Subaru Weak Lensing of Seven Merging Clusters: Distributions of Mass and Baryons

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Chandra and XMM-Newton revealed complicated ICM structures which are expected to be associated with cluster mergers.

Density

Temperature

1E0657-56
(exposure time=500ksec)
Motivation

(1) ICM is dynamically controlled by dark matter.

(2) Understanding the ICM phenomena requires to know the dark matter (mass) distribution.

(3) Mass distributions deduced from X-ray results are ill constrained because the ICM is not in hydrostatic equilibrium.

\[
\frac{1}{\mu m_p n_g(r)} \frac{dP_g}{dr} = - \frac{d\Phi}{dr}
\]

The only method to directly reveal mass distribution without the assumption of dynamical states and mass distributions is to use a weak gravitational lensing effect.
2: Cluster Targets

1: We have not yet known mass distributions in almost all merging clusters!!!

* Various Merging Stages

Main Cluster → Binary

On-going

2\textsuperscript{nd} impact

2: We have not yet known the relationship between dark matter and baryons (ICM and member galaxies) during merger process.
This talk focuses on distributions of mass and baryons in Merging Clusters.

### Table 2. Cluster X-ray Features

<table>
<thead>
<tr>
<th>Cluster</th>
<th>$z$</th>
<th>Type</th>
<th>1 arcmin (kpc/$h_{70}$)</th>
<th>Components</th>
<th>$T_{\text{ave}}$ (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A754</td>
<td>0.0542</td>
<td>On-going</td>
<td>63.1</td>
<td></td>
<td>10.0 ± 0.3$^a$</td>
</tr>
<tr>
<td>A1750</td>
<td>0.0860</td>
<td>Binary</td>
<td>96.7</td>
<td>A1750C</td>
<td>3.87 ± 0.10$^b$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A1750N</td>
<td>2.84 ± 0.12$^b$</td>
</tr>
<tr>
<td>A1758</td>
<td>0.2790</td>
<td>Binary</td>
<td>254.0</td>
<td>A1758N</td>
<td>8.2 ± 0.4$^c$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A1758S</td>
<td>6.4$^{+0.3}_{-0.4}$$^c$</td>
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<tr>
<td>A1914</td>
<td>0.1712</td>
<td>On-going</td>
<td>174.9</td>
<td></td>
<td>10.9 ± 0.7$^a$</td>
</tr>
<tr>
<td>A2034</td>
<td>0.1130</td>
<td>Cold Front</td>
<td>123.2</td>
<td></td>
<td>7.9 ± 0.4$^d$</td>
</tr>
<tr>
<td>A2142</td>
<td>0.0909</td>
<td>Cold Front</td>
<td>101.7</td>
<td></td>
<td>8.1 ± 0.4$^e$</td>
</tr>
<tr>
<td>A520</td>
<td>0.1990</td>
<td>On-going</td>
<td>197.2</td>
<td></td>
<td>7.1 ± 0.9$^a$</td>
</tr>
</tbody>
</table>
3: Summary

1: Weak Lensing analysis is a new observational method to understand galaxy clusters.
   - Complementary to X-ray / Optical Analyses.

2: Subaru + Suprime-CAM is the most powerful instrument of weak lensing analysis.
   - Subaru/Suprime-CAM can carry out WL analysis on almost ALL X-ray clusters
3 : Distributions of Mass, ICM, and member galaxies.

Initial Stage : Mass ~ Galaxies ~ ICM A1750 & A1758

On-Going/Cold front : Mass ~ Galaxies \( \neq \) ICM

Mass behind X-ray core : A754

No significant offset within smoothing scale : A520, A1914 & A1758S

4 : Combined Study (Subaru UM 2005)

Lx-T relation, M-T relation, \( f_{\text{gas}} \) & M/L...

Compare with Temperature, Pressure and Entropy Maps of ICM

Constrain merger geometry & energy input into ICM…
Locuss
(Local Cluster Substructure Survey)

Flux limited Sample: Lx > 5 x 10^{44} erg/s
Redshift : 0.15 < z < 0.30

Subaru/Suprime-CAM : Goal ~40 clusters
Currently ~15 clusters (S05B & S06A , PI: Futamase)
Reduction finished! and observation (S07A)
(Okabe, Takada, Umetsu & Futamase, PASJ, in prep)

HST/ACS: 143 Targets (100 clusters) Simith & Kneib
NOW OBSERVING ( until the end of 2007)

Chandra/XMM-Newton/Suzaku: Mazzotta, Ponman, Finogenov & Okabe
Archival DATA (Chandra/XMM)+ Suzaku ( Low X-ray background )

SZE: SZA Carlstrom & Church

Combined Studies : WL+ SL, WL+X-ray, WL+SZE