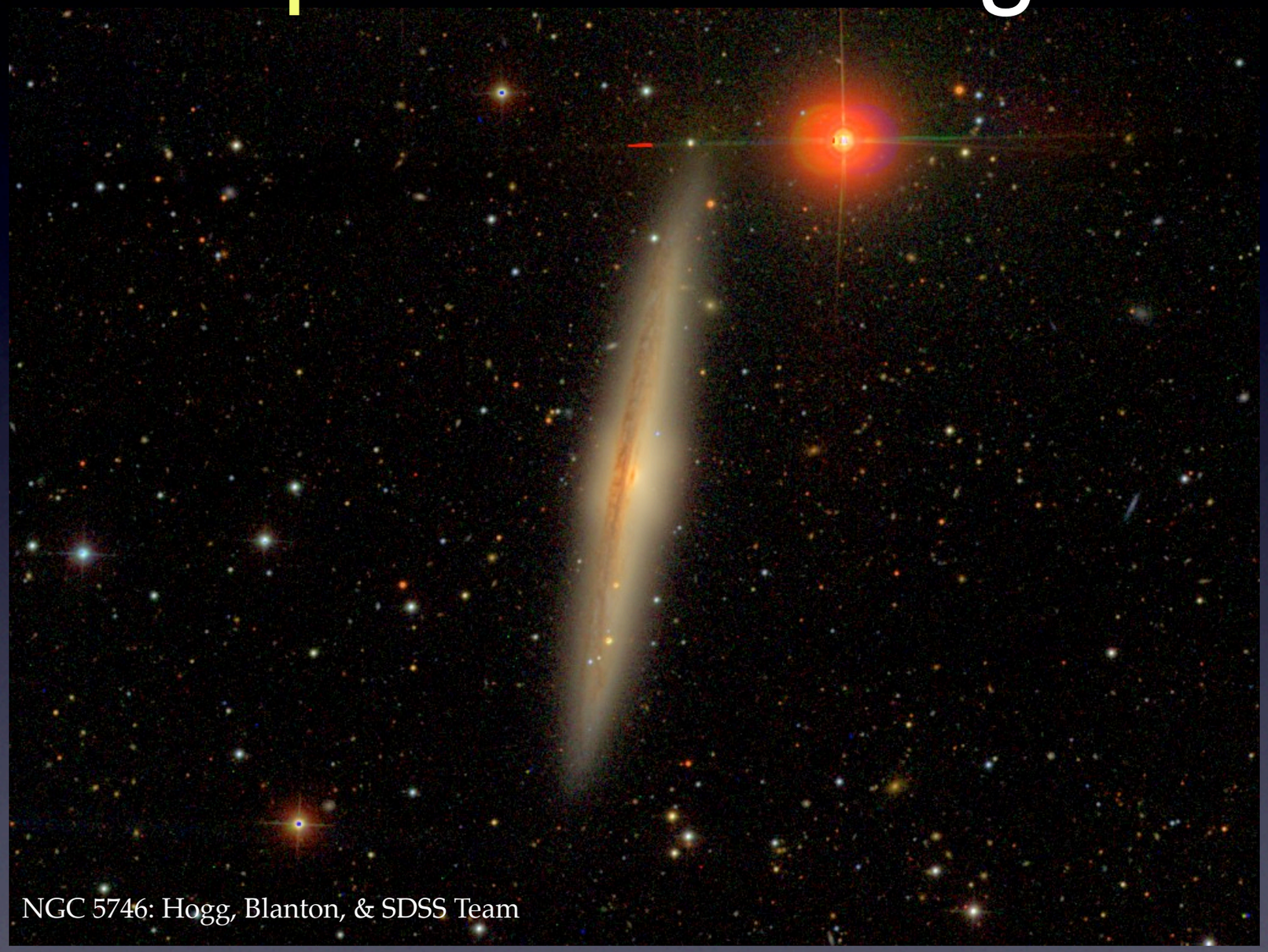
A Chandra search for hot halos around quiescent disk galaxies



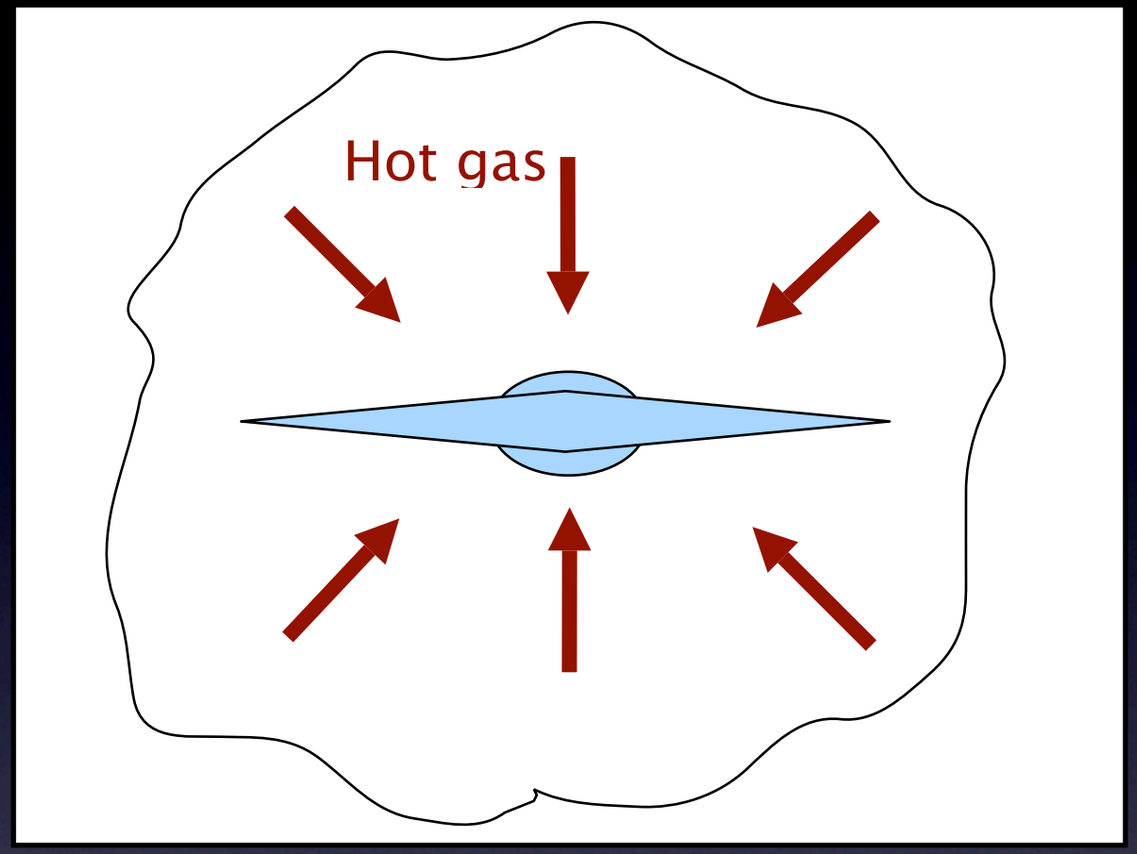
Jesper Rasmussen, Carnegie Observatories

+ J. Sommer-Larsen, K. Pedersen, S. Toft, A. Benson, R. Bower, L. Grove

Why Do We Need Hot Halos?

"Classical" disk galaxy formation (e.g. White & Rees 78):

Infall of gas → shock heating → central cooling → star formation



Evidence for hot gas around Mliky Way:

- ✦ X-ray (O VII) absorption (Fang+ 03)
- ✦ morphology of HVC's

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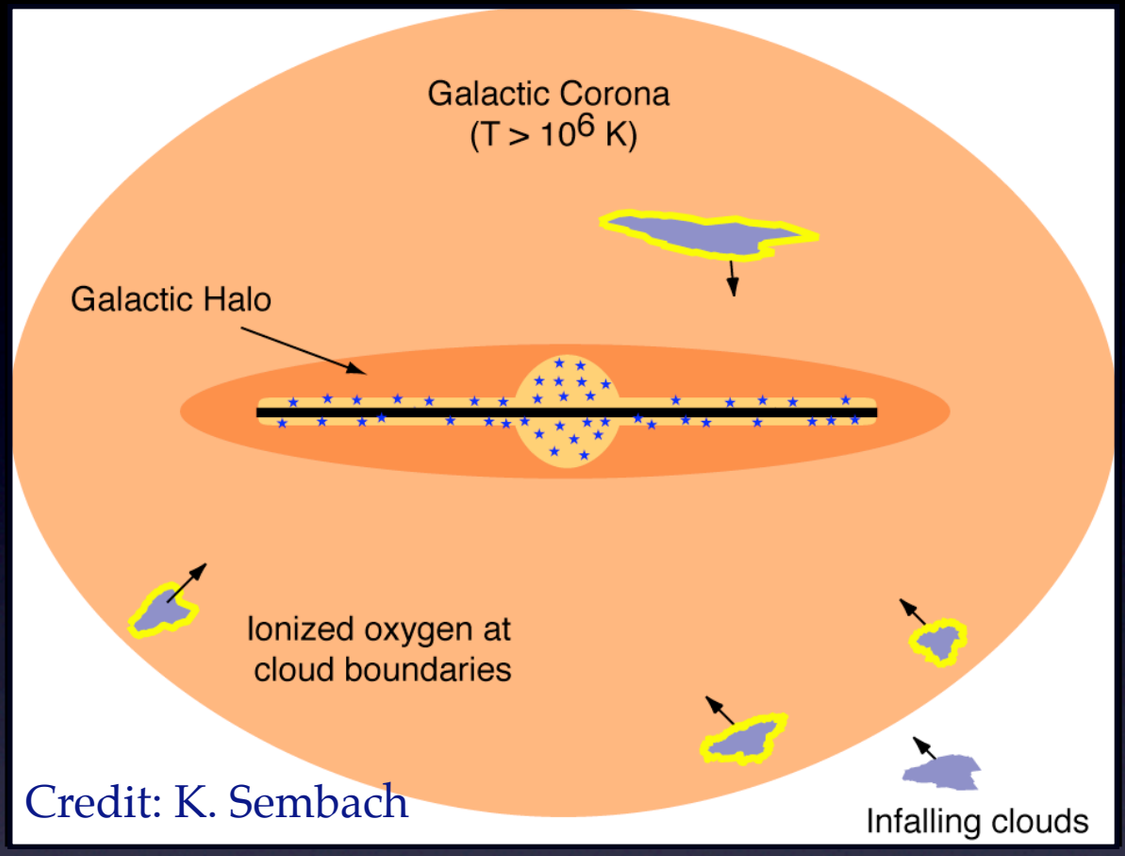

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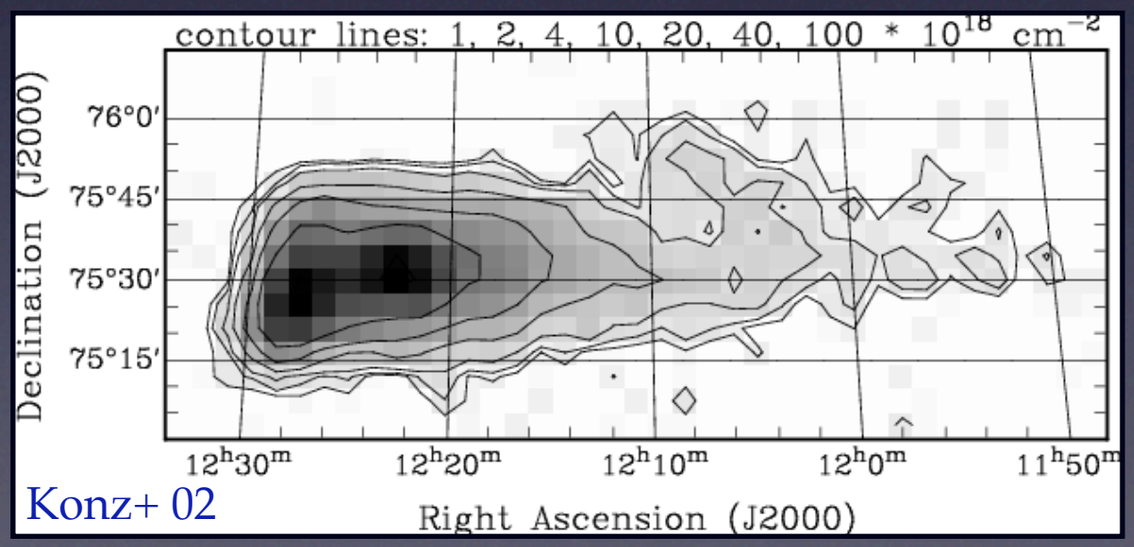
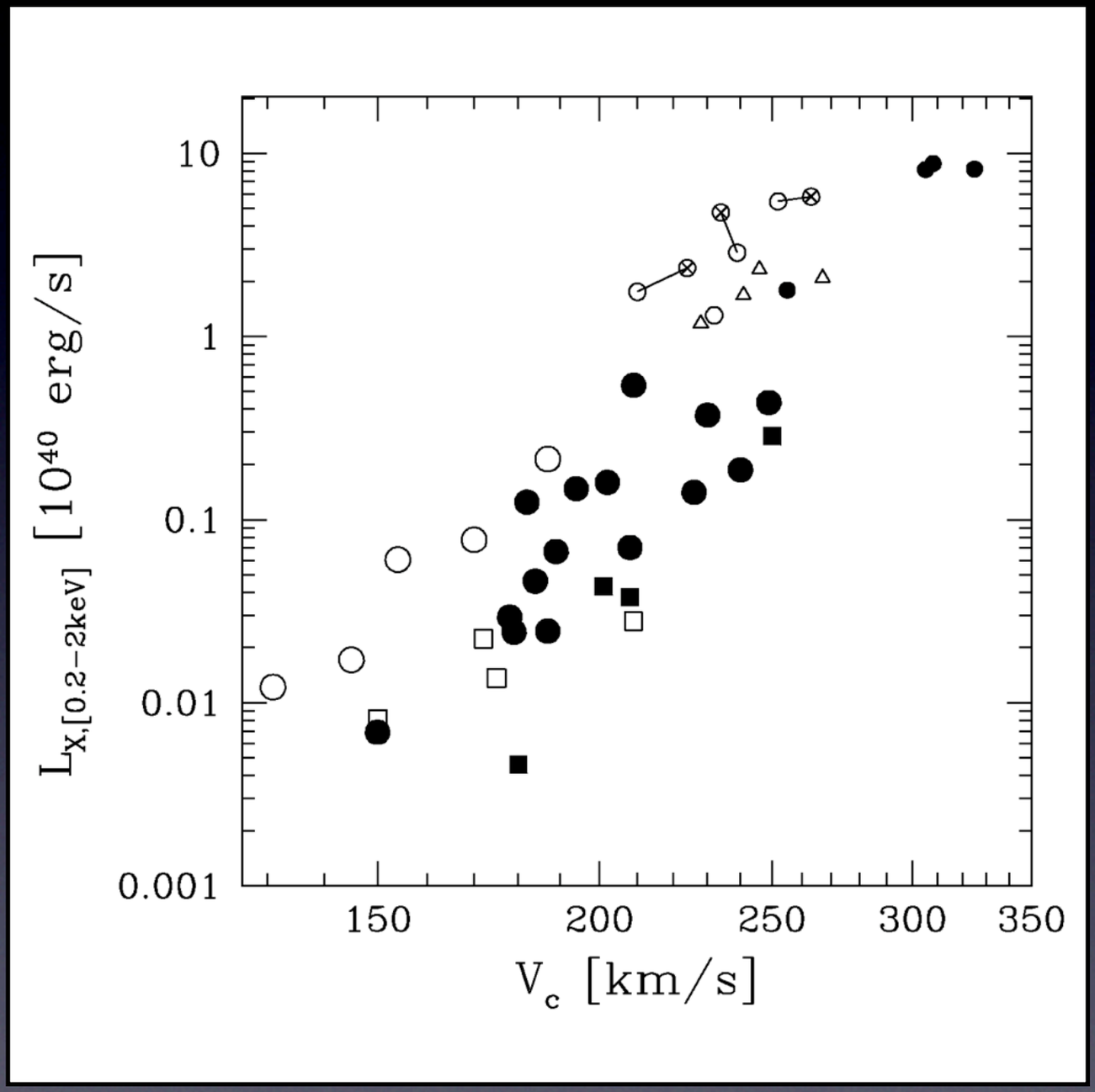


Accreted X-ray Halos: What to Expect?



Cosmo-/hydro simulations (Toft+ 02):

Hot halo $L_X \propto v_c^{5\text{-}7}$

Halos should be detectable around high-mass spirals.

Hot Extraplanar Gas Detected...

...but generally attributed to stellar feedback in the disk (Strickland+ 04, Tuellmann+ 06, Wang 07).

M82: Strickland et al.

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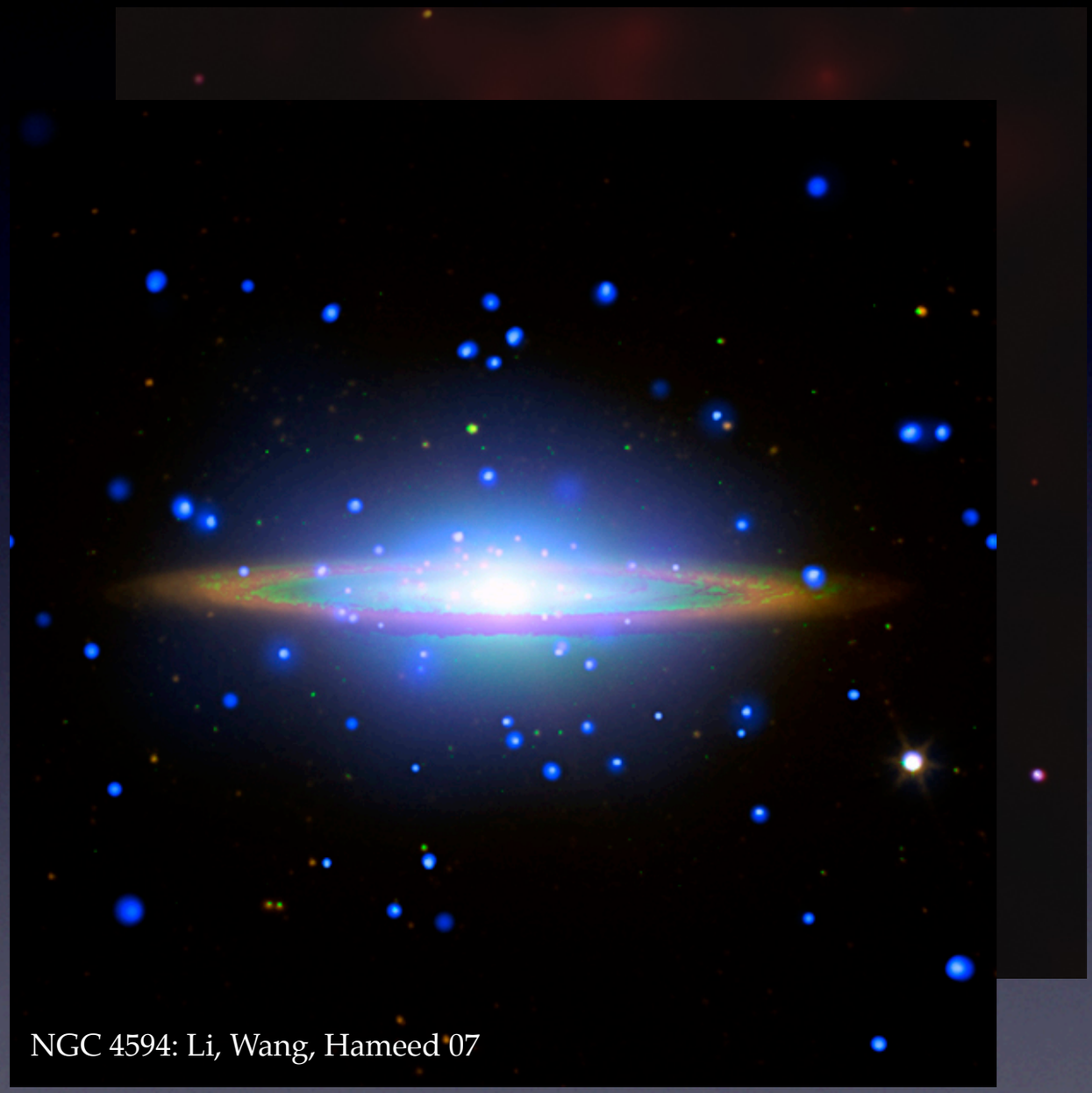

NGC 4594: Li, Wang, Hameed 07

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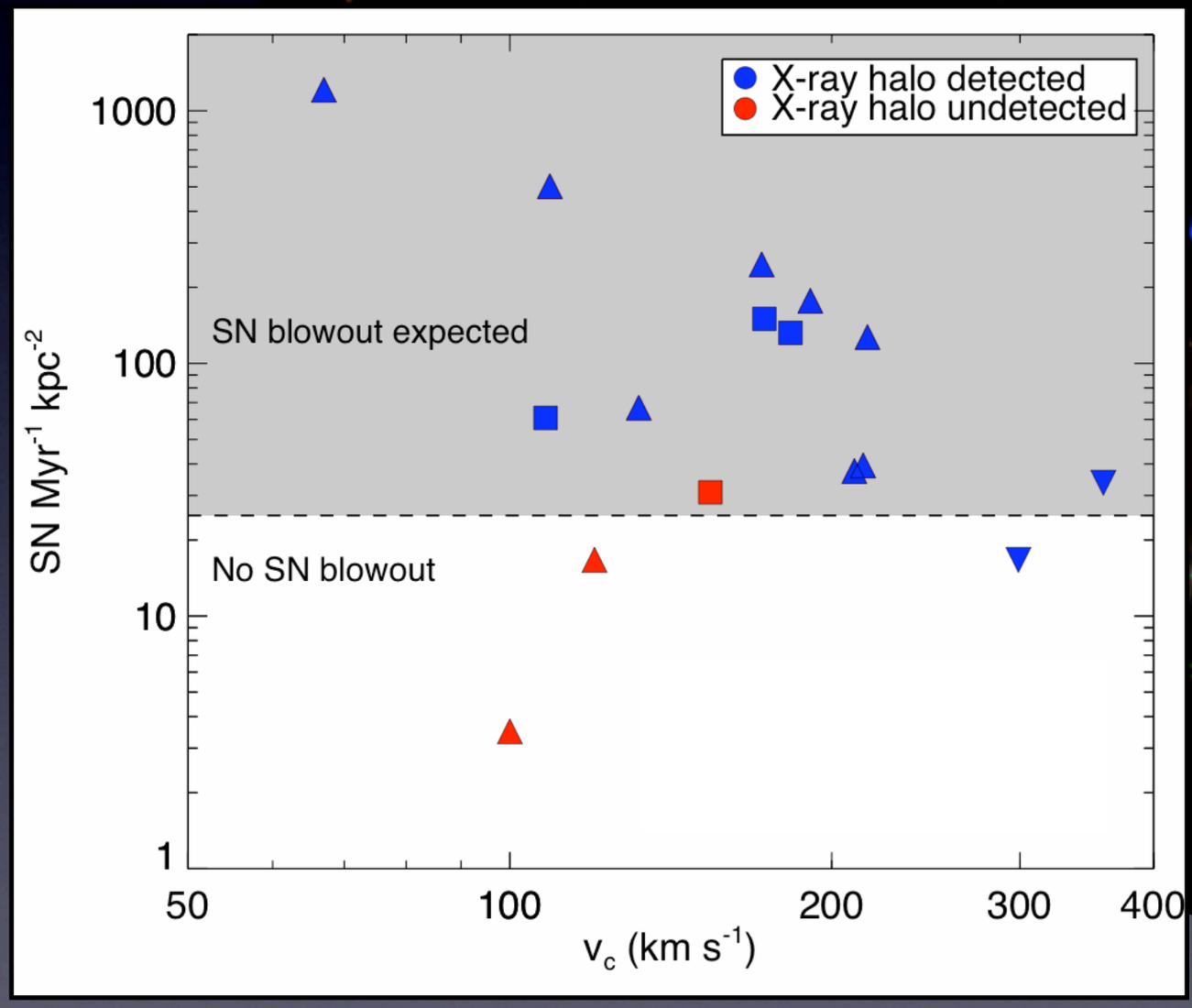

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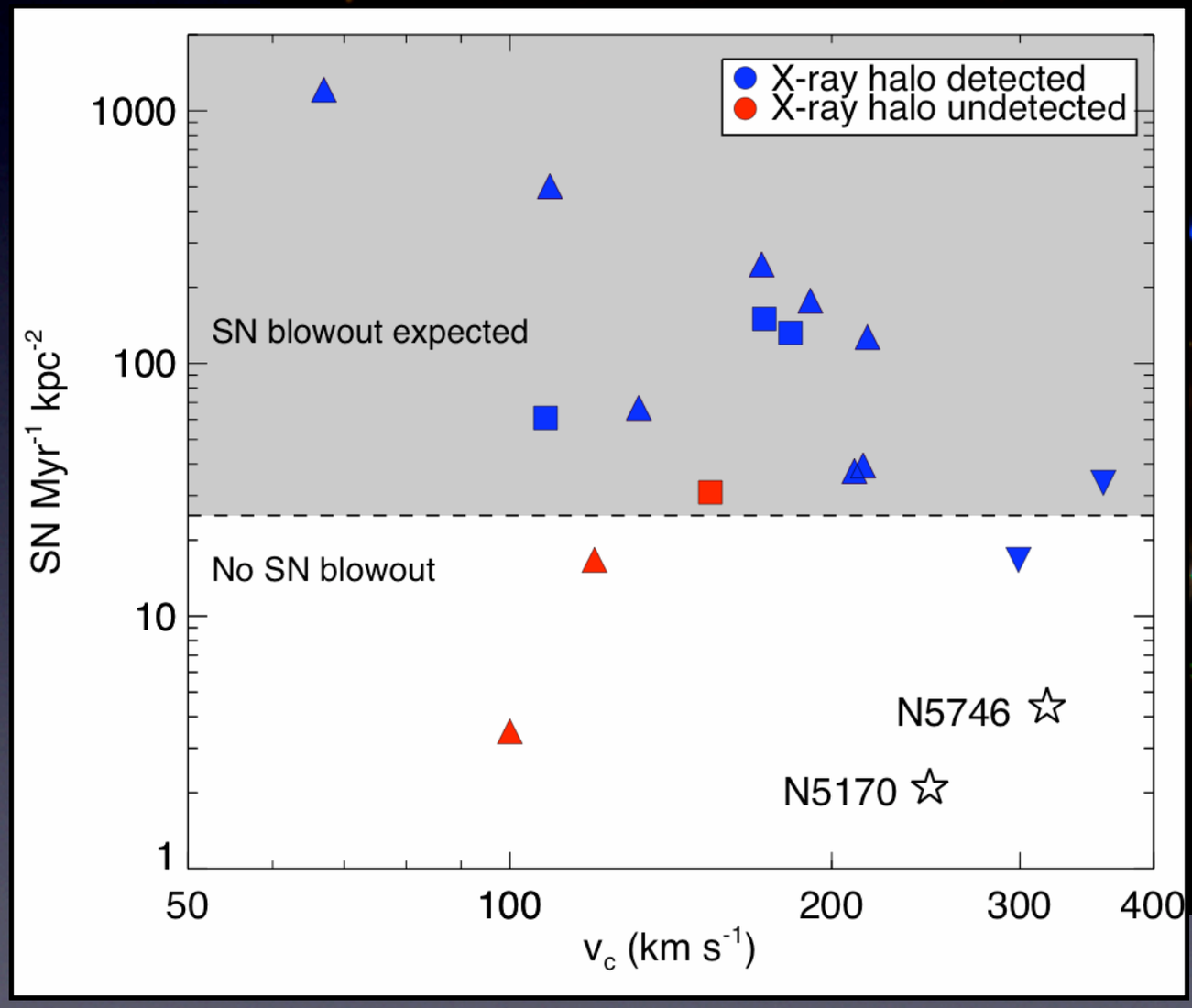
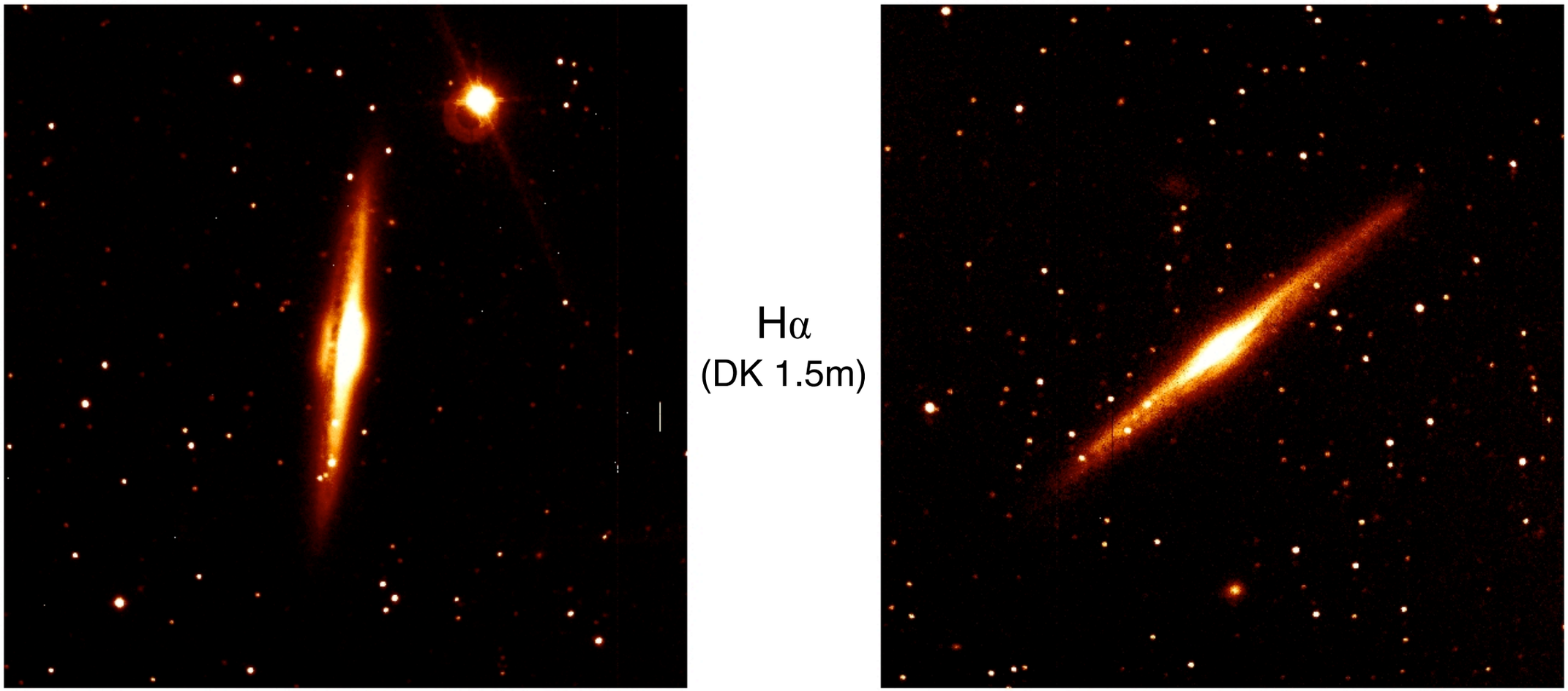


Chandra Observations of Quiescent Spirals



Hα
(DK 1.5m)

NGC 5746: v_c = 318 km/s

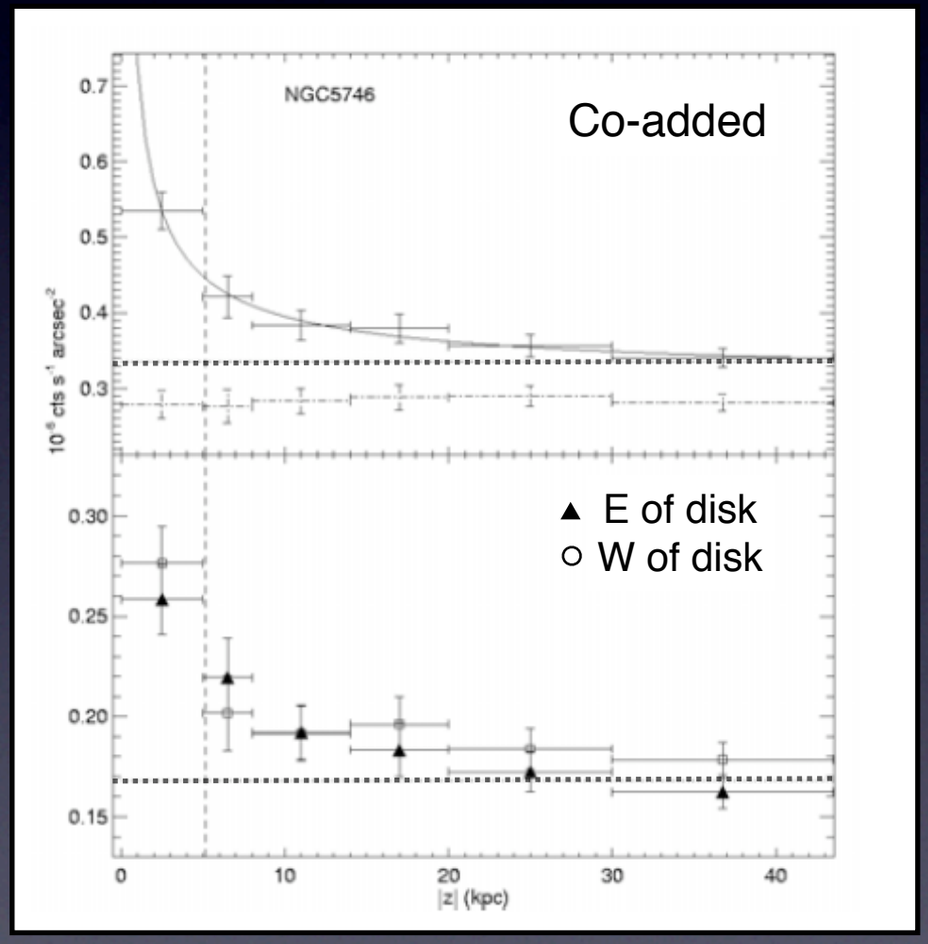
NGC 5170: v_c = 247 km/s

Chandra: 35 ks - enough to detect halo around NGC 5746 (Toft+ 02)

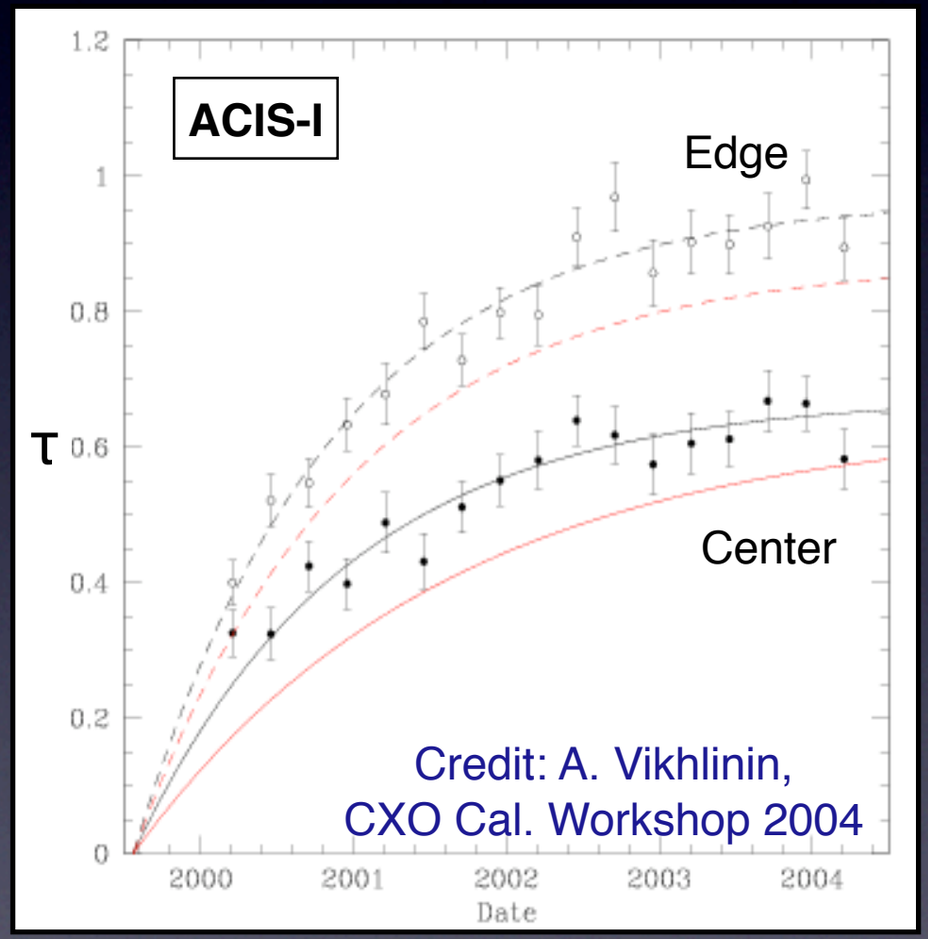
Jesper Rasmussen • 2008 Chandra Fellows Symposium • jr@ociw.edu

Initial X-ray Results: NGC 5746

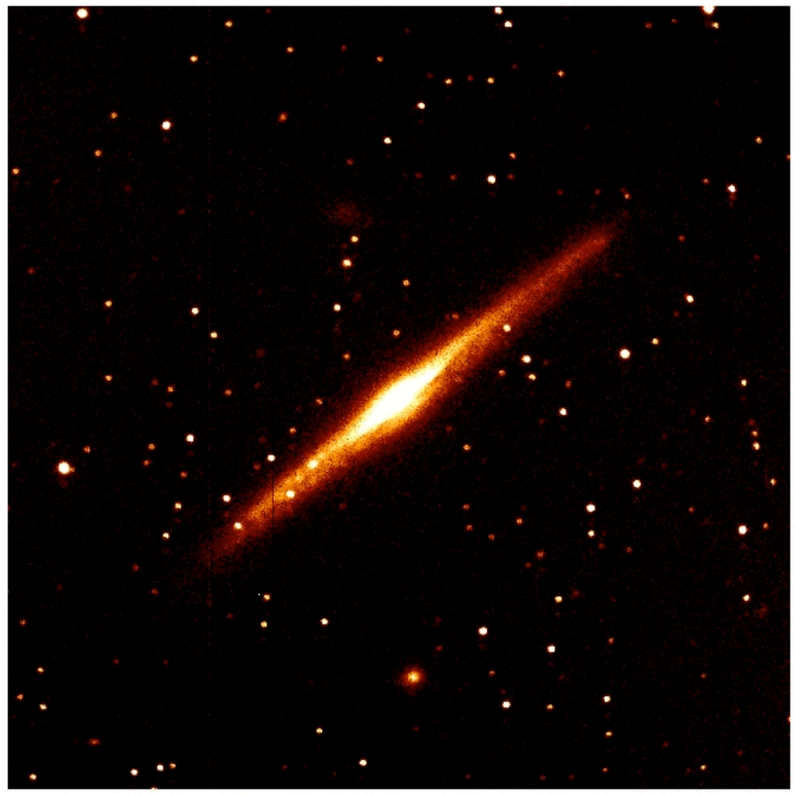
Pedersen+ 06: ~ 4σ detection of hot halo around NGC 5746...



...with CALDB v. 2.26.
But ACIS contamination?



Updated Chandra Analysis (CALDB 3.4.1)



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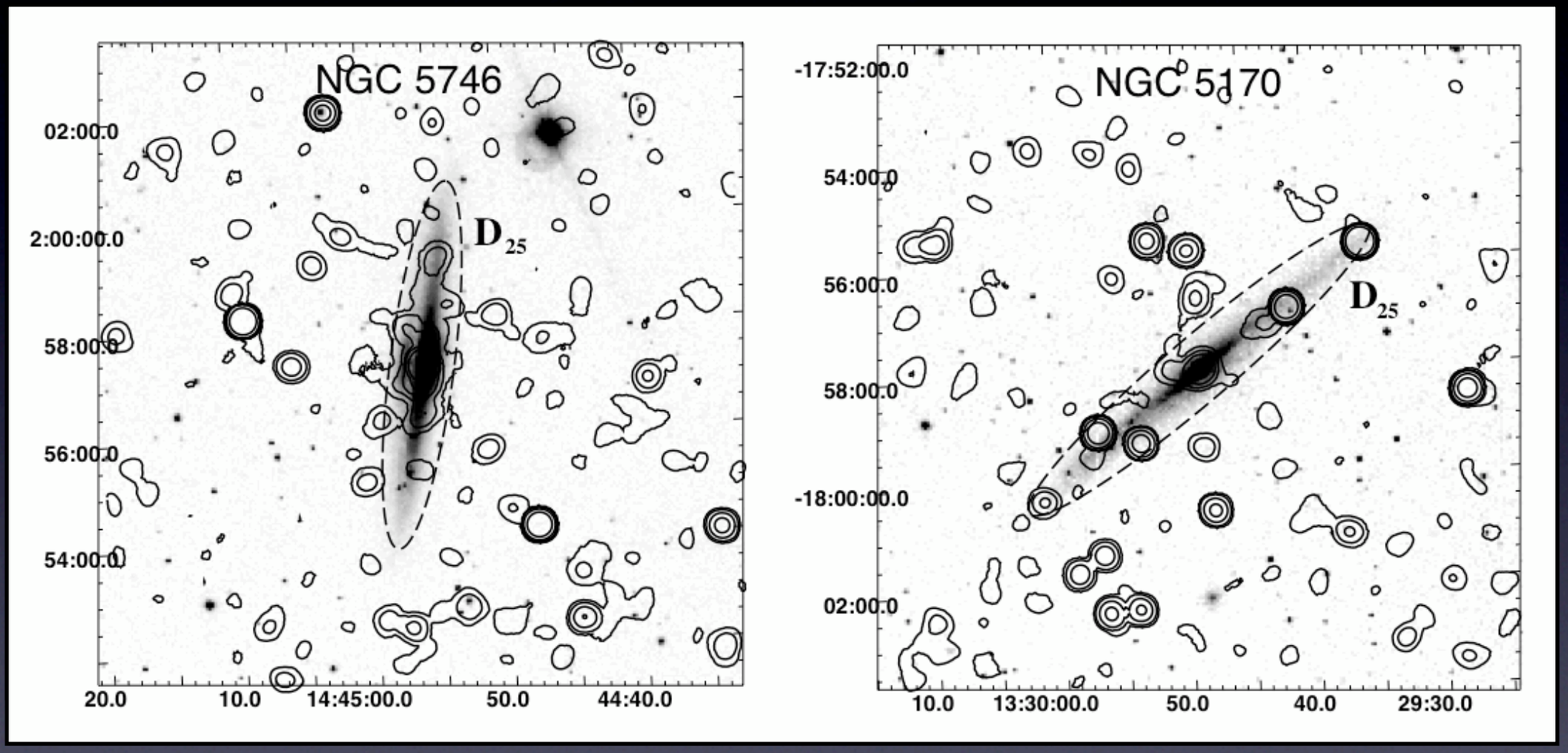
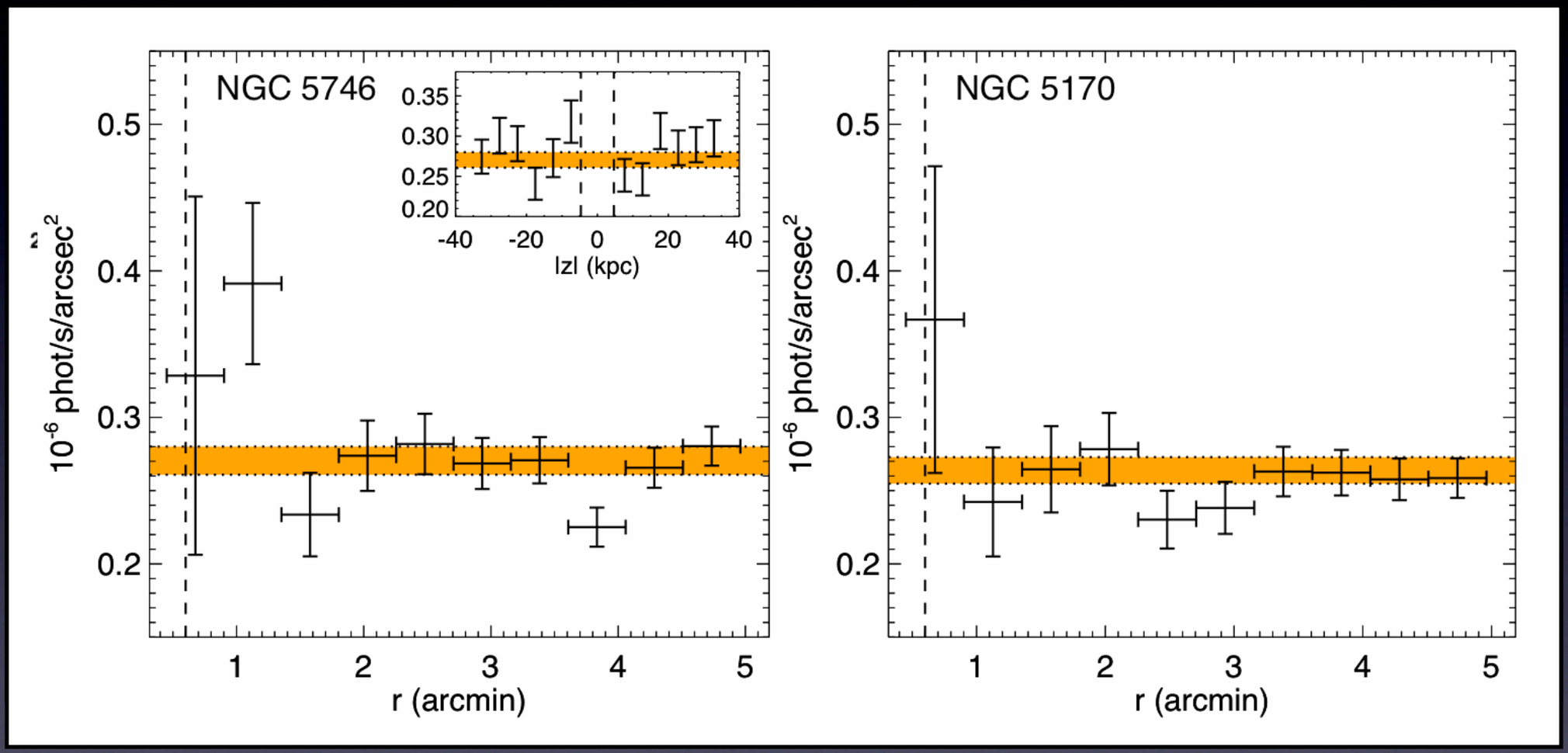
Updated Chandra Analysis (CALDB 3.4.1)

X-ray/Ha overlay



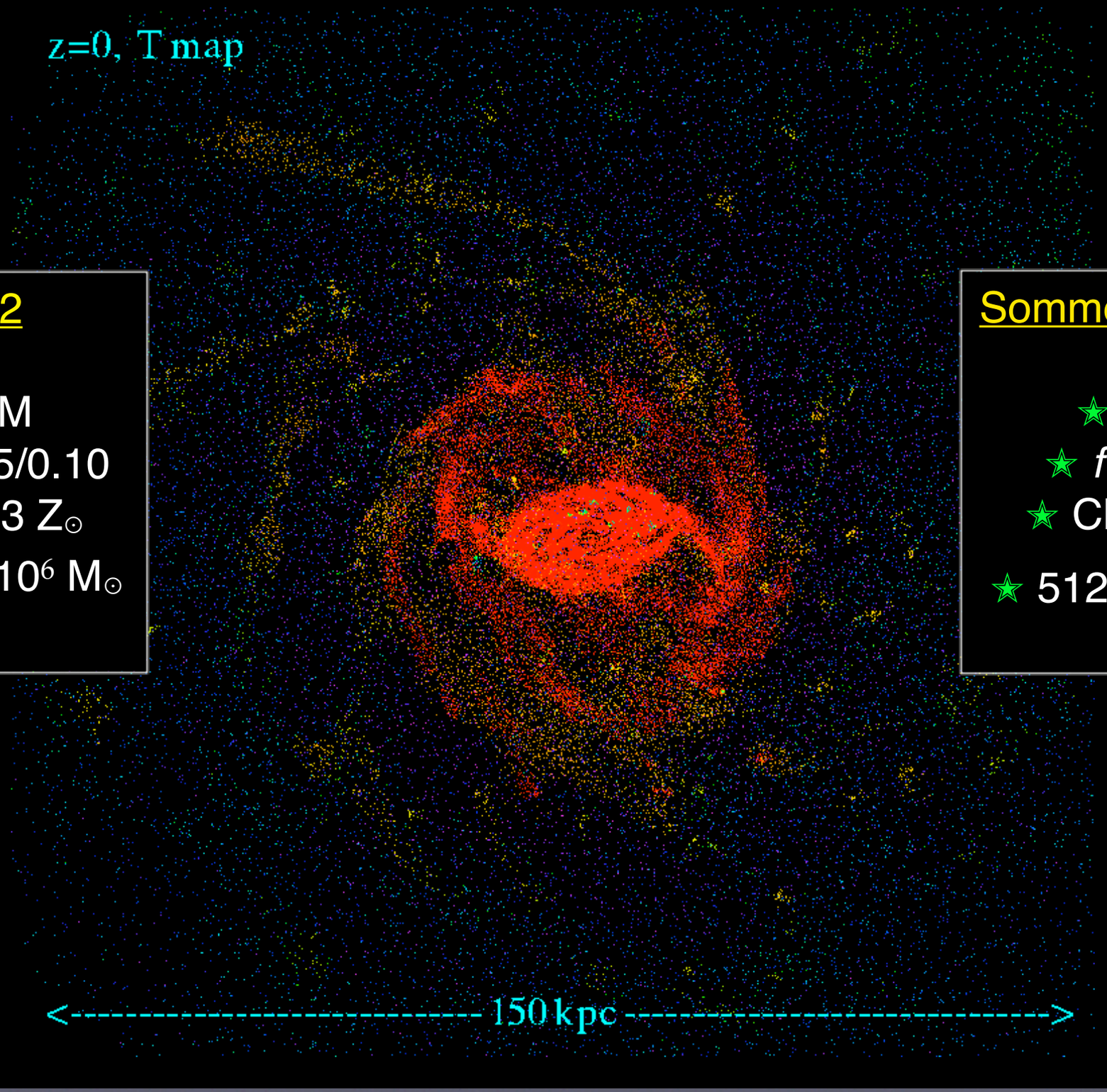
Updated Chandra Analysis (CALDB 3.4.1)

0.3-2 keV surface brightness

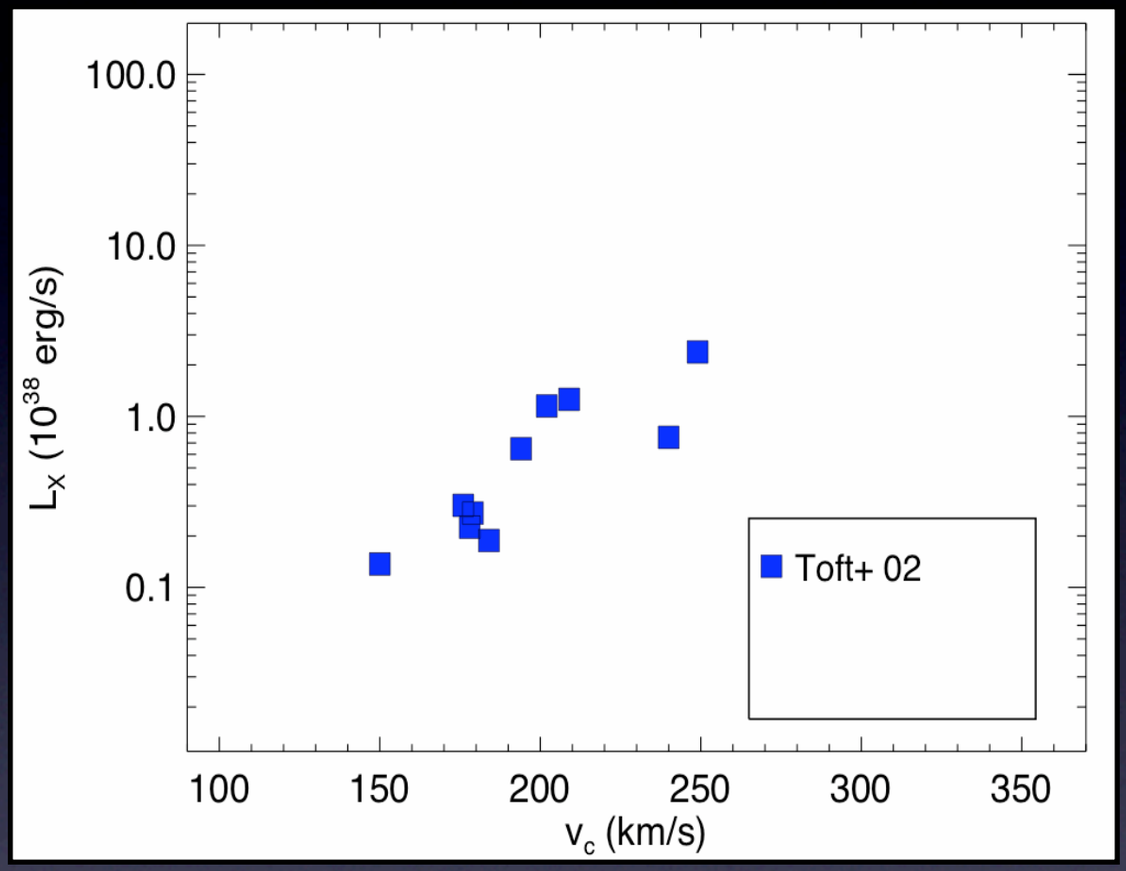


Non-detection → limits to L_X, $\langle n_e \rangle$ for assumed T, Z.

Cosmological SPH Simulations: New & Improved



Confronting Simulations and Observations



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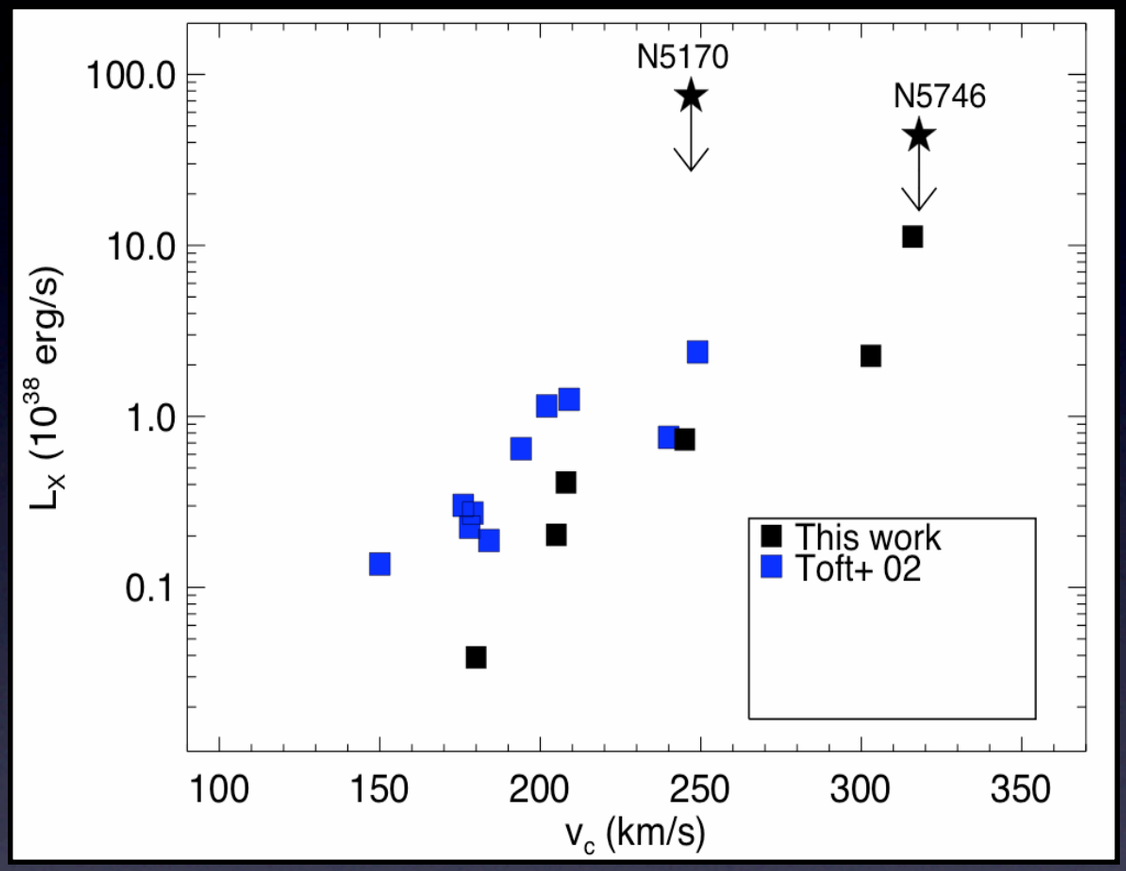

NGC 5746: $L_X < 4 \times 10^{39}$ erg/s

NGC 5170: $L_X < 7 \times 10^{39}$ erg/s

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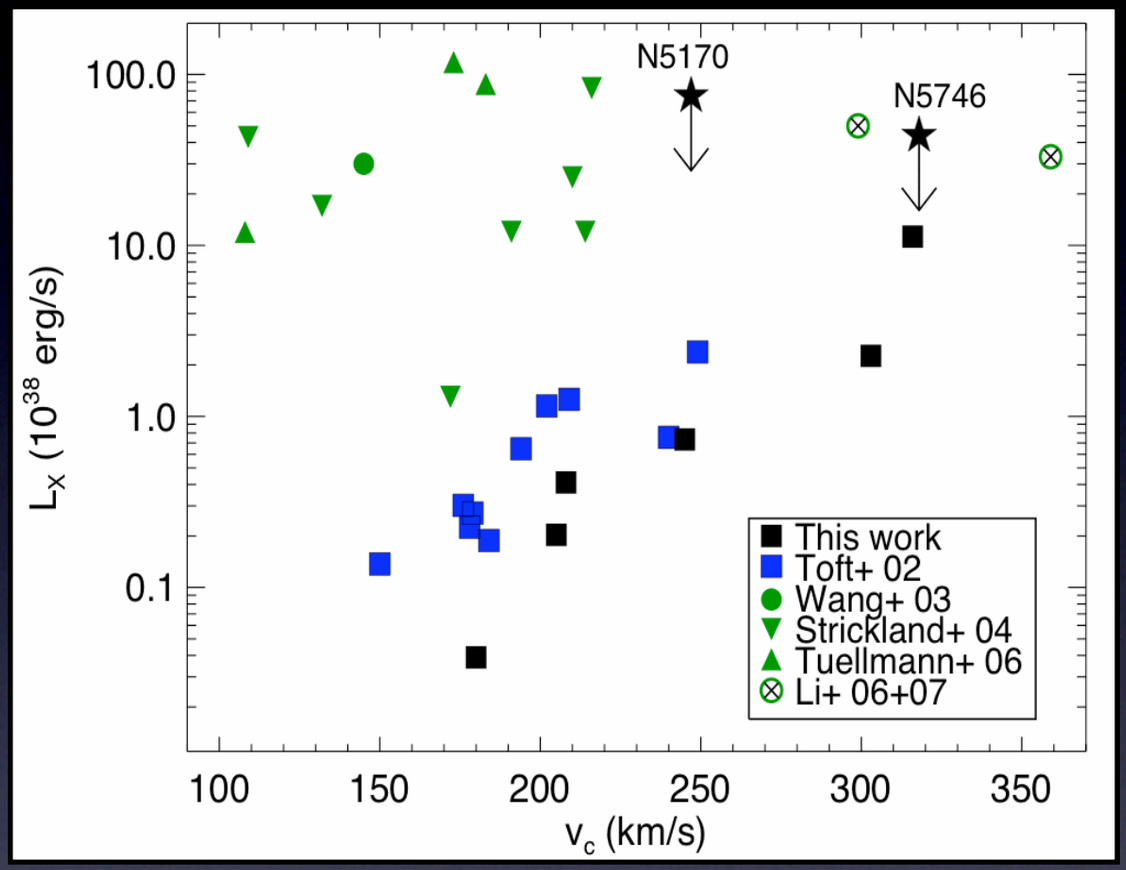

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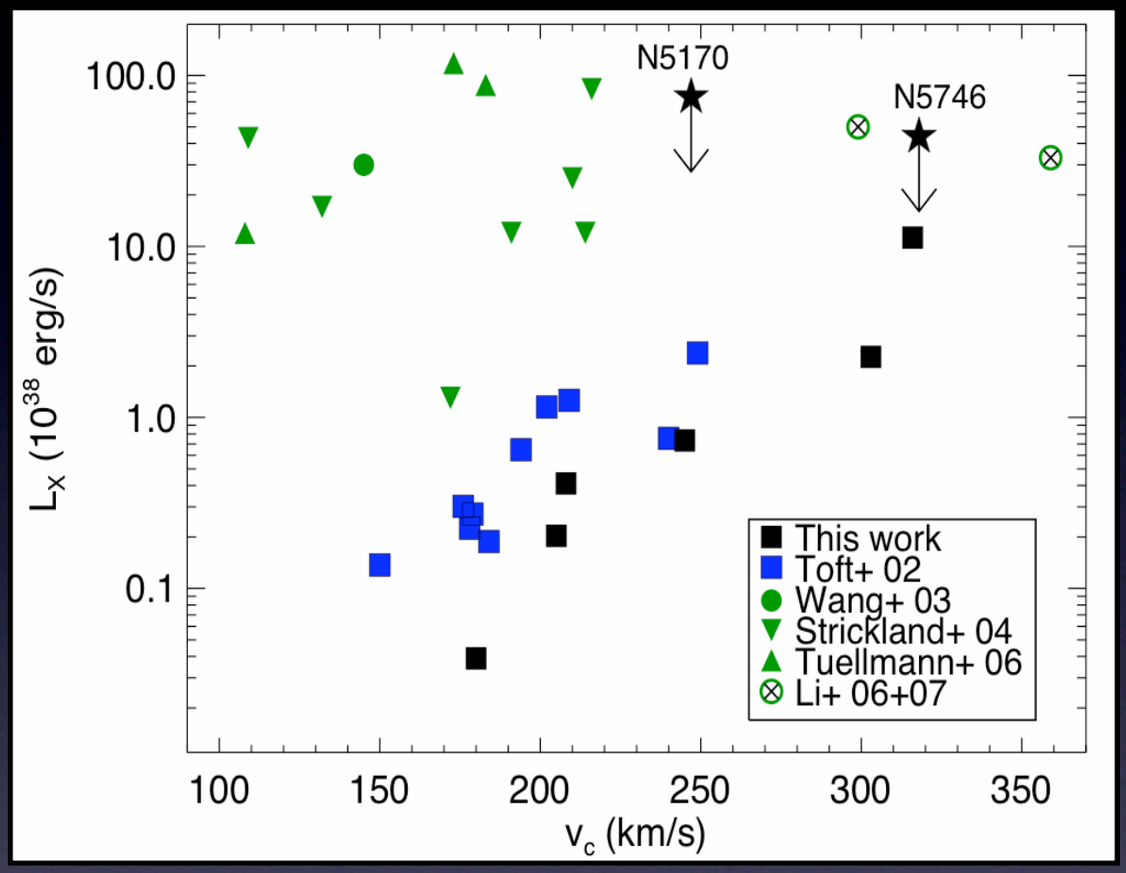

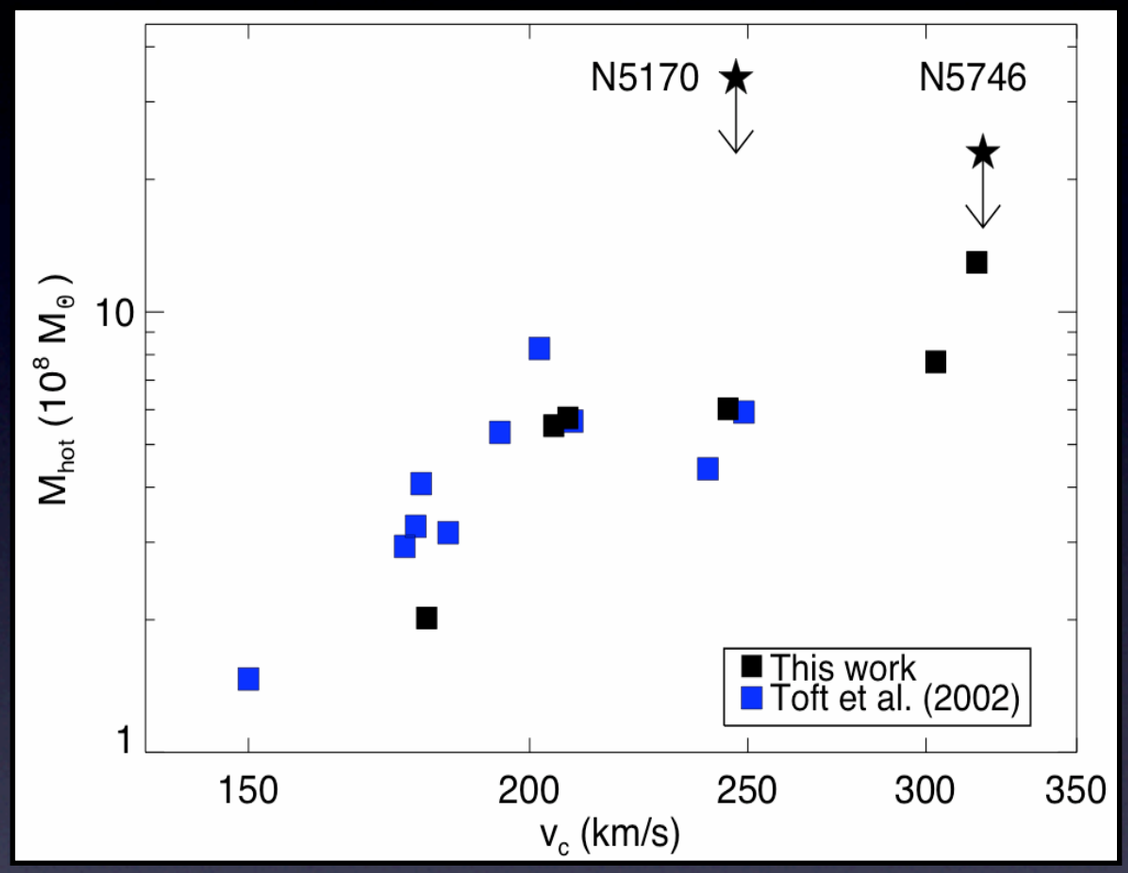

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NGC 5746: $M_{hot} < 2 \times 10^9$ $M_\odot$

NGC 5746: $M_{hot} < 3 \times 10^9$ $M_\odot$

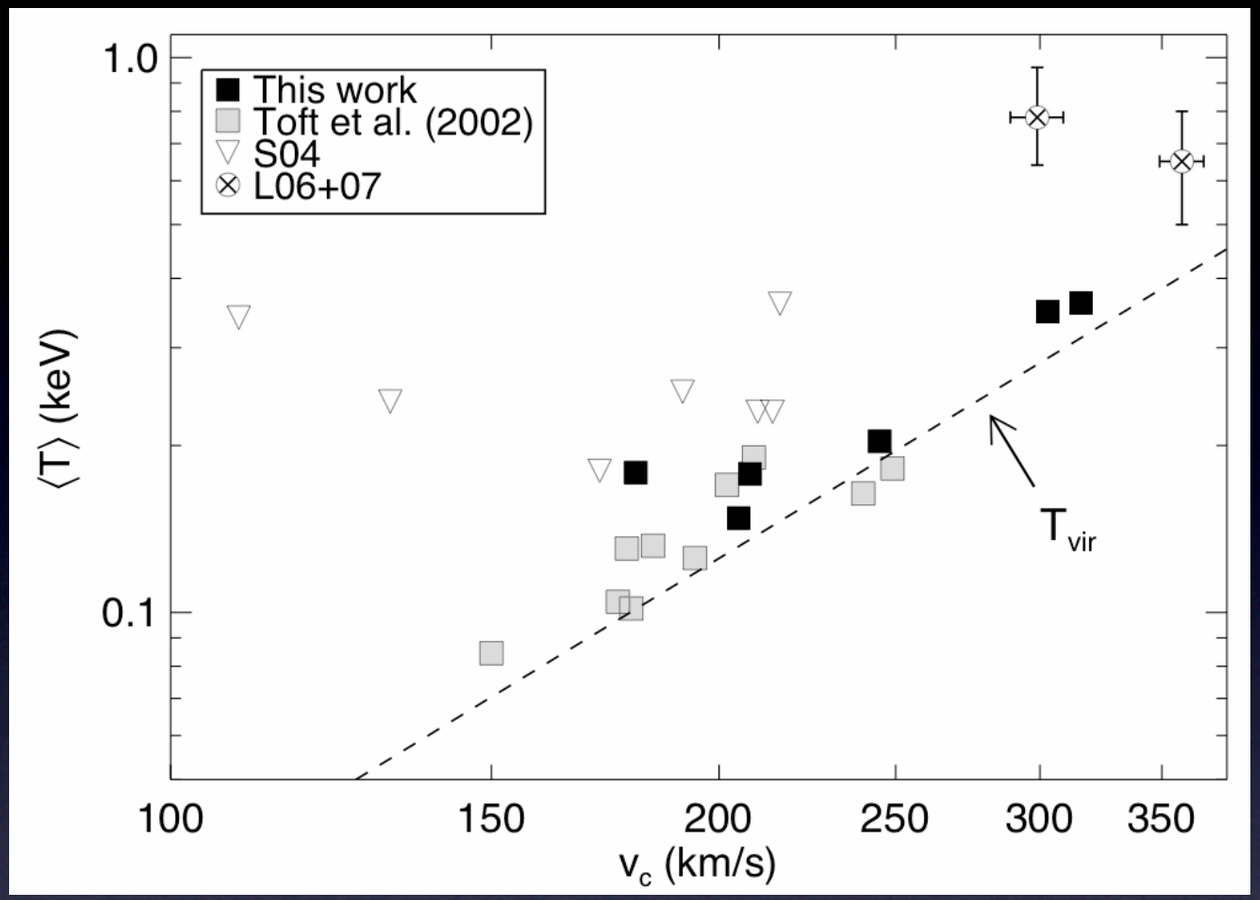
Summary

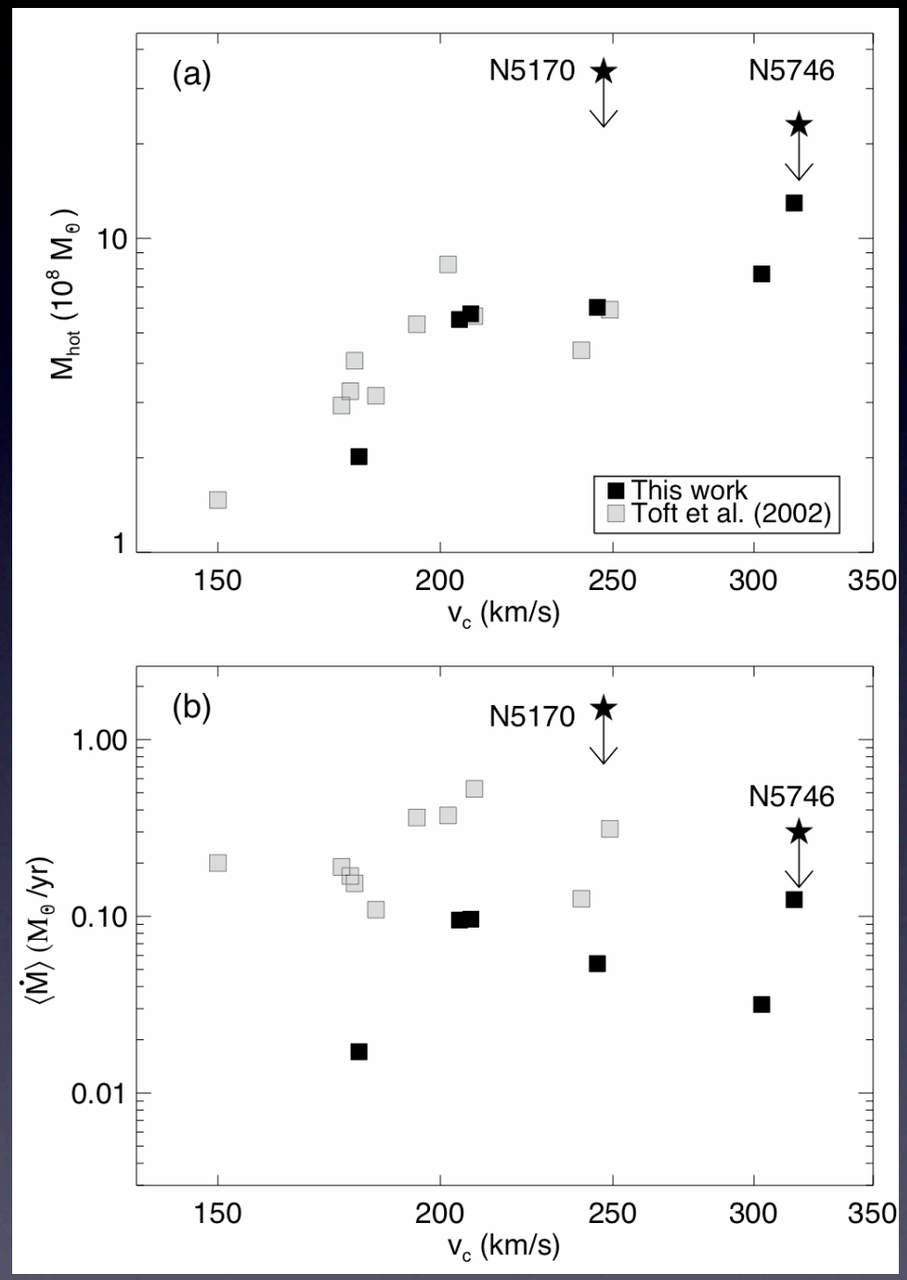
Hot accreted halos not yet detected around spirals.

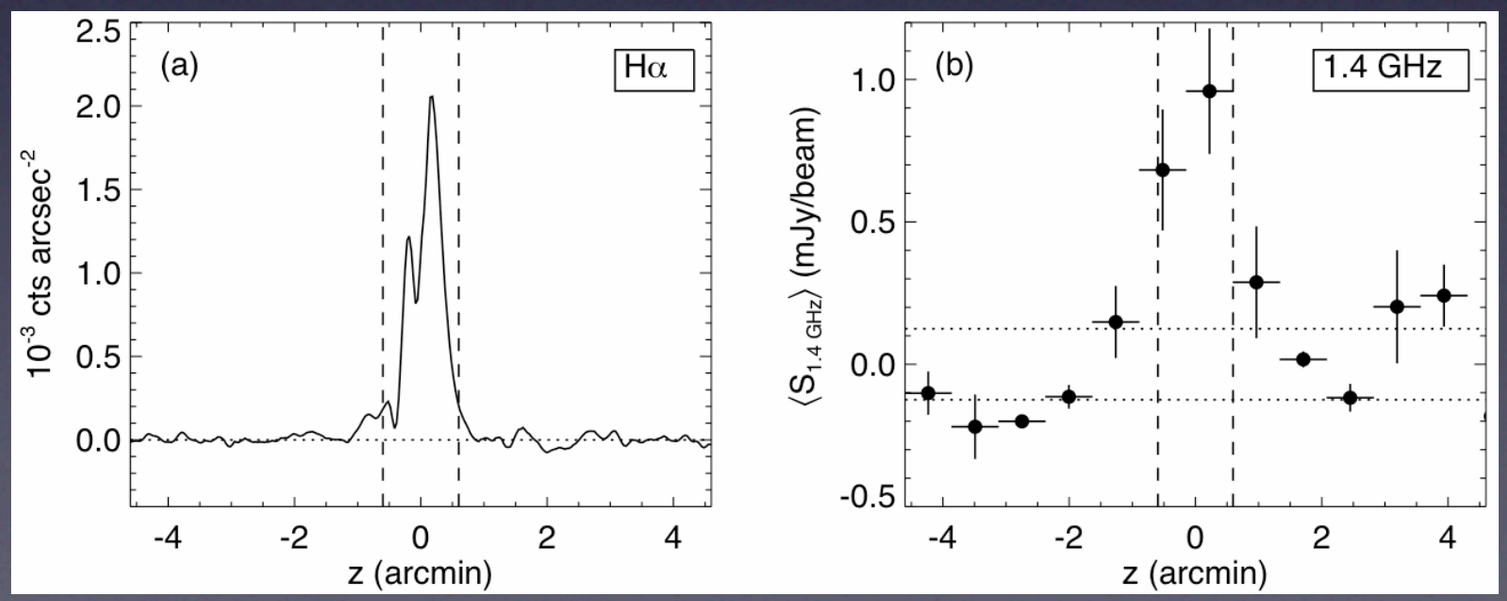
Deeper obs. required
(*Z* would be useful) but halo detection within reach of current instrumentation.

Sim. predictions (L_X , M_{hot}, ...) consistent with obs. but are being challenged at high-mass end

Add. Figs...


This work
Toft et al. (2002)
S04
L06+07
T_vir
⟨T⟩ (keV)
v_c (km/s)


(a)
N5170
N5746
M_hot (10^8 M_⊙)
This work
Toft et al. (2002)
v_c (km/s)
(b)
N5170
N5746
⟨Ṁ⟩ (M_⊙/yr)
v_c (km/s)


(a)
Hα
10^-3 cts arcsec^-2
z (arcmin)
(b)
1.4 GHz
⟨S_1.4 GHz⟩ (mJy/beam)
z (arcmin)