Pushing the boundaries of mid-infrared interferometry to reveal the cores of AGNs

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Abstract

Active Galactic Nuclei (AGNs) are intensely luminous regions at the centers of galaxies, powered by the accretion of material into supermassive black holes. These phenomena emit energy across the entire electromagnetic spectrum, from radio frequencies to gamma rays, often outshining their host galaxies. Mid-infrared interferometry offers a unique window into the dusty structures close to these supermassive black holes. After observing a few dozens of AGNs with MIDI, the most widely accepted model for these structures incorporated dusty winds to the original idea of the dusty torus posed by the Theory of Unification of AGNs. More recently, MATISSE has resolved in detail the two brightest AGNs, revealing complex morphologies and variations in dust properties. The broad wavelength coverage across the L, M, and N bands is essential for determining reliable dust temperatures to understand their relationship with the radiation field, as well as for studying the mineralogical and physical properties of the dust. From these unique examples, the necessity for higher sensitivities is clear: it would allow a larger, statistically significant sample and enable comprehensive analysis to characterize AGNs. Additionally, enhanced angular resolution combined with increased sensitivity would expand our scientific insights by allowing us to resolve clouds and filaments at sub-pc scales. This will facilitate studies of the kinematics, heating and cooling mechanisms, and the launch of dusty winds alongside the chemical cycles of the dust. Some of the critical questions that remain open are: How does the dusty structure vary with luminosity and over time? What is its relation to AGN feeding and feedback at larger scales? How is the dusty wind launched? In conclusion, these enhancements would enable us to probe the physics within the innermost parsecs of AGNs for the first time in many heavily obscured AGNs, albeit requiring a rich uv-coverage. In this talk, I will also discuss the scientific potential of using a mid-infrared polarimeter, with NGC 1068 as a case study. This method opens up new high-resolution avenues in AGN science, allowing for the exploration of magnetic field structures, the identification of magnetohydrodynamic winds, and possibly even pinpointing neutrino production sites.

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