CLDI: Doppler imaging with a difference

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Almhütte June 2002

Outline

I. A short glimpse of Doppler Imaging

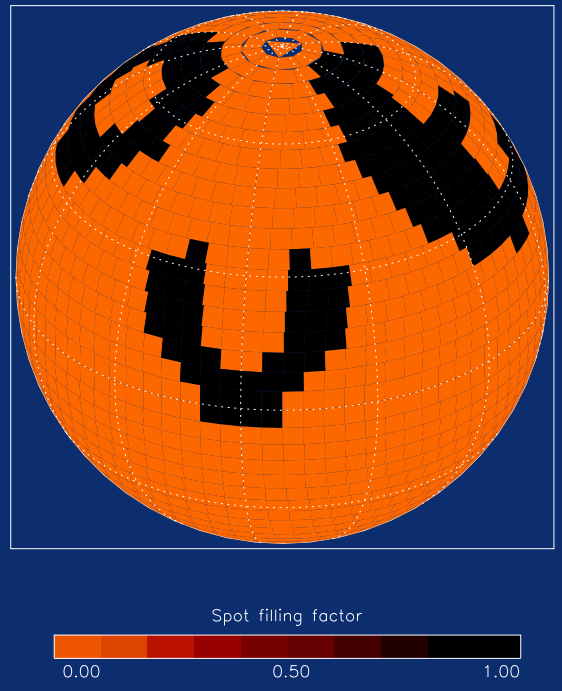
II. CLDI: Philosophy and basic ingredients

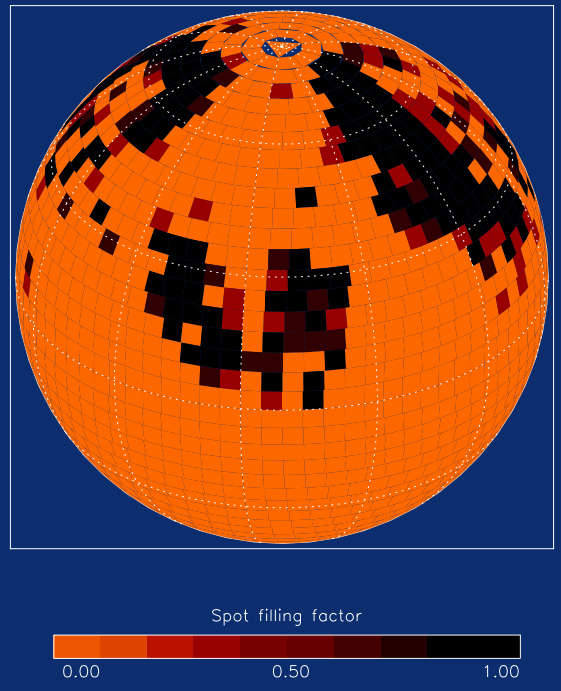
III. CLDI's performance - so far

IV. Feeding CLDI: Extracting line profiles

V. APPENDIX

CLDI: Doppler imaging with a difference





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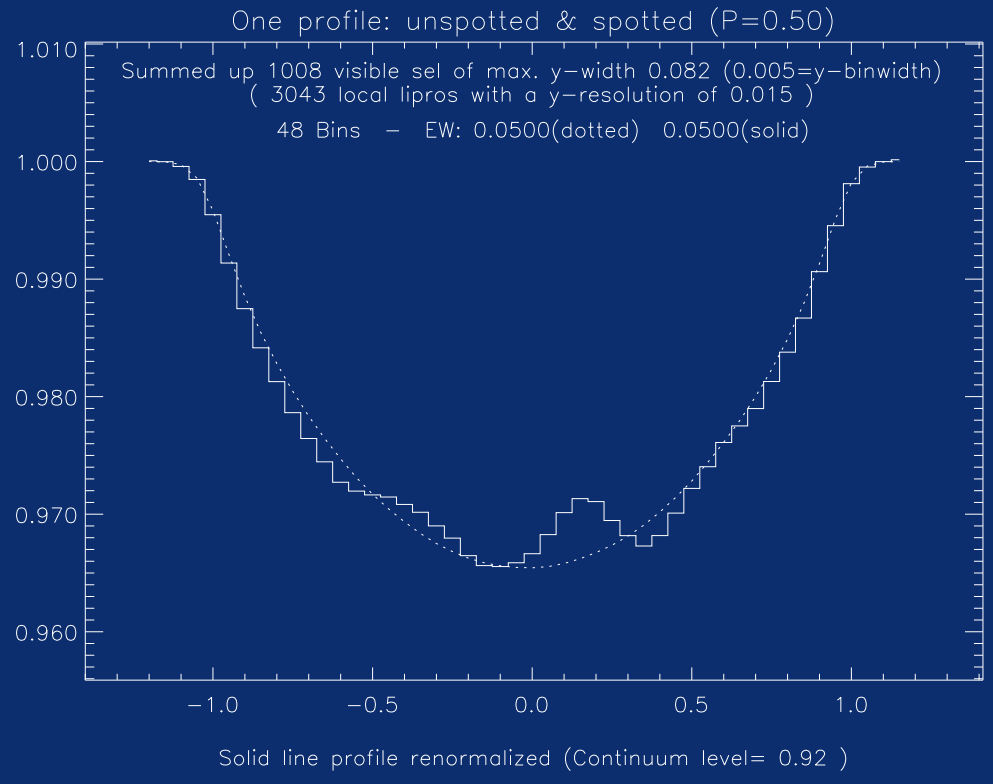
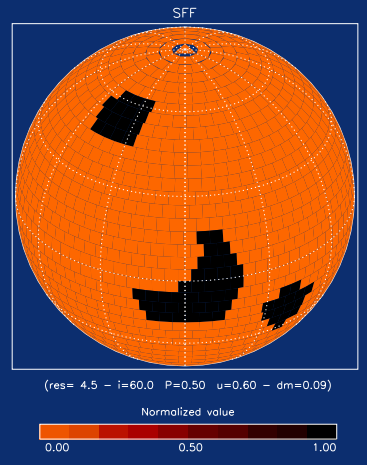
Rotational modulation.

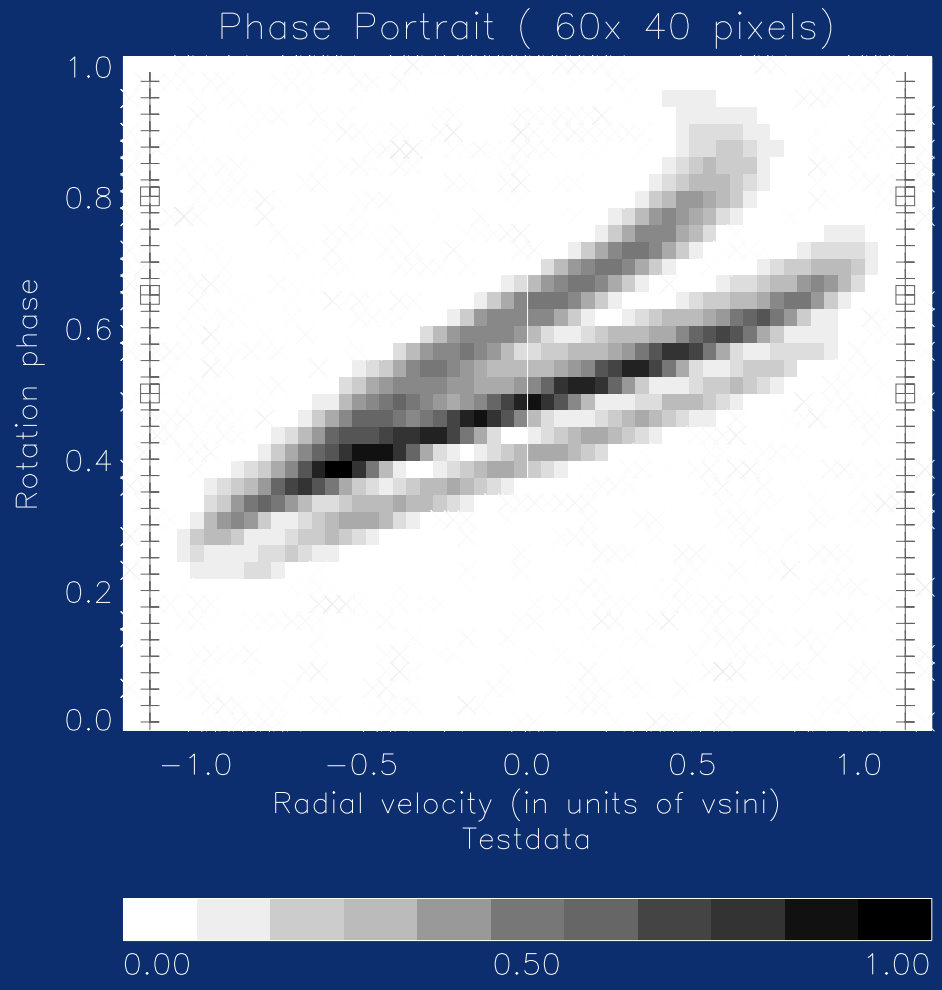
DI: Each line profile a 1D projection



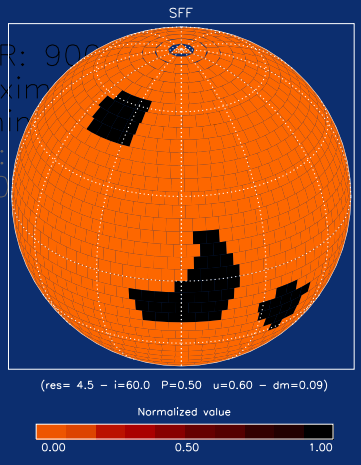


Line profile deformation: single phase

DI: Where is the 2D information?



Inclination: 60.0
Limbdarkng: 0.60



Line profile deformations: time-series

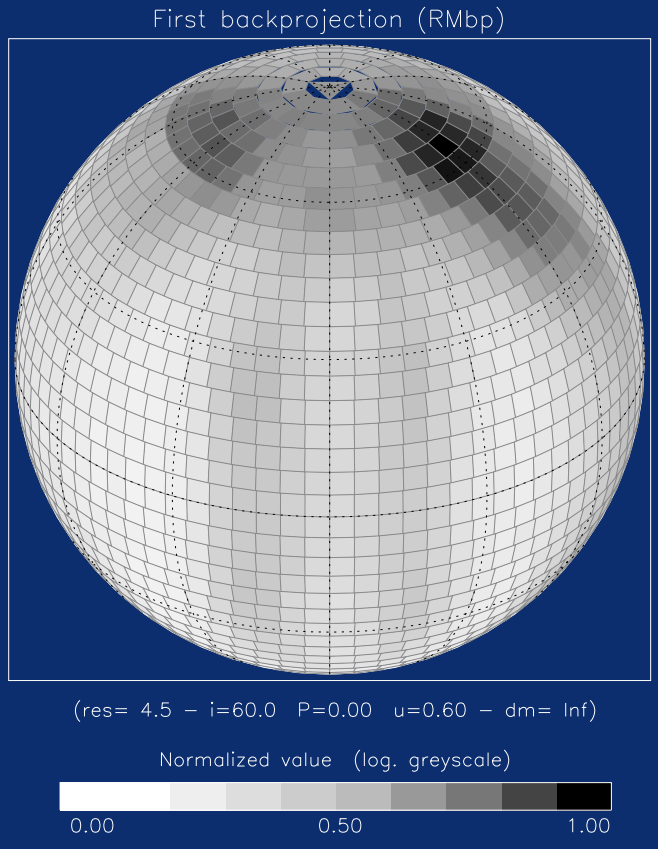
II. CLDI: Philosophy and basic ingredients

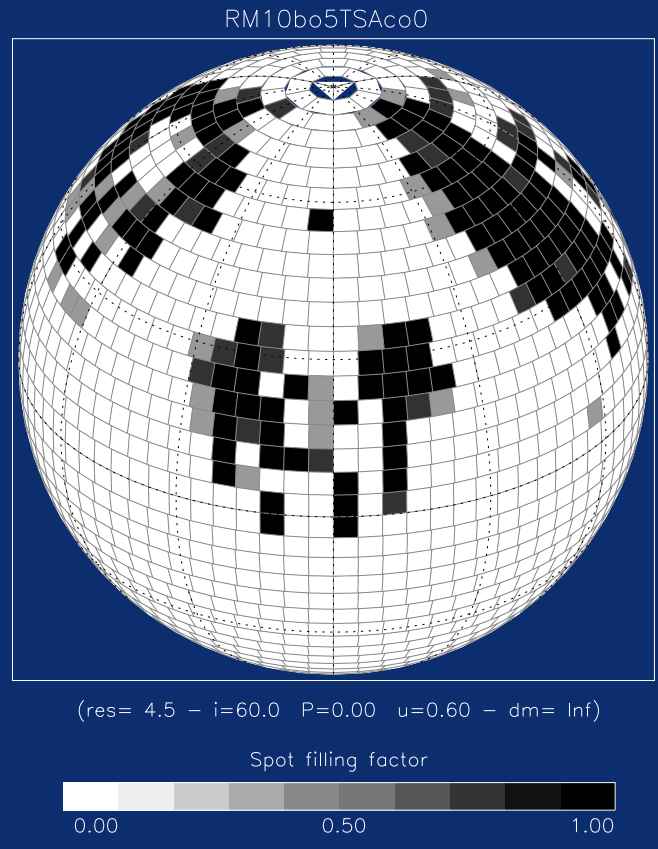
It's inadvisable to ignore the details.

(William Blake, freely adapted)

CLDI: CLEANing

CLEANing: From a surface *sketch* to a *solution*

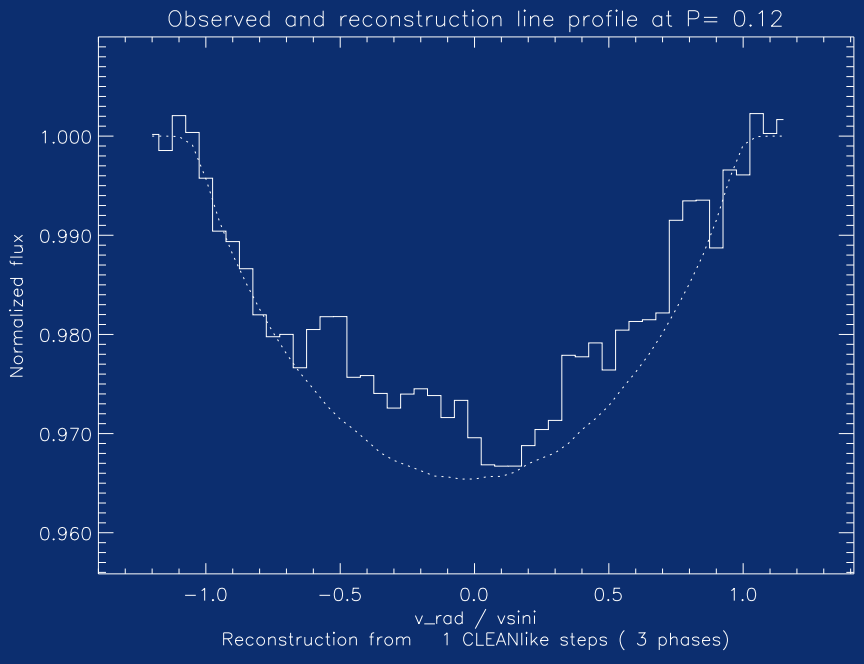


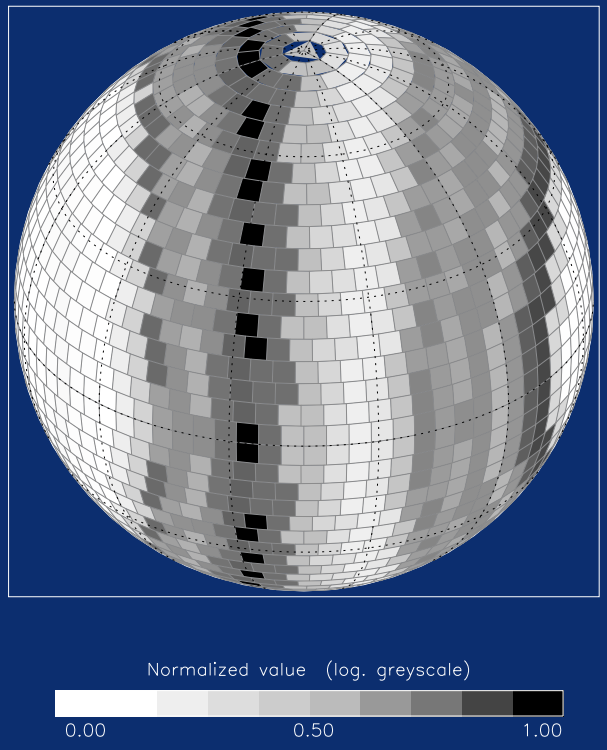


Backprojection and final CLDI-reconstruction

CLDI: Feature tracking I

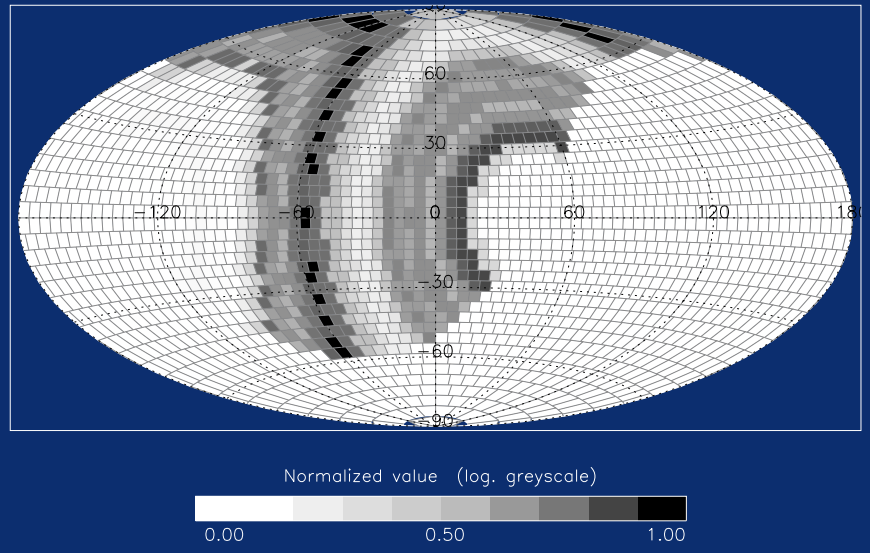
Backprojection using the responsematrix I

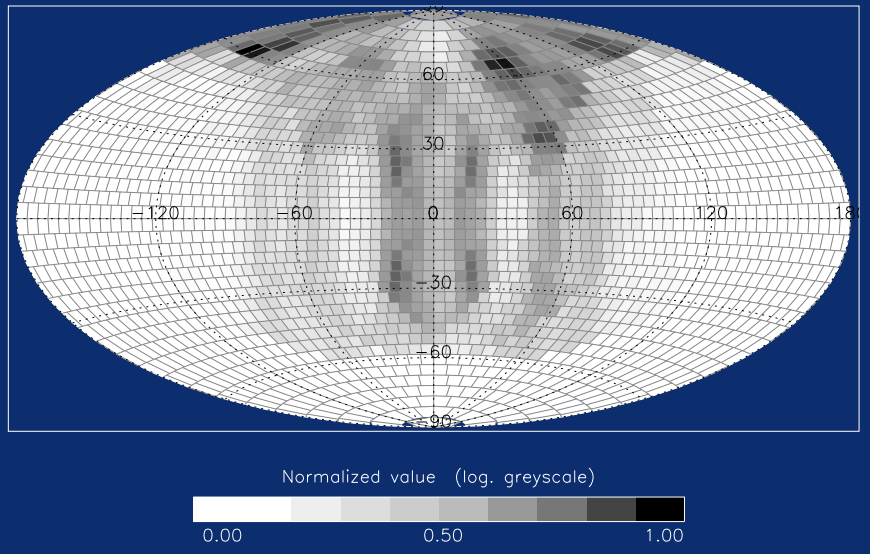




One line profile and its "backprojection" onto the surface

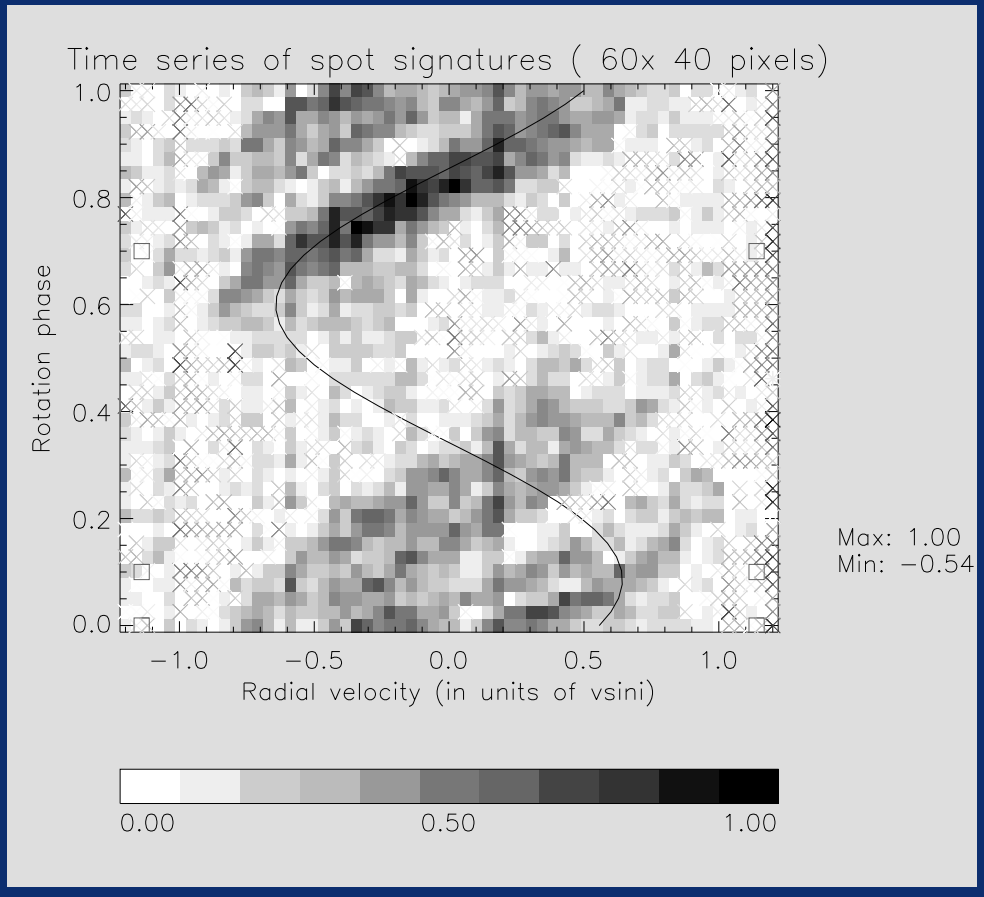
Backprojection using the responsematrix II

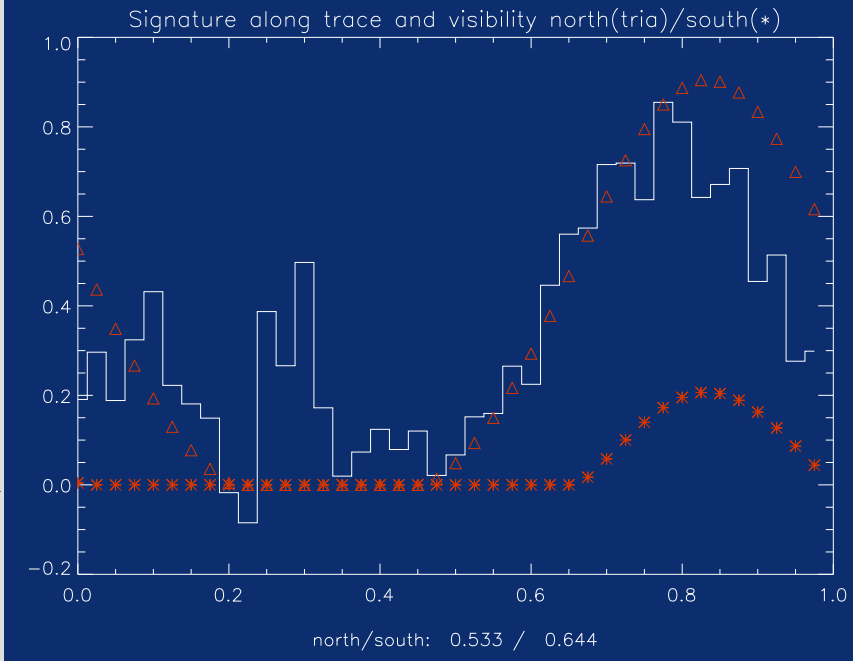




CLDI: Feature tracking II

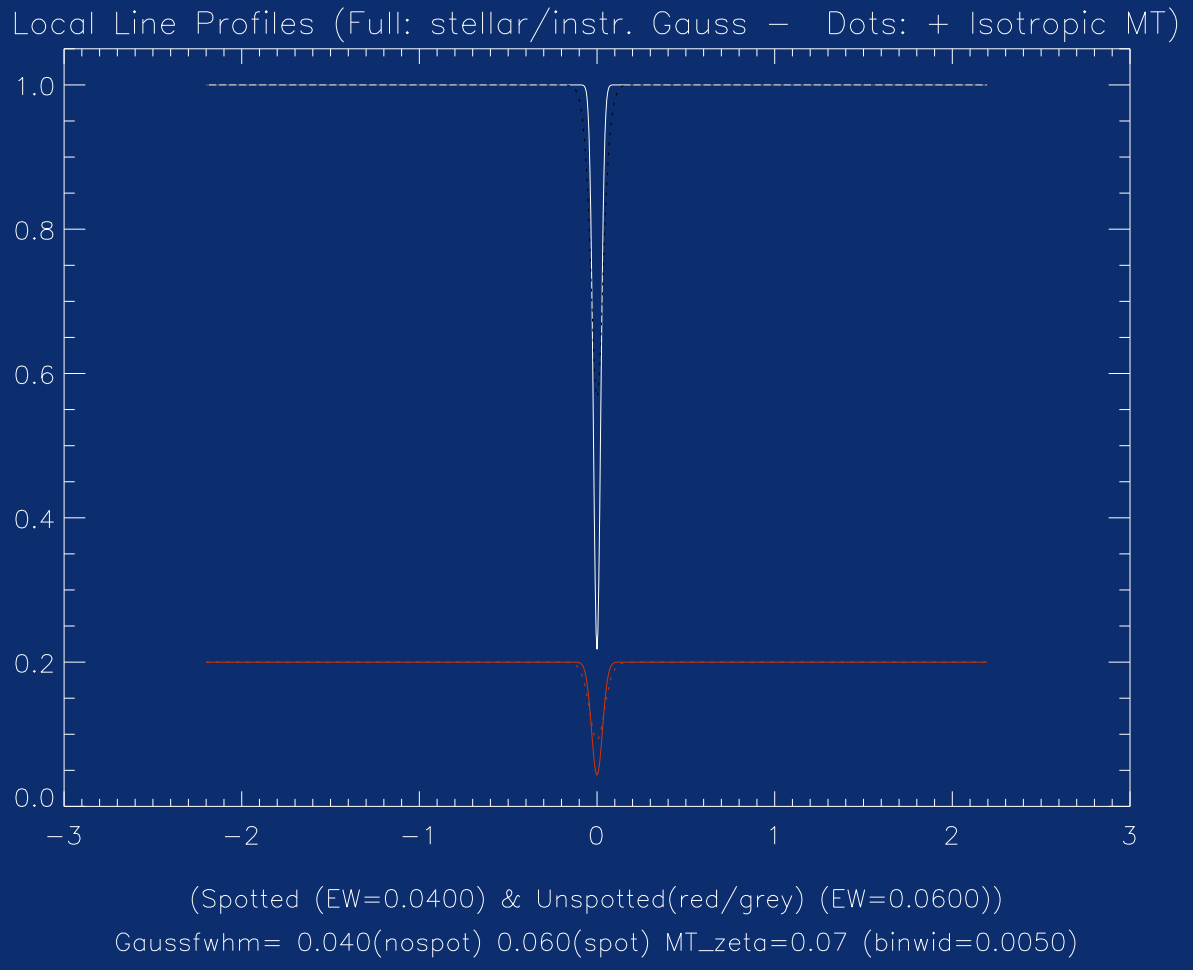
Time-series-analysis





Tracing a spot in the line profiles

CLDI: Line profile synthesis



Example local line profiles used by CLDI
(+ constant limb darkening)

DI's problems and CLDI's answers

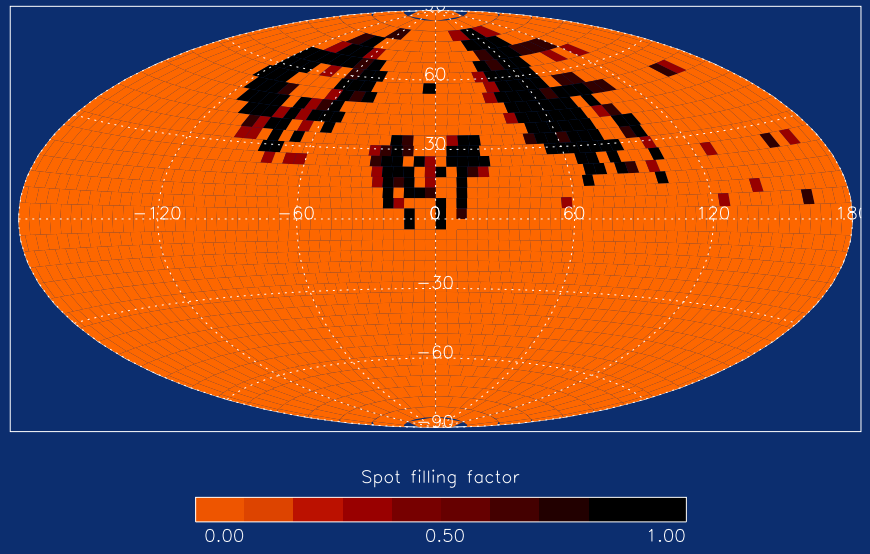
DI's problems

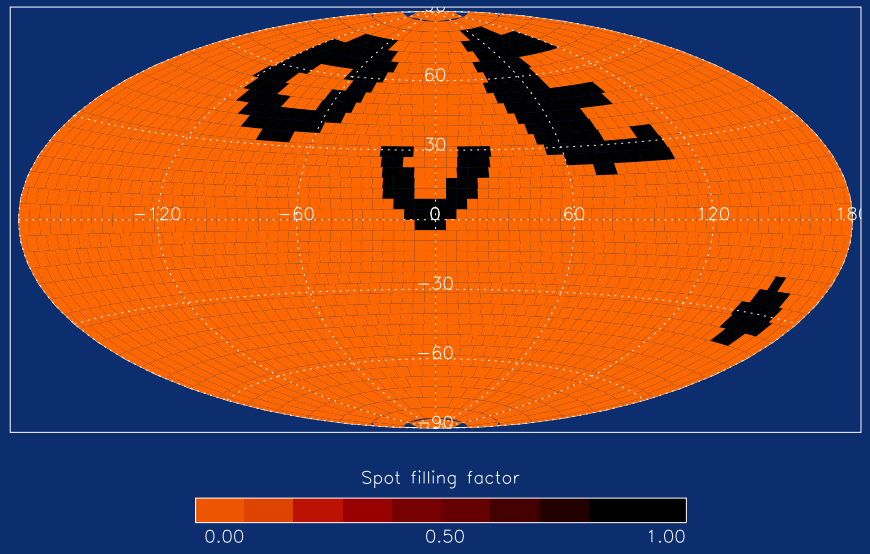
- Incomplete knowledge of stellar parameters
  (worst are atmospheric)
- Preserving latitude information
- Stabilizing against noise

CLDI's ingredients

- Feature tracking
  vs. optimizing "blindly"
- No explicit assumptions about the solution
- 2-temperature surface
- Optimizing rotation line profiles
  vs. optimizing spectra

III. CLDI's performance - so far





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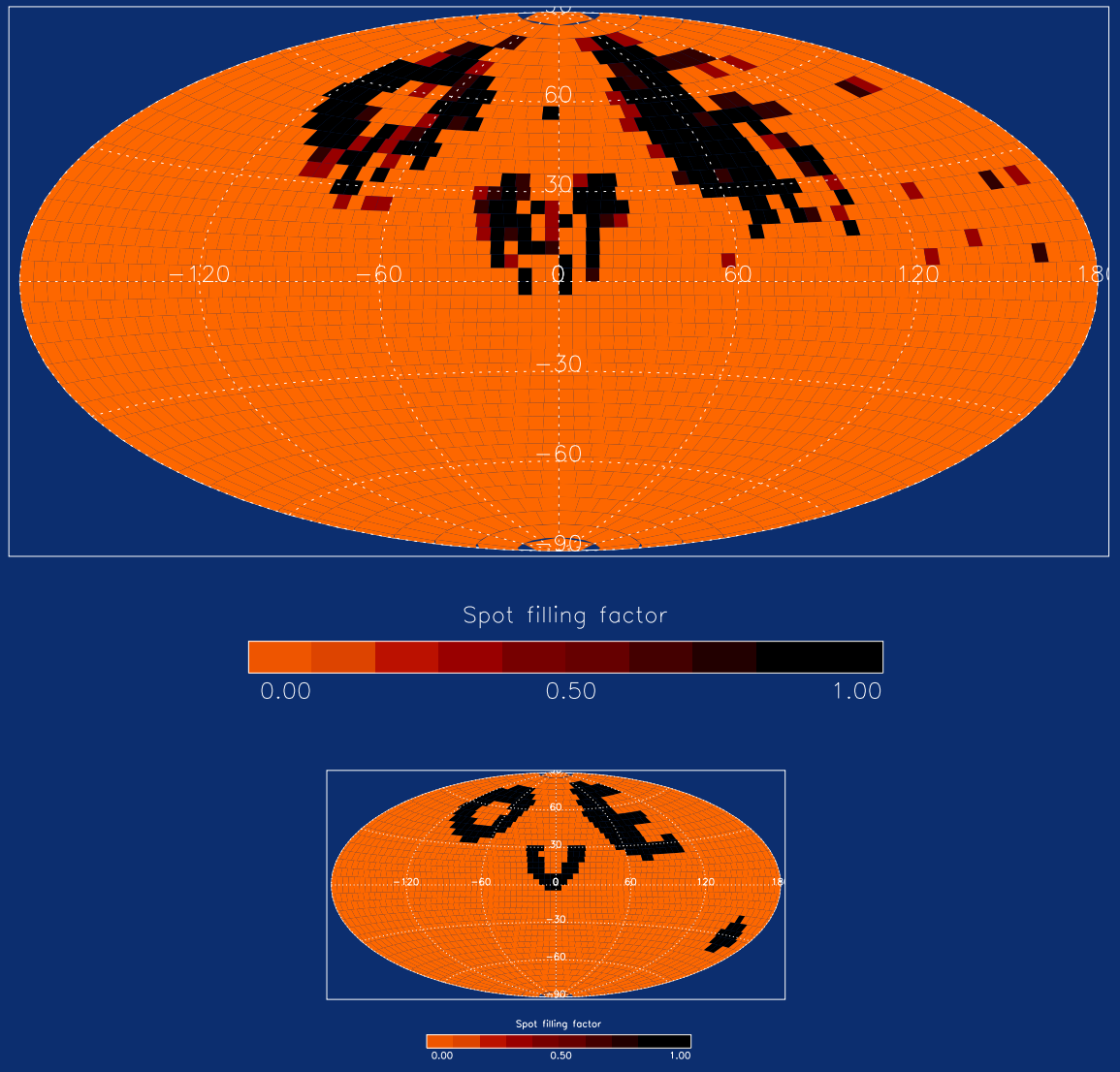
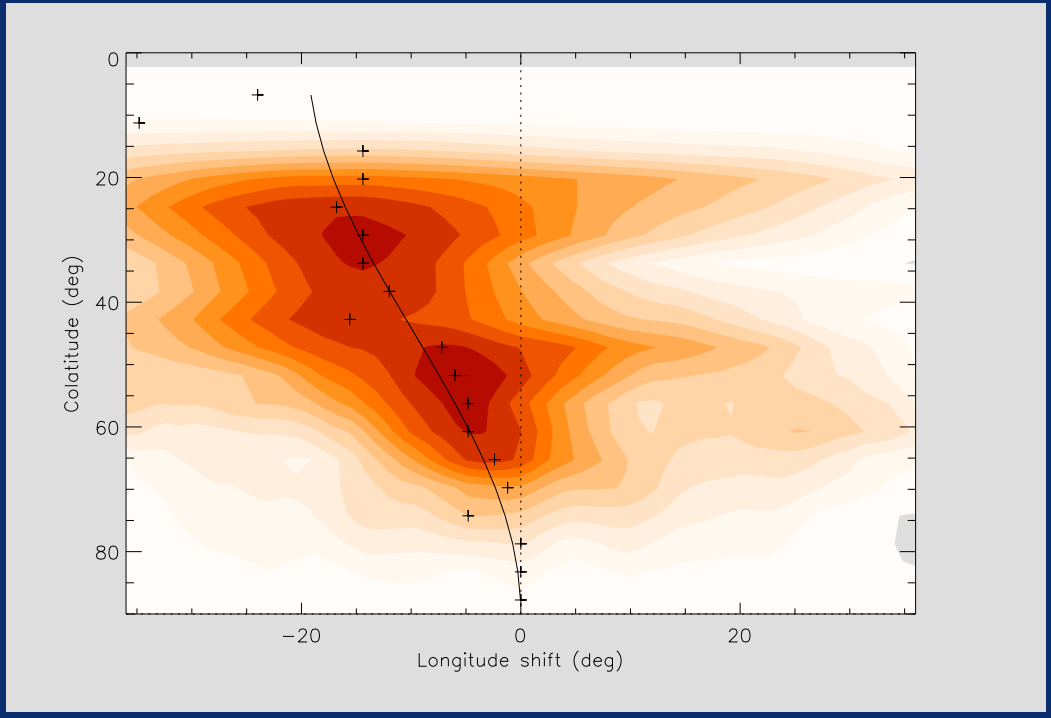
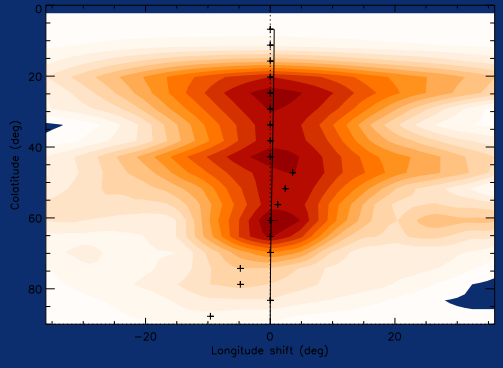


CLDI-reconstruction from noisy realistic synthetic line profiles

Differential Rotation ?

Yes ! Cross-correlations of simulated observations

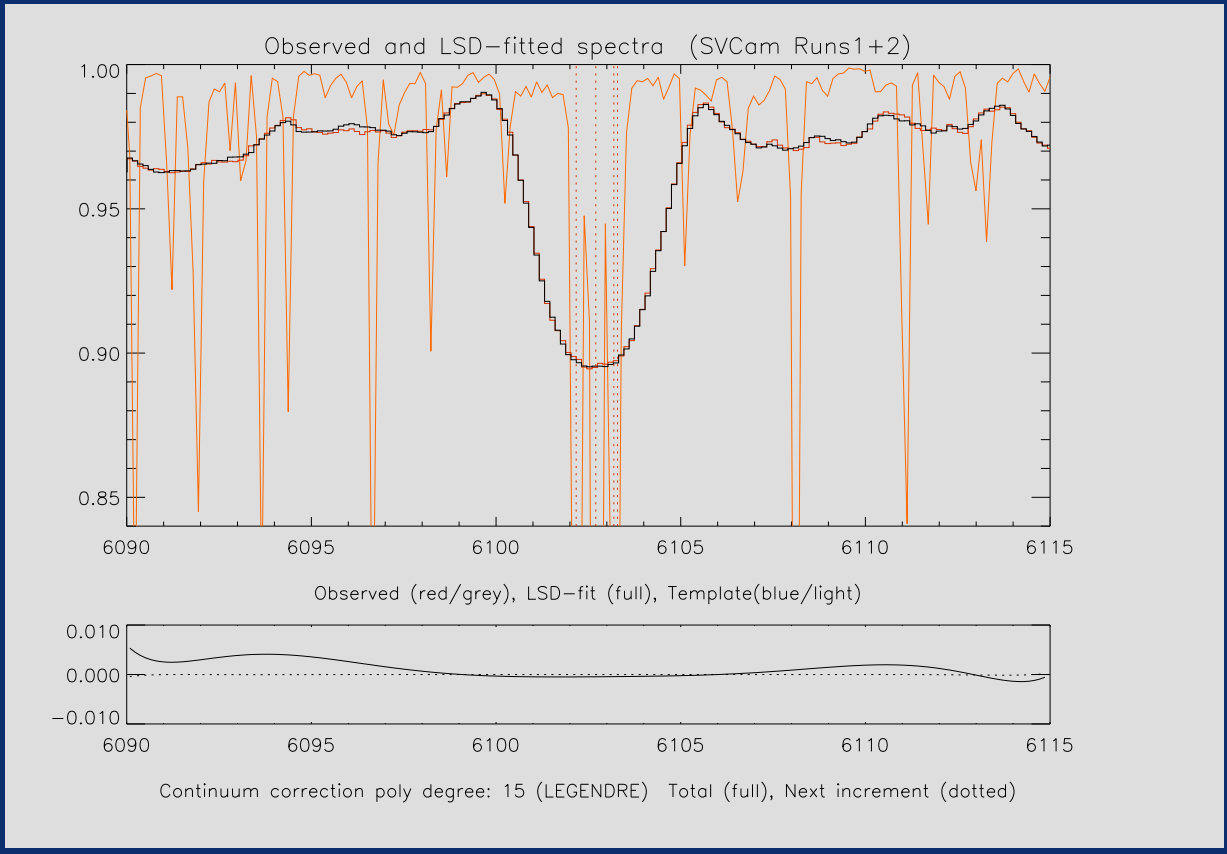


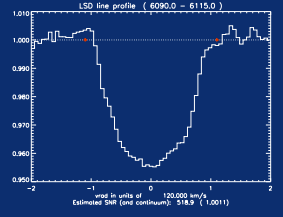


Shear as a function of colatitude

IV. Feeding CLDI: Extracting line profiles

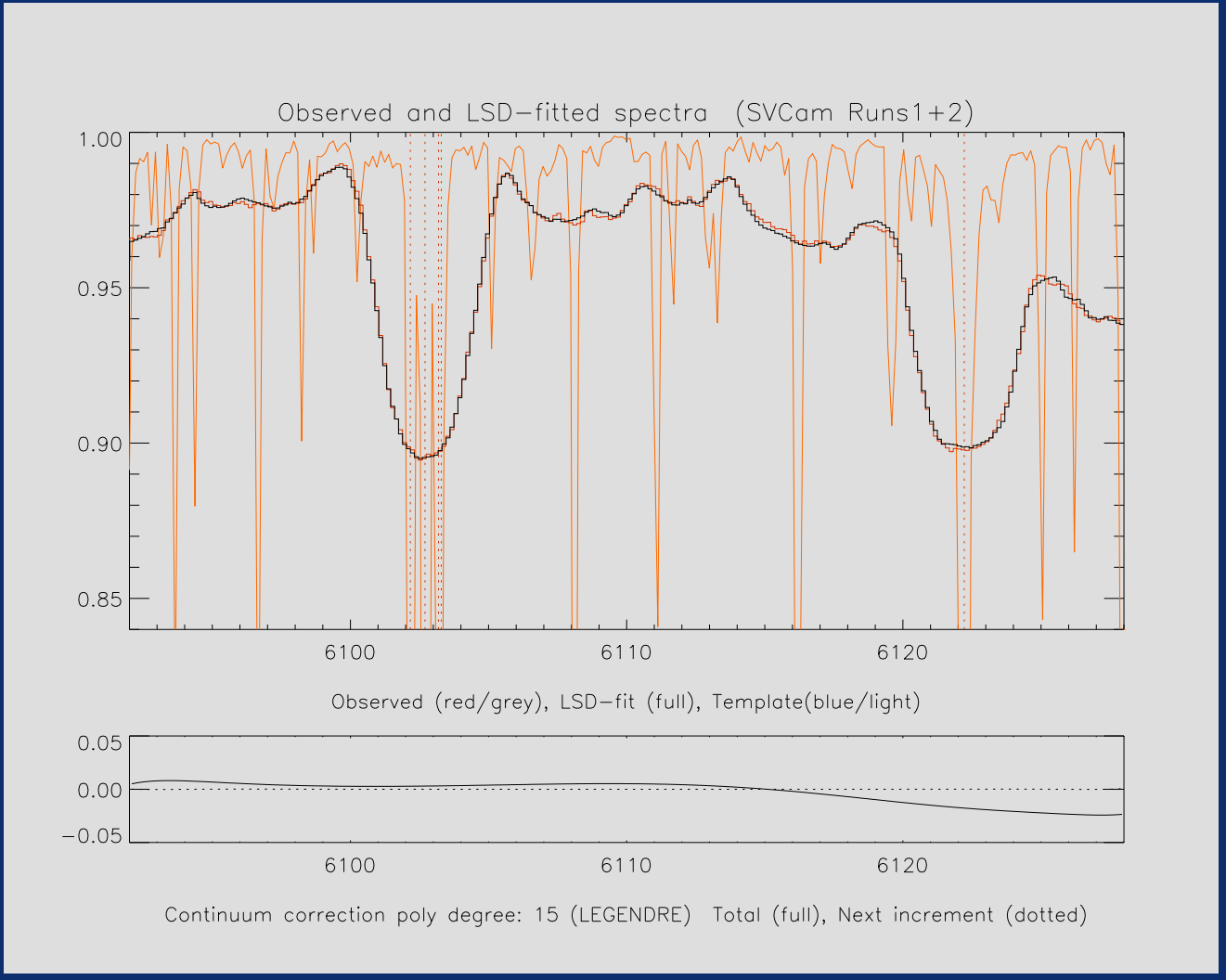
LSD: From a "single" line to a rotation profile





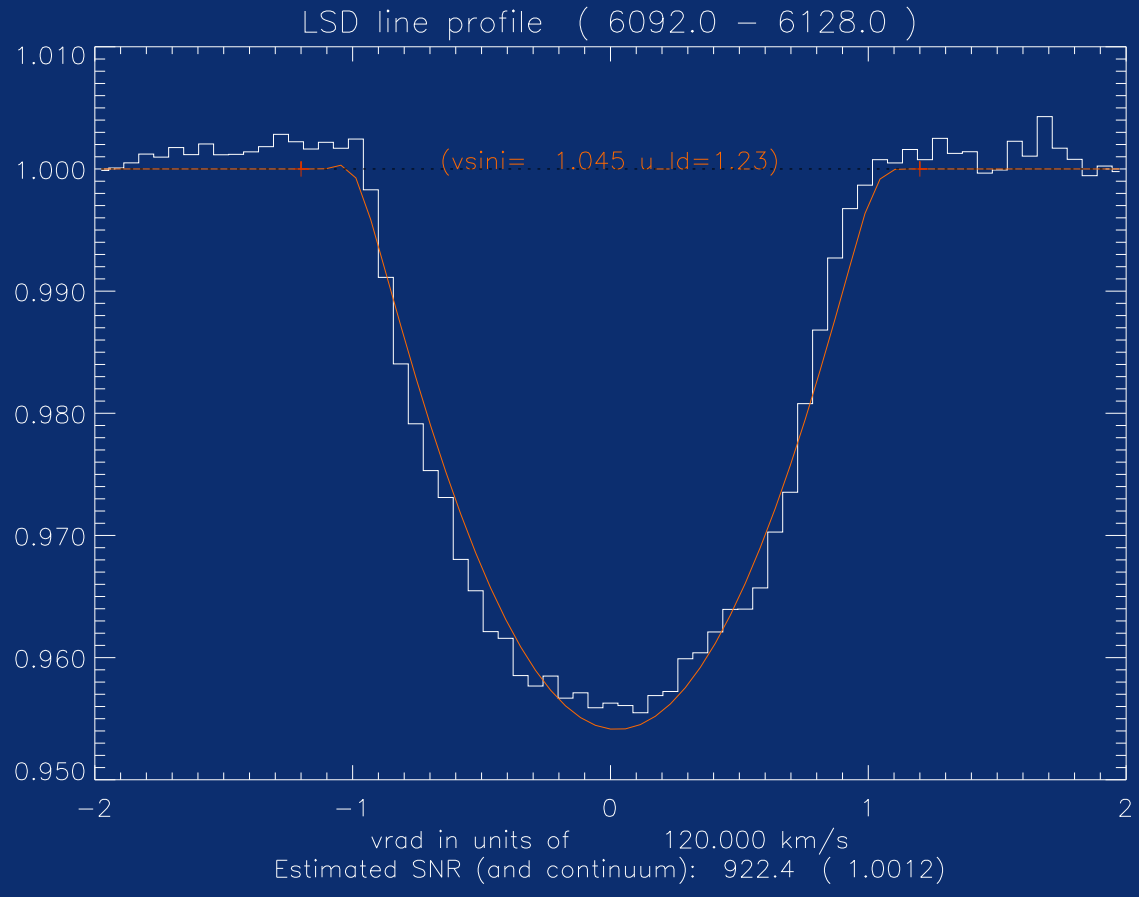
FeI+CaI at 6102 Å(SV Cam) and a template (Sun)

From a line ensemble to a rotation profile I



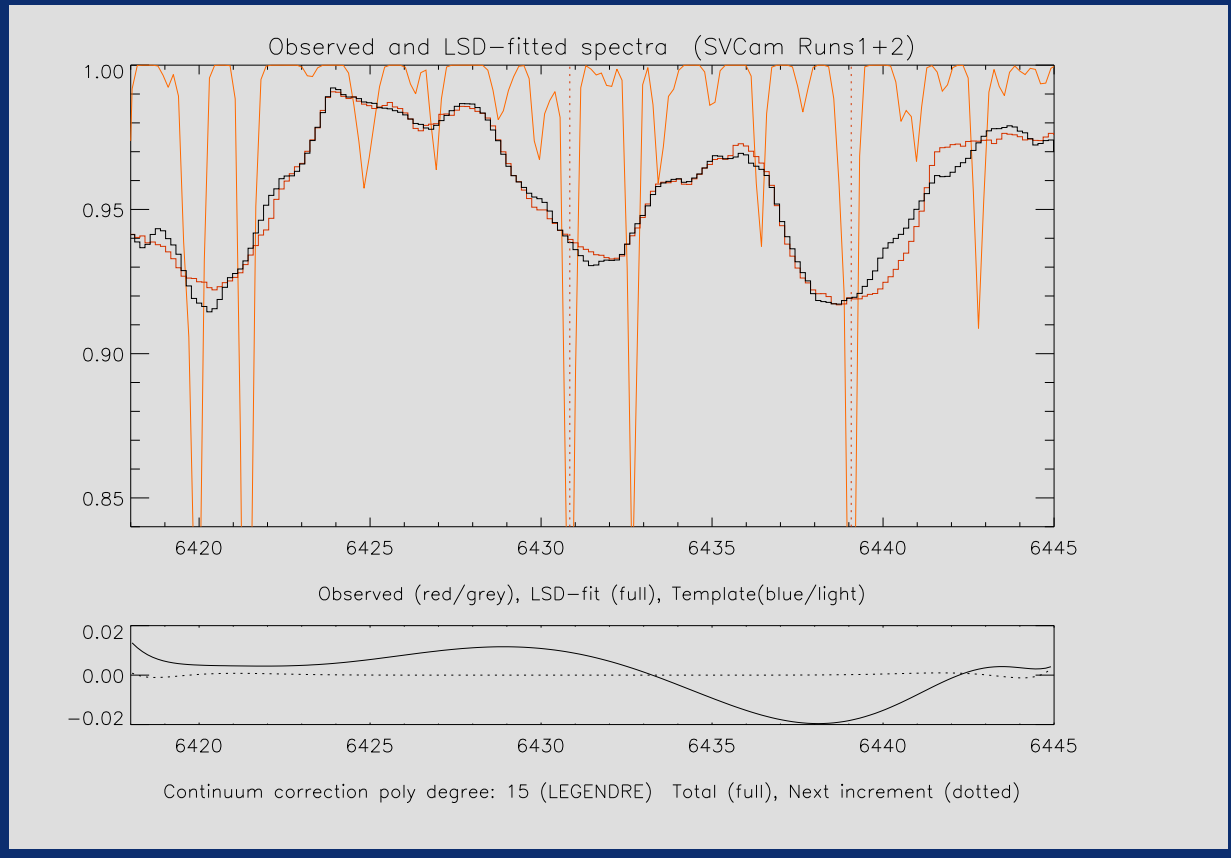
Spectrum range (incl. CaI 6122 Å) and LSD-fit

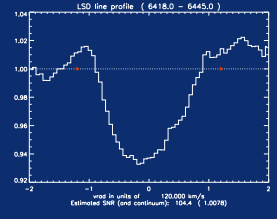
From a line ensemble to a rotation profile II



LSD line profile and analytic fit (rigid rotation profile)

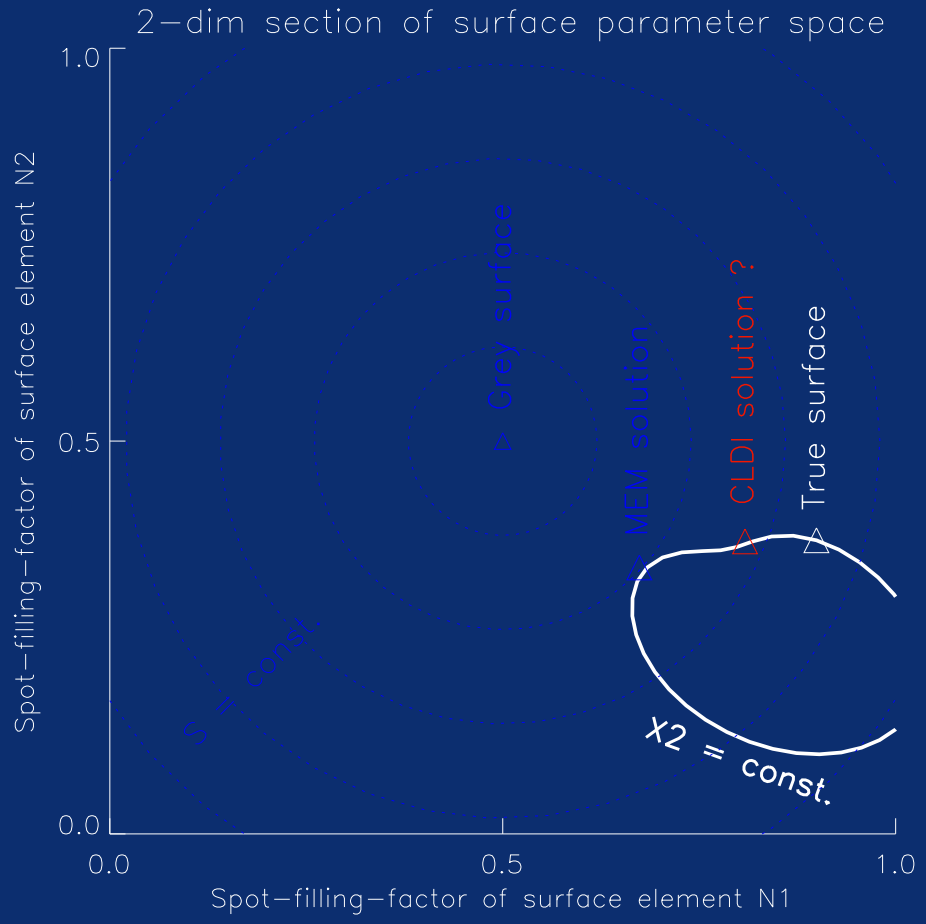
Mind the template !





Spectrum range and a synthetic template (roughly solar)

CLDI: Doppler imaging with a difference II



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A short glimpse of Doppler Imaging
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APPENDIX
CLDI: Why ?
Sun: Surface differential rotation
Solar Interior: Rotation
Stellar Surface Differential Rotation I

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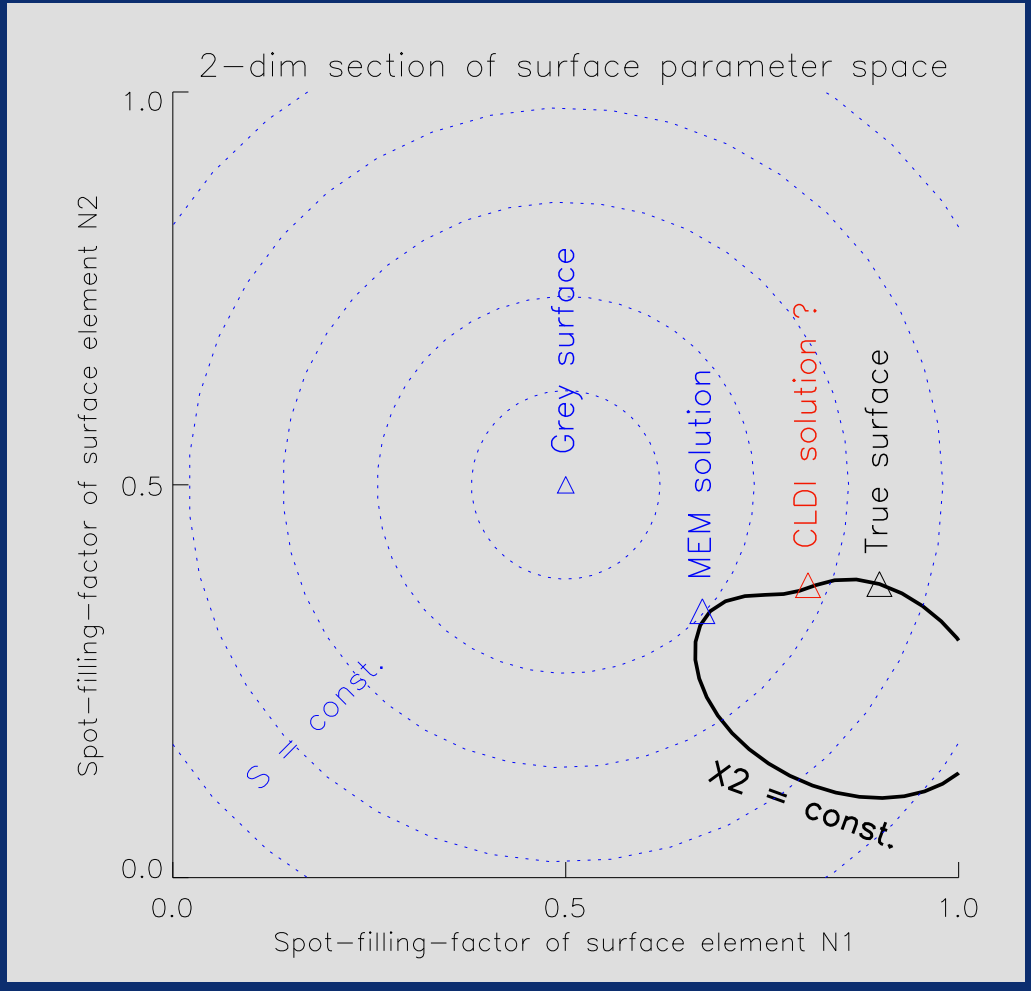
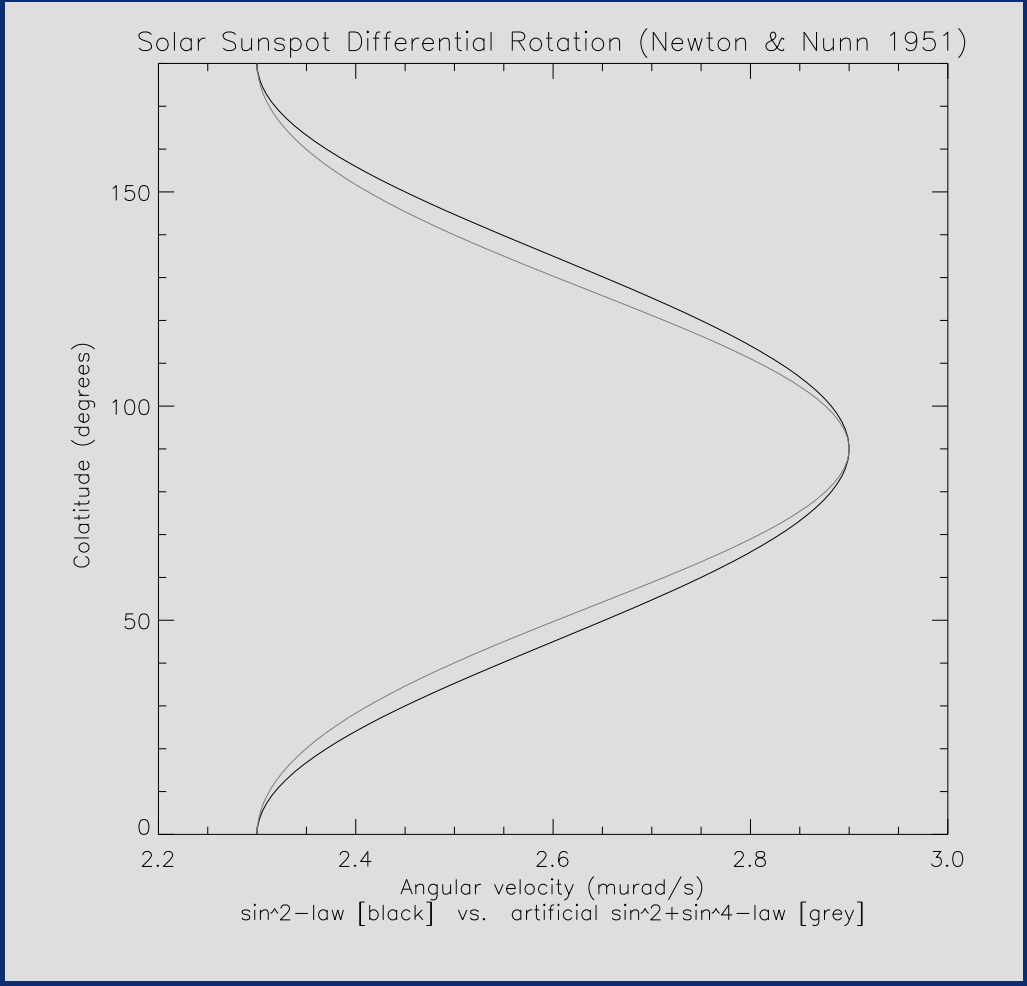
CLDI: Why ?



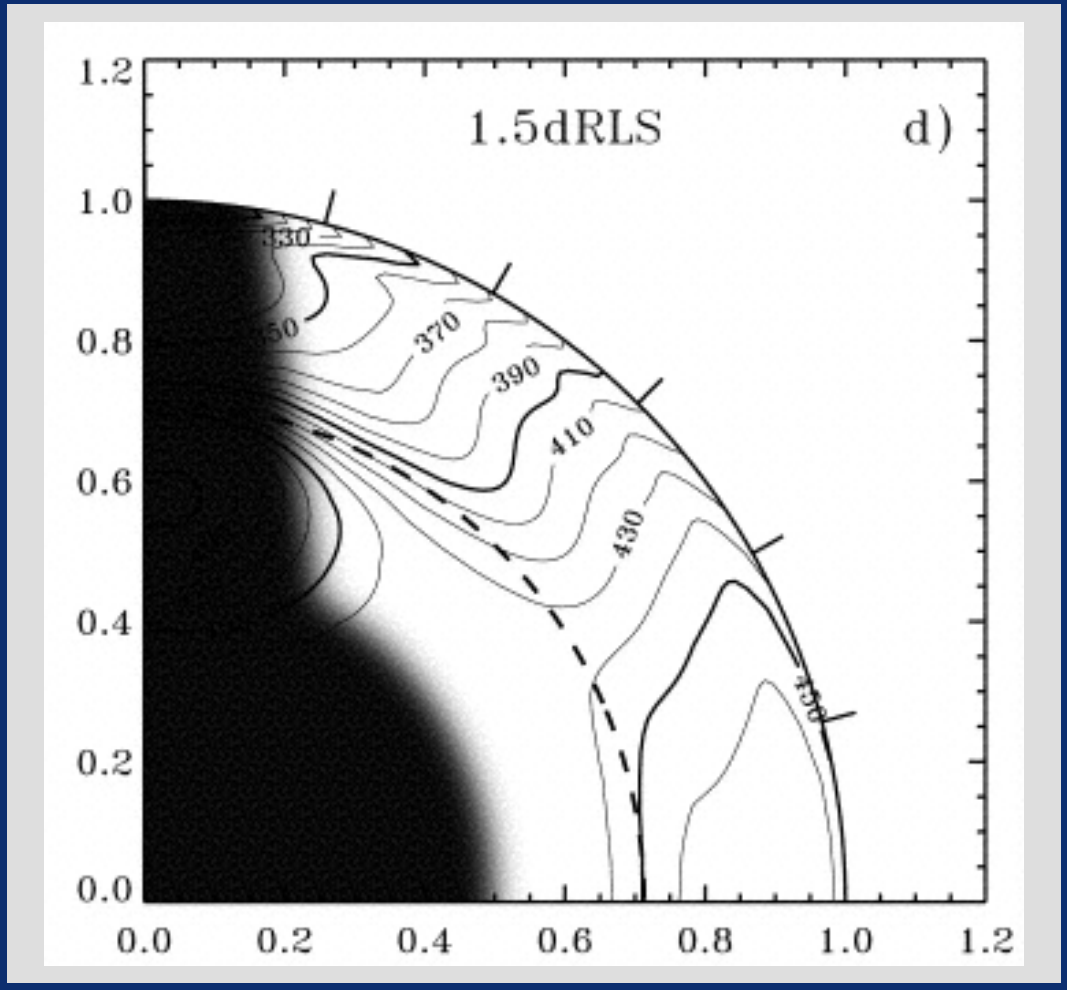
Different solutions for one measured time-series of spectra

Sun: Surface differential rotation



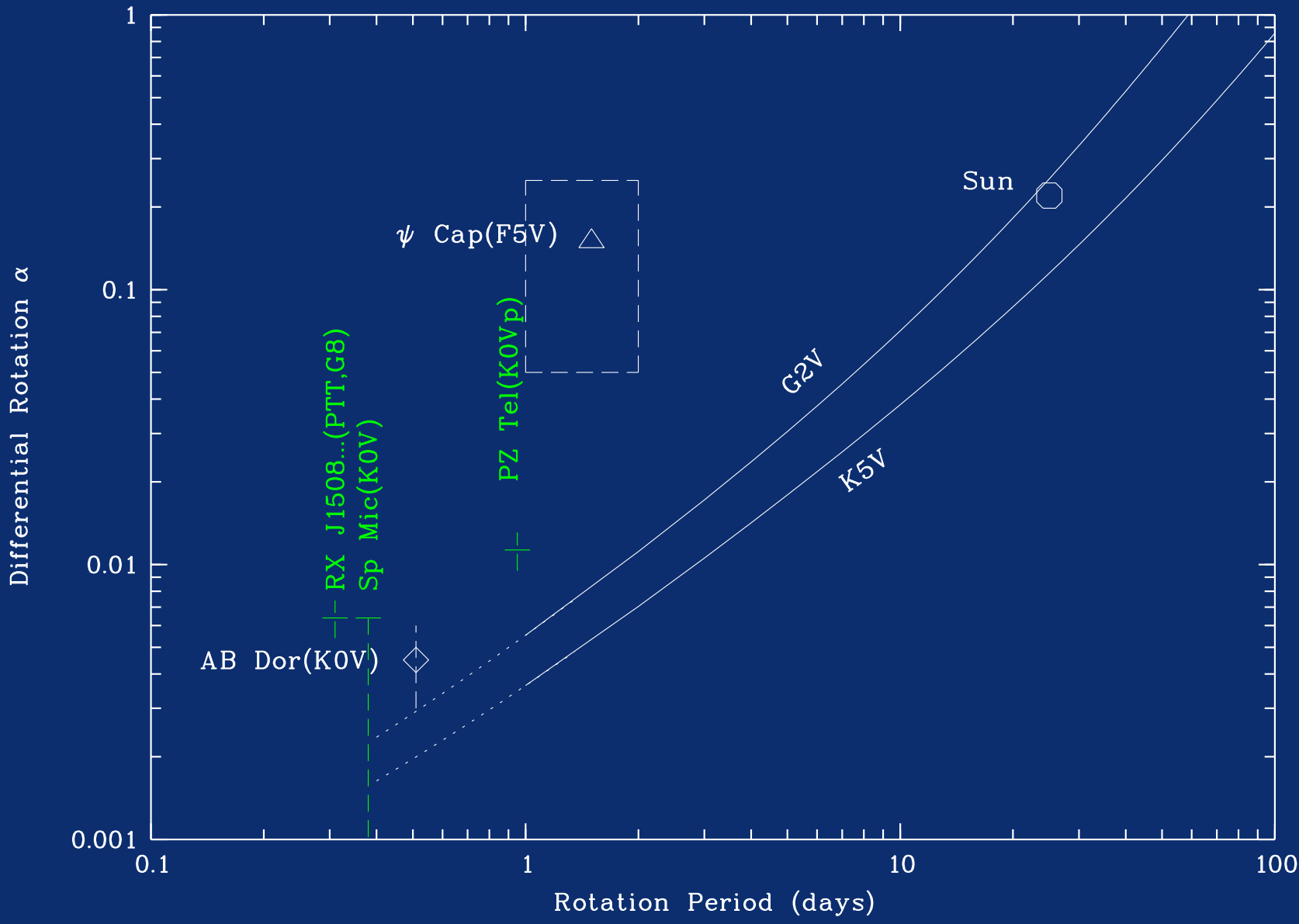
Angular velocity as function
of colatitude (extrapolated)

Solar Interior: Rotation



Inversion of helioseismic data (SOHO SOI-MDI)
Shaded area has no reliable information
(Fig. 3 of Schou et al. 1998)

Stellar Surface Differential Rotation I



(based on Kitchatinov & Rüdiger 1999)