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Technical Note

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# A Rocket Payload Photometer for the Measurement of 5577 (OI) Night Airglow

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**Abstract:**

A photoelectric photometer was designed and constructed to measure the intensity profile of the 5577 Å (OI) radiation from the night sky with a rocket. This note describes the instrumentation and performance of the photometer which was flown from Thumba on February 3, 1973. Results of this flight are discussed elsewhere (Kulkarni, 1976).

## Background for design:

It was known from the mid-latitude rocket measurements that 5577 Å (OI) radiation from the night sky originates in a relatively thin layer (half width ~10 km) at about 97 km average height from the ground (Offermann and Drescher 1973). Hence, if a photometer looking vertically is flown in a rocket it should show almost constant intensity till it enters the emitting layer, if the emission layer is optically thin. The intensity should decrease as the rocket penetrates through the layer. If there is no radiation above this layer, the photometer should show zero intensity during this part of the flight otherwise if some of 5577 A originates from a higher layer this will be shown as a constant intensity upto the apogee of the flight if the second emission layer is above the apogee. The optical filter used for isolating the airglow emission line has a finite width and therefore also allows continuum, which can be substracted by measuring its intensity in the nearby region of the spectrum. The technique is known as the two filter technique (Roach and Meinel, 1955). Hence our complete instrument consisted of two identical photometers with two filters centred on 5577 A and 5566 A .

Instrument:

Figure 1 gives the block diagram of the airglow photometer. Figure 2 shows the details of the photometer tube which contains optics and the detector. Output from the detector goes to the preamplifier.

The photometer jacket is a P.V.C. 2.5" internal diameter (I.D) tube which is again inserted into another P.V.C. tube of 3.5" I.D. In between the two tubes thermocol rings are packed for insulation. During the rocket flight, temperature inside the nose cone of the rocket rises by several tens of degrees. It is known that the dark current of the photomultiplier increases rapidly with the temperature. Hence it was necessary to properly insulate the photomultiplier tube. It was observed that the temperature near the photocathode changed by less than 1°C when the photometer was kept at 85°C for 10 minutes (ambient room temperature 26°C). The optical filter and the objective lens at the top were held by two threaded rings which in the final stage were fixed with araldite. The filter characteristics are given in table 1.

Table 1:

Filter Characteristics.

| Filter | Diameter. | Half width. | Peak* Trans-mission. | $\lambda$ Max | Effective half width * |
|---|---|---|---|---|---|
| 5577 A | 51 mm | 40 A | 74 % | 5584 A | 53 A |
| 5366 A | 51 mm | 100 A | 64 % | 5366 A | - |

* Effective half width is defined as $\int T_\lambda \, d\lambda / T_\Lambda$ where $T_\lambda$ is the transmission of the filter at wavelength and $T_\Lambda$ that at the emission wavelength.

A Fabry lens at the focus of the objective restricted the field of view of the photometer to 3° 56' and focused the objective on the photocathode, thus uniformly illuminating it even if the object field were nonuniform. Both lenses were achromates. One centimeter thick foam pressed to 4 mm against the ring R1 holds the phototube in a moderately tight position. A mu metal shield and the foam packing around holds the photomultiplier tube firmly but without strain. The photomultiplier had S type cathode with very low dark current and a good sensitivity in the green region of the spectrum.

The potted bottom part of the photometer is shown in Fig.3. The D.C. - D.C. converter type H.T. supply was built on a circular card of 2" diameter and was fixed in a copper cylinder 2½" high with a hole at the bottom in a teflon disc R2 for taking the H.T. out. This cylinder was then potted with RTV-602 compound (bubbled under vacuum). The cylindrical H.T. supply was then mounted upside down as shown in Fig.3 so that the H.T.end is near the cathode pin of the photomultiplier. The photomultiplier was seated on the teflon ring R3 which was fixed to the outside tube. This teflon ring was bevelled on inside to match the slanting portion of the photomultiplier. R3 was then sealed inside to the photomultiplier wall and outside to the P.V.C. tube as shown, by a rubber compound R. The assembly was then potted upside down through a hole in the plate P1. Through P1 only two wires go (i) input-7V for d.c.-d.c. converter and (ii) output signal from the photomultiplier. All H.T. points are potted in one single cylinder and there are no H.T. junctions anywhere outside, so that no corona problems would arise at the insitu low pressure. This assembly was tested for (a) vibrations (upto 2 KHz), (b) shock (5 to 10 g) and (c) vacuum ($10^{-5}$ mm of Hg) for corona discharges.

A preamplifier with a gain of about 15, followed by a three stage pulse amplifier of total gain about 250 was used for necessary amplification of the input pulses. A tunnel diode discriminator cutting down the grass noise below 50 mV was used. A monoshot was used to make pulses of equal widths of 10 $\mu$s. This was followed by a ratemeter which converts number of pulses i.e. frequency to corresponding d.c. voltage, this was followed by a d.c. amplifier (see fig.1).

All the above circuit parameters were adjusted to the telemetry requirement of 0-5 V D.C., giving 2.5 to 3 V D.C. when the photometer was exposed to the night sky from the ground. We had also a precalibrated 3"luminuous diameter radio active $C^{14}$ phosphorescent source giving constant light output for calibration. The payload photometer was calibrated with this source (Kulkarni & Sanders 1964). The present circuits were made with discrete components. Integrated circuits have been used in the later version.

Scientific results obtained with this photometer have been reported and discussed elsewhere (Kulkarni, 1976). We thank Mr.R.T.Patel for construction and testing of the payload. All mechanical work was done in the PRL workshop. This work was supported by the Department of Atomic Energy, Government of India.

References:

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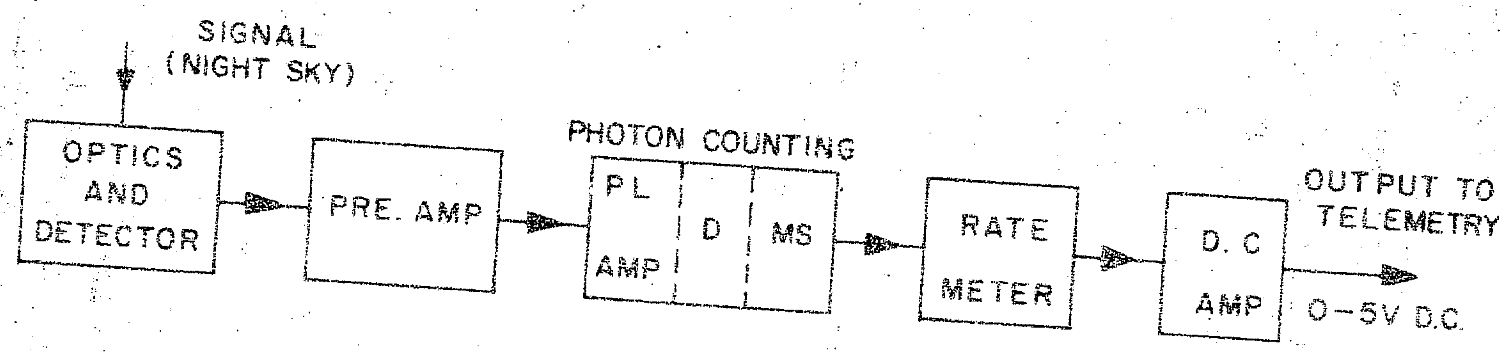


FIG. I. BLOCK DIAGRAM OF AIRGLOW PHOTOMETER PAYLOAD. PL AMP = PULSE AMPLIFIER, D = DISCRIMINATOR, MS = MONO SHOT.

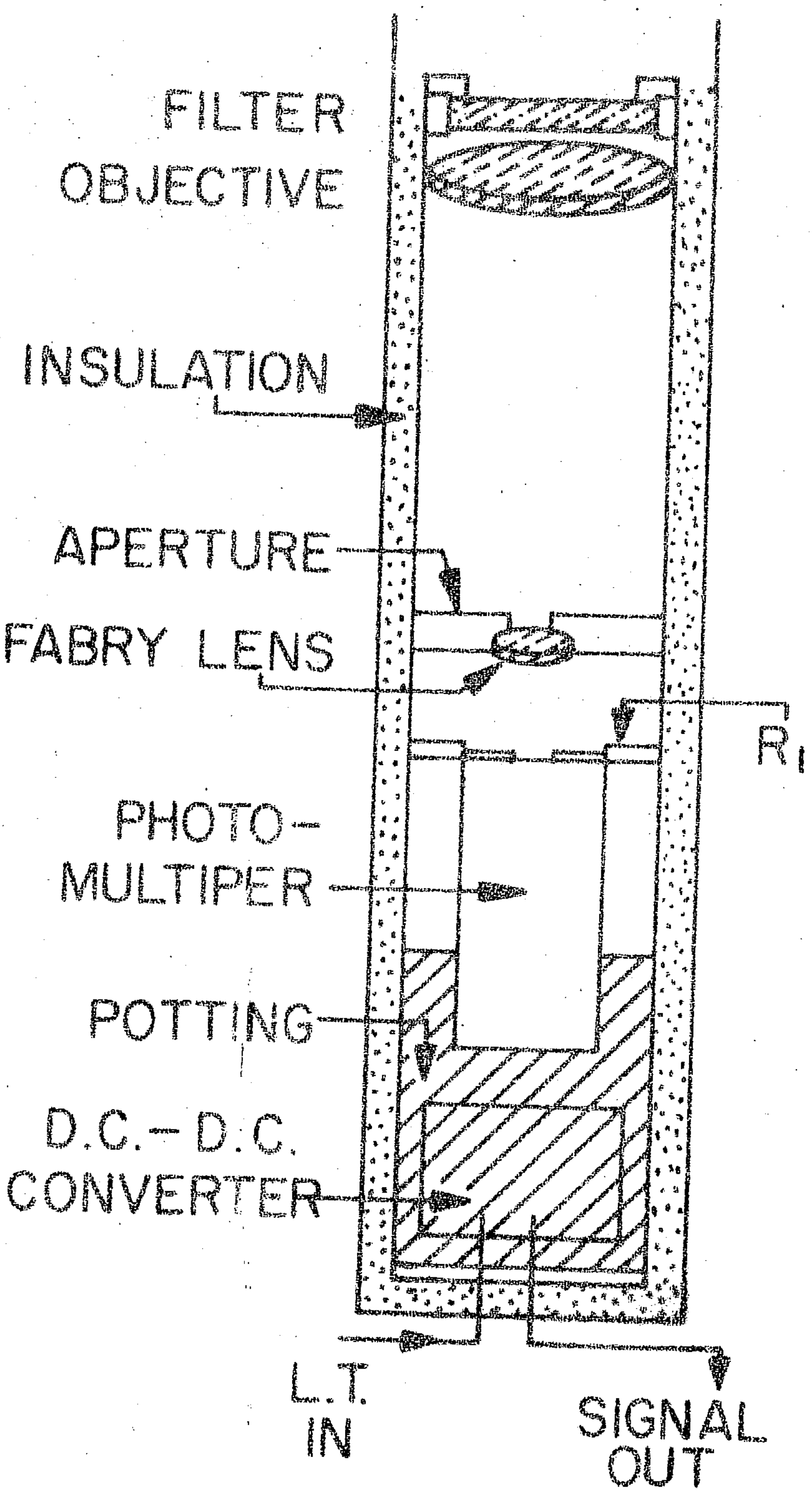


FIG. 2: OPTICS AND THE PHOTOMULTIPLIER IN THE PAYLOAD

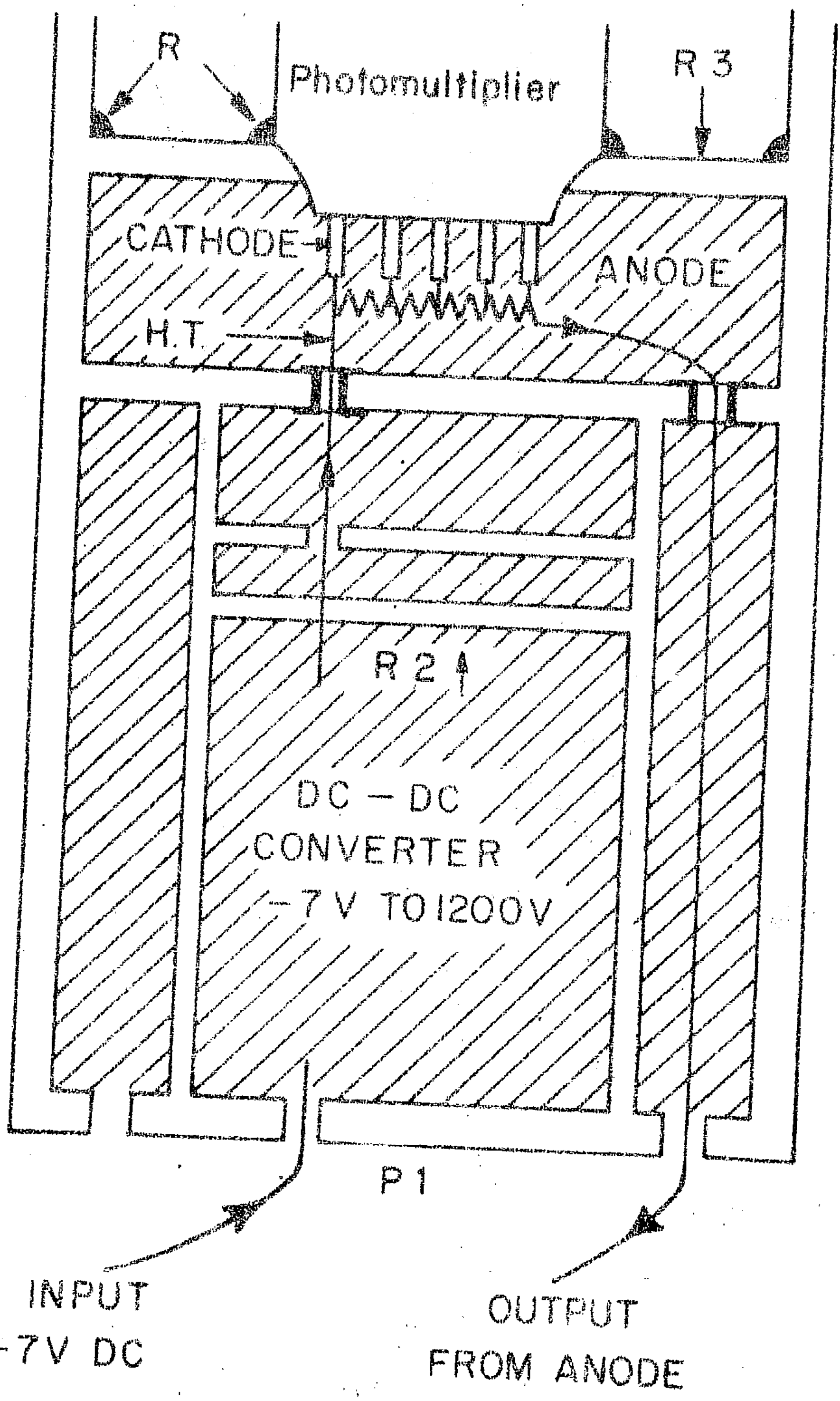


FIG.3 : DETAILS OF THE BOTTOM PART OF THE PHOTOMETER TUBE