Subject : Galaxies and Active Galactic Nuclei

Title : Co-evolution of galaxies and black holes at cosmic dawn

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Outline : With the advent of the ALMA telescope, submillimeter astronomy has entered a golden age. Many of you are likely aware that numerous significant discoveries have been made based on high-resolution, high-sensitivity observations. This lecture will focus on the "co-evolution" of galaxies and supermassive black holes (SMBHs), highlighting key recent findings achieved with ALMA and JWST. First, I will summarize high-resolution observations related to mass accretion onto SMBHs, feedback from active galactic nuclei (AGN) in the local universe, and the star formation in galaxies. Particular attention will be given to the impact of high resolution. Then, the perspective will shift to high redshift, providing an overview of observations of quasars (high-luminosity AGN) and their host galaxies using ALMA and the JWST. I would like to discuss the prevalence of outflows (feedback process from black holes to their host galaxies) and whether galaxy mergers can drive the galaxy evolution, and then explore future research directions.

Learning objectives :
- Learn basic concept of black hole growth and galaxy growth (star formation).
- Obtain overview-level understanding of the co-evolution of galaxies and supermassive black holes.
- Learn current challenges of this research field and discuss future prospects.

Textbooks and references : None. Note that this lecture will mainly handle ALMA's submillimeter observations, but knowledge or skill of submillimeter observations are not required (provided in the lecture).