

The Red Sequence of Five Distant X-ray Clusters

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X-ray Selected Clusters...

Our targets come from the ROSAT Optical X-ray Survey (ROXS, Donahue et al 2002). The ROX Survey

- > covered 4.8 sq deg in both x-ray and I-band
- > found 55 extended x-ray sources (likely galaxy clusters)
- > did not find I-band counterparts to 10 of the 55 x-ray sources in a matched filter search (likely I-band dropouts at high redshift)

This gave us 10 candidate high-redshift clusters.

Observed in the Near Infrared ...

The candidates were observed in the near infrared:

- > KPNO 4m telescope, FLAMINGOS camera, April 2005
- > J and Ks filters. Integration times of 2.5 hours (J) and 1 hour (Ks) per target.
- > Data was used to make the color-magnitude diagrams and IJK color images on this poster

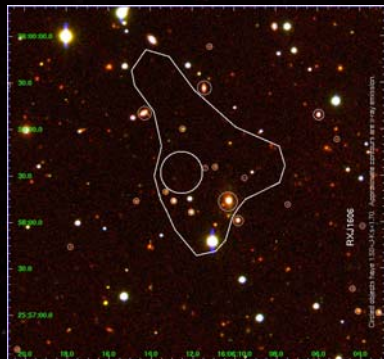
Correct color calibration is essential to this work:

- > Zeropoints calibrated to standard stars observed the same night
- > Zeropoints confirmed with 2MASS stars in the target fields, consistent within 0.05 mag

Confirmed with the Red Sequence...

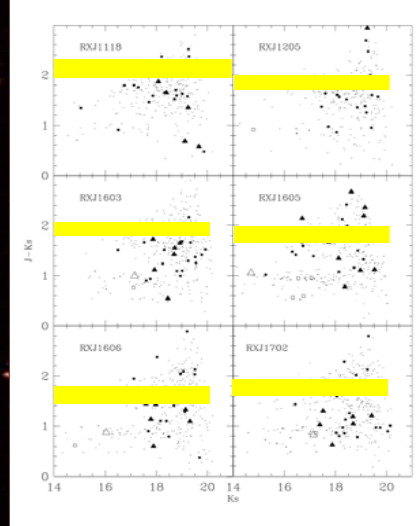
- > Confirmation needed because about half the extended x-ray sources at this flux level are unresolved constellations of point sources rather than true clusters
- > Used search algorithm to find concentration of objects (<50" diameter) with similar J-Ks colors (<0.2 mag spread), centered near the location of x-ray emission
- > Checked for false positives (similar-color field galaxies that happen to fall at x-ray position) by running same search on random field locations. Found 12% chance of false positive (roughly 1 of our 10 targets). RXJ1702 is likely to be a false positive (the field is rich in objects of similar color, but no identifiable cluster center).

> 5 of 10 x-ray sources were confirmed with a red sequence detection

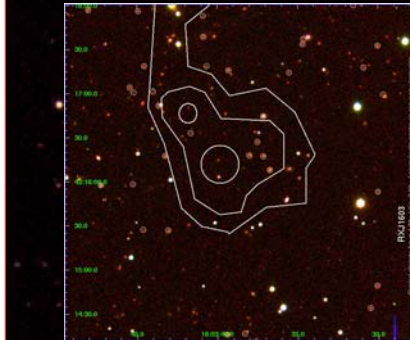


RXJ 1606
Bluest of the five clusters (probably $z < 0.8$)
Possible mergers near BCG

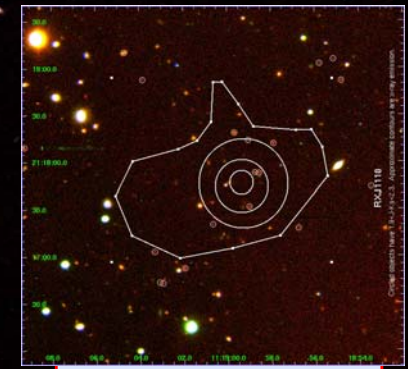
Color-Magnitude Diagrams



Triangles: objects located less than 30" from cluster center
Squares: objects located less than 60" from cluster center
Dots: field objects (more than 150" from center)
Hollow symbols: stars
Highlighted: the red sequence for each cluster



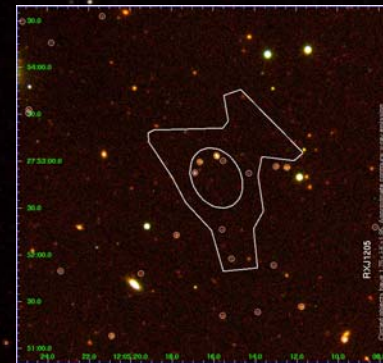
RXJ 1603
The surrounding field contains a supercluster at $z = 0.9$.



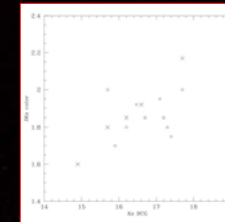
RXJ1118
Redder than known clusters of $z = 1.2$.
Two closest galaxies have projected separation of 21kpc - possible high-z merger?

At high redshift.

- > The colors and brightest galaxy magnitudes match those of known clusters $0.8 < z < 1.2$
- > Thus, this work is consistent with other work that finds the red sequence in place at $z \sim 1$
- > We are pursuing
 - spectroscopic confirmation
 - HST imaging to study morphologies of cluster members (morphology-density relation, possible mergers, possible disk galaxies with red colors, etc.) (Postman et al 2005)
 - Chandra imaging to study substructure of intracluster medium and assembly of cluster (Stanford et al 2001)
 - Spitzer imaging to identify more clusters members



RXJ1205
Color suggests redshift about 1.



J-Ks color of red sequence vs. BCG magnitude
X = clusters presented here
O = clusters in literature with $0.8 < z < 1.2$

An important detection method

Our method: Select clusters in x-ray, then confirm in two near-IR bands.

- > Other ongoing surveys find many high-z clusters using photometric redshifts, but don't know which of the clusters are x-ray luminous (e.g. Elston et al 2006).
- > Our method is similar to Andreon et al (2005) but works beyond $z = 1$ because we confirm the clusters using J-K colors rather than R-z colors
- > X-ray luminous clusters at high redshift are rare (only 5 found in the 4.8 sq deg of ROX Survey)

> X-ray properties help us understand the impact of the environment on mergers and the development of the red sequence.

- > X-ray luminosity and temp give depth of the gravitational potential
- > X-ray substructure shows assembly of cluster
- > This work demonstrates that future large scale x-ray and Sunyaev-Zeldovich surveys can use J,Ks imaging on a 4m telescope to confirm clusters and estimate redshifts

RXJ1605
Richest cluster of the five.
Galaxies centered to the north of the x-ray emission.

References

Andreon, S. et al. 2005, MNRAS, 359, 1250
Donahue, M., Scarf, C. A., Mack, J., Lee, Y. Paul, Postman, M., Rosati, P., Dickinson, M. Voit, G. M., and Stocke, J. T. 2002, ApJ, 569, 689
Elston, R. J. et al. 2006, ApJ, 639, 816
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