Overview of Illustris TNG

IllustrisTNG (The Next Generation) is a suite of Cosmological, Magneto-Hydrodynamical Simulations, run with the AREPO moving-mesh code.

The simulation suite consists of 3 cubic volumes, 50, 100 and 300 Mpc/h on a side. This yields both objects simulated in high-resolution suitable for detailed study of galaxies and their halos, as well as a very large statistical sample of objects for a more comprehensive study of the properties of galaxies and clusters.

Additional runs: DM only counterparts and lower resolution runs (for convergence studies).

Physical Process Incorporated in Illustris TNG:

- Microphysical gas radiative physics: primordial and metal-line cooling and heating with an evolving background radiation field.
- Star formation in the dense interstellar medium.
- Stellar population evolution and chemical enrichment from type Ia and II supernovae, and AGB stars, individually tracking elements: H, He, C, N, O, Ne, Mg, Si, and Fe.
- Stellar feedback driven galactic-scale outflows.
- Formation, merging, and accretion of nearby gas by SMBH.
- Multi-mode Black-Hole feedback:
  - Thermal ‘quasar’ mode at high accretion states (QM).
  - Kinetic ‘wind’ mode at low accretion states (KM).
- Amplification of cosmic magnetic fields from a minute primordial seed field at early times.
- ‘On-the-Fly’ Shock Capturing.

The Effect of BH Feedback on Galaxies and Halo Gas

The gas in Star Forming, central galaxies are much cooler than their virial temperature of their halos (solid line with errorbars).

A significant population of quenched galaxies at $\sim 10^{10} M_\odot$ is as hot, or hotter than the virial temperature of the host.

The gas in the quenched population at intermediate masses has been evacuated.

Massive, quenched galaxies still retain considerable amounts of gas.

On the left, we show the ratio between the cumulative energy injected by the BH in the Kinetic Mode (KM) to that injected by the Quasar (thermal) Mode.

The intermediate-mass quenched population corresponds to the point where the Kinetic Mode becomes increasingly important, and effectively removes gas from the galaxies, despite being sub-dominant in absolute energy injection.