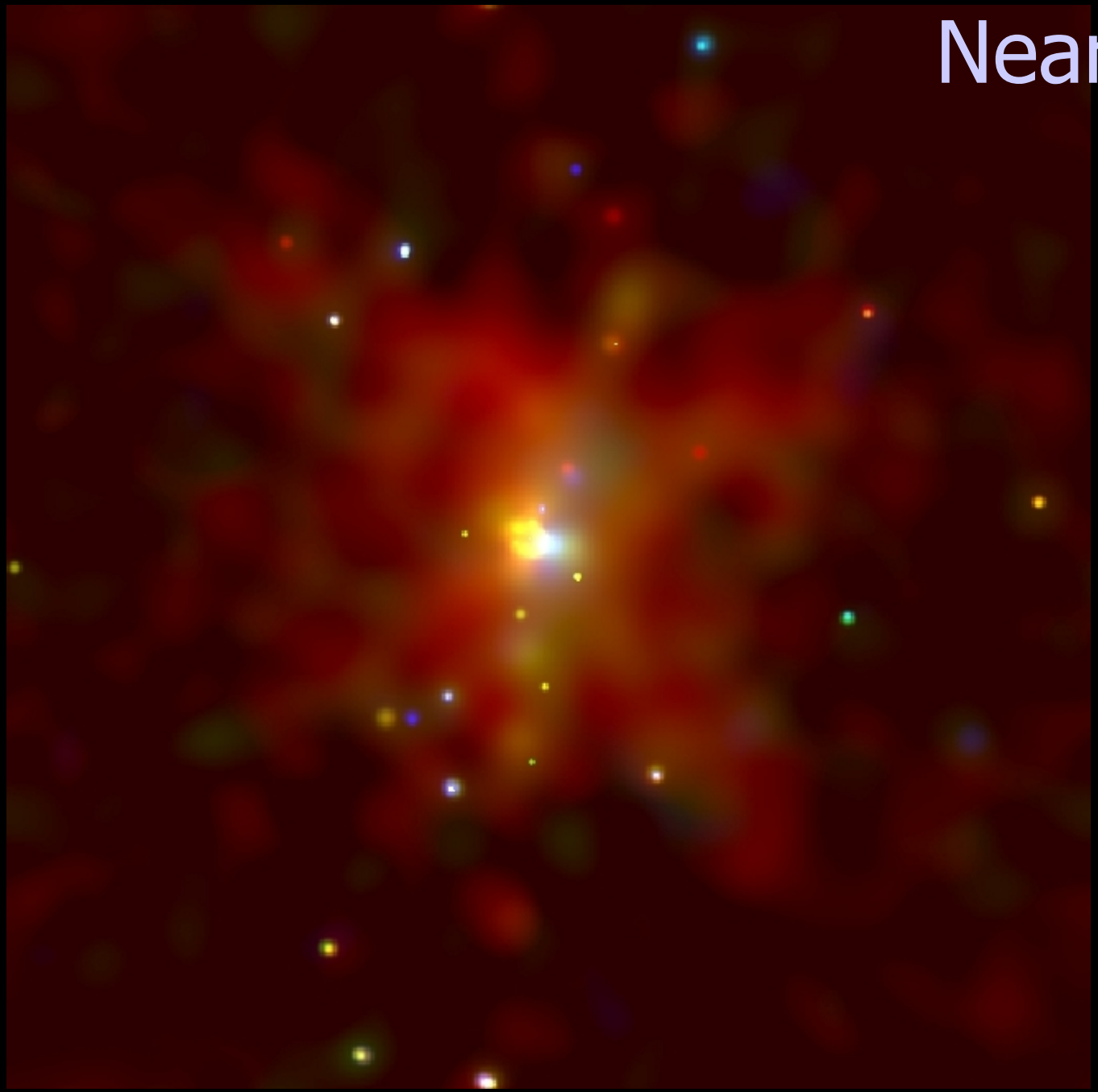


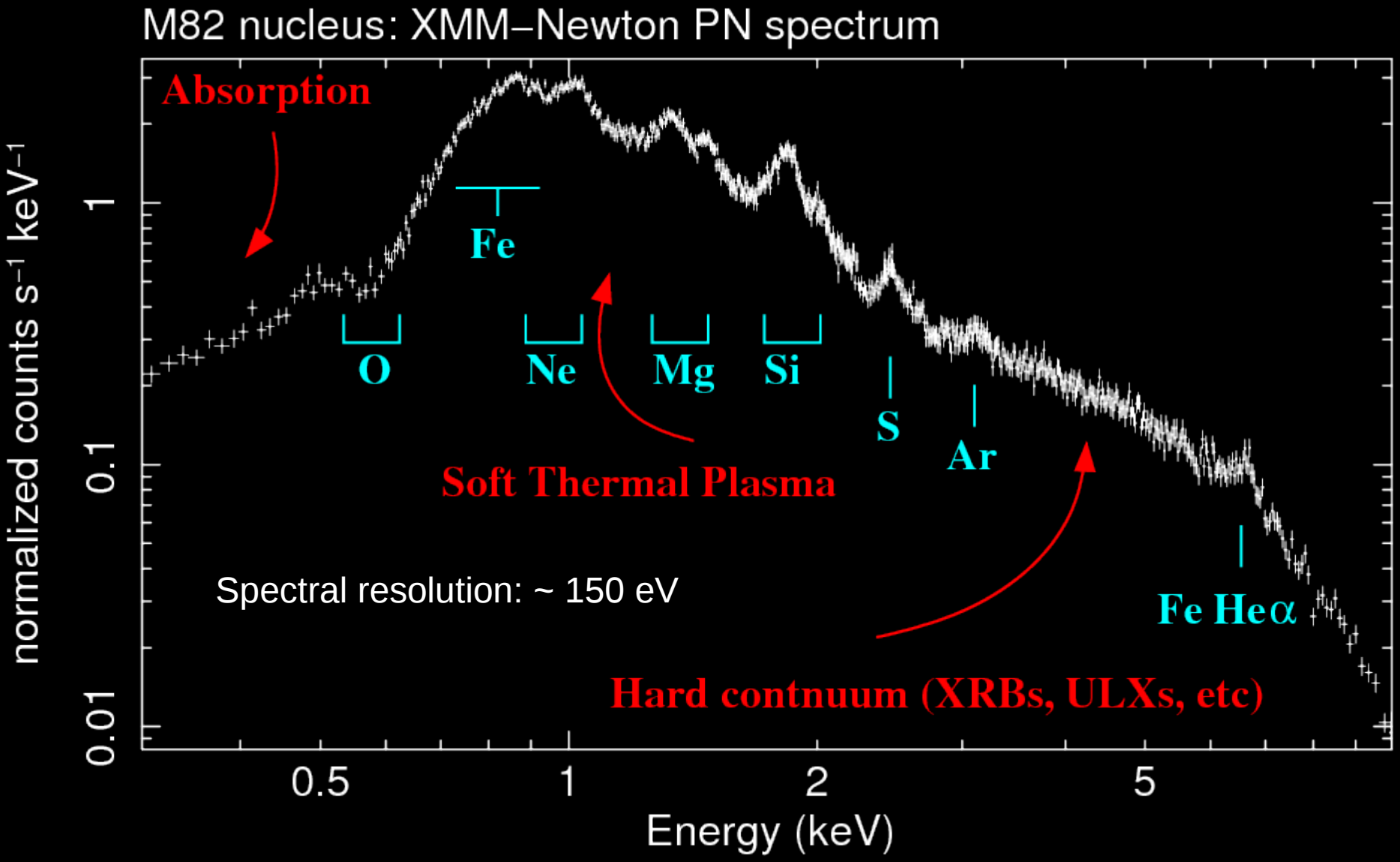
Nearby Starbursts with Suzaku

Dave Strickland
(JHU).

NGC 3079
Starburst (+ Seyfert2?)

Chandra ACIS-S
Red: 0.3-1 keV
Green: 1-2 keV
Blue: 2-8 keV

CCD spectroscopy of starburst galaxies



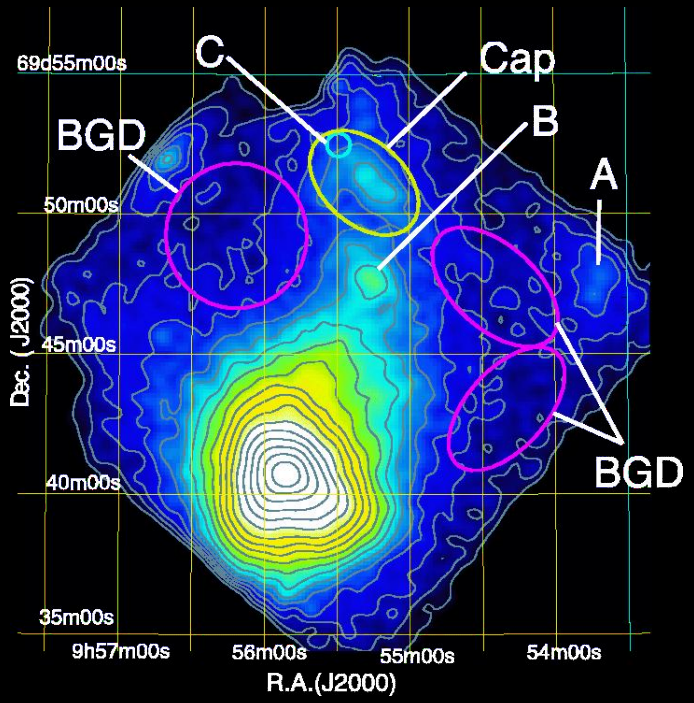
Suzaku and nearby Starbursts

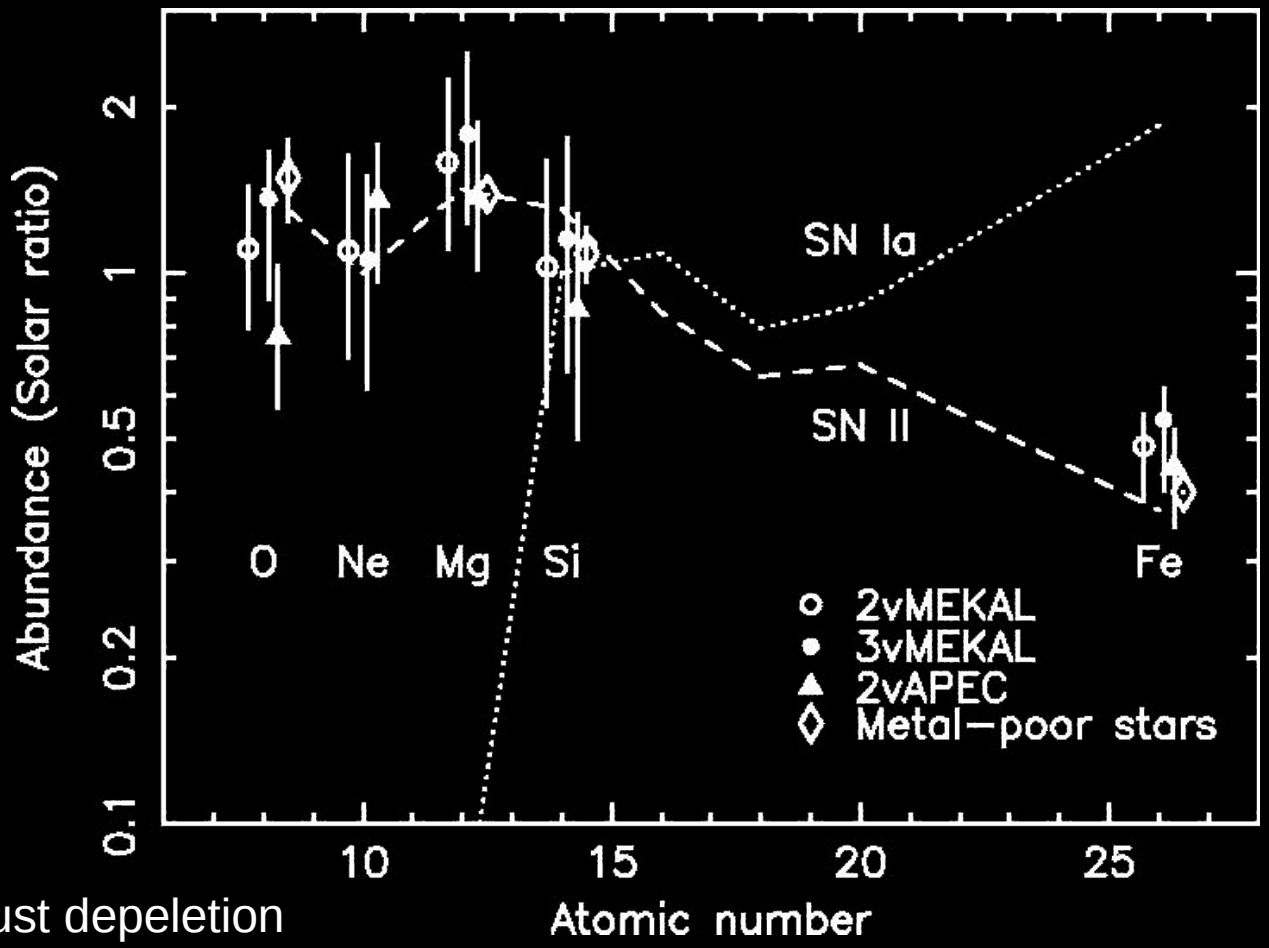
- Very few nearby starburst galaxies have been [or are] scheduled:
  - Pure starbursts (no AGN): M82, NGC 4631 [NGC 253]
  - Starbursts/AGN composite objects: NGC 4945, NGC 3079, ULIRGs.

Suzaku capabilities:

- XRS calorimeter (6 eV spectral resolution):
  - Potential to measure wind velocities in brightest starburst superwinds! Instrument dead.
- XIS (large net effective area):
  - Comparable count rates to XMM-Newton. Chandra/XMM have observed all the best targets already.
- Hard X-ray Detector (10 < E <100 keV):
  - More sensitive than BeppoSAX PDS (?). Starbursts very weak.

Abundance patterns of M82's "cap"

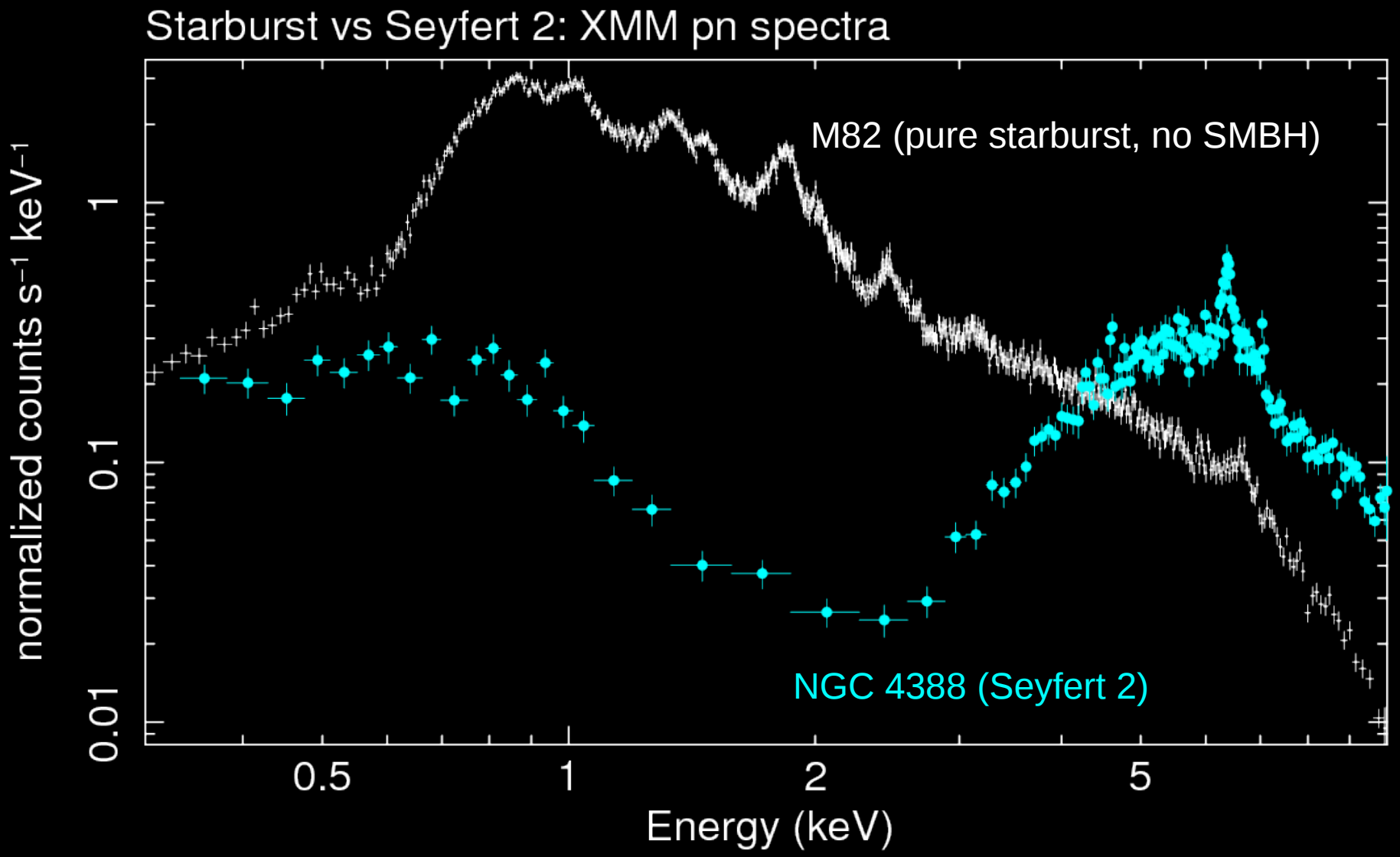




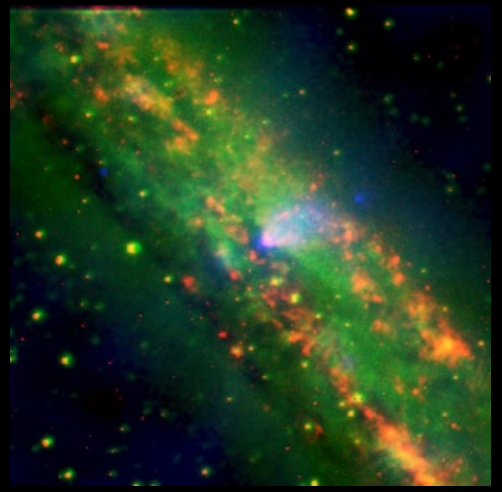
Tsuru et al, 2007, PASJ, 59, 269
Low Fe abundance not due to dust depeletion
Abundance pattern similar to SN type II

Similar results found for NGC 4631 (Yamasaki et al, 2008, PASJ, in press)

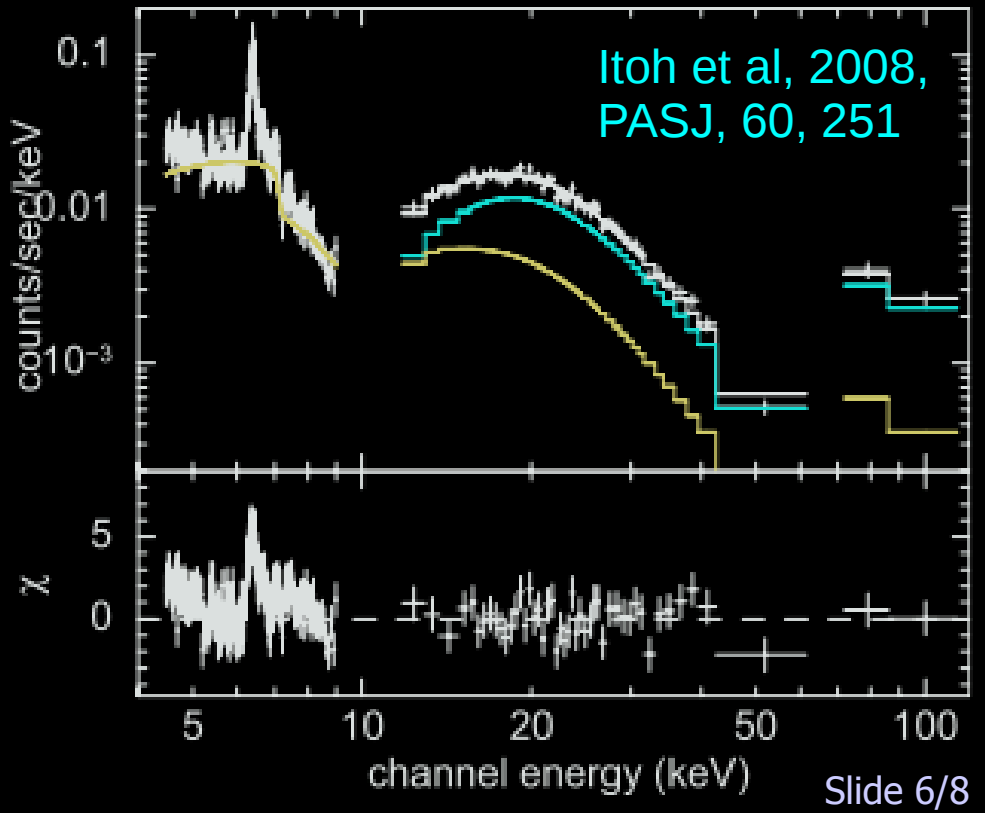
Starburst or Seyfert: An easy case



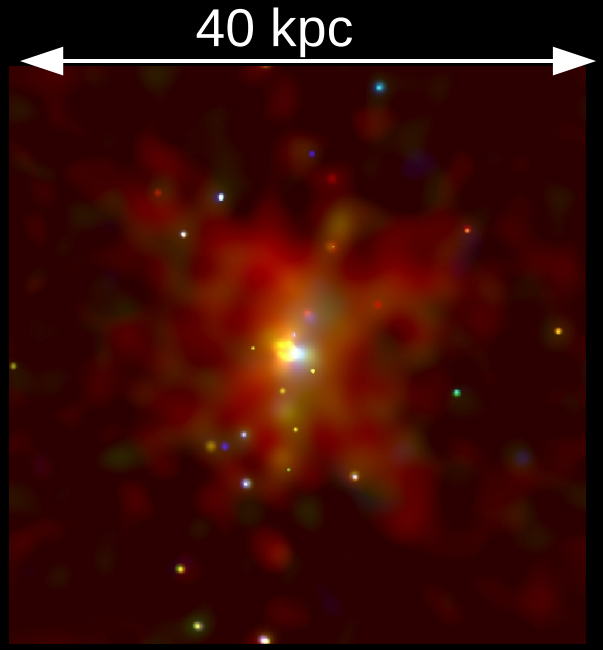
The Seyfert/Starburst connection and superwinds



- Optically obscured starburst regions: SF rate often based on IR (e.g. IRAS) fluxes.
- Obscured AGN can also be significant energy sources:
  - Affects SF rate estimates.
  - Can AGN drives 10-kpc-scale winds?
- Example: NGC 4945 (Itoh et al 2008).
  - Optical and IR diagnostics yield ambiguous estimates for relative fraction of L_{BOL} due to AGN.

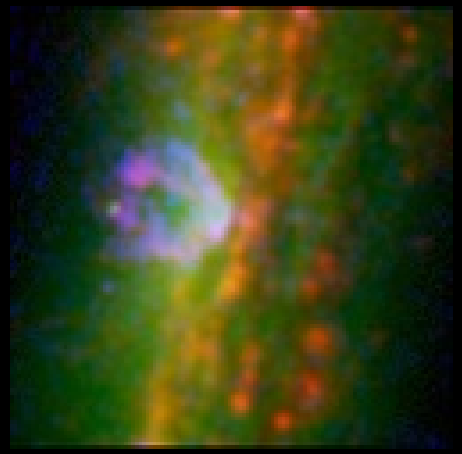


What powers the wind in NGC 3079?



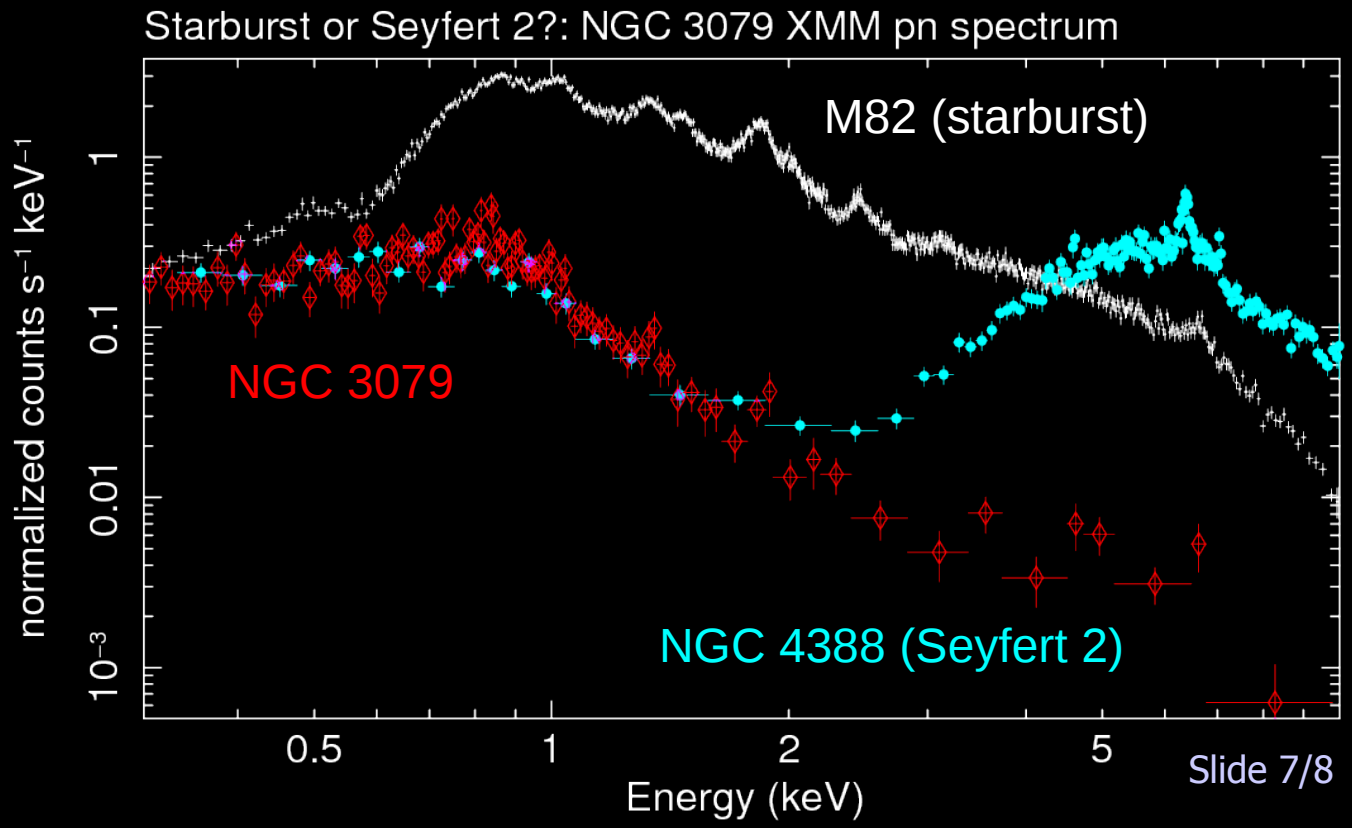
IR-warm galaxy with 40-kpc scale superwind and nuclear superbubble, pc-scale radio jets, 2e6 Msol SMBH.

Below 10 keV looks like a starburst galaxy.



We (Strickland/Levenson) recently obtained ~130 ks of Suzaku observations.

Aim to detect and Compton thick AGN (HXD), constrain abundances (XIS).



Summary

- Relatively few nearby starbursts have been observed with Suzaku.
  - Typically with long (~100 ks) exposure times.
- Good S/N of XIS spectra allow more detailed abundance and ionization state diagnostics of soft thermal plasmas than (shorter) XMM/Chandra observations do.
  - Clarifies the origin and properties of the hot plasma in superwinds.
- In objects where obscured AGN are suspected, HXD observations can:
  - Clarify the intrinsic luminosity of Compton thick AGN
  - Constrain true galactic SF rate and possible role of AGN in driving winds.
- Ultimately Suzaku will probably make a small but significant contribution to our understanding of starburst galaxies.

XIS spectroscopy: The origin of the soft-X-ray emitting plasmas in superwinds

- Soft X-ray nebulae in superwinds are a multi-temperature plasma with 1 < T < 10 million K.
  - SN-enriched material responsible for driving wind?
  - Or ambient disk/halo ISM shock or conductively heated by collision with invisible hot wind?
- ASCA (and Chandra/XMM) results show super-Solar α/Fe (e.g. Ptak et al 1997; Grimes et al 05) in superwinds.
  - Often simulataneously fit α's (O, Ne, Mg, Si, S) due to low number of counts.
  - Results ambiguous (Strickland et al 04) due to Fe depletion onto dust.

➔ **Large effective area of XIS and long exposure times (~100 ks) allows more detailed investigation of soft X-ray abundance patterns:**

- M82's "cap" (Tsuru et al 2007).
- NGC 4631 (Yamasaki et al, 2008, in press).