AGN in Brightest Cluster Galaxies

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AGN 13: Beauty and the Beast, October 11, 2018

Formation and evolution of BCG in a CDM Universe

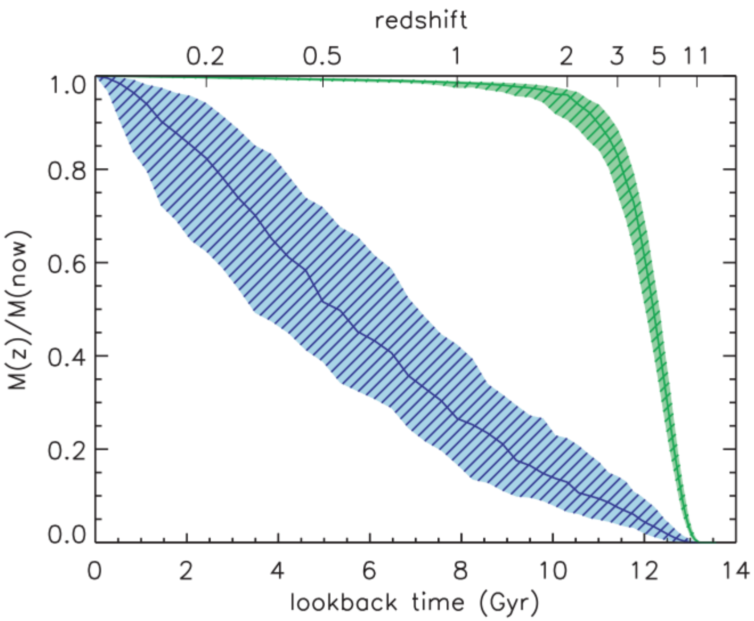
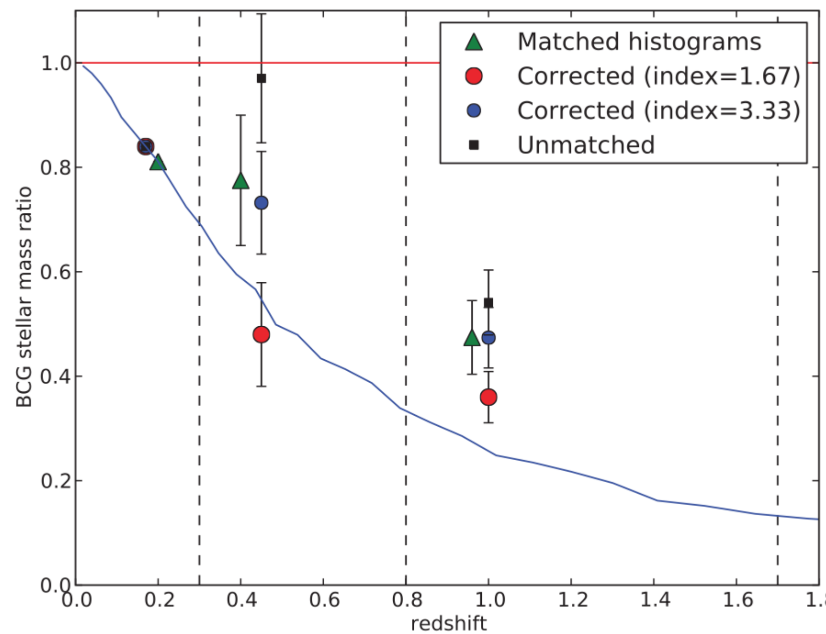


Figure 7. Assembly (blue) and formation (green) histories of our sample of BCGs selected at redshift 0 (as in Fig. 3). Thick lines show the median of the distributions, while the dashed regions show the 15th to 85th percentile range.

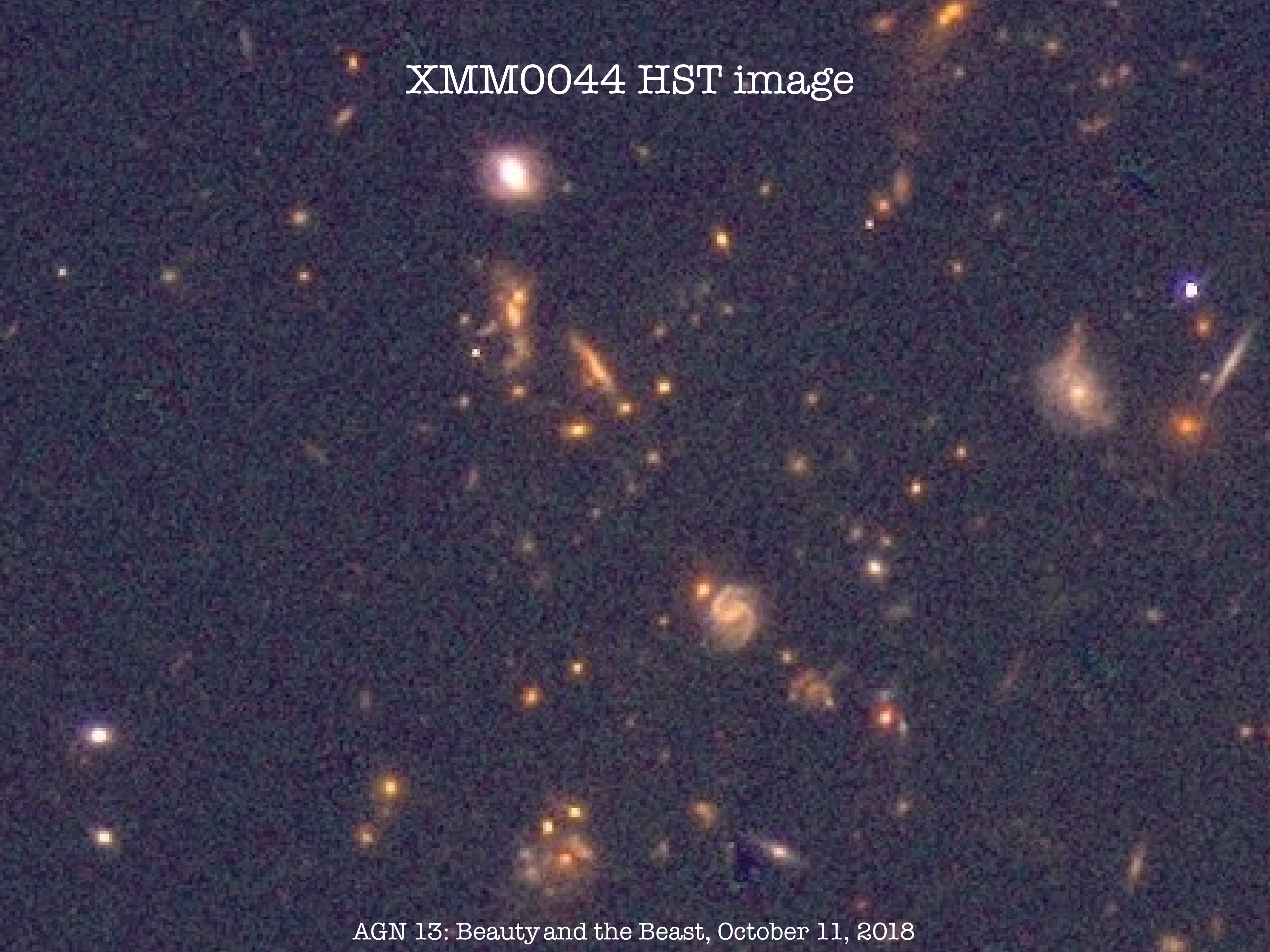


igure 6. The evolution in the median stellar mass of BCGs as a function f redshift. The green triangles take into account the correlation between luster mass and the stellar mass of its BCG by matching clusters according

De Lucia & Blaizot 2007

Lidman et al. 2012

XMM0044 HST image



Chandra Deep Observation of XDCP J0044.0-2033

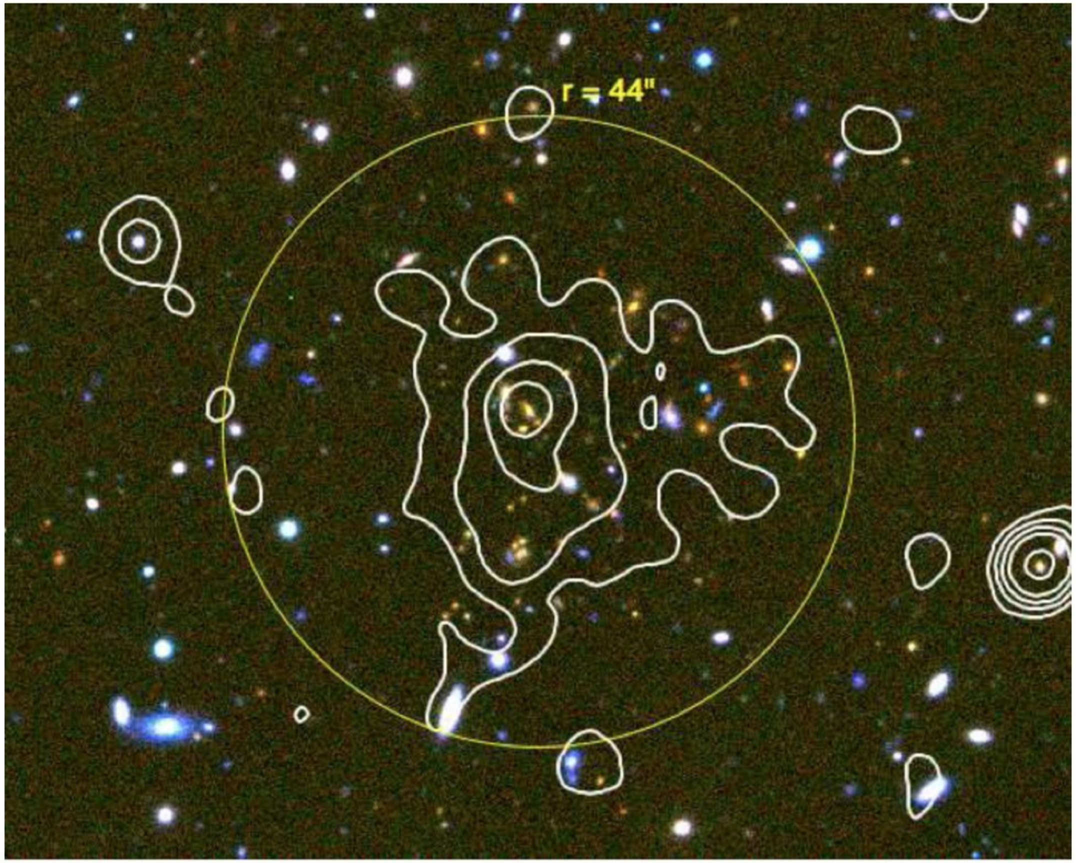


Figure 1. Optical *IJKs* color image of XDCP0044 with *Chandra* smoothed soft-band contours overlaid. Contours correspond to levels of 0.11, 0.3, 0.6 and 1.0 counts per pixel, to be compared with a background level of 3.5×10^{-2} counts per pixel in the original image (1 pixel = 0.″492). The image is obtained from Subaru/Suprime-Cam (*V* and *i* bands) and Hawk-I at VLT (*J* and *Ks* band) and has a size of 2.′5 × 2′. The solid circle has a radius of 44″ (corresponding to 375 kpc at $z = 1.58$), and shows the region used for the X-ray spectral analysis.

PT et al. 2015, ApJ, 799, 93

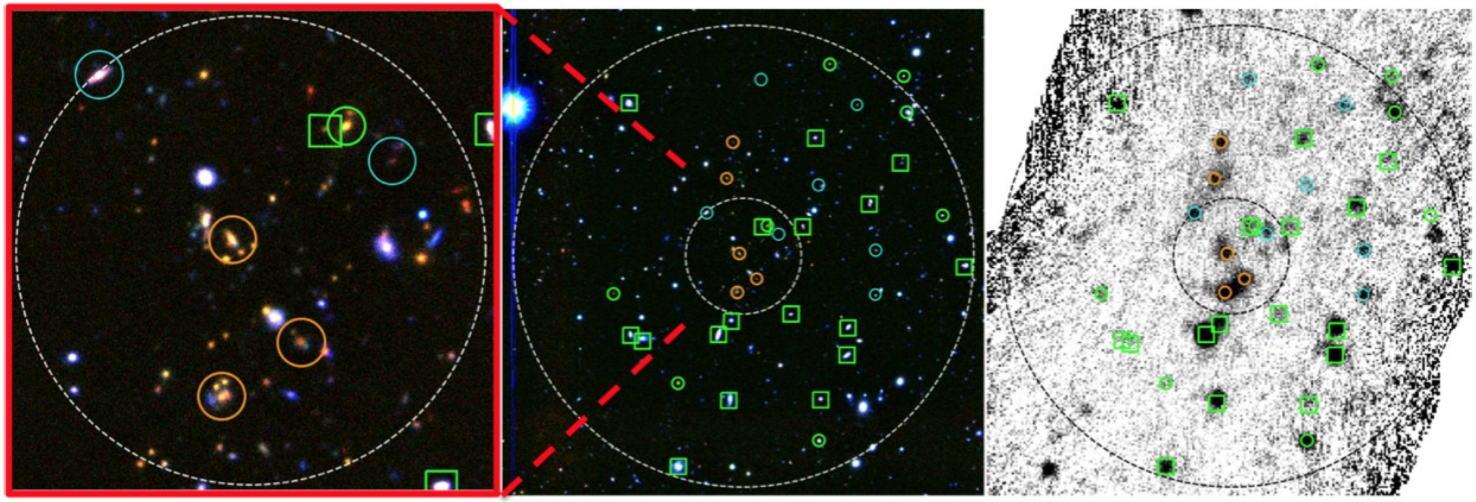
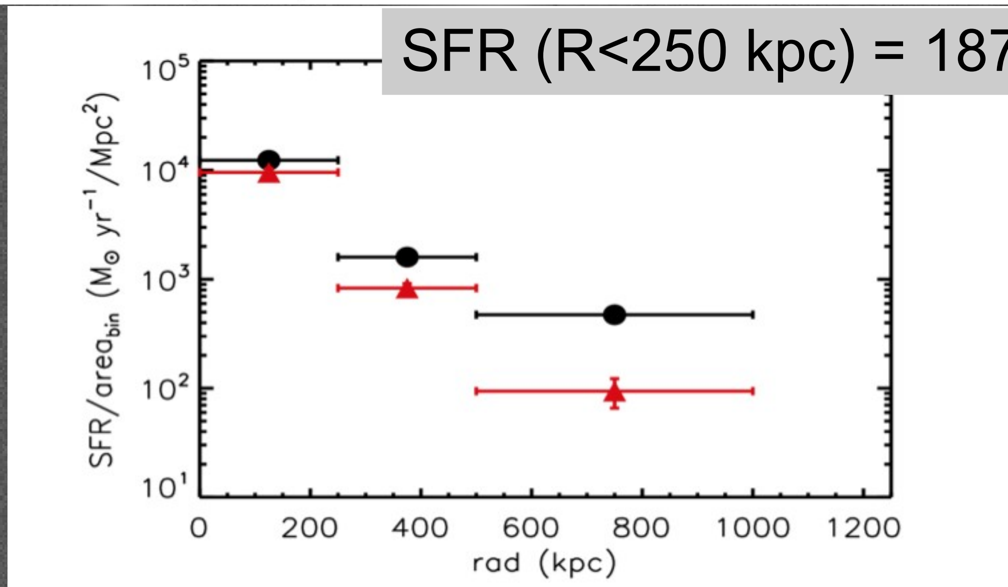


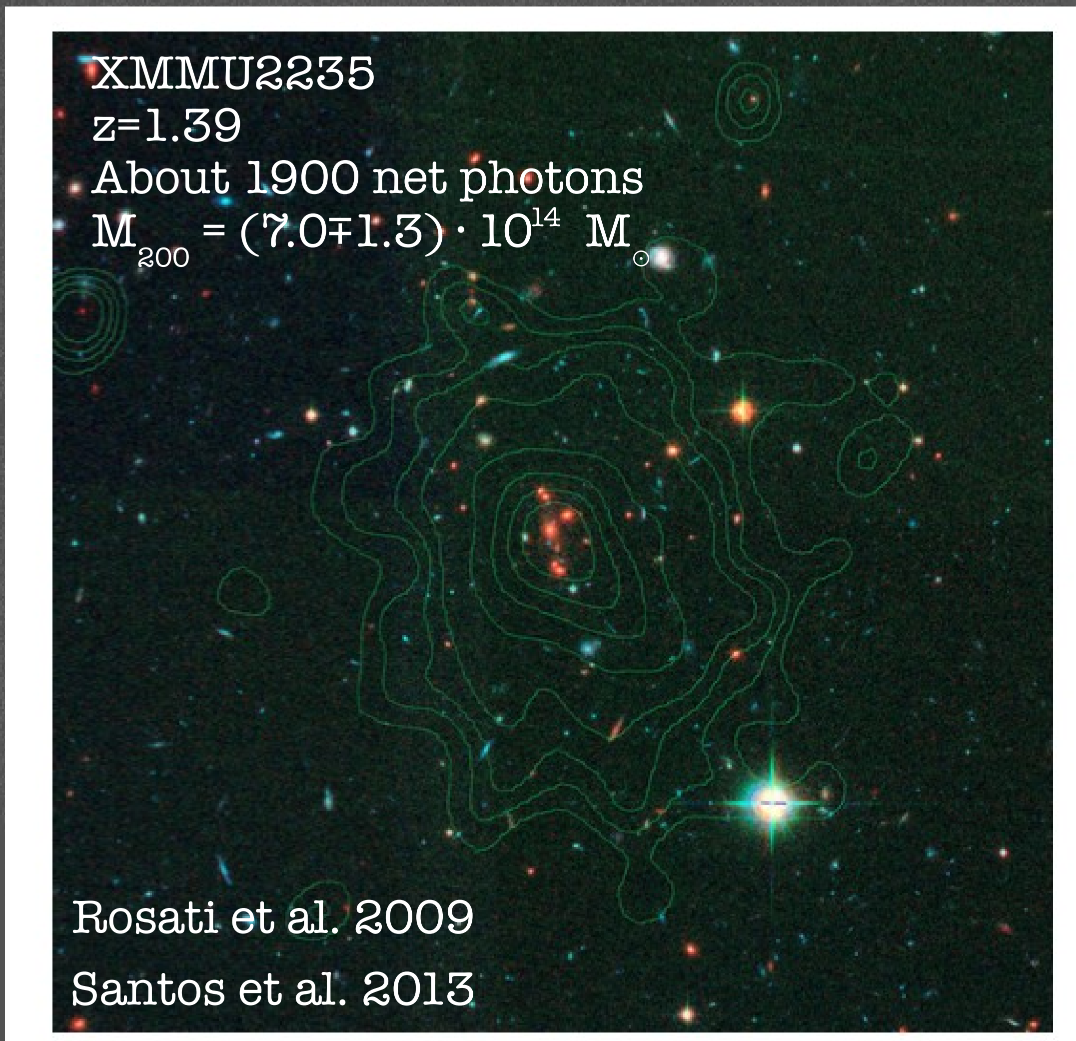
Figure 1. KsJI color composite of the central ~500 kpc (left) of the field of XDCP0044 (middle) and corresponding *Herschel*/PACS 100 μm map (right). Dashed circles have radii of 30″ and 2′ centered on the cluster X-ray center. The 5 spectroscopic members with FIR emission are shown in orange circles, cyan regions indicate the photometric candidates with FIR emission and green regions correspond to spectroscopic (circles) and visual/photo-z (squares) interlopers.

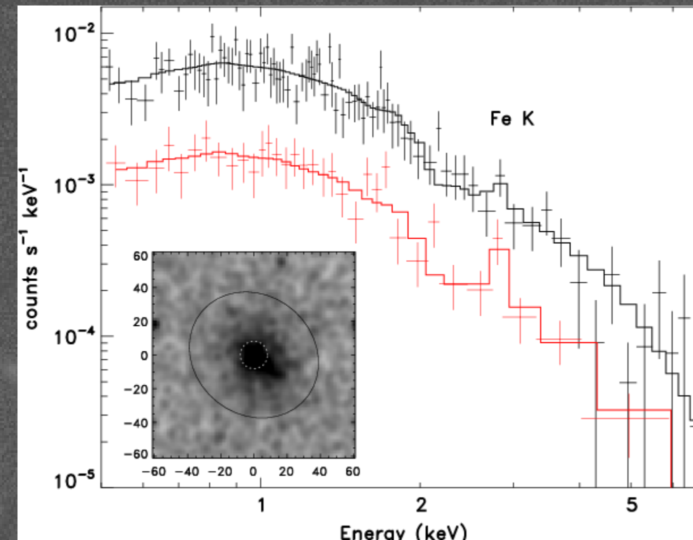
SFR (R<250 kpc) = 1875∓ 160 M/year



Santos et al. 2015, MNRAS, 447, 65

Color image of XMM2235 from the combination of i, z (HST/ACS) and Ks (VLT/ISAAC) filters. Overlaid X-ray contours from Chandra (196 ks)





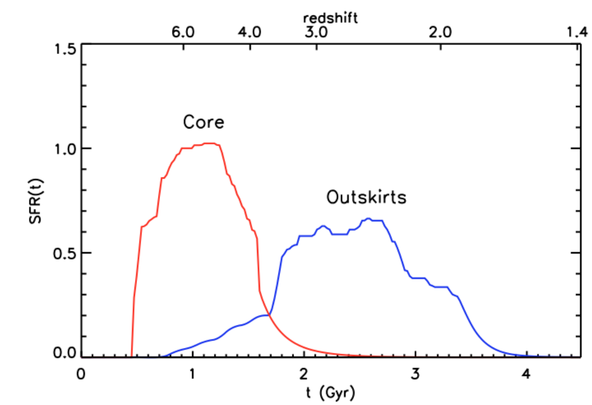
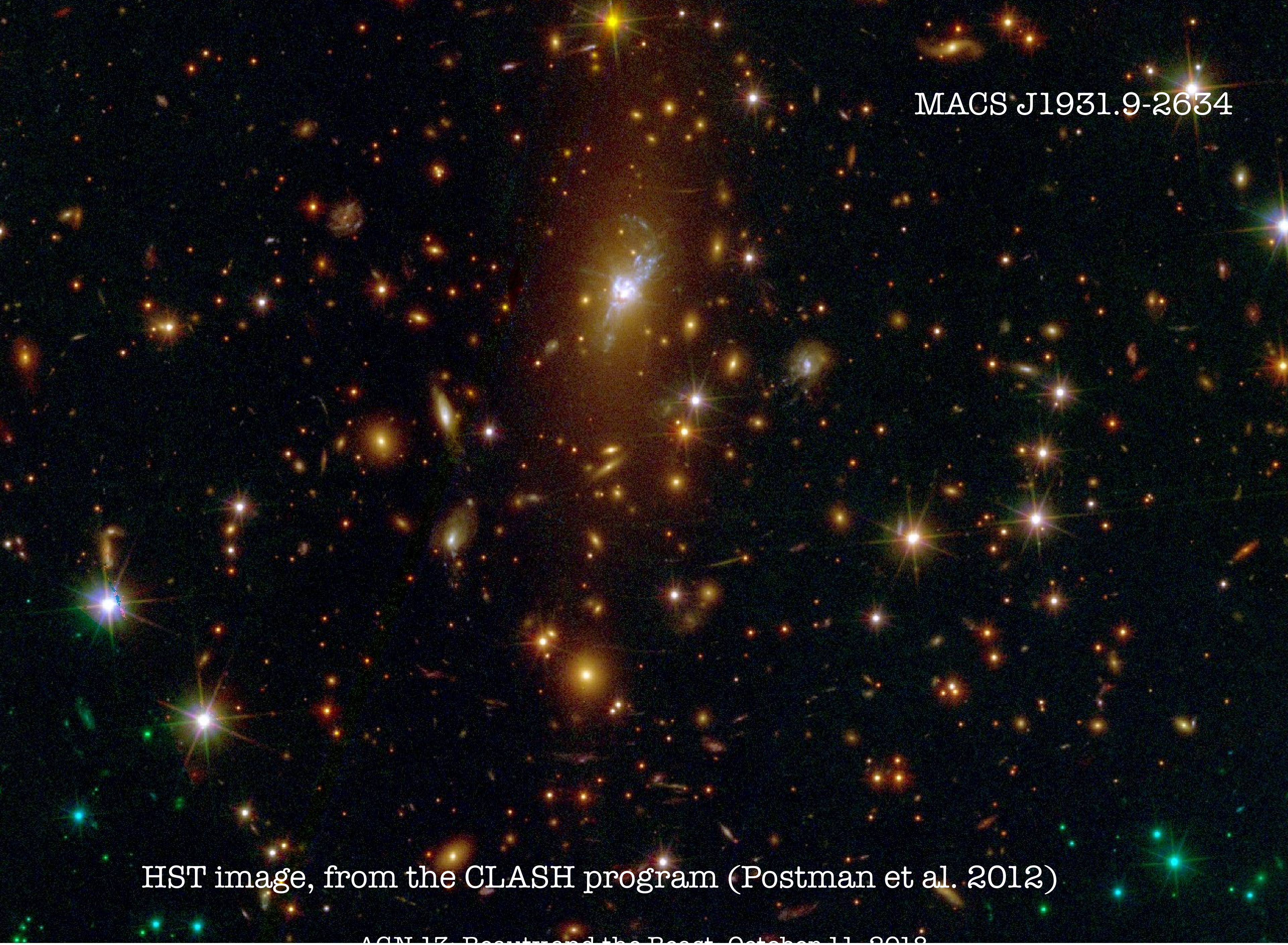


Fig. 5. Star formation histories (in arbitrary units) derived from the fit of the composite spectro-photometric data with BC03 τ-models for the sample of passive galaxies in the core and outskirts of XMM2235. The lower x-axis shows cosmic time; the upper x-axis marks the corresponding redshift.


MACS J1931.9-2634
HST image, from the CLASH program (Postman et al. 2012)


JVLA CLASH follow-up, from Yu et al. (2018)
MACS J1931.9-2634
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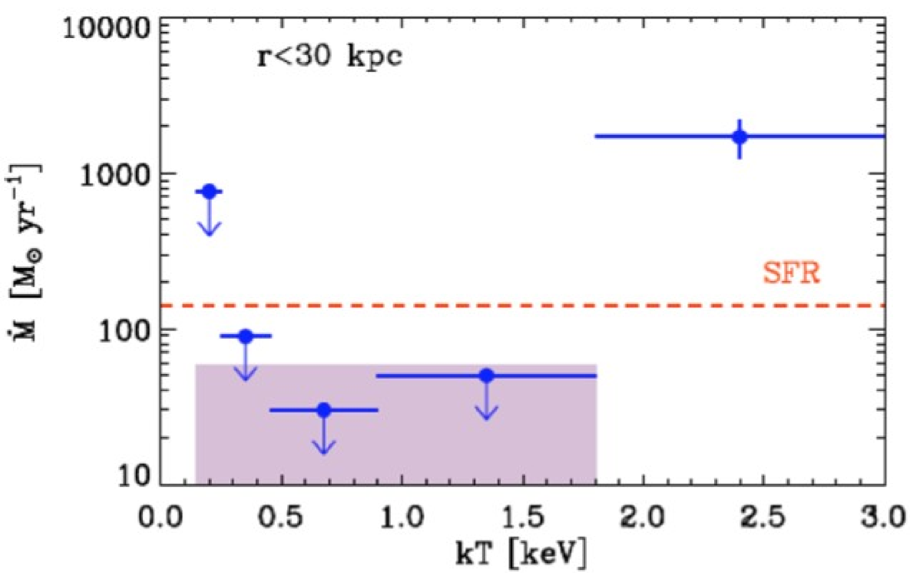
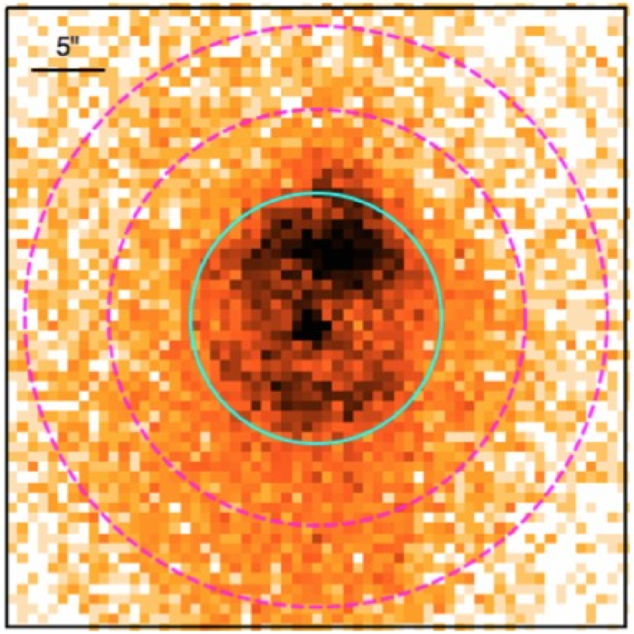
MACS J1931.9-2634
Ehlert et al. 2011

SFR larger than isobaric mass deposition rate allowed by the X-ray spectrum in MACSJ1931

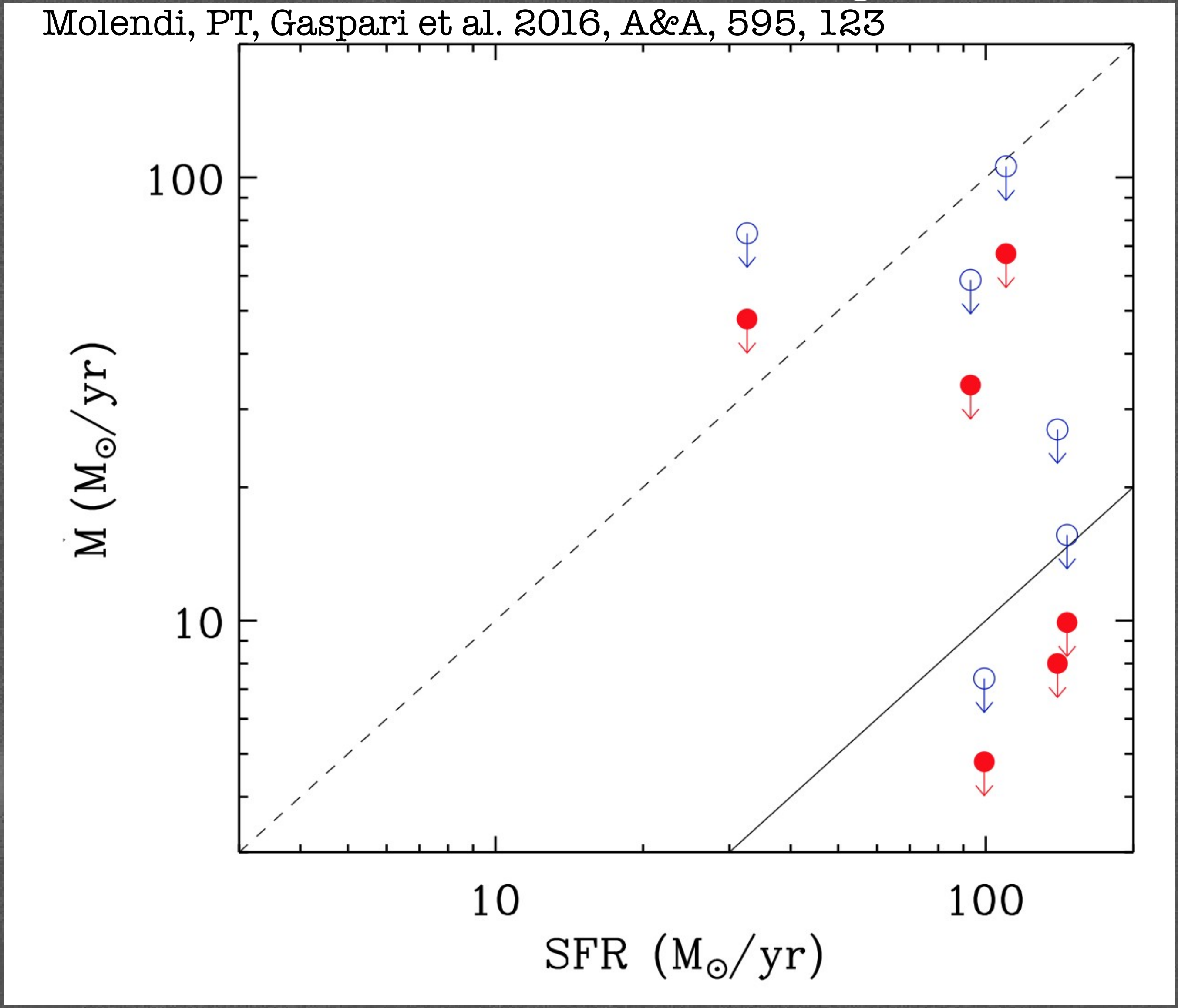
$$\frac{dL}{dT} \propto \frac{5}{2} \frac{\dot{M}\, k}{\mu\, m_P}$$

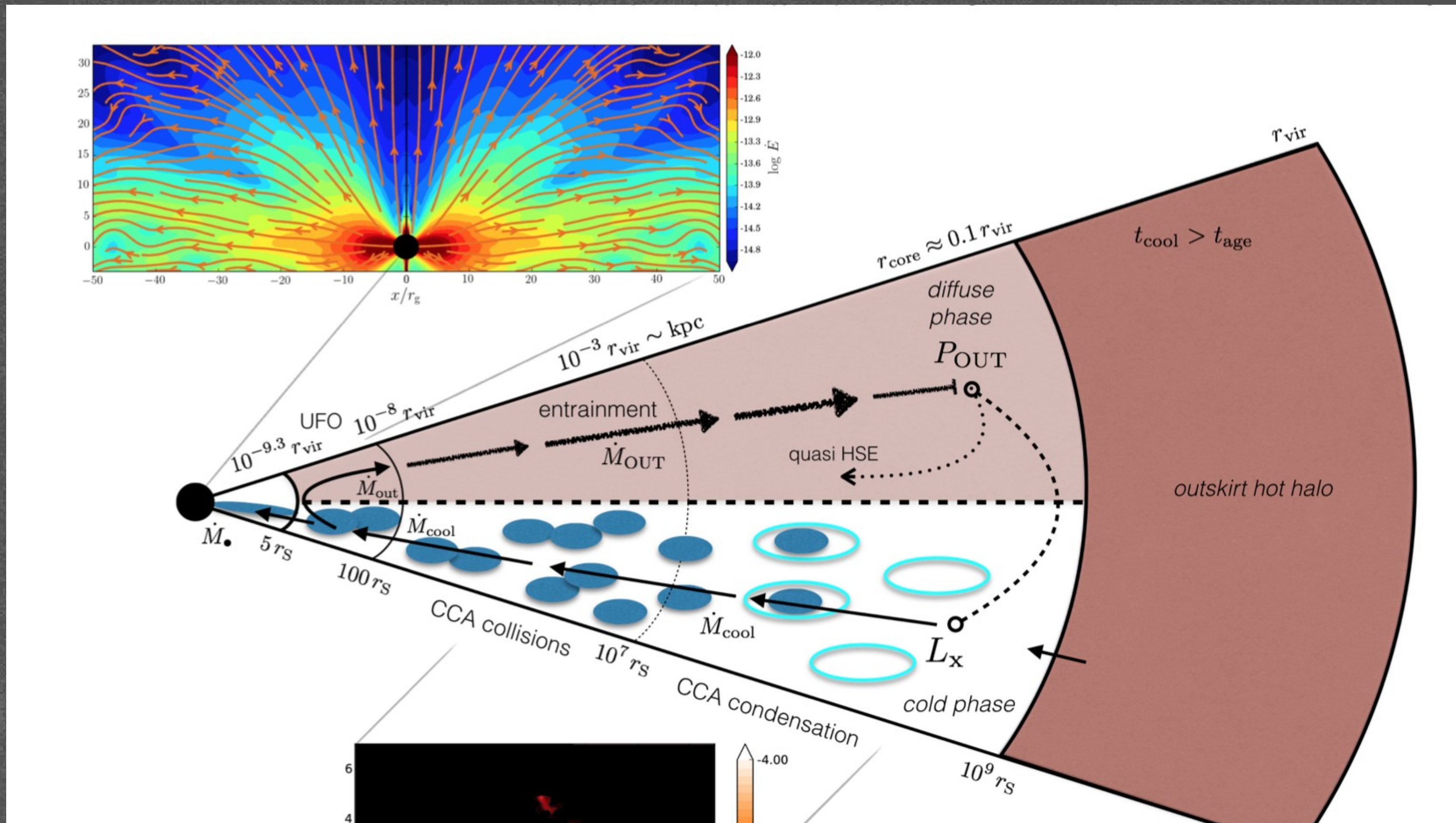


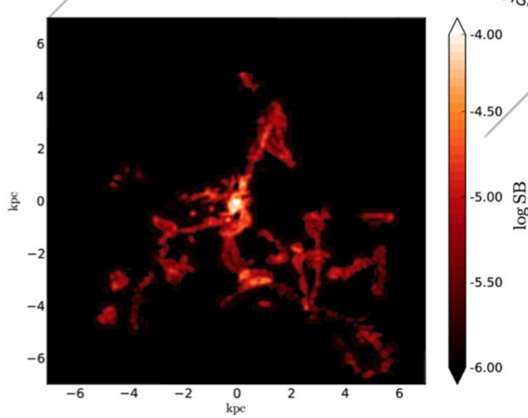


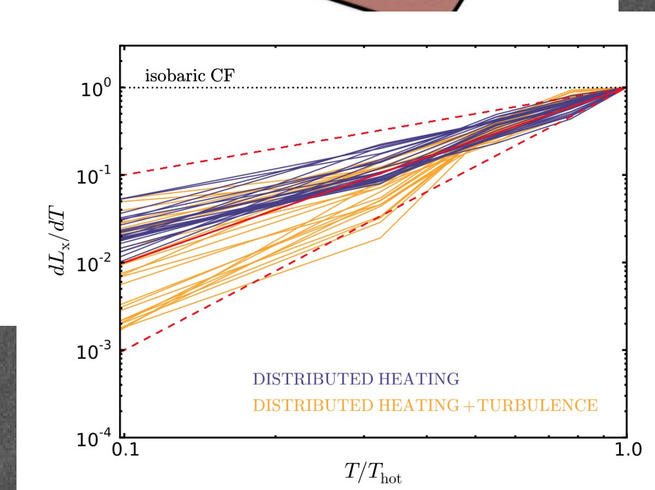
Santos et al. 2016, MNRAS, 456, 99

Current limits on isobaric cooling flows are lower than observed SFR. Way out: SF events naturally slower and non-isobaric cooling



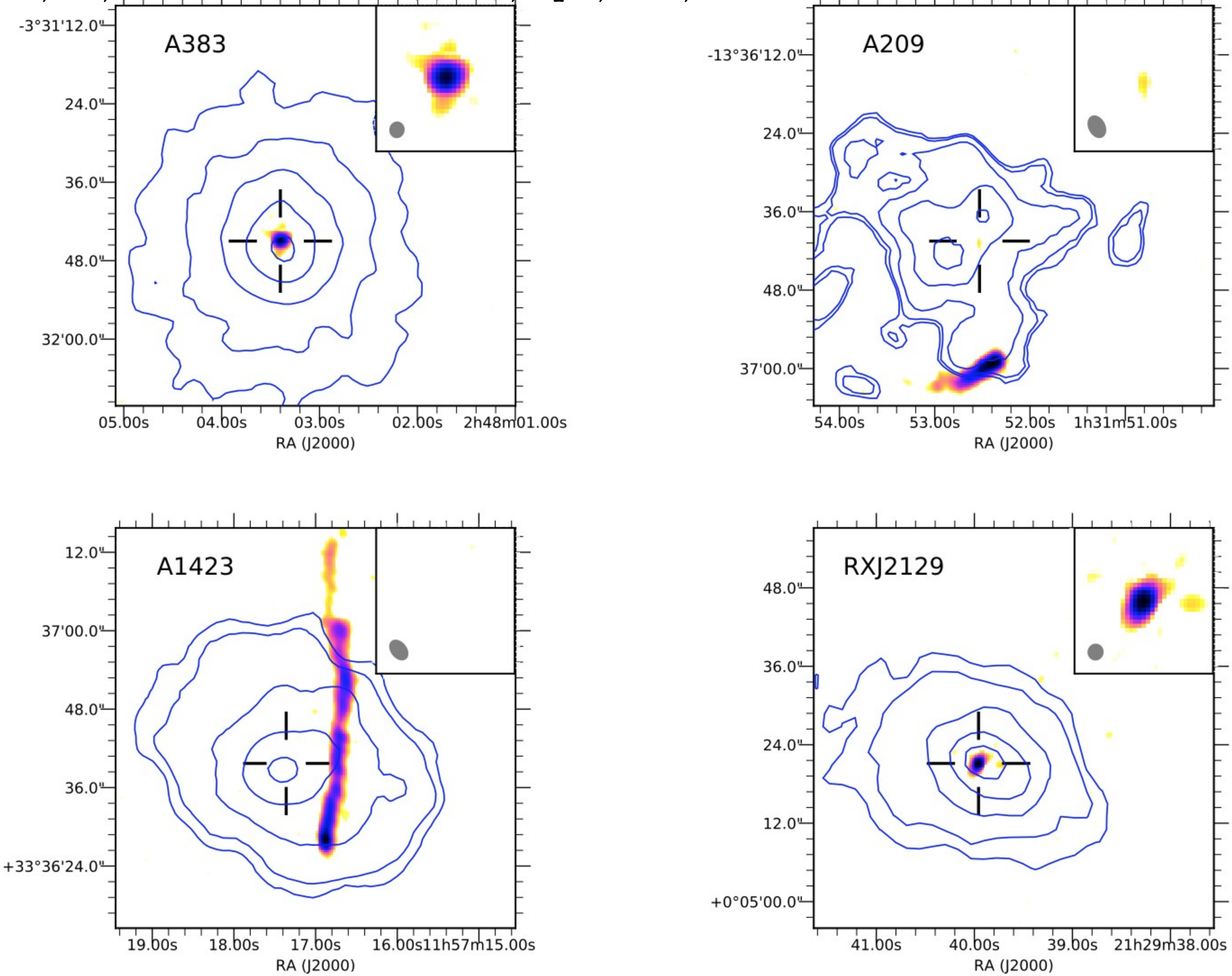




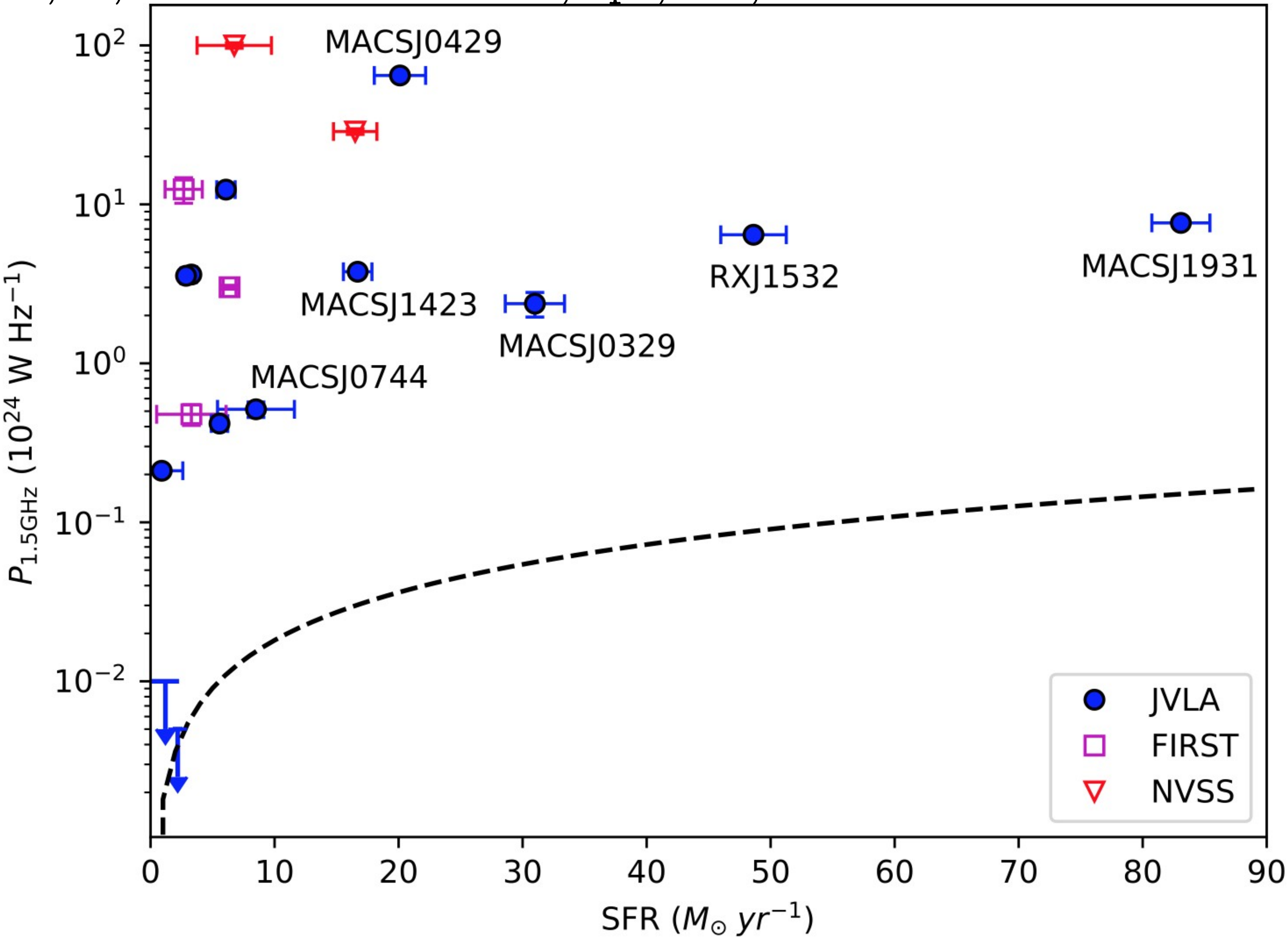


Gaspari et al. 2015
Gaspari & Sadowski 2017

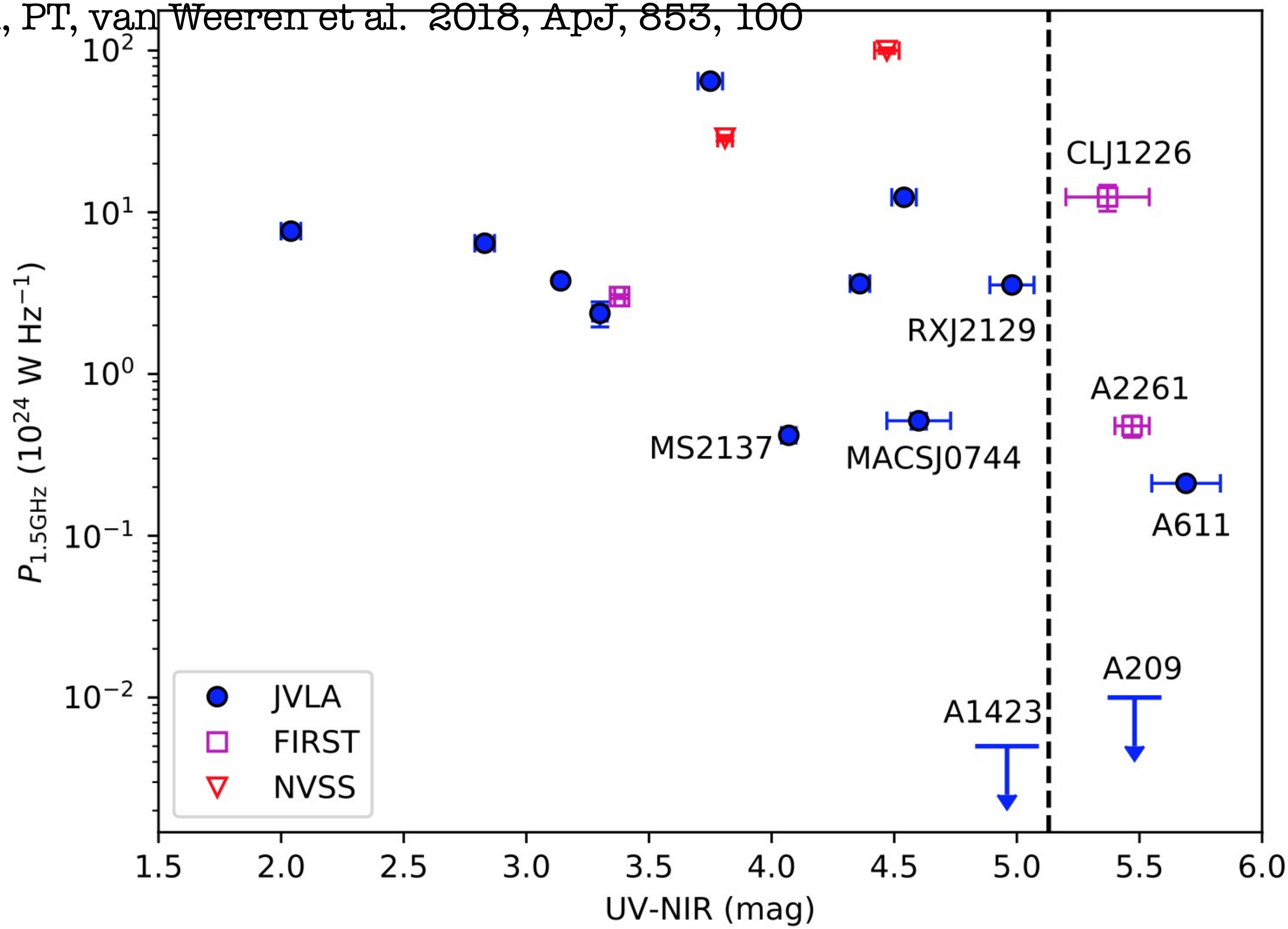
Yu, PT, van Weeren et al. 2018, ApJ, 853, 100



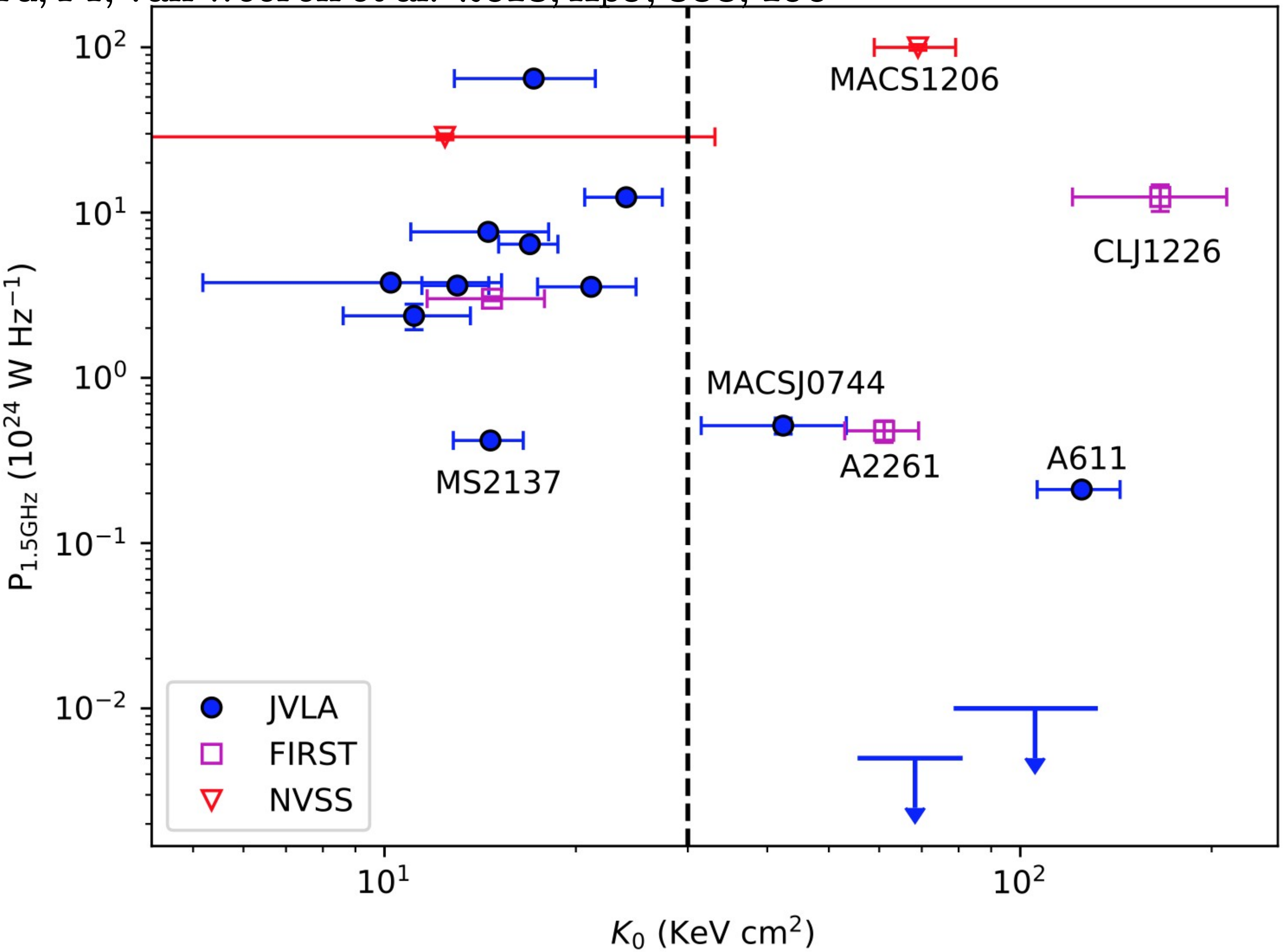
Yu, PT, van Weeren et al. 2018, ApJ, 853, 100

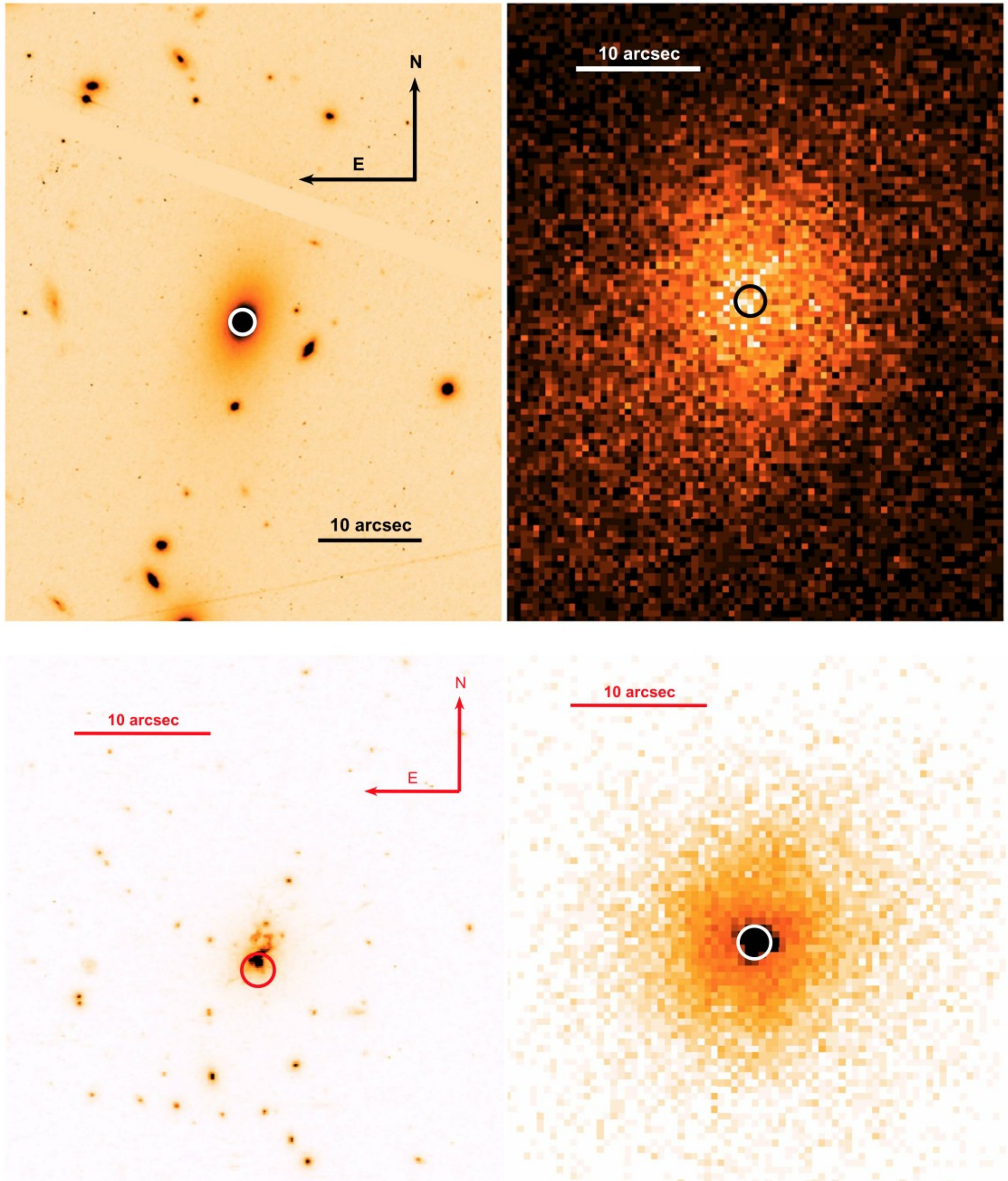


Yu, PT, van Weeren et al. 2018, ApJ, 853, 100

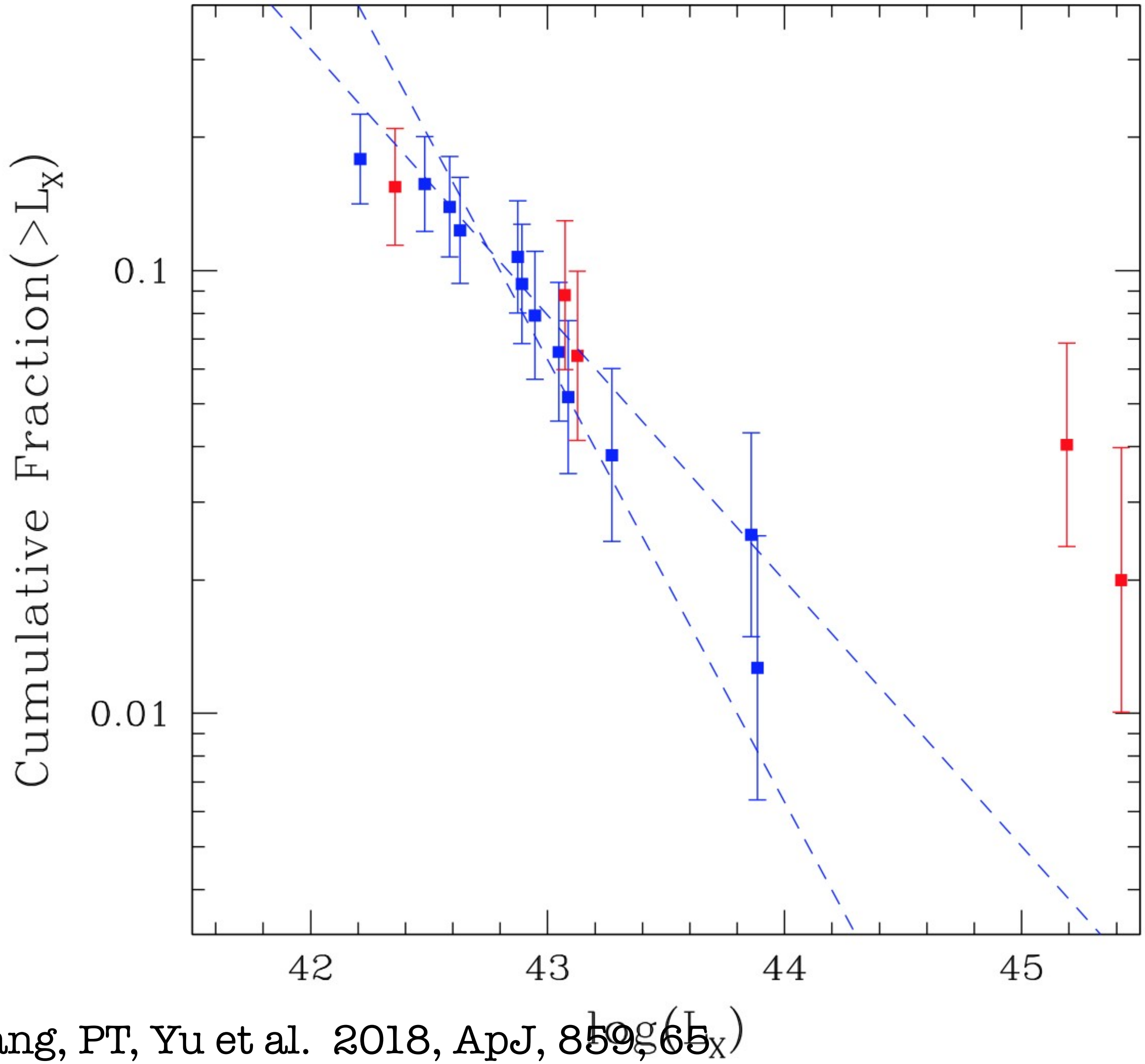


Yu, PT, van Weeren et al. 2018, ApJ, 853, 100



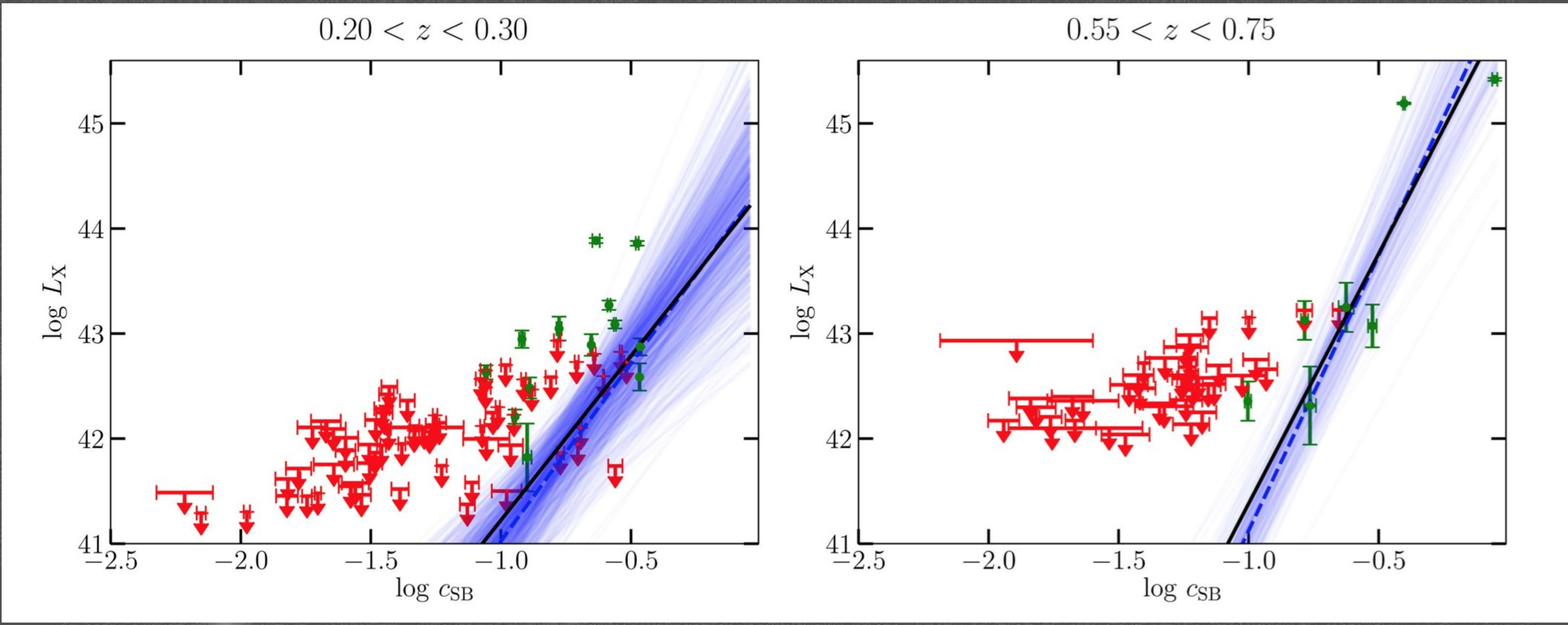


Yang, PT, Yu et al. 2018, ApJ, 859, 65



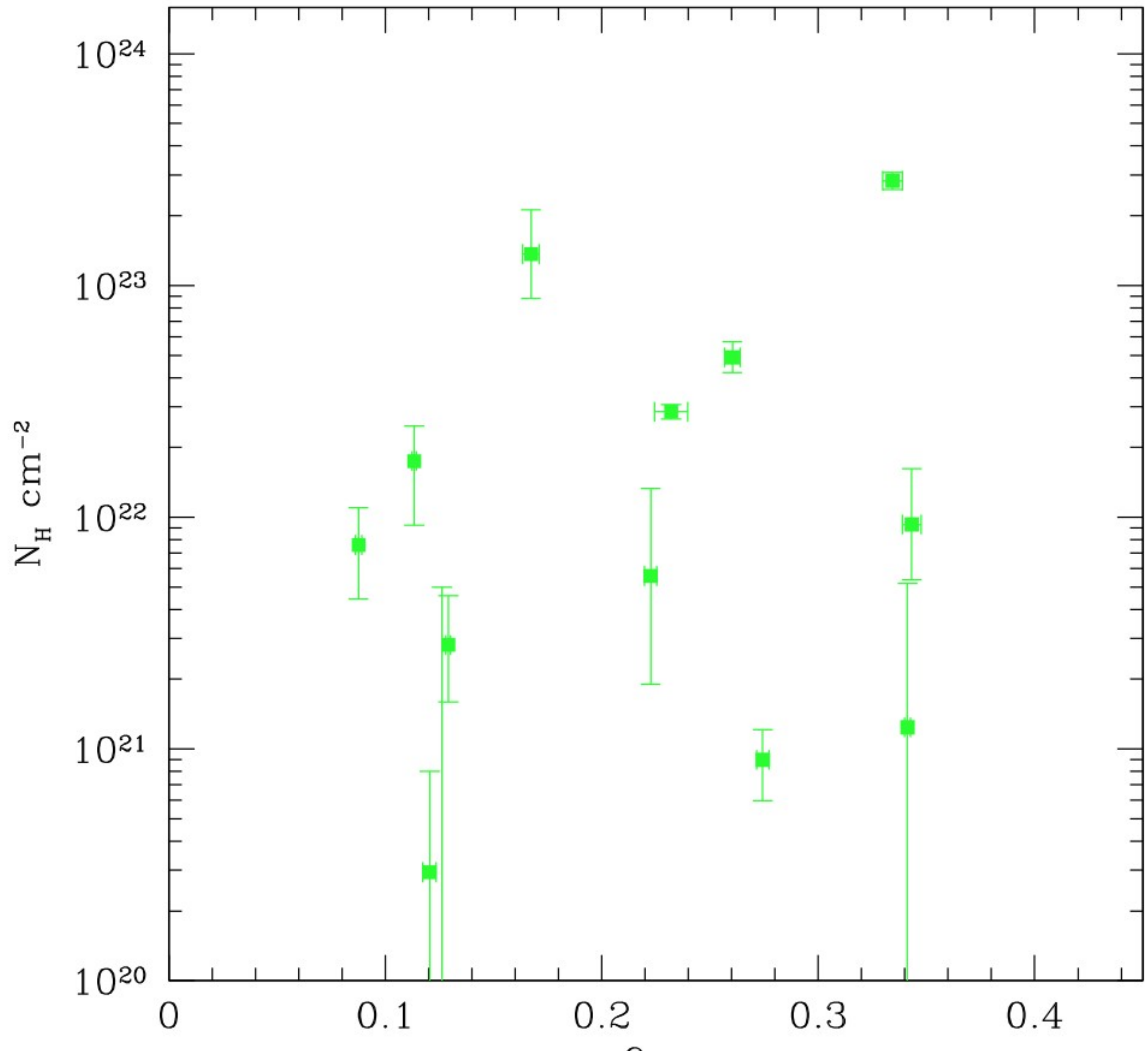
Yang, PT, Yu et al. 2018, ApJ, 859, 65

X-ray nuclear luminosity vs cool-core strength



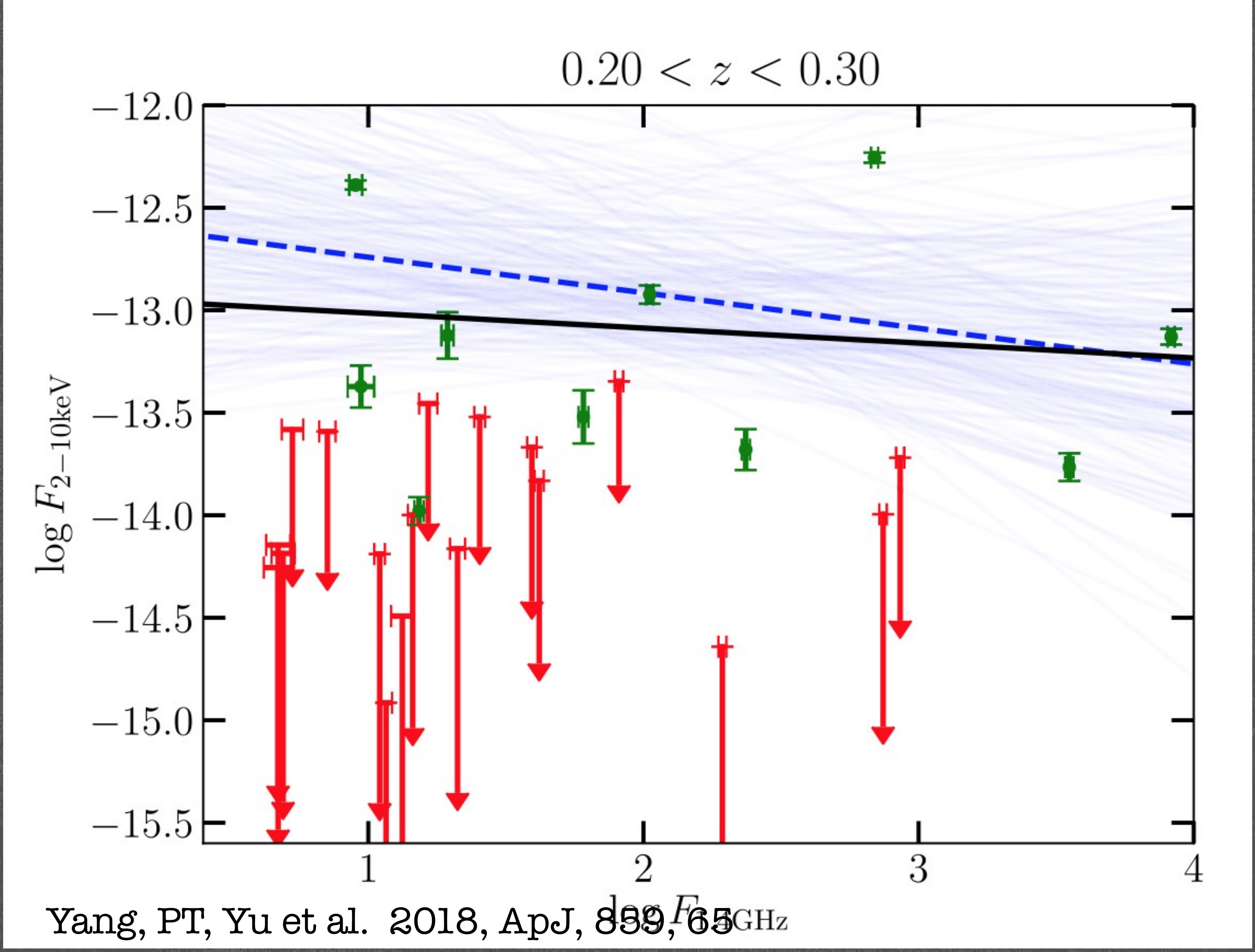
Yang, PT, Yu et al. 2018, ApJ, 859, 65

Correlation between intrinsic absorption and CC strength?



Yang, PT, Yu et al. 2018, ApJ, 859, 65

Correlation between intrinsic radio and X-ray flux?



Yang, PT, Yu et al. 2018, ApJ, 859, 65

Conclusions

A crucial epoch for BCG formation around between $1.3<z<2$, with a strong inversion of the SFR-density relation, and a still unknown role of feedback from nuclear activity.

A correlation between the CC strength and SF + Nuclear activity in the BCG is confirmed, but the time-scales and the duty cycle are not understood (i.e., there is no immediate link between gas cooling and activity).

At least 20% of all the BCG are X-ray emitting above 10^{42} erg/s, and about half of them are intrinsically absorbed ($NH>10^{22}$ cm^{-2})

At $z<1$, X-ray nuclear emission from BCG confirm that the radiation-driven feedback is not dominant, while the lack of evolution in the cumulative XLF of BCG shows that the self-regulation is in place since $z\sim1$.

The lack of correlation between X-ray and radio luminosity, if confirmed, suggests that the mechanical mode feedback is sustained by sub-relativistic outflows rather than relativistic jets.

Future perspectives

Searching for high-z (z>1.6-2) clusters and trace the formation phases of the BCG and the halo dynamics/virialization at the same time.

Finding the gas cooling from the ICM via short-live isobaric cooling episodes or more complex process (like Chaotic Cold Accretion), to feed at the same time star formation and accretion onto the SMBH (possibly on different time scales).

Derive the duty cycle of the different modes of accretion (feeding) and of the associated nuclear activity responsible for the mechanical-mode feedback.

Trace the passage from radiative-efficient feedback to mechanical-mode feedback as a function of cosmic epoch.