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Liquids and Gases

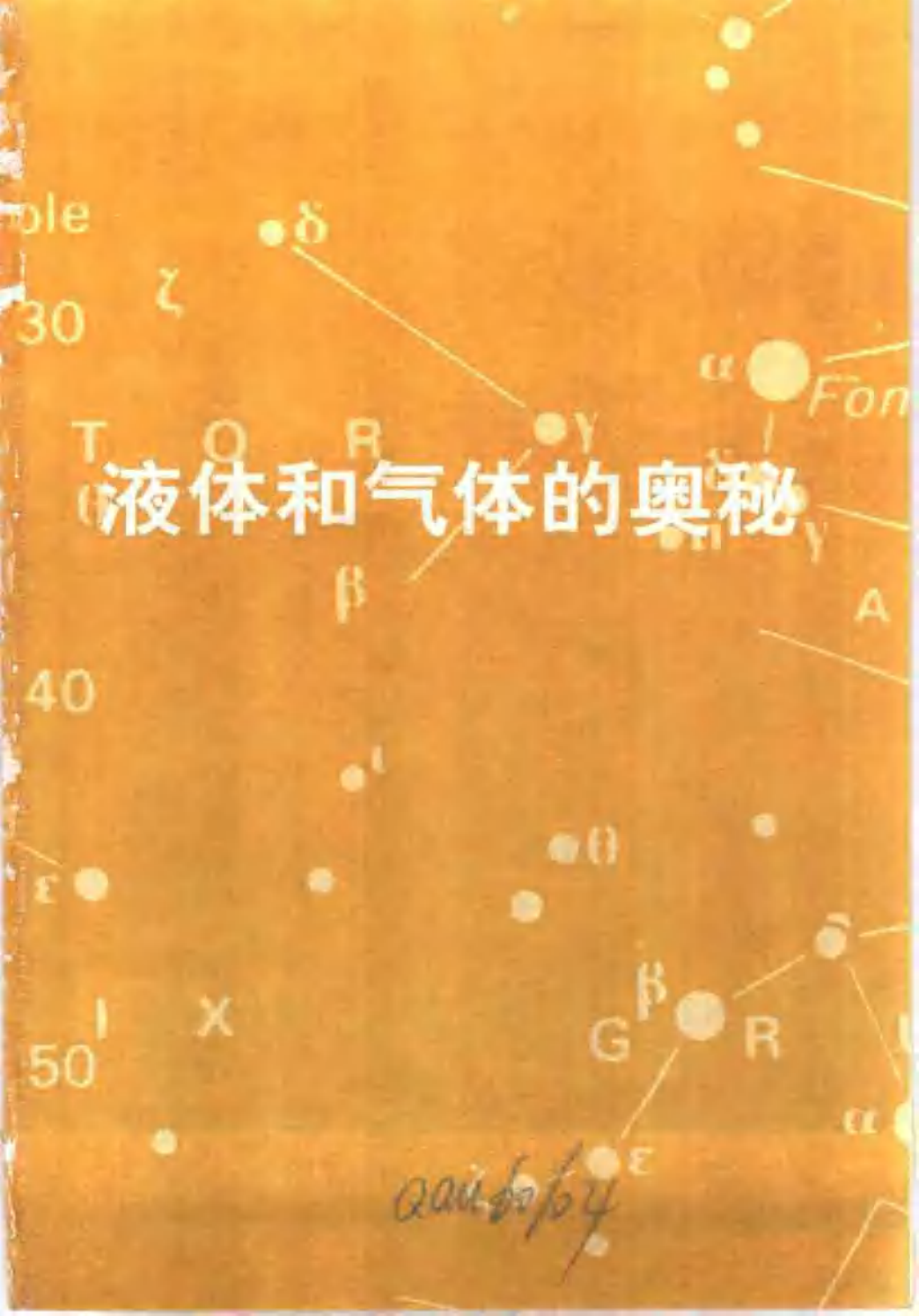
液体和气体的奥秘

by Paul Fleisher

[美] 保罗·弗莱谢尔 著

张 鹏 译

明天出版社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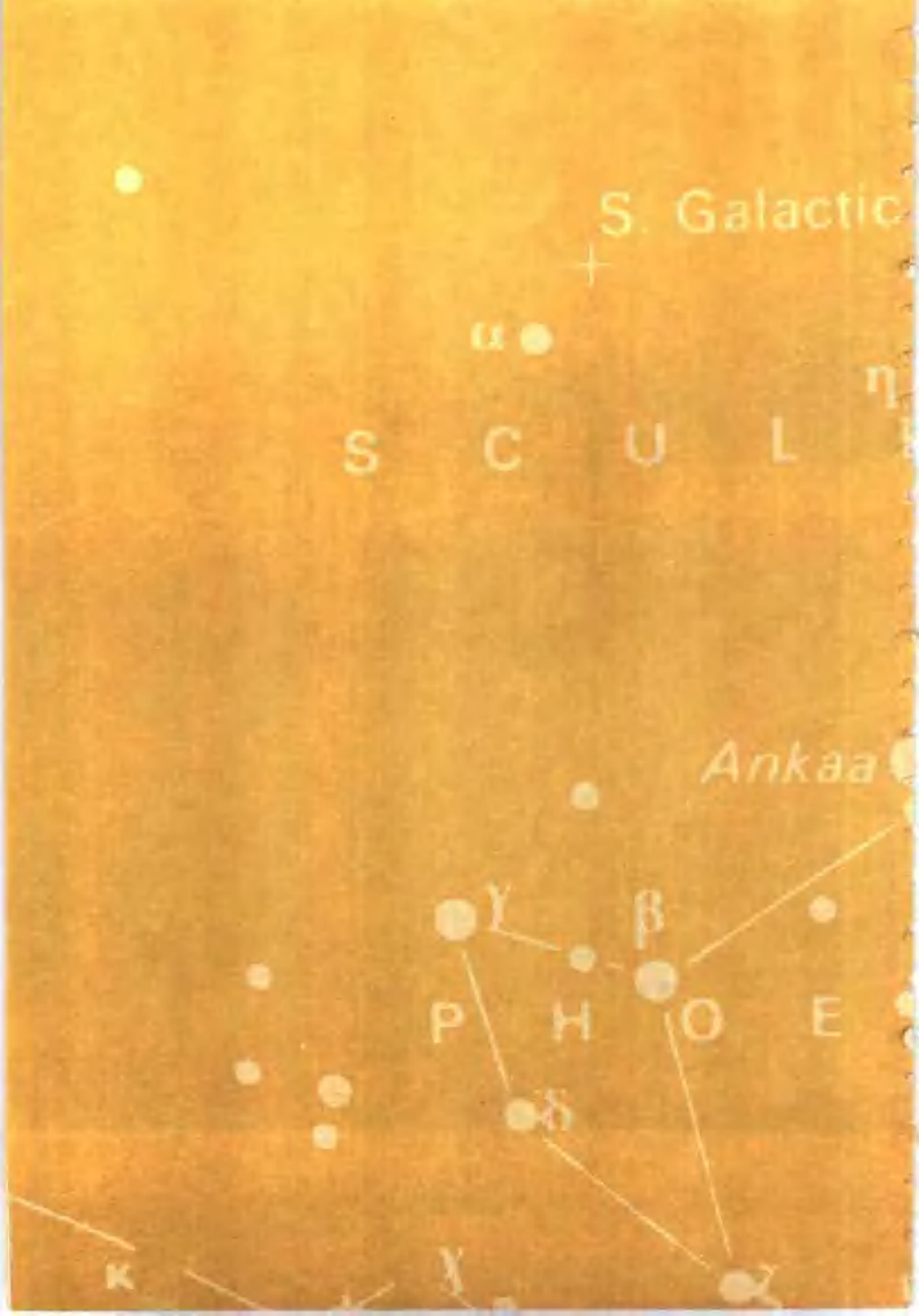
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INTRODUCTION
引言

What Is a Natural Law?

Everyone knows what a law is. It's a rule that tells people what they must or must not do. Laws tell us that we shouldn't drive faster than the legal speed limit, that we must not take someone else's property, that we must pay taxes on our income each year.

Where do these laws come from? In the United States and other democratic countries, laws are created by elected representatives. These men and women discuss which ideas they think would be fair and useful. Then they vote to decide which ones will actually become laws.

什么是自然定律？

人人所熟知法律是一种规则，它告诉人们必须做什么或不得做什么。法律告诉我们开车时不得超过法定的速度限制，不得拿别人的东西，每年须缴纳所得税。

这些法律从何而来呢？在美国及其他民主国家，法律是由民众选举的代表制定的。这些男男女女讨论他们认为公平、有益的见解，然后他们投票决定哪些将成为法律。

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legal 合法的，法律（上）的　　democratic 民主的，民主主义的

But there is another kind of law, a scientific law. You may have heard about Archimedes' principle, for example. It is a scientific law that tells us a floating object displaces (or pushes aside) an amount of water equal to its own weight. If the object is too heavy and dense to push aside enough water, it will sink. Where did that law come from and what could we do if we decided to change it?

但是还有另外一种法——科学定律。譬如，你或许听说过阿基米德原理，它就是一个科学法则，它告诉我们漂浮的物体置换（或推开）与其重量相等的一定量的水。若此物体太重且密度太大不能推开足够的水，那么它就会沉底。这个法则是如何产生的？如果我们决定改变它又能做什么呢？

Archimedes' principle is very different from a speed limit or a law that says you must pay your taxes. Speed limits are different in different places. On many interstate highways, drivers can travel 105 kilometers (65 miles) per hour. On crowded city streets, they must drive more slowly. But Archimedes' principle works exactly the same way no matter where you are. In the country or the city, in France, Brazil, or the United States, a floating object displaces its own weight.

阿基米德原理与速度限制或要求人们赋税的法律都有很大不同。在不同的地方速度限制是不同的，在跨州的公路上，司机可以以每小时105千米（65英里）的速度驾车，而在拥挤的城市街道上，他们必须开得很慢。但无论你在哪里，阿基米德原理却都毫无二致，在农村或城市，在法国、巴西或美国，一个漂浮物体都会置换其自身重量的水。

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displace *v.* 取代(某物)、置换(某物)
object *n.* 物，物体
interstate *a.* 州际的

Sometimes people break laws. When the speed limit is 88 kph (55 mph), people often drive 97 kph (60 mph) or even faster. But what happens when you try to "break" Archimedes' principle? You can't. Here on Earth, if you float one thousand different objects, each one will push aside an amount of water exactly equal to its weight.

All objects obey this law, too: plants, animals, water, stones, and even people. And we know that Archimedes' principle stays in effect whether people are watching or not.

Archimedes' principle is a natural law, or a rule of nature. Scientists and philosophers have studied events in our world for a long time. They have made careful observations and done many experiments. And they have found that certain events happen over and over again in a regular, predictable way.

You have probably noticed some of the same things yourself. Archimedes' principle is a good

人有时会违犯法律。当限速是88千米/每小时（55英里/每小时）时，人们经常开到97千米/小时（60英里/每小时）或更快。但当你试图"违犯"阿基米德原理时情形会怎样呢？你做不到。在地球上，如果你把一千种不同的物体漂浮在水面上，每一种都将推开与其重量完全一样的水。

所有物体也都遵循这一法则：植物、动物、水、石头甚或人。而且我们知道，无论人们是否在监视它，阿基米德原理都是有效的。

阿基米德原理是一个自然法则或自然规律。科学家和哲学家研究世界上的各种事物已经很长时间了，他们仔细观察并做了许多实验，他们发现某些特定的事件往复发生，有规律而且可以预见。

你自己或许已经注意到一些同样的事情，阿基米德原理便是一个很好的例子。当你把一个物

example. When you put an object in water, it will float or sink. Objects that are denser than water will sink. You know that from experience.

A scientific law is a statement that tells how things work in the universe. It describes the way things are, not the way we want them to be. That means a scientific law is not something that can be changed whenever we choose. We can change the speed limit or the tax rate if we think they're too high or too low. But no matter how much we want an object to float instead of sink, Archimedes' principle remains in effect. We cannot change it; we can only describe what happens. A scientist's job is to describe the laws of nature as accurately and exactly as possible.

The laws you will read about in this book are universal laws. That means they are true not only here on Earth, but elsewhere throughout the universe too. The universe includes

体放入水中，它要么漂浮要么下沉。比水的密度大的物体下沉，凭经验你就知道这一点。

科学法则是就世间事物的运作方式所做的一种陈述。它描述的是事物的原貌，而不是我们意愿中的样子，那就意谓着科学规律并不是我们想什么时候改变就可以什么时候改变的。当我们认为速度限制或税率太高或太低的时候，我们可以改变它们。但是不管我们多么想让一个物体漂浮而不下沉，阿基米德原理都会一直有效，我们无法改变它；我们只能描述发生的事情。科学家的职责就是尽可能精确而恰当地描述自然法则。

在本书中你将读到的这些规律都是普遍规律，这意味着它们不仅在地球上是正确的，而且在宇宙的任何其它地方也同样是正确的。宇宙包括我们了解的现存

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philosopher *n.* 哲学家
describe *v.* 描述，记述
in effect 有效

everything we know to exist: our planet, our solar system, our galaxy, all the other billions of stars and galaxies, and all the vast empty space in between. All the evidence that scientists have gathered about the other planets and stars in our universe tells us that the scientific laws that apply here on Earth also apply everywhere else.

的一切：我们的行星、我们的太阳系、我们的银河系、所有其他数不胜数的星星及星系以及所有它们之中浩大空旷的空间。科学家已经收集到的所有关于宇宙中的其他行星及恒星的证据告诉我们：适用于地球的科学规律同样适用于任何其他地方。

In the history of science, some laws have been found through the brilliant discoveries of a single person. Archimedes' principle, for example, is the result of the Greek philosopher Archimedes' great flash of individual understanding. But ordinarily, scientific laws are discovered through the efforts of many scientists, each one building on what others did earlier. When one scientist receives credit for discovering a law, it's important to remember that many other people also contributed to that discovery.

在科学史上，一些规律是通过个人的卓越发现而找到的。譬如，阿基米德原理就是古希腊哲学家阿基米德富有才智的个人顿悟的结果。但在一般情况下，科学规律是通过许多科学家的努力才发现的，每个科学家都是在他人先前所做工作的基础上有所发展。当一个科学家因发现一个规律获得荣誉的时候，很重要的一件事就是，他应该记住其他许多人对于这一发现同样做出了贡献。

Scientific laws do change, on rare occasions, but they don't change because we tell the universe to behave

在个别时候，科学规律的确会变化，但它们变化并不是因为我们要求宇宙要变个样运转。只

differently. Scientific laws change only if we have new information or more accurate observations. The law changes when scientists make new discoveries that show the old law does not describe the universe as well as it should. Whenever scientists agree to a change in the laws of nature, the new law describes events more completely, or more simply and clearly.

有在我们有了新的了解或更准确的观察的情况下，科学规律才会变化。当科学家有了新的发现，表明旧的规律不能像它应该的那样描述宇宙的时候，规律会发生变化。当科学家们认可自然规律的变化的时候，新的规则定会更完整或更简洁明了地描述一些事件。

For example, Aristotle—one of the founders of scientific thought—believed that air had no weight. Early scientists held that belief for almost two thousand years. Finally in the mid-1600s, the Italian scientist Evangelista Torricelli created the world's first barometer. Scientists then realized that the air at sea level does have weight—enough weight to support a column of mercury 76 centimeters (30 inches) high. Several years later, the French scientist Blaise

例如，亚里士多德——科学思想的创立人之一——认为空气没有重量，早期的科学家持有这种看法几乎长达2000年。最终于17世纪中叶，意大利科学家伊万杰林塔·托里拆利制造了世界上第一个气压计，直到那时，科学家们才知道在海平面上的空气的确有重量——能够把水银柱支撑到76厘米（30英寸）高。数年后，法国科学家布莱斯·帕斯卡表明随着你爬得越来越高，空气的重量在减小。

universal *a.* 普遍的，宇宙的
galaxy *n.* 星系，银河
billion *n.* 十亿
brilliant *a.* 灿烂的，有才气的
credit *n.* 信任，声望，荣誉

Pascal showed that the weight of the air decreased as you climbed higher and higher.

Natural laws are often written in the language of mathematics. This allows scientists to be more exact in their descriptions of how things work. For example, the ideal gas law, which we'll learn about later in this book, is actually written like this:

自然法则常以数学语言来记述，这样使得科学家可以用更准确的方式描述事物的运作。例如，我们将在本书的后面了解到的理想气体状态方程是这样被描述的：

$$V\ (\text{volume}) = R\ (\text{gas constant}) \times \frac{T\ (\text{temperature})}{P\ (\text{pressure})}$$

体积　　气体常数　　温度　　压强

Don't let the math fool you. It describes the actions of air and other gases that you are familiar with in everyday life. Writing it this way lets scientists accurately compute the actual volume, temperature, or pressure of a gas in many different situations here on Earth and elsewhere in the universe.

不要让这里的数学把你蒙了，它描述的只是在日常生活中你所熟悉的空气及其它气体的表现。这使科学家可以精确地计算在地球上及宇宙中其它地方许多不同情况下一种气体的实际体积、温度或者压强。

The science of matter and energy and how they behave is called physics. In the hundreds of years that physi-

关于物质、能量以及它们如何表现的科学叫做物理学。物理学家在研究我们宇宙的千百年

cists have been studying our universe, they have discovered many natural laws. In this book, you'll read about some of these great discoveries. There will be some simple experiments you can do to see the laws in action. Read on, and share the fascinating stories of the laws that reveal the secrets of our universe.

间，发现了许多自然规律。在本书中，你将读到一些伟大的发明的故事以及你自己可以验证这些规律的一些简单实验。读下去，去分享揭示宇宙奥秘的规律的迷人故事吧。

decrease *v.* 减少；降低
compute *v.* 计算，估计，用计算机计算
behave *v.* 行为表现，举动（止），运转
situation *n.* 情形，形势
fascinating *a.* 迷人的，醉人的

CHAPTER 1
第 1 章

Archimedes' Principle

阿基米德原理

A two-gallongong ship weighs hundreds or even thousands of tons. Yet it can float on water. How is that possible? The answer begins with one of the oldest and most famous stories in the history of science.

Let's imagine an experiment. You decide to take a bath, so you turn on the water and fill the tub to the very top. Then, with the tub filled just to overflowing, you step in and sit down.

Even without trying, you know exactly what will happen. In fact, you'd better not try it, unless you want to do a lot of mopping up afterward! When you get into the tub, gallons of

一艘两千加仑容量的船重达数百甚至数千吨，但它可以漂浮在水上。这怎么可能呢？要回答这个问题，就得从科学史上一个最古老、最著名的故事说起。

让我们想象一个实验：你决定要洗澡，于是你打开水龙头，将浴盆注满水，然后，当浴盆的水加到刚好要溢出的时候，你走进去坐下来。

即使不试，你也清楚会发生什么。事实上，你最好别试，除非你想事后拖上半天地。当你进入浴盆的时候，许多加仑的水会流到地板上。

water will pour onto the floor.

According to an ancient story, this is just what happened to the Greek scientist Archimedes more than 2,200 years ago. Archimedes sat down in an overly full bathtub, and water flooded over the sides. Seeing the water overflow gave Archimedes a brilliant idea. He was so excited about his new idea that he jumped out of the tub. Forgetting to put on his clothes, he ran through the streets shouting "Eureka!" ("I found it!")

按照一个古老的故事，这是2200年前发生在古希腊科学家阿基米德身上的事。阿基米德坐进一个注入了太多水的浴盆里，水涌出浴盆。看着外溢的水，阿基米德产生了一个卓越的见解，他激动地跳出浴盆，忘了穿上衣服，在大街上跑了起来，大喊着："我找到了！"

Archimedes had been thinking about why some things float while others sink. It couldn't just be a matter of weight. Greek ships were very heavy, and yet they floated. But even a tiny pebble sinks right to the bottom of the sea.

此前阿基米德一直在思考为什么一些物体漂浮于液体表面，而另外一些则下沉。这不单纯是一个轻重问题，希腊的大船很重，却能漂浮，而即使是一块小卵石也会直沉海底。

What Archimedes found in his bathtub was the law of buoyancy. In modern times, this is usually known as *Archimedes' principle* in his honor.

阿基米德在浴缸里发现的正是浮力原理，现在，人们为纪念他，一般把它称作阿基米德原理。阿基米德原理是这样说的：

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oceangoing *a.* 远洋航行的
ton *n.* 吨
overflow *v.* 泛滥，溢出，充溢
mop *v.* 用拖把拖洗，擦，抹
overly *ad.* 过度地，极度地
pebble *n.* 小圆石，小鹅卵石

Archimedes' principle says: Any floating object pushes aside, or displaces, an amount of water equal to its own weight. If a boat weighs 250 kilograms (550 pounds), it must displace 250 kilograms of water in order to float.

Imagine a boat pushing a "hole" into the water. If you measured the amount of water it would take to fill that hole, it would weigh as much as the boat itself. A boat that weighs 100 metric tons (110 tons) must push aside 100 metric tons of water to float.

If you measure carefully, you will be able to see this law at work in the following demonstration. Place an aluminum pie plate on a sensitive scale. Weigh it and record its weight. Next, find an object that will float—like a block of wood—weigh it, and write down its weight.

Put the pie plate back on the scale. Place an empty can or wide-mouthed jar in the center of the plate. Carefully fill the jar with water to the very top. The water should be ready

任何漂浮的物体推开或置换的水与其本身重量相等。如果一条船重250千克（550磅），它一定会置换250千克的水以使能浮在水上。

试想：一条船挤进水里，挤出一个"洞"，如果你能测量出填满那个洞所需的水的话，这些水的重量和船本身的重量是相等的。重达100公吨（110吨）的船一定会推开100公吨的水，以便使自己漂浮起来。

如果你非常仔细测量的话，你会明白这一定律在下面的演示当中的作用。将一只铝制食品盘放在非常灵敏的台秤上称重并记下其重量，然后找一个可漂浮的物体，譬如一个木块，称重并记下它的重量。

把盘子放回到台秤上，在食品盘的中央放上一只空罐或广口瓶，小心翼翼地将广口瓶注满水，直到再加一滴水就会溢出的地步。