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Resolving Accretion Disks around Black-Holes

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Accretion flows around black-holes, neutron stars or white dwarfs are studied since almost 60 years. Although they are ubiquitous and somewhat similar over scales reaching billions in mass and size, their study has been limited because they remain unresolved point like sources in the optical/ultraviolet and X-rays, where they emit. Two main modes of accretion have been identified in Active Galactic Nuclei. In most sources the accretion rate is low and a high pressure, low density, low collision rate, optically thin, radiatively inefficient, two temperature plasma can form (Shapiro 1976; Narayan & Yi 1994,1995). This solution is stable only for low luminosities (<1% LEDD). The Event Horizon Telescope has recently resolved such flows in Sgr A and M87, confirmed several aspects of the model and could detect particles accelerated close to the horizon of Sgr A (Wielgus, 2022) a likely signature of the Blandford-Znajek (1977) process. When the accretion rate is higher, momentum can be dissipated by viscosity and the flow proceeds via geometrically thin disk-shaped structures. These accretion disks provide feedback to their environment by accelerating winds and launching jets in their central regions. The apparent size of accretion disks are of the order of 1-40μarcsec in nearby quasars, Seyfert galaxies and galactic cataclysmic variables and of 0.1-1μarcsec in of low mass X-ray binaries in our Galaxy. Accretion disks have never been resolved.

The signal-to-noise achievable using photon arrival time correlation (or intensity interferometry) depends on the telescopes sizes, detector time resolution, and the number of spectral channels observed simultaneously. Extremely large telescope and 10ps resolution single photon detectors bring the key improvements to reach in the optical angular resolutions better than these achieved in the radio by the Event Horizon Telescope and to obtain the first images of accretion disks around galactic and extragalactic compact objects, a breakthrough.

I will present the goals and the status of the QUASAR project, which started one year ago, aiming at bringing 10ps resolution optical spectrometers on very large telescopes.

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