G2 and Sgr A*: A cosmic fizzle at the Galactic Center

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Questions

• Why didn’t we see anything spectacular from G2?
• What is G2?

• Simulate different cloud structures

• Morsony et al. submitted, arXiv:1508.00384
Simulations Setups

- Start with a cloud 5 years before periapsis
- Orbit from Gillessen et al. 2013
- Gravity from Sgr A* only
- Background co-moving with cloud
- Include cooling
- Resolution of $1.2 \times 10^{14}$ cm $\sim$ 1 mas $\sim$ 8 AU
- Accretion radius of 1 pixel
4 Cloud Profiles

![Graph showing cloud profiles with different radii and densities](image-url)
Norm Density

Time = -5.00 years

\( y \text{ (cm)} \)

\( x \text{ (cm)} \)

-4x10^{16} -3x10^{16} -2x10^{16} -1x10^{16} 0 1x10^{16}
Why didn’t we see anything spectacular?

• Accretion rates
Sgr A* accretion rate - Norm

The graph shows the accretion rate versus time relative to periapsis (years). The y-axis represents the accretion rate in g/s, ranging from $10^{15}$ to $10^{19}$. The x-axis represents the time relative to periapsis in years, ranging from -4 to 4. The graph includes two lines: one for the total accretion rate and another for the cloud accretion rate.
Sgr A* accretion rate

Accretion rate (g/s) vs. Time relative to periapsis (years)

Total

Cloud only
Sgr A* cumulative accretion

Total

Cloud only
Why didn’t we see anything spectacular?

- Not much change in accretion rate
- True for different background density/velocity, accretion radius, cooling
- Cloud accounts for ~ 20% of material accreted after periapsis
- More extended cloud leads to more accretion, but still a small change overall
What is G2?

• Model emission from our simulations
Cloud Br-Gamma

Time relative to periapsis (years)

Br-gamma emission (erg/s)

- norm
- extended
- flat
- rsq
Norm Br-Gamma

<< Nozzle Shock
R2 Br-Gamma

<< Nozzle Shock
Br-Gamma Size
Cloud Br-Gamma vs. Data

![Graph showing Br-gamma emission vs. time relative to periapsis.](image)

- Br-gamma emission (erg/s)
- Time relative to periapsis (years)

Graph legend:
- norm
- extended
- flat
- rsq

Data sources:
- Gillessen et al. 2013
- Phifer et al. 2013
- Pfuhl et al. 2015
- Valencia-S. et al. 2015
Br-Gamma Velocity vs. Data

Time relative to periapsis (years)

Velocity (km/s)

- norm
- extended
- flat
- rsq
- Kepler
Br-Gamma FWHM vs. Data

- Gillessen+ 2013
- Phifer+ 2013
- Pfuhl+ 2015
- Valencia–S.+ 2015

Time relative to periapsis (years)

FWHM Velocity (km/s)
Cloud Bolometric vs. Data

![Graph showing bolometric luminosity vs. time relative to periapsis. The graph includes data from Witzel et al. 2015. The graph plots bolometric luminosity in erg/s on the y-axis and time relative to periapsis in years on the x-axis. The data is represented by different lines labeled 'norm', 'extended', 'flat', and 'rsq'.]
Cloud Bolometric vs. Data

Bolometric luminosity (erg/s)

Time relative to periapsis (years)

Witzel et al. 2015
Cloud X-ray vs. Data

Cloud X-ray luminosity (erg/s)

Time relative to periapsis (years)

Haggard et al. 2014

Cloud X-ray luminosity (erg/s)

- norm
- extended
- flat
- rsq

Cloud X-ray luminosity (erg/s)

- norm
- extended
- flat
- rsq

Haggard et al. 2014
What is G2?

• Can’t explain all observations with one simple model
• Need extended gas for Br-gamma FWHM increase, spatial extent
• Need compact source for narrow post-periapsis emission, constant L’ band luminosity
• Can be dense core, DSO, star
Conclusions

• Why didn’t we see anything spectacular?
  – Cloud is not massive enough, doesn’t get close enough to significantly change accretion

• What is G2?
  – Seems to need an extended gas component and a compact component
Norm Br-Gamma

<< Nozzle Shock
Norm Temperature

Time = -5.00 years

The diagram shows a graph with axes labeled 'x (cm)' and 'y (cm)', with values ranging from $-4 \times 10^{16}$ to $1 \times 10^{16}$ for 'x (cm)' and from $-1 \times 10^{16}$ to $4 \times 10^{16}$ for 'y (cm)'. The color bar indicates a range from 4 to 10.
R2 Density

Time = -5.00 years
R2 Temperature

Time = -5.00 years

y (cm)

-1x10^16

-4x10^16 -3x10^16 -2x10^16 -1x10^16

0

1x10^16

2x10^16

3x10^16

4x10^16

-4x10^16 -3x10^16 -2x10^16 -1x10^16

0

1x10^16

x (cm)
Sgr A* accretion rate

- a
Sgr A* accretion rate