Mapping Extended Line Emission from AGN Above 1 keV

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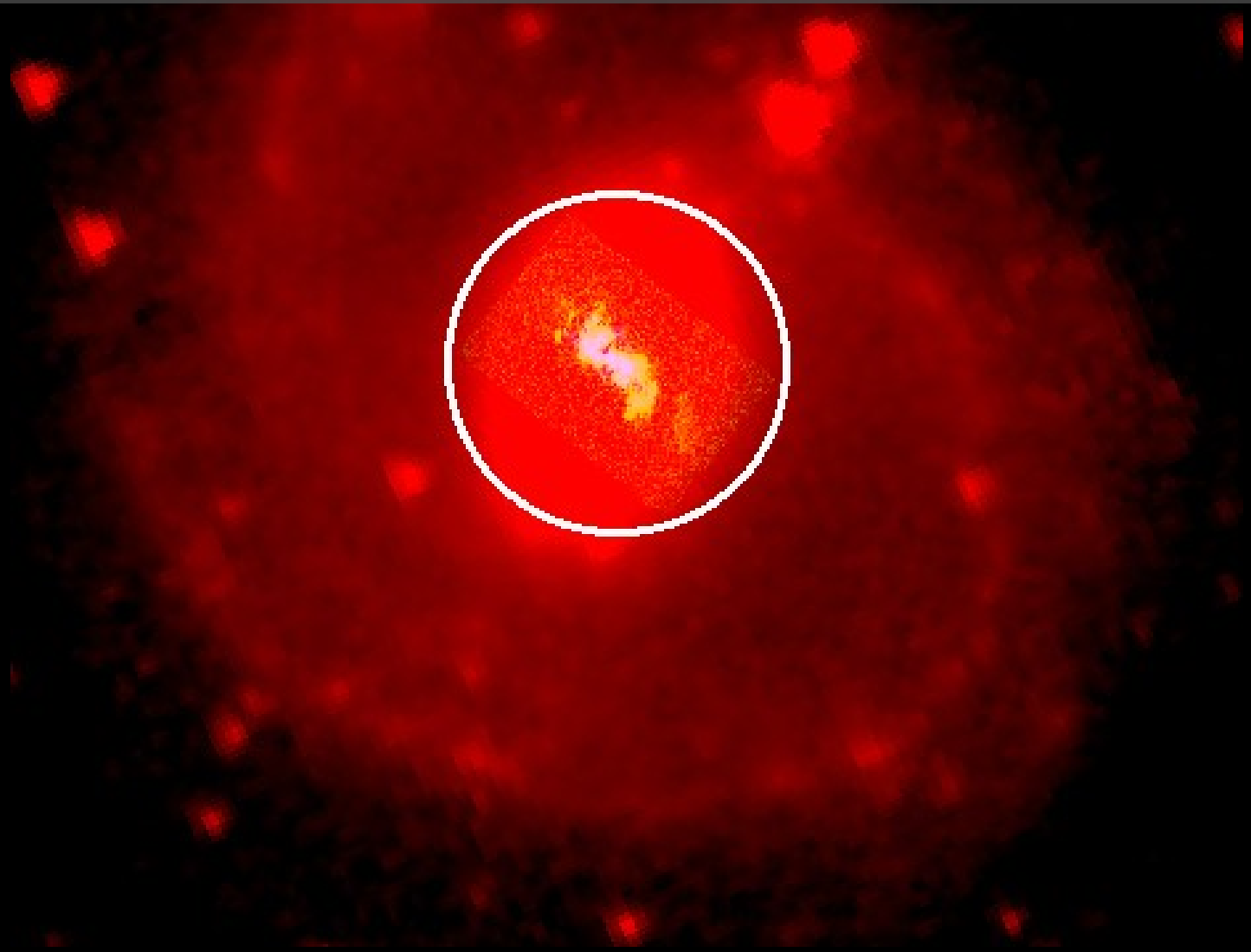
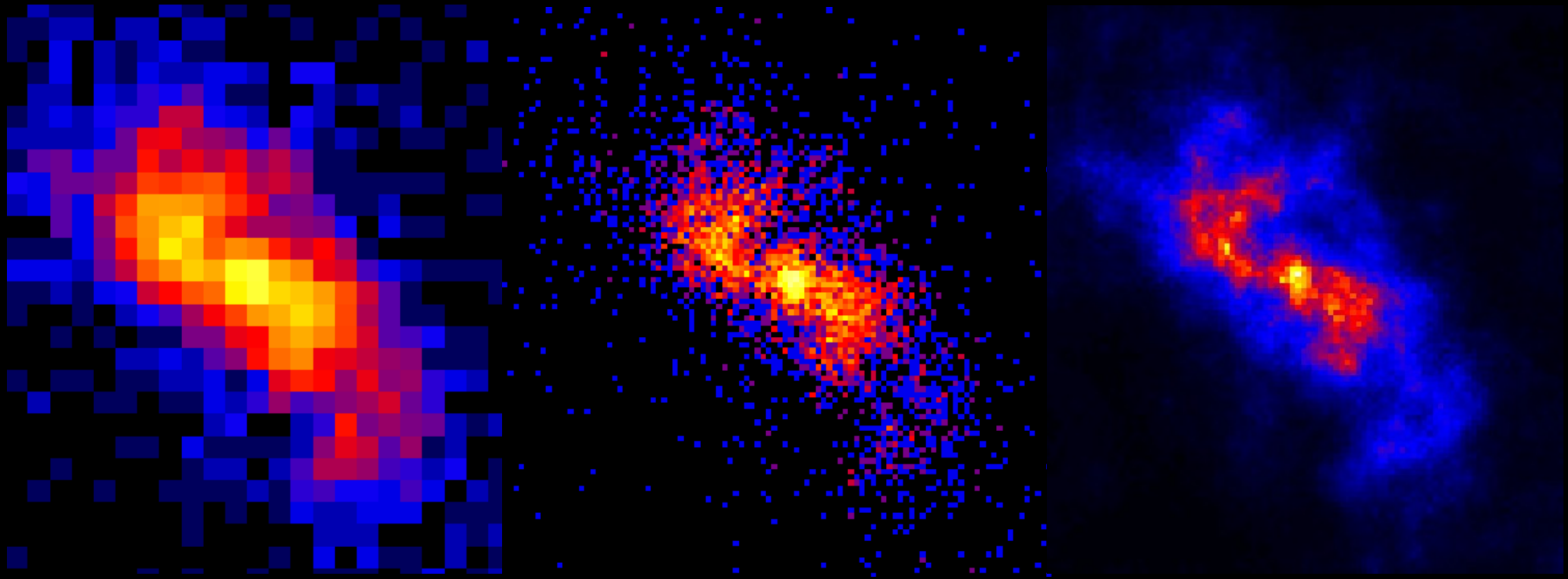
From Chandra to Lynx – CfA, 2017

The NLR:
Where we can see AGN Feedback!



Chandra/Lynx resolution: Key to sub-kpc Jet/Wind Structure



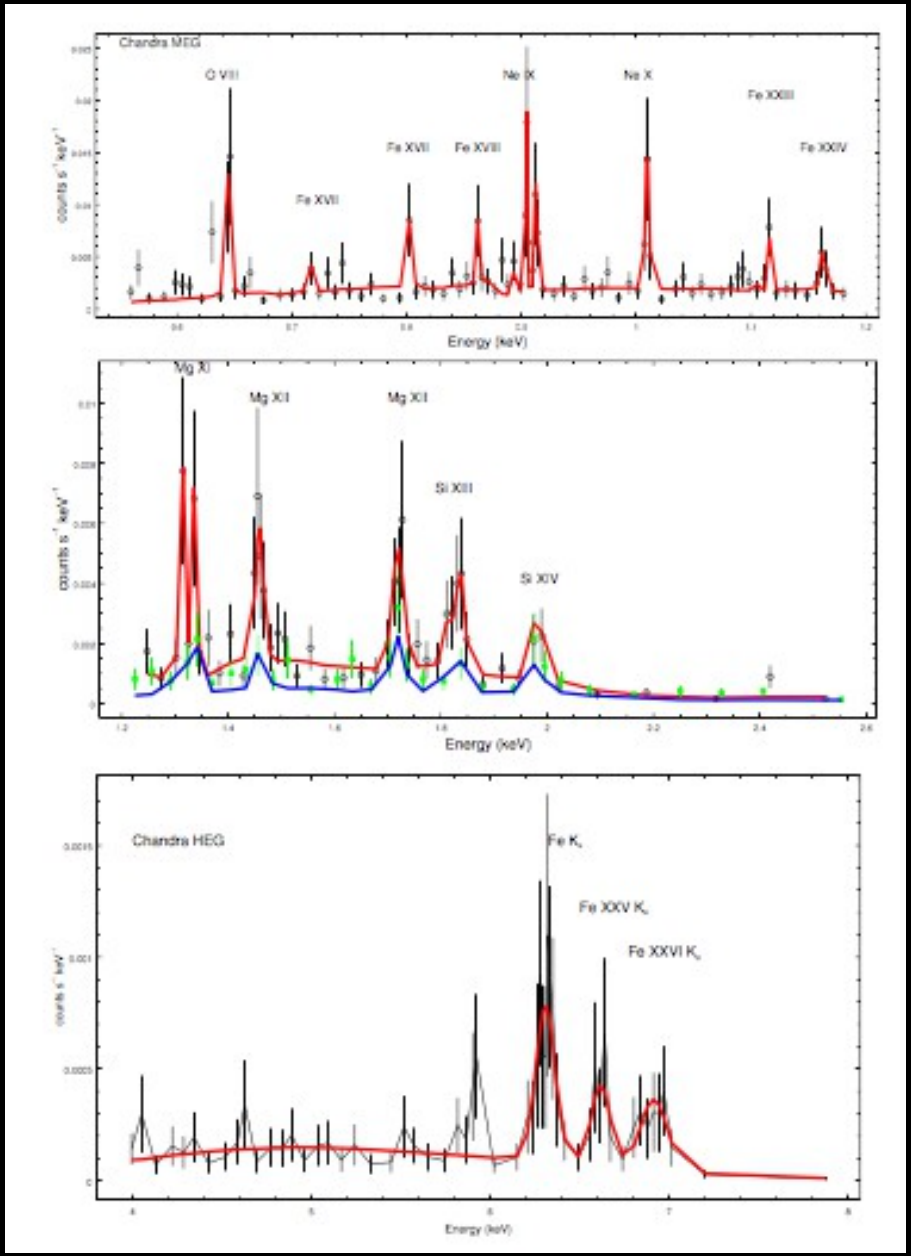
NGC 3393:

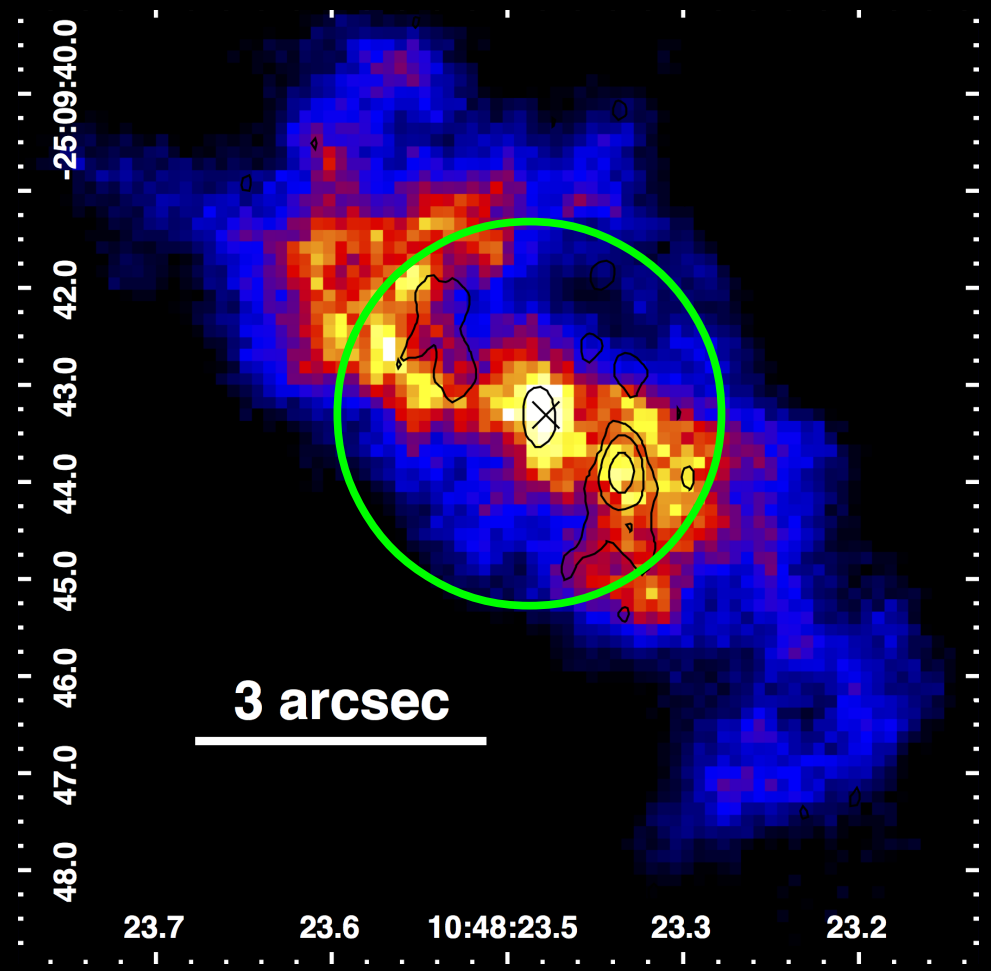
z=0.0125, Compton-thick
1 arcsec=257 pc

Left: Chandra native pixel scale (0.5”)
Middle: Chandra 1/8 subpixel scale
Right: Broadband EMC-deconvolved

From WPM et al, 2017

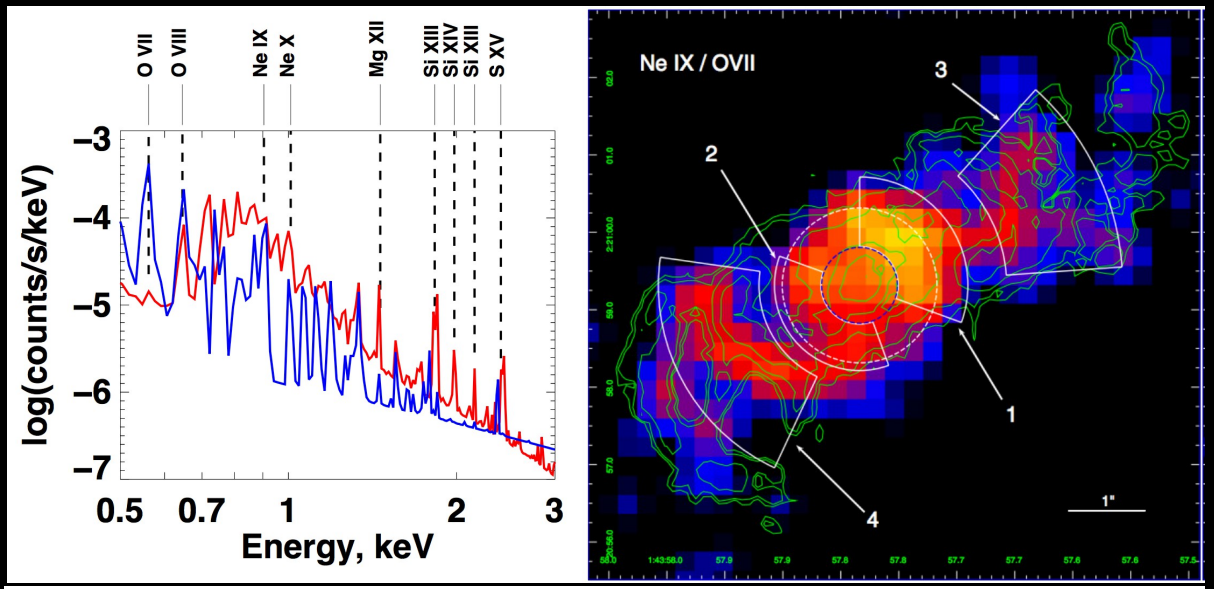
The Necessity of Resolution

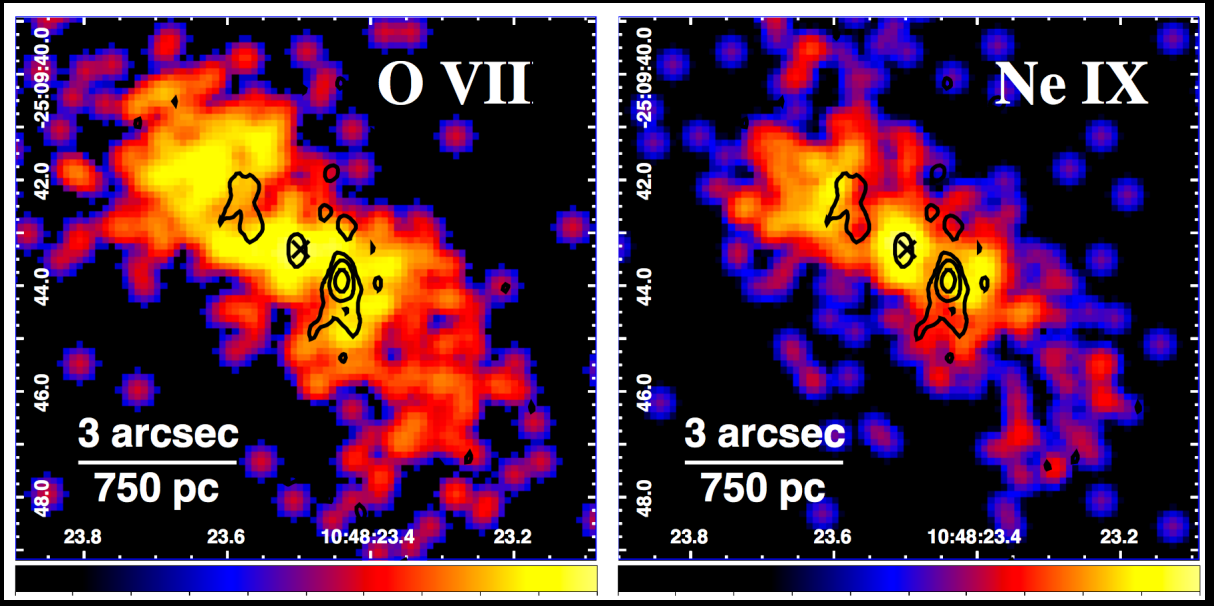




Left: Koss et al, 2015
Right: WPM, 2017

X-ray Line Morphology
Seeing where the shocks happen!





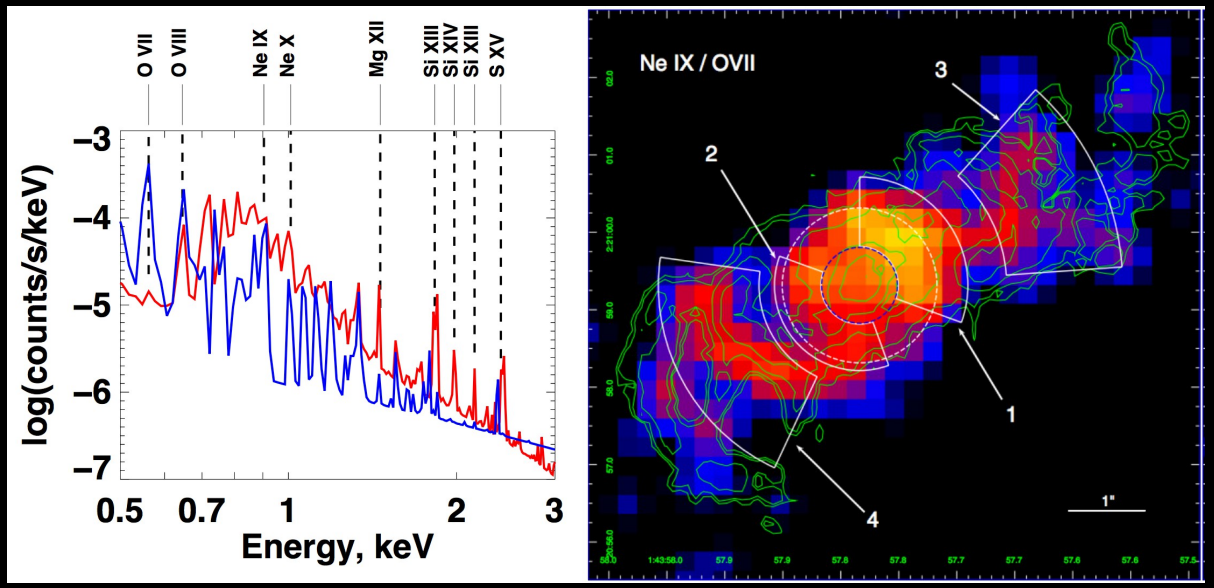
Upper Left:
(Red) collisional plasma
vs
(Blue) photoionization

Upper Right:
Ne IX/O VII from Mrk 573,
Paggi et al 2012

Lower Left:
O VII from NGC 3393

Lower Right:
Ne IX from NGC 3393

Loving Lynx:
0.5” + 2 eV + 2m^2= game-changer



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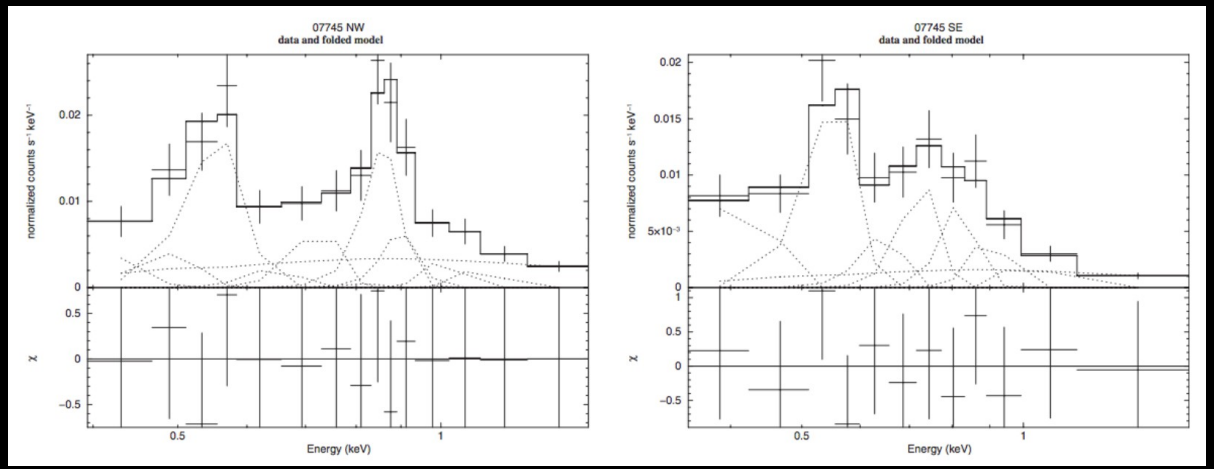
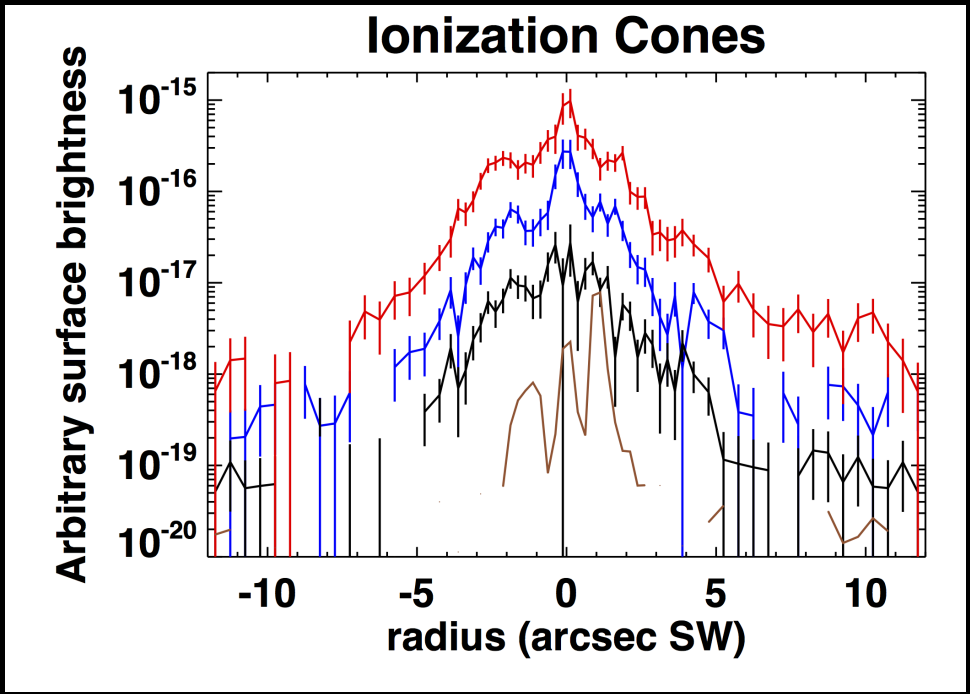


Bottom: line spectra from
Regions 3 (NW), 2 (SE)
Paggi et al 2012

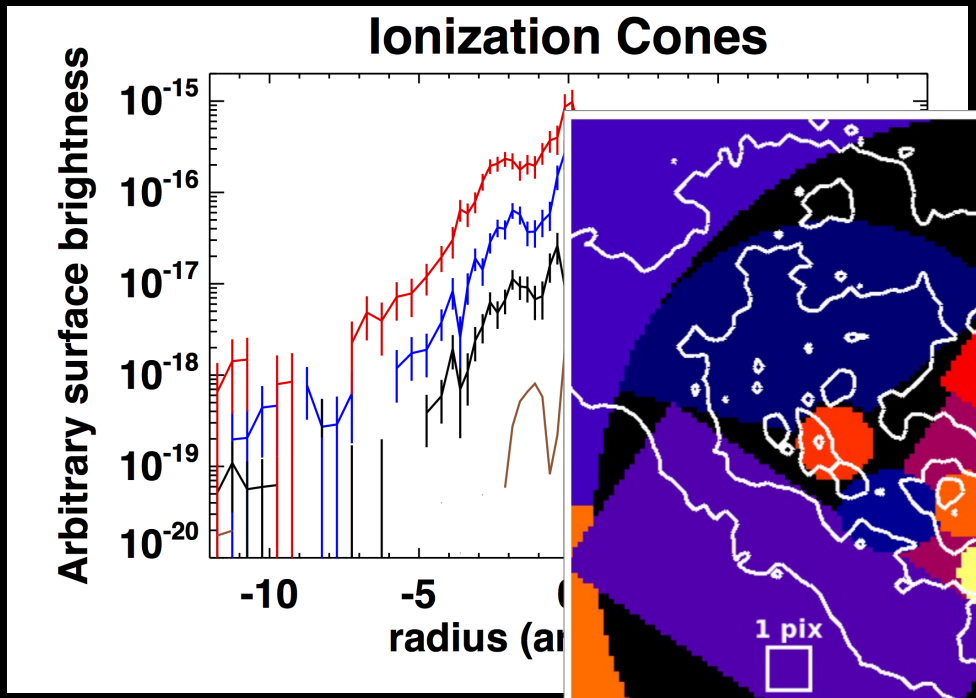
NGC 3393:
Making the most of <0.02 m^2

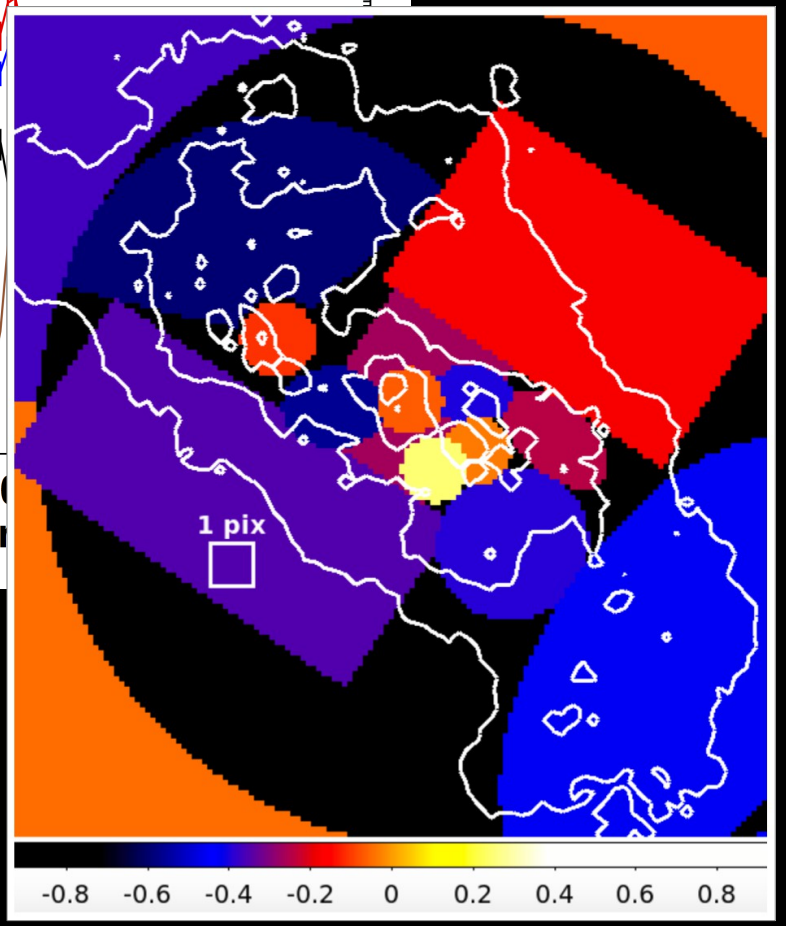


Radial Profiles
of NGC 3393:

Red: O VII (Chandra)
Blue: Ne IX (Chandra)
Black: O VII (Chandra)
Brown: Radio (VLA)

NGC 3393:
Making the most of <0.02 m^2





Hardness ratio:

$$\frac{Ne\ IX - O\ VII}{Ne\ IX + O\ VII}$$

Contours:

Broadband X-ray Intensity

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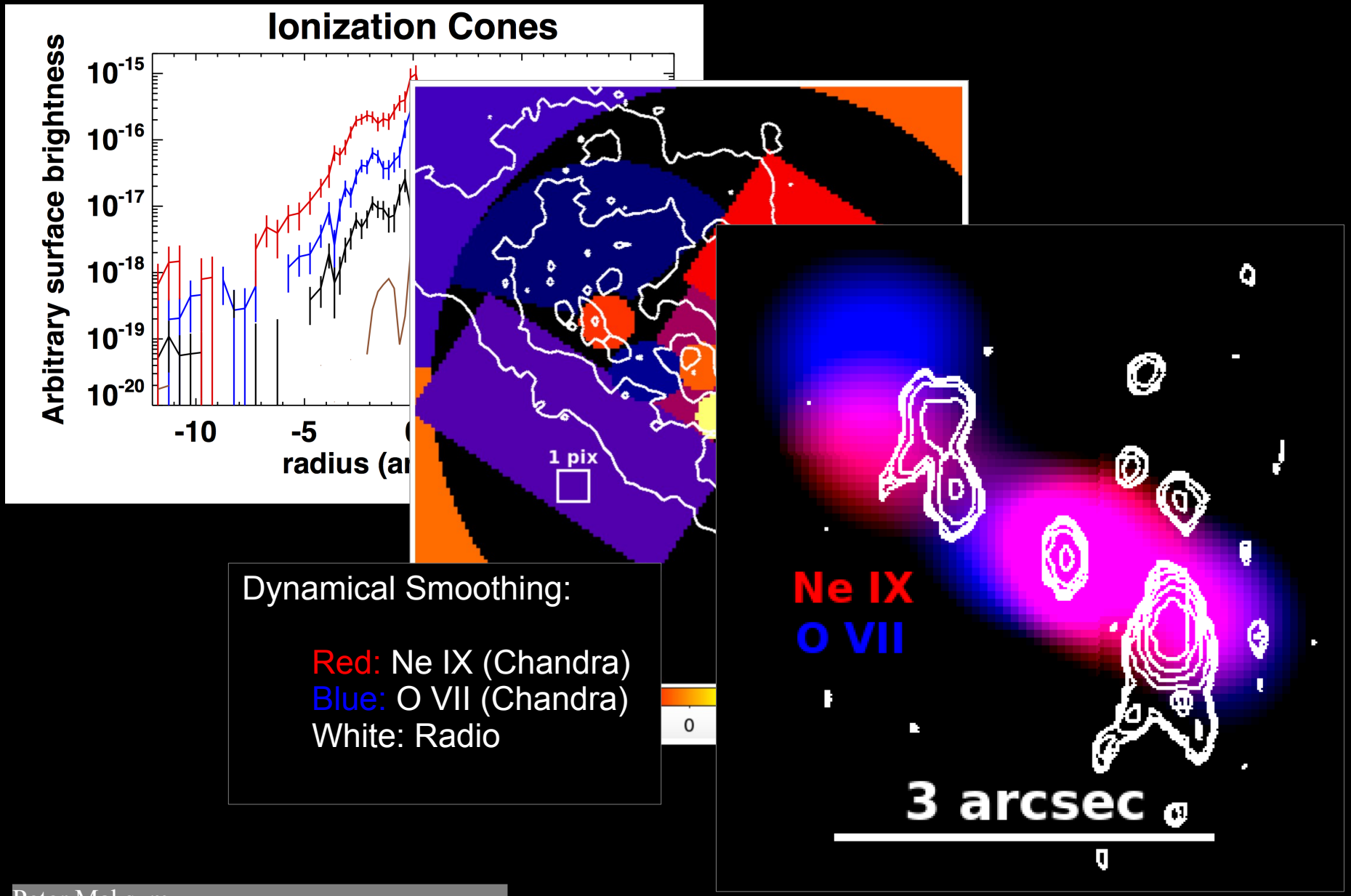
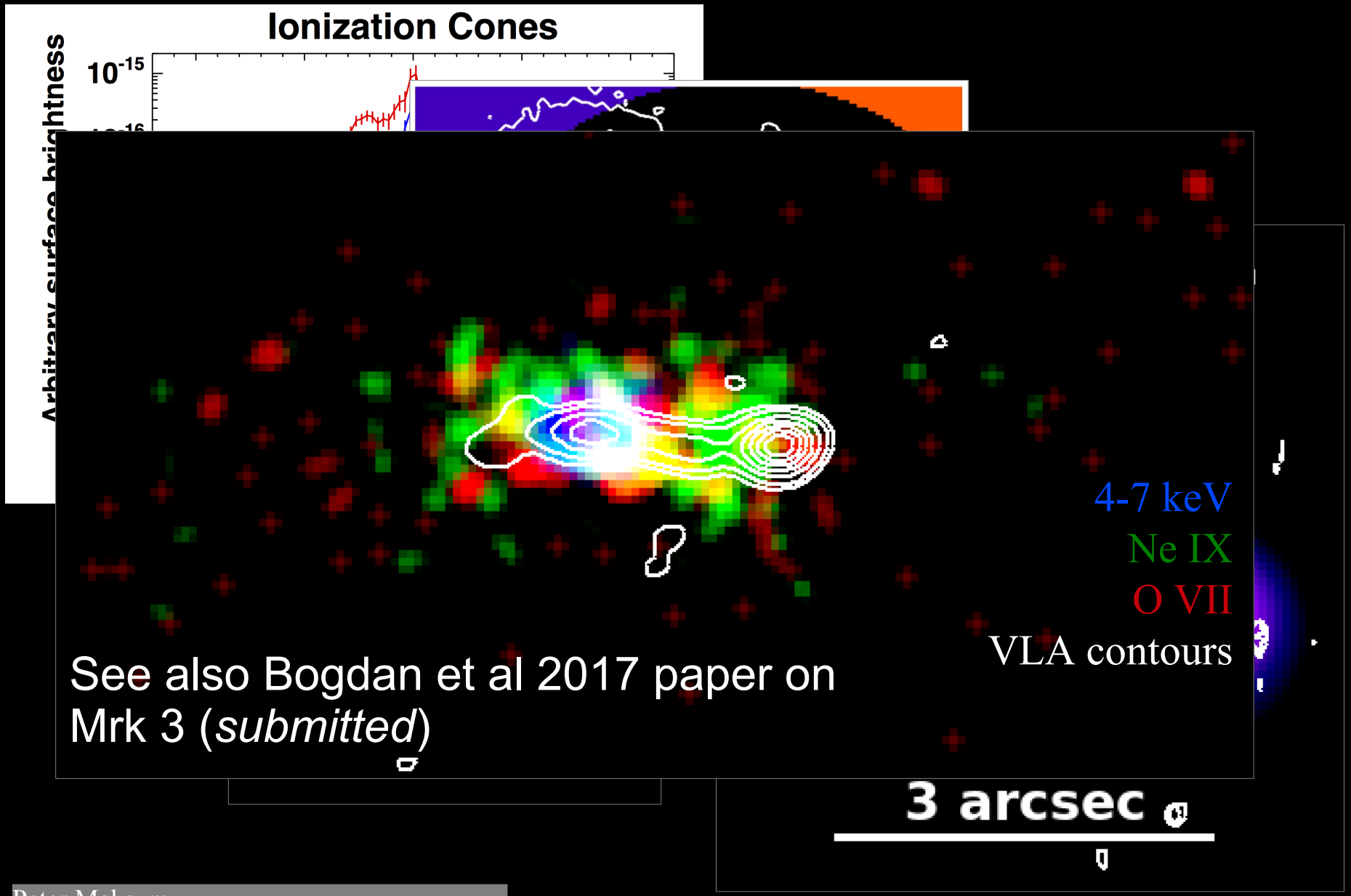
Making the most of <0.02 m^2



Dynamical Smoothing:

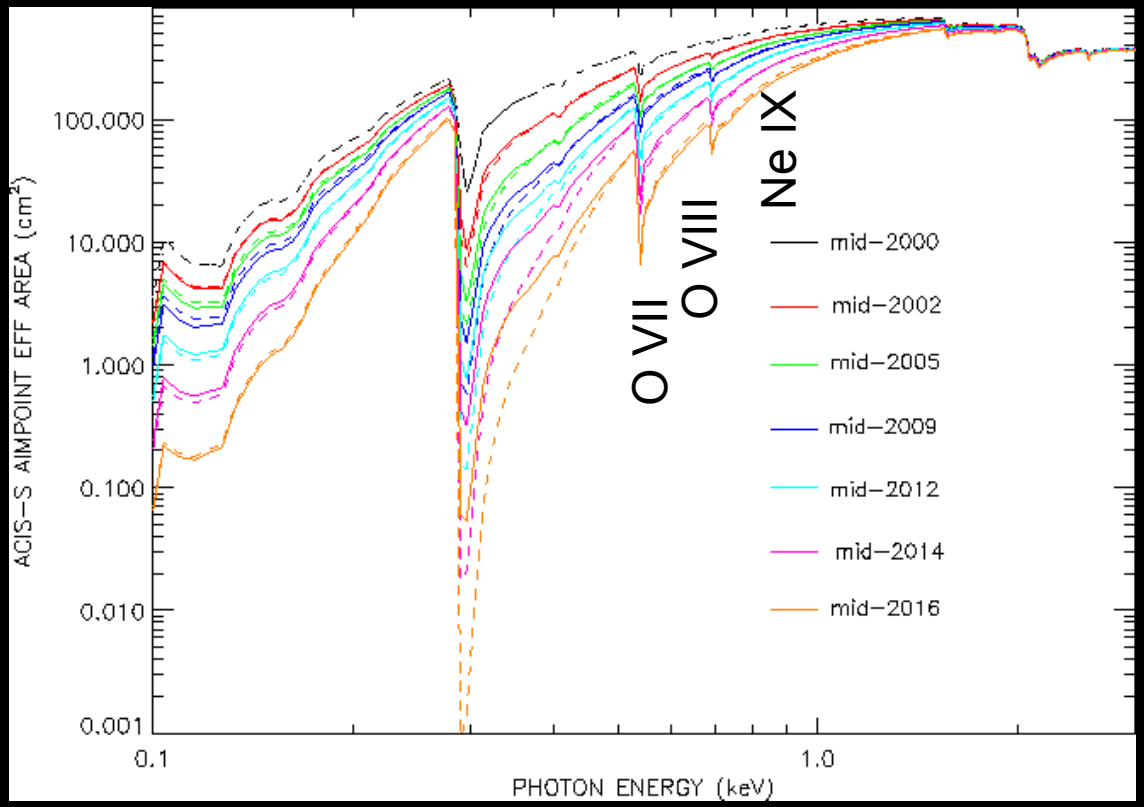
Red: Ne IX (Chandra)
Blue: O VII (Chandra)
White: Radio

NGC 3393:
Making the most of <0.02 m^2



See also Bogdan et al 2017 paper on Mrk 3 (*submitted*)

Dealing with Chandra's Contaminant in Anticipation of Lynx



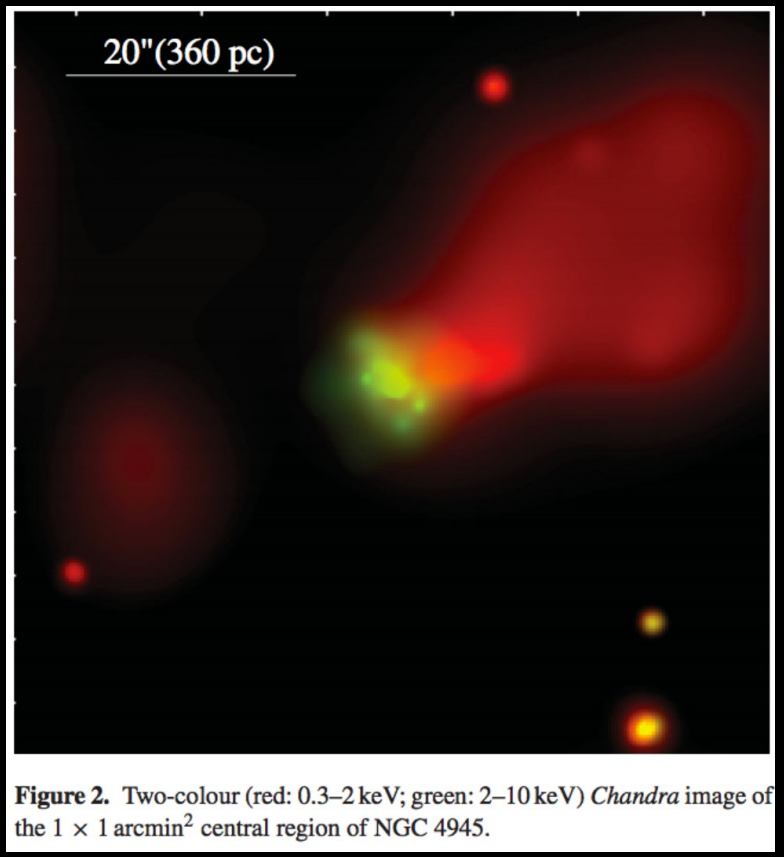
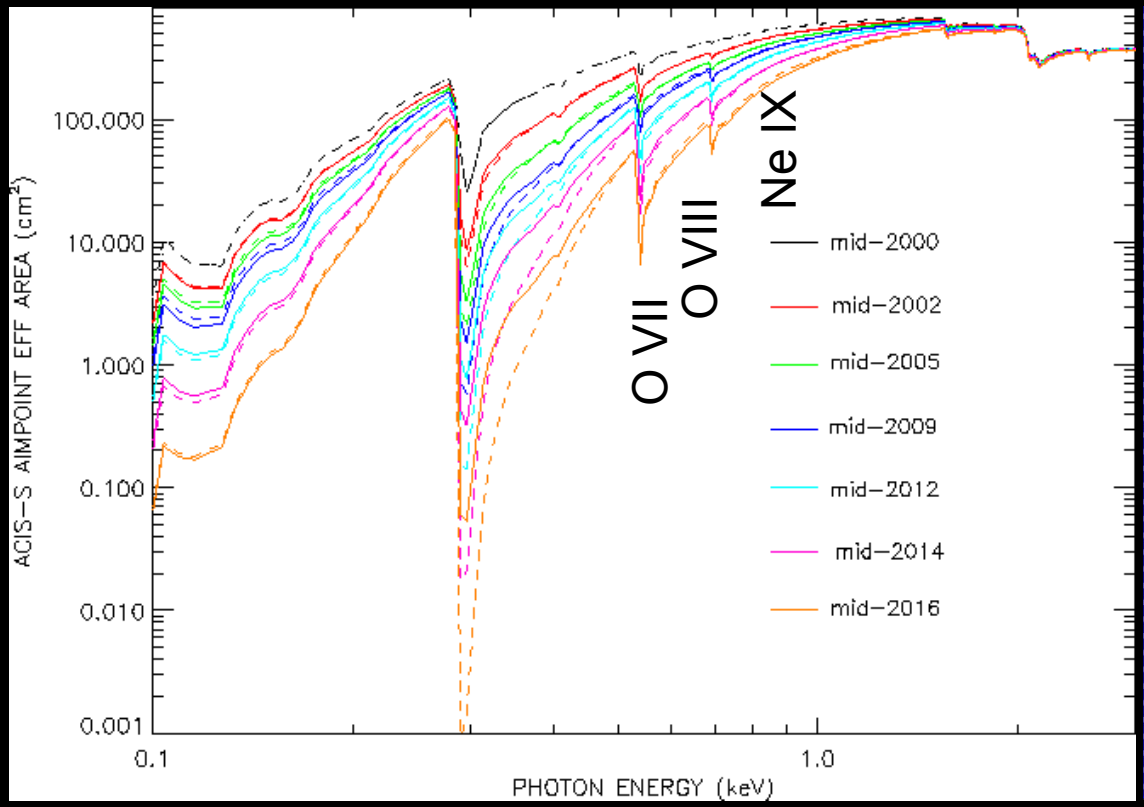
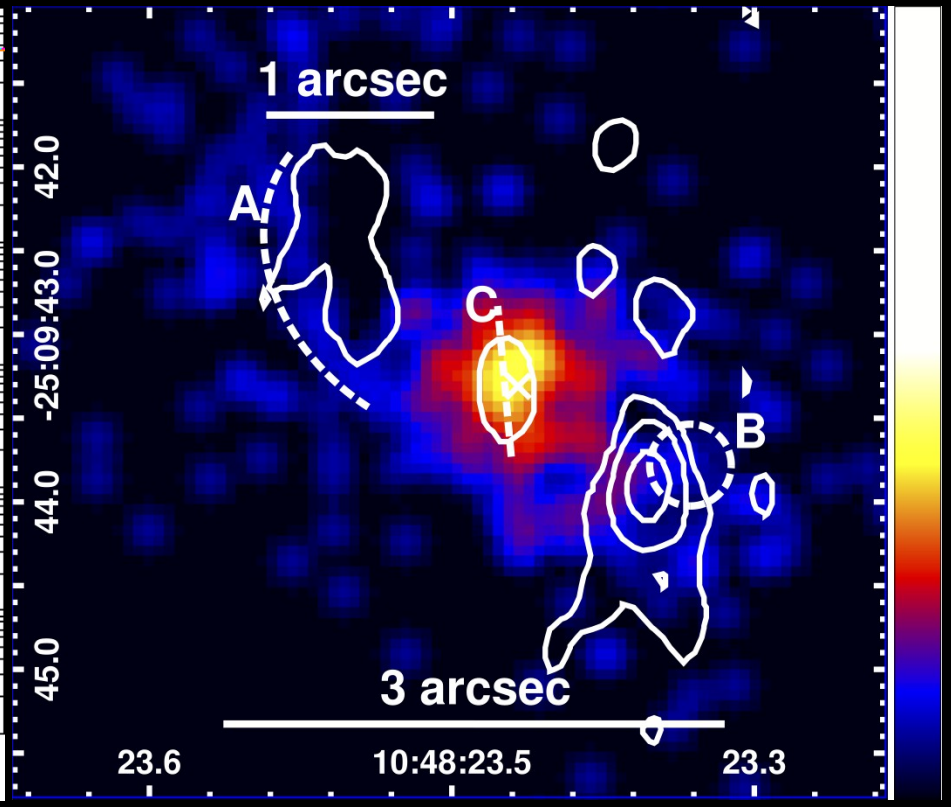


Figure 2. Two-colour (red: 0.3–2 keV; green: 2–10 keV) *Chandra* image of the 1 × 1 arcmin^2 central region of NGC 4945.

Right: NGC 4945,
Marinucci et al, 2012

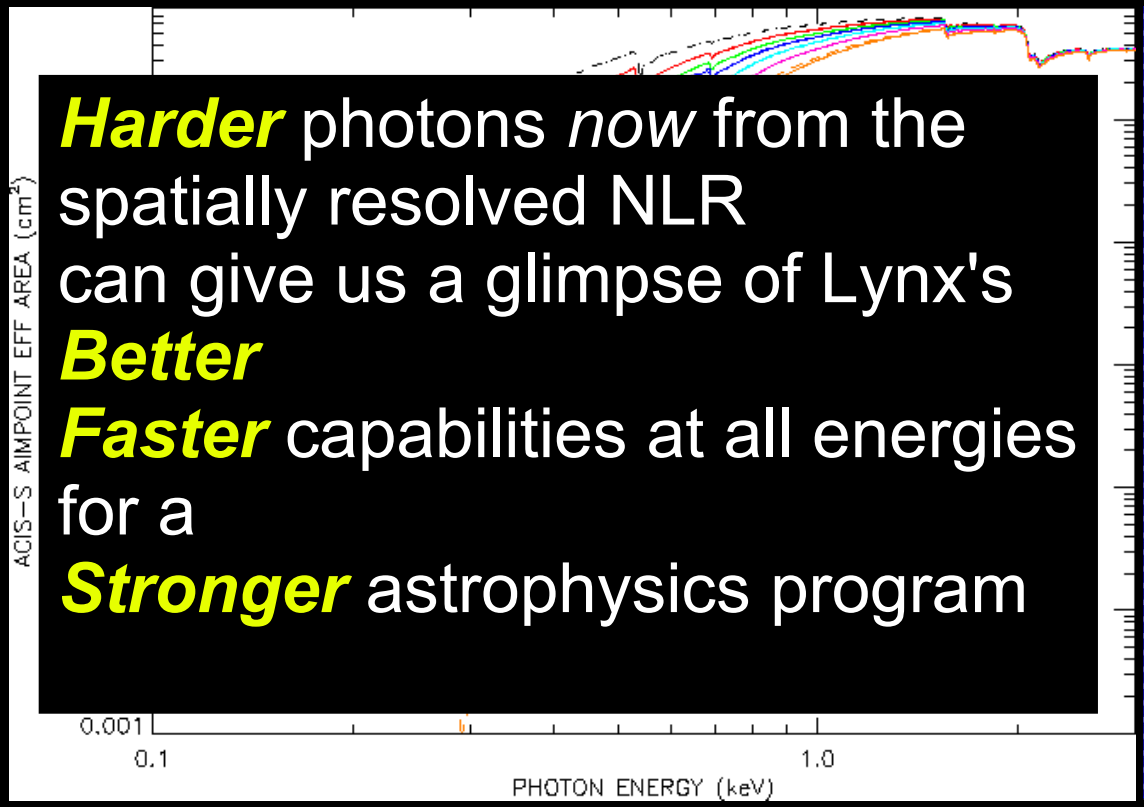
Dealing with Chandra's Contaminant in Anticipation of Lynx



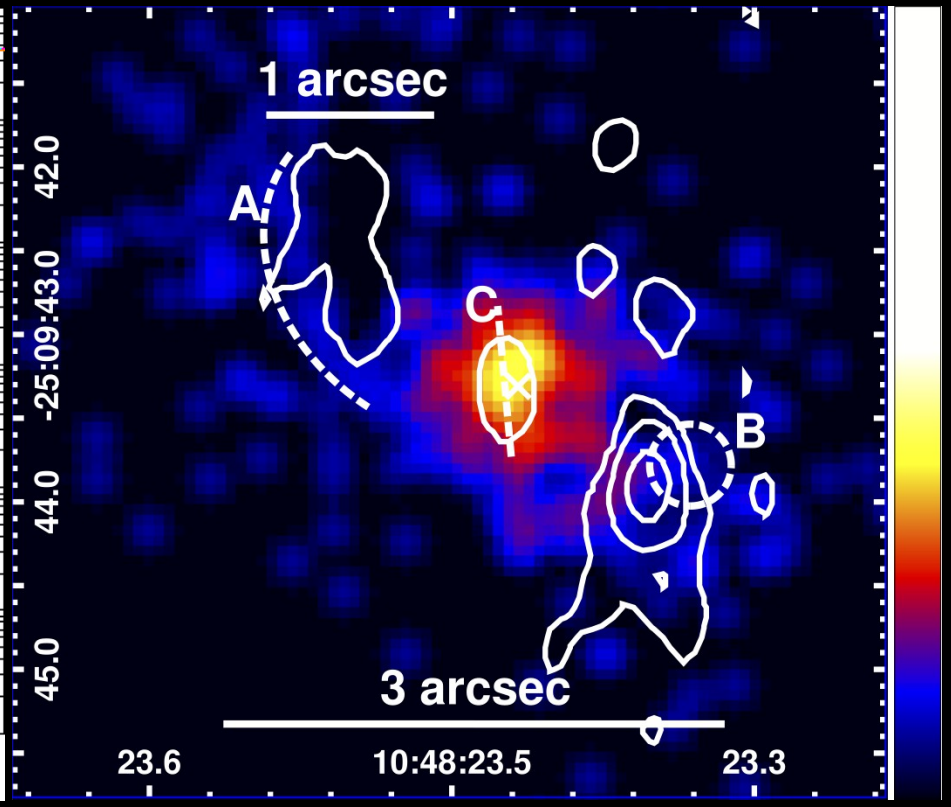


Right: NGC 3393, 2-8 keV
From WPM et al, 2017

Dealing with Chandra's Contaminant in Anticipation of Lynx



Harder photons *now* from the spatially resolved NLR
can give us a glimpse of Lynx's
Better
Faster capabilities at all energies
for a
Stronger astrophysics program



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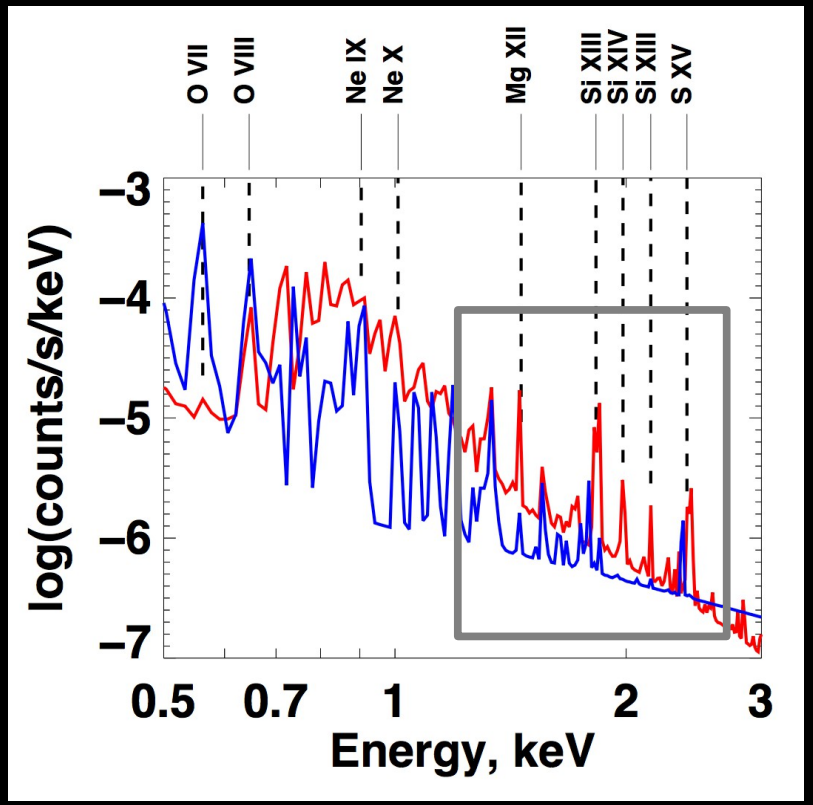
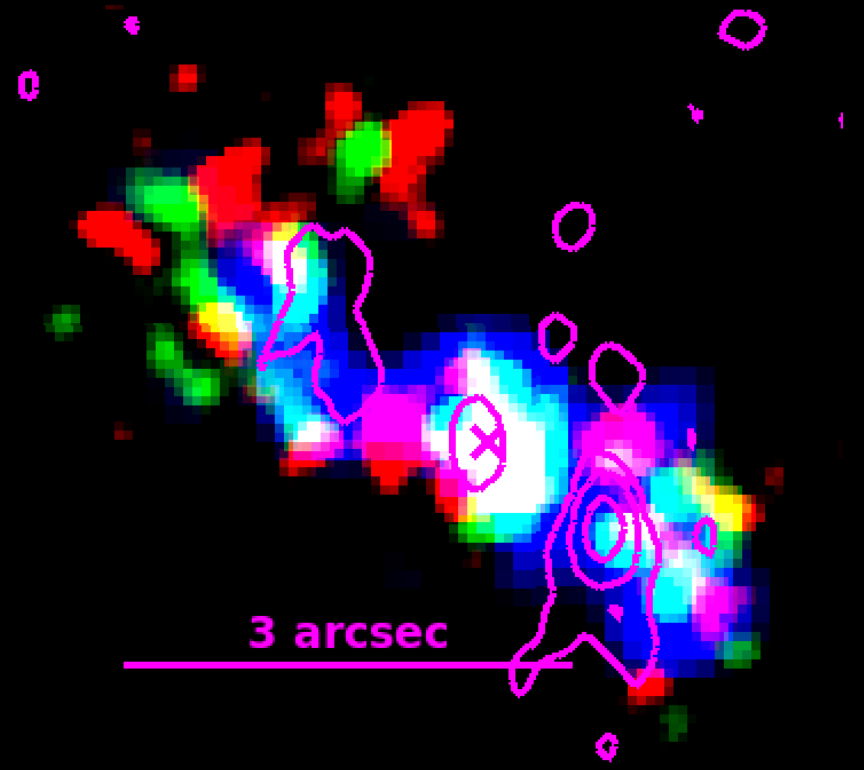
Tracing the Hard(ish) NLR with A Priori Filter Stacking



Photoionization (CLOUDY)
Thermal Plasma (APEC)



Mg XI, Si XIII, S XV resonance
Ne IX
O VII
VLA contours

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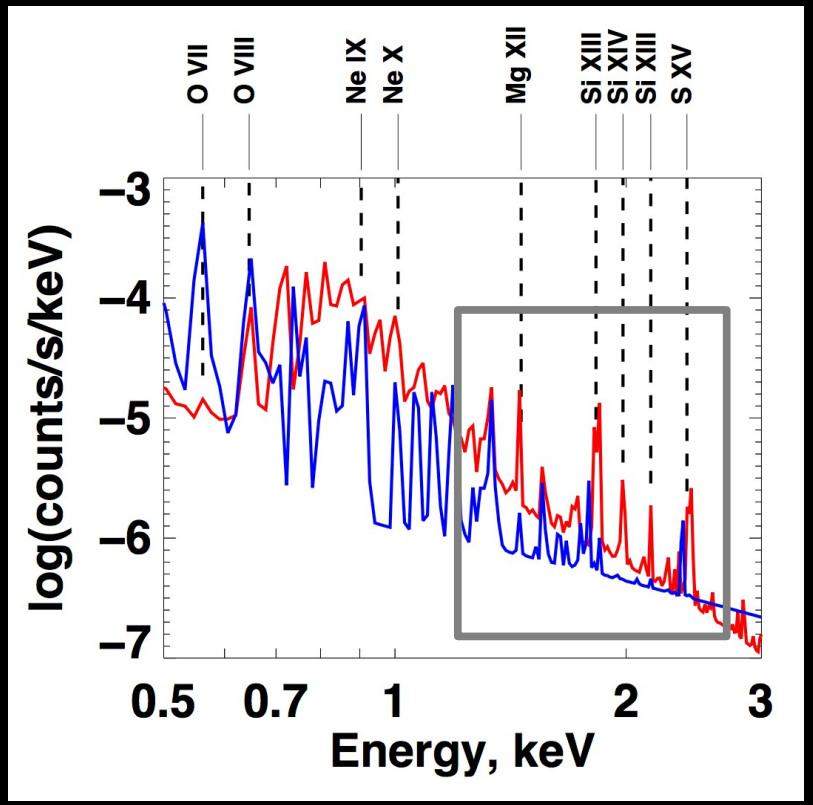
Tracing the Hard(ish) NLR with A Priori Filter Stacking



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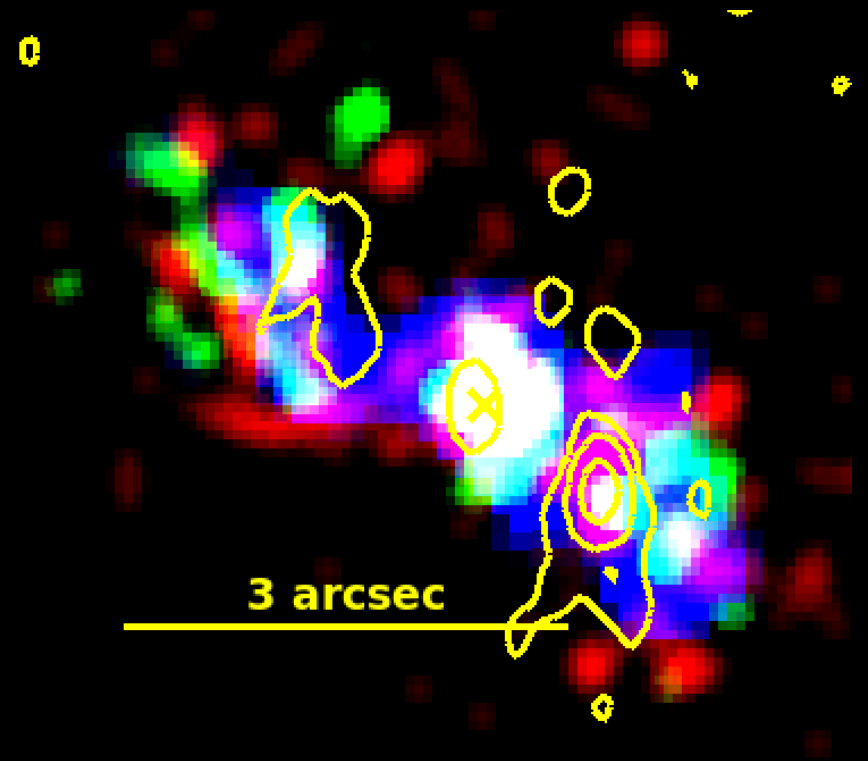

Mg XI, Si XIII, S XV resonance
Ne IX
~1.5-1.8, 2.5-3.0 keV
VLA contours

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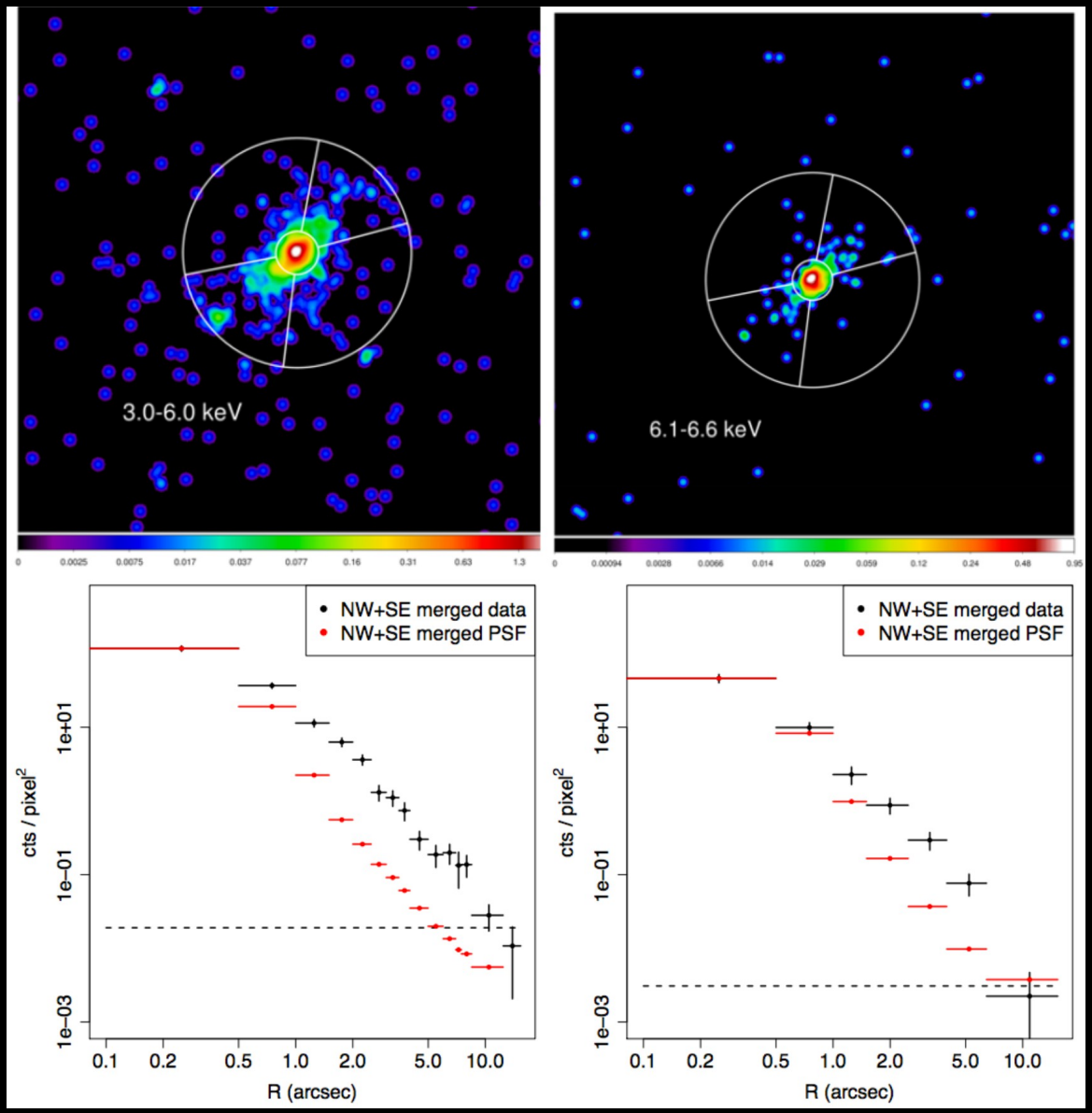
ESO 428-G014
Hard Continuum & Fe Kα @>1kpc !?!?



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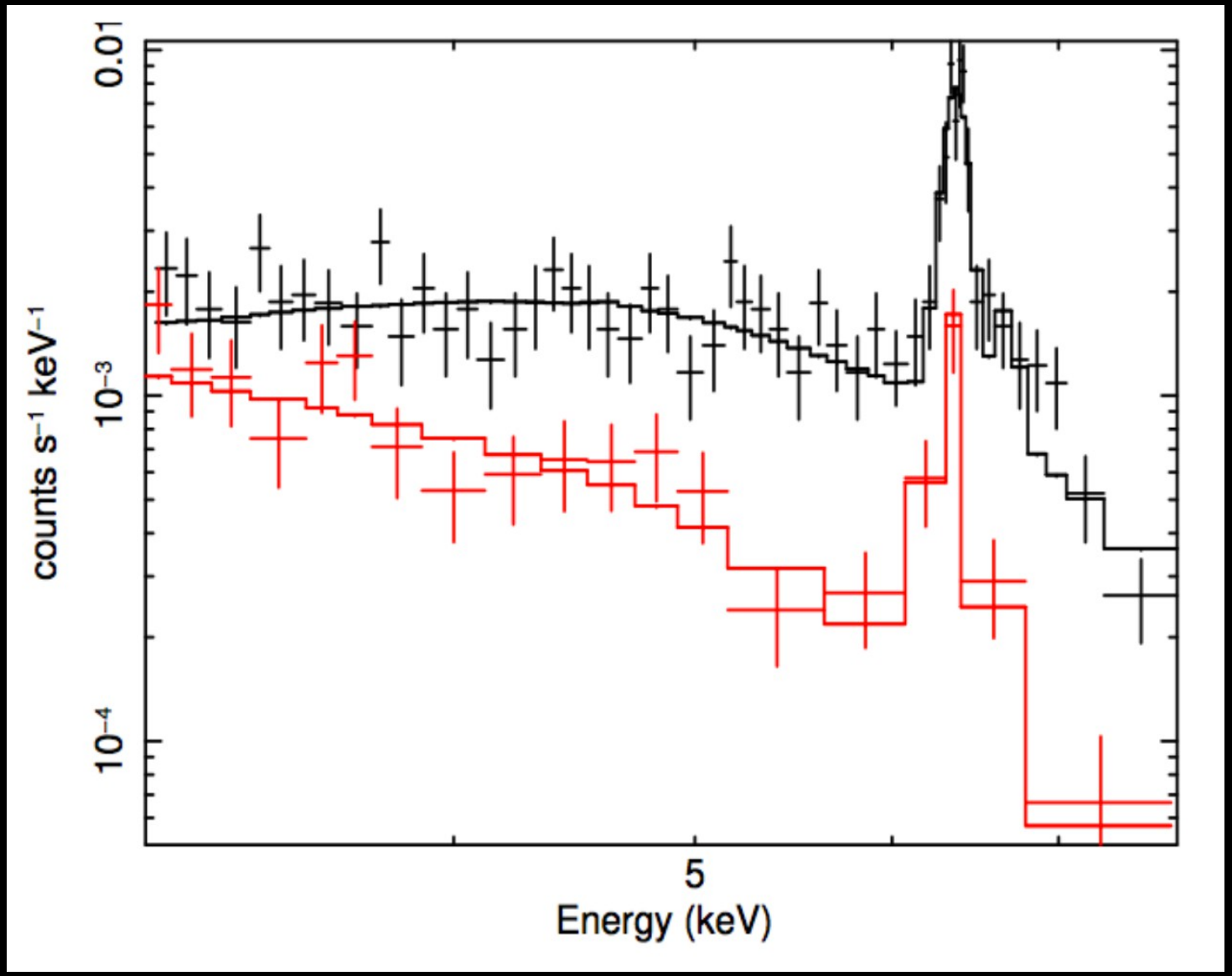
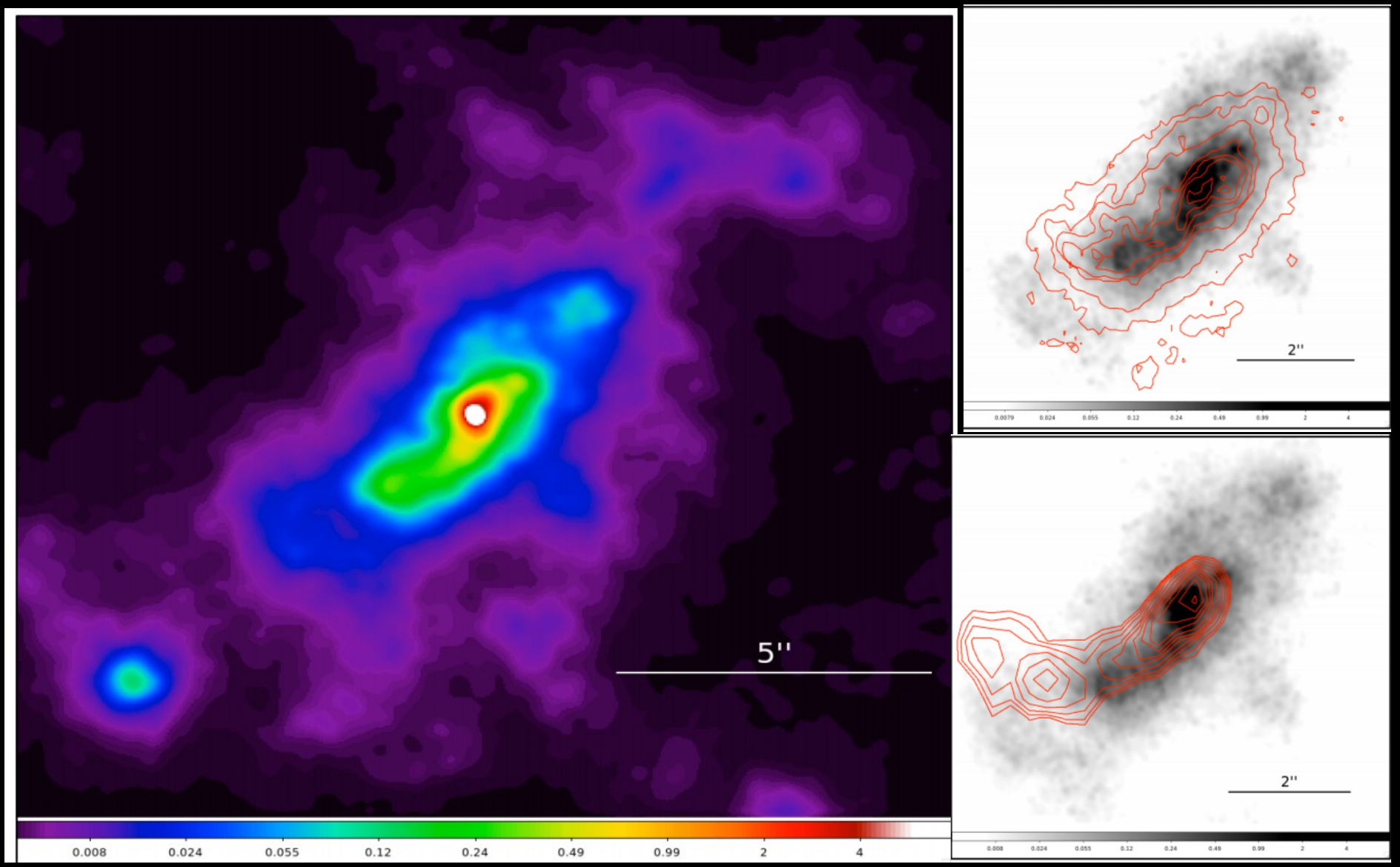
Fabbiano et al, 2017 (incl. WPM)

Hard Continuum & Fe Kα @>1kpc: ~24% of L(3-8 keV)!?!?



Fabbiano et al, 2017 (incl. WPM)

Hard Continuum & Fe Kα @>1kpc: Along the Bicone, not the Torus !?!?



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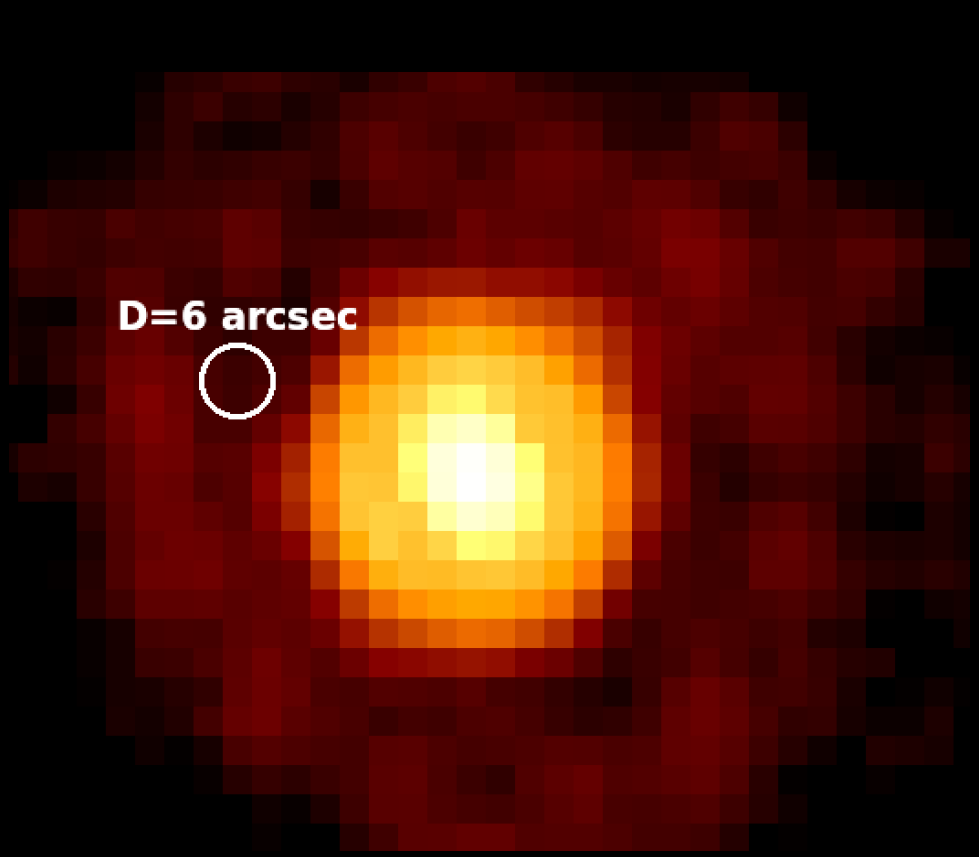
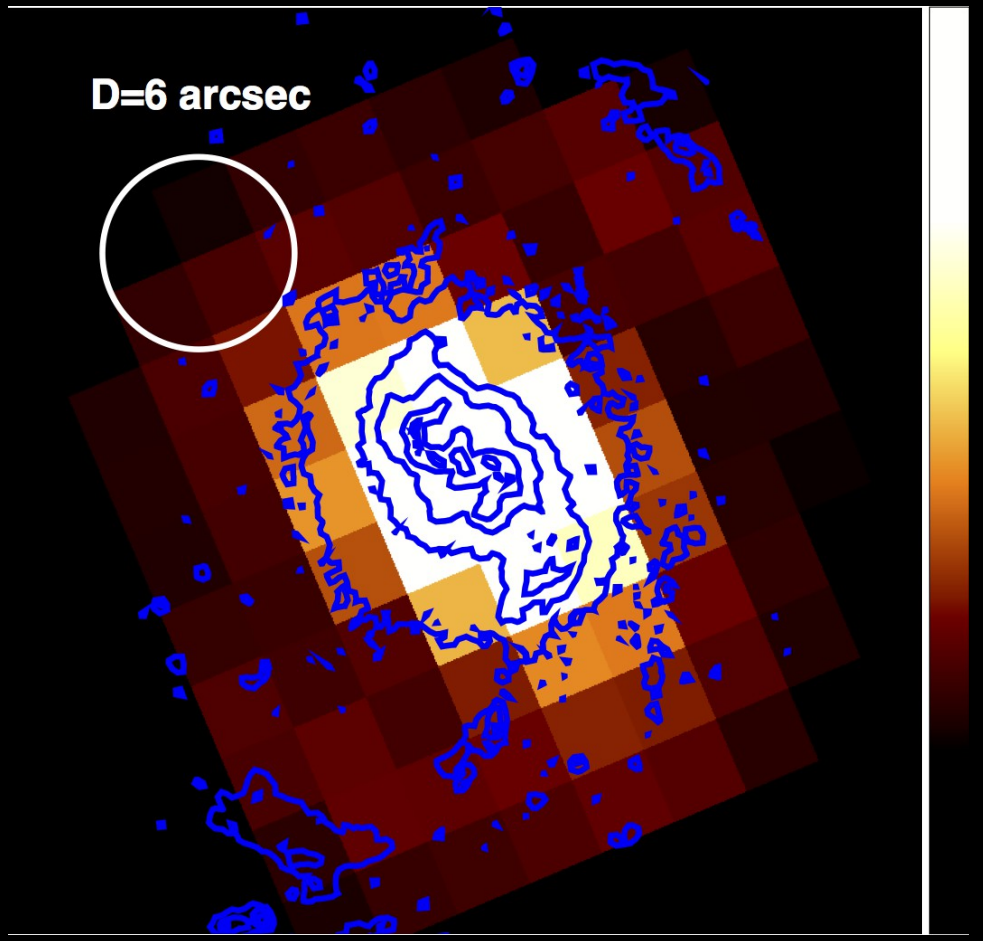
Reflection from a Dusty Wind?





Left: NGC 3393 Spitzer MIPS, 24 micron

Right: Deconvolved & enlarged
with HST NUV contours

Lynx is the Future!

-Lynx's angular resolution and soft effective area is critical for resolving spatially resolving AGN feedback.

-Even microcalorimeter resolution* would be transformative at Lynx effective area (esp. at Fe Kα) – spatial resolution is key*!

The Future Begins Now!

Right now we can use Chandra to:

-demonstrate the presence of wind-driven and jet-driven shocks embedded in the photoionized NLR
-explore the origins of extended scattered X-rays at ~3-8 keV
-show how Lynx can survey hundreds of AGN
→ More photons:
not just faster observations. Simpler analysis!
→ real statistical studies of feedback in action!

Even with dropping effective area <1 keV!

-X-ray astronomers all love Lynx. Let everyone *else* know how much *they* need it!

*I love the grating too! Ask me about TDEs...
**If microcalorimeter pixel size ends up being the resolution bottleneck, an added CCD could be very useful...

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