ABSTRACT. The absolute fluxes and energy distributions of stars are the foundation of the calibration of fundamental effective temperatures and bolometric corrections. In this paper I will review recent progress in the calibration of absolute fluxes and energy distributions in the visual and IR parts of the spectrum. In the visual, the calibration of the absolute flux and energy distribution of Vega has settled down well, and the remaining difficulties include the lack of a worldwide common list of brighter secondary standard stars, the lack of enough satisfactory fainter secondary standard stars and the possibility of variability in Vega. In the IR, the process of arriving at a dependable and accurate calibration, and of linking it to commonly used photometric systems, is in its infancy. A final, and rather special problem, is the question of the calibration of the Sun. The Sun is a special case both because it is so well studied astrophysically and because its extreme brightness makes it very difficult to calibrate photometrically. Some progress has recently been made on the calibration of the absolute flux and energy distribution of the Sun, and I will discuss this work.

1. INTRODUCTION

I am concerned here with the measurement of the absolute flux and energy distribution of the stars within that part of the spectrum which includes thermal radiation from the apparent surface of the star. In terms of the calibration of fundamental stellar quantities, the apparent total flux, \( f \), radiated by a star, is related to the effective temperature, \( T_{\text{eff}} \), and angular diameter, \( \theta = (2R/d) \), of the star, through the equation:

\[
f = \left( \frac{\theta^2}{4} \right) \sigma T_{\text{eff}}^4.
\]
The apparent bolometric magnitude, $m_{bol}$, is related to the apparent total flux through the equation:

$$m_{bol} = -2.5 \log_{10} f + C = V + B.C.,$$

(2)

where $V$ is the apparent visual magnitude in the Johnson UBV system, $B.C.$ is the bolometric correction, and the zero point constant, $C$, is determined by reference to the Sun:

$$m_{bol,*} - m_{bol,0} = -2.5 \log_{10}(f_*/f_0).$$

(3)

The measured quantities in these equations are the apparent total fluxes, the angular diameters, and the $V$ magnitudes of the Sun and stars. The measurement of the $V$ magnitudes of the stars is not a major contributor to the errors here, so I will not discuss it further. The $V$ magnitude of the Sun is discussed below, and the measurement of angular diameters is discussed by Hanbury Brown (1985) and Davis (1985) in this symposium.

The quantity which I have been calling the "apparent total flux" is the integral over wavelength (or frequency) of the apparent monochromatic flux, $f_\lambda$ (or $f_\nu$). In fact, we do not measure the apparent total flux because of the nature of our detectors and the transmission of the Earth's atmosphere, and what is actually done is to measure the apparent monochromatic flux at a number of wavelengths and to perform the integral numerically. The measurement of the apparent monochromatic flux of a star divides naturally into three wavelength ranges: a) the UV, with wavelengths shortward of the atmospheric cutoff at about 0.32 $\mu$m; these measurements must be made from above the atmosphere, b) the "visual," with wavelengths between the atmospheric cutoff and about 1.0 $\mu$m, and c) the IR, with wavelengths longer than 1.0 $\mu$m. The UV is discussed by A. D. Code (1985) in this symposium.

I will further separate the measurement of the apparent monochromatic flux into two parts: the measurement of the absolute monochromatic flux, which is measured at some standard wavelength, such as 5000 or 5556Å, and the measurement of the absolute energy distribution, which is the apparent monochromatic flux normalized to the standard wavelength. I emphasize the term "absolute" to distinguish it from conventional relative photometry, in which the measurement of the program stars is referred to one or more standard stars. We make measurements of the absolute monochromatic flux and energy distribution for only a limited number of stars, which become the standard stars. For traditional and practical reasons the star Vega (Alpha Lyrae = HR 7001 = HD 172167) is the primary standard star. A number of other bright early-type stars have been defined as secondary standard stars; the fluxes and energy distributions of these stars have, for the most part, been determined through careful measurements relative to Vega. In some cases the secondary standards have been measured absolutely. For the sake of brevity, I will