Simulating the Production of ICL in Galaxy Groups and Clusters

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Outline

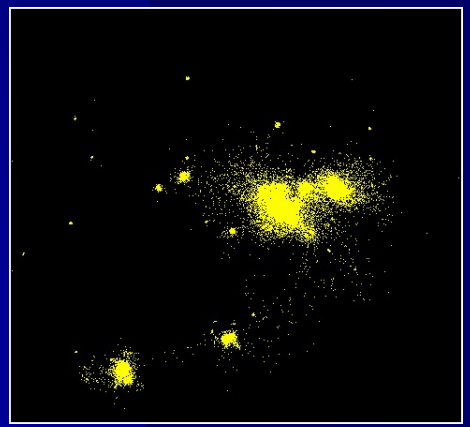
- Simulate observations of ICL
  - Simulated broadband imaging of diffuse light
- Examine the evolution of ICL
  - How does the quantity and morphology of the ICL evolve?
  - What are the mechanism(s) driving ICL production and evolution?

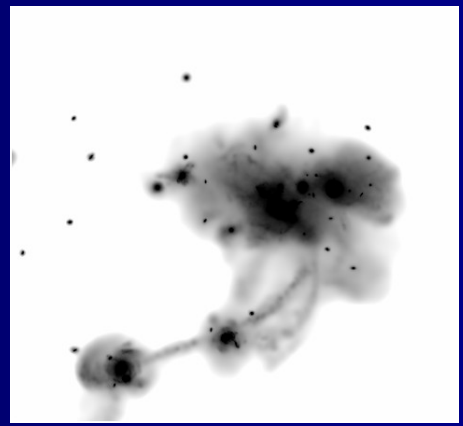
Simulating Observations

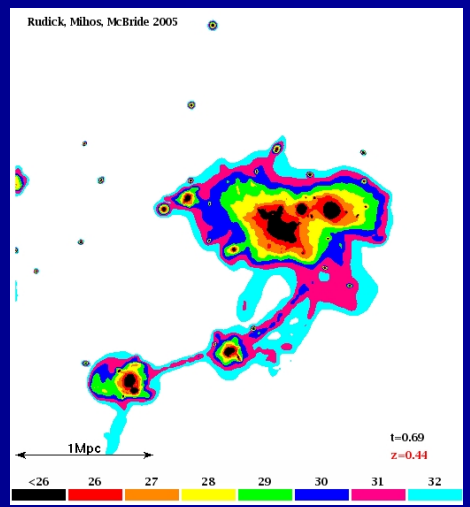
Luminous Particle Distribution

Smoothed Distribution

Surface Brightness Distribution







Smoothing

- Adaptive 2-D Gaussian smoothing kernel on each particle
- Width of Gaussian scaled inversely to local 3-D density
- Scaling parameter chosen to give reasonably smooth distributions
  - Too little smoothing retains artificial discreteness of particles
  - Too much smoothing destroys coherent features

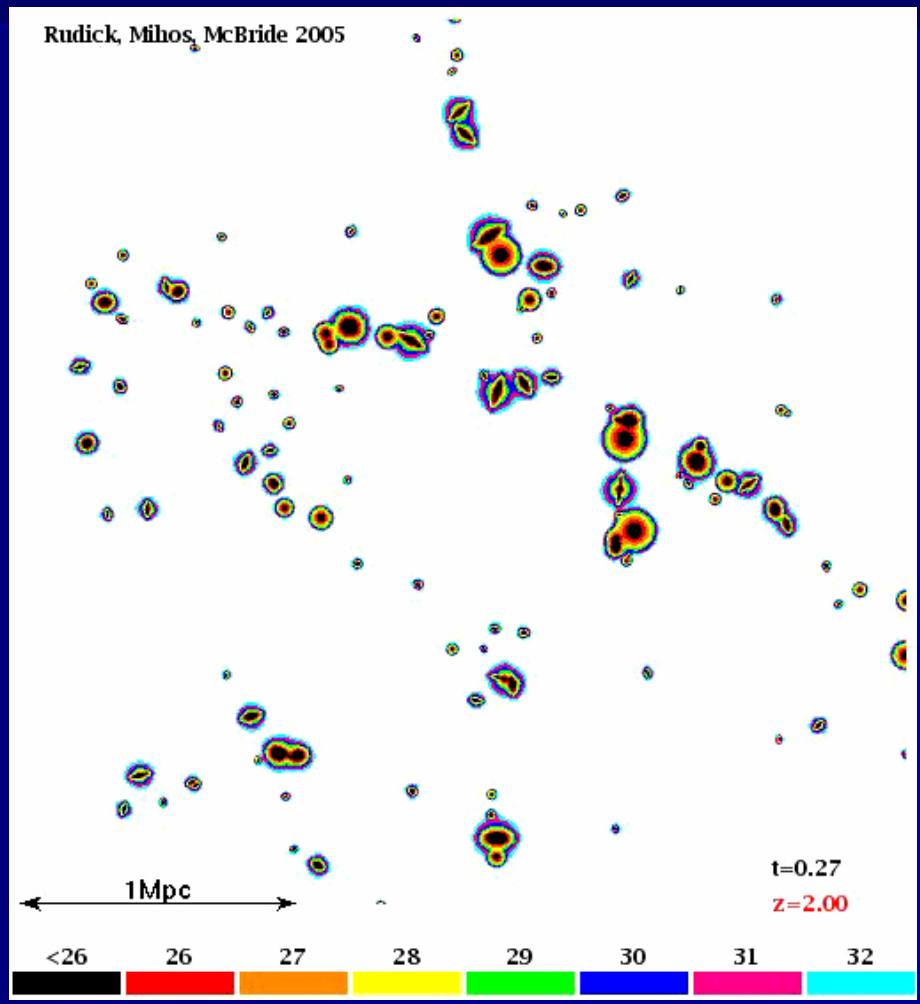
Converting Mass to Luminosity

- Apply a global M/L of 5 (solar units)
  - *V*-band M/L of old population in local universe
- Simplifies physics
  - Gas/stellar formation not included in simulations
  - Global M/L allows direct comparison of images at all evolutionary times
  - NOT cosmological observations, but observing the evolutionary state of the groups/clusters as they would appear in the nearby universe

Presented in Technicolor

(MOVIE)

- 3 clusters
  - ~10^{14} solar masses
  - From z=2 to z=0



All movies from this presentation can be accessed from:

http://astroweb.cwru.edu/craig/diffuse_light/diffuse_light.html

Evolution of the ICL

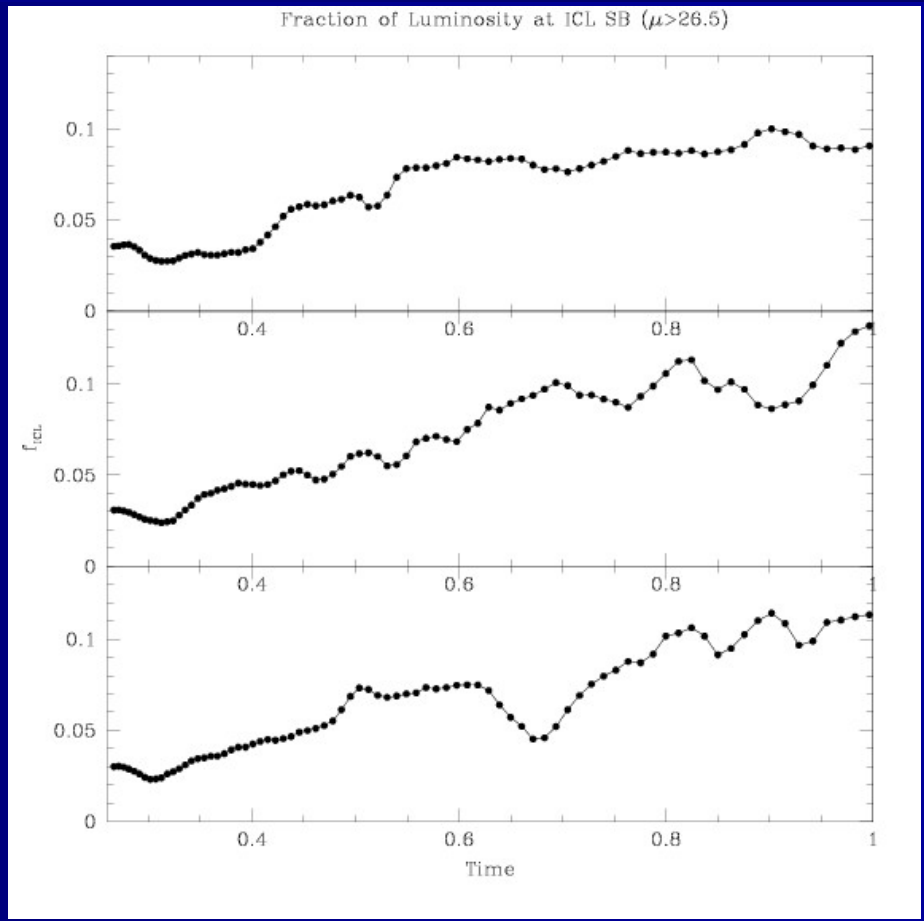
- How does the ICL luminosity evolve?
  - Quantitative measures of ICL
- What causes the evolution?
  - Continual stripping by cluster potential?
  - Group accretion?

Defining ICL

- Previously used definitions:
  - Theory: unbound particles (stars)
    - Unobservable in broadband imaging
  - Observation: excess over $r^{1/4}$
    - Model dependent, not universally applicable
- We define ICL as luminosity fainter than μ_V of 26.5 mag/sq. arcsec
  - Well-defined observable
  - Radius at which ICL has unique morphology

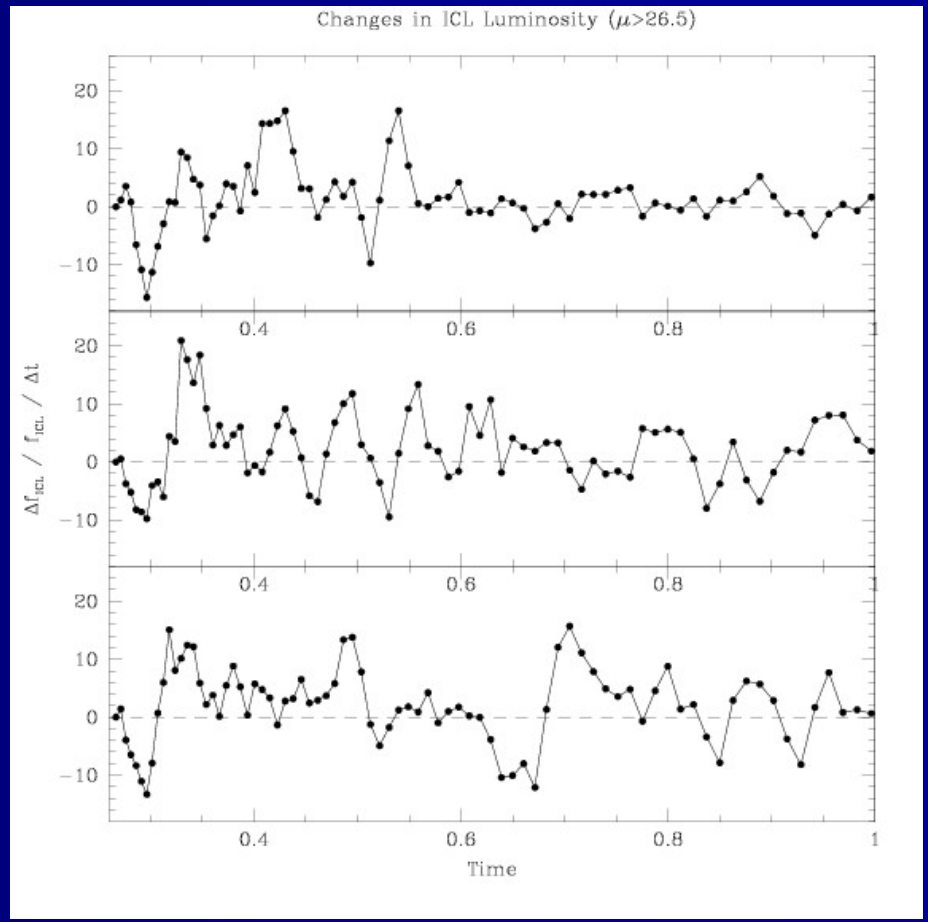
ICL Luminosity with Time

- The fraction of luminosity at ICL surface brightness tends to increases with time
- Increases are very stochastic and non-uniform
- Each cluster has a unique ICL history



Changes in ICL Luminosity

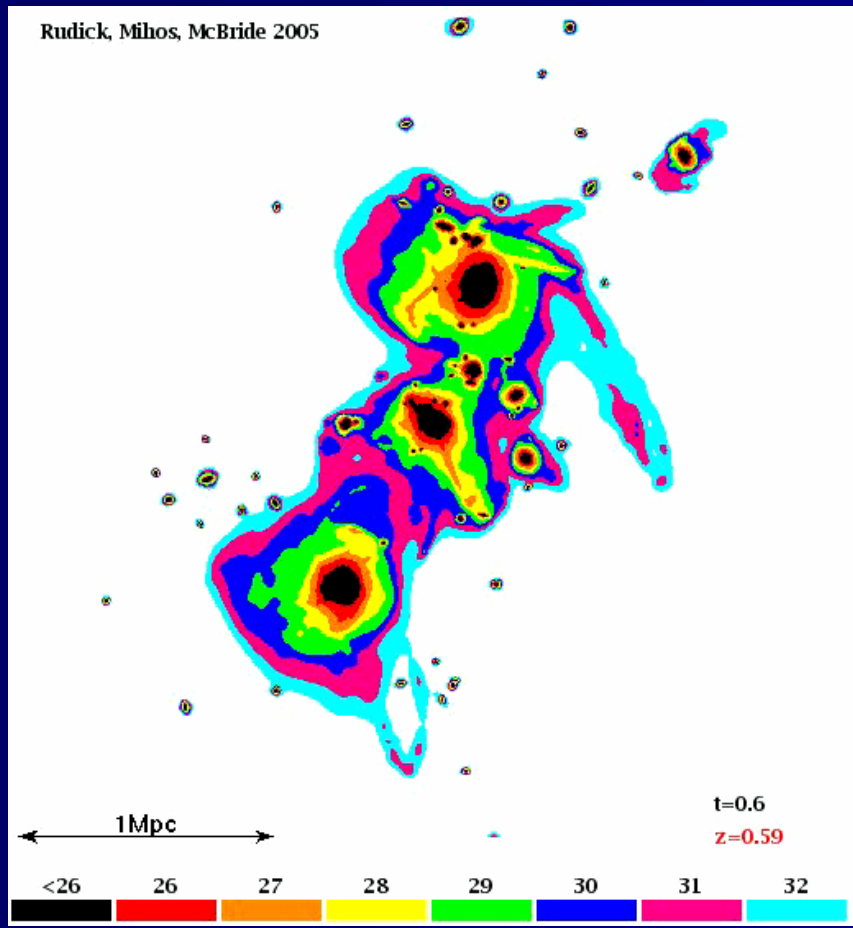
- Fractional change in luminosity per unit time
- ICL luminosity increases tend to come in short, discrete events
- Increases in ICL luminosity are highly correlated with group accretion events

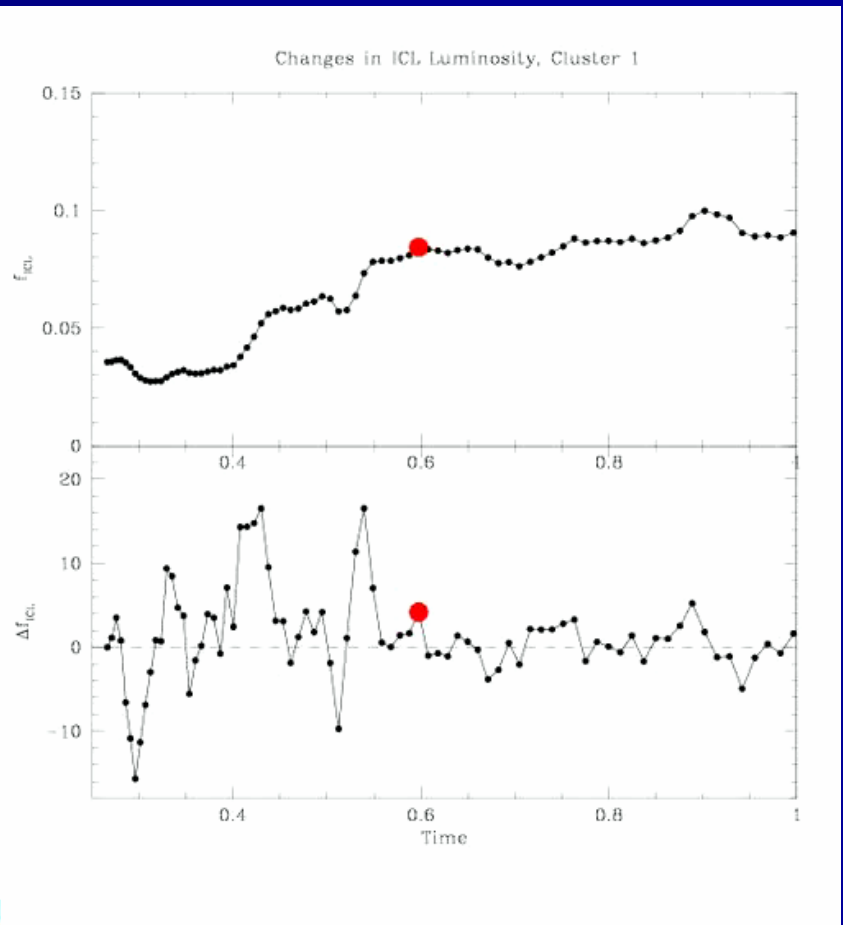


Cluster 1

(MOVIE)

- Three large galaxy complexes
  - The three groups do not merge
  - Very little production of ICL

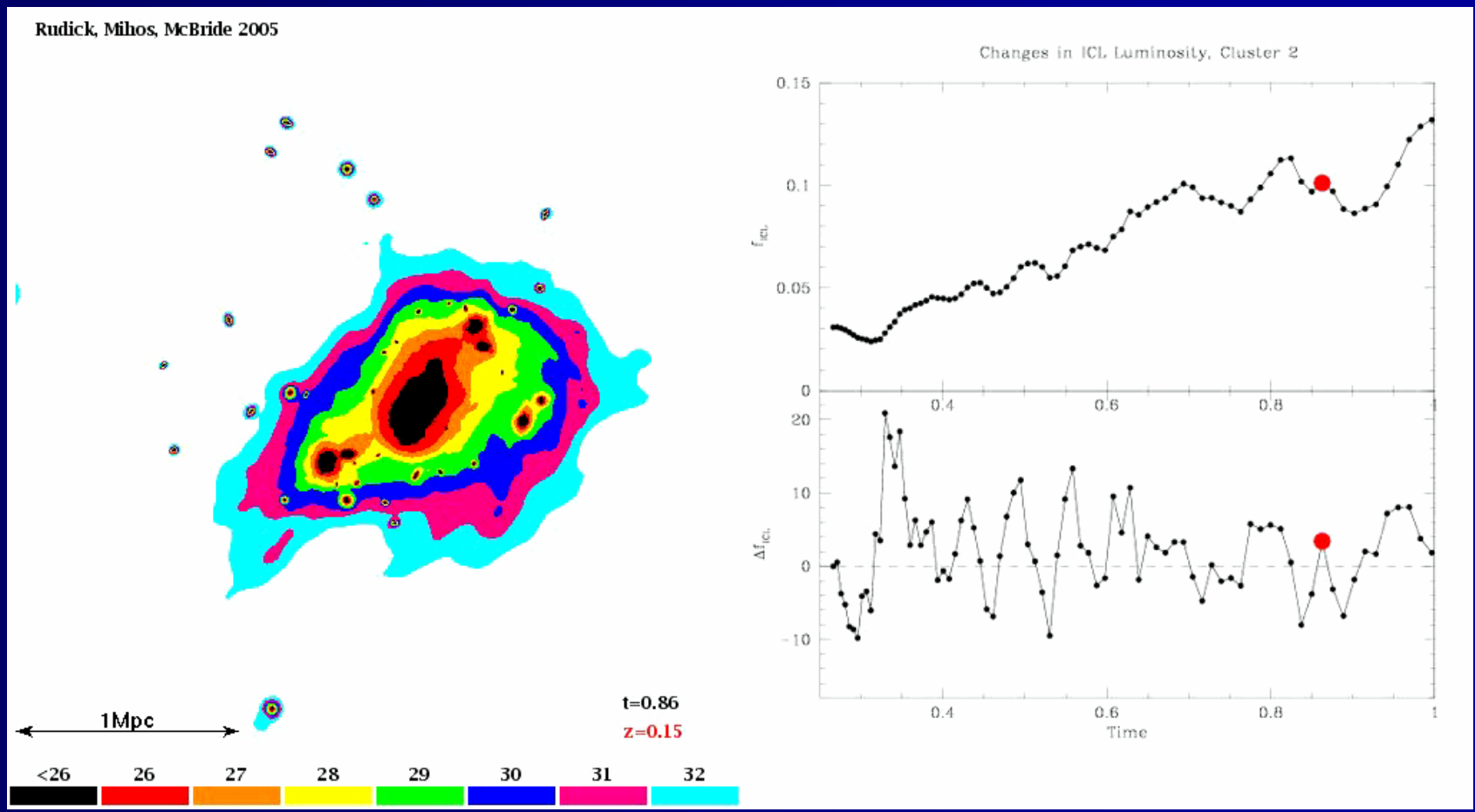




Cluster 2

(MOVIE)

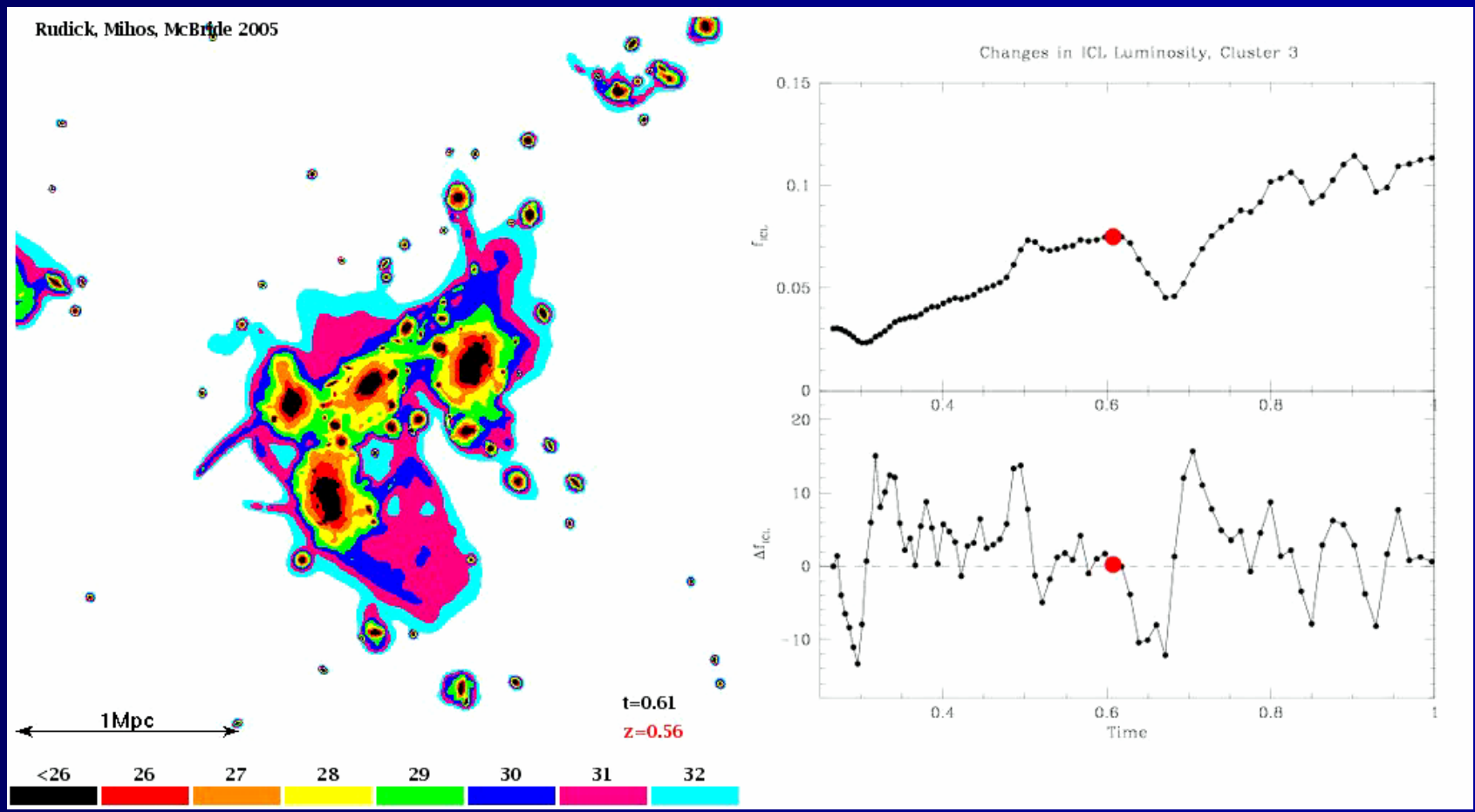
- Small group crashes through large central group from bottom left to top right
  - ICL increase coincides with galaxy exiting center



Cluster 3

(MOVIE)

- Massive collapse of groups
  - Luminosity shifts to higher surface brightness as groups infall
  - Huge ICL production after event



Conclusions

- ICL luminosity tends to increase with dynamical time
- ICL luminosity increases are strongly correlated with group accretion events
- ICL features are tracers of cluster's evolutionary history

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