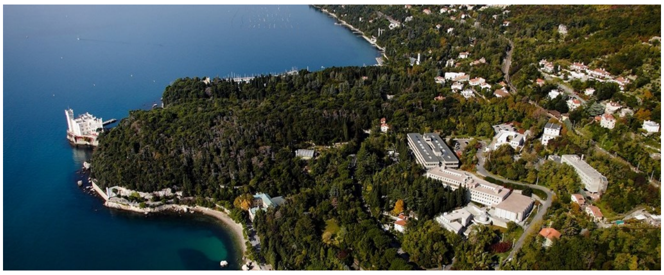

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Dark Matter: Across the galactic scales and cosmic time

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understanding.The discovery of rotation curves of disk galaxies by Rubin et al. (1980) has had far-reaching implications for the fields of astrophysics and cosmology. These findings have introduced the need of an elusive component that astrophysicists have dubbed "dark matter", which is believed to be made up of dark particles that are necessarily beyond the standard model of elementary particles. Since then, dark matter has become a building block of the current cosmological model (ΛCDM), in which the dark matter provides the initial gravitational wells upon which galaxies are built. The role of dark matter in shaping the galaxy dynamics has been firmly established and confirmed in the local Universe. However, until recently, it was not possible to validate it at high redshifts. Thanks to integral field units (IFUs), which are high-resolution spectrographs, we are now able to gain valuable insights into the early Universe and shed light on the formation and evolution of galaxies over cosmic time. In particular, observations based on IFUs allow us to study the resolved velocity profiles, or rotation curves, of galaxies at high redshifts. This enables us to answer some of the most intriguing open questions in modern astrophysics. These include:

1. Is the nature of dark matter cold as presumed in the most successful ΛCDM cosmological simulations?
2. What is the fraction of dark matter in high-redshift galaxies compared to locals?
3. Do dark matter halos evolve similarly to galaxies?
4. Do baryonic processes impact the distribution of dark matter and, if so, can they be constrained?

At the meeting, I intend to elaborate on each of these questions. Specifically, I will present a novel study that employs KROSS, KGES and KMOS3D data, comprising the largest sample (˜300) of disk-like galaxies to date, spanning a redshift range of $0.5 < z < 2.5$. I will present accurate rotation curves and kinematic models for the entire sample and share my results regarding dark matter fraction obtained through a halo-model independent approach. One of my key findings reveals that the dark matter fraction in the inner-to-outer region of galaxies increases with redshift, with typical estimates ranging from 75% to 90% of the total mass. Moreover, the dark matter fraction at a fixed redshift is lower in the inner region than the outskirts, but does not fall below 50%, contrary to previous studies and cosmological simulations. Finally, I will engage in a discussion on how we can examine the assembly history of dark matter halos over cosmic time using current observations of high-redshift galaxies that lack a crucial component, the stellar continuum. This work provides significant insights into the early Universe and galaxy formation, highlighting the need for future advancements in our understanding of dark matter and its role in galaxy evolution. Furthermore, recent observations by JWST, which have identified massive galaxies during cosmic dawn (Labbe et al. 2023), pose new challenges to the standard model of cosmology and further emphasize the scientific significance of these topics. Thus, investigating the rotation curves and dark matter halos throughout cosmic history will be of great importance for advancing our understanding of these phenomena.

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