

SL IO Correct

Applying a correction to the SL orders based on inter-order light.

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In the process of reducing spectral mapping data for M101, we have come across a peculiar disparity between the Short Low One(SL1) and Short Low Two(SL2) spectral orders. For select regions of our sample SL2 would remain low as it approached the SL1 and SL2 intersection, occasionally hitting negative values, resulting in a large mis-match between the two spectra (figure 1). Attempts to apply a simple scaling factor or additive offset resulted in unrealistic data and thus prompted us to seek available alternatives.

Having been aware of the DARKSETTLE routine available through the SCC and Karin Sandstrom's investigation of this very same issue, we began analyzing the off-order light present between the module orders. After some careful visualization, we came to realize that this inter-order light (IO light) not only possessed noticeable spatial structure within the BCD, but varied from BCD to BCD as well. Figure 2 shows the average intensity of this IO light in two regions, one placed between the SL1 and SL3 orders (blue) and the other between SL1 and SL2 (red). The upper inset image illustrates the BCD and row averaged inter-order light. The green vertical bars represent the divisions between different AORS within the data. Although the mean of the entire inter-order light between SL1 and SL2 is stable and lies near zero (purple line), the highly anti-correlated variations seen in IO light measured separately in the upper and lower halves of the array (red and cyan) clearly demonstrate a time-varying, row-based sloping signal. By presuming these variations affects on-order data row by row, we can fit and remove it.

In order to properly account for these features revealed in figure 2, we chose to perform a box-car average over both BCD and BCD-row space, utilizing all pixels between column index 33 and 45 defined as 'off order' as per the flatfield cmask. We specifically avoid off-order pixels closer to the Peak-Up arrays, which have been substantially affected by stray-light and its removal. For each row in each BCD, this resulted in an approximately 5 pixel x 5 row x 5 BCD cube of pixels on which we performed a robust sigma-trimmed average. We recreated a 128x128 'BCD' image by dividing this row-average by the flat-field corresponding to the order in question. The resulting image was then subtracted off of the original BCD and the entire process was iterated over all of the BCDs present in the cube.

The results are an obvious improvement over the uncorrected data. Figure 3 shows

that SL2 now properly matches up with SL1. The overall agreement between the two orders is greatly improved as demonstrated in figure 4. After the correction, the majority of our regions have mismatches less than 20 percent with only a handful of outliers (most of which are in areas where the flux is less than five times the uncertainty). In addition, this correction seems to introduce no significant level of additional uncertainty to our data based on analysis of the noise present in SL1 between 9-10.2 μ m as shown in figure 5.

For documentation on how to use `sl_io_correct`, please consult the header of the procedure. Please note, the visualization option present within `sl_io_correct` requires the Coyote Graphics System, by David Fanning, be part of your IDL path. This tool is designed to work in conjunction with Cubism, by J.D. Smith.

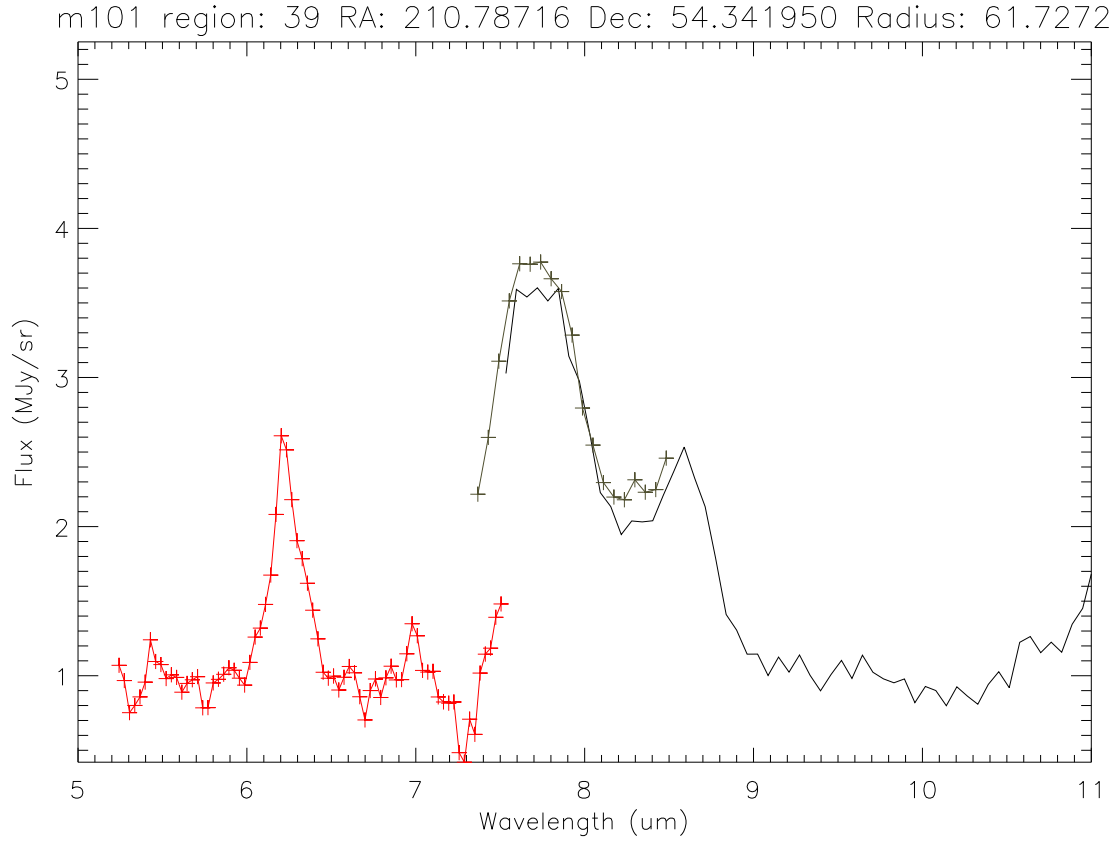


Fig. 1.— Sample spectra taken from data illustrating the mismatch between the IRS short-low two (left) and short-low one (right). Short-low three (middle) is included to demonstrate that short-low two is at fault.

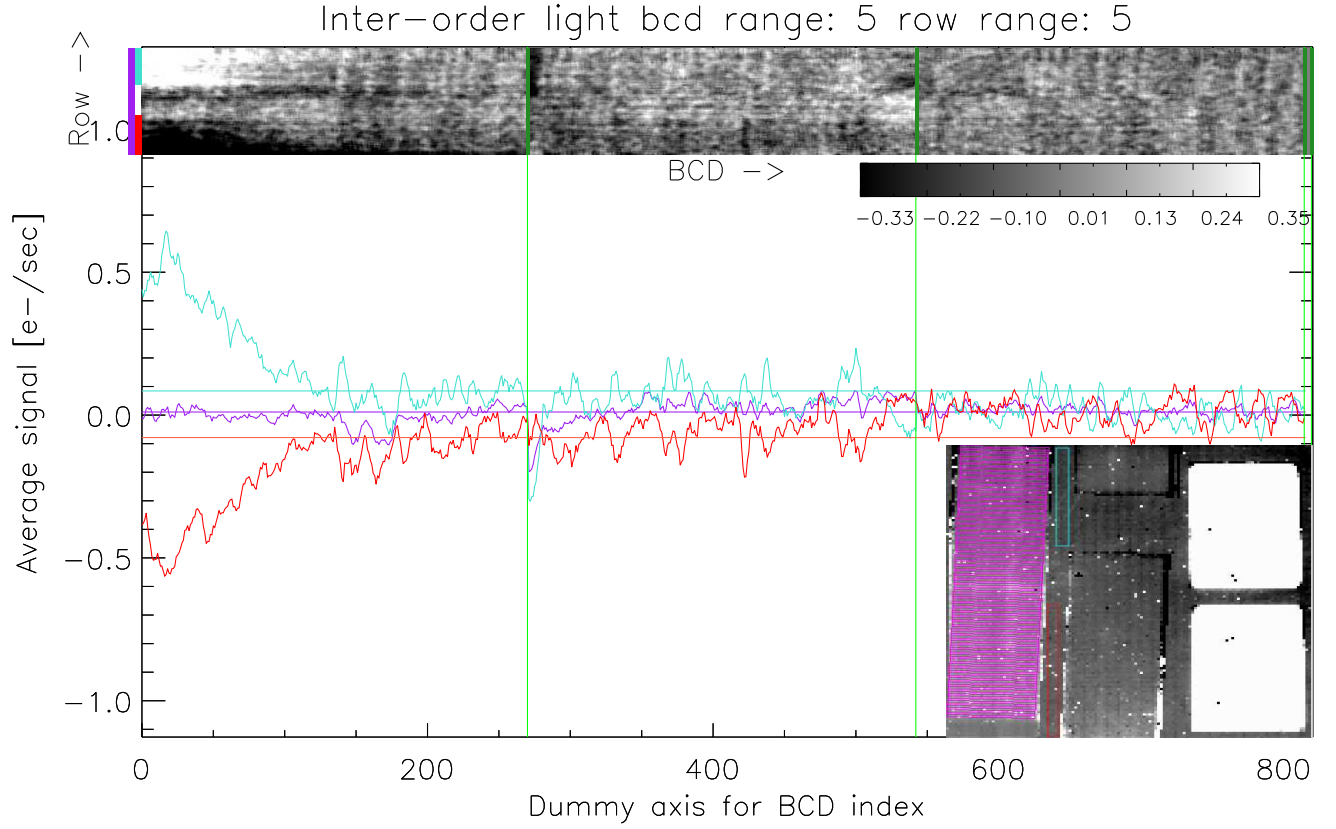


Fig. 2.— Visualization of the inter-order light, averaged over 5 BCDs and 5 rows, found in this dataset. The inset images display the regions averaged over to create this plot (bottom) and the resulting spatial and temporal structure found in the inter-order light (top). The color-coded regions correspond to the sections of the inter-order column that were averaged over in order to create the plot. The green vertical bars represent the boundaries of each of the AORs present in the data set.

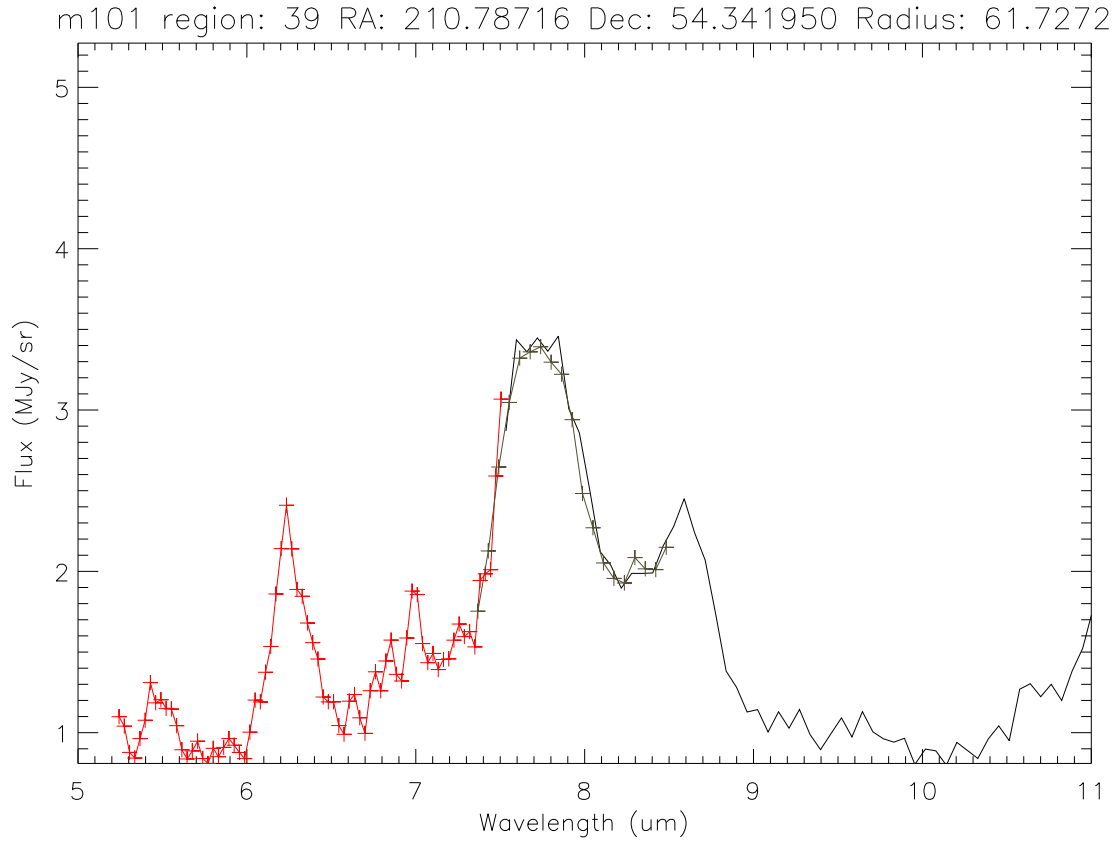


Fig. 3.— Sample spectra taken from the same region as in figure 1 after the IO correction has been applied.

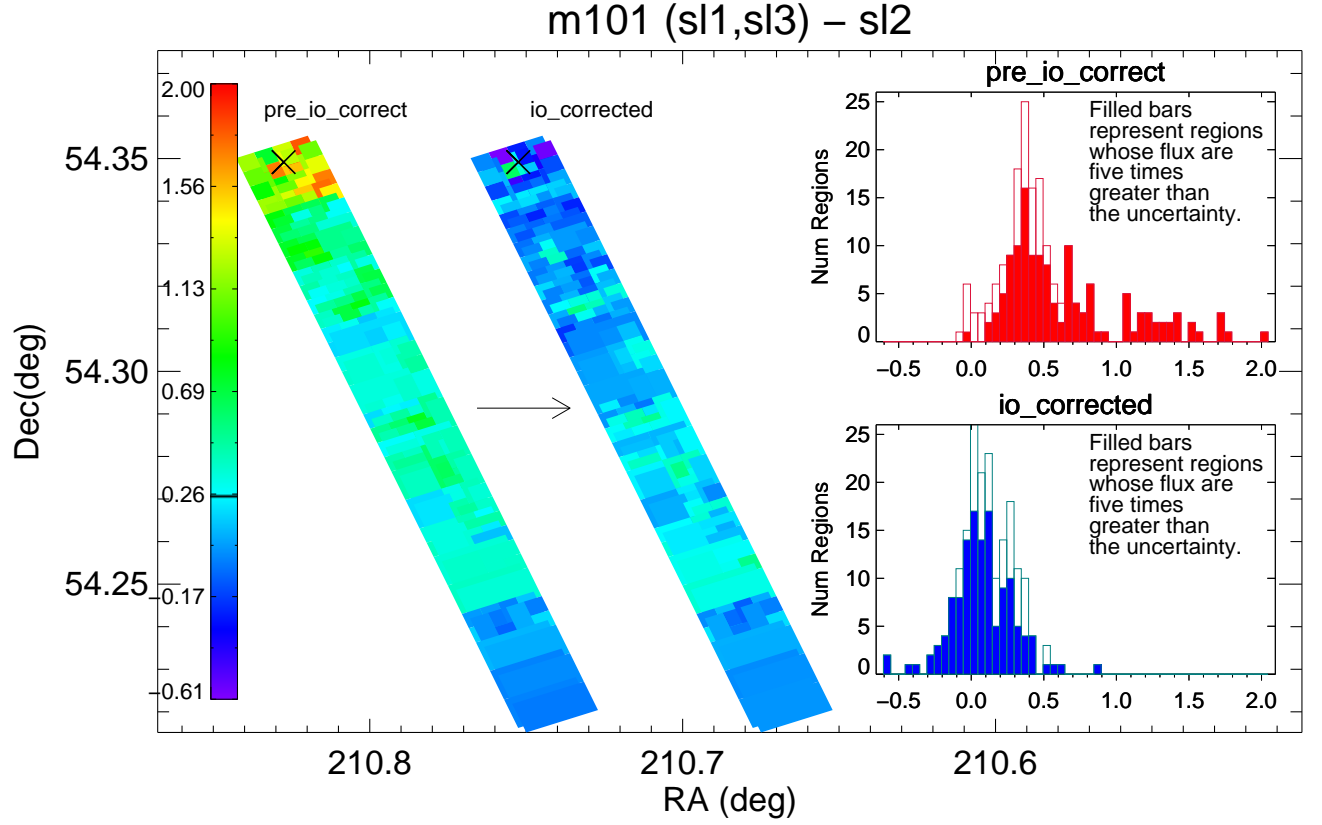


Fig. 4.— Before and after representation of the results of SL IO correct. Over one hundred regions were created using our M101 dataset and the difference between the smoothed-mean flux of the SL1+SL3 and SL2 spectra was calculated for each. The difference between the two spectral orders is seen to decrease both in the visual map but also in a histogram inset of before(top) and after(bottom).

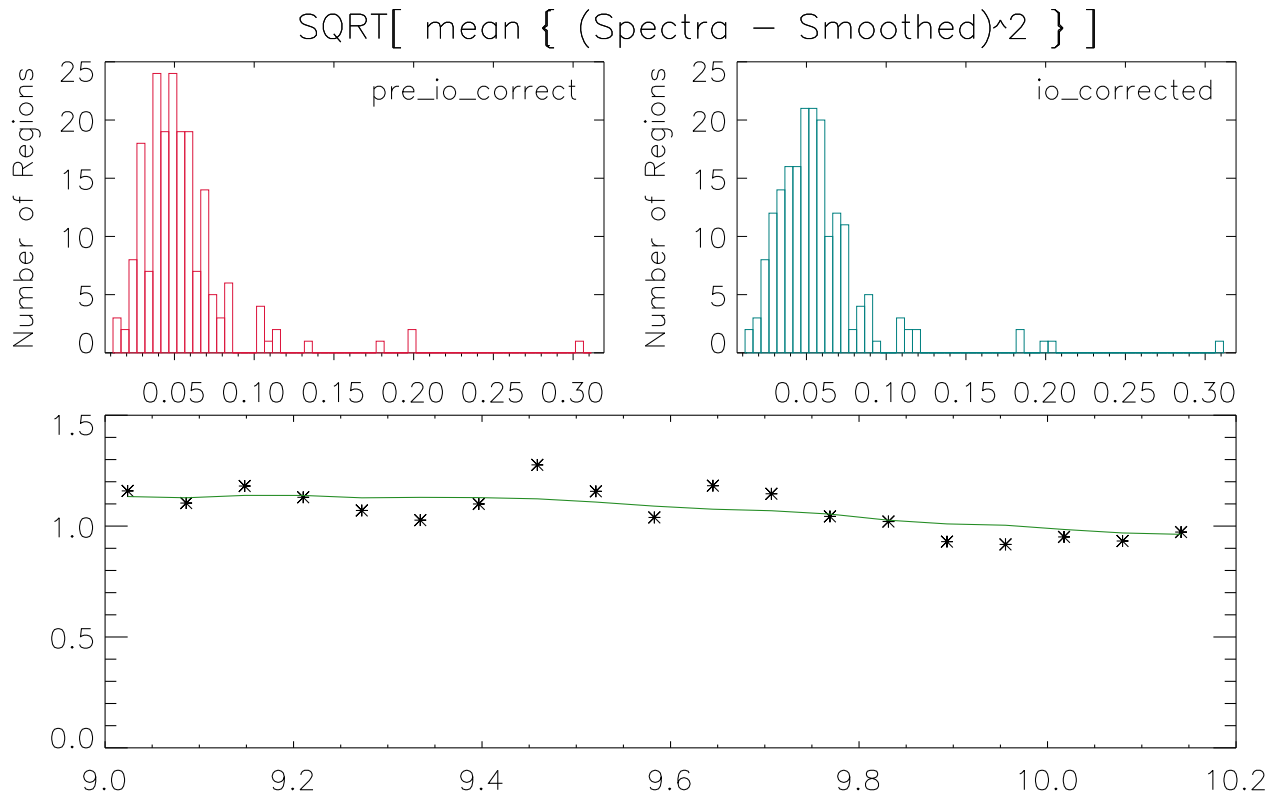


Fig. 5.— TOP: Histogram comparison of average level of noise as derived from the residuals of a smoothed fitting function present in data before and after correction. BOTTOM: Sample section of spectra with smoothed reference line, plotted over the wavelengths used to generate the noise histograms.