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Kinematics of the Radio Core in Active Galactic Nuclei

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The presence of a supermassive binary black-hole in the heart of active galactic nuclei like quasars and radio galaxies has been often discussed because of several lines of observational evidence. Further, it has been often discussed that mergers between or among galaxies result in the formation of quasars, suggesting the inevitable presence of supermassive binaries during the course of evolution. However, all previous observational material is circumstantial and thus much firmer evidence is necessary to establish the presence of supermassive binaries in some quasars. According to observations that suggest the presence of supermassive binary black hole, a typical orbital period is several years. Therefore, monitoring observations of quasars could lead to the discovery of an evident supermassive binary system. Here we report our radio monitoring observations of the radio galaxy 3C 66B using the Very Long Baseline Interferometer (VLBI). We have found that the unresolved radio core of 3C 66B shows well-defined elliptical motions with a period of 1.05 +/-0.03 yr, providing the first direct detection of a supermassive binary.

On the other hand, the position of the radio core in active galactic nuclei is often observed at a different position with a different frequency. Therefore, careful analysis of multi-frequency radio maps of the radio core allows us to measure the position of the central engine much accurately. In astrometric observations, this position can be used as a reference point with a sufficiently high accuracy. In order to improve our understanding of the above issue, we utilized another method, the phase-referencing VLBI technique, to the case of 3C 66A and 3C 66B using the Very Long Baseline Array (VLBA); note that 3C 66A and 3C 66B comprise an apparently close pair of quasars at different redshifts. Adopting the theory of Synchrotron self-absorption, the black-hole position in 3C 66A and 3C 66B was estimated to be 48.4 +/- 1.0 microarcsecond and 17.4 +/- 1.9 microarcsecond from the core position at 22 GHz towards the opposite side of the jet, respectively. This information is also very useful in estimating the kinetic luminosity of the radio core, being a probe of the formation mechanism of the radio jet.