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ALMA2040: a high-definition view of the cold universe with a next-generation ALMA

Thursday 15 May 2025 15:15 (20 minutes)

Invited talk.

In the last 15 years, the Atacama Large Millimeter/submillimeter Array (ALMA) has revolutionized astrophysics by providing unprecedented resolution and sensitivity in observing the cold universe, including the formation of stars, planets, and galaxies. With groundbreaking discoveries ranging from the first detailed images of protoplanetary disks all the way to kinematics of galaxies in the epoch of reionization, ALMA has showcased the vast discovery potential of the (sub-)mm wavelength regime. However, in another 15 years from now, the science landscape will have changed dramatically as new major observational facilities will have started their operations or have come towards advanced maturity in their scientific outcome (e.g., JWST, ELT, Euclid, Gaia, Plato, Ariel, Roman Space Telescope, SPHEREx, LiteBIRD, LISA and others). At the same time, ALMA's current Wideband Sensitivity Upgrade will have been in place for ~10 years, and ALMA itself will have been operational for 30 years. This leaves a significant and crucial hole in the scientific discovery space in the 2040's.

In this talk, we discuss how a disruptive leap in (sub-)mm wavelength-range observations at high and intermediate angular resolutions would provide unique and complementary insights into a wide range of key astrophysical questions, with the potential of yielding a transformational view in our understanding of the universe. These constitute the core of the science case for a next-generation, radically upgraded ALMA-like facility ('ALMA2040'). This is based on a European community-wide effort of >300 scientists and nine different scientific working groups, which have already prepared >70 science pitches across a wide range of astrophysical topics. We will outline the key scientific drivers that could be uniquely addressed with this powerful new (sub-)mm interferometer and discuss their synergy with other major astronomical observatories in the 2040's. By providing fundamental insights into the cold universe across time and spatial scales, ALMA2040 represents a broad and ambitious scientific vision for the future of interferometric observations in the (sub-)mm range.

Presenter: FACCHINI, Stefano