AN OPTICAL FIBER FEED FOR SMALL TELESCOPES

W.G. Weller, T.E. Ingerson
Cerro Tololo Interamerican Observatory
Casilla 603
La Serena, Chile

ABSTRACT. We have constructed an optical fiber link between the CTIO 1.5 meter telescope and the instrument development laboratory located in the 4 meter telescope building. We have successfully observed a variety of objects using the 4 meter échelle spectrograph fed with light from the 1.5 meter telescope. These first observations indicate that the system is extremely stable, both in its spectral response and in wavelength calibration. The principal aim of the project was to provide the capability of recording high resolution spectra at the 1.5 meter, using linear detectors. Even with the loss of light associated with the use of the fiber, a conservative estimate of the speed of the system indicates a factor of 20 increase in speed over the existing coudé spectrograph.

1. INTRODUCTION

Optical fibers have been used for multiple object spectroscopy (Hill, Angel and Scott, 1983) and as a pseudo-coudé feed (Gray, 1983). In the latter use, light is collected by the telescope and conducted to a remote location for analysis and recording. There are several advantages to be gained. Solidly mounted stationary instruments are not subject to flexure effects. Since they do not move with the telescope they can be built at a considerably reduced cost. The environment of such instruments can be controlled to eliminate changes in calibration caused by thermal variations. Also, and very important for radial velocity measurements, errors caused by variations in slit illumination caused by guiding errors, and misalignments of the comparison optics can be virtually eliminated.

There are also disadvantages. The most obvious of these is the loss of light at the fiber. This occurs almost entirely at the input to the fiber, and with care in matching can be reduced to acceptable levels. One also loses the capability of observing extended objects. This can be partially overcome by sampling the long slit with several fibers. Absolute spectrophotometry cannot be done using this type of technique.

J. B. Hearnshaw and P. L. Cottrell (eds.), Instrumentation and Research Programmes for Small Telescopes, 115–116.

2. THE EXPERIMENTAL SETUP

The fiber is positioned at the telescope end of the feed in an adaptor which resembles a standard CTIO photometer. The fiber projects through a mirror in the focal plane of the telescope. This mirror reflects the field into the optics of an ISIT television camera used for acquisition and guiding of the star image onto the fiber. The adaptor also contains a quartz envelope tungsten filament lamp and a Thorium-Argon hollow cathode lamp used as calibration sources.

At the spectrograph end of the feed the fiber is simply clamped in position at the focus of the collimator. This simple system will soon be replaced by a focal ratio matching lens.

The telescope and spectrograph controls are both located in the console room of the 1.5 meter telescope and the observer is not concerned that the spectrograph is located in another building.

3. THE FIBER

There are two important parameters to consider when selecting a fiber. The first of these is the spectral transmission. All-silica fibres are available with good transmission from the ultra violet to the infra-red. We have chosen to use Spectran type SG840. This is a step index fiber with core diameter of 200 microns. At the casegrain focus this translates to 4 arc seconds on the sky. All light in the stellar image is accepted by the fiber.

The second important parameter is the focal ratio degradation. We feed the fiber with an f13.5 beam, and find that the output focal ratio is f4.5. This over fills the spectrograph collimator, and our next improvement of the system will be the inclusion of focal ratio matching optics.

4. FIRST RESULTS

By intercomparing spectra of the Thorium-Argon lamp taken on different nights we have determined that the zero point of the wavelength calibration drifts by no more than .03A (1.3 km/sec at 6500A) from night to night. This was determined from only 23 spectral lines in 3 orders. This performance is expected to improve considerably as our data reduction techniques improve.

5. CONCLUSIONS

The échelle system and fiber feed have proven to be a factor of 20 faster than the existing coudé.

References:
Gray, P.M., 1983, SPIE v.374, p.160-164.
Hill, J.M., 1983, Prepr. Steward Obs. no. 445.

https://doi.org/10.1017/S007418090015123X Published online by Cambridge University Press