Shock-Generated Turbulence In the Innermost 100 pc of the Galaxy Center

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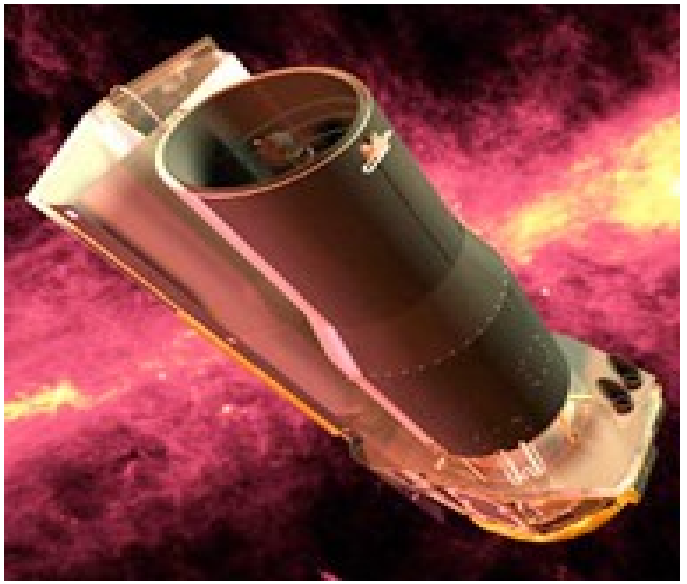

Spitzer IR Observatory – artist illustration

Spitzer's view of the galactic center

Spitzer + Hubble IR Image: Size: ~ 100 pc

SPITZER IR Observations of the innermost 100 pc of the GC

W-R stars : ionizing flux

Observed positions

BH

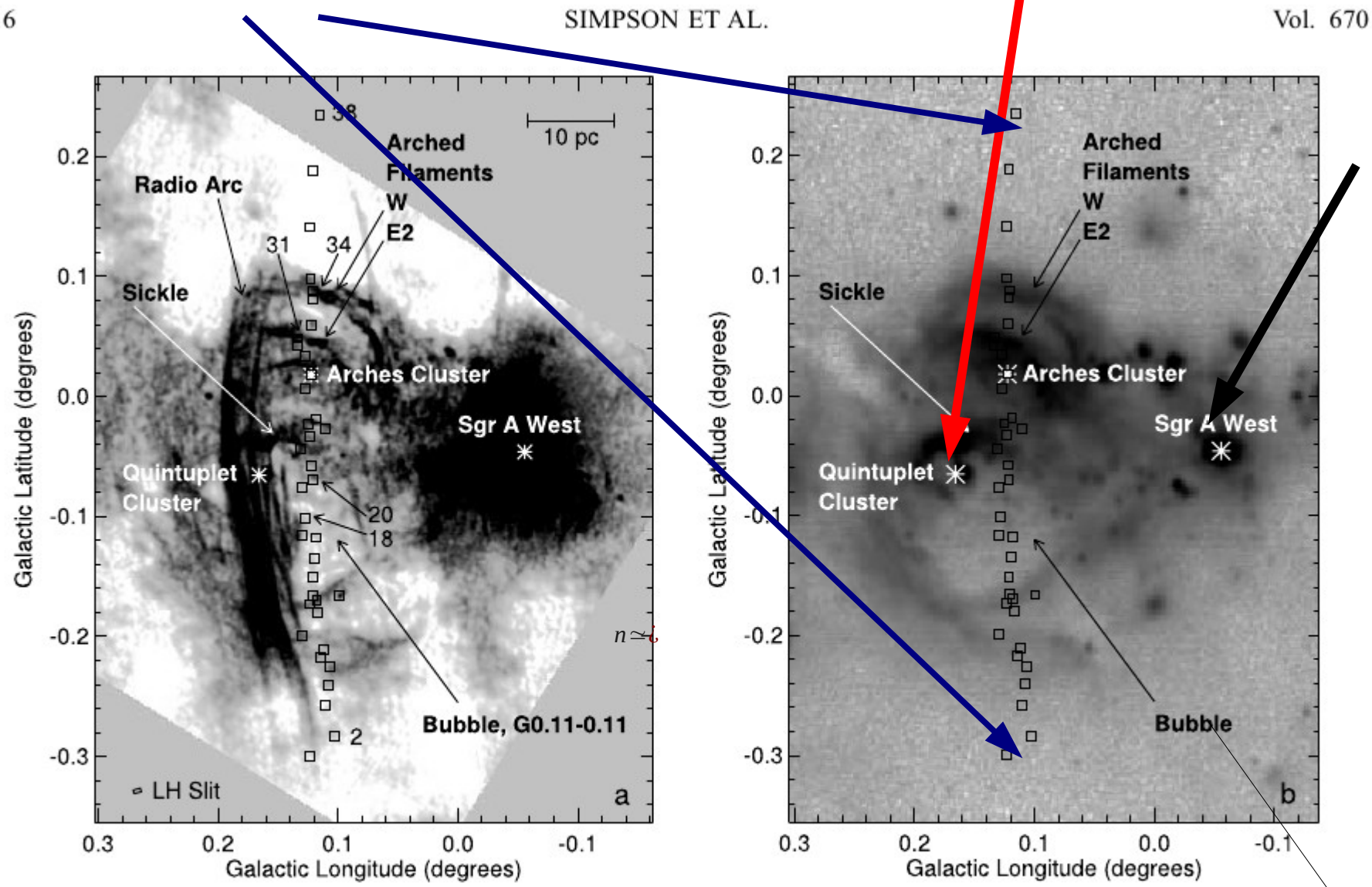

FIG. 1.— Images of the GC region with the observed positions indicated by square boxes. Other positions of interest are labeled. (*a*) Radio continuum (log-log scale) imaged at 21 cm by Yusef-Zadeh & Morris (1987a) with 11″ resolution. The Radio Arc and part of the Sgr A region are nonthermal; the rest of the radio emission is thermal bremsstrahlung. A few positions are labeled with numbers (see Table 1). Also indicated is the size (11″ by 22″) and orientation of the LH slit. Including the small maps, the actual size of the observed positions is 11″ by 30″ for LH and 13″ by 14″ for SH. (*b*) *MSX* band *E* (21 μm) image (log scale) from Price et al. (2001).

Simpson etal (2007)

Mid IR Observations: (10 – 35) μm
75 pc strip in the Bubble perpendicular to the galactic disk about 30 pc East of the MWBH: 32 positions. Resolution: ~2pc.

Physical Parameters:

$$n \simeq (100-1000)\, cm^{-3} \quad T \simeq (300-800)k \quad \Delta V \sim 180\, km\, s^{-1} \quad B \simeq (80-1000)\mu G$$

Concentrated on interpreting the ionic lines

Multiple indicators of strong shocks: e. g.

(i) presence of O+3 which cannot be photo-ionized by stars in the GC because of very high metallicity.

(ii) Increase by a factor of 7 of gas- phase iron interpreted as shock destructed Dust grains: Shock velocities of order 100 km/s invoked

Filamentary structure: Depth estimated: Few pc

Interpretation: Shocked regions by high pressure radiative driven bubble

Contini (2009):

More ***consistent*** Modeling of the coupled effects of shocks and photoionization. Derived values:

Shock velocities: ~ 65-80 km/s

Preshock densities: 1-100 cm^{-3}

Preshock B: (5 – 80) μG

Present Work - Observational Evidence for Turbulence?

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Turbulence implications regarding:

Consistency of the interpretations of Simpson etal (2007) & Contini (2009)

Kinematics

Geometry

Magnetic Field

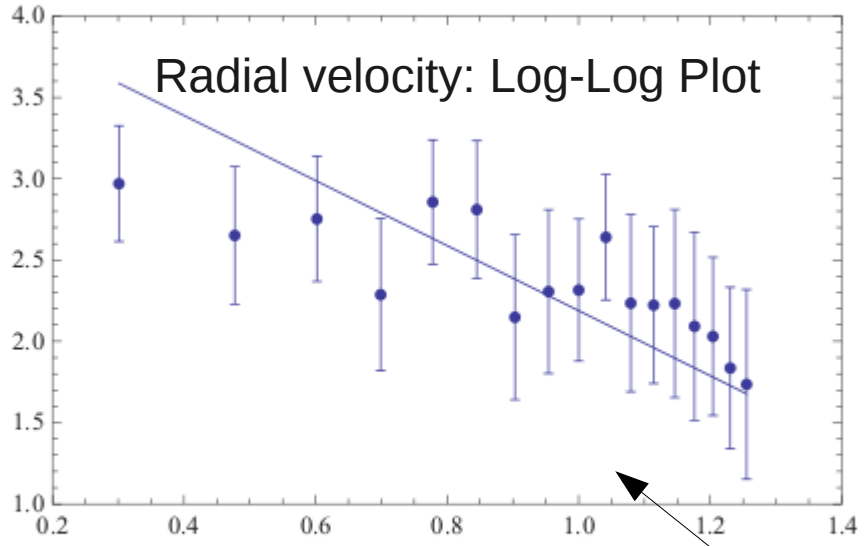

Figure 9. Log of the power spectrum of the radial velocity residuals, in units of (km s^{-1})^2, as a function of the log of the relative wavenumber k. $k = 1$ corresponds to the spatial scale $l_0 = 75$ pc. The line is a power law with index -2.

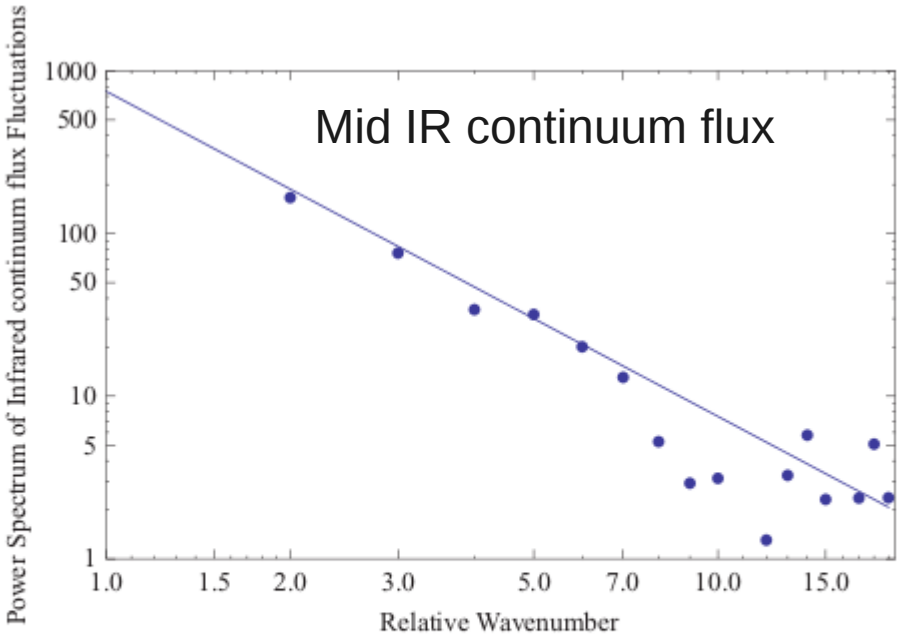

Figure 10. The power spectrum of the fluctuations of the mid-IR continuum at 13.5 – 14.3 μm, in units of Jy^2, as a function of the relative wavenumber k. $k = 1$ corresponds to the spatial scale $l_0 = 75$ pc. The line is a power law with index -2.

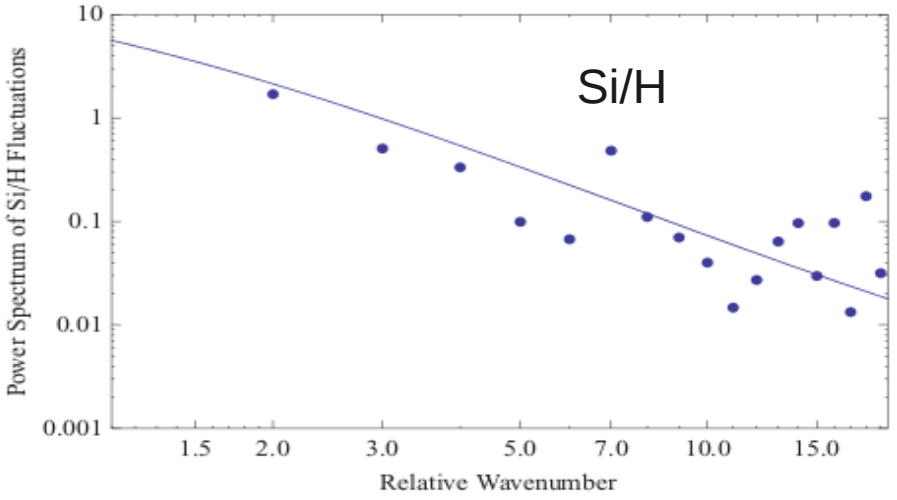

Figure 11. The power spectrum of Si/H fluctuations, in units of 10^{-10}, as a function of the relative wavenumber k. $k = 1$ corresponds to the spatial scale $l_0 = 75$ pc. The line is a power law with index -2.

radial velocity uncertainty $15\,km\,s^{-1}$
observed data points + *random* $\sigma = 15\,km\,s^{-1}$
yield 100 *'observed' data sets.*
Power spectrum computed for each
Reduced $\chi^2 = 0.7$

Results and Conclusions

Radial velocity fluctuations:
Exhibit a power law spectrum with index -2, compatible with
Shock generated supersonic hydro-turbulence

Rms of Radial velocity:
17 km/s (3D velocity: 30 km/s)

Spatial scale: 75 pc

Turbulence Timescale: 4 Myr, comparable to the age of the young star clusters

Depth: 6 pc, consistent with a wall width of a bubble blown by the stellar radiation field

Equilibrium value magnetic Field: 0.15 mG

Power spectrum of the mid IR intensity: same index

Power spectrum of predicted Si abvundance: same index

The Last two lend credibility to the turbulence interpretation of the radial velocity power spectrum