Cosmic Himalayas in CROCODILE: Investigation of quasar overdensities at Cosmic Noon by Cosmological hydrodynamic simulation and Mock Observation

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The recently discovered "Cosmic Himalayas" (CH, Y. Liang et al. 2025) represents an extreme overdensity of quasars (delta = 30) at z~2. Such an unprecedented structure poses critical questions, the first being whether these extreme overdensities can be physically realised within current cosmological models. To address this, we performed statistical analyses (count-in-cells and nearest neighbour distribution) of active galactic nuclei (AGN) using the CROCODILE simulation (Y. Oku & K. Nagamine 2024). Our simulation-based evaluation demonstrated that such extreme quasar overdensities naturally emerge from the non-Gaussian tails of the count-in-cells probability distribution, allowing us to successfully identify CH analogues within the CROCODILE framework. Building upon these findings, we address other key observational mysteries: the spatial offsets observed between the quasar distribution and Lyman-alpha emitters (LAEs) around the CH region; the asymmetric ionisation field with the quasar overdensities. By performing mock observations of our simulated CH analogues using radiative transfer code ART2, we investigate the radiative and environmental properties of these extreme overdensities. This forward-modelling approach allows for a direct, apples-to-apples comparison with observational data, shedding light on the physical mechanisms driving the spatial decoupling of quasars and LAEs in the high-redshift universe.