Hyper-luminous X-ray Souces:
what are they and how can we find them?

R. Scott Barrows
Postdoctoral Research Associate
University of Colorado Boulder

Collaborators: Julie Comerford (CU), Mar Mezcua (Toronto),
Daniel Stern (JPL), Marianne Heida (Caltech)

What do we know about HLXs?

- Extragalactic sources

- Faint optical counterparts

- Spatially offset from the galaxy nucleus

M83 ULX-1

Ultra-luminous X-ray Sources (ULXs):
$L_x > 10^{39}$ erg/s

Hyper-luminous X-ray Sources (ULXs):
$L_x > 10^{41}$ erg/s

M101 ULX-1

What can they be?

How are ULX x-ray luminosities generated?

1) super-Eddington accretion in X-ray binaries

2) sub-Eddington accretion onto masses few x 10 $M_\odot$

3) Supernova remnants and relativistic beaming

How are HLX x-ray luminosities generated?

Not easily be explained by accretion onto stellar mass ($M_\bullet < 100M_\odot$) black holes

Faint stellar counterparts: unlikely to be supermassive black holes ($> 10^6\ M_\odot$)

→ Intermediate mass black holes (IMBHs) with $10^2 M_\odot < M_\bullet < 10^6 M_\odot$

Why are HLXs important?

Cosmological implications of IMBHs: Primordial seed masses of SMBHs

- direct collapse of pre-galactic gas disks ($M_\bullet = 10^4 – 10^5 M_\odot$),

- end-stage of massive Population III stars ($M_\bullet = 10^2 – 10^3 M_\odot$) or

- collapse of dense stellar clusters ($M_\bullet = 10^2 – 10^4 M_\odot$).

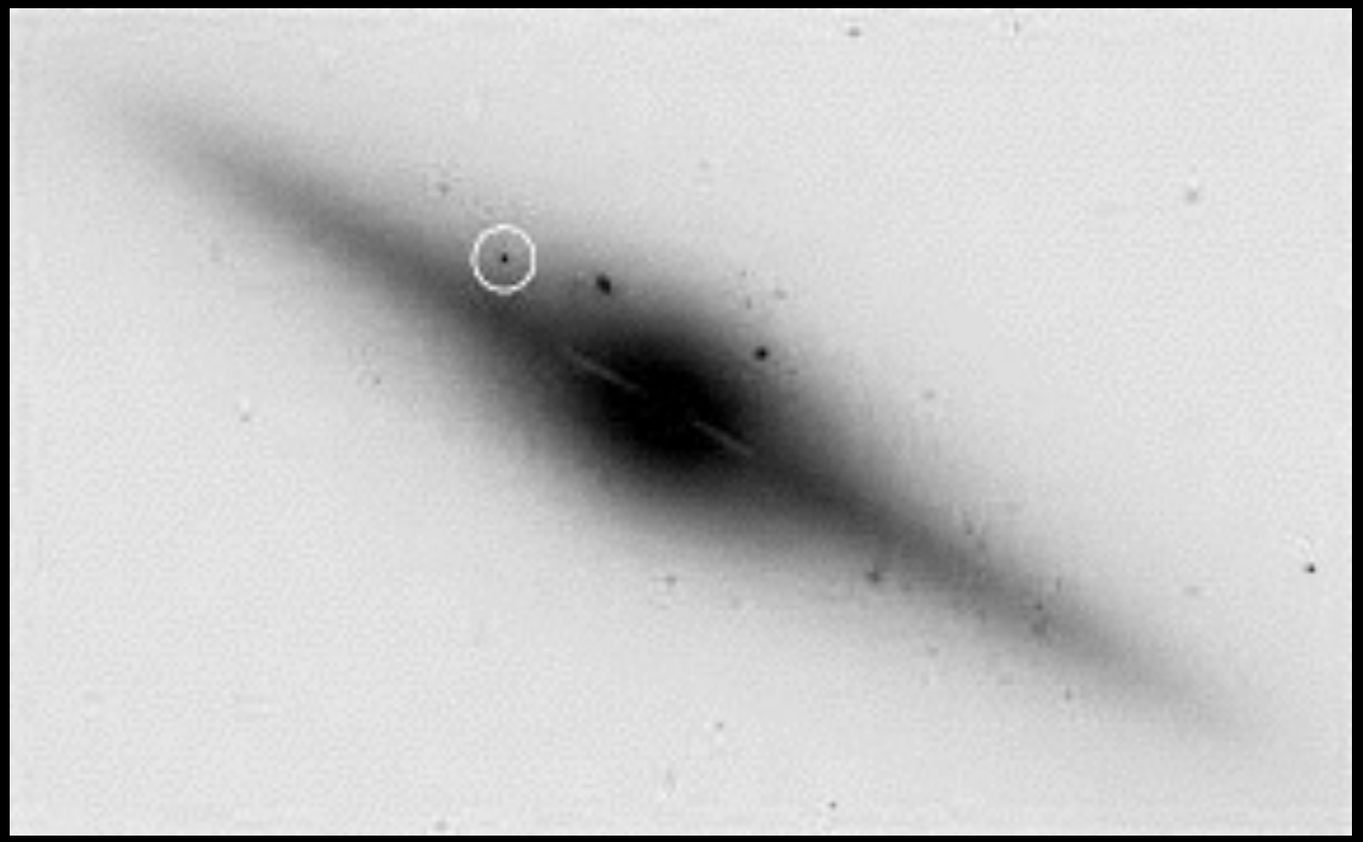
IMBHs in the nearby Universe:

- Not yet evolved to SMBH masses

HLXs:

- IMBHs in the remnant cores of dwarf galaxies

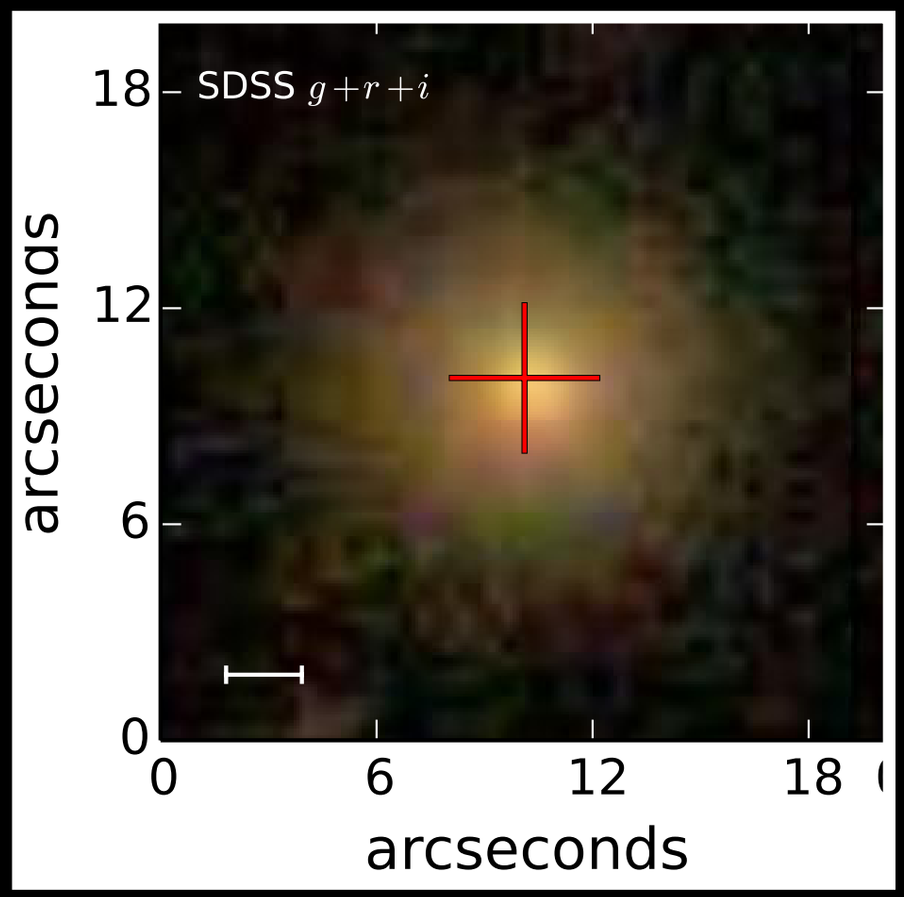
- Few known (<10 $M_\odot$)



HLX-1: Farrell+2009

How can we find more?

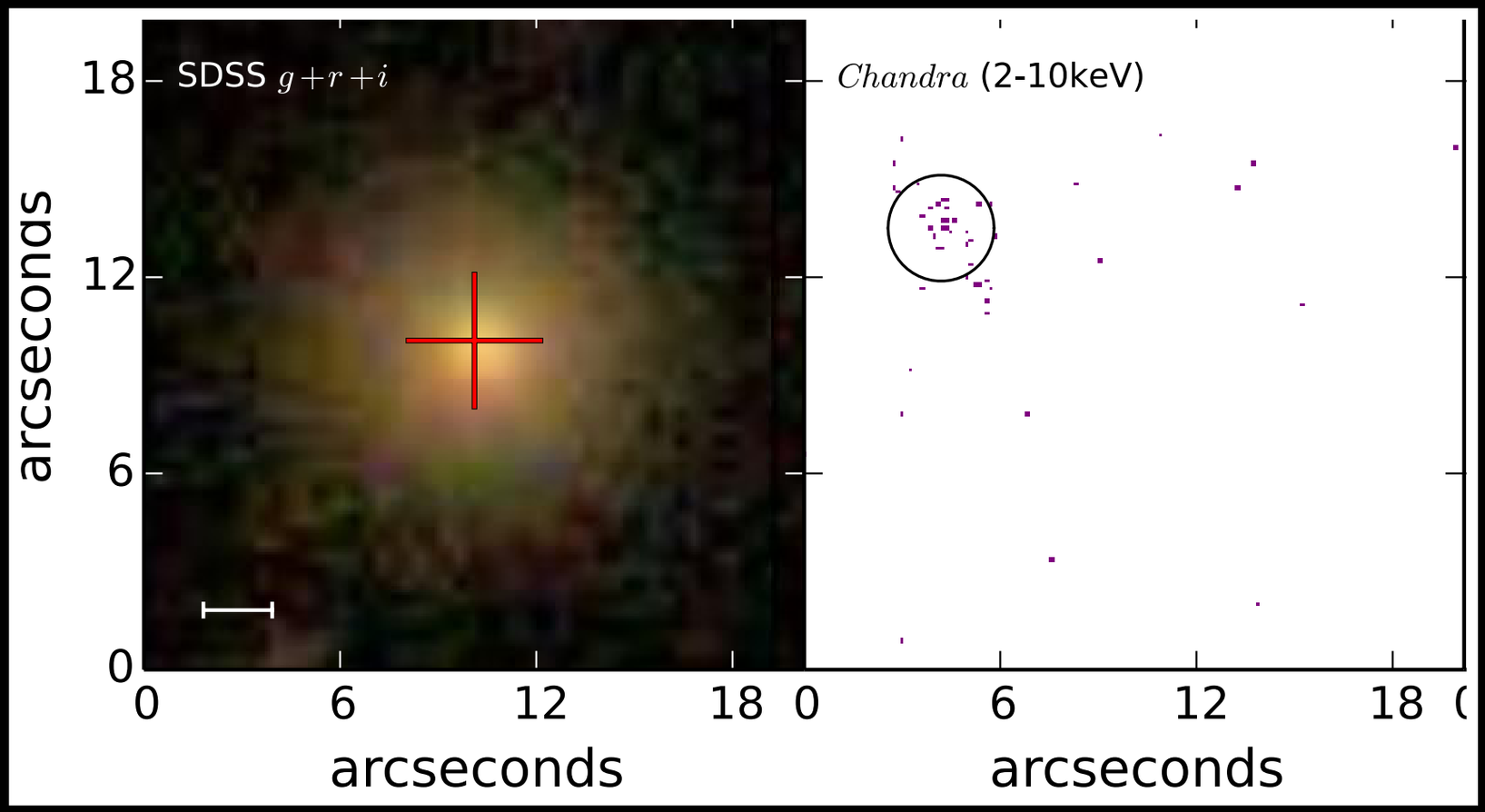
Our program (*Chandra* Cycle 18, PI Barrows): identify off-nuclear X-ray sources in optical galaxy samples using the best X-ray spatial resolution available (*Chandra*) and precise relative astrometry (Barrows+2016)



Start with optical galaxy image

How can we find more?

Our program (*Chandra* Cycle 18, PI Barrows): identify off-nuclear X-ray sources in optical galaxy samples using the best X-ray spatial resolution available (*Chandra*) and precise relative astrometry (Barrows+2016)

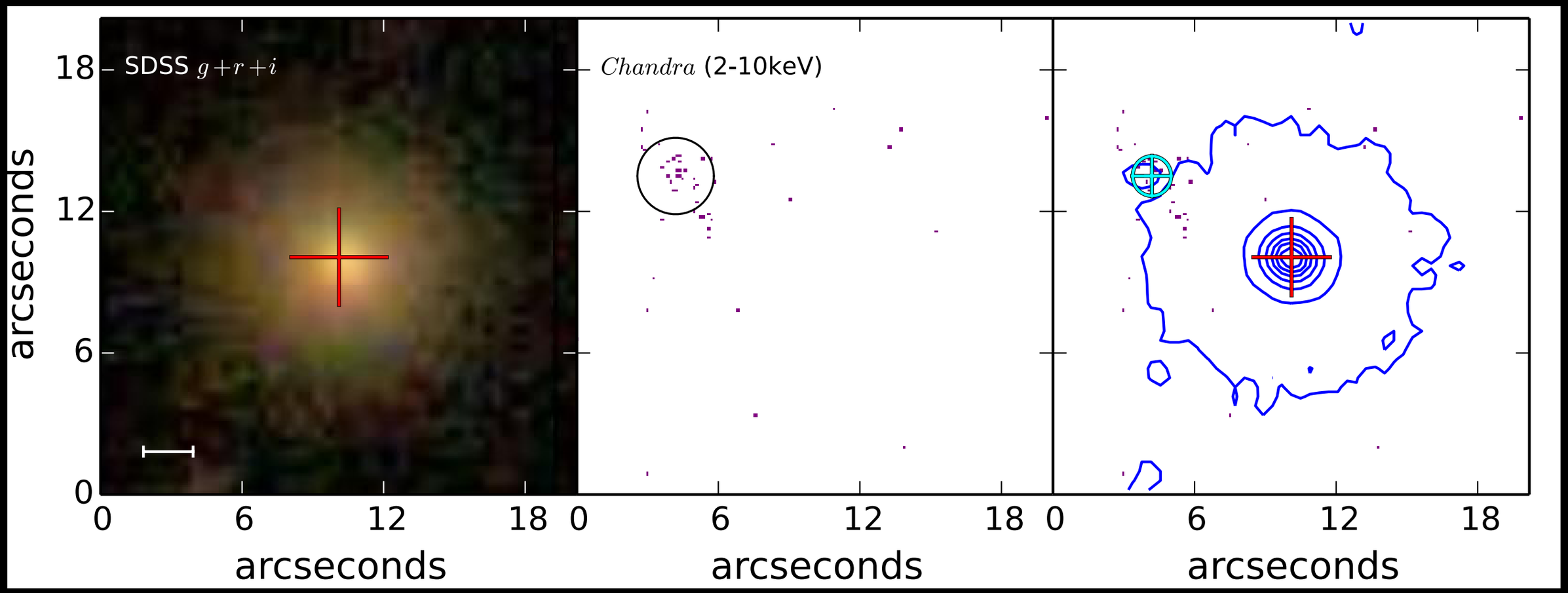


Start with optical galaxy image

Spatially coincident X-ray source (>10^{41} erg/s)

How can we find more?

Our program (*Chandra* Cycle 18, PI Barrows): identify off-nuclear X-ray sources in optical galaxy samples using the best X-ray spatial resolution available (*Chandra*) and precise relative astrometry (Barrows+2016)

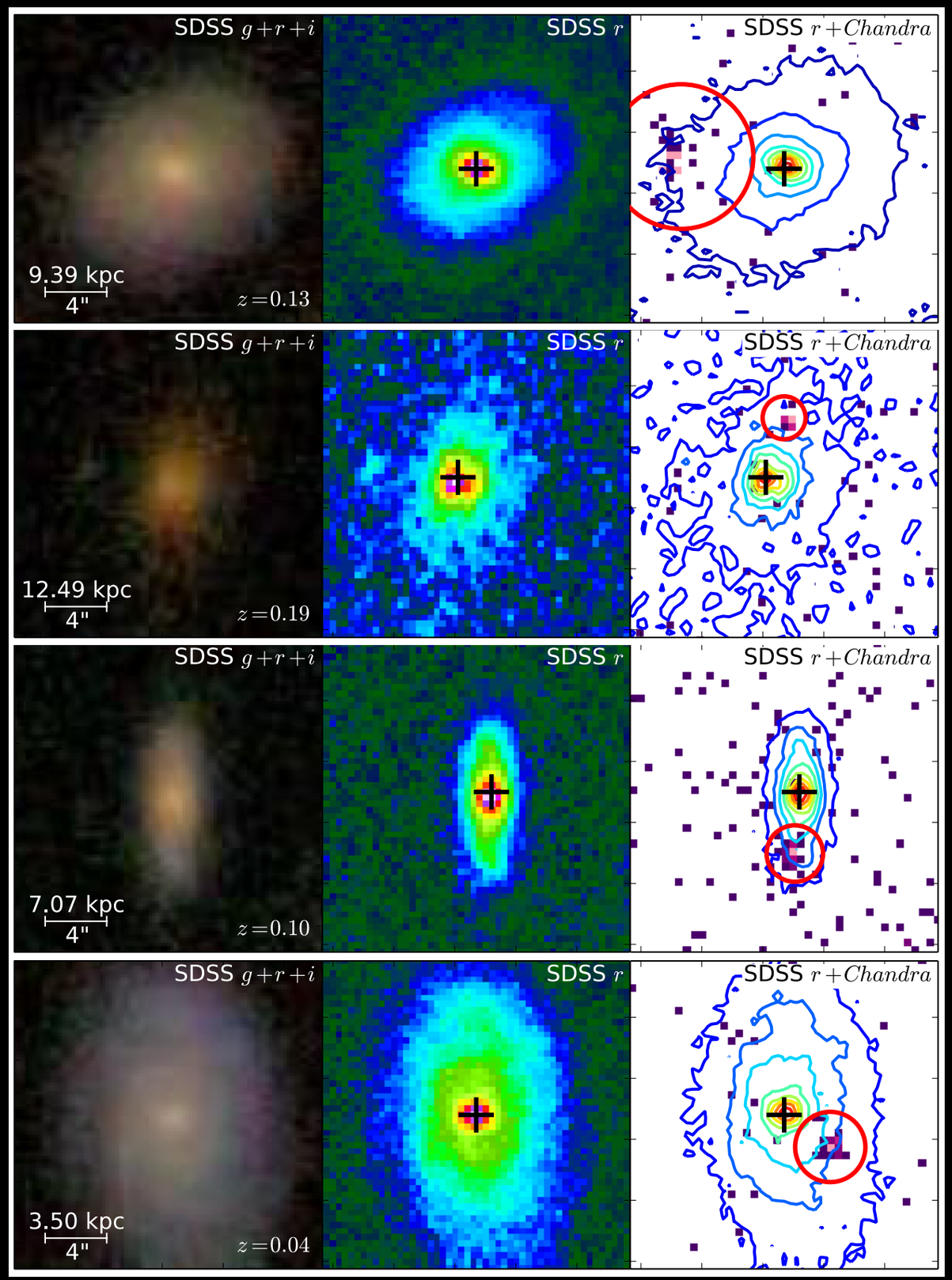


Start with optical galaxy image

Spatially coincident X-ray source (>10^{41} erg/s)

Where is X-ray source within galaxy?

How can we find more?



- We find hundreds more (~300)

and out to intermediate redshifts (z~0.3)

Some big questions:

- What are IMBH typical galaxy environments?
(e.g. star-forming, high metallicity)

- How do IMBHs grow through mergers?

- What is the role of IMBHs in the CXB?

THANKS