The Physical Properties of a Hot Gaseous Halo

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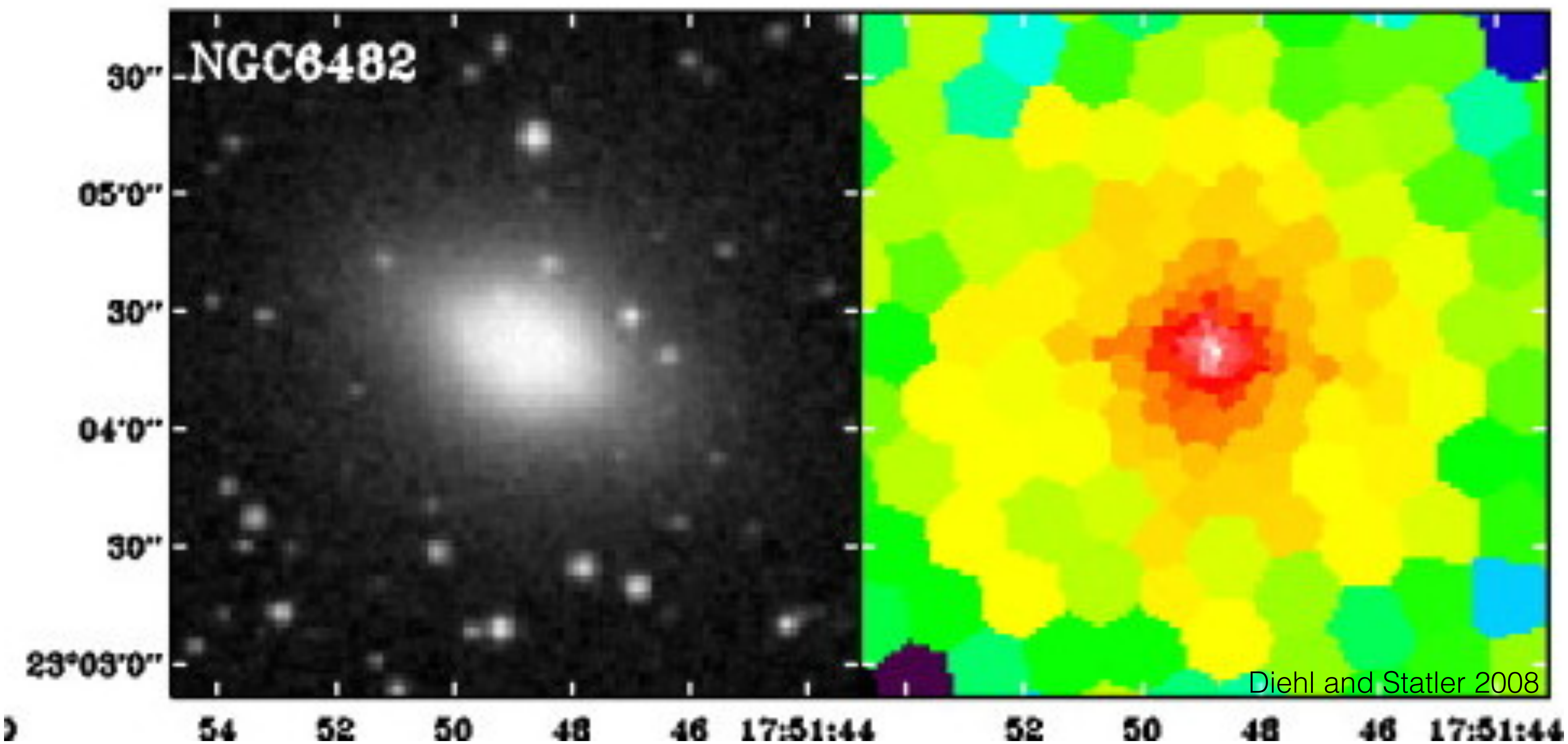
Introduction

We think massive low-z galaxies accrete via **hot mode**
Massive ellipticals all have hot halos
They are **difficult to connect with IGM**…
But we know a lot about their hot halos



Stars (K band) Hot gas (X-ray)

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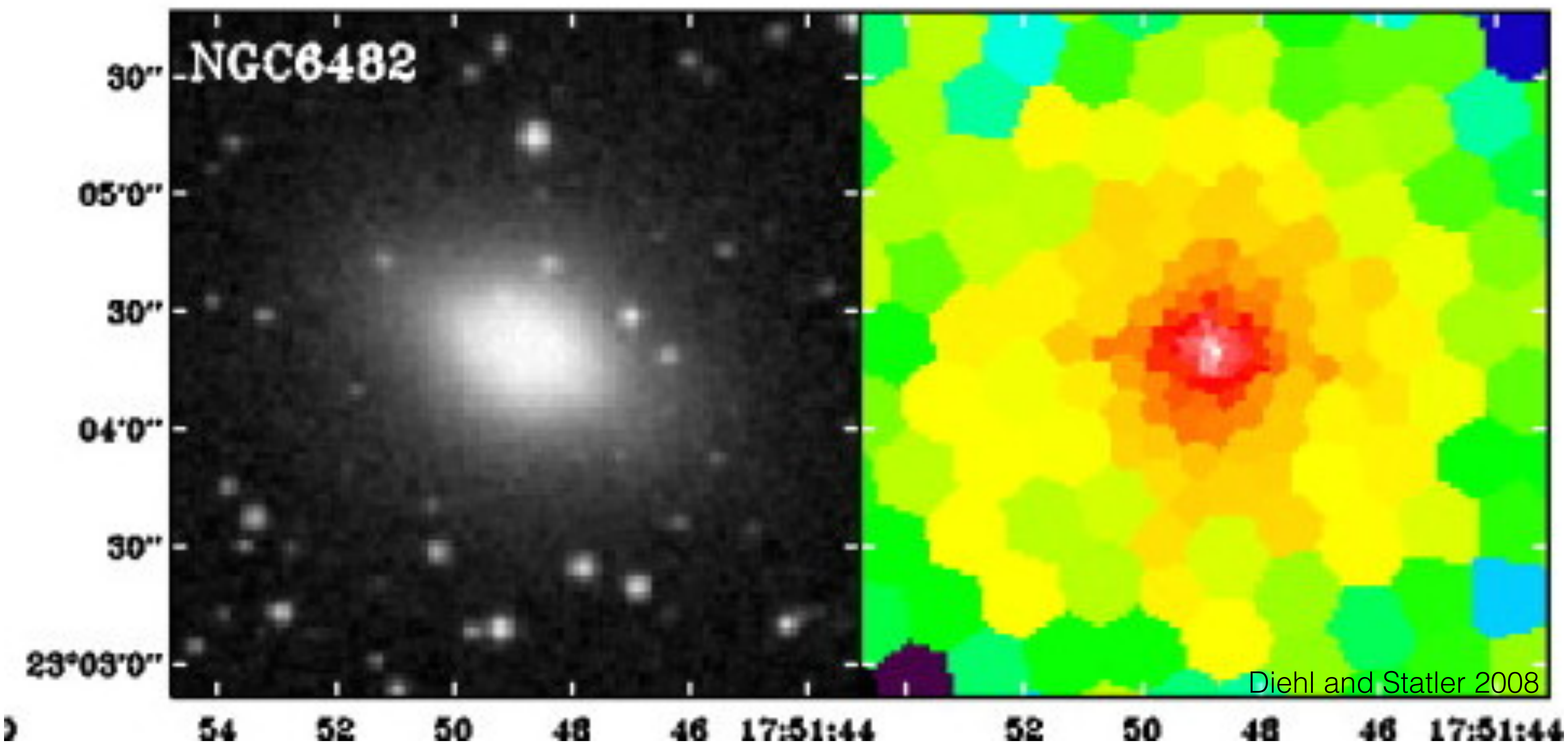
environment
screening by hot ISM



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Want to study spirals instead!

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environment
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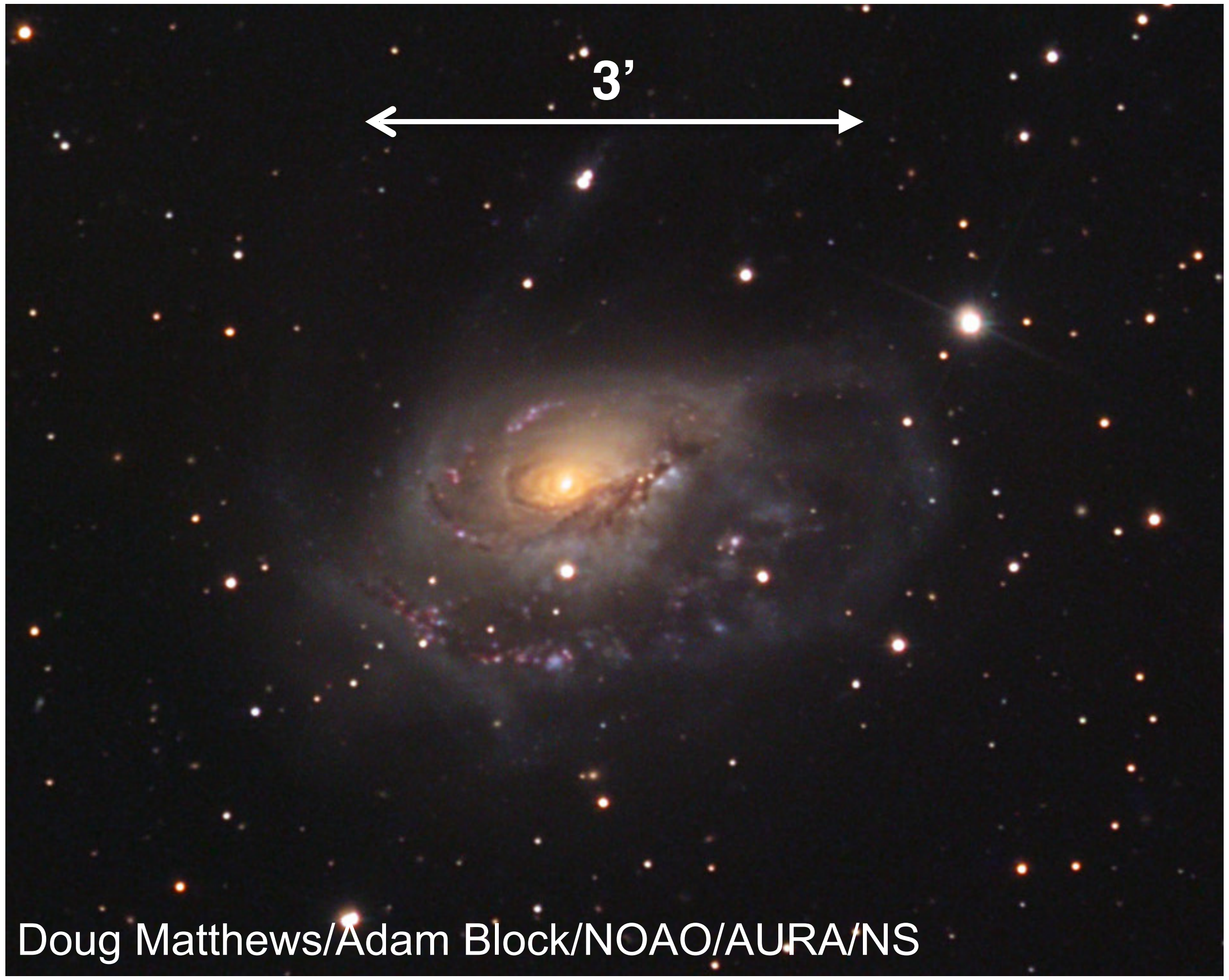
Want to study spirals instead!

Can use **stacking** or **targeted observations**

e.g.
Anderson+13
Planck Collaboration 2013
Greco+14
Anderson+15…

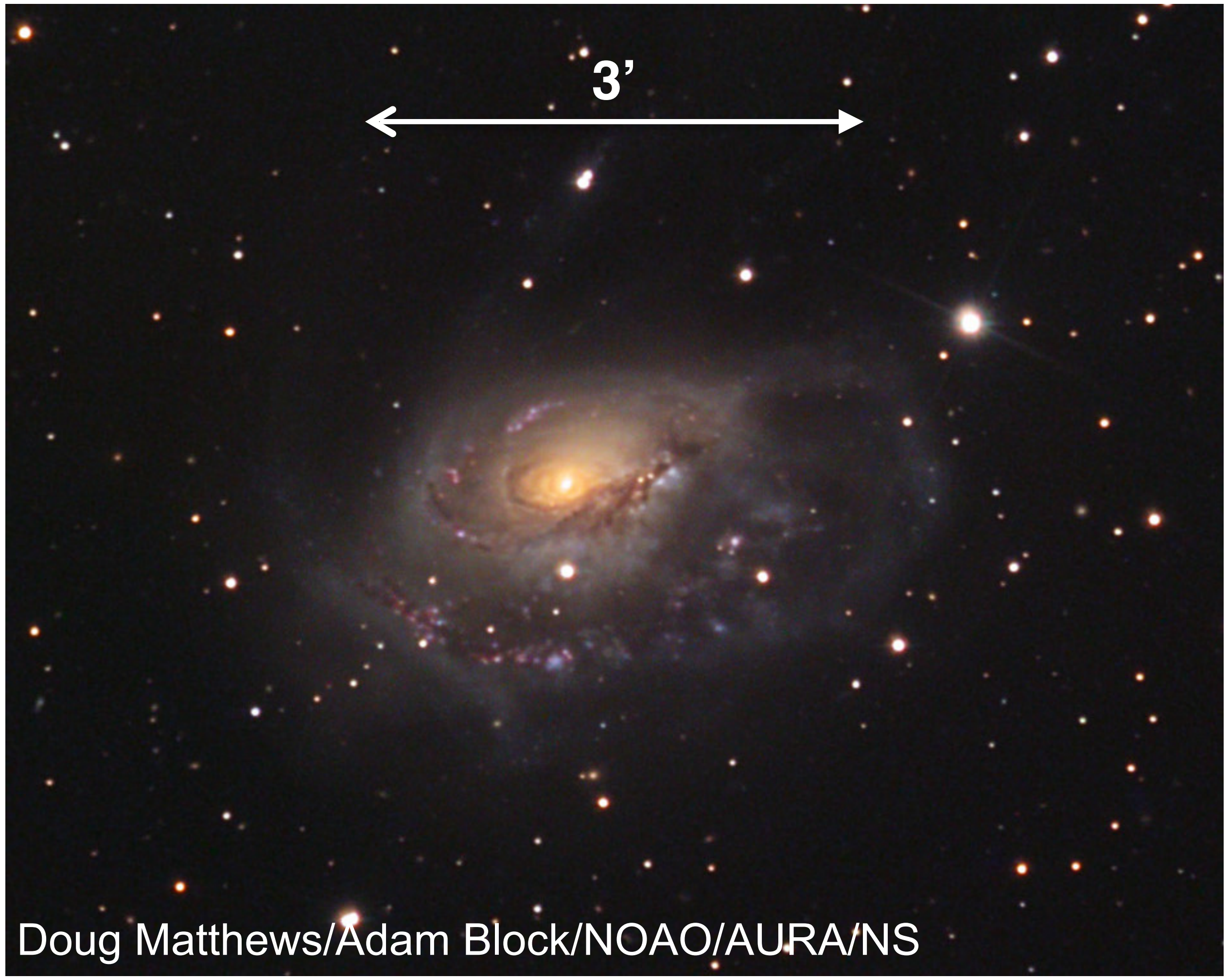
e.g.
Anderson+11
Dai+12
Bogdan+13
Walker+15…

NGC 1961

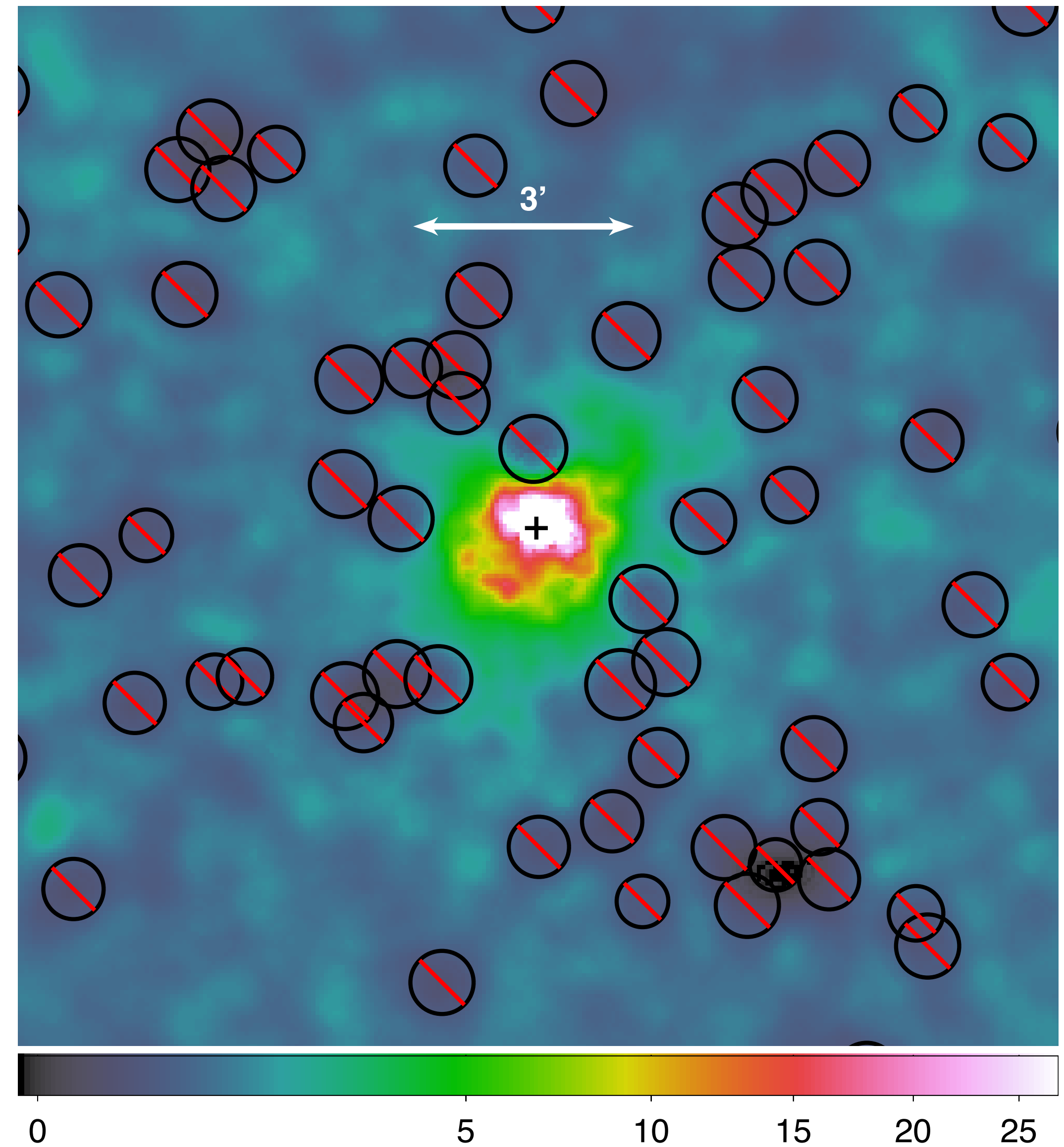


late-type spiral
M* = 3e11 Msun
v_C > 400 km/s
d = 58 Mpc

NGC 1961



XMM-Newton 0.4-1.25 keV



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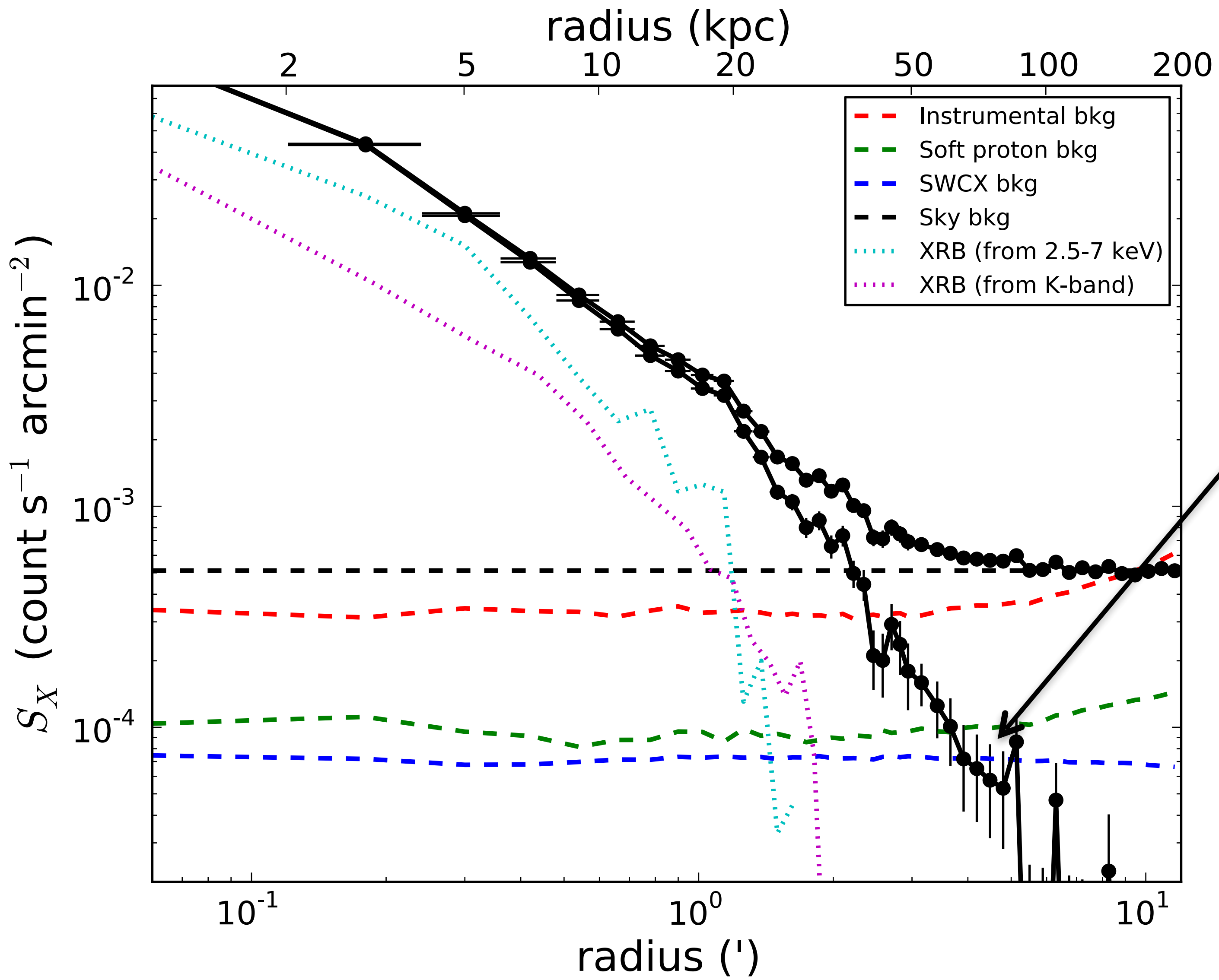
Extended Soft X-ray Emission



diffuse excess
out to ~80 kpc

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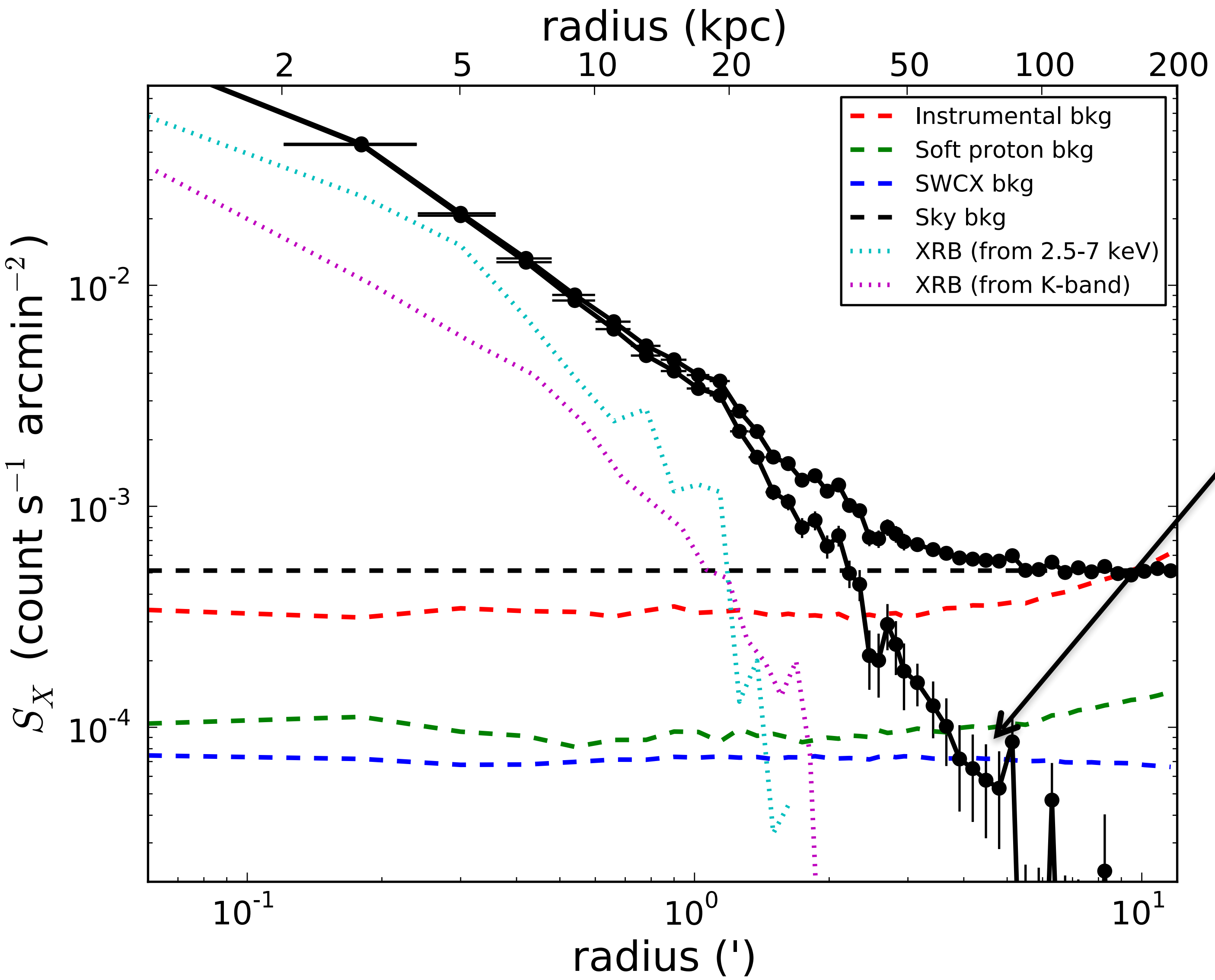

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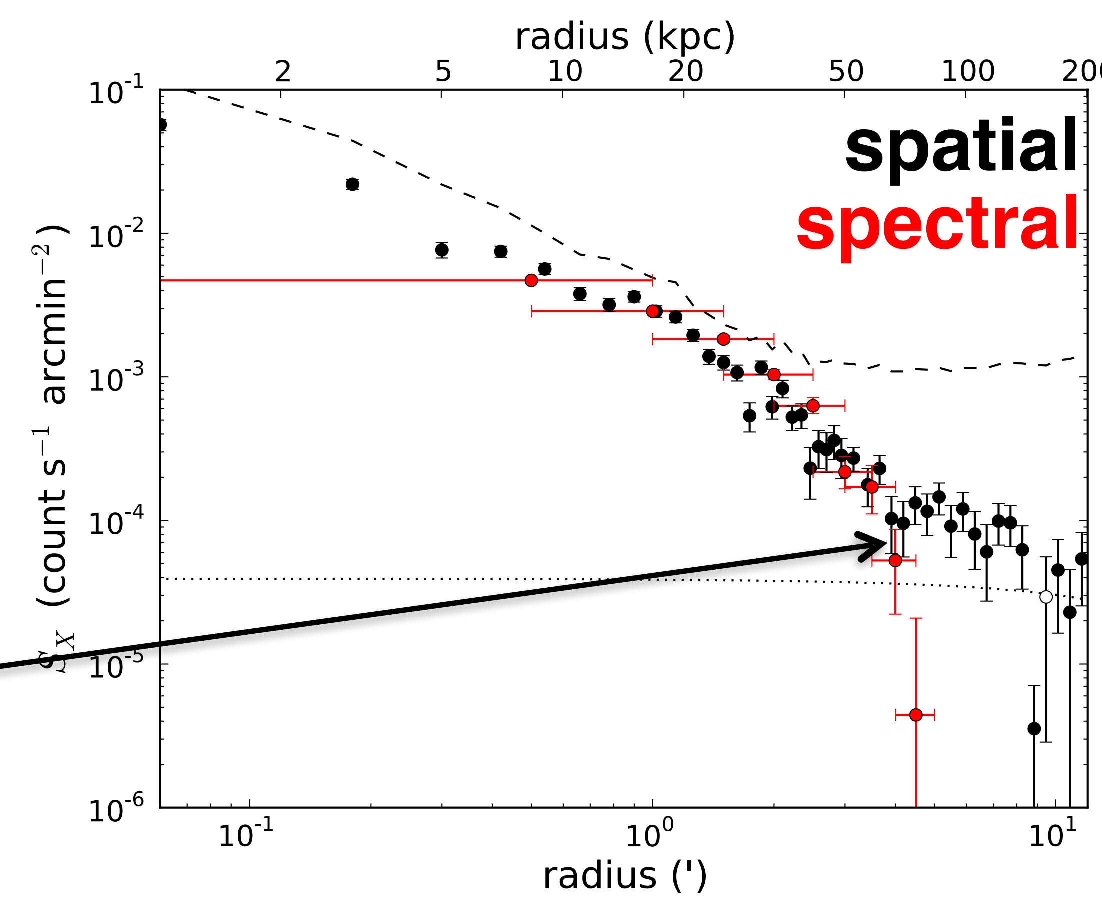
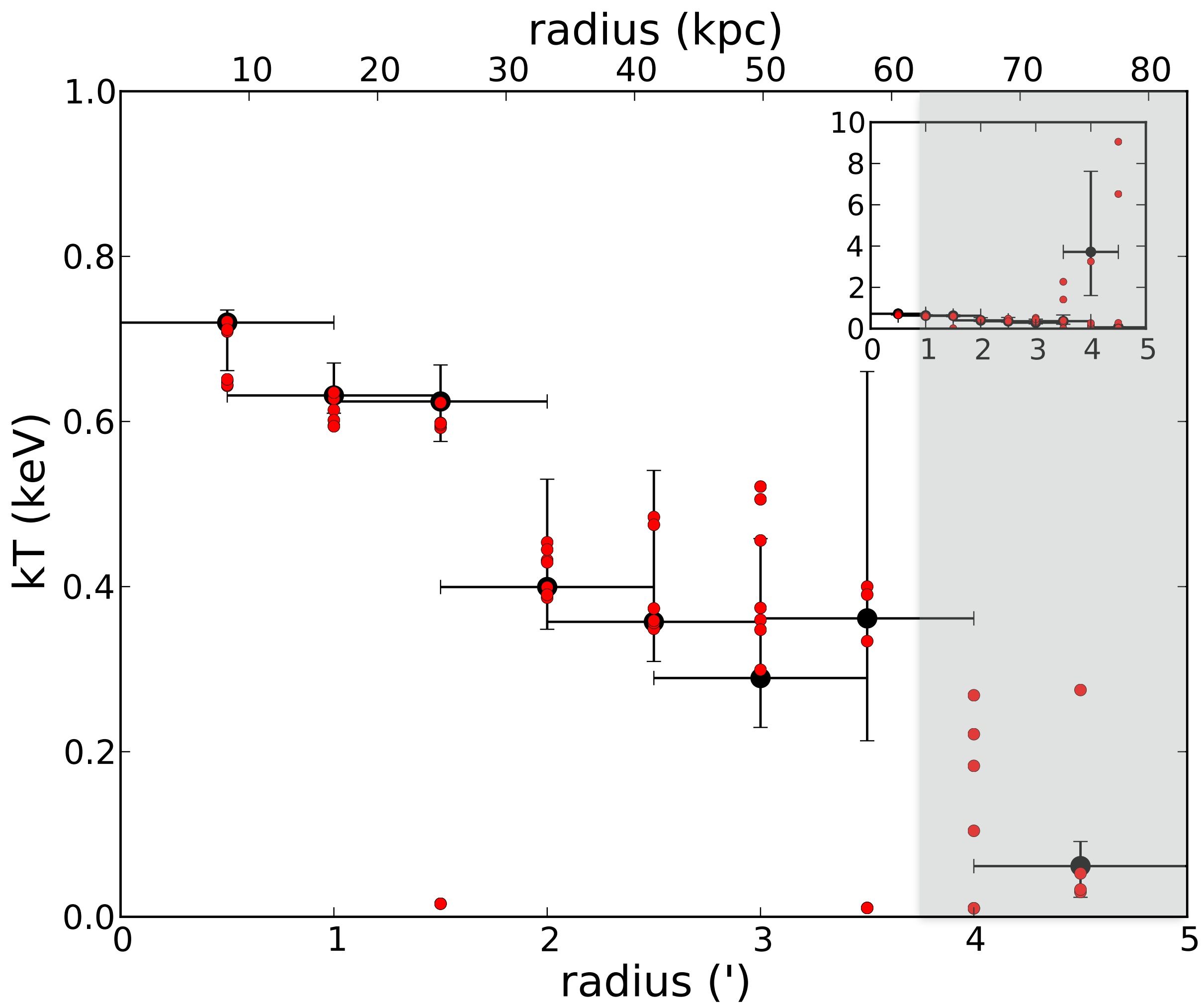


consistent results
out to 60-70 kpc

Temperature and Abundance Profiles



negative T(r) gradient

similar to lower-mass ellipticals

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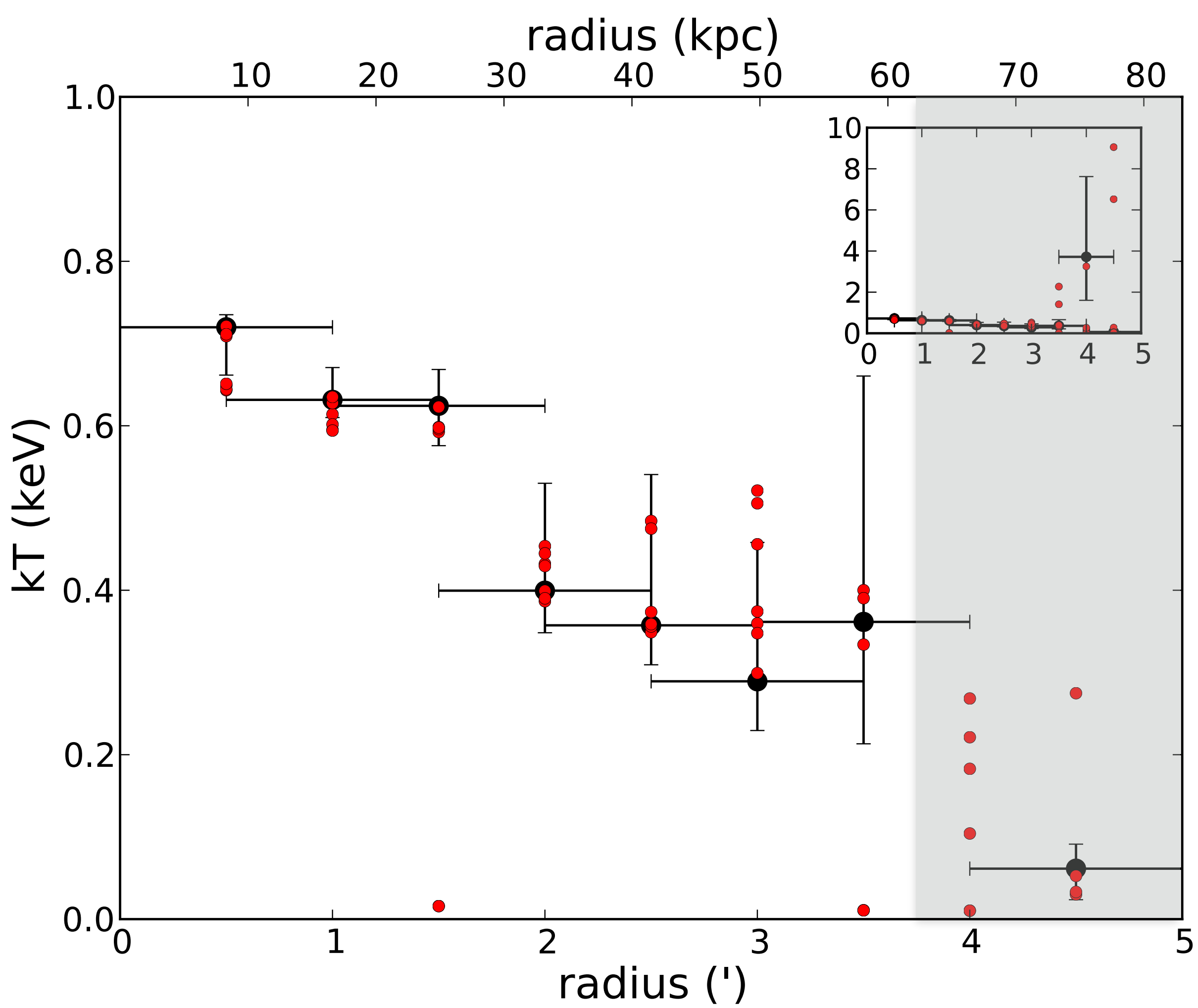
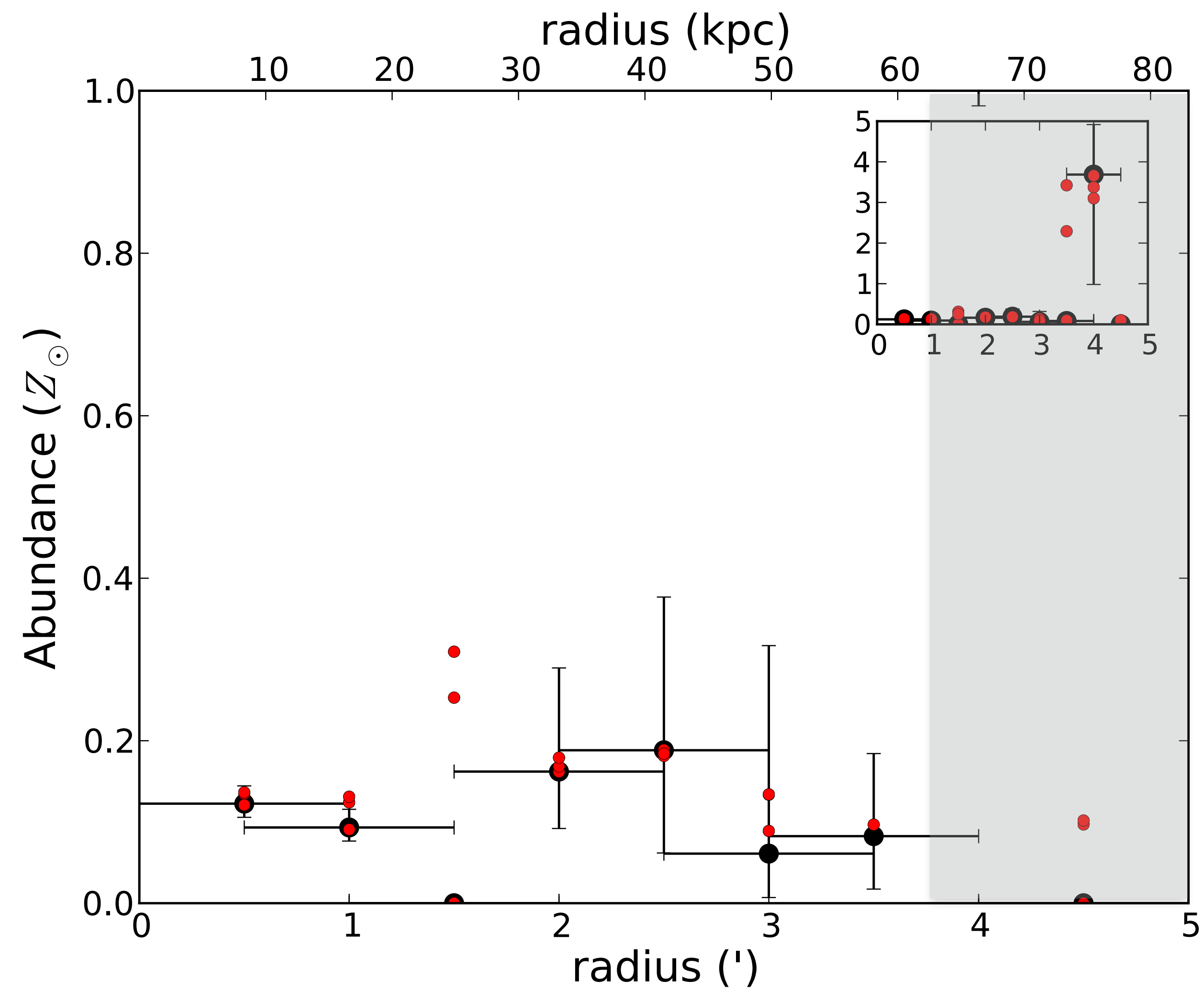




Metallicity is low

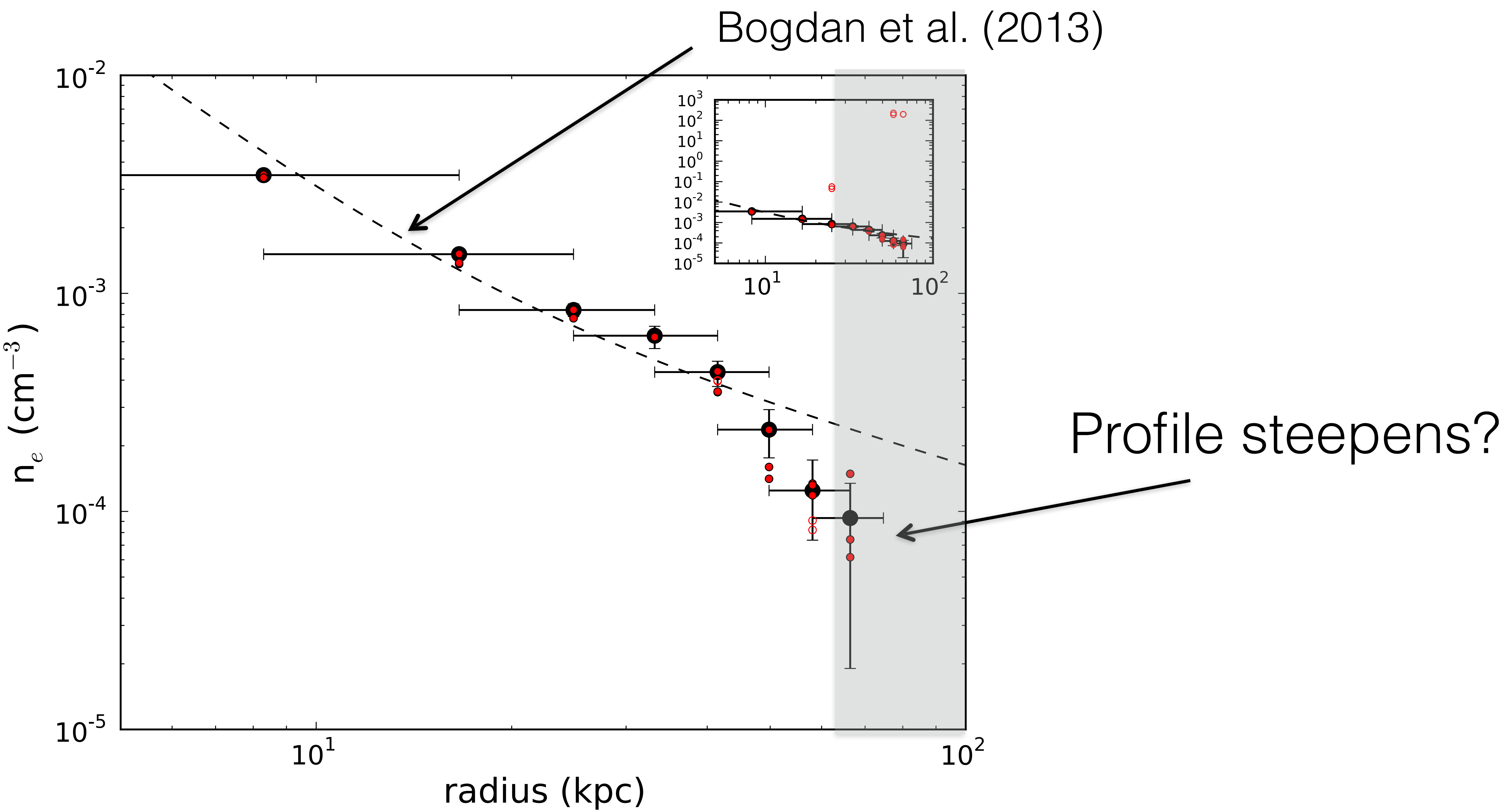
negative T(r) gradient

Z(r) is flat

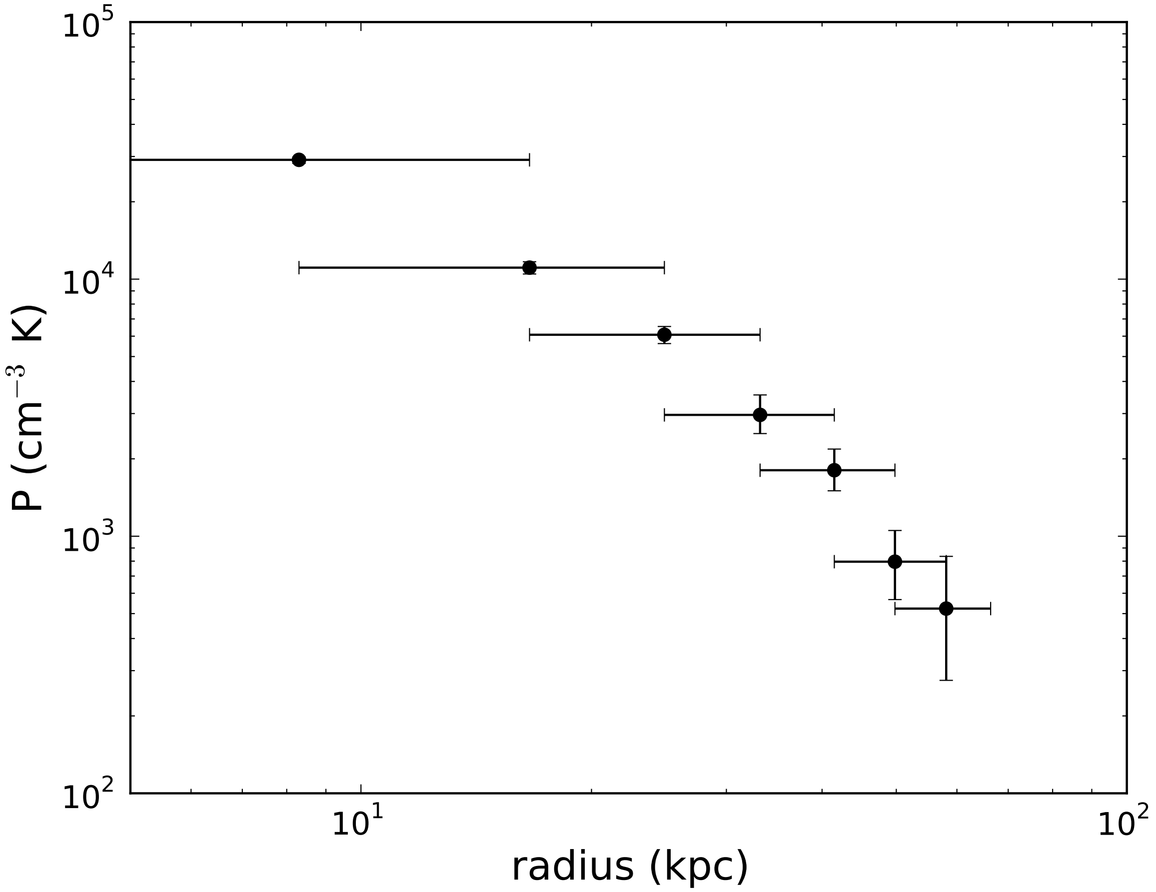
similar to lower-mass ellipticals

2-T models

Deprojected Hot Gas Density



Pressure Profile



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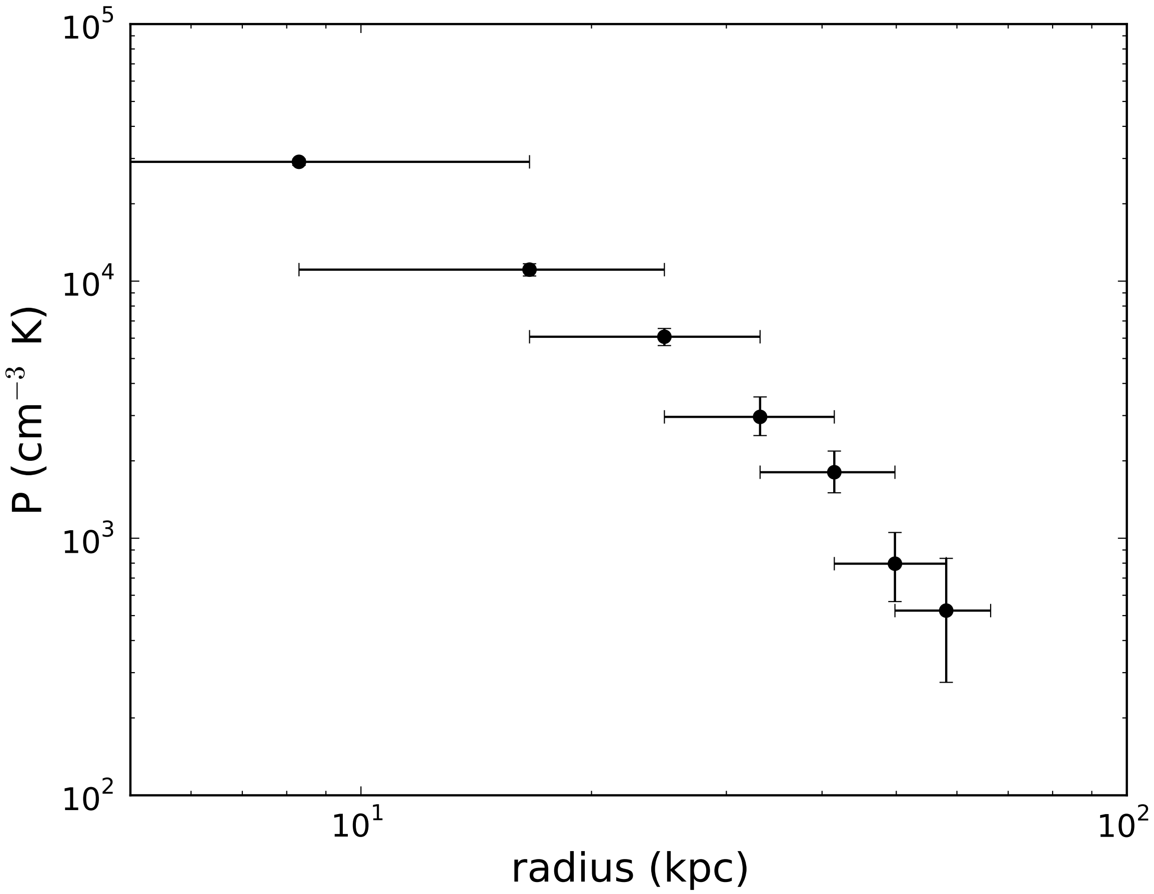
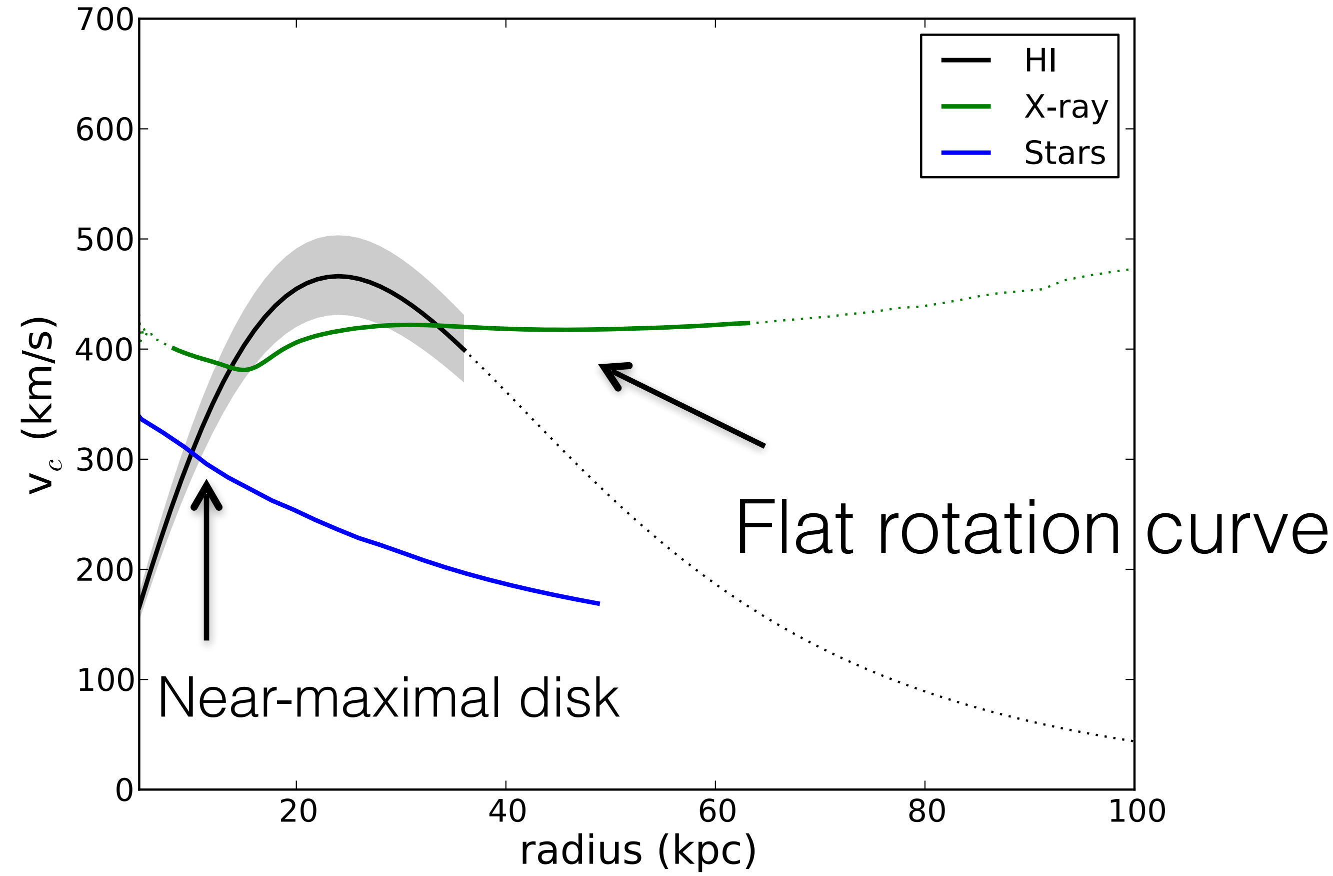
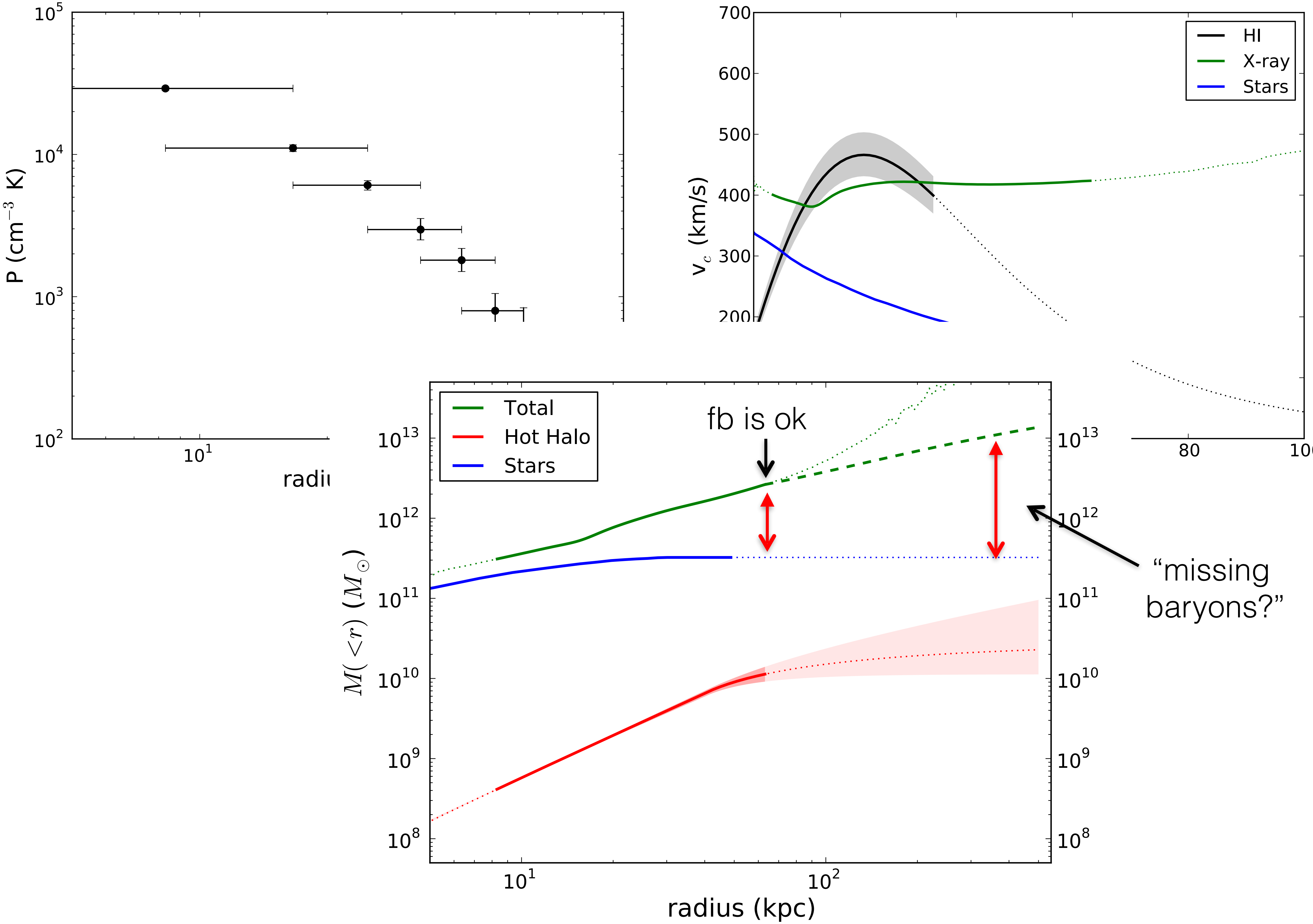


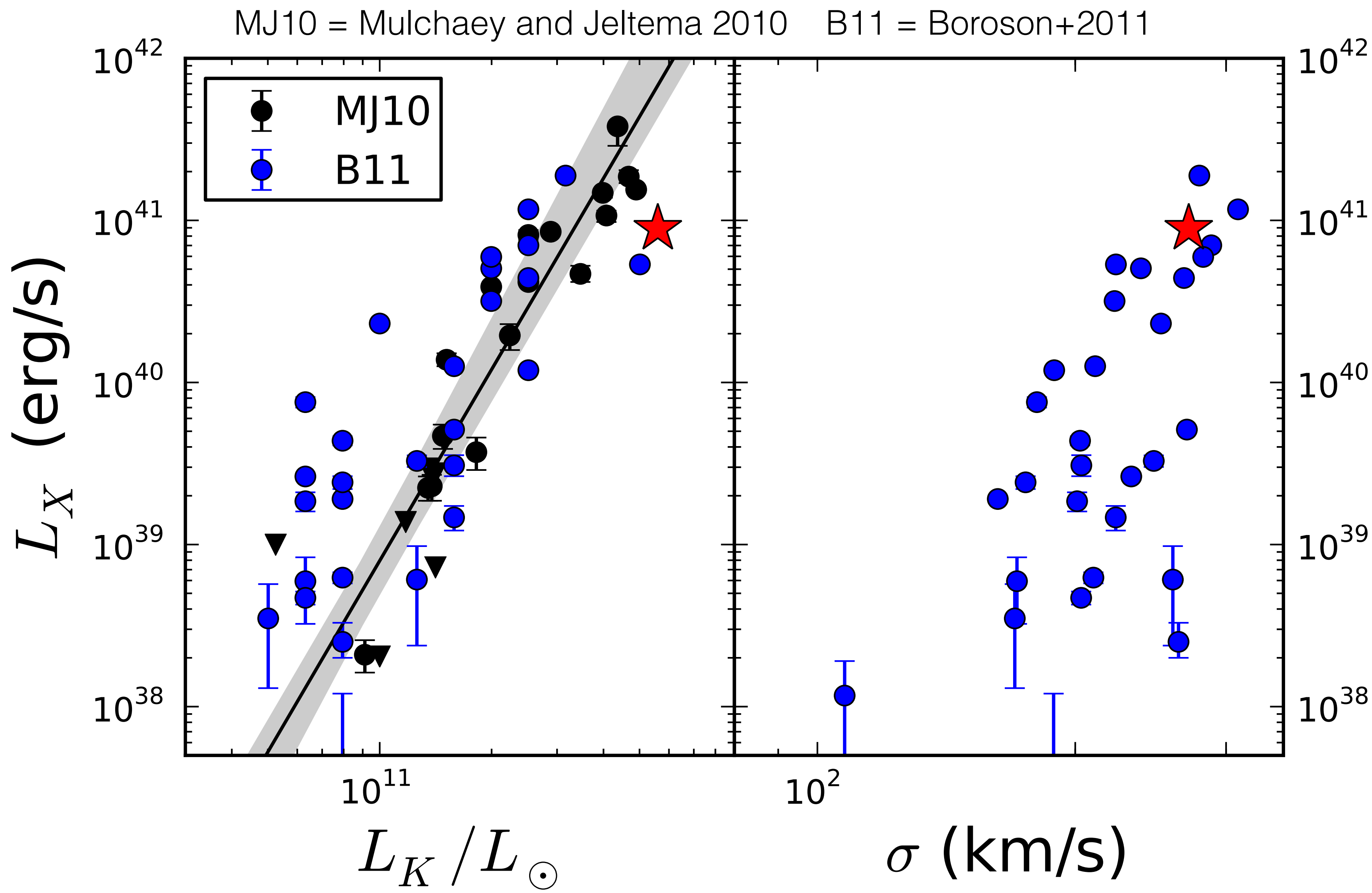


HI: Haan et al. (2008)
Stars: assume a K-band M/L of 0.6
X-ray: Pressure profile + HSE

Pressure Profile



Comparison with Ellipticals



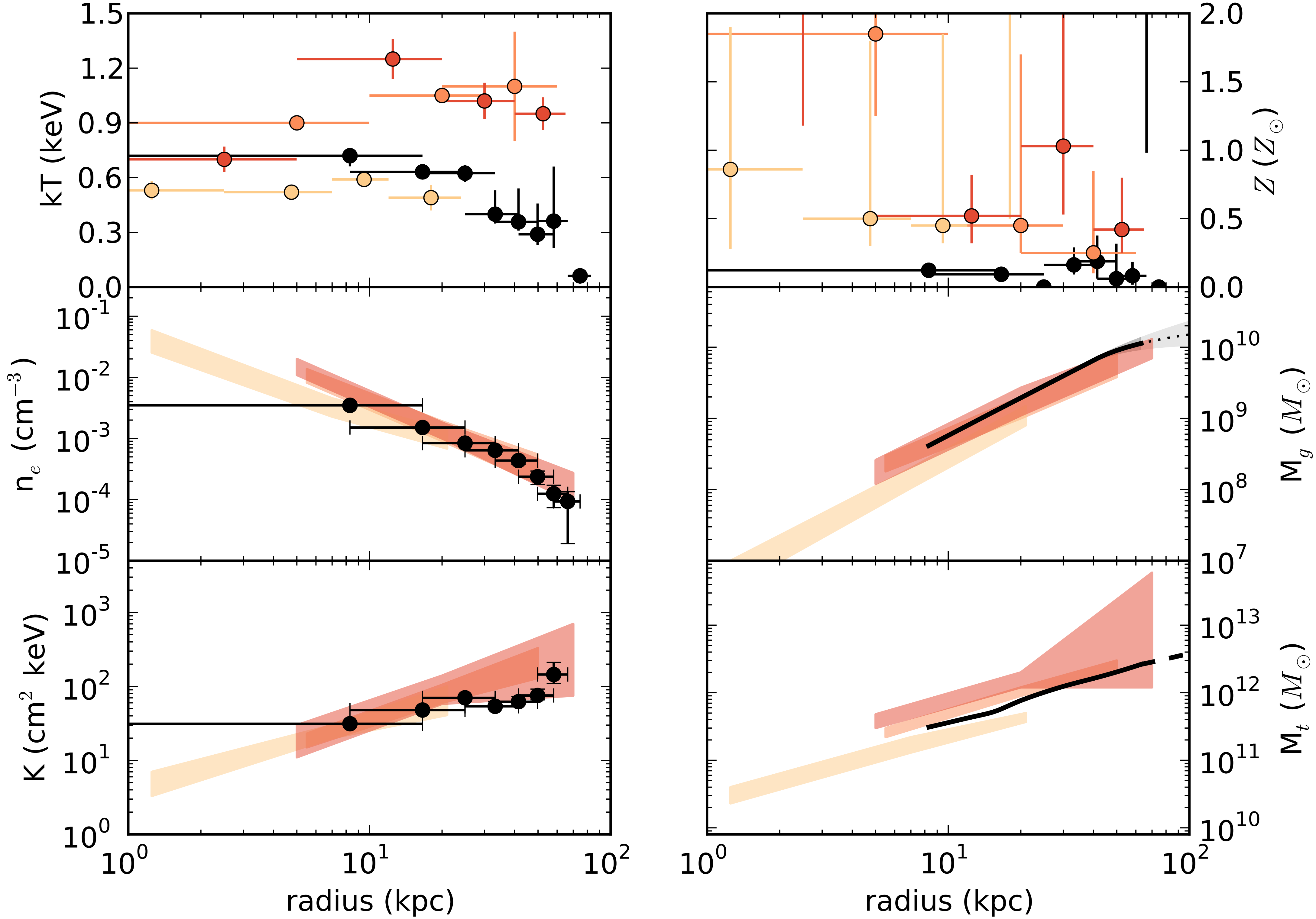
NGC 1961 is below M* - Lx

Agrees with σ - Lx

DM halo controls hot halo, not stars?

(note that spirals live in less massive halos than ellipticals)

Comparison with Ellipticals

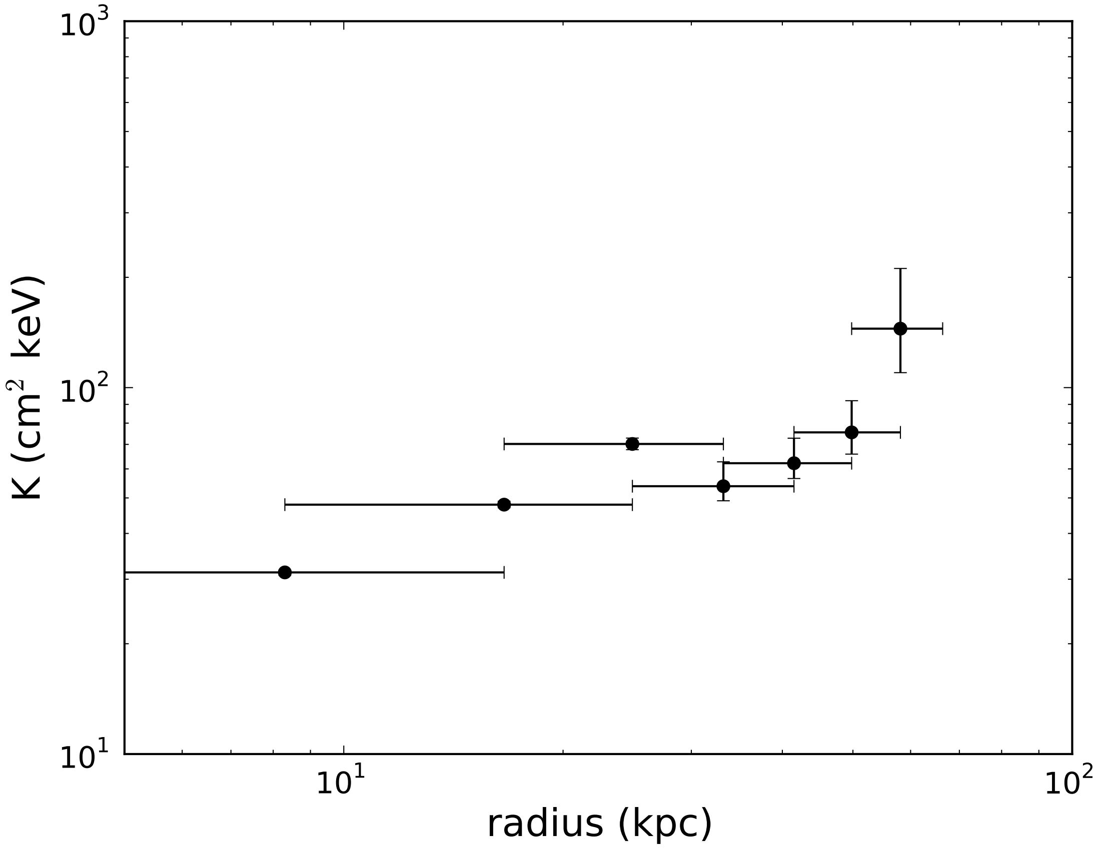


Comparison with O'Sullivan+2004,2005

NGC7796, NGC57, NGC4455

No systematic difference
(except metallicity)

Entropy Profile

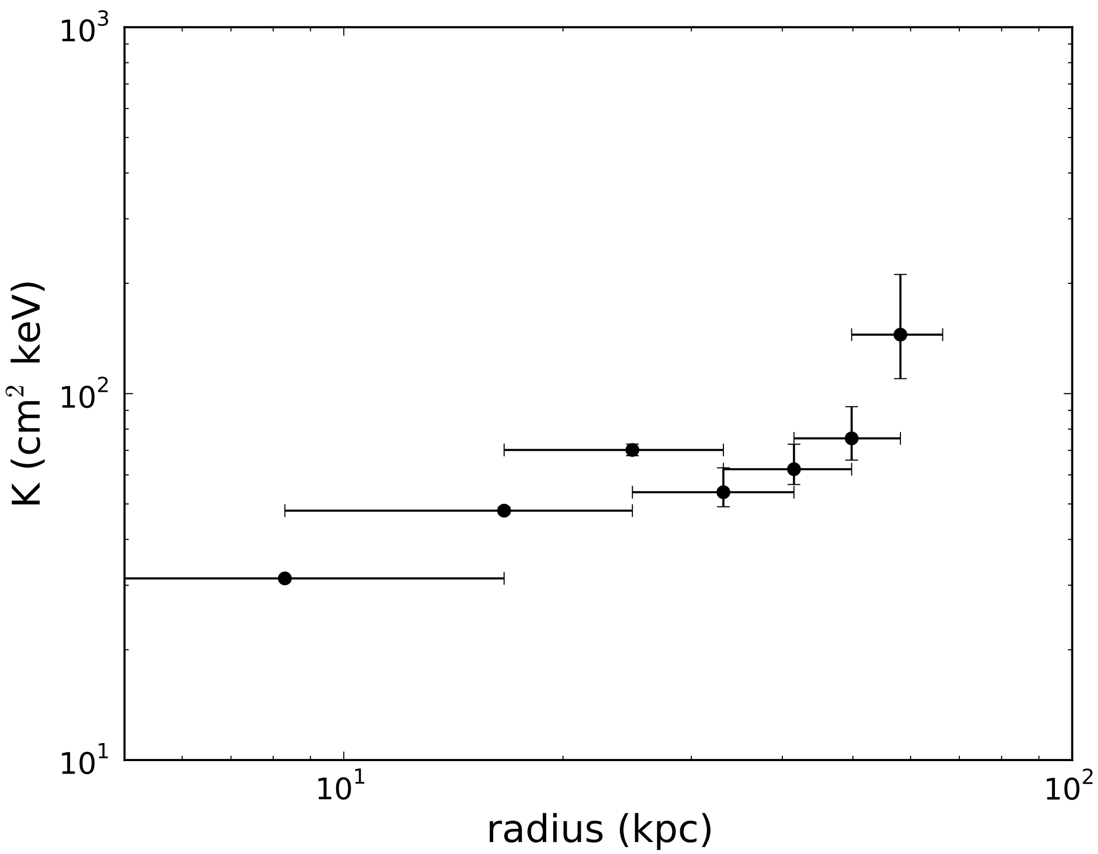


Entropy increases with radius (stable)

Central value is 30 cm^2 keV, which is the transition between CC and NCC clusters (Cavagnolo+ 2008, 2009)

Cooling flow?

Entropy Profile



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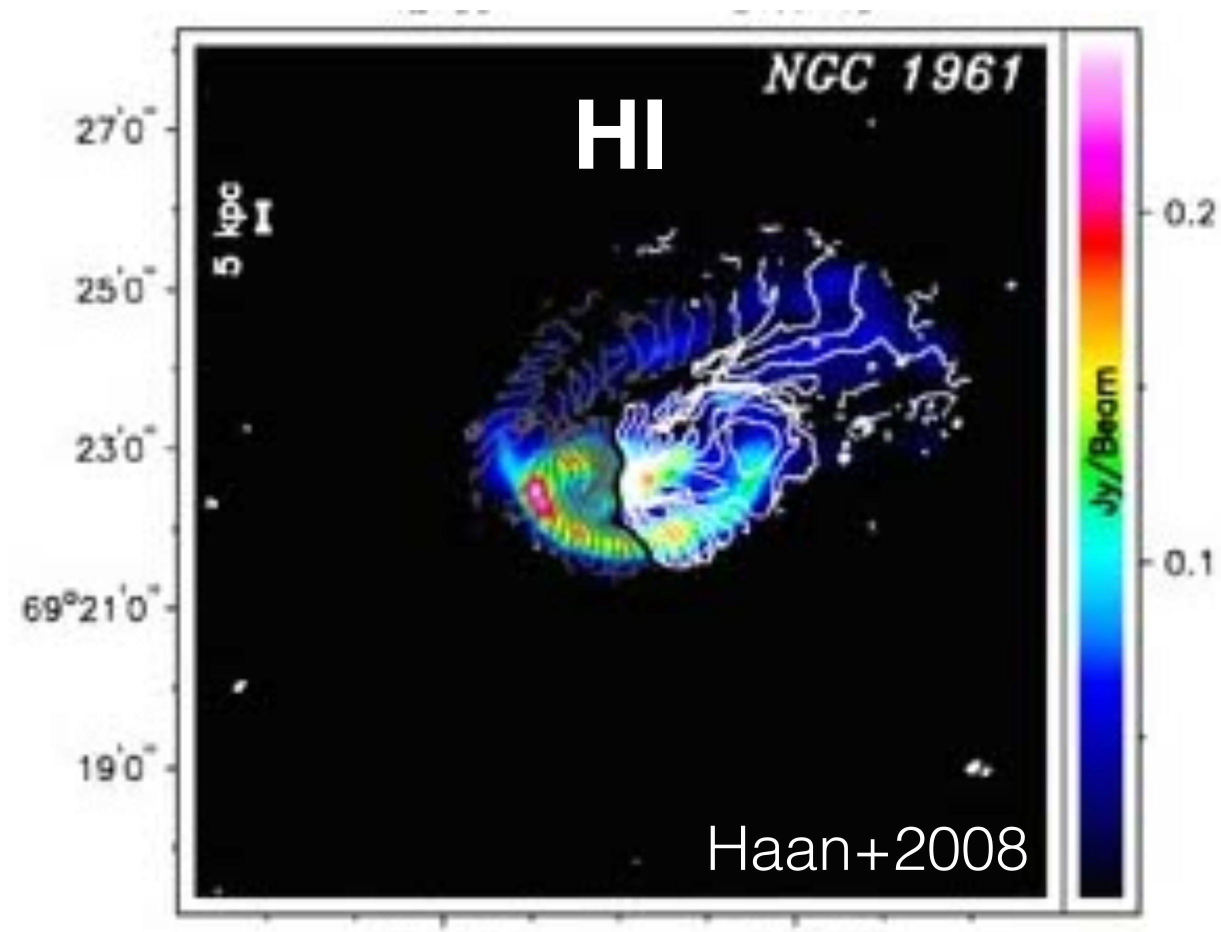

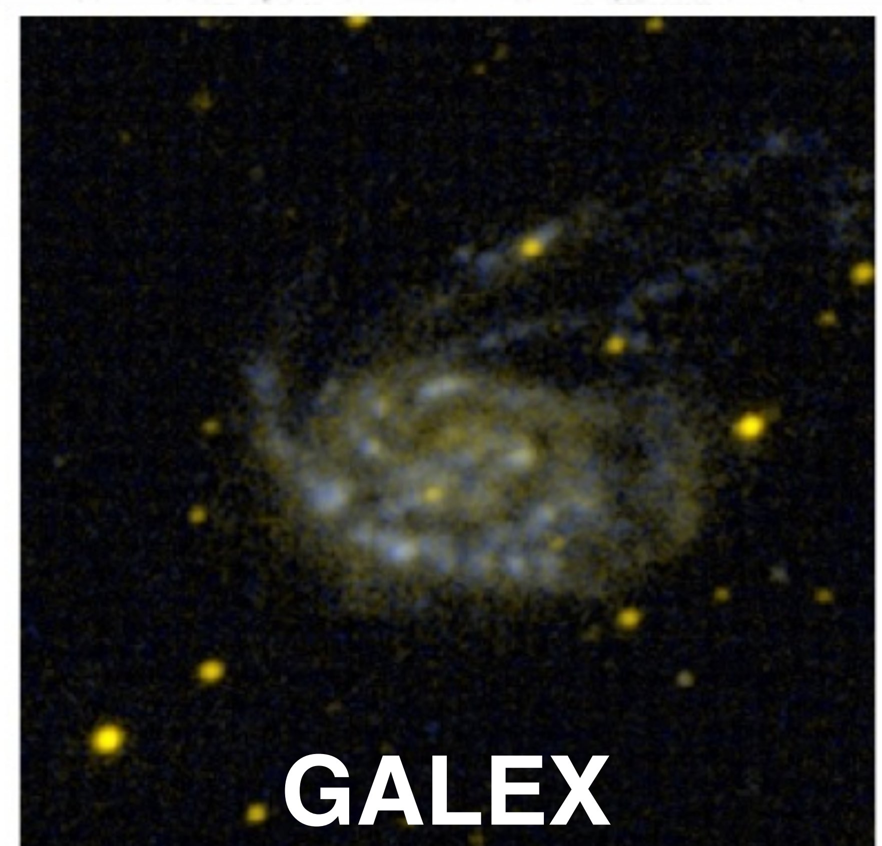

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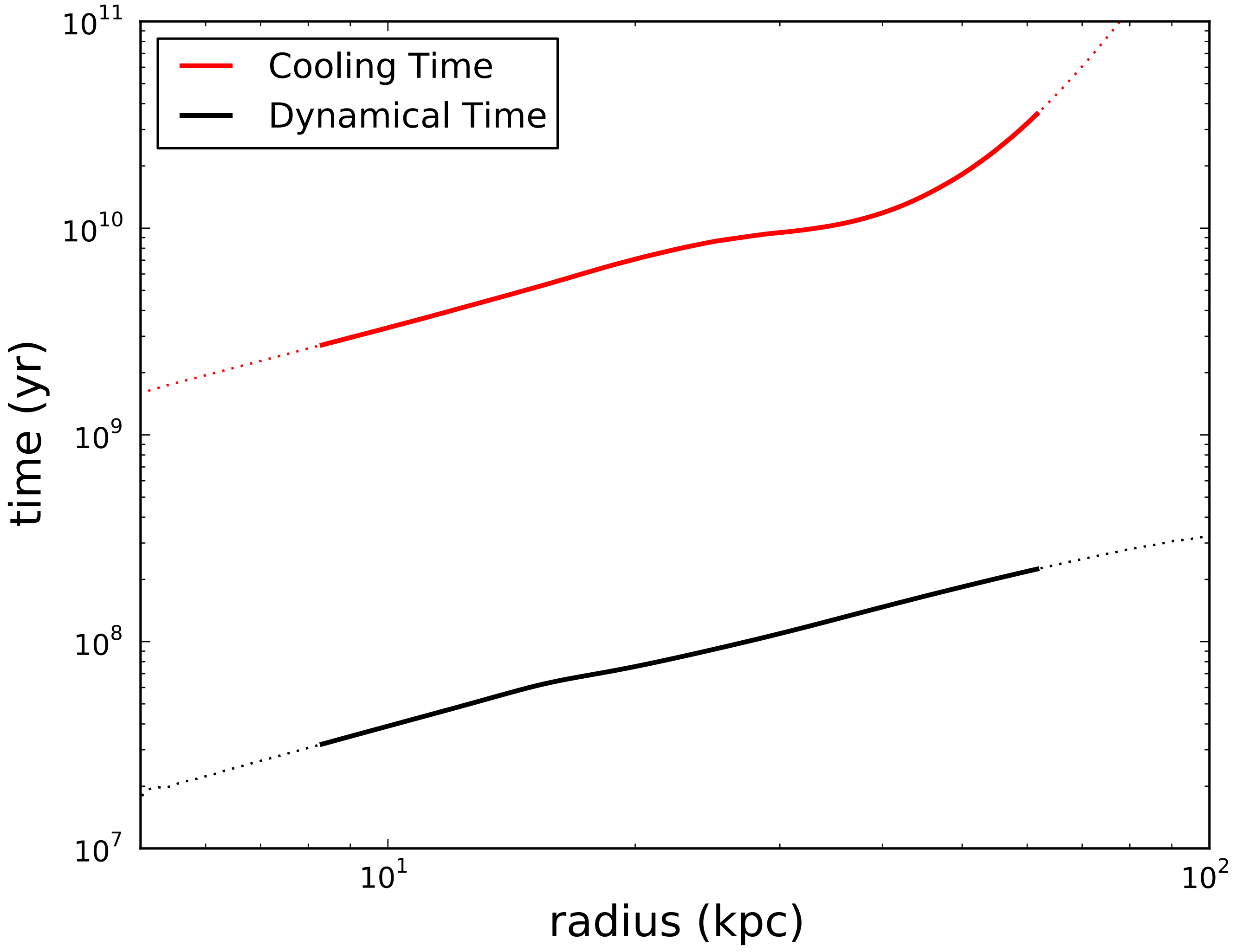

Not a cooling flow

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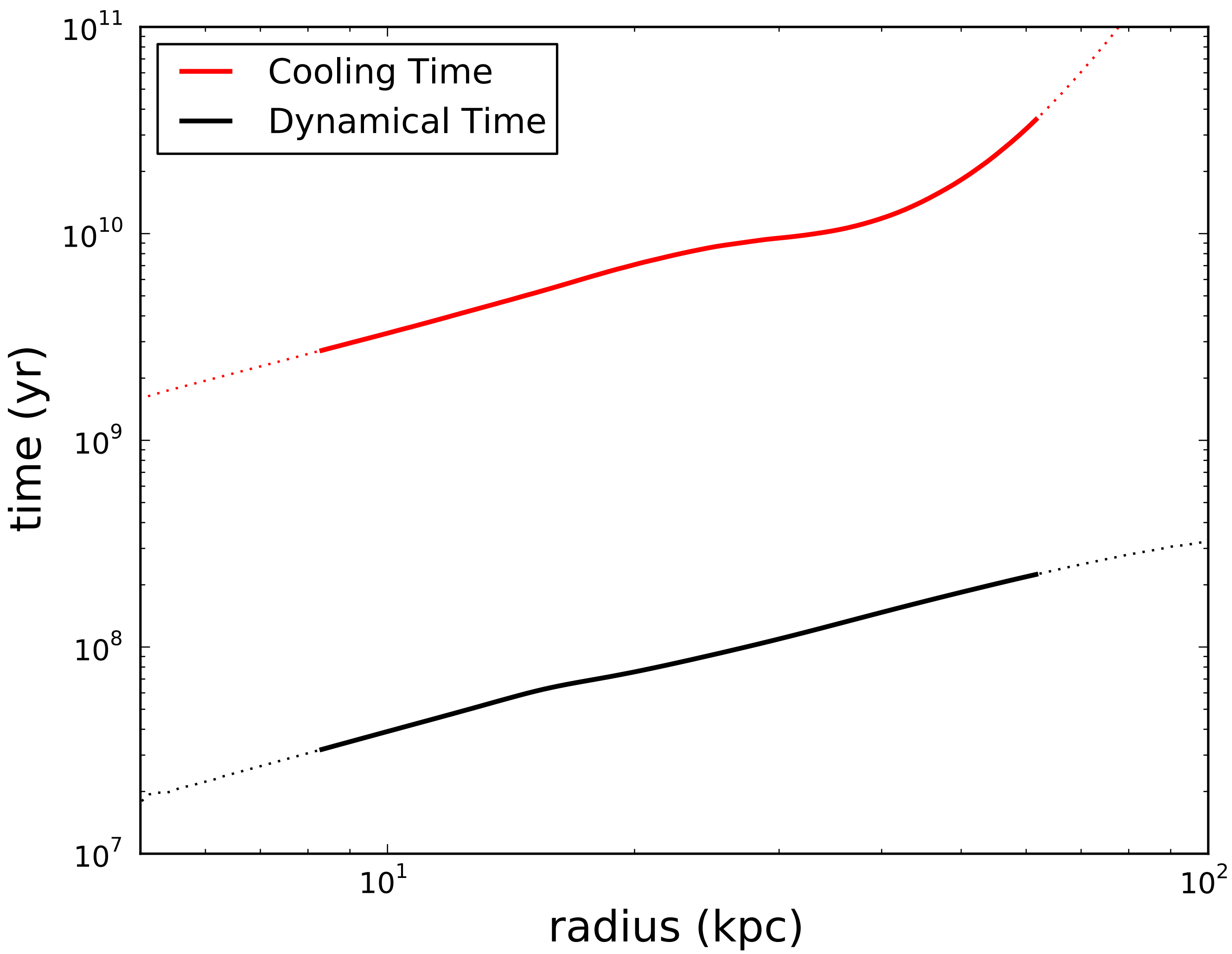

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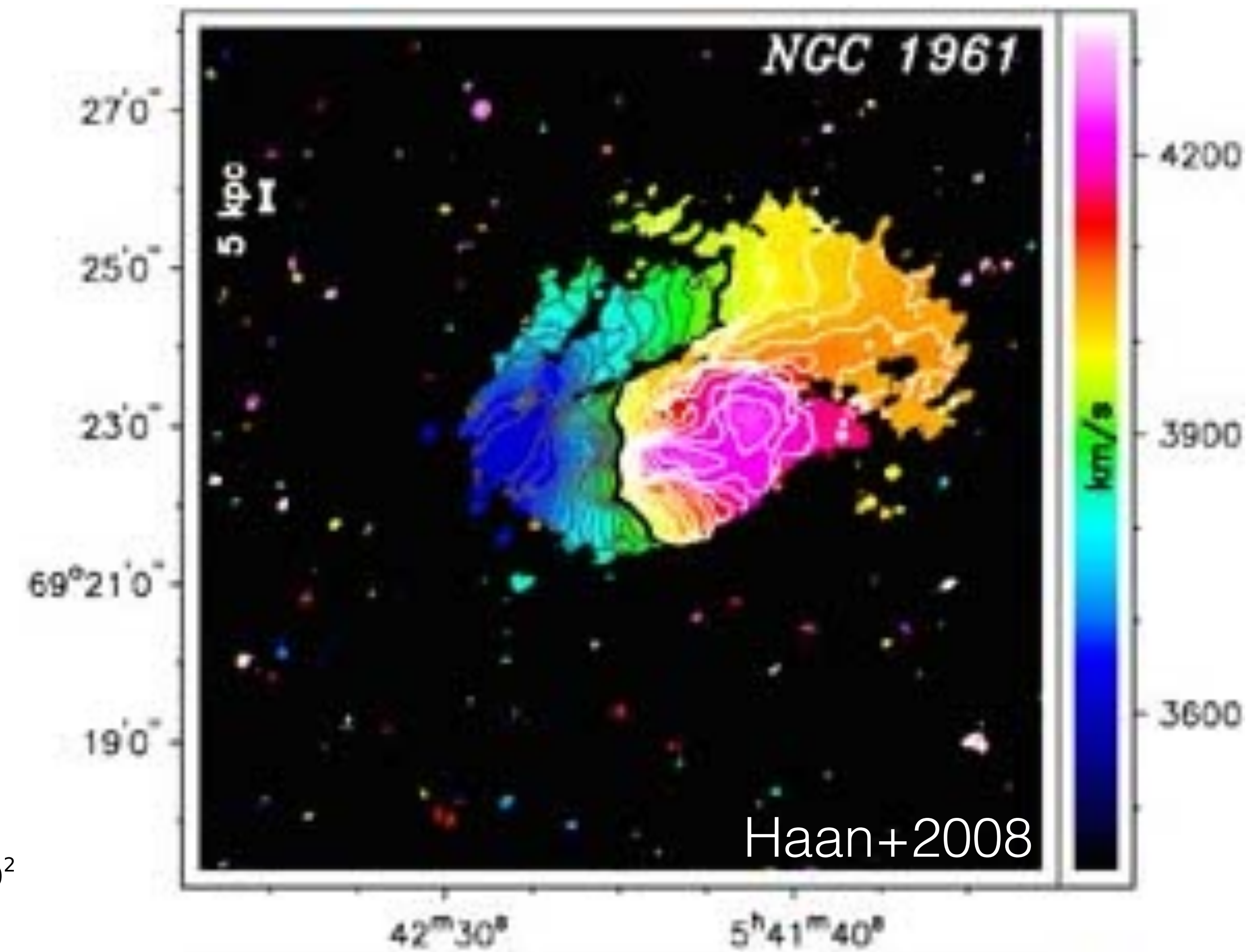

HI velocity field shows the filament has the same velocity of the disk -> accretion?

Conclusions

<u>NGC 1961 hot halo properties:</u>
hot halo extends to at least 80 kpc
T(r) slowly declining
Z(r) flat and probably low
central entropy is intermediate
hot halo is stable against cooling
hot gas mass < stellar mass

Measured DM halo is similar to isolated ellipticals
but NGC 1961 somehow is able to accrete gas