

OBSERVATIONAL SIGNATURES FROM CONTINUUM REVERBERATION MAPPING OF ACCRETION DISKS SURROUNDING LOW-MASS-RATIO SUPERMASSIVE BLACK HOLE BINARIES

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ABSTRACT

It has remained challenging to reliably identify sub-parsec super-massive black hole binaries (SMBHBs), despite them being expected to be ubiquitous. We propose a new method using multi-band continuum reverberation mapping to identify low-mass-ratio SMBHBs in active galactic nuclei. The basic principle is that, due to the presence of a low-density cavity between the mini-disks and the circumbinary disk, the continuum emissions show a deficit at certain wavelengths, leading to a distinguishing feature in the relation between the inter-band time lag and wavelengths $\tau(\lambda)$. Specifically, the relation appears flat at short wavelengths because of the truncated sizes of the mini-disks and transits to a power law $\lambda^{4/3}$ at long wavelength stemming from the circumbinary disk. This transition feature is distinct from the uniform relation $\lambda^{4/3}$ of the standard accretion disk around a single black hole. Using the lamp-post scenario and assuming that only the secondary black hole is active in a low-mass-ratio SMBHB, we design a simple continuum reverberation model to calculate the transfer function of the accretion disks and the resulting $\tau(\lambda)$ relations for various SMBHB orbital parameters. The transition wavelength typically can lie at UV/optical bands, mainly depending on the total mass and orbital separation of the SMBHB. We apply our SMBHB model to the intensive multiwavelength monitoring data of the SMBHB candidate PG1302-102 and find that the SMBHB model can reproduce the inter-band time lags. Remarkably, the inferred total mass and

orbital period from the SMBHB fitting are consistent with values derived from other independent methods.