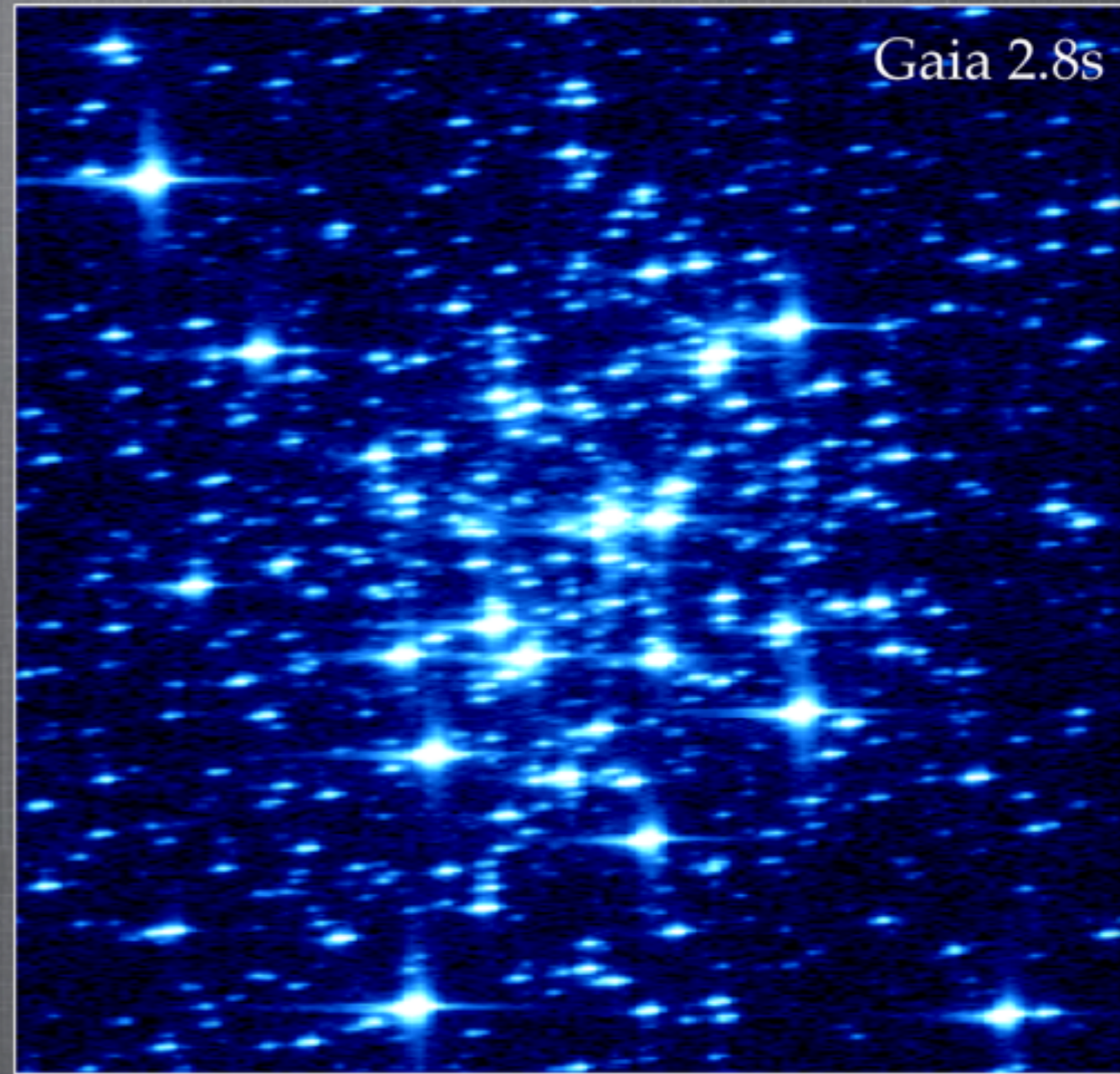
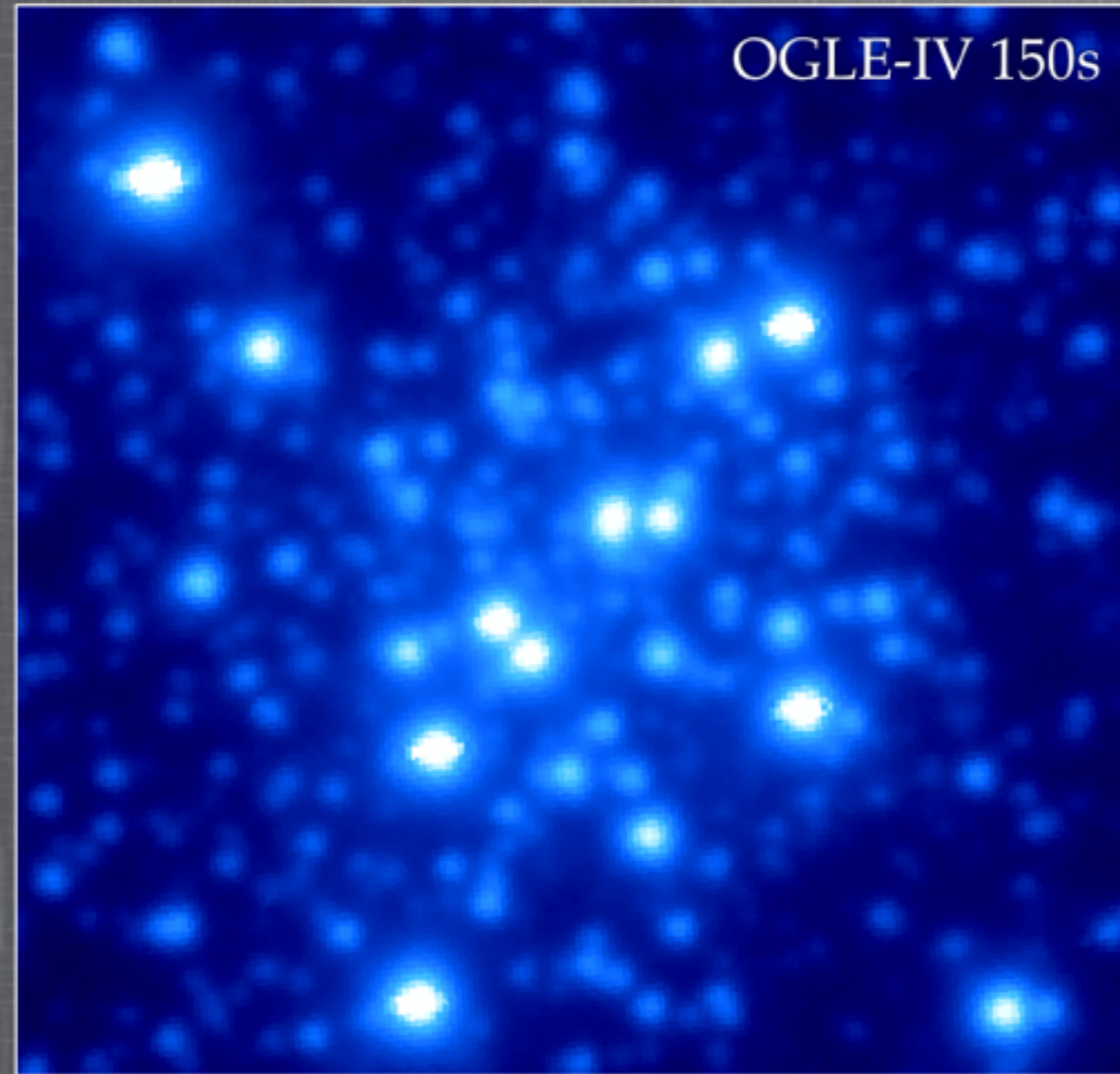
Data courtesy Lukasz  
Wyrzykowski

# Tidal disruption events & Gaia

NGC 1818

OGLE-IV 150s

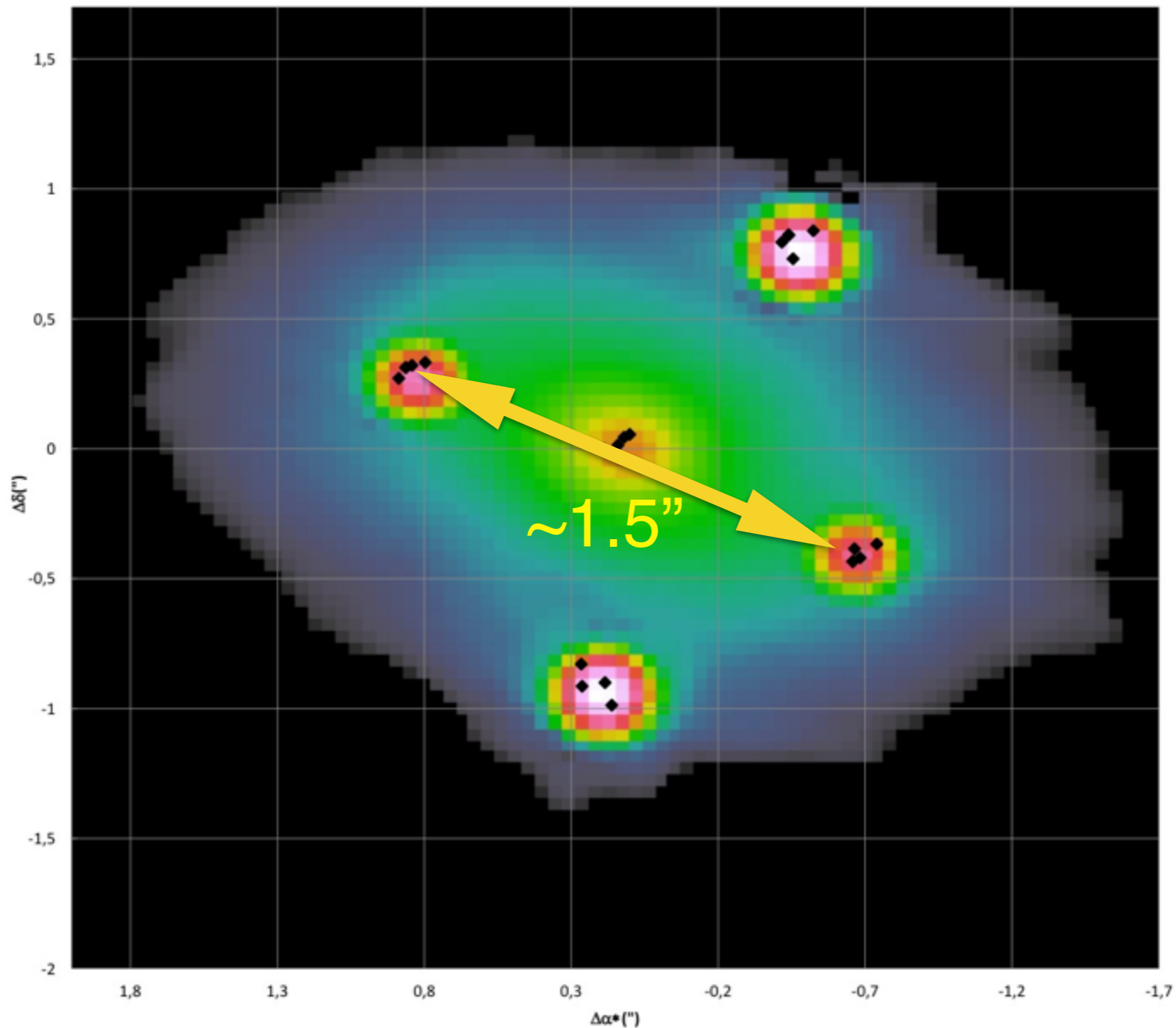
Gaia 2.8s



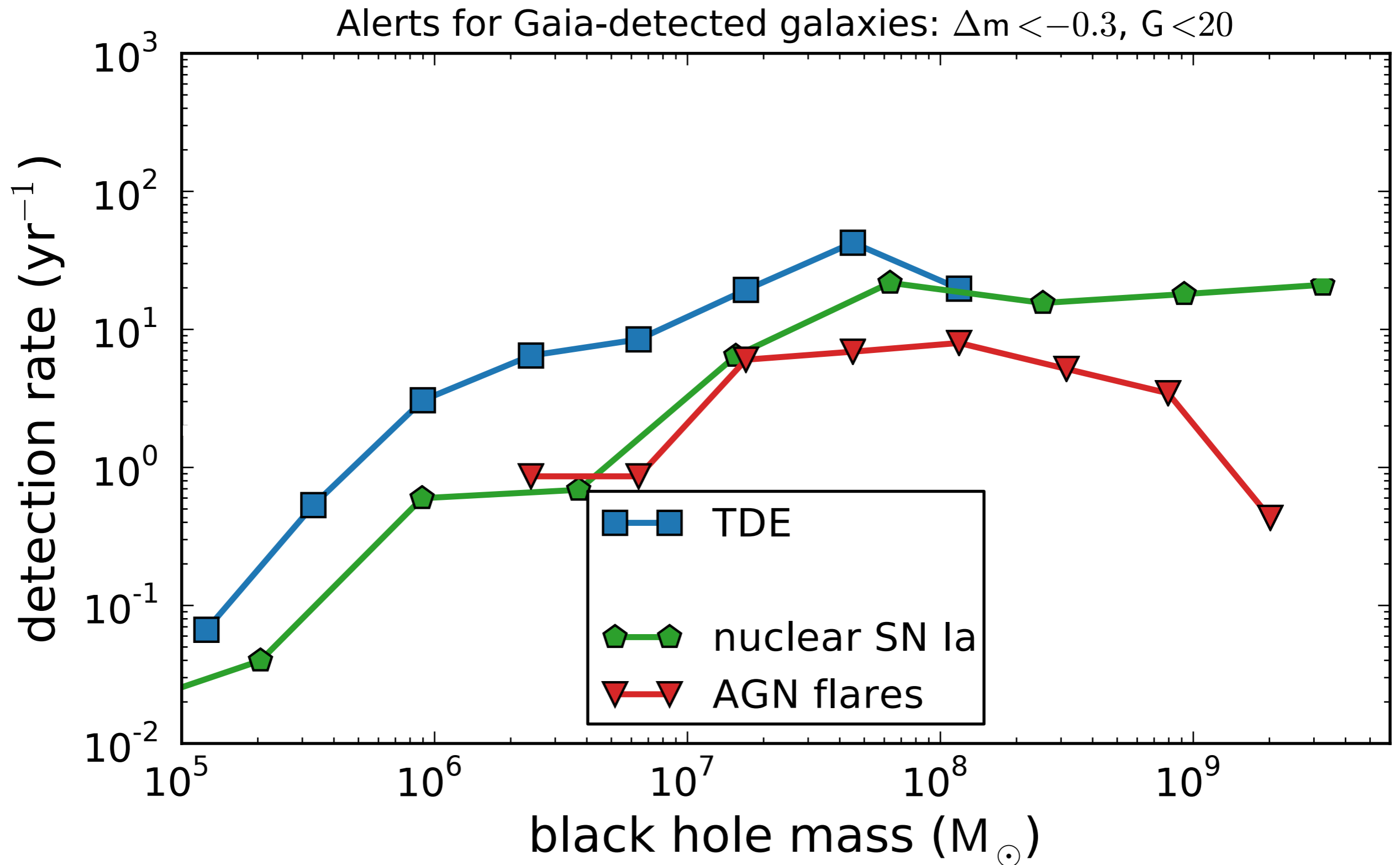
sharp images!



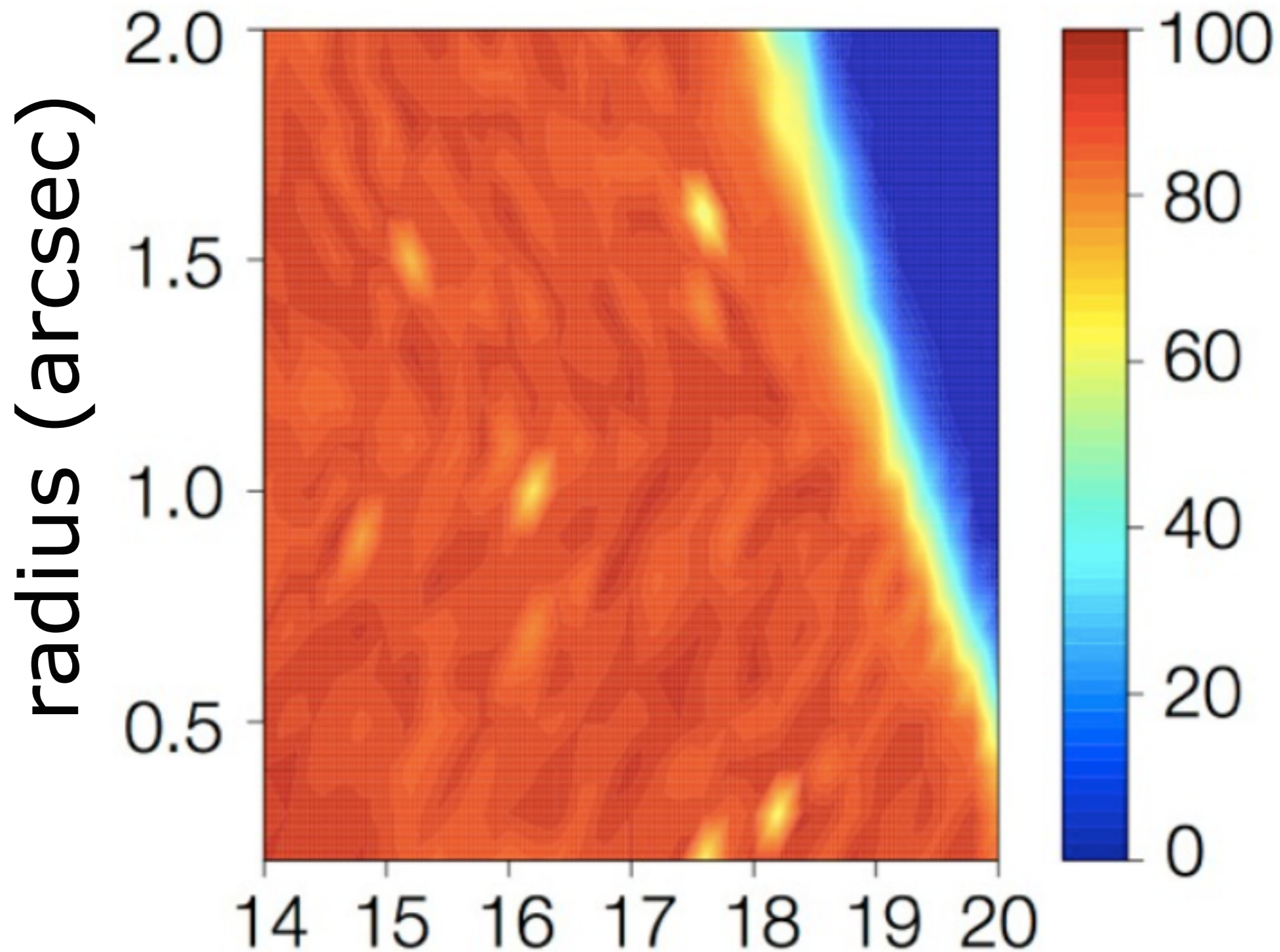
# Tidal disruption events & Gaia



# Tidal disruption events & IMBHs



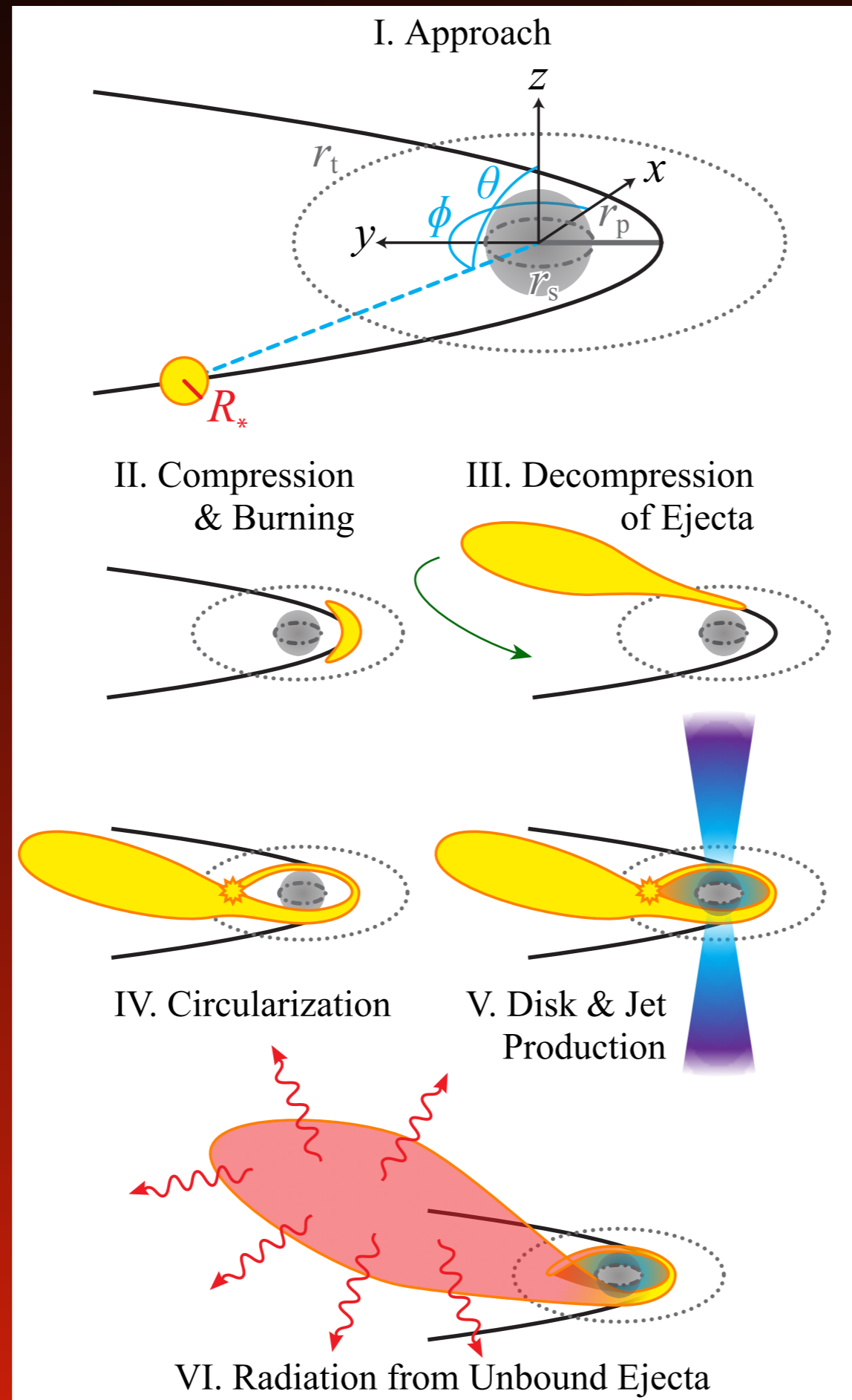
# Gaia extended sources



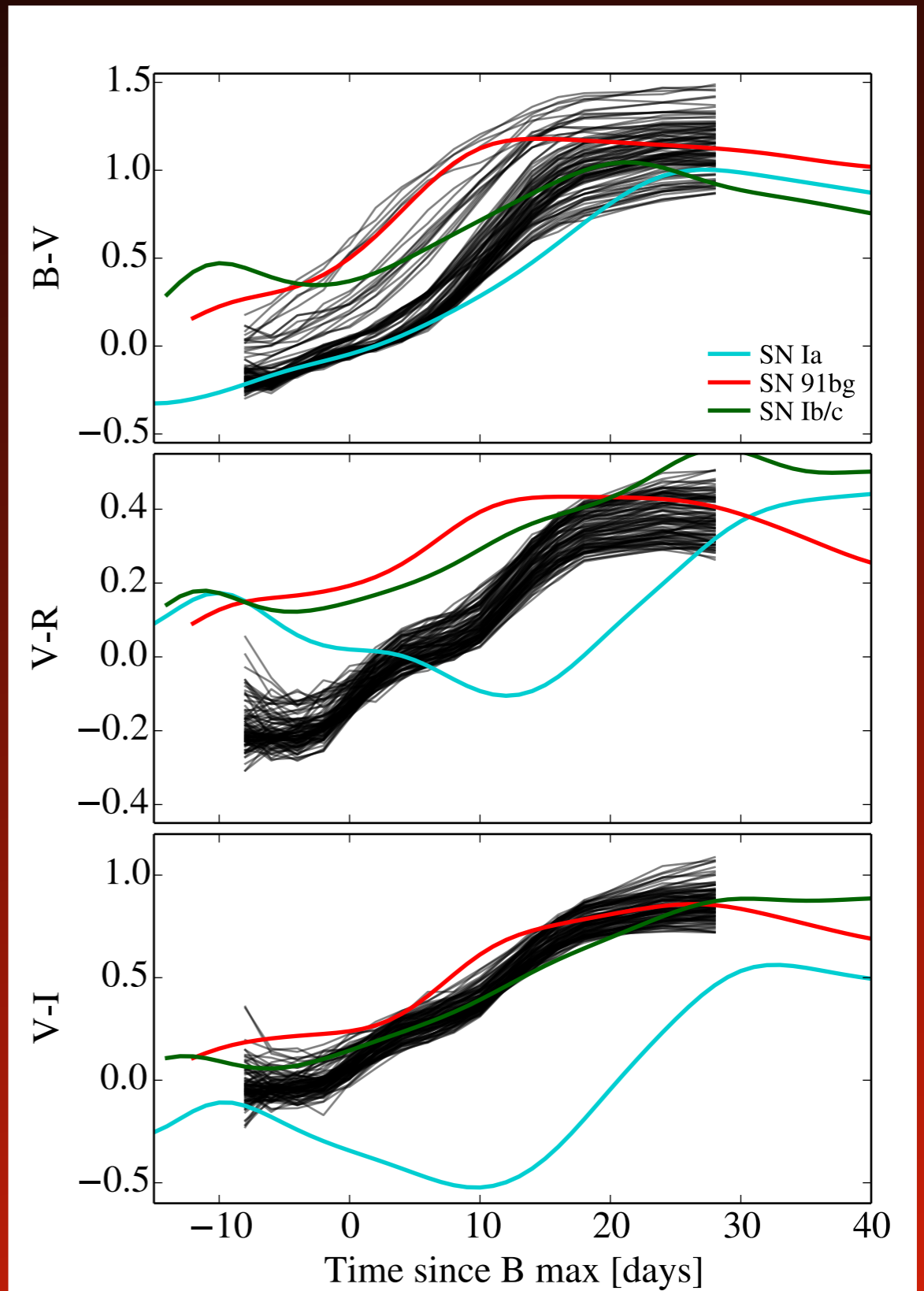
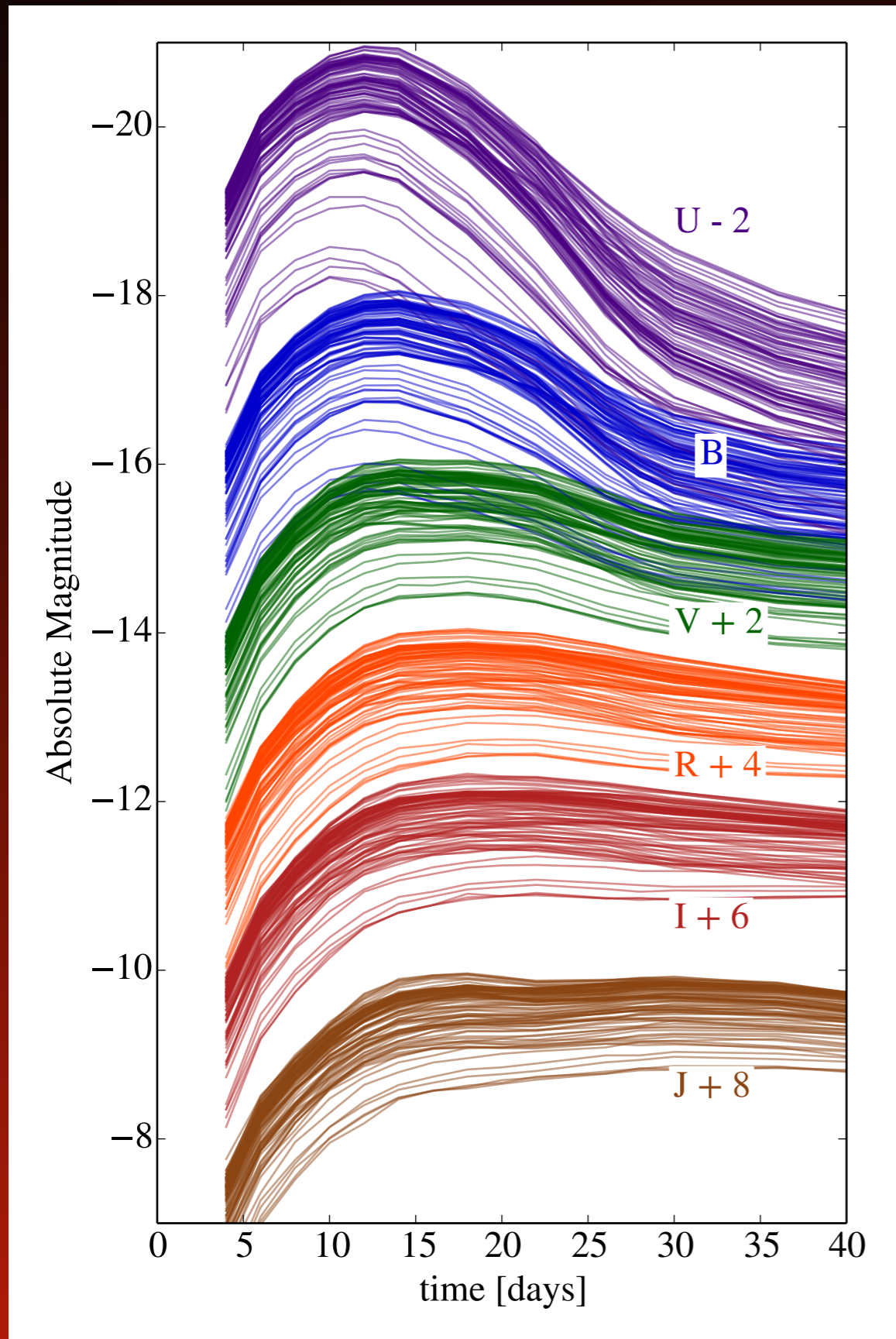
**G mag**

Gaia simulation;  
Ducourant CU4

# Tidal disruption events & IMBHs

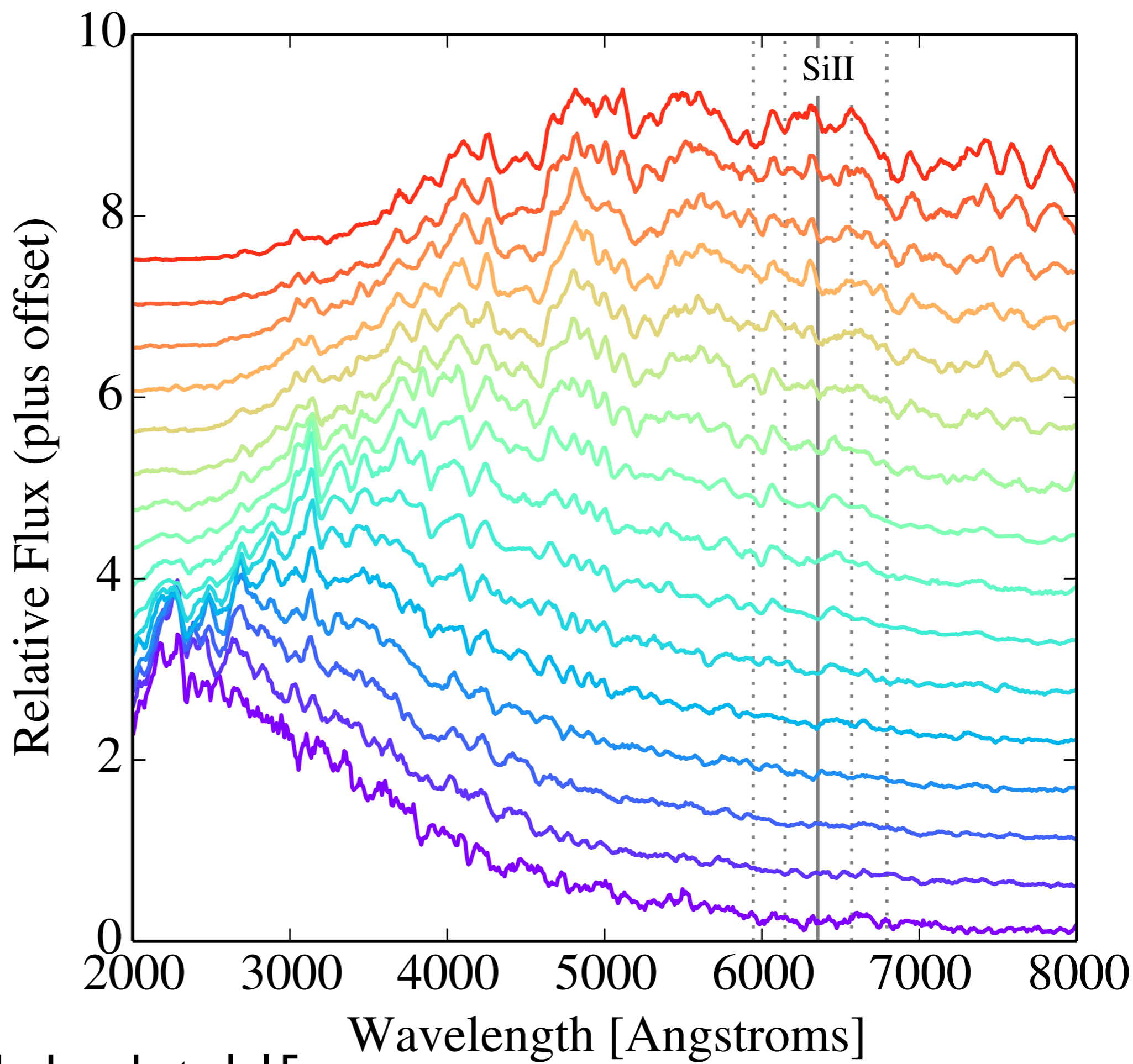


# Nuclear Type $\sim$ Ia



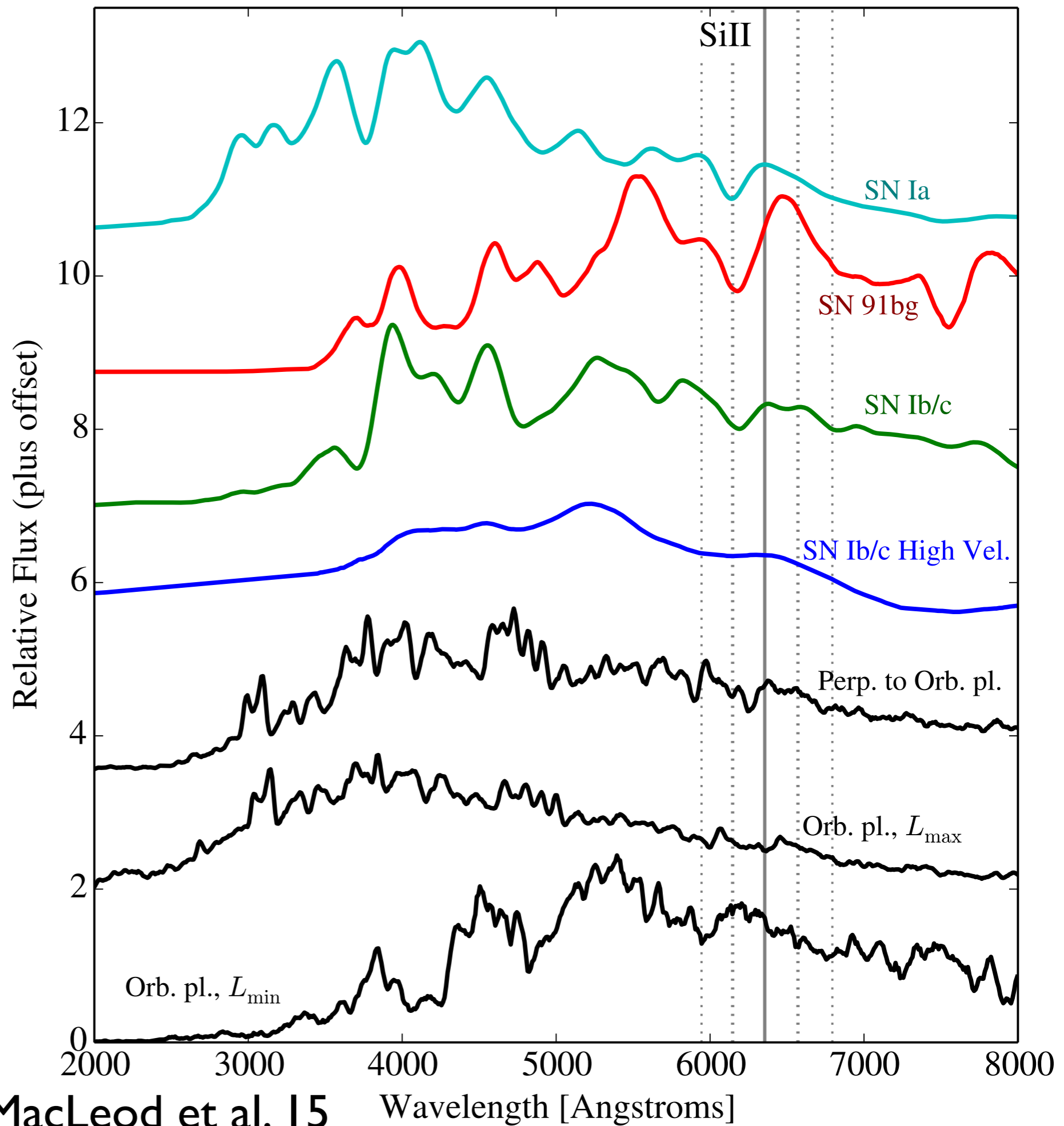
MacLeod et al. 15

# Nuclear Type $\sim$ Ia



MacLeod et al. 15

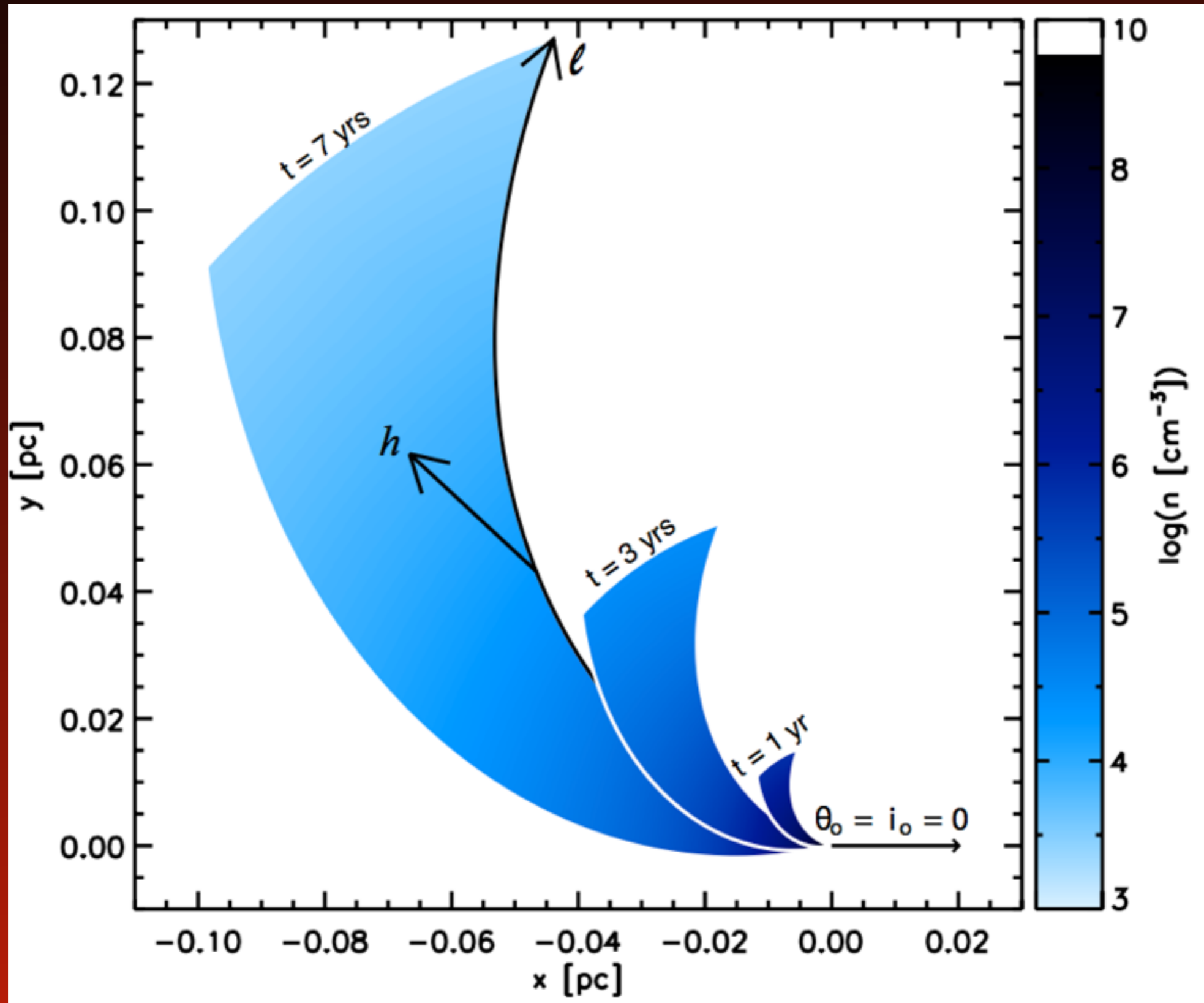
# Nuclear Type $\sim$ Ia



MacLeod et al. 15

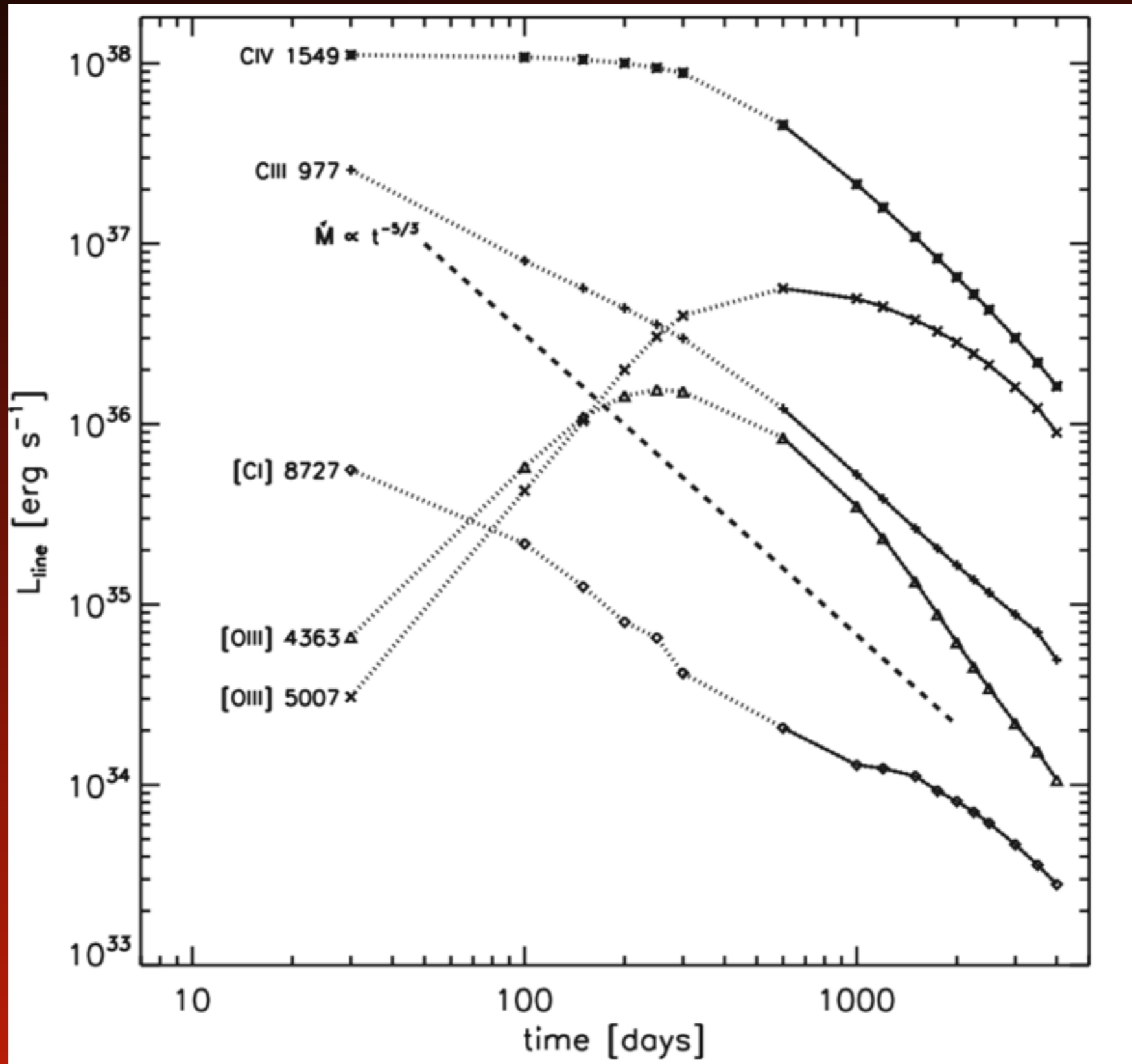
Wavelength [Angstroms]

# Predicted (late time) emission lines optical





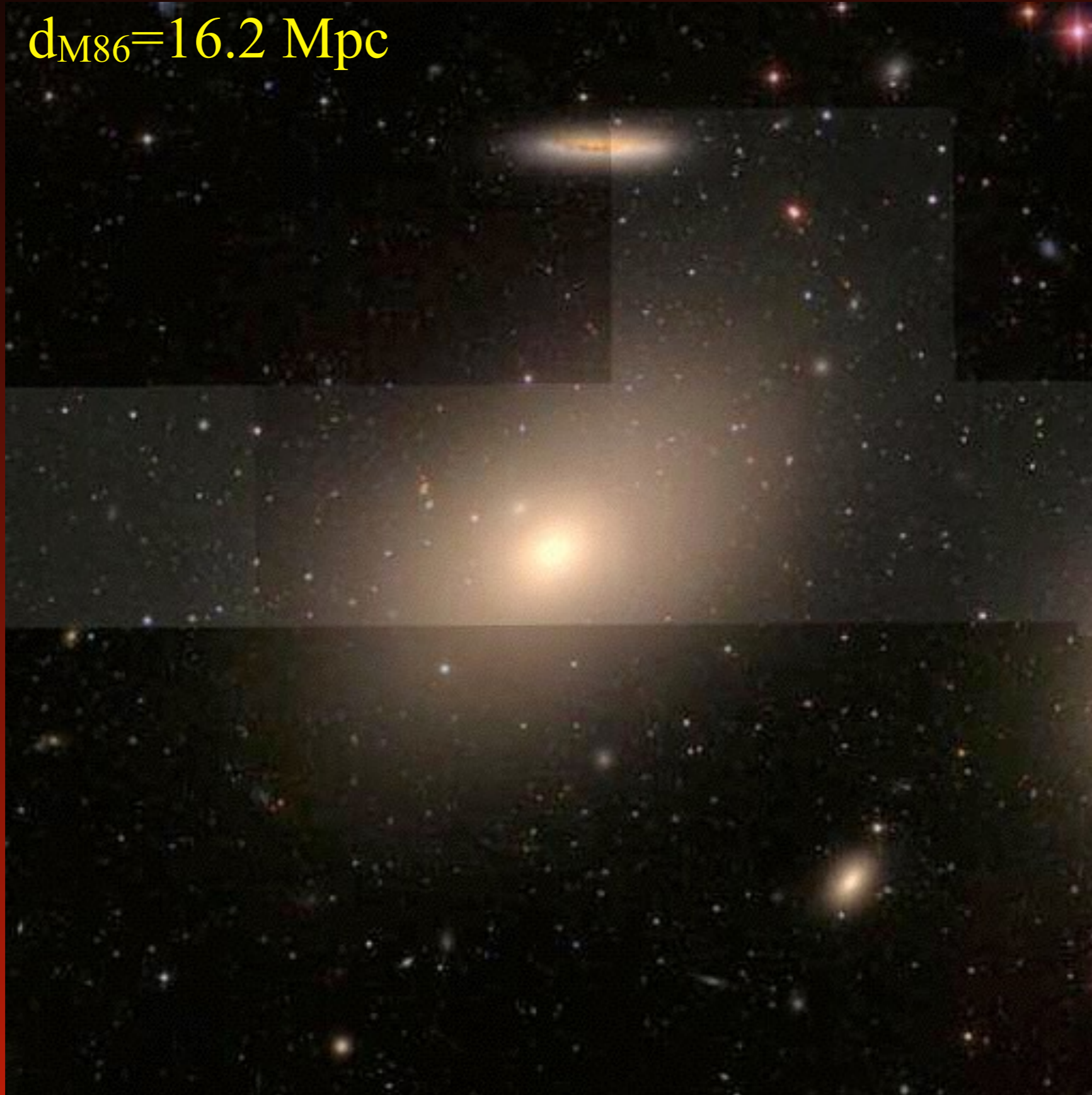
# Predicted optical emission lines at late times



Are there WD TDEs?

# M86

$d_{M86} = 16.2 \text{ Mpc}$



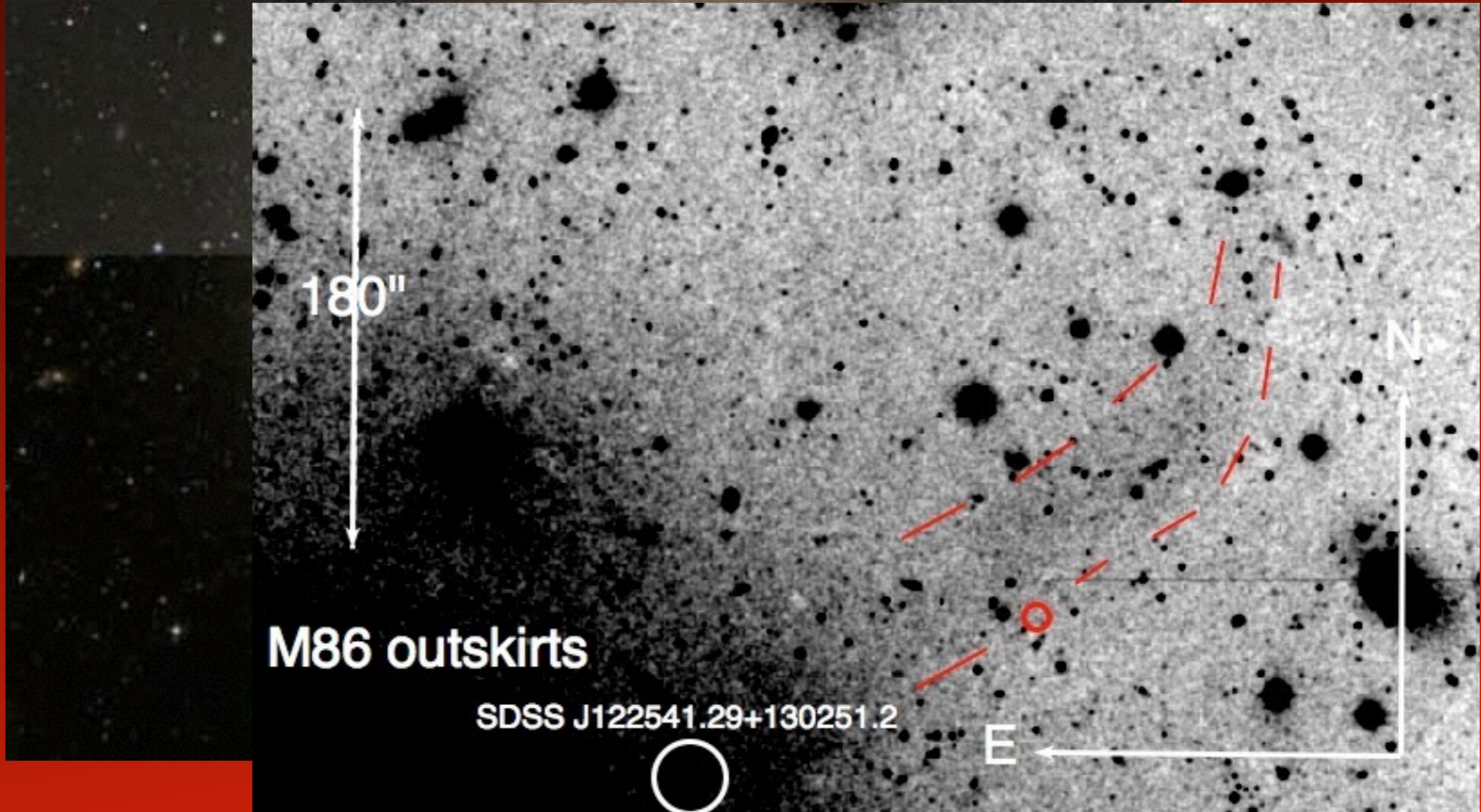
SDSS

# M86

$d_{M86} = 16.2 \text{ Mpc}$



SDSS



180"

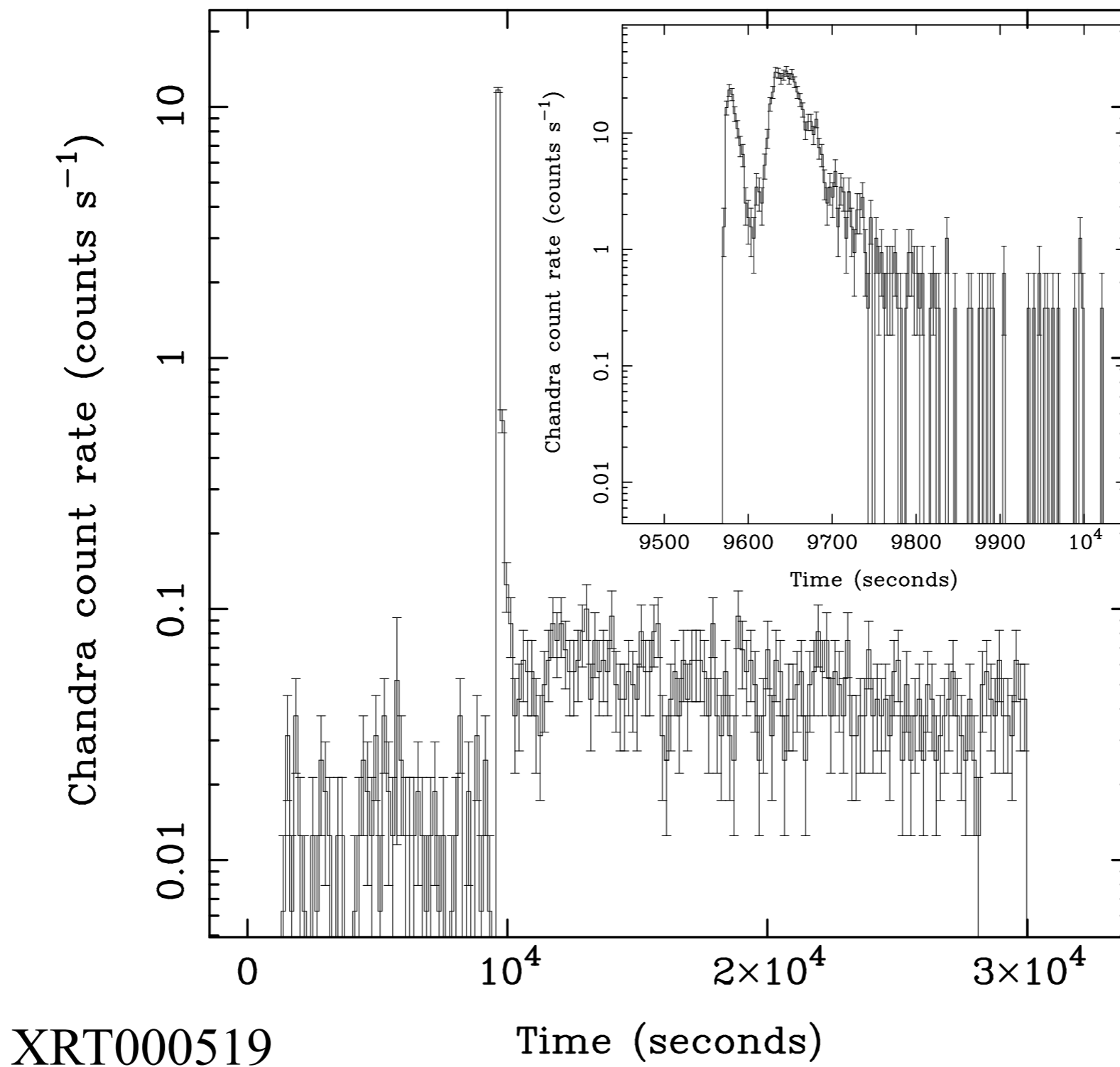
M86 outskirts

SDSS J122541.29+130251.2

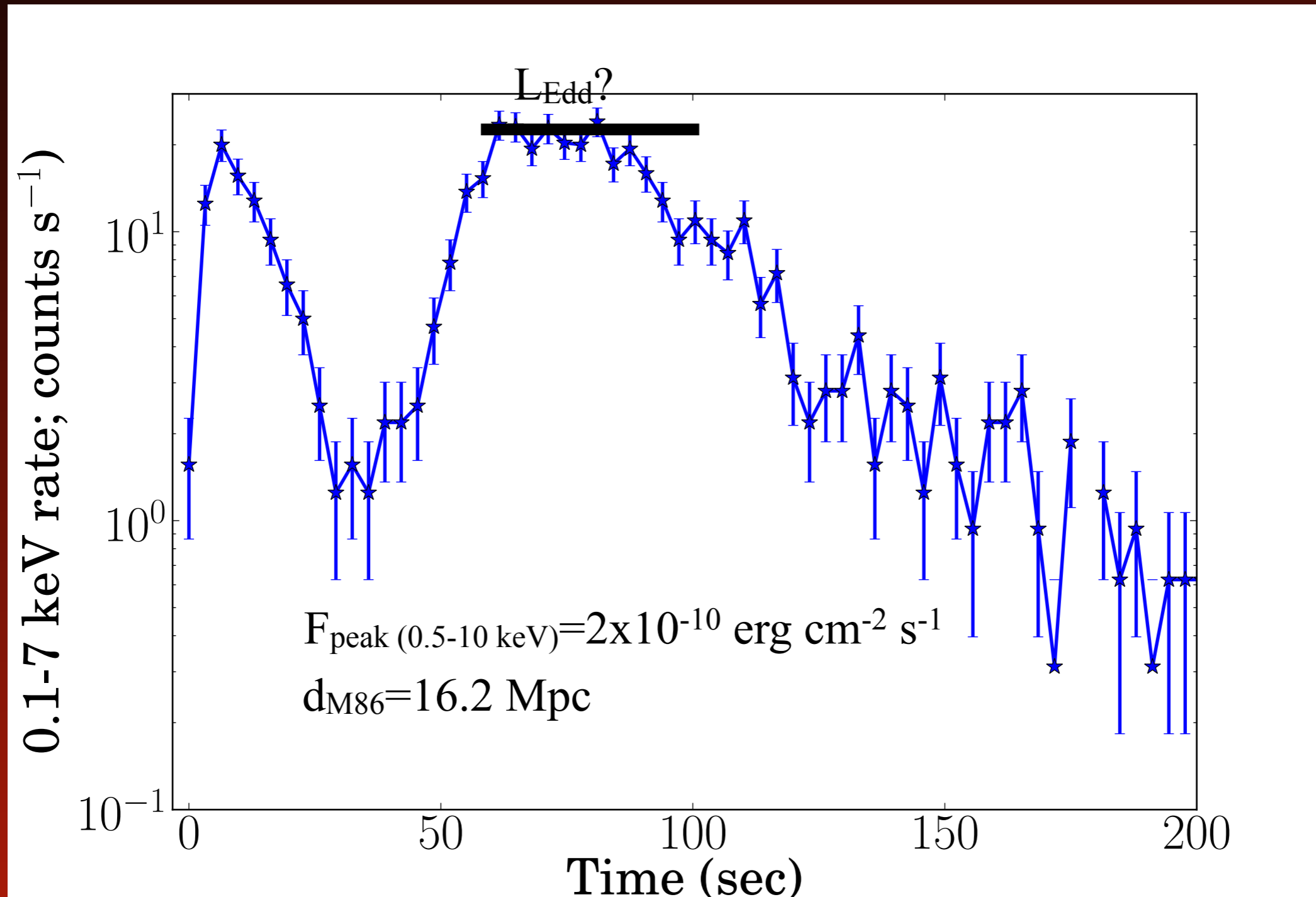
E

N

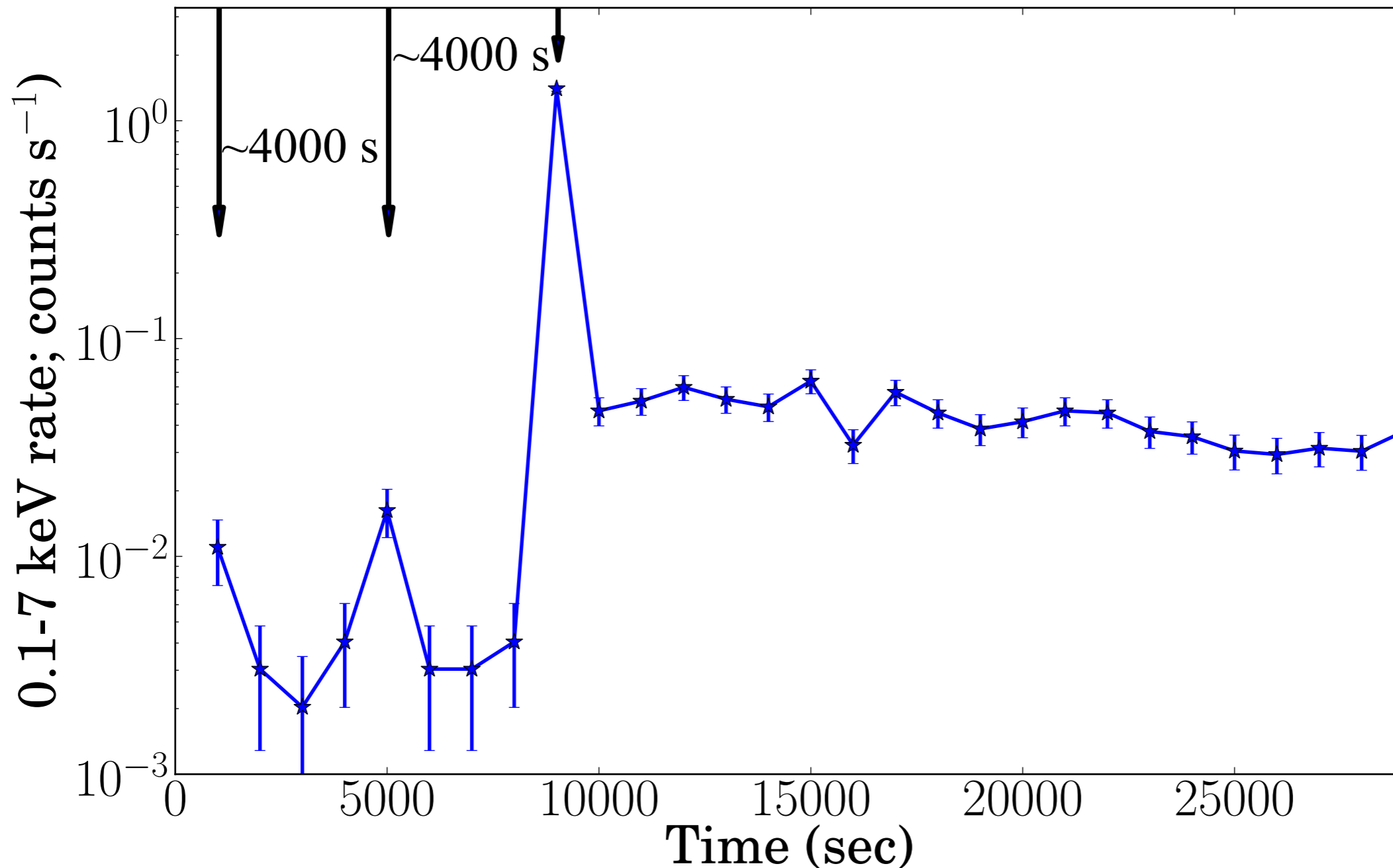
# Detection of a fast X-ray transient



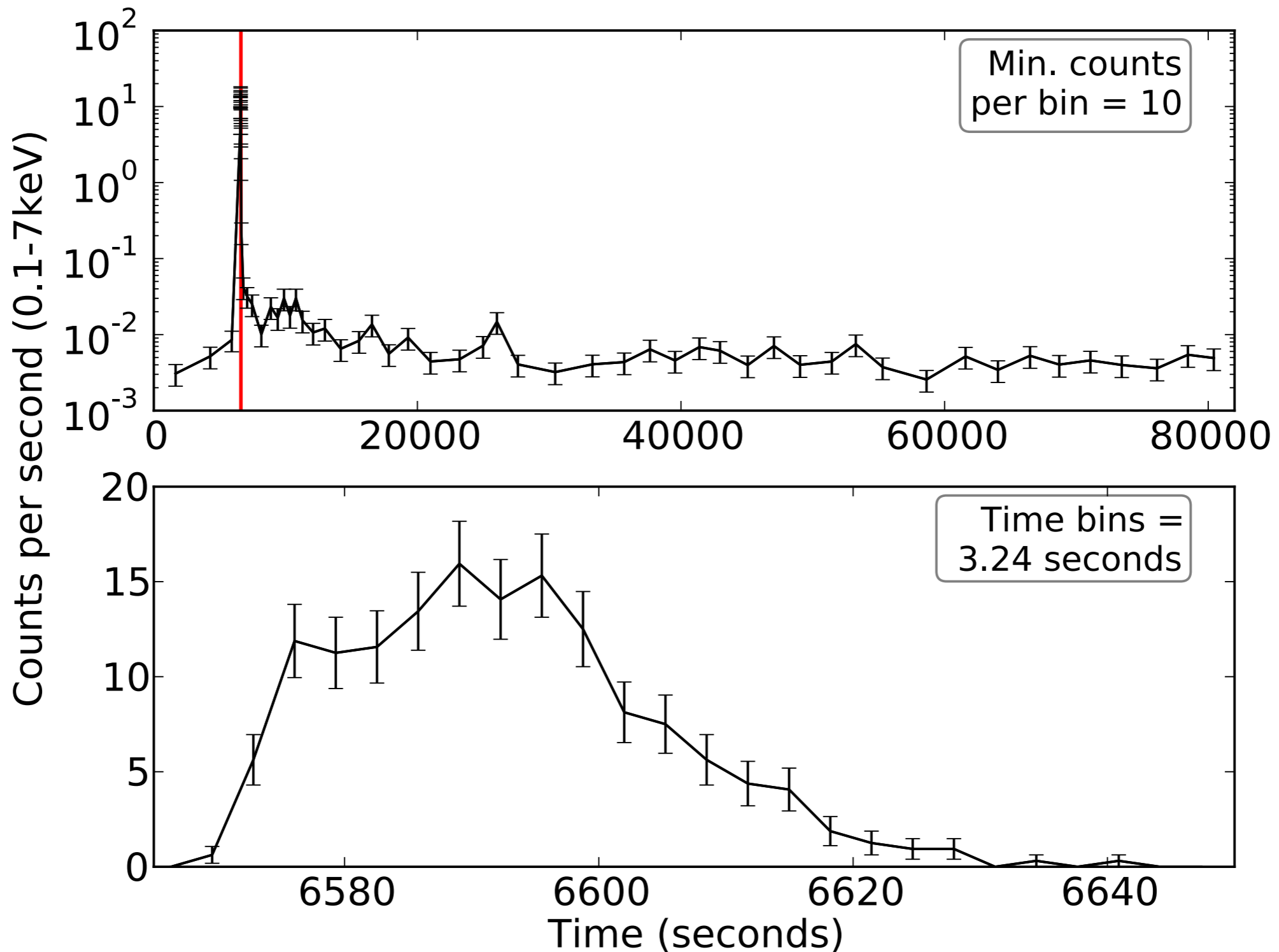
# Interpretations: peak luminosity?



# Precursors to the transient

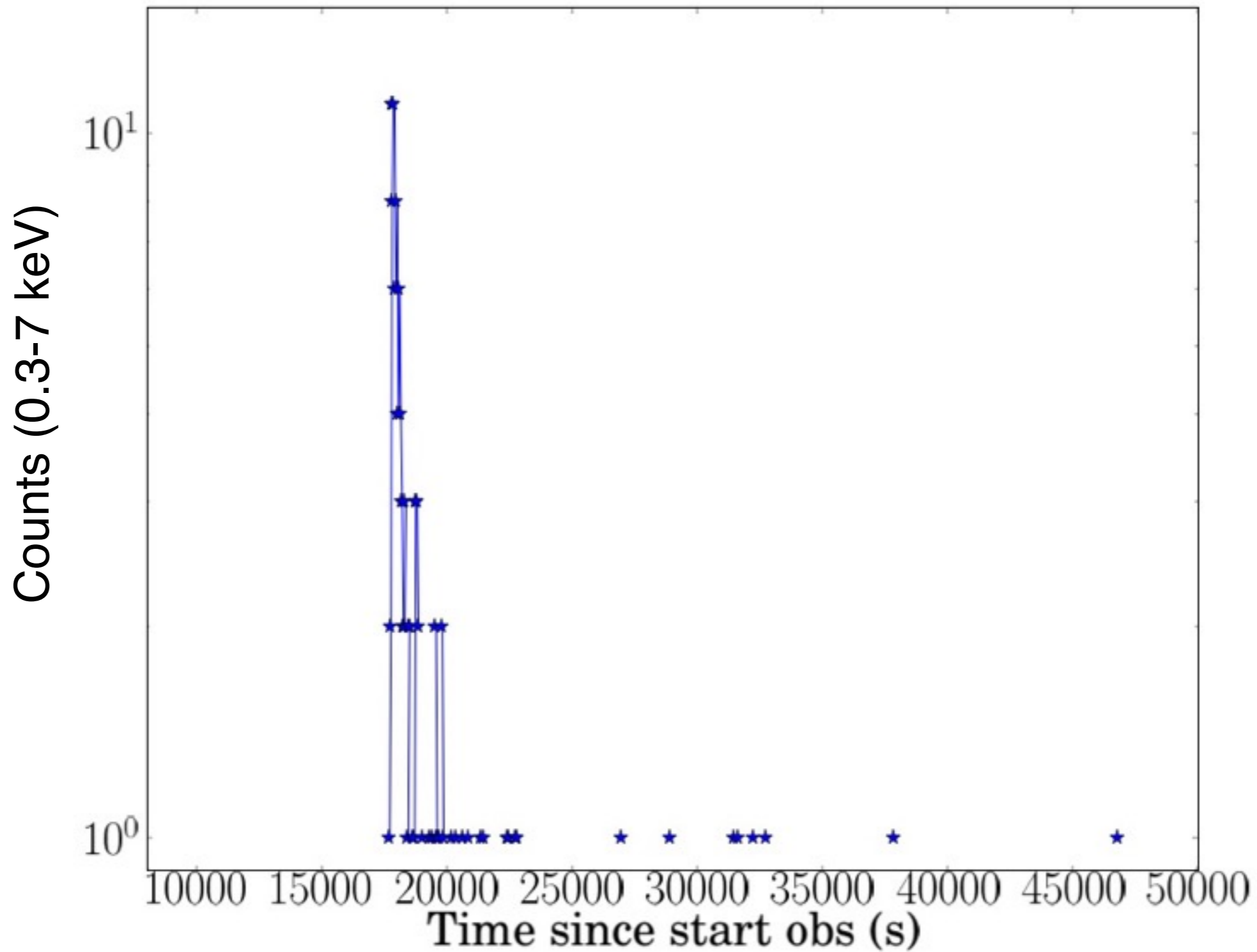


# More fast X-ray flashes:





# More fast X-ray flashes:



# Conclusion:

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

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

Any peculiar (nuclear) Type Ia's?