Ionized Gas in the Inner 2 pc of the Milky Way

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The Galactic Center

- Sgr A* (x)
- Circumnuclear Disk
- Mini-spiral
 - Northern Arm (--)
 - Western Arc (--)
 - Eastern Arm (--)
 - Bar (--)



The Goal

- Use better data
 - Observations of [NeII] emission from the Galactic Center using TEXES, a high-resolution mid-infrared spectrograph, on the NASA IRTF in July, 2003.
- Analyze two interpretations for the gas kinematics
 - 1) Tidally stretched clouds with gas flowing along the streamers (Serabyn et al., Zhao et al.)
 - 2) One-armed spiral structure with gas flowing across the filaments on circular orbits (Lacy et al.)
- Determine the better spectral fit and speculate on the physics behind that interpretation

One Interpretation

- Tidally stretched clouds
- Motion along the streamers - falling in toward Sgr A*
- Northern Arm, Western Arc, and Eastern Arm modeled as separate ellipses with Sgr A* at the focus (Zhao et al. 2009)



Position-Velocity diagram of the northern arm ellipse



And the western arc ellipse

Doppler velocity in Km/s



Position in degrees along ellipse

Position in degrees along ellipse

Position-velocity diagram for the Eastern Arm Ellipse



*This is the least convincing fit, but at the moment, the eastern arm is not addressed in the spiral model

Try Circular Motion

- Shift datacube spectrally to collect all emission that fits circular velocities in a plane specified by a set of parameters.
- The summed spectra after shifting can be compared
- A shows the spectrum before shifting, B shows the best fit





The Spiral



[NeII] emission map summed over all spectral points

Only emission fitting circular velocities within 30km/s with spiral drawn



Position-velocity diagram for spiral

Purely circular motion

Small inward velocity



A Physical Explanation?

- Spiraling inward doesn't fit data
- Density wave not enough mass in gas to self gravitate, contrast too big (10:1)
- Magnetorotational Instability (MRI) common in accretion disks, magnetic forces not large enough for such an open spiral - would very gradually spiral in
- Spiral ionization wave lots of massive stars in dark regions, why is the whole disk not ionized?
- Tidally stretched cloud doesn't fit data well - must it stretch along motion?

No argument is completely airtight

Collapsed spectrum for motion along the spiral



Conclusion

- The data supports the one-armed spiral model - The northern arm and the western arc appear to be one structure in a single plane
- More theoretical work is needed

References:

Zhao et al. (2009), Dynamics of Ionized Gas at the Galactic Center, ApJ (2009) vol. 699 pp. 186 Lacy et al. (1991), Galactic center gasdynamics - A one-armed spiral in a Keplerian disk. ApJL (1991) vol. 380 pp. L71 Montero-Castano et al. (2009), Gas Infall Toward Sgr A* from the Clumpy Circumnuclear Disk. ApJ (2009) vol. 695 pp. 1477