SMA SCIENCE HIGHLIGHTS: THE GALACTIC CENTER

Jim Moran

SMA Advisory Committee, October 13, 2010

The Galactic Center on Three Size Scales

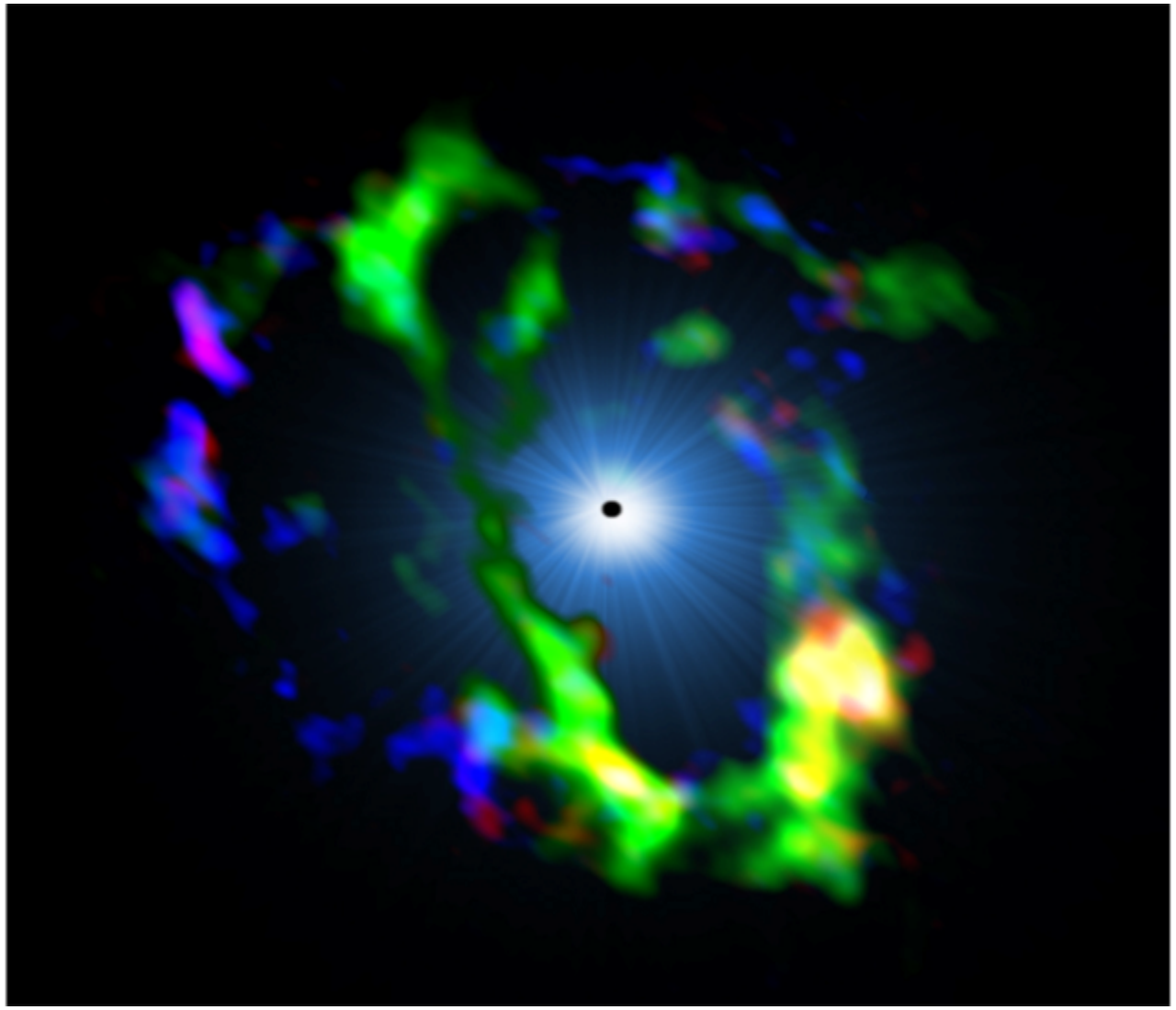
1. Circumnuclear (molecular) Disk (CND) and Minispiral (ionized streamers)
   120 arcs / 5 pc

   Zhao, Blundell, Downes, Schuster, Marrone
2. Black hole accretion envelope (100 R_s)
   1 mas / 0.3 micro pc

   Marrone, Munoz, Zhao, Rao
3. SgrA* radio source
   37 microarcseconds / 0.01 microparsec

   Doeleman et al.

Nine Field Mosaic Image of Circumnuclear Disk in Galactic Center



CN

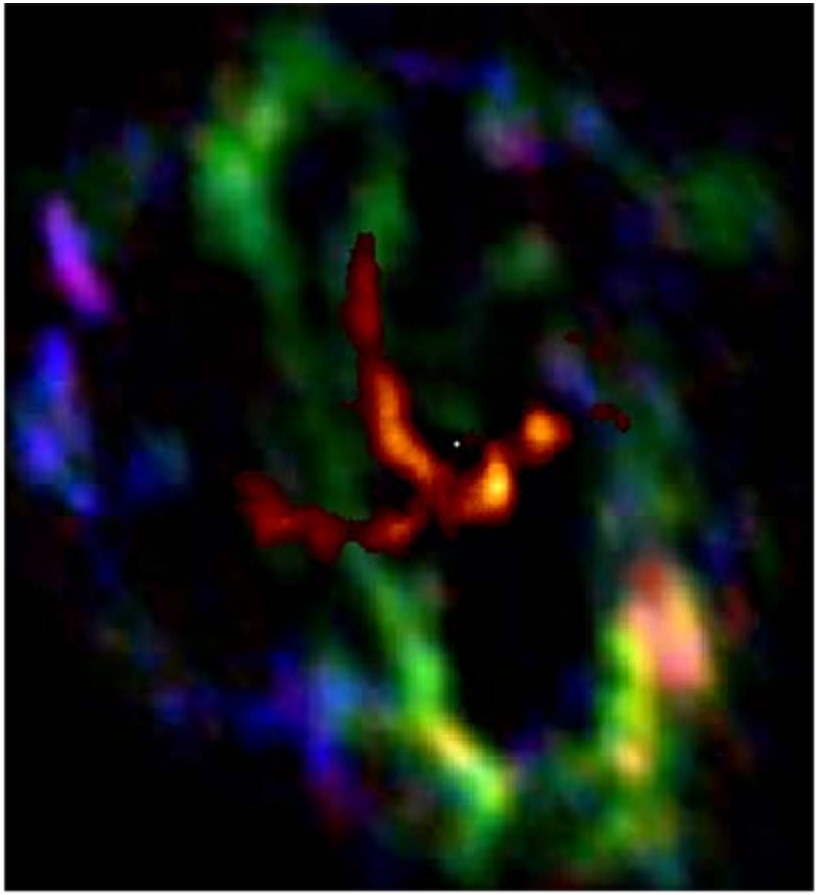
H_2CO

SiO

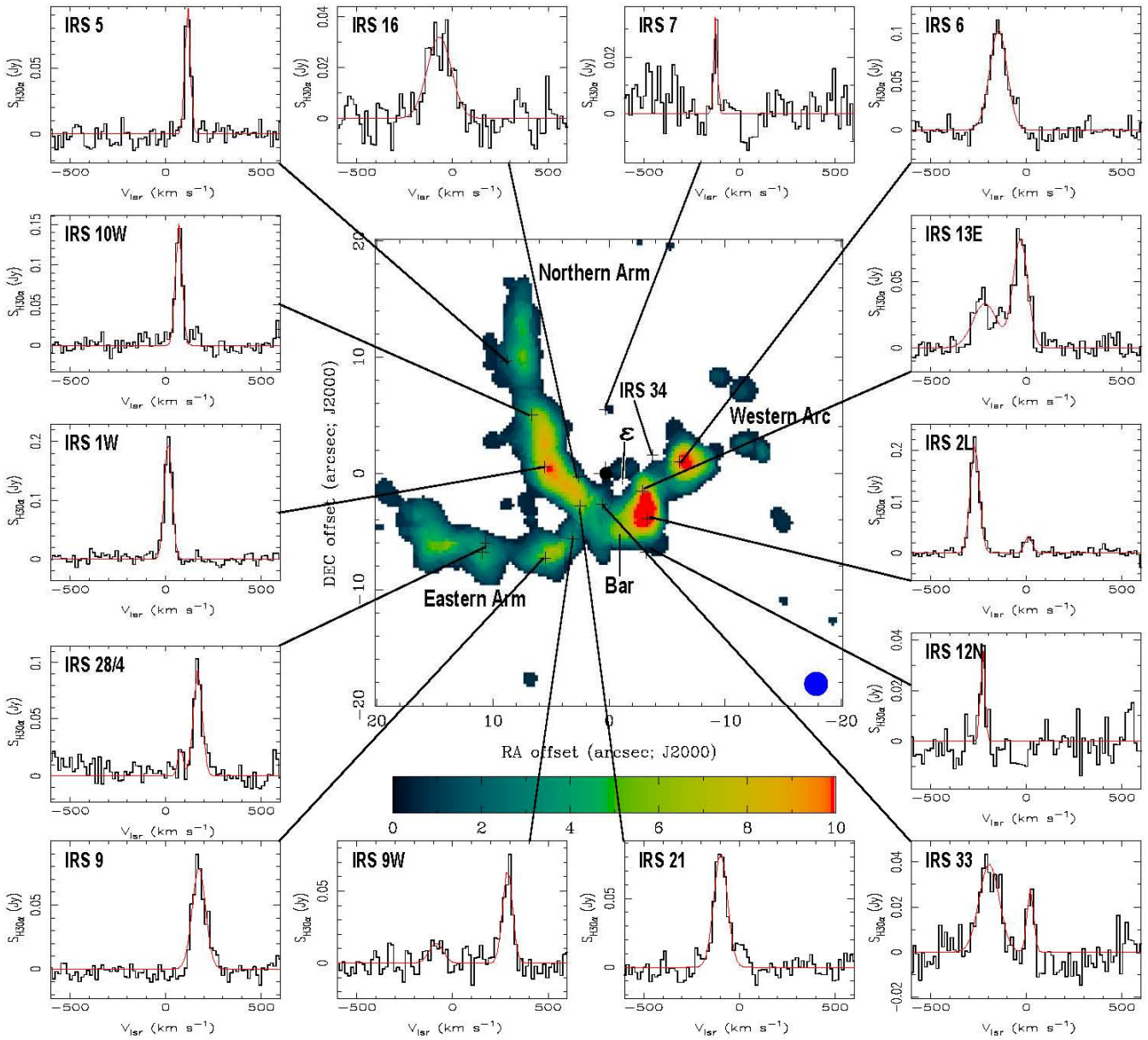
SMA Data
Sergio Martin Ruiz

3 arcmin field
3 arcs resolution
1.3 mm wavelength

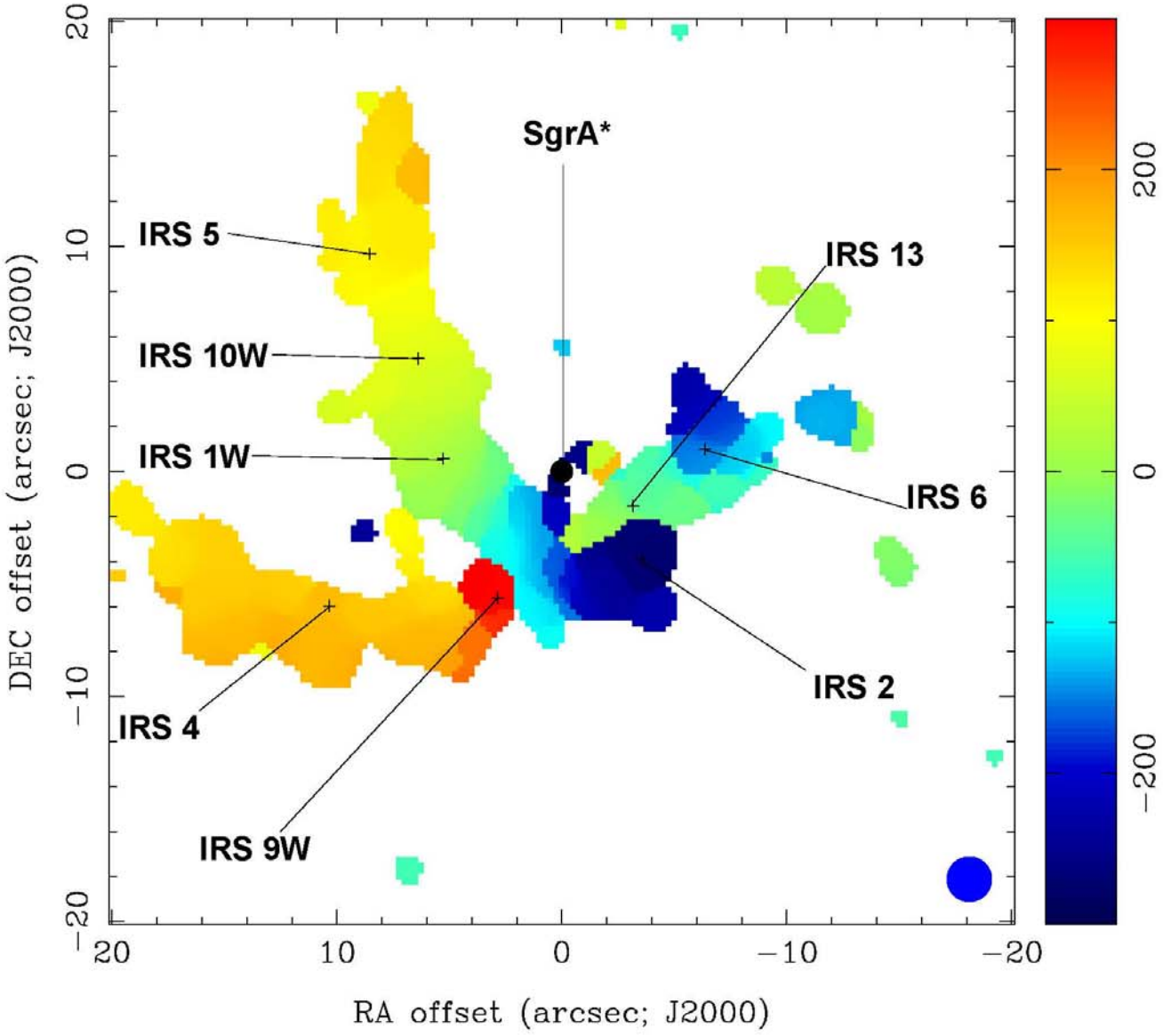
Galactic Center CND with 230 GHz Continuum from Ionized Minispiral



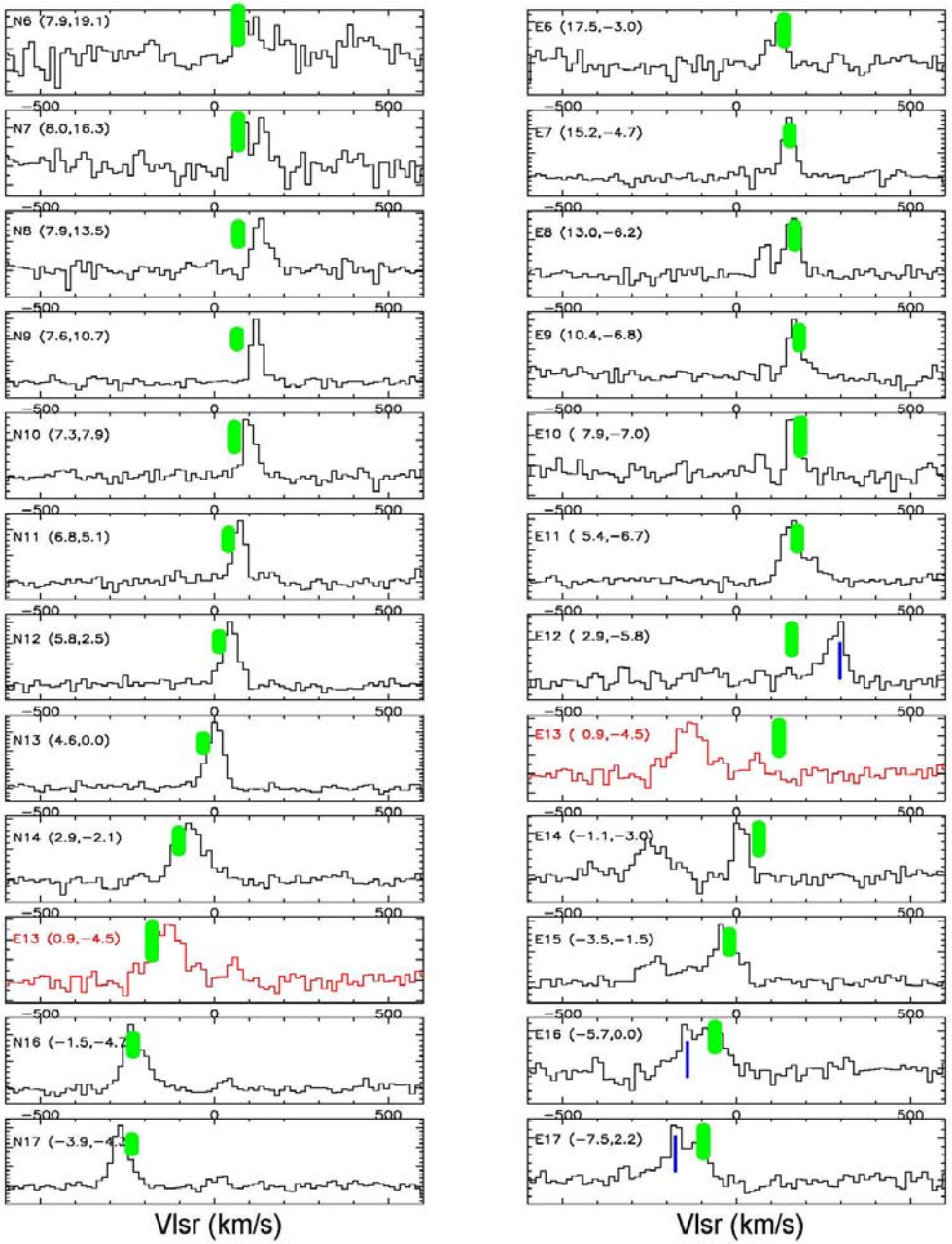
H30α Recombination Line at Prominent Locations



Velocity Distribution of Gas Traced by H30α Emission

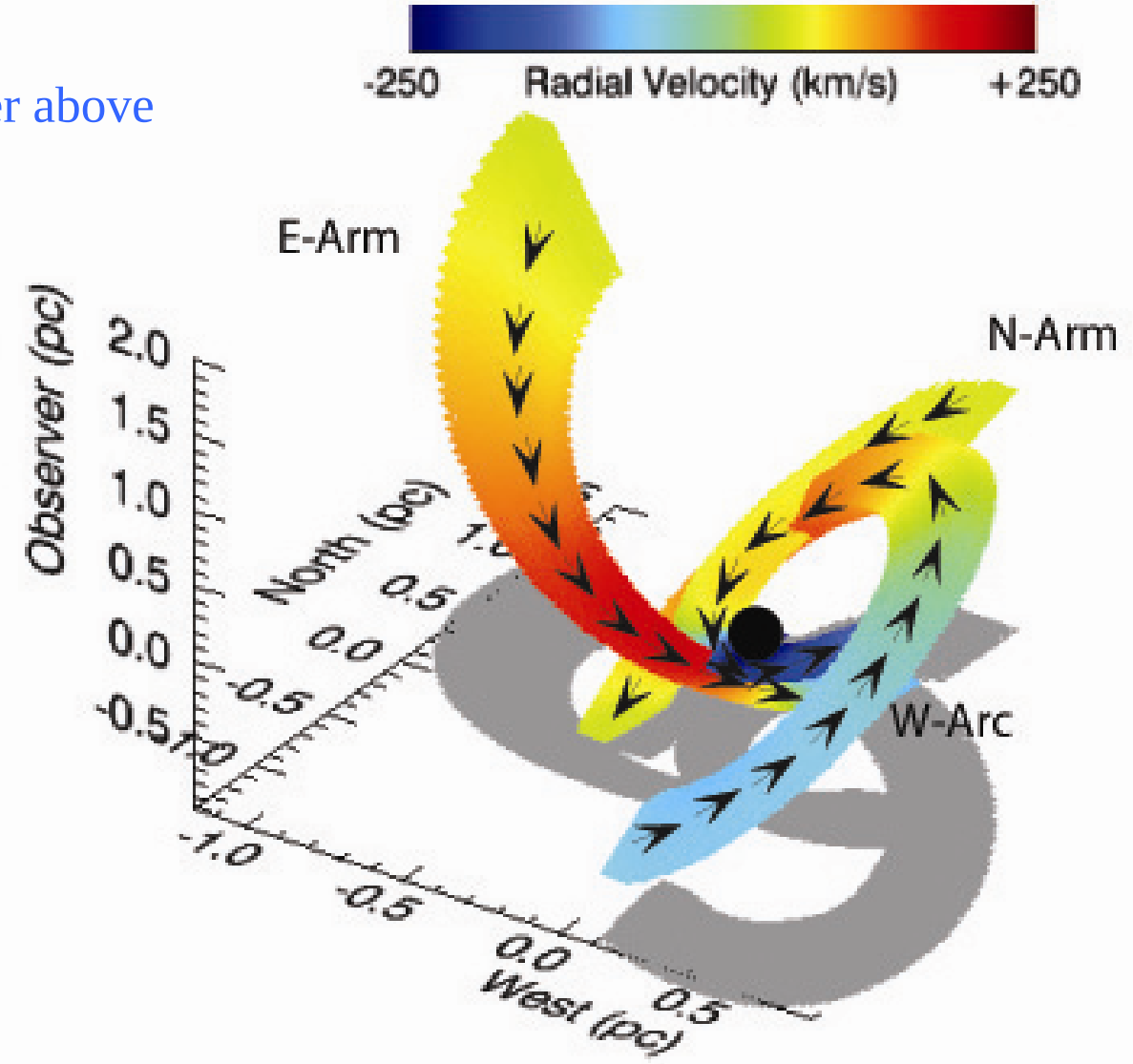


Keplerian Radial Velocity Model



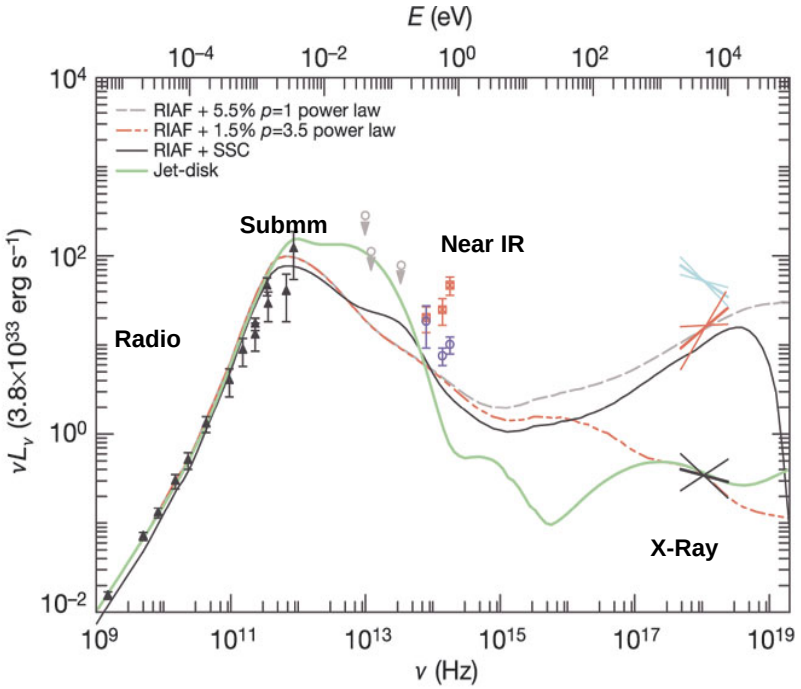
Three-Dimensional Geometry of Minispiral Arms

Observer above

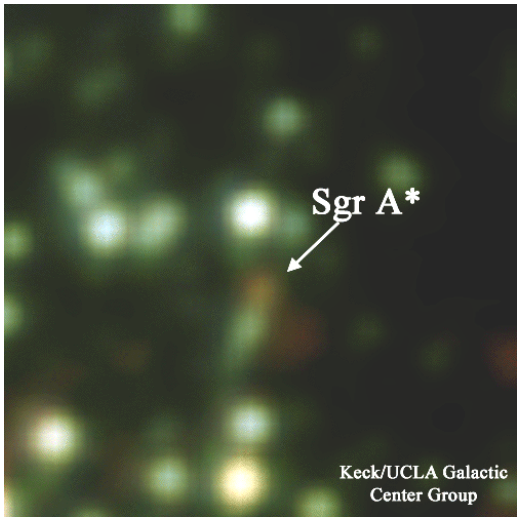


Gray image is in the sky projection

- Very faint source still detectible at most astronomical observing bands
  - SED measurements span 10 decades in frequency
- $L_{SgrA*} \sim 300\ L_{Sun} \sim 10^{-9}$ *Eddington limit*

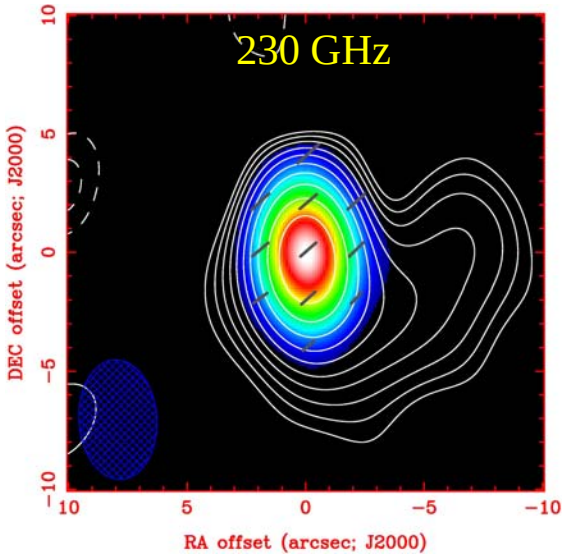


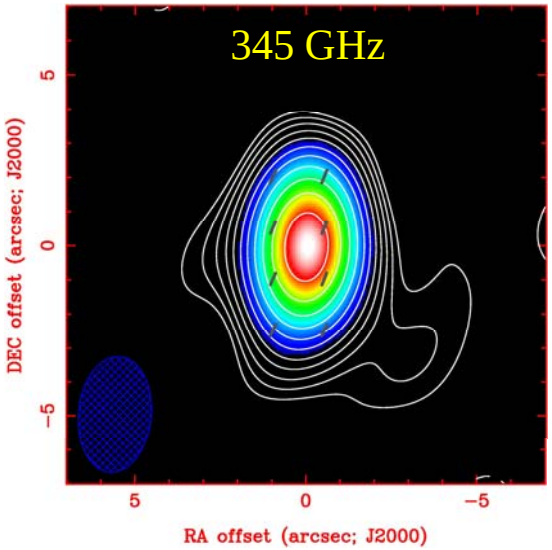
Genzel et al. (2004)

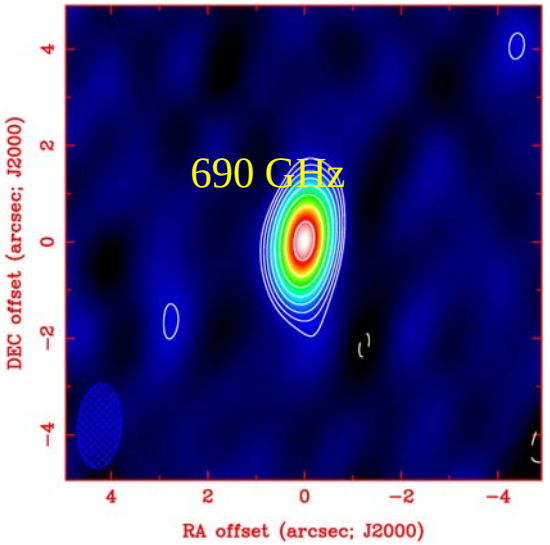


IR flare (Hornstein et al. 2007)

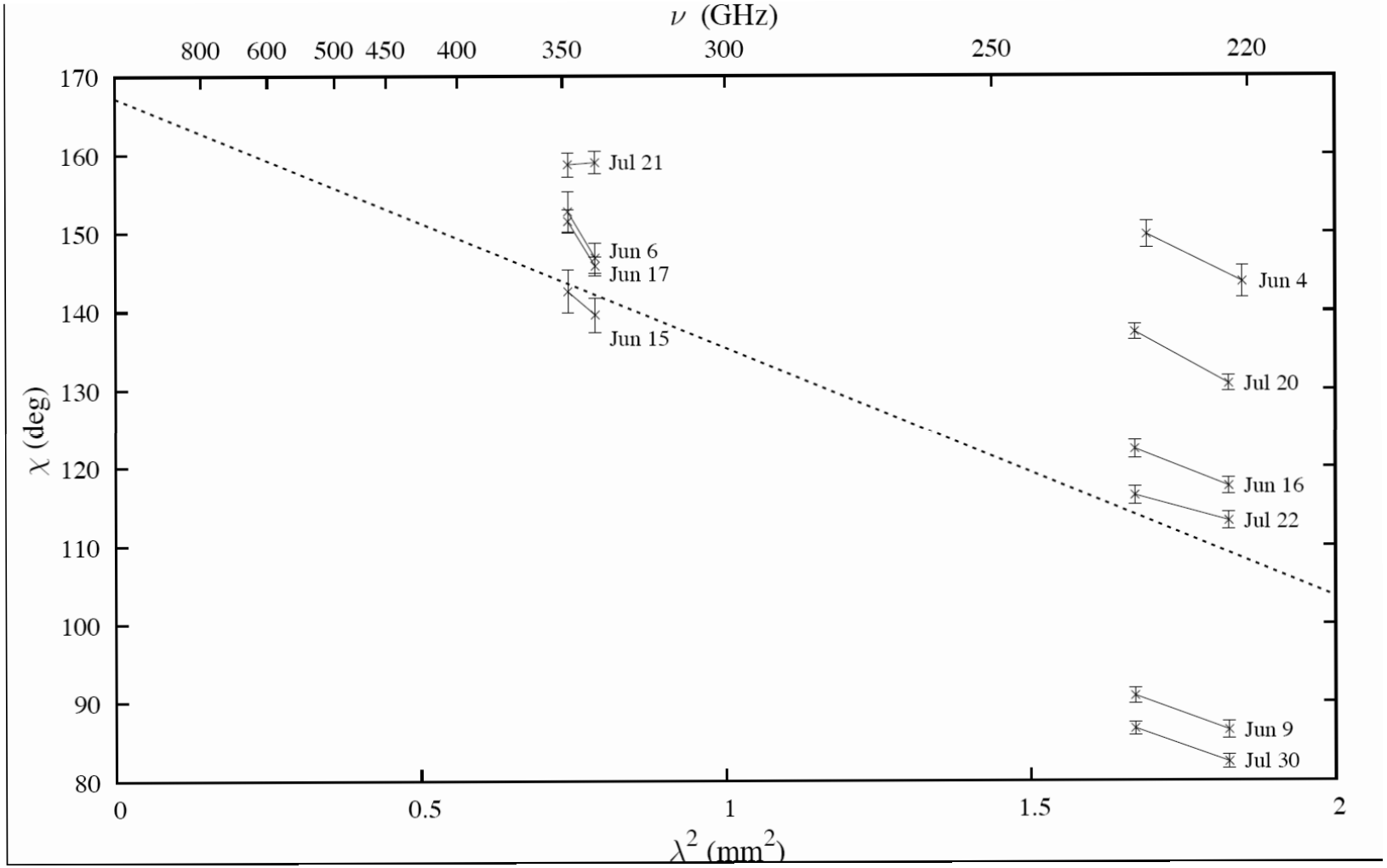
Polarization Images at Various Wavelengths from the SMA







2005 SMA Measurements of Faraday Rotation in Sgr A*



Accretion Rate and Faraday Rotation

$$\chi(\lambda,t) = \chi_0(t) + \lambda^2 RM(t)$$

$$RM = 8.1 \times 10^5 \int n_e \overline{B} \cdot \overline{dl}$$

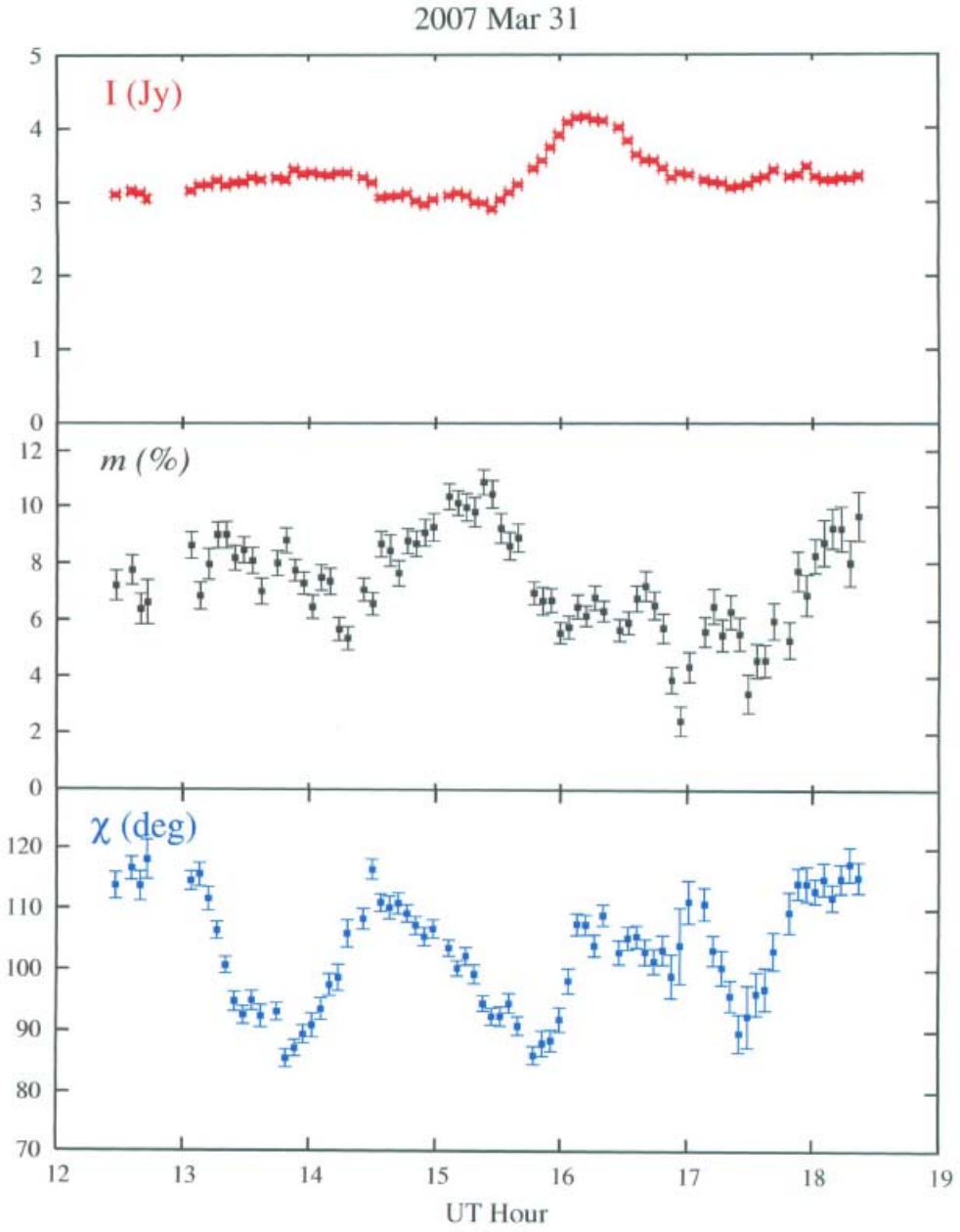
$$RM = -5.1 \times 10^5 \text{ rad/m}^2$$

Assumptions

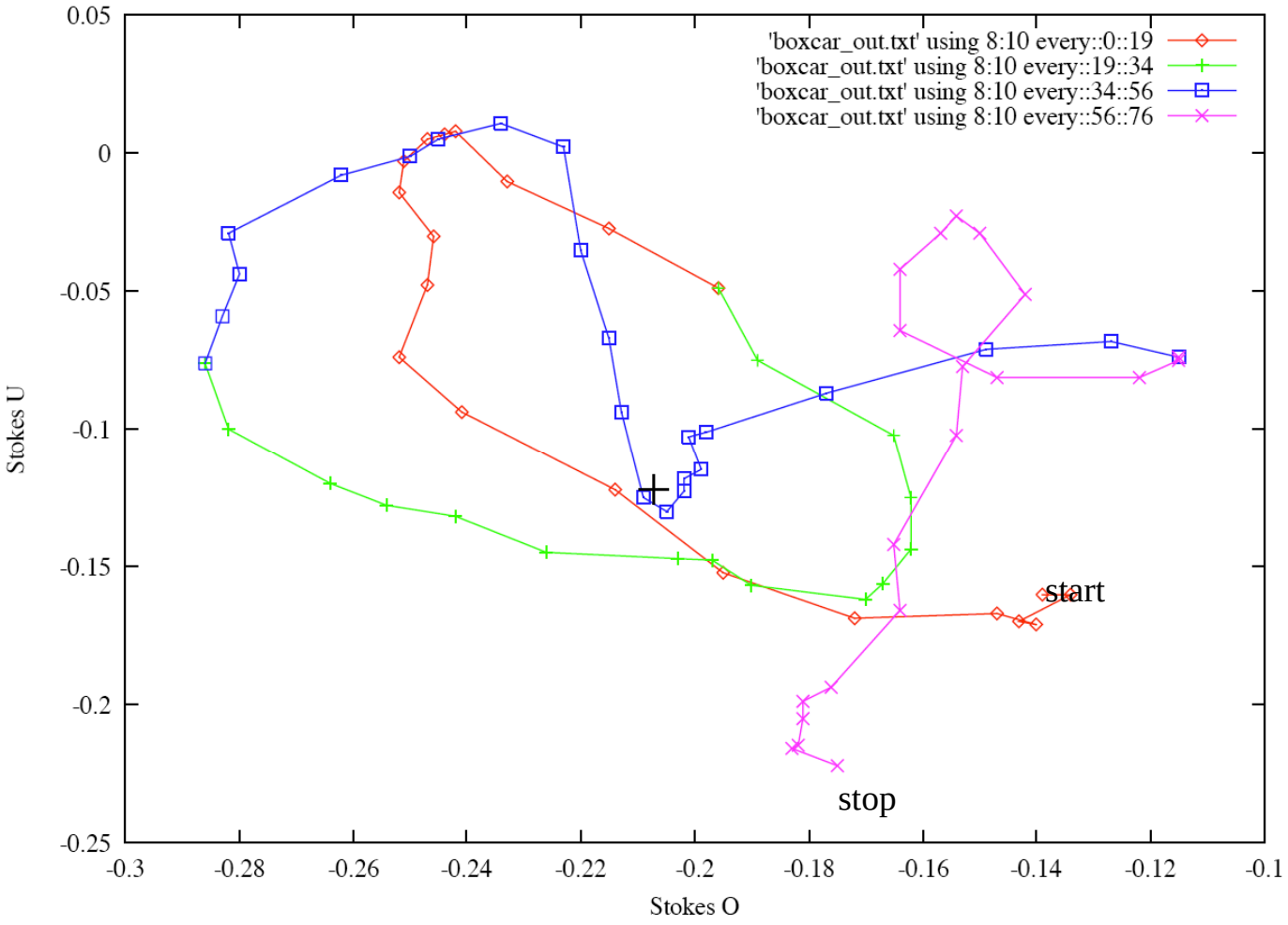
- equipartition
- density power law
- inner radius cutoff of Faraday screen

Accretion rate = 10^{-9}–10^{-7} M_{Sun}/yr

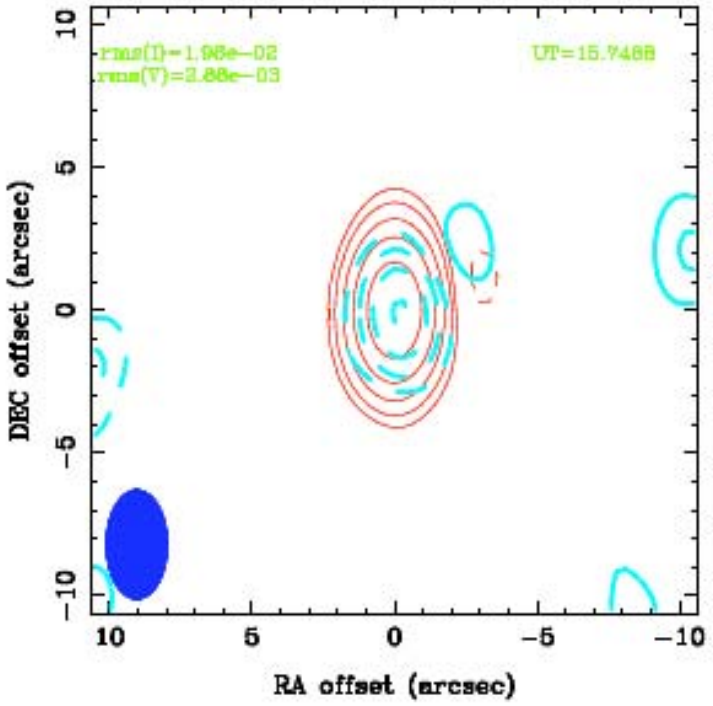
Polarization of Sgr A* at 230 GHz (1.3 mm) (SMA)



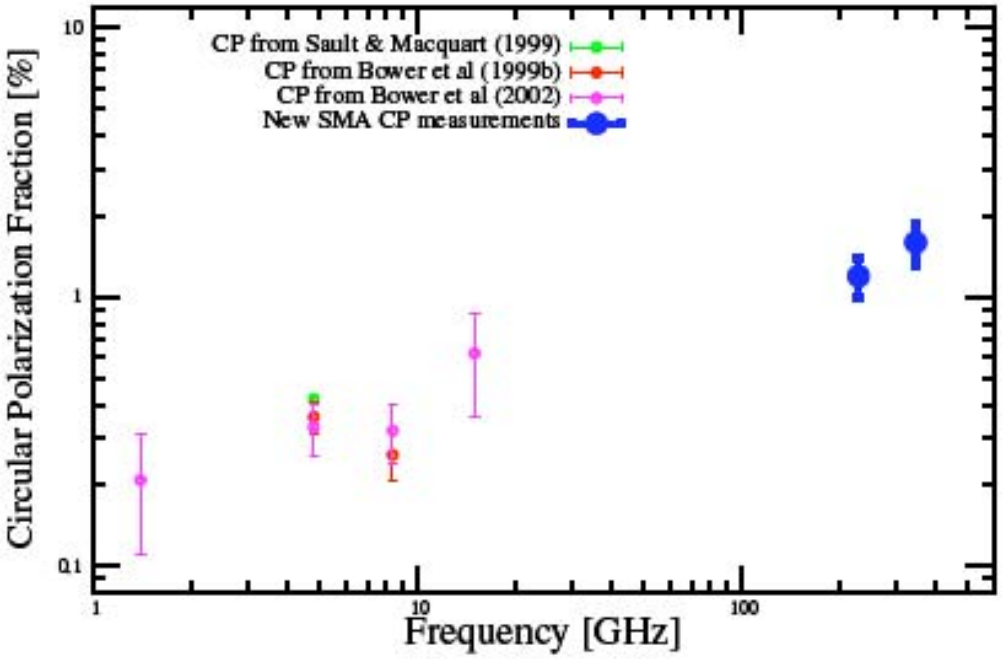
Polarization Track for 3/31/07 Observation of SgrA*



Circular Polarization of Sgr A*

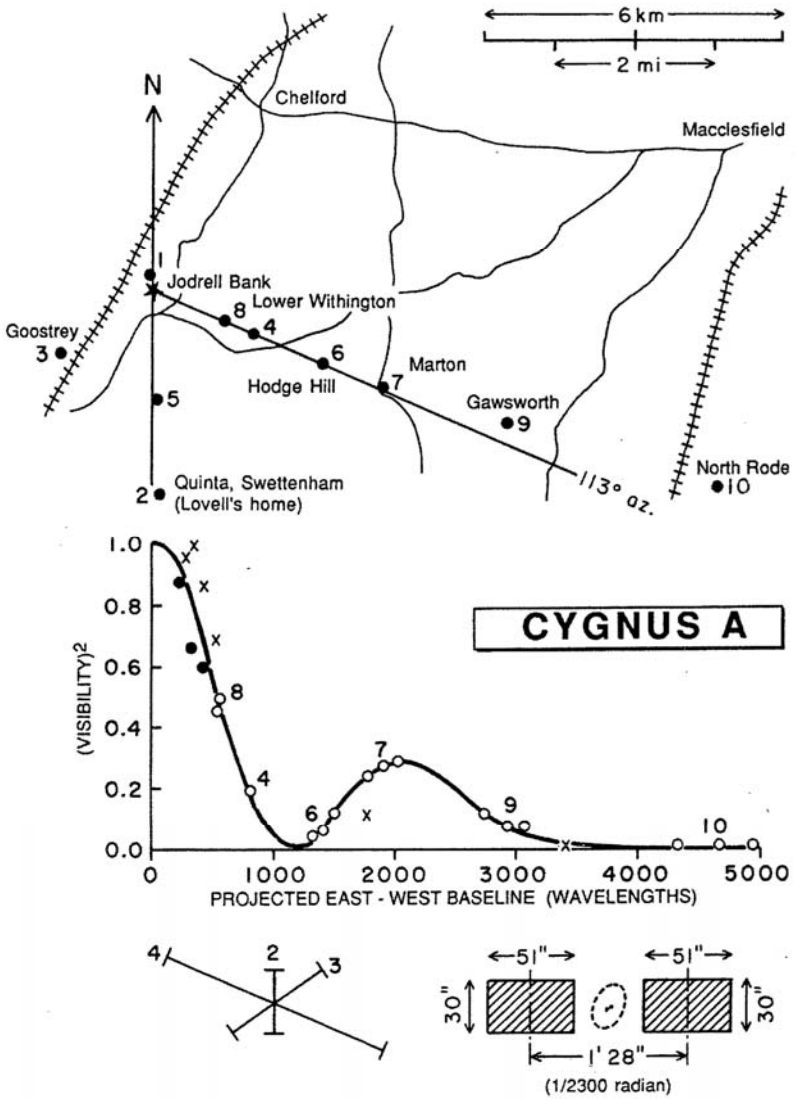


(red) Stokes I
(blue) Stokes V



Fractional Circular Polarization
vs. Frequency

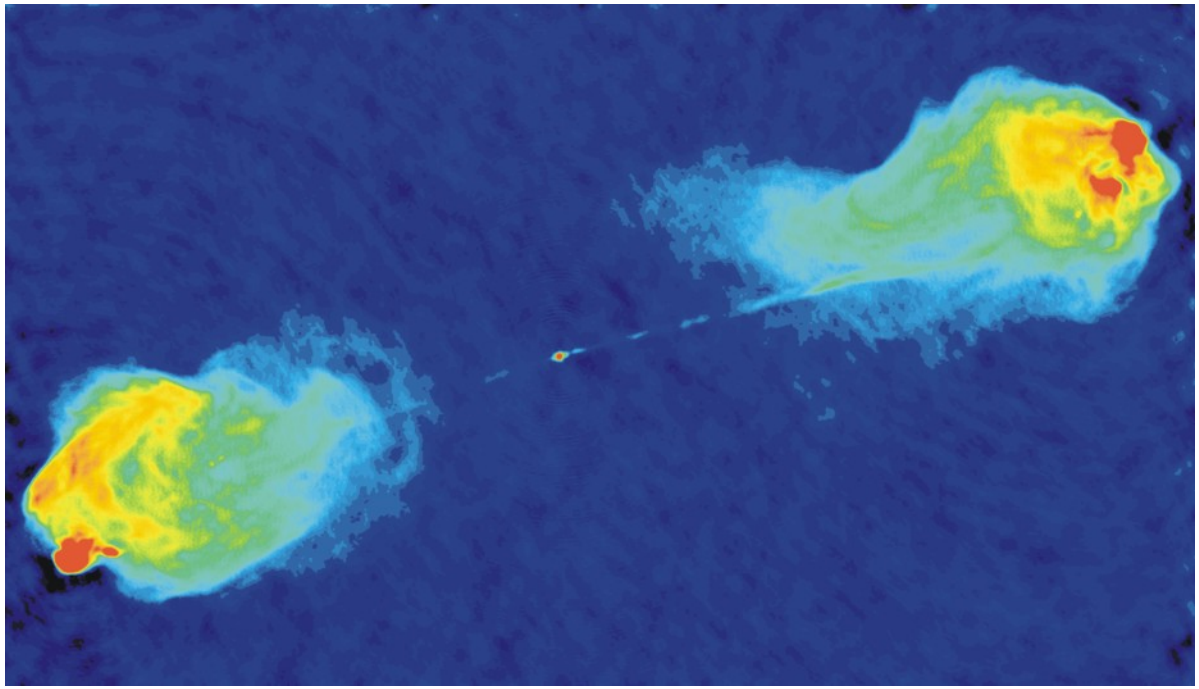
Observations of Cygnus A with the Jodrell Bank Intensity Interferometer



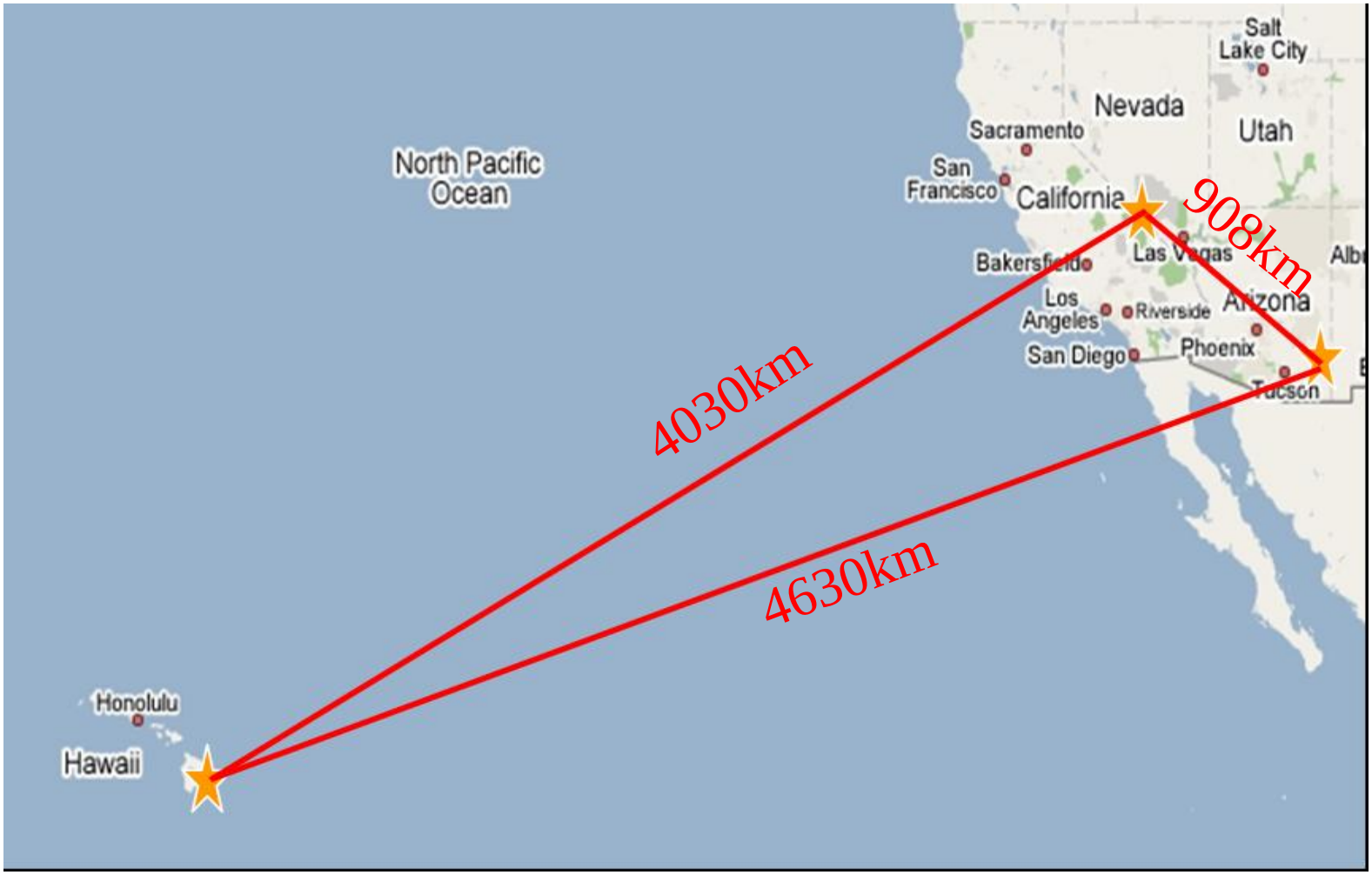
Square of visibility
125 MHz

Jennison And Das Gupta, 1952, see also Sullivan 2010

The Synchrotron Emission from Cygnus A Imaged with the VLA at 6 cm Wavelength

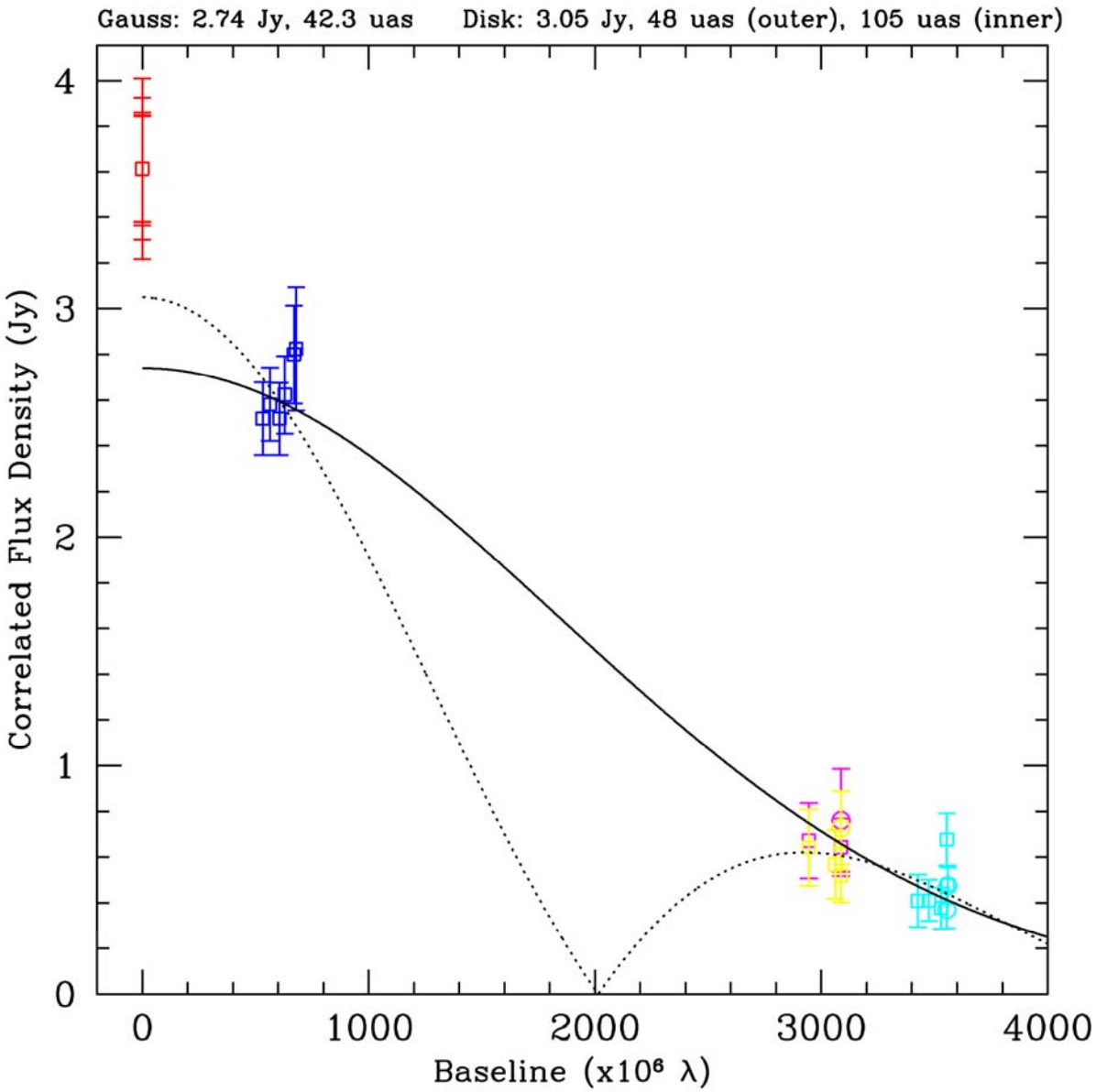


1.3mmλ Observations of SgrA*



VLBI program led by a large consortium led by Shep Doeleman, MIT/Haystack

Day 97, 2009


Gauss: 2.74 Jy, 42.3 uas
Disk: 3.05 Jy, 48 uas (outer), 105 uas (inner)
Correlated Flux Density (Jy)
0
1
2
3
4
0
1000
2000
3000
4000
Baseline (x10⁶ λ)