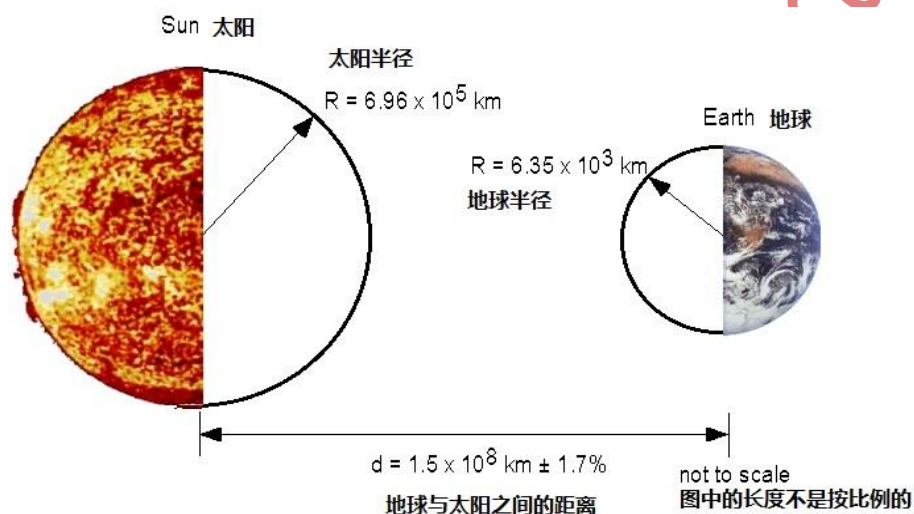


## 2.9 Solar Radiation Outside the Earth's Atmosphere

### 地球大气层外的太阳辐射

The solar radiation outside the earth's atmosphere is calculated using the radiant power density ( $H_{sun}$ ) at the sun's surface ( $5.961 \times 10^7 W/m^2$ ), the radius of the sun ( $R_{sun}$ ), and the distance between the earth and the sun. The calculated solar irradiance at the Earth's atmosphere is about  $1.36 kW/m^2$ . The geometrical constants used in the calculation of the solar irradiance incident on the Earth are shown in the figure below.

地球大气层外的太阳辐射可以通过太阳表面的辐射功率密度 ( $H_{sun} = 5.961 \times 10^7$  瓦每平方米), 太阳半径 ( $R_{sun}$ ) 以及地球与太阳之间的距离来计算。计算可得, 地球大气层处的太阳照度为1.36千瓦每平方米。计算入射到地球的太阳照度用到的几何常数如下所示。



Geometrical constants for finding the Earth's solar irradiance. The diameter of the Earth is not needed but is included for the sake of completeness.

上图中列出了计算地球上太阳照度用到的几何常数。计算中并不涉及地球的直径, 只是为了图片的完整性才在上图列出。

The actual power density varies slightly since the Earth-Sun distance changes as the Earth moves in its elliptical orbit around the sun, and because the sun's emitted power is not constant. The power variation due to the elliptical orbit is about 3.4%, with the largest solar irradiance in January and the smallest solar irradiance in July. An equation<sup>1</sup> which describes the variation throughout the year just outside the earth's atmosphere is:

$$\frac{H}{H_{constant}} = 1 + 0.033 \cos \left[ \frac{360 \cdot (n - 2)}{365} \right]$$

where:

$H$  is the radiant power density outside the Earth's atmosphere (in  $W/m^2$ );

$H_{constant}$  is the value of the solar constant,  $1.353 \text{ kW/m}^2$ ; and

$n$  is the day of the year.

地球的公转轨道是一个椭圆，随着地球的运动，它与太阳之间的距离会发生变化。另外太阳辐射出的功率也不是一个常量，因此地球上真实的太阳功率密度会有所变化。由于椭圆轨道导致的功率变化约为 3.4%，1 月份的太阳照度最强，7 月份最弱（译者注：对于南半球是 1 月最强，7 月最弱，北半球相反）。下面的公式<sup>1</sup>描述了全年中地球大气层外的太阳辐射功率密度的变化情况：

$$\frac{H}{H_{constant}} = 1 + 0.033 \cos \left[ \frac{360 \cdot (n - 2)}{365} \right]$$

公式中， $H$ 为地球大气层外的辐射功率密度（单位：瓦每平方米）， $H_{constant}$ 为太阳常数的值，1.353 千瓦每平方米， $n$ 表示某一天在全年 365 天中的序数。

These variations are typically small and for photovoltaic applications the solar irradiance can be considered constant. The value of the solar constant and its spectrum have been defined as a standard value called air mass zero ( $AM_0$ ) and takes a value of  $1.353 \text{ kW/m}^2$ . The spectral irradiance is given in the Appendix.

一年中的太阳照度的变化程度很小，因此对于光伏应用来说，它可以被认为是常量。我们定义太阳常数的值和对应的光谱为一个标准值，称为  $AM_0$ ，它的值为 1.353 千瓦每平方米。光谱辐照度的分布在“附录”页面中给出。

#### 天数-阳光强度计算器

##### Day of the Year - Sunlight Intensity Calculator

某一天在一年365天中的序数

阳光强度

Day of the Year

3

Sunlight Intensity

1397.6

$\text{W/m}^2$

#### 参考文献

1. Rai GD. Solar Energy Utilisation. In: Khanna Publishers; 1980. p. 44.