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ASTRONOMICAL MEASUREMENTS IN THE INFRARED[1]

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INTRODUCTION

During recent years there has been more and more emphasis upon astronomical measurements in the infrared. To a great extent, this increased emphasis has been stimulated by recent detector developments, which have produced detectors capable of making the difficult long-wavelength observations. Baum (1) has reviewed the characteristics of photosensitive devices, including infrared detectors. He discussed the spectral responses and sensitivities of most of the available detectors and, rather than dissert upon this subject here, we refer the reader to Baum's article.

For the purposes of this discussion, we will divide the infrared spectrum as follows:

(*a*) The Near Infrared, from the visible region to approximately 1 μ. This region corresponds to the wavelength sensitivity range of photomultipliers having S-1 cathodes.

(*b*) The Intermediate Infrared, covering the range of wavelengths from 1 μ to 4 μ, approximately. This region corresponds to the wavelength range for optimum sensitivity of lead sulfide photoconductive cells, cooled by liquid nitrogen.

(*c*) The Far Infrared, covering the range of wavelengths from 4 μ to 22 μ, approximately. There are several newly developed detectors that are sensitive in this spectral region, but the most sensitive is the liquid helium-cooled germanium bolometer developed by F. J. Low (2).

Wavelengths longer than approximately 22 μ will not, for the purposes of the present discussion, be considered as belonging to the infrared, although Low (3) has used his germanium bolometer to make astronomical measurements at 1 mm.

A SURVEY OF INFRARED ASTRONOMICAL OBSERVATIONS

Among the first observers to make astronomical infrared measurements were Pettit & Nicholson (4), whose thermoelectric observations included much stellar radiation in the Intermediate Infrared and a small contribution from the Far Infrared. Until very recently, their data were the observational basis of our knowledge of the bolometric corrections and effective temperatures of stars other than the Sun. About 1950, Fellgett (5) made stellar observations in the Intermediate Infrared, using a lead sulfide cell; Whitford (6, 7) used the same type of detector to make observations of the infrared characteristics of interstellar extinction.

[1] The survey of literature for this review was concluded January 1, 1966.

TABLE IV

THE ABSOLUTE CALIBRATION OF THE PHOTOMETRY

Filter band	λ_0	Absolute flux density for mag=0.00 F_λ	F_ν
U	0.36 μ	4.35×10^{-12} W/cm² μ	1.88×10^{-23} W/m² Hz
B	0.44 μ	7.20×10^{-12} W/cm² μ	4.44×10^{-23} W/m² Hz
V	0.55 μ	3.92×10^{-12} W/cm² μ	3.81×10^{-23} W/m² Hz
R	0.70 μ	1.76×10^{-12} W/cm² μ	3.01×10^{-23} W/m² Hz
I	0.90 μ	$8.3\ \times10^{-13}$ W/cm² μ	2.43×10^{-23} W/m² Hz
J	1.25 μ	$3.4\ \times10^{-13}$ W/cm² μ	1.77×10^{-23} W/m² Hz
K	2.2 μ	$3.9\ \times10^{-14}$ W/cm² μ	$6.3\ \times10^{-24}$ W/m² Hz
L	3.4 μ	$8.1\ \times10^{-15}$ W/cm² μ	$3.1\ \times10^{-24}$ W/m² Hz
M	5.0 μ	$2.2\ \times10^{-15}$ W/cm² μ	$1.8\ \times10^{-24}$ W/m² Hz
N	10.2 μ	1.23×10^{-16} W/cm² μ	$4.3\ \times10^{-25}$ W/m² Hz

ultraviolet measures into a discussion of infrared measures does, however, emphasize the impracticability of strict segregation of astronomical measures by wavelength. As we will see from the discussion of effective temperatures, which follows below, photometric measures in the Intermediate Infrared can be used in the determination of the temperatures of hot stars, whose radiation is concentrated in the far ultraviolet.

EFFECTIVE TEMPERATURES

The effective temperature T_e of a star is defined as the temperature of a black body that produces the same total energy per unit surface area as does the star. Therefore, in order to compute the effective temperature of a star, we must know both its apparent angular diameter and the total flux of energy received from the star per unit area on the Earth; only for the Sun is the diameter known with sufficient precision that an accurate effective temperature (5800°K) can be computed. Several other stars have had their angular diameters measured, however, and when these diameters are combined with the total energies computed according to the procedures outlined above, their effective temperatures can be determined. These stars and their derived bolometric corrections and effective temperatures, are listed in the first three columns of Table V. The diameter of α CMa that was used is that of Brown & Twiss (33) as rediscussed by Popper (34); that of β Aur also follows from Popper's discussion. The diameter of α Lyr was that of Brown (35). The diameter of the mean component of YY Gem was taken from Kron's (36) investigation, and combined with the trigonometric parallax of 0"072 (37). The diameter of β Per A (Algol) was derived from Eggen's (38) discussion and the trigonometric parallax of 0"031 (37). The diameter of μ^1 Sco was derived from the linear diameter given by Harris, Strand & Worley (39) and the moving-cluster distance of Bertiau (40); the star is