阅读空间 · 英汉双语主题阅读

高中和大学低年级适用

科学告诉你

Only Science Knows

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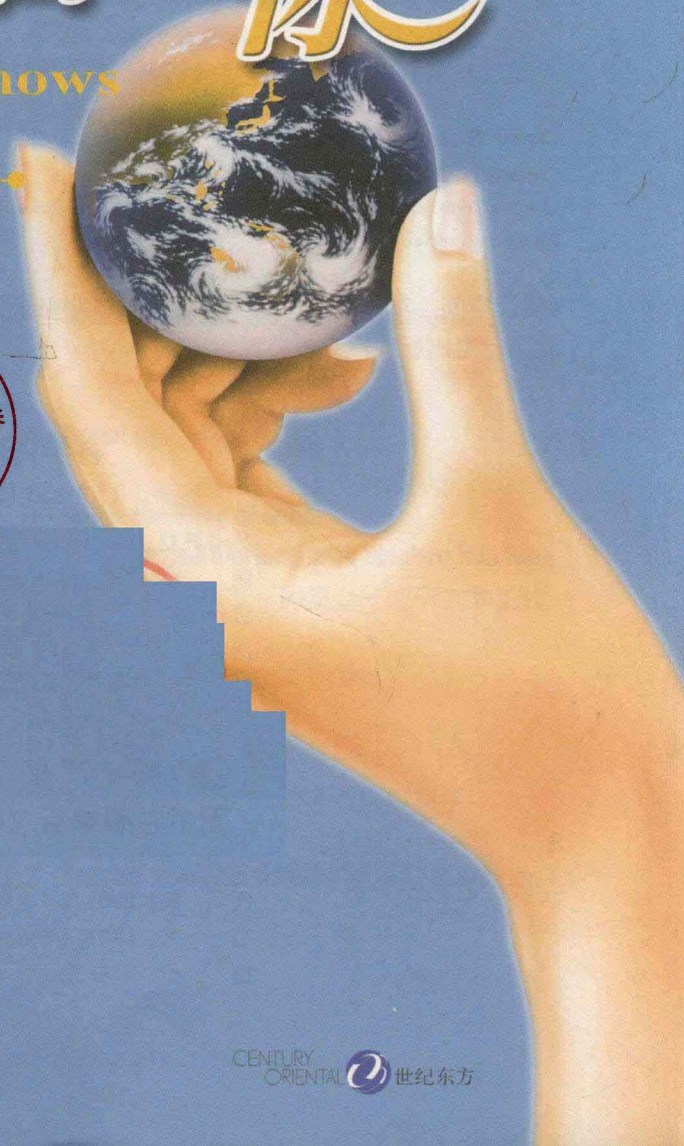
庞丽霞 译



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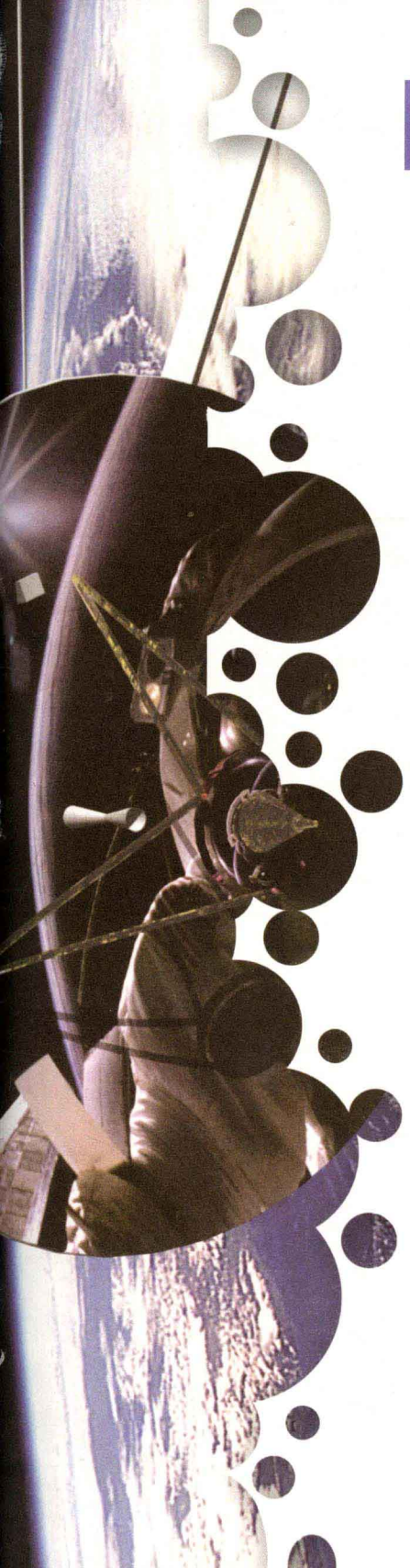

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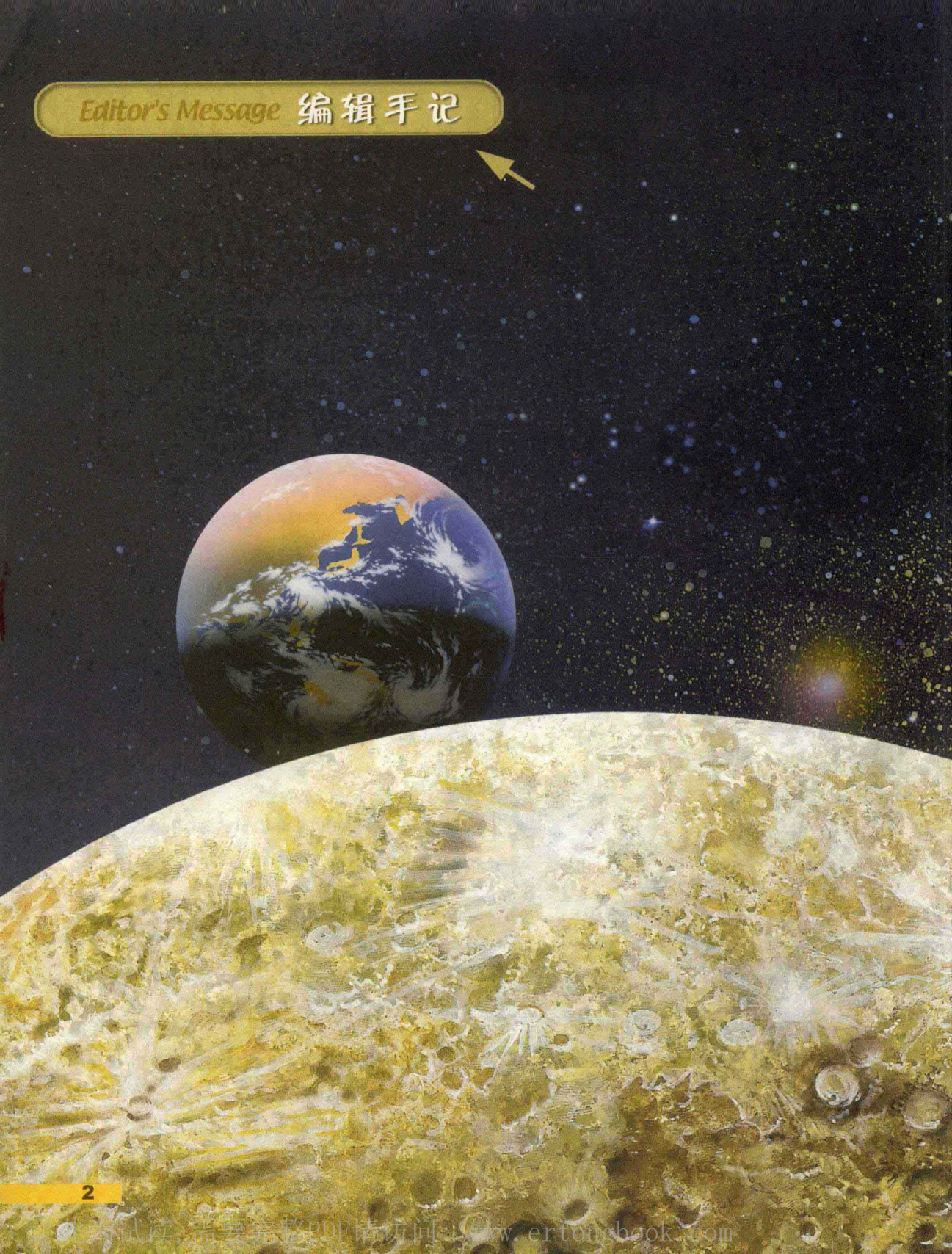
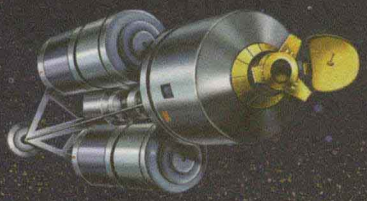




夏洛克·福尔摩斯同世界上两位最伟大的理论物理学家有什么共同之处呢？这就是他们都有着非凡的科学推理能力。小说中的福尔摩斯能够找出谜案的真相，而阿尔伯特·爱因斯坦、史蒂芬·霍金却能够揭开物质世界中一些最令人感兴趣的谜团。

什么是科学幻想？什么是真正的科学？两者的根本区别在哪里？科学幻想是否都会在一定的时候成为科学事实？在科幻世界和现实社会之间想要找到我们的位置即一个空间—时间的社会坐标，就需要在两者之间构建起最短的连接，此时就需要真正的科学出场了。

若想认识我们生活的世界及围绕着世界的一切，就让科学来告诉你吧。

推理大师

by Donald Ruehrwein

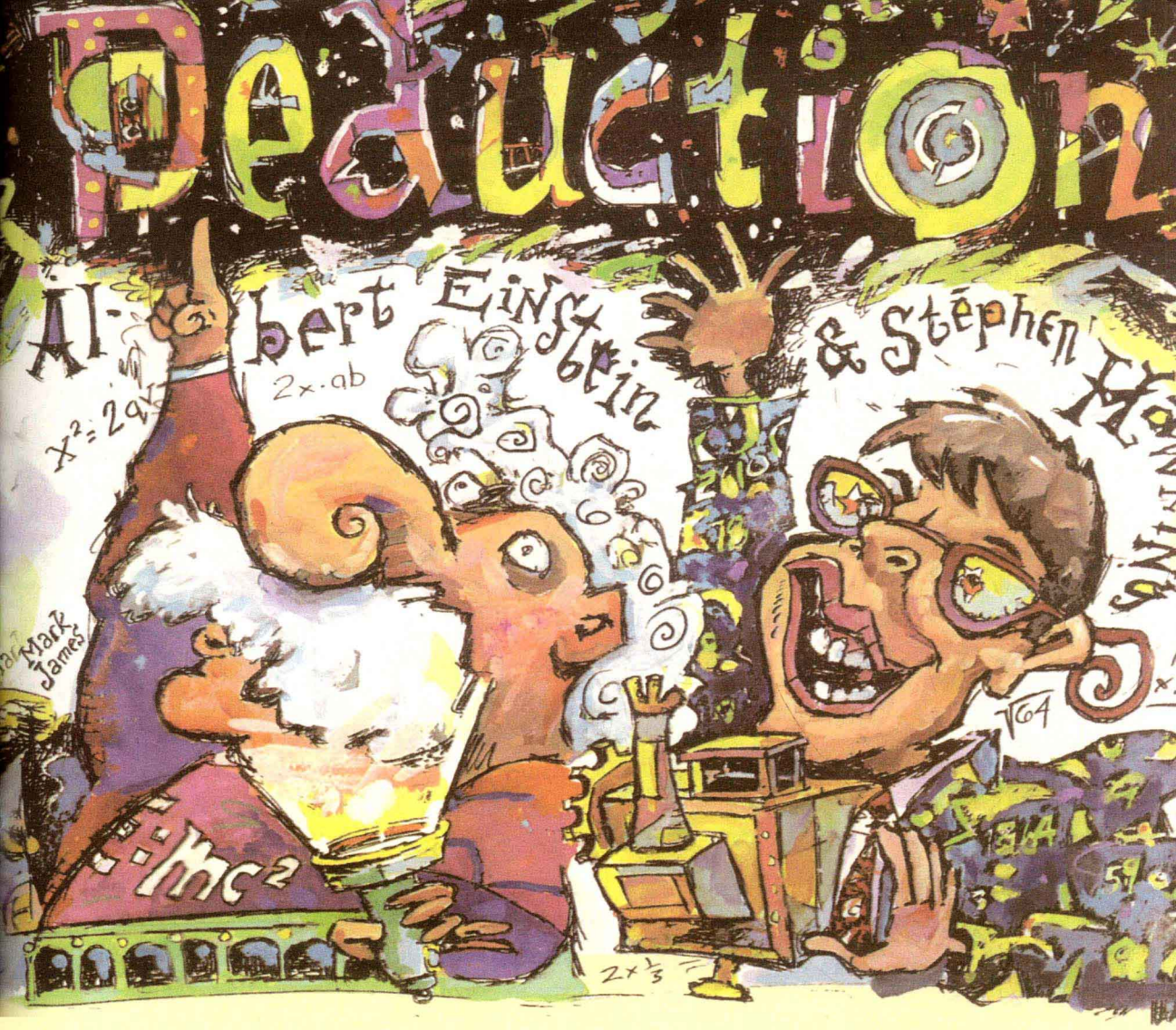
illustrated by Mark James

What does Sherlock Holmes have in common with two of the world's greatest theoretical physicists? Brilliant deductions. While the fictional Holmes is able to deduce the solution to criminal mysteries, Albert Einstein and Stephen Hawking have deduced solutions to some of the most intriguing mysteries of the physical universe. Let's take a look at how they made their deductions.

A young woman shivers with terror. She tells **Sherlock Holmes** of her sister's mysterious death. Now the woman fears for her own life. With this plea

夏洛克·福尔摩斯同两位世界上最伟大的理论物理学家有什么共同之处呢？这就是他们都着有非凡的推理能力。小说中的福尔摩斯能够找出谜案的真相，而阿尔伯特·爱因斯坦、史蒂芬·霍金却能够揭开物质世界中一些最令人感兴趣的谜团。让我们来看一看他们是如何进行推理的。

一位年轻的女子被吓得浑身颤抖。她向**夏洛克·福尔摩斯**讲述了她姐姐神秘的死亡。这名女子现在也在为自己的性命担忧，因此她向福尔摩斯求助。福尔摩斯探案

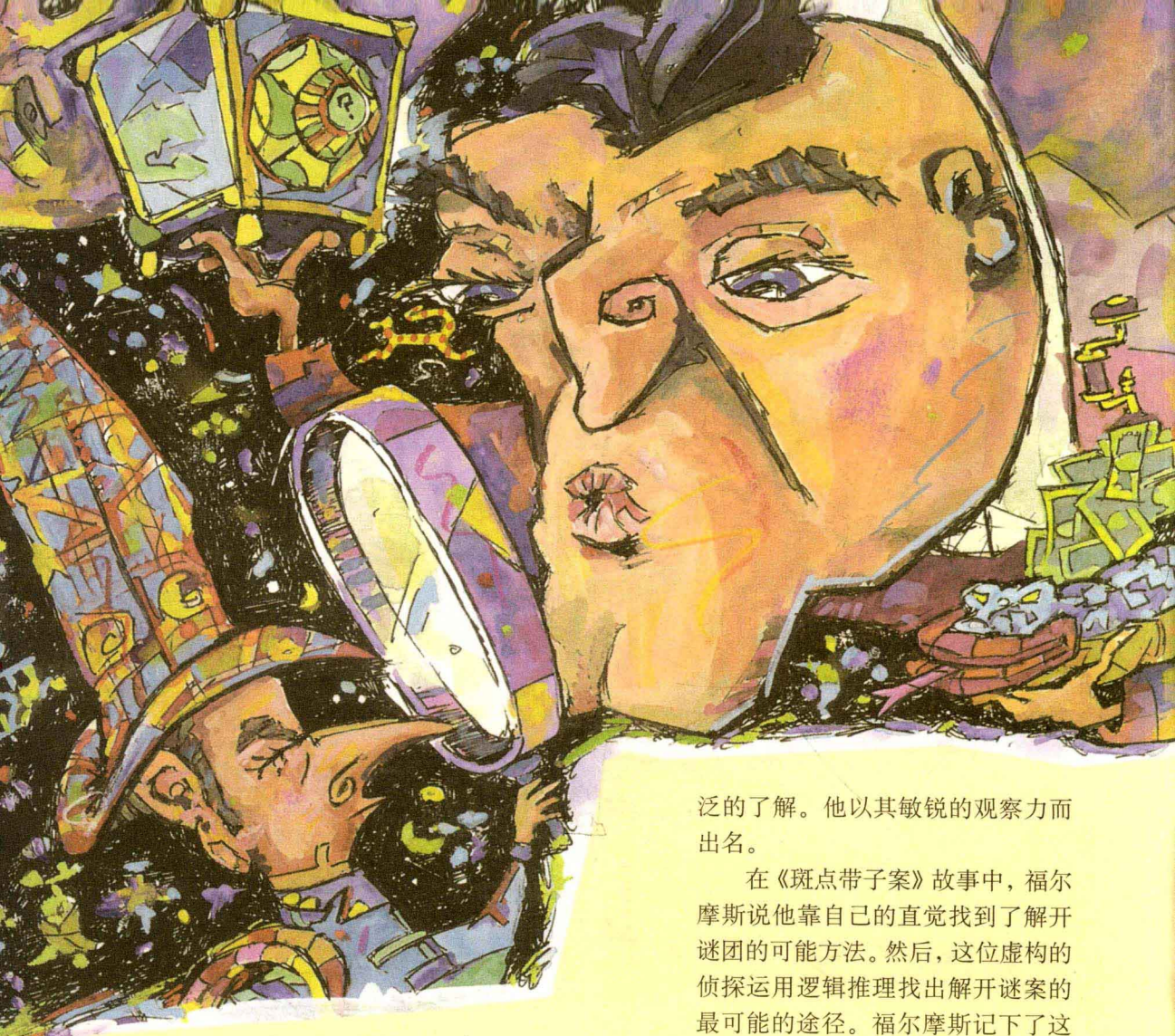


for help, Sir Arthur Conan Doyle, the author of the Sherlock Holmes mysteries, begins *The Adventure of the Speckled Band.* Holmes travels to the woman's home to investigate, and develops a theory of how the sister was murdered. He then sets a trap and exposes the murderer.

Sherlock Holmes uses four powerful tools to solve a mystery: **knowledge**, **observation**, **intuition**, and **deduction**. Holmes has studied many subjects to prepare himself for solving mysteries. He has extensive knowledge of poisonous plants, soil types,

集的作者阿瑟·柯南·道尔爵士，就这样开始了《斑点带子案》的故事。福尔摩斯来到这名女子家中，开始调查。然后，他就这名女子的姐姐被谋杀的过程形成了自己的理论。接着，他设置了一个陷阱，使凶手自己暴露出来。

夏洛克·福尔摩斯在破案过程中运用了四件强大的武器：**知识**、**观察**、**直觉**和**推理**。为了给自己探案作准备，福尔摩斯学习了许多门知识。他对有毒植物、各种土质、化学、解剖学、法律和犯罪史都有着广



chemistry, anatomy, the law, and the history of crime. He is famous for his powers of observation.

In *The Adventure of the Speckled Band*, Holmes credits his intuition for generating possible solutions to the mystery. Then, using logic, the fictional detective is able to deduce the mystery's most likely solution. Holmes notes important details from the woman's report:

* The stepfather has a severe temper and has suffered financial losses.
* He holds money in trust for the sisters.
* He keeps exotic animals.

泛的了解。他以其敏锐的观察力而出名。

在《斑点带子案》故事中，福尔摩斯说他靠自己的直觉找到了解开谜团的可能方法。然后，这位虚构的侦探运用逻辑推理找出解开谜案的最可能的途径。福尔摩斯记下了这名女士向他汇报的一些细节：

* 她们的继父脾气暴躁并且损失了钱财。
* 他受托保管姐妹俩的财产。
* 他饲养一些奇异的动物。
* 在死前的几个晚上，她姐姐曾说听到过奇怪的声音。
* 验尸官也确定不了她的死因。

福尔摩斯后来进行了细致的观察并且做出了以下记录：

* The sister reported hearing strange noises during the nights before her death.
* The coroner could not determine the cause of her death.

Holmes later makes his own detailed observations and notes that:

* There is a small hole in the wall between the sister's room and her stepfather's room.
* The bell cord in the sister's room is not functional.
* The victim's bed is bolted to the floor.
* The stepfather has a safe in his room.

In this case, Holmes's extensive knowledge of exotic animals and untraceable poisons leads him to conclude that the stepfather used a venomous snake to kill the sister. (Be sure to read this story – one of Sir Arthur Conan Doyle's best – to see how the clues unfold.) He tests his deduction by setting a daring trap. Amid much danger and suspense, the murderer is identified and the mystery is solved.

Now, let's see how two famous scientists have used some of these same techniques to solve the mysteries of the universe.

Albert Einstein's theories have drastically changed our understanding of the physical nature of the universe. He is most well known for his work on the quantum nature of light, the speed of light (the special theory of relativity), and the nature of gravity (the general theory of relativity).

In developing his special theory of relativity, Einstein investigated some unusual occurrences that showed up in experiments measuring the speed of light relative to the Earth. The actual measurements showed that the speed of light relative to Earth when Earth was moving toward the light source was the same as it was when Earth was moving away from the light source. Common sense and centuries of experiments with physical objects led scientists to expect that the two measurements would differ. Why didn't they?

In 1905, Einstein proposed an astounding solution to the mystery. He theorized that the properties of an object

* 在姐姐房间与继父房间中间的墙上有一个小洞。
* 姐姐房间的铃绳不起作用。
* 死者的床被固定在了地板上。
* 继父的房间里有一个保险柜。

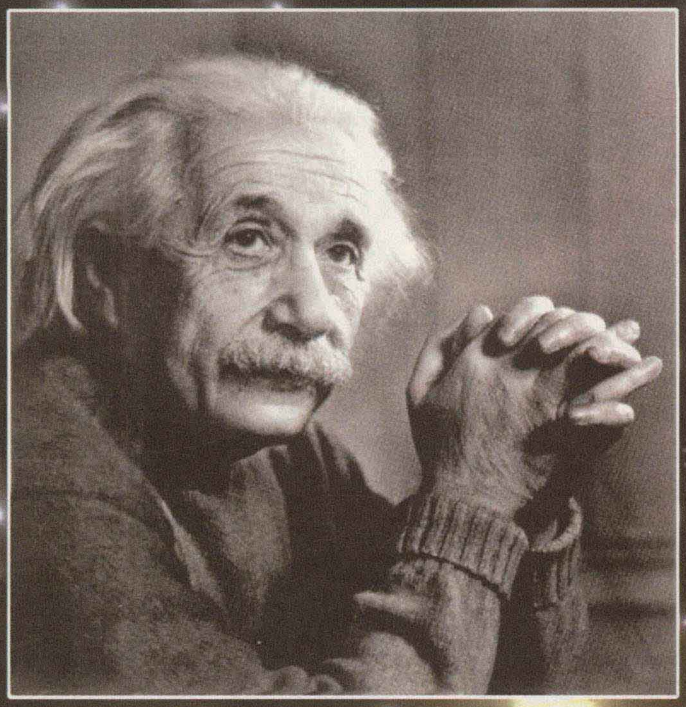
在这一案件当中，福尔摩斯拥有的关于奇异动物和稀有毒药的广泛知识使他得出结论：继父用一条毒蛇毒死了姐姐。(你一定要读一读这个故事，看一看线索是如何一条条地被发现的，它是阿瑟·柯南·道尔爵士写得最好的故事之一。)福尔摩斯大胆地设计了一个陷阱来验证他的推理。在巨大的危险和悬念当中，凶手被找了出来，谜团也被解开了。

现在我们来看一看两位著名的科学家是如何运用同样的技巧来解开宇宙的谜团的。

阿尔伯特·爱因斯坦的理论彻底改变了我们对宇宙的物理性质的看法。他以其对光的量子属性、光速（狭义相对论）和重力性质（广义相对论）的研究而最为出名。

在形成他的狭义相对论的过程中，爱因斯坦对光相对地球的速度进行了测量，并且对实验中出现的一些不寻常现象进行了研究。实际的测量结果显示当地球朝光源运动和远离光源运动时，光相对于地球的速度是一样的。常识和几世纪对物体所做的实验都使科学家们期待这两次测量的结果应当是不同的。然而它们为什么没显示出不同呢?

1905 年，爱因斯坦提出了解开这一谜团的一个惊人的答案。他的理论指出，随着自身运动速度的变



change as its speed changes. As an object travels faster, it becomes smaller and heavier and time passes more slowly. At the speeds that we normally experience on Earth, the changes are extremely small.

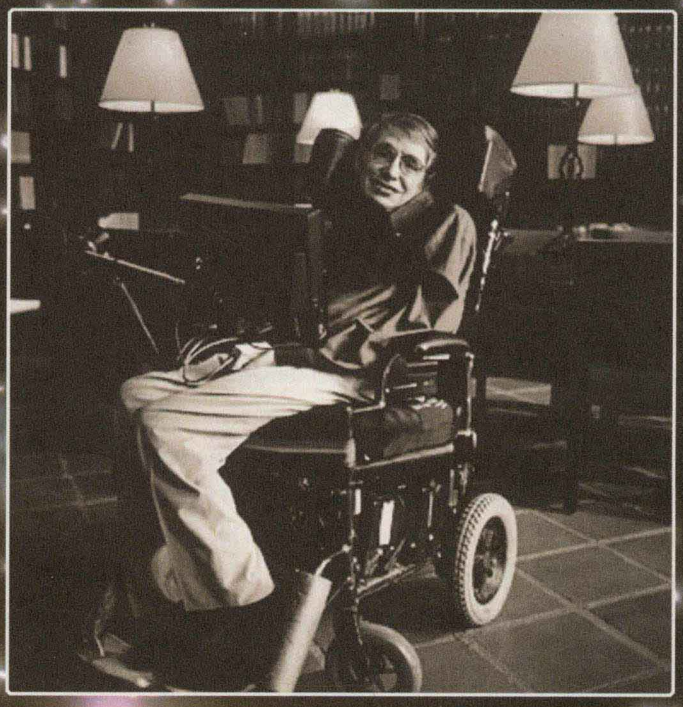
However, as an object approaches the speed of light, the changes become significant. The result is that no matter how fast objects are moving, relative to a source of light, the length of their yardstick and the speed of their clock change, by just the right amounts, so that their measurements always give the same value for the speed of light. Many tests have confirmed the accuracy of Einstein's special theory of relativity.

How did Einstein deduce this revolutionary solution? In Ronald W. Clark's biography of the scientist, *Einstein: The Life and Times*, the author states that "Einstein himself was always ready to agree that inventiveness, imagination, the intuitive approach – the very stuff of which artists rather than scientists are

化，物体的性质也会发生变化。随着物体运动速度变得越来越快，物体也就变得越来越小、越来越重，并且时间也会过得越来越慢。按照我们通常在地球上所经历的速度来看，这些变化是非常小的。

然而，当物体的速度接近光速时，这些变化就极为明显了。结果是，无论物体相对光源运行的速度有多么快，对它们进行测量的长度和时间标准也相应地发生了变化。这些变化恰好使得每次测量所得出的结果与光速的值是一致的。许多实验都验证了爱因斯坦狭义相对论的准确性。

爱因斯坦是如何推出这一具有革命性的答案的？罗纳德·W·克拉克在他写的爱因斯坦传记——《爱因斯坦：生命与时间》一书中指出："爱因斯坦总是



usually thought to be made – played a serious part in his work."

Like Sherlock Holmes, Einstein had prepared himself to solve mysteries, only his subjects were physics and mathematics. The scientist kept in mind observations of the behavior of light that had been made by others. Then, intuition suggested several possible solutions to the mystery, and logic determined the correct solution. The solution included predictions that could be tested and confirmed.

Stephen Hawking's theories have further refined our concepts of the universe. He is best known for his work that explains the nature of black holes and the origin of the universe.

A black hole is an object so dense that it produces extremely strong gravitational forces from which nothing – not even light or any other form of radiation – can escape. In 1973, two other theoretical physicists,

这样认为，独创性、想象力和直觉在他的工作中起到关键作用。而人们一般认为这些品质造就了艺术家而不是科学家。”

同夏洛克·福尔摩斯一样，爱因斯坦也作好准备来解开谜团。只不过他的研究对象是物理和数学。这位科学家大脑中记下了其他人对光的行为所作出的观察。于是，直觉向他提出了一些解开谜团的可能的方案，并且靠着逻辑他确定了正确的答案。这一解答包括了一些可被检验和证实的预测。

史蒂芬·霍金的理论使我们对宇宙的概念得到进一步的完善。他最为出名的成就是对黑洞的本质和宇宙起源所作出的解释。

黑洞是一种密度非常大的物体，它产生极为强大的重力。任何物质，包括光

Yakov Zeldovitch and Alexander Starobinsky, discussed an intriguing concept with Hawking. They theorized that radiation could be produced by quantum effects acting in the space just outside of a black hole. Although the idea seemed to be inconsistent with the very definition of a black hole, Hawking found the logic behind the idea convincing. He was not, however, satisfied with the mathematics used to describe the phenomenon, so he sought another mathematical solution to this mystery.

Hawking went on to develop a mathematical model that explained how this radiation could occur. Hawking's calculations not only verified the basis for what is now called Hawking Radiation, but also provided a precise prediction of the amount of radiation that should be produced by a black hole. Although his calculations have been confirmed by others, the technology does not yet exist to confirm his predictions.

How did Stephen Hawking solve his mystery? Michael White and John Gribbin, in their biography, *Stephen Hawking: A Life in Science*, quote Hawking as saying: "I work very much on intuition, thinking that, well, a certain idea ought to be right. Then I try to prove it. Sometimes I find I'm wrong. Sometimes I find that the original idea was wrong, but that leads to new ideas."

Like Einstein, Hawking prepared himself by studying physics and mathematics. He also used astronomical observations that had been made by others. His intuition then suggested solutions, and he used logic to evaluate them.

或任何形式的射线都不能摆脱它。1973年，另外两位理论物理学家——亚考夫·亚德维奇和亚历山大·斯达罗宾斯基同霍金讨论了一个非常吸引人的概念。他们提出的理论是：作用于黑洞外部空间的量子效应可以产生射线。尽管这一理论看上去同黑洞本身的定义不一致，霍金发现这一想法背后的逻辑是令人信服的。然而，他对描述该现象所用到的数学方法并不满意。于是，他开始寻求另外一个解决这一谜团的数学方法。

霍金又创立了一个数学模型，这一模型解释了这种射线是如何产生的。霍金的计算不仅证实了人们现在所称的霍金射线产生的根据，也对一个黑洞应当产生射线的数量提供了精确的预测。尽管他的计算结果已被其他人证实，但现在还没有能够证明他的预测的技术。

史蒂芬·霍金是如何解决这一难题的？迈克尔·怀特和约翰·葛里宾在他们的传记《史蒂芬·霍金：科学的一生》一书中引用了霍金的原话："我在很大程度上靠直觉工作。当我认为某一想法应当是正确的时候，我就试图要证明它。有时我发现自己是错的。有时我发现最初的想法是错的，但这一错误的想法会使我产生新的想法。"

同爱因斯坦一样，霍金通过学习物理和数学为自己的研究作好准备。他还利用了别人所做出的天文观测结果。他的直觉促使他提出一些解决方法，然后用逻辑推理来检验这些方法。

Become a Science Sleuth

by Donald Ruehrwein

There are plenty of mysteries left in the universe. Choose something in the world of science that is a mystery to you and, like a detective, follow these steps to solve it:

1. Research background information (knowledge).
2. Make detailed observations of the mystery (observation).
3. Generate possible solutions to the mystery (intuition).
4. Evaluate the solutions (deduction).

Do you think step 3 – intuition – is more art than science? Perhaps you're right! Perhaps this part of the process deserves more study.

宇宙中还存在着许许多多的奥秘。在科学世界中选择你感到神秘的东西。然后，像一名侦探一样按照下面的步骤去解开谜团。

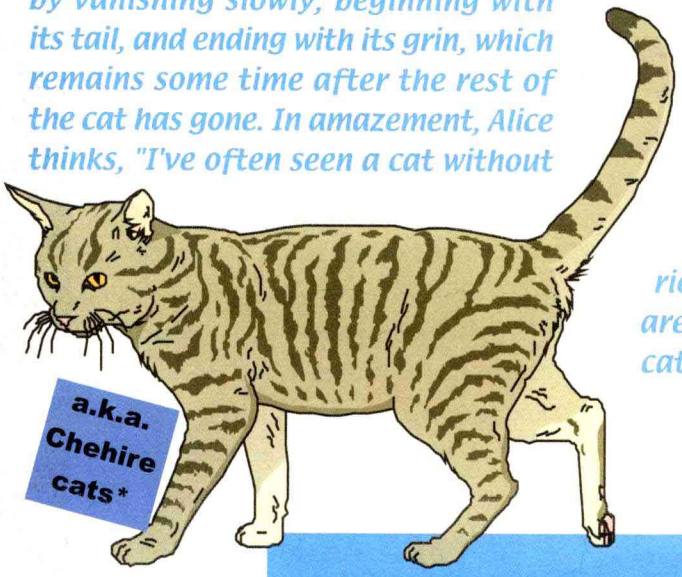
1. 研究背景信息（知识）。
2. 对谜团进行细致的观察（观察）。
3. 设计一些可能解开谜团的办法（直觉）。
4. 检验解决办法（推理）。

你是否认为第三步——直觉更多地是属于艺术而不是科学的范畴呢？也许你是对的。也许整个过程中的这一步骤值得人们更多地去研究。

做一名科学侦探

*In Lewis Carroll's Alice's Adventures in Wonderland, the Cheshire Cat appears and vanishes before Alice's eyes. When Alice asks him not to, the cat responds by vanishing slowly, beginning with its tail, and ending with its grin, which remains some time after the rest of the cat has gone. In amazement, Alice thinks, "I've often seen a cat without a grin; . . . but a grin without a cat! It's the most curious thing I ever saw in all my life."

The phrase "grin without a cat" is sometimes applied to pure mathematics—a science that requires the kind of abstract thought that forms the basis of Stephen Hawking's research on black holes. Because of the very curious nature of black holes, they are often referred to as Cheshire cats.



Black

在刘易斯·卡洛尔的《爱丽丝漫游奇境记》一书中，柴郡的猫在爱丽丝眼前出现又消失了。当爱丽丝告诉它不要这样做时，猫作出的反应是慢慢地消失。先是尾巴，最后是它的笑容。当猫的其他部分都消失后，它的笑容还保留了一段时间。爱丽丝在惊讶之余想到："我经常看到没有笑容的猫。然而，没有猫的笑容是我一生中所看到的最奇怪的的事情。"

"没有猫的笑容"这种说法有时被应用到纯数学当中——这门科学要求人们有某种抽象思维的能力。而正是这种能力才构成了史蒂芬·霍金研究黑洞的基础。因为黑洞的性质十分神奇，它们经常被称作柴郡猫。

Holes

by Terence Dickinson

Black holes are gravity whirlpools so powerful that they can reverse a beam of light, or rip apart an atomic nucleus or an entire star. They are formed when a large object – a massive star – ends its life and collapses into a superdense state. And they pack incredible gravitational punch: Nearby such an object, gravitational forces are so strong that not even light can escape through a black hole's "surface".

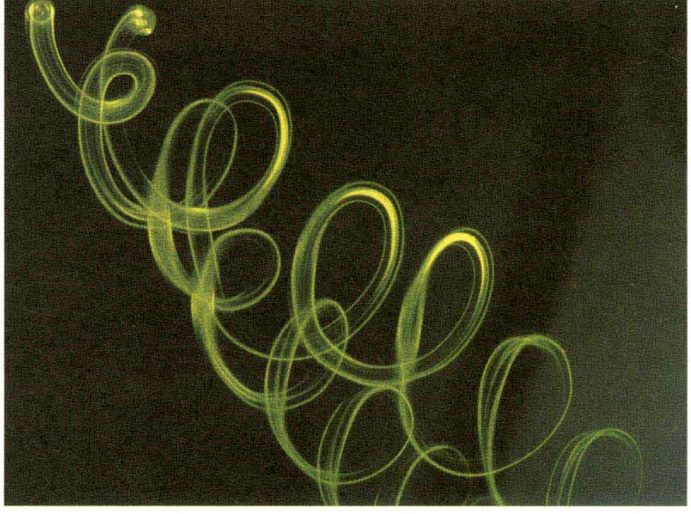
The idea of black holes is so weird that just 40 years ago few astronomers believed they actually existed. They were just a minor theoretical curiosity without a name. Then, in 1969, physicist John Wheeler coined the term "black hole", and the first real evidence that black holes exist came soon after. But the idea that such bizarre objects could exist actually goes back more than two centuries.

In 1784, John Michell, an English clergyman and amateur astronomer and geologist, attempted to calculate the ultimate power of gravity. Familiar with Newton's formulas, Michell knew that for a particle to escape into space from the

黑洞是强大的重力漩涡。它的力量大到可以使光束逆转方向，撕开原子核或一个完整的恒星。当一个巨大的物体——一个庞大的恒星——结束了自己的生命时，它就会坍缩成一种超密度的状态，黑洞就这样形成了。同时它们形成巨大的重力冲击：在这样的物体(黑洞)附近，就连光也不能逃离它的“表面”。

黑洞的概念简直太不可思议了，以至于在40年前几乎没有天文学家相信它们的真实存在。那时，它们仅仅是没有名称的理论上的新奇事物。到了1969年，物理学家约翰·威尔勒创造了“黑洞”一词。很快，人们第一次发现了黑洞存在的真实证据。然而，实际上早在两个多世纪前，人们就想到了这种怪异物体是可能真实存在的。

约翰·米歇尔是一名英国神职人员、业余天文爱好者和地质学家。1784年，他试图计算



sun's surface it would have to overcome the sun's gravity. He calculated that the critical velocity such a particle would have to attain would be 1/500th the velocity of light. (Light's velocity was known with reasonable accuracy in Michell's time.)

出重力到底有多大。由于米歇尔熟悉牛顿定律，他知道一个粒子要从太阳的表面跑到太空中去，它就必须克服太阳的重力。他计算出这样一个粒子的临界速度必须达到光速的 1/500。（在米歇尔的时代，人们对光速的认识已经相当准确了。）

Michell reasoned that if the mass of the sun were somehow increased by a factor of 500, its gravity would increase by 500 times as well. The escape velocity would then be equal to the speed of light. He concluded that "all light emitted from such a body would be made to return toward it by its own gravity." An object with such mass, he conjectured, would be invisible to distant observers. Michell had made the first known prediction of the properties of what we call a black hole.

米歇尔提出，如果太阳的质量通过某种方式增加 500 倍的话，它的重力也会增加 500 倍。那么物体逃逸的速度就会等于光速。他得出的结论是："从这样一个物体上发出的光会由于它自己重力的作用而朝物体的方向返回。"他推测，这种质量的物体是远方的观测者所看不到的。米歇尔对我们所称的黑洞的特性首次作出了预测。

More than 100 years later, in 1916, Einstein's colleague Karl Schwarzschild looked at the problem in a different way. He calculated that if a body of the same mass as the sun could be compressed to a size of only 3 kilometers radius, its gravity would be so powerful the object would swallow itself. This critical size, called the Schwarzschild radius, marks the boundary of a black hole. The Schwarzschild radius for a star 10 times the sun's mass would be 10 times bigger.

一百多年后，爱因斯坦的同事卡尔·施瓦兹实德于 1916 年以一种不同的方式对这一问题进行观察。他计算出，如果一个同太阳质量一样大的物体的体积可以被压缩到半径仅为三公里的球体的话，它的重力就会非常的大，使得它能够把自己吞掉。这一被称为施瓦兹实德半径的临界尺寸规定出了黑洞的边界。对于质量是太阳质量10倍的恒星来说，它的施瓦兹实德半径也是太阳的 10 倍。

A black hole with the Earth's mass would have a Schwarzschild radius the size of a golf ball. But the Earth cannot become a black hole. Nor can the sun. Neither is massive enough for gravity to exert enough pull. The Earth is as compressed as it will ever get. The

地球这么大质量的物体的黑洞所拥有的施瓦兹实德半径同一个高尔夫球大小一样。然而地球不能成为一个黑洞。太阳也不能。地球和太阳的质量都没有足够大，