Astronomy 192
Principles of Astronomical Measurement

Solution to the Sky Brightness Question

The dark night sky brightness at most American observatories is V= 21 mag / $\square''$ which:

$$
\begin{aligned}
&= 4.33 \times 10^4 \; Nits \\
&= 3.2 \text{ magnitude}/\square^\circ
\end{aligned}
$$

And, given 41256 $\square^\circ$ over the sky, $\Rightarrow$ 3283 $\square^\circ$/ster

and 1.3 $\times 10^7 \square''/\square^\circ$, gives

$$
\begin{aligned}
&= 515 \; S_{10} \\
&= \sim 2 \; Rayleigh \; \mathring{A}^{-1} \\
&= 1.6 \times 10^5 \; photons \; s^{-1} \; cm^{-2} \; \mathring{A}^{-1} \; ster^{-1} \\
&= 3.78 \times 10^{-6} \; photons \; s^{-1} \; cm^{-2} \; \mathring{A}^{-1} \; arcsec^{-2}
\end{aligned}
$$

P.S. and for example, this implies that in a V filter on a 1-m diameter telescope one collects

$\pi/4 \times 100^2 \times 1300 \times 3.78 \times 10^{-6}$

= 38.6 photons per second per $\square''$.

For fun, we can also calculate how many photons you see from the night sky when you go out at night!

Your "eyes" have a collecting area of about 1 cm^2, they detect light over a bandwidth of about 2000 Å, and "see" in a wide angle view about 1 steradian. Neglecting absorption, and assuming the QE of the eye is unity, we find from the above

$$\rightarrow \quad 300 \text{ million photons/second}$$

from the *dark* night sky! And that's not counting the stars.

Whoof!