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Dynamical histories of six clusters of galaxies by XMM-*Newton*

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Abstract

Recent studies with high-resolution cameras have extensively showed that clusters of galaxies are not as relaxed as we considered. With its advent technology XMM-Newton allows us to obtain temperature and metal abundance map in detail. In this study, we present our results on six (A194, A1056, A1674, A1882, A2634, A2638) nearby ($z < 0.14$) clusters. These clusters have very poor X-ray atmosphere (ICM), therefore very efficient to study individual galaxies and their evolution within ICM. Based on the temperature maps and morphology of bright member galaxies, we try to understand perturbed galaxy emissions and dynamics of the clusters itself.

Keywords: clusters: galaxies: individual: A194, A1056, A1674, A1882, A2634, A2638 − X-rays

1 Introduction

Before new generation X-ray missions (XMM-*Newton*, Chandra, Suzaku), clusters with spherically symmetric surface brightness distribution had been believed as a dynamically relaxed system. We could hardly map the dynamical structures of even faint clusters. Today we can trace small scale fluctuations caused by a cluster-cluster merging event even in clusters with no clear asymmetric brightness structure. Therefore, ICM has been studied by surface brightness, temperature and metal abundance distributions.

2 Analysis

XMM-Newton archival data is used in order to study evolutional histories of 6 clusters. The source detection is performed at both soft and hard X-ray bands. Figures A shows 0.3-10 keV band X-ray image and brightness contours. We also search the radio properties of the clusters and overlaid the radio contours in red on DSS-optical image (Figures B). The temperature (Figures C) and metal (Figures D) distributions are mapped by wavelet mapping techniques (Bourdin et al. 2004). The X-ray brightness contours are overlaid in black color in all figures for visual aid.

2.1 Abell 194

A194 is nearby (z=0.018) linear-cluster in NE-SW direction. And very faint in X-rays. Its also bright in radio-band. Temperature map indicates large scale dynamics along N-S direction. The hot regions coincides with radio-lopes which is a good example of ICM-radio relation. The central region is not abundant in term of heavy metals. Probably there is no significant metal ejection yet. ICM heating by radio-jets are studied in further.

2.2 Abell 1056

The cluster locates at z=0.08. The clustering is not around the brightest source. The cD galaxy is a strong radio emitter. Extend gas clustering is weak. We detected >20 point sources at the cluster outskirts (>1Mpc). There is no peculiar temperature structure. A closer look at the cool-core shows NE elongation. Metal distribution is in N-S direction. This may be the elongation of the previous dynamics of A1056.

2.3 Abell 1674

It is faint, nearby by cluster at z=0.1066. There is a hot-gas (5.5 keV) passing along the cluster at E-W direction, perpendicular to apparent X-ray elongation. The center has very low metal abundance (<0.07) as also studied by Katayama et al (2005). The west part is cool and has a temperature of 2.5 keV. The hot-gas

is indicative of a recent merger.

2.4 Abell 1882

(z=0.1367) The cluster is composed of three parts. Southern part (center) and 2 blob at the north. The diffuse gas is at a temperature of 2.5 keV. The other parts also show low temperature values (<2 keV). There are plenty of point sources within the cluster and at the outskirts, which gives us a good chance to make a comparative study environmental effects on galaxies.

2.5 Abell 2634

(z=0.0314) The cluster has a very bright cD galaxy, with a strong radio emission. The core gas is at 3 keV. There is peculiar temperature variation associated to radio-jets. The northern part is noticeably hot (4.5 keV). The hot region is accompanied with very low metal abundance <0.1 solar. The cluster is surrounded by high metal gas at NE and SW regions which are evidences of previous mergers.

2.6 Abell 2638

(z=0.0825) The cluster is very faint in X-rays. The cD galaxy is also a radio source. The x-ray sources are aligned in NE-SW direction. The alignment can also be traced at temperature map. The central 5 arcmin region has a uniform temperature at 2.8 keV and very low metallicity (<0.1). There is a cool ($\sim$2 keV) region, possibly entailed to second brightest source at NE.

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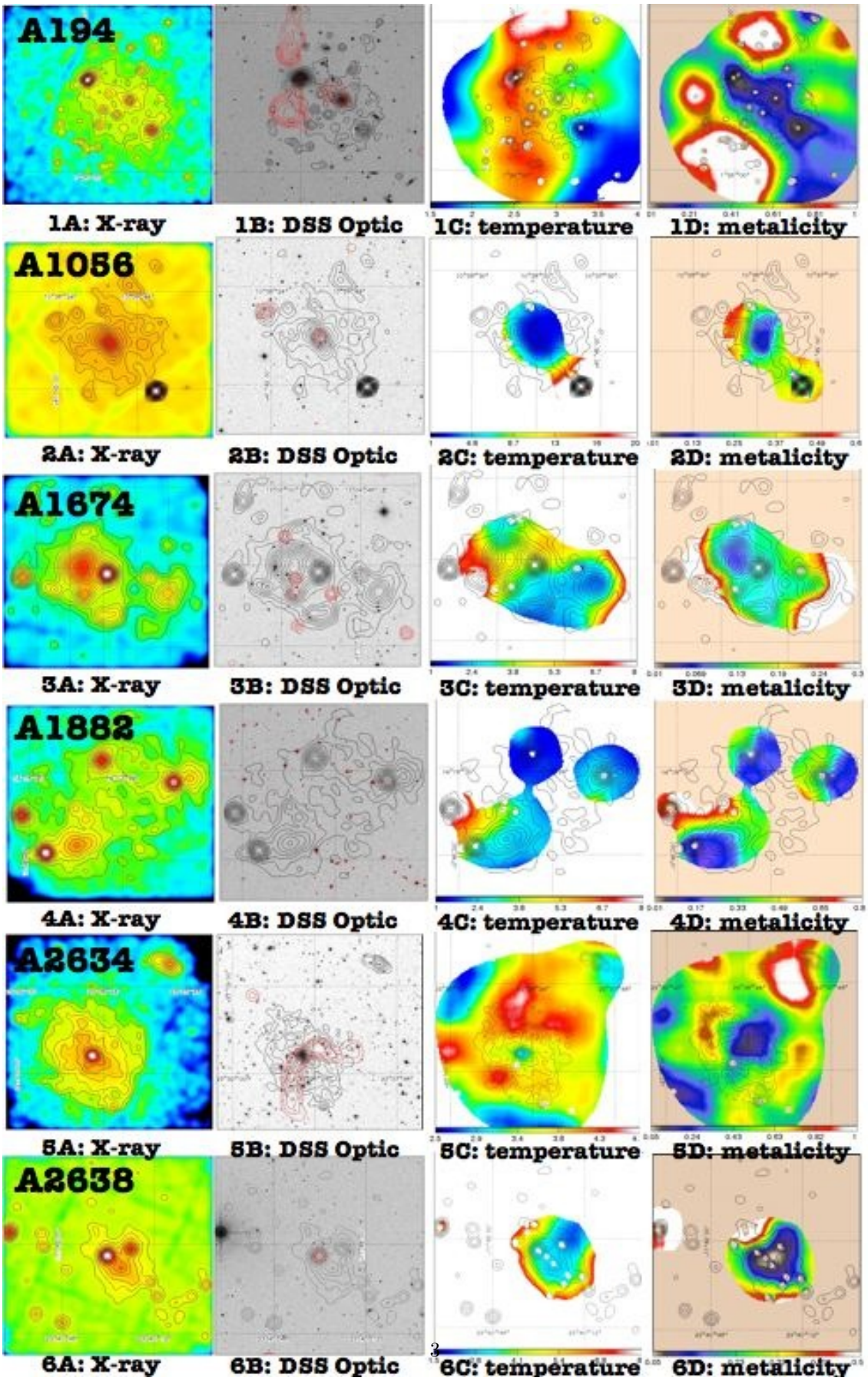

Figure 1: 6 clusters of galaxies, A: X-ray 0.3-10 keV images, B: DSS-optical image overlaid by X-ray and radio contours, C: temperature map, D: abundance map.