IXO
International X-ray Observatory
(formerly Constellation-X)

Supernova & Stellar Feedback Panel: Whitepaper edition.

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Changes since the Feb 21/22 FST meeting

1) Focus exclusively on feedback and kinematics in starburst galaxies (dropped normal SFing galaxies).

2) Key science question: ***What mass of metals can a starburst-driven wind eject into the IGM as a function of the mass of the host galaxy?***

3) Theoretical work on expected superwind velocities in X-ray-emitting phases vs. warm neutral/ionized gas (optical/UV studies).

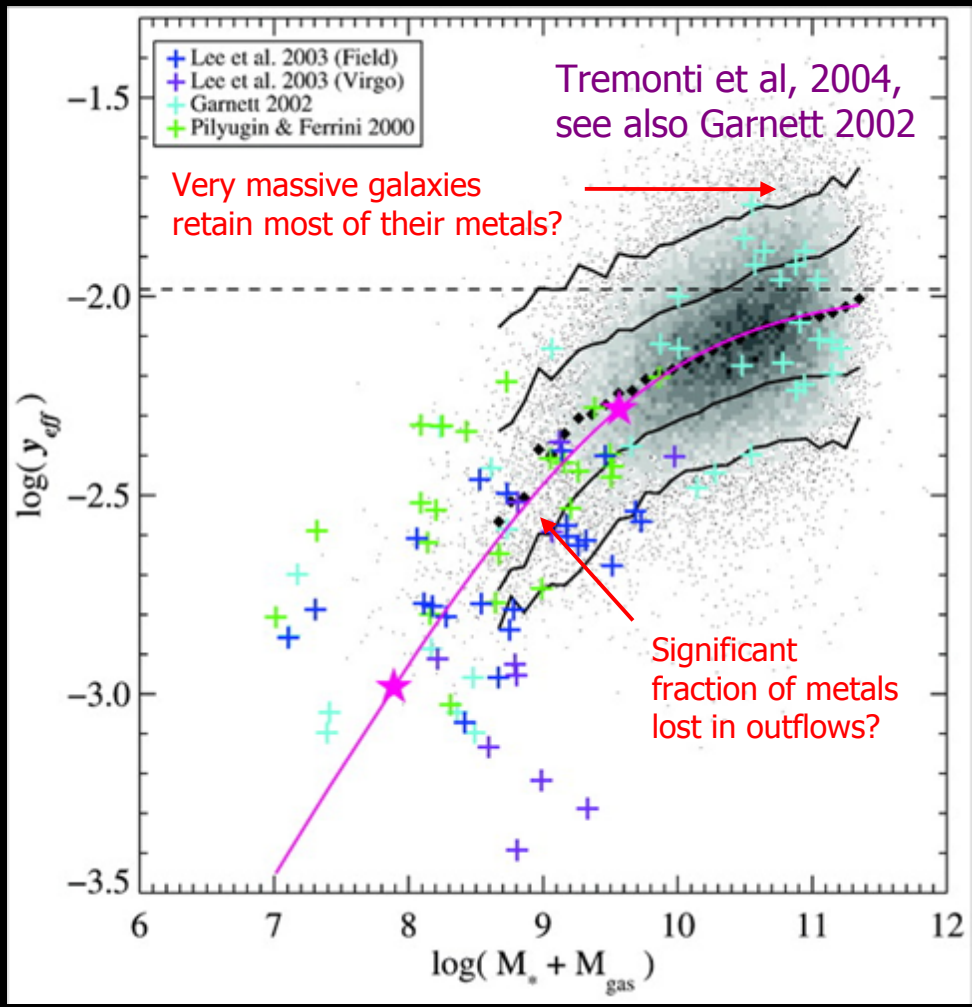
4) Refinement of XMS spectral simulations and influence of the accuracy of the XMS energy scale.

5) Some consideration of measuring v_{HOT} in hard band, or with gratings.

6) Starburst galaxy sample: measure v_{HOT} over a broad range in M_{galaxy}.

What mass of metals can a starburst-driven wind eject into the IGM as a function of the mass of the host galaxy?

- Which galaxies are responsible for the enrichment of the IGM?
- Is the galaxy M-Z relationship (e.g Tremonti et al 2004) really due to metal-loss via winds?
- Most of the energy and metals in superwinds are in the hot phases (NOT probed by optical/UV spectroscopy).
- Need to measure velocity of hot metal-enriched SN ejecta in superwinds in order to assess whether material will escape.



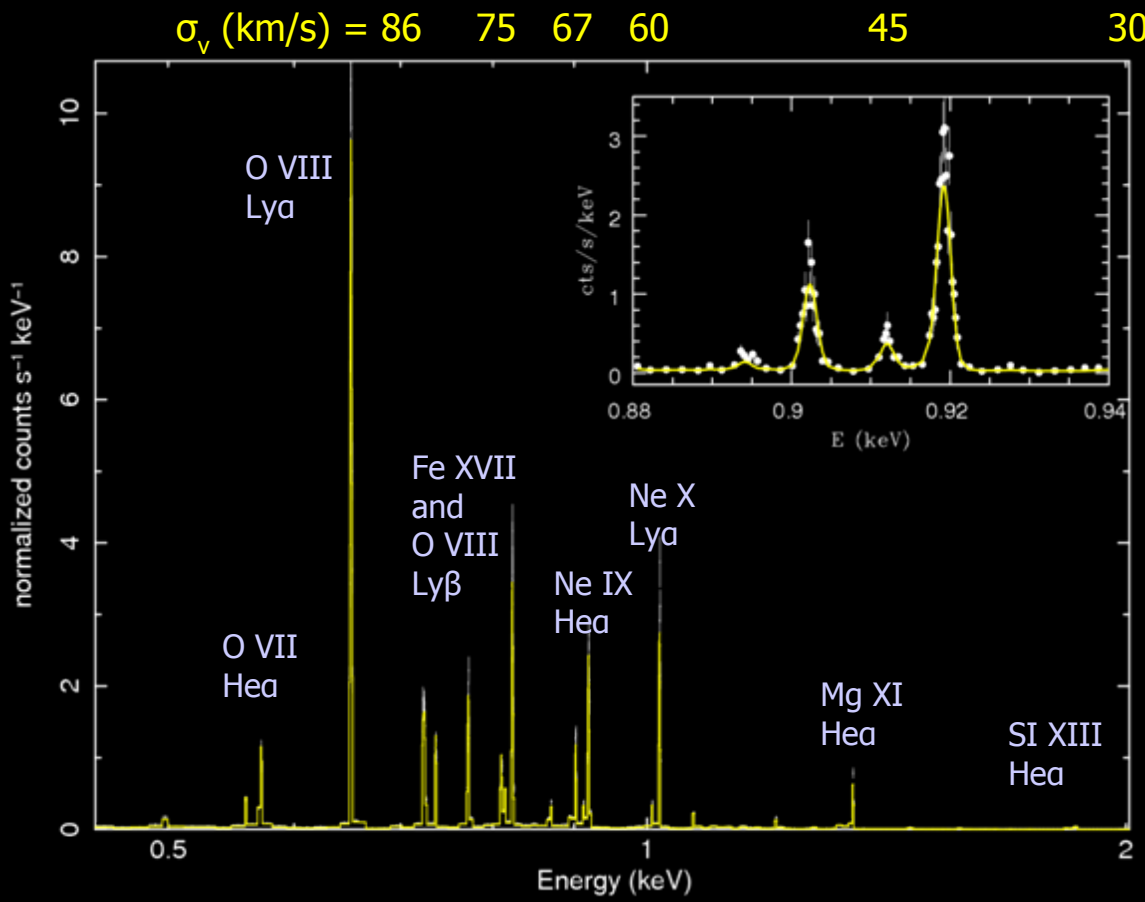
XMS spectra

Escape velocities for local superwind galaxies and Lyman Break Galaxies with $M_* > 10^{10}$ M_{sun} are in the range 300 – 700 km/s.

The XMS calorimeter can measure:

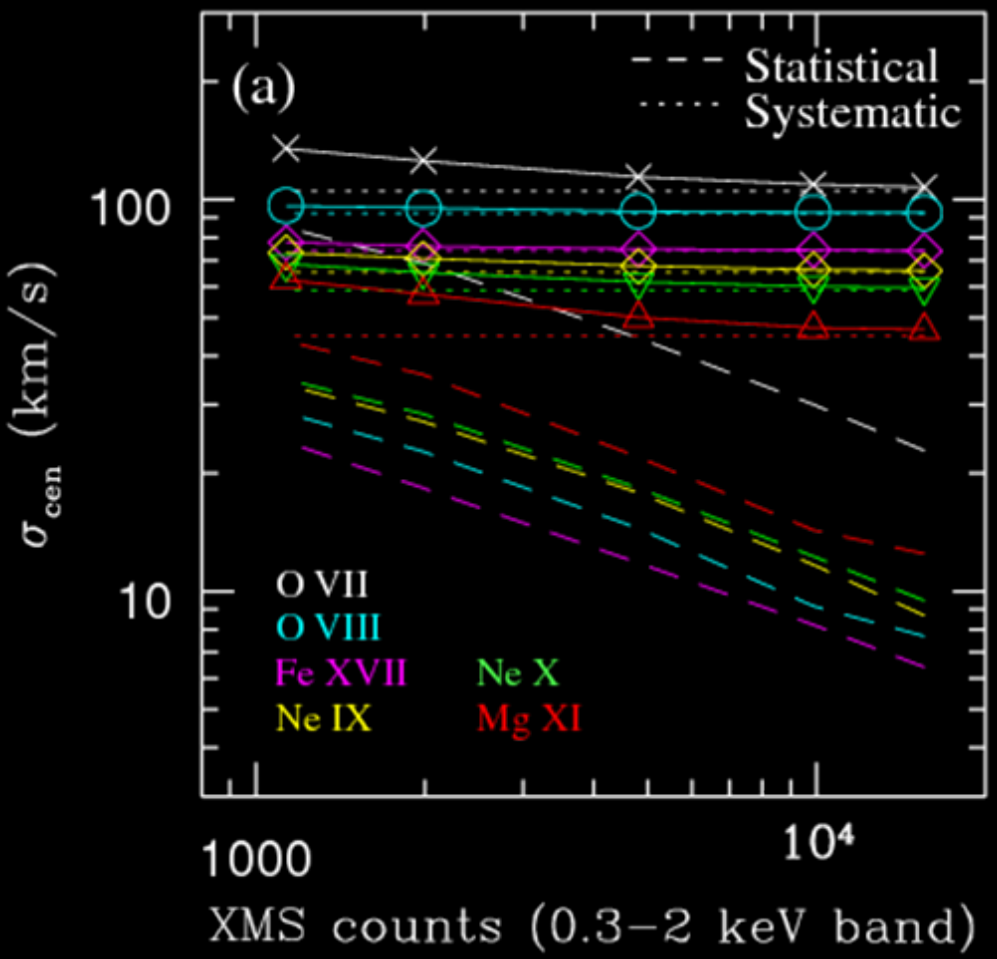
1.) Individual X-ray line energies (redshifts) to an accuracy of +/-0.2 eV (see σ_v in Figure on RHS)

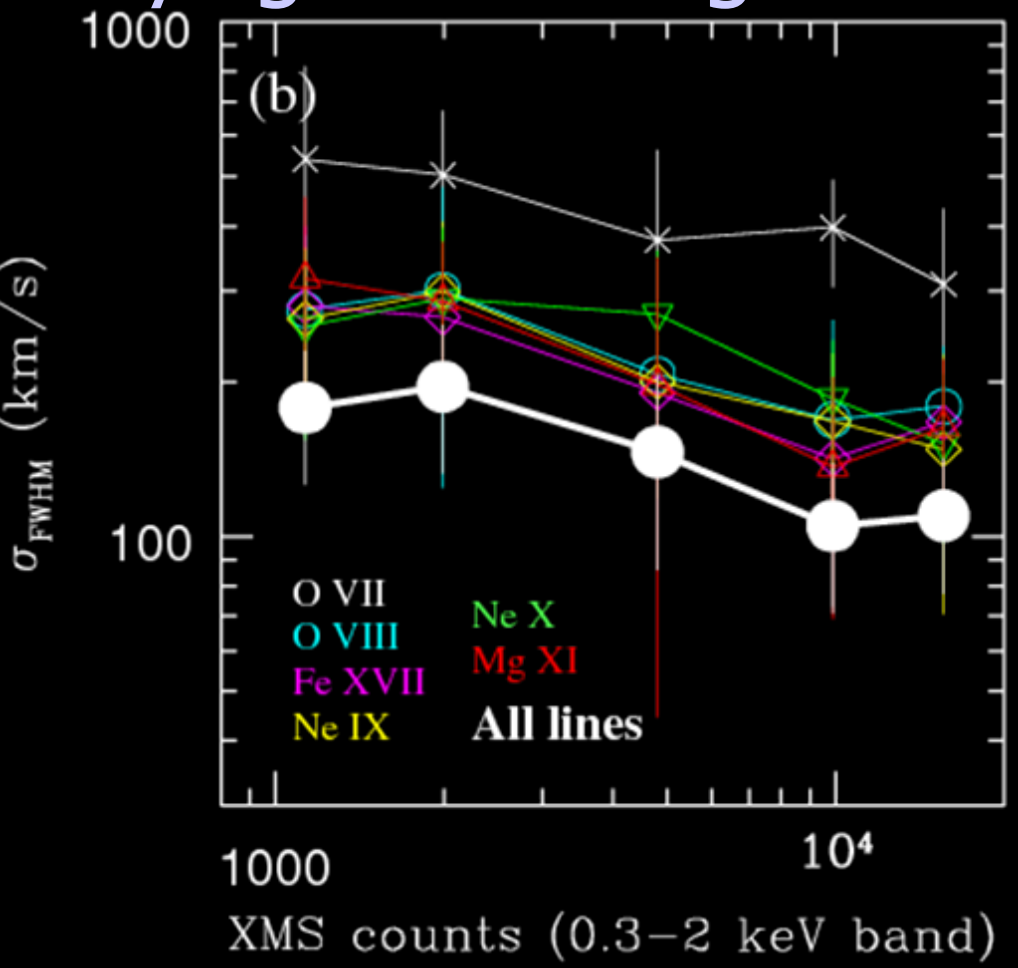
2.) line widths to +/- 200 km/s (individual soft X-ray lines) or +/-100 km/s (combining all soft X-ray lines) in < 100 ksec exposures for even the faintest regions of currently detected superwinds.



Constellation-X XMS spectrum with 17000 detected counts (0.3-2 keV). For any line with > 40 counts the line redshift can be determined to the accuracy shown above (this is dominated by the systematic uncertainty in the energy scale).

XMS velocity sensitivity: good enough





Caveats: (1) No background assumed.

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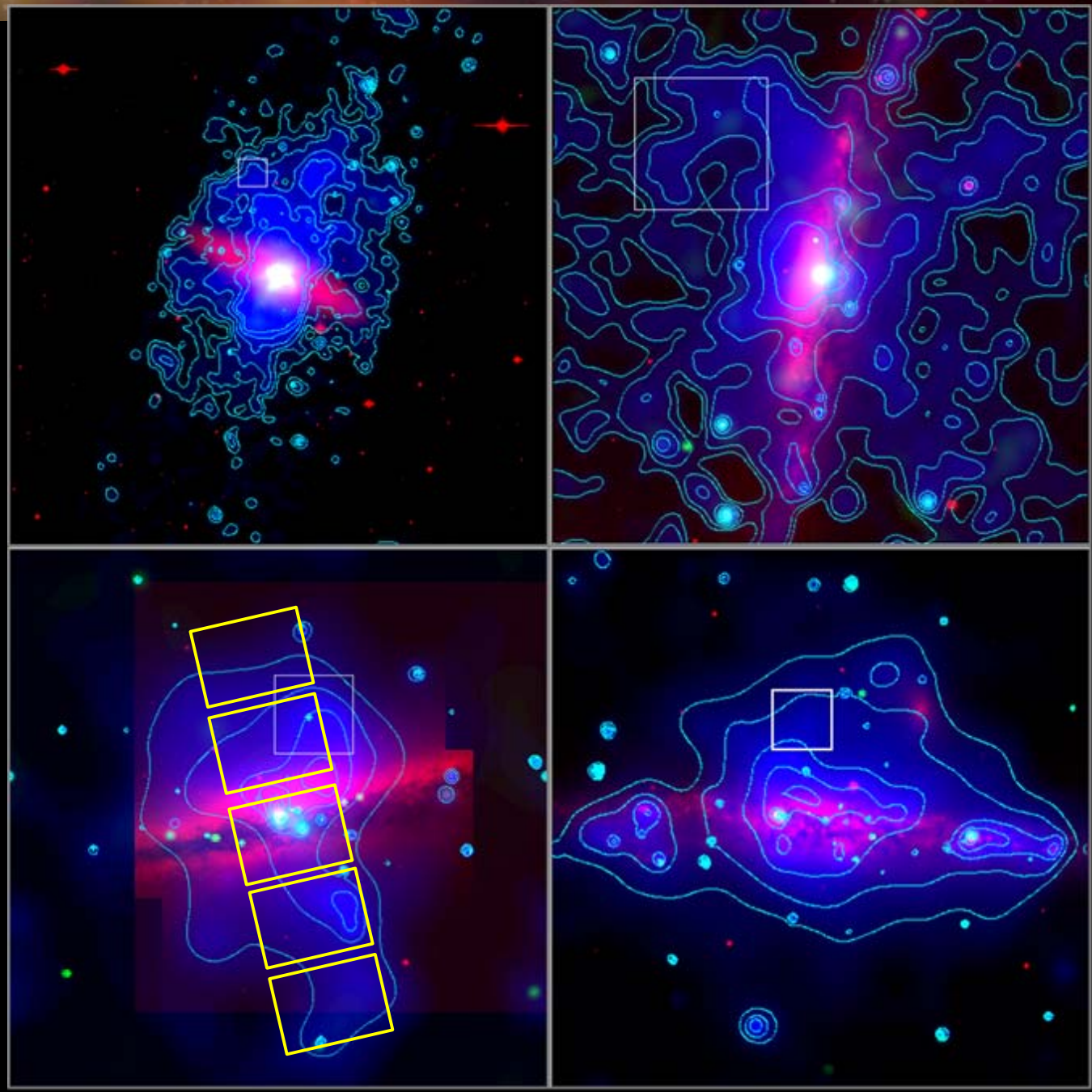
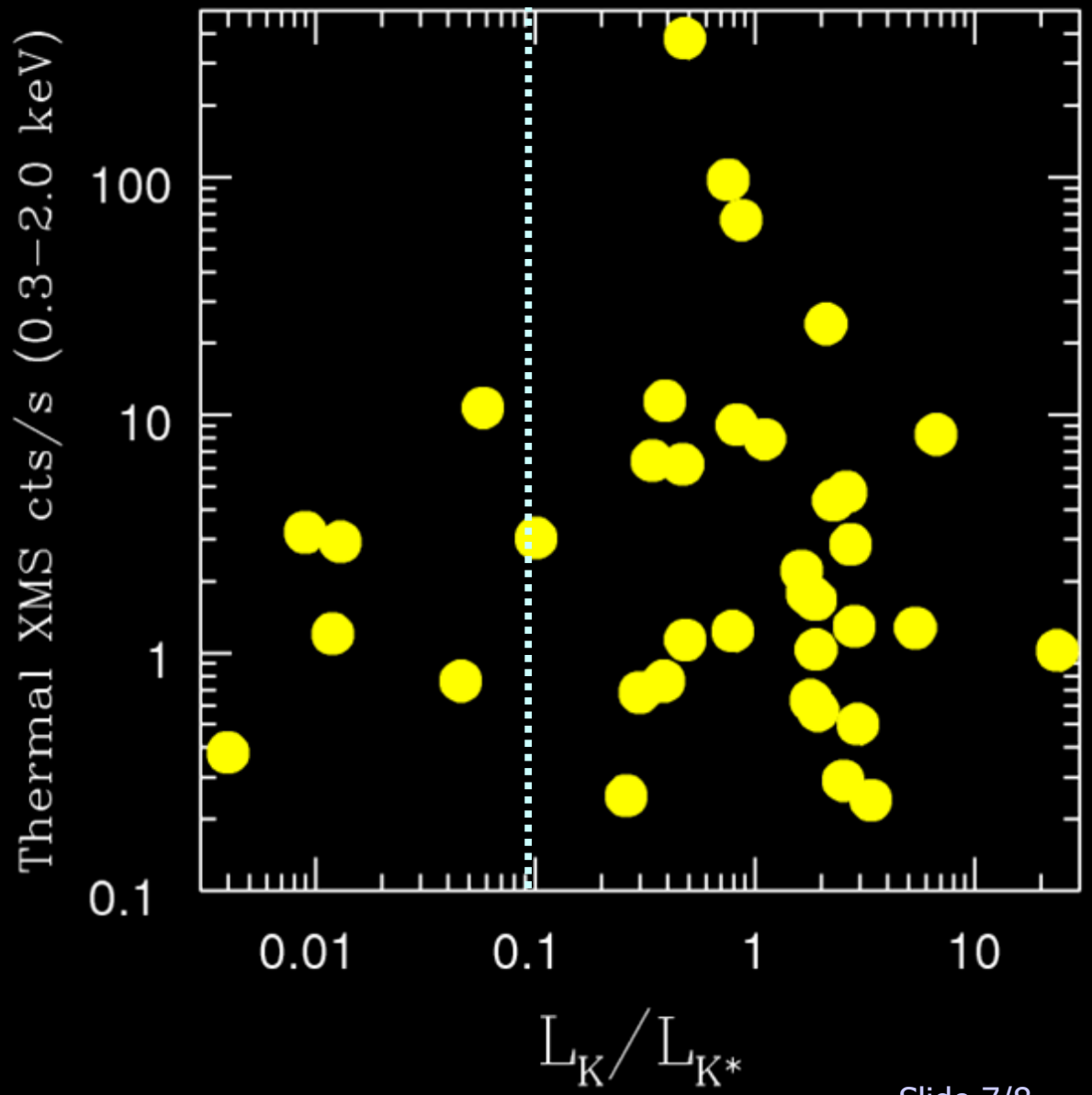
Targets and Observational Strategy

- Starburst sample spanning broad range of galaxy mass.
- Typical angular scales of superwind X-ray nebulae: 0.5 – 10 arcmin.
- Measure velocities in multiple regions per galaxy -> PV diagrams.



Starburst Sample

- Predicted total galaxy+wind 0.3-2 keV XMS count rates for diffuse thermal emission (excluding point sources).
- Based on Chandra/XMM.
- 35 targets with D< 200 Mpc.
- Representative, not complete.
- To get 50000 cts/galaxy (i.e ~ 5 high quality spectra) only need 1.3 Ms to observe these 35 starbursts.



Summary of recent panel activity

1) Focus exclusively on feedback and kinematics in starburst galaxies (dropped normal SFing galaxies).

2) Key science question: ***What mass of metals can a starburst-driven wind eject into the IGM as a function of the mass of the host galaxy?***

3) Theoretical work on expected superwind velocities in X-ray-emitting phases vs. warm neutral/ionized gas (optical/UV studies).

4) Refinement of XMS spectral simulations and influence of the accuracy of the XMS energy scale.

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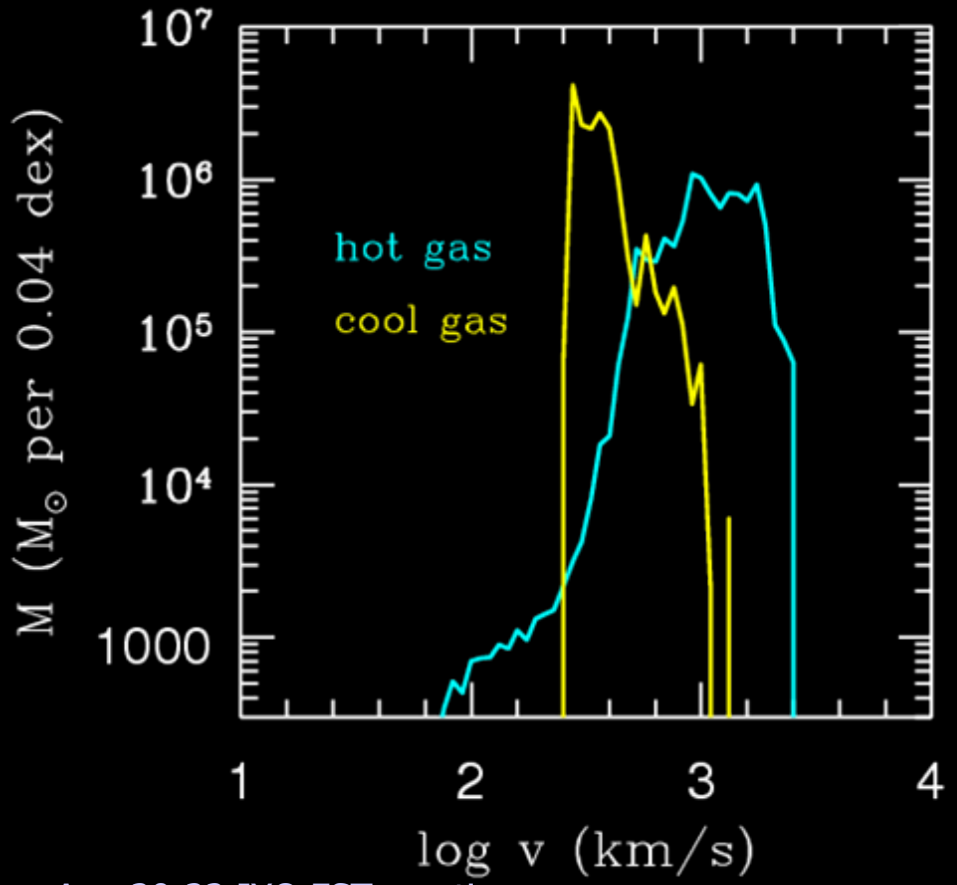
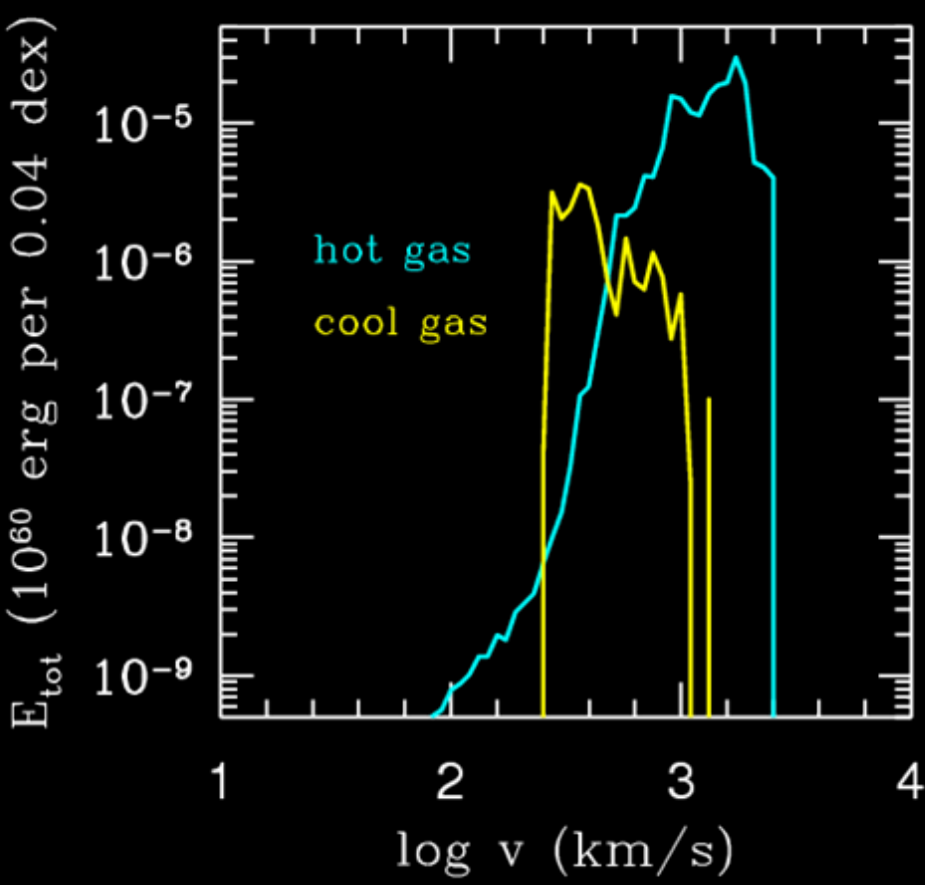
Can only measure v_{WIND} using X-rays

Standard model, halo gas (z>2 kpc)
From Strickland & Dinge, in preparation.

Cool gas: 3.8 < log T (K) < 4.2
Hot gas: 6.3 < log T (K) < 8.3



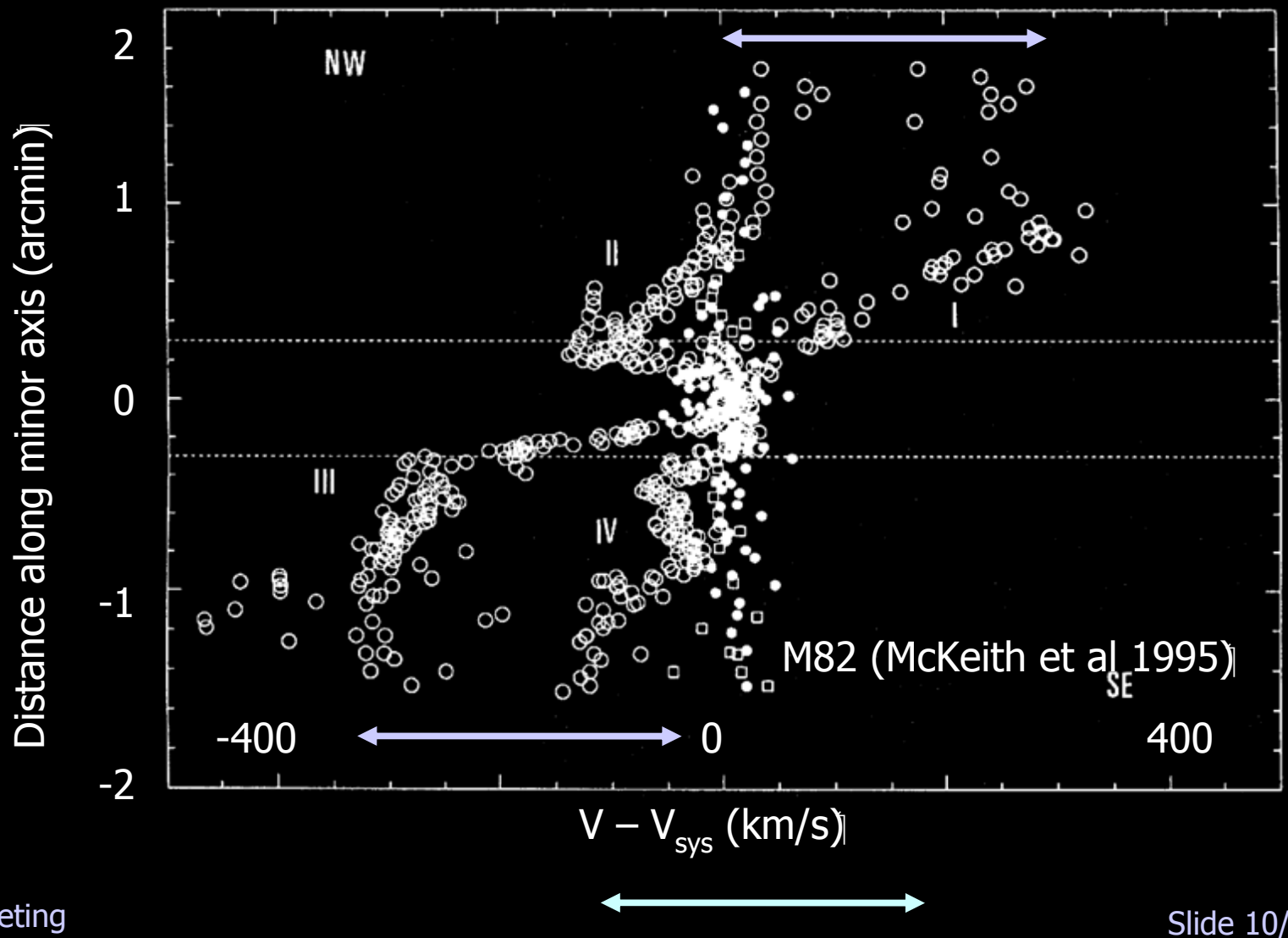


Line offsets and line splitting/breadth

Optical emission lines from roughly edge-on starbursts with winds:

(1) Lines split/broadened by divergence of flow.

(2) Lines offset from galaxy systemic velocity.



Line offsets and broadening cntd.

Optical/UV absorption lines from roughly face-on starbursts with winds:

(1) Broad lines

(2) Line centroid offsets to blue from galaxy systemic velocity.

Again, typical optical/UV line offsets and widths several hundred km/s.