Quenching of Central Galaxies in the Next Generation Illustris Simulations (IllustrisTNG)

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Oct. 06, 2017 The Role of Gas in Galaxy Dynamics — Valletta

http://www.tng-project.org movie: Mark Vogelsberger, IllustrisTNG collaboration
The IllustrisTNG simulations — details

- Updated model for galaxy formation physics
  - New model for AGN feedback
- Magnetohydrodynamics
- Extended scope (3 different boxes)
The IllustrisTNG simulations — the black hole model

two-mode AGN feedback

- low mass, high accretion rate: thermal (rather inefficient)
- high mass, low accretion rate: kinetic (very efficient)

RW et al. (2017)
The IllustrisTNG simulations — the black hole model

two-mode AGN feedback

- low mass, high accretion rate: thermal (rather inefficient)
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Observed and simulated signatures of quiescence

• Use galaxy colors proxy of star formation rate

• Comparison to SDSS

• Kinetic AGN feedback is necessary to get a color bimodality

Nelson et al. (2017)

RW et al. (2017)
AGN feedback in massive galaxies

\[ \log_{10}(\text{stellar mass} [M_\odot]) \]

\[ \log_{10}(\text{specific star formation rate} [\text{yr}^{-1}]) \]

\[ z=4 \quad z=2 \quad z=1 \quad z=0 \]
AGN feedback
in massive galaxies - quenching

RW et al. (in prep.)
AGN feedback in massive galaxies - quenching

RW et al. (in prep.)

CDF

energy injection during quenching [erg s$^{-1}$]

- not important
- cooling loss
- thermal

fraction (> t)

log$_{10}$(stellar mass [M$_\odot$])

rate [10$^{-6}$ Mpc$^{-3}$ Gyr$^{-1}$]

lookback time of quenching [Gyr]

Cooling loss not important

Energy injection during quenching [erg s$^{-1}$]
AGN feedback in massive galaxies - quenching

RW et al. (in prep.)
AGN feedback in massive galaxies - quenching

energy injection during quenching [erg s$^{-1}$]

CDF

fraction (> $t$)

rate [10$^{-6}$ Mpc$^{-3}$ Gyr$^{-1}$]

lookback time of quenching [Gyr]

thermal

kinetic

RW et al. (in prep.)

kinetic feedback quenches galaxies
AGN feedback
in massive galaxies - quiescence

RW et al. (in prep.)
AGN feedback
in massive galaxies - star forming

energy injection during quenching [erg s\(^{-1}\)]

thermal feedback in star forming galaxies
AGN feedback in massive galaxies

RW et al. (in prep.)

CDF

fraction (> t)

rate [10^{-6} Mpc^{-3} Gyr^{-1}]

energy injection during quenching [erg s^{-1}]

thermal
kinetic
quiescent
star forming
What does this mean for galaxies?

- Need low accretion rates to trigger quenching
  - Gas fueling an AGN does not help to quench a galaxy
Major mergers and quenching of galaxies

Di Matteo et al. (2005)

Hopkins et al. (2008)

Pontzen et al. (2017)
Do major gas rich mergers quench galaxies?

RW et al. (in prep.)
Do major gas rich mergers quench galaxies?

most of the quenching events are not triggered by galaxy major mergers
Conclusions

• IllustrisTNG reproduces colors of central galaxies

• Quenching via kinetic feedback at (moderately) low accretion rates

• Luminous AGN do not cause quenching!

• Most quenching events not triggered by a (gas rich) major merger