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FIRST YEAR SCIENCE

美国学生科学读本

英汉双语版

〔美〕威廉·H·斯奈德（William H. Snyder）/著　贺巍/译

上

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天津出版传媒集团
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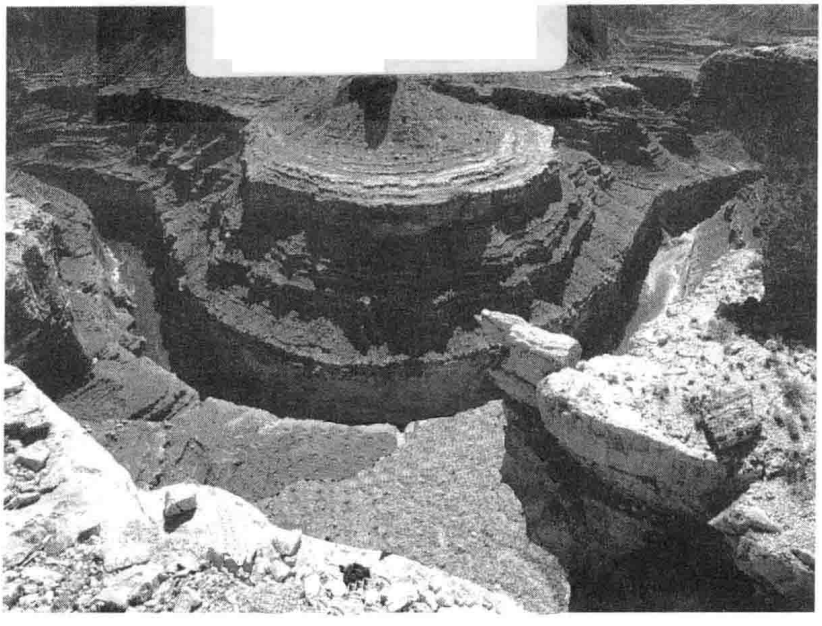

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FOREWORD

译者序

小时候，我们每个人似乎都曾有过一个湛蓝色的科学梦。在那个以天空、大海为背景的梦境中，我们不断追问着一个又一个“什么”和“为什么”：是什么构成了我们的宇宙？为什么世间万物的运动变化这么有规律？地球为什么是圆的？地球的核心里面到底是什么，有神仙吗？为什么大自然有如此绚丽多姿的色彩？为什么生命世界有如此温婉动人的故事？为什么会有我们人类？

今天，科学的发展前沿，已经到了宇宙的边缘和物质最基本的粒子层面，直逼宇宙万物最为核心的部分。我们曾经的这些“梦之问”大多已经有了答案，但是还有不少依然悬而未决。一代又一代的科学家和教育家们，不断地在追寻答案的路上给我们带来好消息，进而又在书本上和教室里娓娓道来，认真而深情地讲给孩子们听。你眼前的这本书，就是这样诞生的。

此书是美国洛杉矶一位名叫威廉·H·斯奈德（William H. Snyder）的中学校长，和他的同事一起，为中学生编著的一本自然科学入门教材。这位校长虽名不见经传，但他广博而细密的自然科学知识却不得不令人钦佩，几乎将当时所有科学门类的基础知识都融进了本书。从日常物体的运动到太阳系的组成；从江河湖海的欢歌笑语到大陆高山的沉吟咏叹；从微小细菌的自生自灭到动植物与人类的生命活动；从风霜雨雪的翻姿飞舞到春夏秋冬的律吕变换……书中应有尽有，每一章都是孩子们感兴趣的一个领域。其中的每一小节，又都是紧扣着主题的阐发与讲述，语调平实生动，情感真挚感人，宛如一位慈祥的老人注视着孩子们充满稚气的眼睛，讲述着一个又一个动人的故事……

翻开此书，我们便似乎回到了美国洛杉矶的中学课堂上，教堂的钟声还在远处回荡，翻飞的黄叶在微风中飘落到窗台上，这位温厚的老校长正和颜悦色地给我们讲述着地球与太阳、昆虫与花朵、高山与大地、天风与海浪。

这里我还想指出作者在书中有意无意地表露出来的两个重要的“微言大义”。

第一，自然条件对人类文明进程的影响。作者在每一章的末尾，都会拿一小节专门讲述该要素对人类的影响，这是一个重要的史观。历史的演进往往并非完全决定于人为，而是跟自然地理条件大有关系。这样的事例古今中外皆不

少见，历史学家黄仁宇先生在谈及著名的淝水之战时，就曾将这一影响后来数百年中国政治格局的战役归因为地理原因，他说：“北人所擅长的骑兵战术，至此地已无法做到有效发挥。南人所长的水军，不仅兵力以舟楫输送，能够争取战场主动，而且将士无行军之劳，粮糈有速达之效。只是这种长处，也不能向北延伸使用。淝水之战时，双方受地形限制的情形，已现其端倪”。本书中这样有趣的例子还有很多，当然也都非常有启发意义，这算是我们在收获科学知识之余，又能体会到的一个史学视角。

第二，对客观世界如何导致生命产生的追问。书中在讲述每一个大自然的环境要素时，作者都会附带提到它对生命诞生的重要性或者促进性。比如大陆与海洋的面积比率、地球与太阳和月亮的距离、大气层的构成、水的特性、土壤的运化、生物体的自身构造等等。虽然作者没有给出这一切为何如此精准巧合的答案，甚至连这个问题也没有正式提出来，但是我们作为后来的读者，不妨对此问题稍稍留意。其实这个问题已经被理论物理学家、宇宙学家、哲学家和神学家们和反复思考和辩论过，并形成了今天的“人择原理”，更进一步产生了强弱不同的数个版本，科学家们至今还在为此争论不已。虽然这个问题到现在依然没有答案，甚至会不会有答案也不知道，但此书从不同侧面给这个问题拉开了序幕，给我们的思考空间也留了很大的余地。

最后要说一说此书的语言。整本书的英语原文平实而舒缓，虽然不乏专业术语，但主体依然醇厚耐读，对于正在学习英语的中学生朋友来说，也是一本上佳的课外阅读范本。

科学梦关乎人类最本真的心灵，对未知世界的好奇与探求更是人类文明永不歇绝的动力。科学的进步也需要一代又一代人前仆后继的努力，这就是科学的托命。正如1988年诺贝尔物理学奖得主莱德曼所坚信的：

在全世界60亿人口中，一定有一颗年轻的、与爱因斯坦同样智慧的心，在等待着被发掘。

这颗心在哪里呢？会是你吗？

贺巍（新浪微博@南山薰风）
2012年12月于成都 翠屏湾

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CHAPTER 1

THE EARTH AND ITS NEIGHBORS

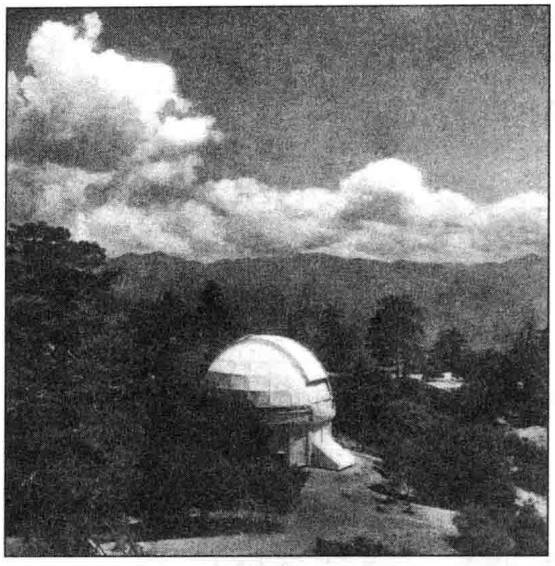
地球和它的邻居们

1. The Evening Sky. —As the light of the sun fades in the evening, we see the stars coming out one by one until at last the sky is studded with them. We notice, too, that the brighter the star is, the sooner it

PART OF THE MILKY WAY.
The plate for this photograph was exposed ten hours and a quarter.

appears. In the morning, just the reverse of this takes place, the stars begin gradually to fade, and the brightest stars are the last to disappear.

We know how brilliant the light of a match or candle appears in a dark room, and how a light of this kind seems to fade out when it is brought into the presence of a strong electric light. It would seem quite probable that the vast light of the sun might have the same effect



DOME OF THE 60-INCH REFLECTING TELESCOPE AT MT. WILSON SOLAR OBSERVATORY.
Pictures of the heavens are taken through a telescope.

upon the light of the stars. This supposition is also supported by the fact that when the sun is covered in an eclipse the stars begin to appear as in the evening. Astronomers are all agreed that if it were not for the greater brilliancy of the sun we should see the heavens full of stars all the time.

In the northern hemisphere the stars, except those at the north, which seem to go around in a circle, appear to rise in the east and to set in the west, just as the sun does. If we observe the stars which rise to the east, southeast, and northeast of us, we shall find that these are above the horizon for different lengths of time.

The ancients noticed these facts, and explained them by saying that the earth was at the center of a hollow sphere, upon the inner surface of which were the stars, and that this sphere was continually revolving about the earth and also slightly changing its position in respect to the earth. We of the present day know that it is the earth that is turning around on an imaginary axis, and also gradually changing its position in relation to the stars. We also know that this axis, if extended far enough, would almost strike a star in the center of the northern heavens, which we call the *North Star*. The points on the surface of the earth through which the axis passes are called the *poles*.

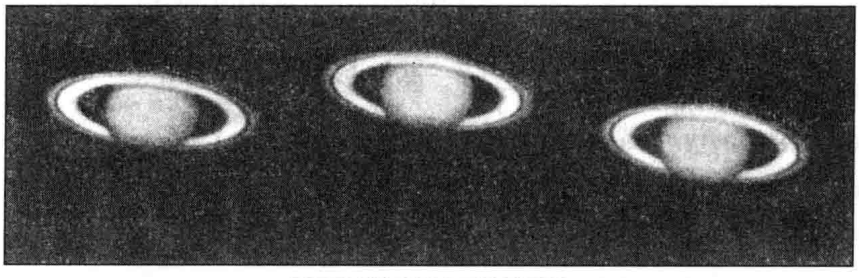
2. The Earth as one of the Planets. —If we carefully observe the bright points which appear in the sky at night, we shall see that almost all of them shine with a twinkling light. There are, however, three of the brightest which give a steady light like that of the moon. When the positions of these three bodies are carefully observed for some time, it will be seen that they are continually changing their places among the

stars, whereas the positions of the stars do not appear to change in relation to each other.

One of these three brightest points has a reddish brown color and has been named Mars, from the Roman god of war. The other two bear the names Venus and Jupiter, one named from the goddess of beauty and the other from the king of the Roman gods. Astronomers call the earth and these three bodies, together with four others, *planets*, and tell us that they revolve around the sun as a center. They have no light of their own as do the true stars, but the light which comes to us from them is a reflection of the light of the sun.

MARS.
Most like the earth of all the planets. It is supposed to have a polar ice cap.

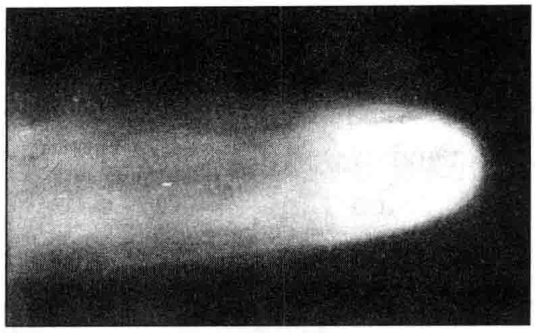
The unaided eye is able at some times to see five of these planets. Astronomers tell us that their change of place in relation to the stars is due to their motion about the sun. If we could stand upon one of these visible planets, our earth would appear to us like one of them. But the surface of some of these planets, like Jupiter or Saturn, is not solid like



THREE VIEWS OF SATURN.
The planet with the beautiful rings.

that of the earth. Our sun, if seen from the distance of one of the stars, would appear like a star.

The list of the planets in the order of distance from the sun is: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. The sun, with the bodies revolving about it, is called the *solar system*. There is reason to believe that ours is only one of many similar solar systems that exist throughout space.



HALLEY'S COMET.
One of the most famous visitors from outer space.
The small white dots are stars seen through the tail.

The planets are by far the nearest of all the starlike bodies, although the distance from the sun to the farthest of the planets is some 2700 million miles greater than the distance from the earth to the sun. The distance of the nearest of the stars however, is probably about 25,000,000,000,000 miles. This distance is so great that it takes light, which travels at the inconceivable rate of 186,000 miles in a second of time, over four and a half years to come to us from this star. From Arcturus, another of the stars, it takes light about 180 years to reach us, and from others very much longer. Sometimes from this outer space comets visit our solar system. Thus we see that our little earth is only a speck in the universe.

In the space between the planets Mars and Jupiter, there has been found a group of small bodies which are called *planetoids* or *asteroids*. The brighest of these is Vesta, not more than 250 miles in diameter.

A famous theory, called the *Nebular Hypothesis*, was suggested many years ago to account for the formation of our solar system. This theory supposes that the materials of which the members of the solar system are composed once formed a cloud or *nebula* of finely divided matter filling an enormous space, and that this matter, by reason of the mutual attraction of the particles, gathered together into what is now our sun with its planets and their satellites. Man is unable to comprehend how

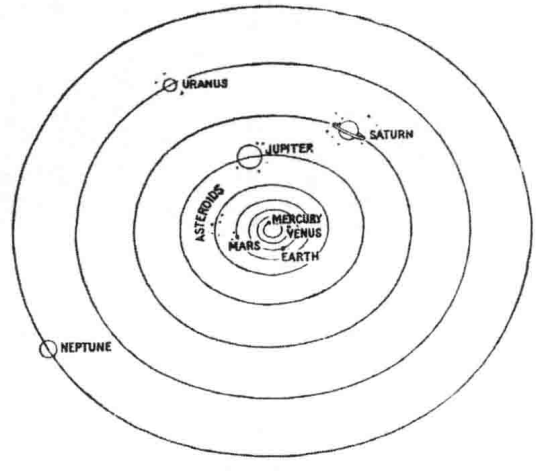


DIAGRAM OF THE SOLAR SYSTEM.
Showing roughly the positions of the various planets and their moons.

matter originated or how matter can either be created or destroyed. But we do know many of the properties of matter.

3. Properties of the Matter Composing the Universe.

Experiment 1. —Pull out the handle of a compression air-pump or bicycle pump. Close the exit valve or stop up the end of the bicycle pump. Now try to push in the handle. What keeps it from moving easily? Try to shove an inverted drinking glass into a pail of water. Why does not the water fill the glass?

All matter as we know it occupies room or space. In other words, it has *extension*. When we pump up a bicycle tire we find that even the air demands room for itself. In the experiment with the air compressor we found that the space occupied by the air could be reduced only to a limited extent. However great the pressure might have been the air would still have occupied a certain amount of space.

Experiment 2. —Place a coin on a card extending slightly beyond the edge of a table. Suddenly snap the card horizontally. Does the coin move?

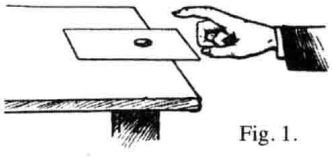


Fig. 1.

Another of our common observations is that a body does not begin to move unless some force acts upon it, nor when moving does it stop unless some force stops it. When the card was snapped from under the coin, the coin did not appear to move because the friction of the paper was not sufficient to transfer any appreciable motion to it. If the coin had been glued to the card, both coin and card would have moved.

Experiment 3. —Revolve around the hand a small weight attached to a strong rubber band. Suddenly let go the band. Does the weight keep on moving in the circular path in which it was revolving?

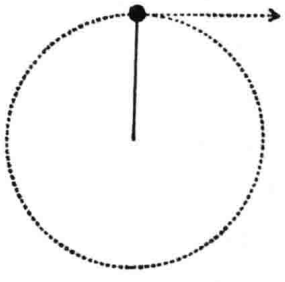


Fig. 2.

When a car is moving along a level track we do not expect it to stop until the friction of the track or some other force stops it. When we revolved

the weight attached to the rubber band and let go the band the weight started off in a straight line. It did not continue in this straight line because a force, *gravity*, pulled it down toward the earth. This property which bodies have of remaining at rest unless acted upon by some force, and when in motion of continuing to move in a straight line with the same speed unless acted upon by an outside force, is called *inertia*. Sir Isaac Newton first stated this fact, and so it is sometimes called Newton's First Law. It is due to inertia that people are thrown out of an automobile if it is suddenly stopped.

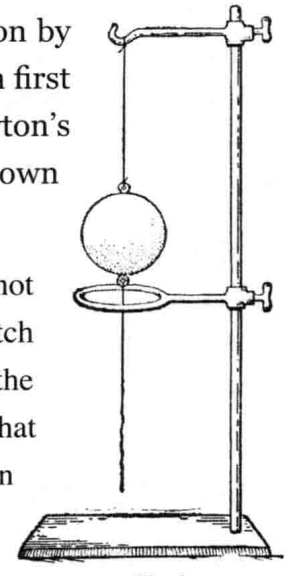
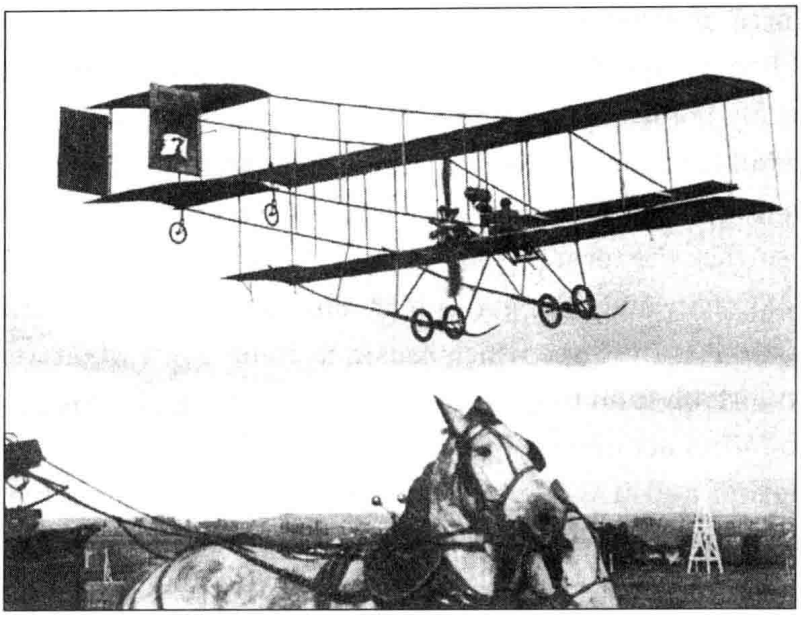


Fig. 3.

Experiment 4. —Suspend a heavy ball by a string not much too strong to hold it. (Place a pad beneath it to catch it if it drops.) Attach a similar string to the bottom of the ball. Attempt to lift it suddenly by the upper string. What happens? Suspend it again and pull down gradually on the lower string. What happens? Suspend it again and pull down suddenly on the lower string. What happens?

When we tried suddenly to lift the suspended ball the force of inertia was so great that it broke the string. When the string was attached to the bottom of the ball and the pull gradually exerted, the upper string broke, since it had both the weight of the ball and the pull of the string to withstand; but when the pull was suddenly exerted, the inertia of the ball was sufficient to withstand the pull, and the lower string broke.

It is the inertia of the water which enables the small, rapidly revolving propeller to move the big ship. The same is true of both the propelling and supporting of flying machines. The resistance which the particles of air offer to being suddenly thrown into motion, their inertia, enables the propeller to push the aeroplane along and keeps it from falling to the ground as long as it is moving rapidly. It is inertia which keeps the heavenly bodies moving in space. Once in motion they must keep on forever unless some force stops them.



A BIPLANE.
The blur shows how swiftly the propeller is revolving.

Experiment 5. —Place a glass globe partly filled with water on a rotating apparatus. Rotate the globe rapidly. What does the water tend to do?

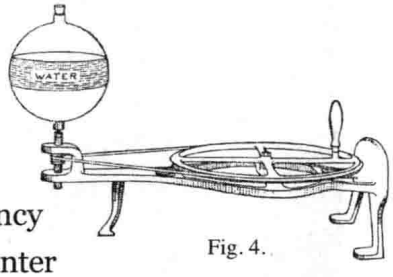


Fig. 4.

Inertia also manifests itself in the tendency of revolving bodies to move away from the center around which they are revolving. Inertia thus manifesting itself is called *centrifugal force*. An example of this was seen in Experiments 3 and 5.

Newton many years ago discovered that all bodies of matter have an attraction for each other and that this force of attraction varies as the masses of the bodies, that is, the more matter two bodies contain the more they attract each other. But this attraction becomes less as the distance between the bodies increases. This lessening of the force of attraction on account of the increase of distance is proportional not to the distance, but to the square of the distance. This means that the attraction between the same bodies when twice as far apart is only one fourth as great; when three times as far apart, one ninth as great, and so on. What causes this attraction no one knows, but the name given

to this force of attraction is *Gravitation*. Gravitation is always acting upon all bodies, and their conduct is constantly affected by it. It keeps the heavenly bodies from wandering away from each other just as the rubber band kept the weight from flying away from the hand.

When this attraction is considered in relation to the earth and bodies near its surface the term *gravity* is used. We are constantly measuring the pull of gravity and calling it *weight*. This is the cause of bodies falling to the earth. It is the force which causes us to lie down when we wish to sleep comfortably, and frequently makes men fall who try to fly.

If two forces act upon a free body, each will influence the direction of its motion and it will go in the direction of neither force, but in a direction between the two. If there are more than two forces, the path will be the result of the action of all the forces. In the case of the weight and the rubber band we found that the moving weight when not held by the force of the band flew away from the hand. The rubber band continually pulled it toward the hand. The result of these two forces, the "centrifugal force" and

THREE FORCES IN PLAY.

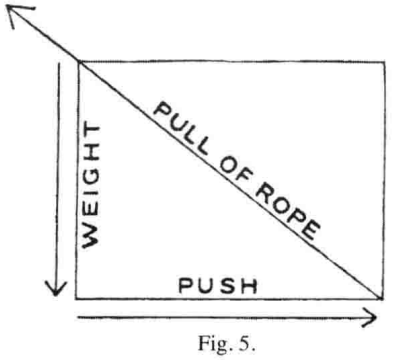
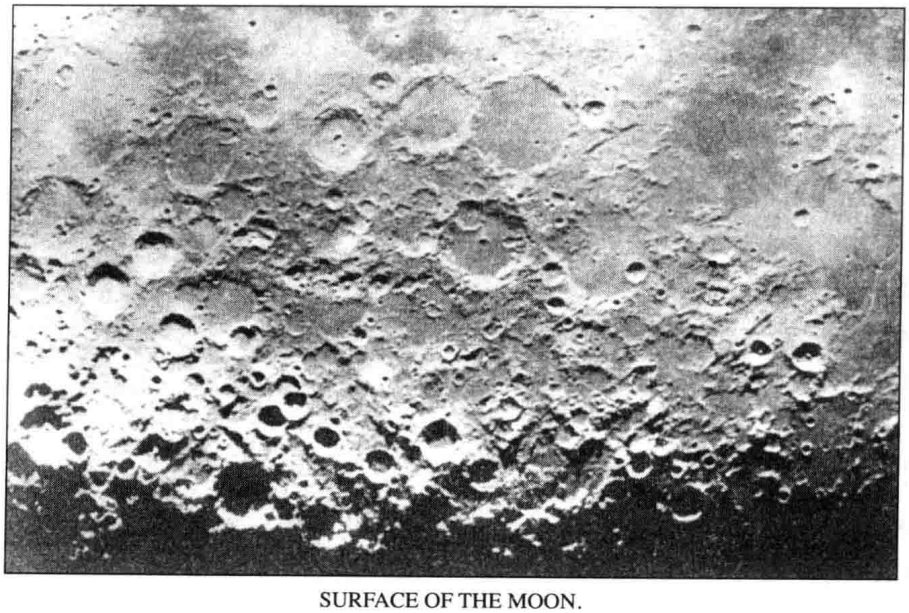


Fig. 5.

the pull of the band, was to make the path of the weight lie between the two. In this case the forces at every instant almost balanced each other, and the path was nearly a circle. It is the force of gravitation acting against the inertia, or the centrifugal force, of the heavenly bodies which holds them in their orbits.

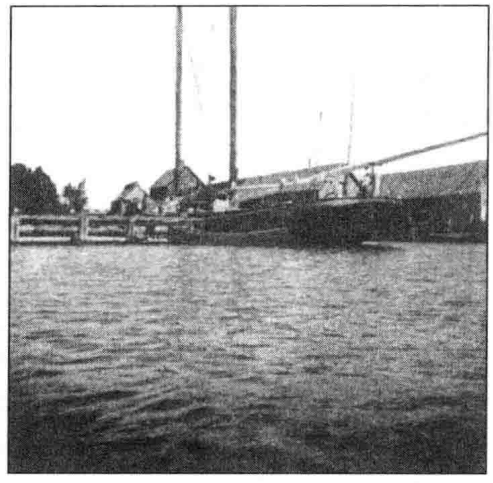
4. Relation of the Earth to Sun and Moon. —Not only do all the planets revolve around the sun, but certain of these themselves have other smaller bodies revolving around them. We call such small bodies *satellites* or *moons*. The earth has one of these satellites and Saturn has the greatest number of all, ten, one having been discovered as late as 1905. Our own moon has a diameter of about 2000 miles and a weight of about 1/80 that of the earth. Its average distance from the earth is about 240,000 miles. Compared with the distance of the other heavenly bodies it is indeed very near.

The sun, although a near neighbor as compared with the rest of the stellar community, is at an average distance of about 93,000,000 miles. It is so big that if it were hollow and the earth were placed at its center with the moon as far away as it now is, there would be almost as great a distance between the moon and the sun's surface as there is between the moon and the earth. A good way to get an idea of the relative size of these bodies is to let a pencil dot represent the moon, a circle an eighth of an inch in diameter the earth, and a circle with a diameter of a little more than thirteen and one half inches the sun.



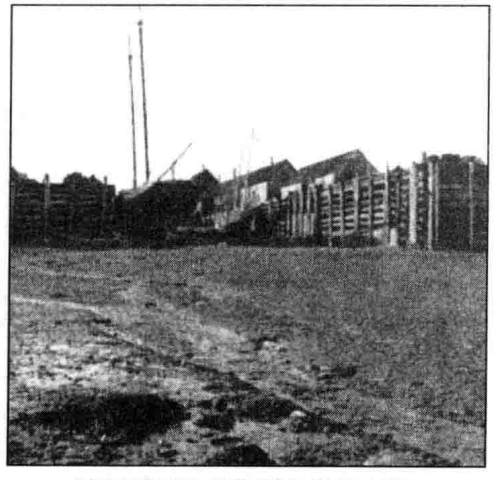
SURFACE OF THE MOON.
Showing the great crater-like depressions.

Both the sun and the moon are of the greatest interest to us, as they have much to do with our existence. If it were not for the sun, we should have almost no heat or light on the earth, and life could not exist. If the sun were much nearer, it would be too hot for life as we know it, and if much farther away, too cold. If it were not for the moon, the beauty and variety of our nights would be largely lacking, and we should have no tides strong enough to sweep clean our bays, removing the sewage, and to help vessels over the bars into some of our harbors. If the distance of the moon were changed, the height of the tides would be changed, and this would greatly affect our coast towns.



HIGH TIDE IN Nova SCOTIA.

Although we see the moon as a very bright object at night for a part of every month, yet it has no light of itself, and all the light it gives us is reflected from the sun. It has a rough, barren, rocky surface, full of great crater-like depressions. As far as known, it has no air or water upon it. As the earth goes around the sun, and the moon around the earth, the position of these three in relation to each other is constantly changing, and it is these changes which give us the varying heights of the tides and the different phases of the moon. It is profitable to try to picture to oneself the changing phases of the moon. A good way to do this is to carry a ball around a bright light and observe what part of the surface is illuminated in the different positions.



LOW TIDE AT THE SAME PLACE.
Showing the clean swept sea floor.