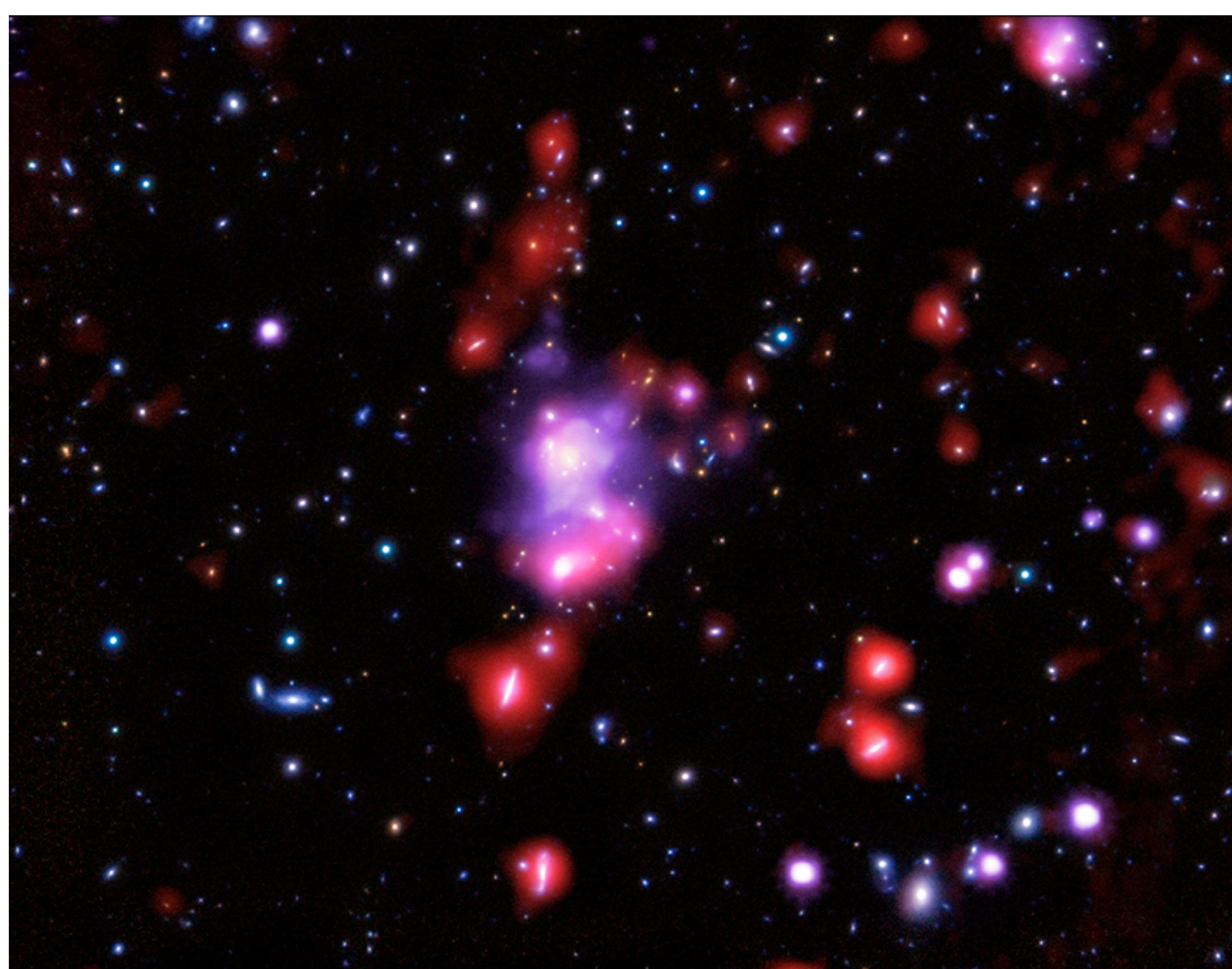


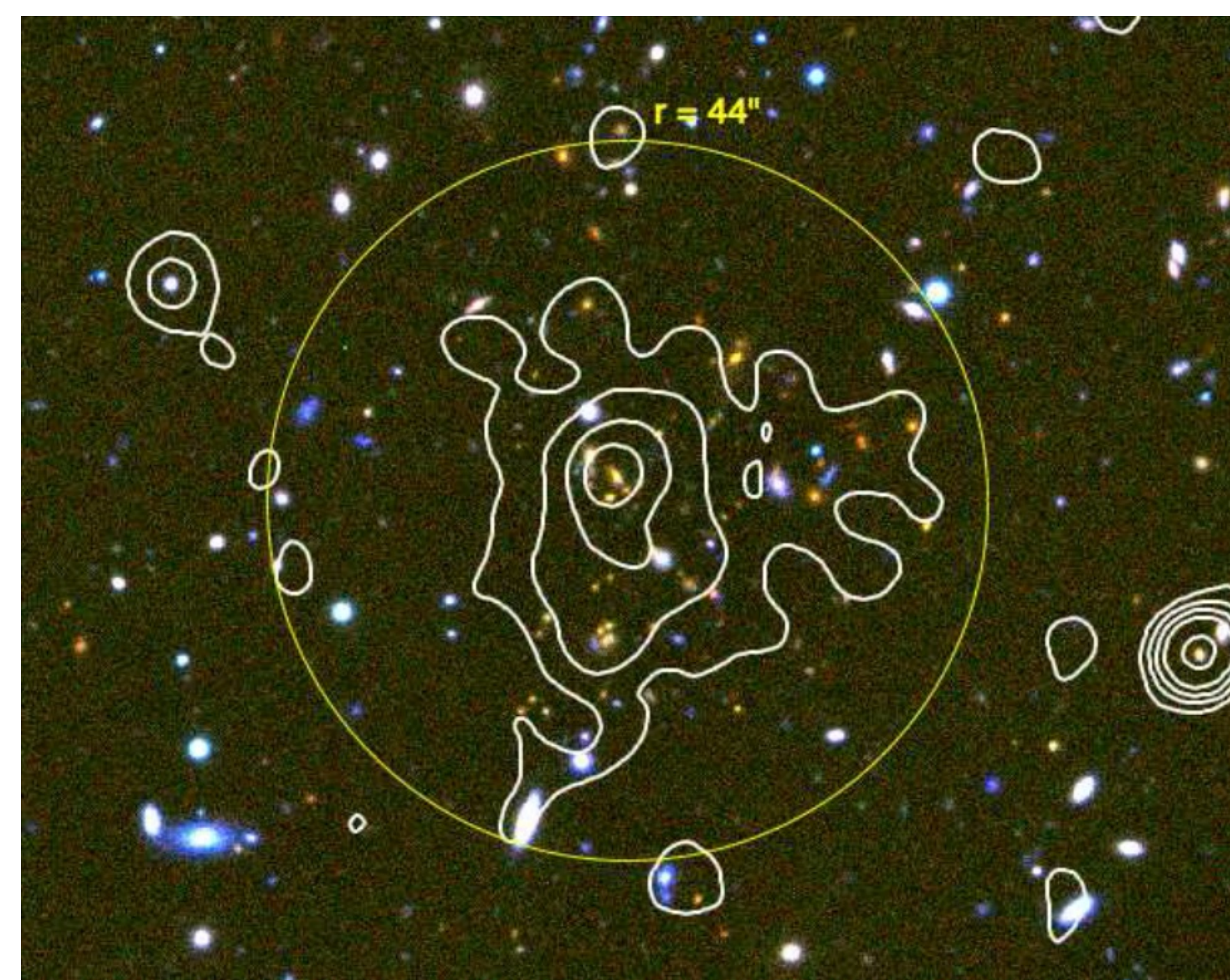
High star formation in the massive galaxy cluster XDCP J0044.0=2033 at $z \approx 1.6$

Bruno Altieri & Ivan Valtchanov (ESAC/ESA)
Joana Santos & Paolo Tozzi (INAF/Arcetri)

- The most massive, distant cluster identified at $z > 1.5$, found in the XMM Distant Cluster Survey.
- Deepest *Chandra* follow-up observation (380ks) confirms the existence of virialized, massive galaxy clusters at $z \sim 1.6$ ie. at a lookback time of 9.5 Gyr
- $M_{200} = 4.7 \cdot 10^{14} M_{\odot}$, $kT = 6.7 \text{ keV}$ (Tozzi+15)

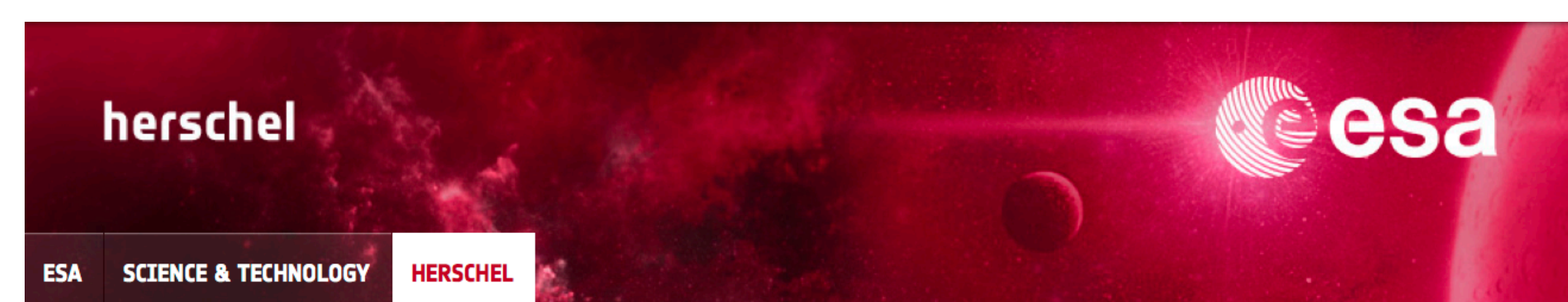


Composite view of XDCP J0044.0-2033: purple/pink in the image corresponds to infrared emission measured by *Herschel* and X-ray emission detected with NASA's *Chandra* telescope. (ESA & NASA/*Chandra* press releases)



Optical IJKs colour image of XDCP0044 with *Chandra* smoothed soft-band contours overlaid

- Strong star formation in cluster core (<250kpc): **1875 M_{\odot}/yr**
- Total SFR (z_{spec}) = 2600 M_{\odot}/yr
- Total SFR ($z_{\text{spec}} + z_{\text{phot}}$) = **4500 M_{\odot}/yr** (<1 Mpc)
- Reversal of star formation density in a massive cluster (Santos+2015)
- bright end of red sequence not completely in place yet (Fassbender+2014:)



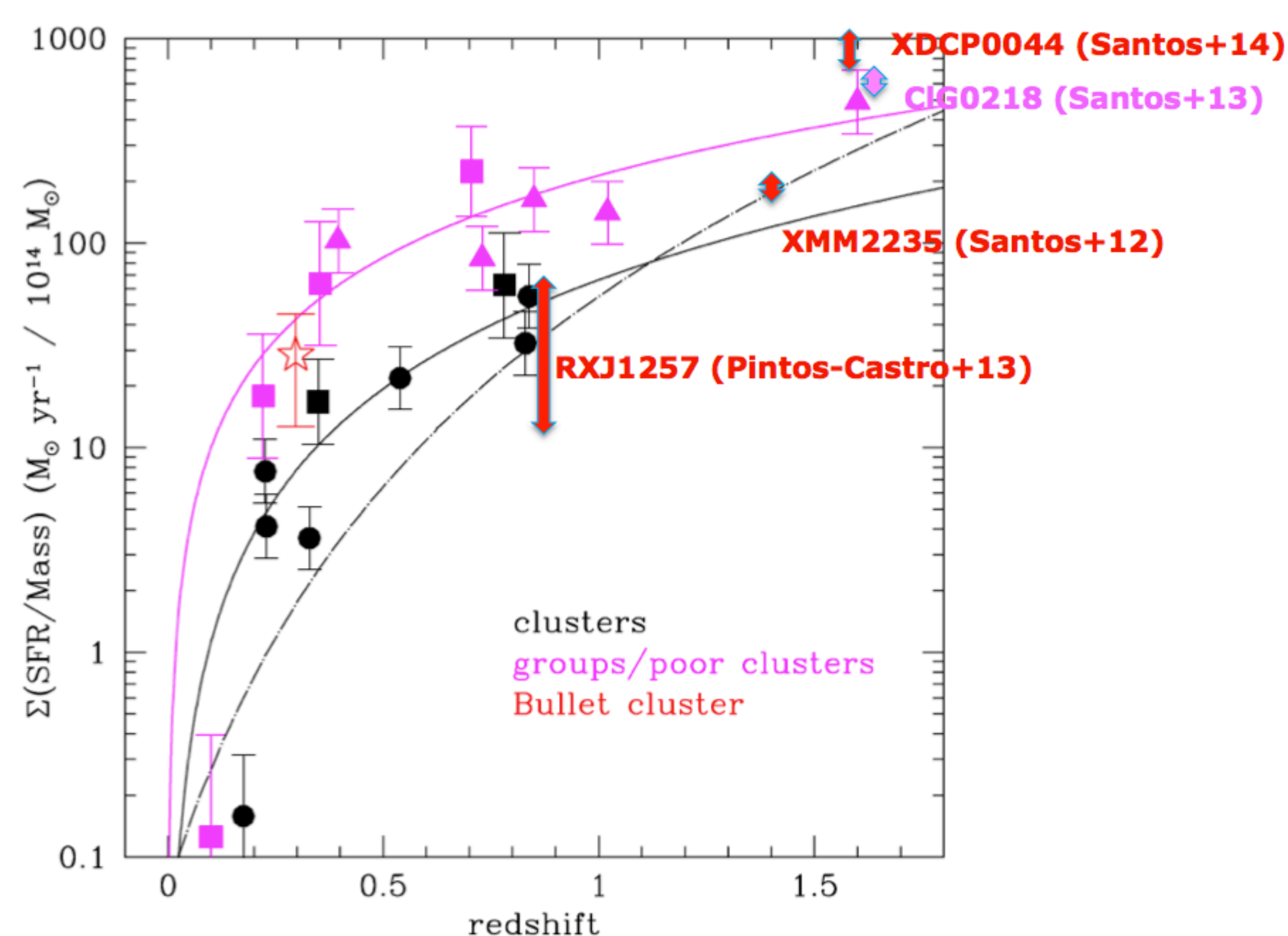
HERSCHEL'S VIEW OF THE EARLY UNIVERSE REVEALS GALAXY CLUSTER FIREWORKS

18 December 2014

Astronomers using ESA's *Herschel* space observatory have found, for the first time, fireworks of star birth within galaxies at the dense core of a massive early Universe galaxy cluster. This frenzy of star formation reveals the young lives of now "red and dead" elliptical galaxies and gives new clues to the evolution of some of the largest structures in the Universe.

Conclusions:

- XDCP0044 confirms a rapid increase of the mass-normalized cluster SFR with redshift (**Santos+15**)
- Many new and enigmatic clump of high- z star-forming galaxies have been discovered by using ESA's *Planck* and *Herschel* satellites (**Dole+15, in press**). Their study should tell us if they are the precursors of today's largest galaxy clusters.



References :

- **Tozzi et al.**, 2015, *ApJ*, 799, 93: *Chandra* deep observation of XDCP J0044.0-2033, a massive galaxy cluster at $z > 1.5$
- **Santos et al.**, 2015, *MNRAS*, 447, 65 : The reversal of the SF-density relation in a massive, X-ray selected galaxy cluster at $z = 1.58$: results from *Herschel*
- **Fassbender et al.**, 2014, *A&A*, 568, 5, Galaxy population properties of the massive X-ray luminous galaxy cluster XDCP J0044.0-2033 at $z = 1.58$. Red-sequence formation, massive galaxy assembly, and central star formation activity.