Achieving light tightness at the INT PF camera

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Abstract

The light tightness of the INT PF camera is assessed by studying the ability of twilight sky exposures to flatfield images taken through one of the 40 Å-passband redshifted Hα filters available at the ING. Large-scale variations of the sky level in the flat-fielded images amount to less than 0.5% of the sky level over the entire chip. Such flat-fielding quality is impressive as compared to the poor results normal in recent years (2-10% errors), and indicate that the redesign of the filter wheel unit in the spring of 1995 has been successful in providing light tightness. The INT PF unit is now suitable for narrow-band imaging of moderate-to-high quality. I point out a number of details the observer should be aware of when preparing his observations.

1 Introduction

One of the main problems for the INT to become the prime imaging telescope of the ING has long been the difficulty to produce flat-fielded narrow-band images. In the years from 1991 to 1994, observers including van der Hulst, Rand and McNamara (Groningen) found that Hα exposures showed strong edge-effects which would not flat-field with twilight flat-field images. Deviatons from flatness were over 10%, making the narrow-band data virtually useless. Cepa (IAC–U. La Laguna) had noted similar problems.

Broad-band data was not free of problems either during the same years, with flat-fielding errors being in the range 1–2%, as compared to ~ 0.2 % in

June 1990 (Balcells & Peletier 1994, AJ, 107, 135). The deterioration seemed to occur at the time of the installation of a bigger shutter to accomodate the 10 arcmin-class EEV and TEK CCDs.

Finding the exact cause of the problem was not straightforward, although van der Hulst had noted that masking the filter edges with black tape improved the quality of the flat fields, which pointed to a light leak problem at the filter wheel. The filter wheel unit of the INT PF was redesigned in the spring of 1995. In this Note I report on the results of flat-fielding of Hα images taken in December 1995. I find that flat-fielding on large scales is better than 0.5%, using simple twilight exposures.

2 Measurements

Two images of a galaxy were taken with the $\lambda\lambda$6655(40) redshifted Hα filter in a moonless night. Two morning twilight exposures were taken. All frames were bias subtracted, the flat field exposures were combined with outlier rejection, and the resulting frame was divided into each of the object exposures. The latter were finally combined with outlier rejection. The resulting image has a sky level of 245 ADU. It is shown in Fig. 1. The gray-scale levels in this figure are set such that black corresponds to 1-σ (6%) below the sky, white corresponds to 1-σ above sky. Clearly, the $\sim$ 10% errors of recent years are not present in this frame. Vertical and horizontal 50-pixel wide cuts in the sky areas of the frame give large-scale variations (peak-to-peak) of at most 0.5%.

Notes:

1. Plastic masks had been placed over the filter.

2. The entire back-side of the PF unit was thoroughly covered with a dark cloth. To what extent the dark cloth around the PF unit helped to make the unit light tight is unclear, as no tests were performed without the dark cloth.

3. Care was taken when placing the filter in the wheel that the mask covered completely the filter edges. Even the large masks built by the Mechanical Section in 1995 are capable of blocking incoming light but can let light through when not placed carefully. That this is the case

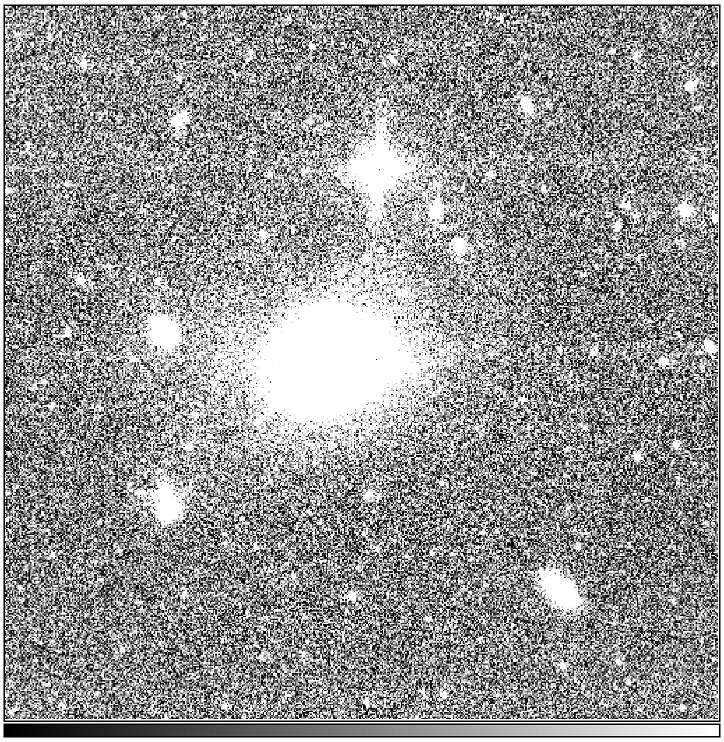

Figure 1: Gray-scale image of a flat-fielded frame taken with the $\lambda\lambda6655(40)$ redshifted Hα filter at the INT PF camera in december 1995. Black corresponds to 1-σ (6%) below the sky, white corresponds to 1-σ above sky.

could be seen by looking at the filter wheel at an angle against a bright light. When the masks were not well centered on the filters a luminous edge was visible. That resulted in additional illumination near the edges of flat field exposures which translated into flat-fielding errors.

3 Concluding remarks

It is encouraging that, after careful work on the PF unit, narrow band imaging can now be done successfully on the INT PF camera.

The redesign of the door to the PF filter wheel in the spring of 1995 has sure something to do with the improvement reported in this Note. In May 1995, the author found that twilight exposures flat-fielded R-band data to better than 0.4%, while, up to February 1995, twilight flat-fielding errors in R-band were in the range 1–2%.

But the recent history of poor performance should be taken as a deterrent againt taking system setup tasks lightly.

The experience gathered to date suggests the following:

- For the support staff:

  1. Build more plastic masks with edges that cover the sides of the filters, and of black mate material.
  2. Make SA's aware of the need for plastic masks on filter wheels, as well as the need for accurate centering of the masks over the filters to avoid oblique light reaching the CCD window.
  3. Encourage SA's to wrap the entire back of the PFCU in dark cloth. Rebuild the old "McCowage" INT dark cloth fitted with velcro stripes, otherwise provide sufficient black masking tape for thorough sealing of the unit.

- For the visiting observer:

  1. Ask the SA to show you the filter wheel and take a look for yourself. Check for mis-centered plastic masks and for bright edges when looking through the filters with the filter wheel placed at an angle against a dome light.

2. Insist that the back of the PFCU be wrapped with dark cloth.

These precautions are necessary for broad-band work as well, if the observer wants flat-fielding to be better than 1.5%. During two nights in May 1995, broad band R and B filters were placed on the INT PF filter wheel with masks. While the R images flatfielded to 0.4% using twilight exposures, the B images flatfielded to no better than 1.5%. Looking through the B filter placed in the filter wheel, at an angle against a a bright dome light, revealed a bright edge due to slight misplacement of the mask.