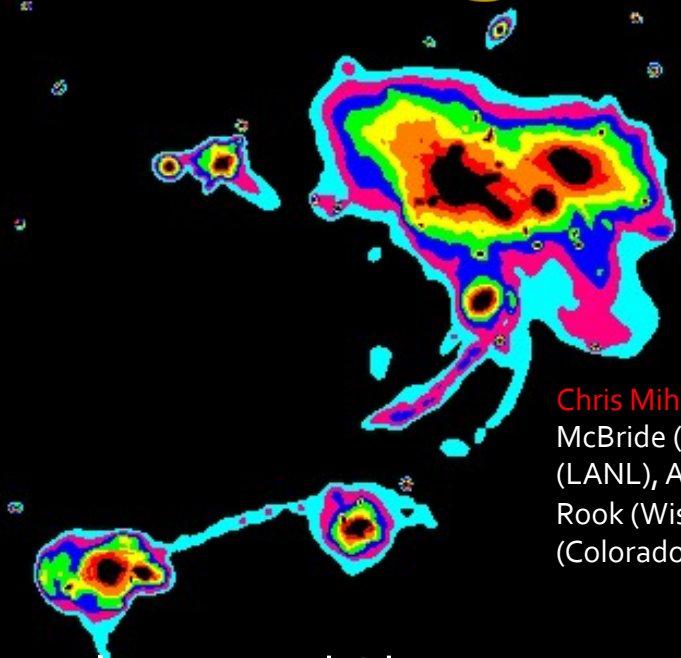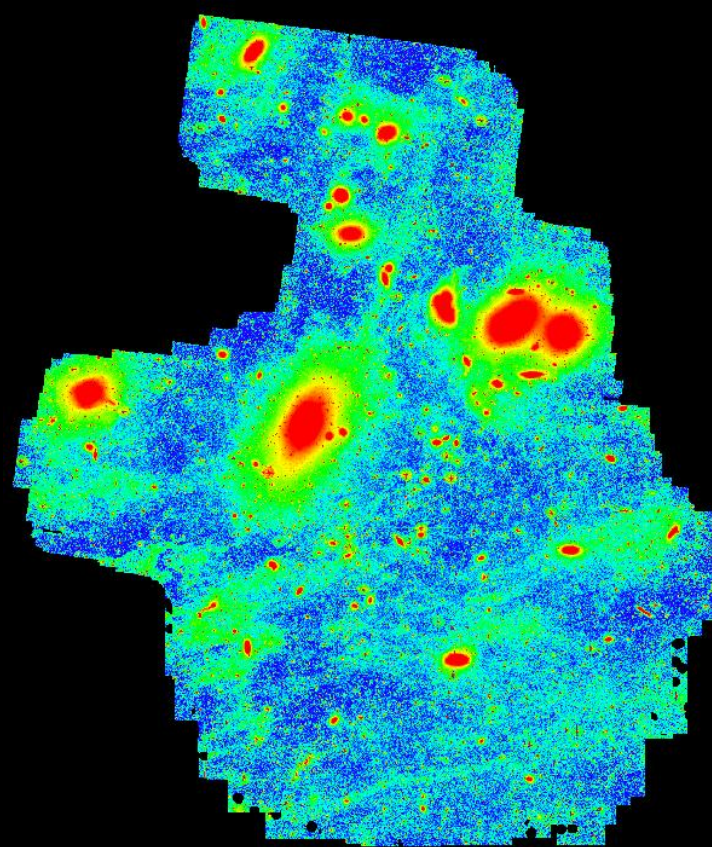# Intracluster Light in the Virgo Cluster
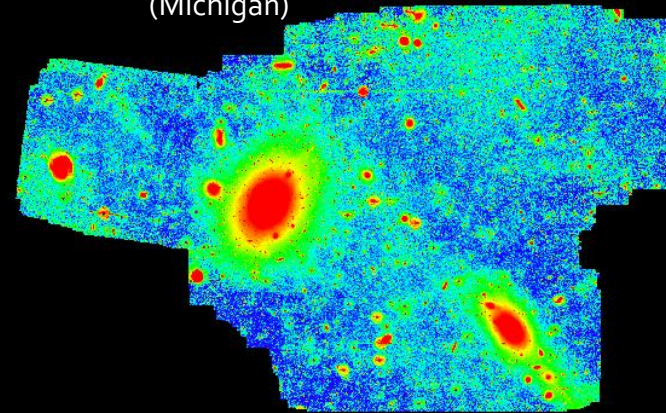

Chris Mihos (CWRU), Cameron McBride (Vanderbilt), Lucy Frey (LANL), Andrew Schectman-Rook (Wisconsin), Matt McJunkin (Colorado)

Chris Mihos (CWRU), Paul Harding (CWRU), Heather Morrison (CWRU), John Feldmeier (YSU), Steven Janowiecki (Indiana), Colin Slater (Michigan)

Simulations and Observations of the ICL Quantity, Morphology, and Optical Colors

Craig Rudick
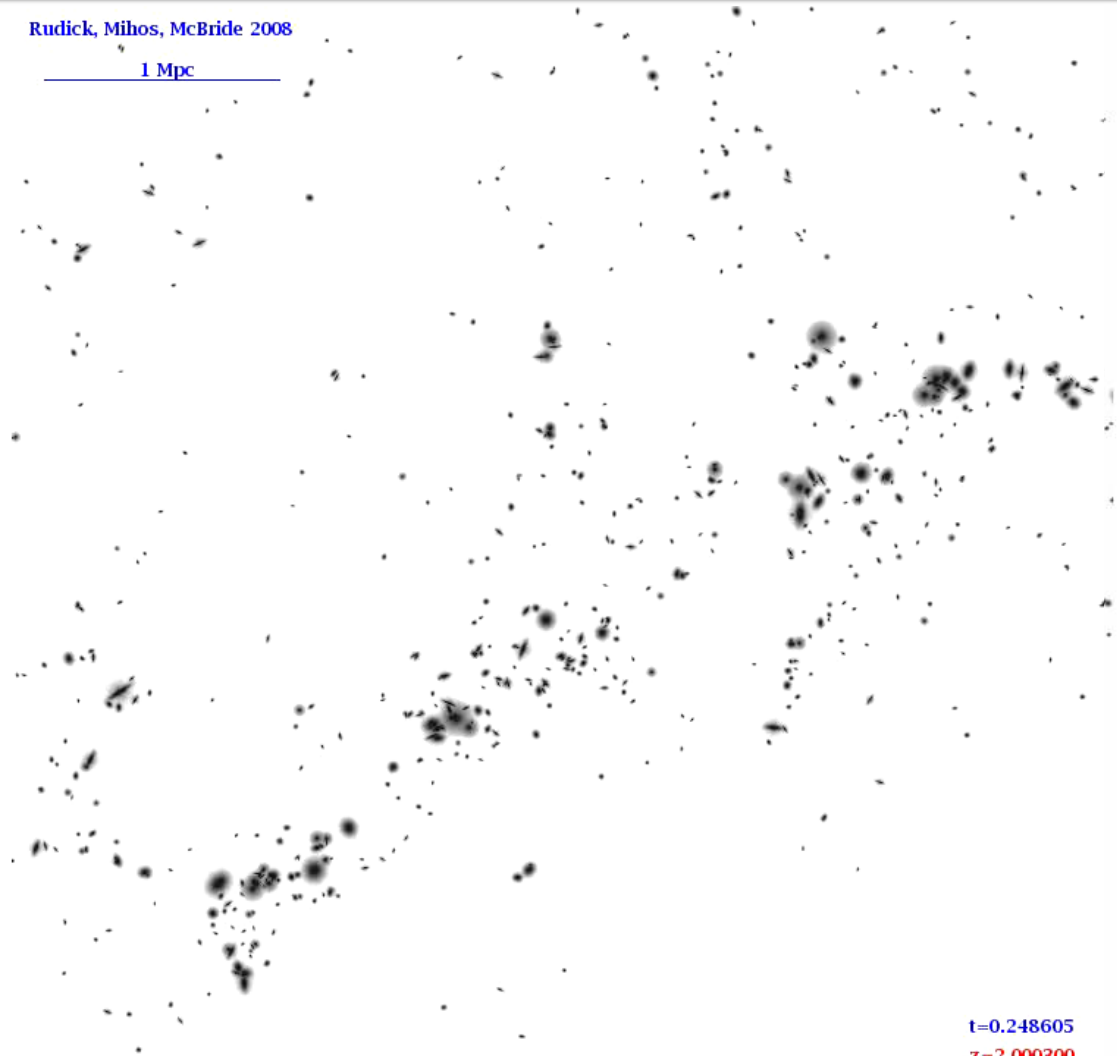Institute for Astronomy
ETH Zürich

ICL Simulations

- Hi-resolution, N-body simulations of cluster assembly
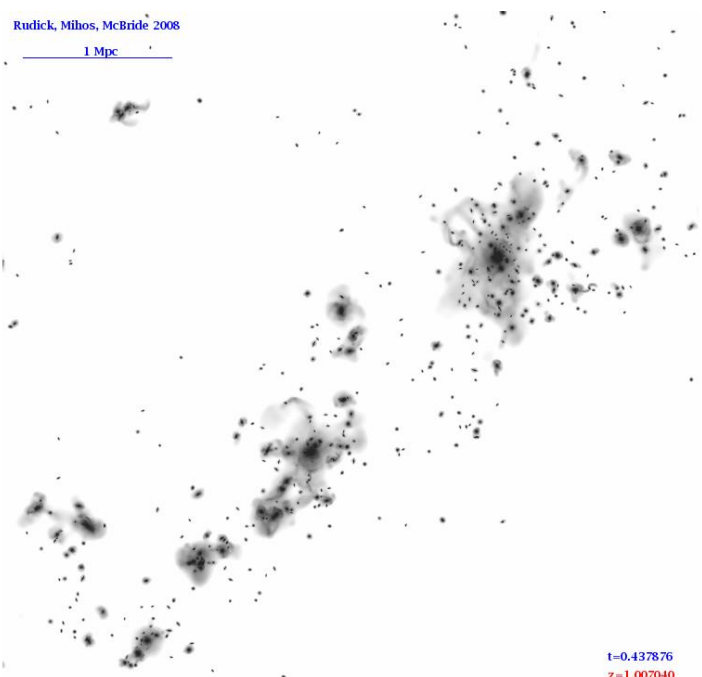- As cluster evolves:
  - ICL is produced
  - ICL morphology evolves

Rudick, Mihos, McBride 2008
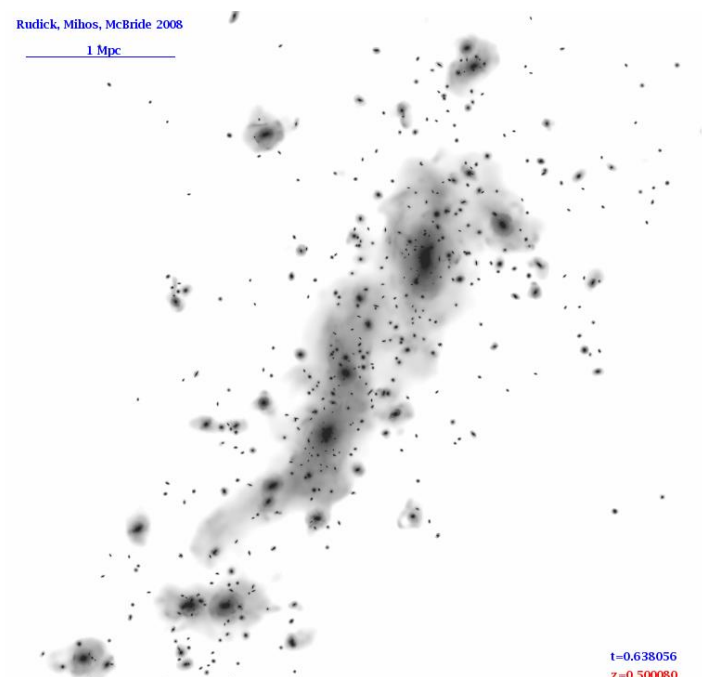
1 Mpc
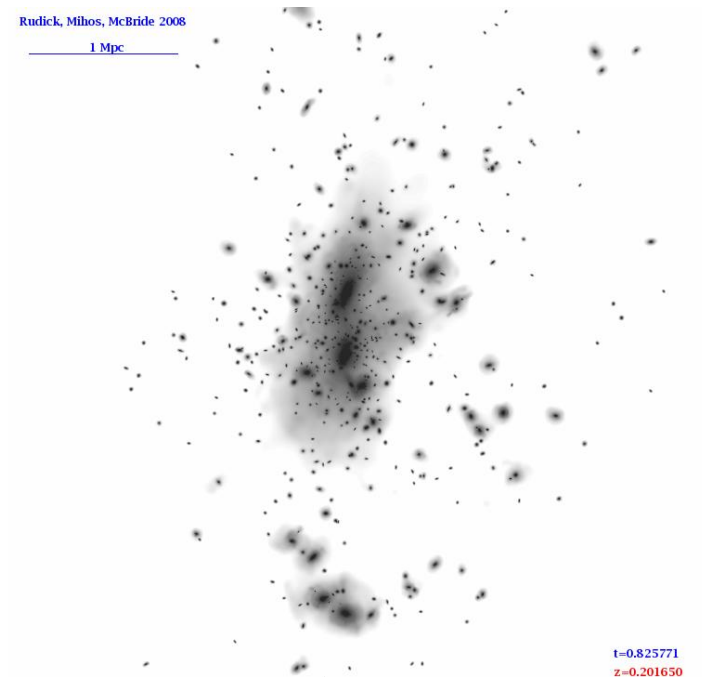
t=0.248605
z=2.000300

Z=1   Z=0.5

Z=0.2   Z=0

Rudick, Mihos, McBride 2008
1 Mpc

t=0.437876
z=1.007040

Rudick, Mihos, McBride 2008
1 Mpc

t=0.638056
z=0.500080

Rudick, Mihos, McBride 2008
1 Mpc

t=0.825771
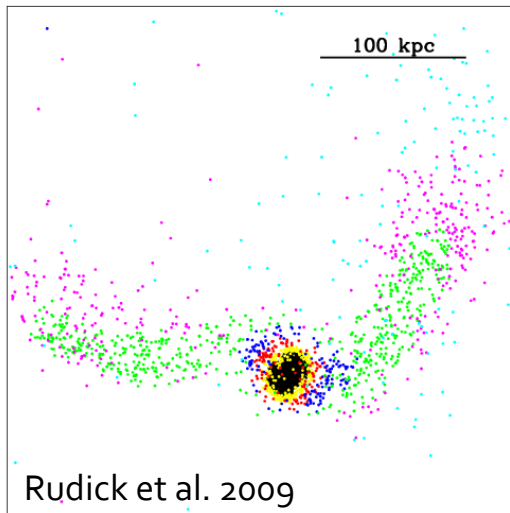z=0.201650

Rudick, Mihos, McBride 2008
1 Mpc

t=1.000000
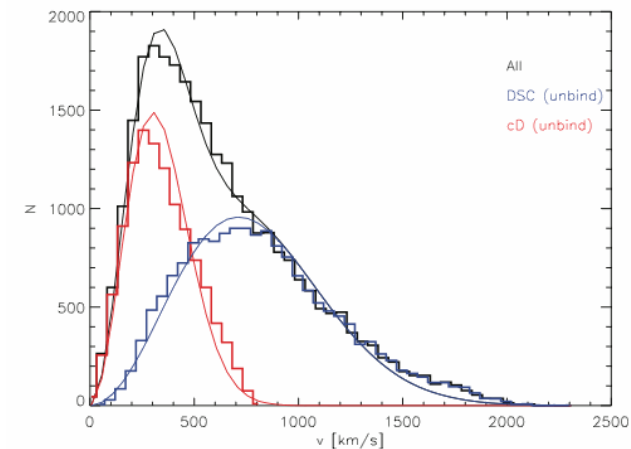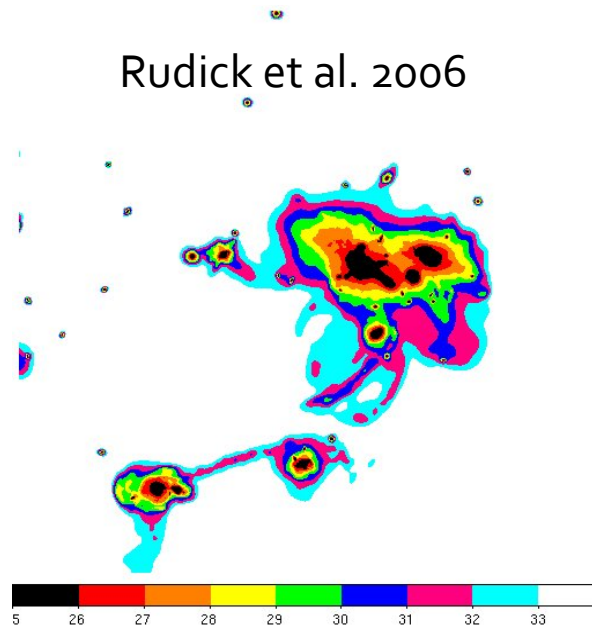z=0.000000

~~How Much ICL?~~ What is ICL?

- **Binding Energy**
- **Kinematics**
- **Surface Brightness**
- **Density**

Rudick et al. 2011

$$\Phi(r) = -4\pi G \left(r^{-1} \int_0^r \rho(r')r'^2 dr' + \int_r^{r_{max}} \rho(r')r' dr' \right)$$
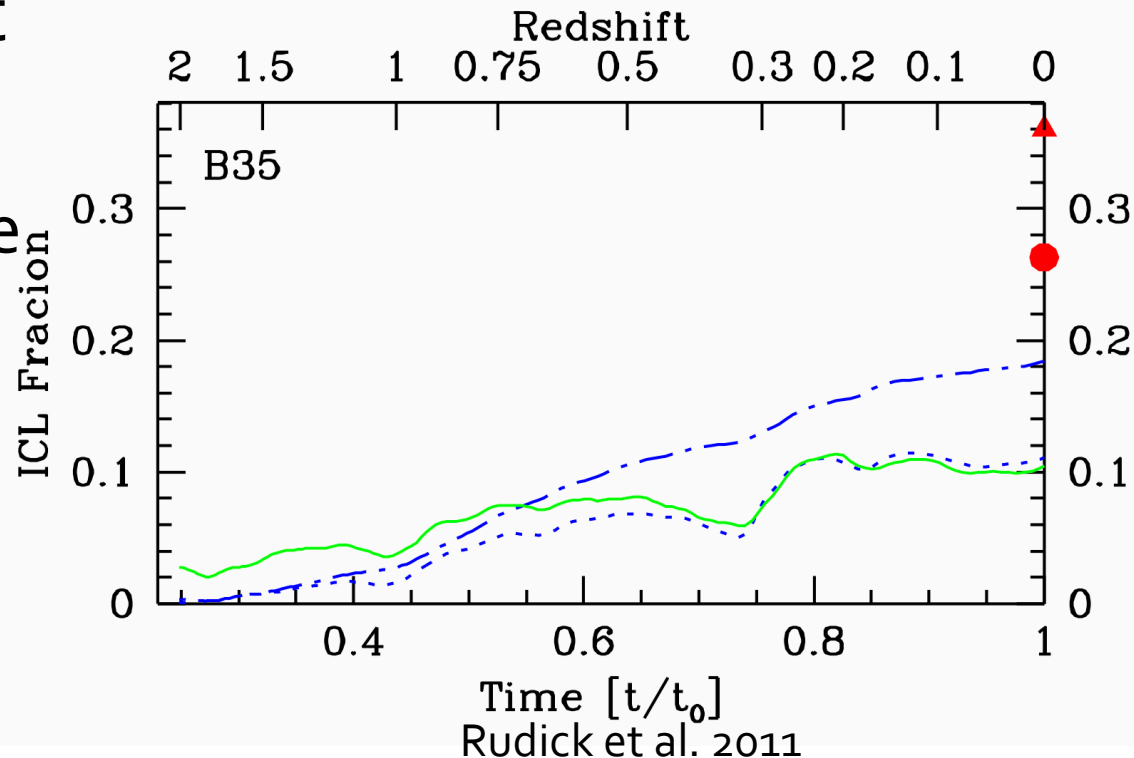
Rudick et al. 2009

100 kpc

Rudick et al. 2006

Dolag et al. 2010
Rudick et al. 2011

All
DSC (unbind)
cD (unbind)
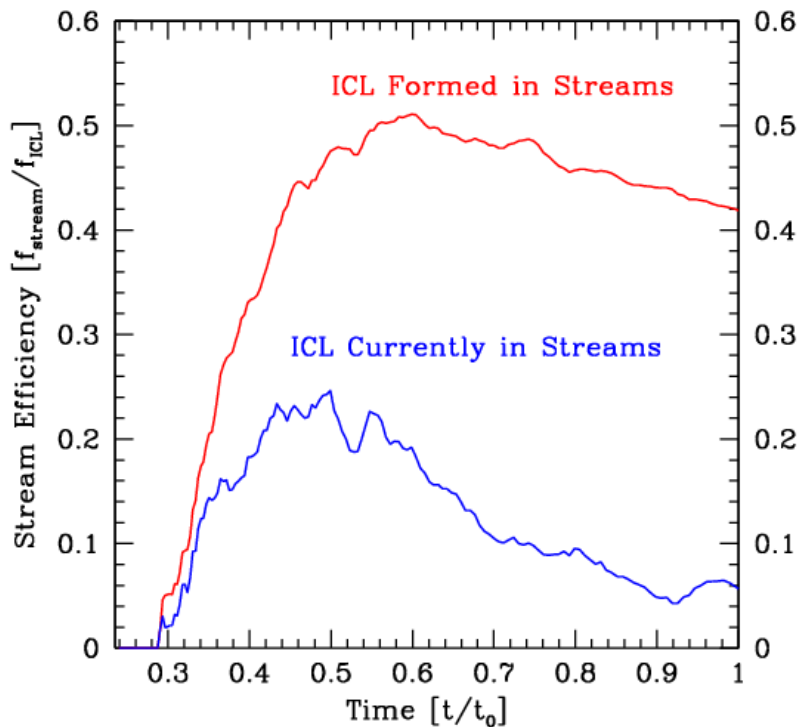
N

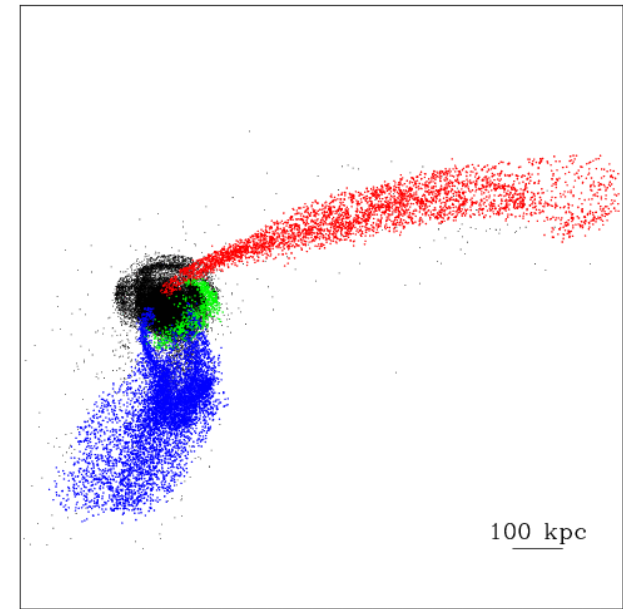v [km/s]

How Much ICL?

- ## Different definitions give VERY different answers!

  - ### 10-36% for the same cluster

  - ### Even more scatter when you consider free parameters of each method

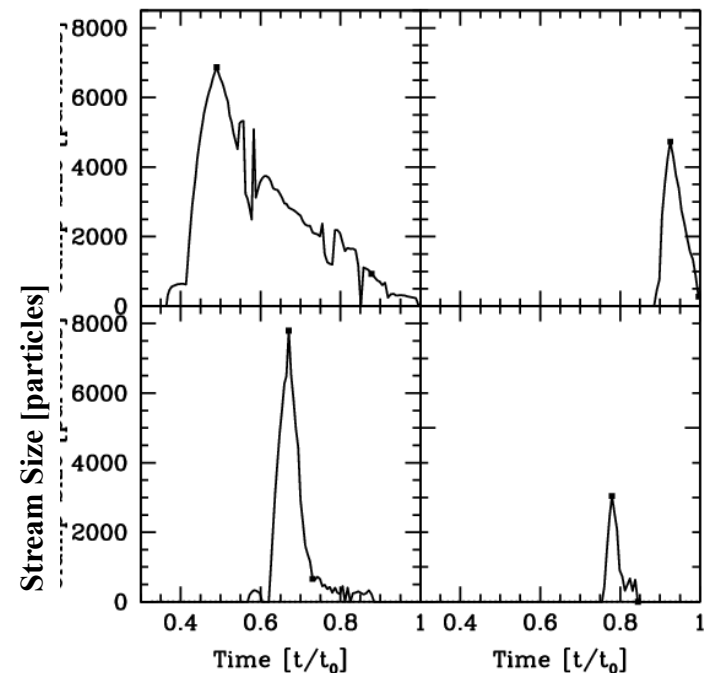 - ### Methods vary systematically

Rudick et al. 2011

ICL Streams

100 kpc

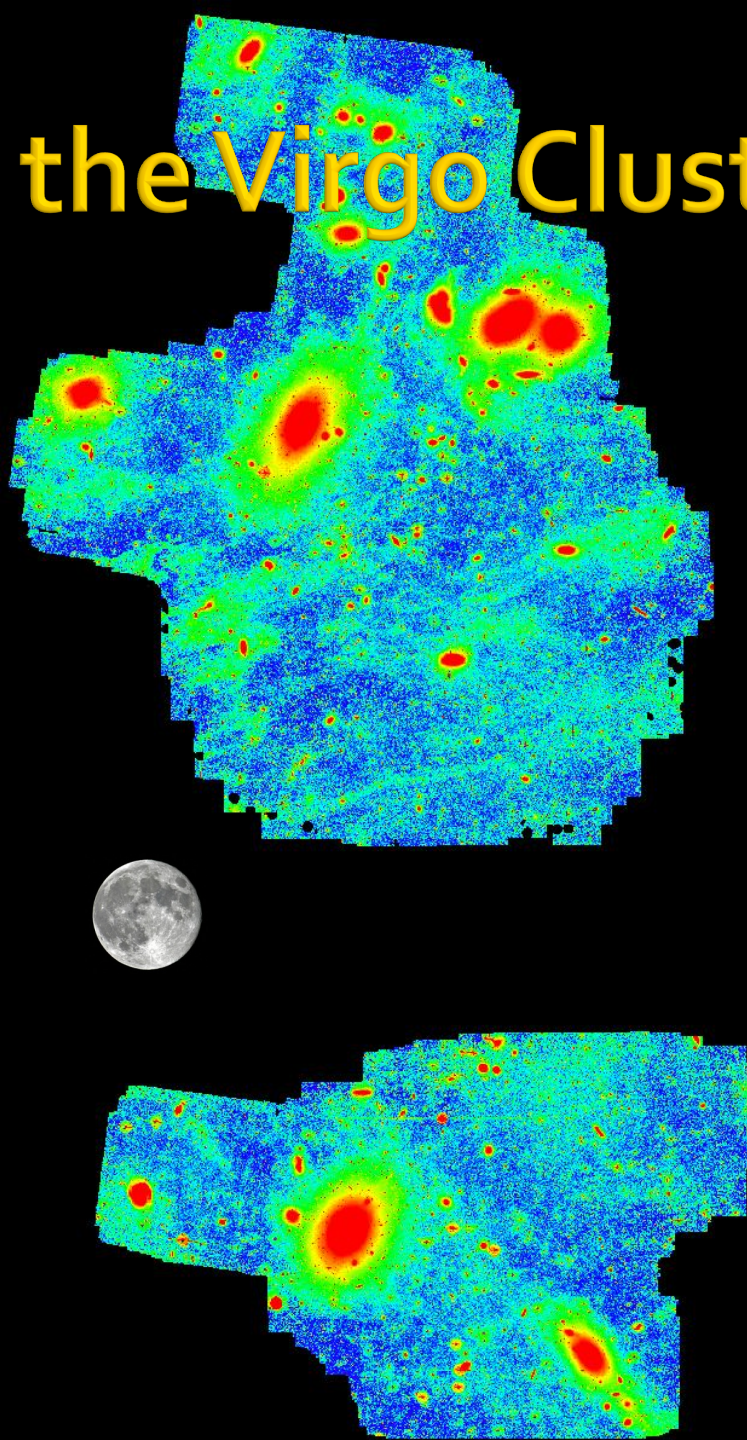- Much of the ICL forms in cold tidal streams
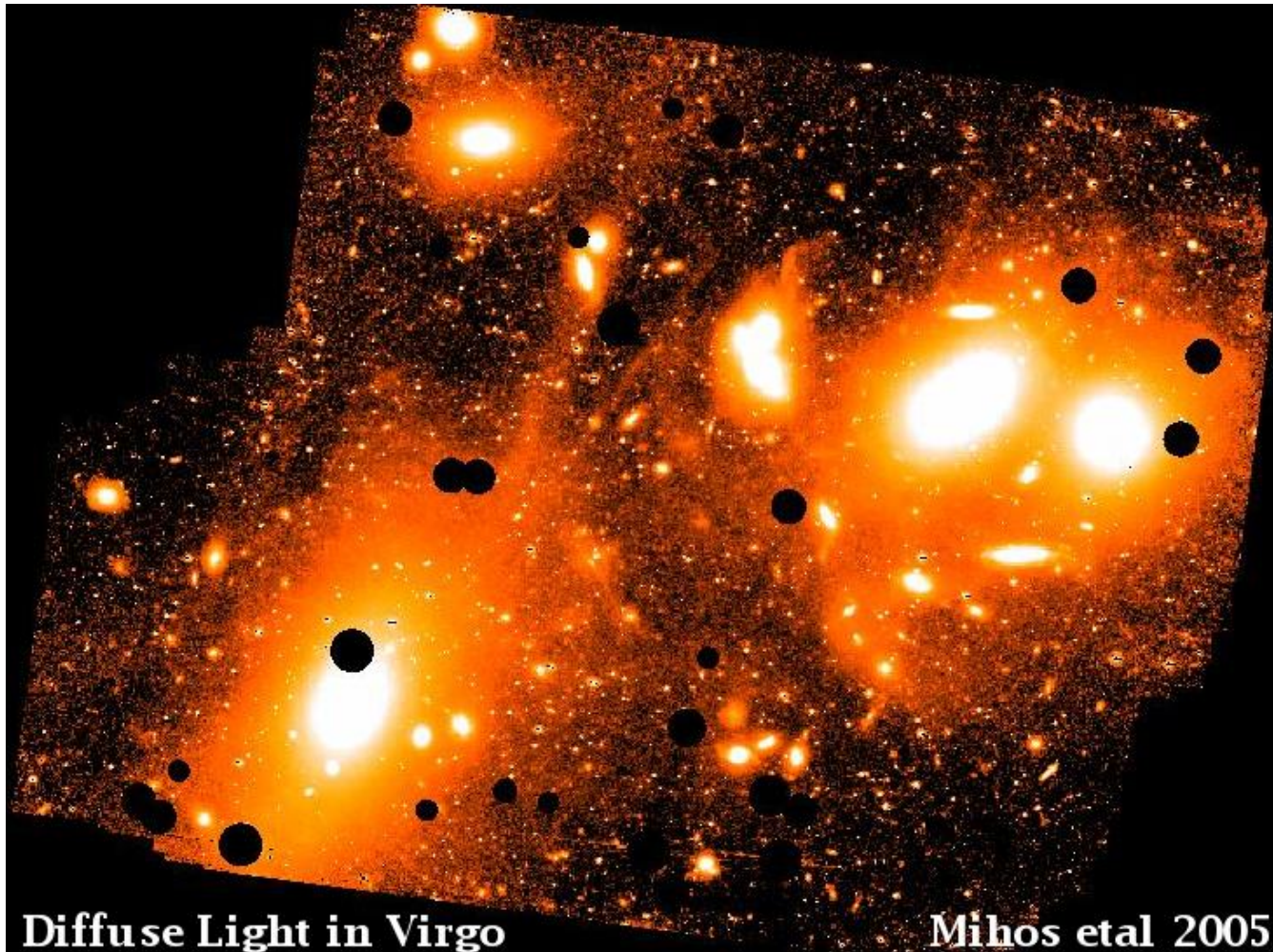- Streams decay to form diffuse background

Rudick et al. 2009

Deep in the Virgo Cluster

- $\mu_V \sim 29$ mag. sq. arcsec
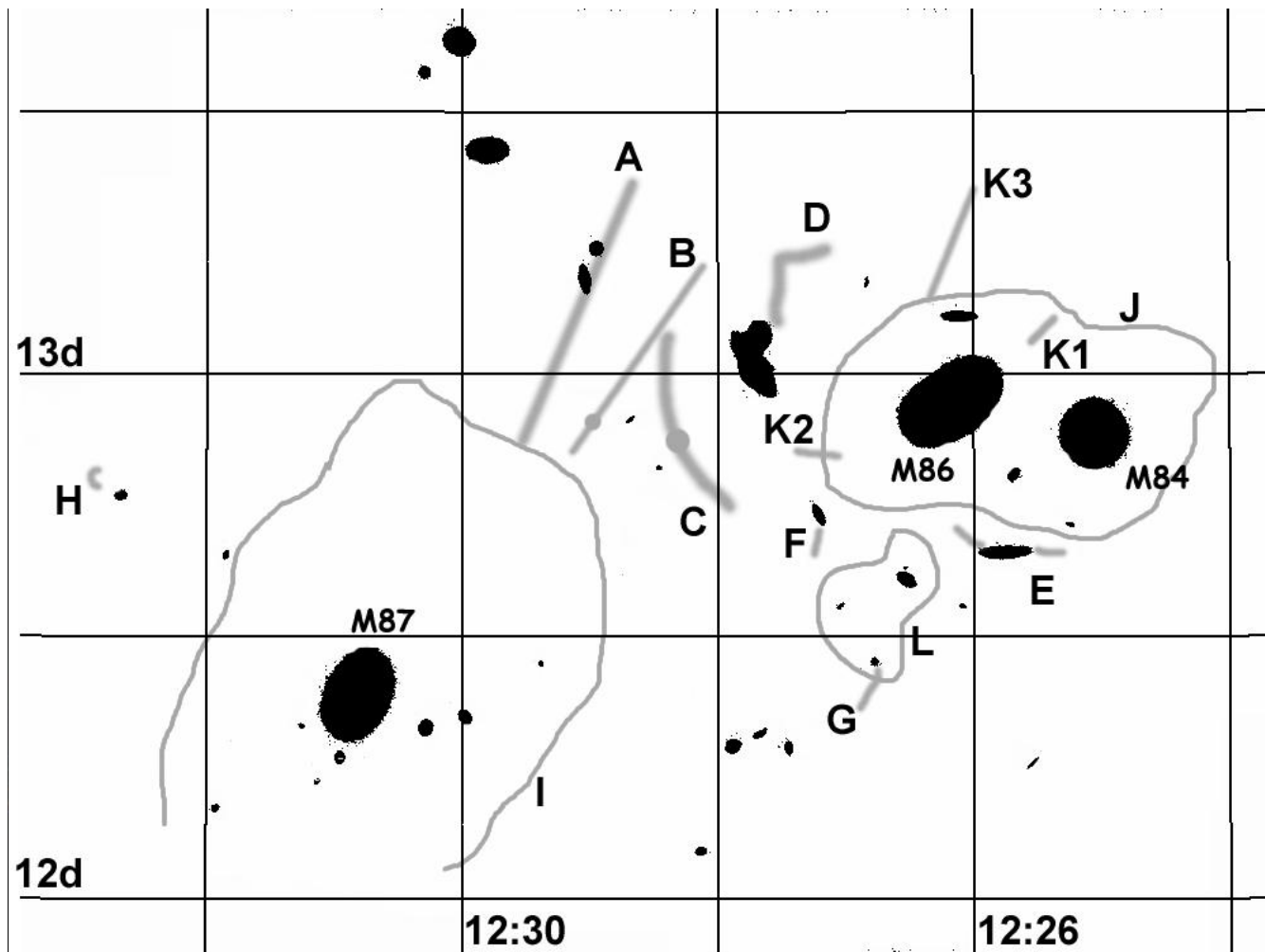
- Fossil Record

Deep in the Virgo Cluster

Diffuse Light in Virgo   Mihos etal 2005

- μ_V~29 mag. sq. arcsec
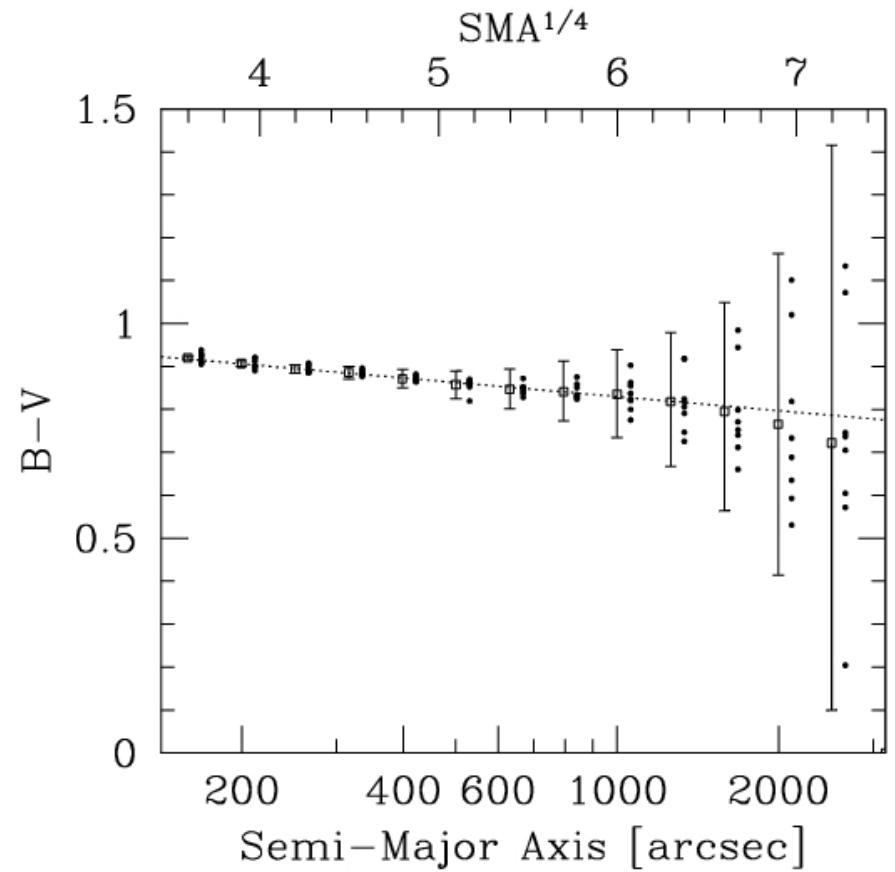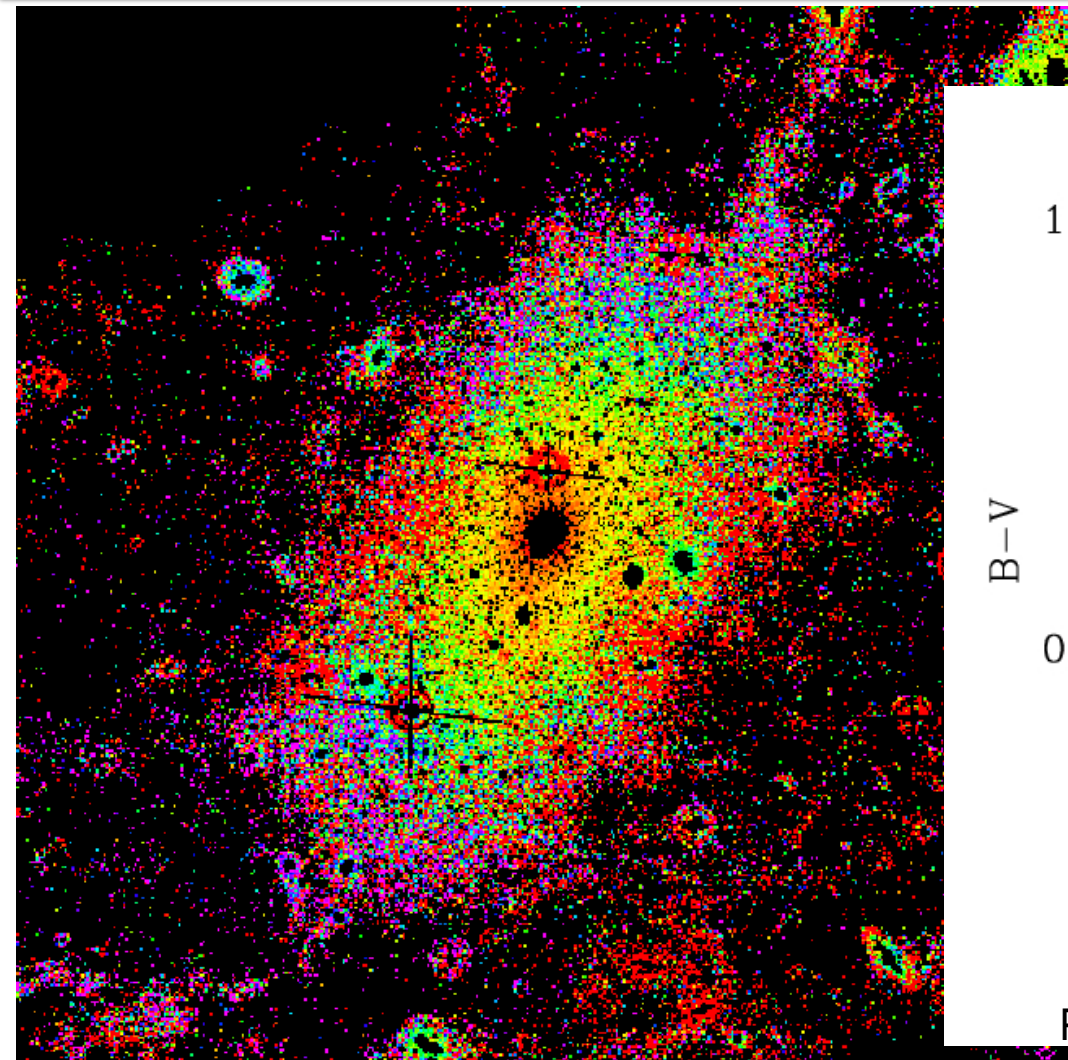
- Fossil Record

Deep in the Virgo Cluster

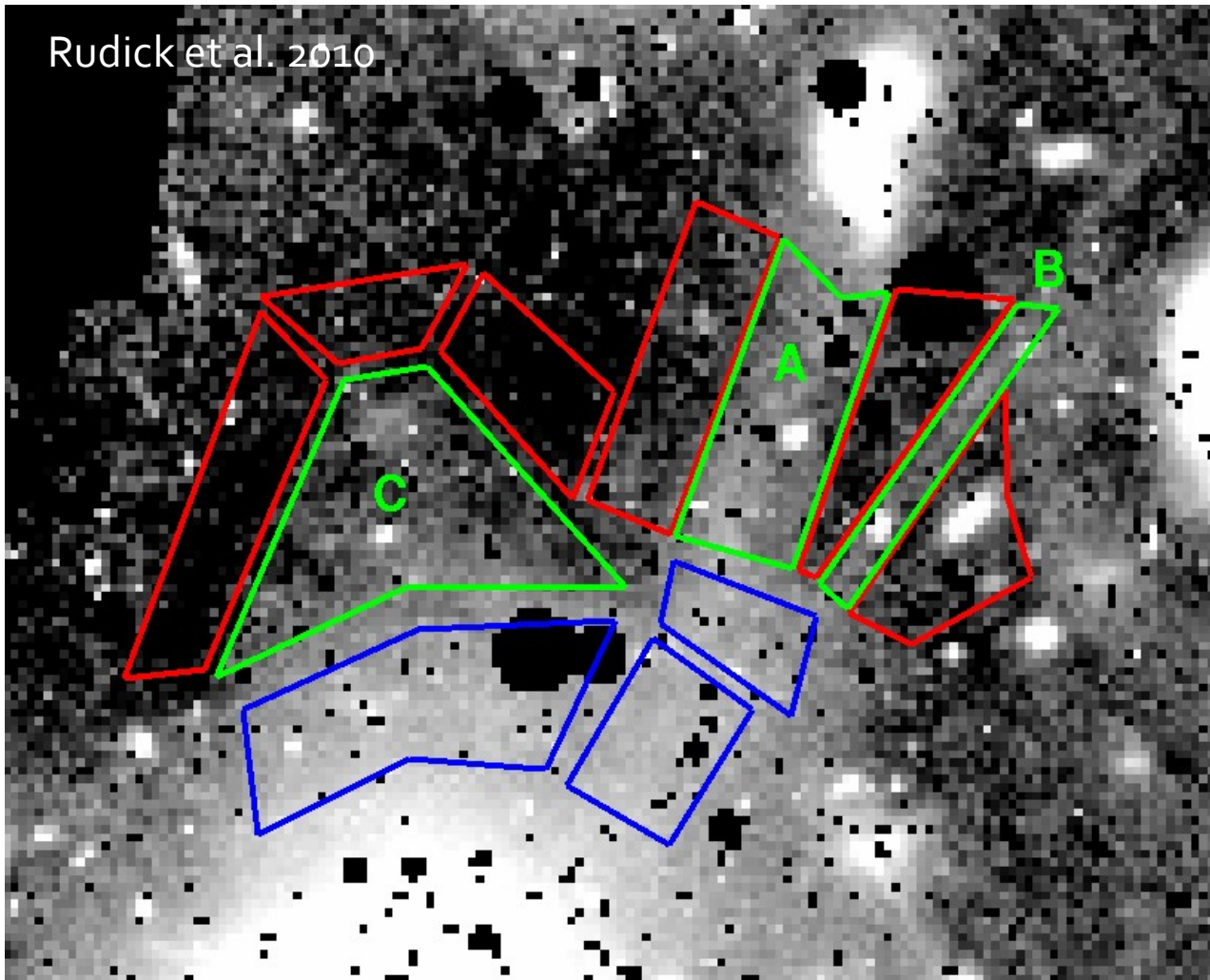- $\mu_V \sim 29$ mag. sq. arcsec

- Fossil Record

M87 Color Profile

Rudick et al. 2010

ICL Colors
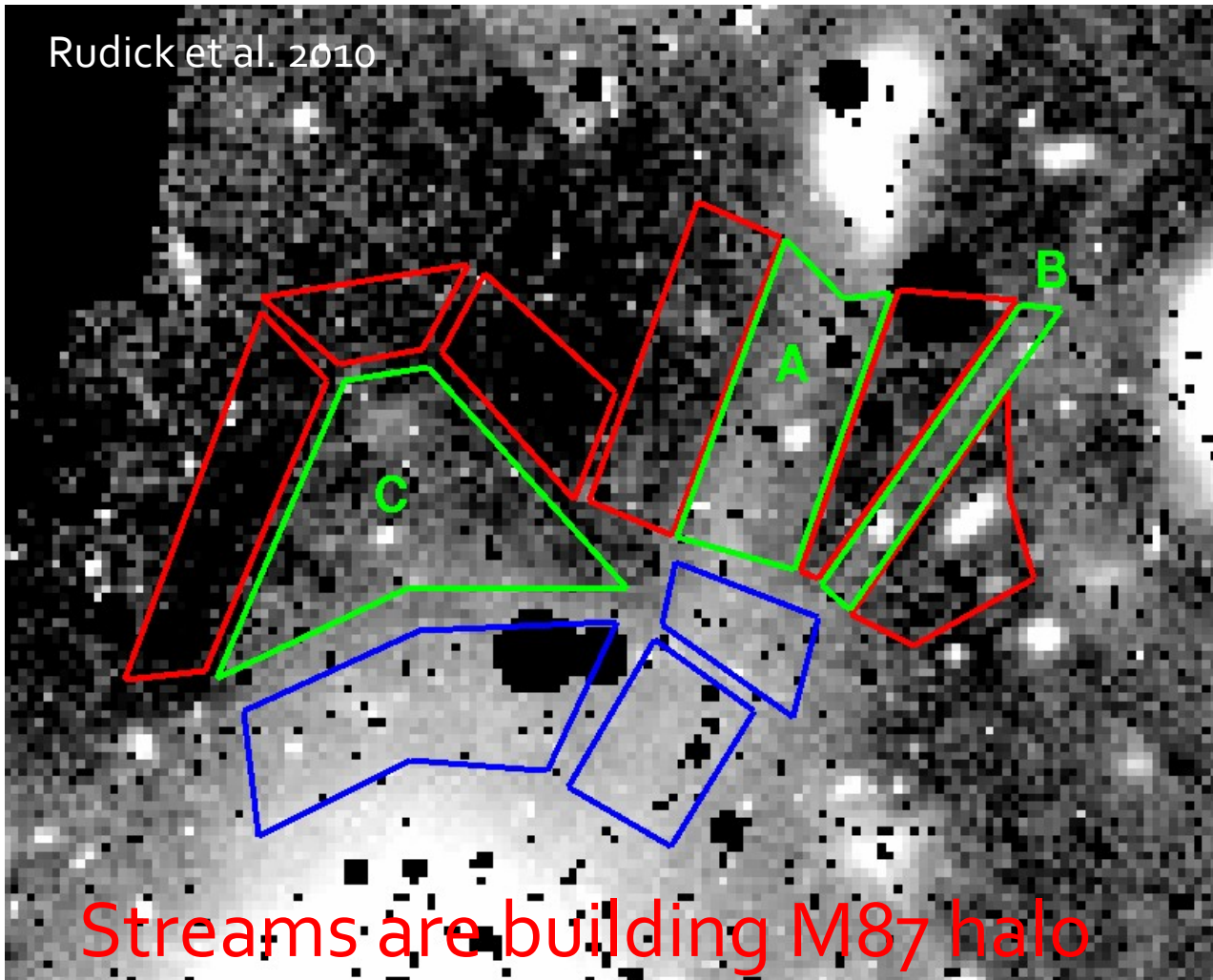

Rudick et al. 2010

- Northern edge of M87
- Identify streams
- Differential photometry
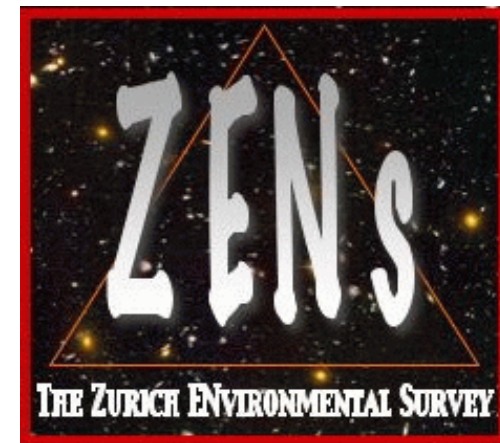- Compare to M87 envelope

ICL Colors

Rudick et al. 2010

Streams are building M87 halo

- A
  - B-V~0.75-1.05
  - μ_V~28.6
- B
  - B-V~0.8-1.2
  - μ_V~29.2
- C
  - B-V~0.7-1.0
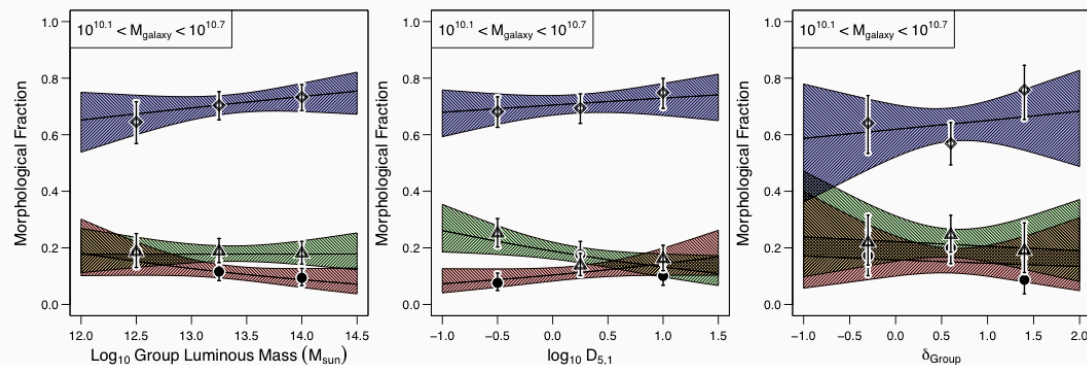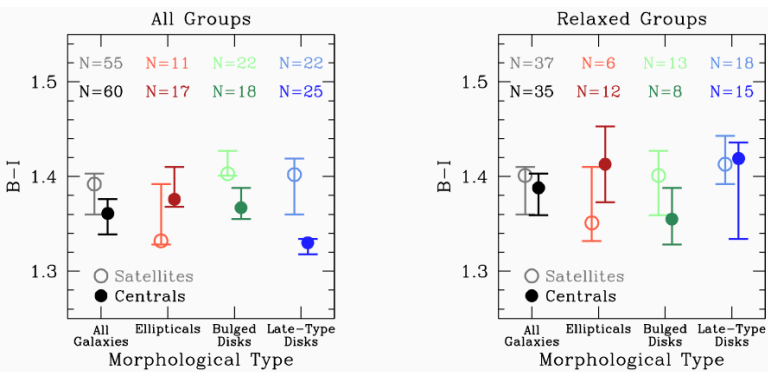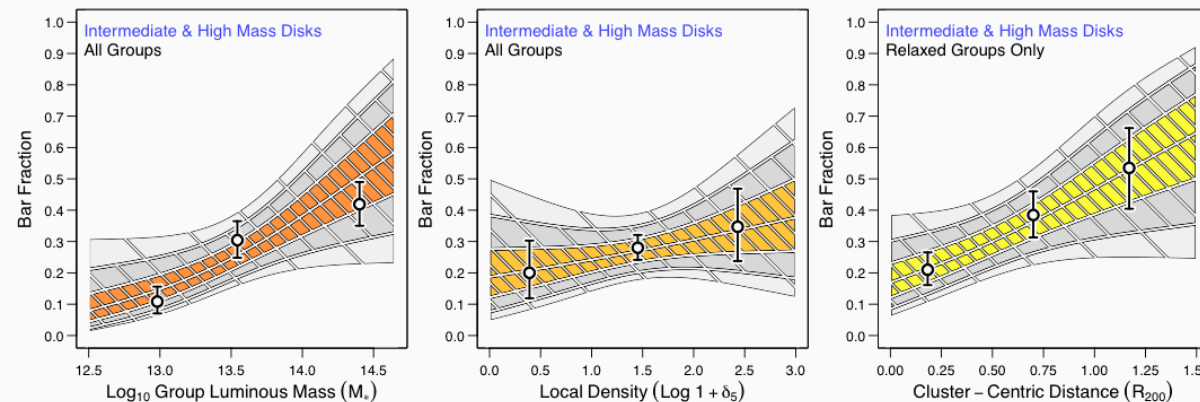 - μ_V~28.7
- M87
  - B-V~0.75-0.85
  - μ_V~27.5

Galaxy Group Environments

ETH ZURICH
Marcella Carollo, Anna Cibinel, Ewan Cameron,
Ting Lu, Antonio Pippino

Coming Soon!

Summary

① ICL quantity is **_very_** dependent on measurement technique.

② We are witnessing M87's halo being built via tidal disruption.