

# Polarimetry on the IRTF



Terry Jones, February 2018



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# High Precision Infrared Imaging Polarimetry

1. Protoplanetary and Debris Disks
2. Mass-loss in Evolved Stars
3. AGN and their Environment
4. Magnetic Fields in Galaxies
5. Exoplanets in Scattered Light
6. Comet Dust
7. Airless Solar System Bodies



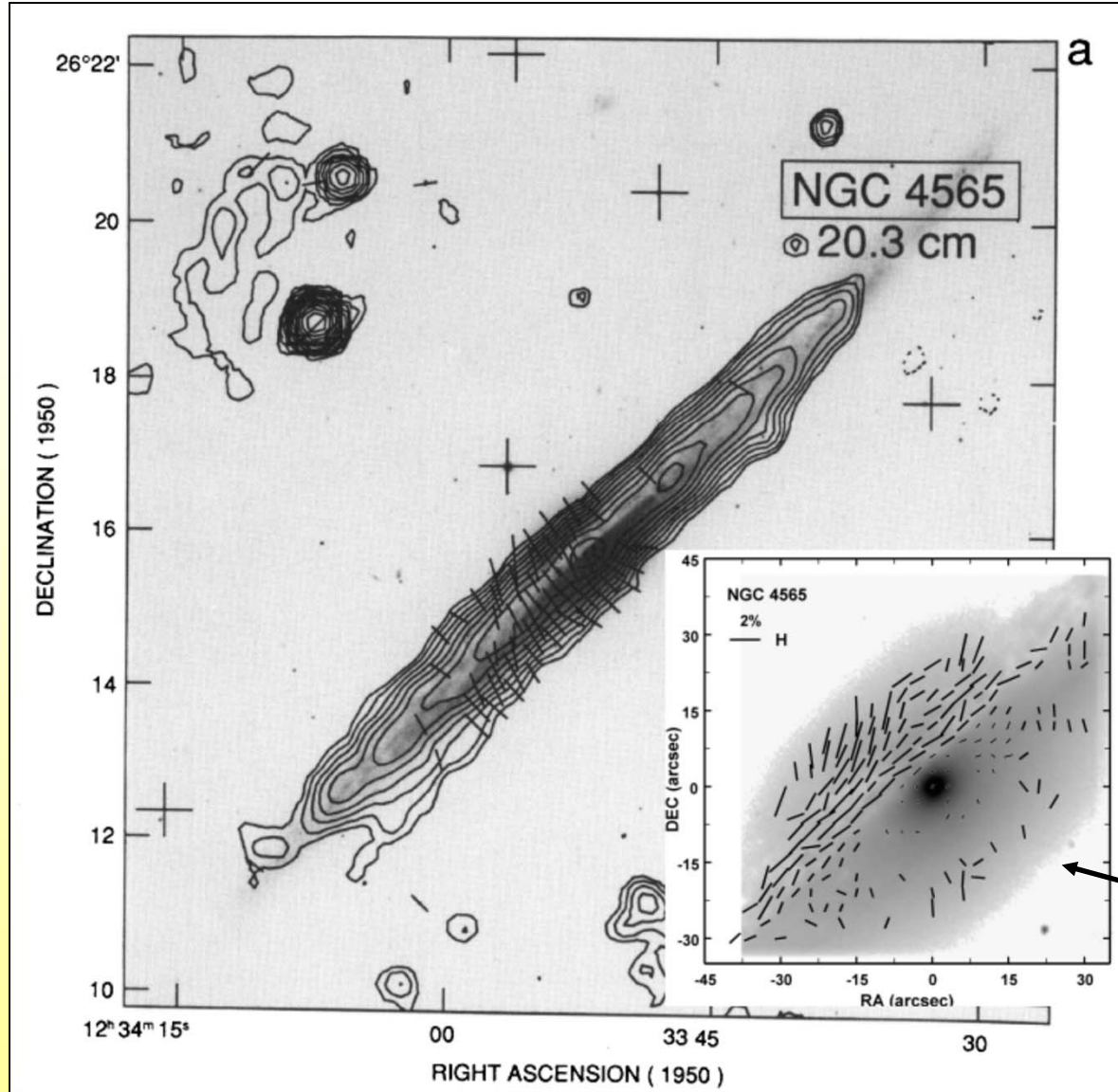
The IRTF has a rich history of Infrared polarimetry.

The Minnesota Infrared Polarimeter (MIRP) was funded by NSF and made numerous, single beam, polarimetric observations of stars and galaxies in the 80's and 90's.

NSFCam was upgraded to enable a polarimetric mode, and imaging polarimetry became possible on the IRTF.

Several examples of Infrared, imaging polarimetry follow:





Polarimetry in H band shows that interstellar polarization does trace the magnetic field geometry in external galaxies. Synchrotron

$$(P \perp \vec{B})$$

nicely agrees with the IR polarimetry in extinction.

$$(P \parallel \vec{B})$$

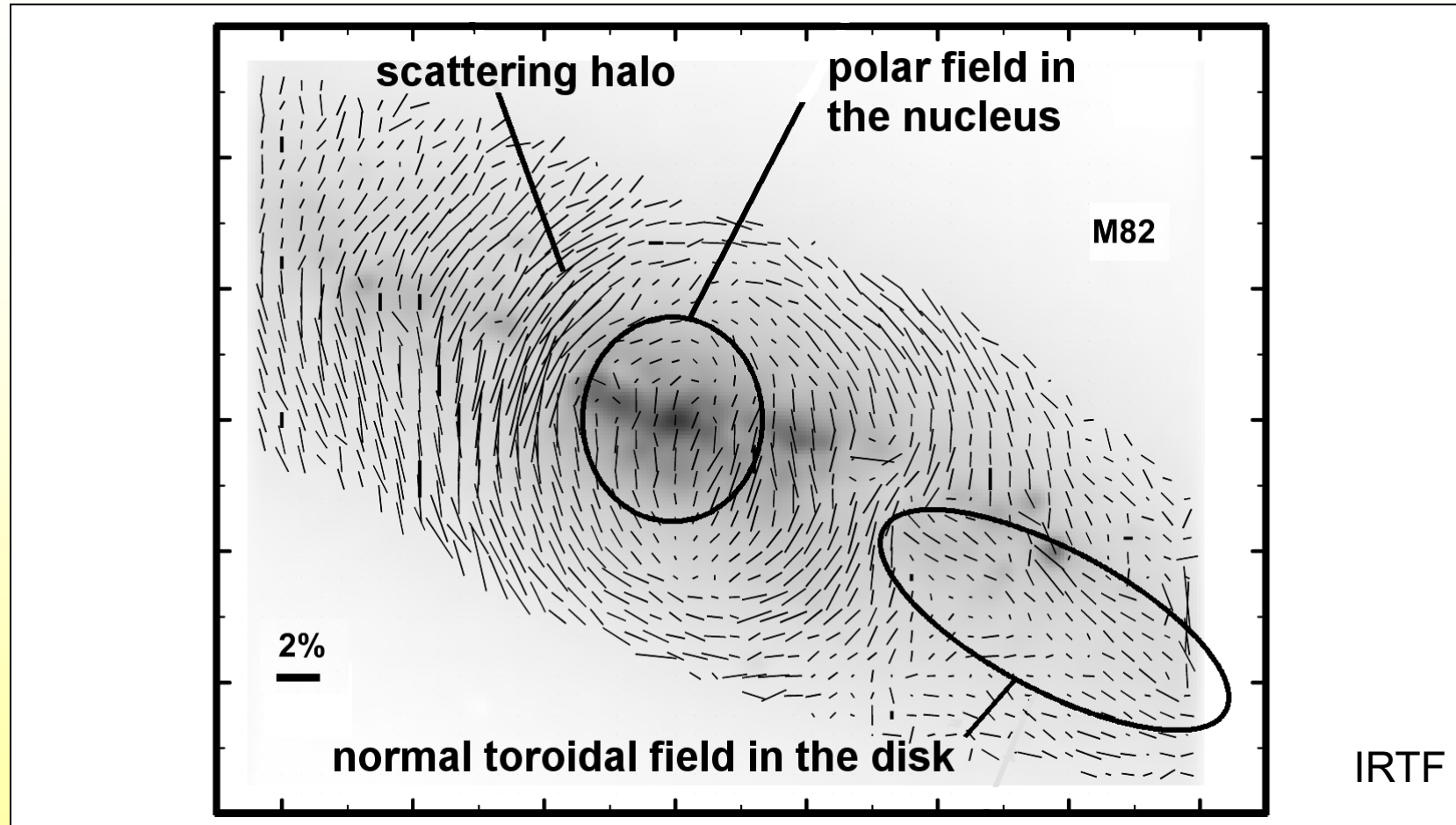
1.65 μm  
IRTF



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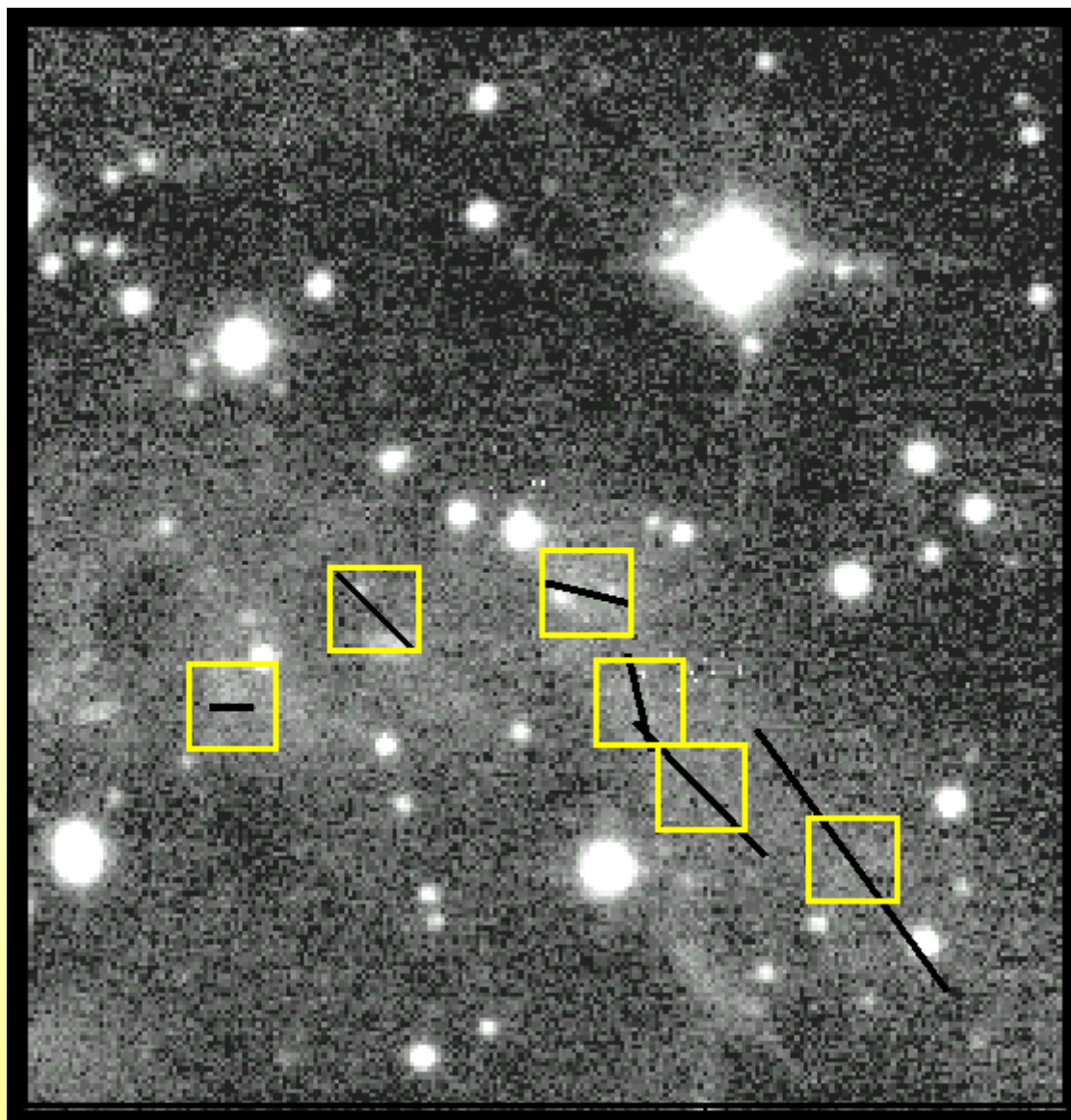
## M82 1.65 $\mu\text{m}$



M82 shows a vertical field in the nucleus. 2/3 of the dust along the line of sight through M82 has a vertical magnetic field.







Cas A  
SN Remnant  
2.2  $\mu\text{m}$

The K band emission is clearly synchrotron, sampling electron energies much higher than in the radio.

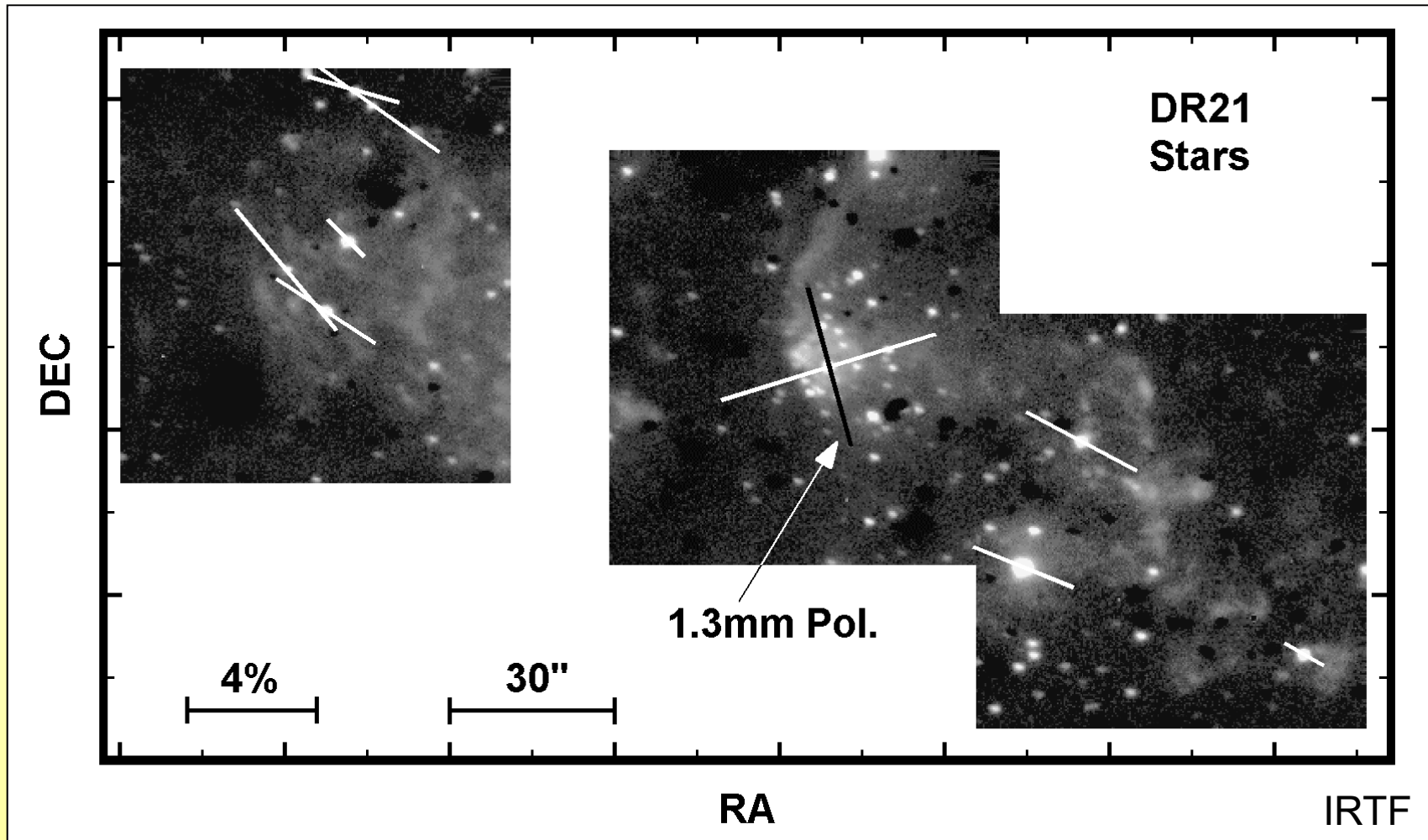
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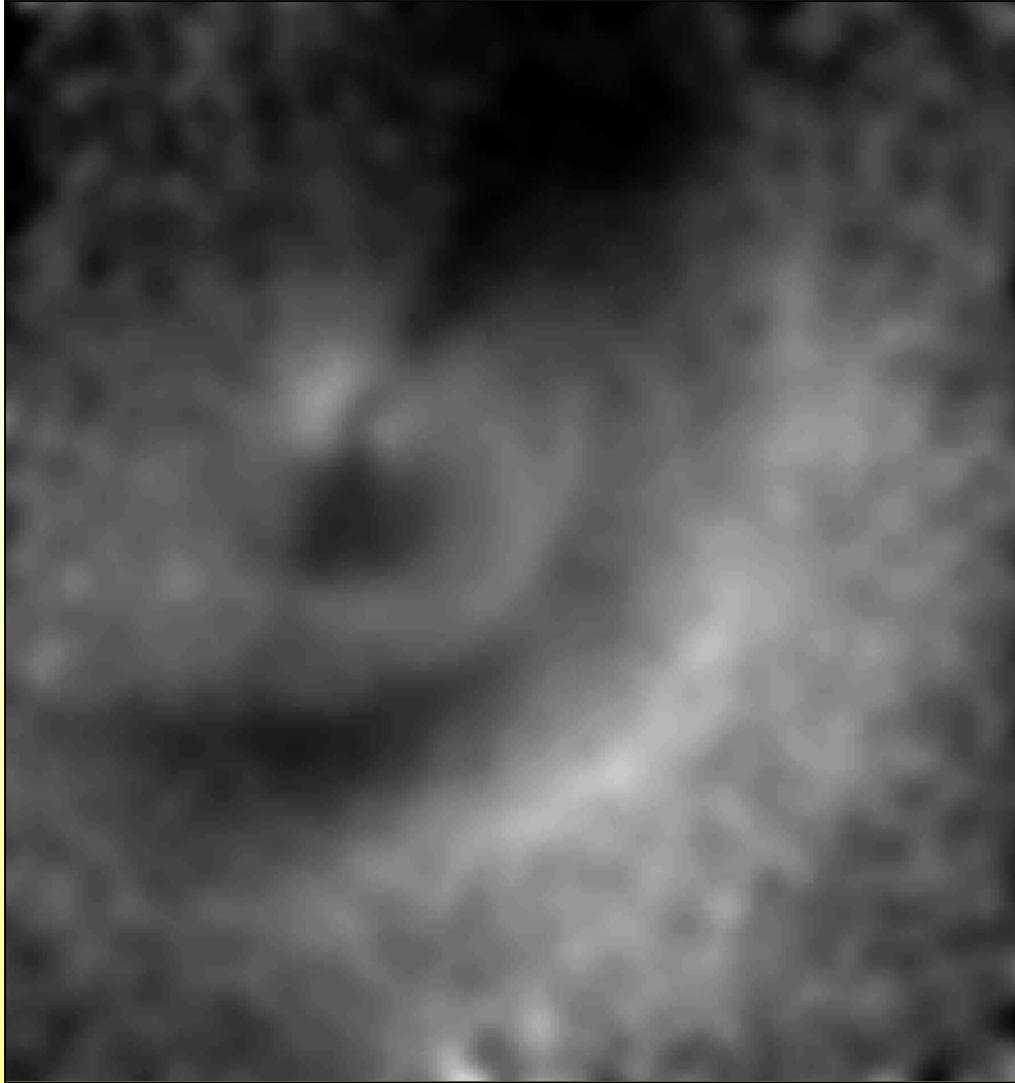
## Massive Bipolar Outflow



The magnetic field in the outflow is aligned with the flow, and probably has no dynamic effect on the outflow.



## Comet Hale Bopp Fractional Polarization at 2.2 $\mu\text{m}$



Fractional polarization is higher in the jet, and gets even higher as the jet ages. Very fragile dust aggregates are losing tiny, 0.1  $\mu\text{m}$ , monomers that add Rayleigh scattering to the comet dust population.

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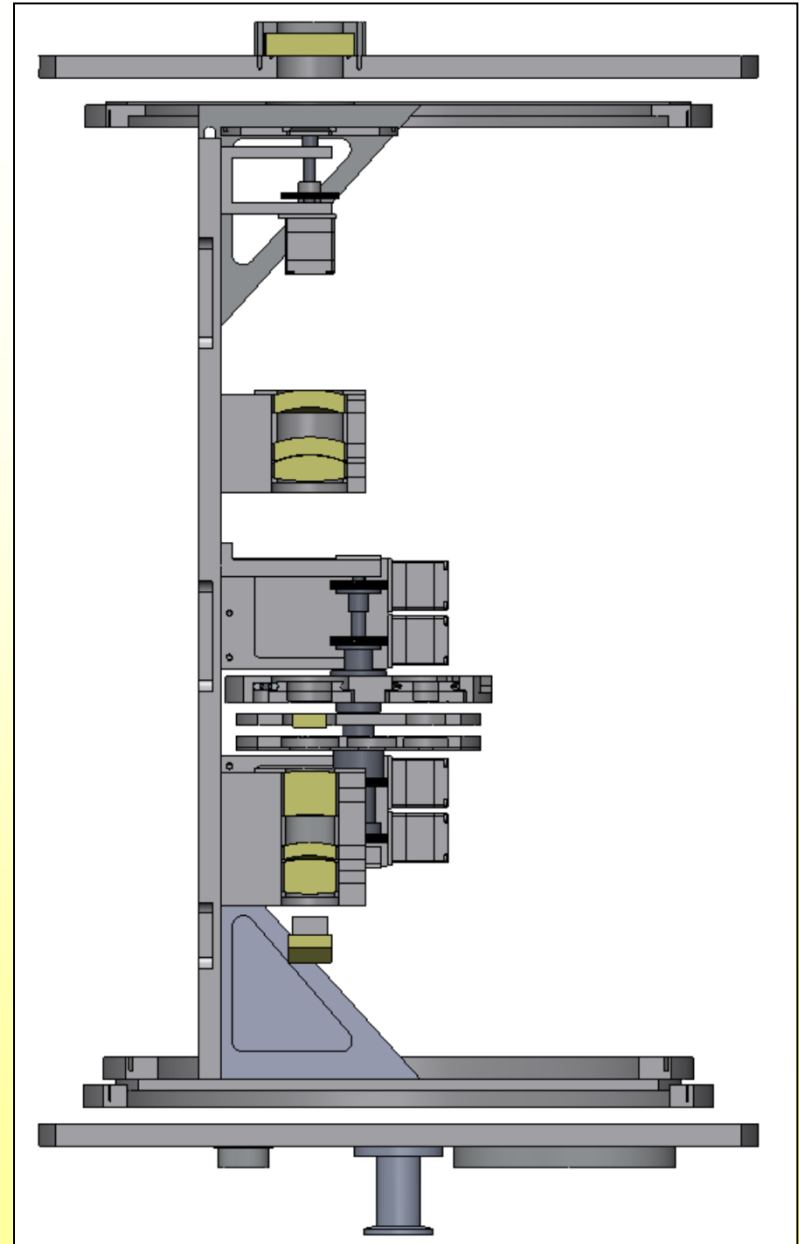
What can be achieved with the combination of an AO secondary and an IR imager optimized for polarimetry on the IRTF?.

I show some results from MMTPol, a 1-4  $\mu\text{m}$  imaging polarimeter on the MMT.

Note that Mauna Kea has 1) much better sky conditions from 3-5  $\mu\text{m}$ , 2) has a more stable sky (airglow, fluctuations in transparency), 3) the IRTF can work in the daytime, 4) and the IRTF can track non-sidereal objects much better than the MMT.

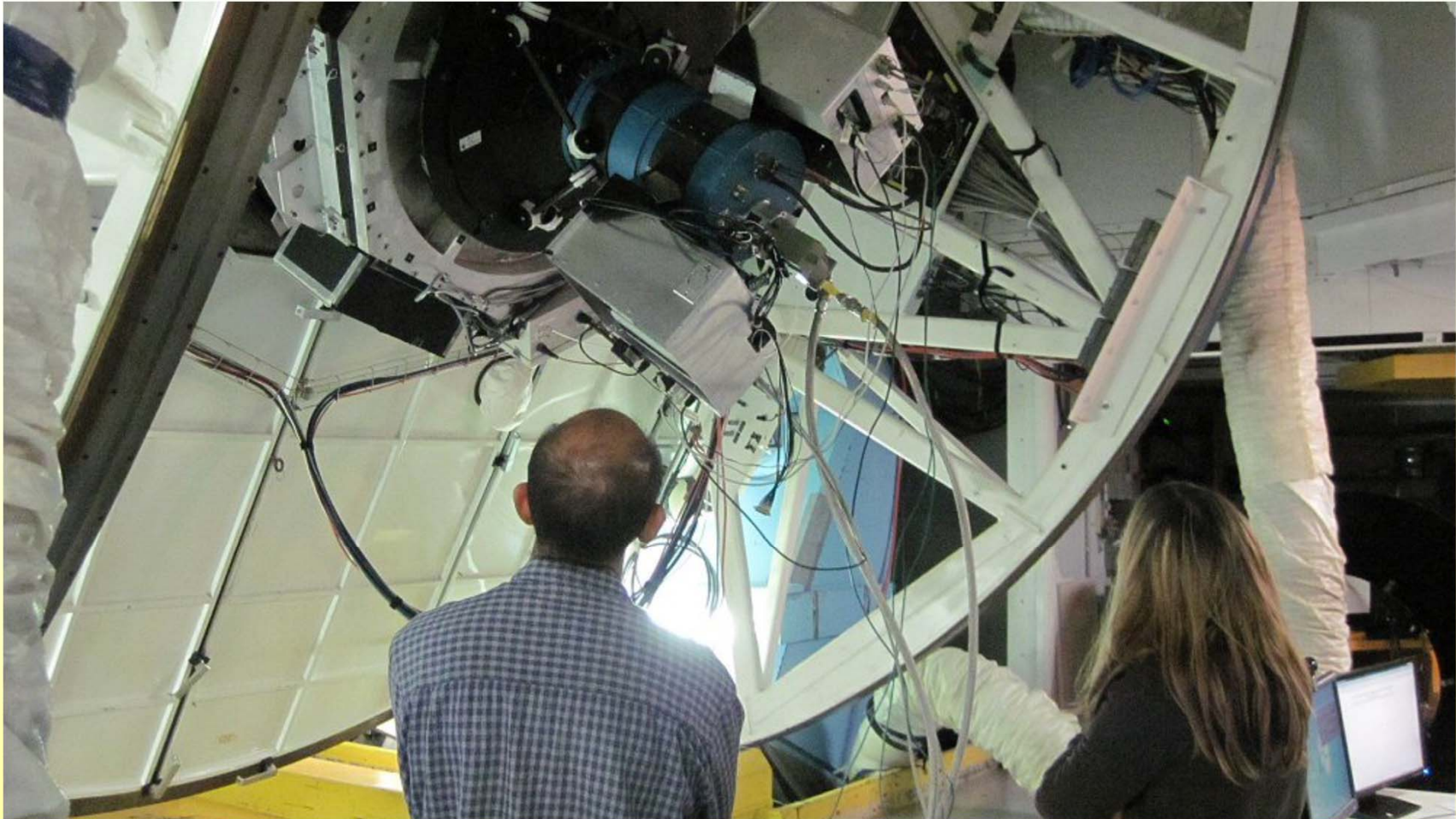


MMTPOL



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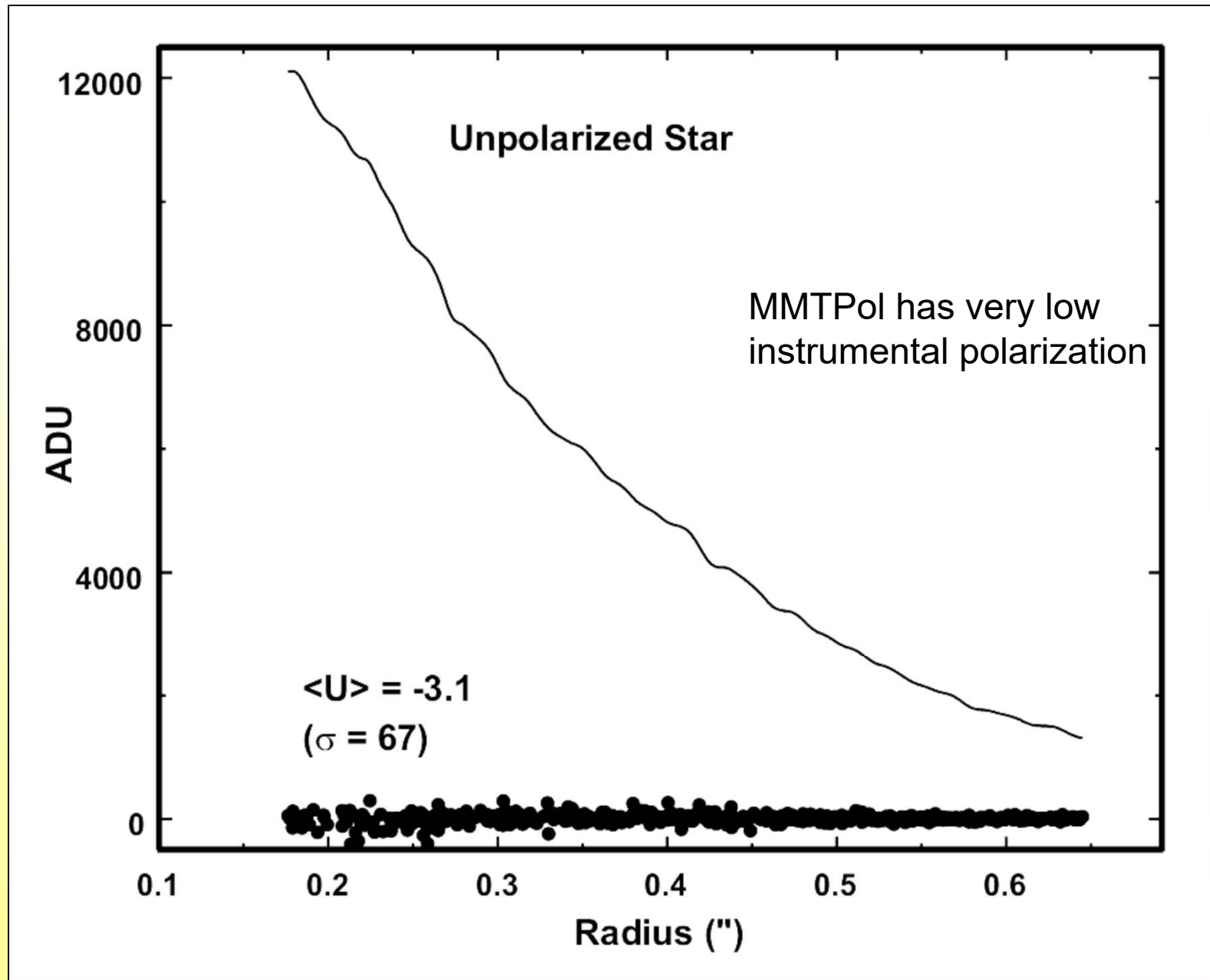


Dinesh Shenoy and Morag Hastie



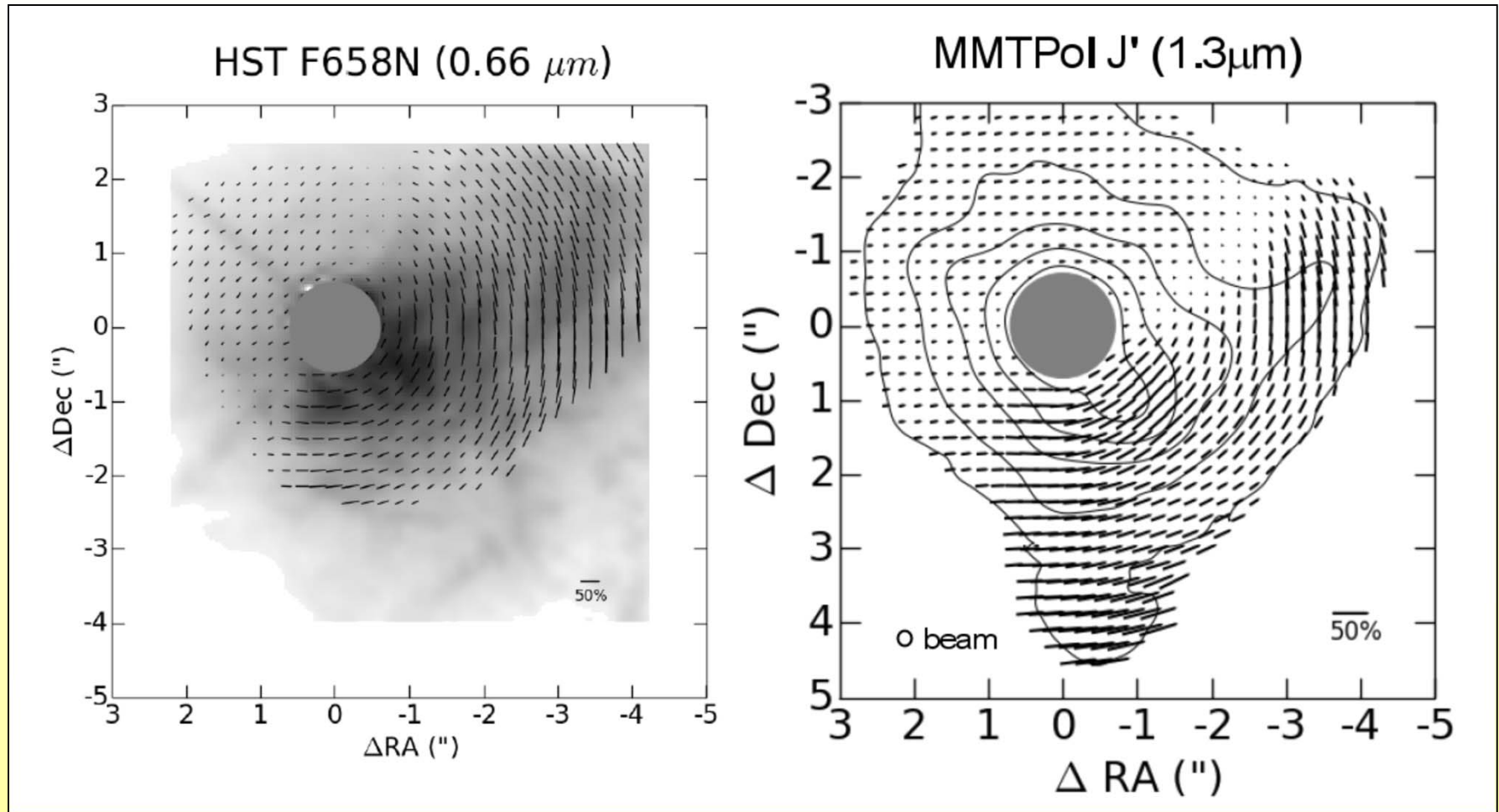
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# Mass-Loss Wind in VY CMa



Observing in the IR allows us to penetrate deep into  
dusty, mass-loss winds.

MMTPol

Shenoy et al 2015



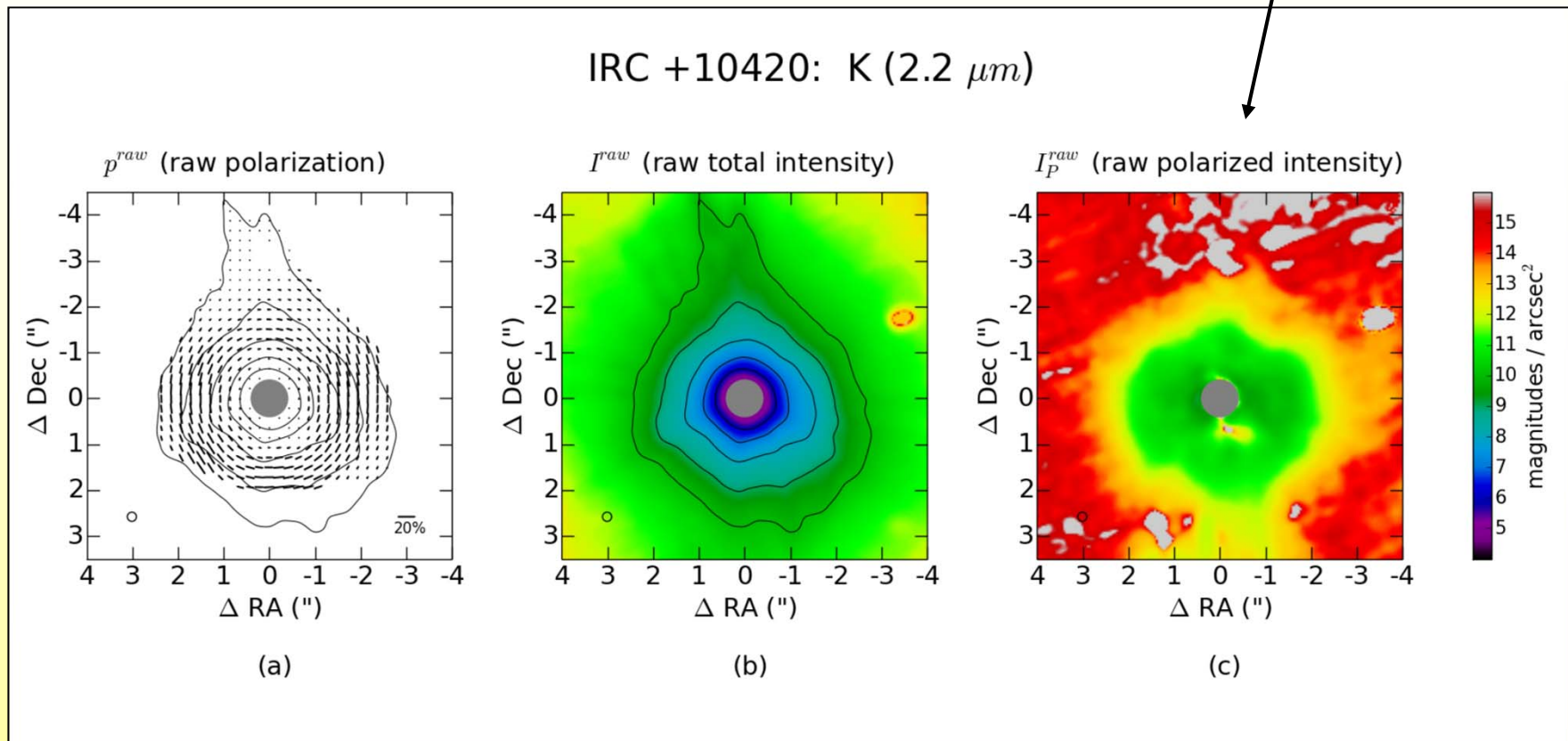
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# Equatorial Disk In a Yellow Hypergiant

Face-ON equatorial disk.



Imaging in Polarized Intensity reveals circumstellar features hidden in total intensity images.

MMTPol

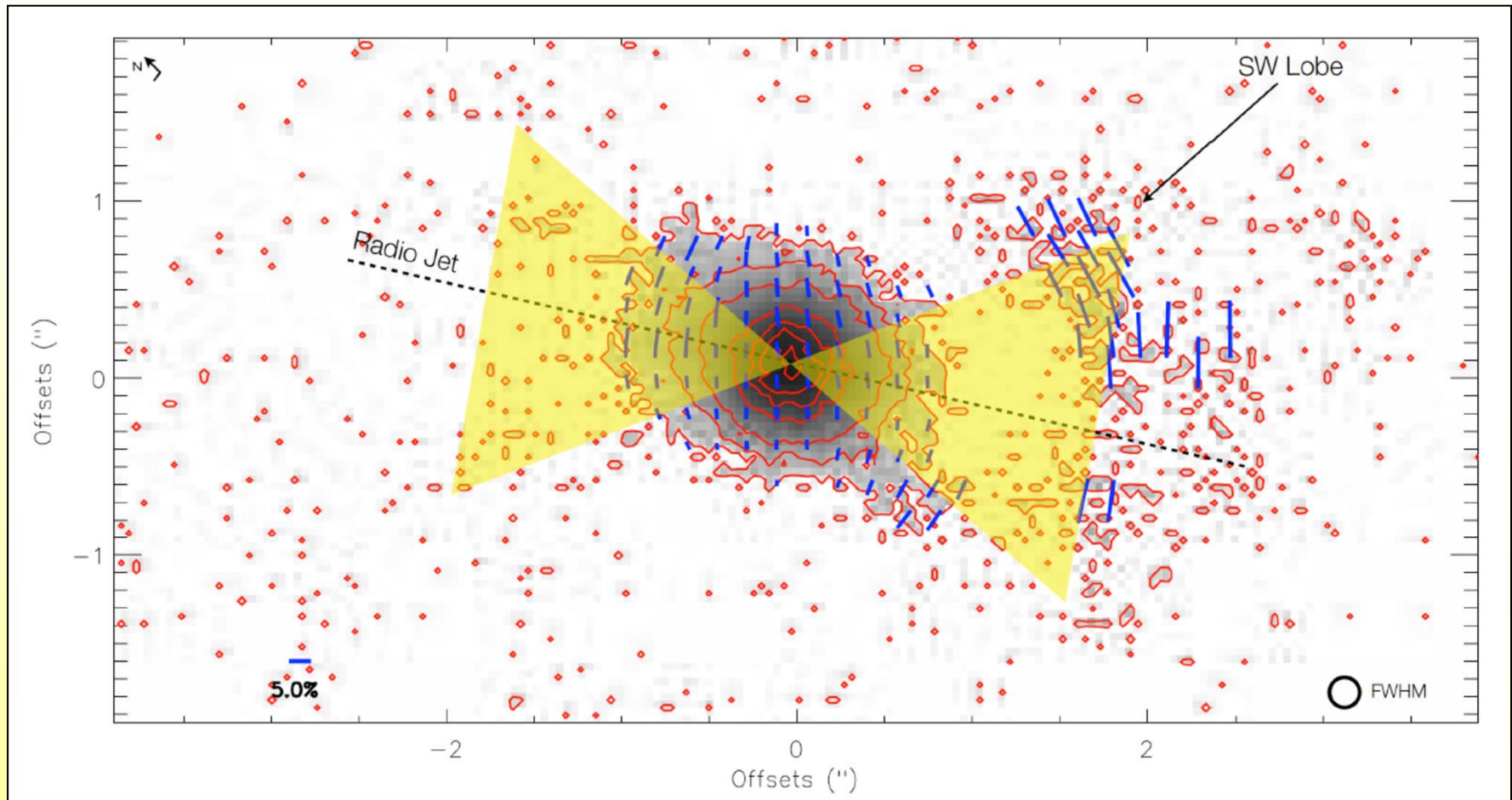
Shenoy et al 2015



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## NCG 1068 2.2 $\mu\text{m}$



The magnetic field geometry in the torus  
around the AGN in NGC 1068.

MMTPol  
Lopez et al. 2015



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# Thoughts

1. Imaging polarimetry is an exciting technique with many interesting science applications.
2. The IRTF with an AO 2ndary is an IDEAL platform for high-precision, IR imaging polarimetry.
3. Take polarimetry into account when designing future instrumentation. Do not absent mindedly render polarimetry impossible.
4. I haven't even touched spectropolarimetry.





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