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X-ray manifestations of AGN feedback, mergers and satellite accretion with the IllustrisTNG simulations

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With the cosmological magneto-hydrodynamical simulations IllustrisTNG (https://www.tng-project.org/), we are putting together ever more quantitative and plausible evidences as to the role that feedback from SMBHs can have in determining the physical properties of the gas in and around galaxies, all the way up to the mass scale of galaxy clusters. Powerful energy injections originating from the innermost regions of massive galaxies can drive 100s-1000s km/s gas outflows (Nelson+2019a, Pillepich+2021) that in turn shock heat the gas within and around them (Weinberg+2017), decreasing the density (Terrazas+2020, Davies+2020) and increasing the entropy and cooling times of the gaseous haloes (Zinger+2020). In practice, according to our models, SMBH feedback strongly modulates the physical properties of the gas that determine its X-ray emission and the kinematics of the hot gas (Truong+2020, Truong+2021a,b). The same model for SMBH feedback produces the most diverse manifestations in the gas distribution, thermodynamics and kinematics: from large-scale, coherent features of overpressurized and X-ray emitting gas that impinge into the gaseous halo of simulated Milky Way- and Andromeda-like galaxies and that are reminiscent of the eROSITA and Fermi bubbles in the Galaxy (Pillepich+2021); to pressure waves around brightest cluster galaxies that are reminiscent of the ones observed in Perseus. At the same time, the intra-halo gas is also affected by accretion events, such as satellite galaxies plunging into massive clusters at supersonic speeds. With IllustrisTNG, we predict that such galaxies, which undergo ram pressure stripping and are often called jellyfish, frequently produce large-scale bow shocks in their surrounding intra-cluster medium (Yun+2019). I will give an overview of these simulation-based results, our attempts to connect them to future X-ray imaging and IFU observations, and introduce a new simulation suite: TNG-Cluster (co-PIs: Pillepich/Nelson), where we deliver ~350 haloes more massive than 10^14.5 Msun, including ~90 truly massive clusters (~10^15 Msun), with the same all-encompassing underlying full-physics IllustrisTNG model and with a baryonic mass resolution of ~10^7 Msun and ~kpc-level spatial resolution.

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