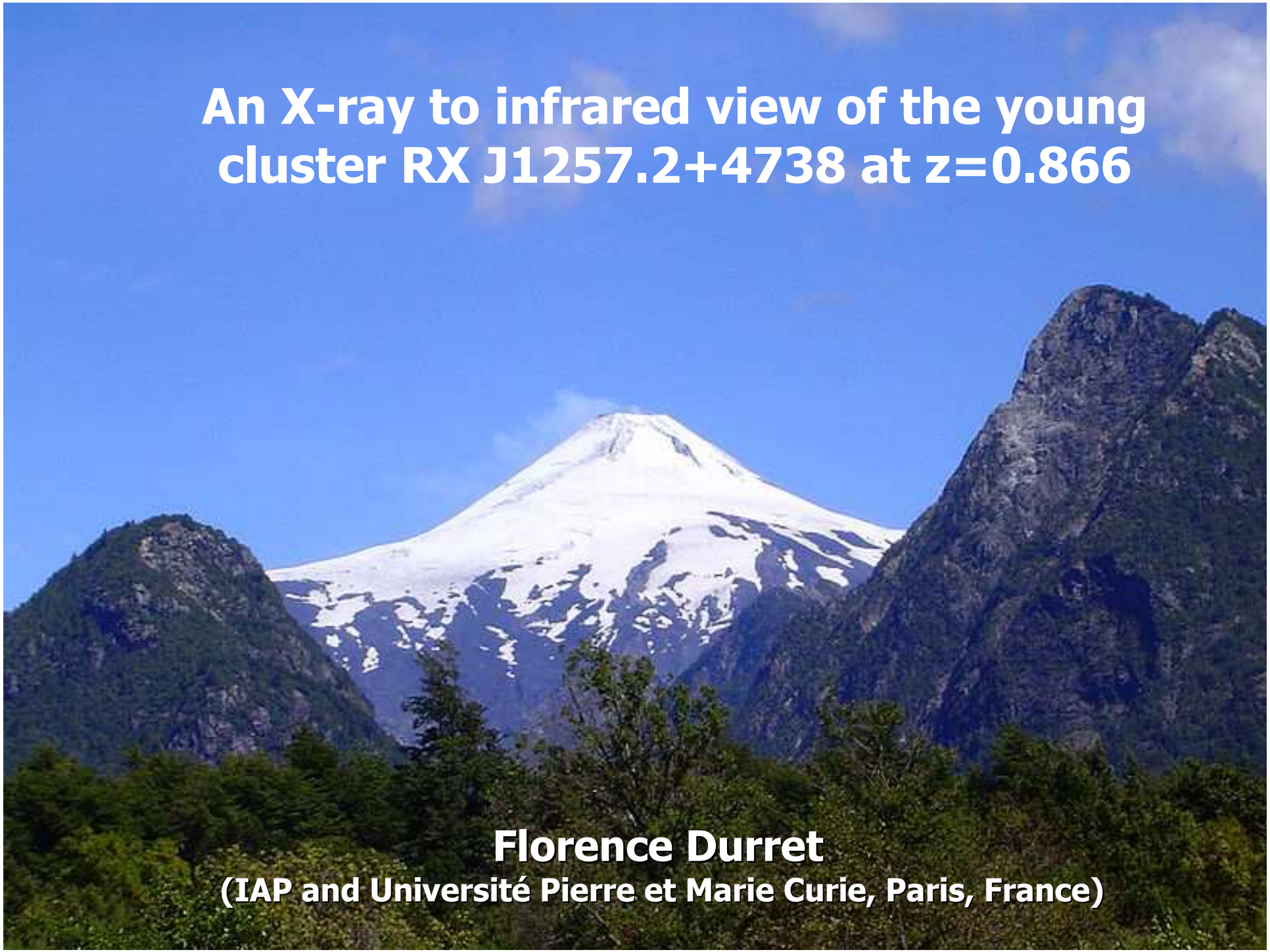

An X-ray to infrared view of the young cluster RX J1257.2+4738 at z=0.866

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- P.I. Melville Ulmer

- Reference :

  M. Ulmer, C. Adami, G.B. Lima Neto, F. Durret, G. Covone, O. Ilbert, E.S. Cypriano, S.S. Allam, R.G. Kron, W.A. Mahoney, R. Gavazzi

  A&A 503, 399 (2009)

The discovery of RX J 1257.2+4738

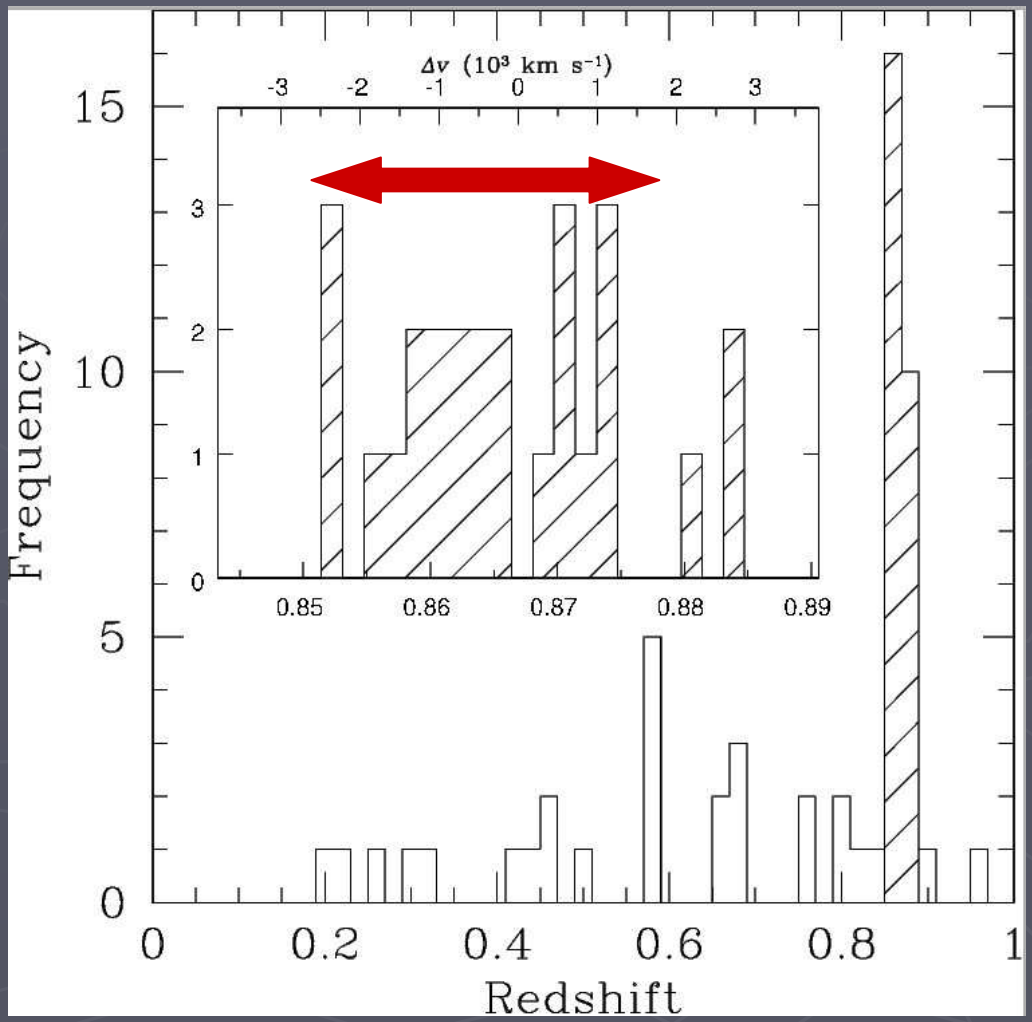
- Optical follow up of the SHARC survey at various wavelengths
  (also see Adami et al. 2007, A&A 472, 373)

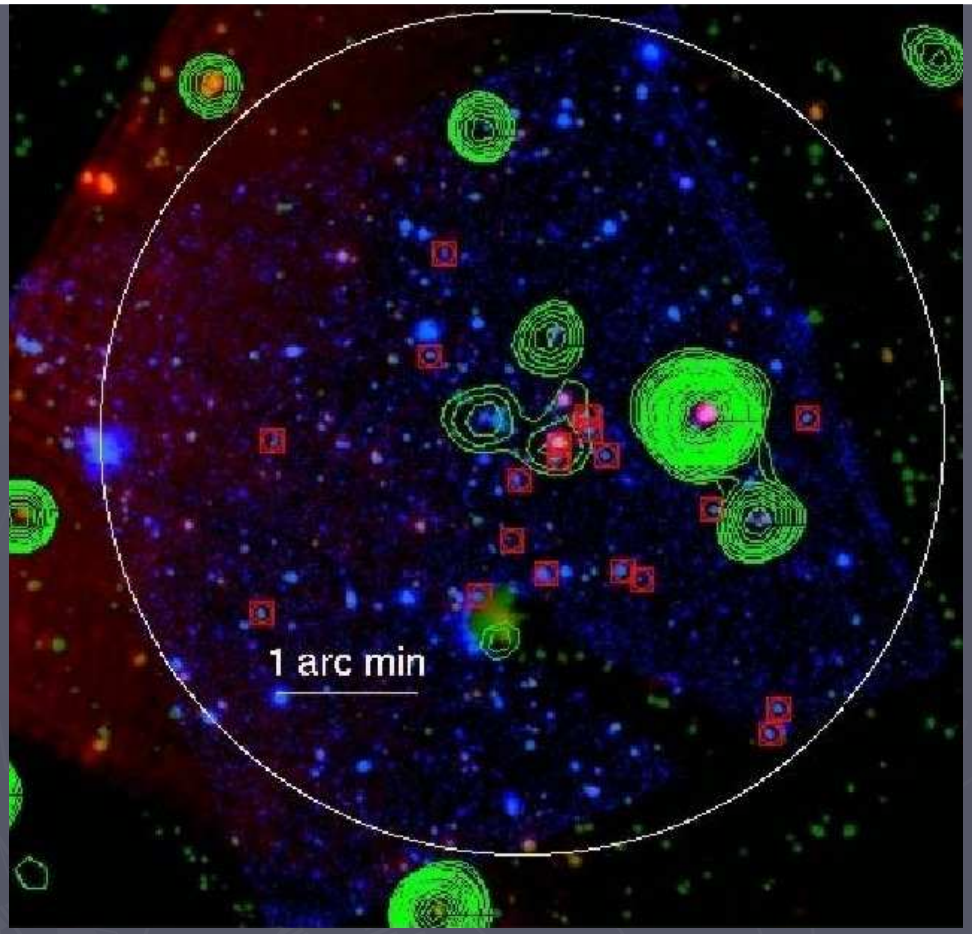
- The cluster RX J1257.2+4738 was found by comparing a ROSAT image with i' and K_s ground based images, taken in particular to determine if the red galaxies were young and dusty or old early type galaxies

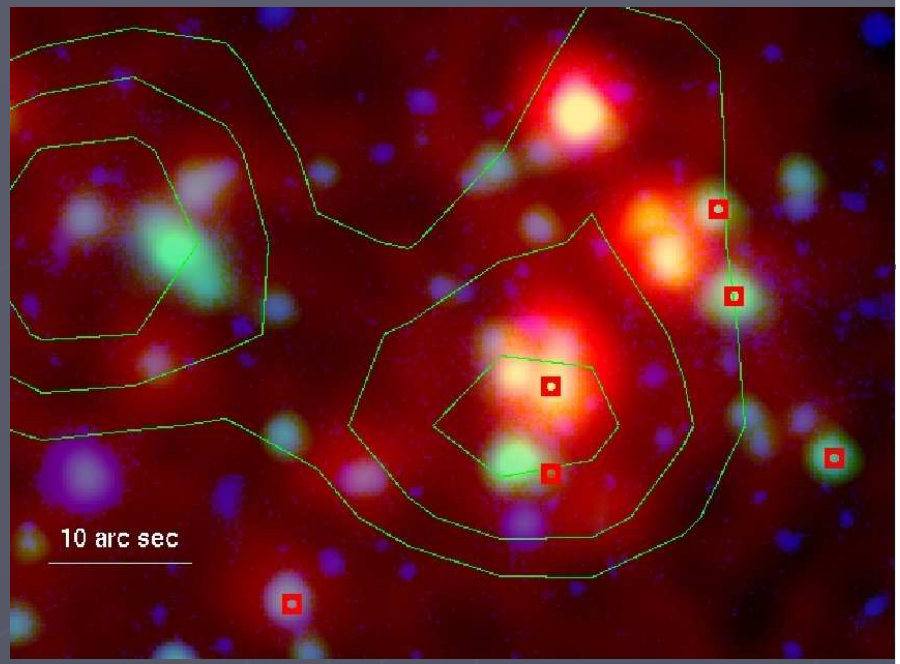
- New observations :
- Chandra, XMM-Newton (flares!)
- Spitzer IRAC and MIPS 24 μm
- Imaging: Gemini Gmos i' and z', Subaru MOIRCS J and K_s
- Spectroscopy: Gemini Gmos (45z along the line of sight,~19z in cluster)

Galaxy redshift histogram: there is a cluster!

Cluster:
0.85<z<0.874







Left: MIPS 24μm (coded as R), IRAC-3.6 μm (coded as G) and i'-band (coded as B) image showing the spectroscopically determined members detected by the MIPS (magenta boxes). Circle = 3 arcmin radius or 1.3 R_{virial}

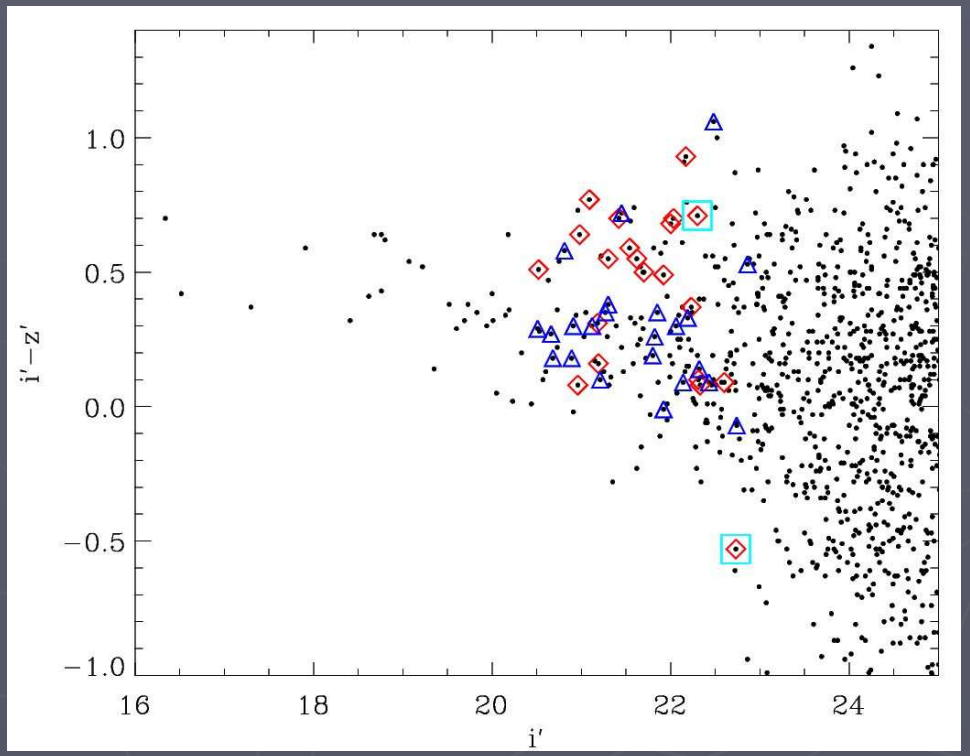
Right: same on zoomed scale with i-band (restframe blue) greatly suppressed to bring out the MIPs flux.

Green contours = [0.3-2] keV in XMM-Newton image.

Results:

- Some of the galaxies detected with MIPS are found even in the cluster core (LIRGs or ULIRGS? see Brodwin's talk)
- The very red population of galaxies marks the cluster location
- Assuming all of these MIPS detected galaxies are young and dusty is consistent with the hypothesis that the galaxies have just fallen into this new born cluster

Color magnitude relation computed from i' and z'



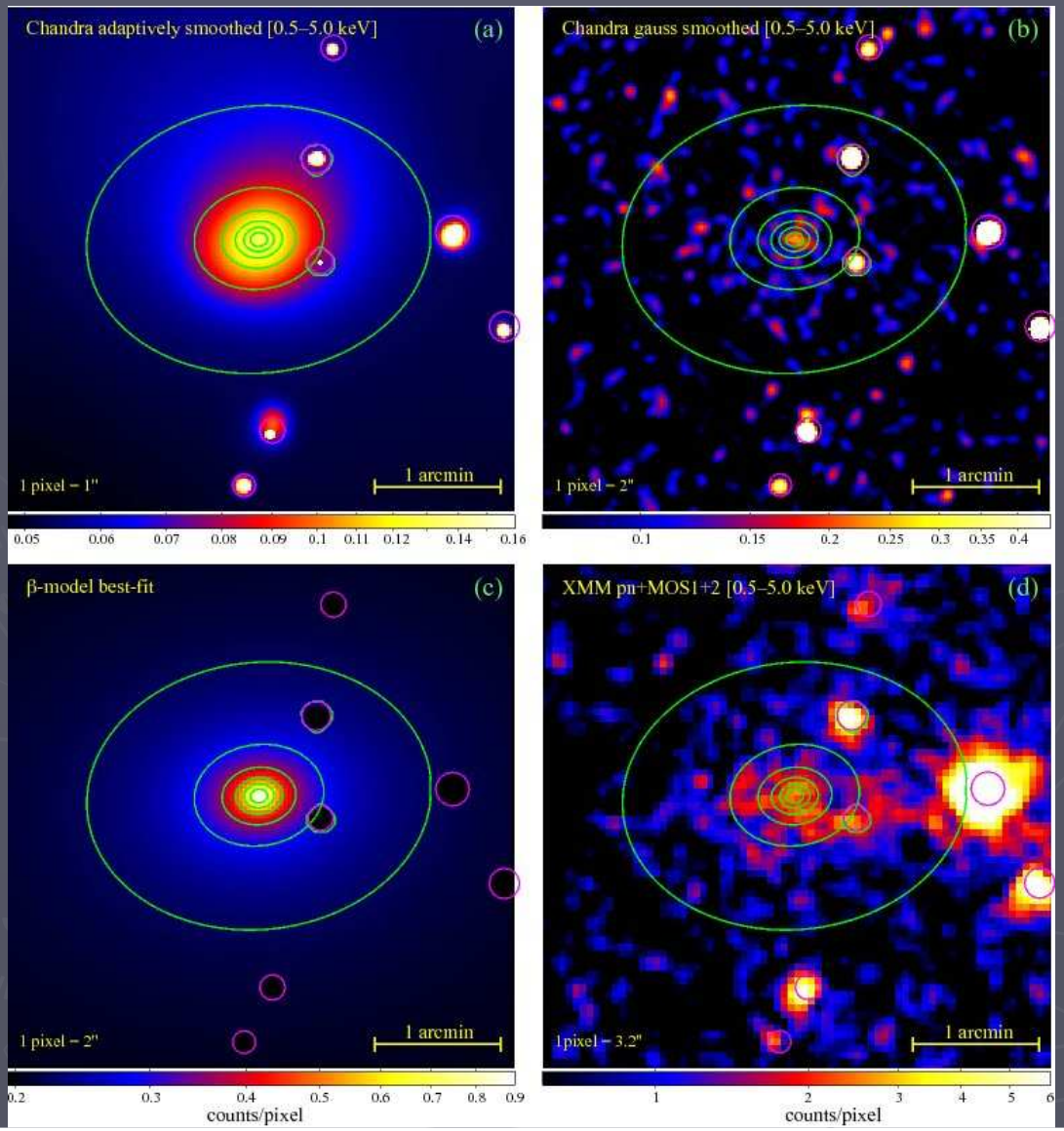
Red diamonds = galaxies with spectroscopically determined redshifts in the cluster ($0.850 \leq z \leq 0.874$)

Blue triangles = galaxies with spectroscopically determined redshifts outside the cluster

Black dots = all galaxies

Cyan squares = the only two galaxies at the cluster redshift not detected in the MIPS 24 μm band

X-ray imaging of Cl 1257 in the [0.5-5.0] keV band



(a) Adaptively smoothed Chandra ACIS-S image with a minimum signal-to-noise ratio of 3 per smooth beam

(b) Chandra ACIS-S image smoothed with a fixed width Gaussian (kernel radius of 10")

(c) Best-fit 2-D β-model;

(d) Composite image with all available XMM-Newton data smoothed with a Gaussian kernel (radius 6.4").

Green ellipses = logarithmically spaced isocontours of the best-fit β-model

Magenta circles = masked regions (point-sources detected with *Chandra)*

Color bars show scaling in counts /pixel.

Implications of X-ray data:

- Difficult to determine true cluster emission profile (many X-ray point sources along the line of sight and few photons)
- The Serna-Gerbal method applied to galaxies with redshifts in the cluster gives a velocity dispersion of 600 km s^{-1}, a mass of 6 10^{14} M_{sun} and shows the existence of two subgroups
- The cluster may be bimodal, from X-ray and optical distributions

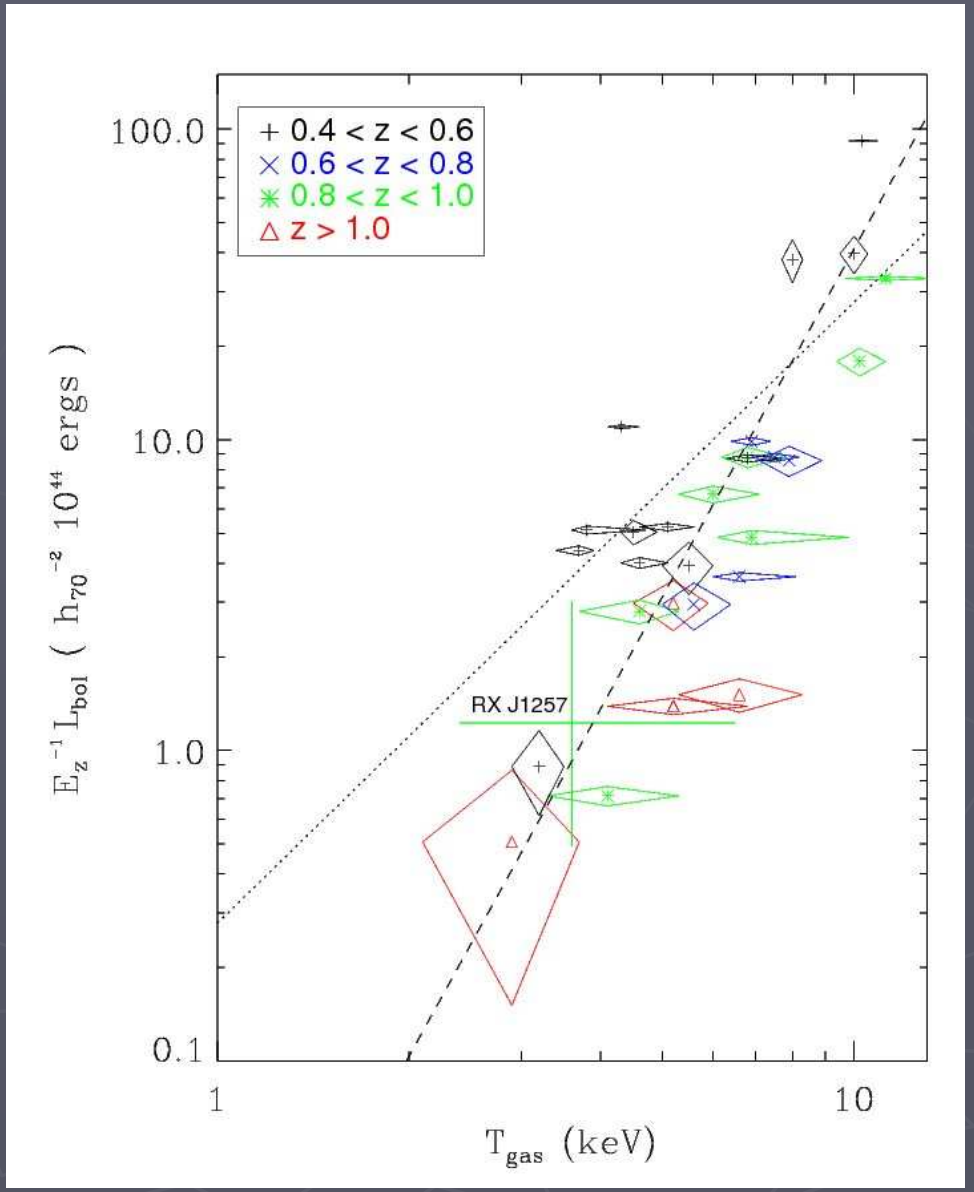
L_X versus kT based on Ettori et al. (2004) A&A, 417,13

Dotted line: fixed at the predicted slope of 2

Dashed line: best fit (slope free)

kT=3.6 keV

$L_X = 2\ 10^{44}$ erg s^{-1}



Implications:

- Cl1237+4738 is comparable to other high z ($z \geq 0.6$) clusters:
  - too low L_X for its temperature (also see Castellano's talk: distant massive clusters tend to be underluminous in X-rays)
  - or too high kT for its X-ray luminosity
- These high z clusters may be in the process of infall and not yet peaking in L_X
- Perhaps much of their initial heating has come from some other source besides infall

Conclusions

We have found an X-ray emitting cluster of galaxies at z=0.866 that is still in the process of formation, based on:

- Bimodal distribution of X-ray emission and of galaxy population
- Most spectroscopically confirmed members are detected by MIPS at 24 μm
- The Serna-Gerbal method shows the existence of substructures
- kT is too high, or L_X is too low

- kT too high suggests significant energy input prior to infall, such as Population III SN (rather than galactic outflow which would have made the 24 μm emission of late type galaxies faint)
- L_X too low is expected for not fully merged clusters (Ventimiglia et al. 2008)

- The cluster has a high fraction of red dusty galaxies

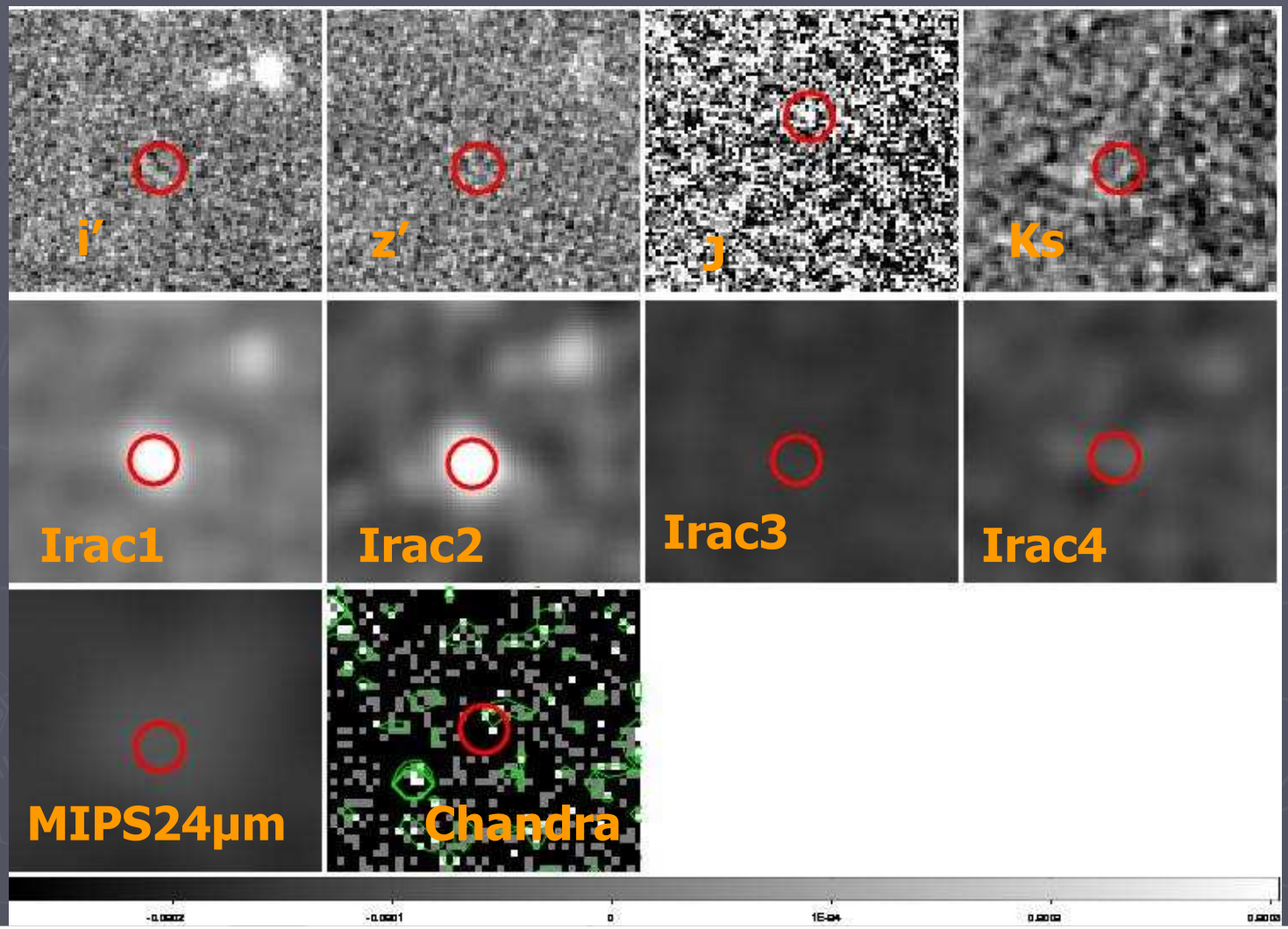
- Comparable to Ricardo Demarco's cluster at z=0.837

A by-product : searching for very high z objects

- Thanks to gravitational lensing magnification, Spitzer IRAC and Gemini i-band data allowed us to identify 34 objects that could be at $z \geq 7$
- Some candidates are also detected in X-rays (AGN)
- If $z > 7$ AGN have the same spectra that produce the X-ray background (i.e., a spectral break at about 40 keV), then the objects with the softer X-ray spectra are likely to be at higher redshift than the harder sources
- We need redshifts! Subaru proposal submitted for all candidates

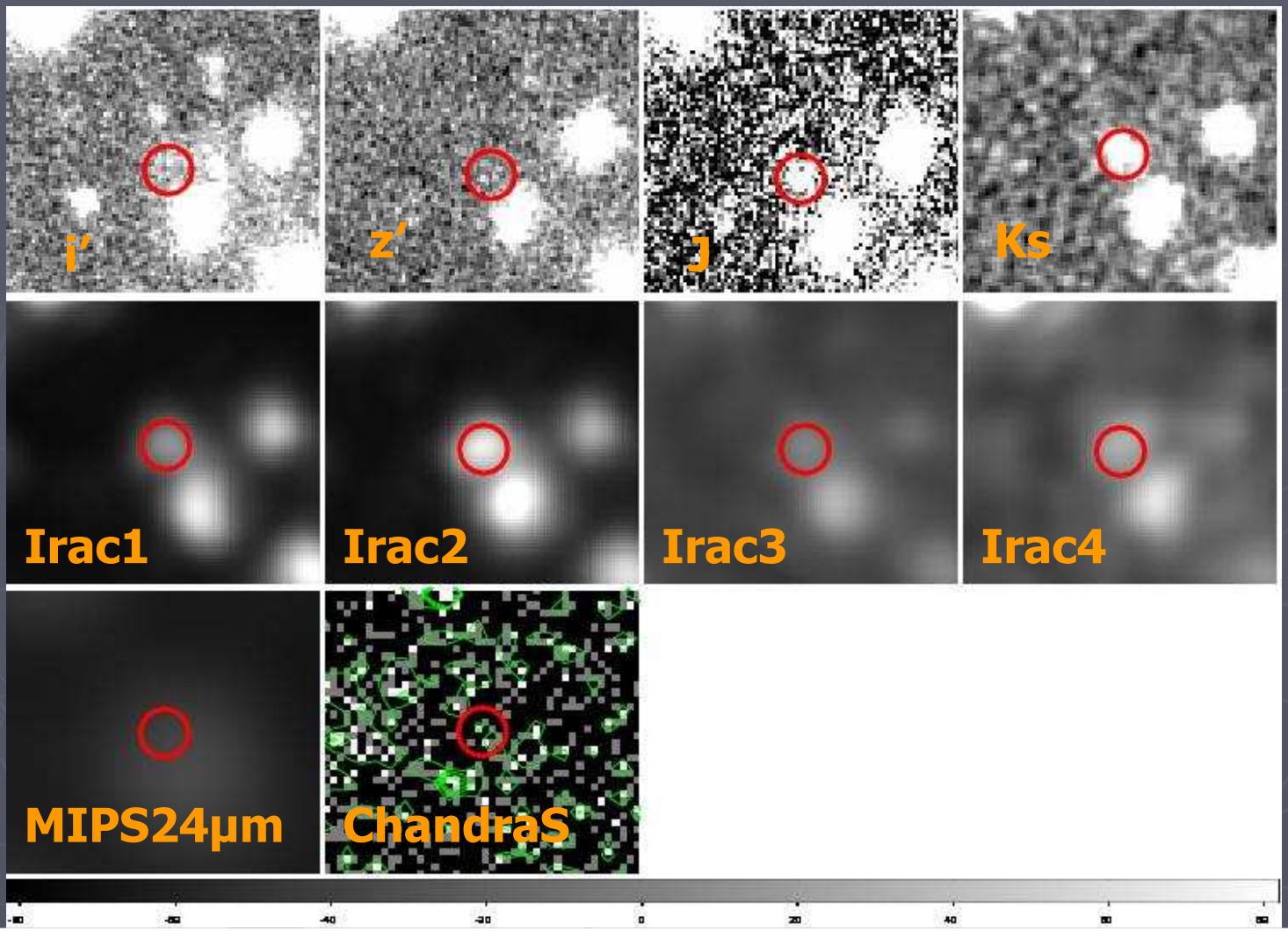
z>7 galaxy candidate at J~24.1

Images are 30x30"



z>7 galaxy candidate at J~22.8

Images are 30x30"



Many, many more distant cluster candidates (up to z=1.25)

- Looking for clusters of galaxies in the Canada France Hawaii Telescope Legacy Survey (ugriz bands)
  (see Rémi Cabanac's talk for details)

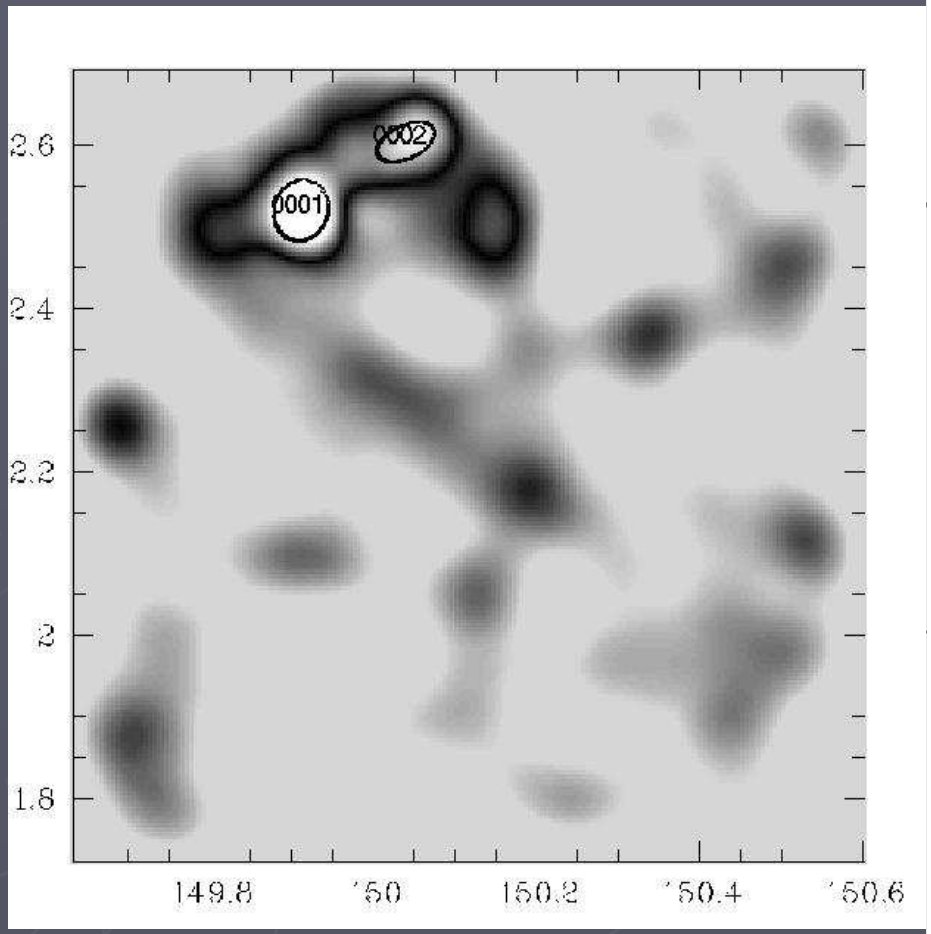
- Method:
- estimate photometric redshifts for all galaxies
- build galaxy density maps in photo-z bins of 0.1
- detect structures in these maps with SExtractor at a chosen significance level (typically 2σ to 6σ)

- Validate method by applying same procedure to the millenium simulation (modified to be comparable to our data)

- Results: 1200 cluster candidates

- Cluster candidates at z>= 1
- 141 at 3σ
- 79 at 4σ
- 46 at 5σ
- 31 at 6σ

Spectroscopic followup planned, collaborators welcome!



Reference : Adami, Durret, Benoist et al. 2009, A&A in press, arXiv:0910.3827


Thank you, gracias, merci
to all the organizers!