

According to *Astrophysical Quantities, Third Edition* by C.W. Allen, p. 197, the visual magnitude of a star and its energy flux above the earth's atmosphere are related by the equation

$$m_V = -2.5 \log(\int V_\lambda f_\lambda d\lambda) - 13.74 \quad (1)$$

where  $\int V_\lambda f_\lambda d\lambda$  is measured in  $\text{erg cm}^{-2} \text{ s}^{-1}$ ,  $V_\lambda$  is the response curve of the photometric  $V$  filter as a function of wavelength, and  $f_\lambda$  is the radiant flux from the star smoothed through absorption lines. Defining

$$F = \int V_\lambda f_\lambda d\lambda \quad (2)$$

to be the total energy flux in the photometric  $V$  band, one finds

$$\log F = -\frac{2}{5}(m_V + 13.74) \quad (3)$$

Taking the effective wavelength of the photometric  $V$  band to be 550 nm, the energy per photon in the band is found to be

$$h\nu = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-27} \text{erg s} \cdot 3 \times 10^{10} \text{cm/s}}{550 \times 10^{-7} \text{cm}} = 3.62 \times 10^{-12} \frac{\text{erg}}{\text{photon}} \quad (4)$$

So that the total energy flux from the star in the photometric  $V$  band measured in photons  $\text{cm}^{-2} \text{ s}^{-1}$  is therefore given by

$$\log F_\gamma = -\frac{2}{5}(m_V + 13.74) - \log(3.62 \times 10^{-12}) = -\frac{2}{5}(m_V - 14.86) \quad (5)$$

Using the full 45 cm diameter aperture of an IOTA telescope, one would therefore expect a photon flux of about  $1.4 \times 10^9$  photons/second from a magnitude zero star.

Photometric measurements using the APD system and the south telescope at IOTA on the night of Dec 20-21, 1999 are tabulated below. Extrapolating these values back to zero magnitude, one finds about  $2.3 \times 10^6$  photons/second. Since the beam has been split twice before reaching the APD (once for the star trackers, and once for the beam combining), the net system efficiency is found to be

$$\frac{9.2 \times 10^6}{1.4 \times 10^9} \sim 0.7\% \quad (6)$$

Table 1: APD photometry of 12 stars at IOTA

Star	$m_V$	Counts (Hz)	Background (Hz)	Counts - Background
HR1708	0.08	1634766	1119	1633647
HR2990	1.14	758653	825	757828
HR1791	1.65	502228	1102	501126
HR2088	1.90	402023	869	401154
HR1577	2.69	206765	1067	205698
HR2540	3.60	89496	796	88700
HR2219	4.35	47055	843	46212
HR2696	4.90	27807	772	27035
HR2793	5.13	22801	749	22052
HR2643	5.93	11041	767	10274
HR2438	6.03	10493	751	9742
HR2452	6.46	7128	751	6377