



PAIRwise velocities in the context of the cosmic web

Throughout history, humanity has elucidated the origin and fate of our cosmos. Thanks to a current floodage of high-quality data, these questions have evolved from mere philosophical contemplations into a thoroughly established scientific field of research. While we now know that the universe comprises **70% dark energy**, **25% dark matter**, and **5% normal matter**, uncovering the exact values and underlying nature of these components remains an **open question**. Even more, a true understanding of the connection between the structures we can see, such as galaxies, and the underlying distribution of invisible dark matter is incomplete.

In order to investigate such urgent tasks and contribute towards a finer determination of the composition of our universe, this research proposes a novel approach centred on the motions of well-separated galaxy pairs – a rich source of information about gravity and the universe's energy composition.

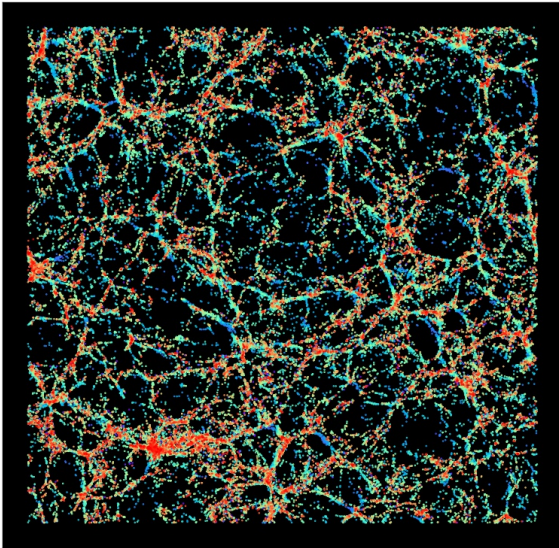


Fig. Spatial distribution of galaxies in a simulation box. Each dot represents one of the nearly 8 million of galaxies, and we can see how in regions with high concentration of galaxies, the dots are redder (meaning that these are high-density zones of the universe) while the blue dots are predominantly in the emptier or less concentration regions of the box.

The existing templates to describe the pairwise motions are incomplete. We seek to remediate that. Two fundamental ideas guide this exploration. Firstly, **galaxies in distinct density environments exhibit different dynamics**, shaping our understanding of "galaxy bias," the link between dark and luminous matter. Secondly, accounting for the disruption in galaxy pairs due to **cosmic mergers** extends the applicability of our models, **unlocking information at smaller scales**.

Ultimately, our goal is to **extract precise values for the components of the cosmological model**. By comparing our model with data, we aim to place constraints on the parameters defining the universe's composition. This research not only satisfies our curiosity about the cosmos but also has the potential to reshape our fundamental understanding of the universe, influencing future explorations.