



中国科学院粒子天体物理重点实验室

Key Laboratory of Particle Astrophysics Chinese Academy of Sciences

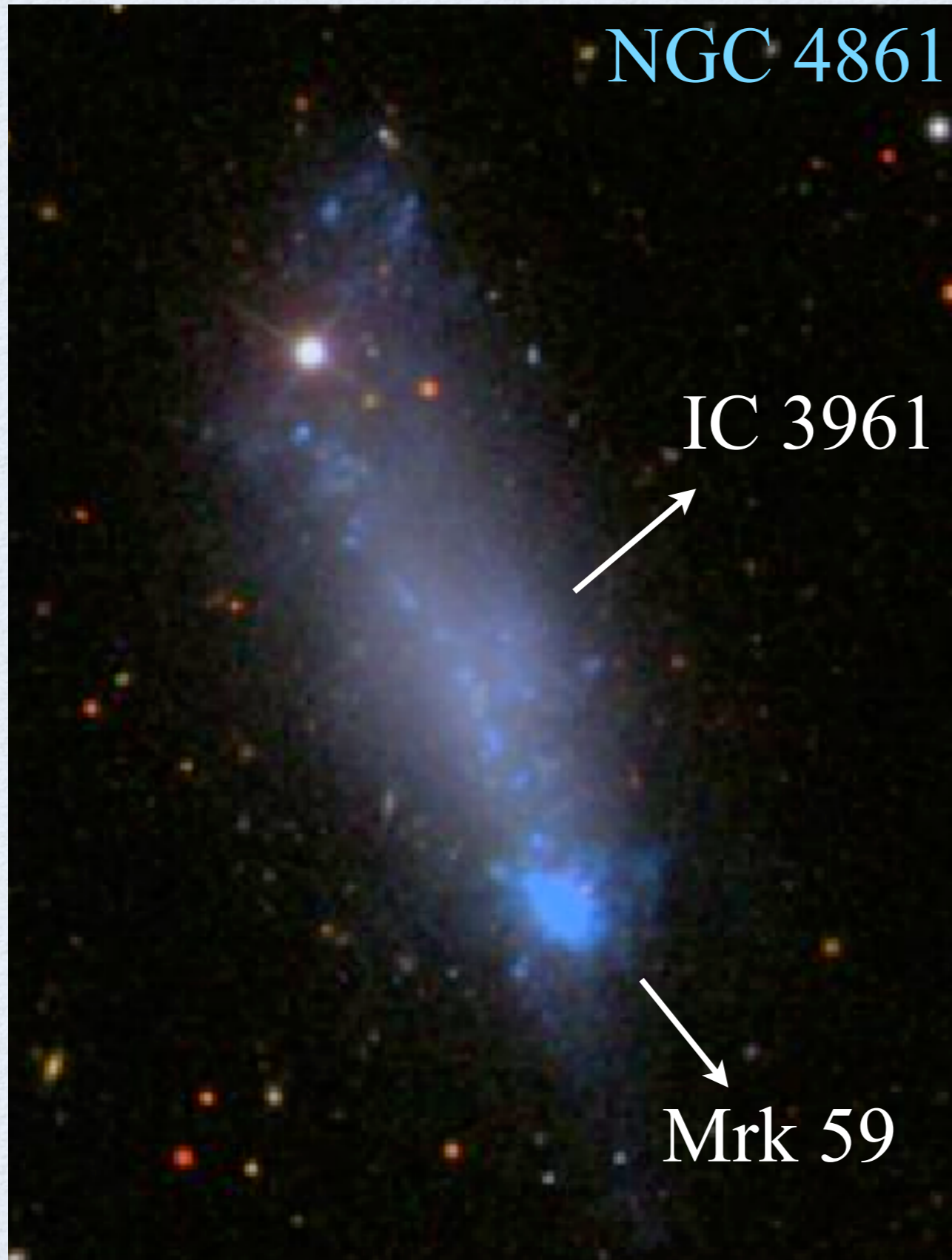
A Candidate Nuclear IMBH in a Blue Compact Dwarf Galaxy

20 Years of Chandra Science Symposium
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Blue Compact Dwarf Galaxy NGC 4861



NGC 4861 belongs to a class of cometary Blue Compact Dwarf Galaxies (BCDs: the local analogue of galaxies in the early Universe).

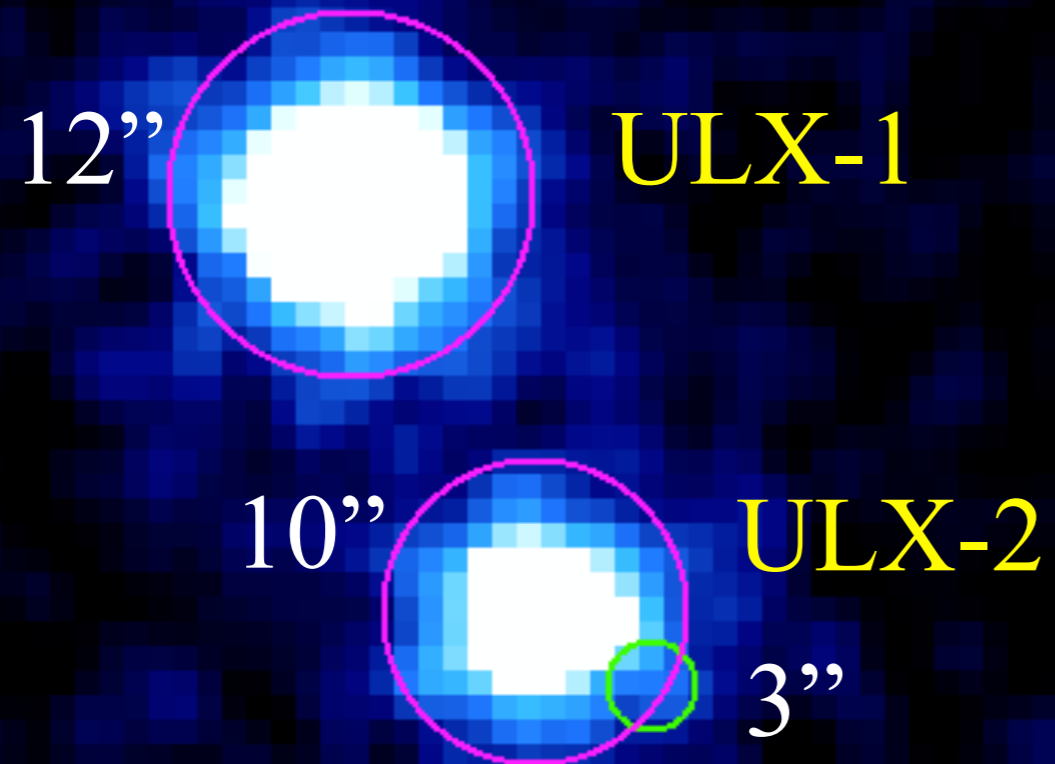
It consists of a dwarf irregular (IC 3961, a chain of HII regions) with a bright knot (Mrk 59 = I Zw 49, bright supergiant HII region).

It is a relatively young star-forming galaxy with very low metallicity:
 $Z \sim 0.13 Z_{\odot}$ (Mapelli et al. 2011)

Distance $\sim z = 0.003 \pm 0.00001$
 ~ 11 Mpc

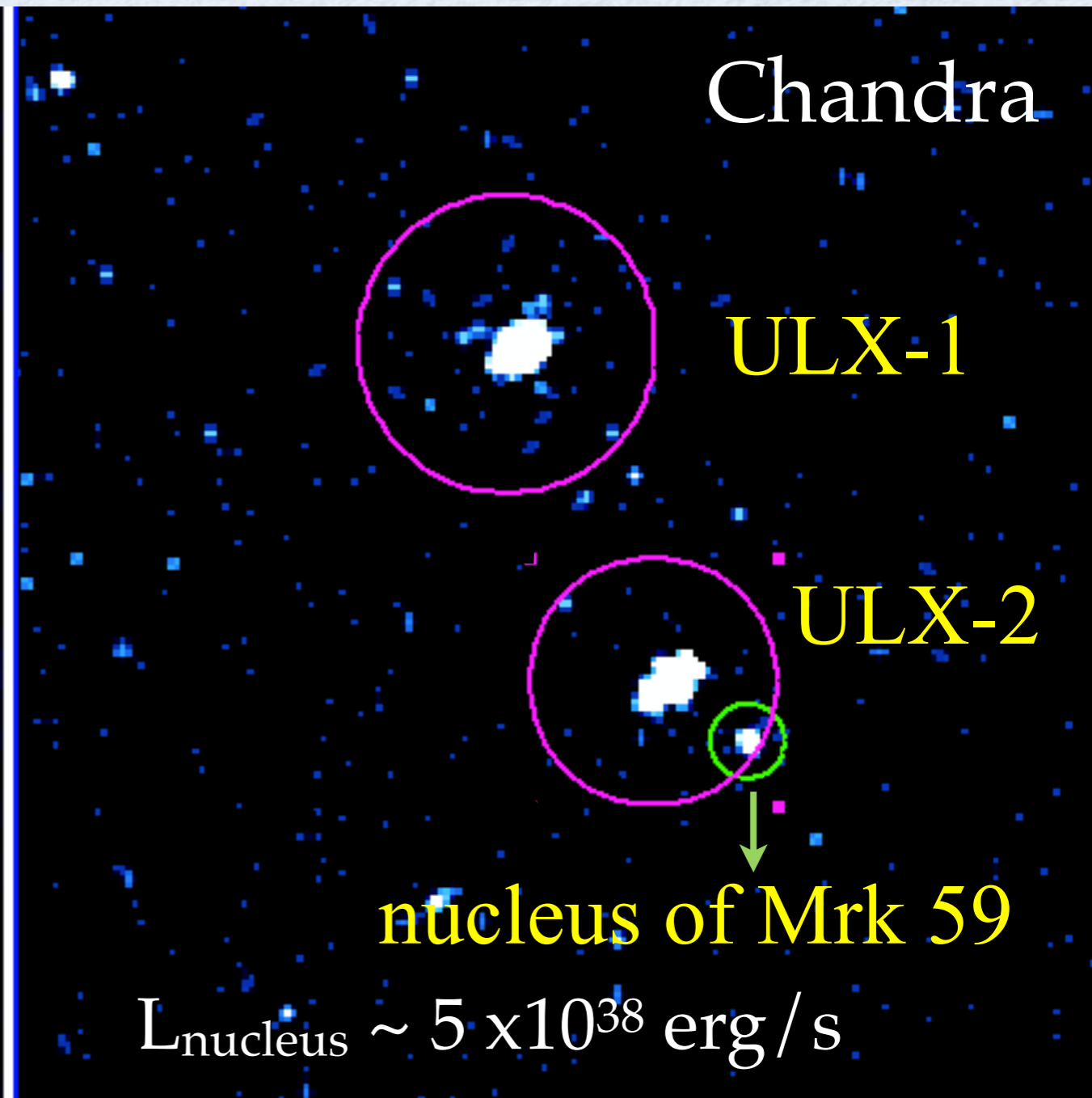
X-Ray Sources in NGC 4861 (XMM & Chandra)

XMM-Newton

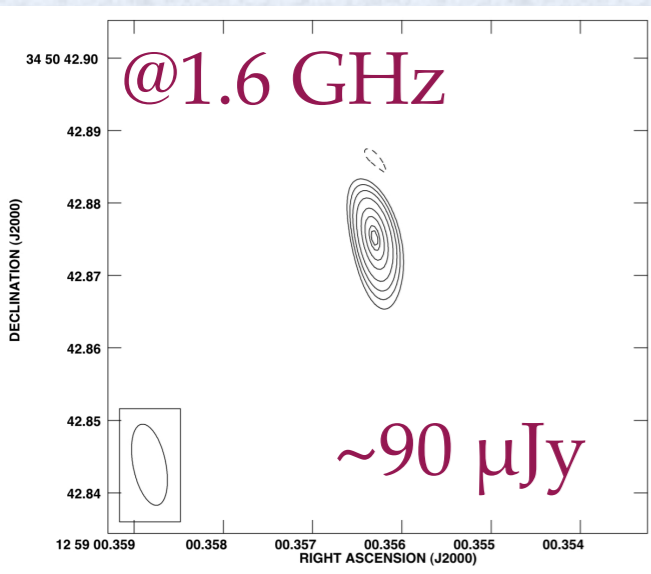


$L_{\text{ULXs}} \sim \text{a few times } 10^{39}\text{-}10^{40} \text{ erg/s}$

Chandra

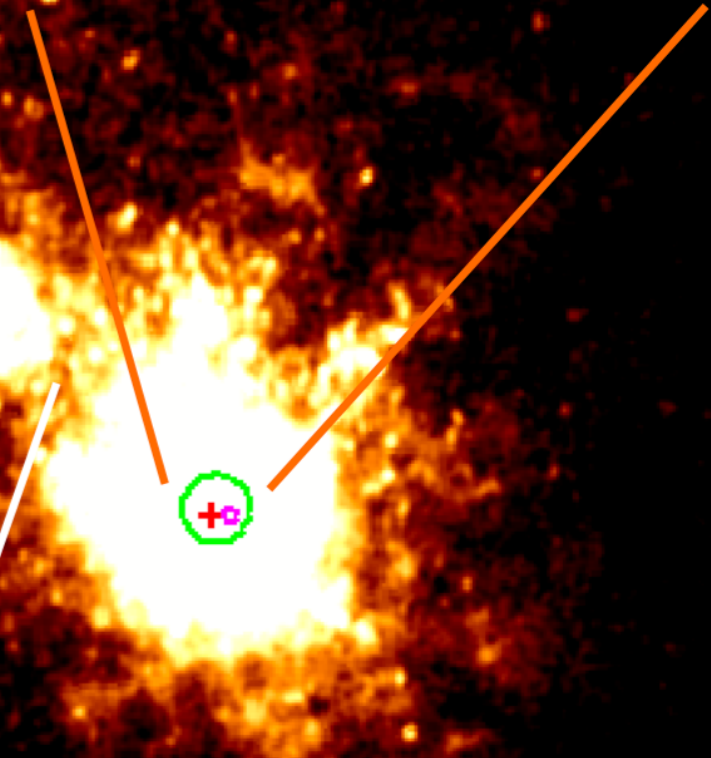
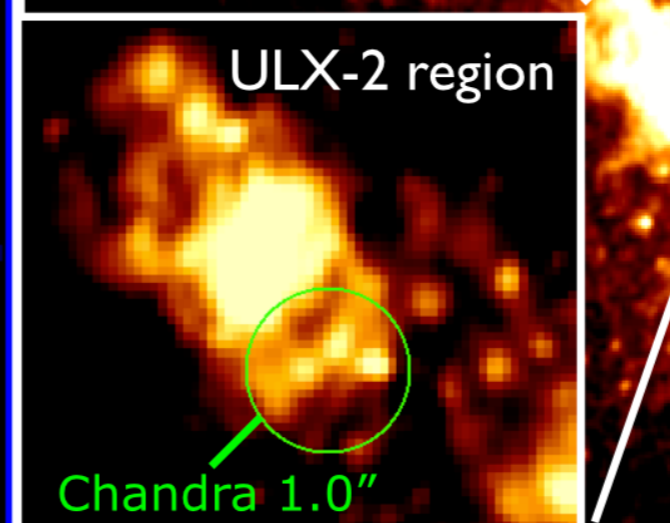
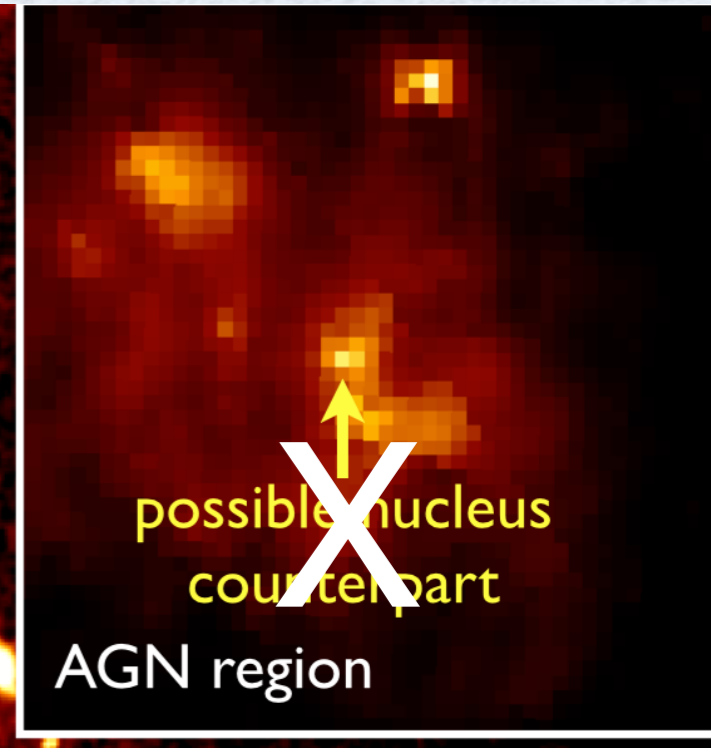
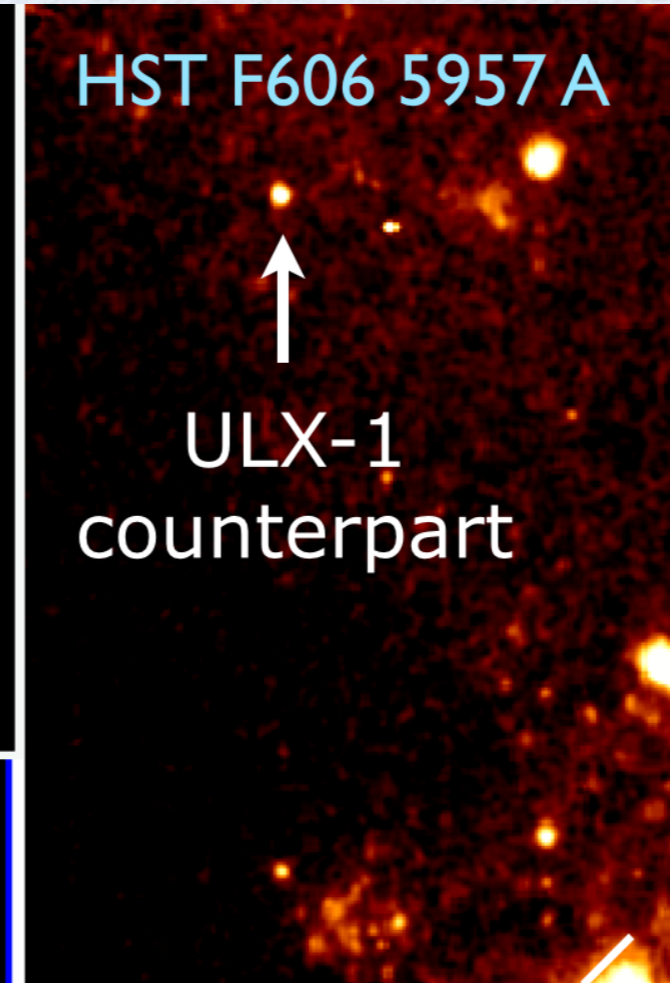
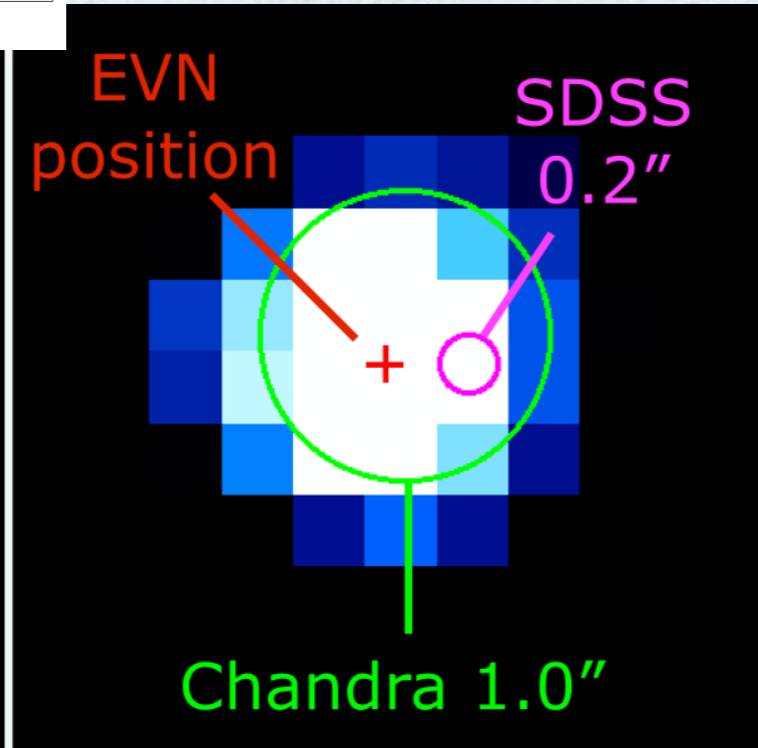
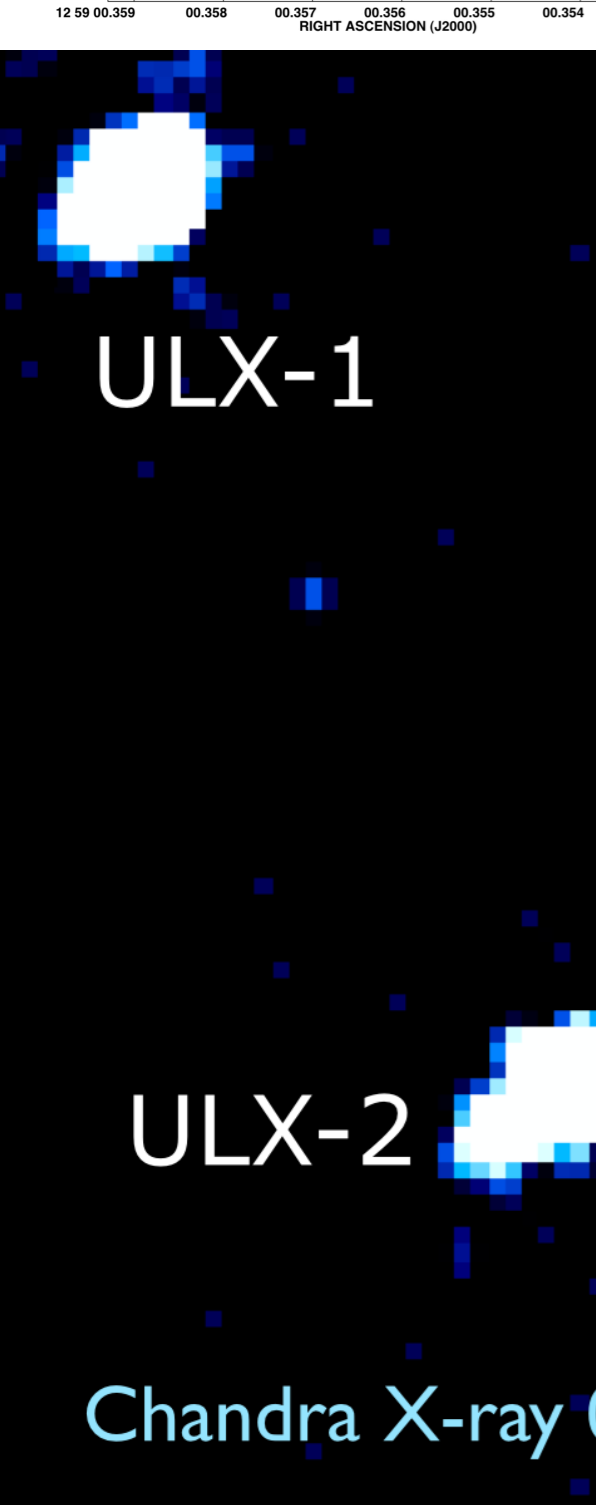


$L_{\text{nucleus}} \sim 5 \times 10^{38} \text{ erg/s}$

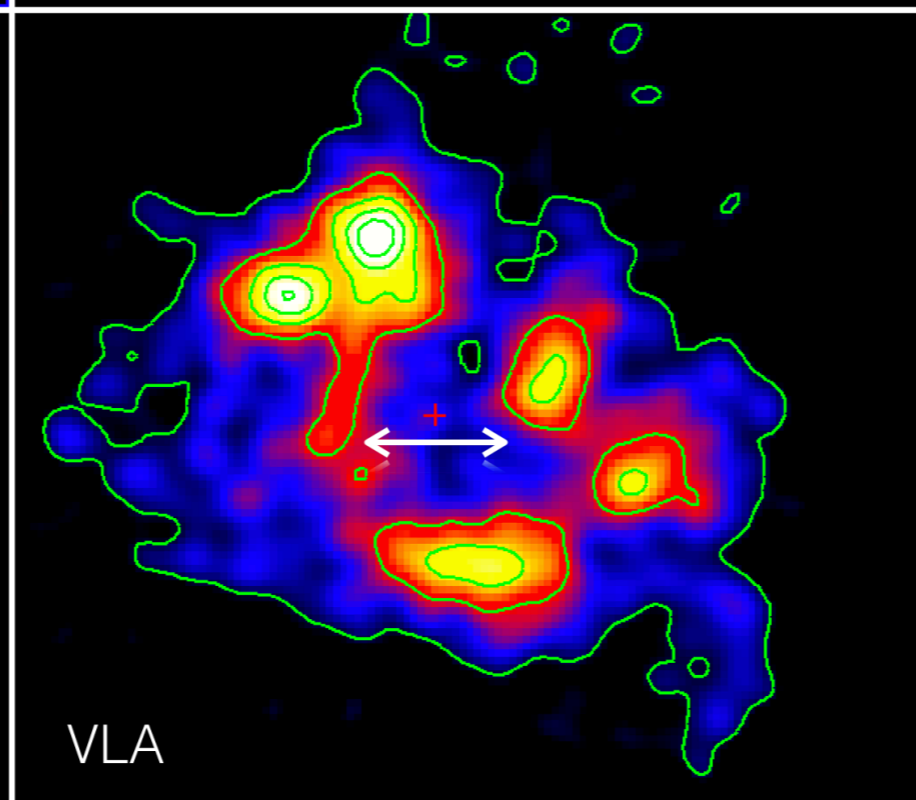
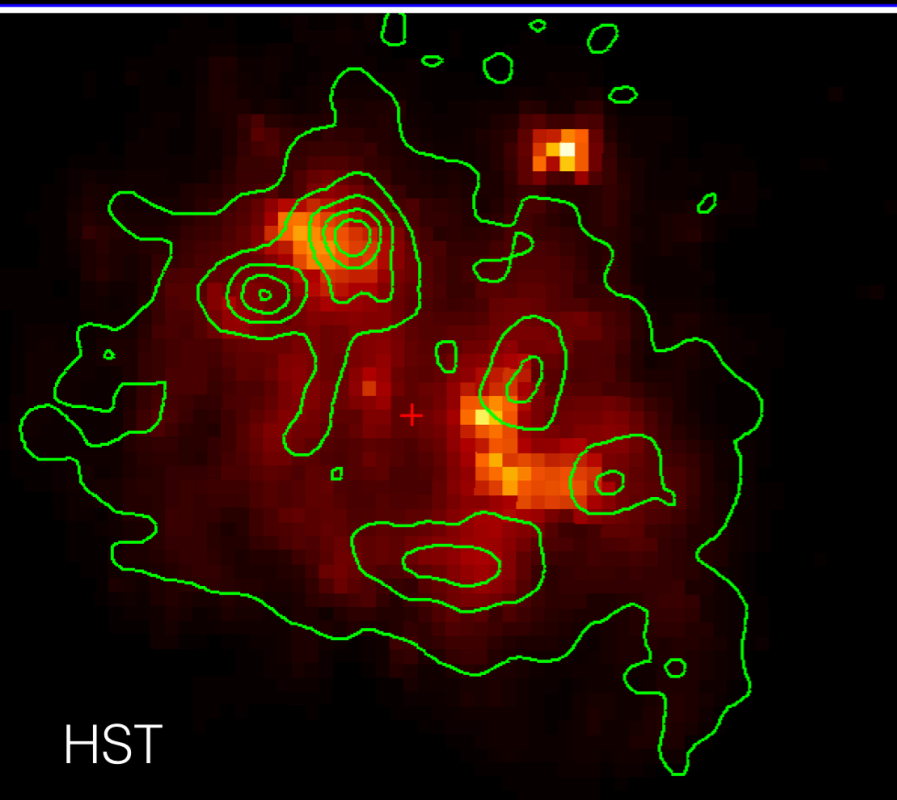
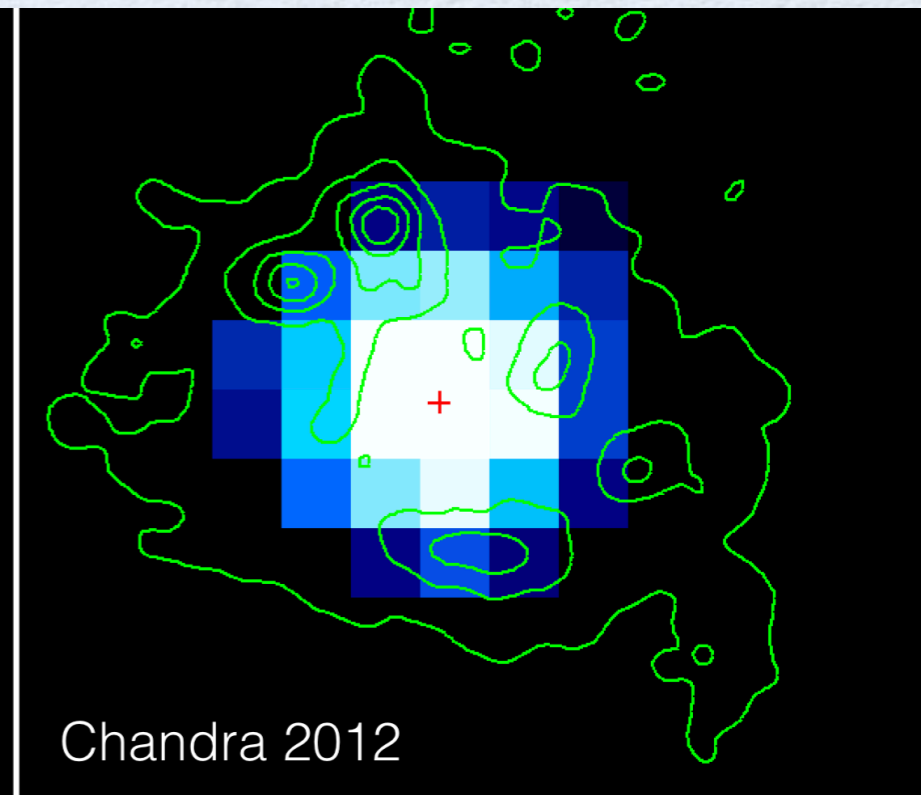
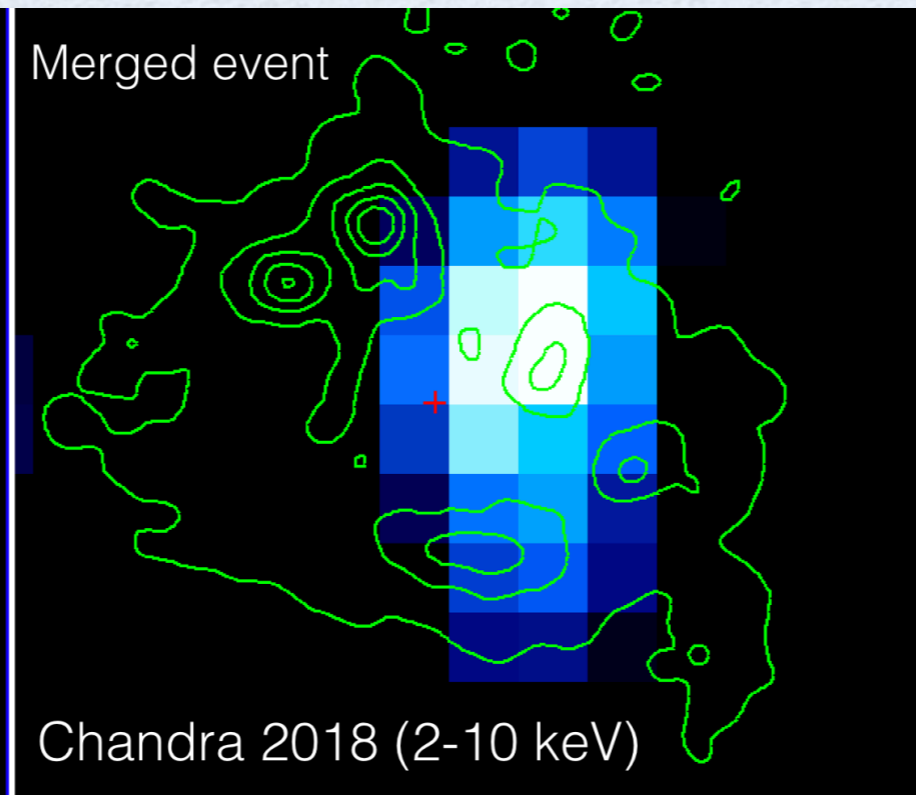
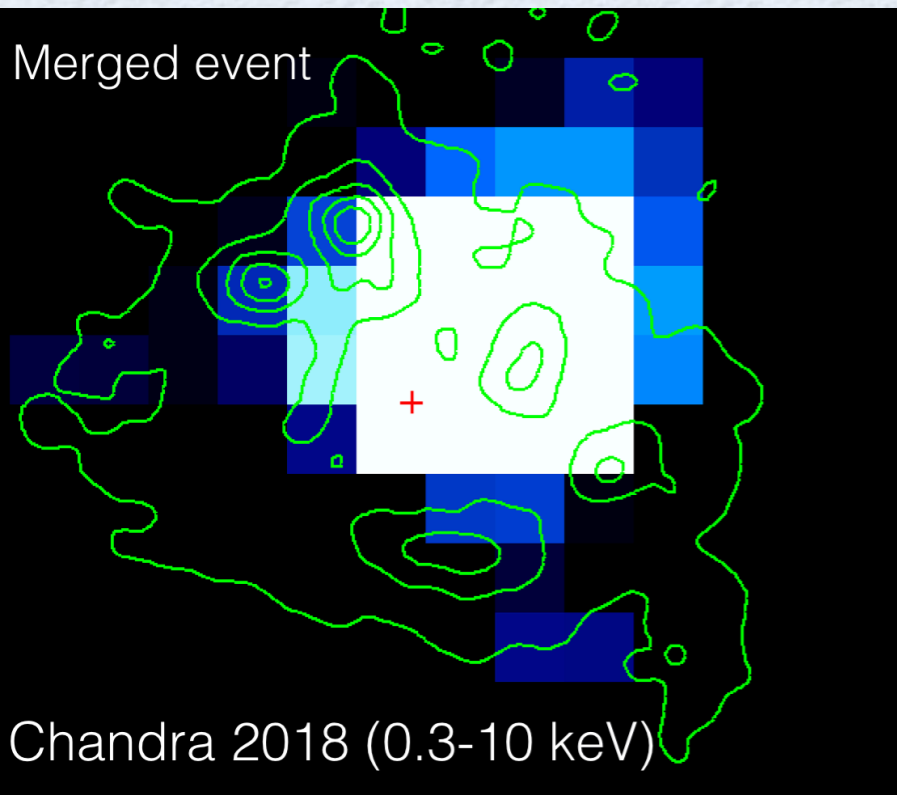


size upper limit $\sim 9.9 \text{ mas} \times 3.8 \text{ mas}$
 ($\sim 0.5 \text{ pc} \times 0.2 \text{ pc}$ at 11 Mpc)

An Intermediate Mass Black Hole in the center of Mrk 59 ?



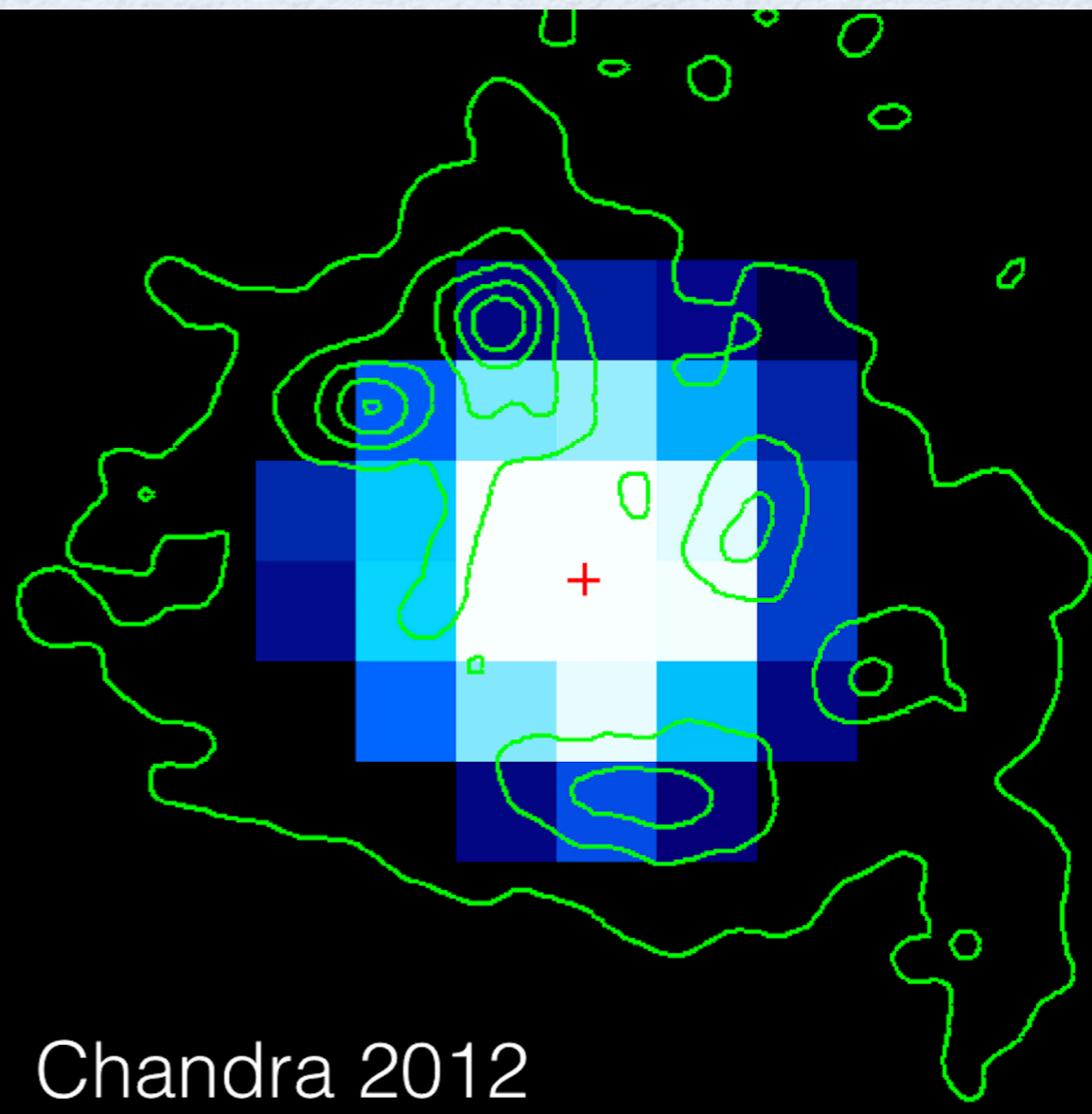
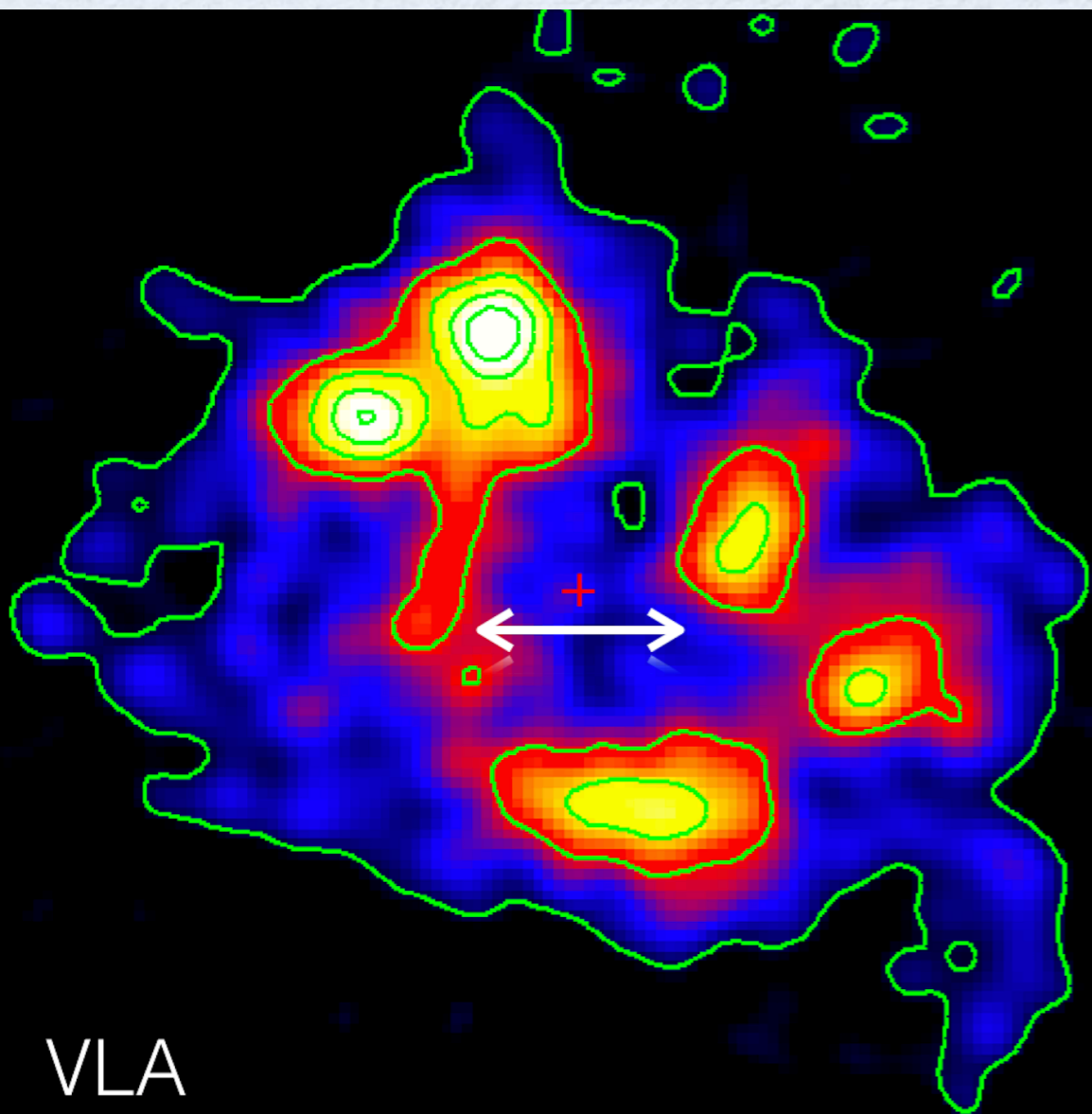
Chandra X-ray 0.3-7 keV

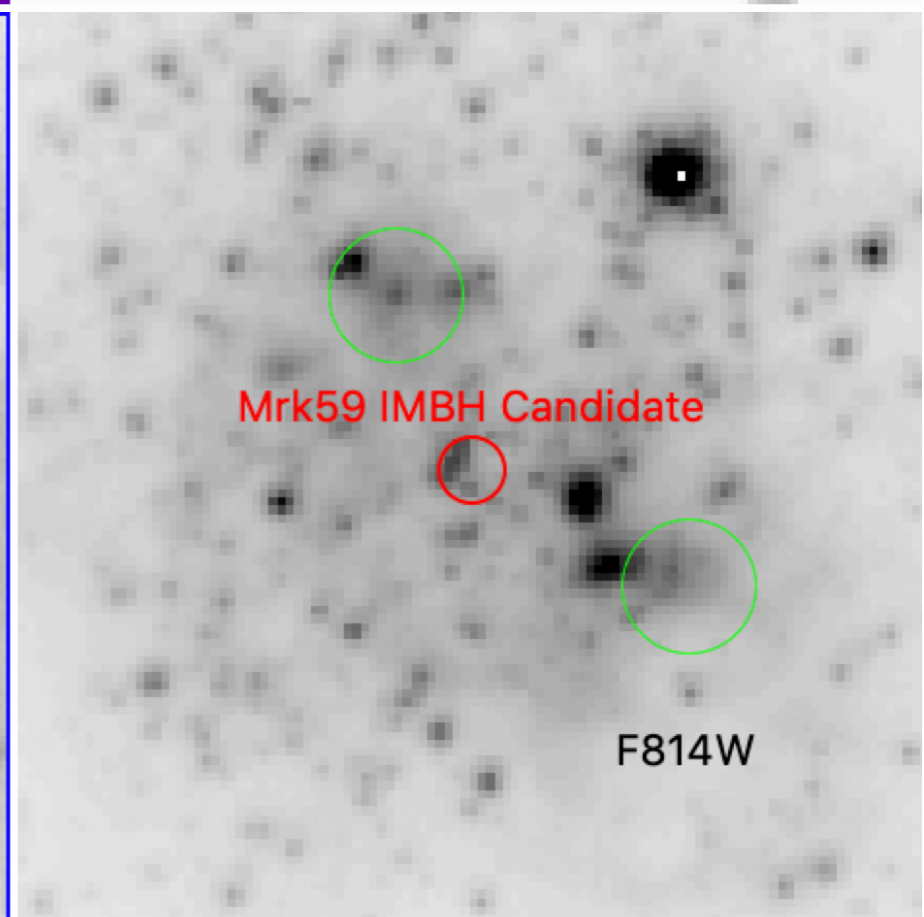
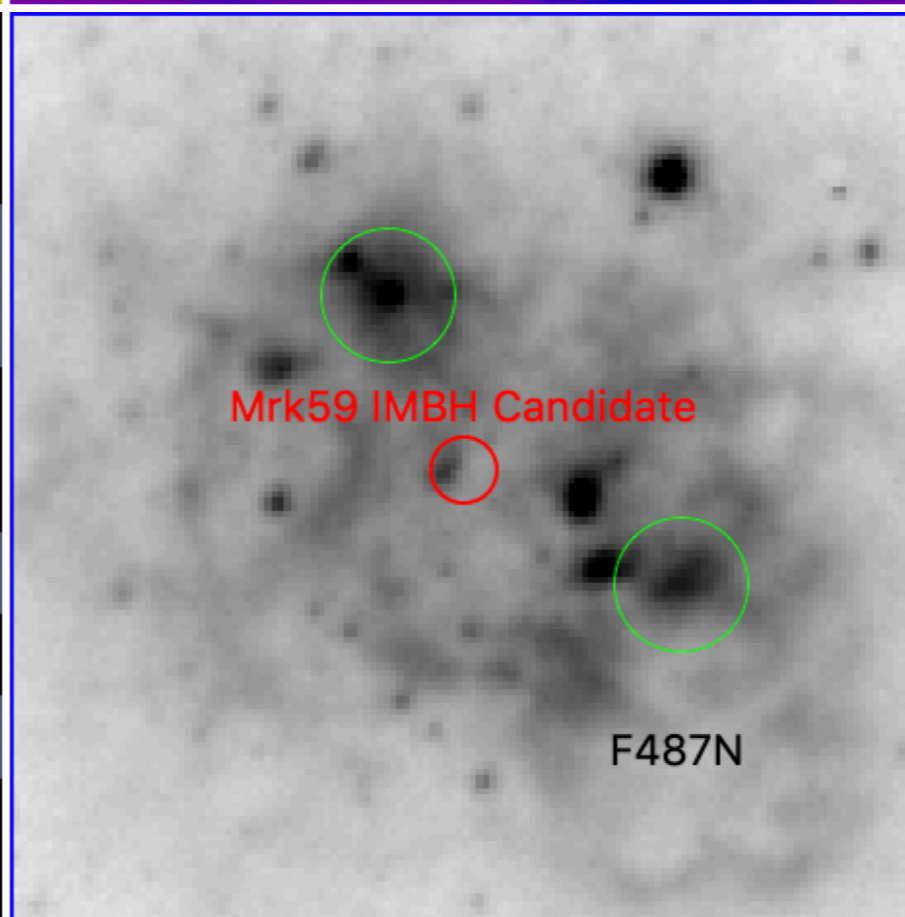
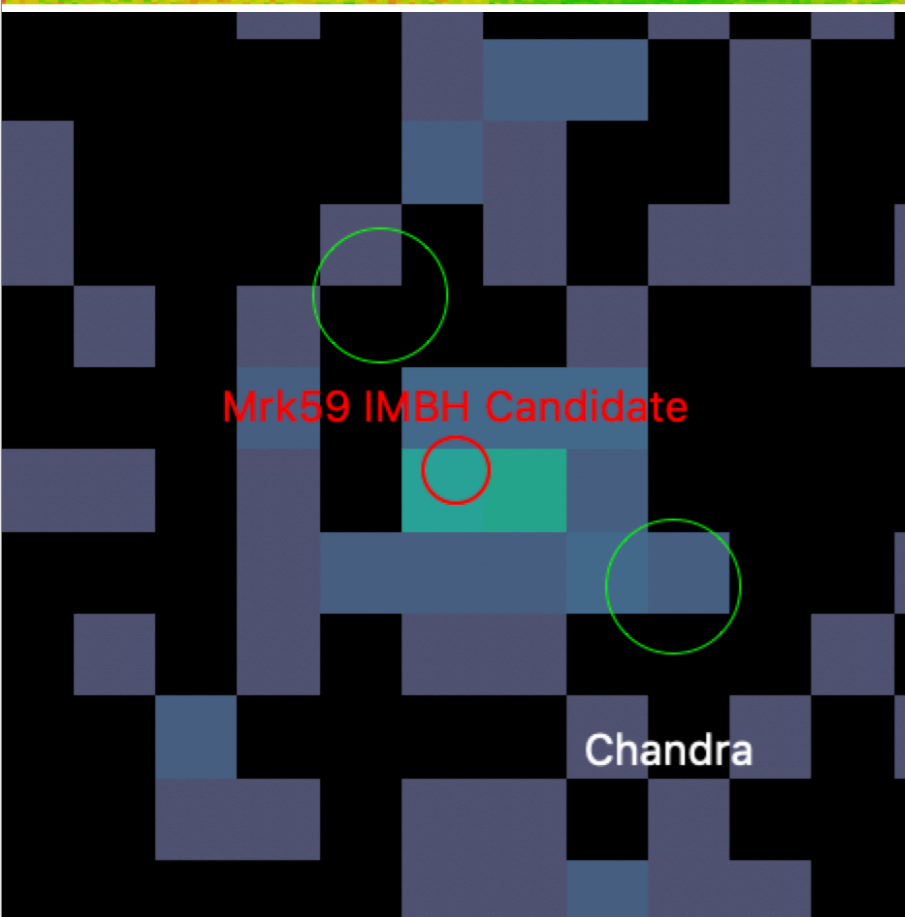
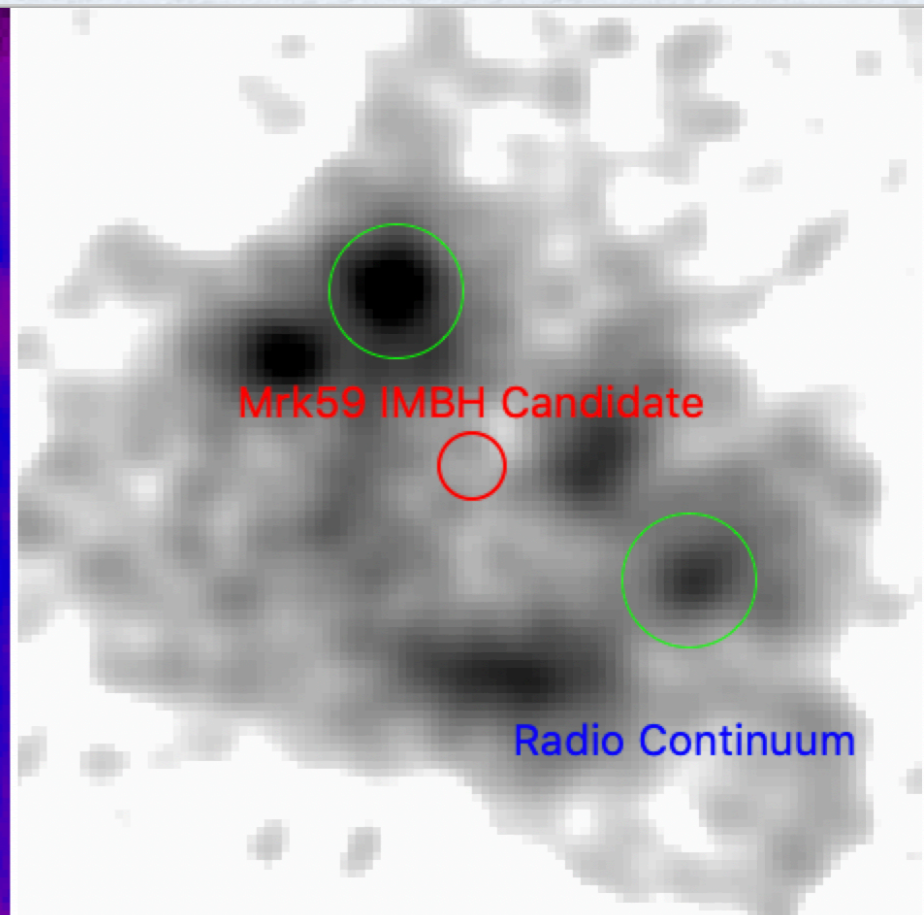
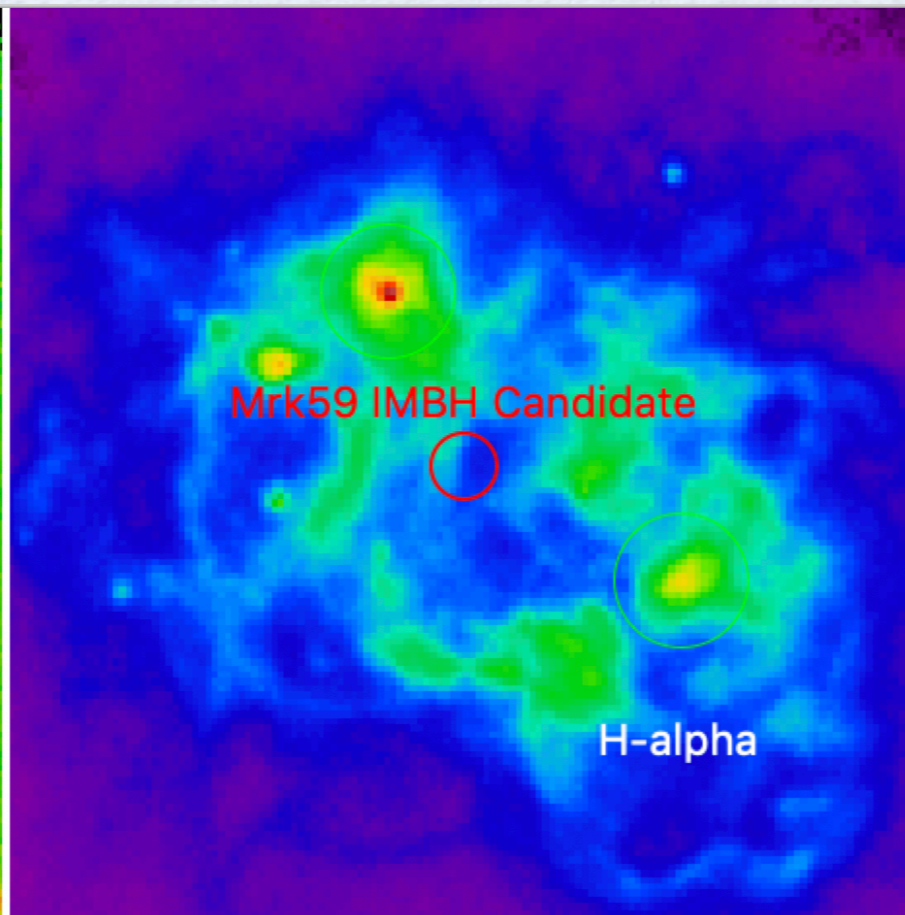
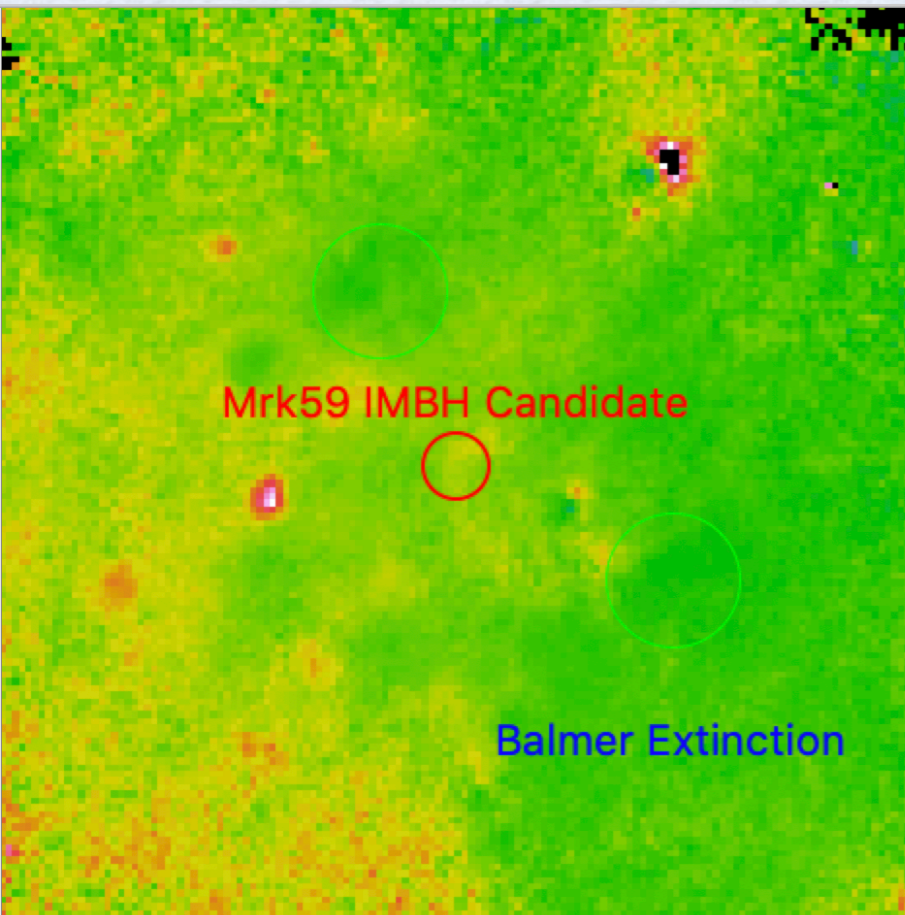


Red Cross => EVN 1.6 GHz position
Green Contour => VLA Contour

0.3-10 keV ~ 91 counts
2-10 keV ~ 8 counts
(background subtracted)

white arrow ~ 1"





Mass Estimations

$L_X \sim 5.4 \times 10^{38}$ erg/s (2-10 keV, $d=11$ Mpc)

Assuming $N_H=1 \times 10^{23}$ /cm², power-law index =1.8, and most of photons at high energy (> 2 keV) are obscured.

or

$L_X \sim 8.7 \times 10^{36}$ erg/s (from not very constrained spectral fitting)

$L_R \sim 2.8 \times 10^{34}$ erg/s @ 5GHz.

Using the fundamental plane relation for accreting BHs:

$$\log L_R = 4.8 + 0.78 \log M_{BH} + 0.67 \log L_X \text{ (Gultekin et al. 2014)}$$

We get $M_{BH} \sim 6 \times 10^4 M_\odot \Rightarrow$ IMBH (uncertainty ~ 0.7 dex)

or

$M_{BH} \sim 2 \times 10^6 M_\odot \Rightarrow$ SMBH

Alternative Phenomena?

Supernova Remnants (SNRs), X-ray Binaries (XRBs),
Low-luminosity AGNs (LLAGNs)....

$$R_X = L_R/L_X = \nu L_\nu(5 \text{ GHz}) / L_X(2-10 \text{ keV})$$

SNRs $\Rightarrow \log R_X \sim -2.7$ to -1.7

XRBs $\Rightarrow \log R_X < -5.3$

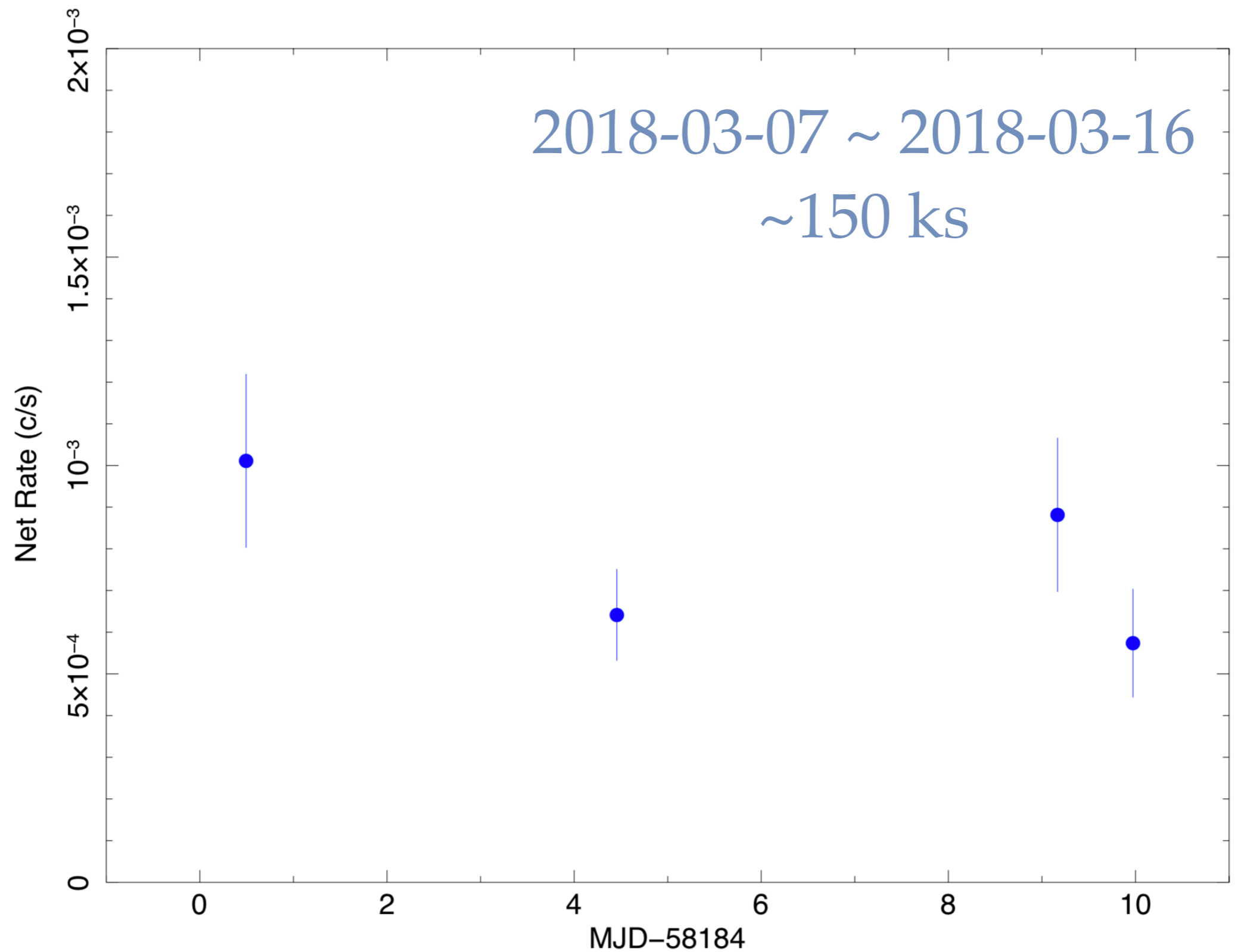
LLAGNs $\Rightarrow \log R_X \sim -3.8$ to -2.8

IMBHs $\Rightarrow \log R_X \sim -5.3$ to -3.8

Mrk 59 $\Rightarrow \log R_X \sim -4.3 \Rightarrow$ IMBH (if $L_X \sim 5.4e38$ erg/s)

Mrk 59 $\Rightarrow \log R_X \sim -2.5 \Rightarrow$ SNR (if $L_X \sim 8.7e36$ erg/s)

Variability in short timescale



Summary

We found a possible accreting black hole in the center of Mrk 59, assuming a high column density and an obscured nature, we estimated a black hole mass of $\sim 6 \times 10^4 M_{\odot}$, consistent with the mass for IMBHs.

(or could the source be a SNR? or a SMBH?)

The nature of the source is still to be confirmed!