Evidence for a Tilted Elliptical Ionized Gas Disk in Galactic Center

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Quick History of Galactic Center

As seen by J. H. Oort
Expulsive phenomena Four different regimes of expulsive phenomena have been established; presumably all four are causally connected with the nucleus:

“Something out of the ordinary appears to be required.”

- Hinting at a need for SMBH  
  (J. H. Oort 1977, Annual Review)

1. Arm-like HI features
2. Massive Complexes of Molecular Clouds
3. Ionized Gas within R ~ 50pc
4. High Velocity Streams within 1pc

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Many Discrete Models

- 3 kpc arm
- Expanding arm
- Feature E
- More roman numerals....

From...


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Tilted, Rotating, Expanding Circular Gas Disk

From Burton & Liszt / Liszt & Burton (1978)

Seen in HI 21cm and CO

Tilted 22°

Inclination of 78°

Rotation + Radial Expansion

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Tilted Elliptical Streamlines - No Expansion!

From Liszt & Burton (1980)
Tilted 13.5°
Inclination of 20°
Major axis at angle of 48.5°
Updates on the Model Needed!

Model Reoptimization in progress

Use Histogram of Oriented Gradients to compare data with synthetic cubes

(Krishnarao, D., Benjamin, R. A., Haffner, L. M. in prep.)

What about Ionized Gas?

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Thank you WHAM!

Download the WHAM-Sky Survey at www.astro.wisc.edu/wham

www.astronomy.dk
Detection of Titled Elliptical Disk with WHAM
LS 4825

HST UV Absorption Lines

(Savage et al. 2017 arXiv: 1707.06942)

l = 1.67, b = -6.63

Detection of Ionized Gas near Galactic Center around v = -114 to -98, -78, and 92 km/s

O I, C II, Si II, N I, Mg II, Fe II, S II

Absorption from Outflow (or from this tilted disk?)

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**LS 4825**

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WHAM Line Ratios

\[
\begin{align*}
[SII]/\text{H}α &= 0.61 \pm 0.04 \\
[NII]/\text{H}α &= 1.38 \pm 0.06 \\
[SII]/[NII] &= 0.45 \pm 0.02 \\
[OIII]/\text{H}α &= 0.13 \pm 0.02 \\
[SII]/\text{H}α &= 0.47 \pm 0.02 \\
[NII]/\text{H}α &= 1.29 \pm 0.04 \\
[SII]/[NII] &= 0.38 \pm 0.02 \\
[OIII]/\text{H}α &= 0.09 \pm 0.02 
\end{align*}
\]
WHAM Line Ratios

[SII]/Ha = 0.61 +/- 0.04
[NII]/Ha = 1.38 +/- 0.06
[SII]/[NII] = 0.45 +/- 0.02

Scutum Cloud (27°, 3°)
[SII]/Ha ~ 0.2
[NII]/Ha ~ 0.4
[SII]/[NII] ~ 0.4
(Madsen et al. 2005)

[SII]/Ha = 0.47 +/- 0.02
[NII]/Ha = 1.29 +/- 0.04
[SII]/[NII] = 0.38 +/- 0.02

PRELIMINARY
**WHAM Line Ratios**

- \([\text{SII}]/\text{H}\alpha = 0.61 \pm 0.04\)
- \([\text{NII}]/\text{H}\alpha = 1.38 \pm 0.06\)
- \([\text{SII}]/[\text{NII}] = 0.45 \pm 0.02\)

**HII Regions**
- \([\text{SII}]/\text{H}\alpha \sim 0.1\)
- \([\text{NII}]/\text{H}\alpha \sim 0.25\)

**Diffuse Ionized Gas**
- \([\text{SII}]/\text{H}\alpha \sim 0.4\)
- \([\text{NII}]/\text{H}\alpha \sim 0.5\)

(Madsen 2004)

- \([\text{SII}]/\text{H}\alpha = 0.47 \pm 0.02\)
- \([\text{NII}]/\text{H}\alpha = 1.29 \pm 0.04\)
- \([\text{SII}]/[\text{NII}] = 0.38 \pm 0.02\)

PRELIMINARY
How does this Disk tie in with the Fermi Bubble?
Conclusions:

WHAM has detected evidence for an Ionized Disk of Gas coinciding with and extending beyond the HI Tilted Disk of gas near Galactic Center.

Optical emission line ratios -> physical conditions of Galactic Center environment (Gas mass, temperature, ionization levels, pressure, etc.)

Kinematic Gas model near Galactic Center being updated (Krishnarao, Benjamin, Haffner in prep.)

Future Work: consider revised model in context of Fermi Bubble (outflow)

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