X-Ray Imaging of the Jet From the Supermassive Black Hole M87

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243.20 — Constraining LIGO: N-Body Simulations of Black Holes in an AGN Disk!

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The gravitational wave detections made by LIGO suggest the need for an efficient source of Stellar Mass Black Hole (sBH) Binary formation and merger. Dense gas disks around supermassive black holes offer a promising environment for the formation and merger of these sBH binaries. The interactions between the torque from the dense gas in the disk and sBHs help form binaries which can quickly result in a black hole merger. I demonstrate, using N-body simulations, how sBH on prograde and retrograde orbits interact with each other during an AGN disk lifetime. My work shows that these gas disks are potentially excellent sources of sBH mergers detectable with LIGO. In future work, we hope to gauge how much of the LIGO measured sBH merger rate comes from mergers in gas disks at the centers of galaxies!

243.21 — "Supersoft" X-ray Quasars & their Spins

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"Supersoft" X-ray quasars are supermassive black holes that are actively accreting large amounts of material and whose X-ray spectra are dominated by low energy emission. Such a spectrum may indicate that the emission is dominated by a thermal component from the accretion disk around the black hole. Modeling such a spectrum can provide valuable constraints on the size of the inner edge of the accretion disk, which depends on both the mass of the black hole and its spin. Typical quasar spectra have contributions from both a thermal disk component and one or more non-thermal components, often modeled as power laws. There are usually degeneracies between these spectral components, limiting the constraints on the accretion disk parameters that we can obtain from broadband X-ray spectral modeling. However, these supersoft X-ray quasars may be completely dominated by the thermal disk component, offering a rare and rather unique opportunity to obtain strong constraints on the size of the accretion disk and therefore the spin of the black hole.

There are only a few dozen supersoft X-ray quasars for which X-ray data exist. We present results from modeling Chandra X-ray Observatory data for these supersoft X-ray Quasars. The spectral fitting has allowed us to constrain the accretion disk parameters, in particular the black hole spins and sizes of the innermost stable circular orbits. When combined with independent mass estimates from optical spectroscopy, this research may provide an avenue to tightly constrain the spins of these black holes.

243.22 — X-Ray Imaging of the Jet From the Supermassive Black Hole M87

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The supermassive black hole, M87, has long been a target of interest for the study of black hole physics and relativistic jets across the electromagnetic spectrum. In April 2017, the Event Horizon Telescope and many ground- and space-based observatories undertook a campaign to study nearby supermassive black holes, including M87, at many wavelengths. With the inclusion of phased ALMA, the EHT data should have sufficient resolution to image the event horizon of the black hole. As part of this campaign, we observed M87 with the Chandra X-ray Observatory for a total of 26.24 ks over two exposures, enabling us to study M87 at high energy. We report the results of imaging and spectroscopy of the X-ray jet, focusing on the X-ray nucleus, which includes emission from both the core and a bright knot in the jet called HST-1. We present a deconvolved image to explore the relative intensity of the core and HST-1. Our analysis of this deconvolved image suggests that HST-1 was significantly fainter than the core. We found no evidence of strong variability in the X-ray brightness during our observation, but compared to the historically recorded spectra of the core, we discovered a slight decrease in the photon index (to Γ=2.05+0.06/-0.07, compared to a typical value of Γ=2.25+/-0.10 in the recent past). M87 was also fainter than in recent observations (L_X1.25x10^{41} erg s^{-1}). In light of the historical variability of HST-1, we explore the possibility that the lower photon index may be due to a smaller HST-1 contribution to the nuclear emission.