SIMULATING *ASTRO-H* OBSERVATIONS OF GALAXY CLUSTER GAS MOTIONS: WHAT WE CAN EXPECT AND IMPLICATIONS FOR FUTURE MISSIONS

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with

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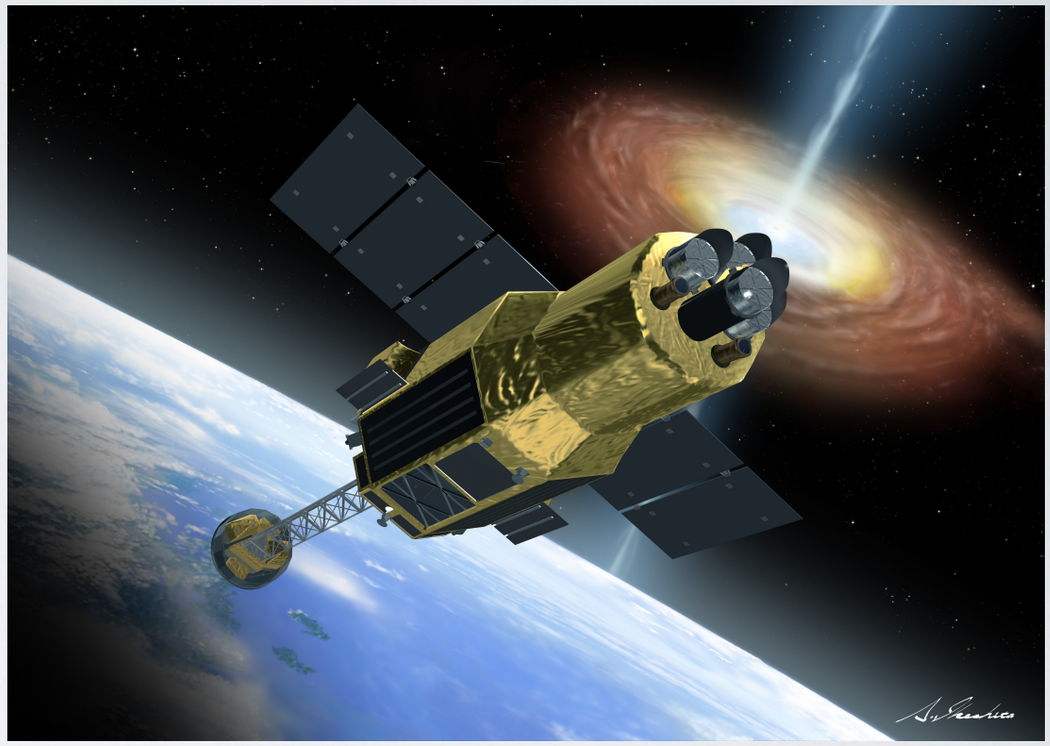
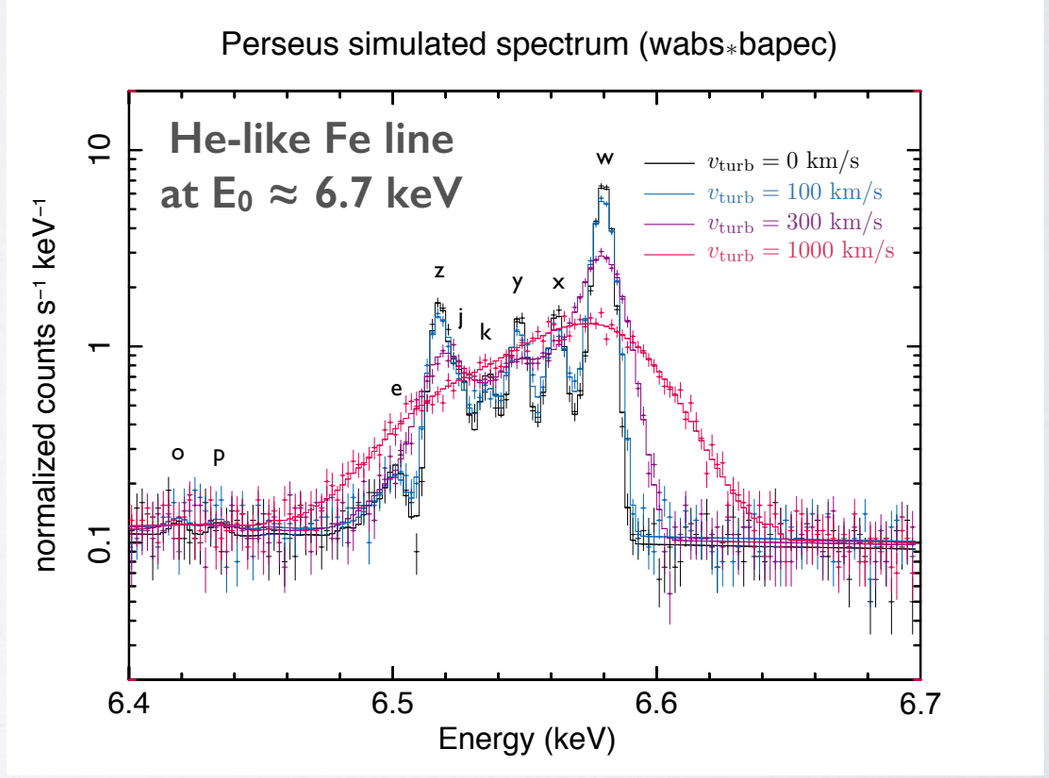
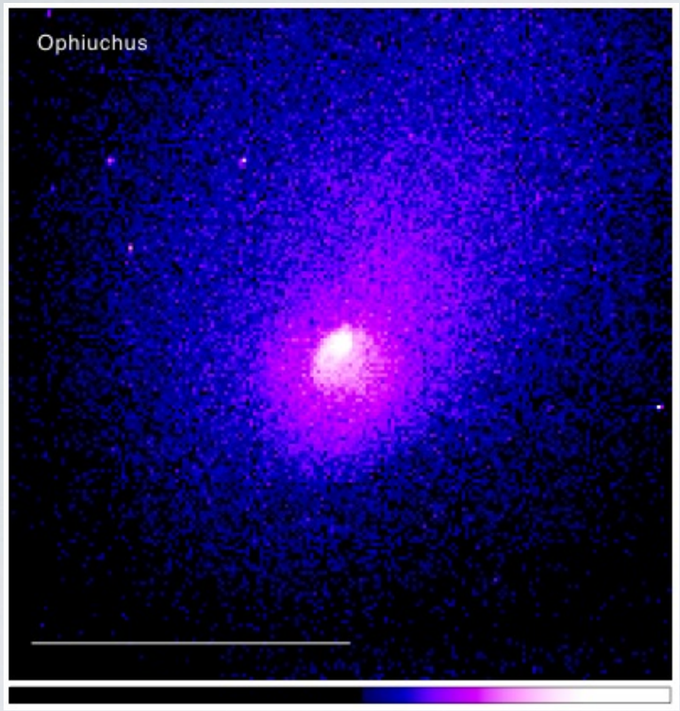
ASTRO-H MISSION

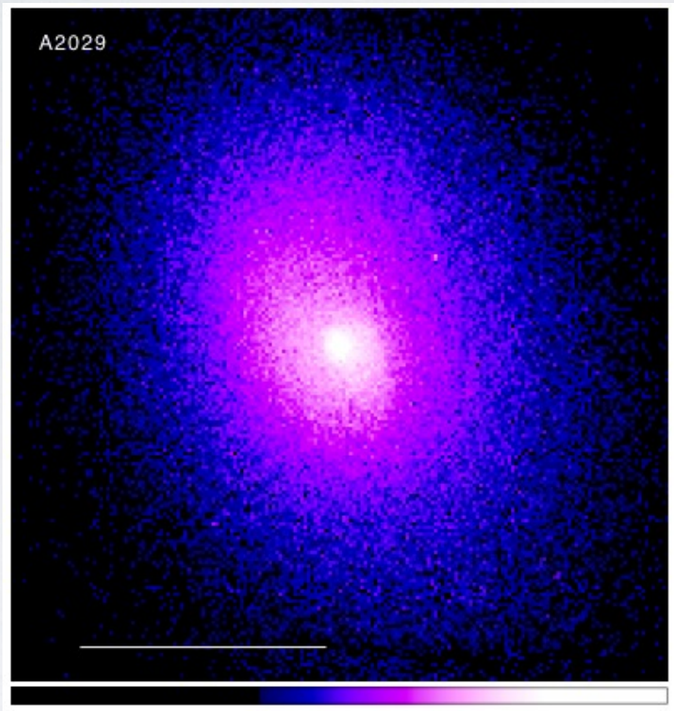
- To be launched early next year
- Soft X-ray Spectrometer (SXS):
  - 3'x3' FOV
  - ~5 eV spectral resolution
  - ~1' spatial PSF

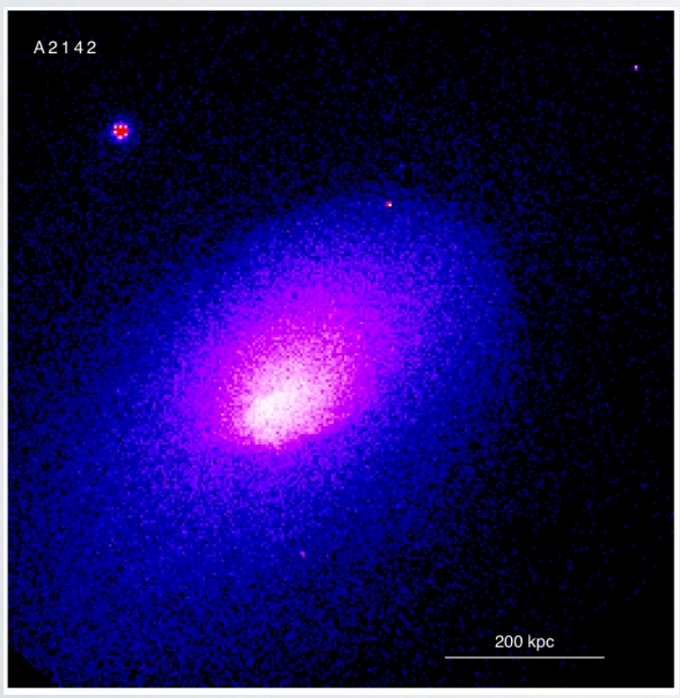


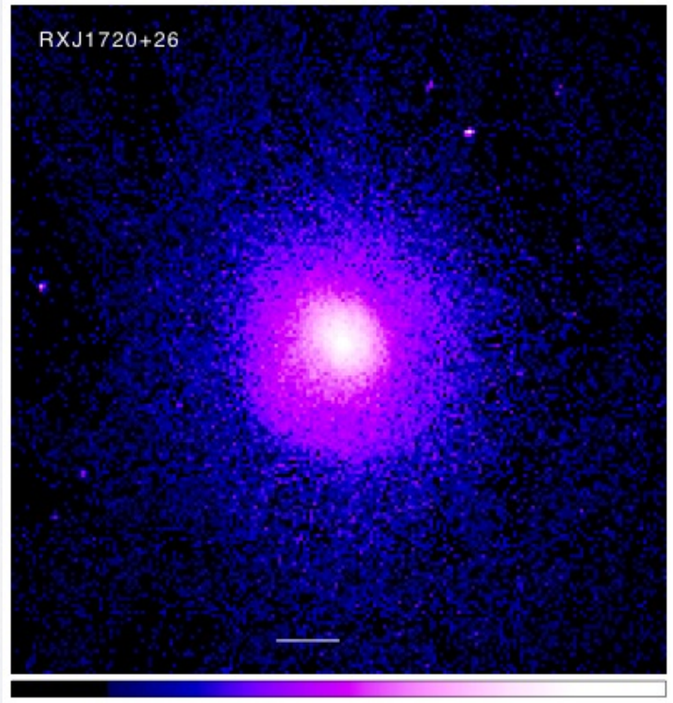


CORE GAS SLOSHING

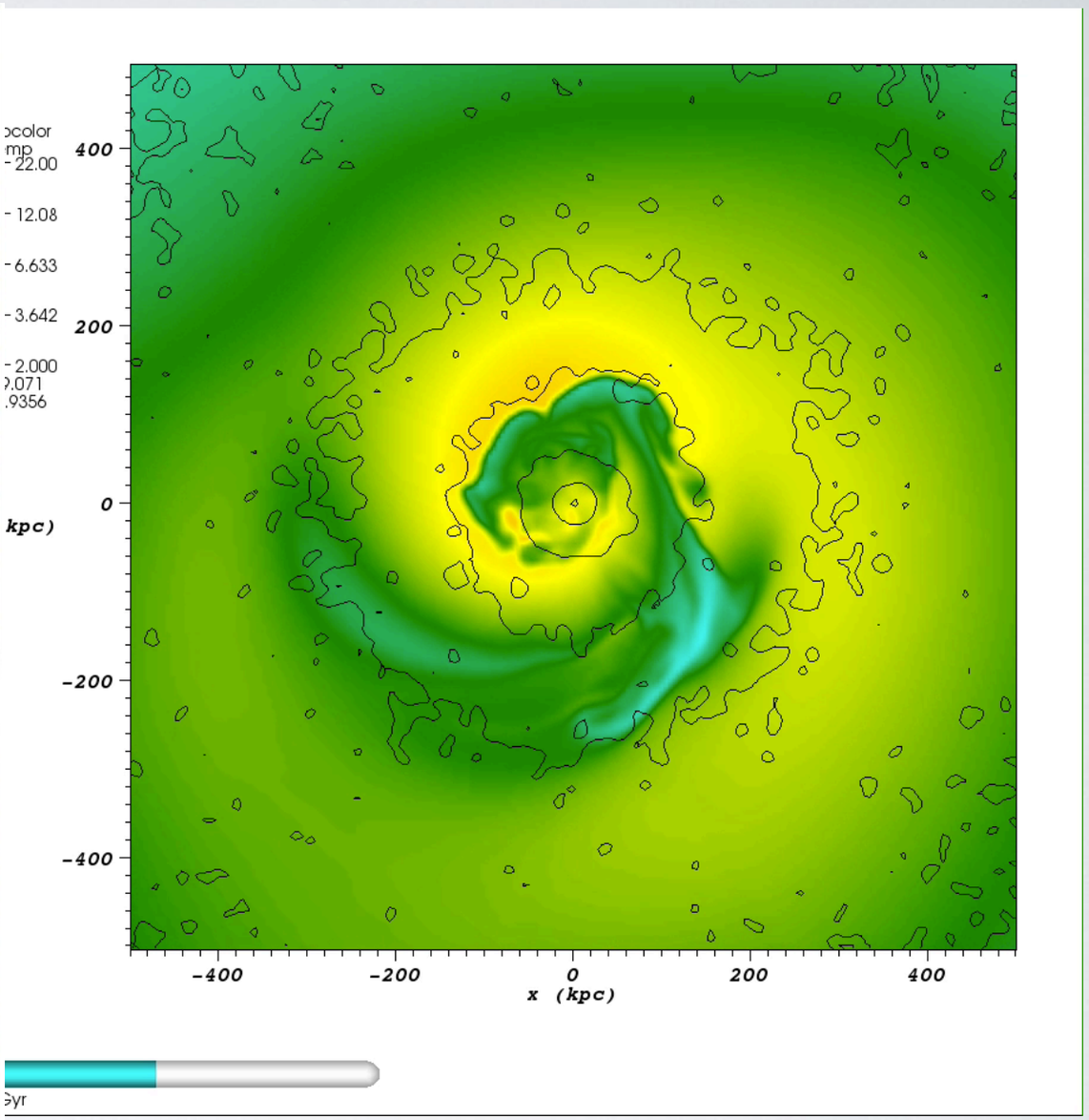








Markevitch & Vikhlinin 2007



ZuHone, Markevitch, & Johnson 2010

- Can we detect these sloshing motions with *Astro-H?*

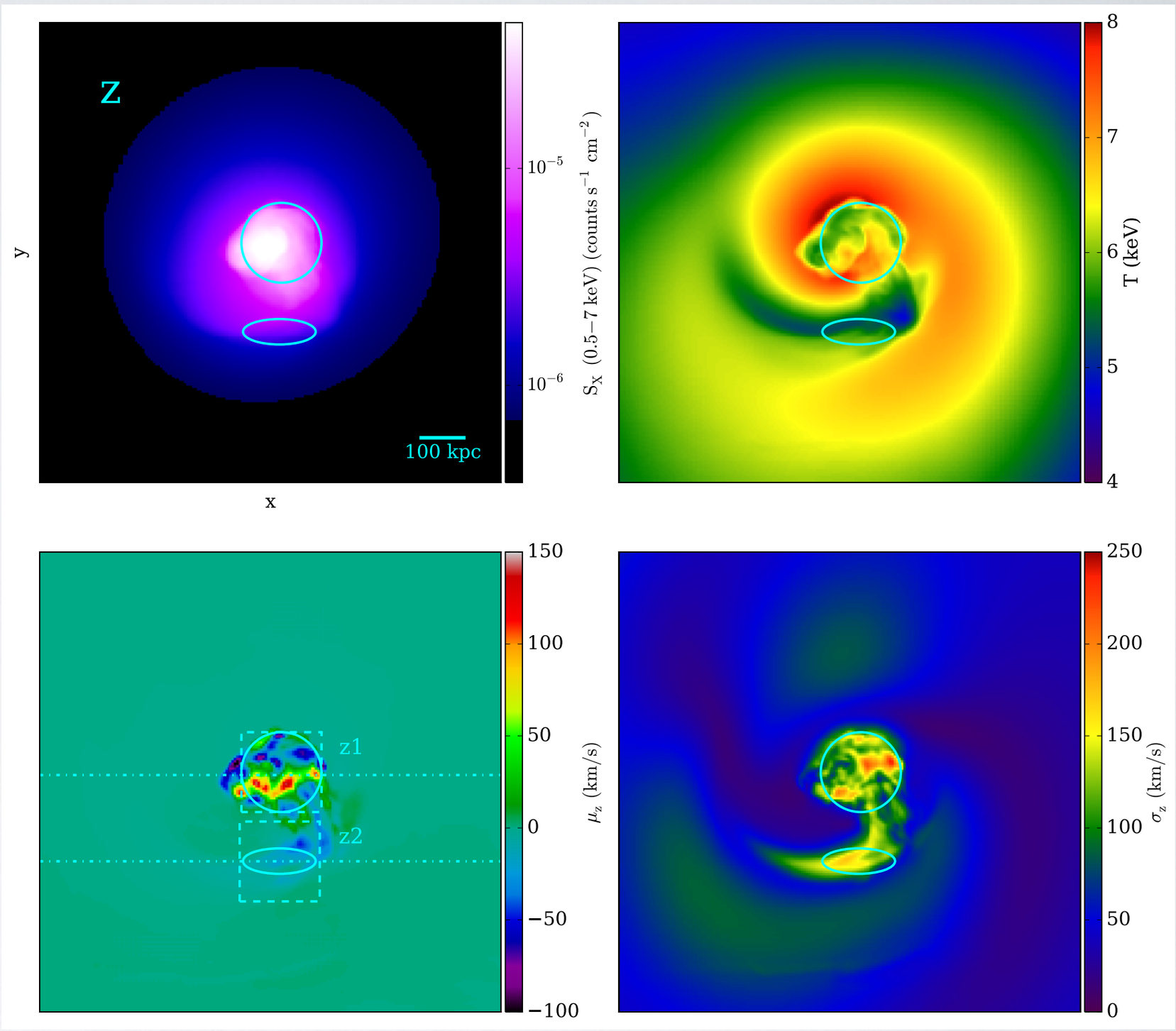
- If so, what effect will these motions have on the shift and shape of spectral lines?

- Can we use this spectral analysis to tell us something about microphysics?

LOOKING PERP TO PLANE

SB

T



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Inviscid

arXiv:1508.04426

LOOKING INTO THE PLANE

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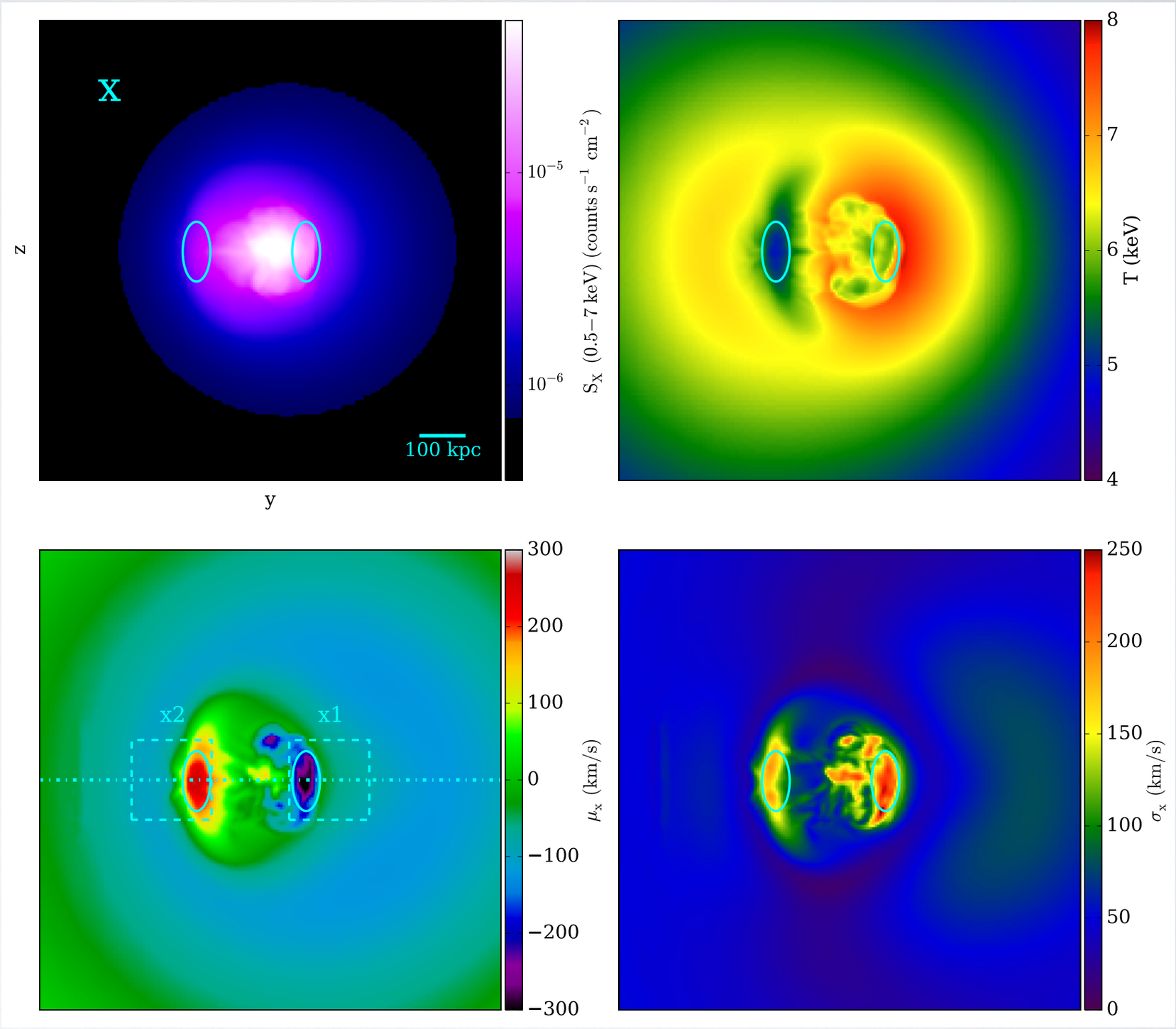

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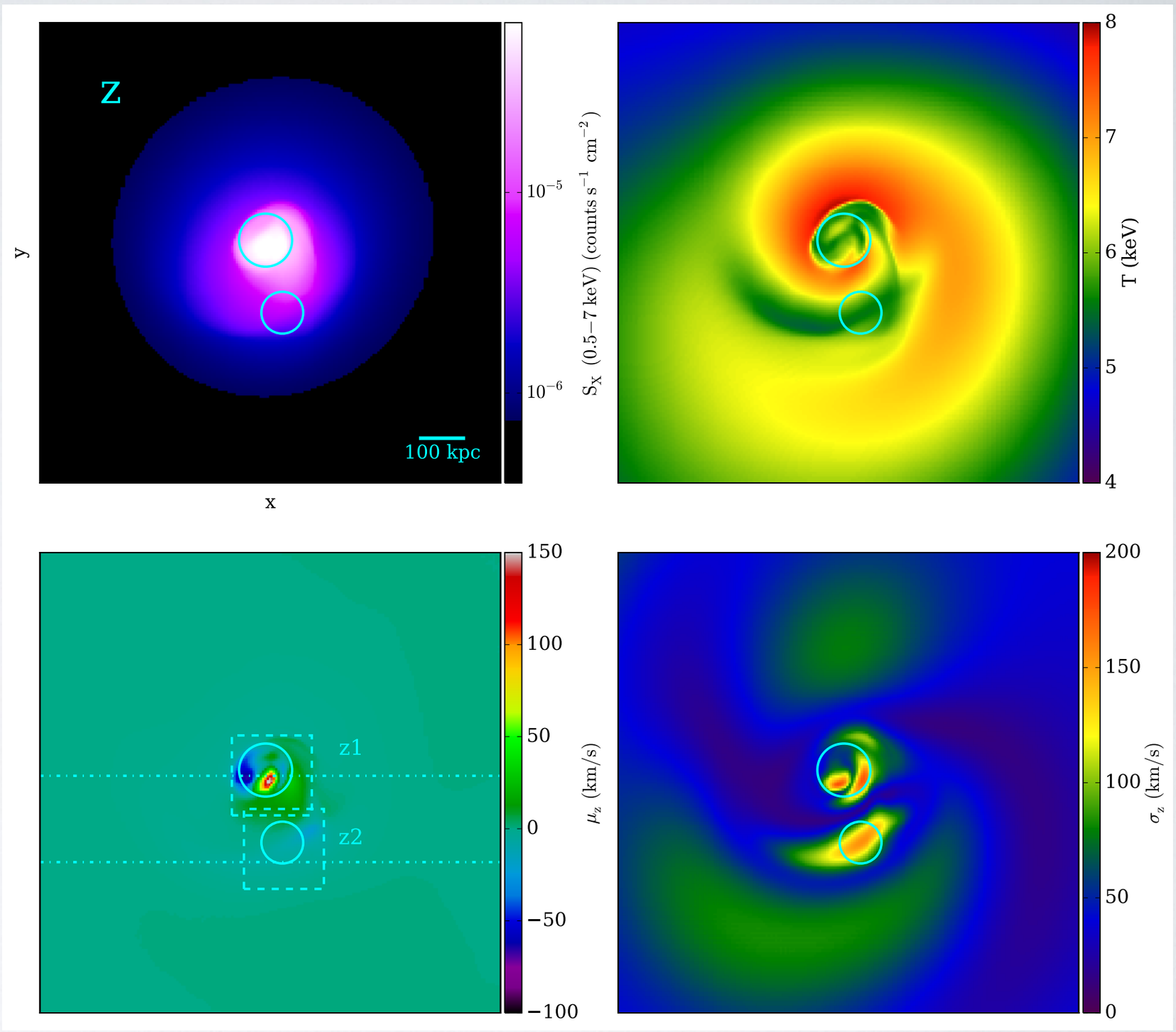

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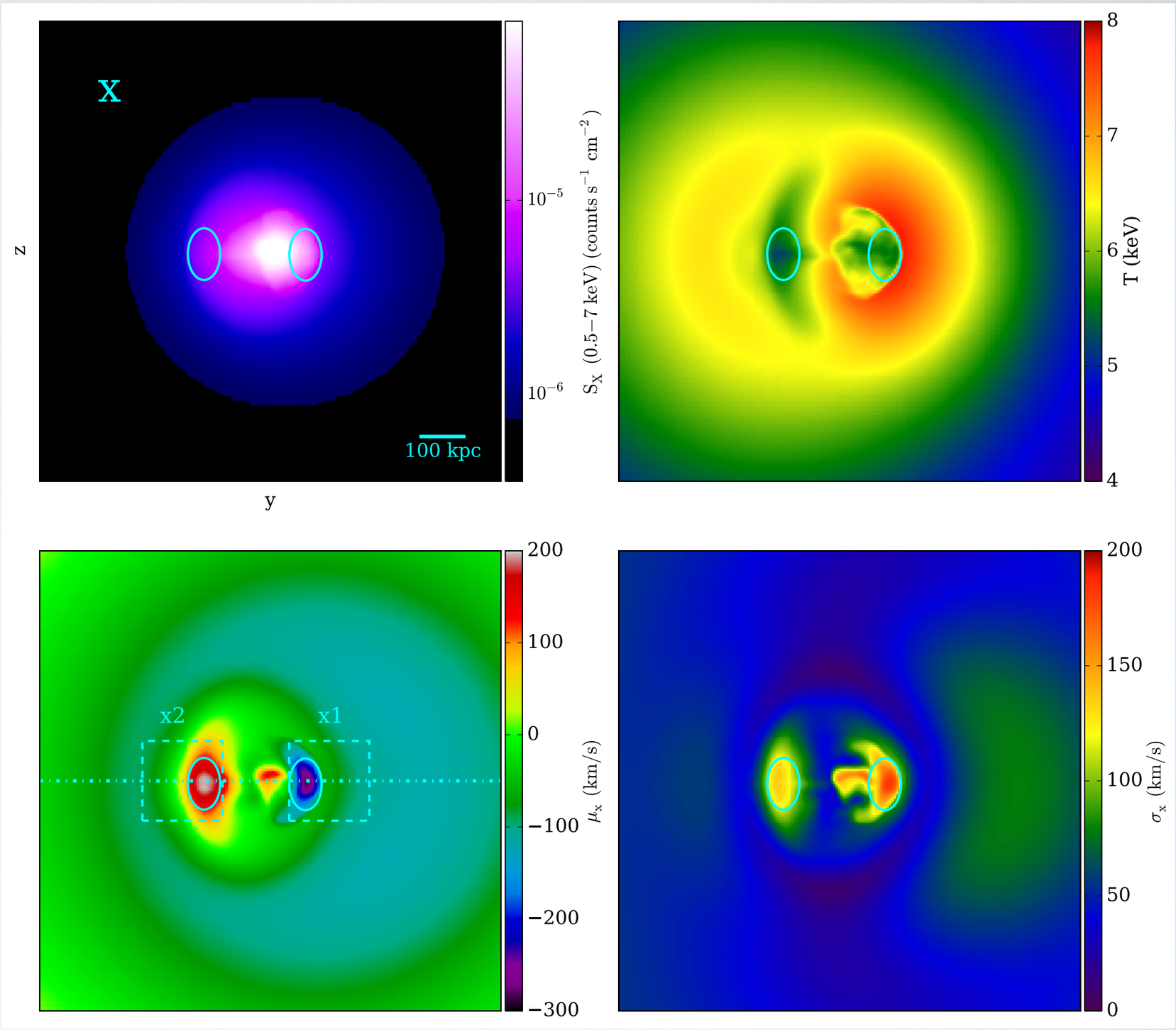

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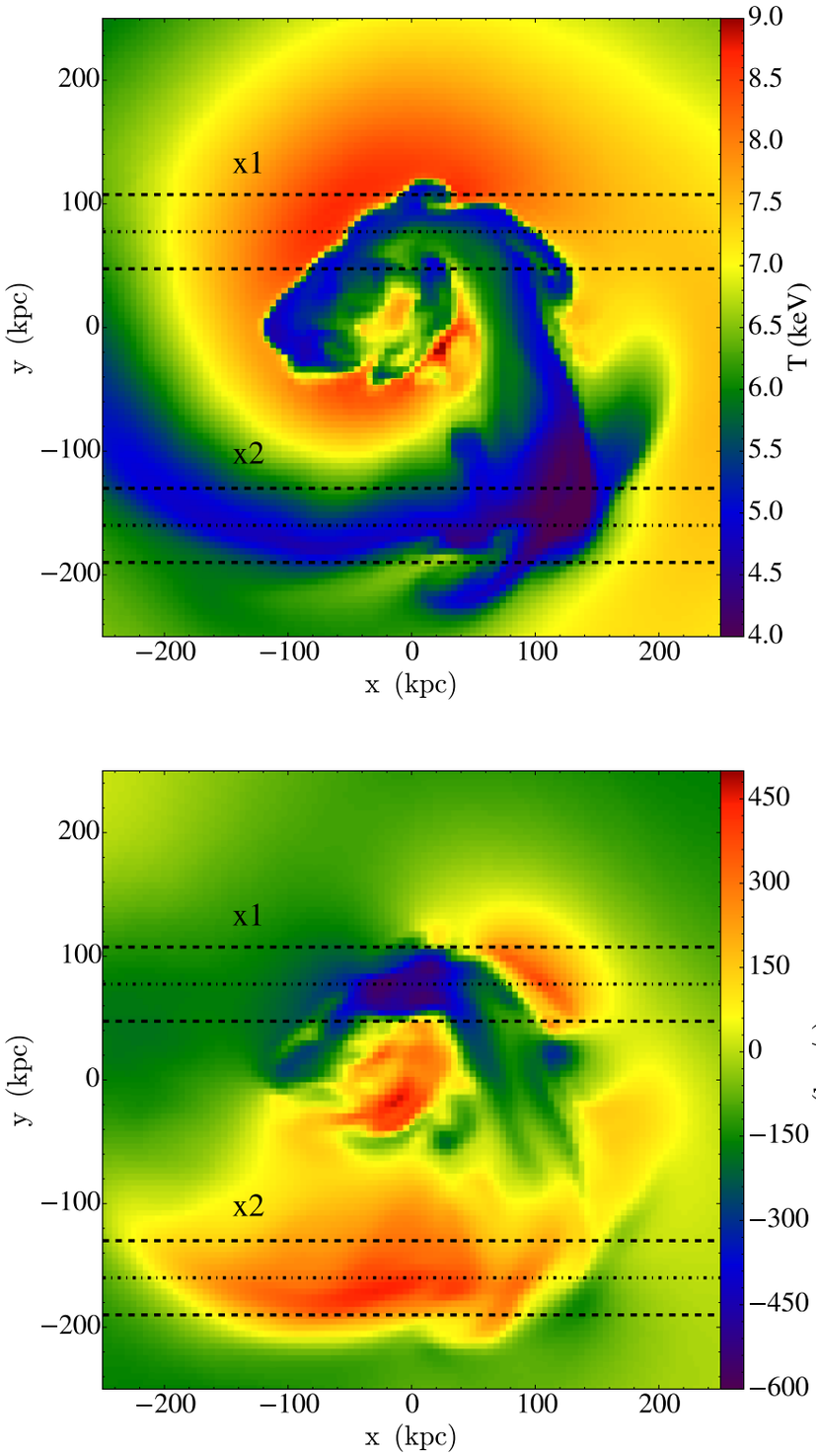
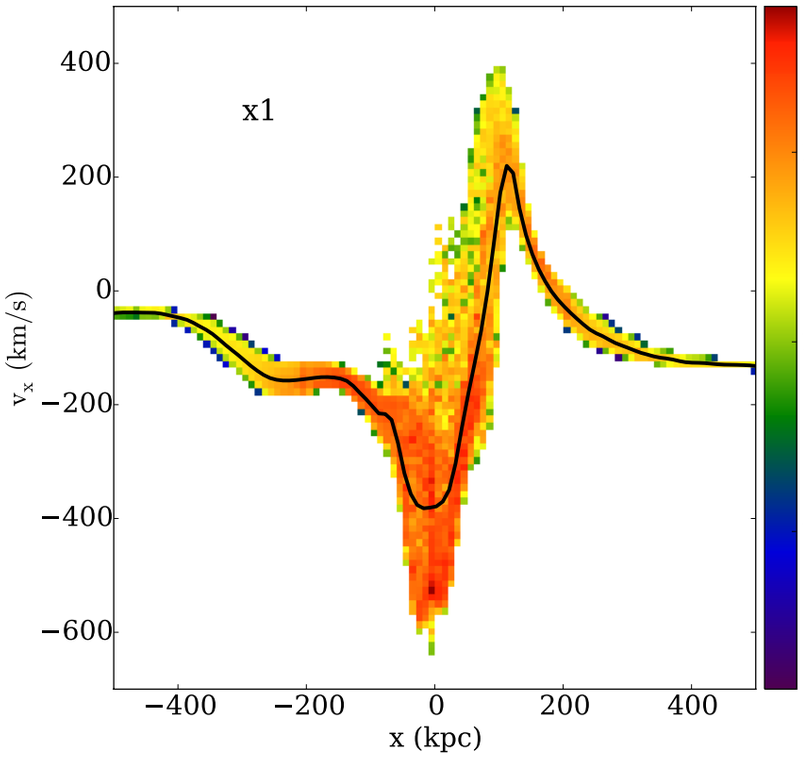
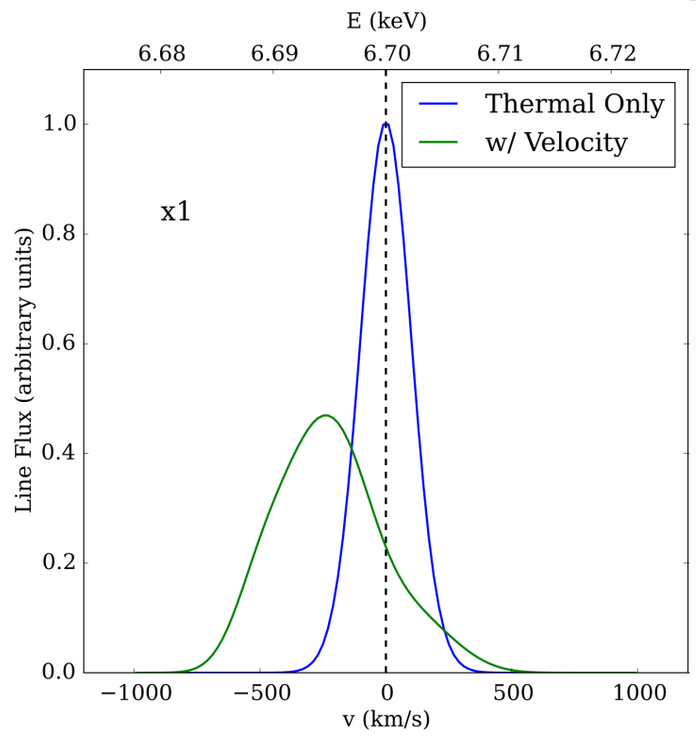
Viscous

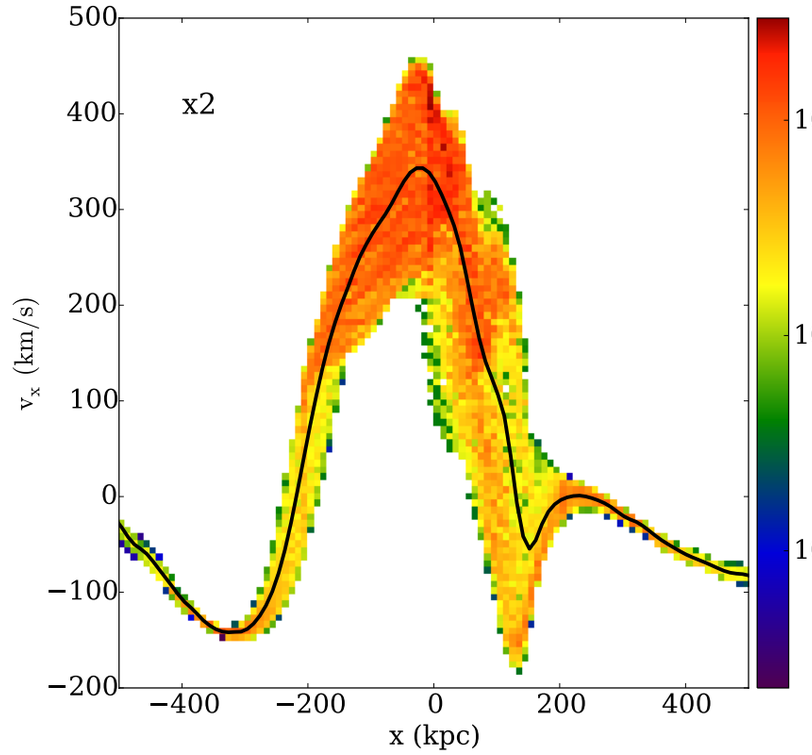
arXiv:1508.04426

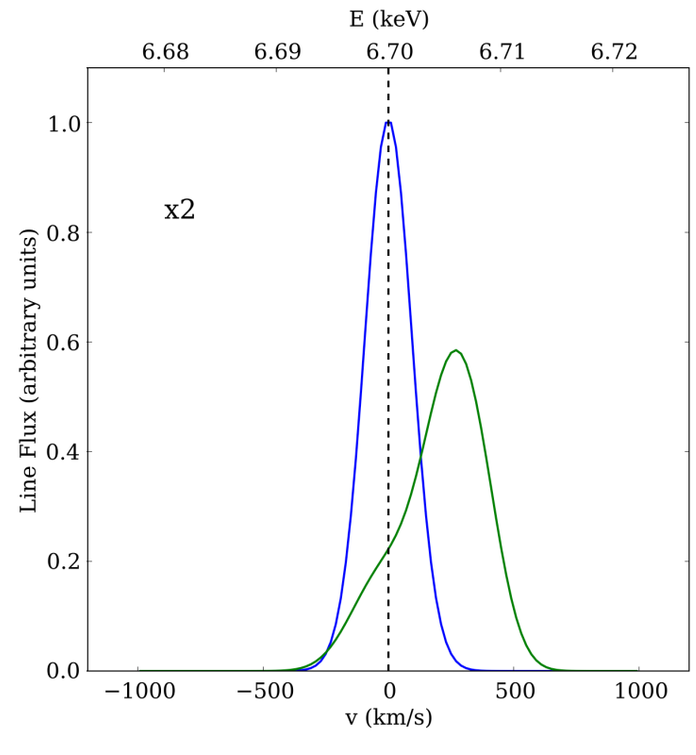
INVISCID: IN THE PLANE



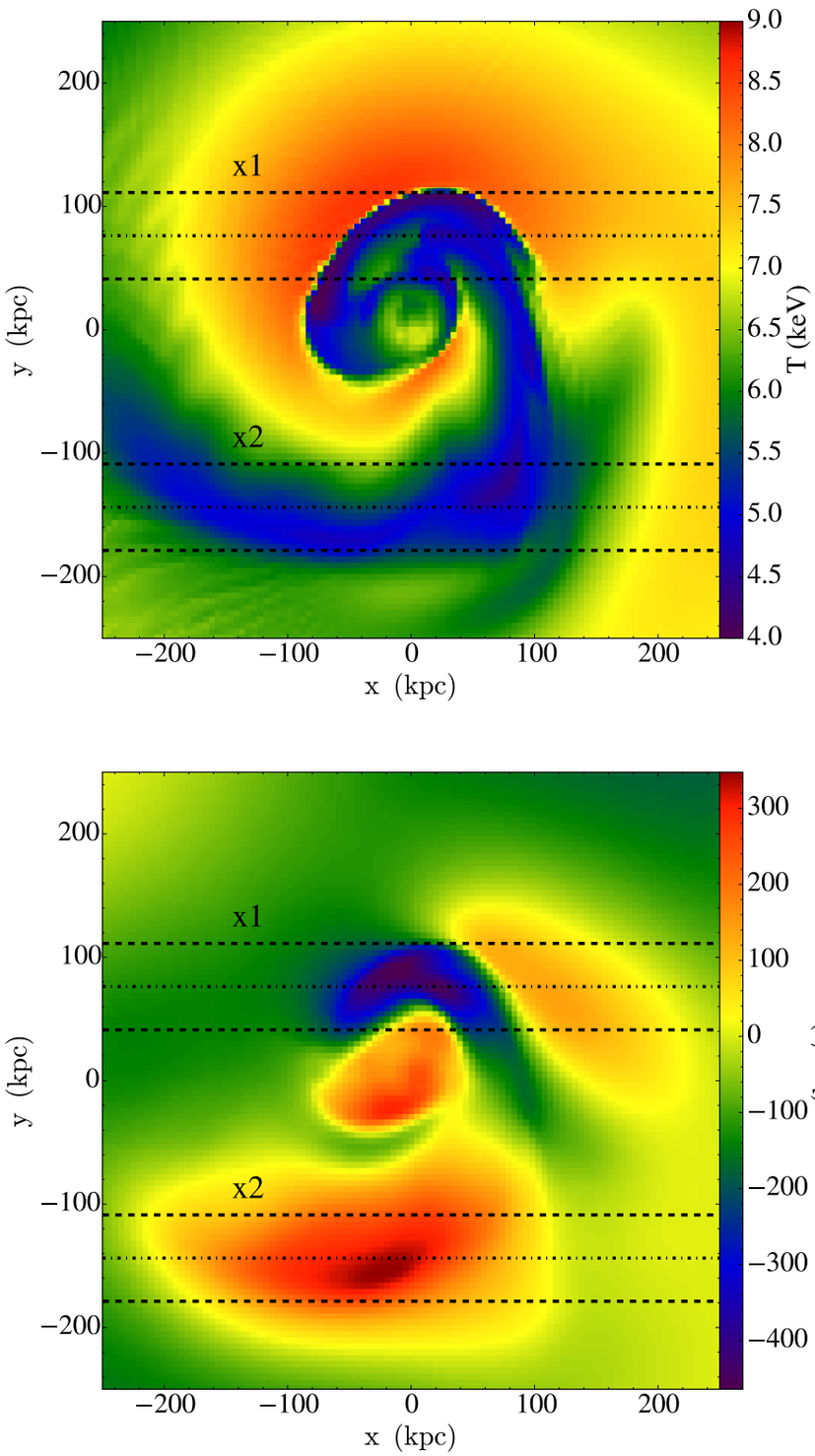


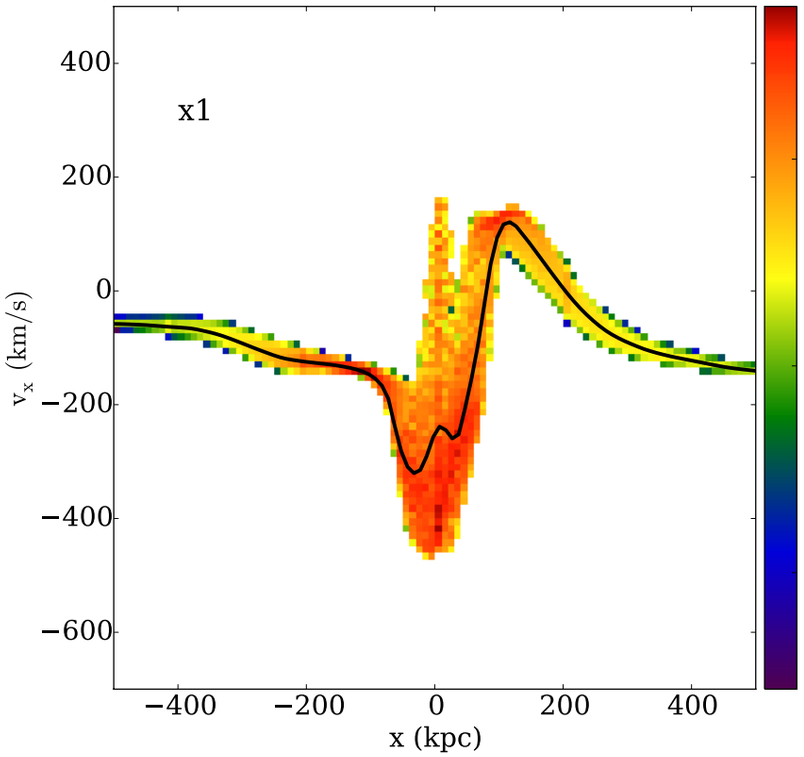


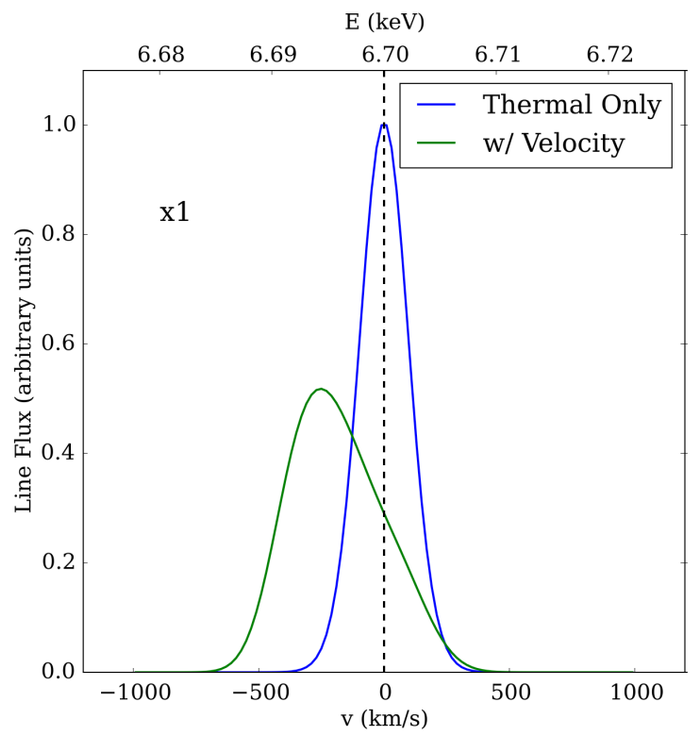


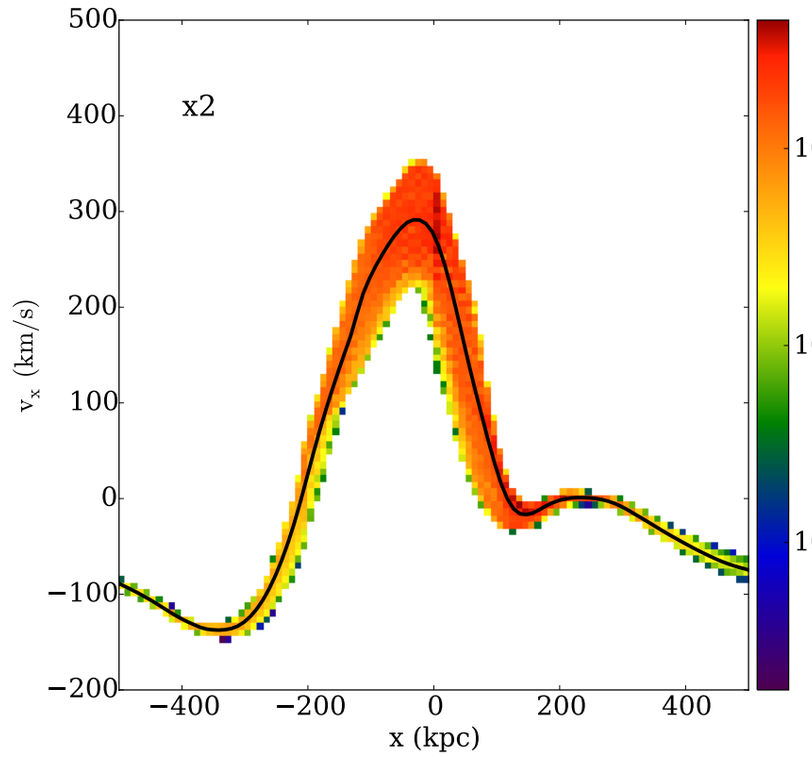


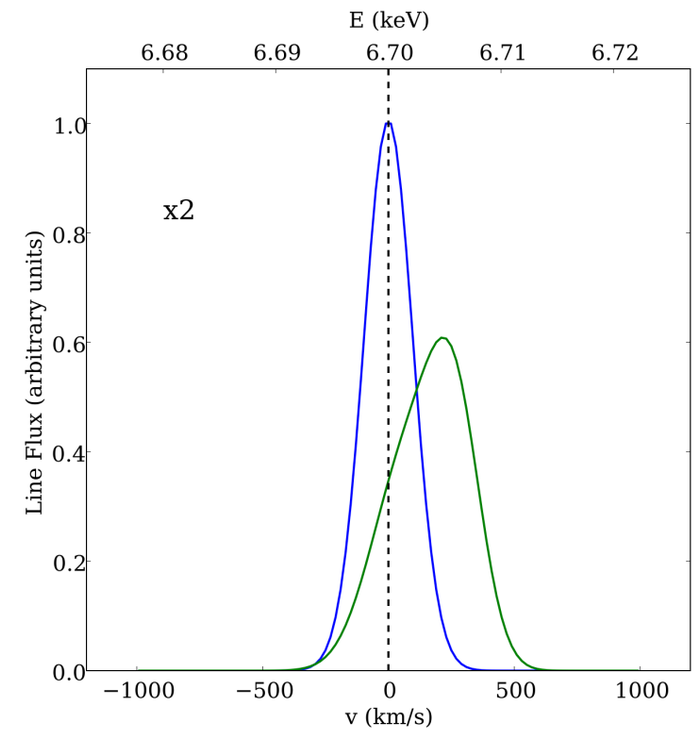
VISCOUS: IN THE PLANE



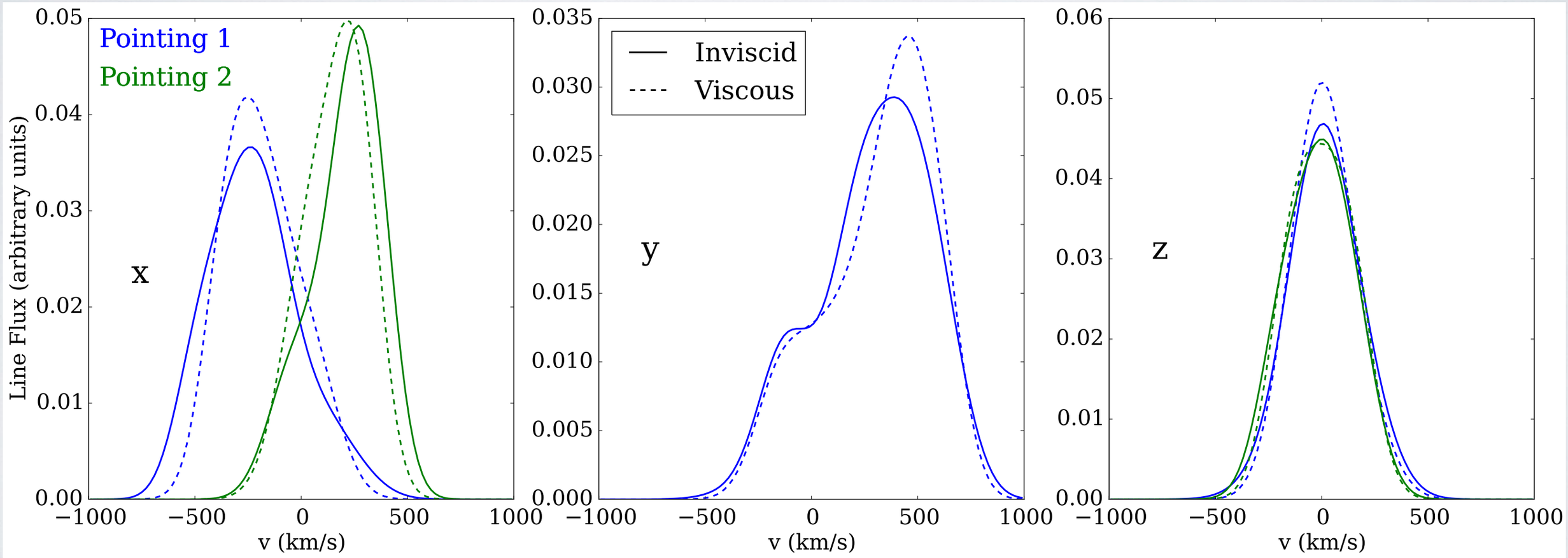






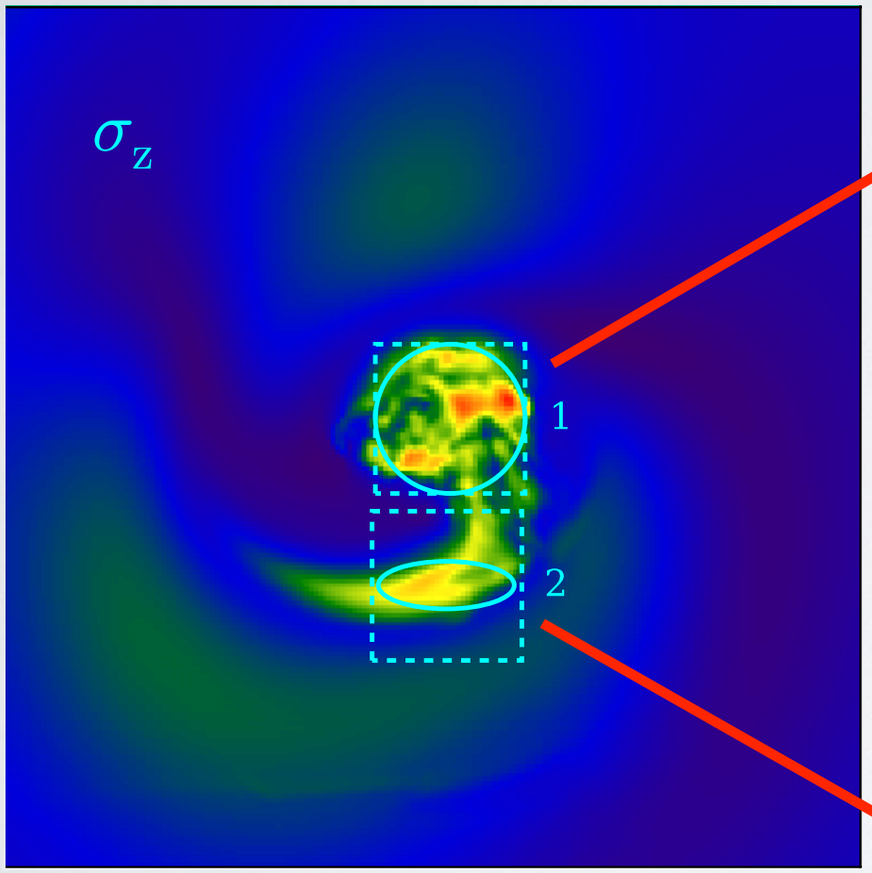


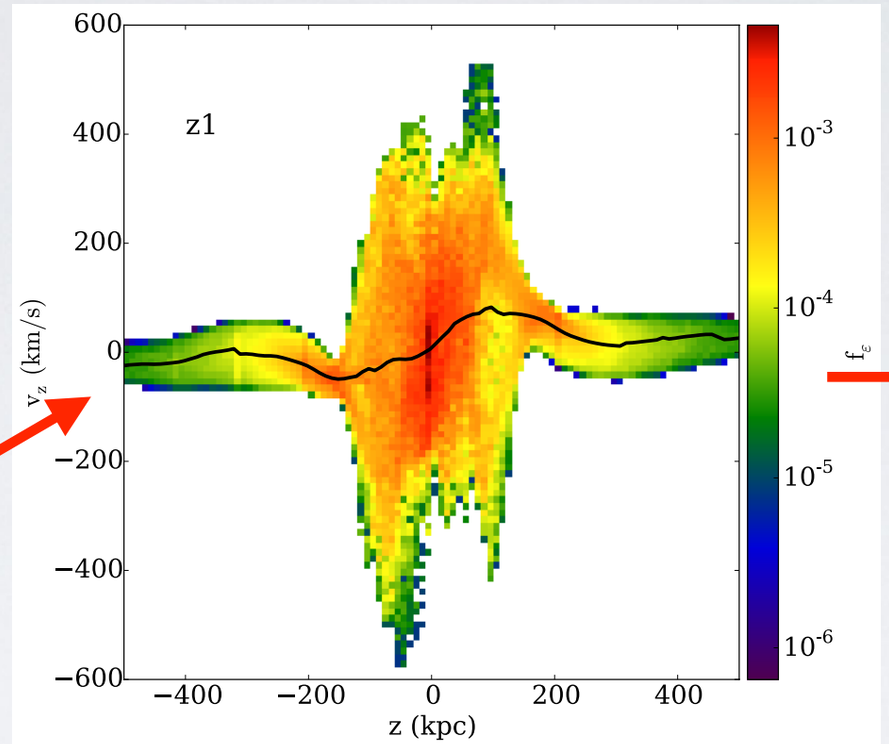
DIFFERENT VISCOSITY, SAME SHAPE

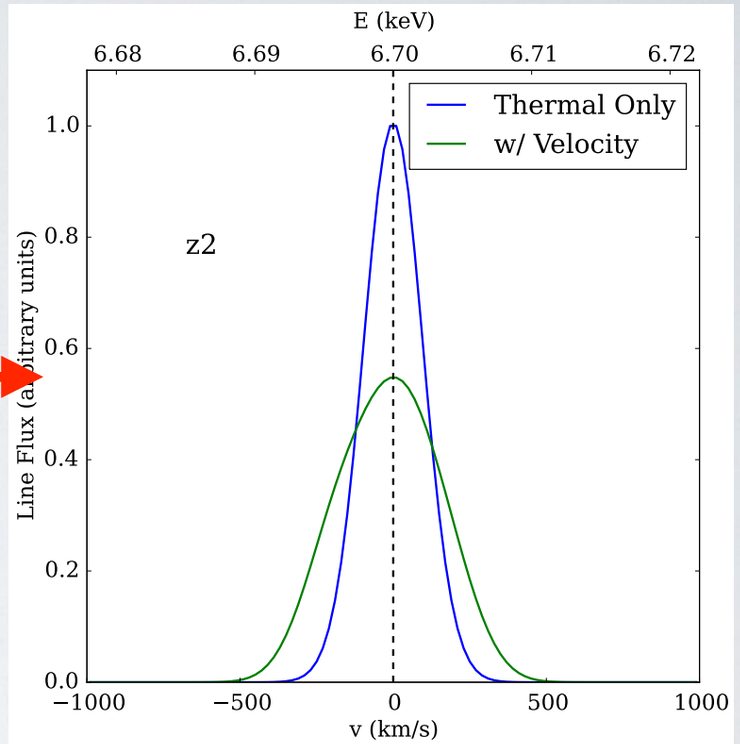


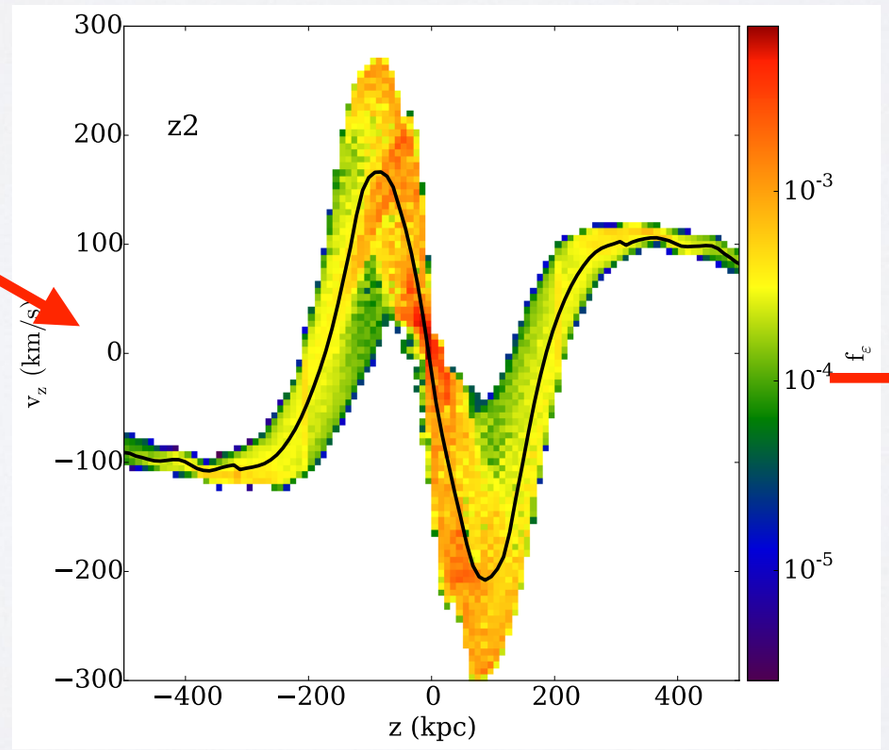
arXiv:1508.04426

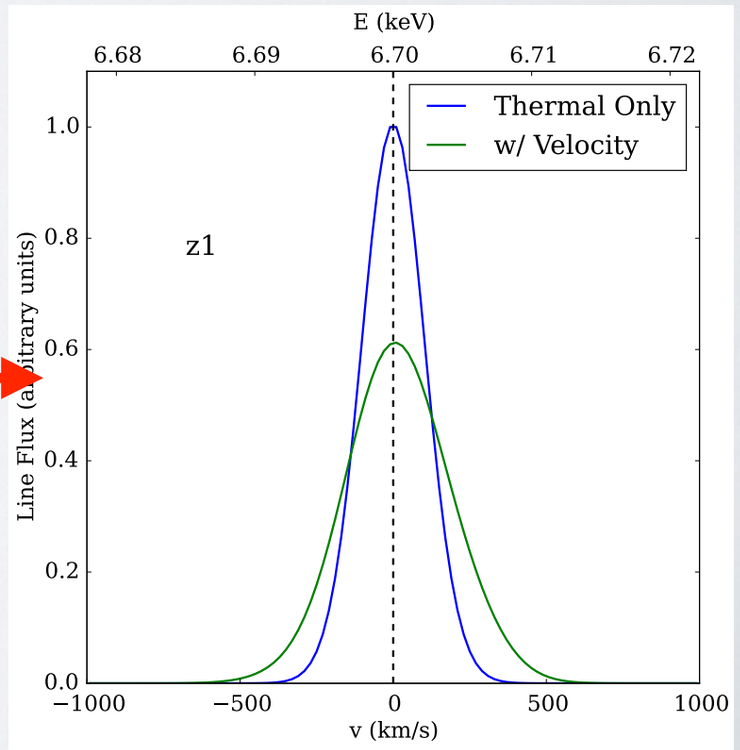
DIFFERENT MOTIONS, SAME SHAPE (SOMETIMES)





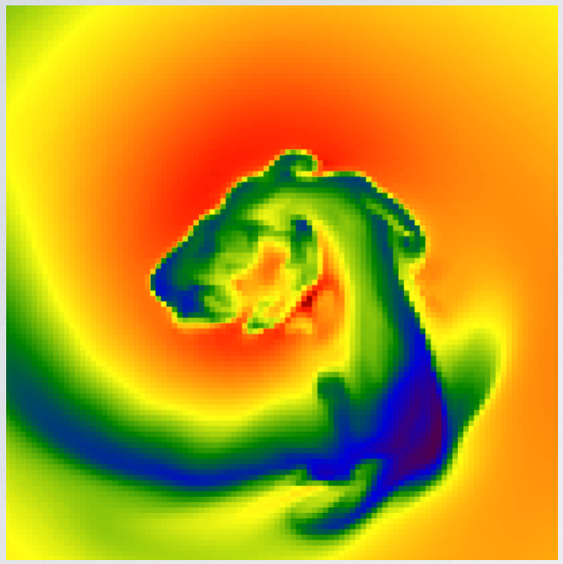






arXiv:1508.04426

SYNTHETIC OBSERVATIONS



+ PHOX

http://yt-project.org

http://www.mpa-garching.mpg.de/~kdolag/Phox/

(Biffi et al 2012, 2013, MNRAS)

event lists: RA, Dec, E → **SIMX** → **"real" event files**

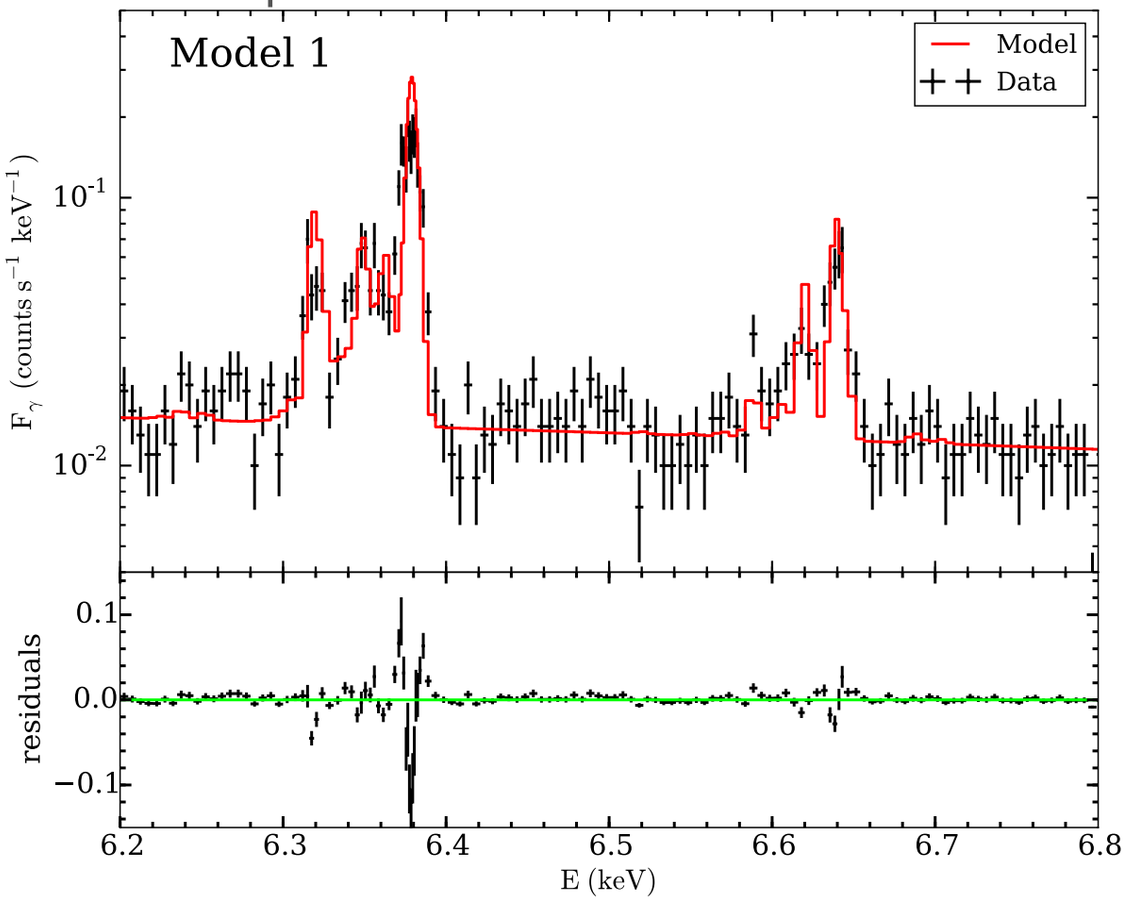
http://hea-www.harvard.edu/simx/

ZuHone et al 2014, arXiv:1407.1783

http://www.youtube.com/watch?v=fUMq6rmNshc

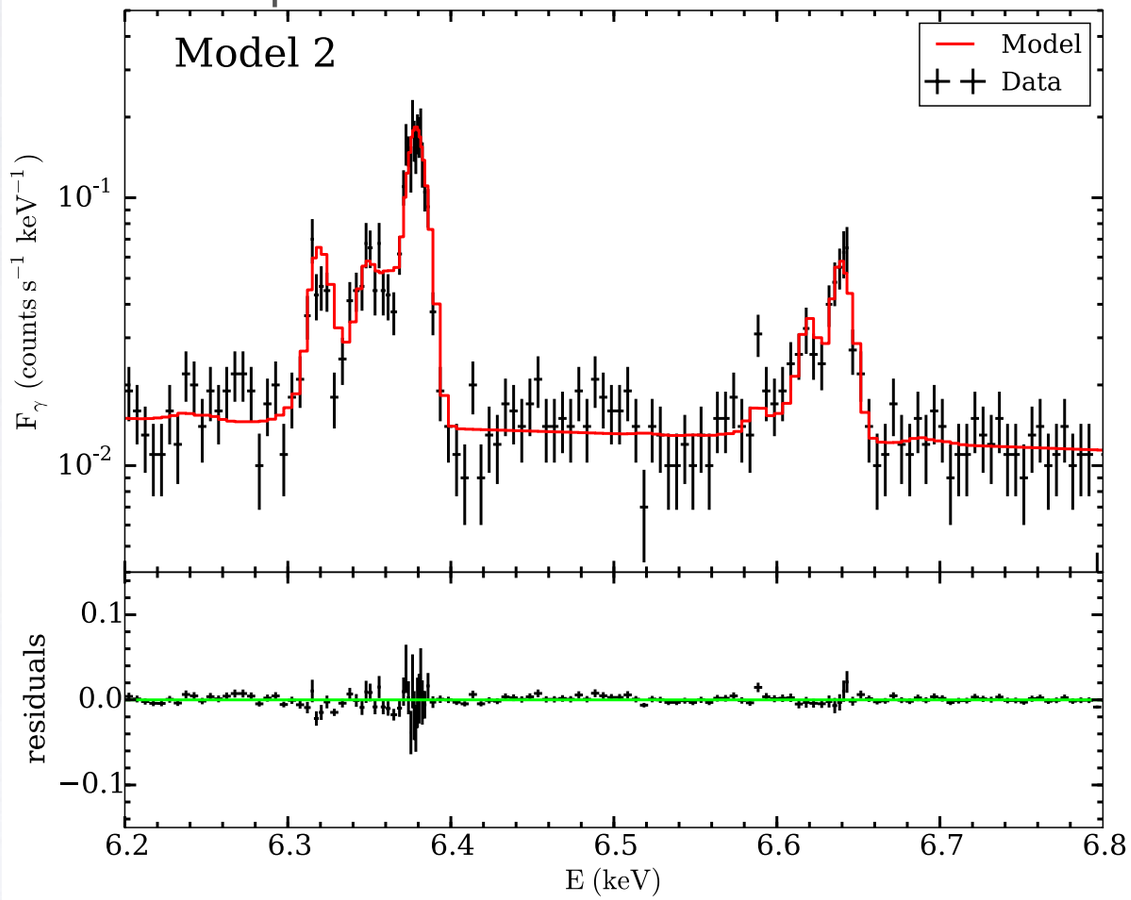
FITTING SPECTRA

exposure time = 200 ks

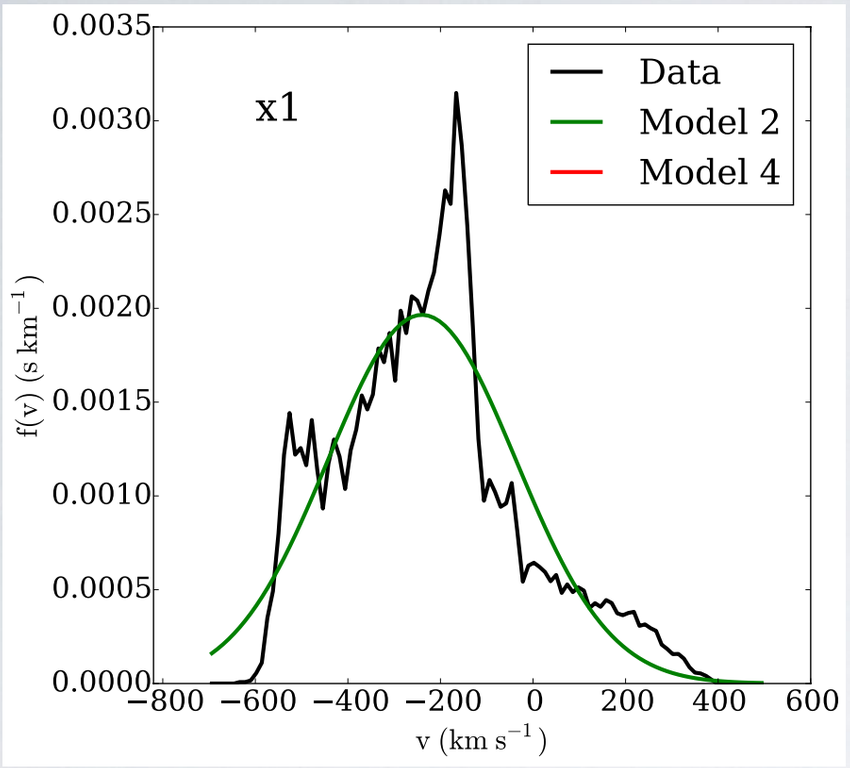


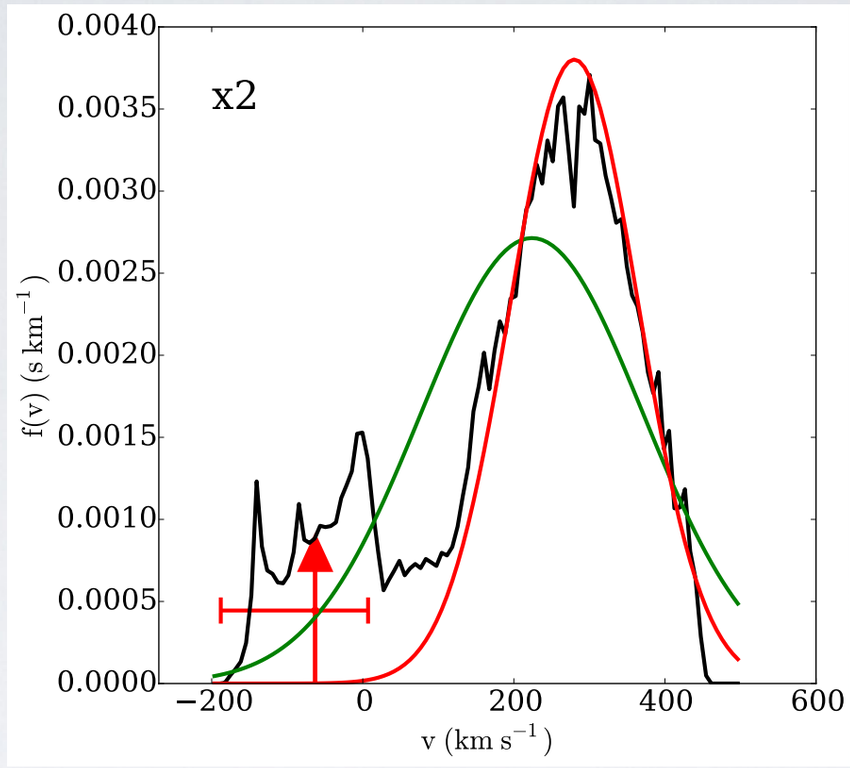
Model 1: Single-T APEC model, w/ thermal broadening only

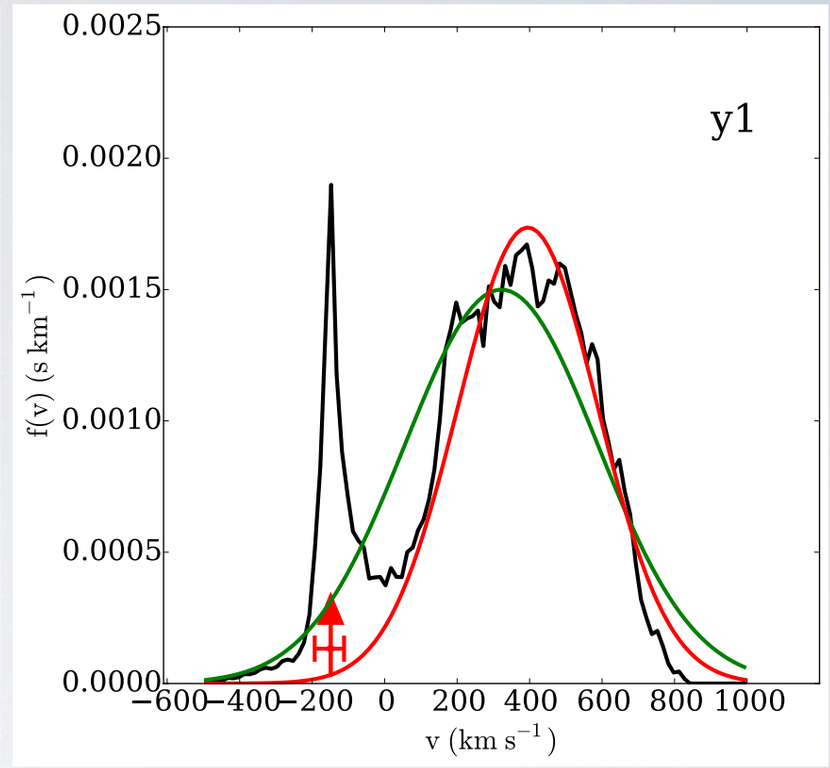
exposure time = 200 ks

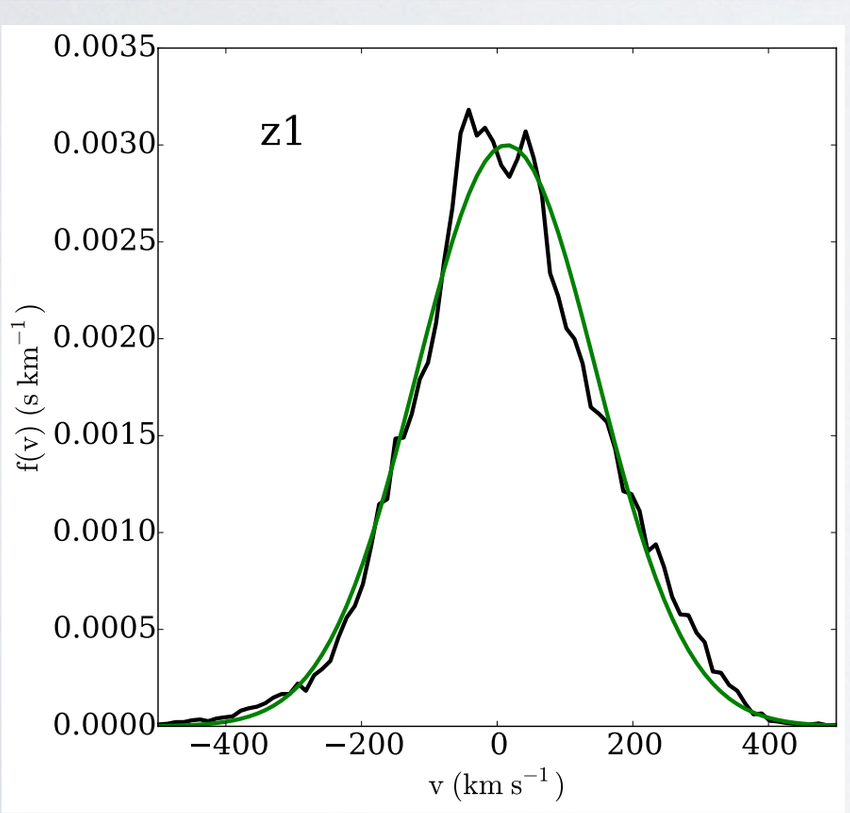


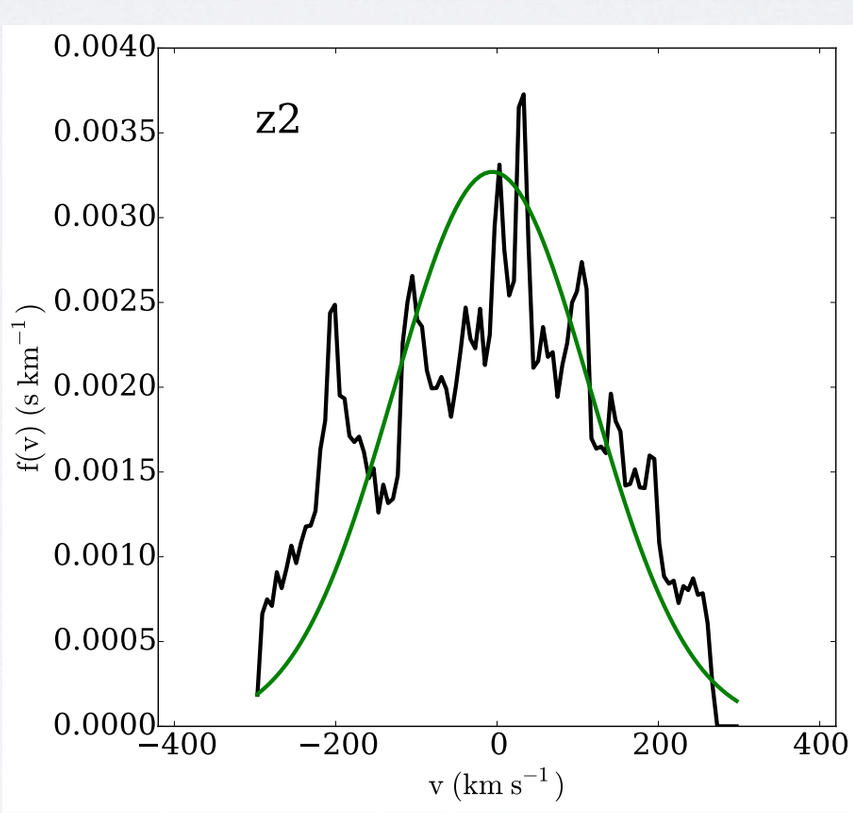
Model 2: Single-T APEC model, w/ thermal and Gaussian velocity broadening









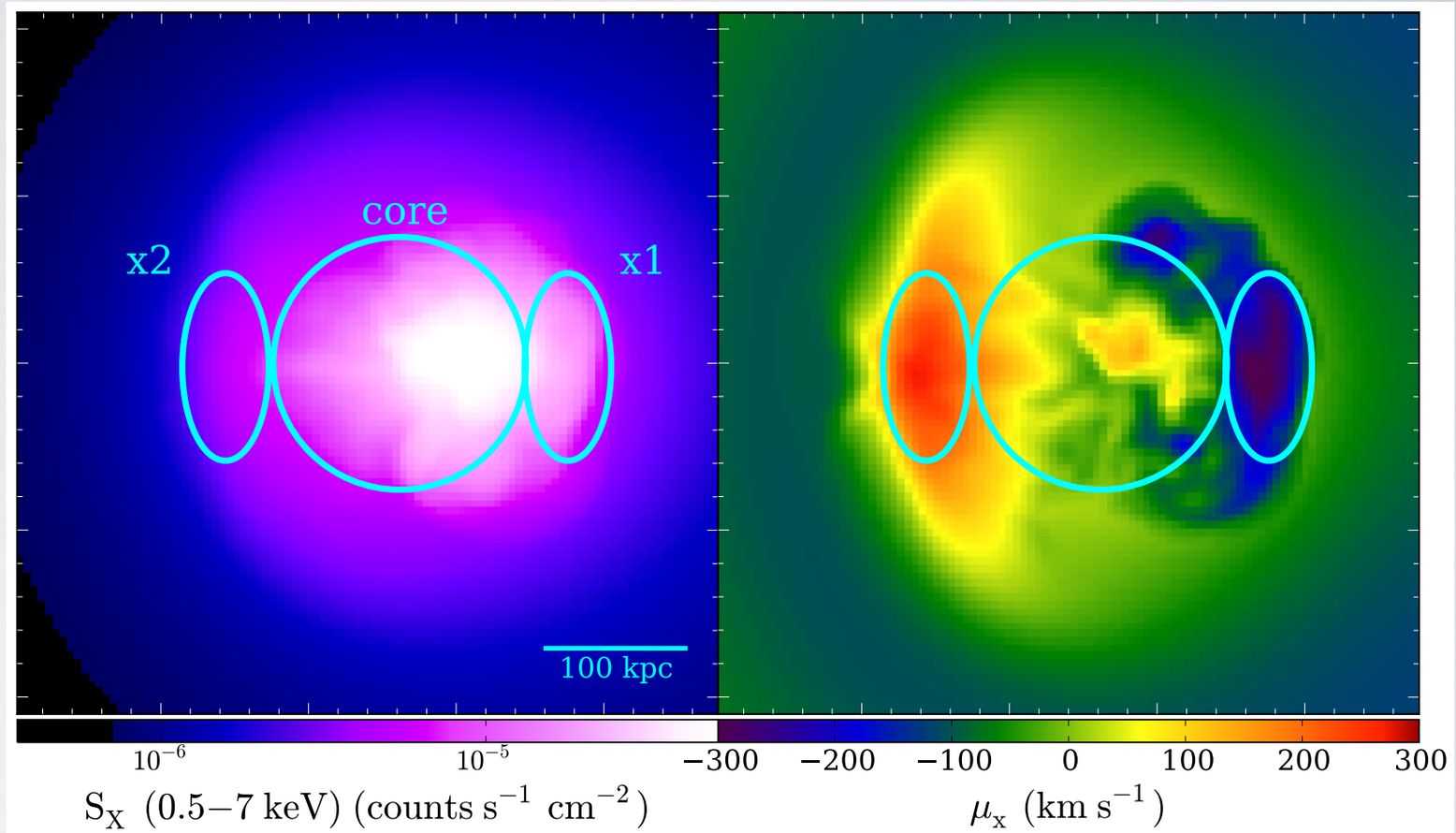


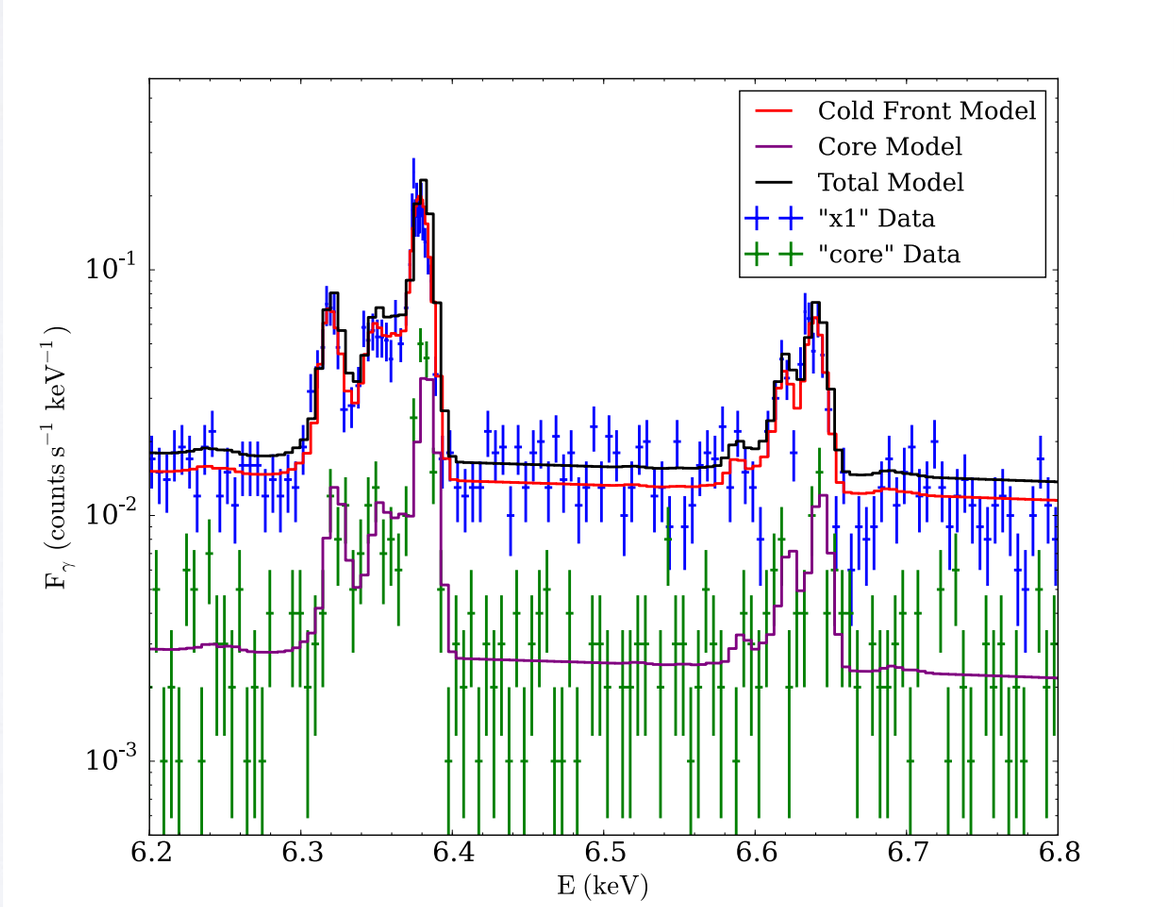
Predicted vs. Real Velocity Distributions

arXiv:1508.04426

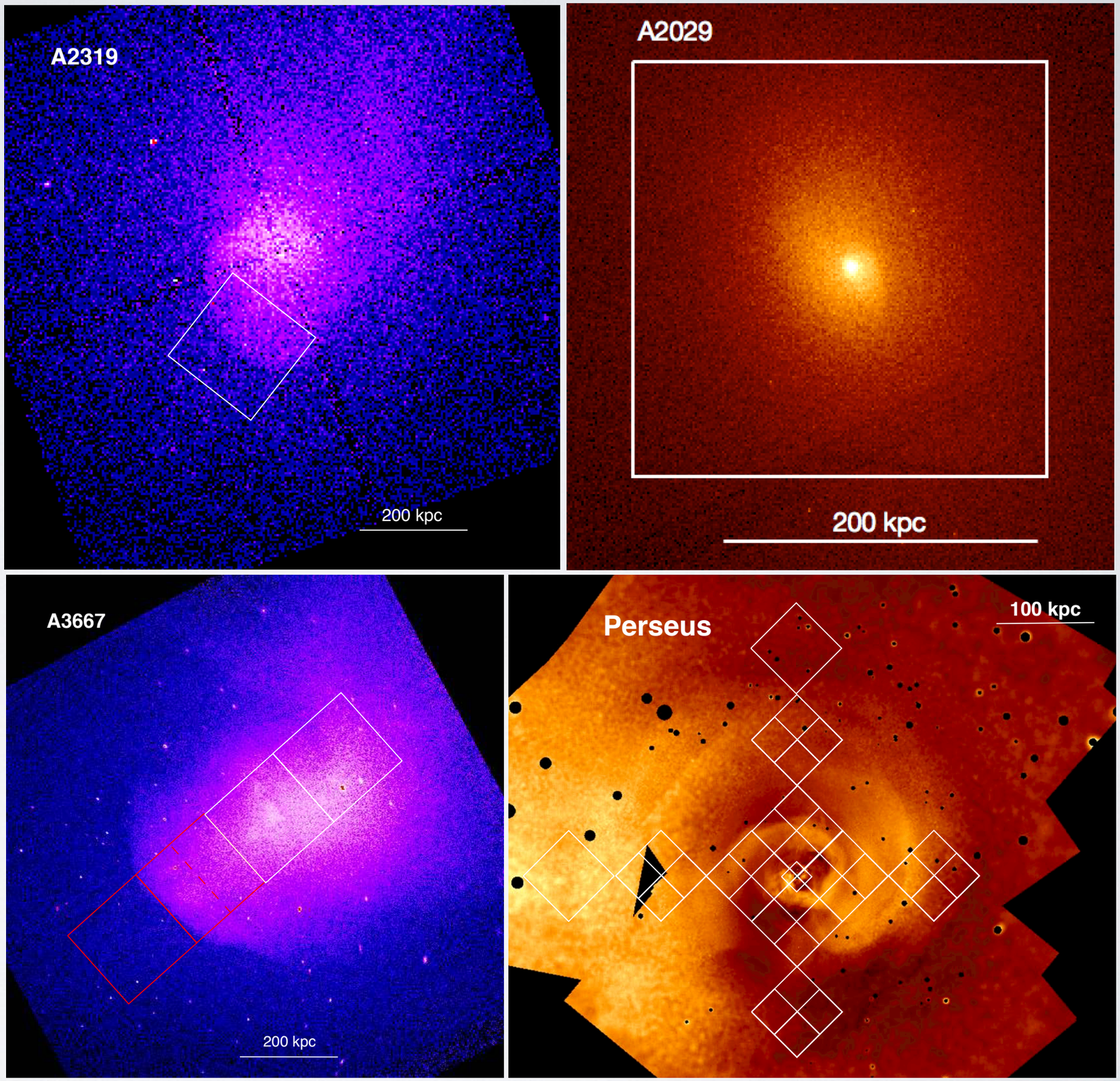
ACCOUNTING FOR PSF SCATTERING

arXiv:1508.04426





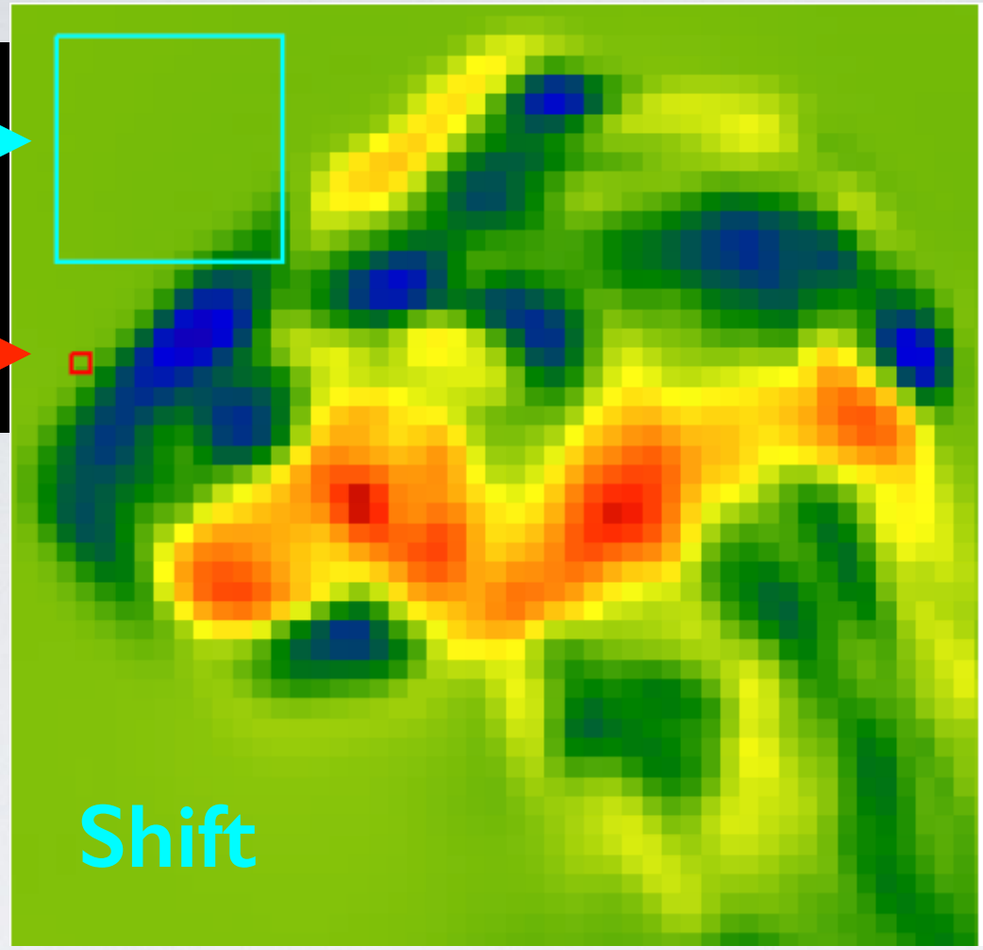
Where should we look?

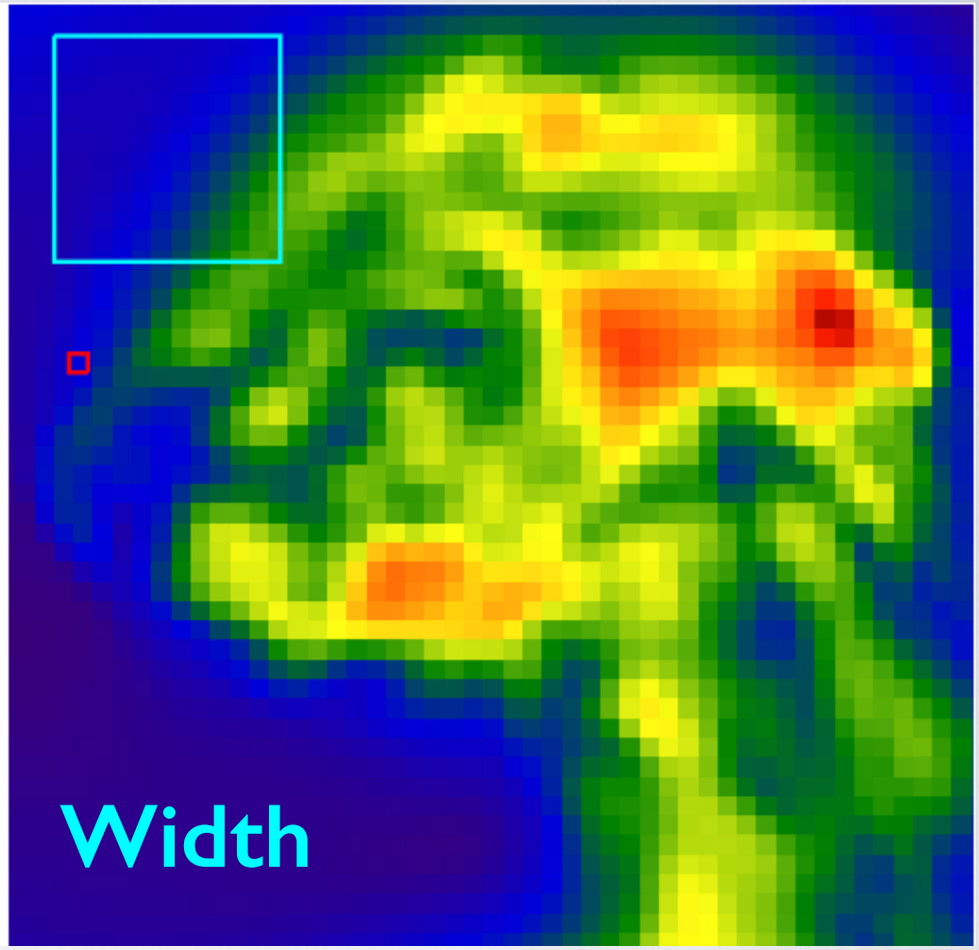


Astro-H →

Athena →

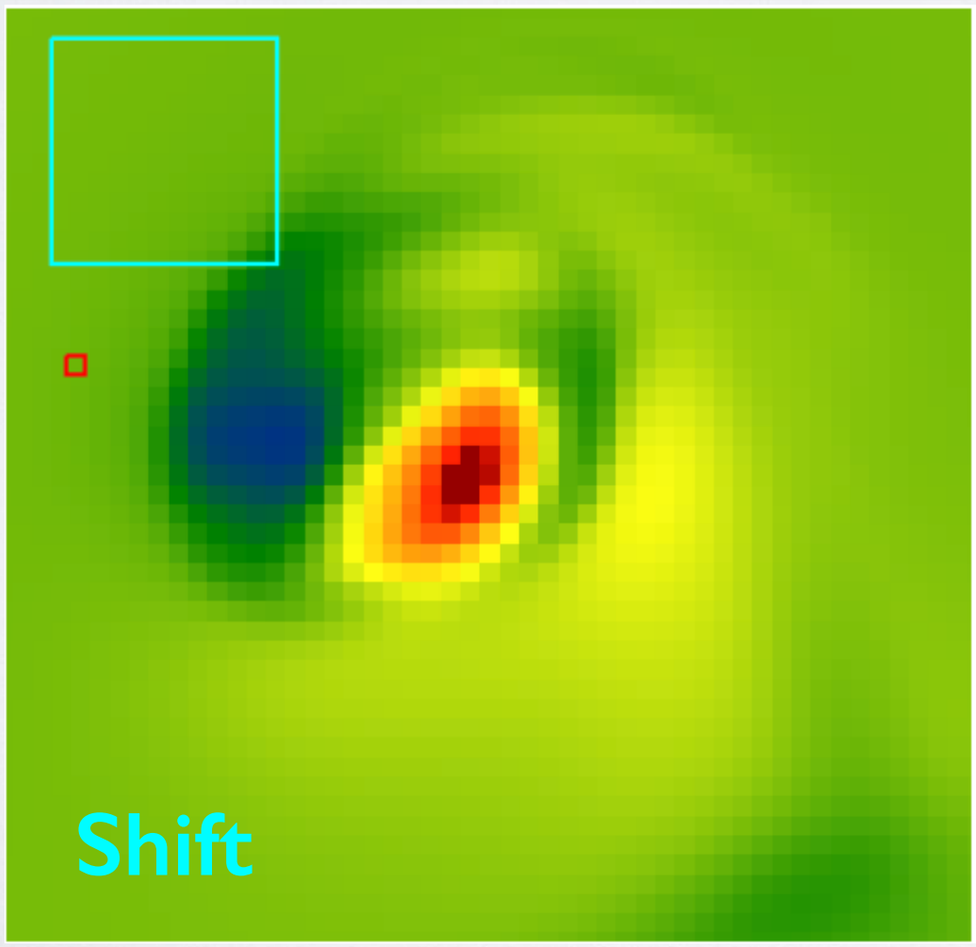
Inviscid

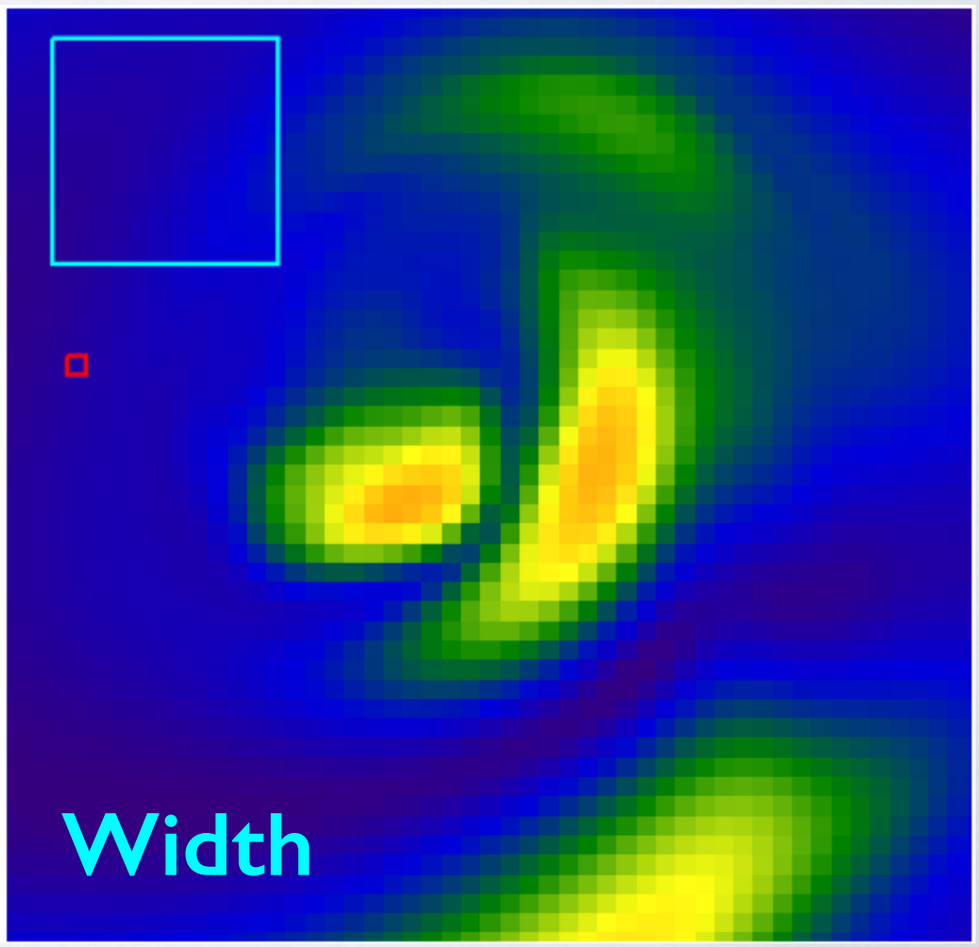




Cluster at
z = 0.05

Viscous





SUMMARY

- *Astro-H* will be able to measure line shifts and widths from sloshing motions in nearby galaxy clusters

- It will be difficult to distinguished line broadening from sloshing motions vs. turbulent motions

- Constraints on viscosity are probably limited

- Must worry about systematics—Gaussian models for non-Gaussian velocity distributions, PSF scattering from core

- What do we need? Better spatial resolution! (Athena, X-ray Surveyor, etc.)