

***Chandra* temperature maps  
for galaxy clusters with radio halos**

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**(based on Govoni et al., astro-ph/0401421)**

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**Radio halos (diffuse, Mpc-size, unpolarized sources):**

- from electrons with  $\gamma \sim 10^4$ , synchrotron lifetime  $\lesssim 10^8$  yr
- observed in merging clusters (Feretti 1999; Buote 2001)

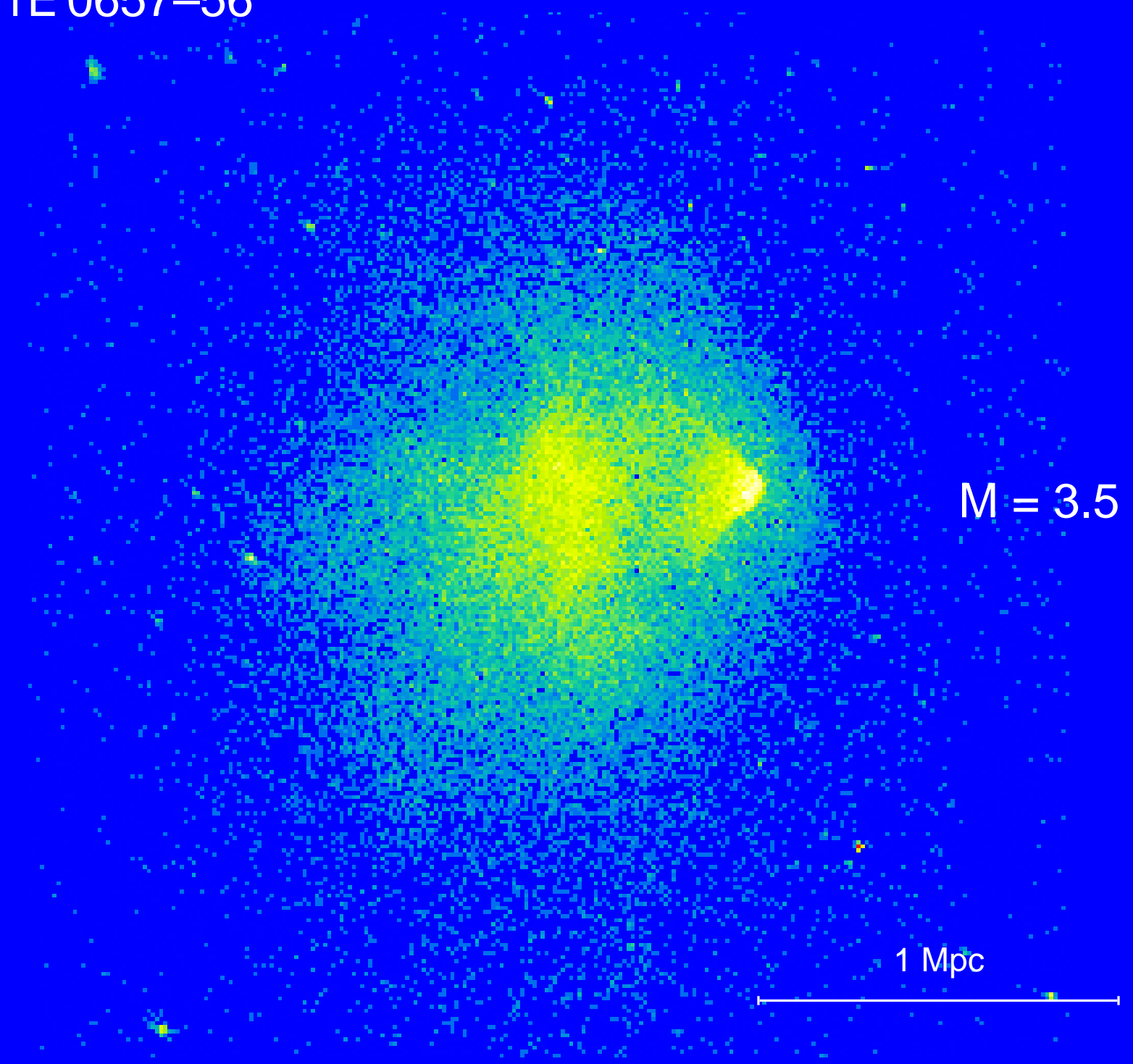
**Mergers dissipate more than enough energy (simultaneously on a Mpc scale) to generate halo electrons — but the exact (re-)acceleration mechanism is unclear**

**Proposed mechanisms:**

- **Merger shocks** (e.g., Harris et al. 1980; Tribble 1983; Fujita & Sarazin 2001)  
— but need a relatively strong shock with  $M > 4 - 5$  (Brunetti 2002), very rare if any
- **Turbulence** (e.g., Schlickeiser et al. 1987; Brunetti et al. 2001; Fujita et al. 2003)

**Can try to distinguish the two observationally, by comparing gas  $T$  maps and radio images**

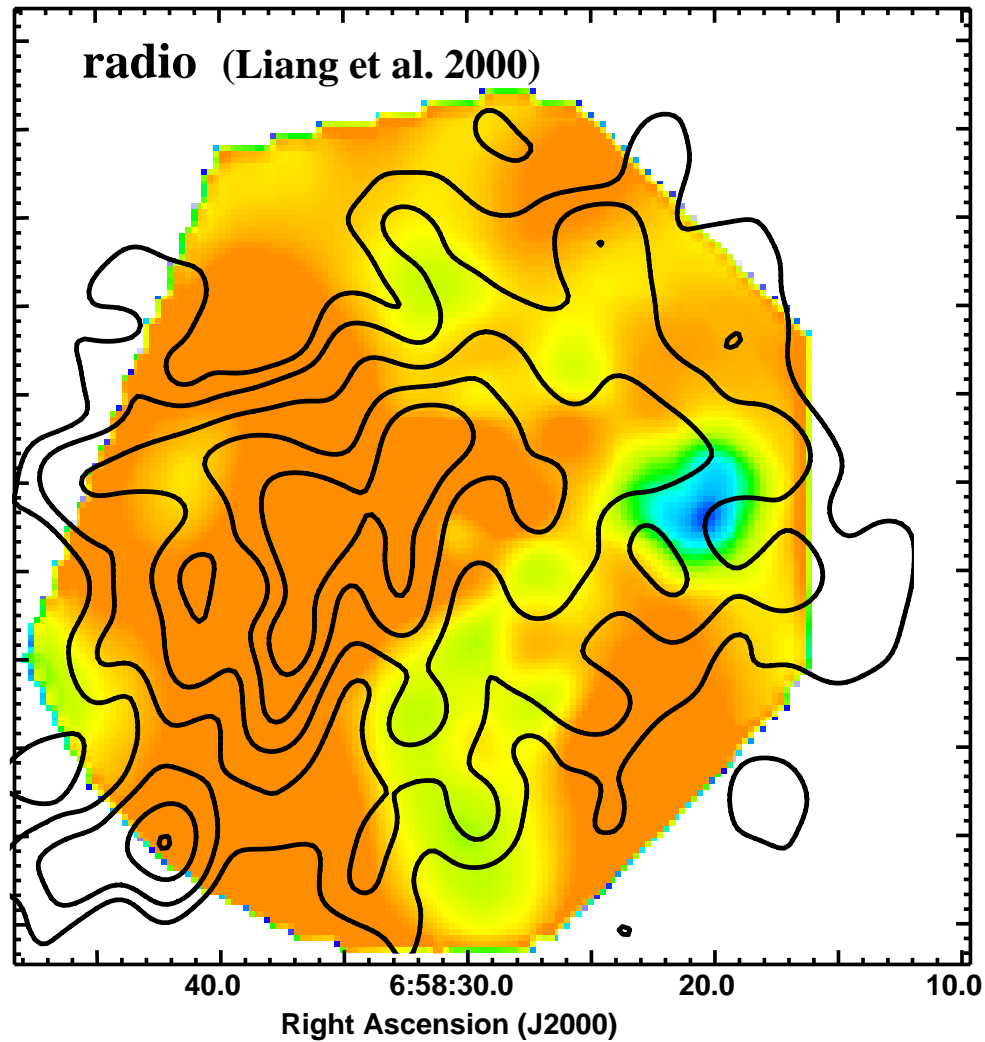
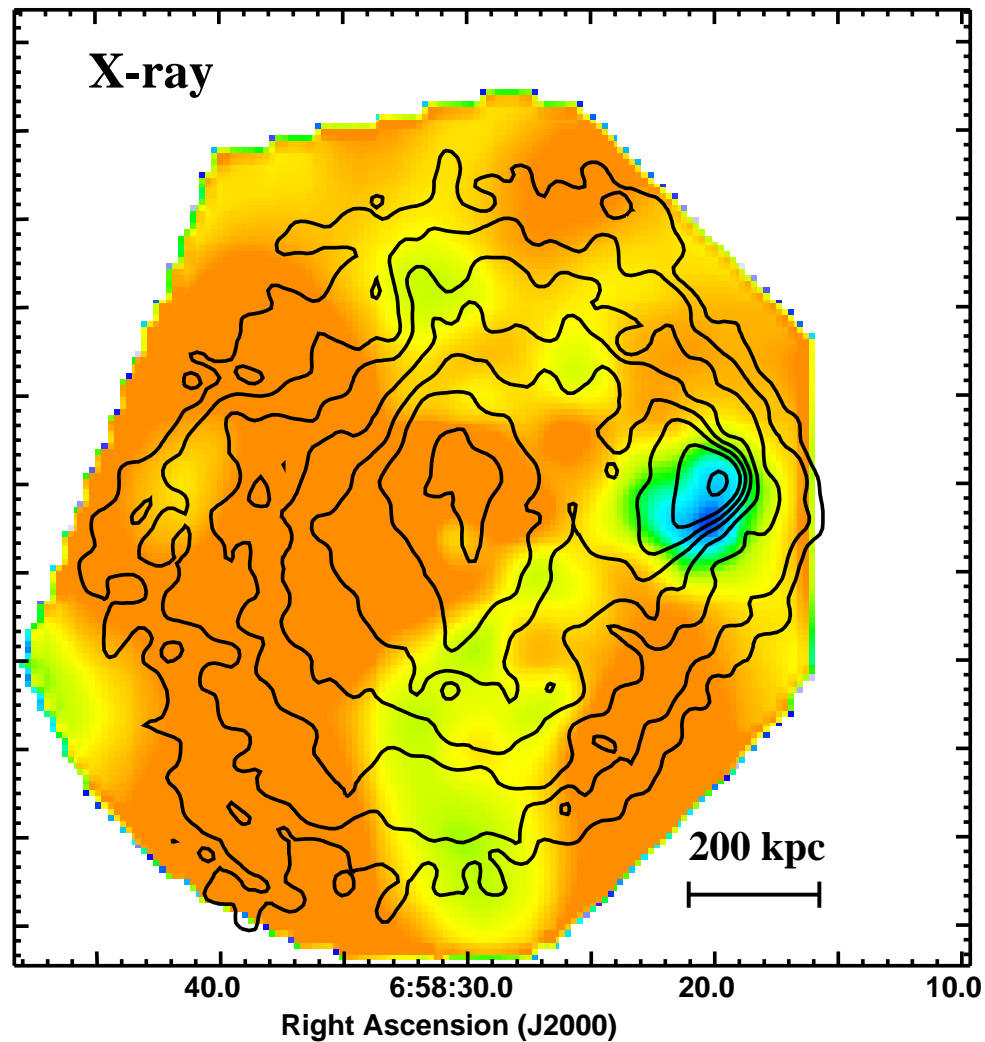
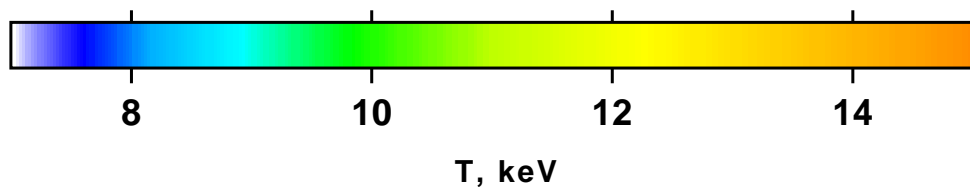
1E 0657-56



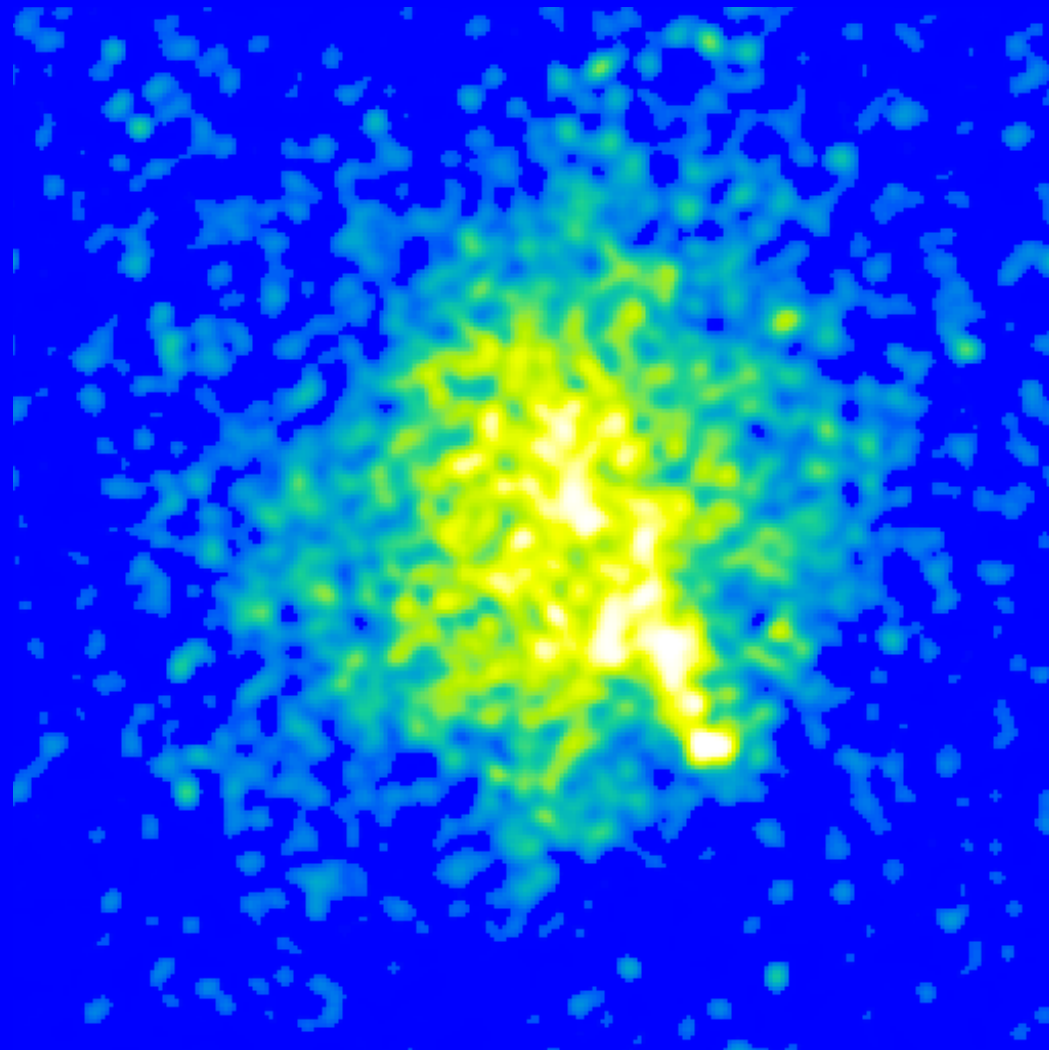
M = 3.5

1 Mpc

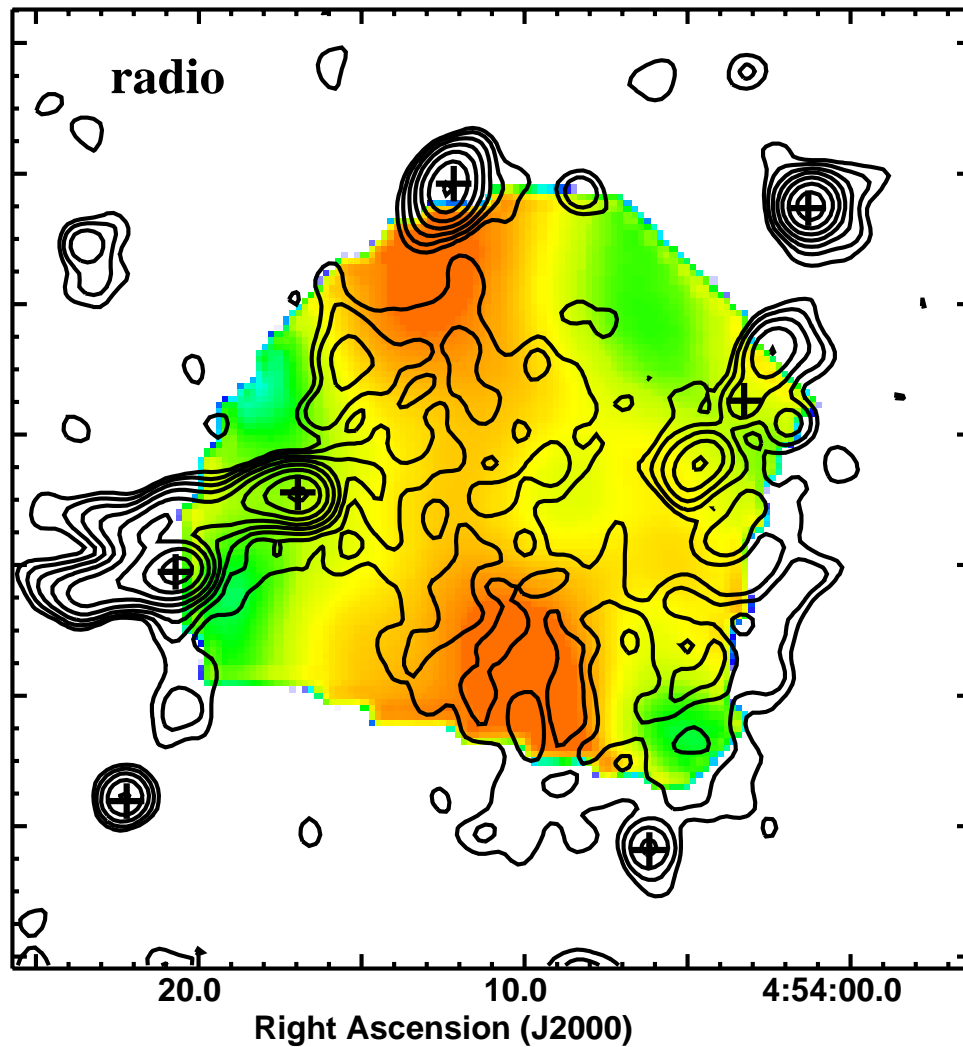
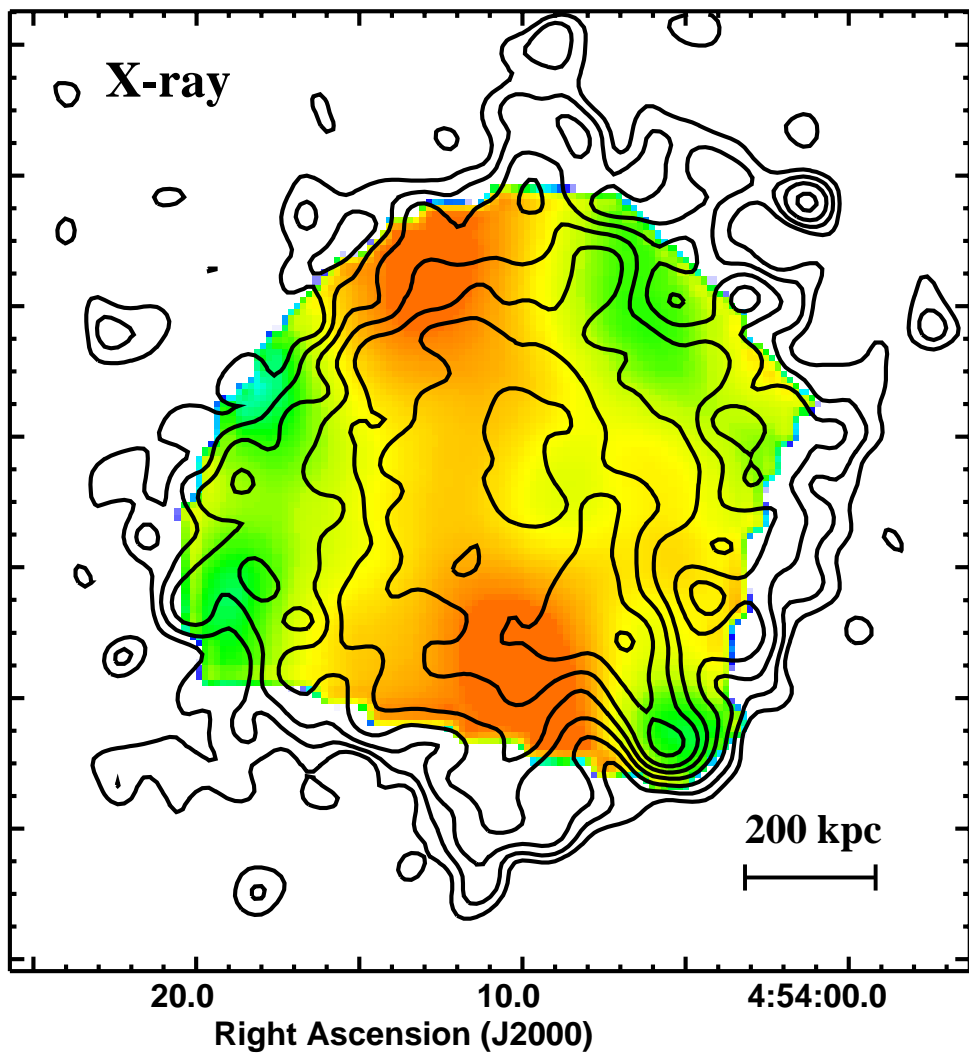
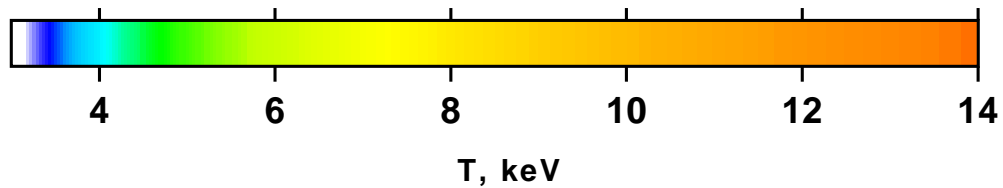
# 1E 0657-56



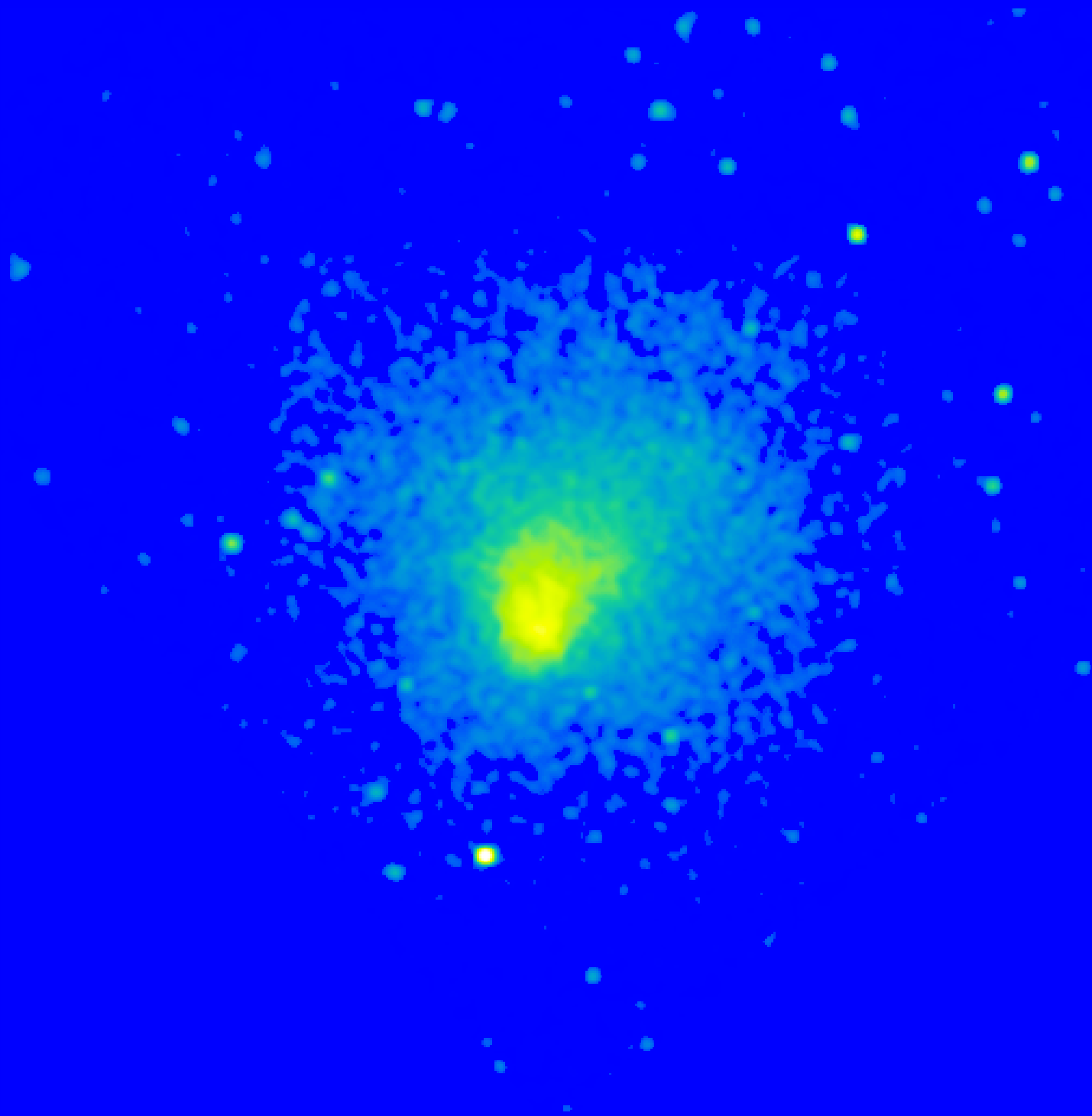
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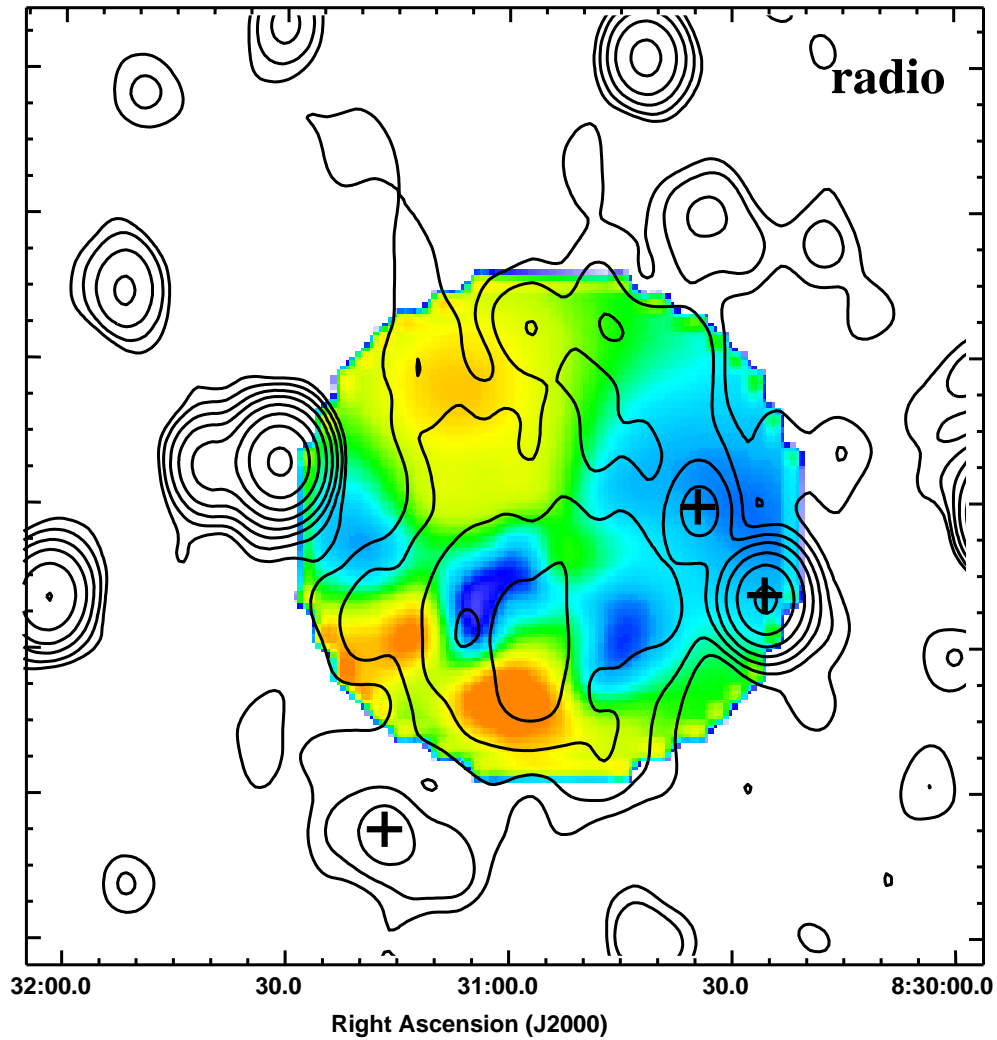
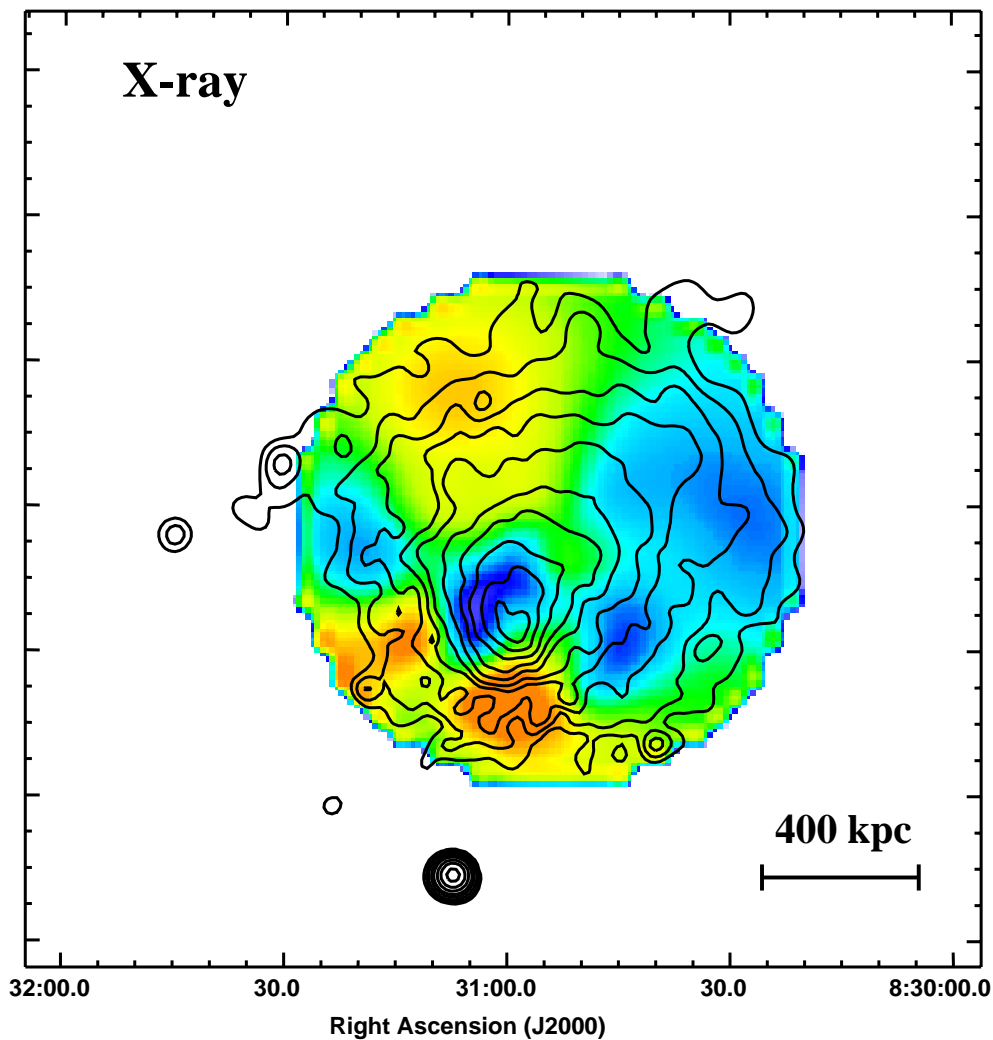
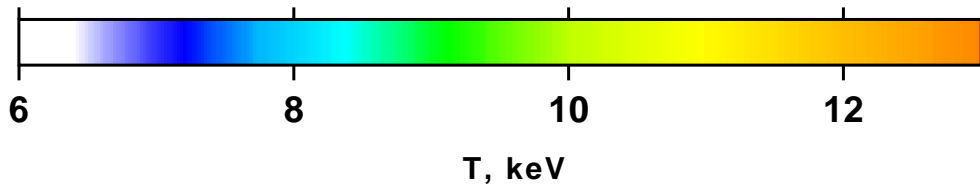
# A520



A665

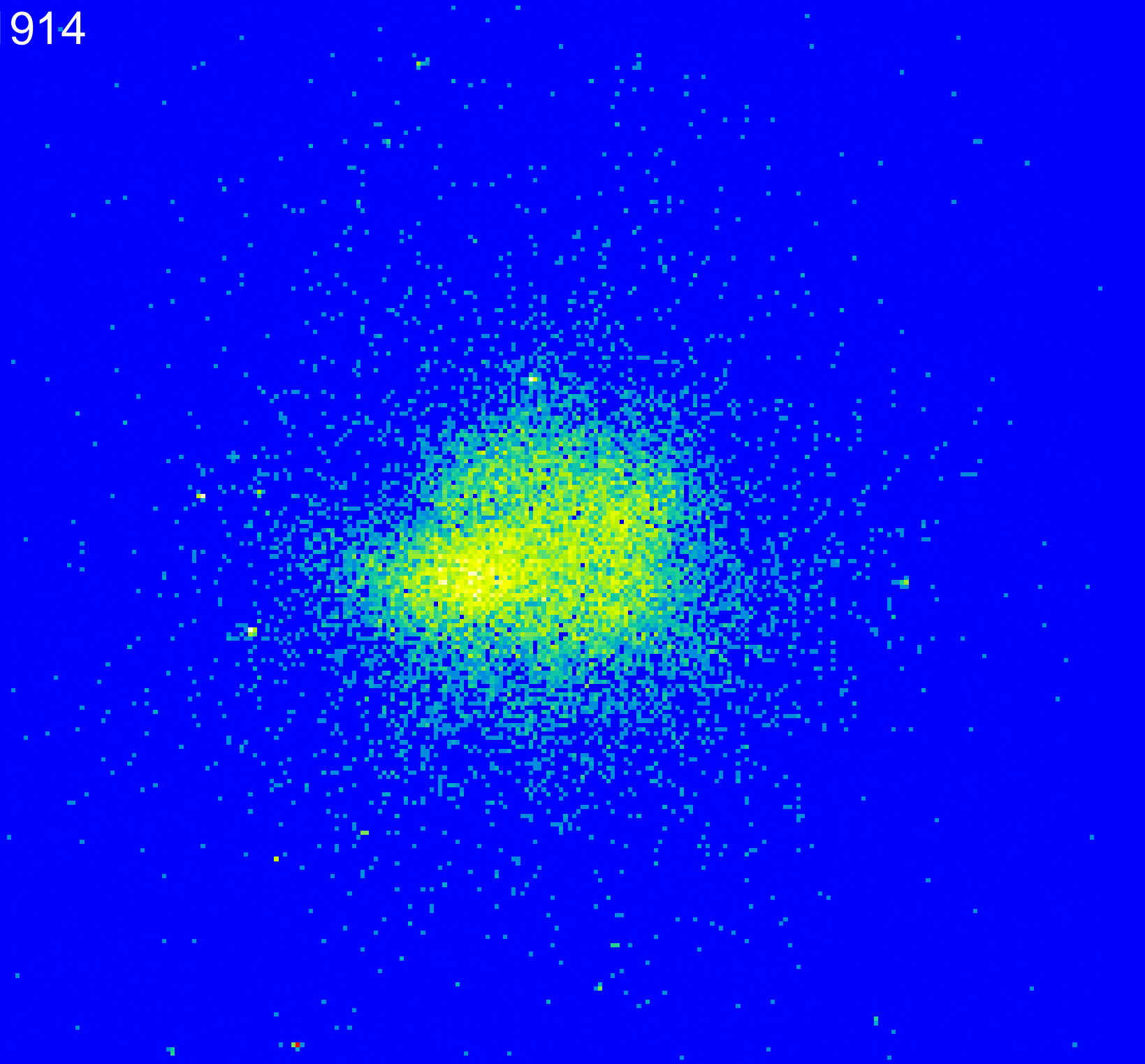


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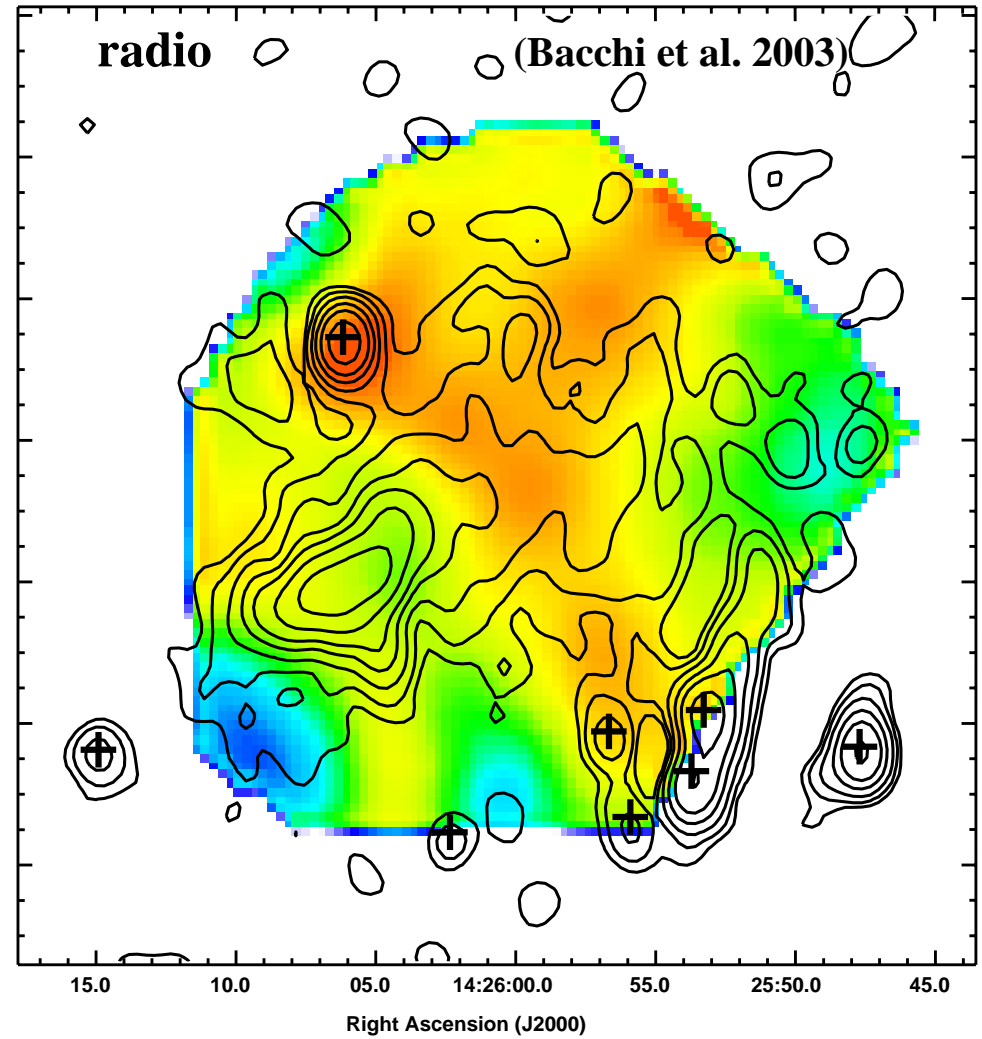
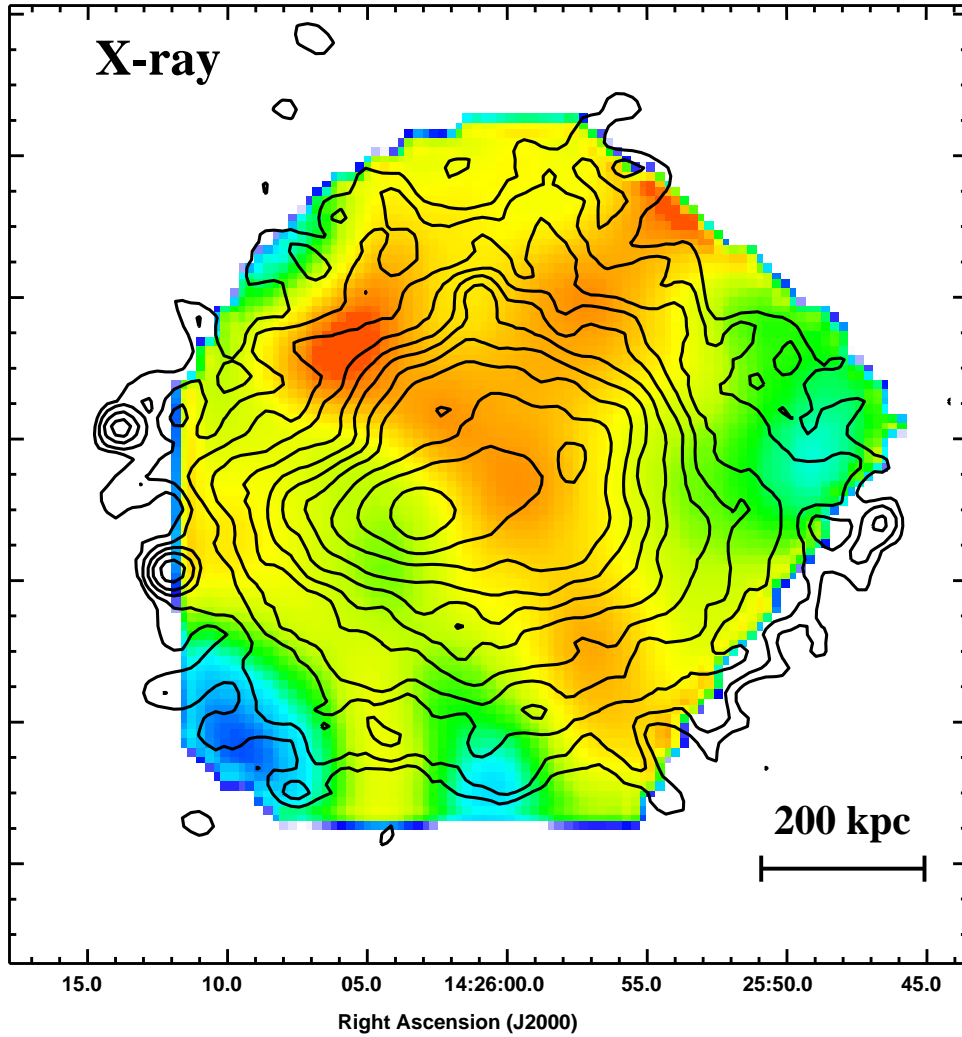
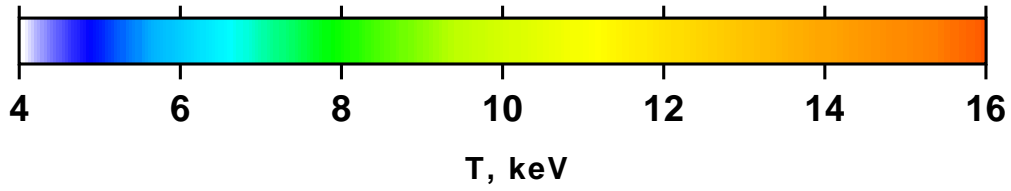




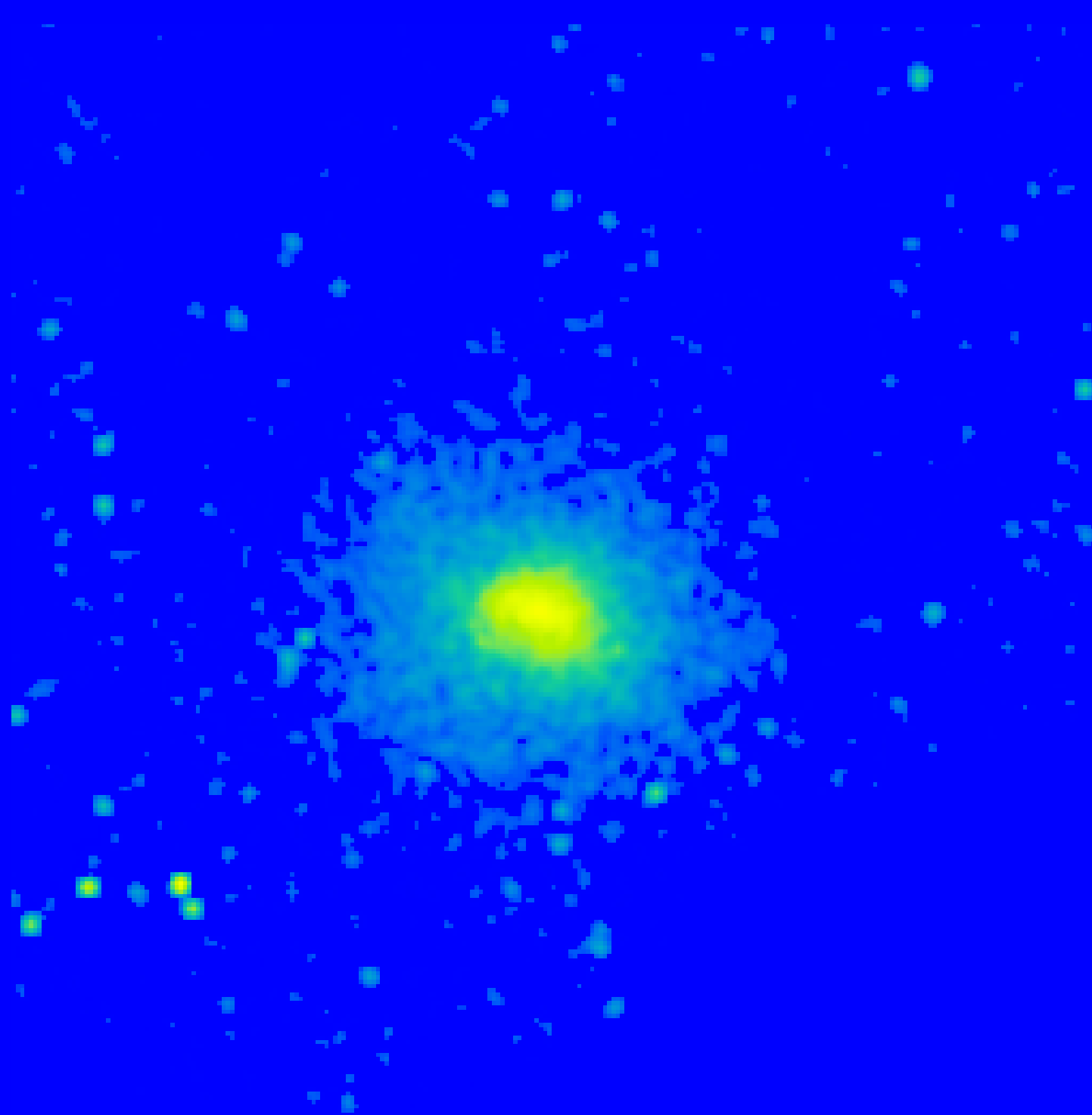
A1914



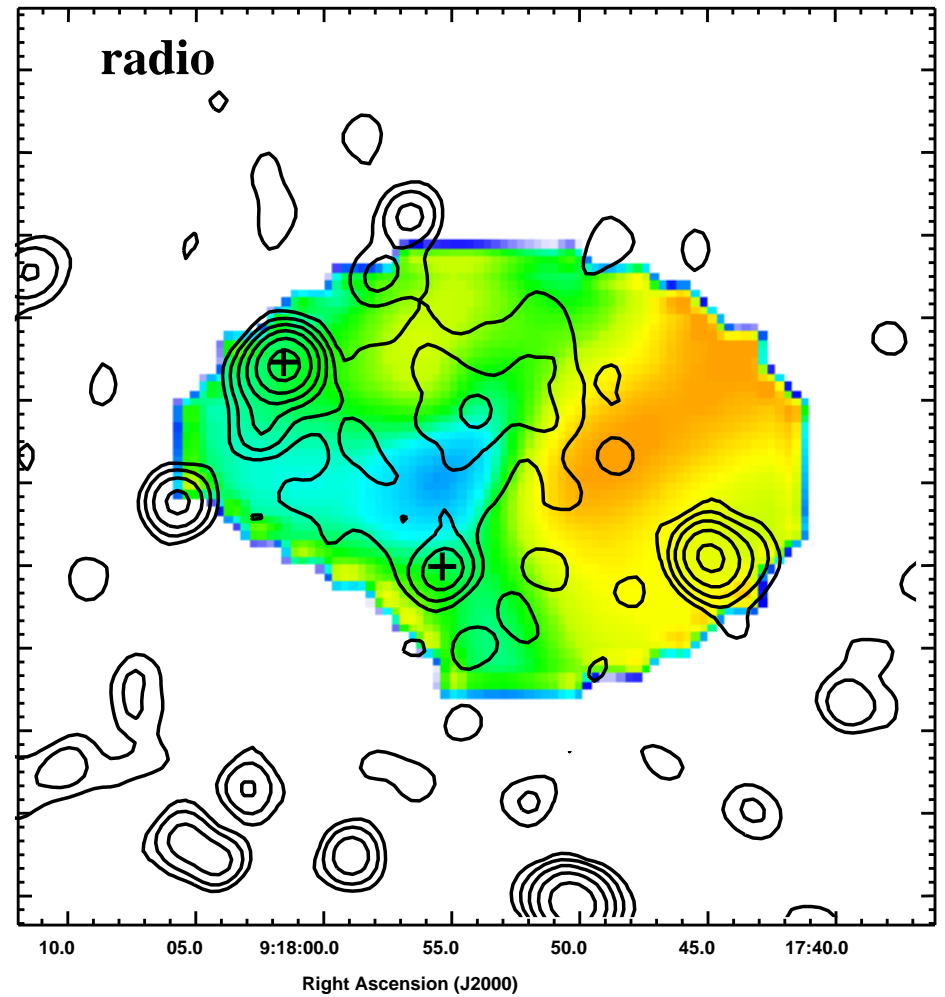
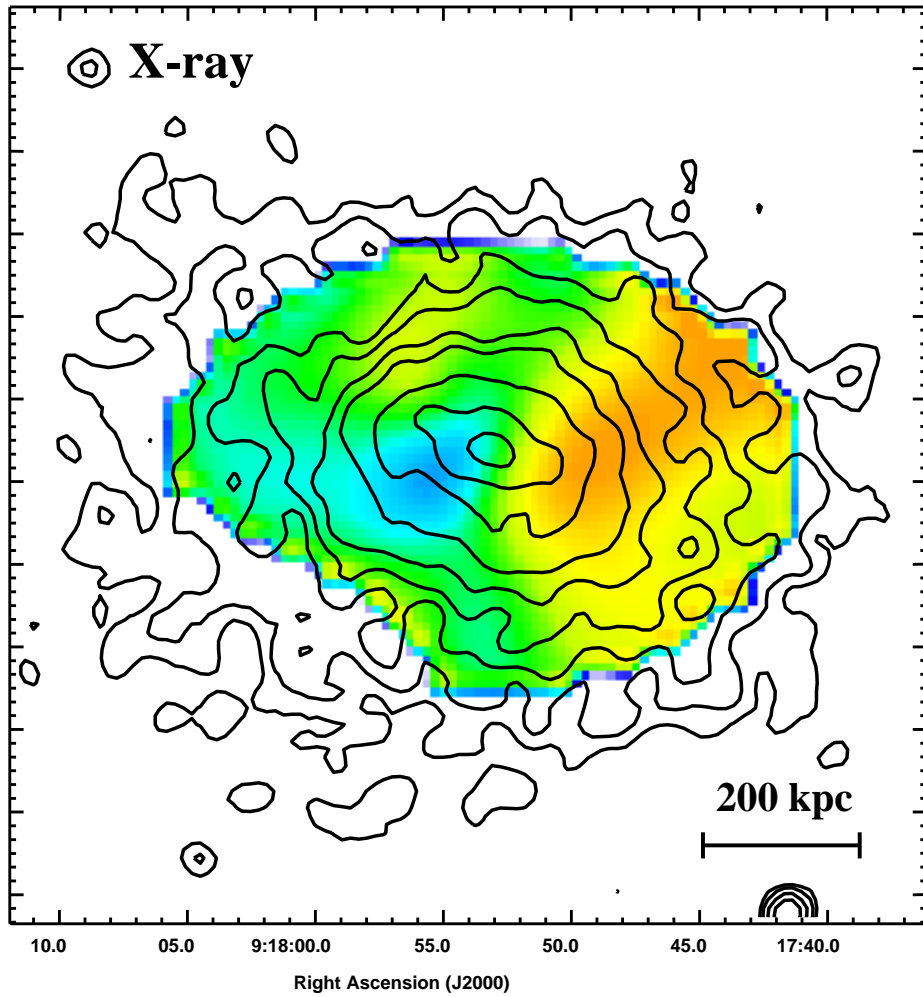
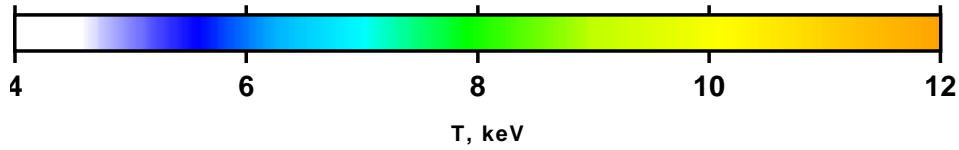
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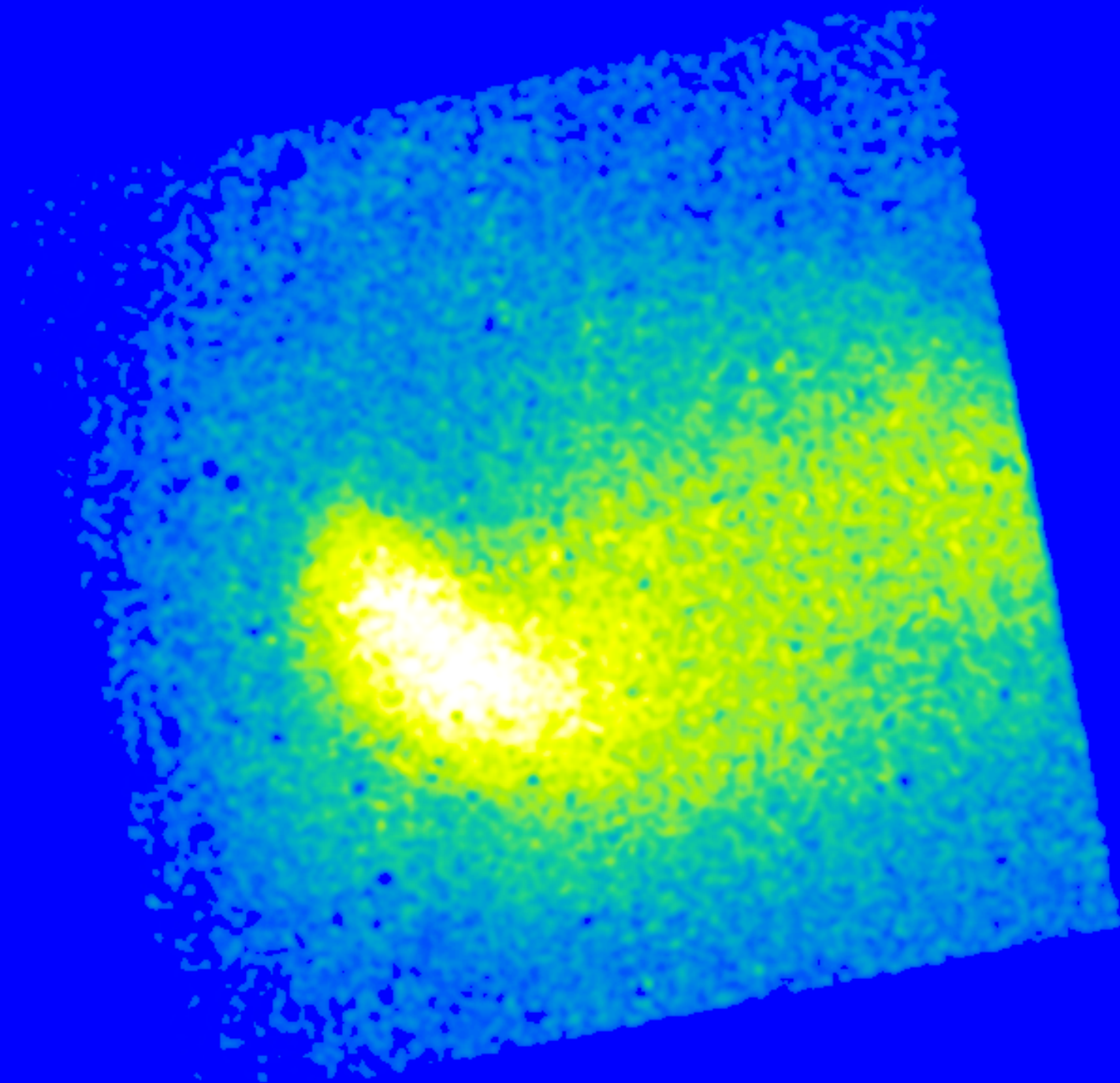
A773



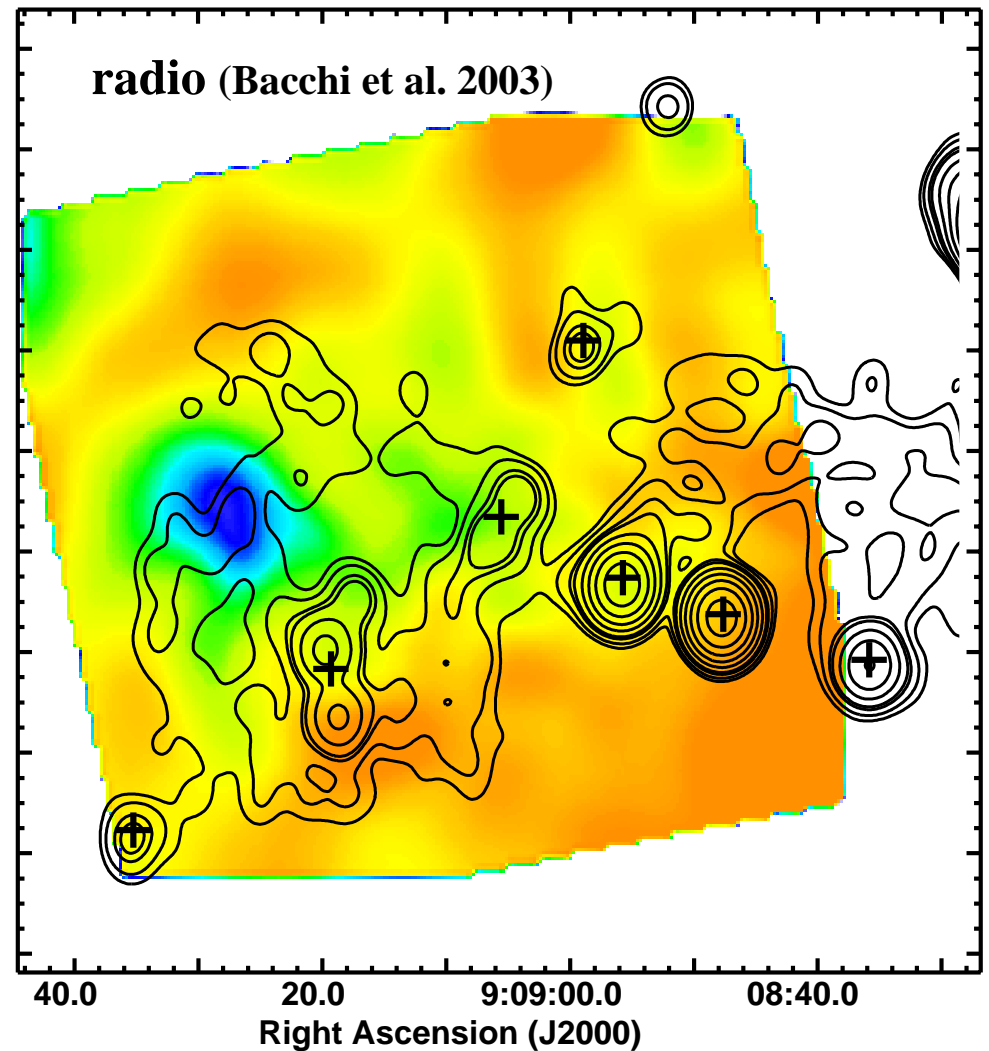
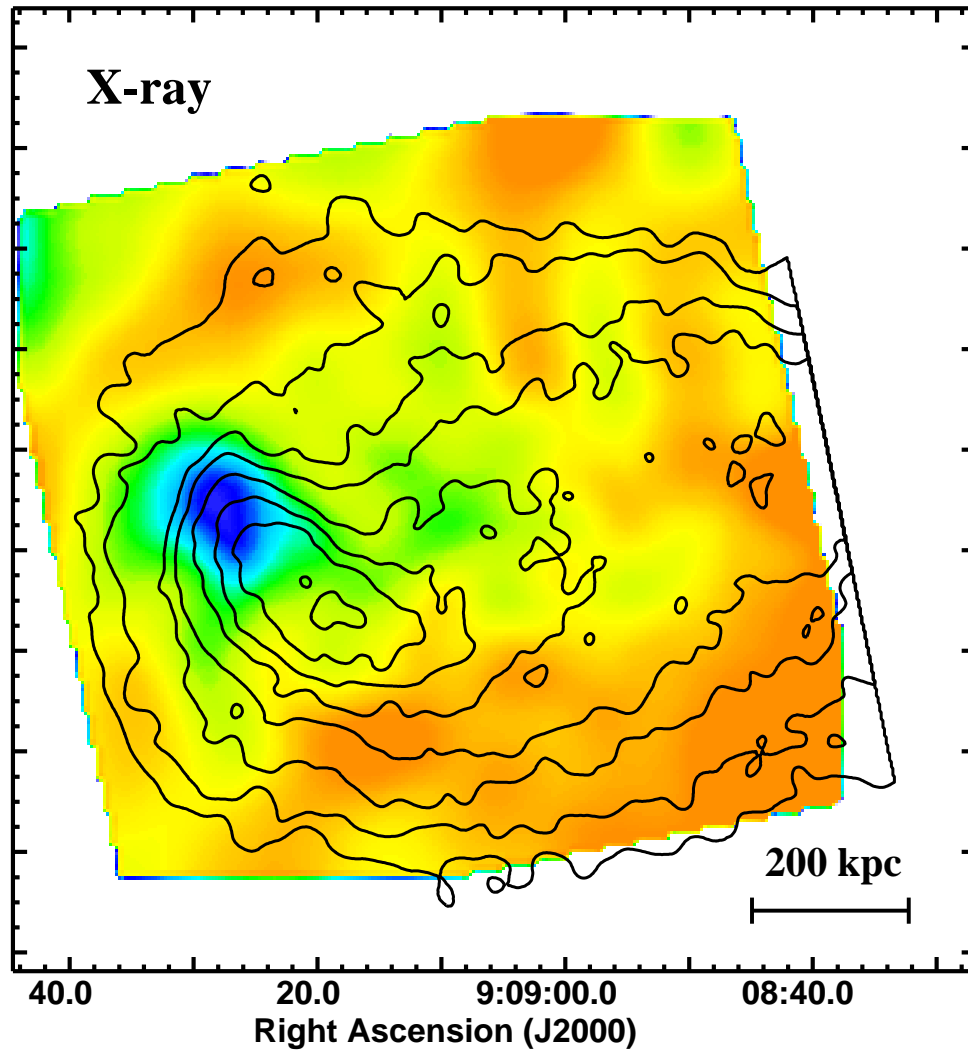
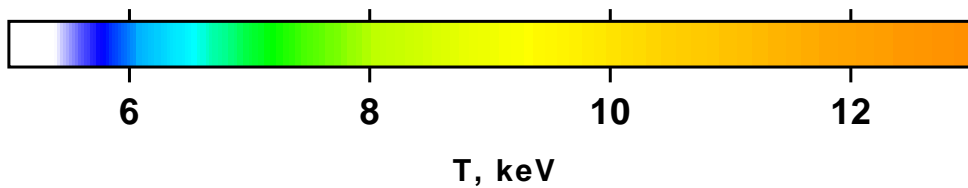
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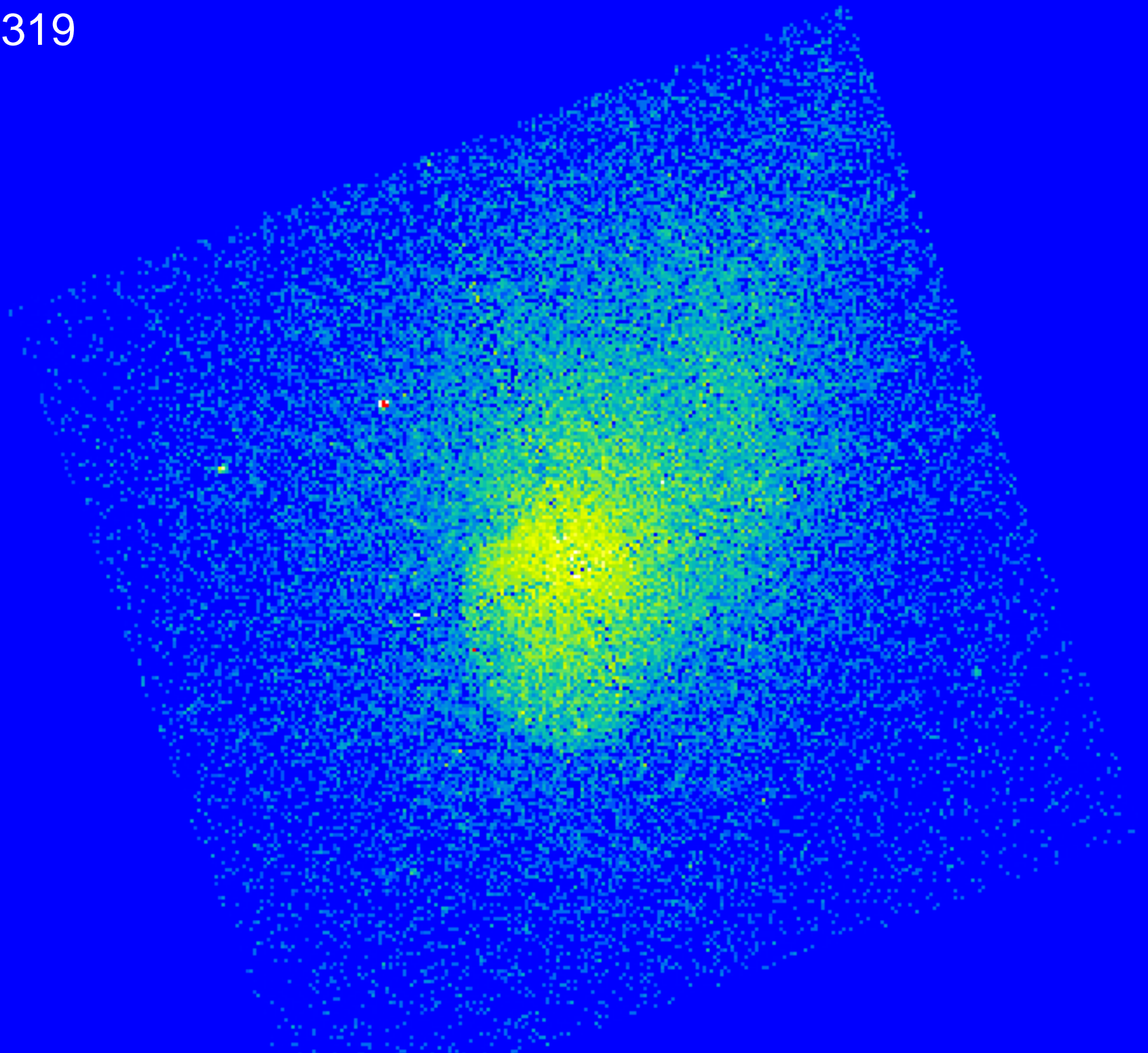
A754



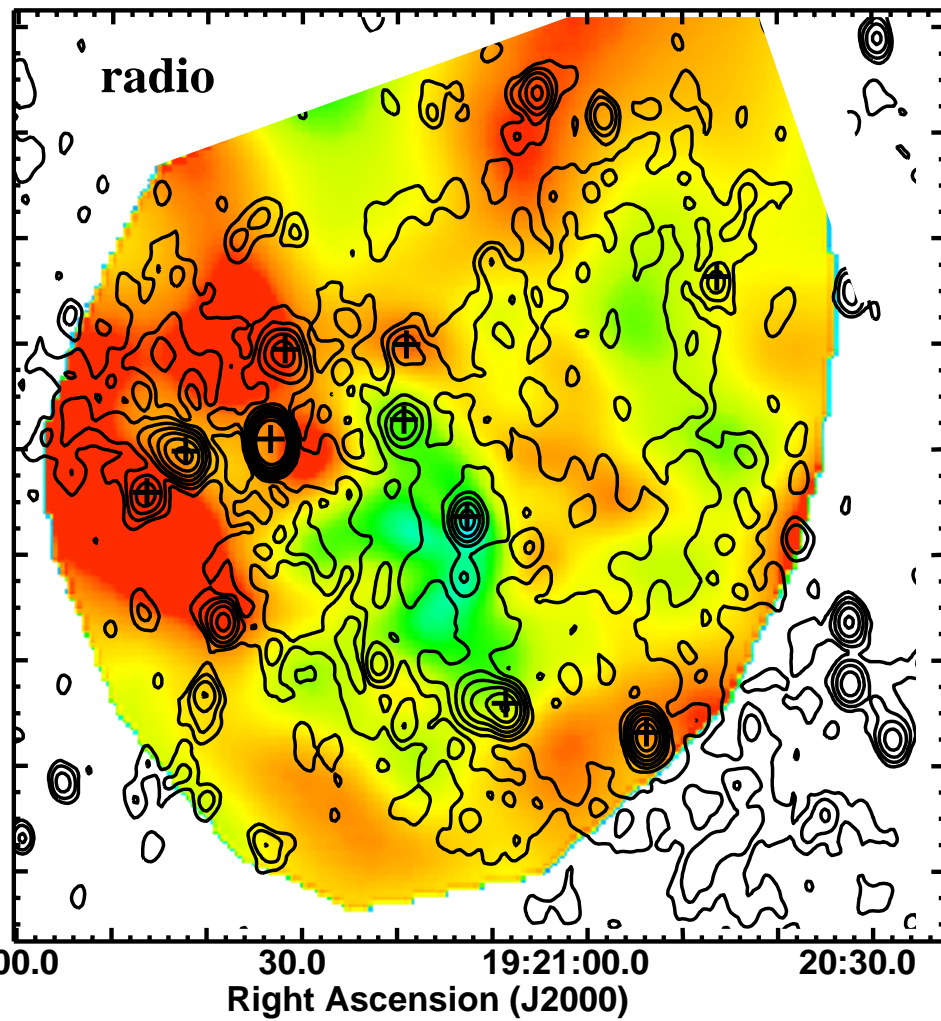
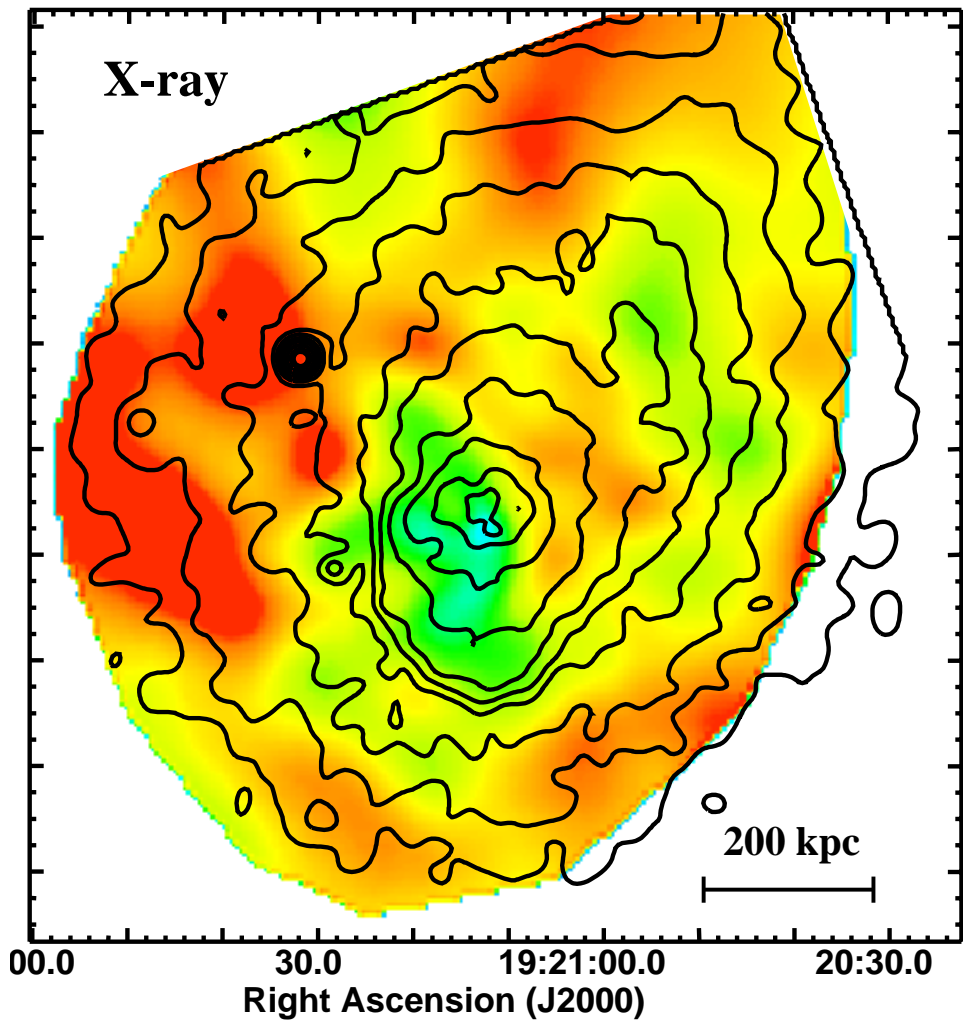
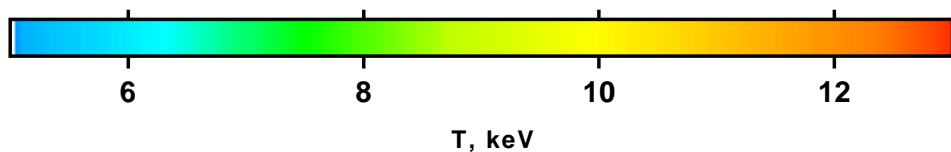
# A754



A2319



# A2319





# Conclusions

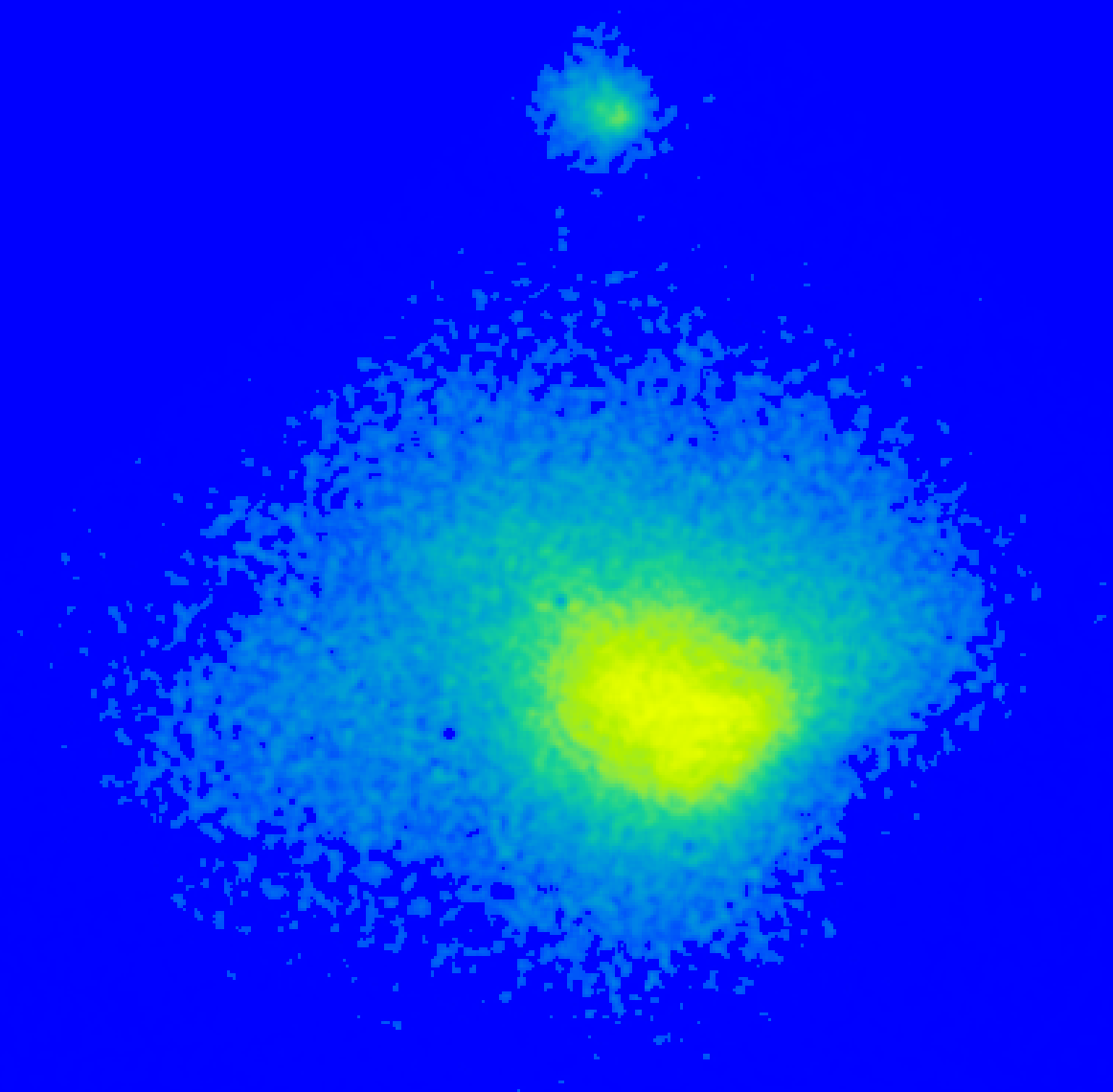
- $T$  – radio spatial correlation is seen in many clusters (1E 0657–56, A520), but there are clear counterexamples (A754, A773, A2319)  
— arguing against shocks (and, by exclusion, *for* turbulence) as the dominant mechanism
- However, in 1E0657 (and perhaps A520, A665), edges of radio halos coincide with  $M \sim 2 - 3$  bow shocks

**So, both mechanisms appear to be present** (and shocks need not be particularly strong)

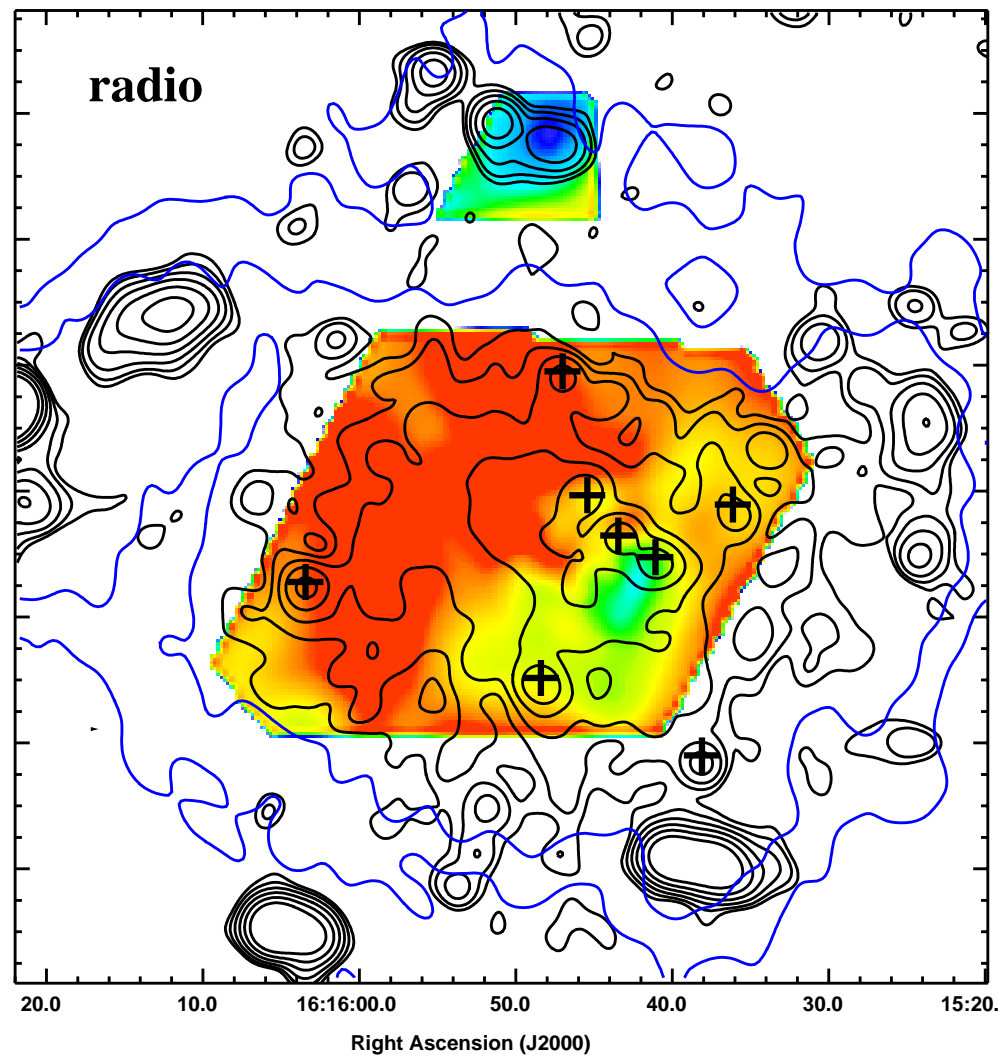
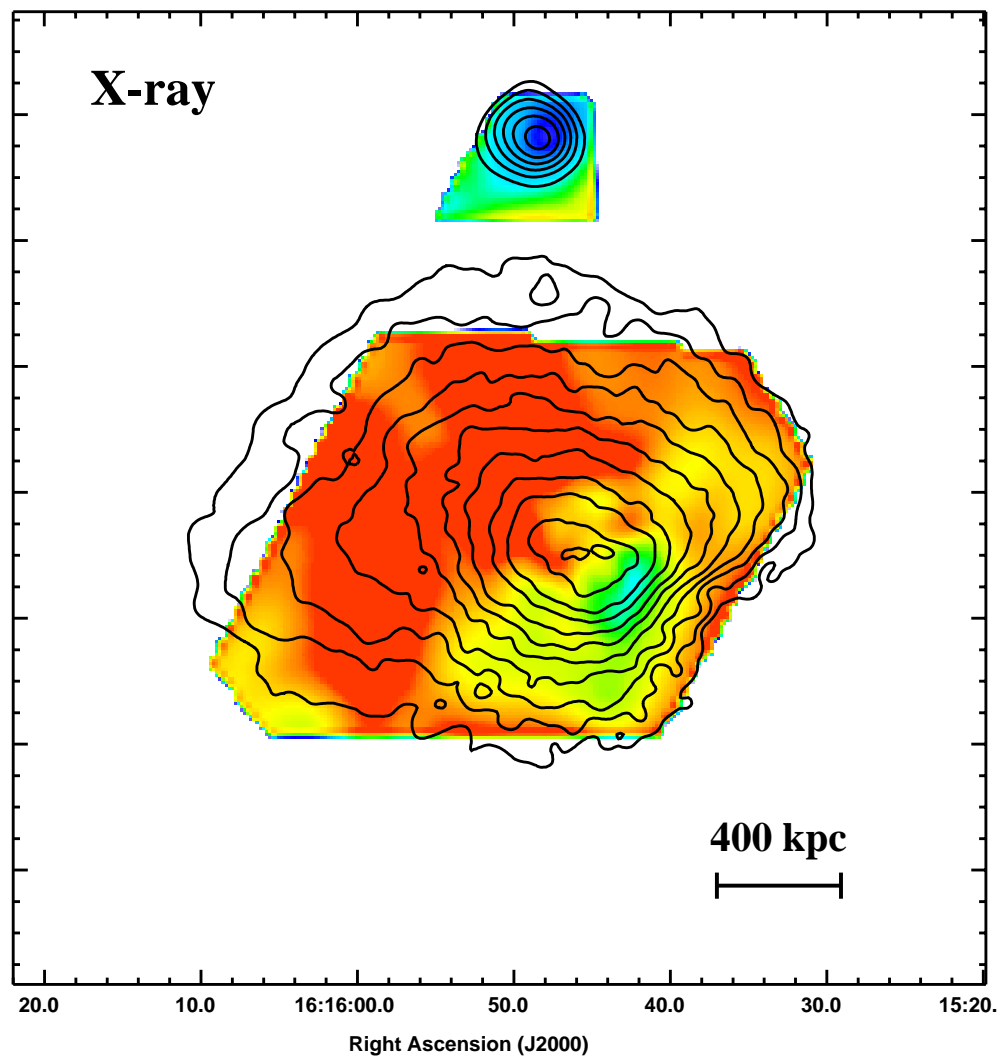
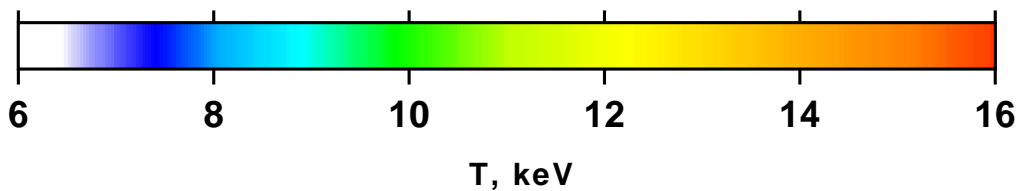
**Need:**

- Radio steepness maps, and better-resolution radio images, for 1E0657, A520, A665  
— clusters in which shocks and turbulence can be separated spatially

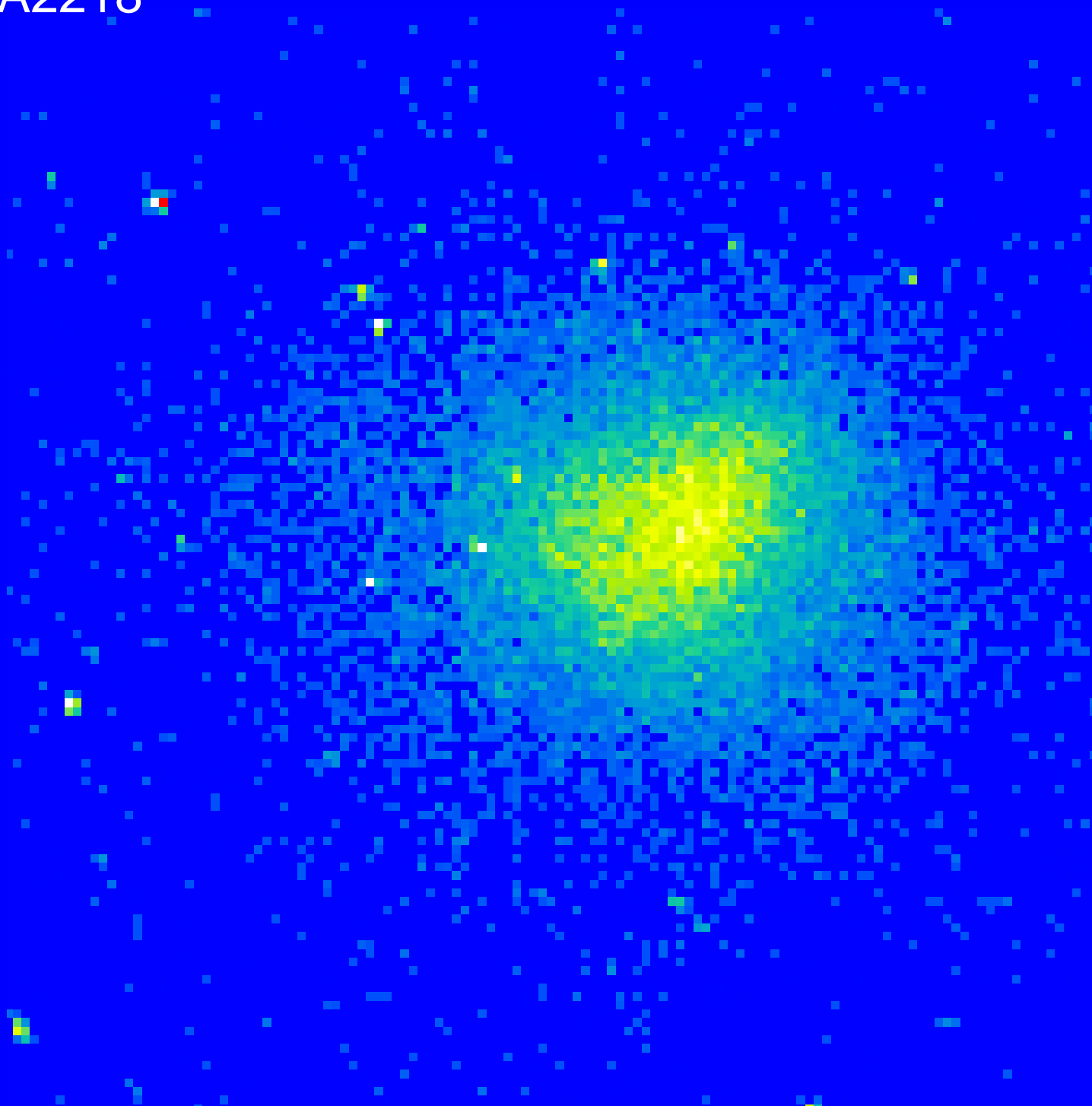
A2163



# A2163



# A2218



# A2218

