Search for plasma heating mechanisms in non-cD clusters

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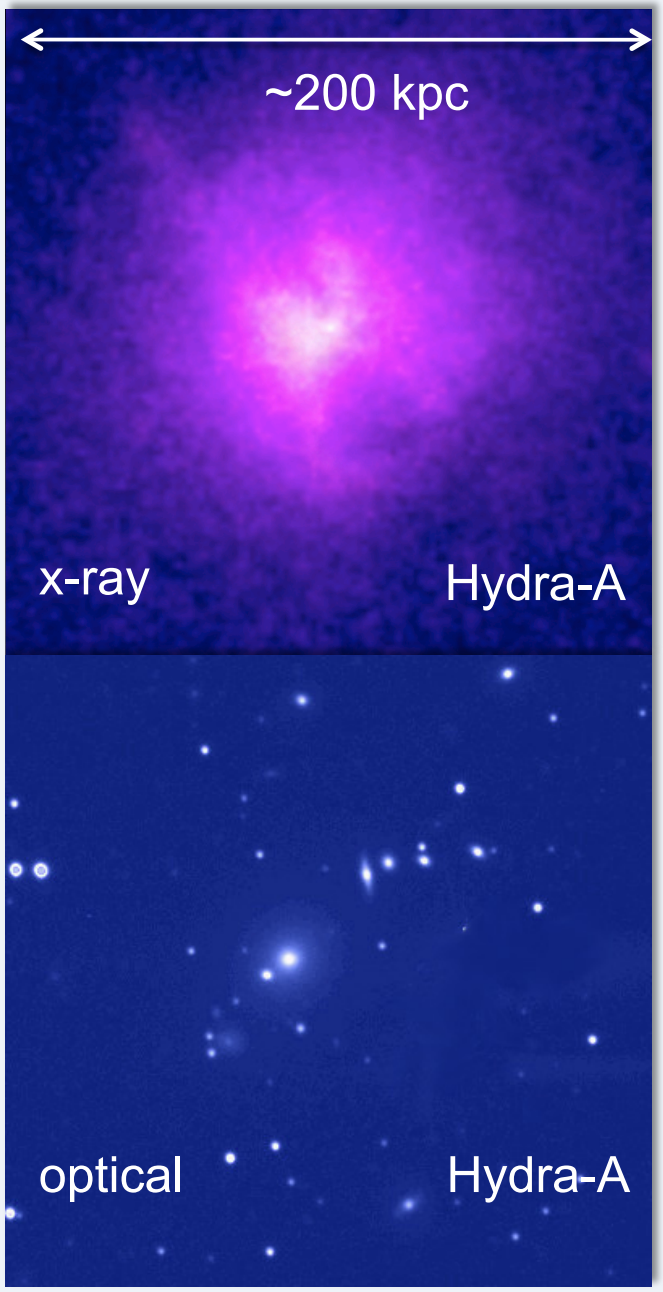
1) Clusters of Galaxies

- Largest gravitationally bound systems

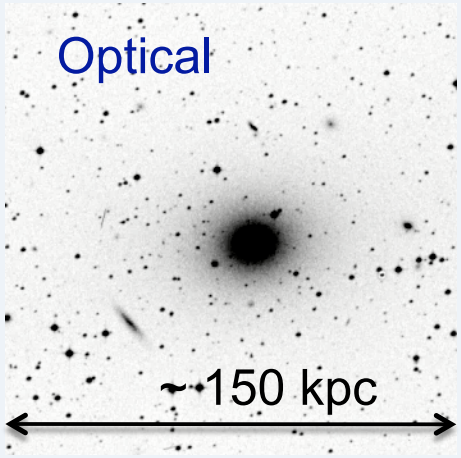
  M_{vir} ~$10^{14\text{-}15}$ M_{sun}, R_{vir} ~ 1-3 Mpc

- Mass constituents
  - ~ 85% Dark matter
  - ~12% X-ray emitting plasma
    - Intracluster medium (ICM), T= $10^{7\text{-}8}$ K
  - ~3% Galaxies
    - 1st observed part



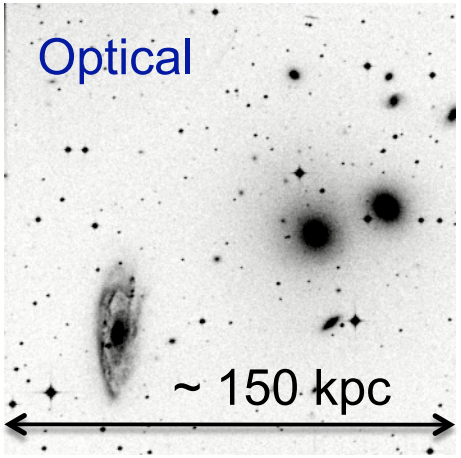
2) cD and non-cD Clusters

cD Clusters (Bautz-Morgan I)



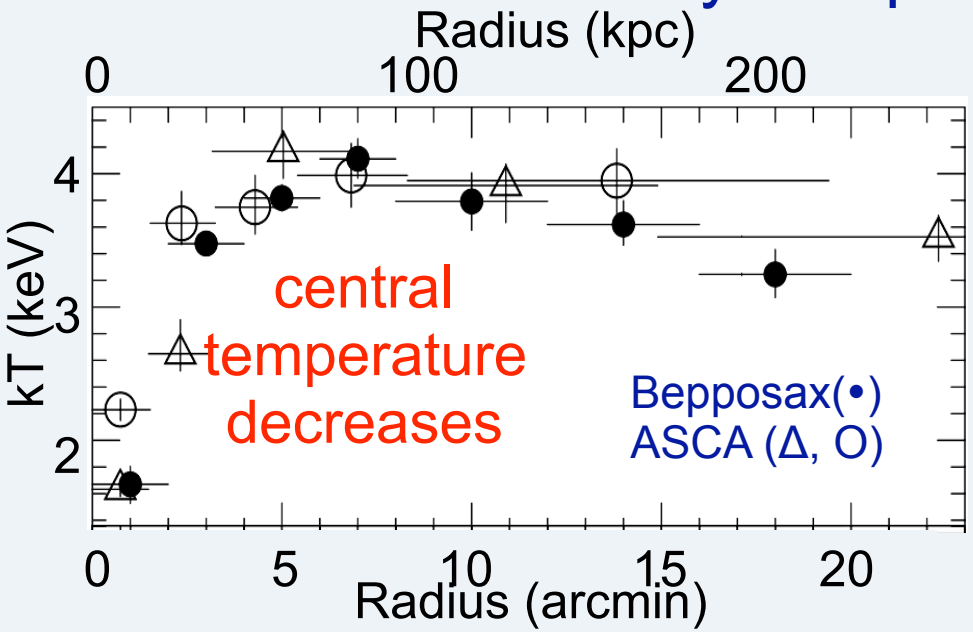
- Centaurus Cluster
- Central-dominant cD (elliptical) galaxy

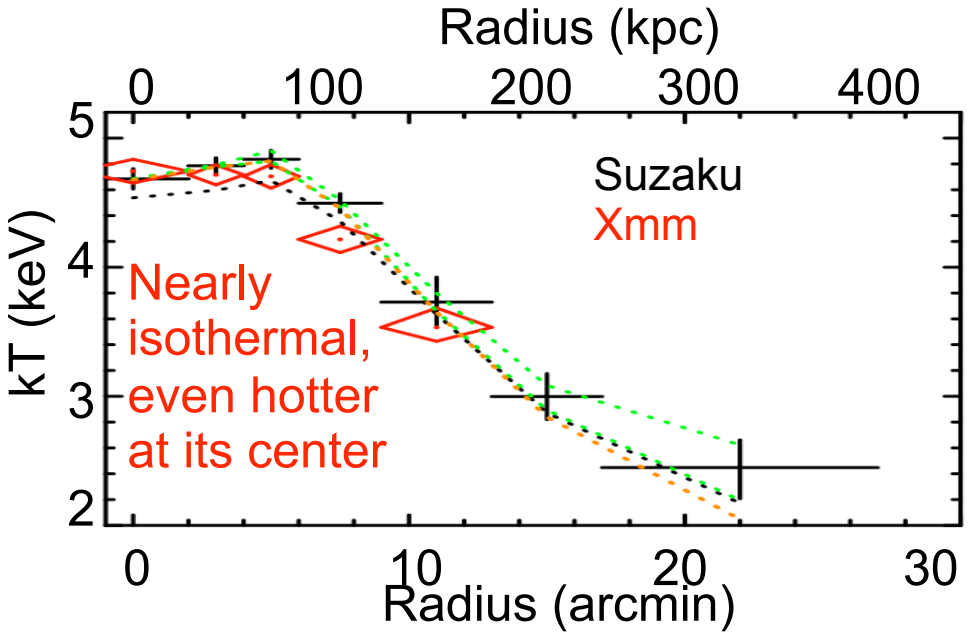
non-cD Clusters (B-M III)



- Abell 1060
- Several galaxies at their centers

X-ray Temperature Profile





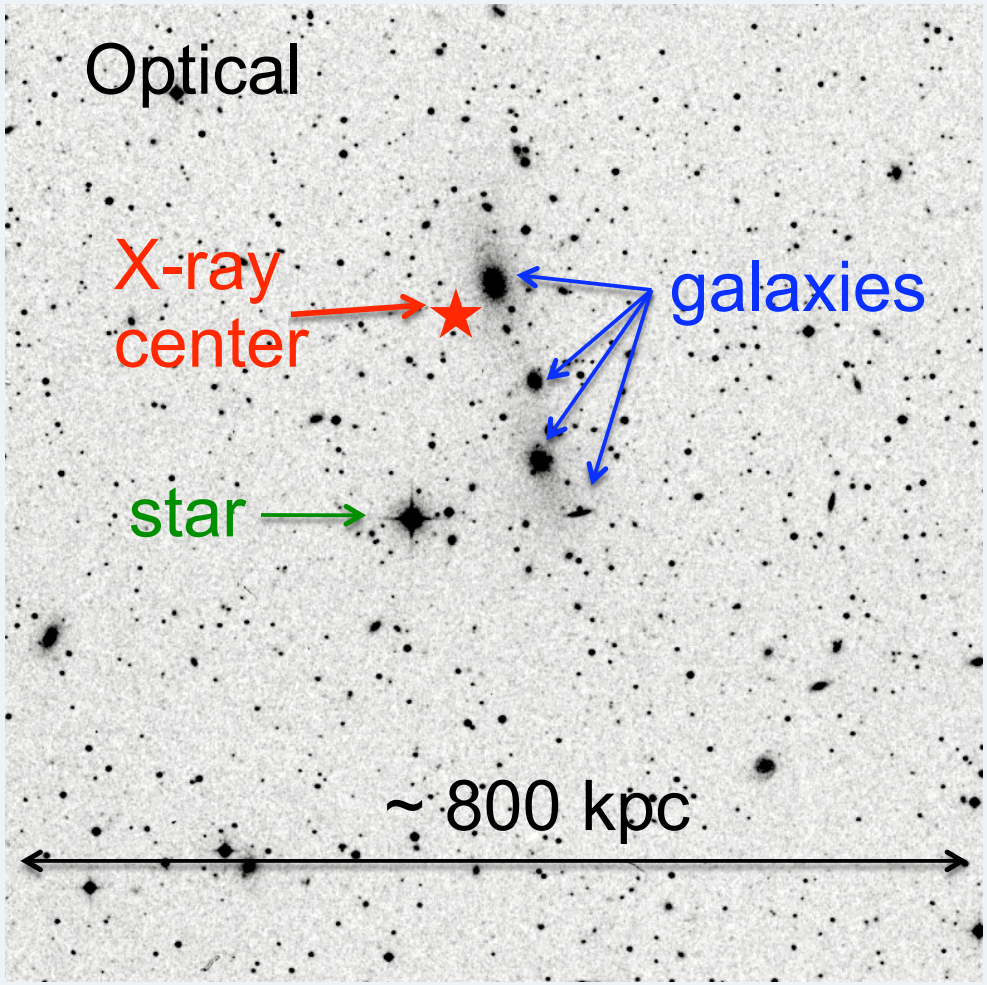
3) Motivation & Method

- ICM temperature of cD clusters is decreasing towards the center. However the best studied non-cD cluster shows the opposite temperature gradient.

- non-cD clusters have not been studied so much →study another non-cD cluster to clarify whether it resembles Abell 1060 or not.

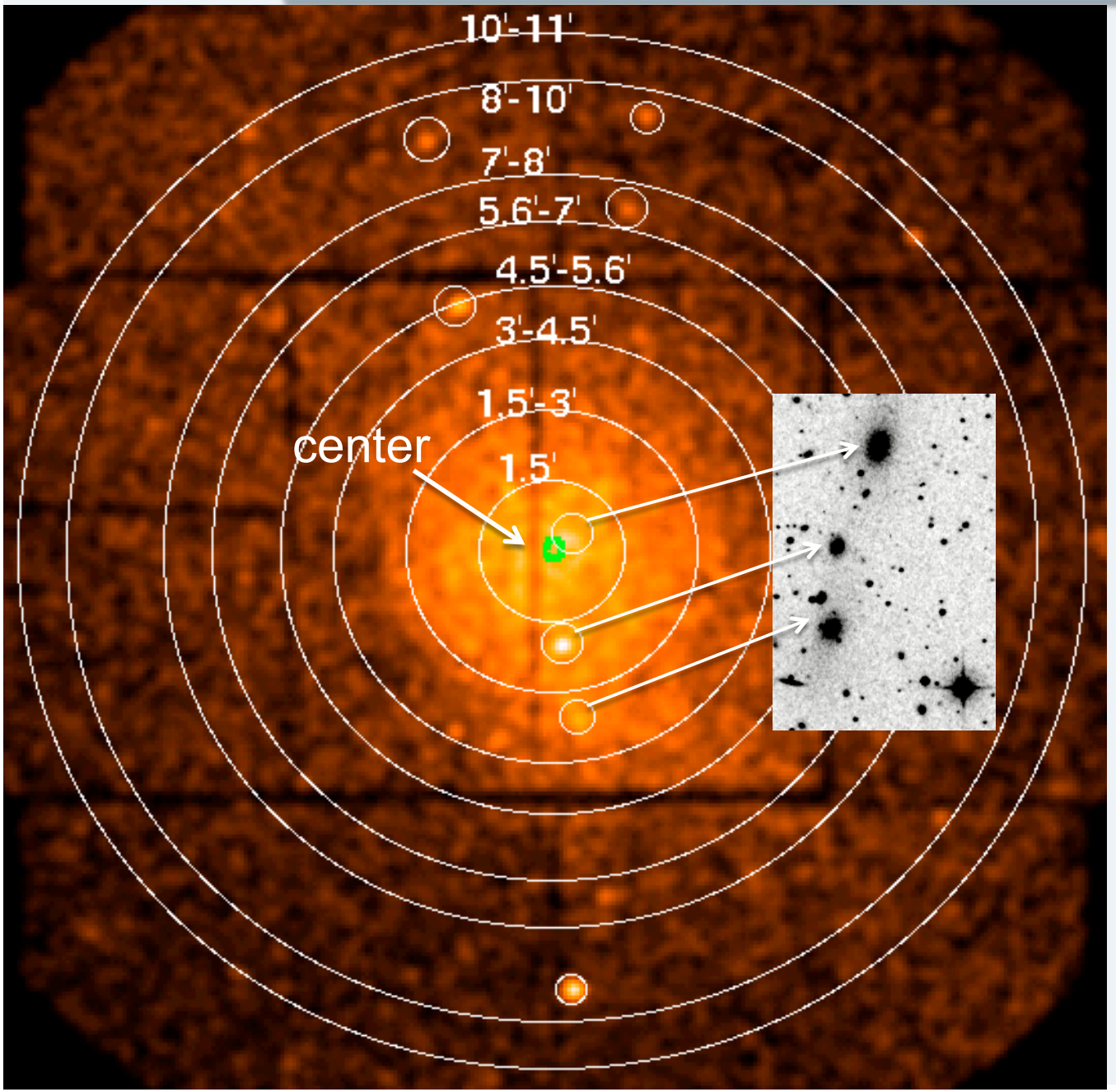
- We searched for the clusters which have similar properties to Abell 1060:
  - non-cD clusters (Bautz-Morgan Type III)
  - Circularly symmetric X-ray emission (not strong mergers)
  - Average temperature: kT~3-4 keV (medium richness)

4) Abell 2147



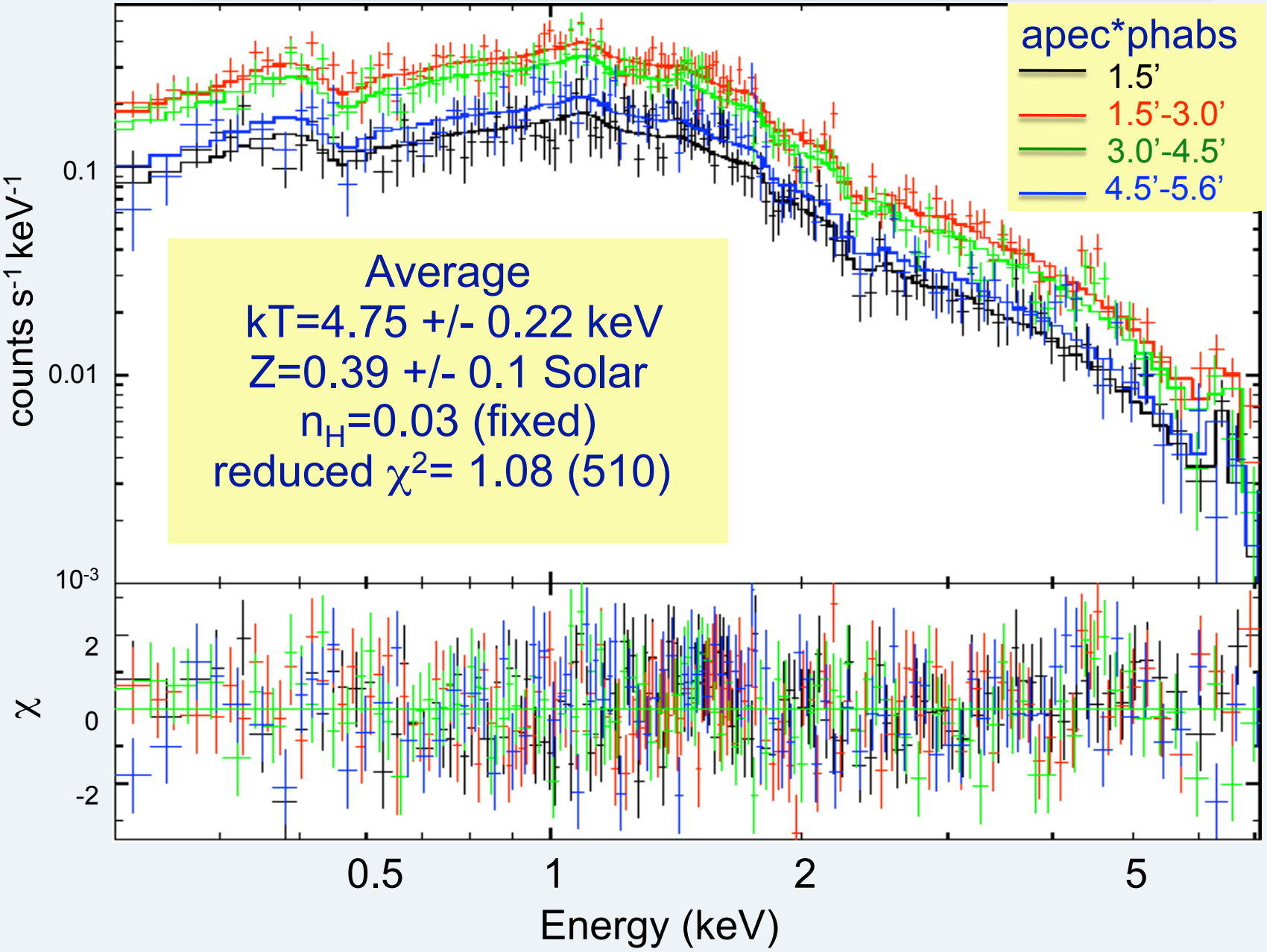
- Properties
  - non-cD (B - M Type III)
  - regular, x-ray morphology
  - z=0.035
  - kT ~ 4.4 +/- 1.6 keV (Fukazawa et al. 1998)
- Data
  - Public data
  - XMM-Newton Observation, 2008
  - Exposure: 12 ksec

5) A2147: X-ray Image



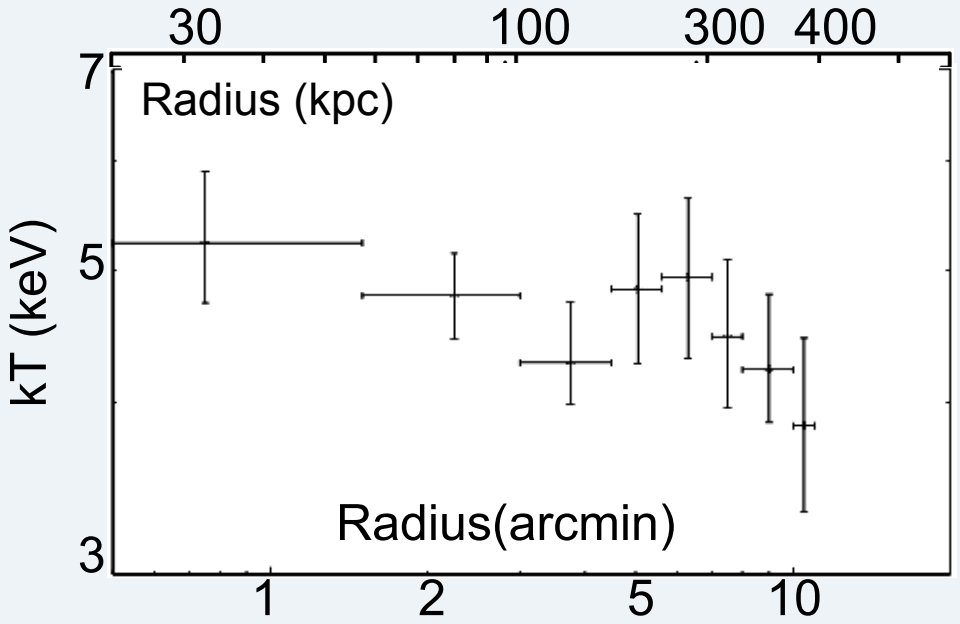
- mos2
- 0.2-12 keV
- no background subtraction
- no vignetting correction
- excluded point sources and individual galaxies

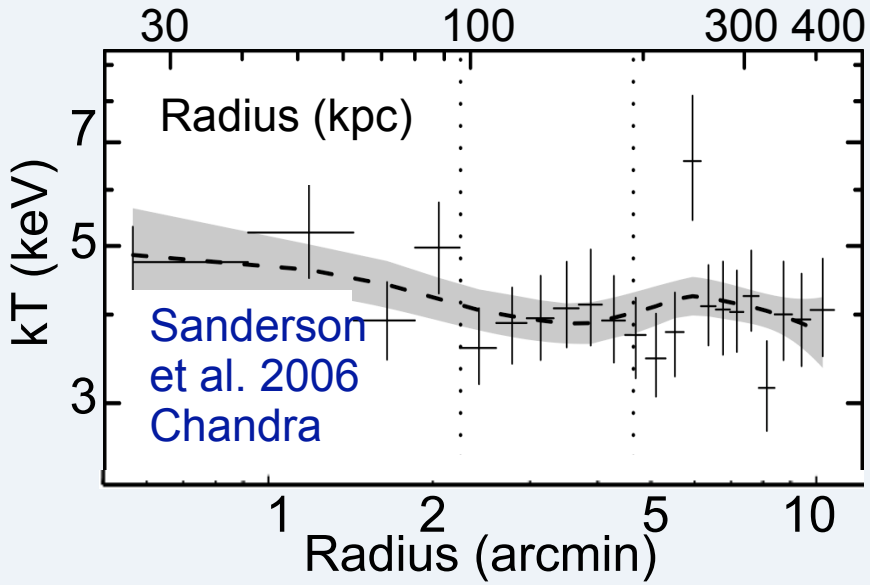
6) A2147:Spectral Analysis



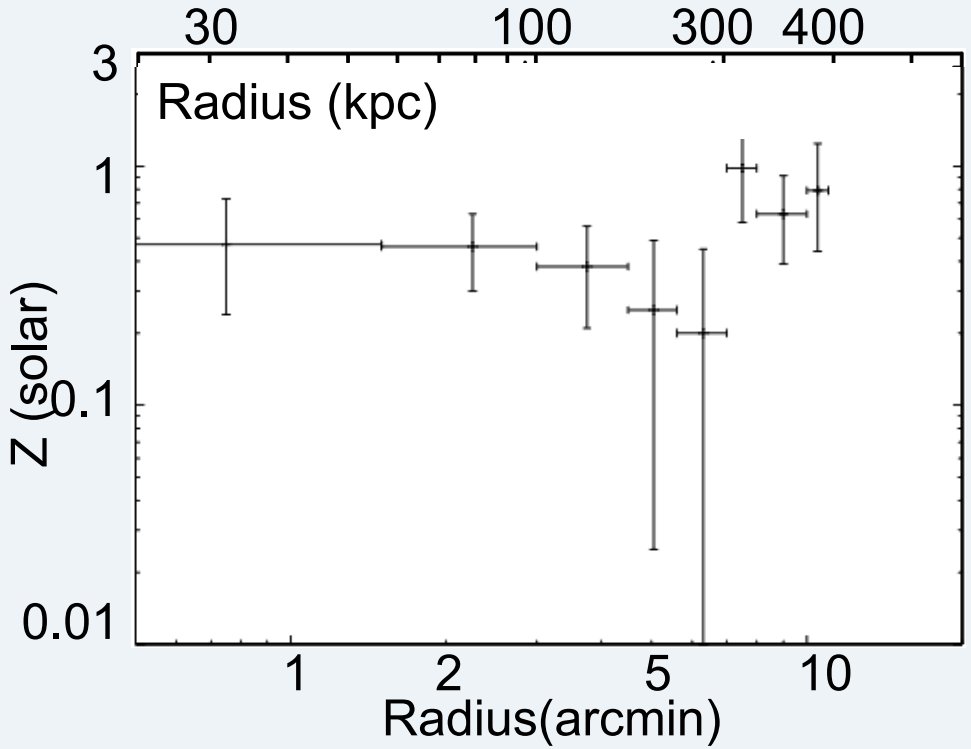
7) A2147: Radial Profiles

Temperature Profile





Abundance Profile



- The ICM temperature of A2147 is isothermal over ~400 kpc region.
- Abundance profile is also constant.

8) Discussion

- Upper limit for cool component
  - Cool/hot emission measure(~n^2*V) ratio of
    - Centaurus (cD) : 1.02+/-0.09 (ASCA, Fukazawa et al. 1998)
    - A2147(non-cD) : <0.2 (ASCA, Fukazawa et al. 1998)
- Comparison with Abell 1060
  - The ICM temperature at the central region
    - A1060: even hotter inside a central ~200 kpc region (Sato et al. 2007)
    - A2147: isothermal over ~400 kpc region

Some heating mechanism might be operating at the center of Abell 1060.

- Supernova heating?
- Active galactic component?
- Galaxy motion? (Makishima et al. 2001)

Summary

- We analyzed XMM-Newton data of non-cD cluster, A2147.
- Temperature and abundance profile was flat out to ~400 kpc.
- Best studied non-cD cluster, Abell 1060 has a central peak in its temperature profile.
- This suggests existence of strong heating mechanism in Abell 1060 center and not in Abell 2147.