



Technical Report

Adjustment of the Goodman spectrograph 600 old grating

04 March 2020

César Briceño, Nicole David & Sergio Pizarro

Motivation

For some time now the 600 old grating has produced spectra with significant inclination along the dispersion direction (~ 105 pixels over the 4100 pixel length of the detector, or 2.5%), and moreover, the illuminated region of interest on the detector was shifted all the way to the upper part of the detector, possibly cutting off part of the spatial extent of the long slit. The inclination alone was sufficient to prevent the Goodman spectroscopic pipeline¹ from being able to extract the 2-D spectrum.

In Figure 1 at right we show the grating before being intervened. As can be seen, the grating is mostly square within the holder, with about 1mm clearance on 3 sides, except at the top, where it is flush with the edge of the holder. Not visible in the image are four set screws with nylon tips in the holder frame, that allow adjustment of the grating position within the holder. Two screws on the left side, one at the top and one at the bottom. A bronze leaf spring located in the inner right side of the holder frame (not visible in this image), helps maintain the glass substrate of the VPH grating pressed against the four set screws.

In Figure 2 we show a spectrum of the $V=6.7$ mag HD 60753 spectrophotometric standard star obtained the night of Feb 12, 2020 with the 600_old grating in its MID mode, which spans the wavelength range 435-702nm. We used the Spectroscopic 2x2 mode (2070x948 pixels, 2x2 binning) and 1 arcsec wide long slit.

The inclination is obvious at a glance. There is a 51 binned pixel difference in the vertical position between the right and left end of the spectrum. This translates into 102 native pixels across the 4088 pixel length of the unbinned spectrum (2044 binned pixels). This 2.5% inclination poses a problem for the extraction routine of the spectroscopic pipeline, but most important it also complicates unnecessarily the background subtraction. Finally, this inclination also means that the upper part of the red end (right part) of the 2-D image is falling off the detector. This can be better seen the the HgArNe comparison lamp spectrum shown below in Figure 3.

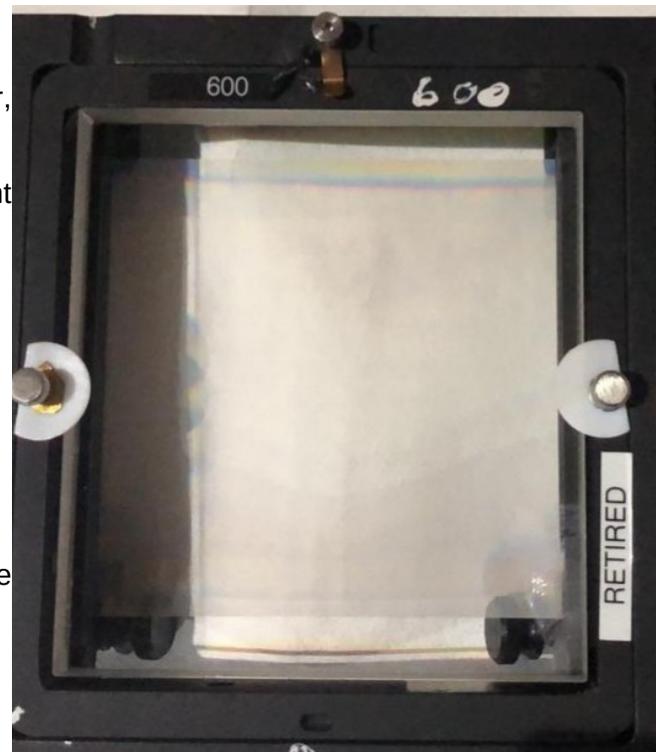


Figure 1: 600_old grating in its holder before any adjustments



Figure 2: Spectrum of the standard star HD 60753 obtained on Feb 12, 2020 with the 600_old grating, 2x2 binning, 1" long slit and MID setup (435-702nm). The grating was in its previous position within the holder, as shown in Figure 1. The vertical difference between both ends of the spectrum is 51 pixels, equivalent to 2.5%.



Figure 3: Spectrum of a HgArNe comparison lamp taken with same setup as that of Figure 2 above. The spectral lines toward the red (right) are cutoff as the image of the spectrum falls off the upper part of the detector.



Fix and Results

In order to correct the inclination of the spectrum we went to SOAR on Feb 27, 2020 to try to improve the horizontal alignment of the spectra, by adjusting the 600 old grating within its holder. We adjusted the set screws on the left side of the grating holder frame, and the screw in the upper part. After each adjustment we obtained images of a quartz lamp spectrum to check for inclination. After three iterations we reached the limit of how far the grating glass substrate could be adjusted within the holder. We show the final position in Figures 4 and 5.

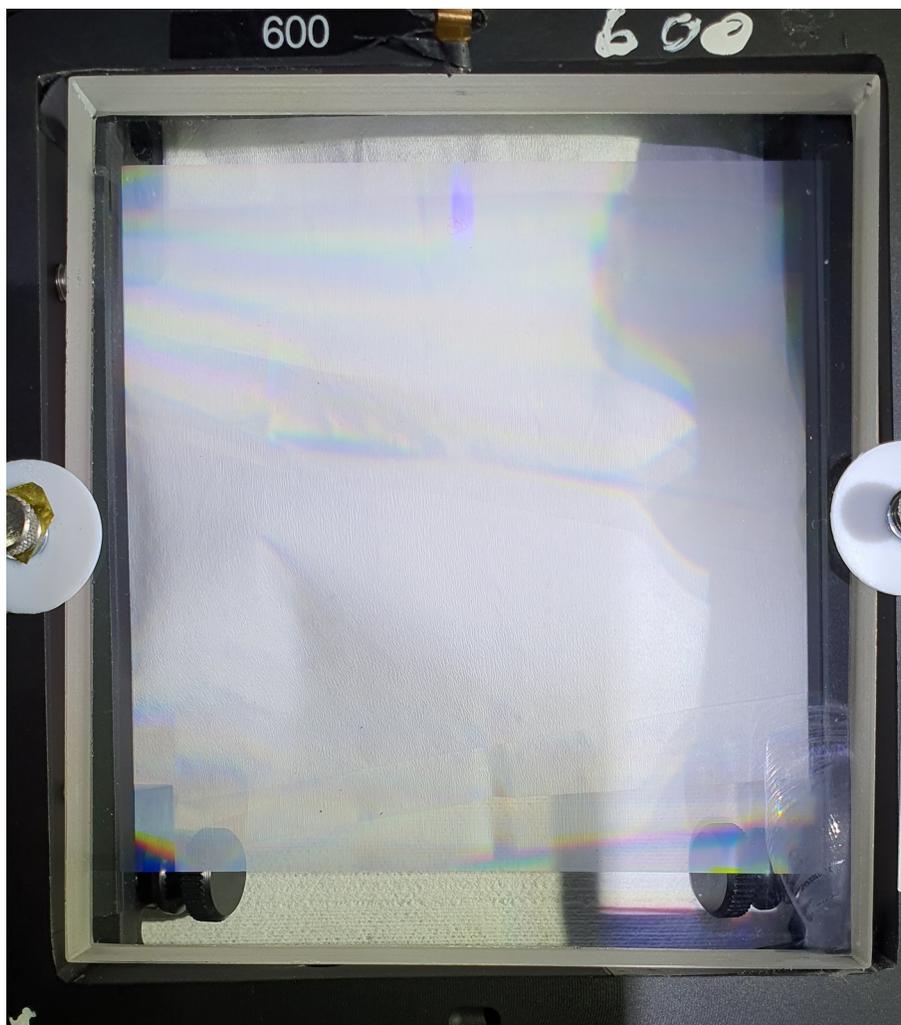


Figure 4: 600_old grating in its holder after the final adjustments. The clockwise inclination of the grating is clearly seen. No more rotation can be applied because the glass is touching the lower right and upper corners of the frame holder.

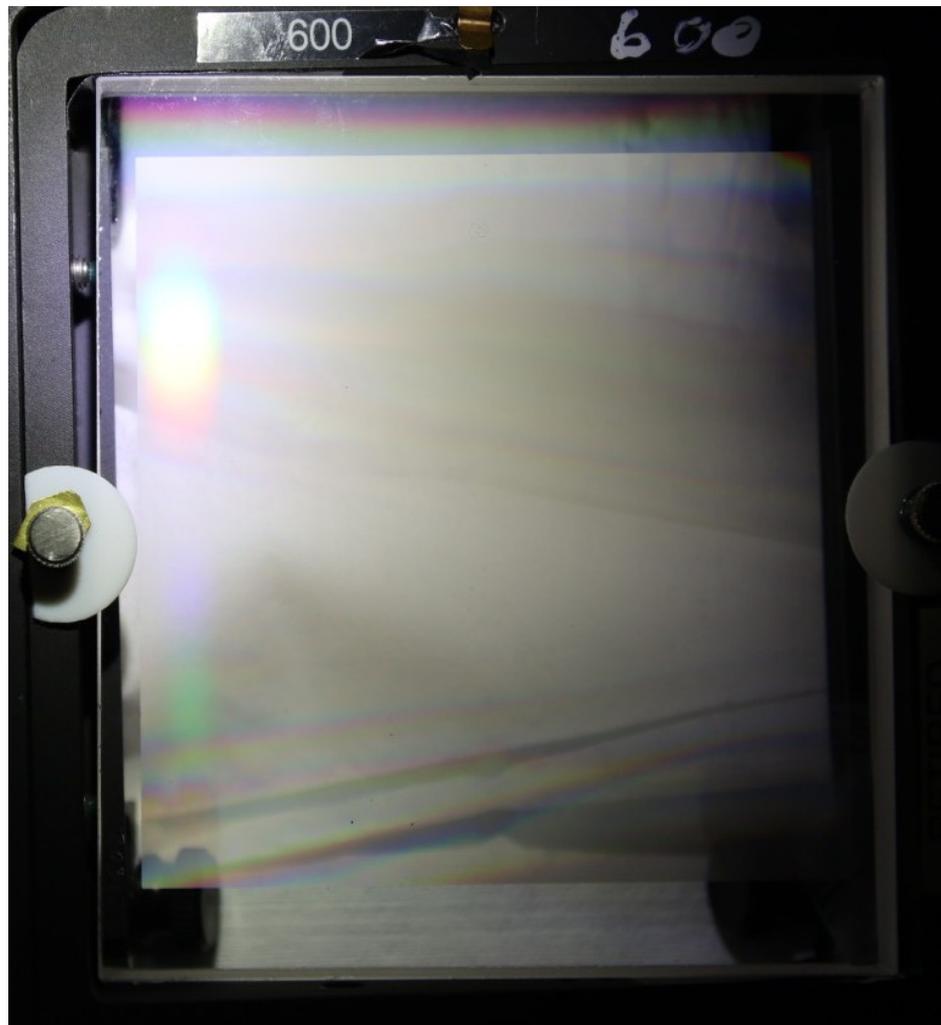


Figure 5: Another view of the 600_olD grating after adjustments had been finalized. The nylon-tipped adjustment set screw on the upper left side of the frame holder is clearly visible, pressing against the glass.

At the position reached in Figures 4 and 5 we measured a vertical difference of 15 binned pixels (30 unbinned pixels) between the left and right end of the spectrum of the same standard star HD 60753. The new observation was obtained on the night of March 1, 2020, and is shown in Figure 6. This is an improvement of a factor 3.4 times in the inclination of the spectrum. On the same night we verified that the live version of the Goodman spectroscopic pipeline is now able to automatically reduce the spectra from the 600_olD grating, with no manual intervention, just using the default parameters.



NSF's National Optical-Infrared
Astronomy Research Laboratory

As a possible future improvement we think a new grating holder could be fabricated at the CTIO Instrument Shop incorporating an inner frame with the appropriate clockwise inclination, so that we can achieve a completely horizontal spectrum, and have it better centered vertically on the detector.

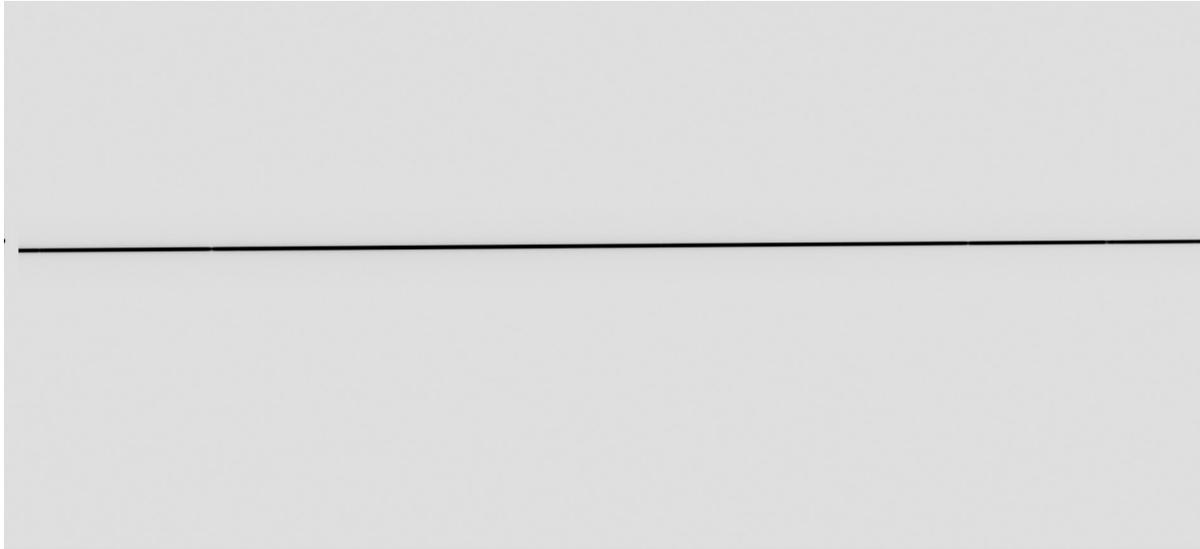


Figure 6: 600_old grating spectrum of the star HD 60753 obtained on 01 Mar 2020 with the same setup as that of Figure 2, after adjusting the tilt of the grating within the frame holder, as shown in Figures 4 and 5. The inclination of the spectrum is noticeably smaller, having diminished from the 2.5% value in Figure 2 to 0.7%.

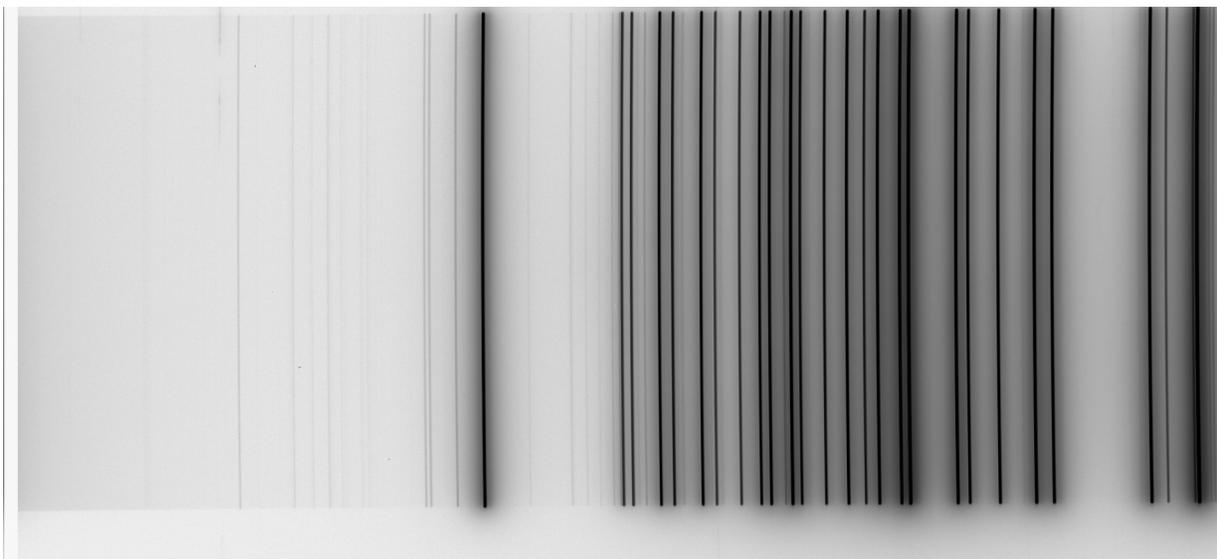


Figure 7: 600_old grating HgArNe comparison spectrum obtained on 01 Mar 2020 with the same setup as in Figure 6. Because the spectrum is now both more horizontal and better centered in the vertical direction, it is entirely spanned by the detector, even at the upper right edge.