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Cosmology in Silico

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Simulations play an ineliminable role in contemporary cosmology. Given the enormous range of processes involved-from stars forming to clusters of galaxies and cosmic filaments- and their non-linear nature, only numerical simulations can tell us what the standard cosmological model implies for structure formation. Simulations are thus indispensable to extract predictions from models, but also to supplement sparse or non-existing observations, and to help designing the observational surveys. This ubiquity of simulations in cosmology raises an important concern. Indeed, a few astrophysicists have insisted that simulations suffer from numerical artefacts that none of the traditional methods to assess their reliability have successfully detected. These artefacts significantly impact our ability to track the logical consequences of the physical model implemented. As a result, when simulations fail to reproduce observations, there is no tool available to determine whether this discrepancy stems from numerical artefacts or constitutes a genuine failed prediction, and thus a motivation to revise our models. Yet, not only this concern has been neglected, but the race to an ever-increased resolution and more realistic simulations have made the problem even more complex. In this talk, I present a new method for evaluating the reliability of cosmological simulations, based on the reasoning of these astrophysicists who have contested traditional procedures for verifying simulations.