Bull. Astr. Soc. India (1998) **26**, 383-386

OMR spectrograph at Vainu Bappu Telescope, Kavalur

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Abstract. A new spectrograph has recently been put in operation at the Cassegrain focus of the 2.3m Vainu Bappu Telescope (VBT) at Kavalur. The spectrograph was designed and built by Optomechanics Research (OMR) Inc., Vail, Arizona, U.S.A. A choice of 4 gratings and 2 cameras permits a range of dispersions between 450Å mm^{-1} and 10Å mm^{-1}. All routine operations of the spectrograph can be performed from the control console located in the VBT control room and the required information is available to the control computer which can also precisely position the grating and compute the resolution achieved. Remote guiding is performed using a peltier-cooled CCD. It is possible to obtain spectra of 17 mag objects at 10Å resolution and 16 mag objects at 5Å resolution routinely.

1. Introduction

The information content of a spectrum of a celestial source is vastly higher than that of an image or a photometric datum. The constraints on sky conditions needed for obtaining differential spectrophotometric observations are, on the other hand, much less stringent. Typically spectroscopic nights are twice the number of photometric nights from any given site. Hence it is necessary for any astronomical observatory to make available efficient spectrographs affording different resolutions desired by different astrophysical programmes. The Vainu Bappu Observatory, Kavalur has a long tradition in equipping telescopes with spectrographs since the establishment of the observatory by the late Prof. Vainu Bappu. The Cassegrain focus of a telescope would normally house a versatile medium-resolution spectrograph that can permit a choice of dispersions based on the nature of the astrophysical problem and the brightness of the object being studied.

The 2.3m Vainu Bappu Telescope (VBT) at VBO, Kavalur, was initially equipped with a Boller & Chivens spectrograph acquired at a nominal cost from the Anglo-Australian Telescope (AAT), Siding Spring, Australia, as part of the Image Dissector Scanner decommissioned by the AAT. The spectrograph was known to be inefficient due to a variety of reasons, and there was further loss in efficiency since it was used at the *f*/13 Cassegrain focus of VBT whereas the basic design was *f*/15. A part of the inefficiency was alleviated by replacing the original gratings with new larger format gratings, and the original camera with a wider aperture camera.

The spectrograph has found productive years in the studies of novae, supernovae, planetary nebulae, post-AGB stars and interstellar bands, and is presently being converted into a spectropolarimeter.

A new state-of-the-art, efficient, medium-resolution CCD spectrograph was acquired recently from the Optomechanics Research Inc., Vail, Arizona, U.S.A. and was put in operation during the observing season of 1997.

2. The spectrograph

The spectrograph has a 25-mm long slit with a minimum width of 40μm and a maximum width of 950μm. The slit jaws are polished in order to help centring and guiding. The collimator is an off-axis paraboloid of focal length 1 m, clear aperture of 110 mm and tilt of 6°. There is a set of four manually interchangeable gratings available as listed in Table 1. Two cameras are available, both with a clear aperture of 100 mm. The short camera is a semi-solid folded Schmidt of effective focal length 150 mm and the long camera is a folded Schmidt of effective focal length 420 mm. The detector is Tektronix 1K CCD with 24μm pixels which is also being used for imaging at the VBT. The 2-pixel resolutions obtainable in the first order are listed in Table 1, the second order resolution being a factor of 2 better.

Table 1. Grating characteristics.

l/mm	Blaze Å	Resolution Short cam. Å	Long cam Å
150	5460	21.2	8.0
300	7620	10.6	4.0
600	7500	5.3	2.0
1200	7500	2.7	1.0

There is a six-position filter-wheel with a clear aperture and order separation filters: Corning 4-71, Schott BG37, BG,39, GG475, RG695. Two wavelength comparison sources (Fe-Ne and Fe-Ar Hollow Cathode sources) and one flat-field (Tungsten-Halogen Quartz lamp) are also available.

The centring of the objects on the slit and guiding on or off the slit is accomplished by a peltier-cooled Star I CCD with liquid circulator which can achieve an operating temperature of -40° C nominally. The CCD system obtained form Photometrics Ltd., Tucson, has a scientific grade Thomson TH7883 CCD chip of 23μm pixel size and 384 × 576 format. It can view a 2 arcmin × 3 arcmin field. The integration time can be varied from 0.1s to 9.9s using a menu displayed on the guide monitor and a mouse. It was possible to guide on 17 mag objects with a few seconds integration time during grey moon period.

3. Control console

The control console situated in the control room can remotely move the grating, select filters, focus the collimator as well as the guide CCD, select the calibration source, adjust the slit width

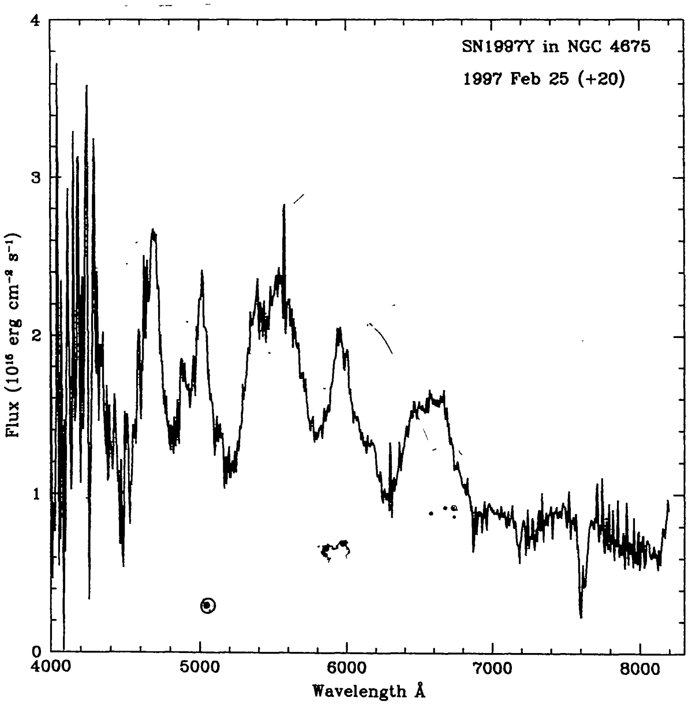

Figure 1. Spectrum of the supernova SN1997Y in NGC 4675, obtained 20 days past its maximum at a V magnitude of 16.0.

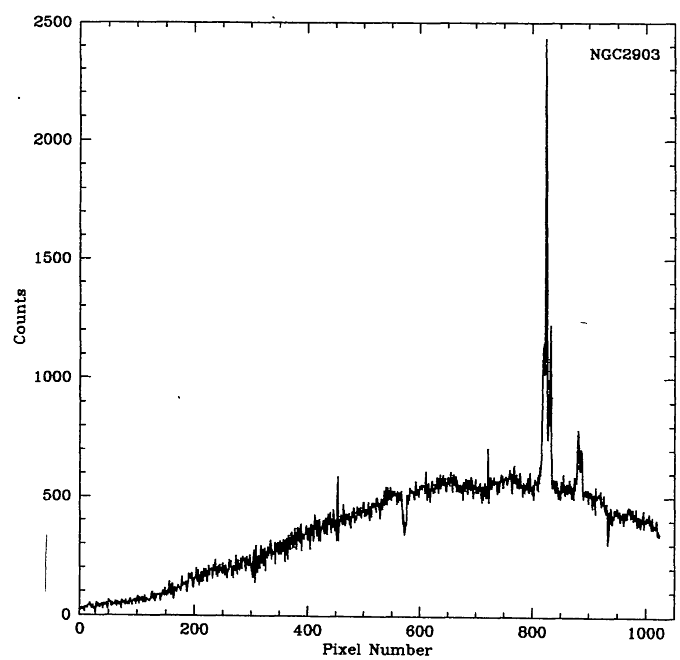

Figure 2. Spectrum of the nucleus of the strarburst galaxy NGC 2903. Note the emission lines of Hα, [N II] and [S II] as well as strong absorption of Na I D.

and move the dekker. The spectrograph shutter can either be opened from the control console, or using the CCD software package. All the relevant positions are displayed through potentiometric readout. There are also indicators on the source on/off, shutter open/close.

4. SPEC software

An add-on card in the control PC and SPEC software provide for setting the zero point of the grating position, and positioning of the grating with an accuracy of $0.^{\circ}045$. The computer can also sense the grating and camera in use, slit width, and compute dispersion and resolution. It displays the filter in use, advises on its suitability, source in use, slit width and resolution, collimator focus reading, central wavelength and dispersion.

5. Performance

Fig. 1 shows the spectrum of 16.0 mag supernova 1997Y (Anupama 1997: AJ in press) obtained with the 300 l/mm grating and 150 mm camera. The signal-to-noise ratio is about 15 limited largely by the bright moonlight which gave counts similar to the stellar spectrum. The spectrum of the nucleus of galaxy NGC 2903 obtained with the 600 l/mm grating and 150 mm camera with a 40 min exposure time is shown in Fig. 2. This was also recorded under similar conditions and reaches a signal-to-noise ratio of 25.

Acknowledgements

We are grateful to Prof. R. Cowsik for his enthusiastic support to the project. We thank the technical and observational staff at VBO for their untiring help during installation and testing.