

# **Diffuse Intergalactic Light in Intermediate Redshift Cluster: RX J0054-2823**

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# Intracluster light (ICL)

- **Diffuse light present in galaxy clusters**
- **Low surface brightness** 25
- **Associated to a diffuse stellar population**
- **Studies:**
  - **ICL fraction in clusters**
  - **Colors, metallicity, dynamics**
  - **When BCG, profiles**
  - **Tidal features**
- **Relevant information for galaxy and cluster evolution:**
  - BCG formation, dwarf galaxies disruption, star formation
  - Baryon fraction
  - Trace dark matter

# The Challenges

- **ICL surface brightness less than 1% of sky.**
- **Flat fielding**
  - Scattered light from moon and bright stars;
  - Non uniform backgrounds from city-lights, Zodiacal light, or airglow;
  - Fringing;
  - Light concentration from instrument optics.
  - CCD bleeding
- **Illumination corrections**
  - Spatial fluctuations in instrument transmission
- **Sky level**
  - Must be determined over large areas
  - Affected by faint background galaxies

# Our approach

## The Consecutive Differential Image (CDI) technique:

(Melnick, Selman, & Quintana, 1999 PASP)

- Similar to the not-and-stare technique used for IR background subtraction.
- Subtract pairs before flat fielding and then flat field before combining all pairs.

## The gains:

- Sky deviations from flatness proportional to the second derivative of the sky brightness :

$$\left(\frac{\Delta I}{I}\right)_{CDI} \propto \left(\frac{\Delta r}{r}\right)^2$$

- For a 10' dithering pattern, 60 degrees away from the moon, the deviation from uniformity is thus  $\left(\frac{\Delta I}{I}\right)_{CDI} \propto 2 \times 10^5$

- For the superflat method the deviations are proportional to the first derivative, thus,  $\left(\frac{\Delta I}{I}\right)_{SF} \propto 3 \times 10^3$

**The price: higher photon noise.**

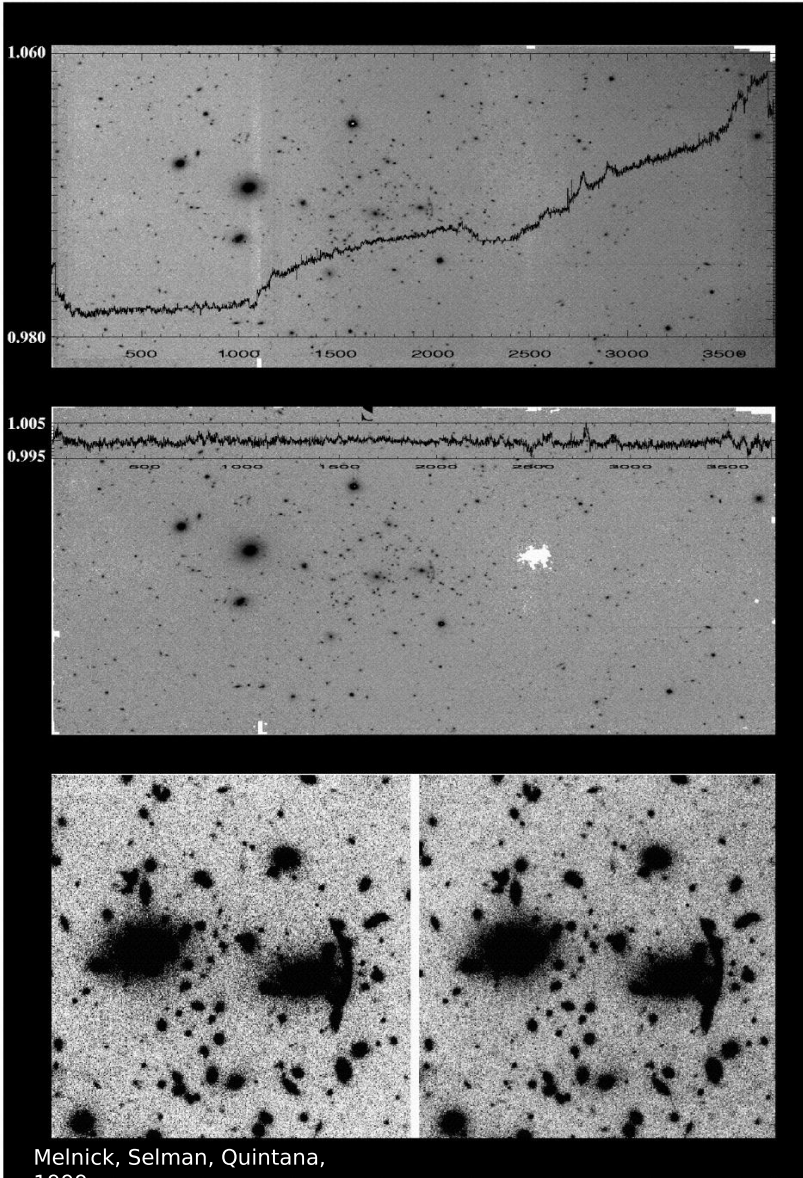


# SOI observations of A370

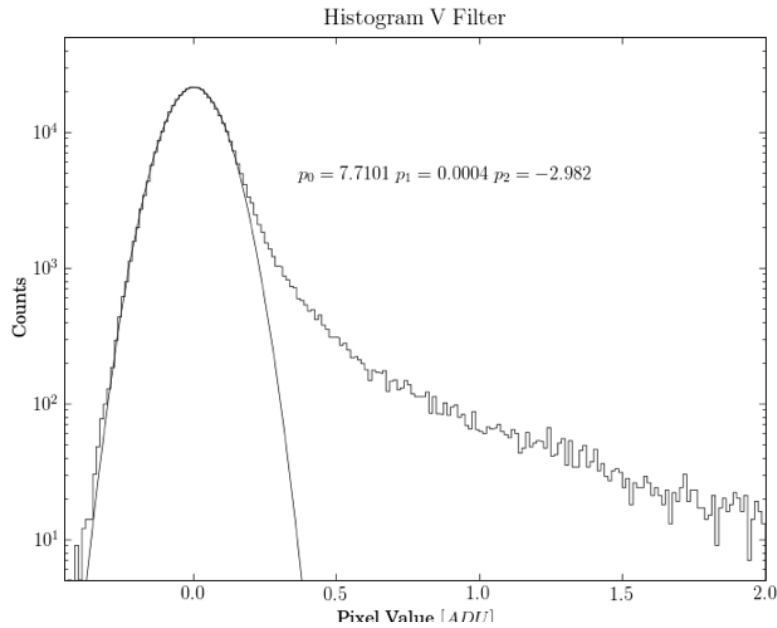
Super-flat

CDI gives better  
uniformity

At the price of higher  
noise.



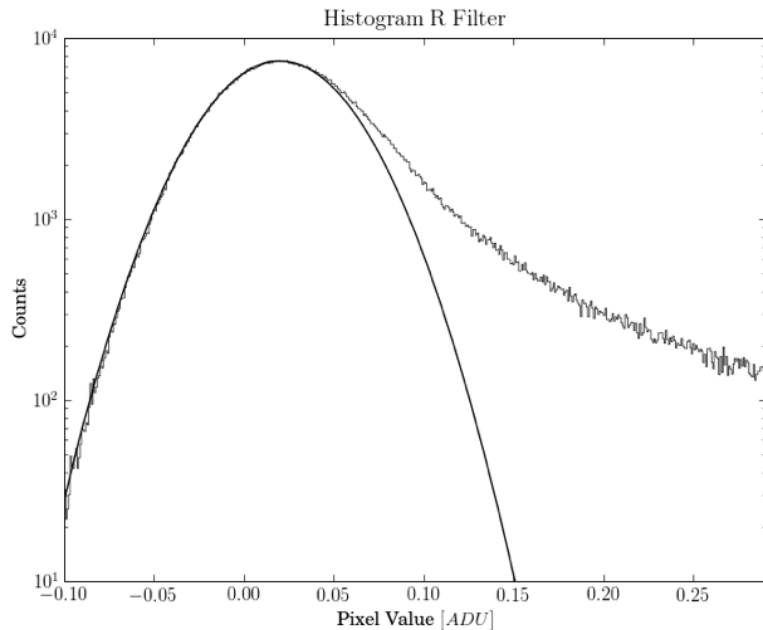
# Background subtraction



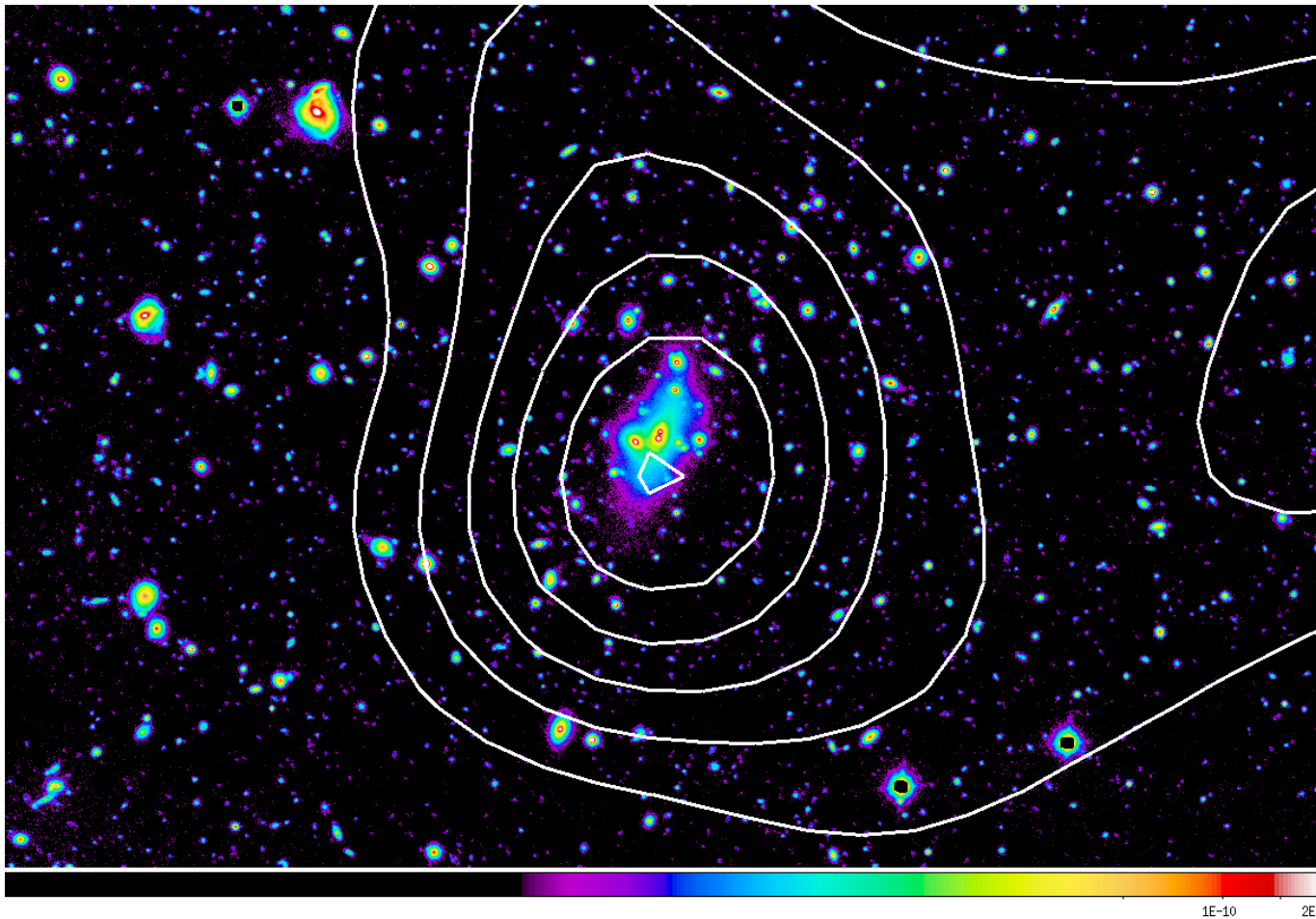
For a Gaussian background, the log-histogram of the pixels in the reduced image must be an inverted parabola (Melnick, Selman, & Quintana, 1999).

This can be used to check that for systematic effects in the data reduction.

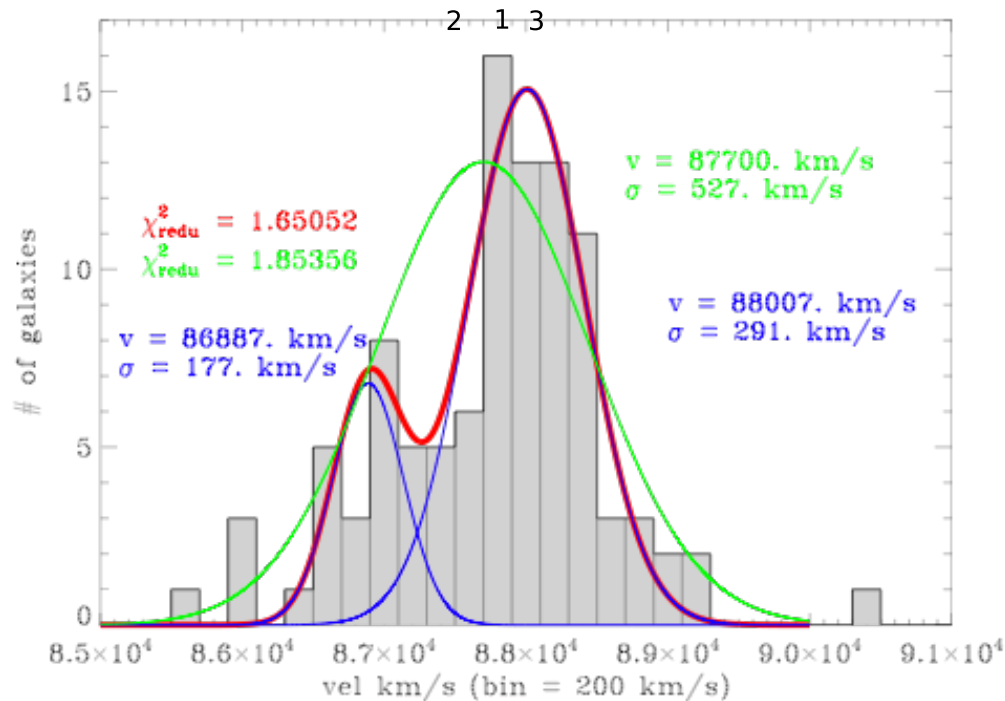
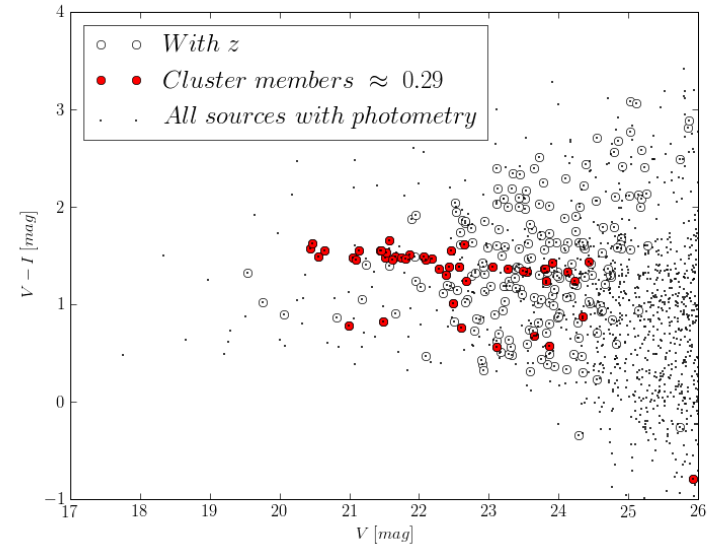
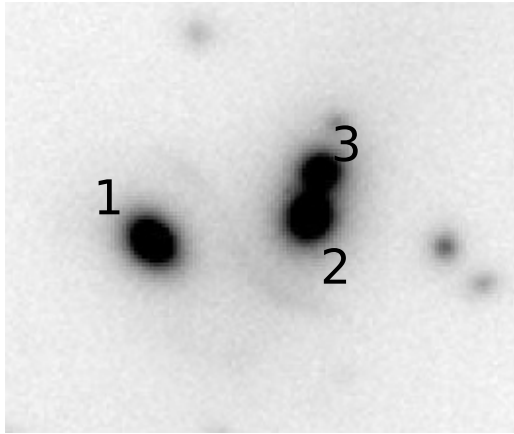
Our background subtraction for J0054 is very good.



# RX J0054-2823



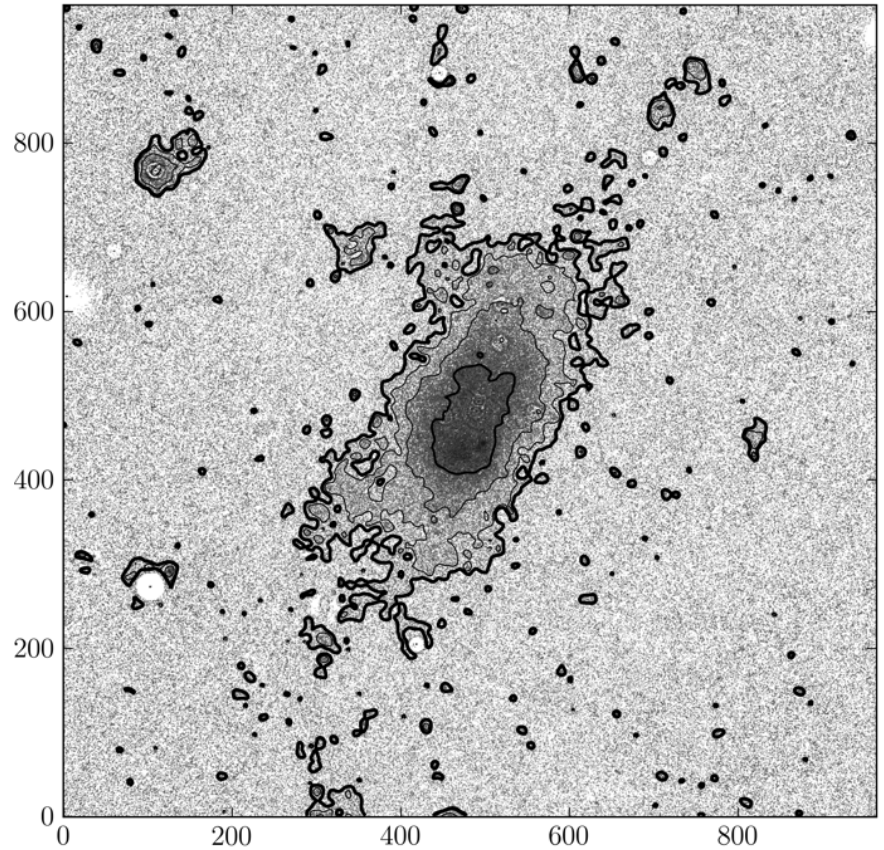
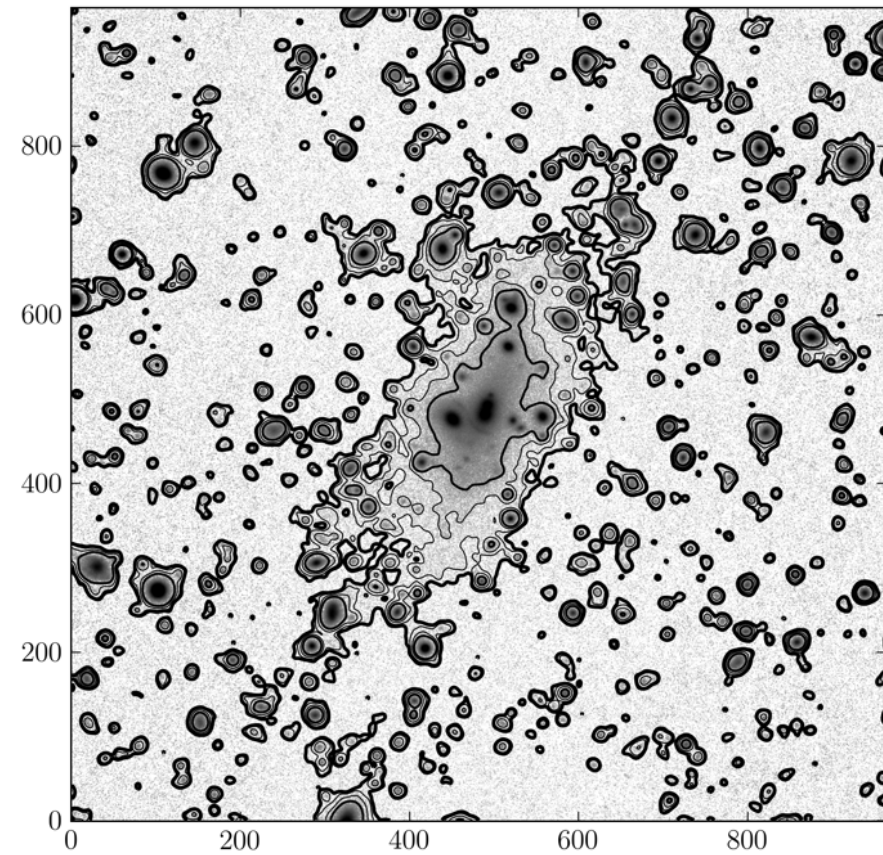
# The Cluster



- Double RV histogram suggests a merger of two clusters;
- The three central giant galaxies have very similar radial velocities; 97 member galaxies
- The blue-shifted galaxies appear to define a distinct structure (filament?);
- All this suggests an advanced merger stage.
- Virial mass for the 1-cluster solution is in good agreement with the mass expected from the X-ray luminosity  
 $M_{\text{Vir},1} = 3.3 \times 10^{14} M_{\text{sun}}$



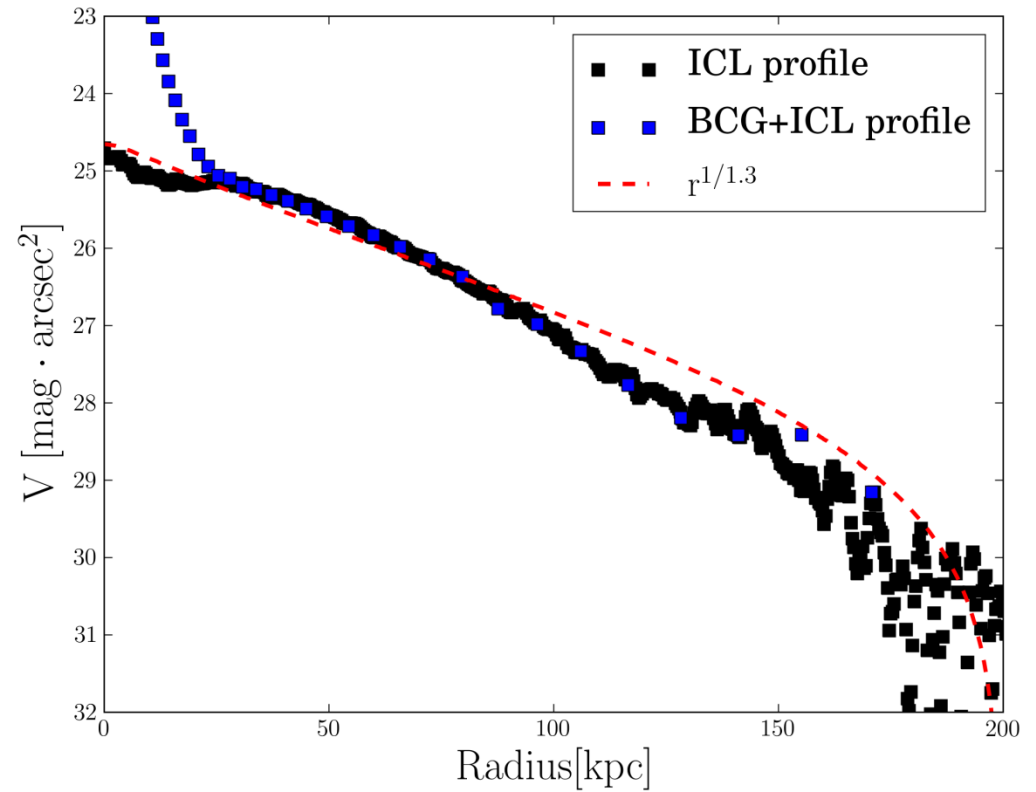
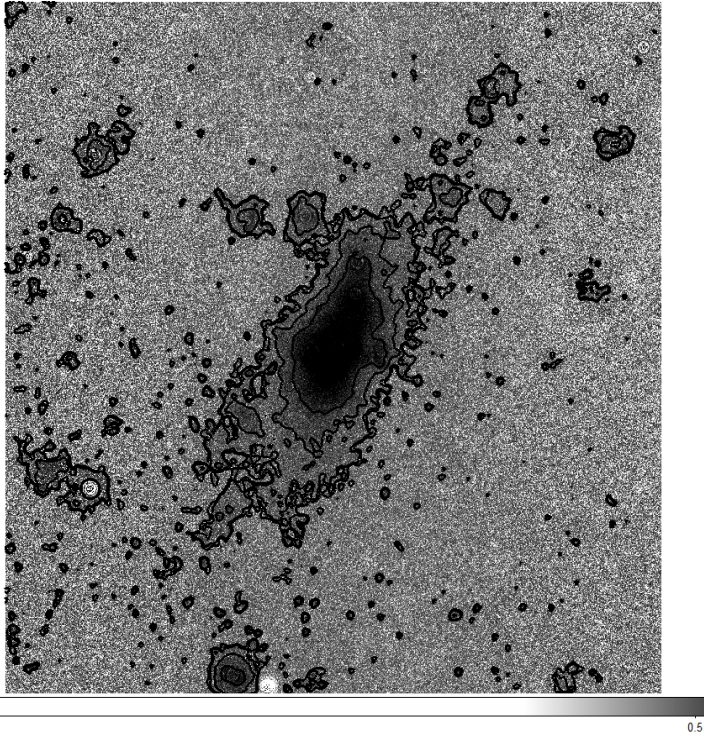
# ICL in V-band



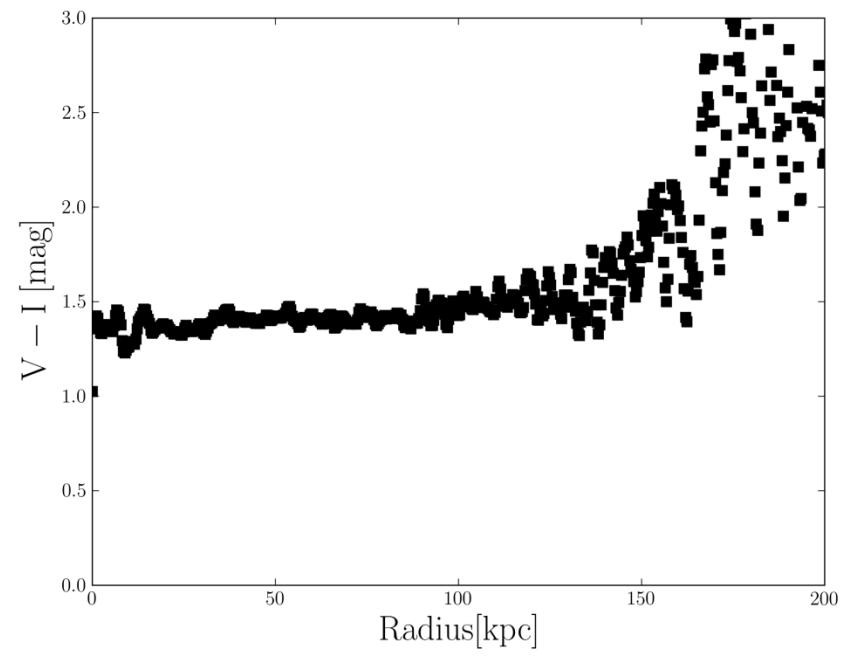
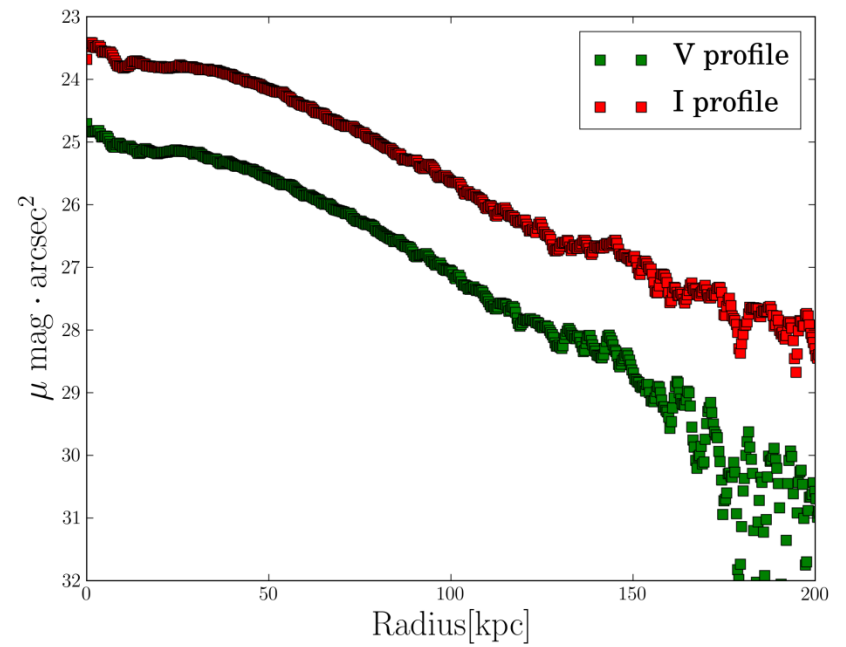
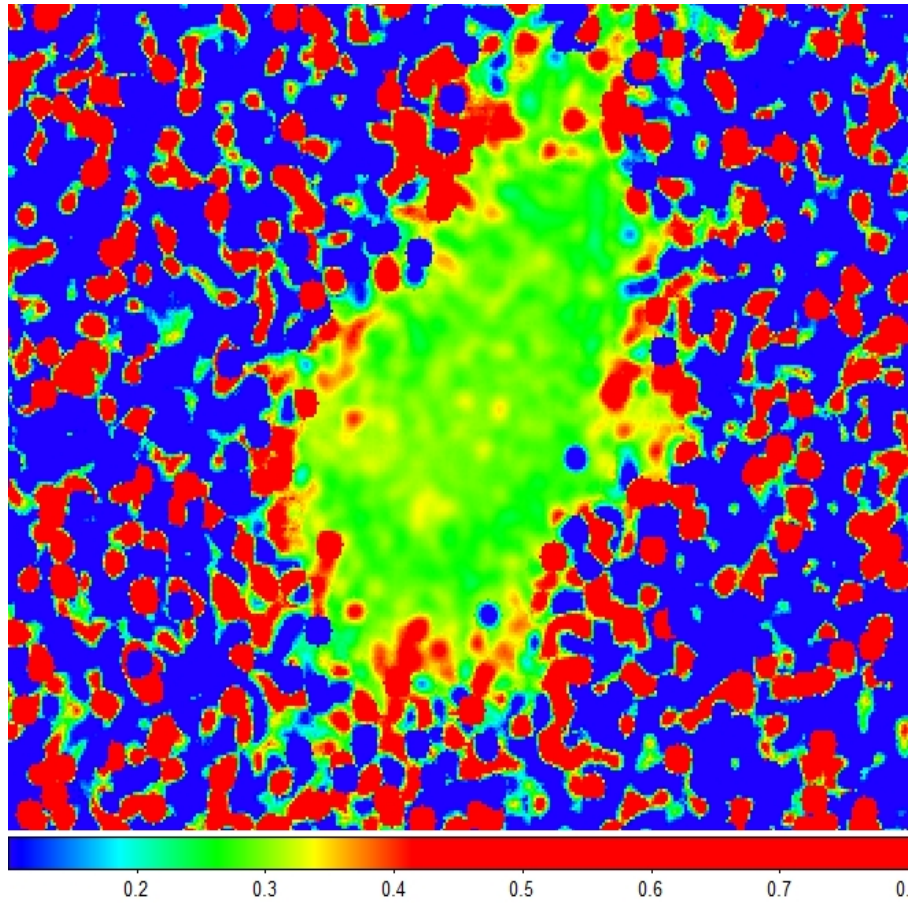
Cleaned image using ov-wav (Da Rocha et al. 2008)

Contours: 26-29 mag/sq."

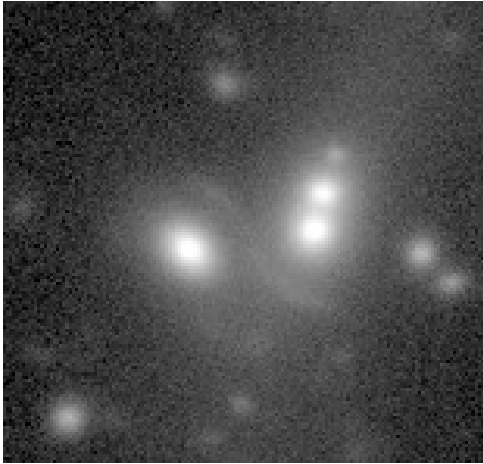
# ICL in V-band and profiles...



# ICL Colors



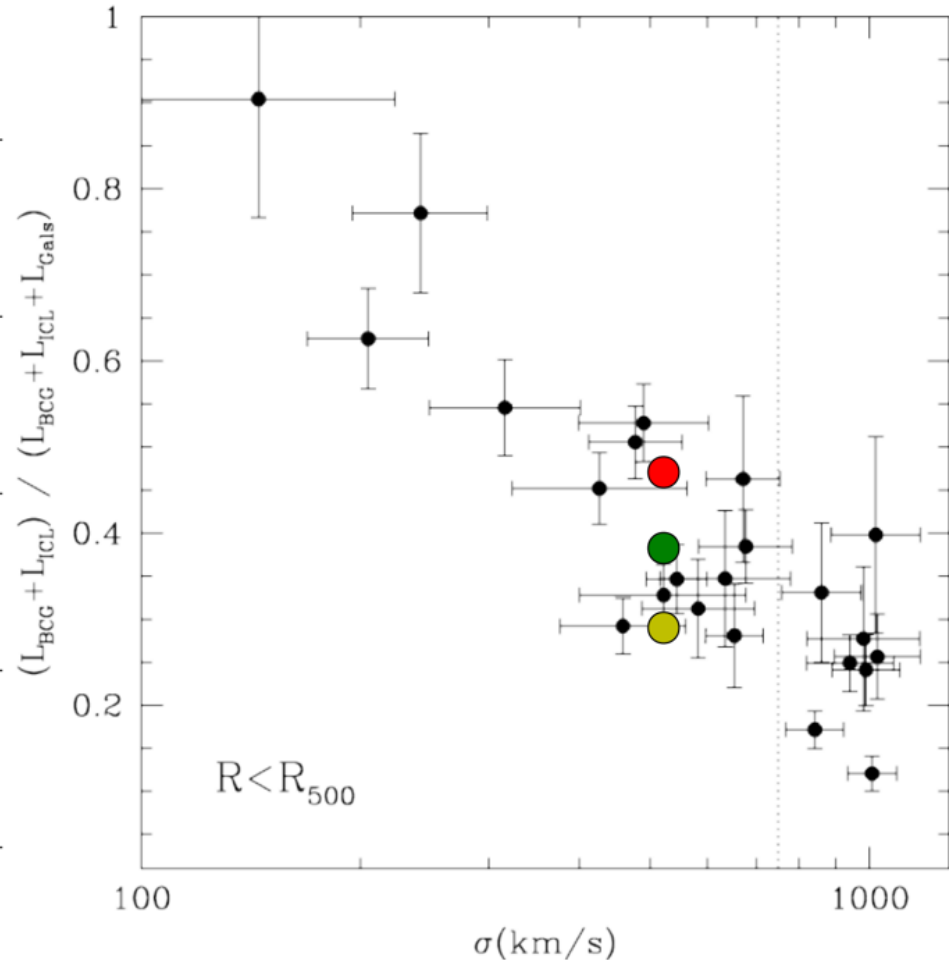
# ICL versus velocity dispersion



Fraction of light in the Brightest Cluster Galaxy (BCG) plus ICL correlates with velocity dispersion

J0024 has 2-3 BCG's. Depending on which is `the BCG' we get three points in the diagram

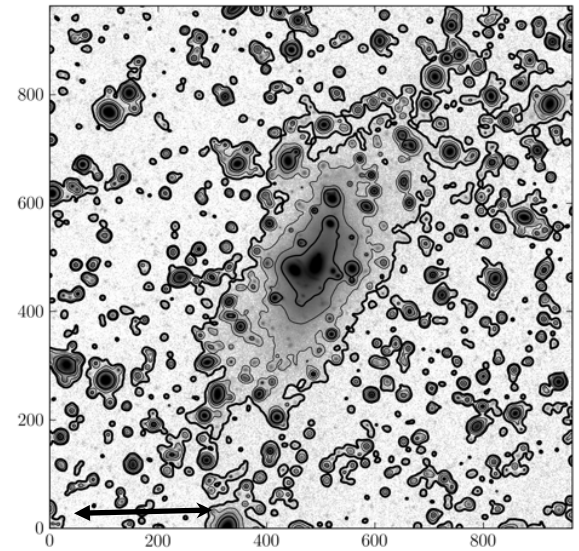
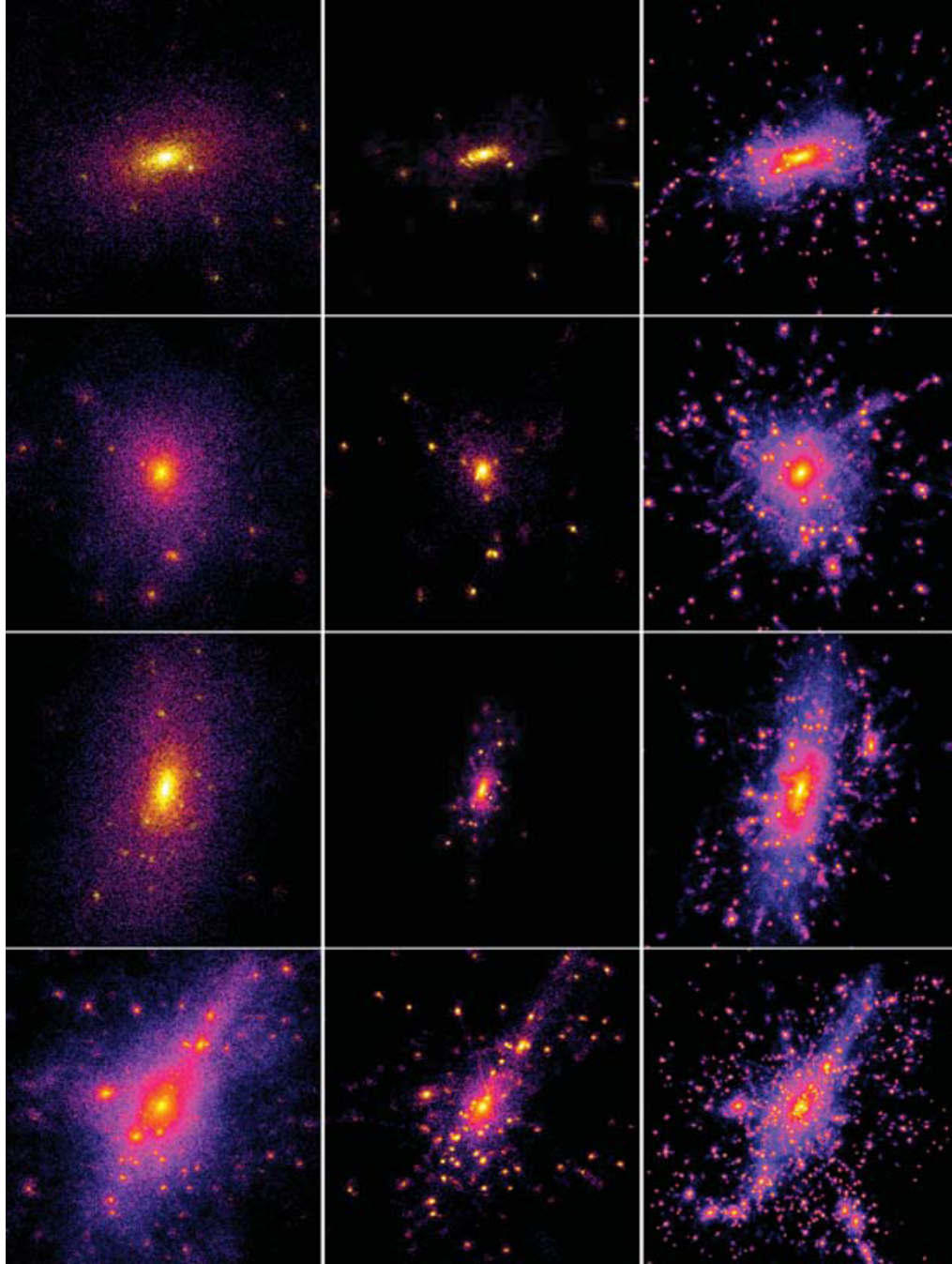
Total cluster light and ICL must be partitioned accordingly



Gonzalez, Zaritsky, & Zabludoff, 2007



S



100kpc

Dynamical simulations resemble J0054 at the end of the evolution ( $t=1$ ;  $z=0$ ), except for the scale;

J0054 appears to be much more compact and is at  $z=0.29$ . Also ICL is more elongated.

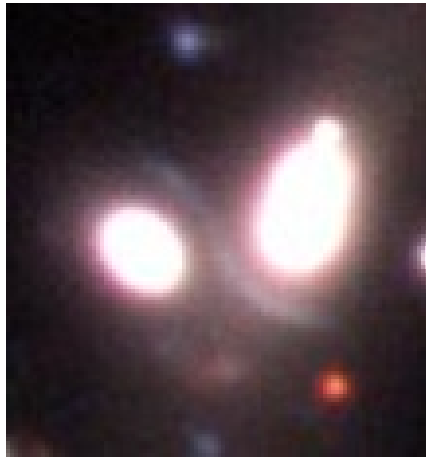
black: < 26 mag/sq."

red: 26-27

yellow: 27-28

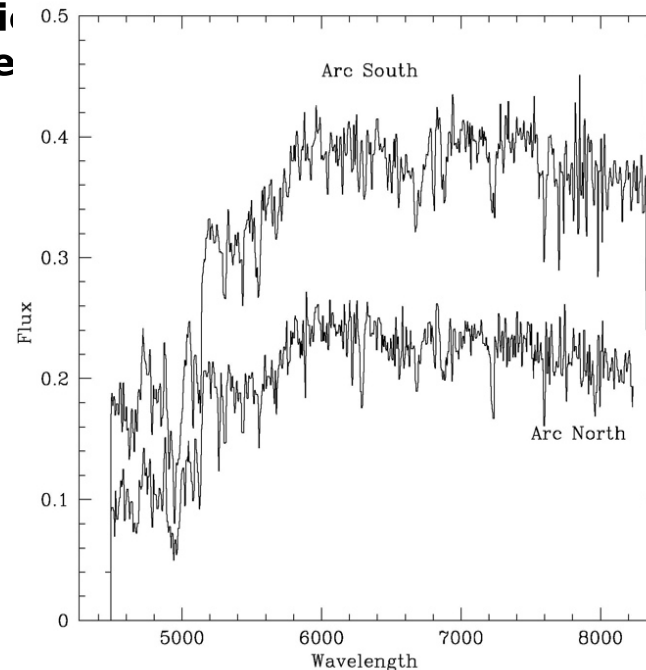
green: 28-29

# The s-shaped arc



- The arc is clearly bluer than the cD galaxies (and the ICL)
- The spectrum of the arc does not show emission lines and its redshift is consistent with the radial velocity of the cluster
- When the ICL light is subtracted, no evidence is found that the arc is a lensed background galaxy;

• The arc  
galaxy  
by the



no spiral  
likely crushed  
r

# Conclusions so far...

The color of the ICL is analog to the RCS color of the cluster.  
ICL luminosity fraction is around 30 to 40%

The BCG+ICL fraction is very close to that expected from the velocity dispersion if the three central galaxies are the BCG.

The s-shaped arc in the X-ray cluster MX J0054-2823 at  $z=29$  is most likely not the image of a background galaxy lensed by the cluster. The s-shaped feature is a cluster galaxy in the process of being tidally destroyed by the three giants in the cluster center

Simulations predict that during collapse some clusters will have three dominant structures in their central regions. However, J0054 appears to be more compact than simulations would predict, and seems to have reached the predicted structure at an earlier phase.

MX J0054-2823 appears to be an interesting object to test models of cluster evolution and ICL formation.