Spatially resolved emission line spectroscopy

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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

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

Liu et al. 2010
M31 Spectroscopy

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

Liu et al. 2010
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!

- 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

Liu et al 2010
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