Optical/Infrared Interferometery

How is OIR interferometry different from radio interferometry? OIRI resource page

1. If telescopes are large (>r_o) we need an adaptive optics system (1 per telescope) to assure phase coherence over whole aperture.
2. No amplification (without loss of phase; addition of noise. So splitting a signal between multiple baselines =>fewer photons/baseline. vlticonfigurations
3. Transmission by mirrors=>loss of signal (sometimes >50%) , polarization wierdness, sometimes limits field of view (we ignored this in radio case). This also tends to limit maximum baseline length to a few hundred meters. Transmission by fibers is experimental but causes wavelength dispersion problems.

4. Delay lines are also mirror devices. They need to operate with accuracy <1μ so they are usually laser metrology stabilized. Broad bandwidths require either very accurate delay lines or instrumental spectral dispersion (but this may cost Signal/Noise).VLTI delay line page, vlti tunnel

5. Correlation by beam addition and power detection instead of ditigal mutliplication. This is more sensitive to backgrounds. Because of high backgrounds it is usually necessary to modulate OPD deliberately to see signal.

   a. Temporal Delay modulation with movable mirrors

   b. Spatial Deay modulation = “multiaxial recombination”

6. Detectors are typical IR detectors but they have to be fast to follow atmospheric changes. Readout noise can then be an important limitation.Atmospheric fluctuation times of order

1-500 millsec. Need fast detectors and bright sources.

7. Fast atmospheric variations –seeing changes—make calibration of correlated fluxes difficult. Difficulties in maintaining AO level has led to the use of spatial filtering to enforce phase coherence (often involves loss of light) and concommitent simultaneous measurement of total transmitted light (“photometry”). The resultant measure is “visibility” rather than coherent flux.

8. Phase stability and calibration are difficult, so data interpretation is often in terms of amplitudes only of complex numbers. This, and the difficulty of obtaining many UV points has led to an emphasis on interpretation by model fitting rather than imaging. Special phase techniques – wavelength differential phase; closure phase—allow some imaging possibiities

9. Fainter sources may require a *fringe tracker* that stabilizes the fringe motion and allows long

integrations. This is the equivalent of adaptive optics on a single telescope. The fringe tracker can be more sensitive than the main interferometer because:

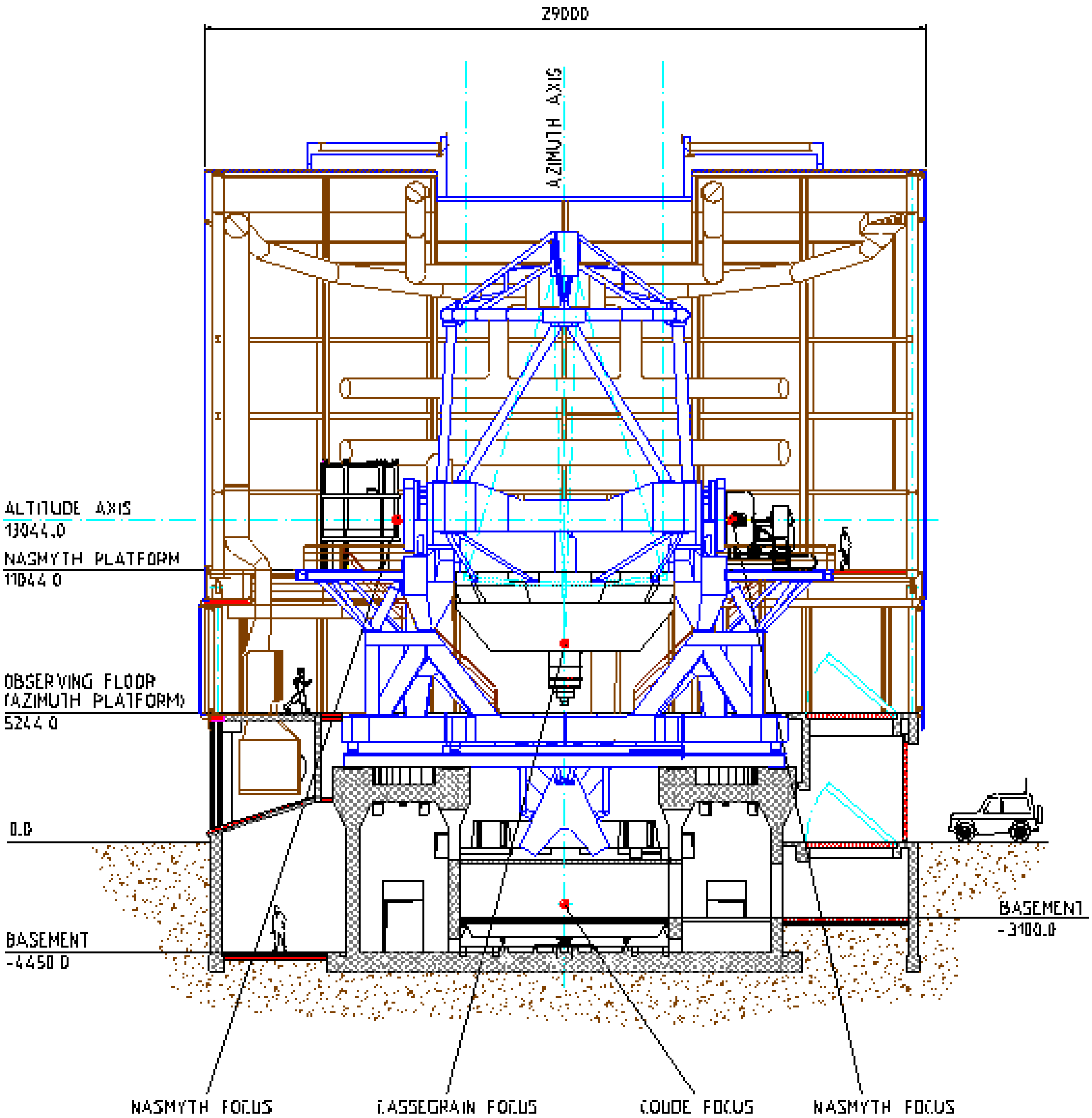
a. It uses a lower spectral resolution

b. It uses a different wavelength

c. It looks at a different star

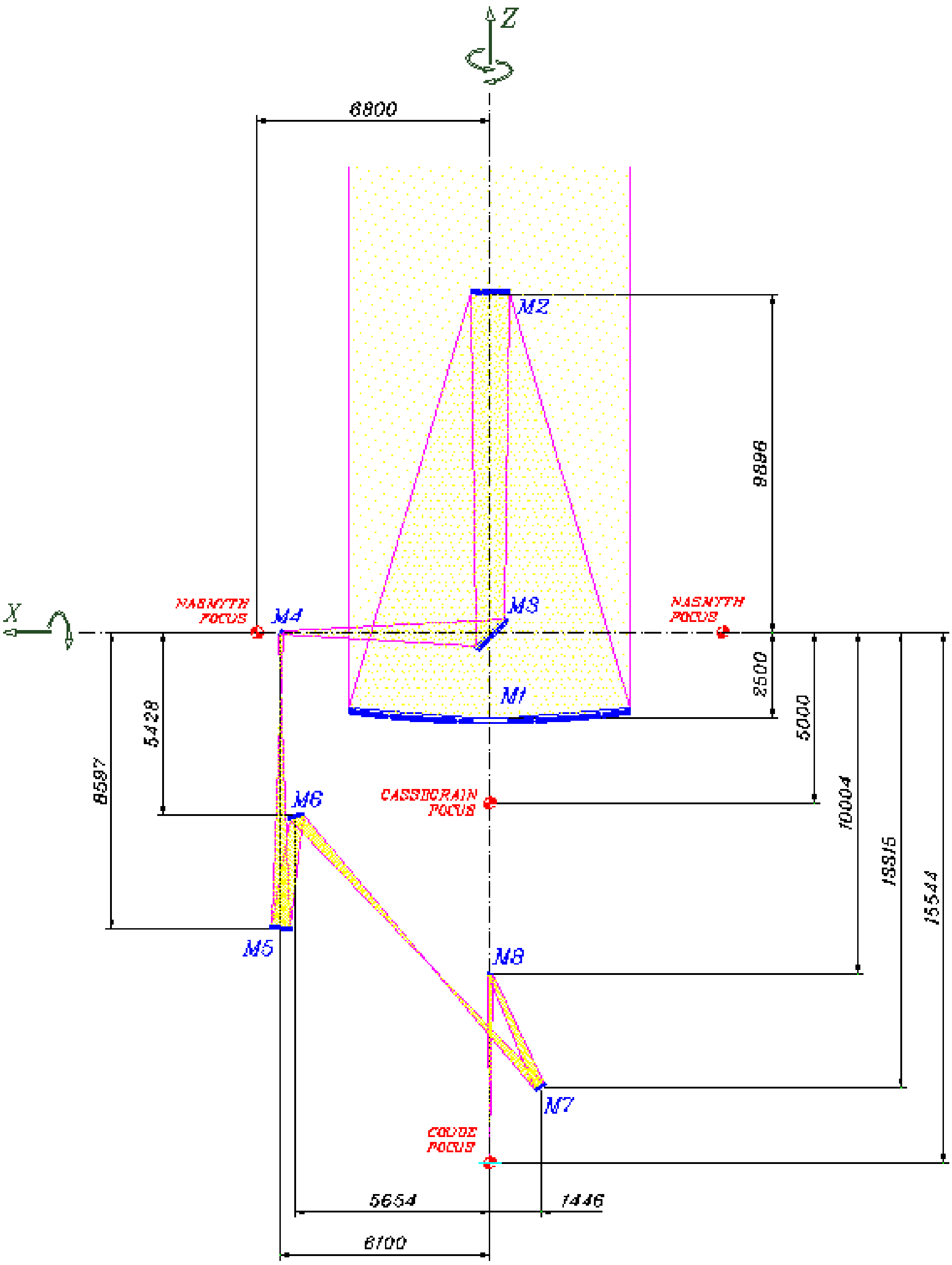
EUROPEAN SOUTHERN OBSERVATORY

VERY LARGE TELESCOPE



FRONT VIEW (Section)

OPTICAL LAYOUT



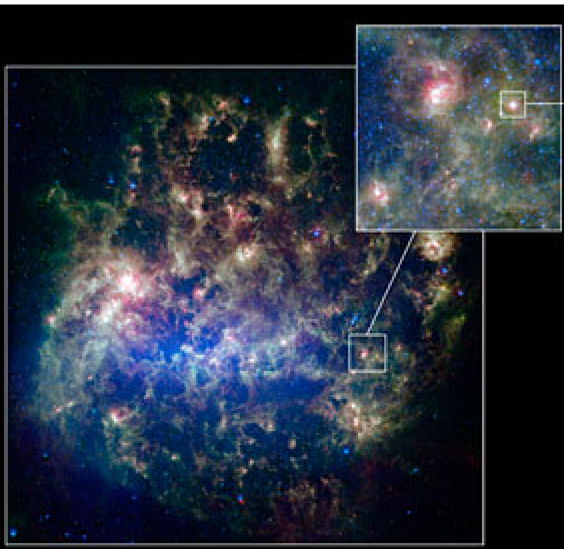
vlti fringe tracker layout

amber layout,midi

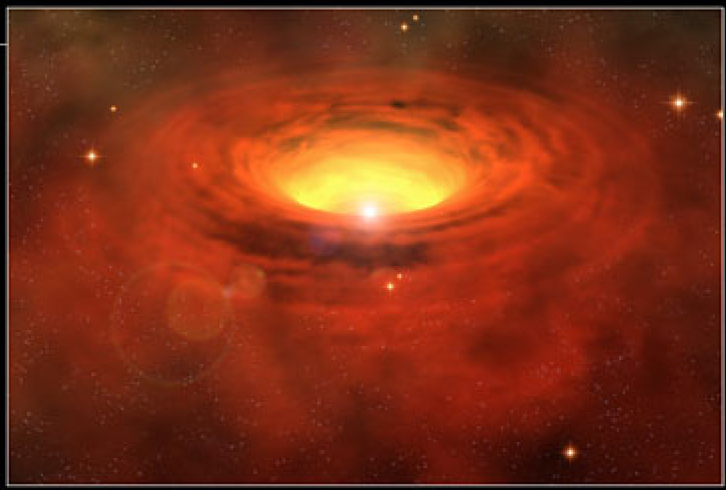
keck home page

magdalena ridge observatory

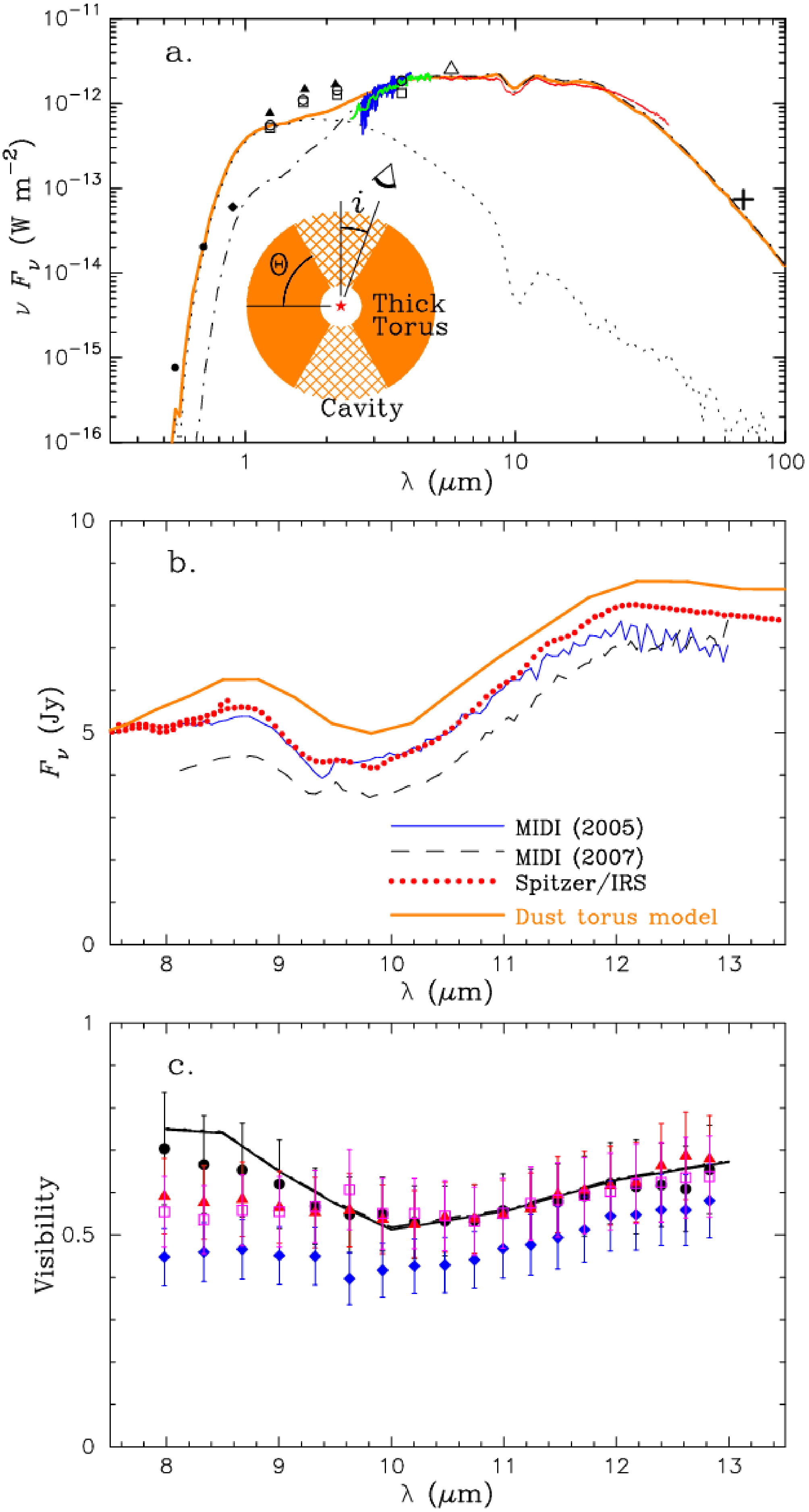
Some Results:AGN: NGC 1068



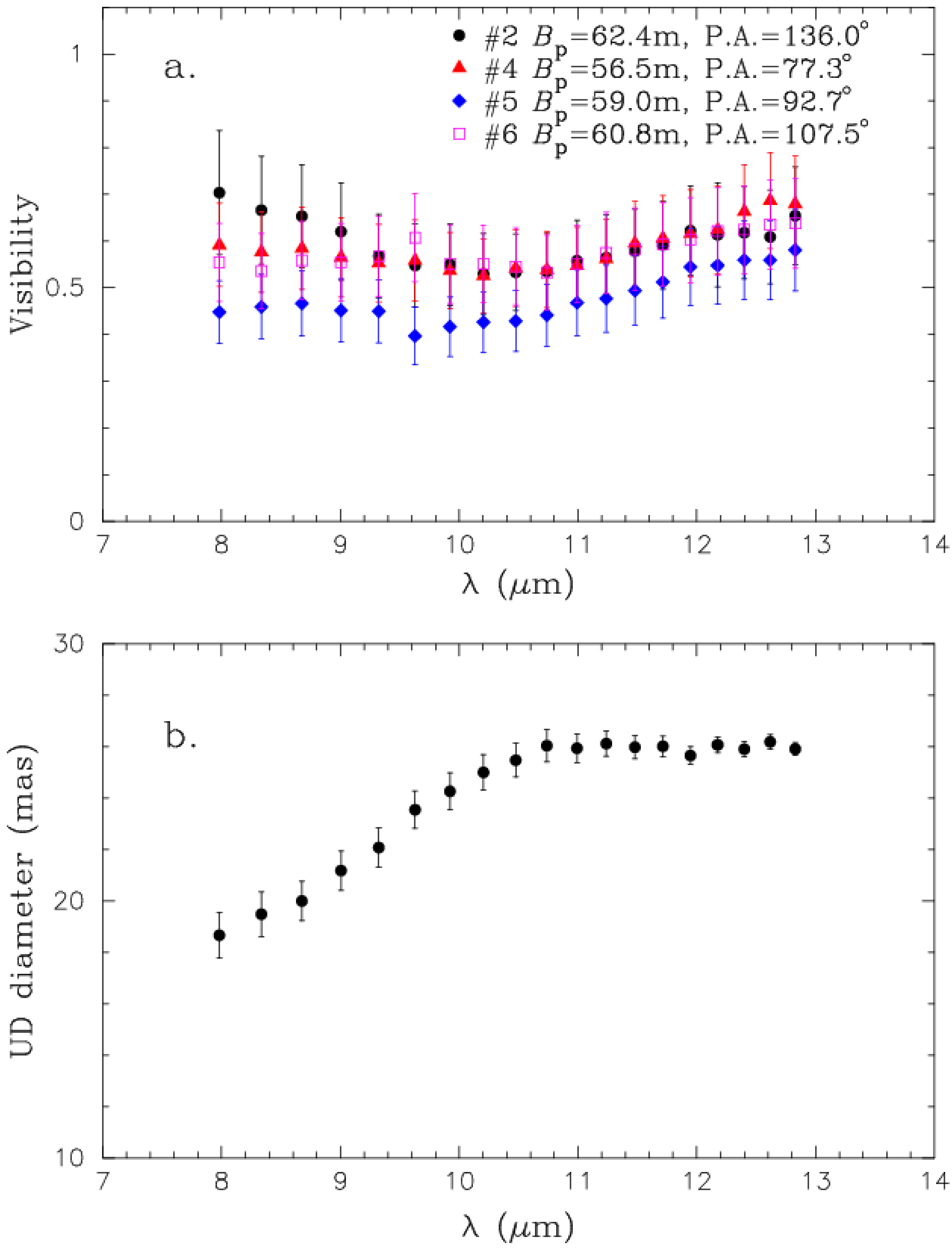
The Large Magellanic Cloud (Spitzer Space Telescope)



Star WOH G64 - Artist Impression (ESO)



a.
Thick
Torus
Cavity
Θ
i
νF_ν (W m^{-2})
λ (μm)
b.
F_ν (Jy)
MIDI (2005)
MIDI (2007)
Spitzer/IRS
Dust torus model
λ (μm)
c.
Visibility
λ (μm)


a.
#2 B_p=62.4m, P.A.=136.0°
#4 B_p=56.5m, P.A.=77.3°
#5 B_p=59.0m, P.A.=92.7°
#6 B_p=60.8m, P.A.=107.5°
Visibility
λ (μm)
b.
UD diameter (mas)
λ (μm)

[oblate star]