Investigations of the Galactic Center Circumnuclear Disk –Yat-Tien Lee
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1. Description of the CND

A dense disk of gas -- the circumnuclear disk, or CND -- surrounds the Galactic black hole (GBH) at the Galactic center. It contains 10^4 - 10^5 solar masses of very warm, very turbulent, and clumpy molecular and atomic gas. Its inside edge, starting at a radius of about 1 pc, is heated and ionized by the massive, young stellar cluster surrounding the GBH. Inside the central cavity, there appears to be several hundred solar masses of ionized and atomic gas. The inside edge of the CND is also impacted by the collective strong winds from the central young cluster, and this might be what is responsible for defining and keeping the inner edge where it currently is. The CND is about 0.4 pc thick at its inner edge. The disk extends out to several parsecs, with different extents in different directions. It is not clear whether this is because the CND is dynamically unrelaxed or whether local dynamics have deformed it. The velocity field of the CND is well characterized, and is consistent with being Keplerian, although the radial velocities have suggested a warped morphology to some investigators. Far-infrared polarization measurements have revealed that the CND has a strong toroidal magnetic field, as might be expected from a disk subjected to the strong shear induced by the tidal field of the GBH. No star formation is presently evidenced in the CND.

It would be valuable to use AstroBEAR to model the dynamics of the CND, and thereby to answer
multiple questions:

1. The Inside Interface

What is the nature of the interface between the wind emanating spherically from the center, and the dense gas in the CND? Does this interface undergo Rayleigh-Taylor type instabilities, and what are the consequences of such instabilities for inward migration of the gas? (There are a few tongues of apparently infalling gas inside the CND and appearing to be connected to the CND -- were these produced by an instability?) What effect does the toroidal magnetic field have on the gas dynamics at the interface? Does the inside interface migrate inward as a result of viscous evolution?

2. The Outer Boundary of the CND

We might presume that the slow migration of gas from the Central Molecular Zone feeds the CND at its outer boundary. What role does such an inflow of gas play in the disk's evolution? (The alternative is that an infalling cloud formed a dispersion ring, but for various reasons, that is problematical.)

3. Clumpiness

Molecular line observations show that the CND is rather clumpy, but it is not clear how this can be the case in the strong tidal field of the GBH. The typical size and molecular hydrogen density of the clumps are 0.4 pc and 10^5 cm^-3 respectively, although there may be a population of unresolved clumps. Some have argued that the clumps are self-gravitating, which means that their masses approach or exceed 10^6 solar masses each. That is not consistent, however, with the sub millimeter and IR continuum data. So is there some MHD phenomenon that might lead to transient clumping?

4. Limit Cycle of Activity?

On a time scale of 10^7 years, the stellar winds will fade and the CND will migrate inward. Eventually, the disk will approach the GBH. Will the resultant accretion provoke the next episode of star formation, thereby creating a new cluster of massive stars and pushing the CND out again to its present distance? We don't propose to model this entire evolution but In a subsequent calculation to be carried out later, we would model the disk as the accretion and star formation are under way. By including as much relevant physics as possible, such as the magnetic fields, we can elucidate how such a cluster forms.

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needed: spatial domain of ~ 10 pc. Spatial resolution of at least a few hundred elements across the
domain, if possible. Temperature range: 100 K -- 10^4 K. Density range: 10^2 - 10^6 cm^-3 or more.
Magnetic fields could be introduced at a later stage.
Two fluids might be adequate: molecular+atomic and ionized.