第三课 科学的方法和科学中用到的方法

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Unit 3

SCIENTIFIC METHOD AND THE METHODS OF SCIENCE

It is sometimes said that there is no such thing as the so-called 'scientific method'; there are only the methods used in science. Nevertheless, it seems clear that there is often a special sequence of procedures which is involved in the establishment of the working principles of science. This sequence is as follows: (1) a problem is recognized, and as much information as appears to be relevant is collected; (2) a solution (i.e. a hypothesis) is proposed and the consequences arising out of this solution are deduced; (3) these deductions are tested by experiment, and as a result the hypothesis is accepted, modified or discarded.

As an illustration of this we can consider the discovery of air-pressure. Over two thousand years ago, men discovered a method of raising water from one level to another by means of the vacuum pump. When, however, this machine passed into general use in the fifteenth and sixteenth centuries, it was discovered that, no matter how perfect the pump was, it was not possible to raise water vertically more than about 35 feet. Why? Galileo, amongst others, recognized the problem, but failed to solve it.

The problem was then attacked by Torricelli. Analogizing from the recently-discovered phenomenon of water-pressure (hydrostatic pressure), he postulated that a deep 'sea of air' surrounded the earth; it was, he thought, the pressure of this sea of air which pushed on the surface of the water and caused it to rise in the vaccum tube of a pump. A hypothesis, then, was formed. The next step was to deduce the consequences of the hypothesis. Torricelli reasoned that this 'air pressure' would be unable to push a liquid heavier than water as high as 35 feet, and that a column of mercury, for example, which weighed about 14 times more than water, would rise to only a fourteenth of the height of water, i.e. approximately 2.5 feet. He then tested this deduction by means of the experiment we all know, and found that the mercury column measured the height predicted. The experiment therefore supported the hypothesis. A further inference was drawn by Pascal, who reasoned that if this 'sea of air' existed, its pressure at the bottom (i.e. sea-level) would be greater than its pressure further up, and that therefore the height of the mercury column would decrease in proportion to the height above sea-level. He then carried the mercury tube to the top of a mountain and observed that the column fell steadily as the height increased, while another mercury column at the bottom of the mountain remained steady (an example of another of the methods of science, the controlled experiment). This further proof not only established Torricelli's hypothesis more securely, but also demonstrated that, in some aspects, air behaved like water; this, of course, stimulated further enquiry.

人们有时候说没有所谓的“科学的方法”；只有在科学中用到的方法。然而，人们似乎也常常清楚地看到在建立有效的科学原理时涉及到一个特殊过程。这个过程有下面几个阶段：1. 发现一个问题，收集与此问题有关的尽可能多的信息；2. 提出一个解决方案（即一个假设）和推断出这个解决方案产生的结果；3. 用实验来验证这些推断，实验结果最终决定假设是否成立、是否需要修改，或者完全放弃。

我们可以把大气压的发现作为一个例子来说明上面这个过程。两千多年前，人类发现了一种用真空泵把水从一个平面上升到另一个平面的方法。可是到十五、十六世纪当人们把这个机器推广应用时，发现不论这个真空泵造得有多完美，都不能垂直把水提升到 35 英尺以上。这是为什么？伽利略和其他一些人都注意到这个现象，但是没有能解决问题。

后来托里切利研究了这个问题。通过类比近期发现的水压现象（静水压力）他假设有一个很厚的“大气海洋“环绕地球；他想，就是这个大气海洋的压力施压在水的表面，从而使其在泵的真空管里上升。于是一个假设就形成了。接下来是推断这个假设产生的结果。托里切利琢磨这个空气压力对比水重的液体的提升不会超过 35 英尺。比如一个水银柱比水重 14 倍，那么它倍提升的高度就可能是 14 分之一，2 大约.5 英尺。他于是就用了众所周知的实验来验证他的推论，结果发现水银柱跟他预测的高度相吻合。实验从而证明了假设。

帕斯卡做了进一步的推论。他认为如果这个“大气海洋”存在，它在底部（海平面）的压力应当比往上面位置的压力大一些，从而水银柱的高度会随着距海平面的高度的上升而等比地下降。于是拿着一个水银管从山下上到山顶，观察到水银柱在登高过程中稳步下降。而另一个水银管放在山下的水银柱高度保持稳定（这是另一个叫做控制实验的科学方法的例子）。这就不仅进一步更准确地证明了托里切利的假设，而且还揭示了空气和水在某些方面有共同之处；这当然就激励起更进一步科学探索。