The gravitational wave detections made by LIGO suggest the need for an efficient source of Stellar Mass Black Hole (sBH) 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!

"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.