Invited Talks Abstracts

The epoch of the first quasars in cosmological simulations

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Massive black holes are fundamental constituents of our cosmos. Understanding their formation at cosmic dawn, their growth, and the emergence of the first, rare quasars in the early Universe remains one of our greatest theoretical challenge. Hydrodynamic cosmological simulations self-consistently combine the processes of structure formation at cosmological scales with the physics of smaller, galaxy scales. They capture our most realistic understanding of massive black holes and their connection to galaxy formation. I will focus on the predictions for high-z quasars/BHs and their host galaxies in the ASTRID and BlueTides simulations. Current and next generation facilities and the advent of multi-messenger astrophysics brings new exciting prospects for tracing the origin, growth and merger history of massive black holes across cosmic ages.

The obscured and unobscured environment of high-z quasars

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Luminous quasars at high-redshift are the most strongly clustered population known, and should thus reside in massive dark matter halos surrounded by large overdensities of galaxies. Most quasar environment studies have been aimed at detecting overdensities of optical-selected galaxies around quasars, but to-date such detections have been strongly elusive, revealing contradictory results. This might be the result of the low number statistic and incomplete sampling of the galaxy population around quasars. In this talk, I will review the current studies and results of high-z quasar environments and then present the results of our survey that is aiming to detect both the obscured and unobscured population of galaxies in the environment of 17 quasars at z~4. These observations provide strong evidence that quasars trace massive structures in the early universe stressing the importance of multi-wavelength studies, and highlighting important questions about galaxy properties in high−z dense environments.

Black hole formation, evolution, and environment at high redshift

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Massive black holes (MBHs) are ubiquitous in the Universe. Current constraints on their origins include the observations of high-redshift quasars less than 1 Gyr after the Big Bang, and the diversity of MBHs observed in the local Universe. Around us, indeed, their mass spectrum spans many orders of magnitude from low-mass MBHs in local dwarf galaxies to the most massive MBHs in large elliptical galaxies. I will review today's prevailing MBH formation mechanisms to explain these observations. Large-scale cosmological hydrodynamical simulations are becoming indispensable to face the challenge of MBH formation, growth, and co-evolution with their host galaxies in different environments. I will discuss what we have learned from these simulations, how their modeling strongly impact the population of MBHs and active MBHs, and how we can use them to prepare next-generation space missions (e.g., JWST, Roman, Athena) and maximize their scientific return.

Cold gas and dust in star-forming galaxies at high redshift

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In this talk I will review our current knowledge of the cold gas properties of normal galaxies across cosmic time. Great progress has been achieved thanks to ALMA and the upgraded capabilities of NOEMA, in particular based on the observations of the CO and [CII] transitions and the dust continuum. I will put emphasis in three areas: 1) the evolution of molecular gas fractions and gas depletion timescales, 2) outflow demographics and the importance of the molecular gas phase, and 3) cold gas kinematics. I will finish by introducing the new ALMA Large Program CRISTAL that will provide, together with observations from HST and JWST, a census of the the gas, dust, and stars on kiloparsec scales in normal galaxies when the Universe was only 1 Gyr old.

Do quasars care about the environment?

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I will highlight some of the interesting contrasts between the environments of star forming galaxies and quasars during the first 2 billion years of cosmic time, and address possible implications for reionization, cluster formation and seed black holes.

Probing reionization and galaxy formation with the most distant galaxies

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The Epoch of Reionization (EoR) represents a milestone in the evolution of our Universe. Great uncertainties still exist not only on the timeline and topology of this transition, i.e. on how the fraction of neutral intergalactic medium changed as a function of time and space, but also on which were the main sources of the ionizing photons. In my talk I will discuss how spectroscopic observations of the most distant galaxies, in particular Lyman alpha emitting galaxies can help us understand the EoR, reviewing the most recent results and describing the exiting new discoveries that will be made possible by the upcoming spectroscopic facilities.

The discovery and study of high-redshift quasars with the survey facilities of the 2020's

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With well over 200 quasars now known with redshifts >5.7, the community has moved from the initial excitement of discovery to studying these objects, and their demographics, in detail. I will describe recent results from the HSC SHELLQS survey of low-luminosity (M_1450 between -22 and -25) high-redshift quasars as well as other compilations, including constraints on the quasar luminosity function, the relationship between black hole mass and host galaxy properties, and the presence of companions. Of particular interest is whether there is a population of obscured quasars at these redshifts; I will highlight an intriguing population of narrow-line quasars whose nature

remains unclear. I will discuss the opportunities for further discovery and study of high-redshift quasars with the next generation of observatories, including the Rubin Observatory, JWST, and Euclid.

Probing the most distant quasars and their environments with current and upcoming facilities

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Quasars, as the most luminous type of active galactic nuclei, are believed to be powered by accreting supermassive black holes (SMBHs), hosted by massive galaxies and inhabit the most biased dark matter halos. Luminous quasars in the epoch of reionization (EoR) provide unique probes to the formation of the earliest SMBHs, the assembly of massive galaxies, the growth of the large-scale structures and the reionization of intergalactic medium. In this talk, I will first review the current surveys of the most distant quasars and then present the on-going and upcoming multi-wavelength follow-up observations of a statistical sample of z~7 quasars with the current and upcoming state-of-the-art facilities. These observations will provide unprecedented constraints on the connection between SMBHs and their hosts as well as their primordial environment and allow us to probe the formation of the earliest SMBHs in a cosmological context.
