The Feedback Acting on Baryons in Large-scale Environments simulations of galaxy, group and cluster formation

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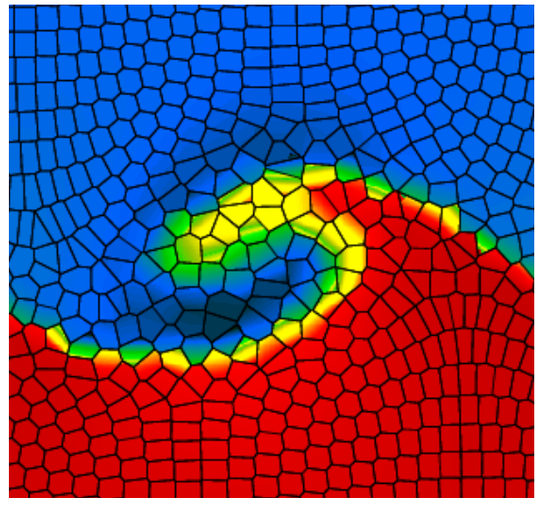
The FABLE simulations of galaxy, group and cluster formation

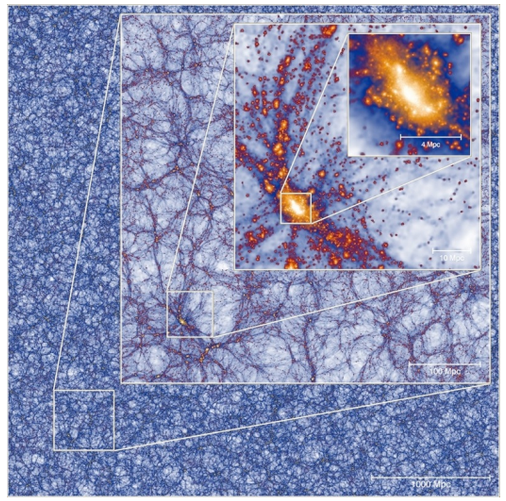
Nick Henden

- study galaxy groups & clusters with the moving-mesh AREPO code



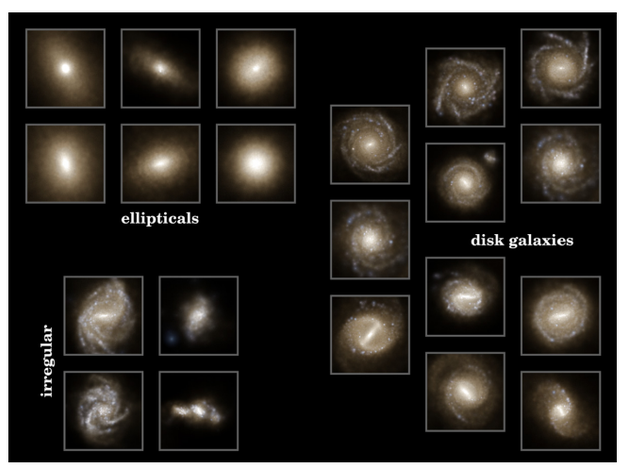
mesh geometry in AREPO

- boxes + zoom-in re-simulations of Millennium-XXL clusters



Millennium-XXL
3 Gpc/h box

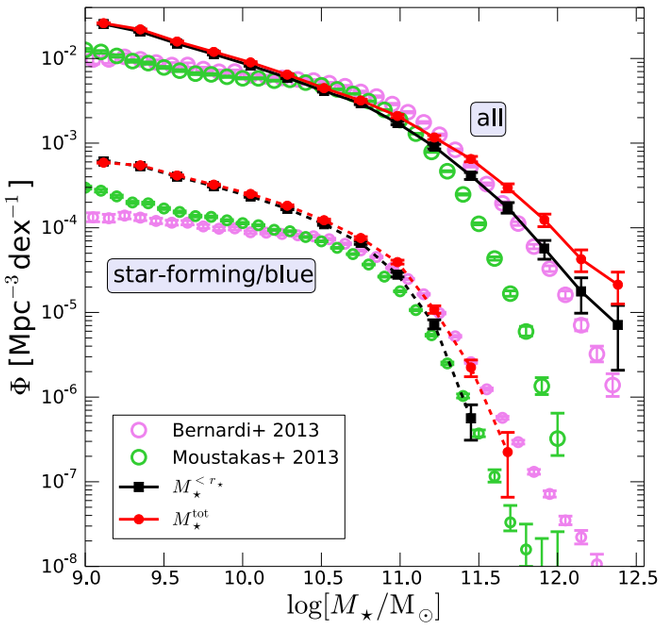
- update the galaxy and AGN physics



use Illustris project as starting point

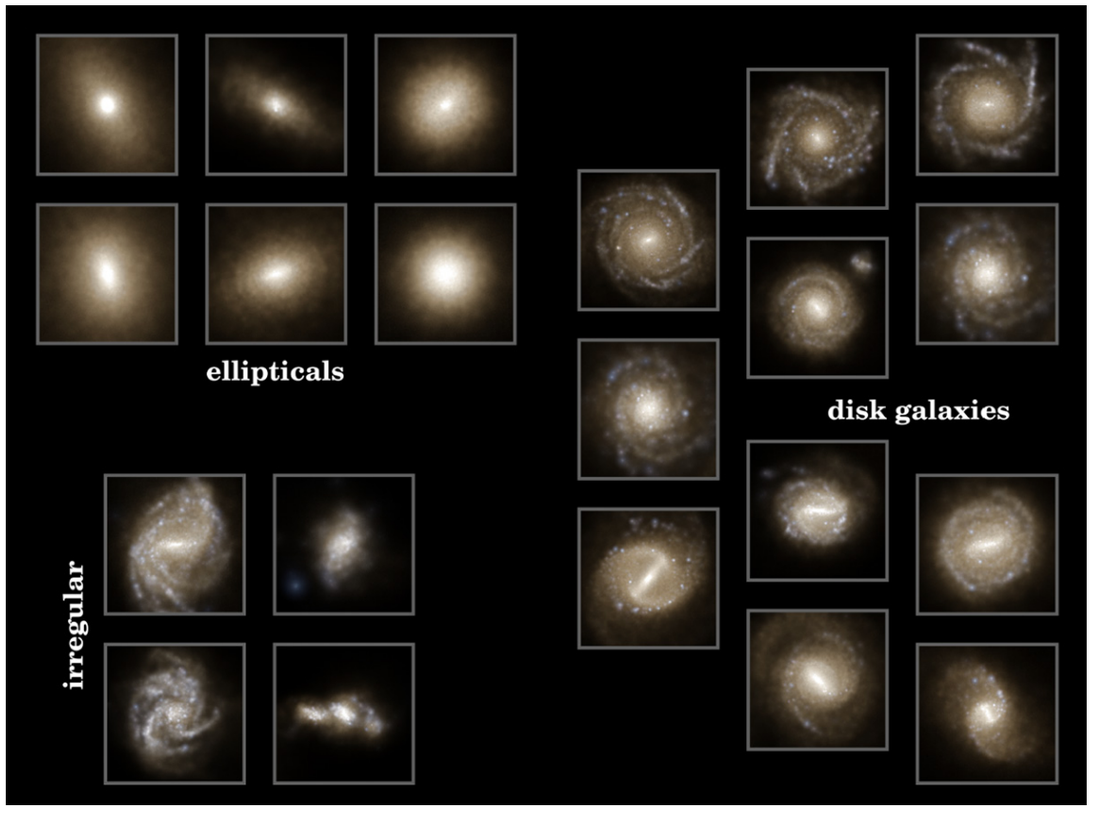
Results from the Illustris Simulation

galaxy stellar mass function

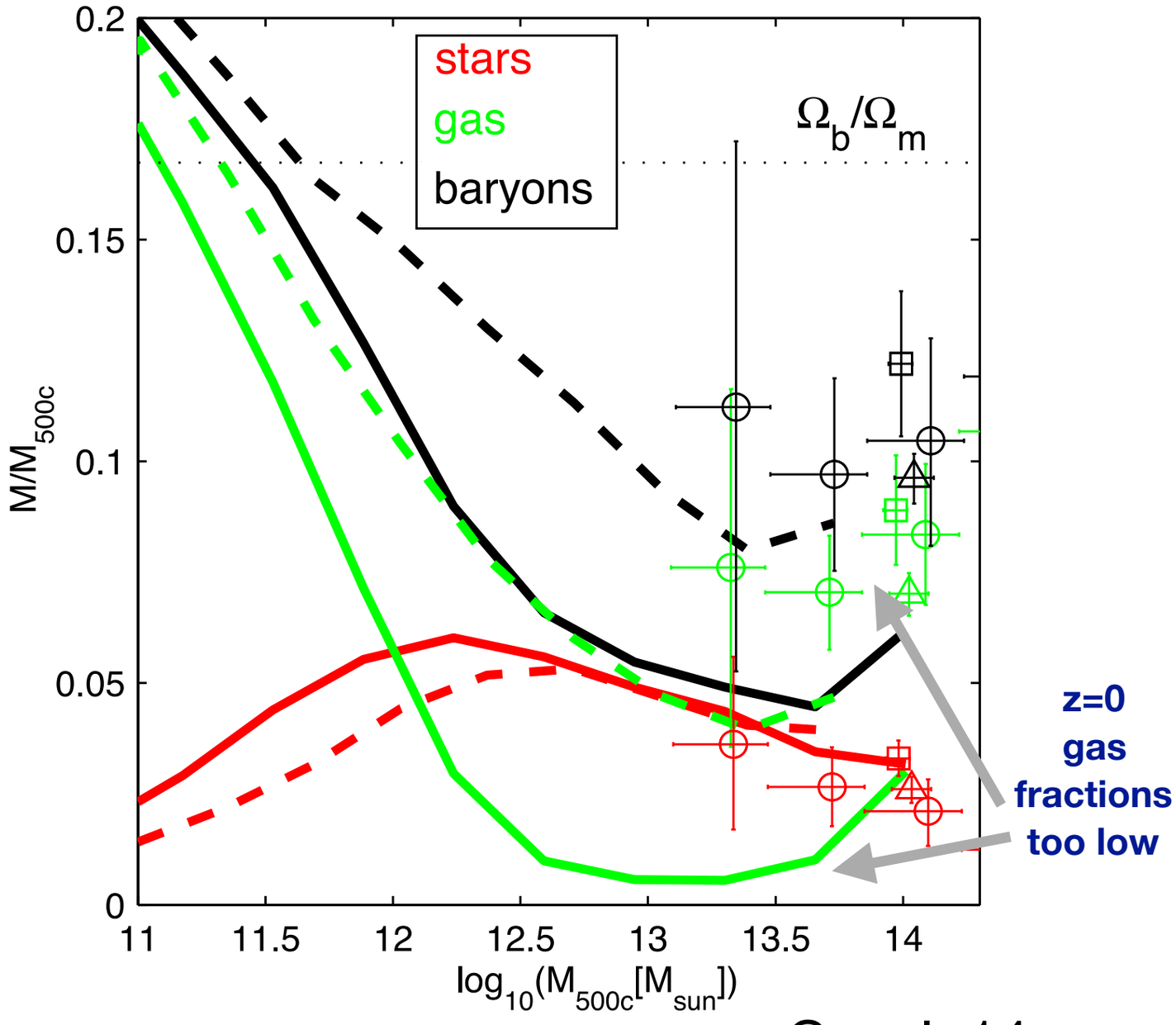


Vogelsberger+14

different morphological types



gas mass fractions in Illustris

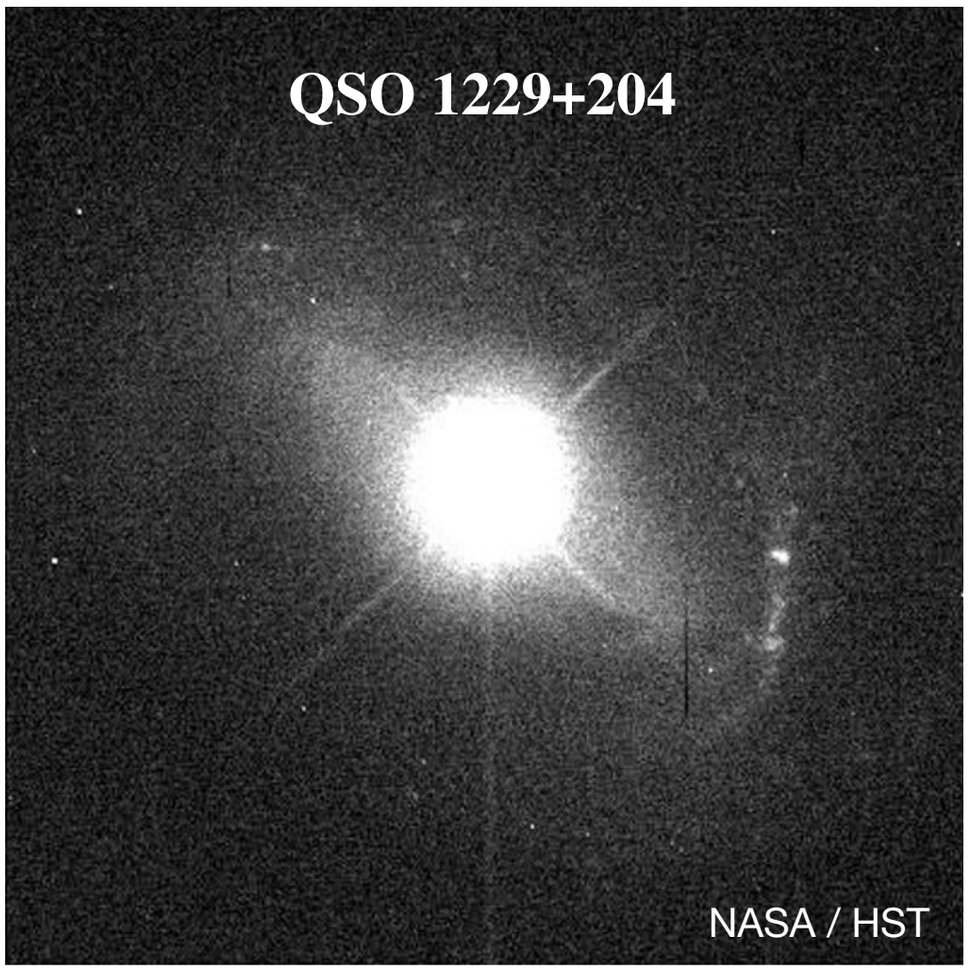


Genel+14

Vogelsberger+14

AGN feedback

quasar mode of AGN



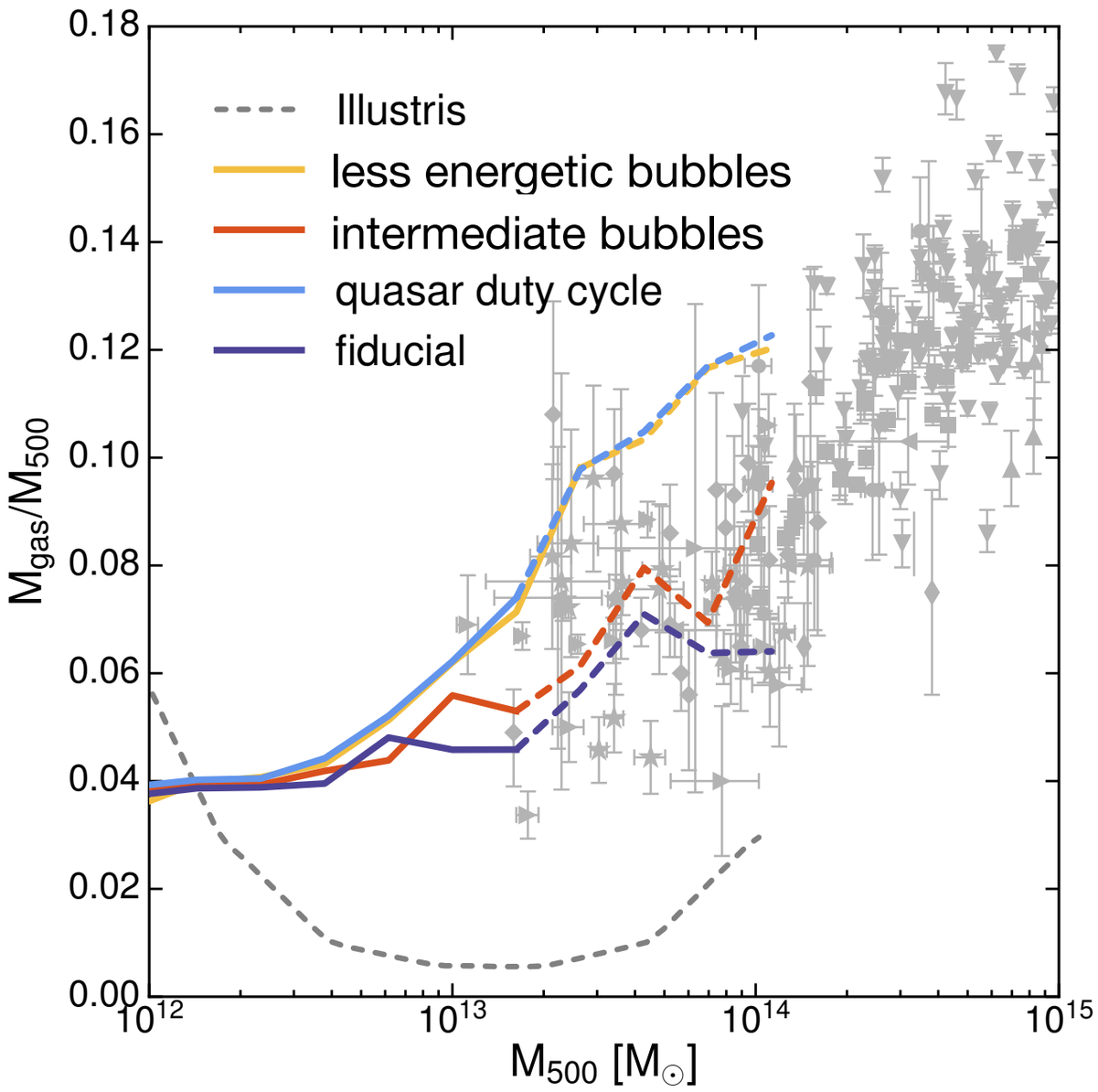
modelled by (continuous) injection of thermal energy around BHs

radio mode of AGN

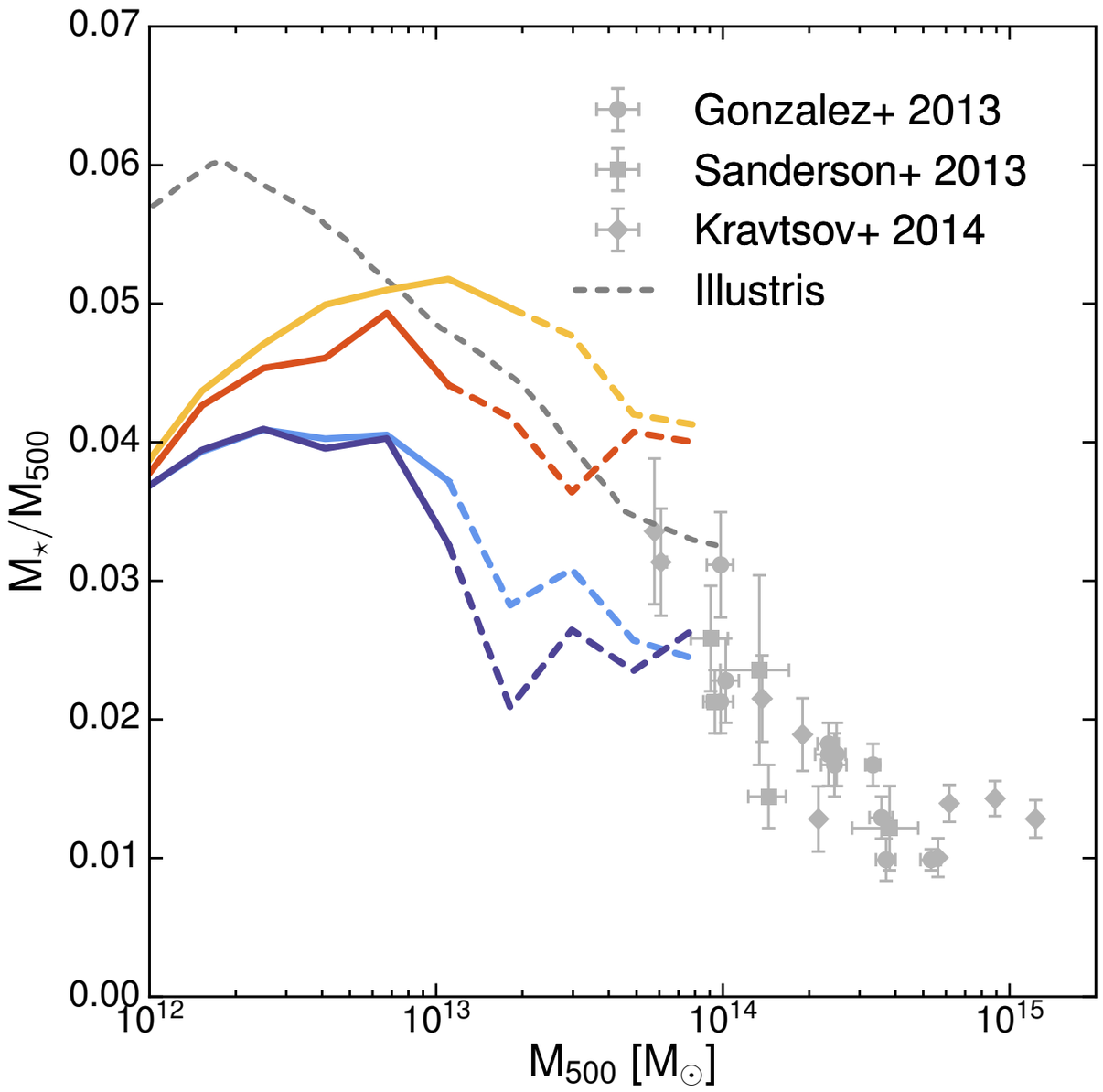
modelled by recurrent thermal injection of bubbles

Effect of quasar and radio mode feedback on stellar and gas fractions

effect of AGN feedback on gas fraction



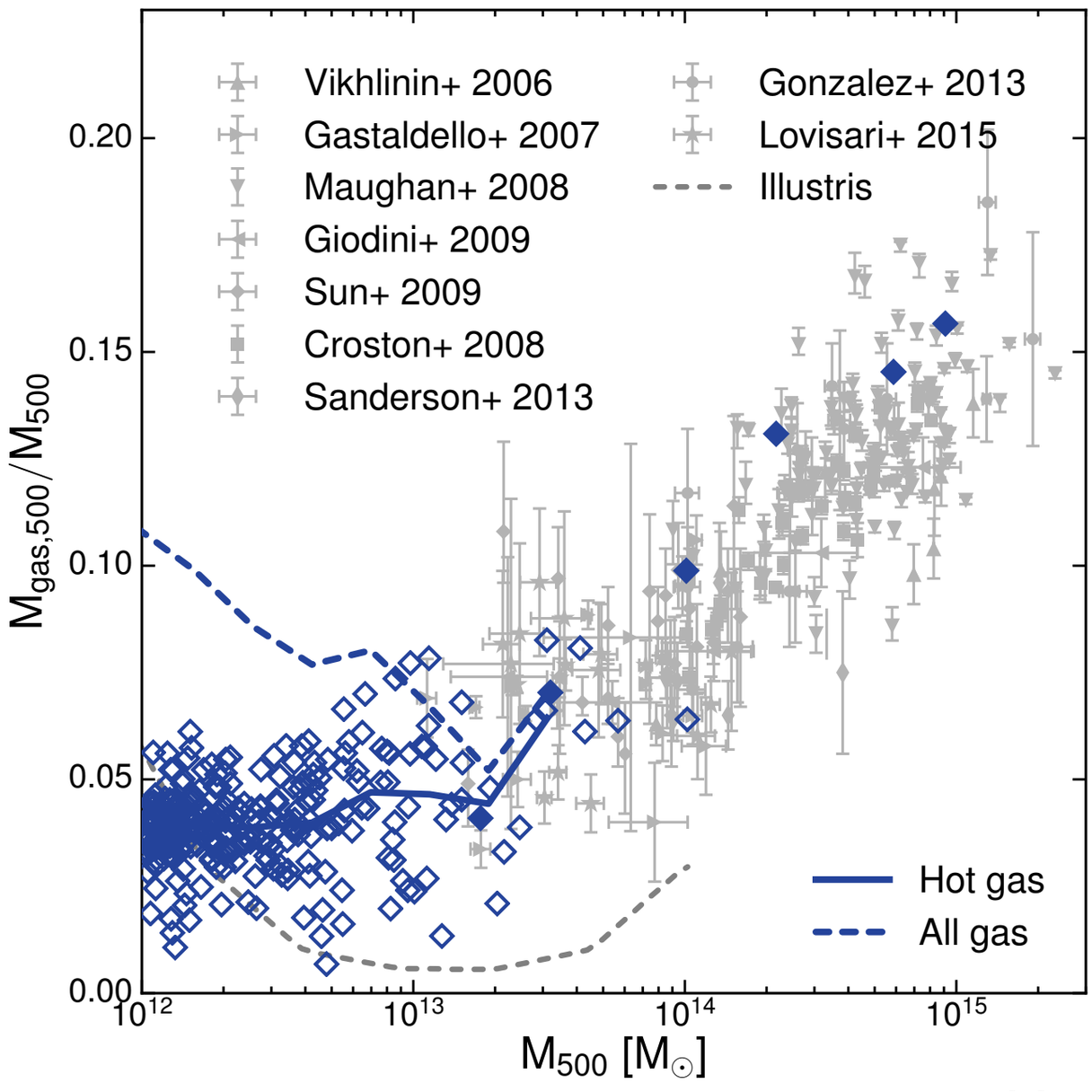
effect of AGN feedback on stellar fraction



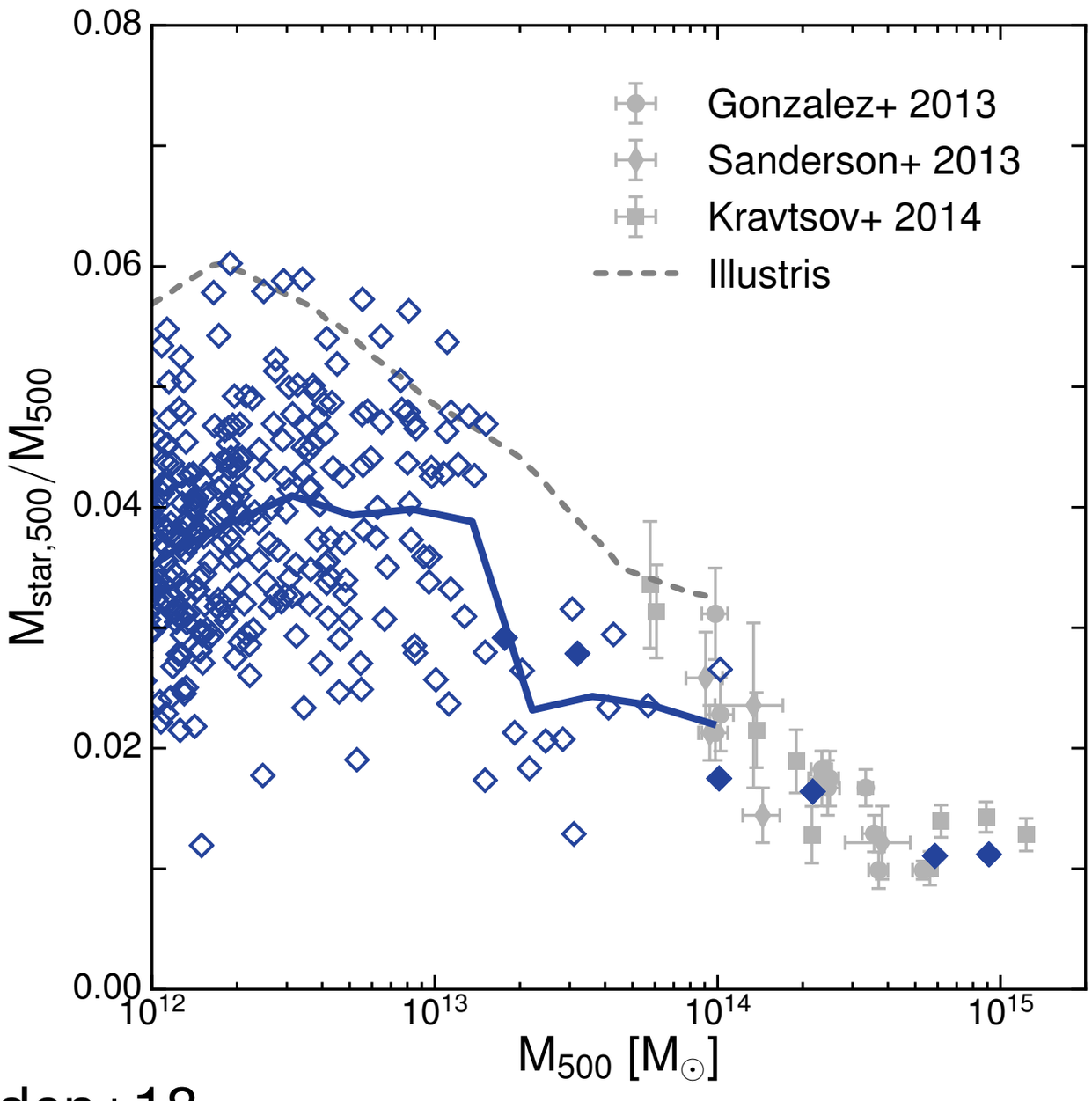
Henden+18

The FABLE simulations of galaxy, group and cluster formation

gas mass fraction



stellar mass fraction



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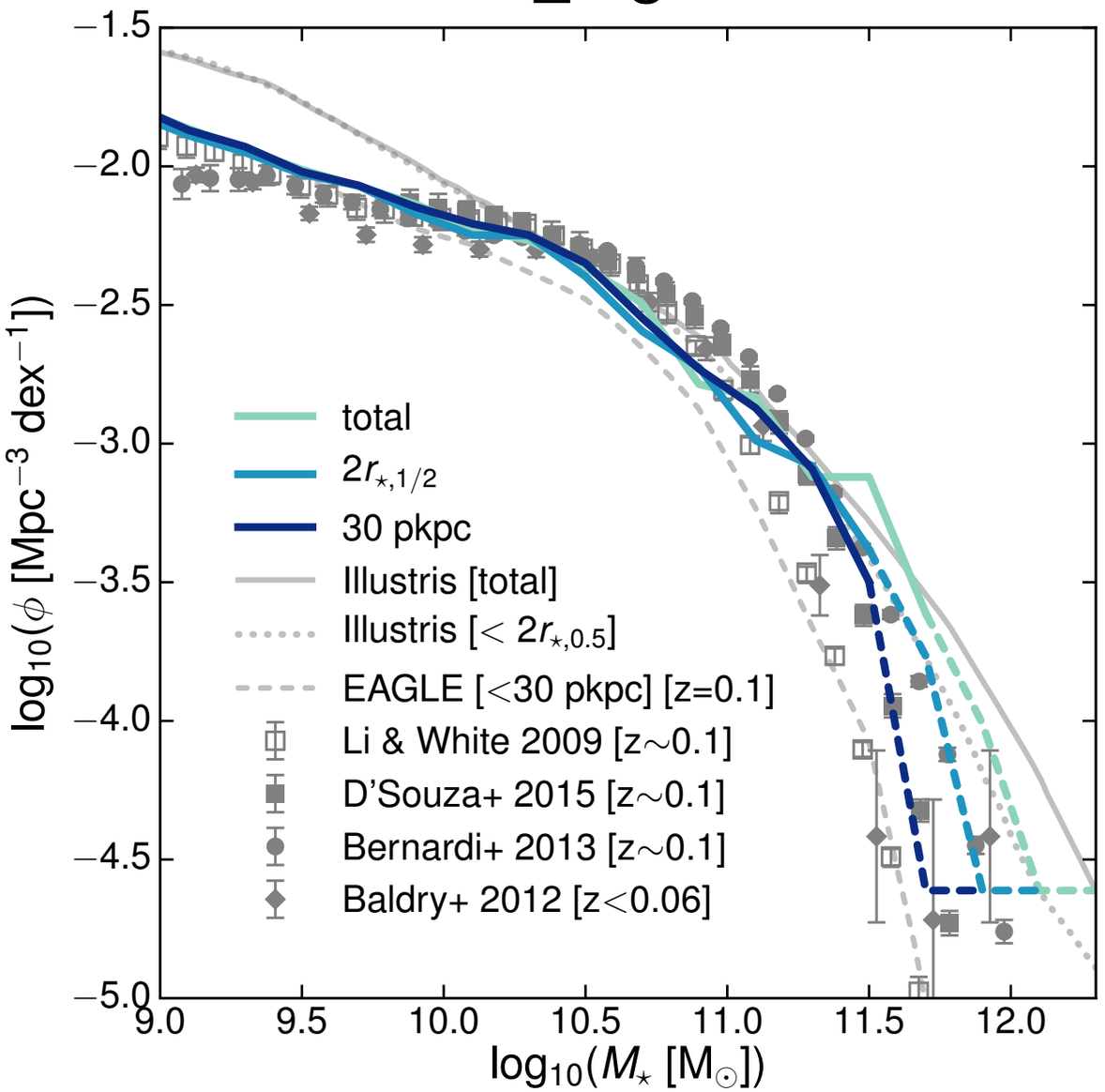
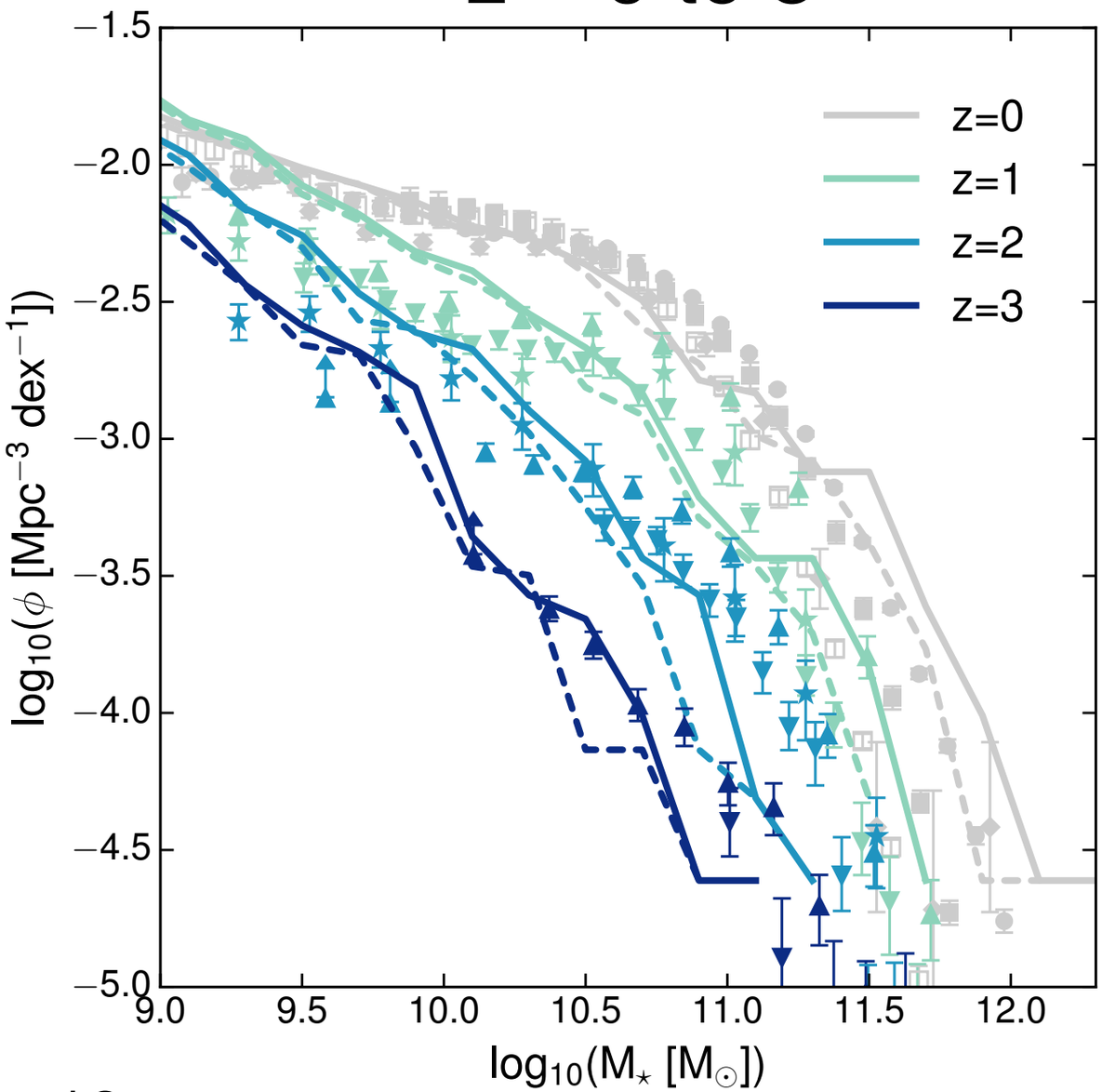
The FABLE simulations of galaxy, group and cluster formation

galaxy stellar mass functions





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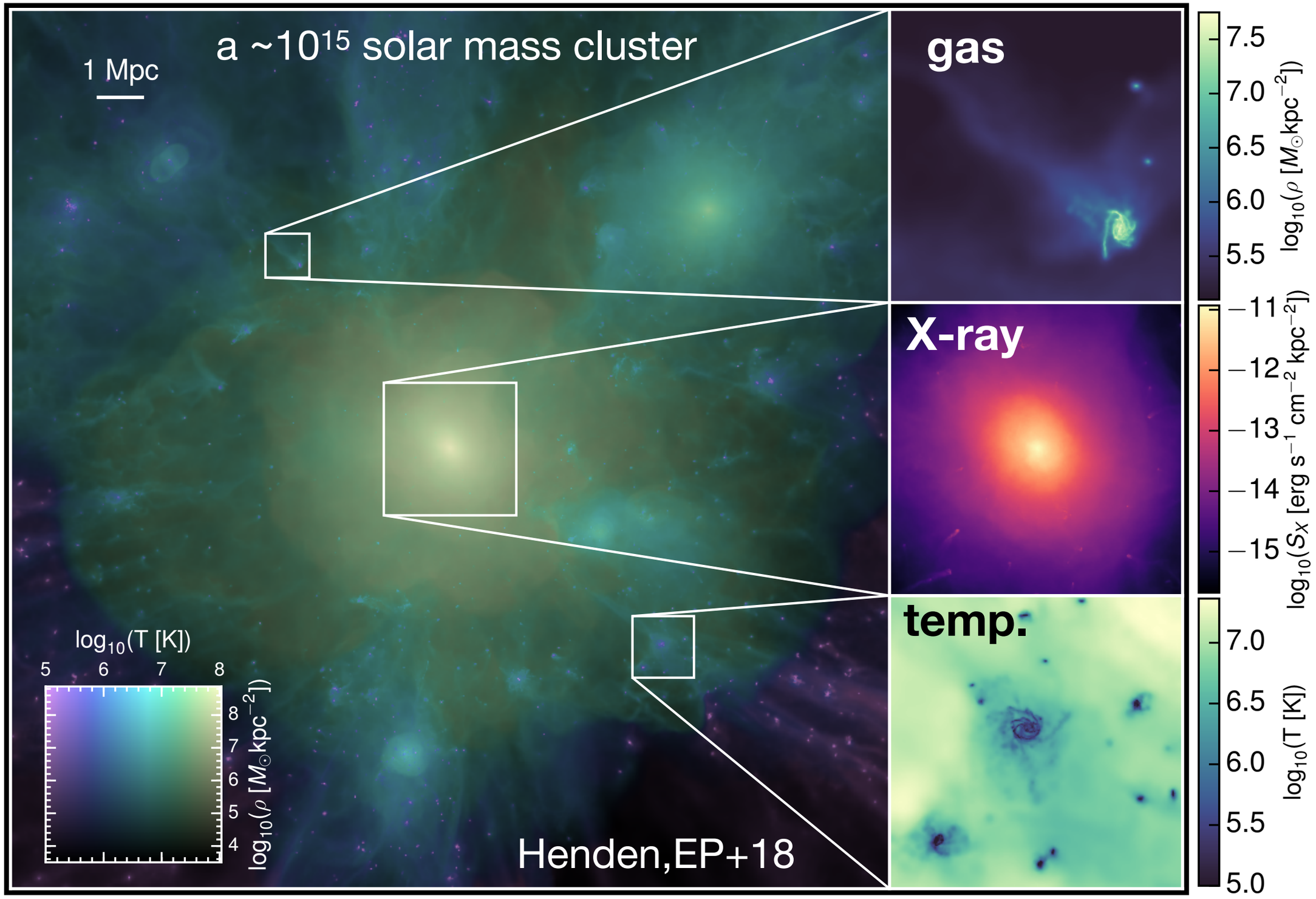
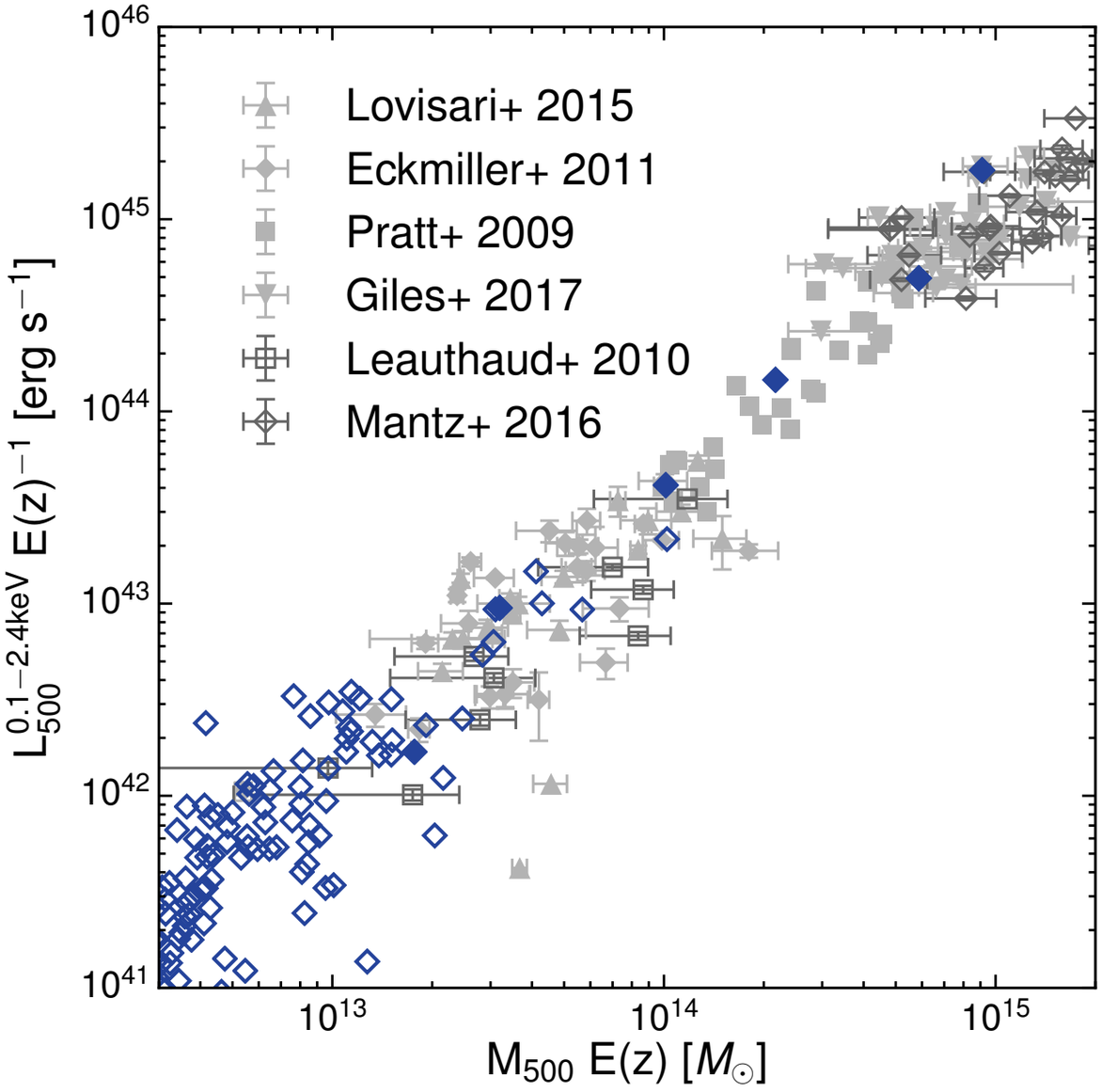
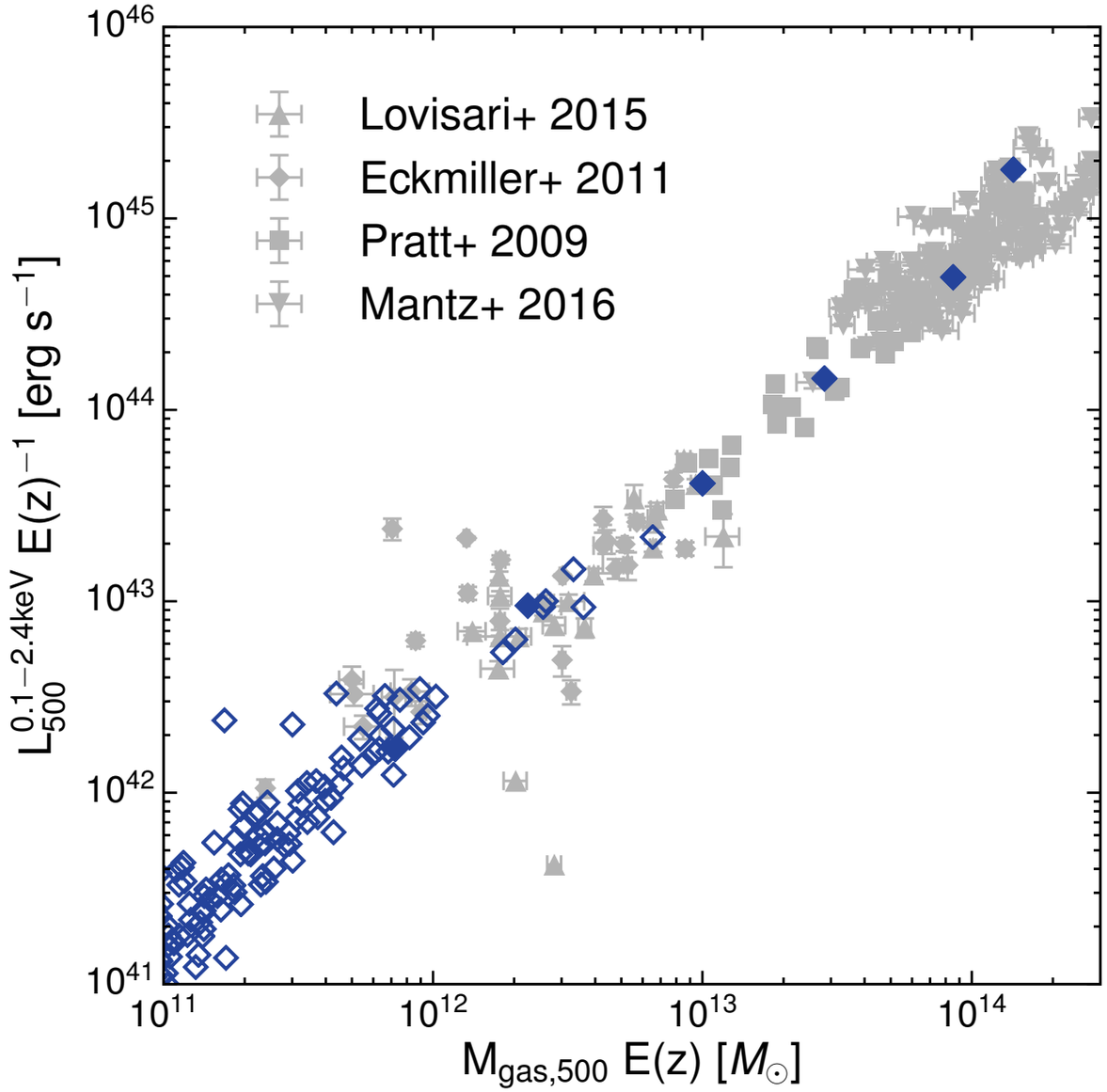
The FABLE simulations of galaxy, group and cluster formation



X-ray luminosity - mass relations





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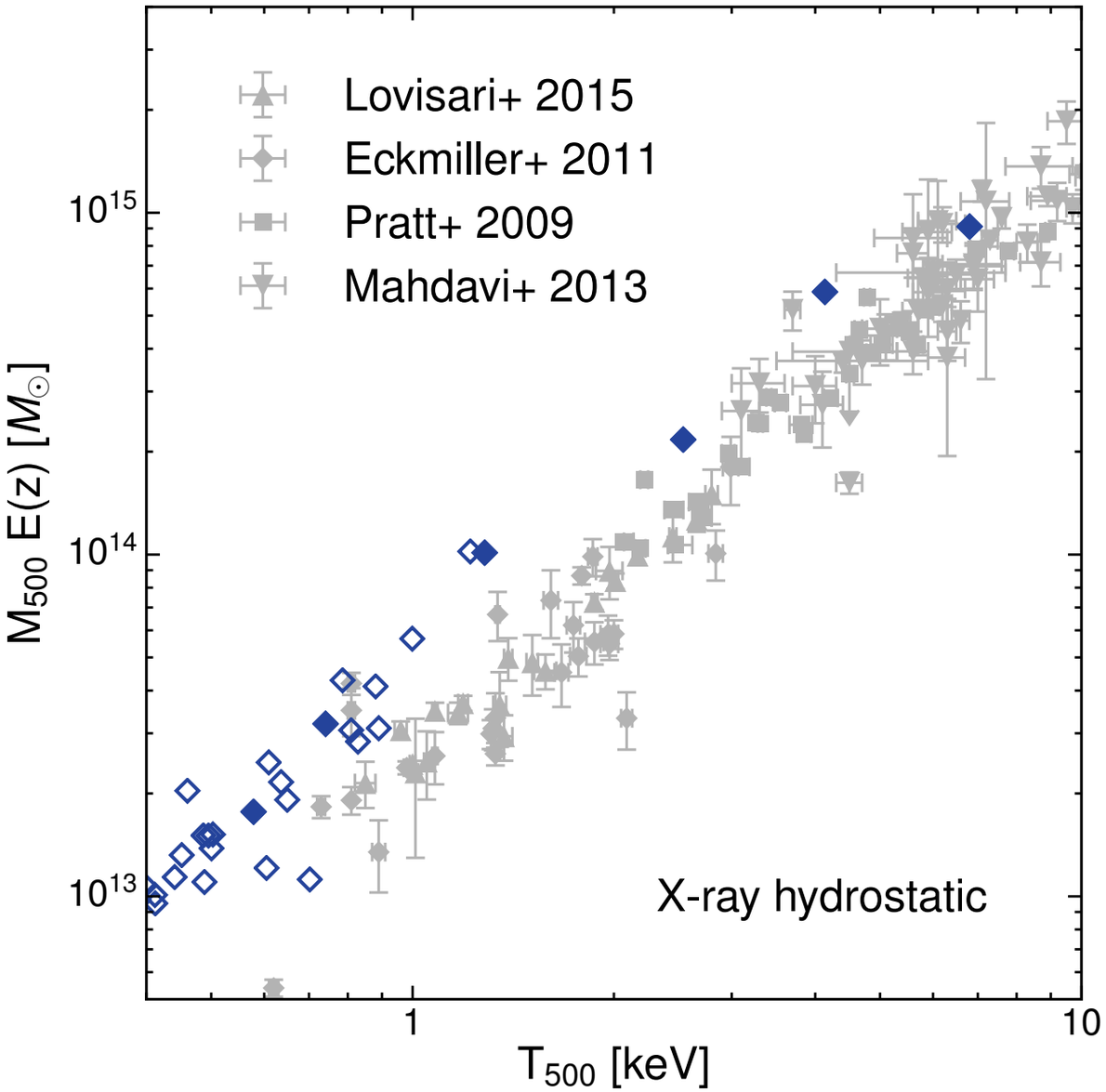
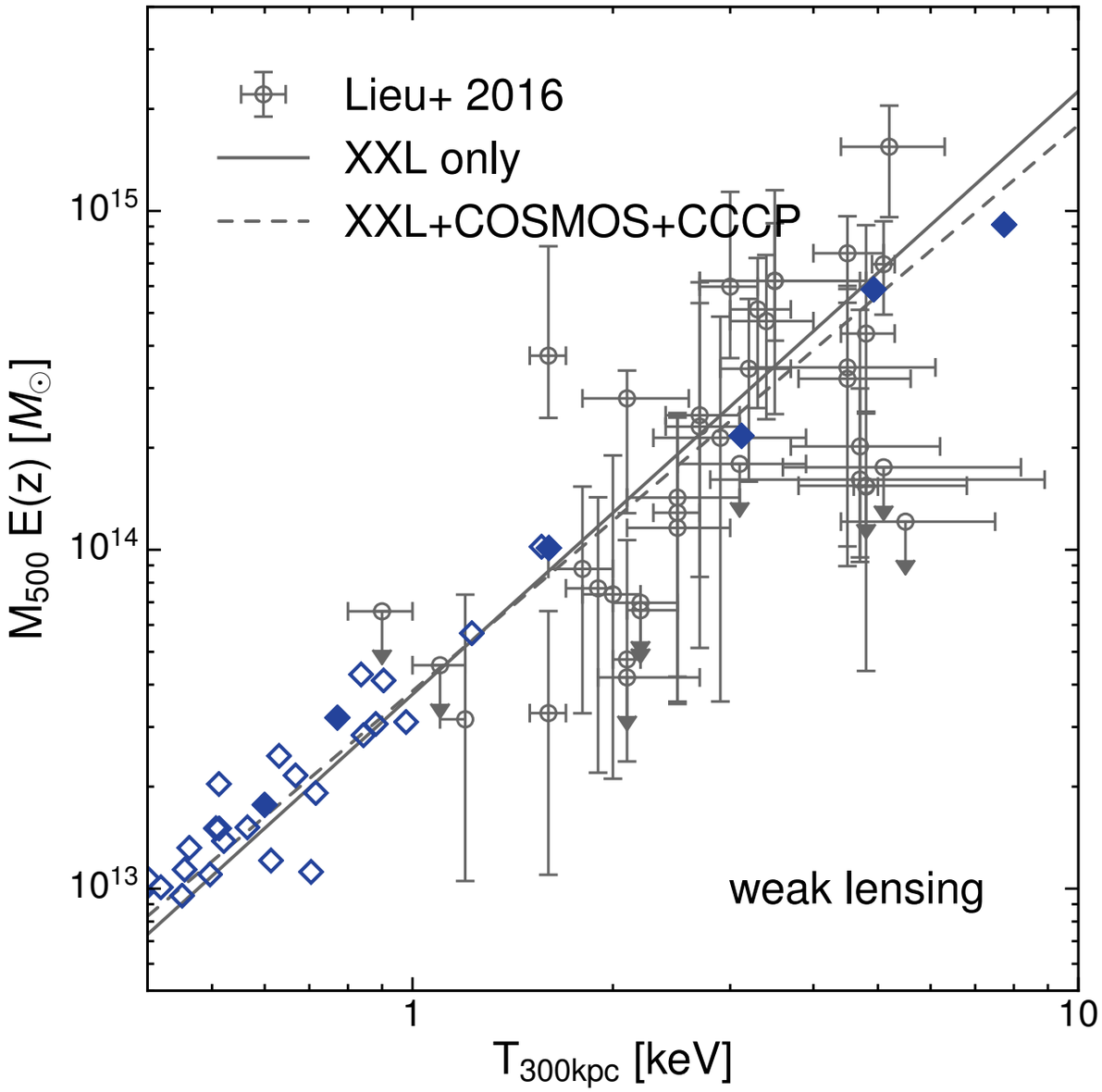
M-T relation in FABLE





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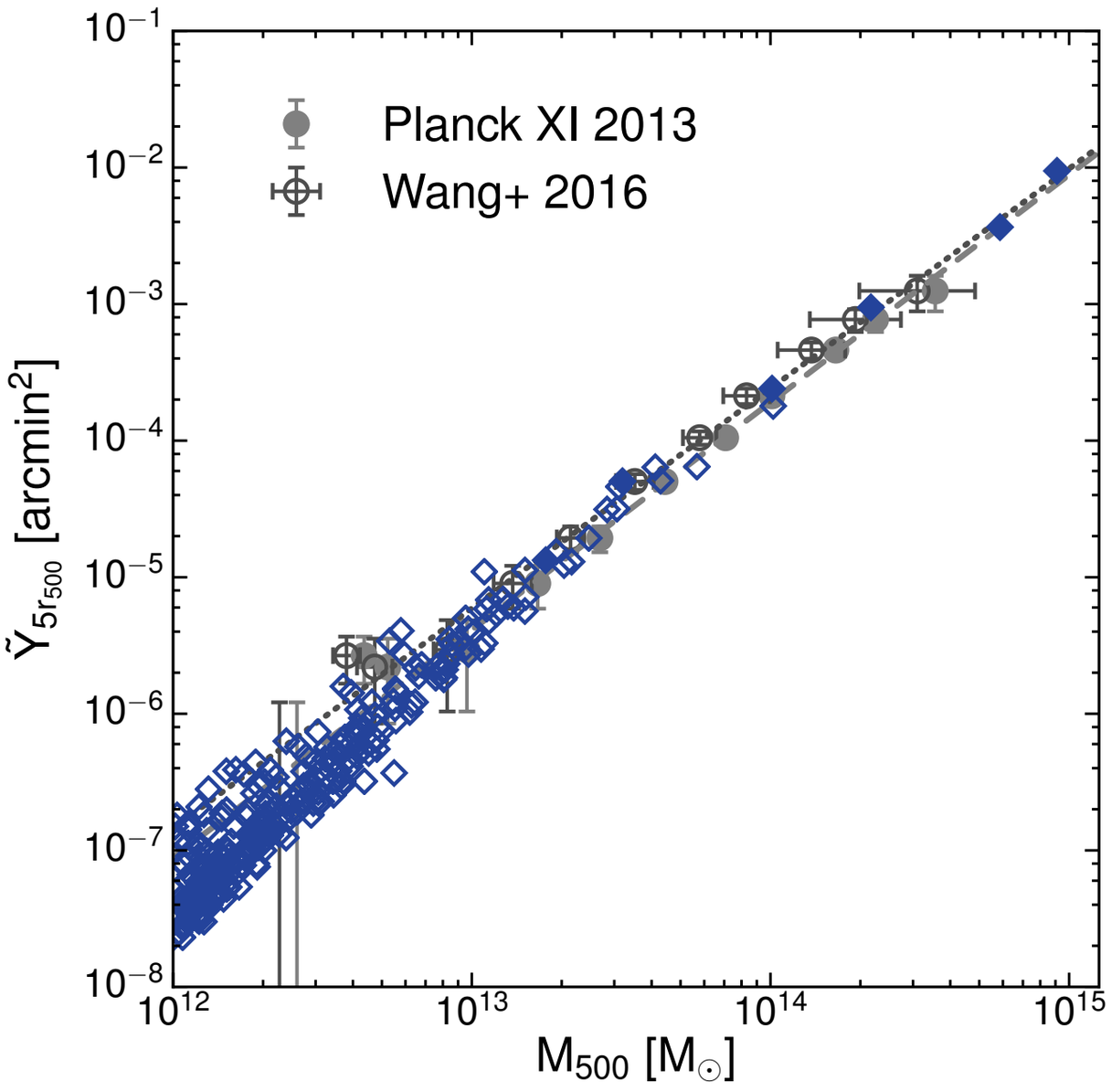
Sunyaev–Zel'dovich Y_{SZ}-mass relation

Planck



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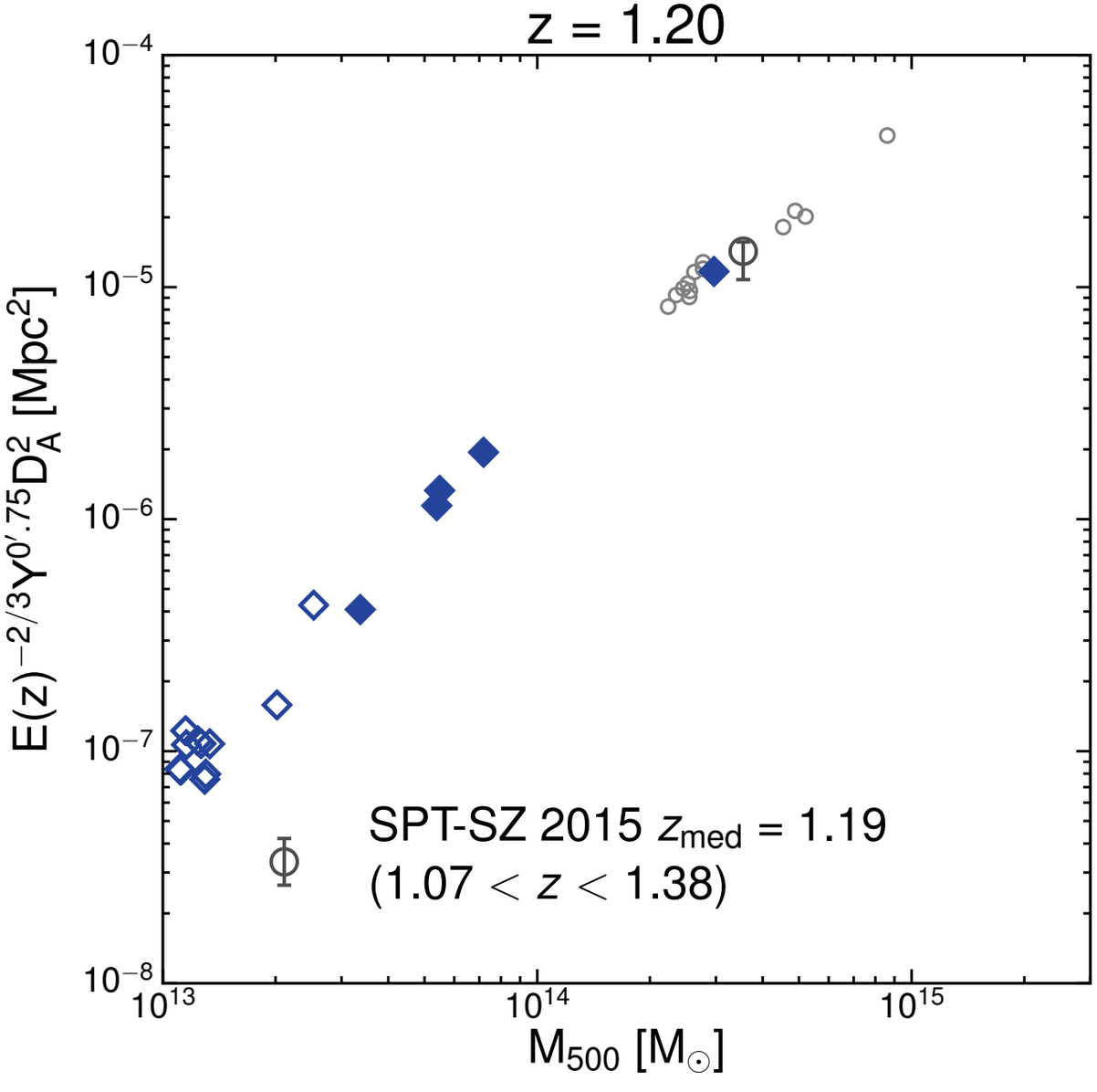
high-z SPT

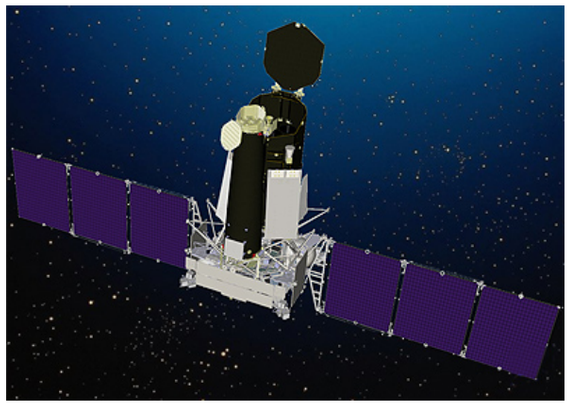


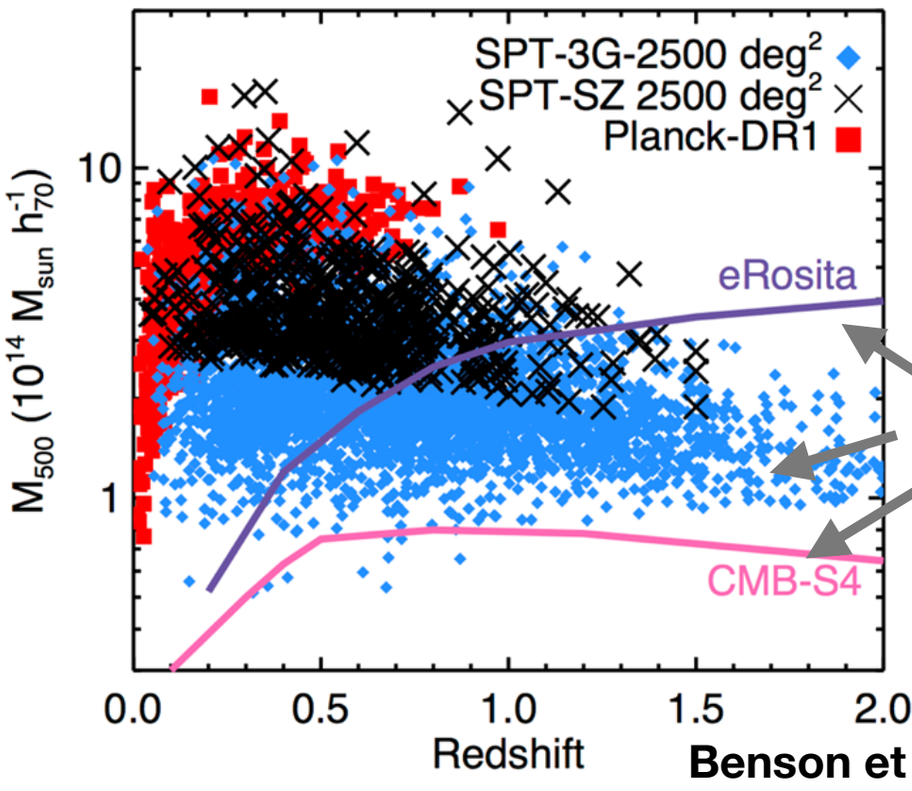
Henden+18, in prep.

hass relation

SPT-3G

eRosita (+ 4MOST)





upcoming high-z cluster samples

projections

Benson et al. 2014

M_{500} [$M_\odot$]

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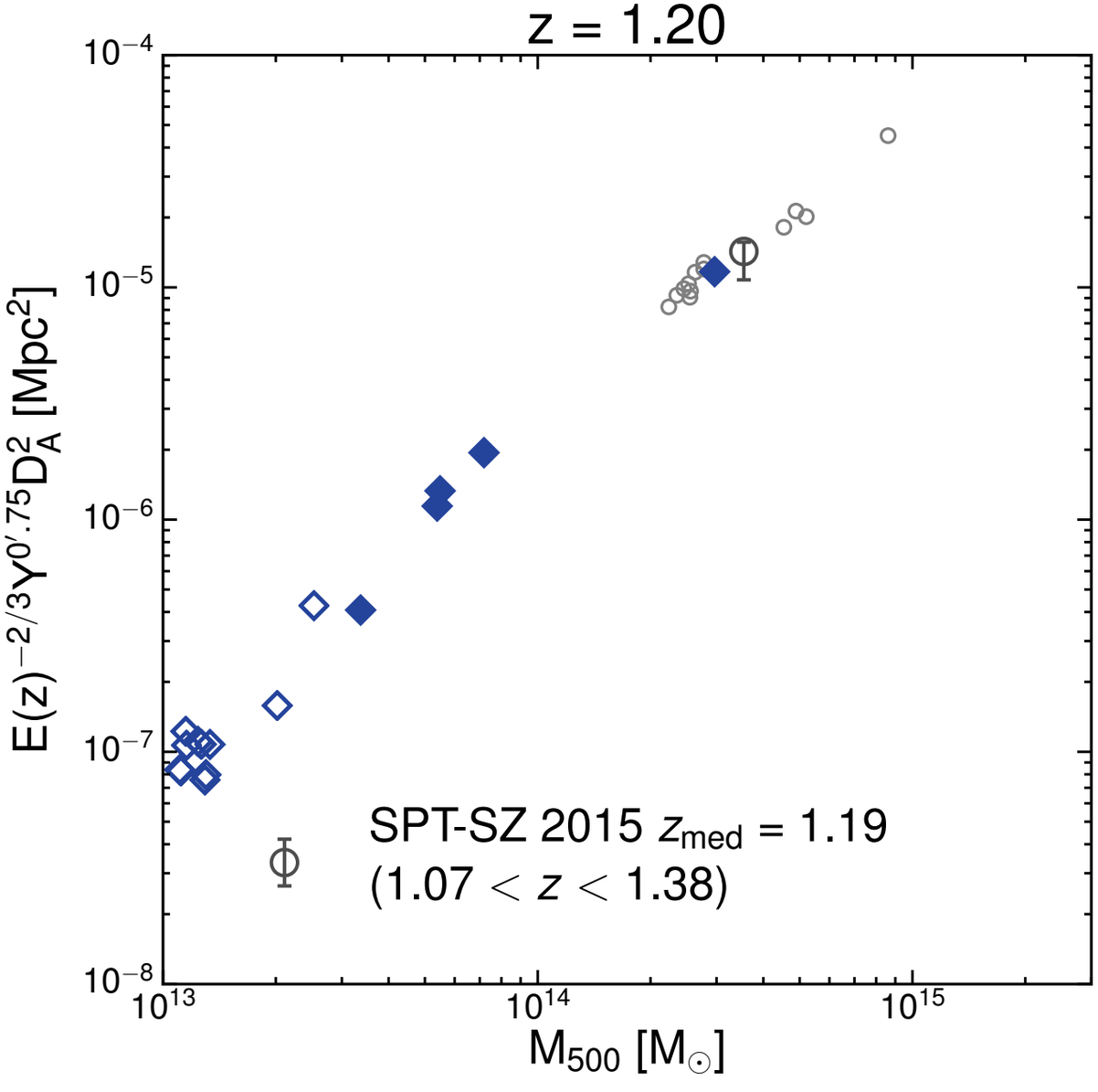
high-z SPT



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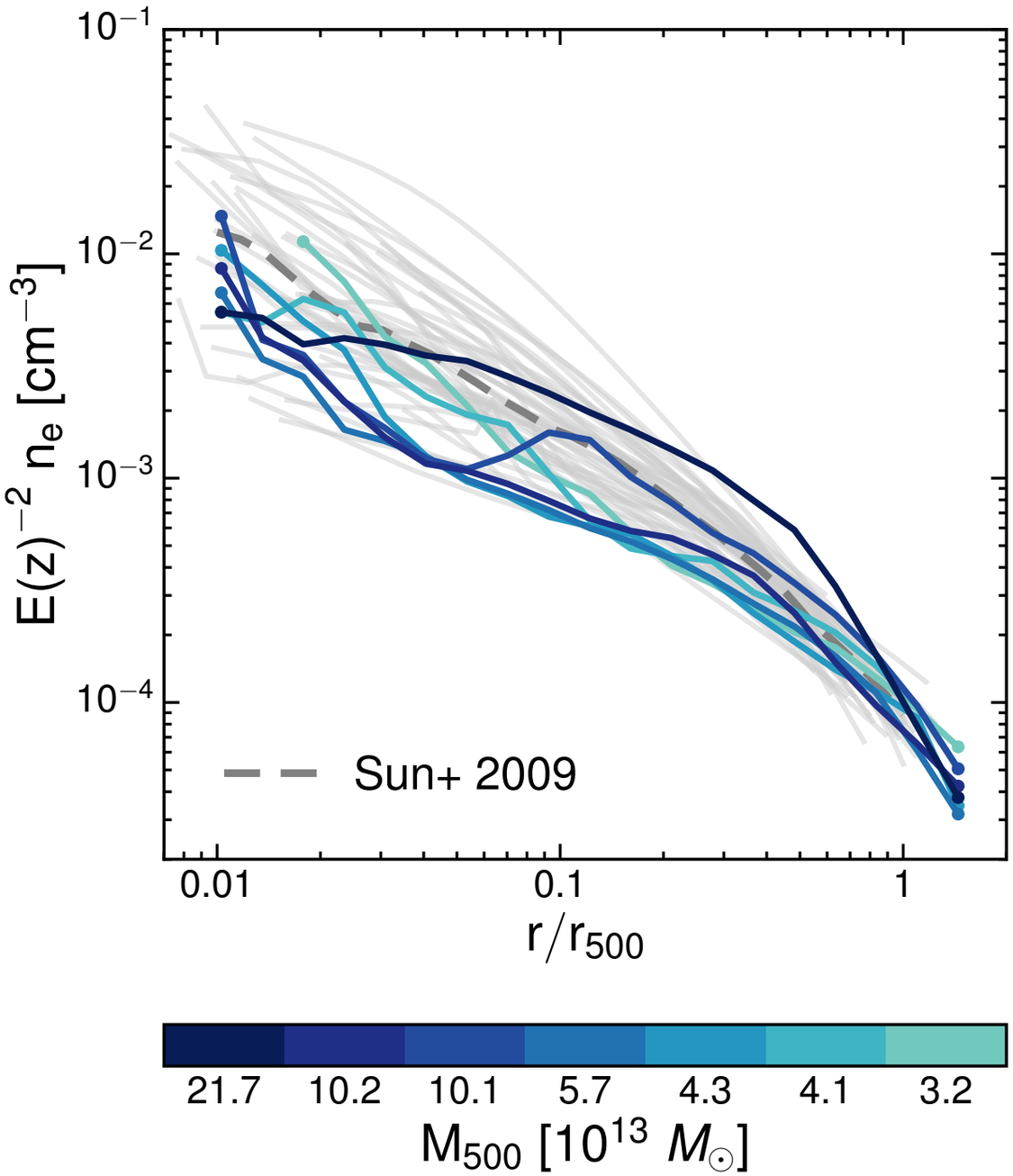
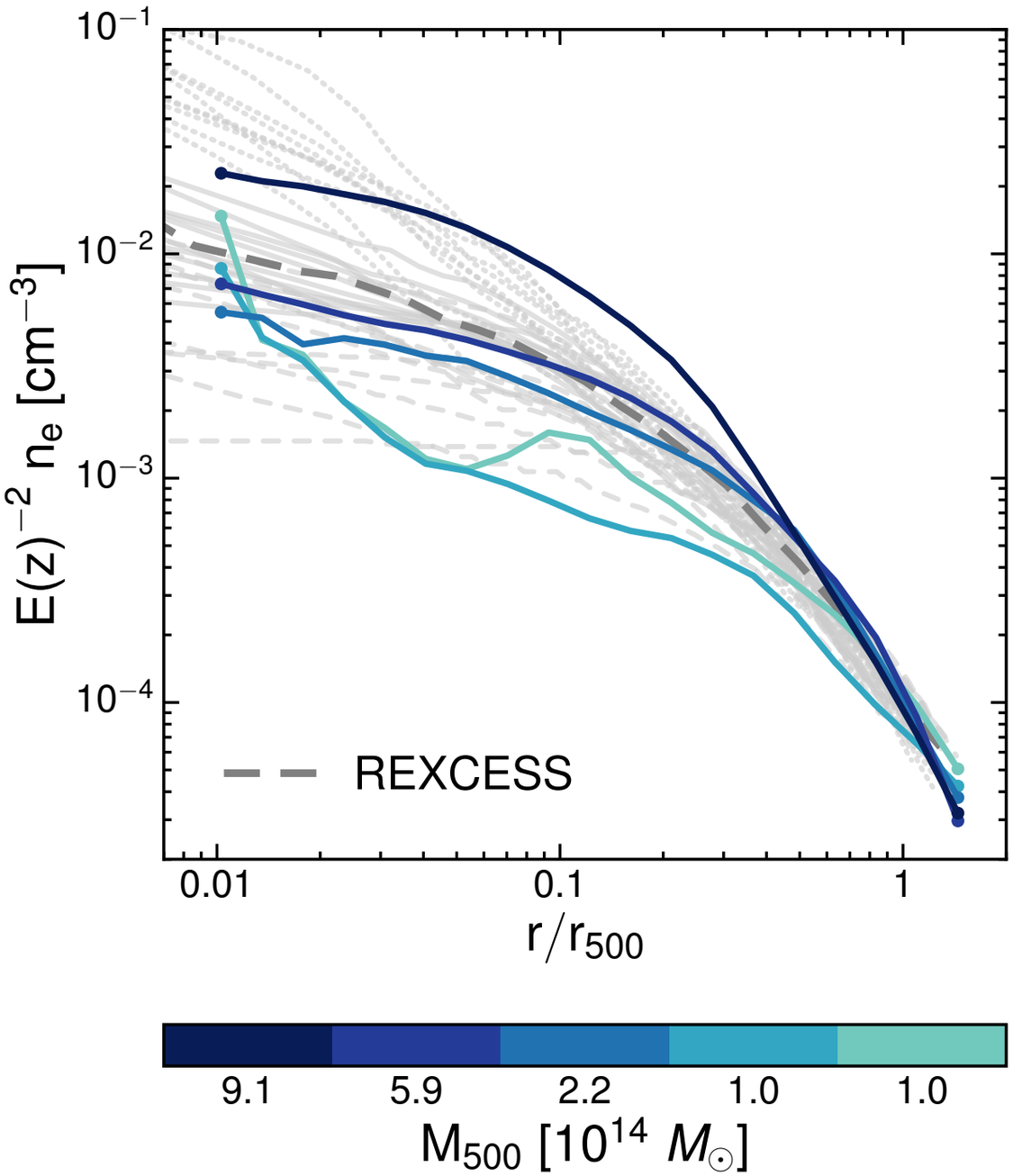
Intragroup / Intracluster medium density profiles





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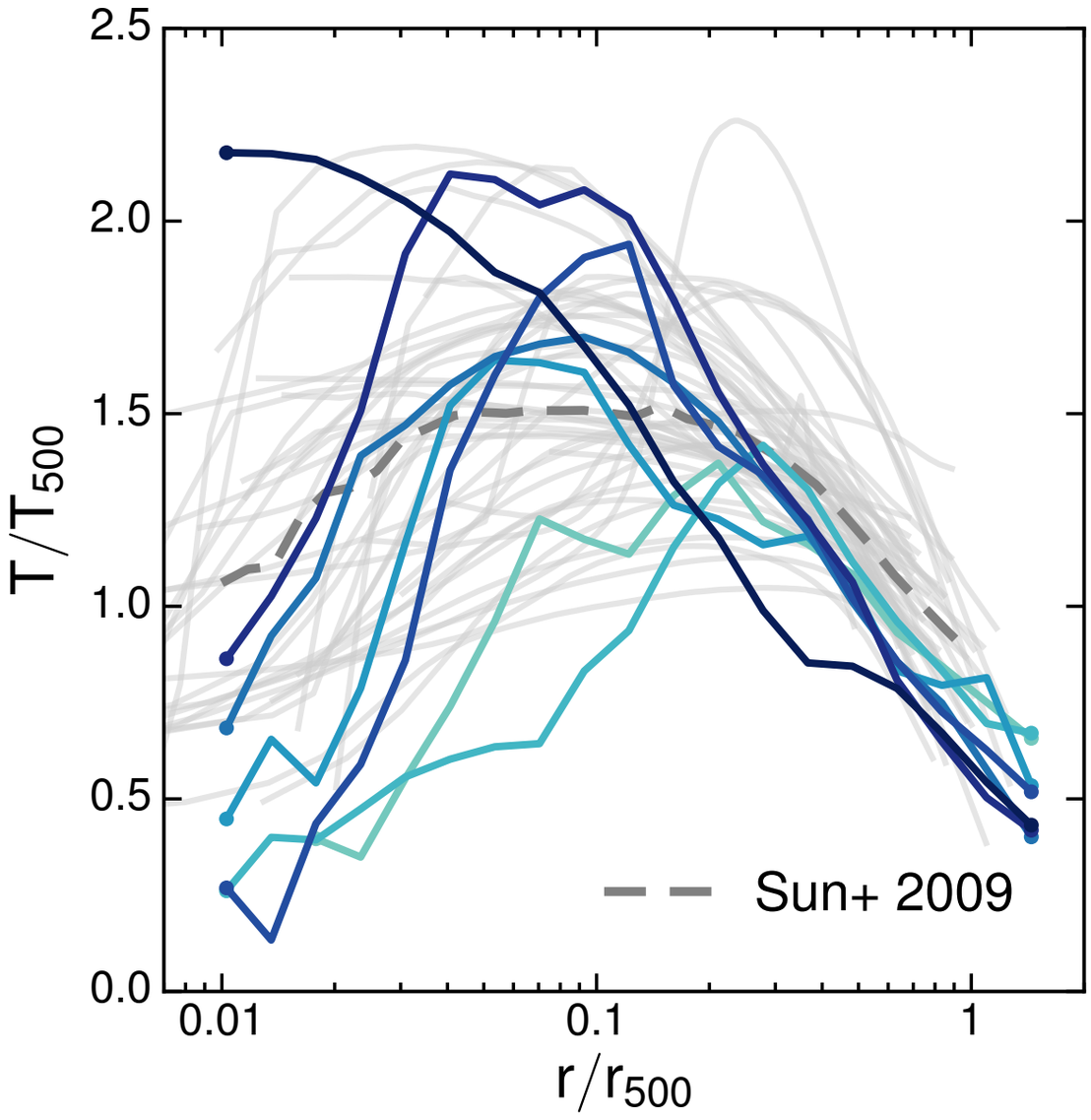
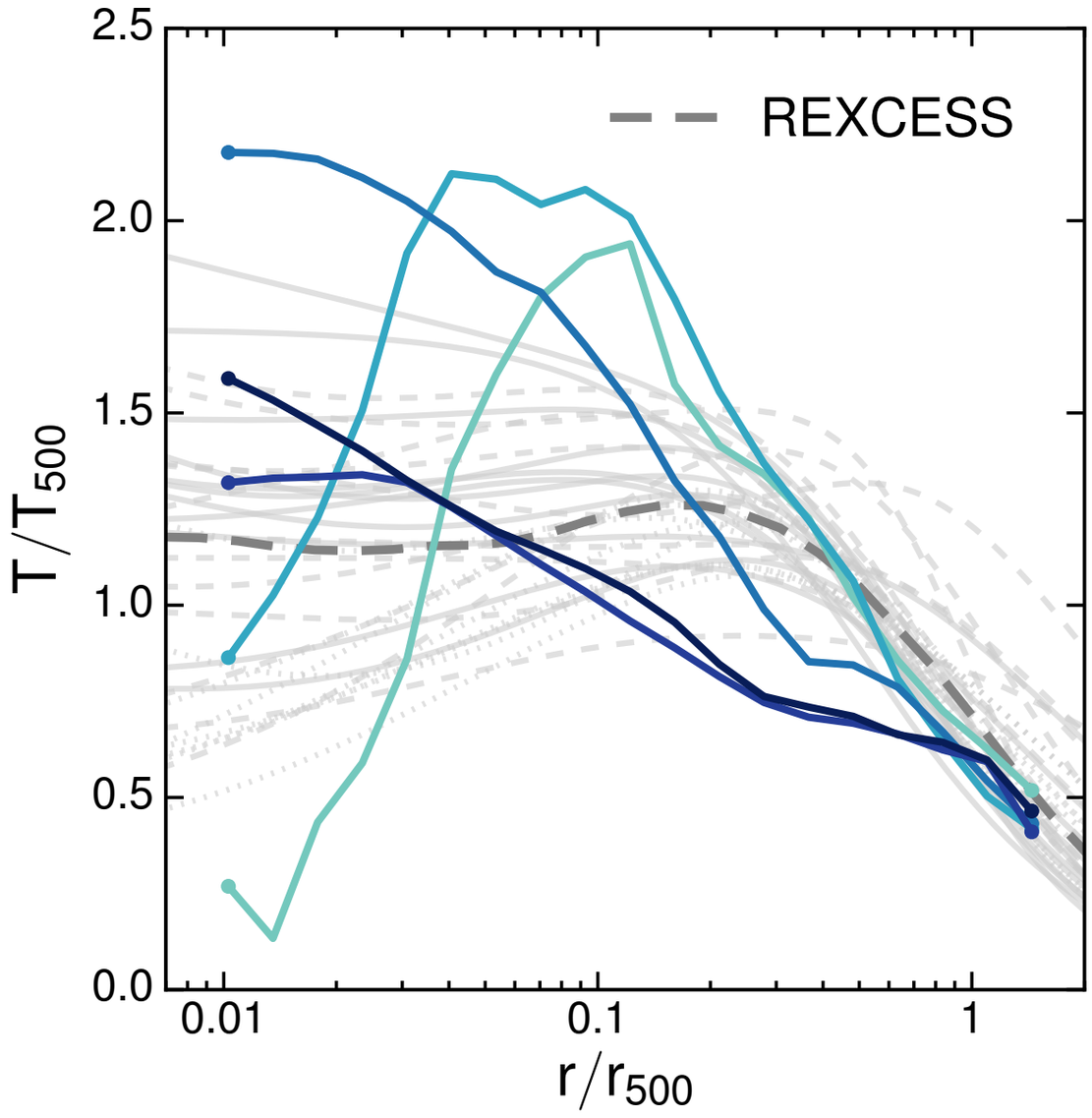
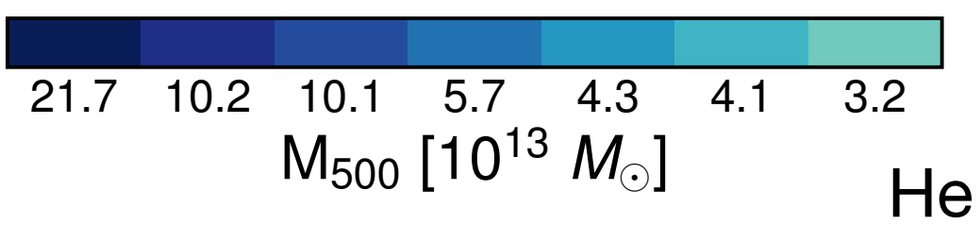
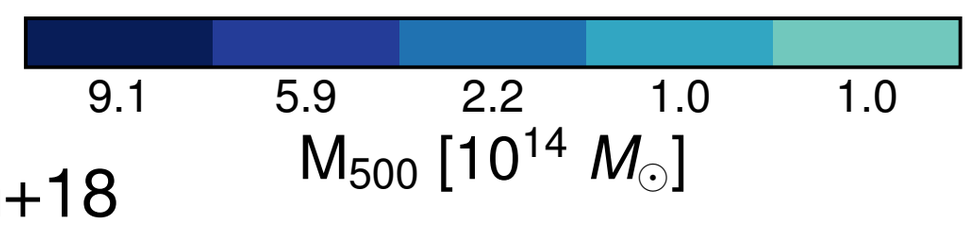
Group / cluster temperature profiles









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Summary

- radio mode controls gas mass fractions, quasar mode can suppress stellar fractions
- FABLE simulations reproduce a wide range of properties of the galaxy, group and cluster populations, e.g.:
  - galaxy stellar mass function
  - group/cluster gas and stellar fractions
  - mass-observable scaling relations
  - ICM profiles
- understanding mass bias is important for further improvement of group and cluster simulations
- FABLE useful for interpreting cluster cosmology studies and studying cluster physics
- but still room for improvement in core regions of clusters and groups (jets, non-thermal pressure needed?)