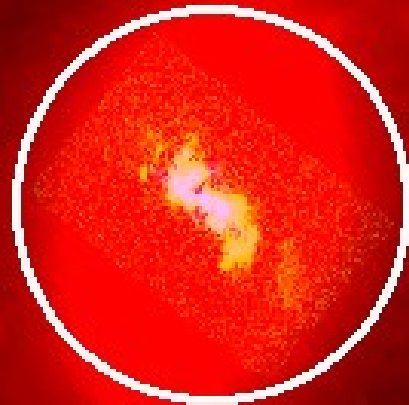


Imaging the Narrow Line Region with *Chandra*



Peter Maksym
Chandra Science
for the Next Decade
2016/8/16

Chandra Science for the Next Decade
Peter Maksym – 2016 August 16th

Going deeper
to resolve AGN environments
with today's premier X-ray IFU

CHEERS:

Nearby AGN with
extended evidence for
radiative and
kinematic feedback

Voorwerpjes:

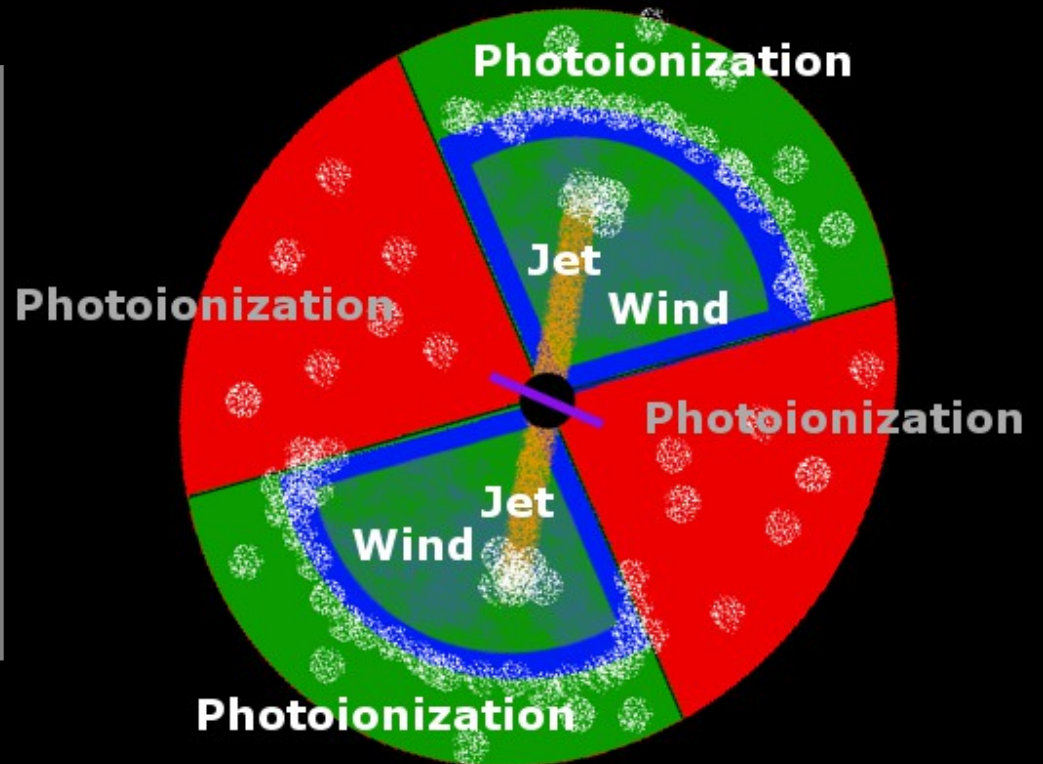
Galaxy-Zoo selected
extended NLRs with
evidence for AGN
shutdown



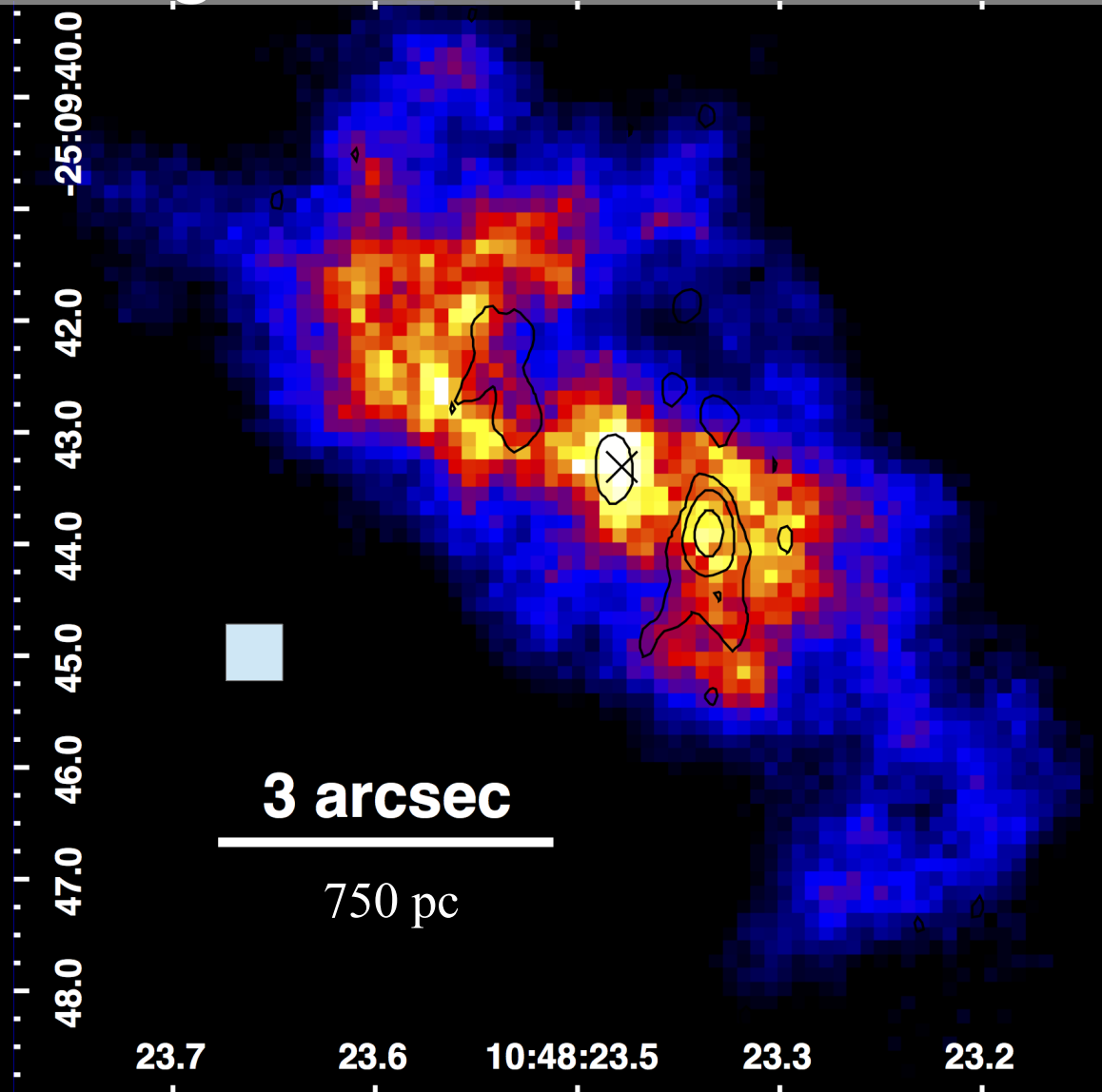
with Pepi Fabbiano, Martin Elvis, Margarita Karovska,
Alessandro Paggi, John Raymond, Junfeng Wang,
Thaisa Storchi-Bergmann, Bill Keel,
Kevin Schawinski, **Lia Sartori**, Chris Lintott, Vardha Bennert

CHEERS:

Nearby AGN with
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radiative and
kinematic feedback

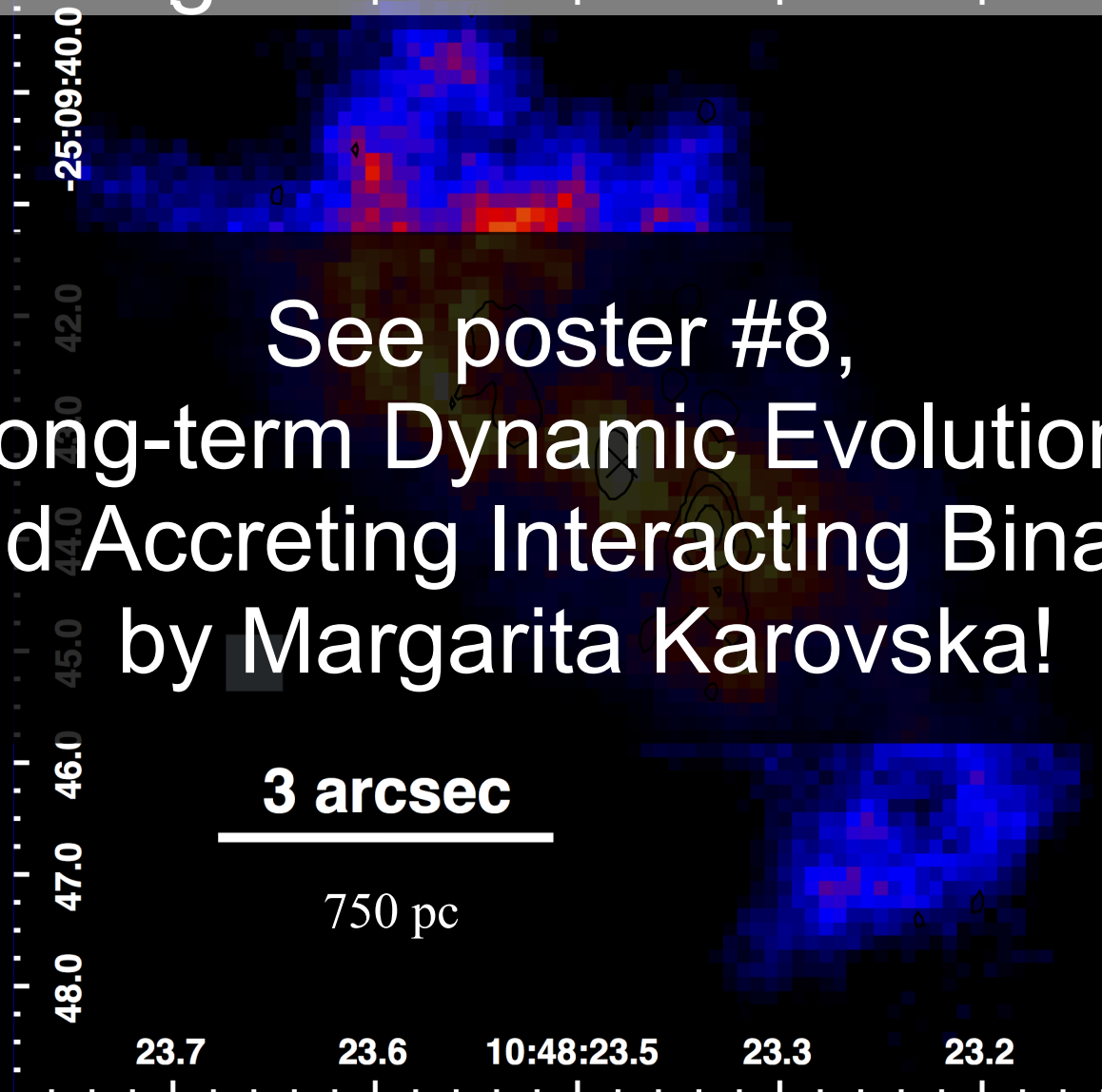


CHEERS and NGC 3393: Getting the Most out of Chandra

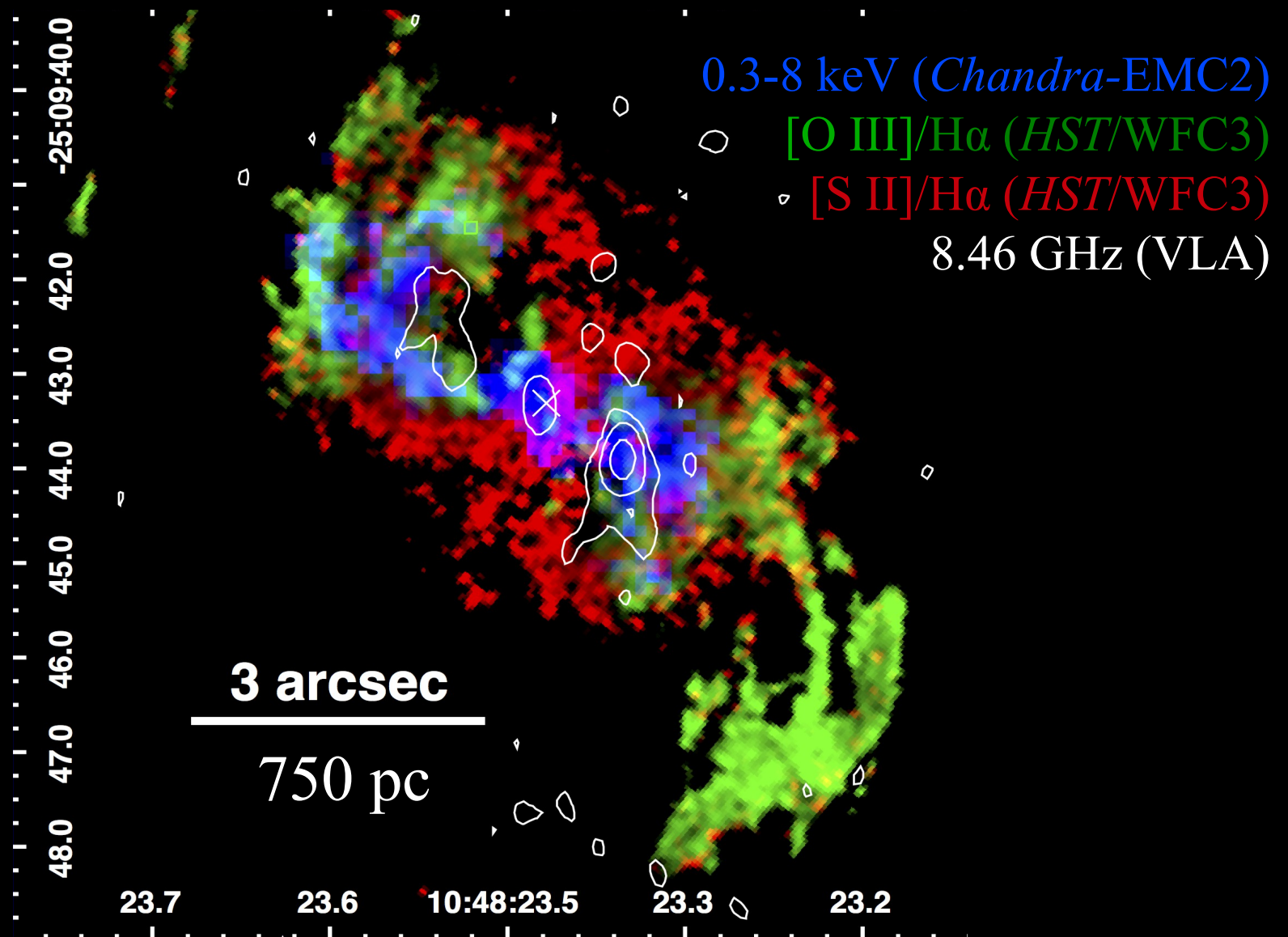


CHEERS and NGC 3393: Getting the Most out of Chandra

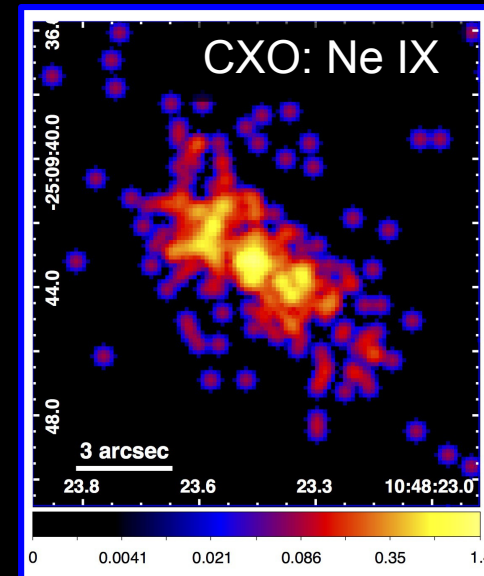
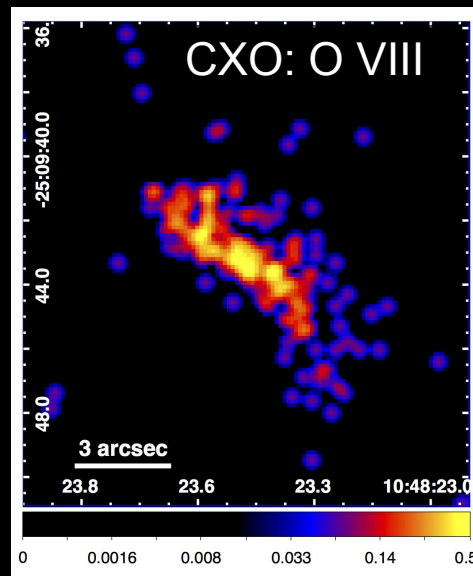
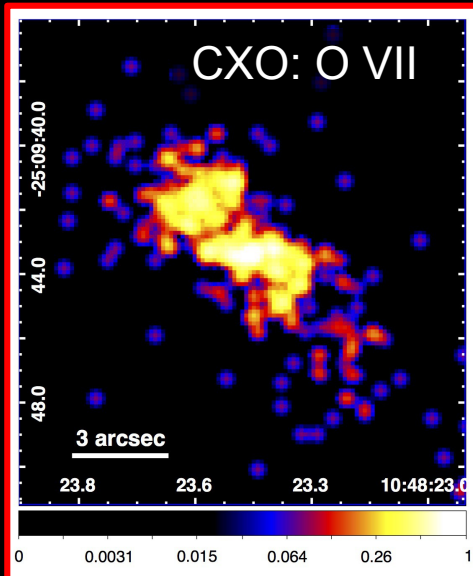
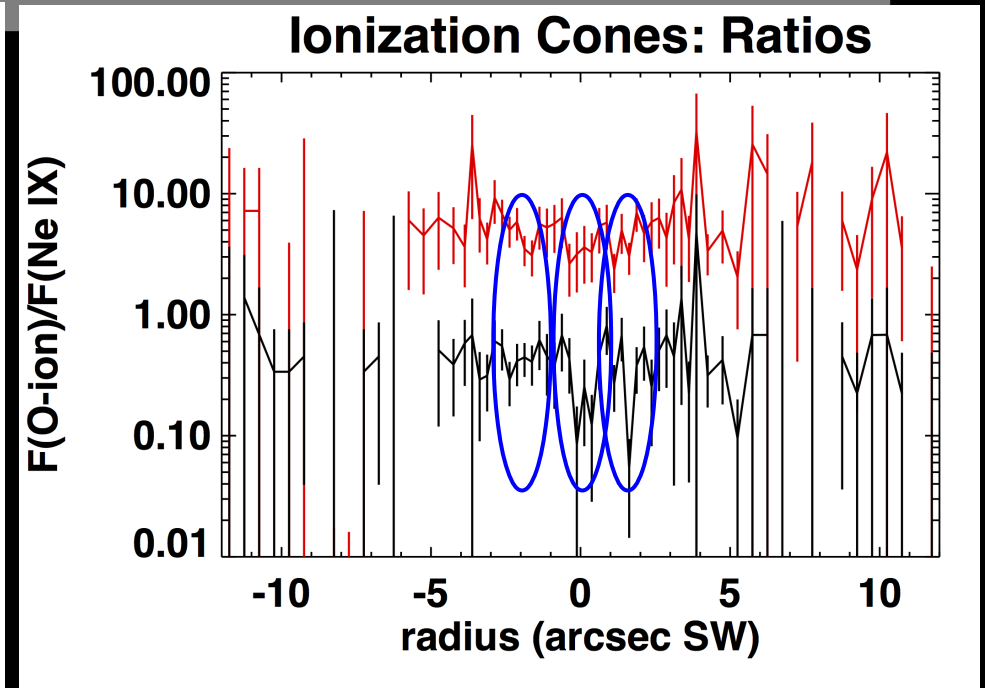
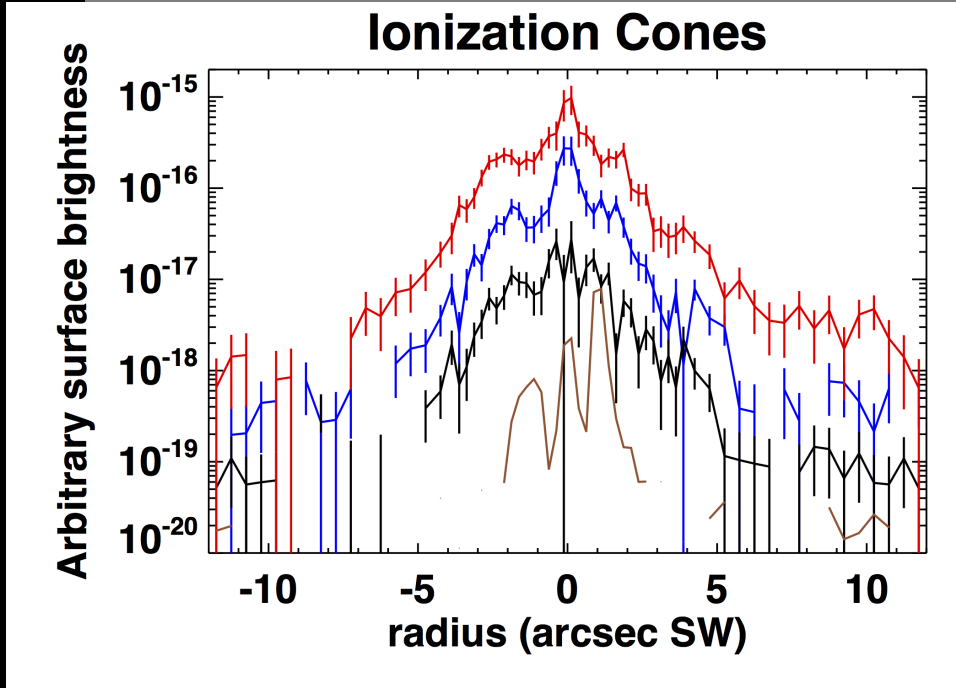
See poster #8,
“Long-term Dynamic Evolution of
Wind Accreting Interacting Binaries”
by Margarita Karovska!



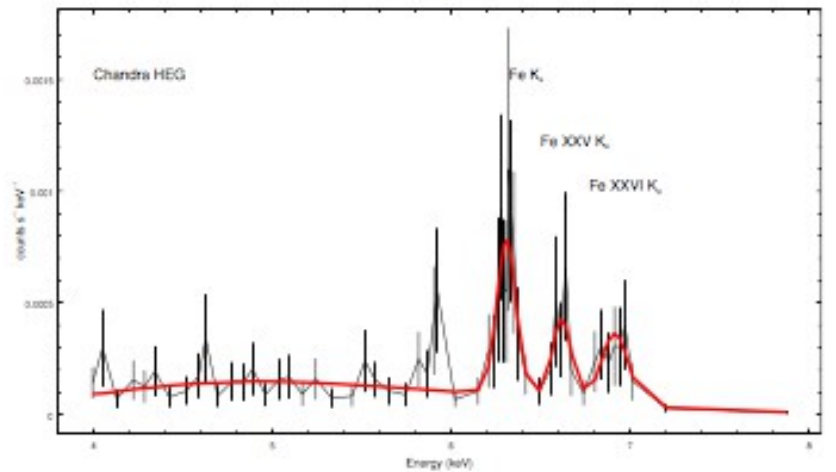
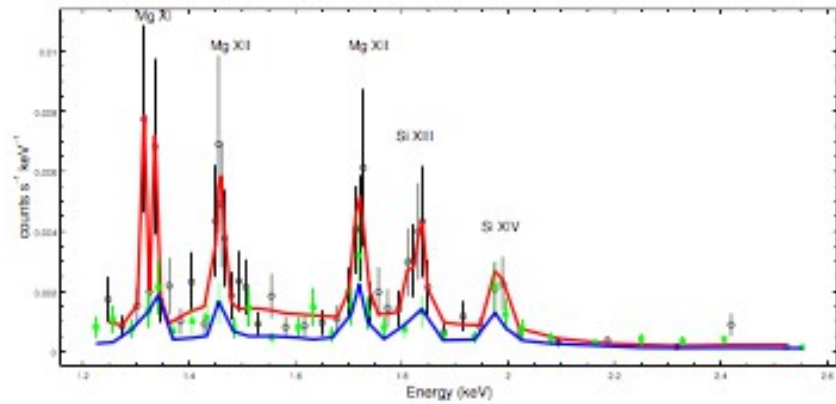
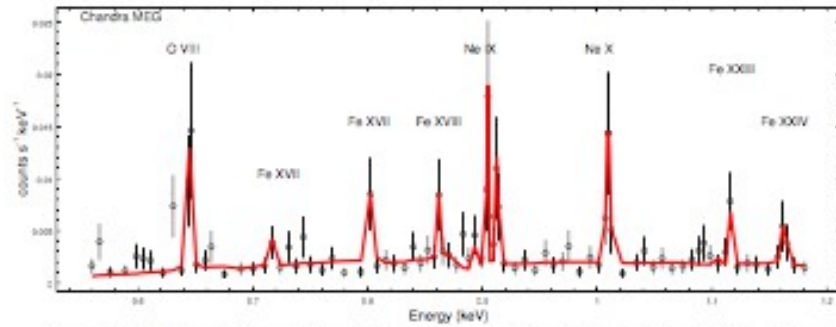
NGC 3393: Distinctive Ionization Regimes



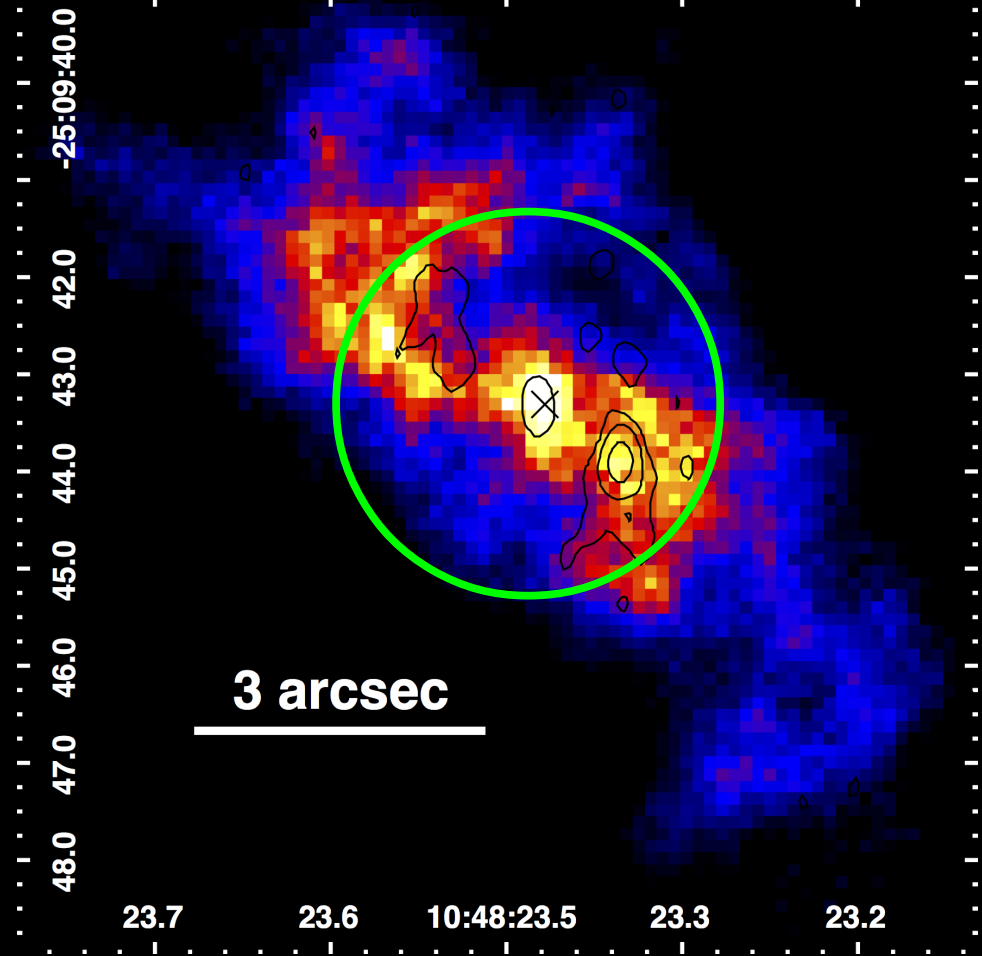
Photoionization vs. Shocks with Chandra

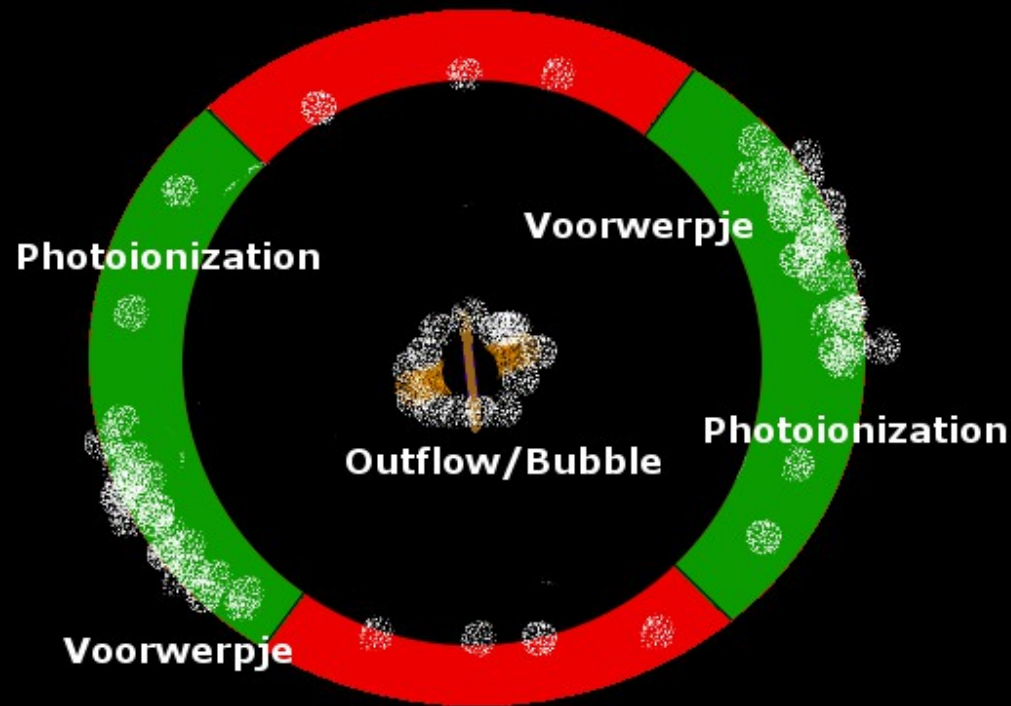


The Necessity of Resolution



Extended up to ~4 keV!





Voorwerpjes:
Galaxy-Zoo selected
extended NLRs with
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shutdown

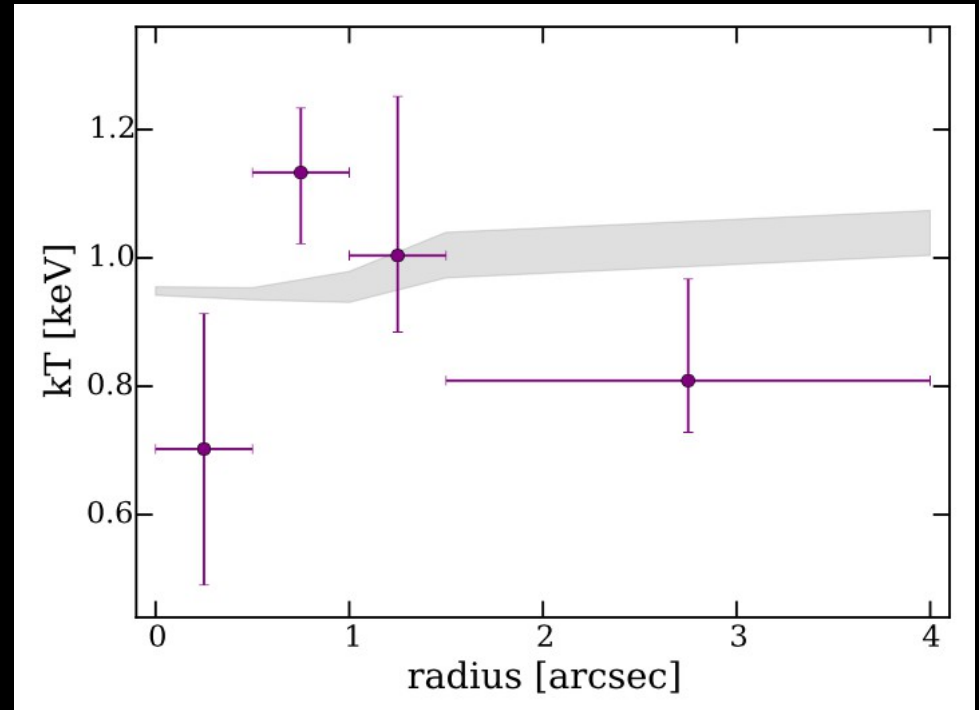
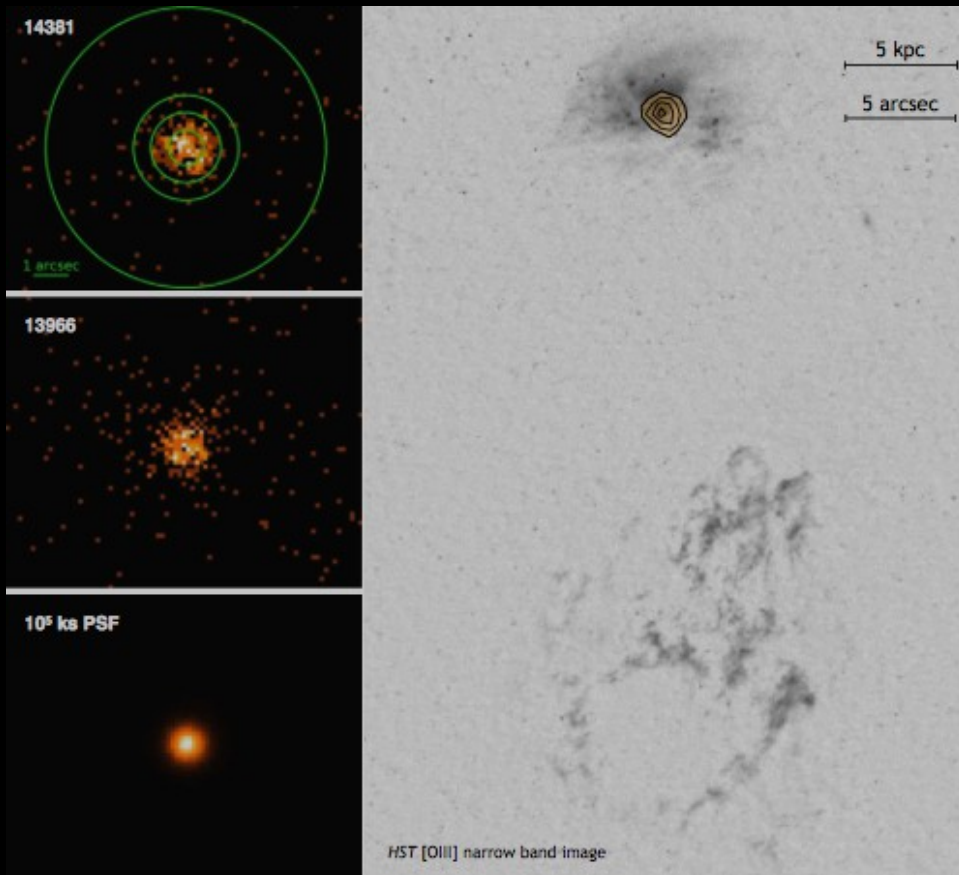
Hanny's Voorwerp: Our Nearest (ex-)Quasar



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Left: Garrett et al, 2011
Right: Keel et al, 2012

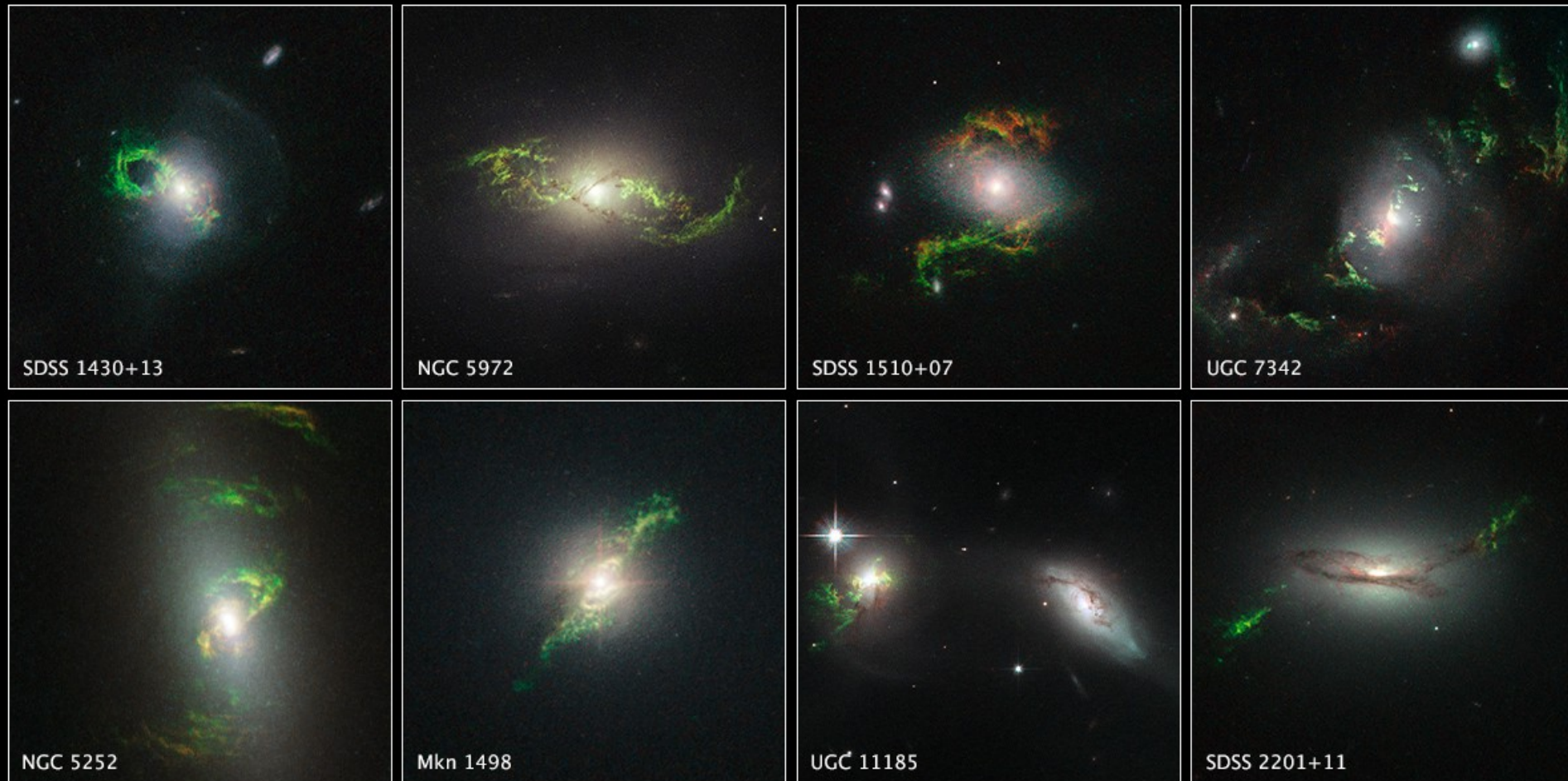
Sudden Radiative-Kinematic Mode Switching?



Sartori et al (incl. WPM), 2016

Bubbles, Filaments & Tidal Streams

Extended Gas in Active Galaxies ■ *Hubble Space Telescope* ■ WFC2 ■ ACS/WFC ■ WFC3/UVIS



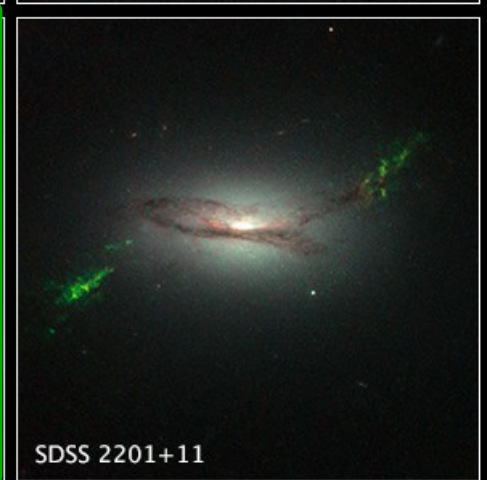
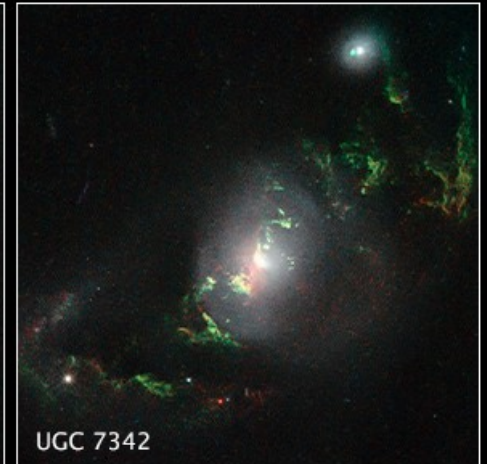
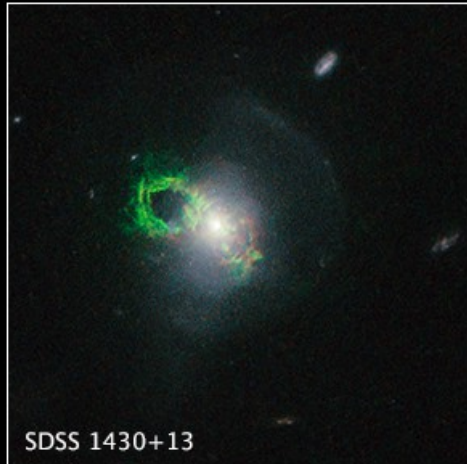
NASA and ESA

STScI-PRC15-13a

Keel, WPM et al, 2015

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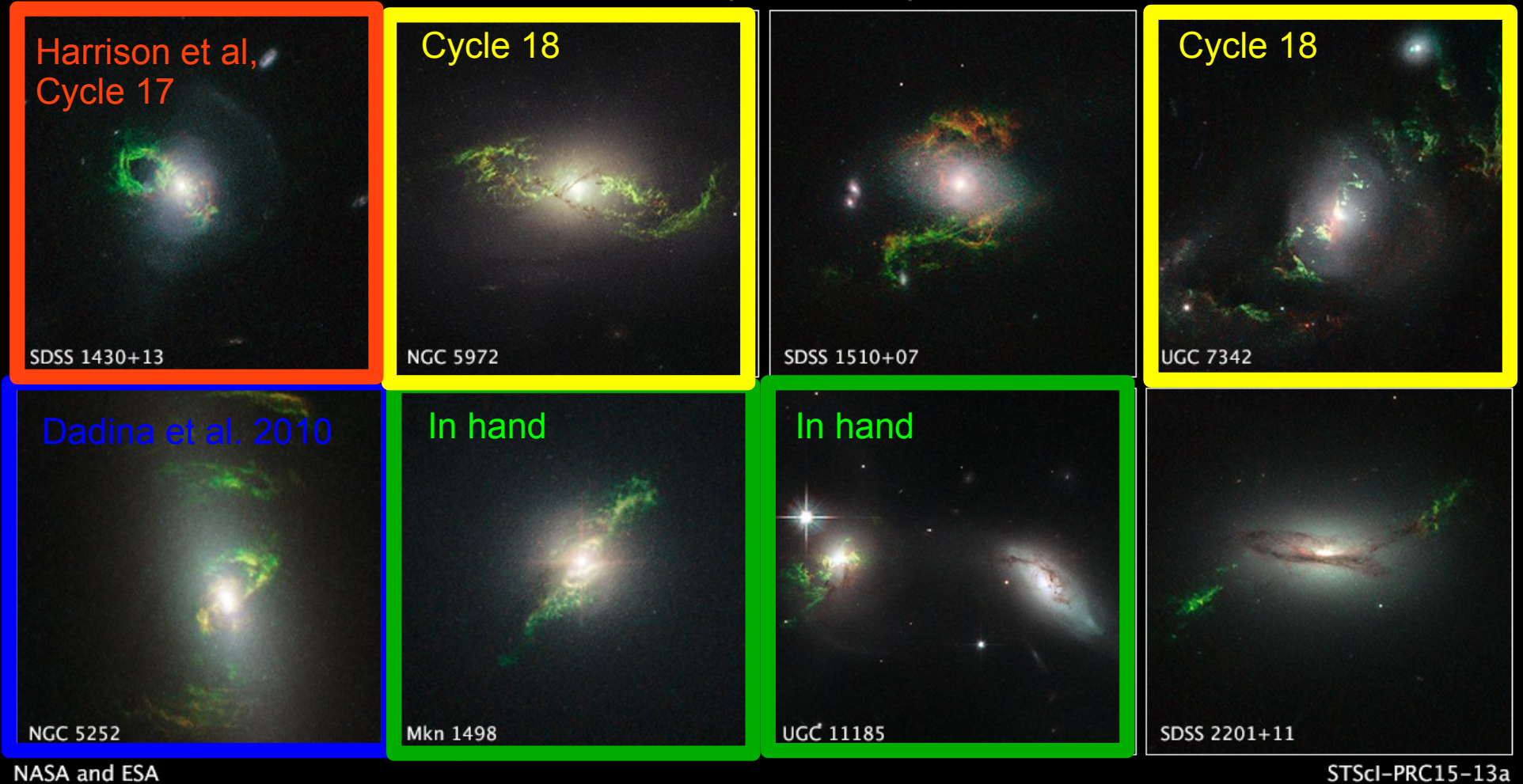
NASA and ESA

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Keel, WPM et al, 2015

Bubbles, Filaments & Tidal Streams

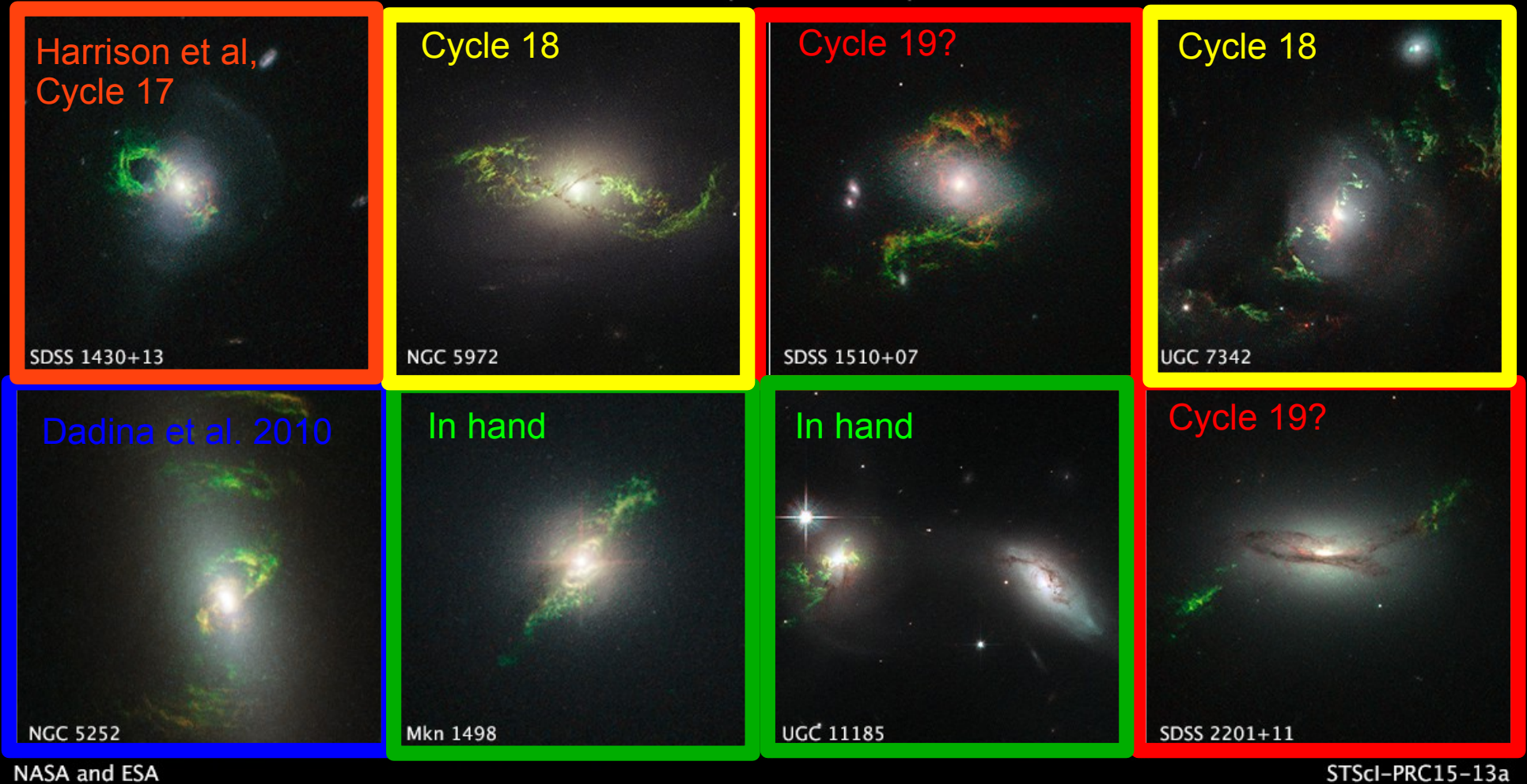
Extended Gas in Active Galaxies ■ *Hubble Space Telescope* ■ WFC2 ■ ACS/WFC ■ WFC3/UVIS



Keel, WPM et al, 2015

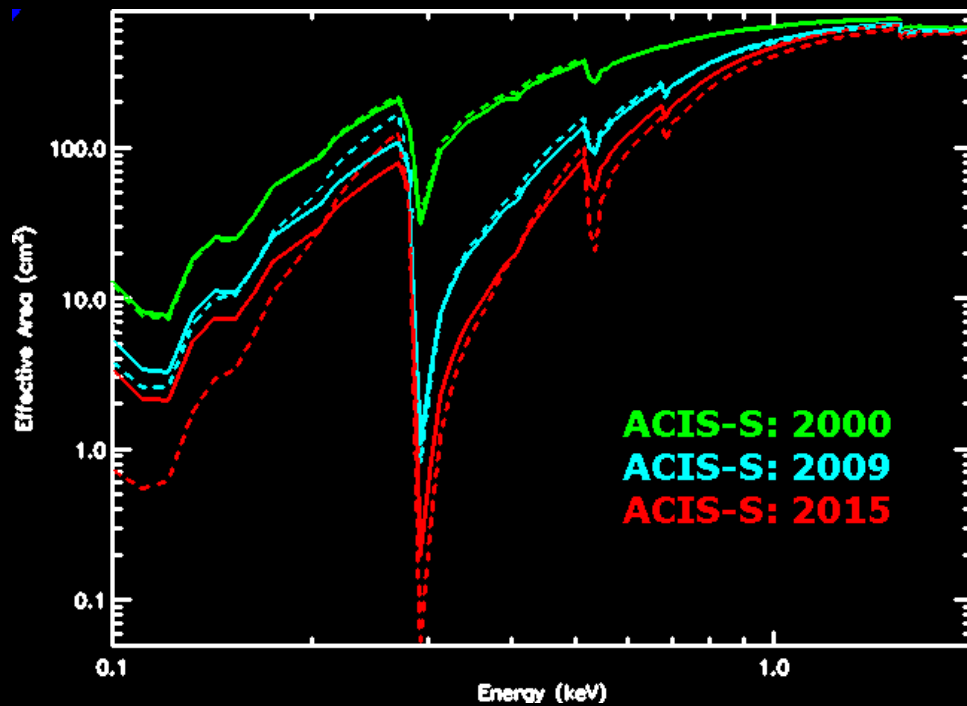
Bubbles, Filaments & Tidal Streams

Extended Gas in Active Galaxies ■ *Hubble Space Telescope* ■ WFC2 ■ ACS/WFC ■ WFC3/UVIS



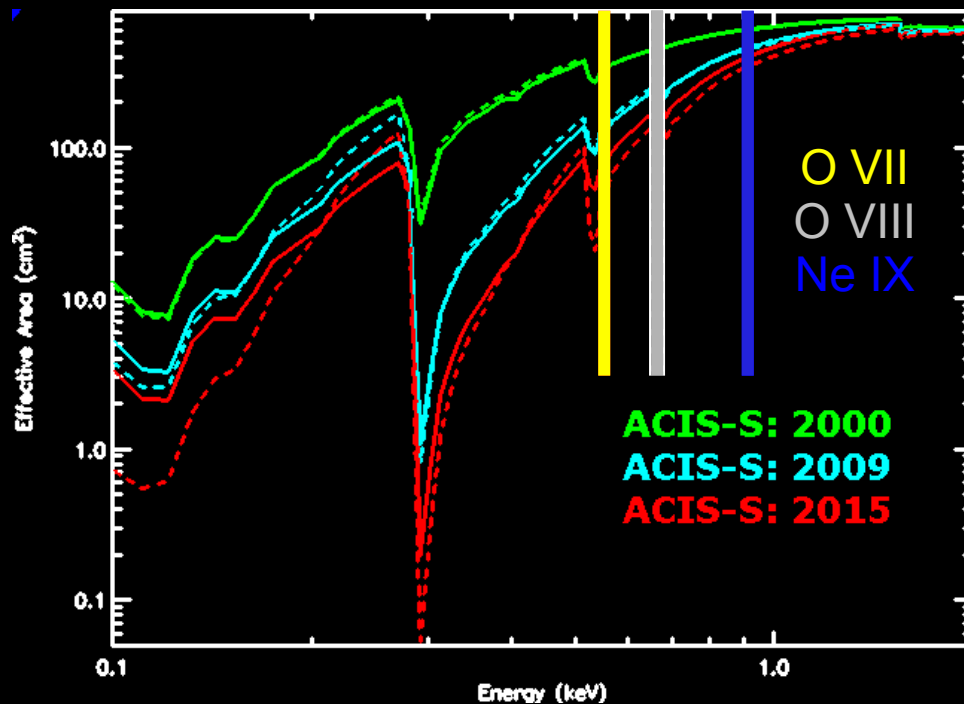
Keel, WPM et al, 2015

The NLR and ACIS Contaminant



--NLR emission: some as hard as ~4 keV, and Fe K α *but* most photons are below 1 keV...

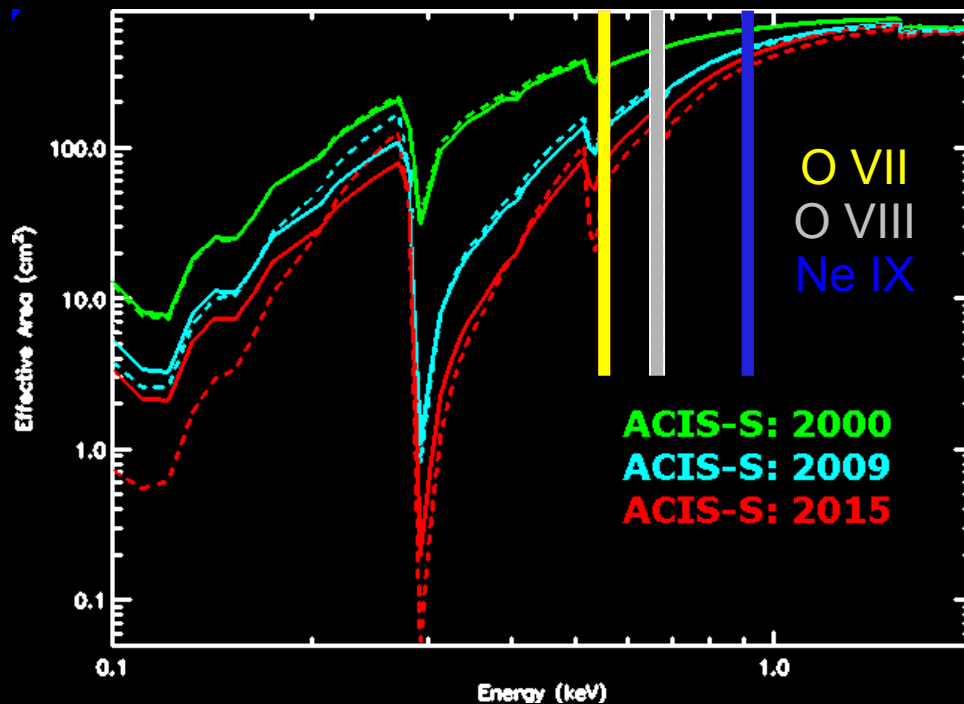
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We are rapidly losing our ability to make resolved studies of the NLR.

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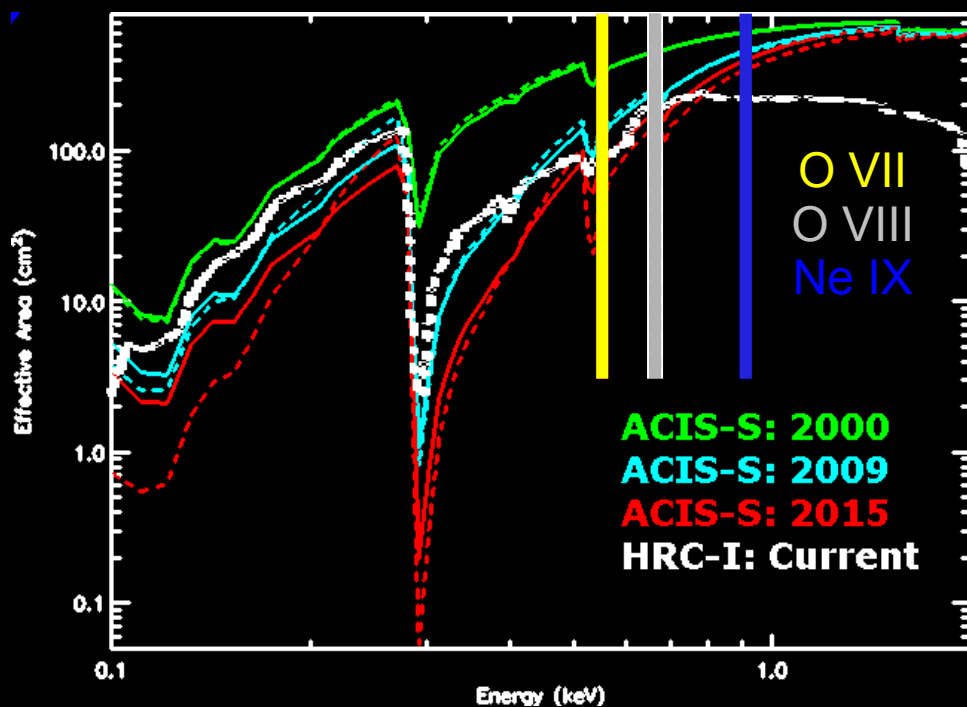


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--A cue from Hubble's UV initiative?

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A cue from Hubble's UV initiative?

--HRC becoming competitive?

Summary

Voorwerpjes and CHEERS point to AGN feedback Chandra can resolve!

- Substantial complexity on sub-arcsecond scales!
(LINER regions bicone edge, outflow-ISM structure, jet-ISM hotspots, etc)
- Resolved evidence for large AGN variation and mode switching on \ll Myr scales
- Sites of jet-ISM or wind-ISM interaction may be physically small relative to the integrated system (~ 10 s of pc vs \sim kpc)
- Hard emission may be extended on \sim kpc scales, up to a few keV!
- The correlation between X-rays and optical line emission is not simple in AGN

Summary

...but

Contaminant is a particularly bad problem for the NLR, and will only get worse.

Creative approaches are needed to mitigate it!