Spatially resolved emission line spectroscopy

By: Shawn Roberts
University of Massachussetts-Amherst
In collaboration with Q. Daniel Wang

Barnard et al. 2013

Goals of this talk

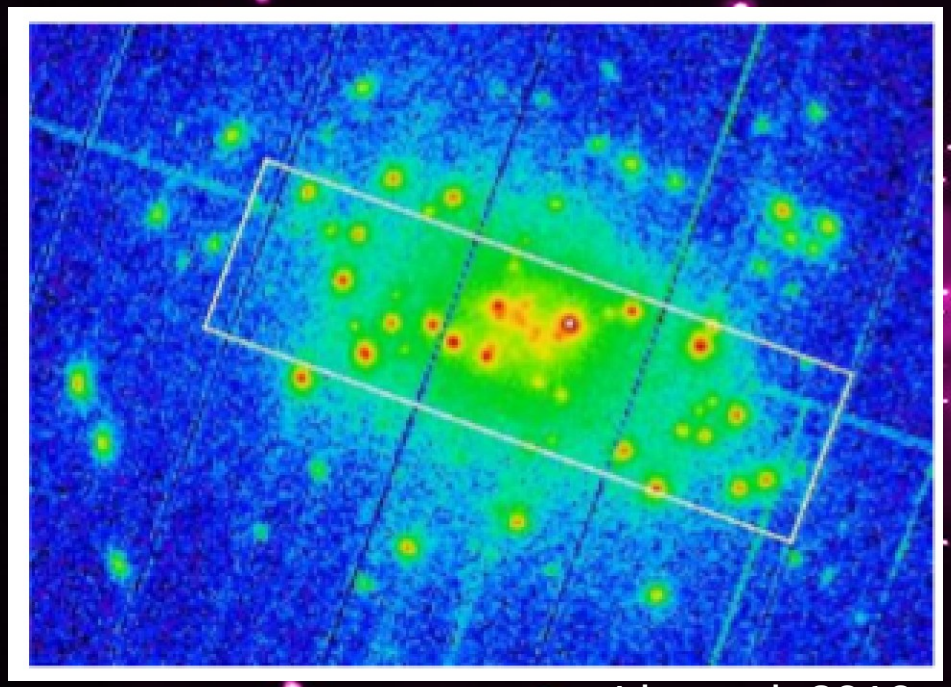
As you saw yesterday, galactic nuclei all show peculiar spectral features. How can we illuminate the physics driving these peculiarities?

- By spatially resolving emission line diagnostics.

We don't have to wait for missions such as Athena or the X-ray surveyor to begin doing spatially resolved high resolution spectroscopy.

Even though spatial, spectral, and kinematic information are all confused, with proper modelling, we can begin to unravel the three

M31

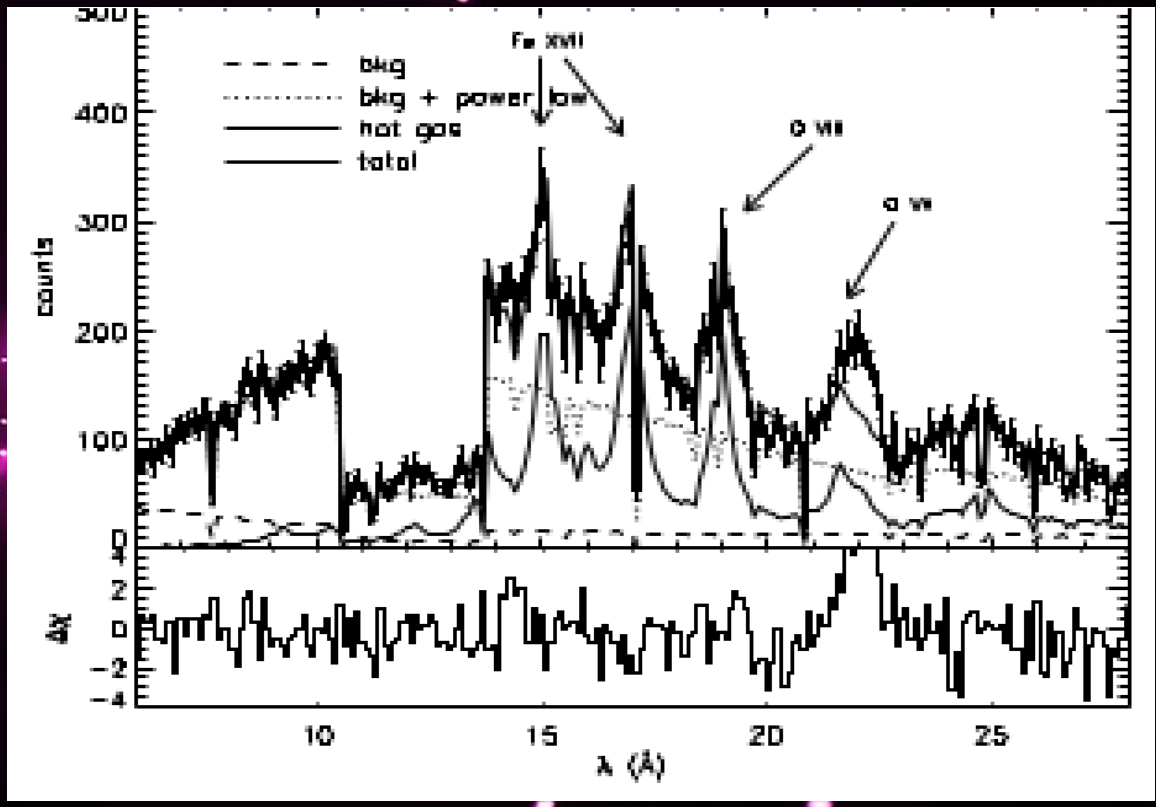


Liu et al. 2010

- Wealth of archival data
- Physical size dominates the line broadening
- Spectral features we can't explain

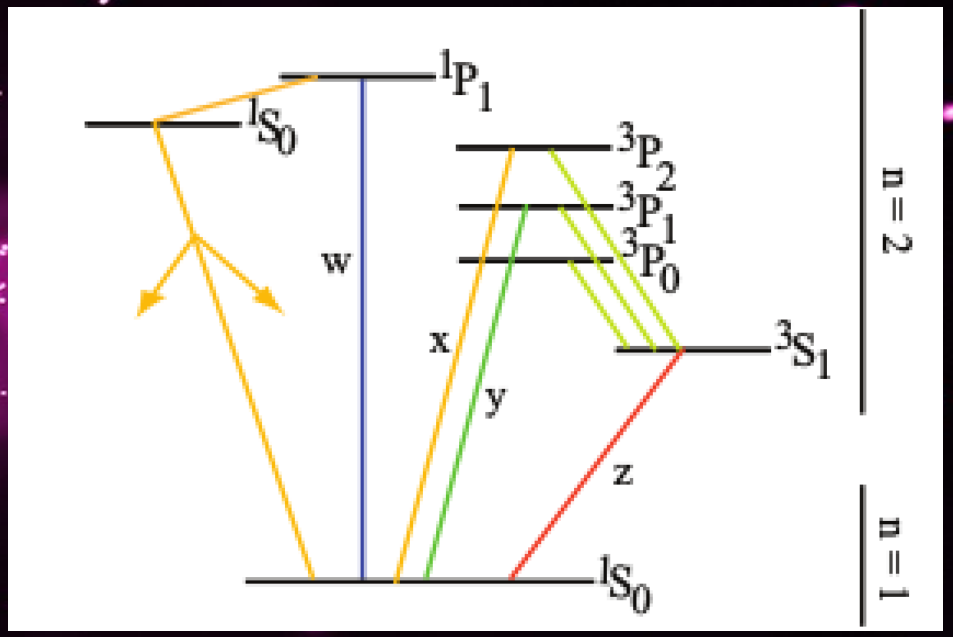
M31 Spectroscopy

- Broad emission lines
  - Spatial extent
- RGS 1 spectrum shows strong residuals for OVII



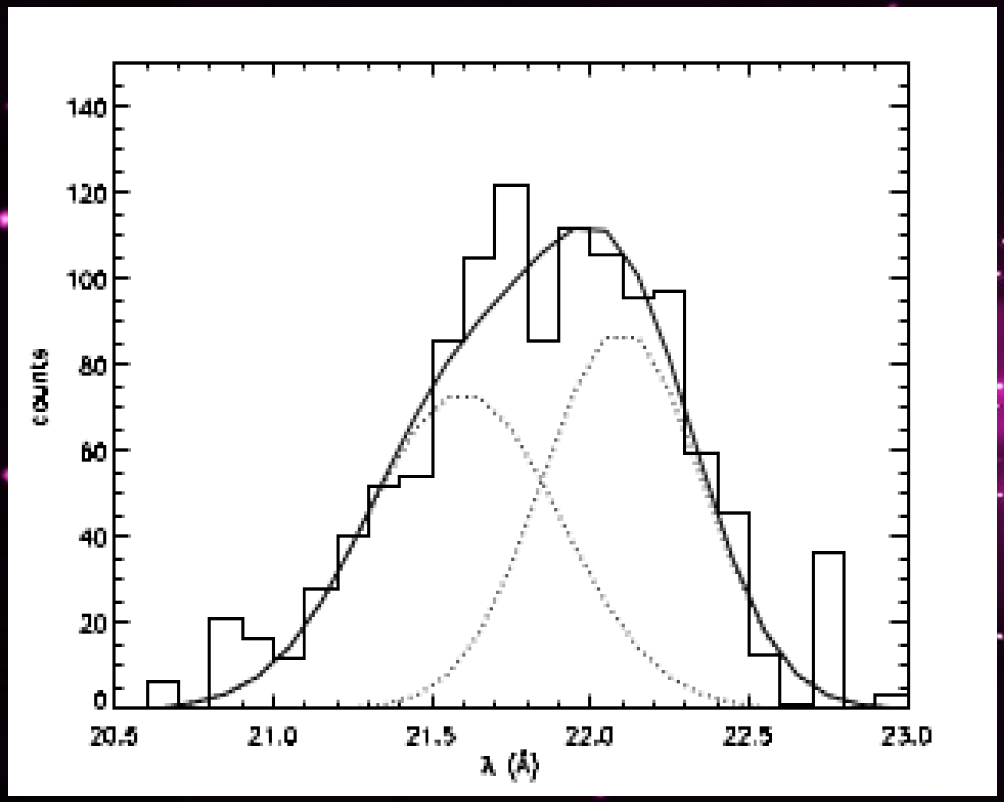
He-like diagnostics

- Simple, but powerful
- G-ratio, (f+i)/r, commonly used as a diagnostic
- Highly sensitive to non-thermal emission processes
  - CX
  - Overionization
  - Resonance line scattering



Smith et al. 2009

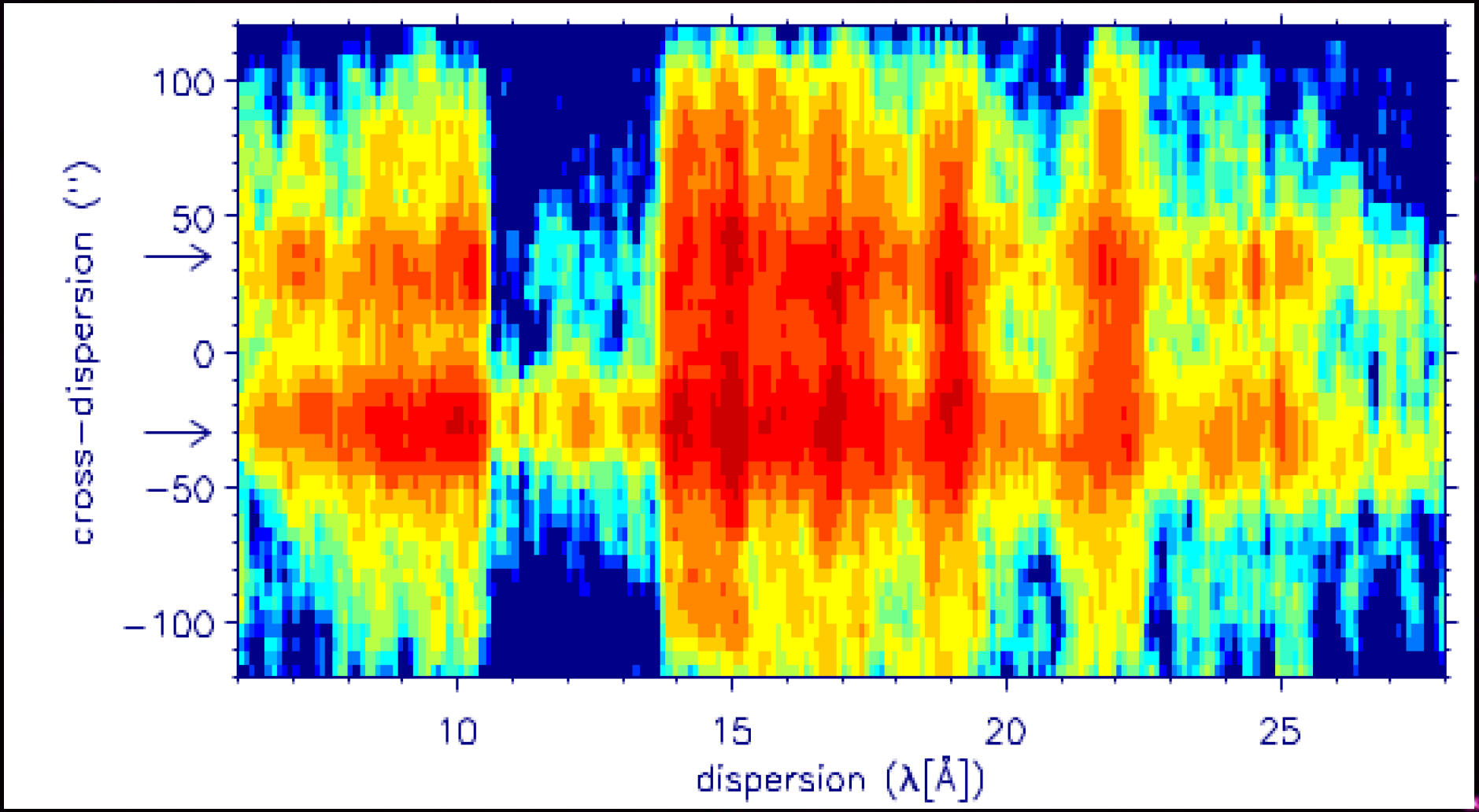
Non-thermal Processes!



Liu et al 2010

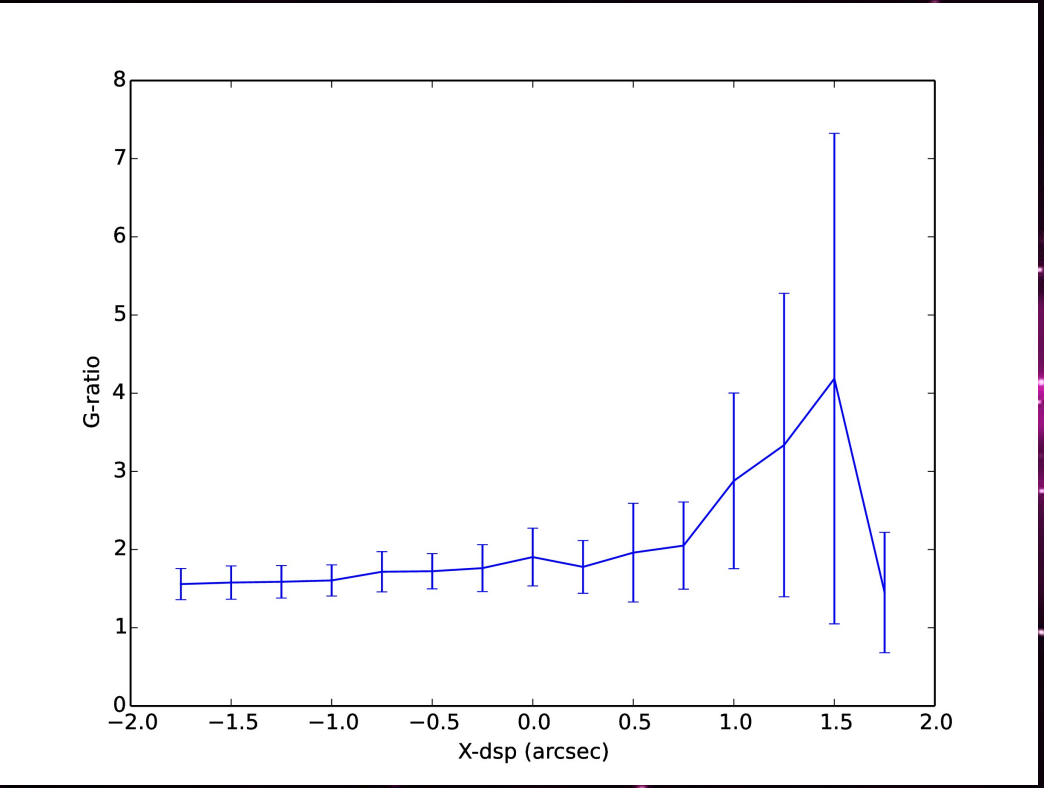
- G-ratio: ~1.5
- Need a spatial comparison of spectral characteristics with multiwavelength data
- For diffuse sources, confusion between spatial and spectral information in dispersion direction

Cross dispersion spectral cuts: 1-d information



Liu et al. 2010

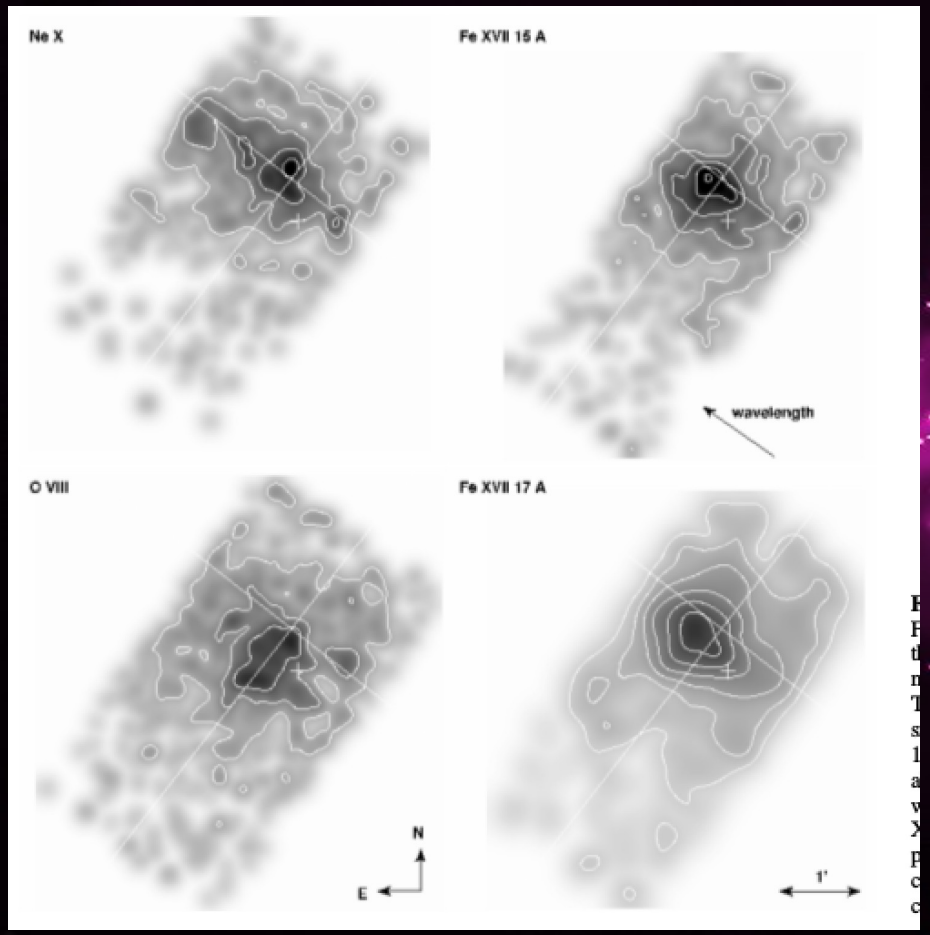
Cross dispersion G-ratio



- Stay within 4' width
- Elevated G-ratio throughout x-dsp direction
  - But, still well within X-ray emitting region
- How to do better?

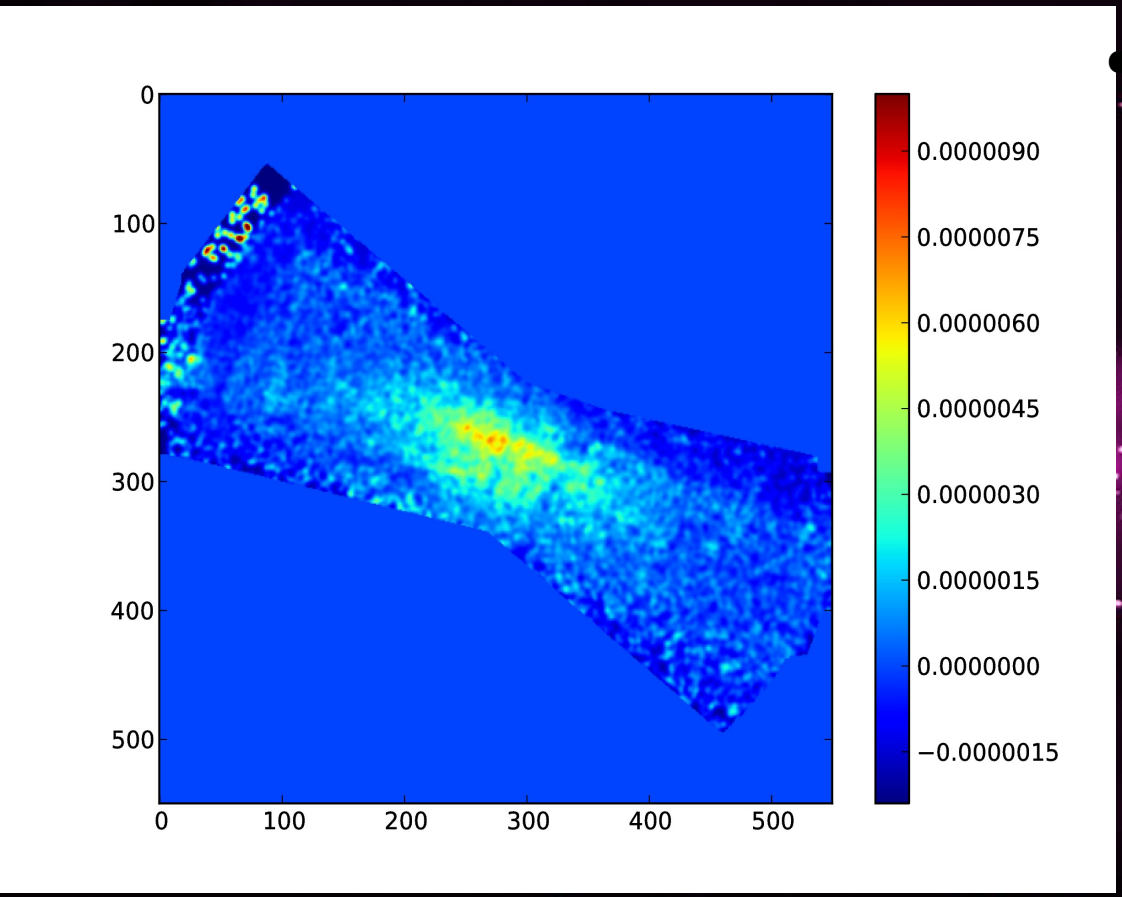
Line Mapping

Bauer et al. 2007



- Sort of straightforward for isolated lines
- Only been done a couple times
- And not a ton of new science can be done from spatially extracting a couple isolated lines, in and of themselves.

Back to M31: OVIII

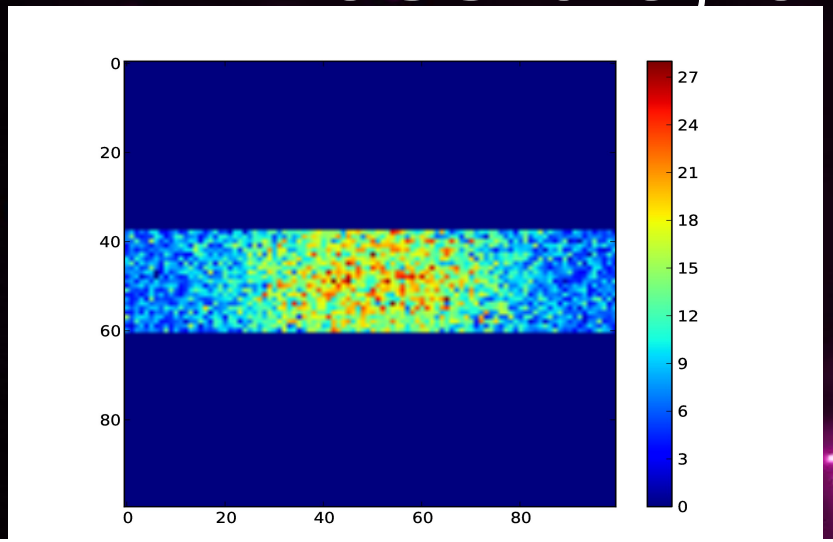


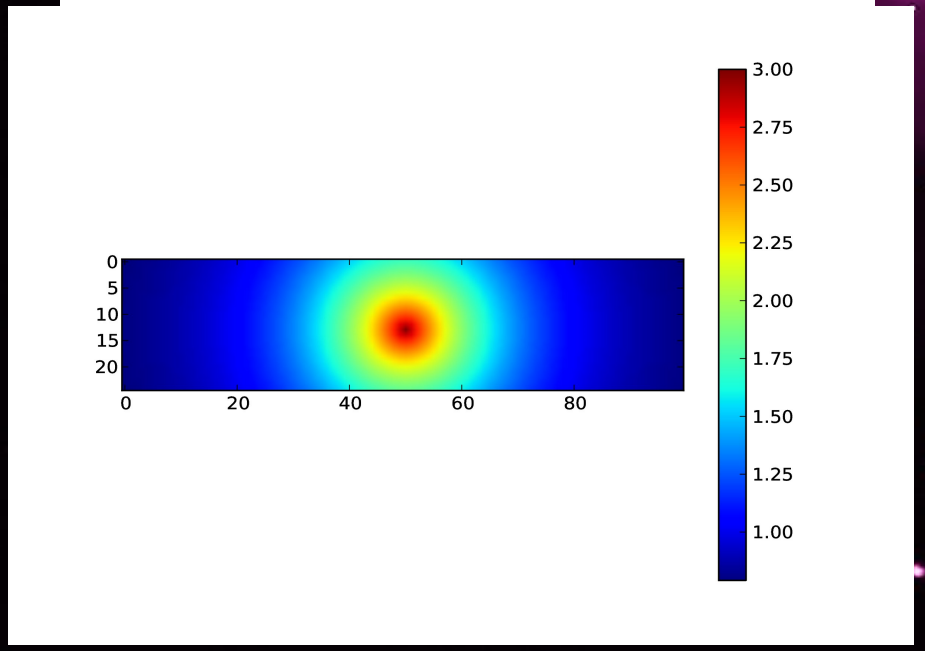
- Comparing to other lines and broad band images can help constrain temperature structure and importance of resonance line scattering.

Line Mapping He-like complexes: Possible, or pie in the sky?

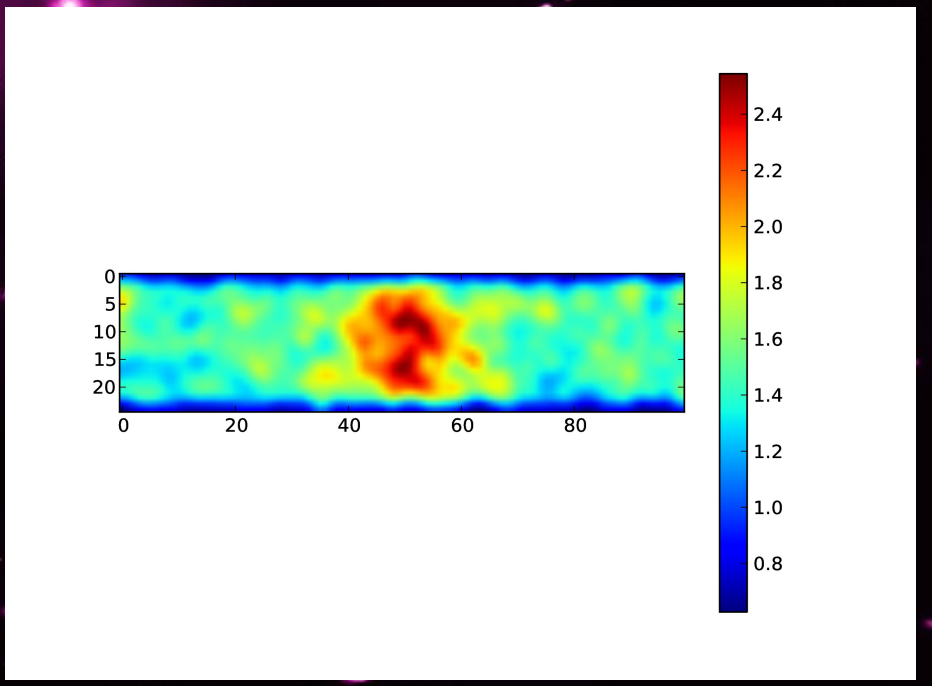
In principle, possible.

Line Mapping He-like complexes: Possible, or pie in the sky?





- Different roll angles breaks degeneracy
- Physical constraints on the G-ratio can further constrain morphology of individual lines.



Conclusions

- There are things that can be done to extract more information from the grating data. To the archive!
- This, in principle, extends to blended lines.
- Future:
  - Active star-forming galaxies (e.g., M82)
  - Chandra grating data
  - Constrain AGN duty cycle?
  - Kinematics? Outflow structure?
  - Guidance on observations in the age of the calorimeter