Number of object photons hitting the chip

Assuming a wavelength of 555 nm and an extinction (attenuation of light in the atmosphere) of 0.28 mag *(https://en.wikipedia.org/wiki/Extinction_(astronomy))*, the following formula can be used to determine the number of incoming photons: *(https://www.uni-ulm.de/fileadmin/website_uni_ulm/nawi.inst.251/Didactics/quantenchemie/html/PhAllF.html)*

$$N = \frac{E_V}{E_{Photo}}$$

E_v is the illuminance, into which the apparent visual brightness mv in [mag] is included *(https://de.wikipedia.org/wiki/Scheinbare_Helligkeit)*:

$$E_V = 10^{-0.4\left(\frac{m_V}{mag}+14.2\right)} lx$$

‚lx' is the unit of illuminance and can be converted to W/m² at 555 nm by a factor of 0.01464. *(https://www.translatorscafe.com/unit-converter/de-DE/illumination/1-11/lux-watt/centimeter%C2%B2%20(at%20555%20nm)/)*, where applies: 1 W = 1 J/s.

If the extinction of 0.28 mag is included, the formula results:

$$E_V = 10^{-0.4\left(\frac{m_V+0.28\,mag}{mag}+14.2\right)} \frac{J}{s*m^2}$$

E_{Photon} is the energy of the photons at 555 nm *(https://en.wikipedia.org/wiki/Photon)* and is calculated from:

$$E_{Phot} = \frac{h*c}{\lambda}$$

h - Planck constant with $6.626 * 10^{-34} Js$
c – speed of light with 299,792,458 m/s

Combined, this results in the formula:

$$N = \frac{E_V}{E_{Photo}} = \frac{10^{-0.4\left(\frac{m_V+0.28\,mag}{mag}+14.2\right)} \frac{J}{s*m^2}}{\frac{h*c}{\lambda}}$$

$$N = \frac{10^{-0.4\left(\frac{m_V+0.28\,mag}{mag}+14.2\right)} * 0.01464 \frac{J}{s*m^2}}{\frac{6.626*10^{-34} Js * 299{,}792{,}458 \frac{m}{s}}{555*10^{-9} m}}$$

$$N = \frac{10^{-0.4\left(\frac{m_V+0.28\,mag}{mag}+14.2\right)} * 0.01464}{3.579*10^{-19}} \; Photonen/s/m^2$$

A similar formula is derived in https://articles.adsabs.harvard.edu/pdf/1993JRASC..87..123R (formula 10), but using the surface temperature **T** of a star.

$$N = 6.85 * 10^{14} * \frac{10^{-0.4m_V}}{T} \; Photonen/s/m^2$$

If the typical surface temperature of a medium-sized star (A0) of 10,000 K is used here, similar values are obtained.

Apparent magnitude of the star [mag]	Photons/s/m² on the earth's surface (wavelength)	Photons/s/m² on the earth's surface (temperature)
0	66,033,136,364	68,500,000,000
2	10,465,546,830	10,856,518,368
4	1,658,677,393	1,720,642,206
6	262,882,651	272,703,412
8	41,664,092	43,220,578
10	6,603,314	6,850,000
12	1,046,555	1,085,652
14	165,868	172,064
16	26,288	27,270
18	4,166	4,322
20	660	685
22	105	109
24	17	17
26	3	3
28	0	0

This consideration refers to the area of 1 m². If this is considered for a telescope aperture of e.g. 8" of a Schmidt-Cassegrain-Telescope, the following values are achieved:

- Assumption: Use of an 8" SC telescope → Ø203 mm mirror → 637.7 mm² mirror area.
- SC telescopes have a Schmidt plate mirror (Ø75 mm → 235.6 mm² mirror area) at the front entrance glass plate for deflection, which has to be subtracted from the effective mirror diameter, because no photons enter the tube at this point.
- This leaves a remaining effective mirror area of 402.1 mm² → 0.0004021 m².
- For an object with an apparent magnitude of 14 mag 170.000 photons per second hit one square meter of the earth surface.
- Calculated on the effective mirror area, only **68 photons per second hit the mirror** and thus the whole chip.