2.3 Photon Flux

光子通量

The photon flux is defined as the number of photons per second per unit area:

$$\Phi = \frac{\#\ of\ photons}{sec \cdot m^2}$$

光子通量被定义为单位时间内通过单位面积的光子数：

$$光子通量 = \frac{光子数}{秒 \cdot 平方米}$$

The photon flux is important in determining the number of electrons which are generated, and hence the current produced from a solar cell. As the photon flux does not give information about the energy (or wavelength) of the photons, the energy or wavelength of the photons in the light source must also be specified. At a given wavelength, the combination of the photon wavelength or energy and the photon flux at that wavelength can be used to calculate the power density for photons at the particular wavelength. The power density is calculated by multiplying the photon flux by the energy of a single photon. Since the photon flux gives the number of photons striking a surface in a given time, multiplying by the energy of the photons comprising the photon flux gives the energy striking a surface per unit time, which is equivalent to a power density. To determine the power density in units of W/m^2, the energy of the photons must be in Joules. The equation is:

$$H(W/m^2) = \Phi \times \frac{hc}{\lambda} \text{ using SI units}$$

$$H(W/m^2) = \Phi \times \frac{1.24}{\lambda(\mu m)} \text{ for wavelength in } \mu m$$

$$H(W/m^2) = \Phi \times qE(eV) \text{ for energy in } eV$$

where Φ is the photon flux and q is the value of the electronic charge $1.6 \times 10^{-19}\ C$.

光子通量对于确定激发的电子数以及太阳能电池产生的电流值至关重要。因为光子通量中不含有关光子的能量（或者波长）的信息，所以光源中的光子的能量或者波长还需要明确给出。在给定波长的情况下，我们可以利用光子的波长或能量以及对应的光子通量来计算该波长下光子的功率密度。光子通量乘以单个光子的能量就可以得到功率密度。因为光子通量给出了一段时间内到达某一表面的光子数，如果乘以单个光子的能量，乘积就等效于功率密度。如果我们想得到的能量密度的单位为瓦每平方米，光子的能量单位应该为焦耳。相关公式为：

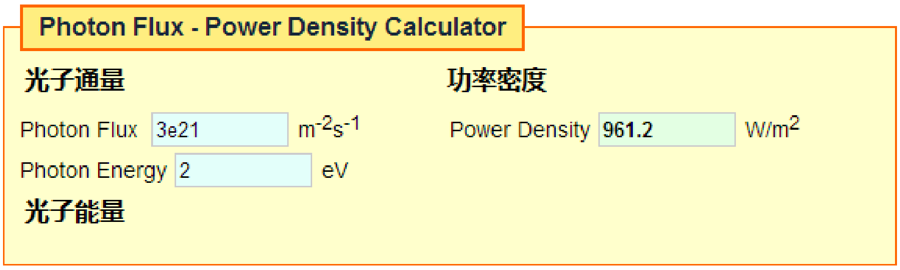
$$能量密度（瓦/平方米） = 光子通量 \times \frac{hc}{\lambda} \text{ 适用于国际单位制}$$

$$能量密度（瓦/平方米） = 光子通量 \times \frac{1.24}{\lambda(\mu m)} \text{ 适用于光子的波长单位为微米时}$$

$$能量密度（瓦/平方米） = 光子通量 \times qE(电子伏特) \text{ 适用于光子的能量单位为电子伏特时}$$

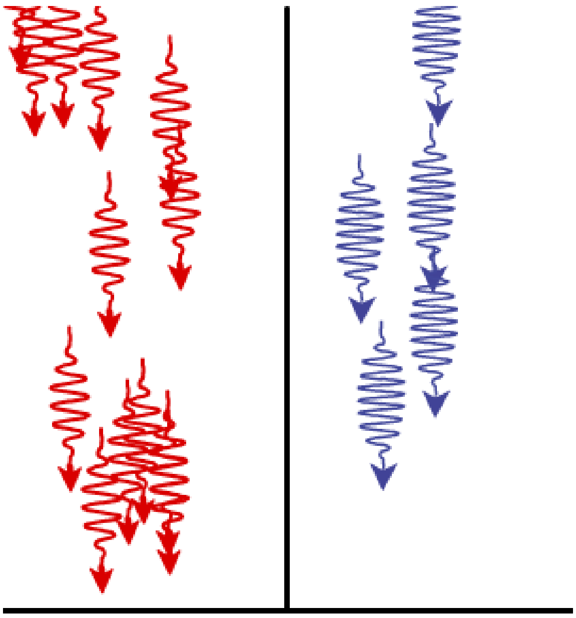
公式中，Φ是光子通量，q是单个电子所带的电荷数，1.6×10^{-19} 库伦。

光子通量 - 功率密度计算器



One implication of the above equations is that the photon flux of high energy (or short wavelength) photons needed to give a certain radiant power density will be lower than the photon flux of low energy (or long wavelength) photons required to give the same radiant power density. In the animation, the radiant power density incident on the surface is the same for both the blue and red light, but fewer blue photons are needed since each one has more energy.

上述公式表明在相同的辐射功率密度条件下，带有高能量（或者短波长）的光子的通量比带有低能量（或者长波长）的光子的通量低。在动画中（译者注：在原文地址有效），表面入射的红光和蓝光的辐射功率密度是相同的，但是蓝光的光子数少，因为单个光子所带的能量高。



For the same light intensity, blue light requires fewer photons since the energy content of each photon is greater.

对于相同的光强，蓝光所需的光子数少因为单个光子的能量高。

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