爱上科学
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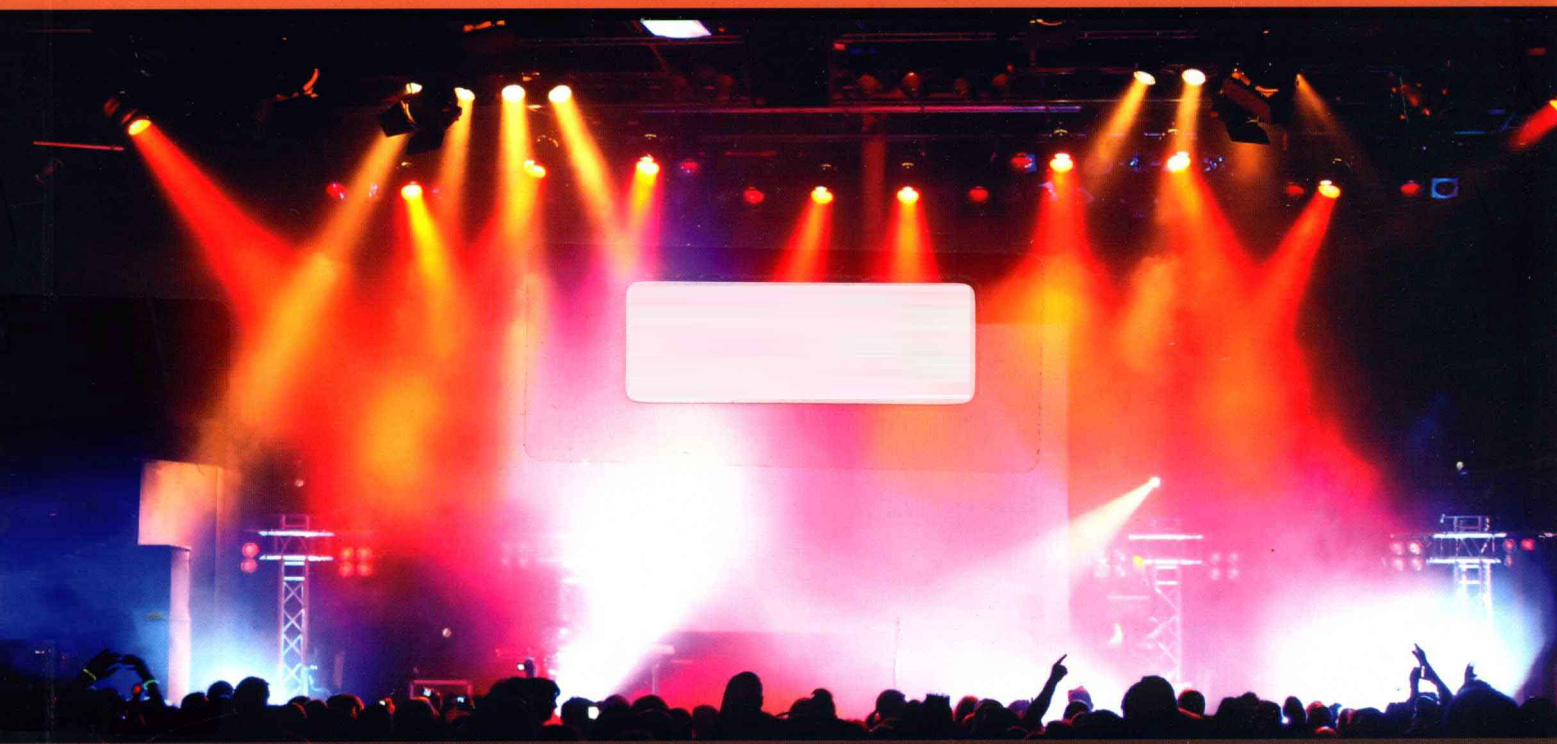
爱上科学

INTRODUCING • 物理系列
PHYSICS

绚丽的光与声

LIGHT AND SOUND 双语版

[英] Graham Bateman 编
吴媛媛 译
熊雪亭 审



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内容提要

《爱上科学》系列科普丛书为读者全面地讲述了科学知识和原理，以通俗的文字、生动的图表为特色，每本书介绍一个或几个主题。从日常生活中有趣的现象出发，引导和培养读者学习的兴趣，扩宽读者的视野，同时还可以帮助读者学习英语词汇、练习英语阅读。丛书涵盖物理、化学、生物、科技与发明这4个系列。适合对科学知识感兴趣的广大科普爱好者阅读。

本书是物理系列中的一本。物理系列解释和说明了物理学知识及其发展史，包含物理学发展史许多重大的物理发现以及著名的物理学家。用通俗生动的语言展示物理学的魅力，引发读者对物理学的兴趣和探索。同时包含丰富有趣的物理小实验。

本书展示光和声音背后的秘密，从生活中有趣的光和声音现象出发，通过一系列有趣的实验，让青少年在观察和探索中体会光和声音许多性质和原理。书中含有“科学词汇”栏目，提取每章重点知识词汇。同时还有“试一试”栏目，包含丰富有趣的家庭小实验，有助于提高大家的动手能力。

丛书编委会

丛书序

这是一个科技新时代，我们曾经认为遥不可及的科学，时刻围绕在我们身边。你是否曾经怀疑过所谓的“2012，世界末日”，或者好奇过在地下高速飞驰的地铁，抑或每天都在关注着PM2.5……这说明科学已然走进了你的生活。学习科学，分享科学，爱上科学，让我们共同聆听来自科学的声音。

《爱上科学》系列科普丛书是一套引进版系列科普丛书，译自英国大型出版商棕熊图书（BROWN BEAR BOOKS）有限公司出版的著名系列科普图书《Facts at Your Fingertips》，其独特的科学解读视角、生动的科普画面、优美的图文设计，得到了欧洲读者的青睐，尤其是得到了欧洲青少年的极大欢迎。本丛书为读者全面地讲述了各个领域的基础科学知识和基本事实，以精彩的主题、通俗的文字、生动的画面为特色，从我们身边的素材和现象出发，激发和培养读者学习的兴趣。

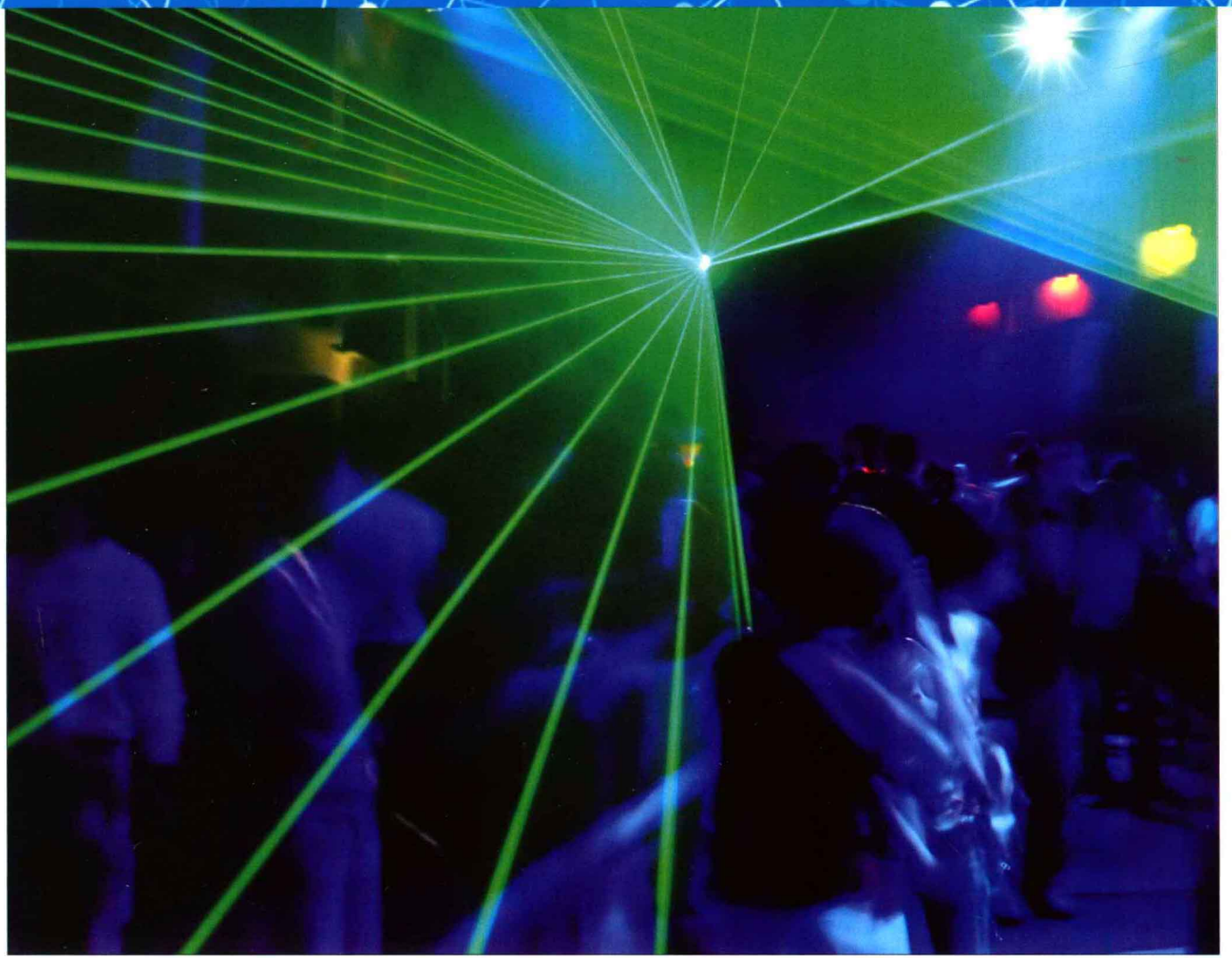
丛书涵盖物理、化学、生物、科技与发明四大系列。物理系列阐释和说明了物理学知识及其发展史，包含对物理学发展史许多重大的物理发现以及著名的物理学家的介绍。化学系列主要阐释现代化学的基本概念，涵盖化学反应、有机化学、生物化学、金属、非金属、分子、原子、物态等多方面内容。生物系列主要阐释生命科学的基本概念，并探讨有关生物学的各个方面，包括植物学、微生物学、动物和人类、遗传学、细胞生物学以及生命形式等。科技与发明系列主要介绍各种科技成果以及相关发明，覆盖多个领域，包括建筑、交通、医学、军事、能源以及航空航天等，指导读者认知和学习各种科学技术，拓宽视野，引发思考，提升创新能力以及发明意识。

本丛书还具有中英双语的独特设计，让读者在阅读中文时，能对照性地阅读英语原文，为他们提高科学领域的英文阅读能力以及扩展科学类英语词汇量提供了很好的帮助。

丛书中还有“试一试”栏目，该栏目包含了丰富有趣的家庭小实验，为大家在生活实践中验证科学知识提供了更多的选择。

学无止境，让我们一起爱上科学！

目录 CONTENT



《爱上科学——绚丽光与声》讲述了基础物理学研究的过程和现实意义。光与声音都是以波的形式传播的能量类型。光是电磁辐射的一种，但是与无线电波和X射线等其他形式的电磁辐射不同，我们可以用肉眼看到它。声波必须通过介质传播，这种介质通常是我们周围的空气，声波也可以通过液体和固体传播。在这部丛书中，我们将讨论光的性质，其中包括光是如何产生，如何传播，如何被反射、折射，以及光的颜色和人们如何用眼睛看到光这些特性。本书还会介绍声音的性质以及声音产生和记录的方法，这包括人类的耳朵如何听到声音以及我们的发声器官如何发出声音。

针对上述内容以及物理学发展过程中的主要科学家，我们采用了大量直观图表、生动的插图、电磁特性的详细描述，并对主要的“科学词汇”进行了定义，内容丰富，形式多样。本书中有一个特色内容叫“试一试”，主要是对一些实验内容进行简要介绍，通过这些实验，我们就可以开始对物理应用进行初步的研究了。

PRODUCING LIGHT

Light is a type of radiation—the only type that we can see. It is produced whenever anything gets very hot, for example, in a candle flame or an electric bulb s filament. There are also cold sources of light, such as a fluorescent tube or a firefly.

Flames from a burning fuel such as wax or oil provided people with their earliest sources of light. Candles are made by surrounding a stringlike wick with a cylinder of wax. The heat of the flame melts the wax next to the wick, and the wax burns to produce light. An oil lamp also has a wick that dips into a reservoir of oil such as kerosene. In the candle and the oil lamp, the burning of the fuel is an example of combustion—a chemical reaction in which the fuel combines with oxygen, giving out heat and light in the process.

The first major improvement on wicks came with gas lighting, using flammable coal gas. This gas normally burns with a yellow smoky flame. But by introducing air and adding a mantle, a white light is produced. The mantle is a mesh coated with the oxides of various rare metals, which become incandescent—emitting a bright light—when they are heated by the gas flame.

SCIENCE WORDS

- **Fluorescent bulb:** Also called a fluorescent tube, an electric lamp consisting of a tube containing mercury vapor, with electrodes at each end. Electric current flowing between the electrodes makes the mercury vapor emit ultraviolet light. This strikes the lining of the tube, which is made from phosphor, a substance that gives off bright white light.
- **Incandescence:** The emission of light by an object that is heated to white heat.
- **Incandescent lamp:** An electric bulb that has a filament (usually made of tungsten) in a glass globe containing traces of an inert gas such as argon. The electric current heats the filament to incandescence.

A firefly—also called a lightning bug—is a type of beetle that produces a flashing light from its abdomen. Different species flash at different rates so that they can recognize one another. The light is produced by a chemical process within the bug's body.

Light from electricity

The earliest form of electric light was the arc light. Developed by the English scientist Humphry Davy (1778–1829) in 1808, it consists of two carbon rods, called electrodes, with their ends a short distance apart. When the electrodes are connected to a high-voltage supply, a very bright spark (called an arc)

forms between the electrodes. Modern arc lights, with metal electrodes, are used in movie projectors and searchlights.

When an electric current passes along a piece of thin wire, the wire gets hot. It may get red hot and even white hot before it melts or burns away. In the 1870s, inventors in the United States and Great Britain tried to find ways of making an electric bulb with a filament that would get white hot without it burning away. In 1879, Thomas Alva Edison (1847-1931) in the United States and Joseph Swan (1828-1914) in Britain independently produced incandescent electric bulbs.

As a filament they used a thin carbon fiber enclosed in a glass vessel from which all the air had been pumped out. Modern bulbs have a thin piece of tungsten wire as a filament and contain an inert gas-one that does not react chemically-such as argon, rather than a vacuum.

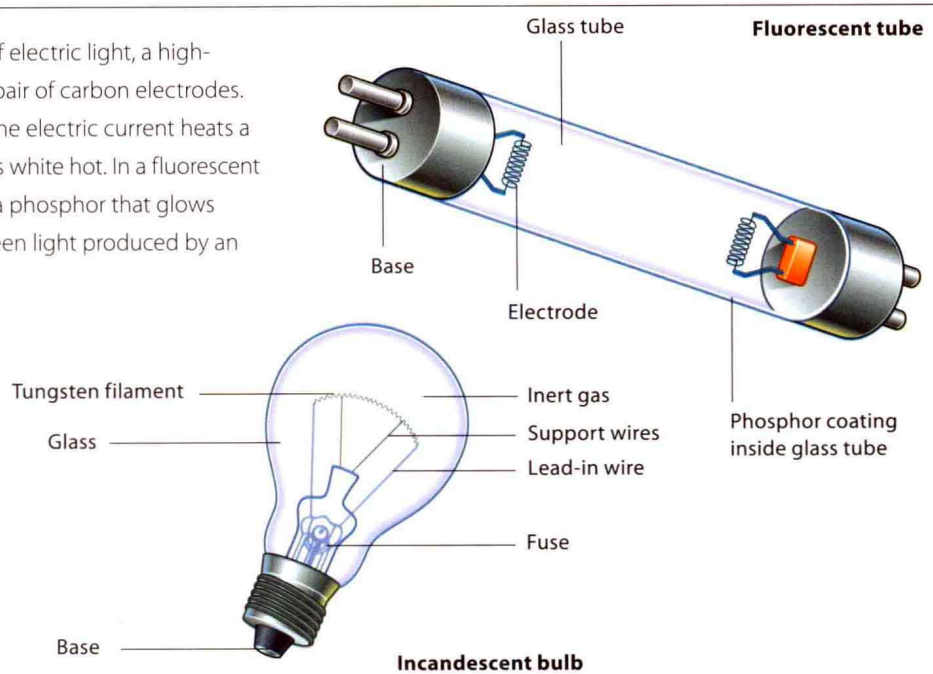
Cold light

Toward the end of the 19th century scientists experimented with passing electricity through gases: metal electrodes carried current to and from a glass tube containing gas at low pressure. Neon gas, for example, produces a bright orange light, as used in advertising signs. Mercury vapor produces a blue-green light. The inside of a modern fluorescent tube is coated with a phosphor, which gives off white light when illuminated by a mercury-vapor light inside it.

In the natural world, some animals and plants produce light. Fireflies (which are actually beetles) and glowworms (beetle larvae) are familiar examples, and there are also some deep-sea fish, such as the angler fish, that emit light to attract their prey in the blackness of the ocean bottom. This type of light production is known as bioluminescence.

ELECTRIC LIGHT

In the arc light, the earliest type of electric light, a high-voltage spark passed between a pair of carbon electrodes. In a modern incandescent bulb, the electric current heats a tungsten filament until it becomes white hot. In a fluorescent tube, the main light comes from a phosphor that glows when illuminated by the blue-green light produced by an electric current flowing through mercury vapor.



光是一种辐射——它是唯一一种我们能够用肉眼看到的辐射。物体发热就会产生光，例如，蜡烛的火焰和灯泡的灯丝。冷光源也是存在的，例如，荧光灯或是萤火虫。

燃料燃烧产生的火焰带给人们最初的光源，例如蜡或是油的燃烧。人们将线状的灯芯外面裹上圆柱形的蜡制成蜡烛。火焰的热量融化了灯芯外面的蜡，蜡燃烧从而产生光。油灯也有一根灯芯，灯芯的一端浸在装满煤油的蓄油箱里。蜡烛和油灯里燃烧的火焰是氧化反应的一个实例。氧化反应是物质与氧发生的化学反应，这个过程会释放出光与热。

人们对灯芯的改进产生了气体照明设备，它采用的是可燃烧的煤气。这种气体燃烧时通常会产生黄色的烟状火焰。但是，通过引入空气并加上覆盖物，就产生了白光。这个覆盖物涂满多种稀有金属氧化物，这些氧化物被煤气火焰加热时会发出白色的光。

萤火虫是一种腹部会发光的甲壳虫。不同种类的萤火虫所发出的光亮度不同，这样，它们可以辨别彼此。这种光来自虫子身体内的化学反应。

科学词汇

- **荧光灯：**也称作“荧光灯管”，是一种由含有汞蒸气的玻璃管构成的电灯，灯管两端内置电极。电流通过两个电极之间时，管内汞蒸气产生紫外线光。这种光“点燃”灯管内壁的磷化剂，释放出明亮的白色灯光。
- **白炽光：**物体加热至白热时释放出的光线。
- **白炽灯：**一种装有灯丝（通常由钨丝制成）的玻璃灯泡。灯泡内含有例如氩气之类的惰性气体。电流加热灯丝从而产生白炽光。

电能产生的光

弧光灯是电灯的最早的形式。这种光设备由英国科学家亨弗瑞·戴维（1778—1829）于1808年研制，它由两个被称为“电极”的碳棒构成，这两个电极的末端稍稍分开。当两个电极被连接到高电压时，电极中间就会产生明亮的电火花（称作“弧光”）。现在带有金属电极的现代弧光在电影放映

机和探照灯中使用。

当电流通过一条细电线时，电线会变热。在电线熔化或被烧掉之前，它会发出赤红色的热光甚至是白光。19世纪70年代，美国和英国的发明家们试图制成一种电灯泡，让它的灯丝发出白光但不烧成灰烬。1879年，美国的托马斯·阿尔瓦·爱迪生（1847—1931）和英国的乔瑟夫·斯旺（1828—1914）分别独立制造出白炽灯泡。他们采用一种碳纤维作灯丝，将它盘放在一个抽成真空的玻璃容器里。现代电灯泡采用钨丝做灯丝，灯泡内并非真空而是充满氩气或其他惰性气体——这种气体不产生化学反应。

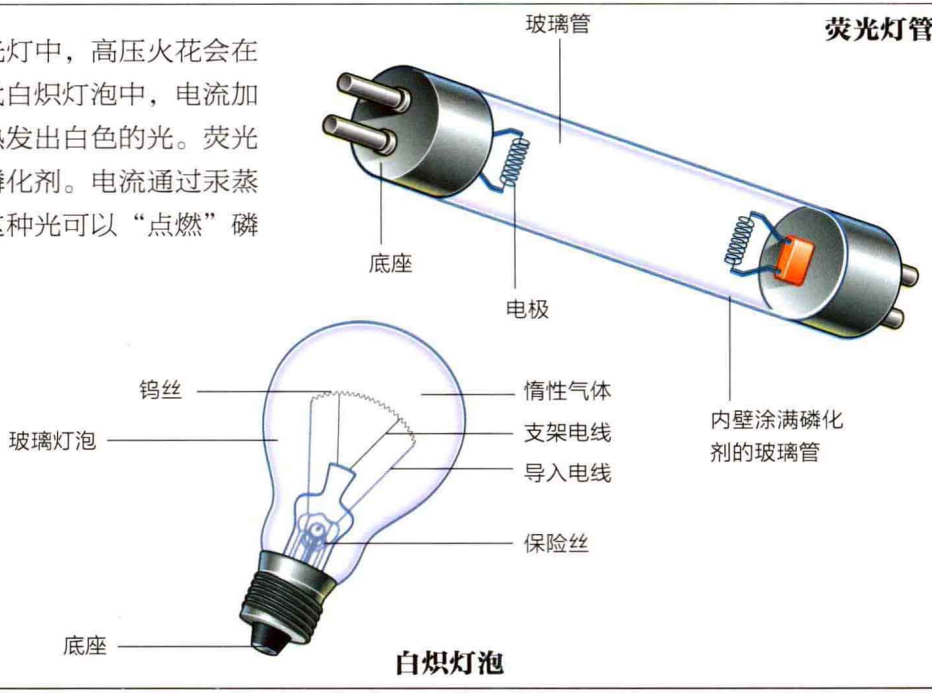
冷光

19世纪末，科学家们在实验中将电流通过气体：金属电极携带电流从充满低压气体的玻璃试管中来回通过。例如，氖气会产生明亮的橘黄色灯光，人们将它应用在广告牌上。汞蒸气会产生蓝绿色灯光。现代荧光灯的内部涂满磷化剂，当汞蒸气从里面点亮这种荧光剂后，它会发出白色的光。

自然界中，有些动物和植物也会发光。萤火虫（一种昆虫）和萤火虫幼虫（昆虫的幼虫）就是大家熟悉的例子，深海中也有通过自身发光在黑暗的海洋底部吸引猎物的鱼类，例如琵琶鱼。这样的发光方式我们称作生物发光。

电灯

在电灯的早期形式弧光灯中，高压火花会在两个电极之间产生。在现代白炽灯泡中，电流加热灯泡中的钨丝直到它变热发出白色的光。荧光灯管中，主要的光源来自磷化剂。电流通过汞蒸气时会产生蓝绿色的光，这种光可以“点燃”磷化剂从而使它发光。



LIGHT AS A FORM OF ENERGY

All forms of energy can be converted into one another. We saw on the previous pages that chemical reactions and electricity can produce light. Here we look at how light can be changed into other forms of energy, thus enabling plants to grow and also producing enough electricity to power, for example, a space probe.

The major source of energy on Earth is light from the Sun. Without it no form of life could survive for long. That is because sunlight provides the energy for photosynthesis, the process by which green plants convert carbon dioxide (from the air) and water (from the soil) into oxygen and foods such as sugars and starches. Animals are either herbivores (plant eaters), or carnivores (i.e. they eat other animals that eat plants). So if there were no sunlight, there would be no plants or animals.

SCIENCE WORDS

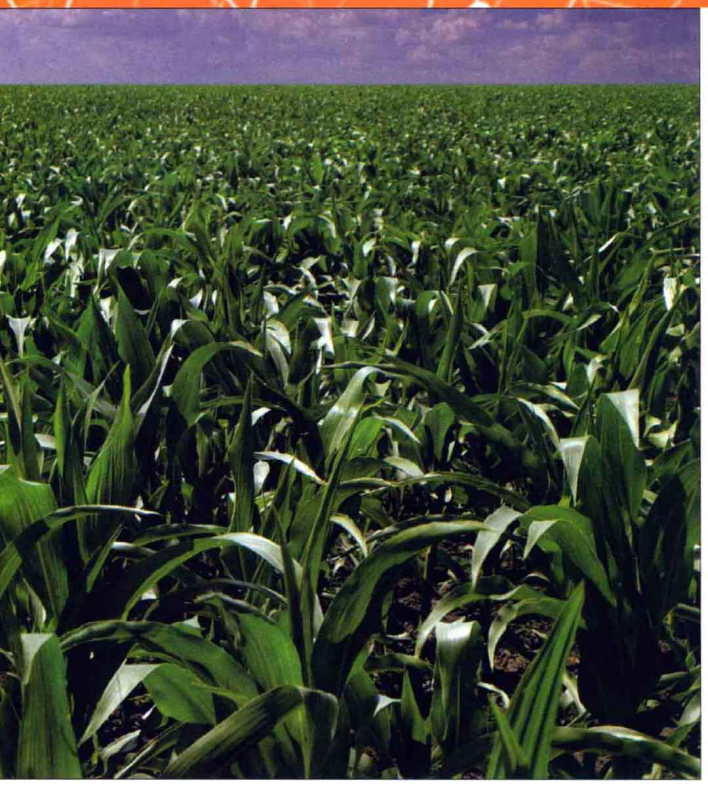
- **Electron:** A subatomic particle with a negative electric charge. Electrons surround the nucleus of an atom. They play a key role in electricity, magnetism, and conducting heat.
- **Photoelectric cell:** Also called a photocell, a current-producing device consisting of an element such as silicon that emits electrons when struck by light.
- **Solar panel:** 1. A device consisting of hundreds of photoelectric cells used, for example, to provide the electric power for space probes. 2. A thin tank containing water and painted black. It absorbs the Sun's sradiation, which heats the water.

A field of growing corn soaks up the sunshine, using the energy of sunlight to convert carbon dioxide and water into sugar and oxygen. The sugar is stored in the plants, while the oxygen passes into the air.

Light into other energy forms

In photosynthesis, light energy is converted into chemical energy, which is then stored in sugar and other plant tissues. This is a natural, biological process. But the conversion of light into electricity involves some quite advanced physics.

The simplest form of conversion takes place in a photoelectric cell, like the type used to measure light levels in a photographer's light meter. The key to a photoelectric cell is a substance, such as the semi-metallic element silicon, that emits electrons when light shines on it. The electrons are collected and form an electric current. Photoelectric cells are used to turn streetlights on and off automatically (they respond to the amount of daylight) and in burglar alarms.



The current produced by a single photoelectric cell is very small. For larger currents, hundreds of cells are constructed as panels. Large solar panels of this type are used to power the communications and control systems of space probes.

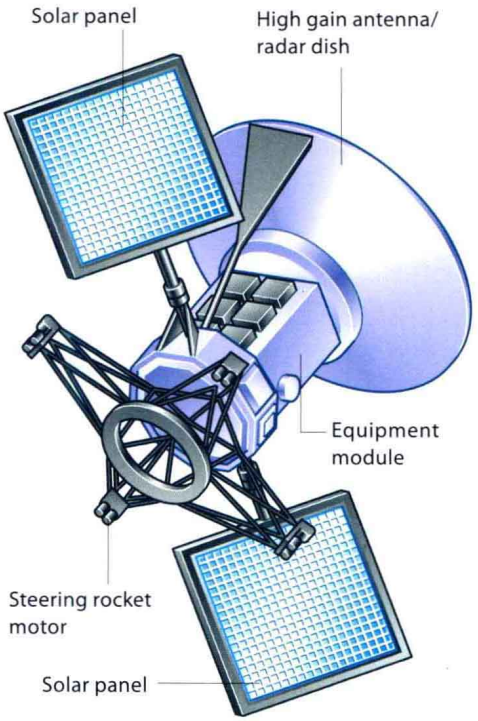
Solar panels on a roof collect the Sun's light radiation and convert it into electricity for use in the home. In another type of solar panel, the radiation heats water for the home 's hot-water system.

Light into heat

Solar panels of a different type can be seen on the roofs of some buildings. They consist of very thin hollow panels containing water, with one of the large surfaces blackened and positioned so that it faces the Sun for most of the day. The blackened surface absorbs solar radiation and heats water that is pumped through the panel. The warmed water may be used in a heating system—it takes less extra energy to heat water that is already warm than to heat cold water.

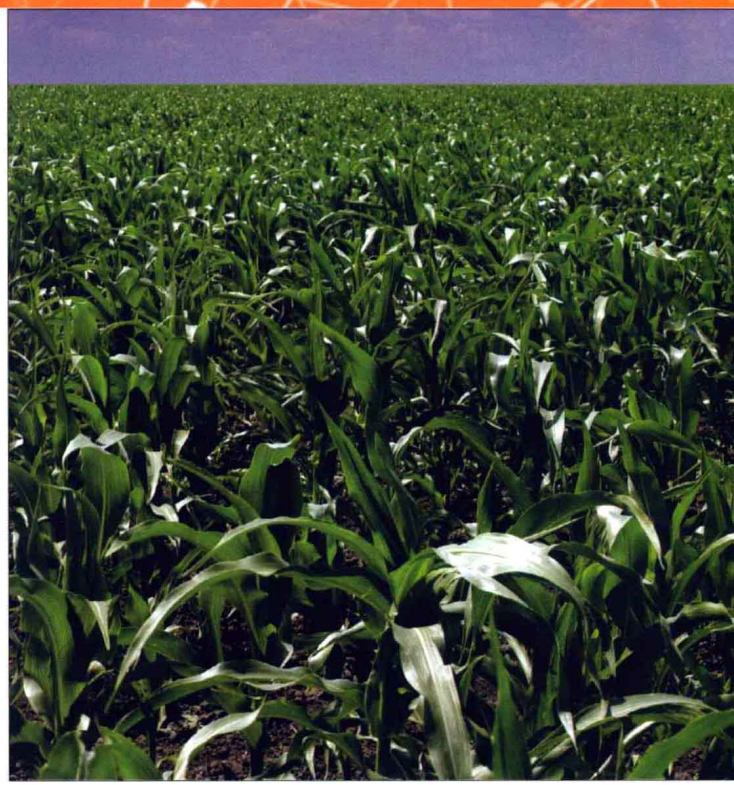
POWER IN SPACE

The large "paddles" on the Magellan space probe each contained hundreds of photocells. They converted sunlight into electricity to power the probe' s electronic systems.



任意形式的能量都可以相互转化。通过前几页的学习，我们知道化学反应和电能都可以产生光。这一章我们要学习如何将光转化成其他形式的能量，也就是光如何帮助植物生长以及如何产生足够的电能，为航天探测器等用电设备提供能量。

地球上的主要能源来自阳光。没有阳光，万物都无法生存。这是因为阳光为光合作用提供能量。光合作用是指绿色植物将二氧化碳（来自空气）和水（来自土壤）转化成氧气以及糖和淀粉等食物的过程。地球上的动物分为食草类（以植物为食物）和食肉类（以食草类动物为食物）。所以，没有阳光，地球上就没有动物和植物。



田地里的玉米在尽情地吸收着阳光。它们借助光能将二氧化碳和水转化成糖分与氧气。其中糖分储存在植物里，氧气被释放到空气当中。

科学词汇

- **电子：**带负电的小于原子的粒子。电子包围在原子核的周围。它们在电学、磁学以及导热方面发挥着重要的作用。
- **光电管：**又称作“光电池”，一种产生电流的元件。内部含有硅之类的元素，这种元素被光照射后会释放电子。
- **太阳能集热器：**（1）含有数百个光电管的装置，可以为太空探测器等提供电能。（2）内部装满水的容器，外壁涂成黑色。它通过吸收太阳辐射给水加热。

光转化成其他能量形式

光合作用中，光能被转化成化学能存储在糖分和其他植物纤维中。这是一个自然的生物过程。但是光能转化成电能则需要非常复杂的物理过程。

光电管是光能转化成电能的最简单形式。光电管就像是摄影师用来测试光亮度的曝光表中的零件。它含有一种重要的半导体元素，如硅。这种元素经过光的照射会释放电子。电子经过聚集会产生电流。道路两旁的自动路灯（根据阳光的多少自动调节）和防盗警报器都采用了光电管。

单个光电管产生的电流量非常小。将大量光电管集合在一起，组成集热器就可以产生大量电流。航天探测器上的大型太阳能集热器就是用来为它的通信和控制系统提供能量的。

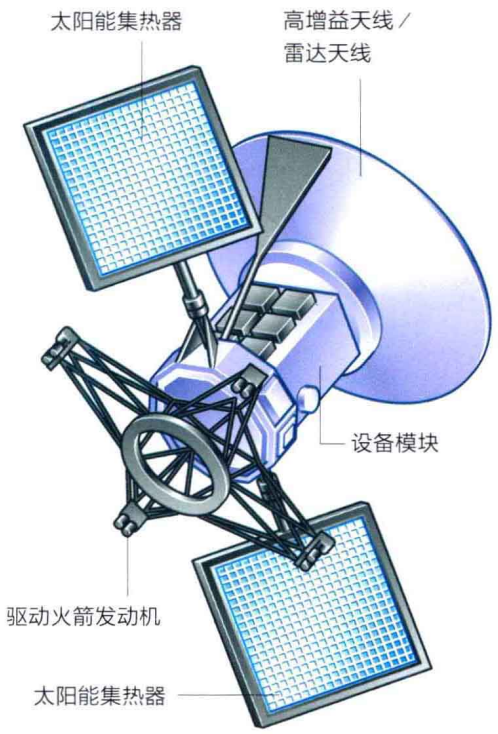
屋顶上的太阳能集热器收集阳光辐射并把它们转化成电能以供家庭使用。另一种是太阳能集热器可以用收集的辐射加热家庭热水系统中的水。

光转换成热

我们看到许多大楼顶上装有各式各样的太阳能集热器。这些很薄的中空的集热器内装满了水，它们的表面是黑色的。人们将它们固定在屋顶上，这样它们就可以终日对着太阳。集热器黑色的表面吸收太阳辐射，给抽进集热器内的水加热。热水可以在供热系统中得到使用——比起直接加热冷水，这样加热已经温热的水会减少很多能源消耗。

太空中的能量

图中麦哲伦太空探测器上两个大大的像桨一样的电池板上聚集了数百个光电池。它们将光能转化成电能给探测器的供电系统提供能量。



PROPAGATION OF LIGHT

Light from a source such as the Sun or an electric lamp travels out in all directions at an incredibly high speed. It travels in straight lines. Light passes right through transparent substances such as glass and clear plastic. Substances that do not allow light to pass through them are called opaque, and opaque objects cast shadows.

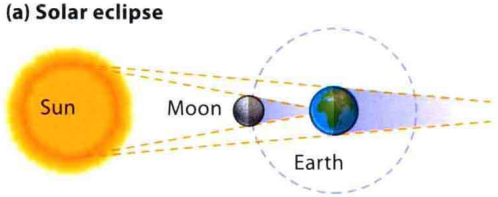
Proving that light travels in straight lines is easy because it makes opaque objects in its way cast shadows. The shadows produced by a small concentrated light source have sharp edges. The shadow is the area that the rays of light from the source cannot reach.

LUNAR AND SOLAR ECLIPSES

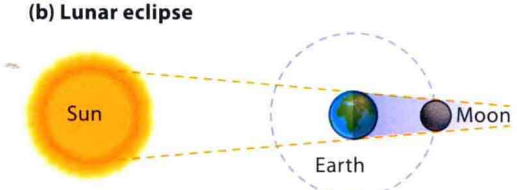
(not to scale)

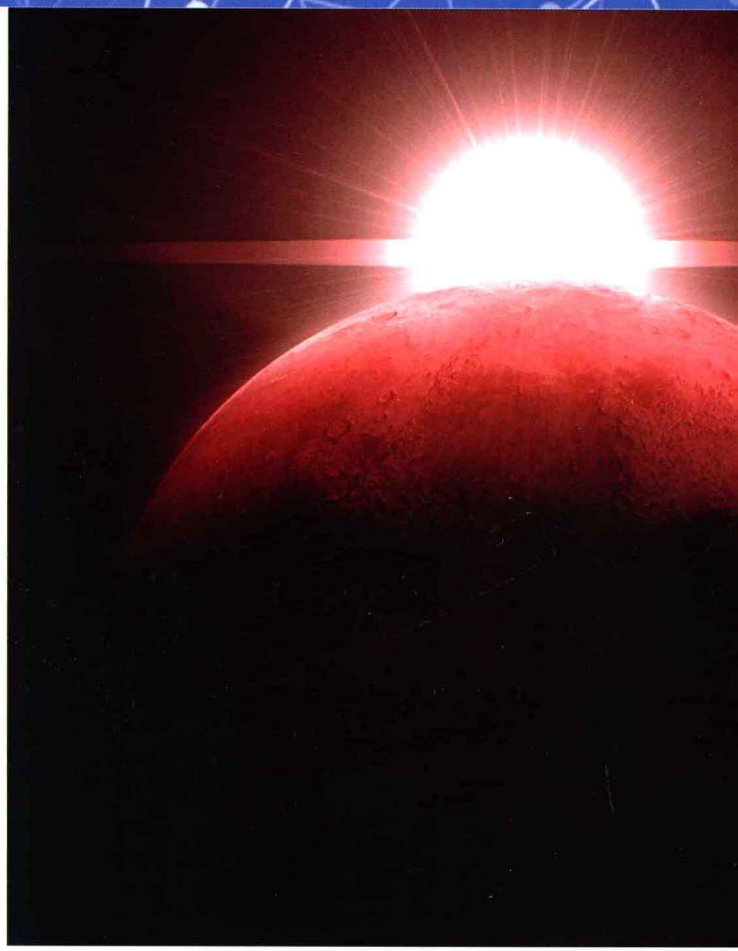
During a solar eclipse (a) the Moon passes between the Earth and the Sun, stopping the Sun's light from reaching the Earth. During a lunar eclipse (b) the Earth blocks light from the Sun so that the light cannot reach the Moon and let it shine.

(a) Solar eclipse



(b) Lunar eclipse





The biggest shadow we can ever see is the shadow of the Earth itself. The Sun makes the Earth cast a long shadow into space, pointing away from the Sun. Occasionally the Moon moves into the Earth 's shadow. The Moon shines by reflecting light from the Sun. But when the Earth 's shadow falls on the Moon, the Moon ceases to shine. This is called an eclipse of the Moon, or a lunar eclipse.

Sometimes the Moon, moving in its orbit, passes exactly between the Earth and the Sun. A shadow of the Moon tracks across the face of the Earth. For anybody in this shadow, the Moon blocks out the light of the Sun, and it becomes nearly as dark as night. This is called an eclipse of the Sun, or a solar eclipse.

Solar eclipses are important to astronomers because they allow