

A new look at old friends

The mass distribution of galaxy clusters
1E0657-56 & RX J1347-1145

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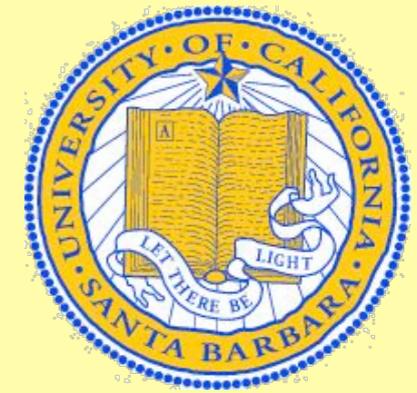


Douglas Clowe, Anthony Gonzales, Maxim Markevitch, Steve Allen, Harald Ebeling, Phil Marshall, Bill Forman, Christine Jones, Peter Schneider, Thomas Erben, Marco Lombardi, Tim Schrabback, Dennis Zaritsky, Tommaso Treu, Roger Blandford





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Weak vs. Strong Lensing



Weak vs. Strong Lensing

Romans

vs.

Gauls



Strong and Weak Lensing United

- * We combine strong and weak lensing constraints in a "non-parametric" fashion (parametrisation as general as possible).
- * Need to properly include weak lensing constraints in the vicinity where multiple images form (and the lens is not weak any longer).
- * Include redshift information for strong (and weak) lensing sources.

Bradač et al 2005



Strong and Weak Lensing United

- * Following the idea of Bartelmann et al (1996) we parametrise the lens by considering the values of the potential ψ_k on a regular grid.
- * The penalty function includes weak lensing (extended to the cluster centre), strong lensing and regularisation.

$$\chi^2(\psi_k) = \chi_\epsilon^2(\psi_k) + \chi_M^2(\psi_k) + \eta R(\psi_k)$$

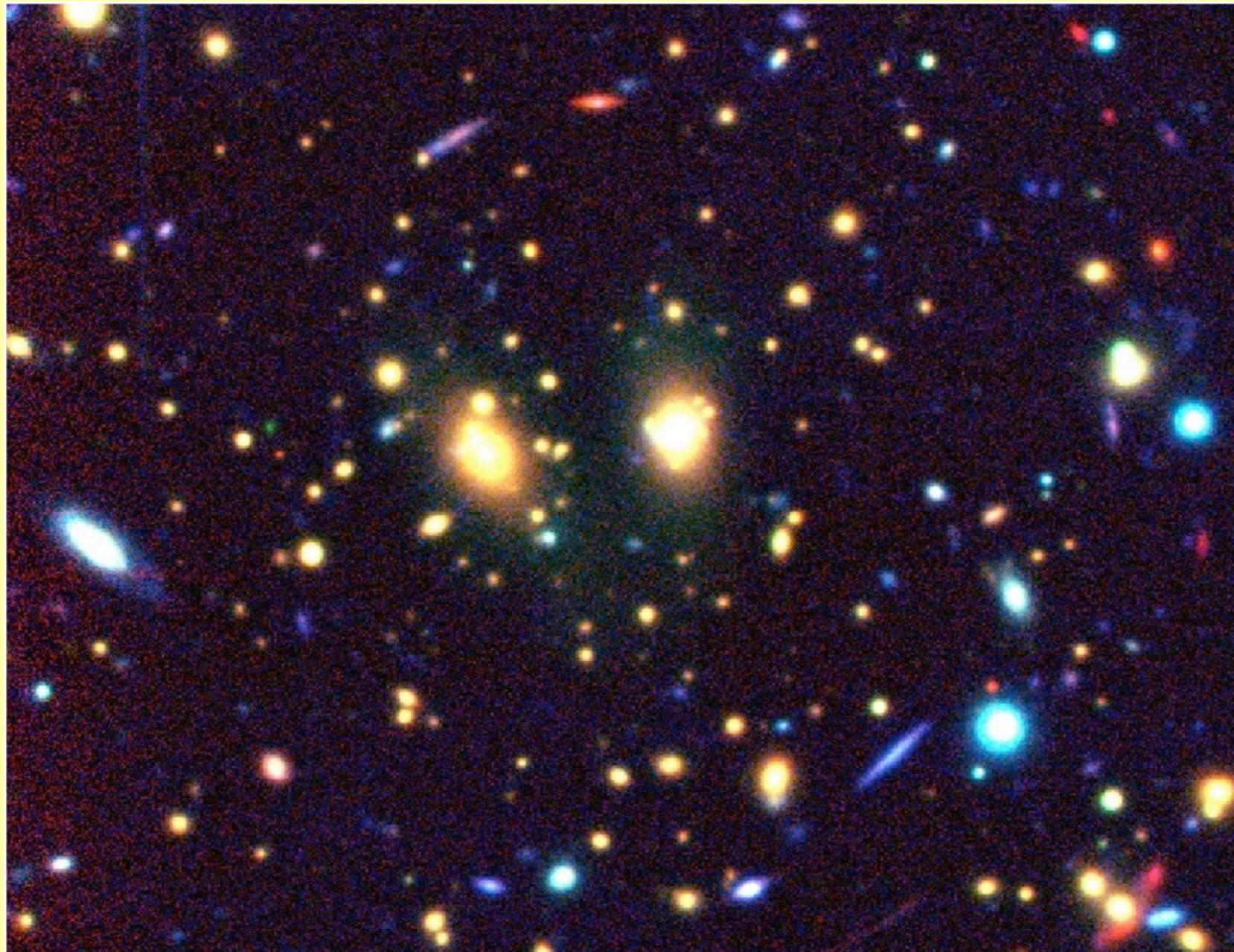
- * Start from some trial solution, linearise and iteratively solve the equation

$$\frac{\partial}{\partial \psi_k} \chi^2(\psi_k) = 0$$



RX J1347-1145

- * One of the most luminous X-ray clusters known
- * Post merger system

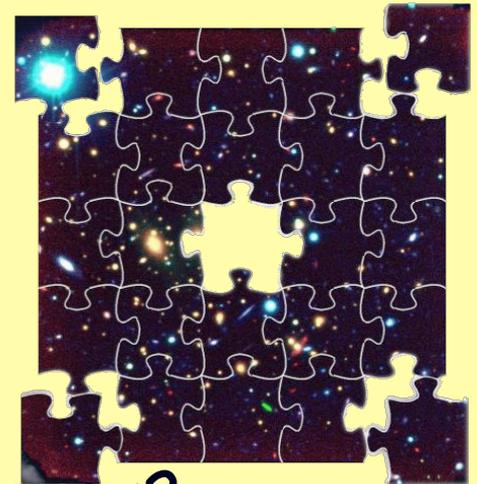


The puzzle of RX J1347-1145

* Factor of 3 difference in mass estimates

$$M_{\text{dyn}} < M_{\text{SL}} < M_{\text{WL}} < M_{\text{Xray}}$$

- > Dynamics - preferentially measuring subcluster only?
- > Strong Lensing - false identification of multiple images
- > Weak Lensing -> mass sheet degeneracy issues?
- > X-ray -> Hydrostatic equilibrium??

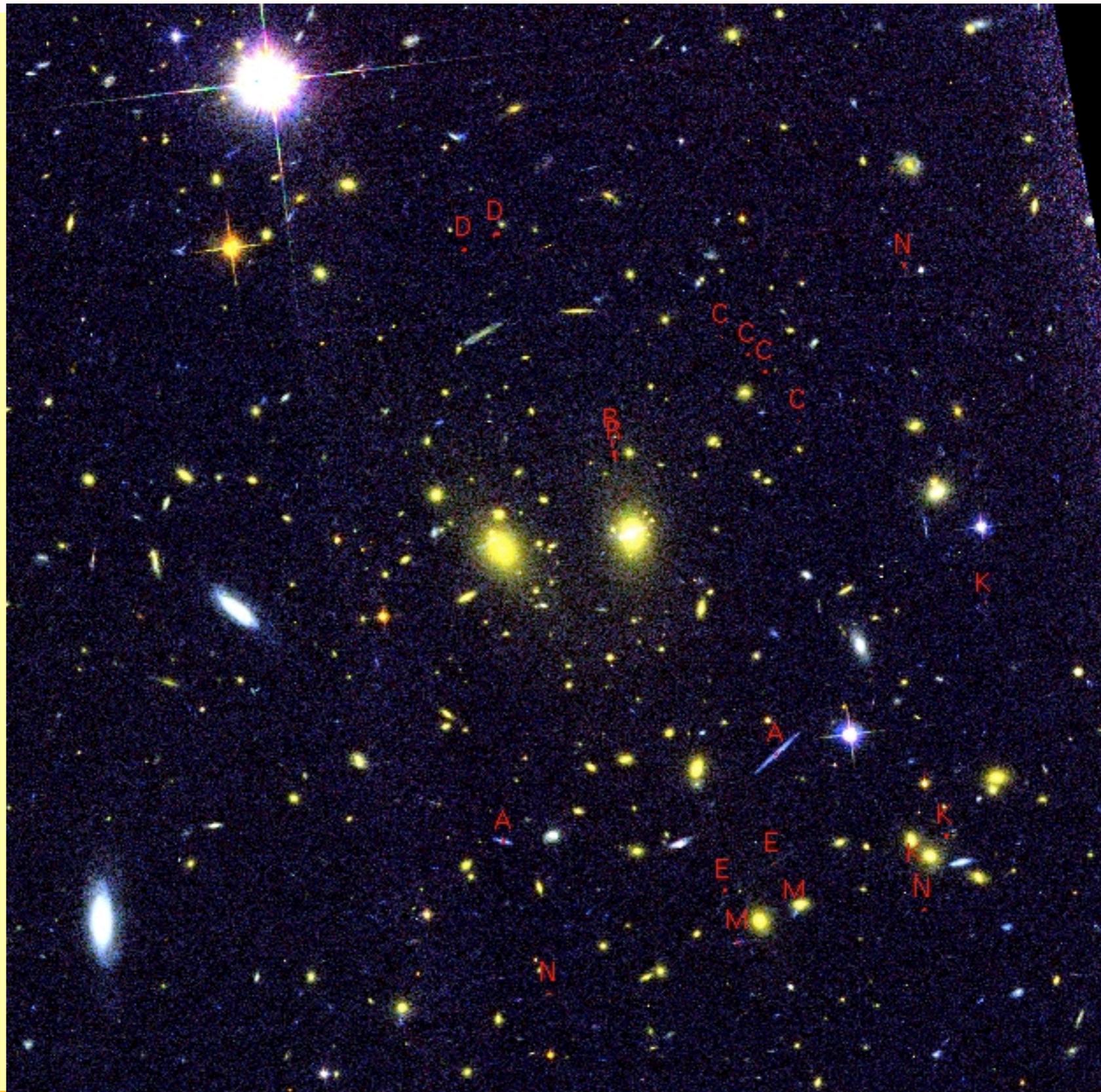


SWUnited @ RX J1347-1145

- * New ACS data -> important for strong lensing
- * Multi colour (UBVR_IJHKs from the ground, ACS F475W F814W F850LP from space)
- * Search for strongly lensed sources not trivial
 - > Stare at images for days (grad student can do it)
 - > Be cunning about it (undergrad student can do it!!)
- * See A. Halkola's poster



SWUnited @ RX J1347-1145



SWUnited @ RX J1347-1145

- * Match image candidates in colour space does not work -> best candidates obviously not lensed.
- * Need to include lensing geometry (work in progress with M. McCourt) -> special thanks to JPK for lending us the LENSTOOL

Simple lens model



Fit image positions (MCMC)



For each chain predict counter images



Search for color matches in the vicinity

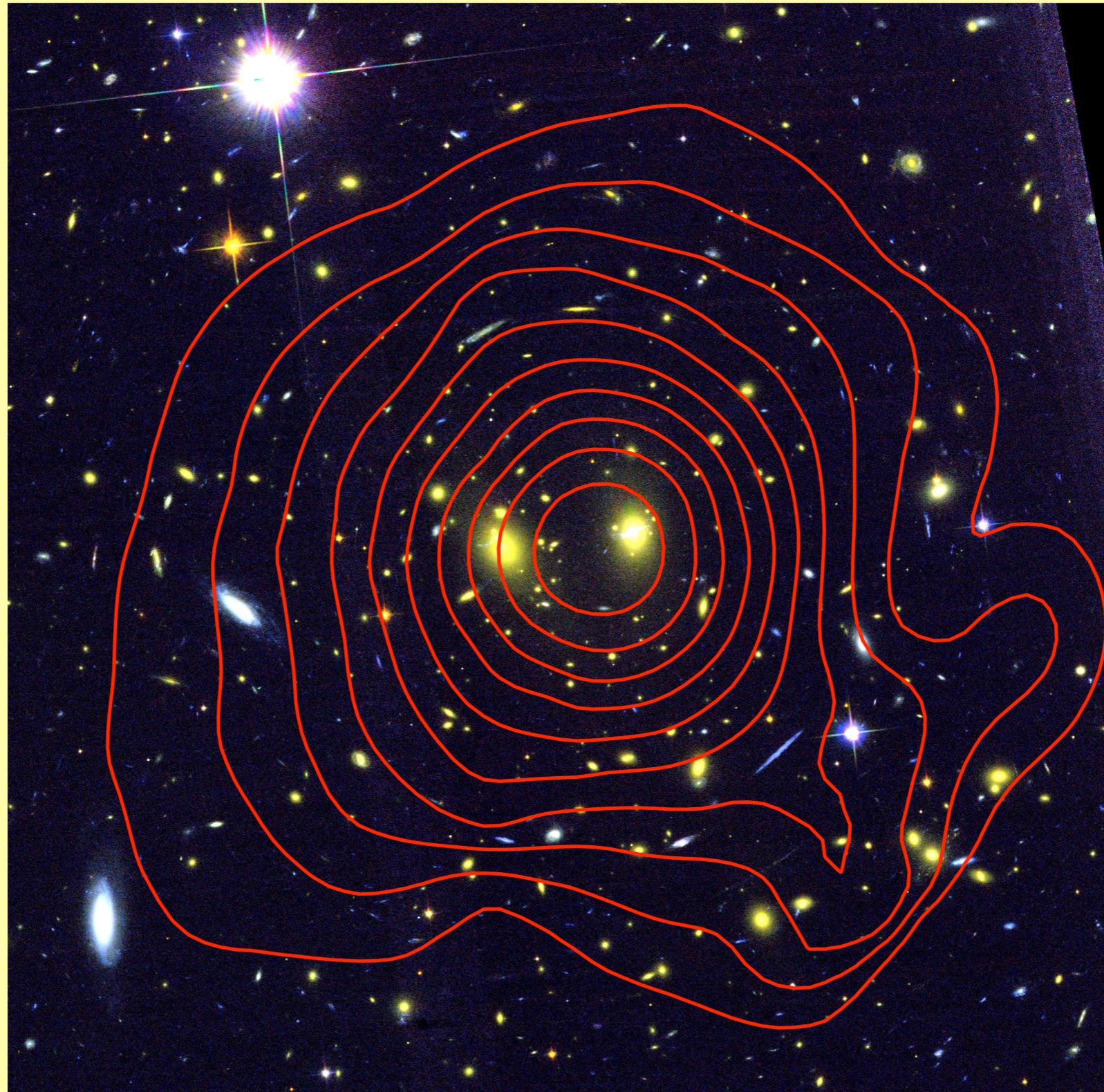


SWUnited @ RX J1347-1145

- * Weak lensing with ACS camera not trivial either
- * PSF spatial and temporal variability
- * Weak lensing analysis a la Schrabback et al. (2006)



SWUnited @ RX J1347-1145



Puzzle Resolved? Lensing vs. Xray

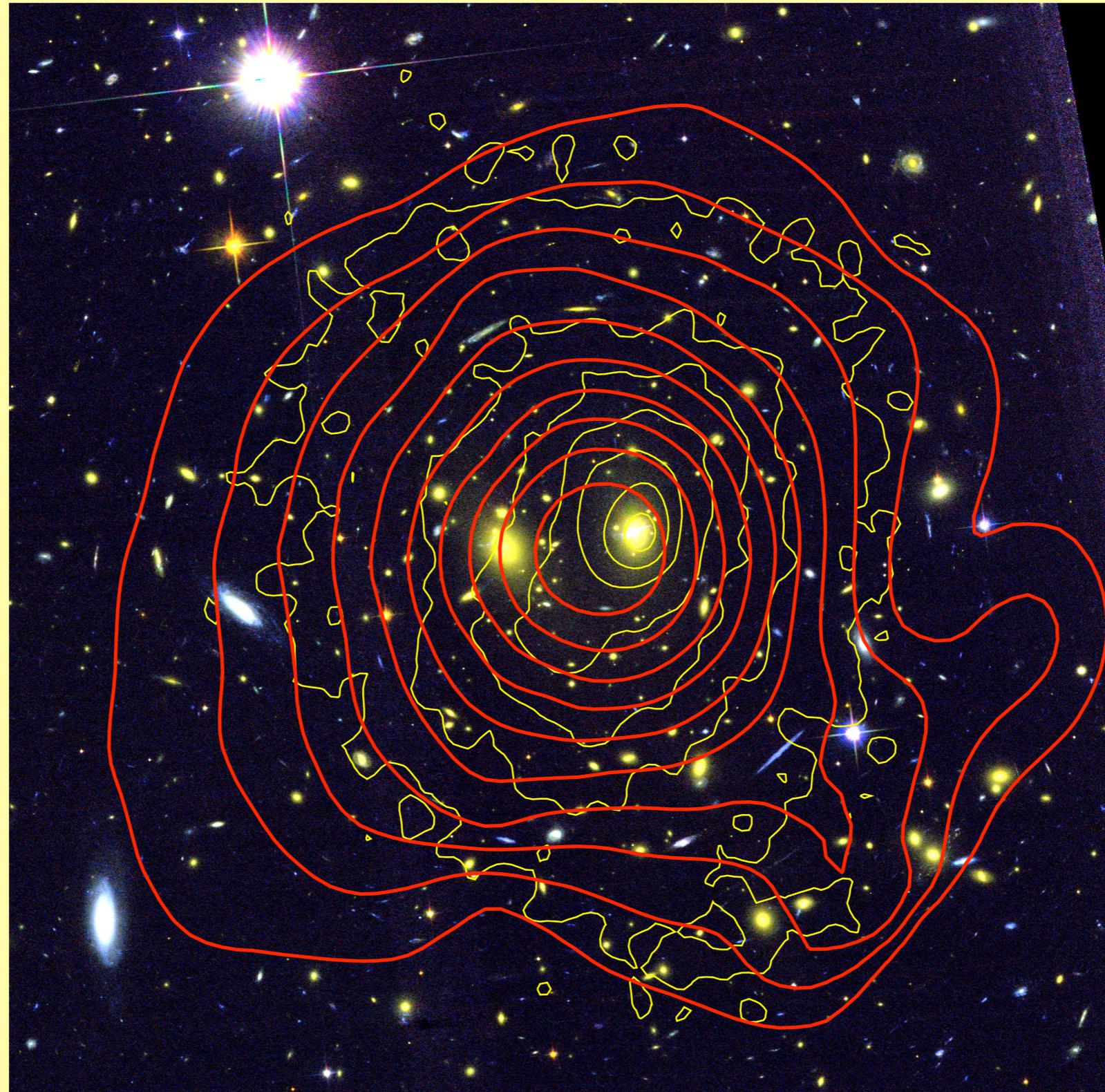
* X-ray

=> XMM data by Gitti et al. 2007 (comparing with old lensing results)

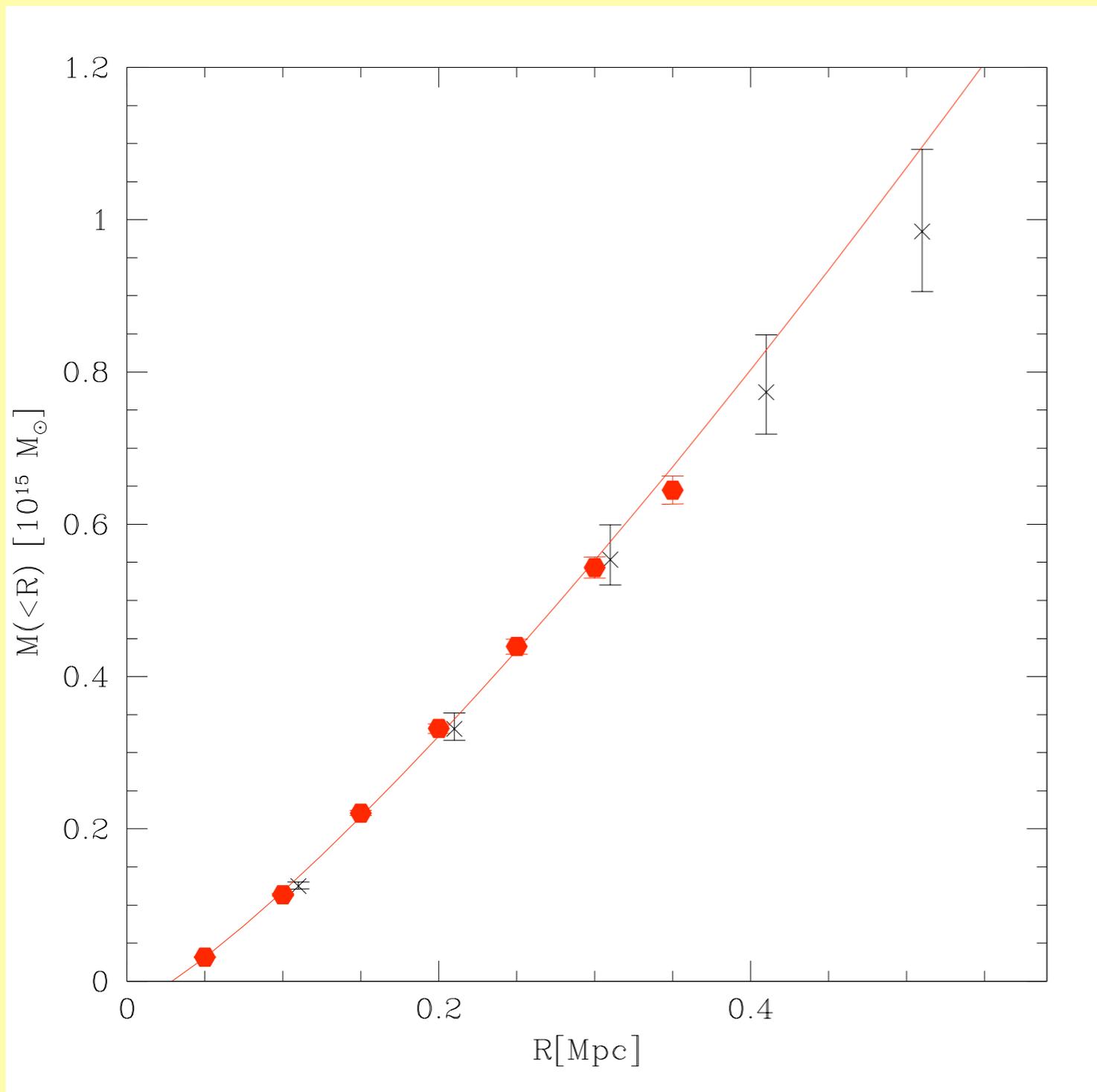
=> 67ks worth of Chandra data taken between 2000 and 2003 (S.Allen, A.Mantz,E.Million)



Lensing vs. Xray



Lensing AND Xray - mass estimate



$$M(<R) \propto R^{n_i}$$

$$n_i = 1.2$$

Assume isothermal:

$$\sigma = (1600 \pm 100) \text{ km s}^{-1}$$

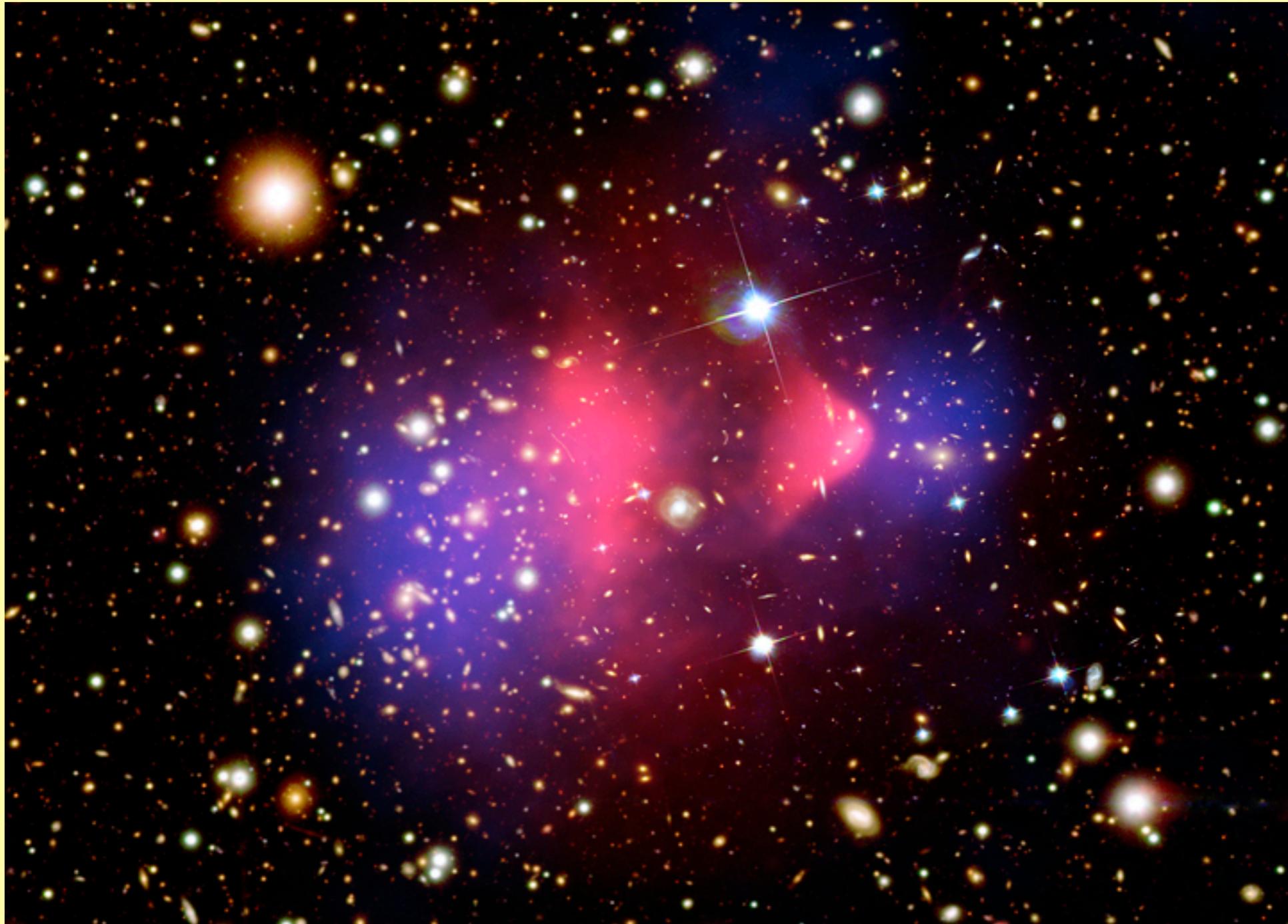


SWUnited & Clusters

- * Combining strong and weak lensing is a great way to measure cluster masses.
- * Mass sheet degeneracy is broken through redshift information (strong and/or weak lensing)
- * Central mass profile can be studied well
- * Study dark matter!



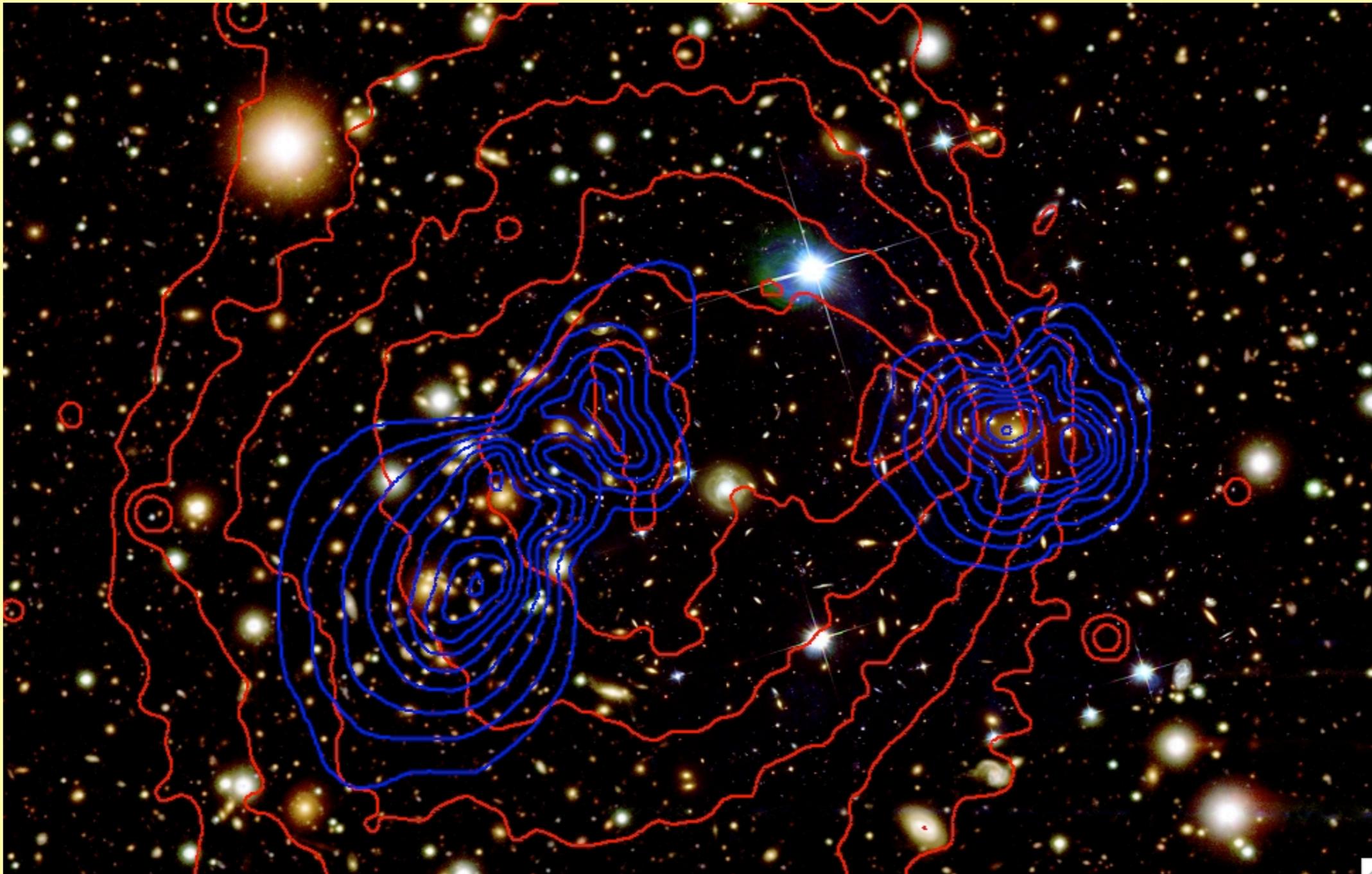
The bullet cluster



Clowe, MB et al 2006



SWUnited and the bullet cluster



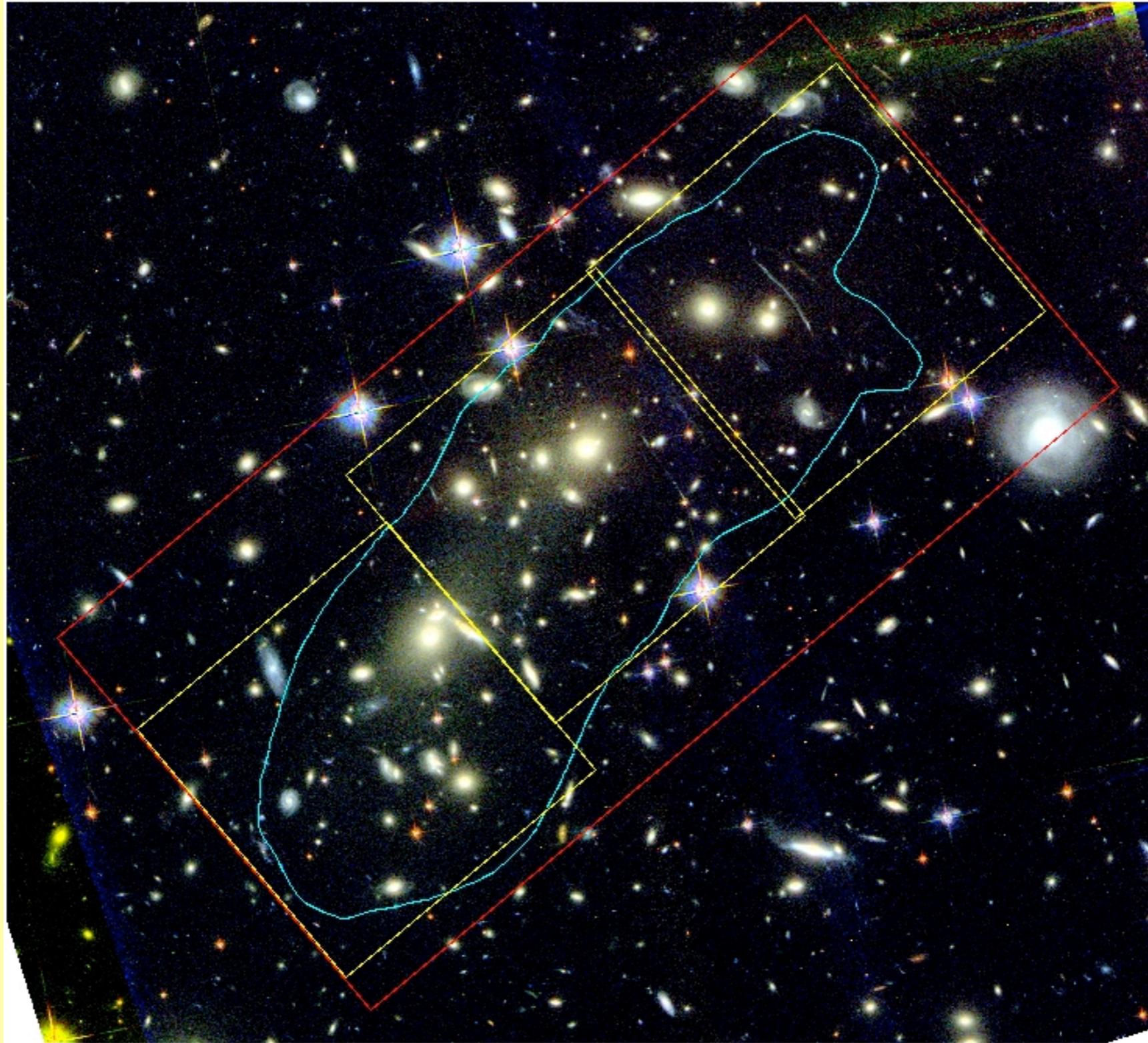
Bradač et al 2006



Future...what I will do in SB



Silver Bullet for High- z Universe



Silver Bullet for High- z Universe

- * Need IR data
- * For 3 NICMOS pointing to HAB = 27 (5-sigma) we expect to see 1 – 2 sources at $z \geq 7$ (assuming luminosity fct. from Bouwens and Illingworth 2006).
- * Without the Bullet < 0.1 sources
- * For WFC3 to HAB = 28 (10-sigma , 10 hours observations) we expect to see ~7 sources at $z \geq 7$ (blank < 3).



“Science is a collaborative effort, between us and the universe. We propose ideas, the universe smacks them down -- or occasionally agrees (S. Carroll).”

