Raspodela temperature u AR Sunčeve površine

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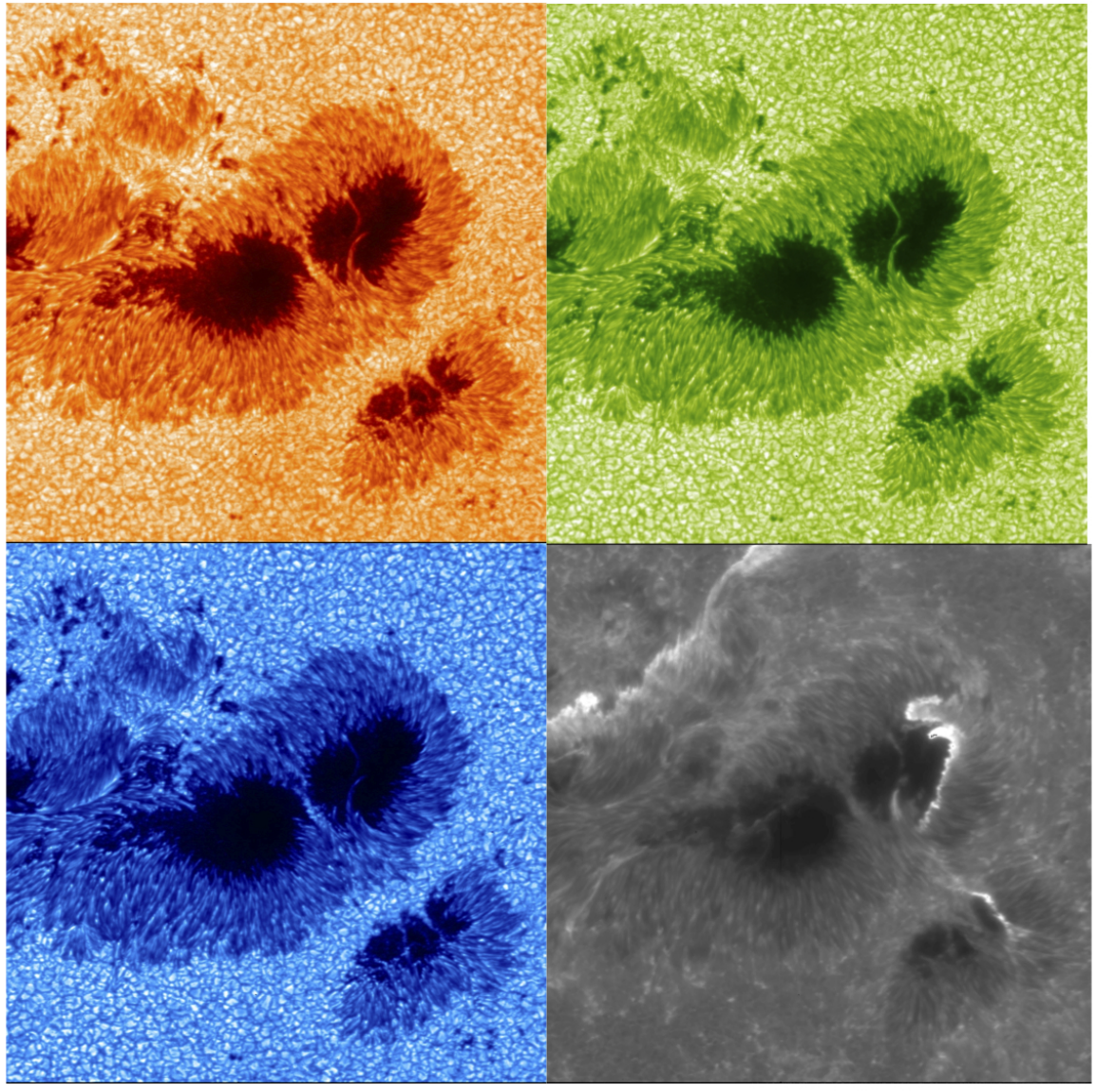
IX SAR

23. april 2016.

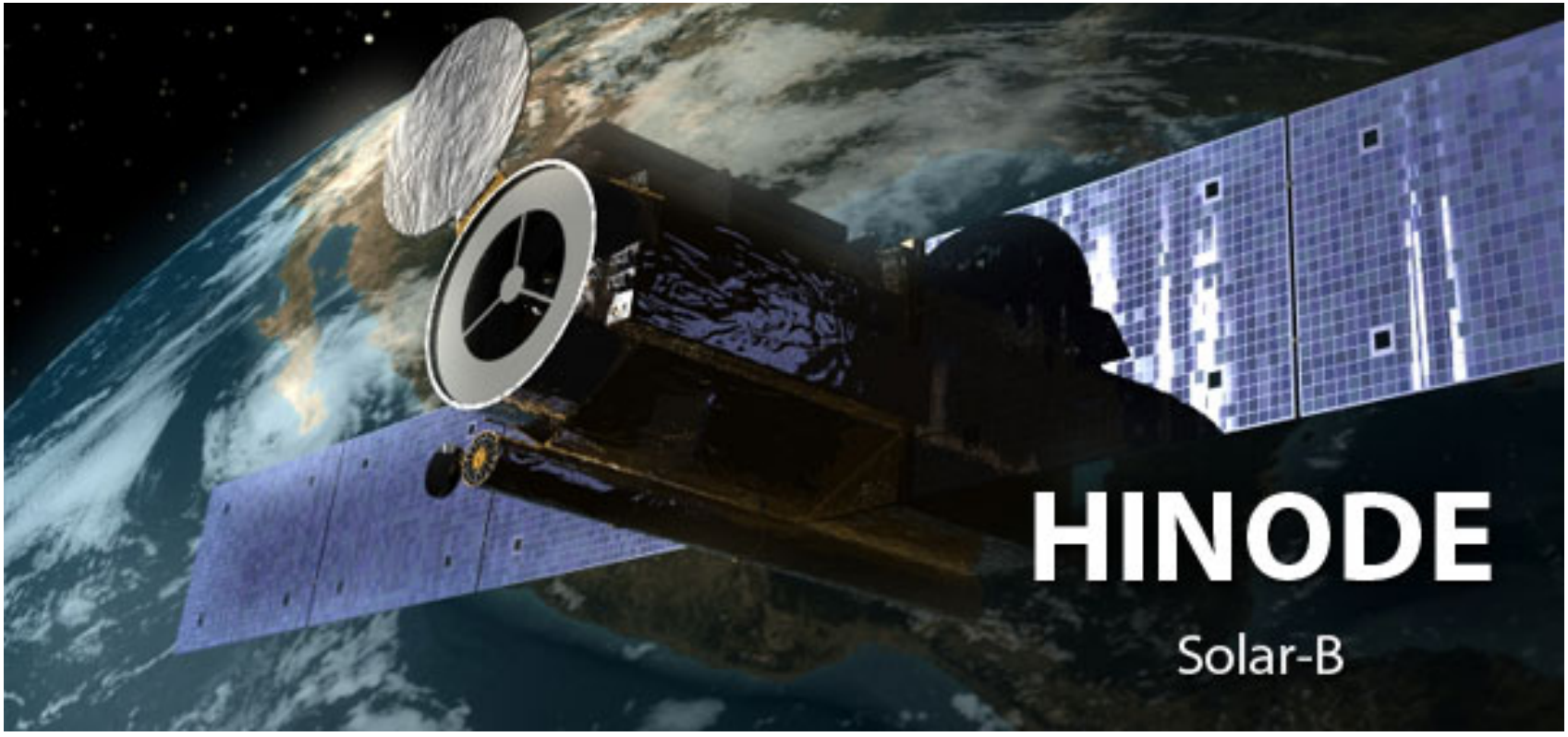
Plan i program:

- Pege na Suncu
- Hinode
- Obrada (Bias, Dark, Flat i LD)
- PSF + dekonvolucija
- Model
- Drugi model?
- Rezultat

Pege i AR (12.7.2012.)



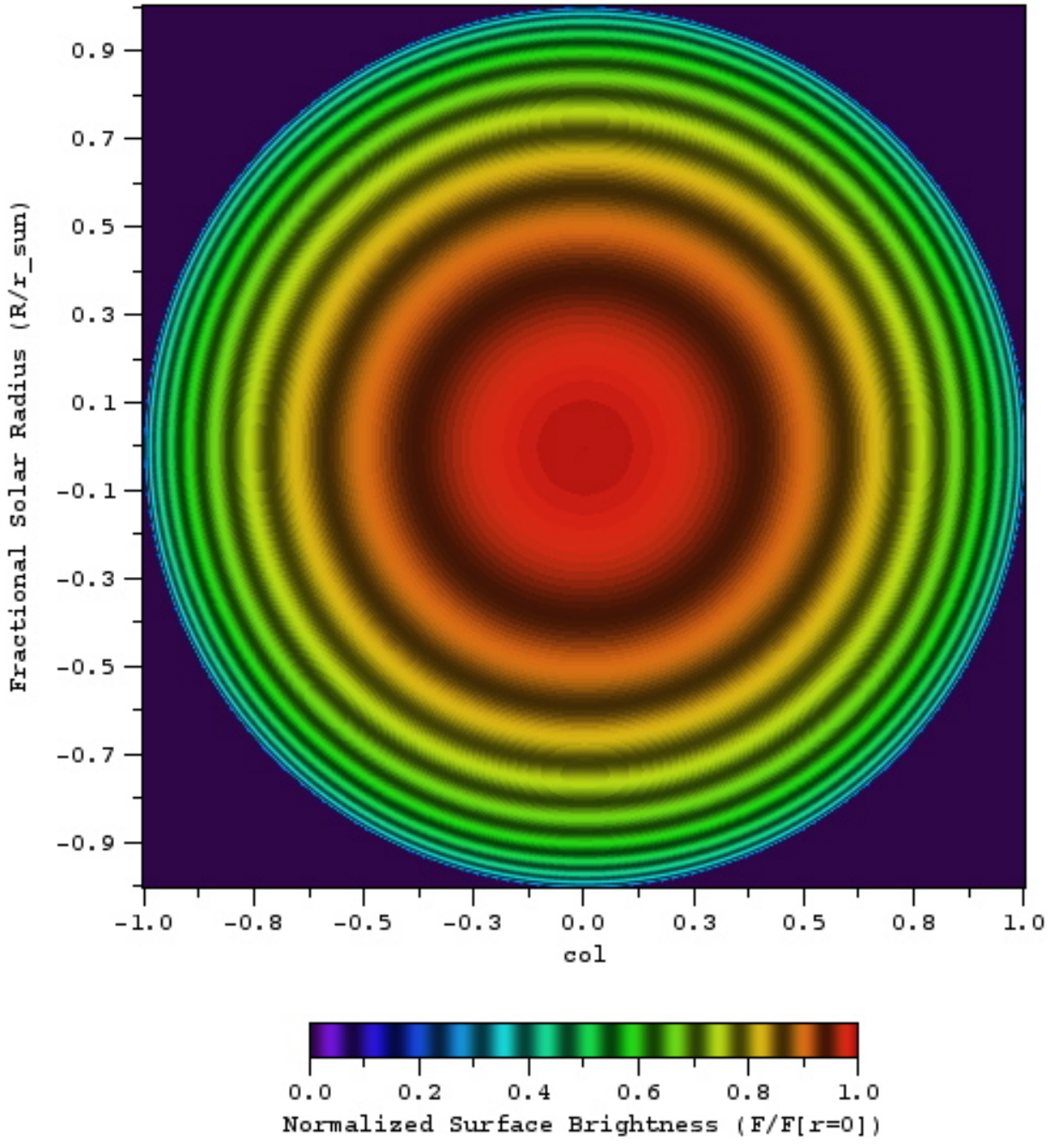
Hinode



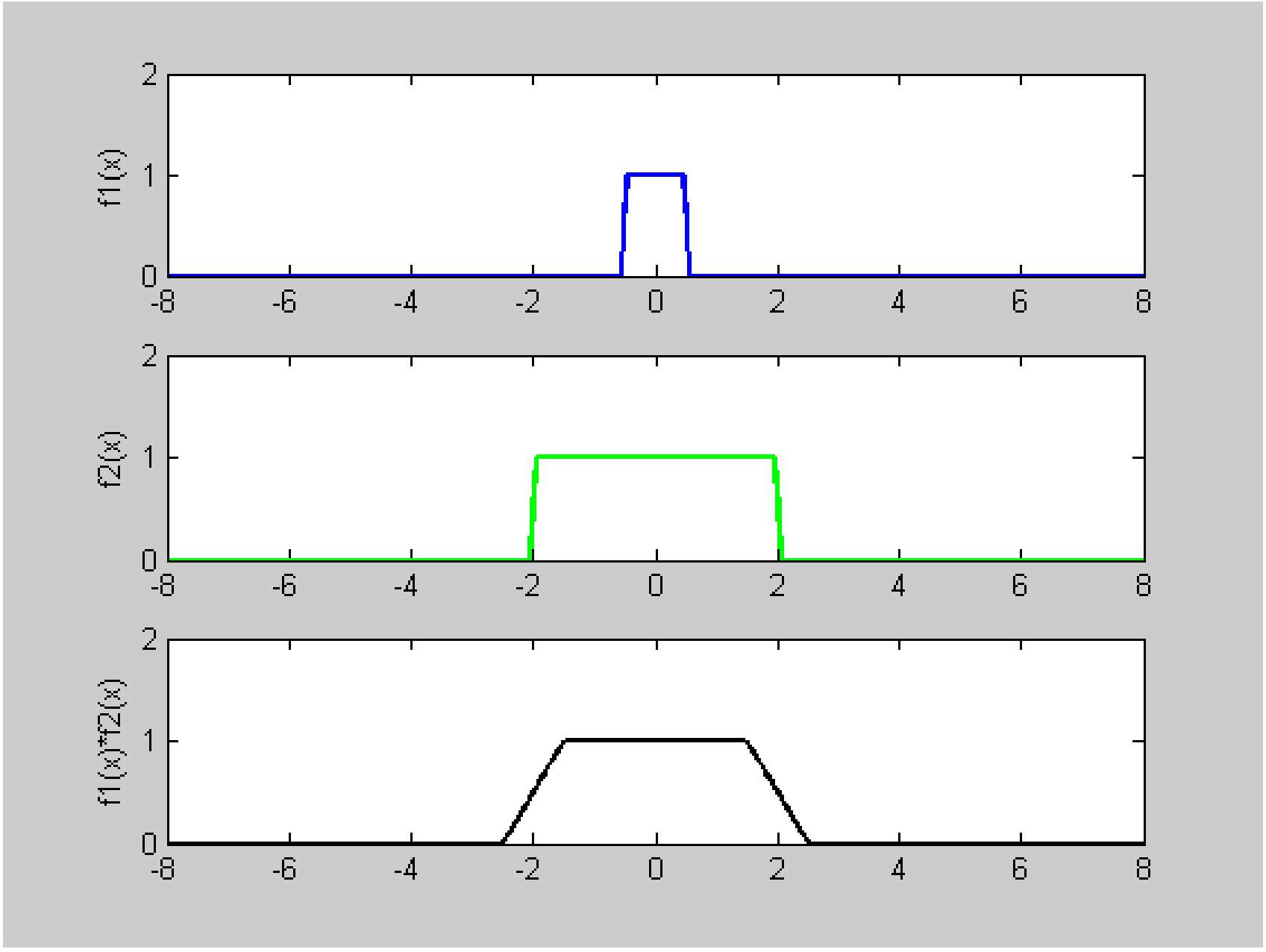
Solarsoft

- Unified Solar astrophysics reduction library aka SolarSoft (SOHO, SDO, HINODE, Trace....)
- Redukcija i co-aligment
- + misc funkcije

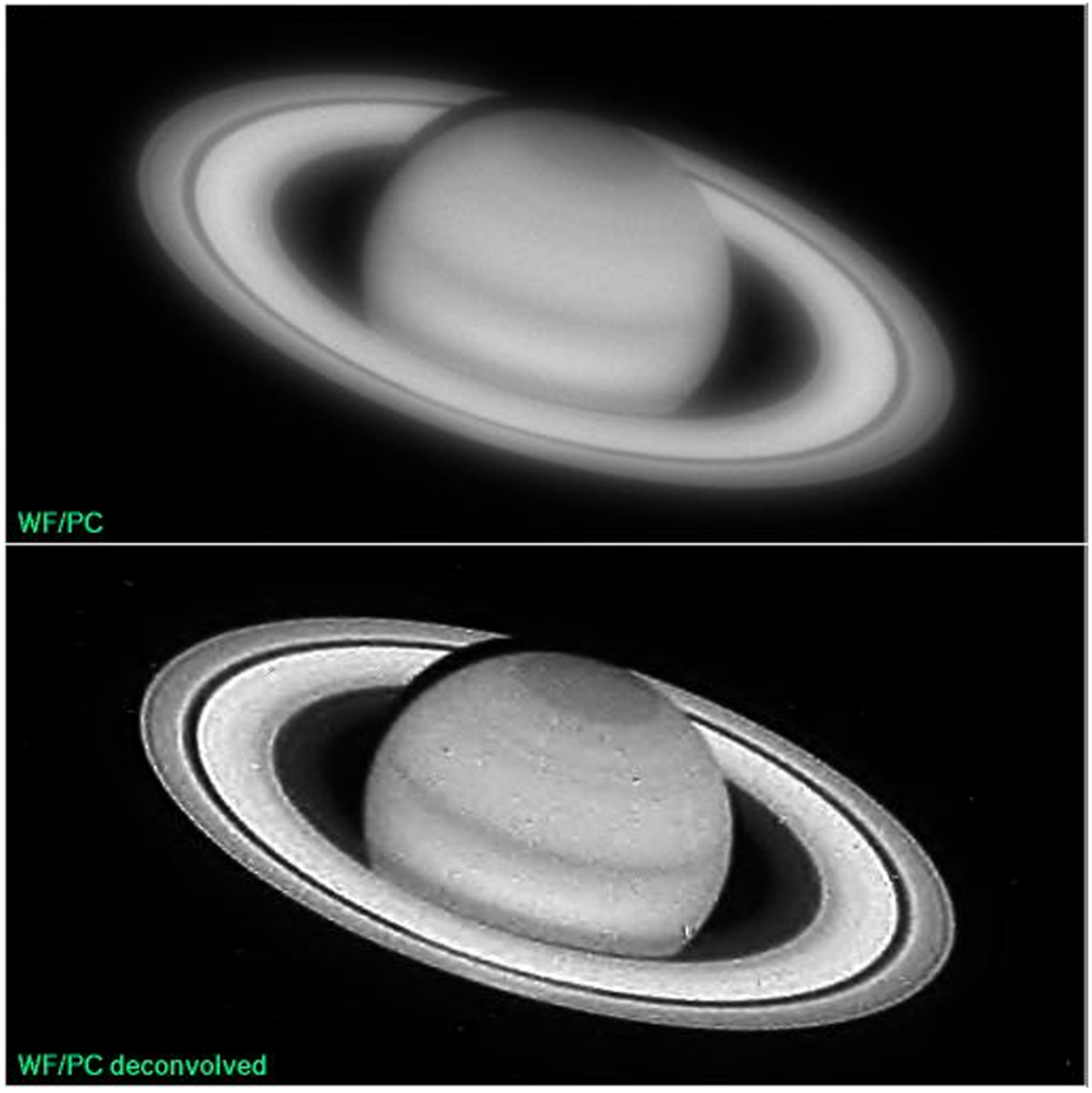
Limb darkening



Konvolucija



Dekonvolucija



Kako do PSF-a?

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LETTER TO THE EDITOR

Stray light correction and contrast analysis of Hinode broad band images

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Received .....; accepted .....

ABSTRACT

The contrasts of features in the quiet Sun are studied using filtergrams recorded by the Broad-band Filter Imager on the Hinode/Solar Optical Telescope. In a first step, the scattered light originating in the instrument is modeled using Mercury transit data. Combinations of four two-dimensional Gaussians with different widths and weights were employed to retrieve the point-spread functions (PSF) of the instrument at different wavelengths, which also describe instrumental scattered light. The parameters of PSFs at different wavelengths are tabulated. The observed images were then deconvolved using the PSFs. The corrected images were used to obtain contrasts of features such as bright points and granulation in different wavelength bands. After correction, *rms* contrasts of the granulation of between 0.11 (at 668 nm) and 0.22 (at 388 nm) are obtained. Similarly, bright point contrasts ranging from 0.07 (at 668 nm) to 0.78 (at 388 nm) are found, which are a factor of 1.8 to 2.8 higher than those obtained before PSF deconvolution. The mean contrast of the bright points is found to be somewhat higher in the CN-band than in the G-band, which confirms theoretical predictions.

Key words. Sun: granulation – Sun: photosphere – instrumentation: high angular resolution

1. Introduction

The contrast of granulation and of magnetic features is an important diagnostic of their thermal structure and provides insight into the energy transport mechanisms acting in them. The contrast of granulation, bright points and other small scale features is influenced by the point spread function (PSF), the width of whose core is a measure of the spatial resolution, while the strength of the wings is determined by the amount of light scattered within the instrument (or in the atmosphere, if present). In particular, the scattered light strongly reduces the contrast. Bright points, which are smaller in size than the granules, are more strongly affected. If the PSF is known, then it can be used to deconvolve the observed image and thus to approximately retrieve the original intensities.

Contrasts measured with the Hinode Solar Optical Telescope (SOT, Tsuneta et al. 2008, Suematsu et al. 2008, Kosugi et al. 2007) are of particular interest due to the combination of high spatial resolution and the absence of seeing, leading to almost constant observing conditions. The value of the Hinode SOT observations would be further enhanced if the PSF could be determined and compensated for (e.g. as done by Mathew, et al. 2007 for MDI continuum images).

The PSF of the Hinode Spectro Polarimeter (SP) was determined by Danilovic et al. (2008) by modeling the SOT/SP optical system using the ZEMAX optical design software. After convolving solar granulation data from MHD simulations with the computed PSF, they found that the *rms* contrast of the simulated granulation matches closely the observations from SOT/SP. Wedemeyer-Böhm (2008) used Mercury transit and eclipse images to obtain the PSF of the Hinode/SOT/Broadband Filter Imager (BFI) instrument, but did not apply the obtained PSF to deducing the true contrast in the BFI wavelength bands. In this paper we obtain the PSF of the Hinode/SOT/BFI instrument also using observed Mercury transit images, but following the approach successfully applied to MDI images by Mathew et al. (2007). We use the retrieved PSF for the deconvolution of the images observed with the Hinode/SOT/BFI instrument to recover the original intensities. In Sect. 2 we describe the method used for the retrieval of the PSF. In Sect. 3 we present initial results showing the difference in granulation contrast before and after the image correction. Conclusions are given in Sect. 4.

2. Image correction

We used images recorded on 8th Nov. 2006 during a Mercury transit to obtain the PSF of the instrument. Full pixel resolution (0.05448 arcsec/pixel) images in the CN and G-bands and also in blue, green and red continuum bands were available. The theoretical resolution (λ/D) of the Hinode/SOT ranges from 0.16 to 0.28 arc-sec between the CN-band and red continuum wavelengths. In the absence of instrumental scattered light Mercury should appear completely black, whereas in the observations it obviously is not (Fig. 1). The open circles in Fig. 1 indicate the radial (azimuthally averaged) intensity profile of Mercury observed in the G-band, which shows a scattered light level of around 7 - 8% near the center of Mercury's disk. Significant stray

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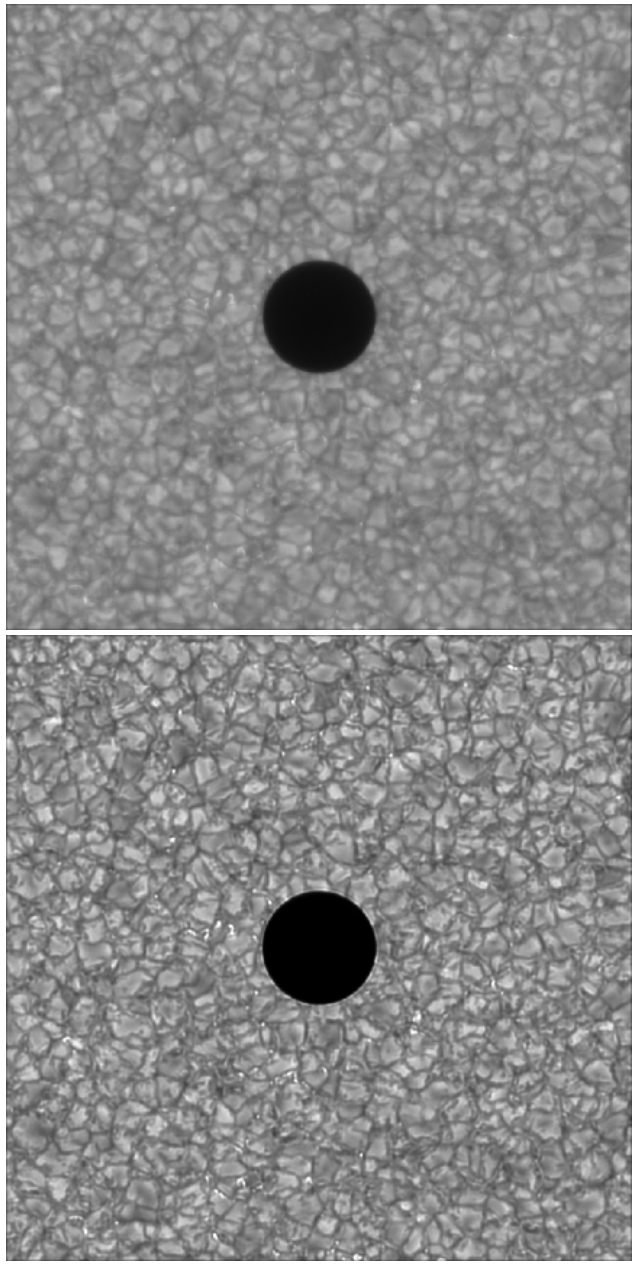
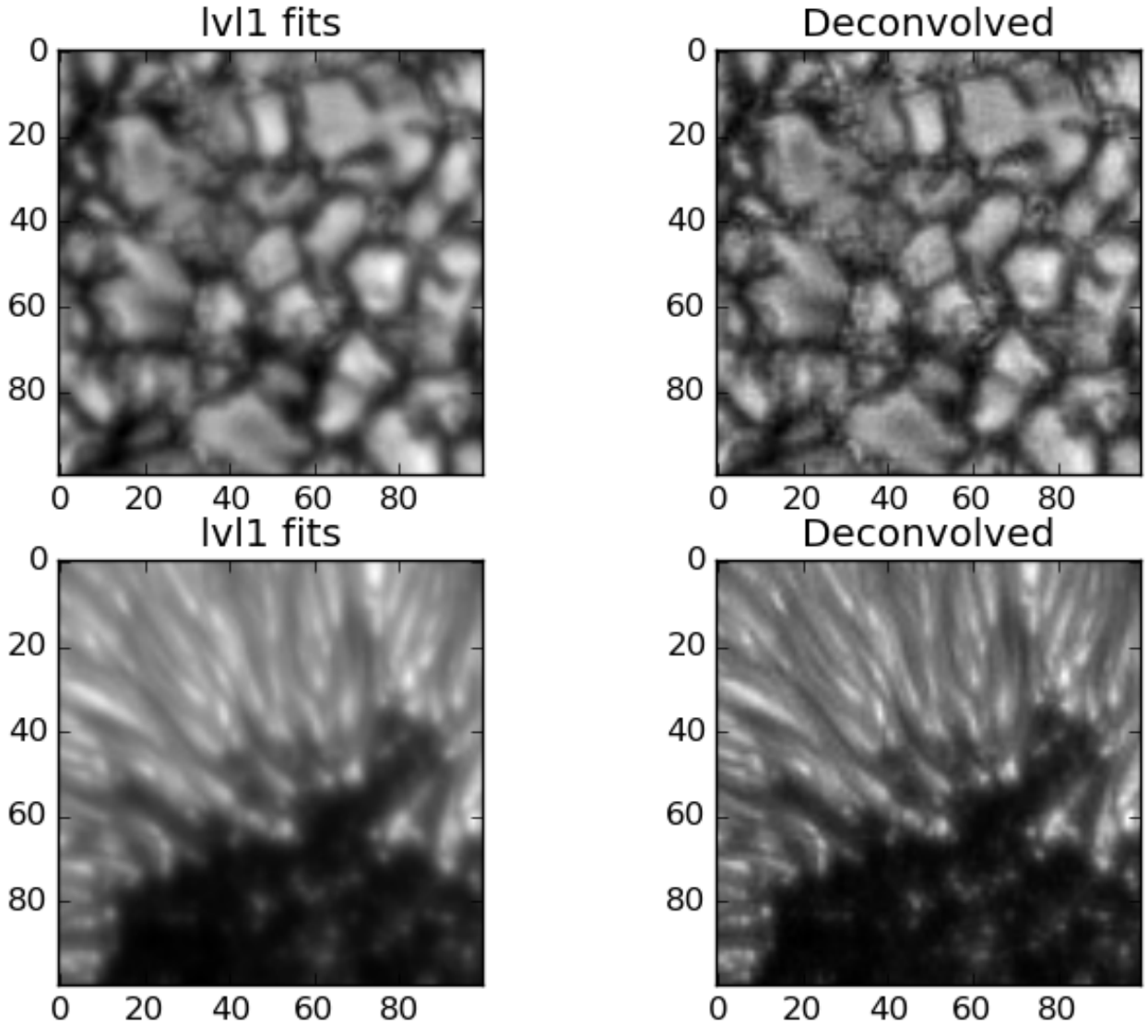


A kako to izgleda na našim snimcima? (BC)

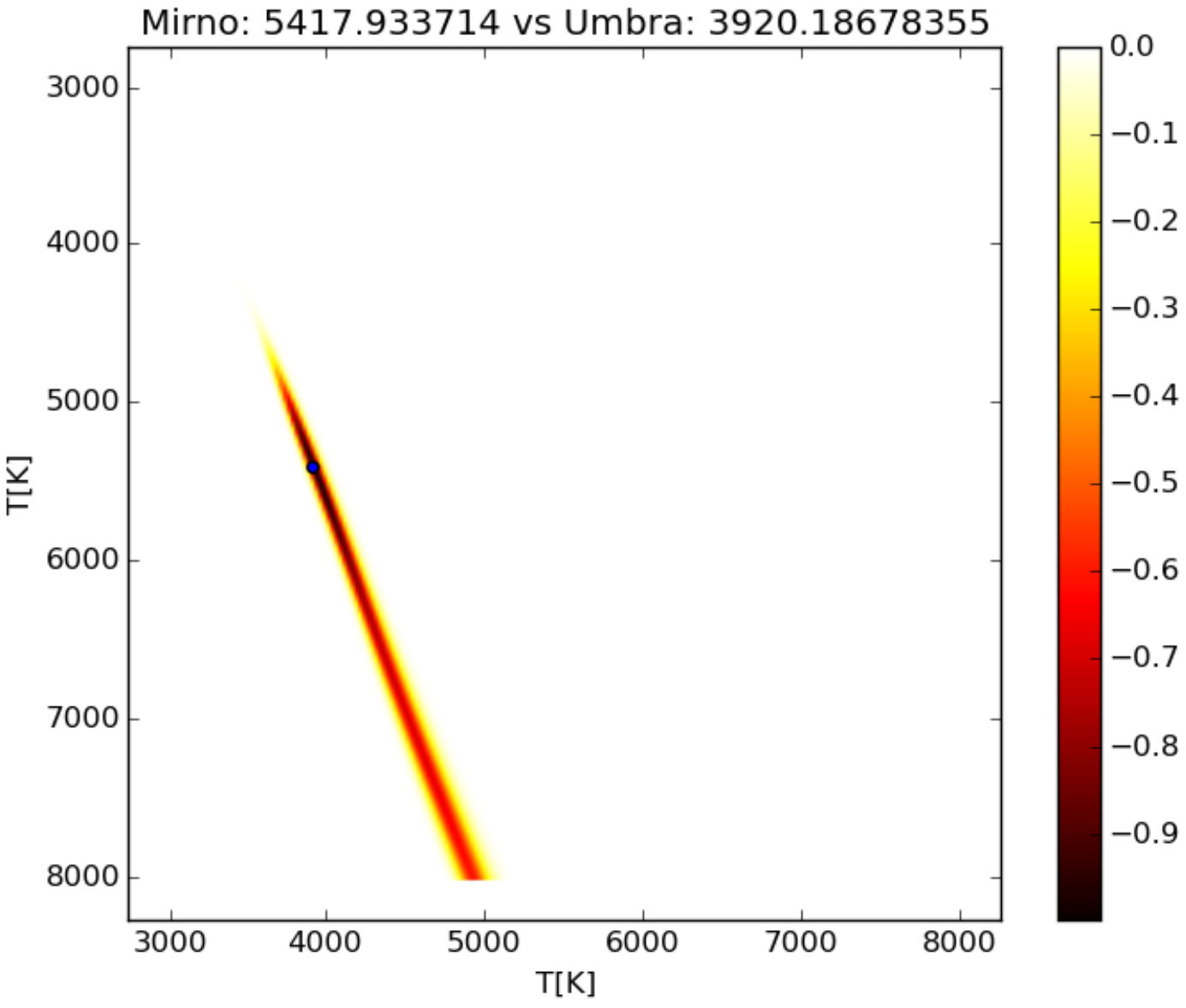


Kako da znam koliko je to toplo?

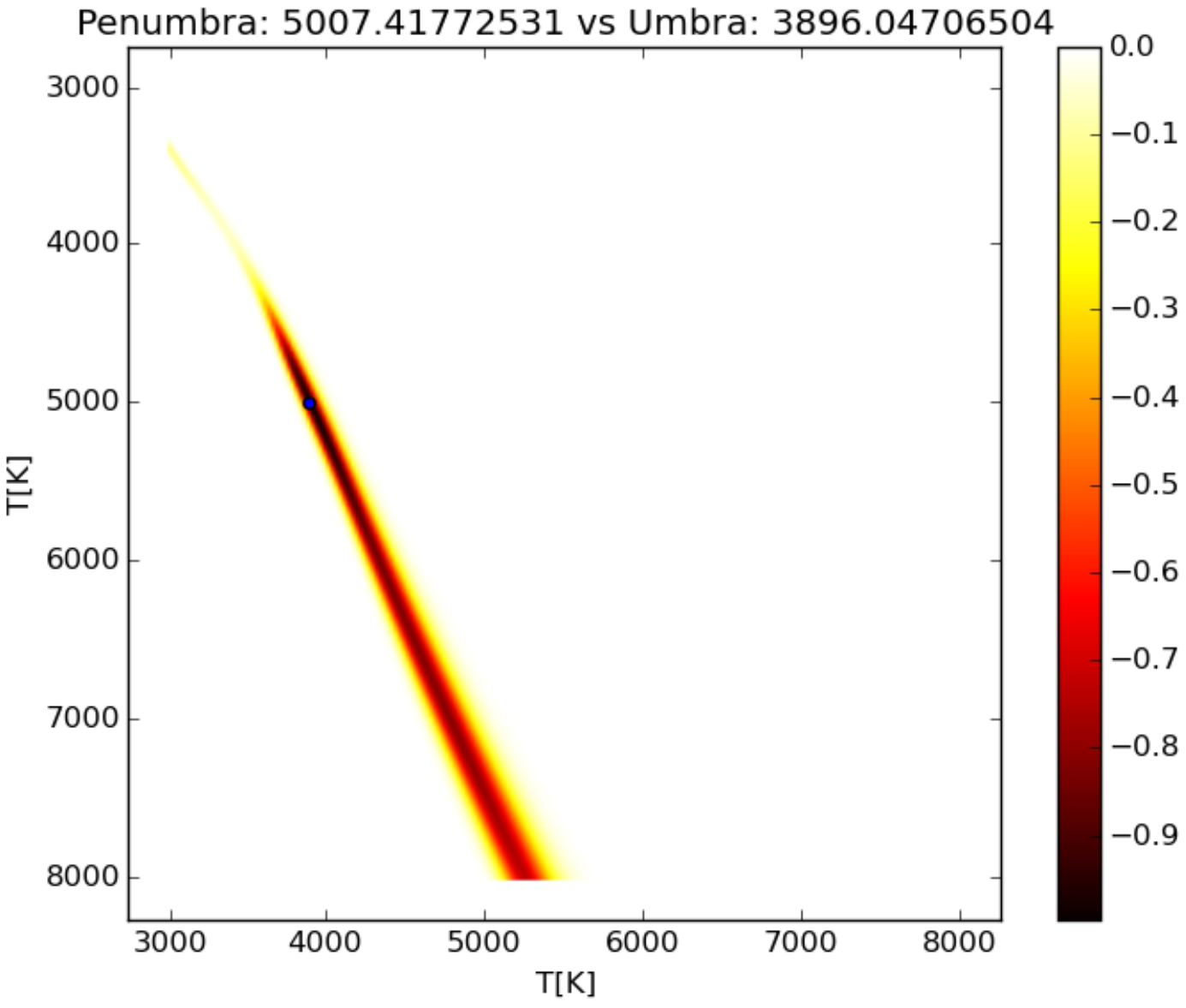
$$I_f = k \int_{\lambda_1}^{\lambda_2} B(\lambda, T) \cdot f(\lambda) d\lambda$$

$$\chi^2 = \sum_{n=r,g,b} \frac{\left(\frac{I_{i,a}}{I_{i,b}} - \frac{mereno_{i,a}}{mereno_{i,b}} \right)^2}{\sigma^2_{mereno,i}}$$

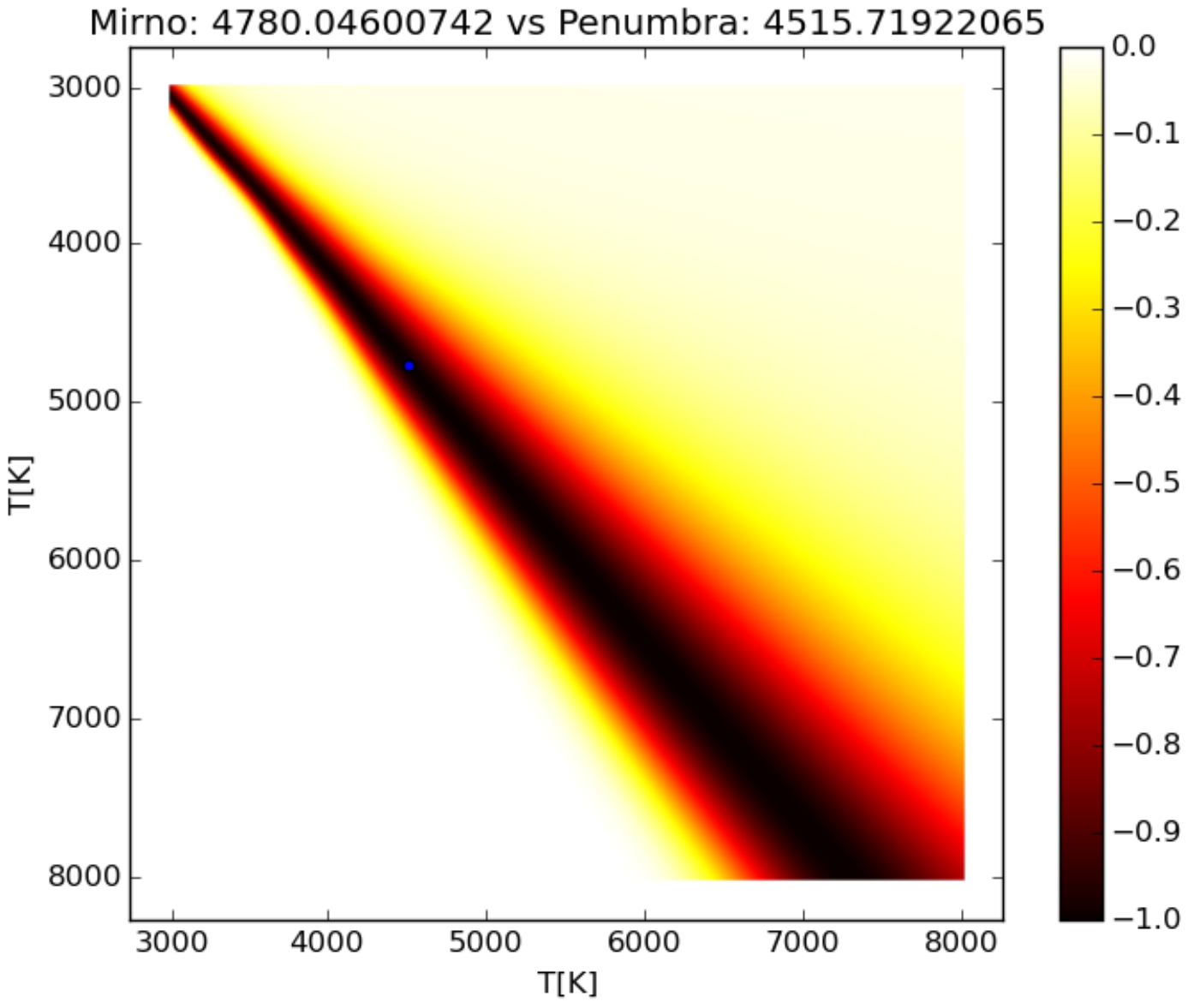
Ok, i?


Mirno: 5417.933714 vs Umbra: 3920.18678355
3000
4000
5000
6000
7000
8000
T[K]
3000
4000
5000
6000
7000
8000
T[K]
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9

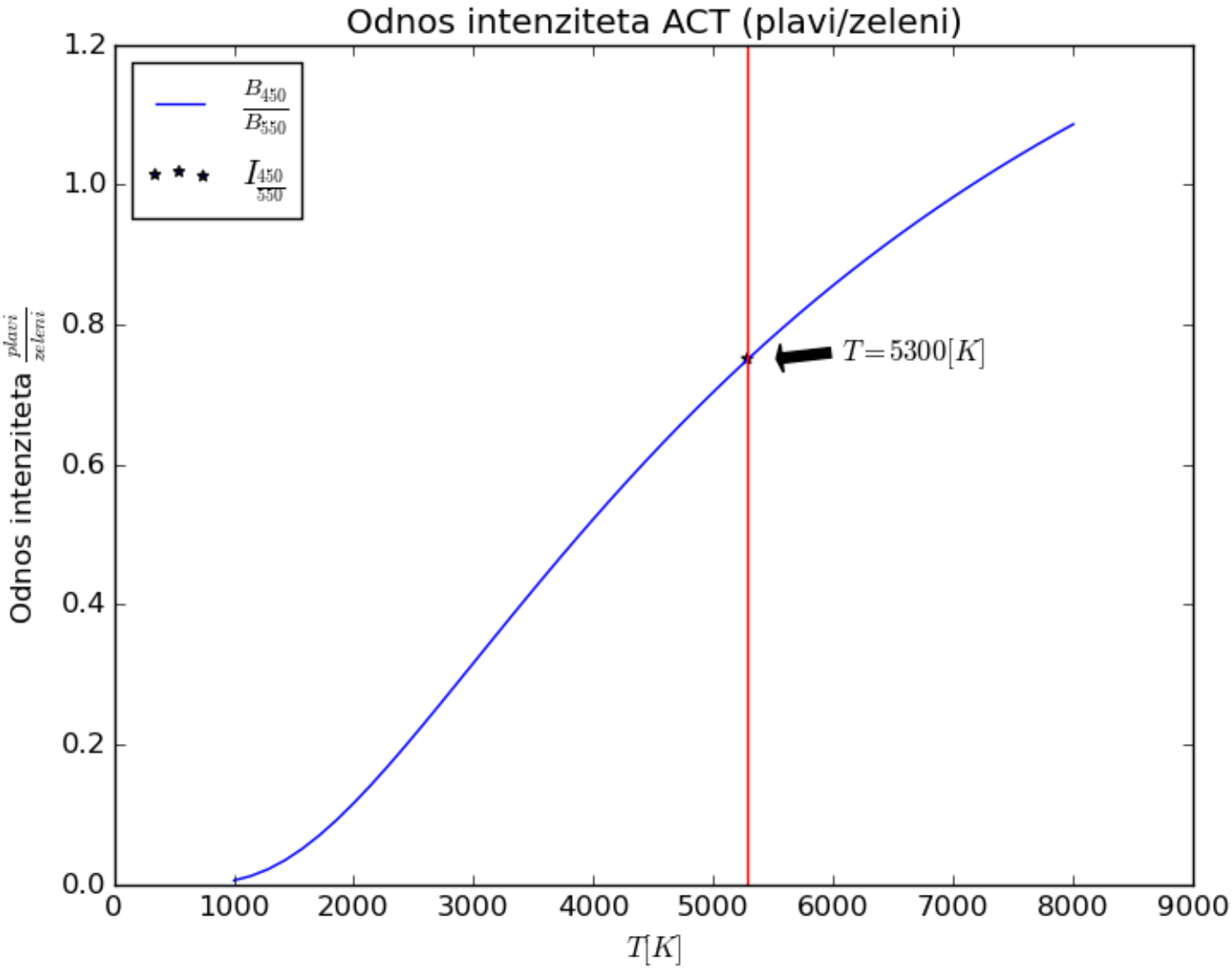
A ovo malo tamnije?



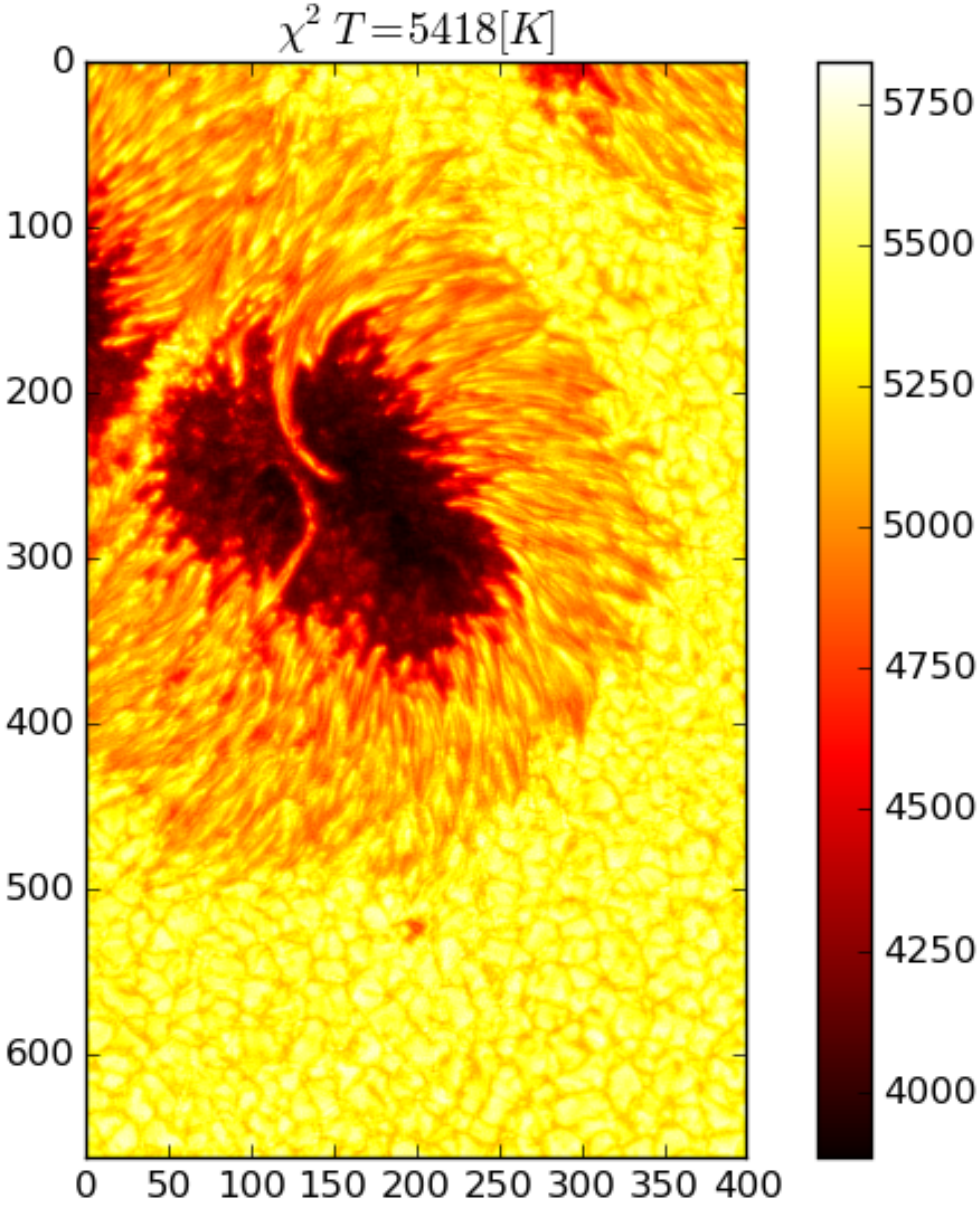
A šta sad sa ovim?



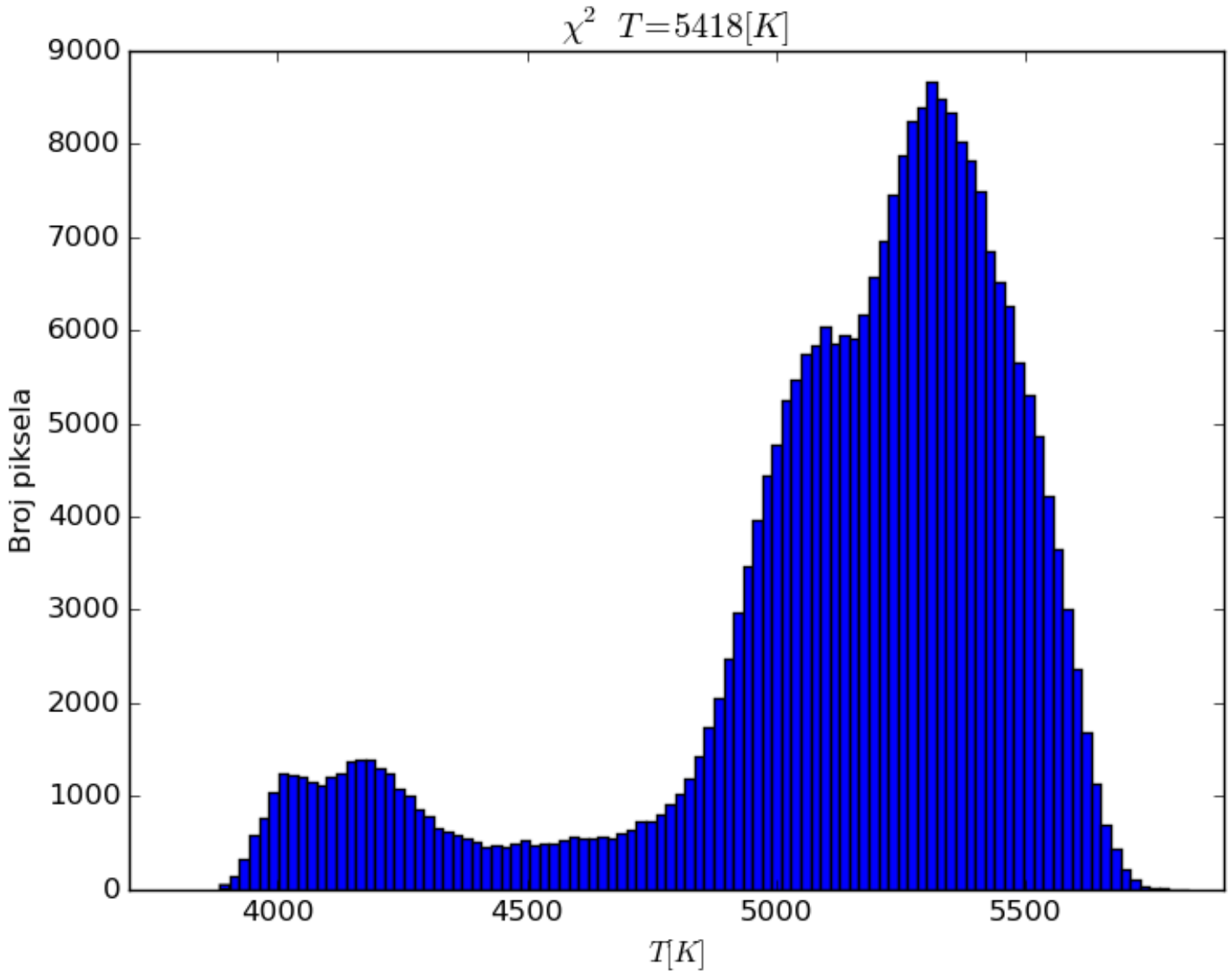
A kako zapravo ljudi rade?



Heatmap


χ^2 T=5418[K]
0
100
200
300
400
500
600
0 50 100 150 200 250 300 350 400
5750
5500
5250
5000
4750
4500
4250
4000

Histogram


χ^2 $T=5418[K]$
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Broj piksela
4000
4500
5000
5500
$T[K]$

I šta sad još može da se radi?

- Evolucija srednje temperature u penumbri
- Da li $\vec{B}$ utiče na T_{sr}
- Svašta nešto....