# The Dados Spectrograph with a 1200 l/mm grating

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This article describes some improvements of the Dados spectrograph based on using a new 1200 l/mm grating. For the purpose of using the grating with 1200 l/mm a new special grating holder had to be made. Because the resulting spectra have higher resolution and higher dispersion than the spectra acquired with the standard 200 l/mm and 900 l/mm gratings a new neon calibration unit had to be made. The original neon calibration lamp assumes that the spectrograph is taken down from a telescope so that the calibration spectrum could be acquired after connecting the lamp to the 2" nosepiece. This caused problems with the accuracy of calibration that were highly pronounced with the 1200 l/mm grating. The new solution of the neon calibrator allows accurate nonlinear calibration without having to move the spectrograph.(Fig.2) Because the spectrum of neon does not have enough usable calibration lines in the green and blue spectral regions it was necessary to find yet another calibration source. A test proved that a small Xenon tube used in photographic flash units provides a number of stable lines in the blue and green regions of the spectrum which are suitable for calibration purposes. The Xenon tube is powered from the inverter for CCF lamps as described below.

Fig.1: 1200 l/mm grating in its holder

Fig.2: The Neon calibration unit in a holder that can be easily pulled out or inserted in the ring attached to the Dados.

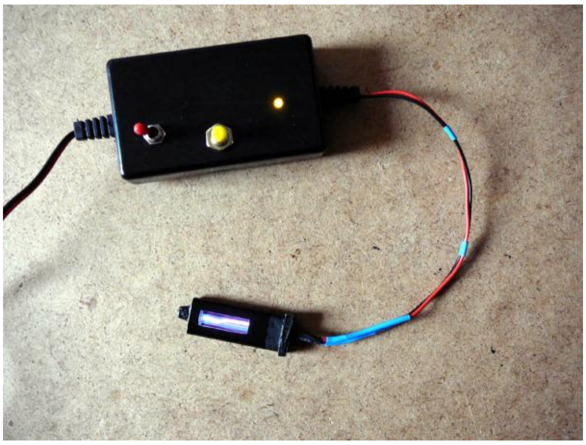

Fig.3: The Xenon calibration tube. The tube is mounted in the holder that has the same shape as the holder of the Neon glow lamp above. Thus it can be easily inserted in the ring just like the glow lamp holder.

## Xenon calibration tube

The Dados with the 1200 l/mm grating was tested acquiring a spectrum of the blue-green region of the Sun. Calibration was done using the Xenon tube shown on the Fig.3 above. The telescope was aimed very near to the Solar disc. Meade 8" ACF OTA, IS DMK31 camera. Just for safety reasons the inverter for the Xenon tube was equipped with the timer which automatically switches the unit off after 60 seconds.

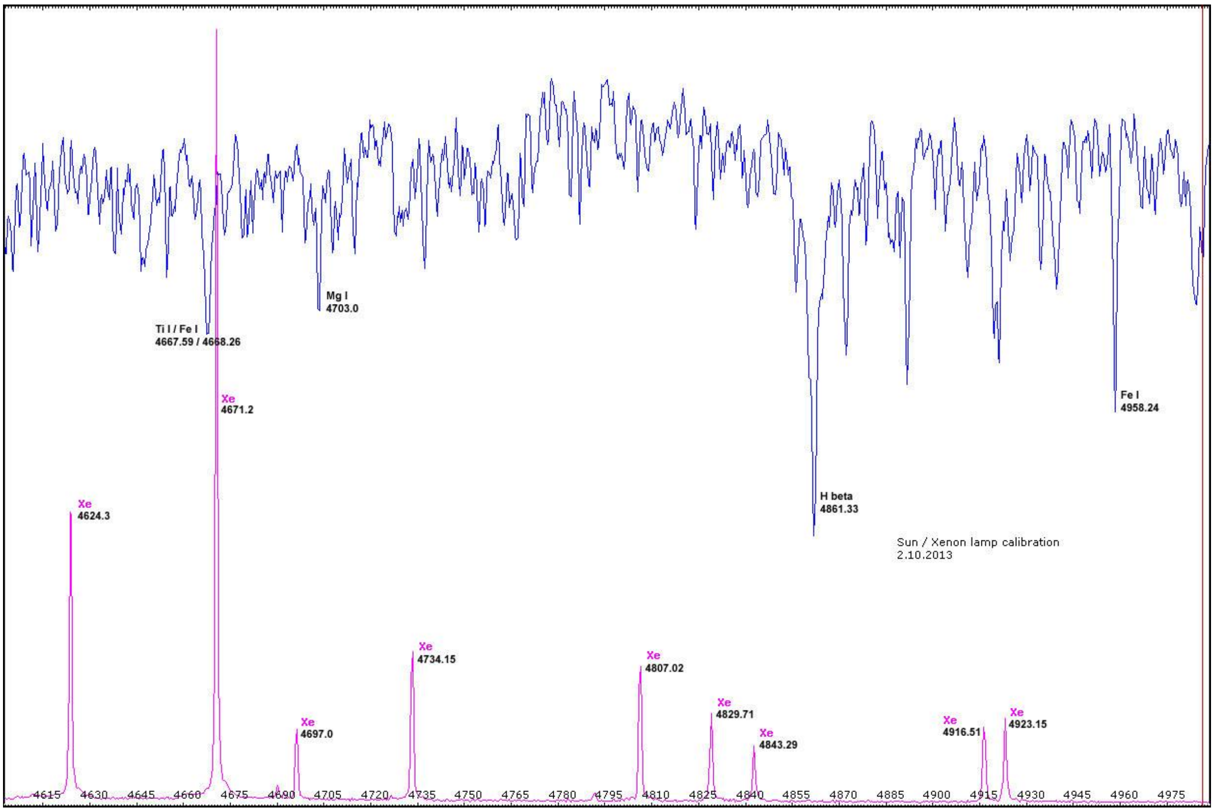


Fig.5: The blue-green region of the solar spectrum calibrated with the Xenon tube


Fig.6: The inverter with timer for the Xenon calibration tube

## In the observatory

The exposure time of stars with apparent magnitude of about mag=1.0 while taking a spectrum of the H-alpha region with the 1200 l/mm grating was about 23 seconds. Therefore the guide camera inserted in the slit viewer was used.
The Dados must be coupled to the telescope using the T-2 adapter. The 2“nosepiece is much less rigid and thus too flexible. Slight relative movements between the spectrograph and the telescope cause inaccuracies in the spectral images and problems with accurate calibration.
The images of star spectra are always accompanied by the images of calibration lamp spectrum taken before and after the star spectrum exposure and by the dark images to get a hot pixels map. The image of spectrum is then cropped and preprocessed in IRIS program for hot pixels deduction and consequently processed using VisualSpec program.

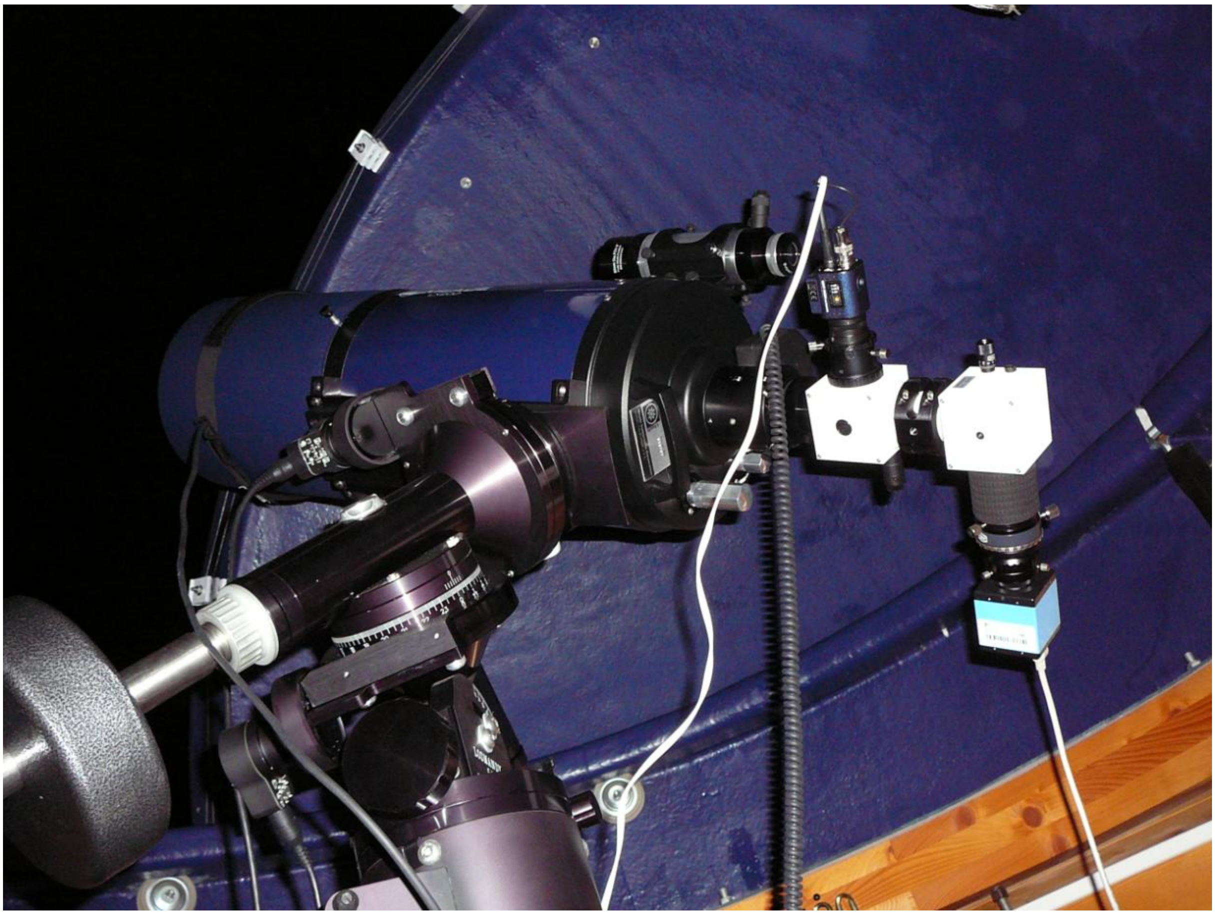

Fig.4: The Dados attached to the Meade 8“ ACF OTA with a guide camera in the slit viewer

## Radial velocities

A more sophisticated task was to measure relative radial velocities of the stars with a measurable red shift. The three suitable stars I chose were αAur, αTau and αOri. All the three are fairly close together in the sky. A direction of the velocity vector of the Earth´s heliocentric motion relative to the three stars is very similar and for the purpose of the task can thus be omitted. The goal was to measure the relative radial velocities of these three stars with respect to the Earth. I acquired spectral profiles of αAur, αTau and αOri in the H-alpha region. The spectra were then processed and merged into a single graph. No calibration was done. I only compared the position of H-alfa line of the three stars to get Δλ. Of the known dispersion for the Dados with 1200 l/mm grating and the DMK31 camera for H-alpha, which was 0.399 Å/px it was then just a pure mathematics to compute $\Delta v_r$. (Fig.7)

$$\Delta \mathbf{v_r} = \mathbf{c(\Delta\lambda / \lambda)}$$

c = 299792 km/s  λ = 6562.852 Å

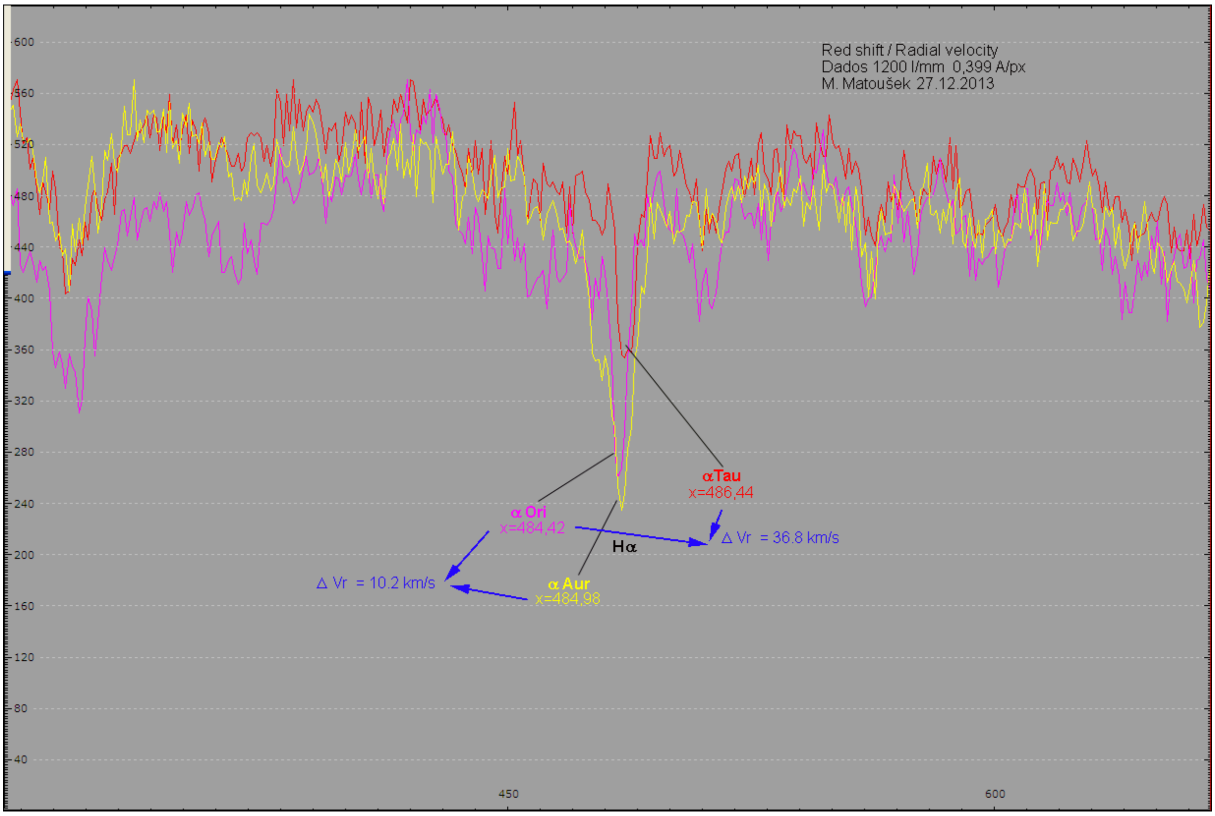


Fig.7: Relative radial velocities of αAur, αTau, αOri with respect to the Earth

To obtain the absolute value of the relative velocity the spectrogram has to be calibrated using a spectral calibration lamp.(Fig.8) The neon calibration unit described above has seven applicable lines in the region of interest. It is enough for accurate nonlinear calibration. Nonlinear calibration is necessary because the dispersion is a function of wavelength and it varies significantly in the spectrogram width, especially when the 1200 l /mm grating is used. I chose Aldebaran, the star which has quite a high radial velocity.The value of computed heliocentric correction was applied by VisualSpec program. It calculates the velocity vector of the Earth in the direction to Aldebaran. The $v_r$ of Aldebaran was then calculated on the basis of the corrected red shift of H-alpha line and the result was 54,4km/s. This corresponds well to reality.

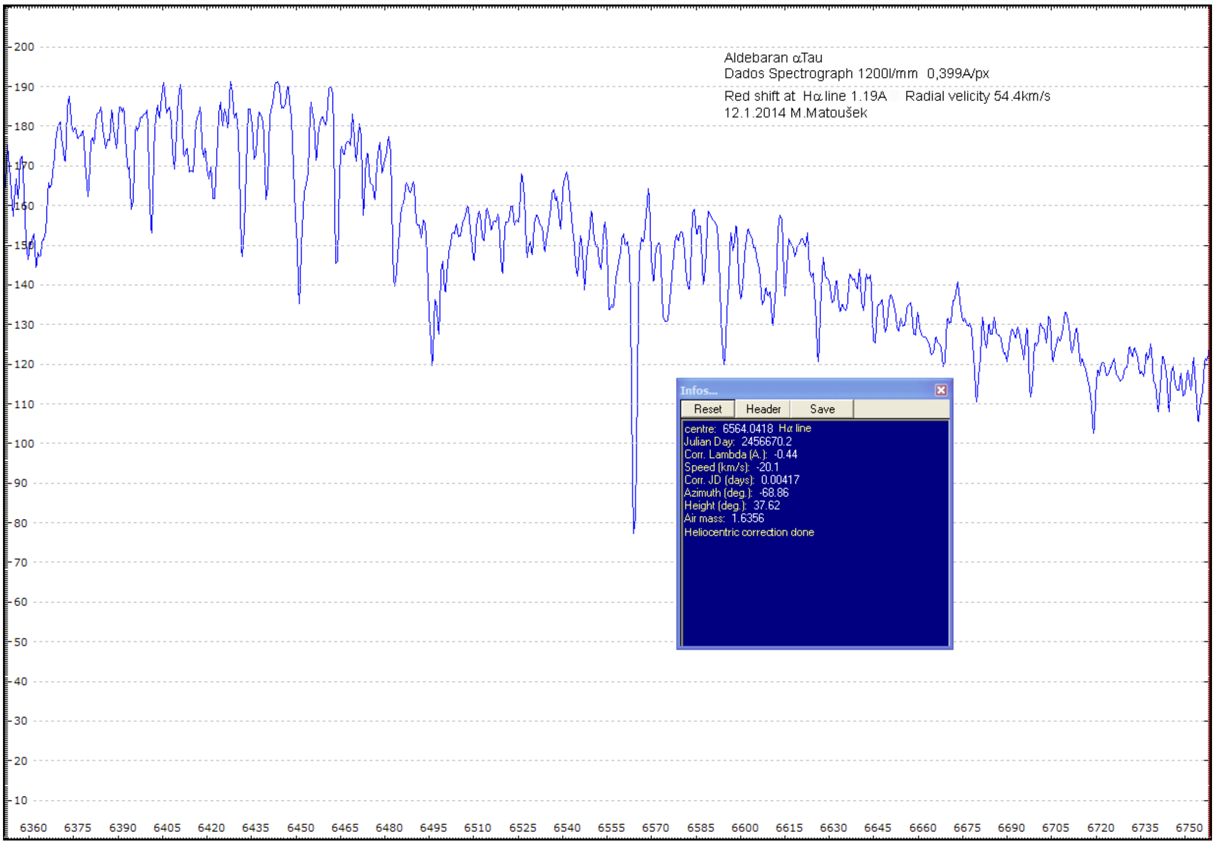


Fig.8: The radial velocity of αTau (Aldebaran)

Fig.9: A rough spectrum of Aldebaran as it comes from the camera.(cropped). Meade 8" ACF OTA, 27sec. exp., IS DMK31 camera.

## Conclusion

The Dados spectrograph with the 1200 l/mm grating is capable to handle very interesting tasks including radial velocity measurements and can compete with much more expensive devices.

Measured resolution (R) with the 1200 l/mm grating at λ 656 nm and 25μm slit and 4,65μm pixel =16000

Dispersion at λ 500 nm = 7.95 nm/mm

Bibliography:

1. Instruction manual for the Dados Spectrograph
2. Richard Walker: Spectroscopic Atlas for Amateur Astronomers
3. Jeffrey L. Hopkins: Using Commerial Amateur Astronomical Spectrographs