Investigating the Circumstellar Disks of Hot Stars using Long-Baseline Interferometry

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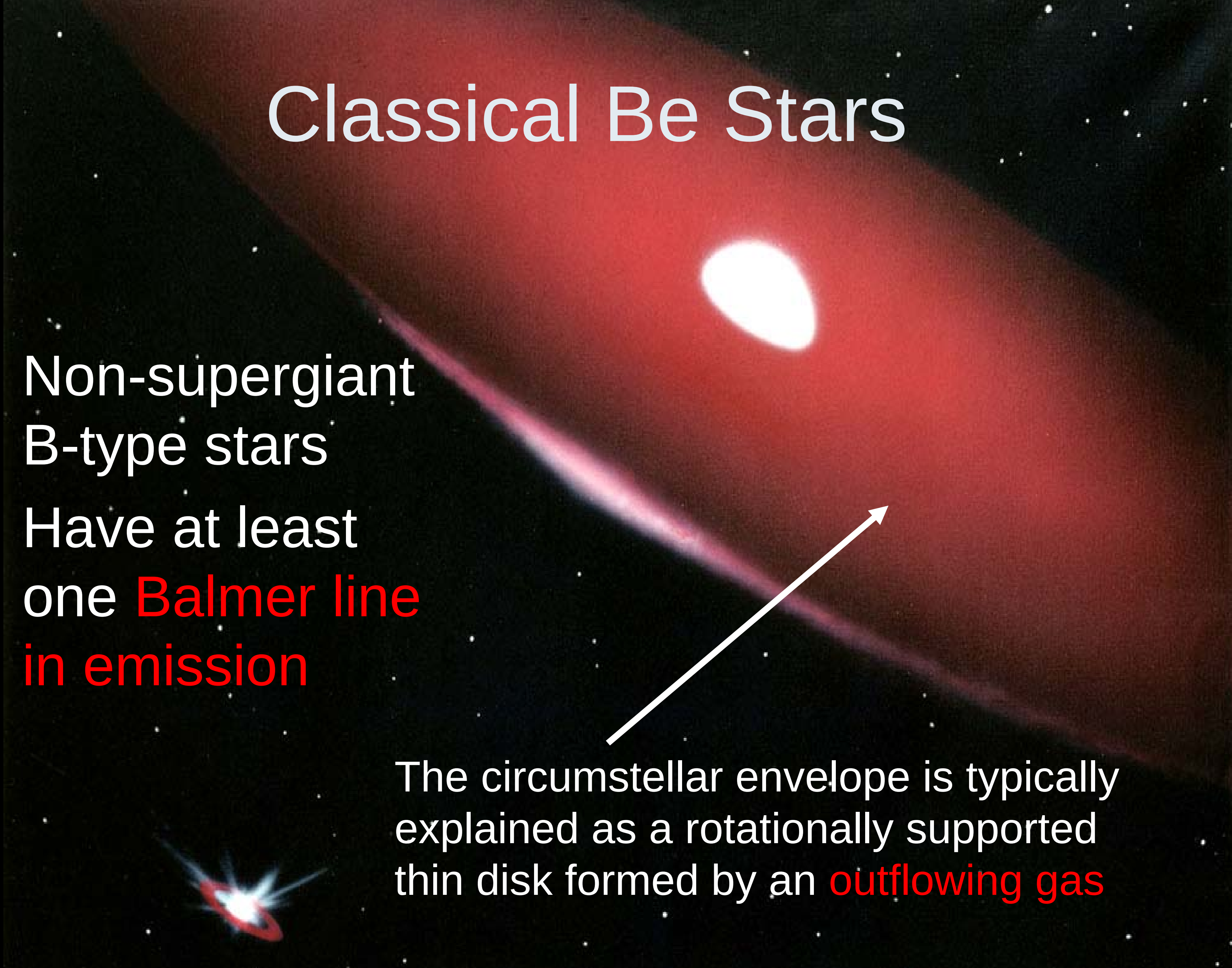
Outline

- Introduction to Be stars
- Scientific Motivation
- Description of the NPOI
- Recent Results
- Current Projects
- Future Projects

Classical Be Stars



- Non-supergiant B-type stars
- Have at least one Balmer line in emission

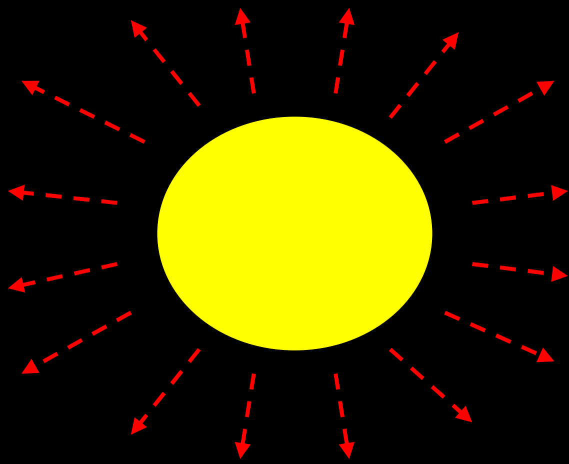
The circumstellar envelope is typically explained as a rotationally supported thin disk formed by an outflowing gas

Scientific Motivation

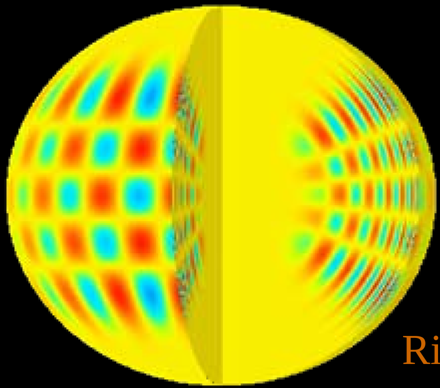
- ~ 20% of all B stars are in the Be stage
- What causes B stars to become Be stars is not fully understood
  - NRPs might be involved
  - Magnetic fields might be involved
  - Rapid rotation appears to be necessary
- Unique testing lab for theories related to
  - Rotationally enhanced mass loss
  - Stellar angular momentum distribution
  - Magnetic field evolution

Theory

Mass-loss



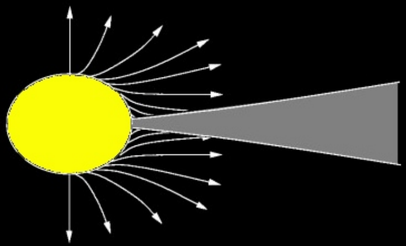
Wind



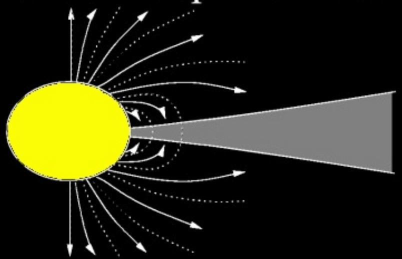
NRPs ?

Rivinius at al., 1998

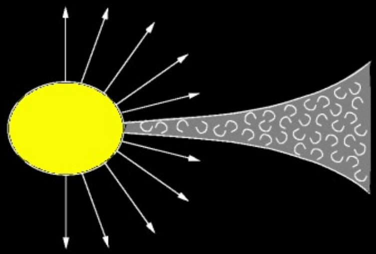
Disk Formation



Bjorkman & Cassinelli, 1993

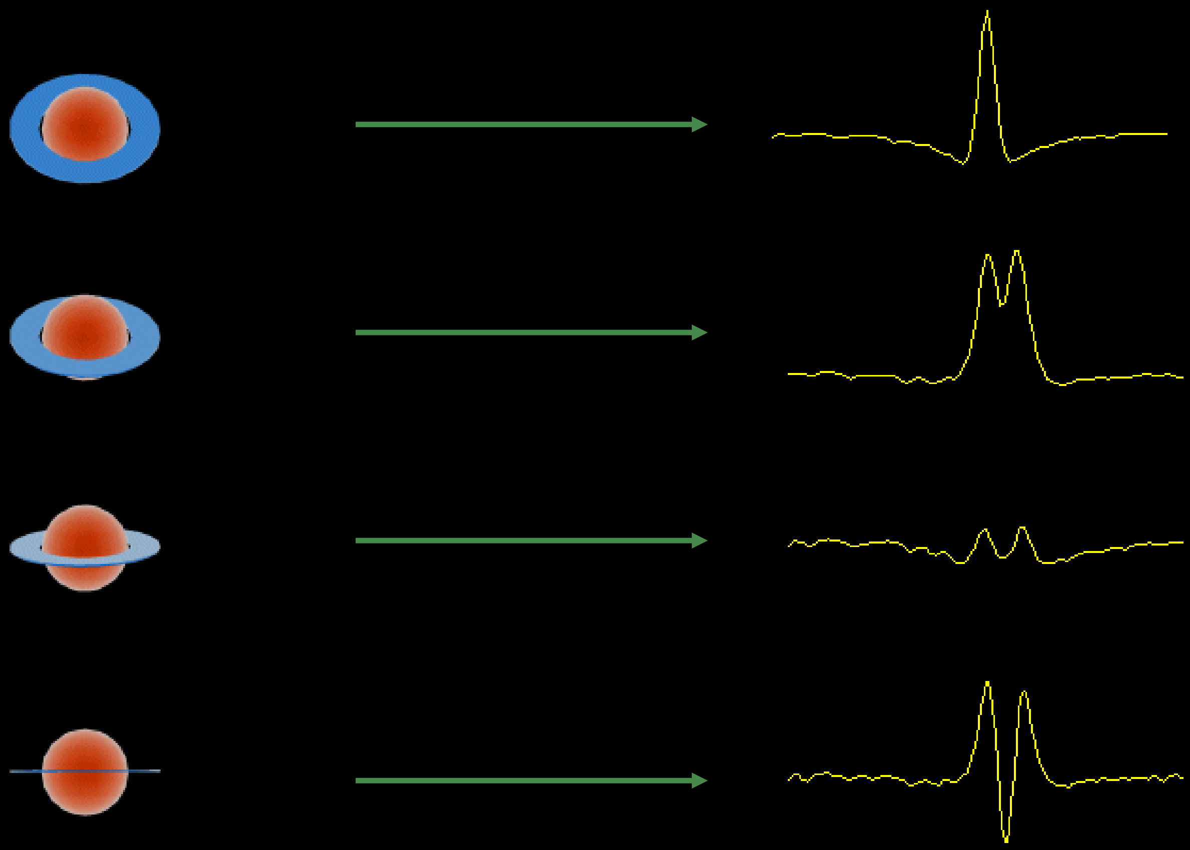


Cassinelli, et al. 2002

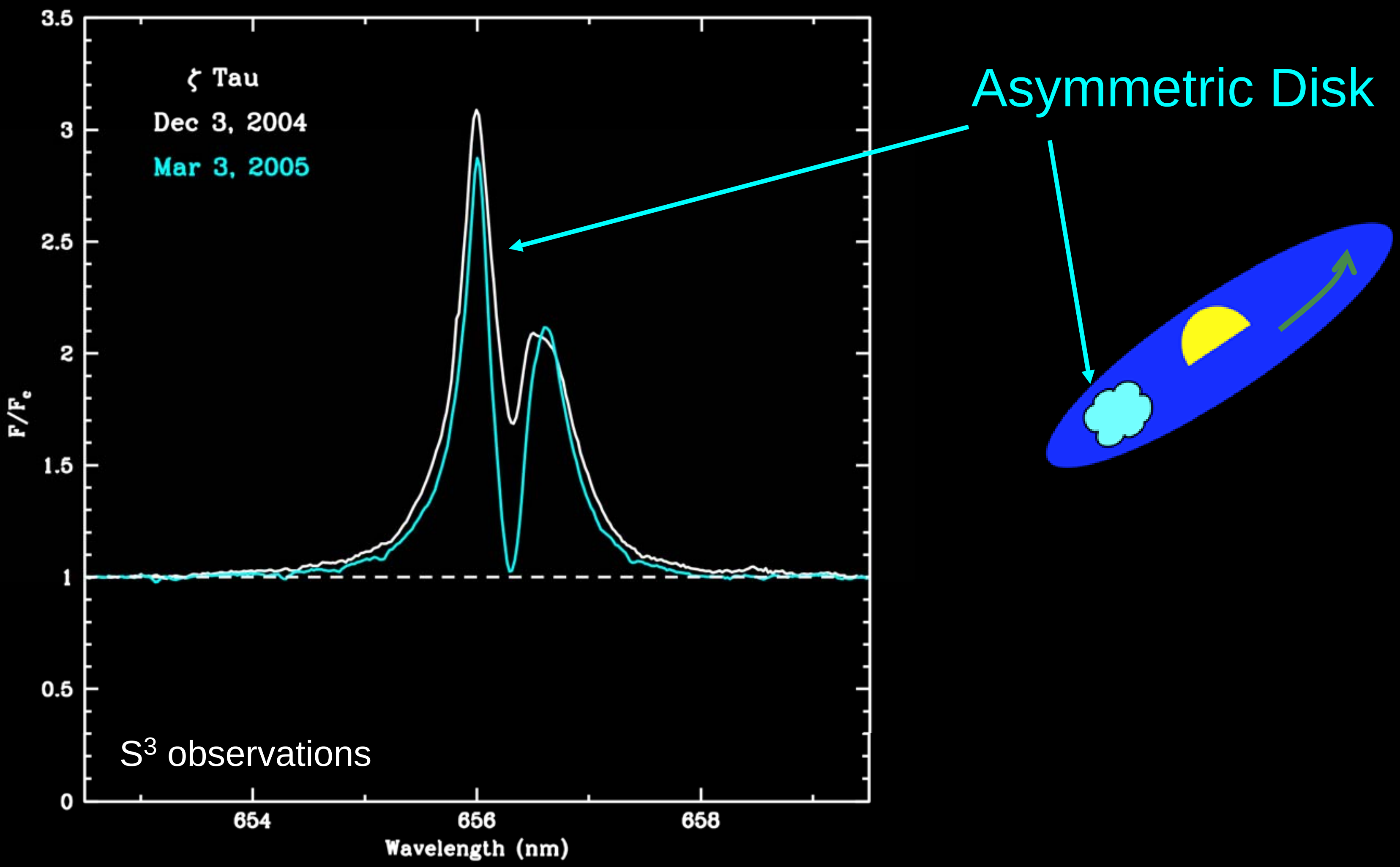


Okazaki 2001

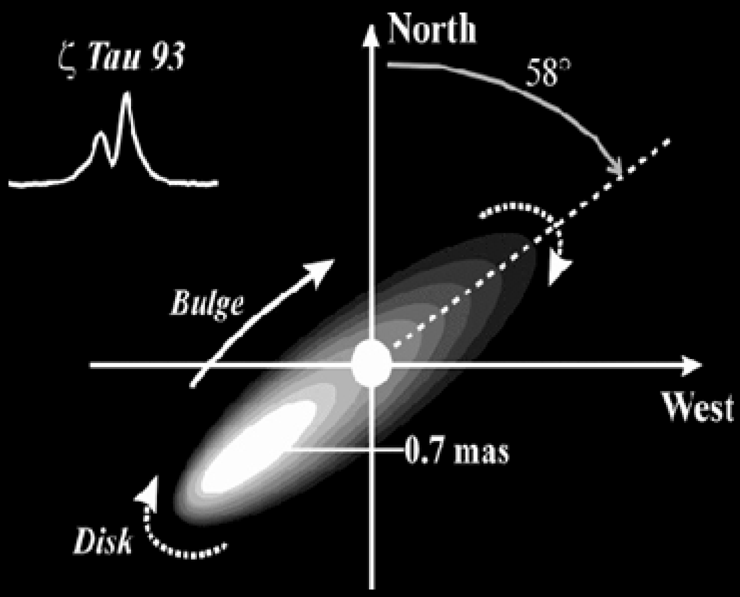
Circumstellar Disks

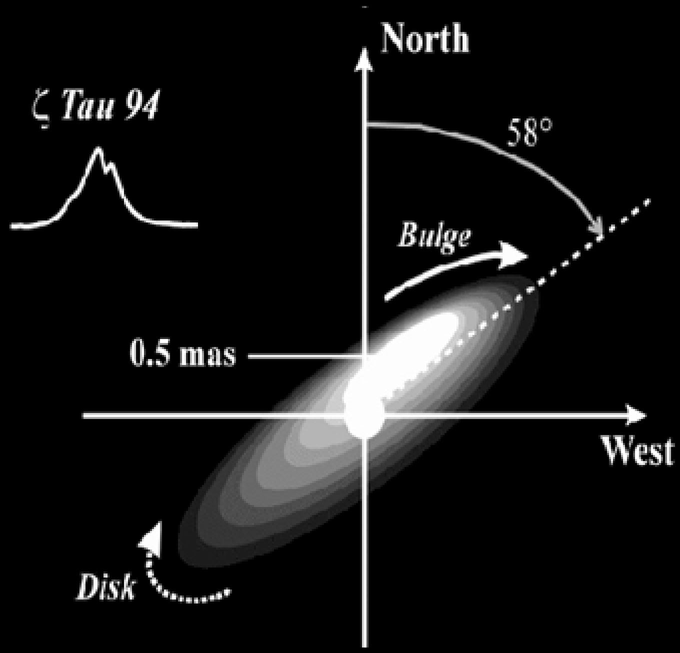


Asymmetric Intensity Distributions



One-armed Oscillations

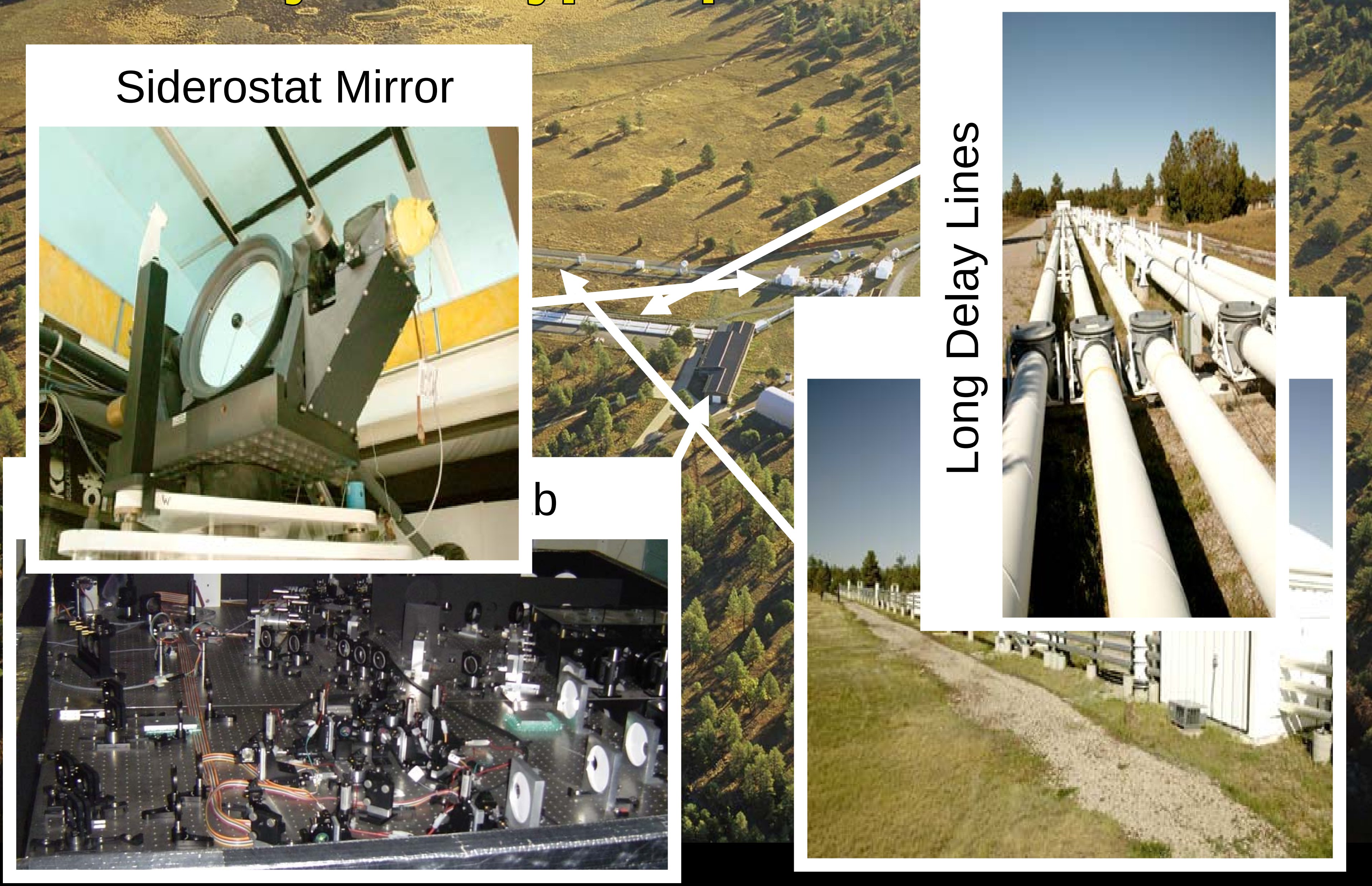




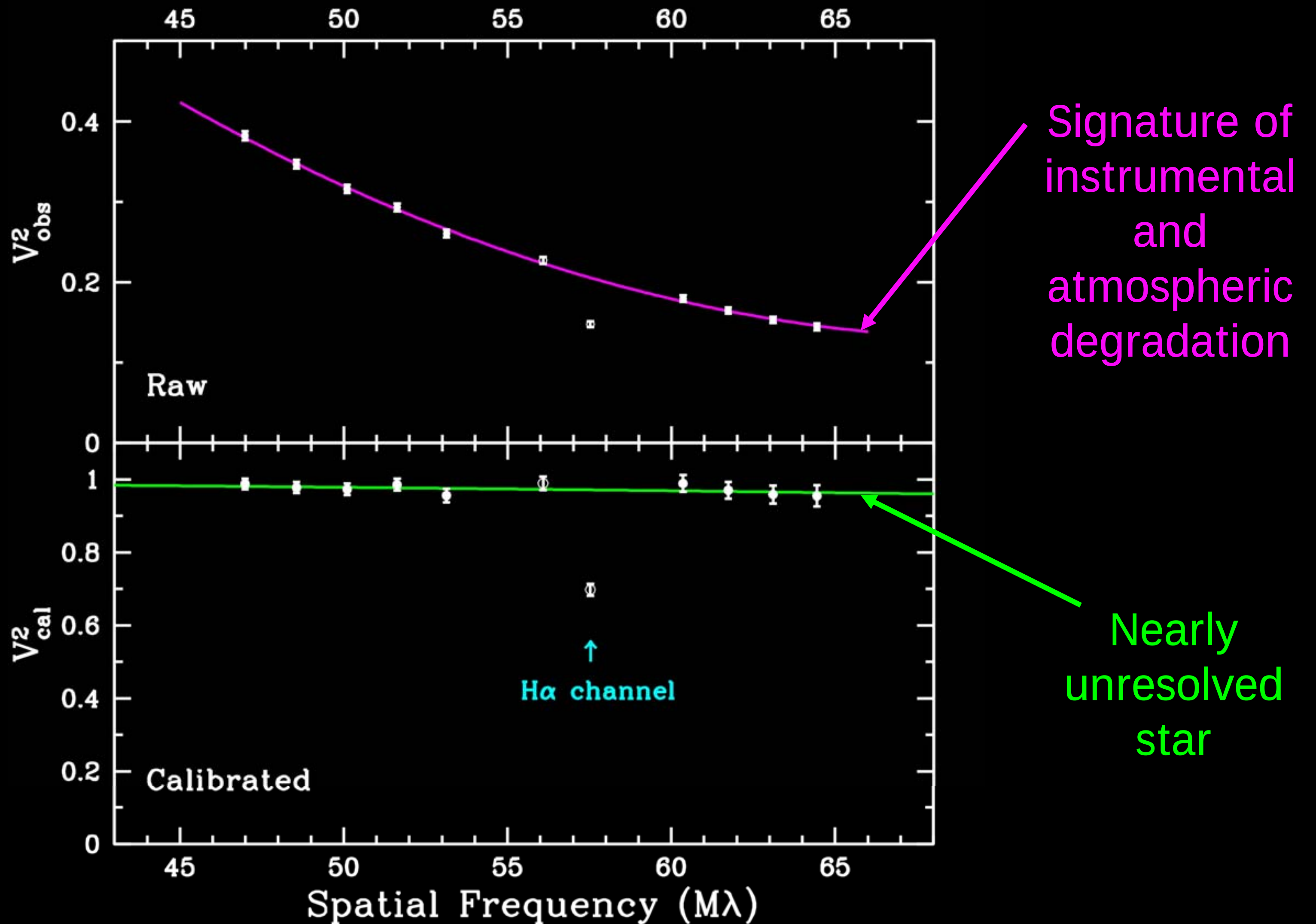
Vakili et al. 1998

The Instrument

The Navy Prototype Optical Interferometer

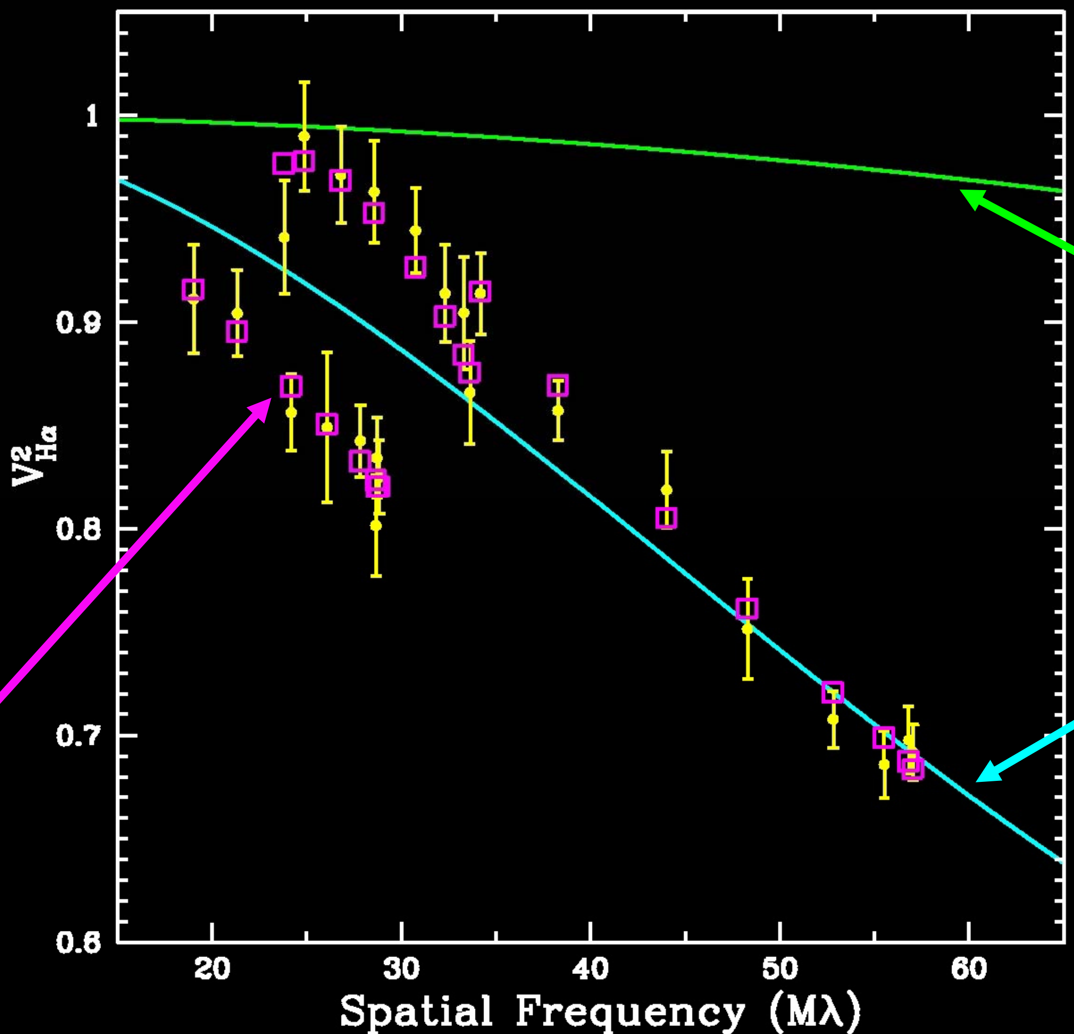


Calibration



Model Fitting

ζ Tau



Uniform Disk
0.39 mas

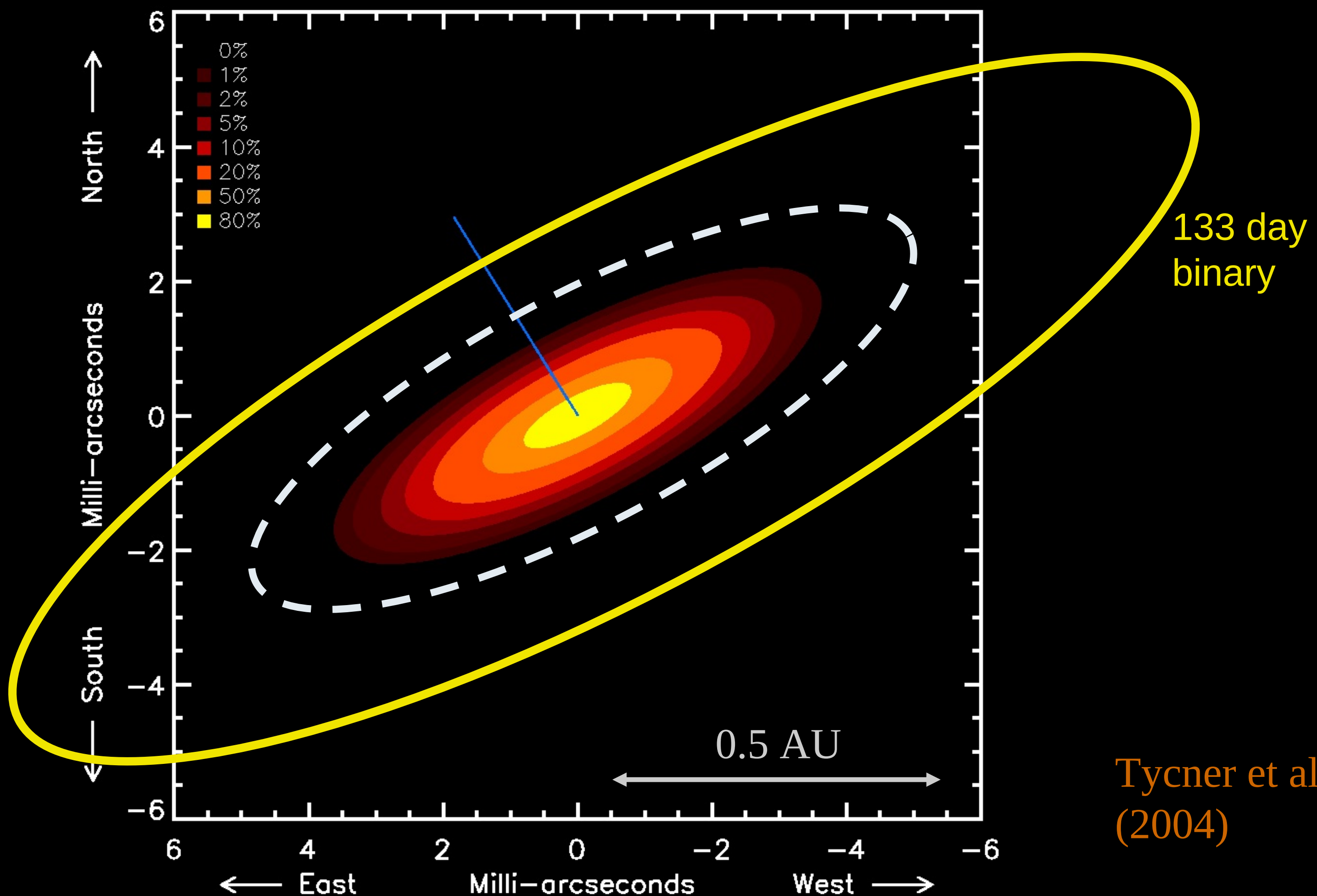
Elliptical
Gaussian

Circularly
symmetric
Gaussian

Recent Results

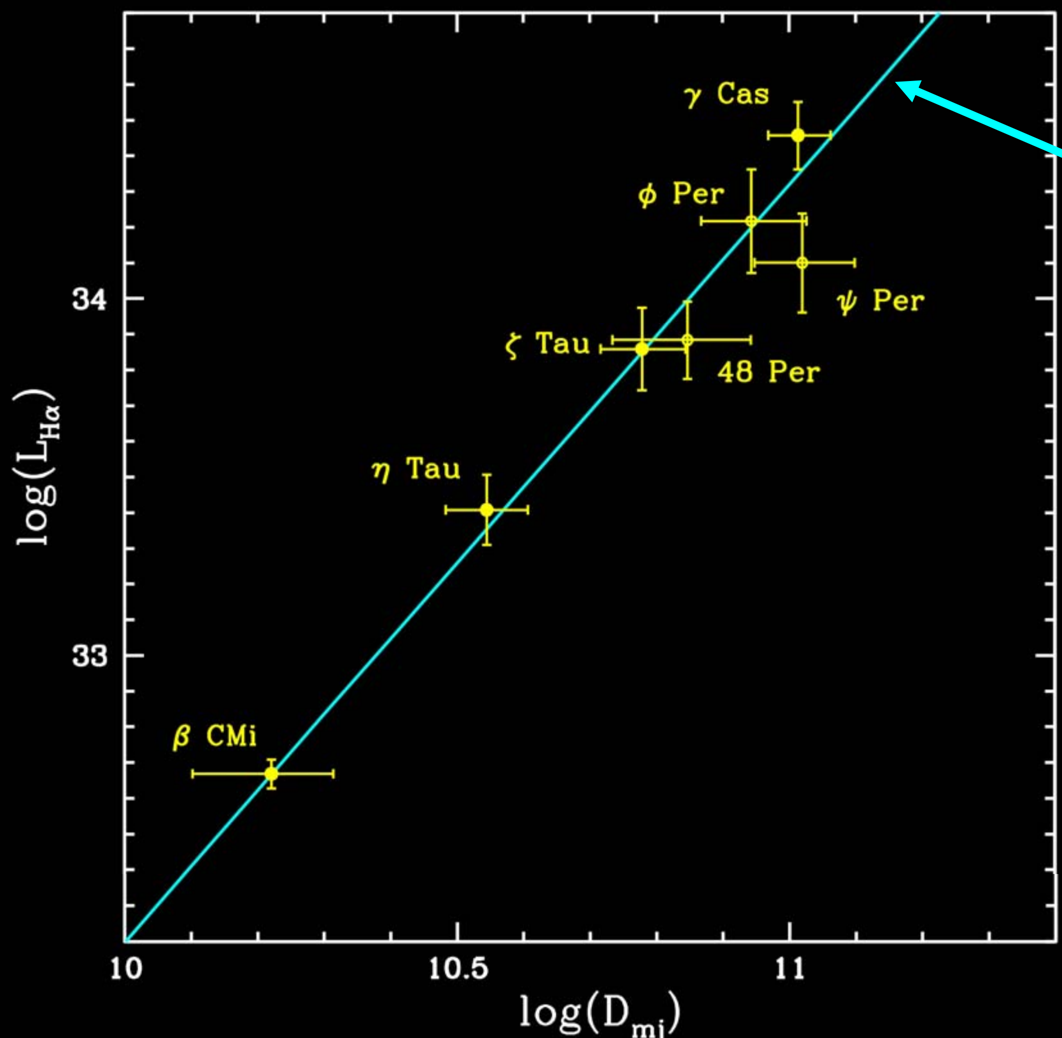
Disk Truncation

ζ Tau



Tycner et al. (2004)

Disk Luminosity vs Size

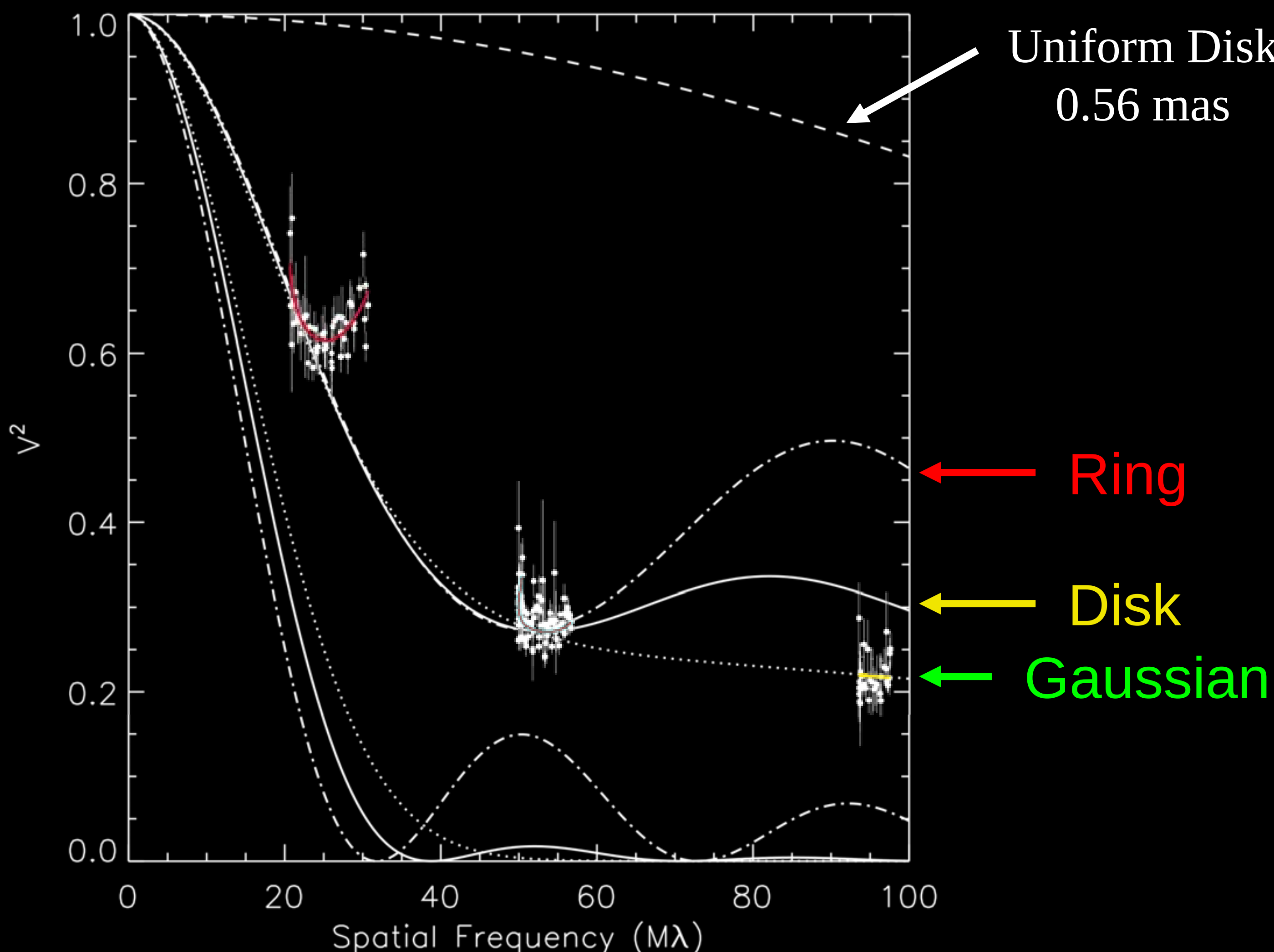


The slope implies that $L_{H\alpha} \propto D^2$

Tycner et al. (2005)

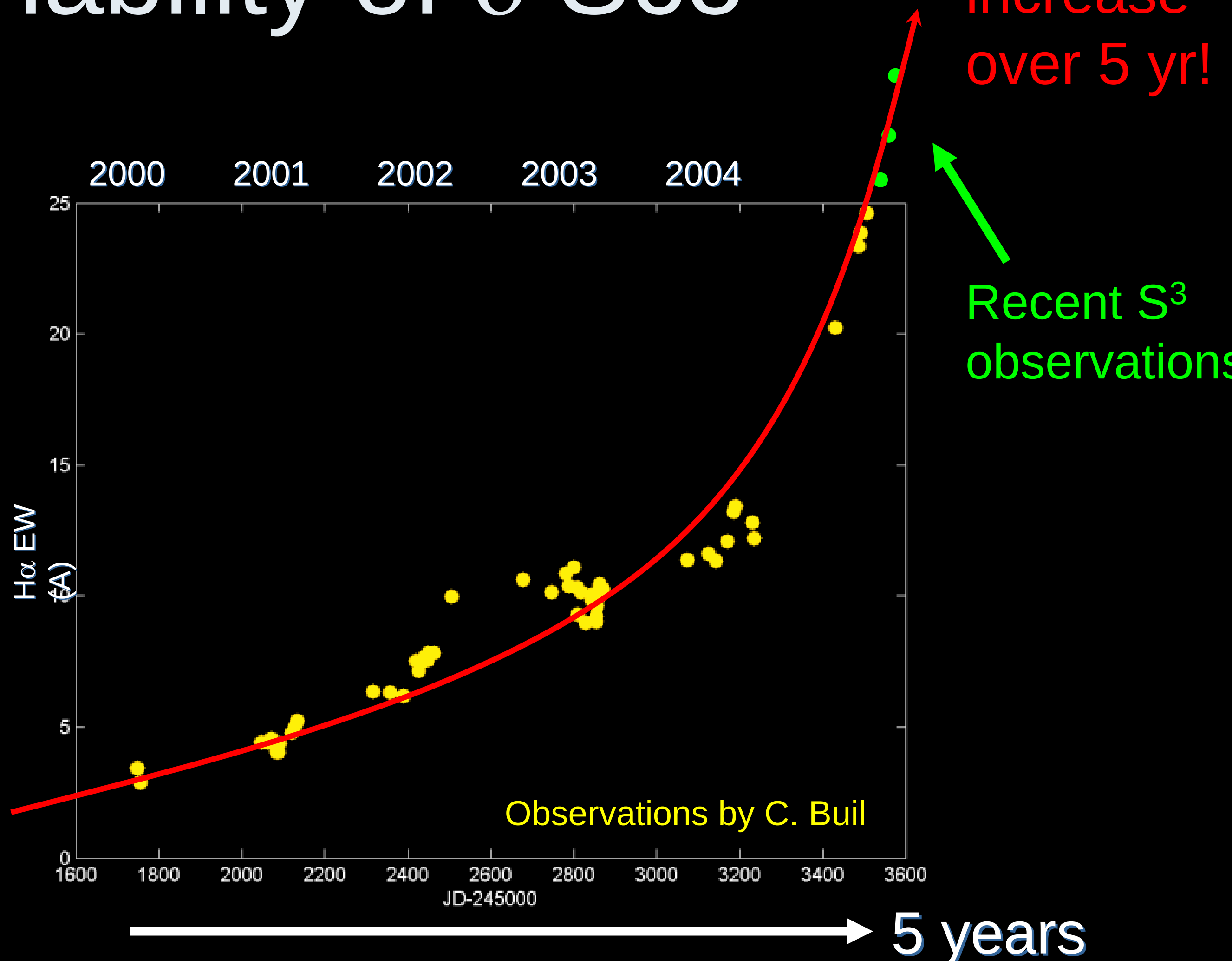
Intensity Distributions

Data shown for
γ Cas
Tycner et al.
(to be submitted)



Current Projects

Hα variability of δ Sco

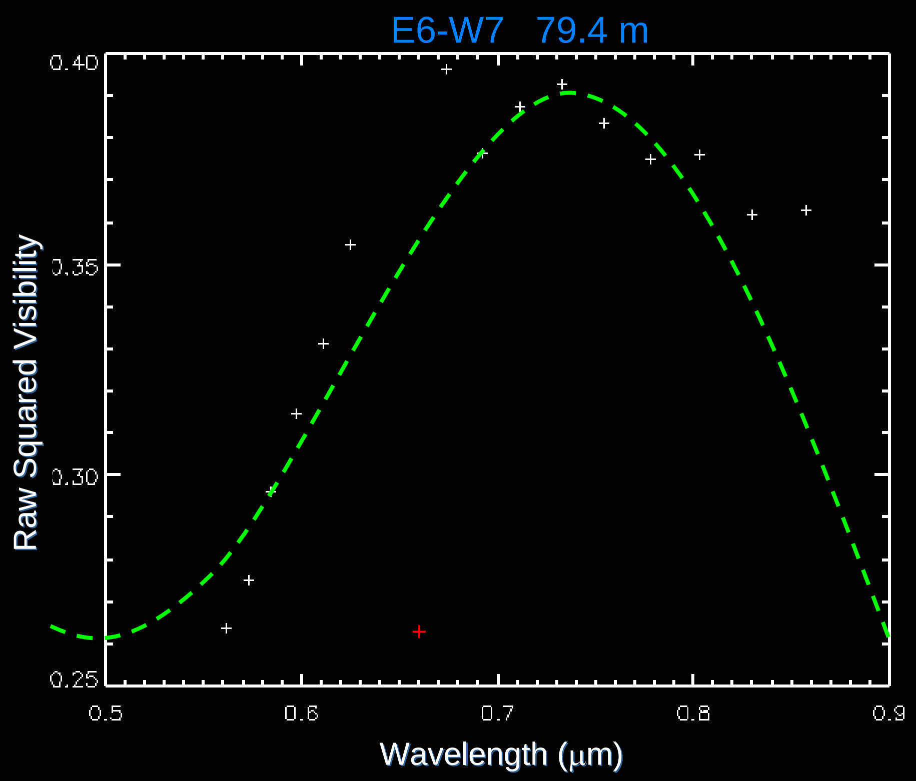


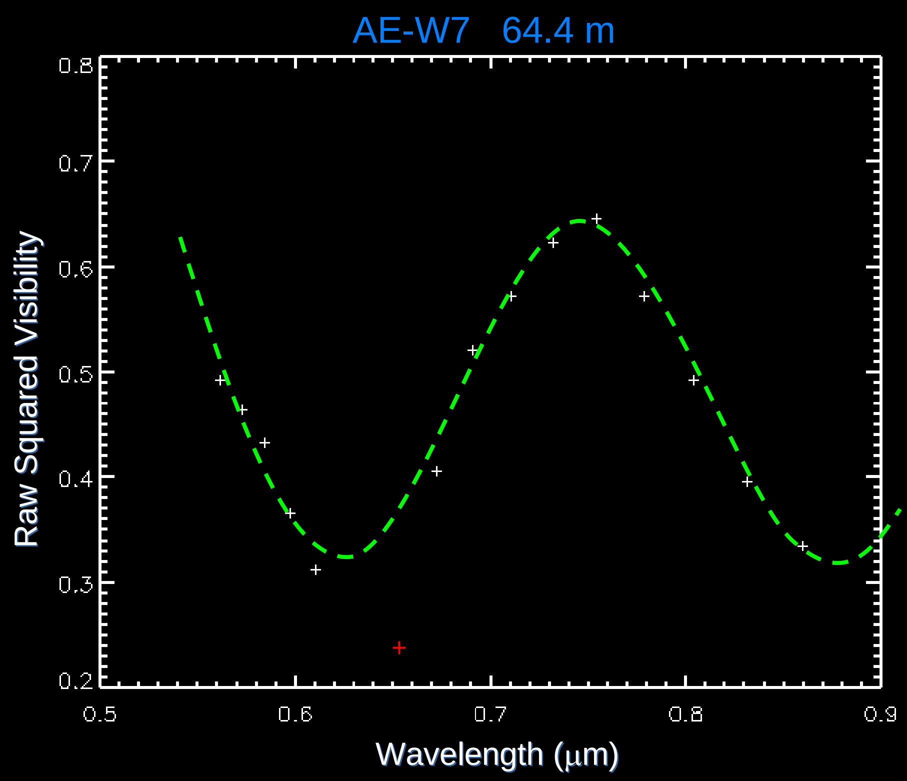
V = 2.3

δ = -22º

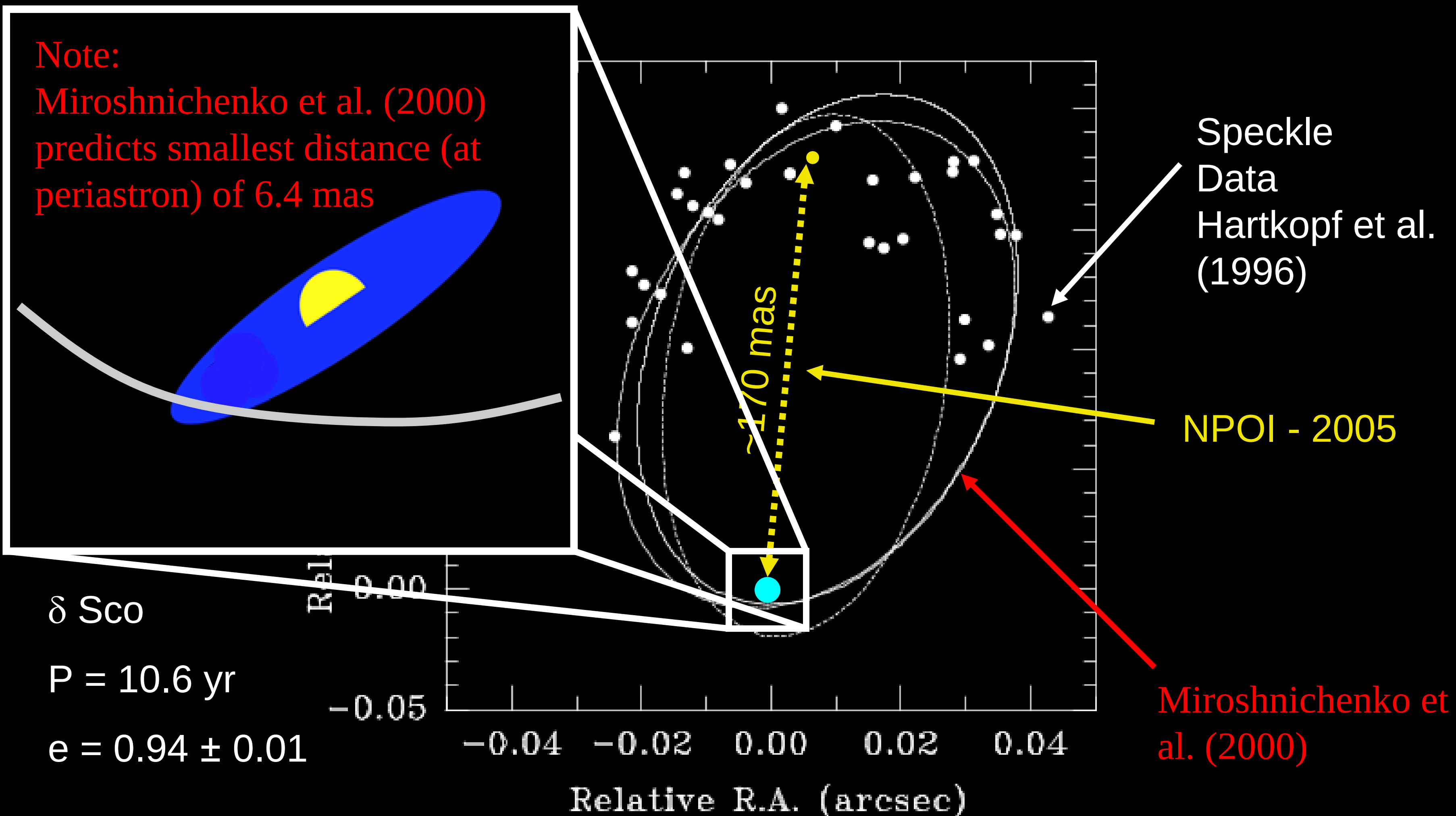
5 years

NPOI Observations of δ Sco





Predicted Disk Disruption



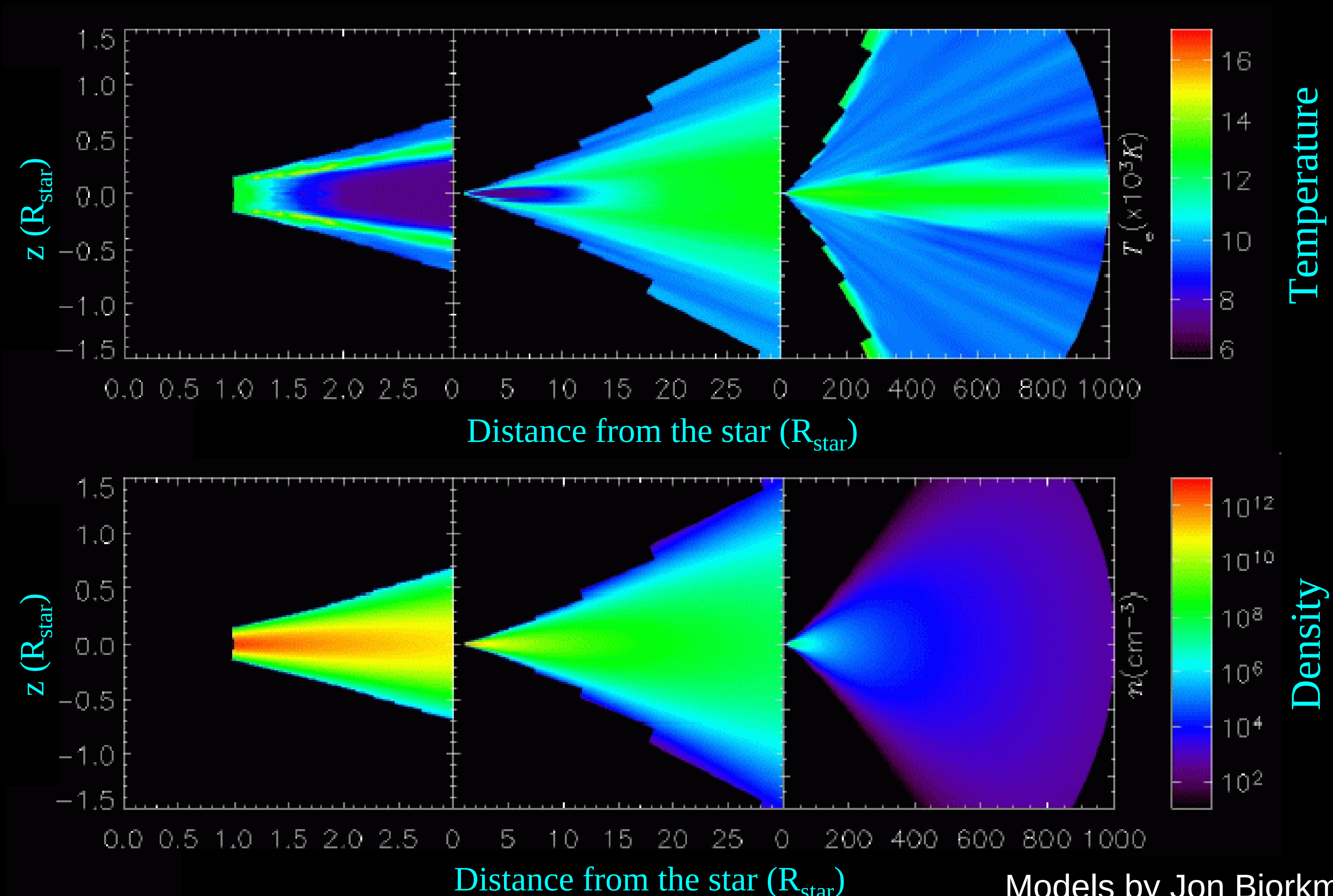
δ Sco

P = 10.6 yr

e = 0.94 ± 0.01

Future Projects

Testing NLTE Models



Models by Jon Bjorkman

Summary

- NPOI is optimized for studies of Be stars
- Observations at high spatial frequencies can be used to test current models
- It is now possible to study directly the interactions between disks and binary components