The SFMS and starbursts in *Illustris*

**Time Since Big Bang: 4 Billion Years**

Vogelsberger+14

Chris Hayward (Caltech)
Star Formation Across Space and Time, 13 November 2014
Outline

• The *Illustris* simulation
• The star formation ‘main sequence’ in *Illustris*
• Starbursts in *Illustris*
• Is the main sequence a red herring?
The *Illustris* simulation

- Cosmological hydro sim w/ (106.5 Mpc)$^3$ volume
- $1820^3$ DM particles & $1820^3$ gas cells
- Softening $\sim0.7$ kpc
- See Vogelsberger +14a,b, Genel +14…
Included ‘physics’

• Cooling (primordial & metal-line)
• Effective equation-of-state ISM treatment
• Stochastic star (cluster) formation
• Stellar evolution, gas recycling, & chemical enrichment
• Kinetic feedback from SNe
• SMBH seeding, accretion, & merging
• AGN feedback (quasar-mode, radio-mode, & photoionization)
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The star formation main sequence and stellar mass assembly of galaxies in the Illustris simulation

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Please hire me!
The star formation main sequence

Sparre, CCH+14
SSFR evolution

Sparre, CCH+14

Genel+14
Scatter in the SFMS

Sparre, CCH+14
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Definition of starbursts

Rodighiero+11
A paucity of starbursts

 Rodighiero 2011
Low. res. $z = 2$
Low. res. $z = 0$

$1.5 < z < 2.5$

Sparre, CCH+14
Burstiness of SFHs

A) Late SF
- Galaxy SFH
- Mean
- Mean+PC₀
- Mean+PC₀+PC₁

B) Early SF

C) Random

D) Random

E) Random

Normalised SFR [Gyr⁻¹] + offset

Lookback time (Gyr)

Sparre, CCH+14
Variability timescale

Cumulative fraction of variance

Number of PCs included


- $M_* = 10^9 M_\odot$
- $M_* = 10^{10} M_\odot$
- $M_* = 10^{11} M_\odot$
- $M_* > 1.57 \times 10^{11} M_\odot$
- 95% limit

Sparre, CCH+14
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Red Herrings

THE "MAIN SEQUENCE" IS NOT A USEFUL CONSTRAINT

Hopkins+14
Redshift evolution of SFMS normalization is qualitatively recovered in *Illustris*, but normalization too low at $z \sim 2$

However, the existence of an SFMS is not a useful constraint

Starburst fraction is less than that inferred from observations

**Problem:** SFR is closely coupled to DM accretion rate

**(Potential) solution:** better feedback models and higher res