AN AUTOMATED PHOTOMETER FOR A ONE METER TELESCOPE

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ABSTRACT. A new photometer is described which has some unique optical features. Emphasis is given to those features that improve the measurement precision and efficiency of use.

We have designed and are constructing an automated photometer with some unique features, primarily in the viewing and measuring optics. Upon completion this photometer will be installed on the one-meter telescope at Mount Laguna Observatory, which is operated by San Diego State University in partnership with the University of Illinois. The basic philosophy of this instrument is through the use of good design practices and high quality optical images to produce precise measurements and achieve efficiency in its operation by the astronomer.

The photometer can be operated either at the telescope using an eyepiece, or from the control room, in which case viewing is done using an intensified CID system. In both cases all component movements (e.g. filter wheel) are motor driven. The optical design allows a single eyepiece to be used for both wide field viewing and centering in the focal plane aperture. There is also an even number of reflections to produce a correct view of the sky. All lens surfaces have anti-reflection coatings to minimize reflection losses. A flip mirror allows the observer to select either a blue (EMI 6256) or red (RCA C31034) sensitive photomultiplier housed in thermoelectrically cooled boxes.

Although temperature effects on photometric measurements, particularly on filters, have been known for twenty years, few photometers control this important variable. In addition, most of the electronics of the pulse counter will be inside the photometer, and these components will produce more precise results if they are held at a constant temperature. In our photometer the temperature will be actively controlled to better than one degree Celsius using platinum RTD's as temperature sensors and resistors as the heating elements. The photometer will be held at a temperature of 26 degrees Celsius year round. Such a system is already working in our solar radiometer. The RTD's will also give us a readout of the temperature, which will be

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recorded periodically with the photometric data. Temperature control will necessitate a quartz window at the optical entrance to the photometer, but this additional light loss will be more than compensated for by the increase in precision. It will also keep dust and moths out of the photometer. In order to minimize the heat dumped into the dome the entire photometer will have an inch of insulation around it; this is what we do with the solar radiometer.

The optical design increases precision in four ways. First, good optics produce a sharp image of the focal plane diaphram, and this, coupled with proper diaphram illumination, allowsprecise centering of the object to be measured. This is particularly important when trying to measure faint stars or faint, diffuse galaxies. Second, one needs a large diameter beam on the filters to minimize the effects of filter nonuniformity. Third, many filters in use are interference filters, and the central wavelength depends on the cosine of the angle of incidence. It is necessary therefore to minimize the angular divergence of the rays passing through the filter. Our solution is to pass parallel light through the filters. Last, the diameter and placement of the lenses is such that there is no vignetting of the measuring beam.

A standard light source will be added, which will be useful in the measuring process and as a diagnostic in case of problems. The microprocessor that controls the instrument will also use the measurement technique of F. Rufener (Geneva Observatory) of calculating various statistical quantities to evaluate each measurement.

Several features of the photometer that allow convenience are not unique, such as being automated, or in the use of a remote, intensified viewing system. Our choice of a CID with two microchannel plates of intensification is based on economy. First, it has economy of size. Second, the microchannel plates are separate and can be replaced at a cost of only $2000 if the device is "zapped" by a bright source. If our current ISIT goes, then the entire device must be replaced at a cost of $14,000. A related convenience is that the interface between the telescope and photometer contains an ISIT and optical components allowing the change in just 15 minutes from the photometer to the Observatories' fiber optics coupled spectrograph.

It is all too common to find in astronomical photometers serious problems of vignetting and/or optical aberrations, particularly in the viewing optics. Our optical system stresses proper design, such as the addition of field lenses, and the use of high quality components, such as a Clave eyepiece and commercial enlarger lenses for the relay optics, to avoid these problems. This allows the astronomer to see and center fainter objects, and also to center all objects faster. Thus more objects can be observed per night.

Most photometers have two sets of viewing optics, one before the focal plane aperture with a wide field for finding objects, and one after with high magnification for centering. This is both awkward for the observer and would require two, costly remote viewing devices. Our system allows both wide and magnified views through the same eyepiece. In addition, we have added a roof mirror to give us an even number of reflections so that the view through the eyepiece has the same orientation as most published finding charts.