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Tracing Accretion State Transitions in AGN: Insights from Photoionisation Simulations and IR Nebular Diagnostics

Accretion states, which are universally observed in stellar-mass black holes in X-ray binaries, are also anticipated in active galactic nuclei (AGN). The luminosity-excitation diagram (LED), based on IR nebular emission-line ratios, successfully identifies distinct accretion regimes in AGN —from jet/corona-dominated emission in low-luminosity AGN (LLAGN) to disc-dominated emission in Seyfert galaxies and quasars. To characterise the evolution of the ionising continuum across these states, we present new photoionisation simulations using theoretical continua from the JED-SAD model. Our simulations successfully reproduce the observed distribution of AGN along the LED sequence across a diverse sample of 320 sources, establishing a robust link between nebular line excitation signatures and the underlying accretion physics. A multi-diagnostic analysis, incorporating faint transitions from high-ionisation species recently observed by JWST, indicates that disc-dominated nuclei require a gradual softening of their ionising continuum bluewards of the UV bump, consistent with the contribution from a soft X-ray excess component. Conversely, LLAGN exhibit ionisation signatures indicative of a harder, jet/corona-dominated continuum. These findings demonstrate that IR nebular lines uniquely probe the extreme UV/X-ray regime, otherwise inaccessible due to hydrogen absorption, offering crucial insights into the accretion physics of supermassive black holes.

Contribution

Oral talk

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