# Observing a magnetosphere with interferometry

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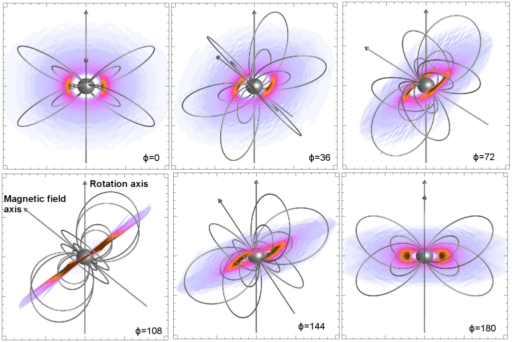
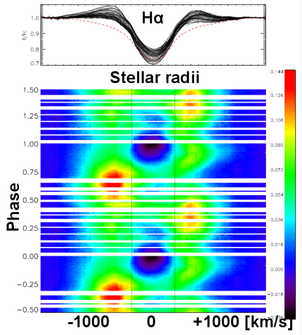
# The magnetosphere of HR 5907 ($V \approx H \approx K = 5.5$)




- Rapidly rotating B2V star with tens of kG dipolarish field
  - ➙ At intersection of mag and rot equators clouds accumulate
  - ➙ Clouds are magnetically bound in forced corotation, P=0.51 d.
- Pictures above span half a rotation cycle

# The spectroscopic signature




- Across emission lines, one side approaches, one side recedes.
- Because of bound corotation, projected velocity maps to radius
  - Two cycles are shown for clarity

# Some guesswork on observables

## Phase offset vs. continuum

$$\Delta\phi \propto \alpha \frac{B}{\lambda}$$

Photocenter displacement of line emission vs. unresolved point source?

- Emitting plasma at 3-4 $R_\star$ (because at 3-4 $v \sin i$)
- Can estimate density, since we have Balmer decrements
  - ➙ $\mathrm{Br}\gamma$ emissivity, about 10% of continuum.

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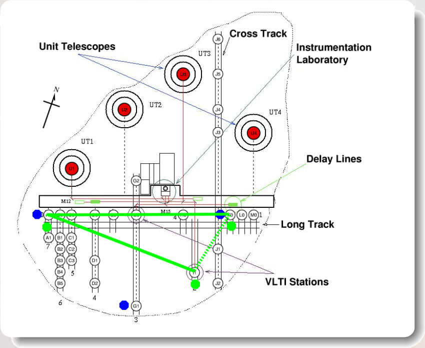
  - ➙ $\mathrm{Br}\gamma$ emissivity, about 10% of continuum.
  - ➙ $4/2 \times 0.1 \rightarrow 20\%$ of photospheric diameter
- At Hipparcos distance, photospheric diameter 0.15 mas
  - ➙ Displacement: 30 $\mu as$
- In K-band and at 100 m BL this should be about 4 degree in phase.

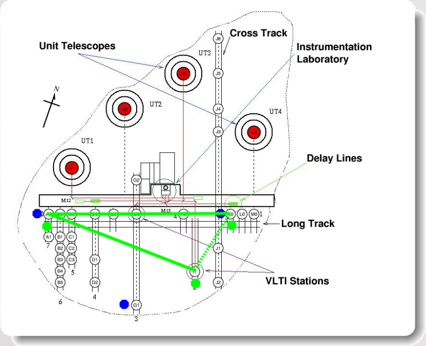
**Feasible with AMBER**

# Observing strategy



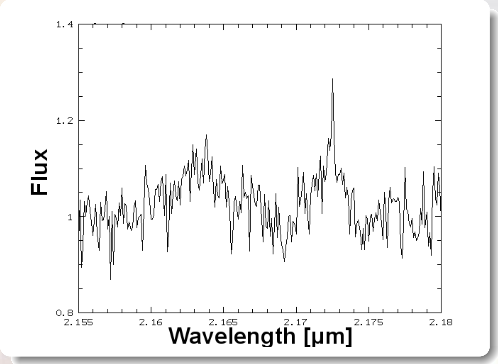

- Two “opposite” appearances of magnetosphere (n.5 cycles)
- Observe at identical projected baseline (same LST)
- $P_{\rm rot}$ implies observations two weeks apart, observed April 2011

# The first secret principle of interferometry



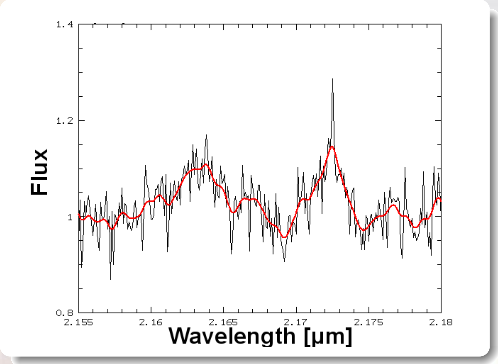

- It never works the way you plan: $\phi = 0.47$
- First run 100% weather loss (domes closed)
- Second run 50% weather loss (seeing), inadequate triplet
  - ➙ but there are advantages!

# The observed data



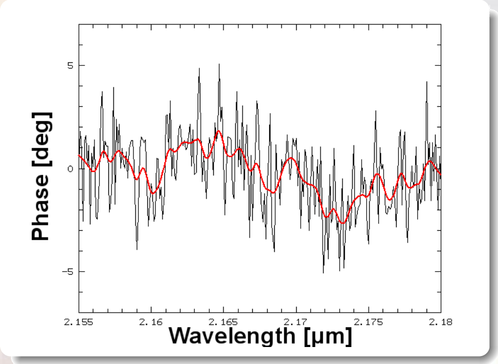

- Noisy!

# The observed data



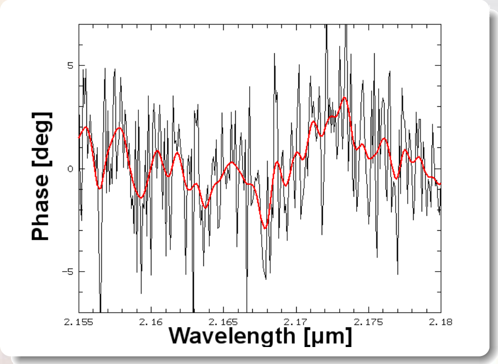

- Noisy! Filter for clarity
- on the flux,

# The observed data



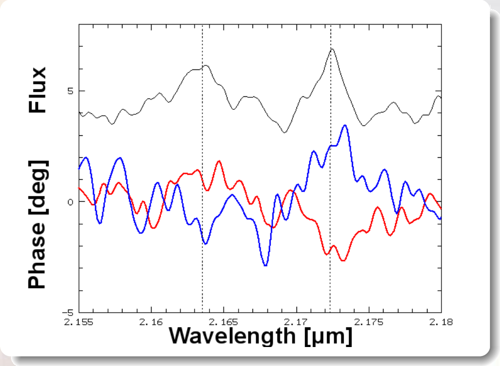

- Noisy! Filter for clarity
- on the flux, and phase on BL 1

# The observed data



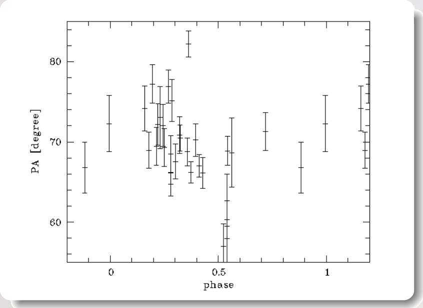

- Noisy! Filter for clarity
- on the flux, and phase on BL 1 and BL 2

# The observed data




- Noisy! Filter for clarity
- on the flux, and phase on BL 1 and BL 2
- Data pretty much at the limit, but everything right in place!
  - ➙ Due to baseline limitations, very weak constraint on target

# Polarimetry comes to help




- Continuum polarimetry measures orientation of clouds
  - ➙ and its phase modulation
- Polarization angle essentially E–W (75°), meaning CS material is N–S (−15°)
  - ➙ Array is aligned at +19.55° → Small angle!

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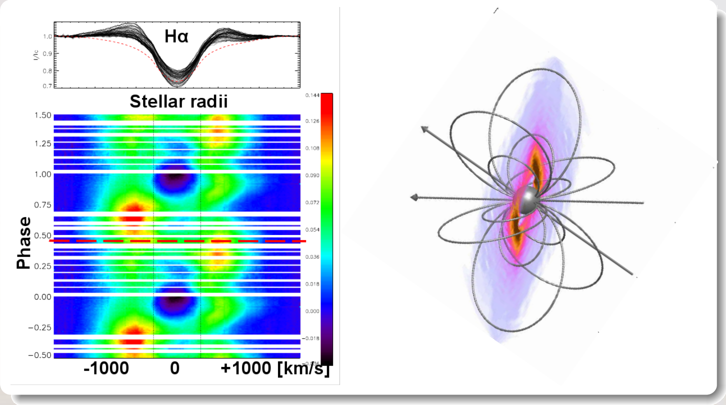


- Combining both datatypes, model can be constrained
- Red lobe extends to about 5 to 6$R_\star$, but blue one only to 3 to 4$R_\star$ at time of observation.

# Summary

- Observationally extremely challenging, but feasible.
- First interferometric detection of magnetically bound material

- Data so far hardly enough to constrain model
  - ➙ Already clear: Have to give up symmetry. Model has been developped to that point.
- Strategy change: Apply for more data in service mode with UTs
- Complementary polarimetry allwos interpretation of data to some extent

- Target varies rapidly, but with precisely known ephemeris. Would require load of time, but how about an “interferometric movie”?

# Ceterum censeo