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IUCAA 2 meter telescope and its first light instrument IFOSC

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Abstract. The various features of the IUCAA 2-meter telescope, its site parameters and considerations made for preserving the local seeing in terms of ventilation, thermal emissivity of the dome etc are described. The first light back-end instrument for this telescope, i.e. Iucaa Faint Object Spectrometer and Camera (IFOSC), too is described in some detail.

Keywords : Telescope – atmospheric seeing – spectrometer

1. Introduction

A 2-meter optical telescope is being set up on a hill near Godegaon (about 80 kms North of Pune). It is anticipated that it would be used for about 50% of the time by researchers from the University sector, and hence it would provide the University sector with an access to a fairly large telescope for astronomy in optical and near IR bands. The telescope will be fairly automated and operable with user friendly software to keep the ease of University sector's participation. The closeness of the site to IUCAA would help in maintaining the telescope with technical resources located at IUCAA, without having to go for large scale resources for this at the site.

The first light backend instrument for this telescope will be a faint object spectrometer and camera, which is called IFOSC. This instrument will have a software interface, as a part of the telescope control system, which will be sufficiently user friendly. The main features of IFOSC are its wide wavelength coverage, large field of view and possibility of low, medium and high resolution spectroscopy with a large selection of grisms and filters

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etc. The instrument is a modified version of EFOSC made at ESO, and it was designed and fabricated at the Copenhagen University Observatory; the collimation-camera combination was first designed at ESO and subsequently the design was modified at IUCAA to suit the constraints of manufacturing. The front end of IFOSC consists of a calibration unit containing the spectral lamps, integrating sphere etc. and has been designed and developed at IUCAA.

In the following sections we present status and key details of the subsystems, i.e. the site, the telescope, dome & buildings, observatory control system, and IFOSC.

2. Status and key details of the subsystems

2.1 The Site

The telescope will be installed on a hill near Godegaon, which is about 80 km North of IUCAA. The relevant parameters of the site are:

- Coordinates: Lat. 19 deg. 4.35 arcmin N Long. 73 deg. 50.68 arcmin E
- Altitude: $\sim$ 1000 meters
- Median seeing: $\sim$ 1.5 arc-minutes
- Mean Atmospheric Extinction: B $\sim$ 0.46 and V $\sim$ 0.28 mag/airmass
- Sky Brightness: B $\sim$ 21.8; V $\sim$ 20.9 and R $\sim$ 19.5 mag/sq. arc-sec
- Photometric nights: 80-100 per year Spectroscopic nights: 150 +/- 20 per year

For more details on site characterization please refer to Das et.al. (1999)

2.2 The Telescope

Following are the specifications of the telescope:

- Manufacturer: Telescope Technologies Limited, Liverpool, UK
- Type: 2 meter Alt/Azimuth f/10 Cassegrain focus (Ritchey-Cretien)
- Field Size: $\sim$ 40 arc-minutes with field corrector; images $<$ 0.6 arc-sec

- Open loop tracking accuracy: < 0.5 arc-sec (upto 10 minutes) Closed loop tracking accuracy (with auto-guider): < 0.2 arc-sec (over 1 hour)

- Autoguider limiting magnitude: ~ 17

2.3 Dome and buildings

The IUCAA observatory occupies a land on the hill top of an area approximately 100 × 100 meters. The telescope building is at the north edge of this plot (which is at a slightly elevated height) and the services building (which houses the guest rooms, canteen, library etc.) is at the south edge. All the heat generated within the telescope building is ventilated out near the services building, which is situated about 80 m away.

Ideally dome of a telescope should be in thermal equilibrium with the ambient air during the observations in the night. This requires (a) a low thermal time constant of the dome and free air flow, (b) negligible radiation coupling of the dome to the cold sky outside, and c) minimal heating during the day. Typically, the observatories use a white paint which helps in minimizing daytime heat. But the same paint, being a very efficient radiator of thermal IR, produces strong cooling during the night. A good option is to have the dome with an aluminium surface which has low emissivity for solar radiation and thermal IR. As our dome is made of steel, we have chosen to use aluminium paint with a low resin content (about 1.5 - 2.5 litre of resin for every kg of aluminium powder) to get a low emissivity in the visible as well as in the thermal IR.

The ground floor of the telescope building houses various equipments like the oil pumps, axes transformer and other electrical power related units which would generate and dissipate about 50 kW of heat. If this heat is allowed to flow out of this building, then it would affect the local seeing. To resolve this issue, exhaust fans have been placed at the services building ($\sim$ 100 meters away), which would suck this hot air and in turn keep the telescope building at slightly below the local atmospheric pressure ($\sim$ few mm of water pressure). Thus it avoids any significant amount of hot air leak from this building.

The cylindrical dome has a diameter of about 11 meters and a mass of about 50 tons supported on 12 wheels. The drive is based on two AC motors (which are fluid coupled to gear boxes) placed on two of these dome support wheels. The slew rate is about 5 minutes per rotation of the dome. The fluid couplings provide a soft start and stop and also avoid overloading of the motors.

A multiturn shaft encoder mounted on shaft of one of the idling wheels, measures azimuth of the dome; the reading for zero position is frequently reset by a set of four sensors placed 90 degrees apart. The desired azimuth of the dome is obtained by driving the motors for an estimated time in the desired direction and the new position is checked. This process is repeated till the position is reached within an angle of $\sim$ 0.5/cosine(telescope elevation); the cosine factor takes care of the fact that near the zenith, a large interval in azimuth angle corresponds to a small space angle.

2.4 Observatory control system

The IUCAA telescope will have a front end software interface called the Observatory Control System (OCS) sketched in Figure 1. Keeping the ease of use in mind and the popularity of web-style menus, most of the features and accesses to various options will be through web-like clickable pages.

2.5 IUCAA Faint Object Spectrometer & Camera: IFOSC

Objectives

- The IFOSC was designed with the following objectives:
  - Direct imaging & spectroscopy
  - Good wavelength coverage and Wide field coverage
  - Minimum ghosts and maximum transmission
  - Any filter and grism combination to allow low, medium and high resolution spectroscopy in B,V and R bands

Specifications

- Field of view: 11.5×11.5 sq. arc-minutes
- Input plate scale: 10.3 arc-sec/mm
- Output plate scale: 44 μm/arc-sec (reduction factor of 0.45)
- CCD Camera: 2K $\times$ 2K Loral 15μ pixels or 2K $\times$ 2K EEV thinned & back illuminated 13.5 μ pixels
- Wavelength range: 350-850 nm Resolution: 500-3000
- Ghosts: $\sim$ 0.001-0.0001 Central brightening: $\sim$ 1%
- Lenses coating: Super Triolin multilayer wide band ARC ($<$ 1% surface reflection)
- Calculated Sensitivity (magnitude limit) for a 1000 secs integration time & S/N =50: 18 mag at R=500; 17mag at R=1500 and 16 mag at R=3000

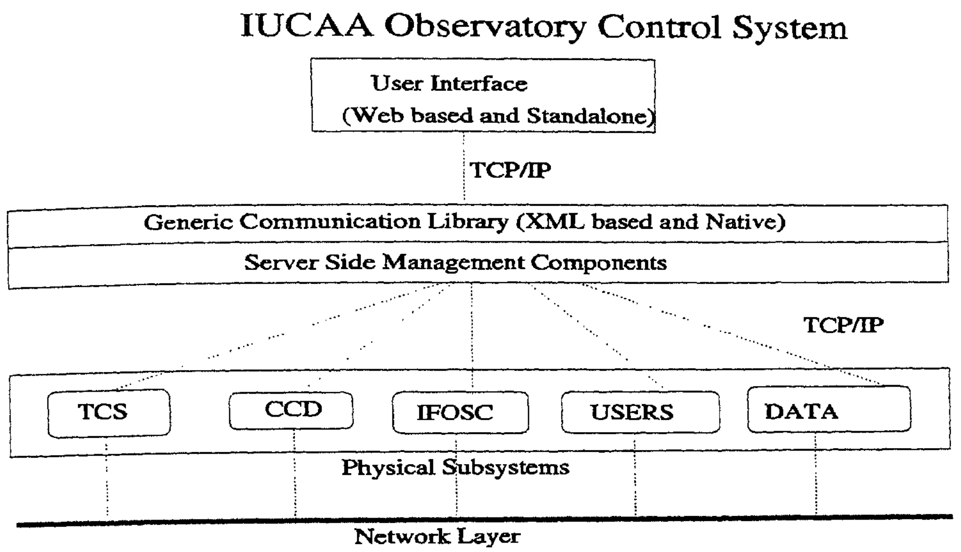

Figure 1. A sketch of the OCS user interface for IUCAA telescope

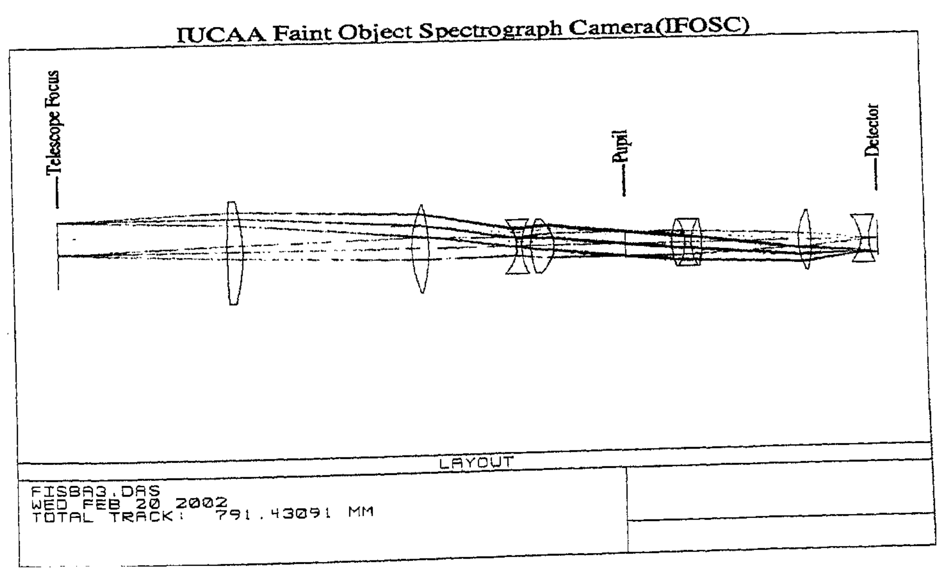

Figure 2. IFOSC Optical Layout

Table 1. Grism Table

Grism	Peak (nm)	Wavelength Range (nm)	Resolution (Å/arc-sec)	Efficiency
IFORS5	400	330-630	9.1	0.80
IFOSC5	600	520-1030	9.2	0.75
IFORS1	400	330-554	4.1	0.70
IFOSC7	500	380-684	4.4	0.65
IFOSC8	600	580-835	3.7	0.60
IFOSC10	400	330-650	19.1	0.80
IFOSC11	500	370-742	13.6	0.80
IFOSC12	600	520-1040	38.6	0.80
IFOSC9		330-1150	1.4	0.40 (13th order)
IFOSC13		330-860	1.5	0.50 (3rd order)

The Figure 2 shows the optical layout of IFOSC. The Table 1 shows the available choice of grisms, wavelength ranges and expected resolutions.

2.6 Future plans

The following accessories are being planned for IFOSC: (a) use of a pupil mask at the position shown in Figure 2 for online monitoring of telescope's optics by wavefront analysis, (b) a multislit option (the multislit mask is made using the technique of making a PCB cards), and (c) a spectro-polarimetric option.

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References

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