

THE MOON

A POPULAR TREATISE

By

GARRETT P. SERVISS

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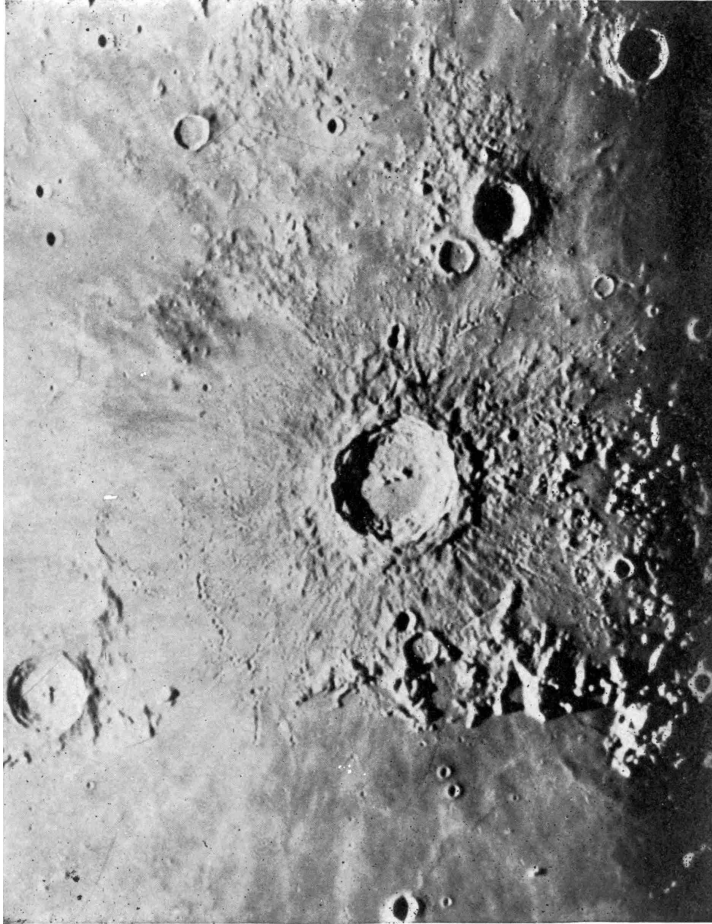
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THE MOON



COPERNICUS AND THE CARPATHIAN MOUNTAINS.

PREFACE

THE reader familiar with astronomical literature will doubtless remark a certain resemblance between the plan on which this book is written and that of Fontenelle's "Conversations on the Plurality of Worlds," a French classic of the eighteenth century. The author freely acknowledges that it was the recollection of the pleasure which the reading of Fontenelle's book gave him, years ago, that led to the adoption of a somewhat similar plan for this description of the moon. But, except that in both cases the conversational method is employed, no great likeness will be found between what is here presented and the work of the witty Frenchman.

Having been invited by the Messrs. Appleton & Co. to prepare a small volume, to be based on a series of lunar photographs representing the moon as it appears on successive evenings during an entire lunation, the author felt that the work should be made as entertaining as possible. He has, therefore, avoided technicalities, while endeavoring to present all the most essential facts known about our satellite. What he has written is intended for the general reader, who desires to learn the results of the great advances in astronomy without being too much troubled with the scientific methods by whose aid those results have been reached.

This is the first time, as far as the author is aware, that a series of lunar photographs, showing our satellite in its varying aspects from New to Old Moon, has been presented in a book, accompanied with a description of the mountains, plains, volcanoes, and other formations shown in each successive photograph. The reader is enabled to place himself, as it were, in an observatory of the first

rank, provided with the most powerful apparatus of the astronomer, and, during an entire month, view the moon in her changing phases.

The photographs here reproduced were made at the Yerkes Observatory, and the most grateful acknowledgments are tendered to Prof. Edwin B. Frost, its director, for generously consenting to their use for this purpose. He could only have been induced to do so by his desire to see the fruits of the admirable work accomplished by his associates enjoyed by an ever-widening circle.

The series of photographs representing the moon on successive evenings were taken with the 12-inch telescope of the Yerkes Observatory by Mr. James Wallace, who employed a color filter that he constructed specially for this telescope, which possesses a visual and not a photographic objective. The larger scale photographs, representing certain selected regions on the moon, were taken by Mr. Ritchey, now of the Carnegie Solar Observatory at Mount Wilson, California, with the great 40-inch telescope of the Yerkes Observatory. It is unnecessary to speak of the extraordinary quality of these photographs, which have been admired by astronomers in all lands.

It should, perhaps, be added that while the director of the Yerkes Observatory has shown confidence in the author by intrusting to him the use of these photographs, yet, neither Professor Frost, nor Messrs. Wallace and Ritchey are in any way responsible for the statements made in this book. The author has taken pains to be accurate, but if any errors of fact or opinion have crept in, he alone must be blamed for them.

GARRETT P. SERVISS.

CHÂTEAU D'ARCEAU,

CÔTE D'OR, FRANCE, JUNE, 1907.

INTRODUCTION

INTRODUCTION

ONE serene evening, when the full moon, rising slowly above the tree tops, began to spread over the landscape that peculiar radiance which, by half revealing and half concealing, by softening all outlines, and by imparting a certain mystery to the most familiar objects, fascinates at once the eye and the imagination, I was walking with a friend, a lady of charming intelligence, in a private park adjoining an old mansion in one of the most beautiful districts of central New York. For a long time we both remained silent, admiring the scene before us, so different in every aspect from its appearance in the glare of daylight—each occupied with the thoughts that such a spectacle suggests. Suddenly my friend turned to me and said:

“Tell me—for, like so many thousand others, I am virtually ignorant of these mysteries of the sky—tell me, what is that moon? What do astronomers really know about it?”

“But,” I replied, “you certainly exaggerate your ignorance. You must have read what so many books have told about the moon.”

“Not a word,” was the reply, “or at least, what I have read has made little impression upon my mind. I read few books of science; generally they repel me. But face to face with that marvelous moon, I find it irresistible, and my desire for knowledge concerning it becomes intense. I remember something about eclipses, and something about tides, with which, I believe, the moon is

concerned. I recall the statement that the moon has no atmosphere, but does possess great mountains and volcanoes. Yet these things are so jumbled in my memory with technical statements which failed to interest me, that really my ignorance remains profound. But I have heard that many surprising discoveries have been made lately concerning the moon, and that astronomers have succeeded in taking wonderful photographs of scenes in the lunar world. I have, indeed, seen copies of some of these photographs, but beyond awaking curiosity by their *bizarre* effects of light and shadow, they impressed me little, for lack, I suppose, of information as to their meaning. I beg you, then, to tell me what is really known about the world of the moon. There it is; I see it; I experience the delightful impressions which its light produces—but, after all, what is it, and what should we behold if we could go there? I once read Jules Verne’s romance of a trip to the moon, but unfortunately his adventurers never really got there, and I finished the story with a keen sense of disappointment because, in the end, he told so very little about the moon itself. As for the professional books of the astronomers they are useless to me. Then, please tell me that which, at this moment, with that wonderful orb actually in sight, I so much desire to know.”

It was not possible to resist an appeal so earnestly urged, but I felt compelled to say: “Since you remember so little about the fundamental facts which generations of astronomers have accumulated concerning our nearest neighbor in the sky, I must, for the sake of completeness, and in order to put you *au courant* with the more captivating things that will come later, begin at the beginning, and the true beginning is not among the mountains of the moon, but here on the earth. We must start from our own globe—as the moon herself did.”

“What do you mean by that?” my friend asked with a tone of surprise.

“Have you not read, somewhere, in the last ten years, that the moon was actually born from the earth?”

“Yes, now that you mention it, I dimly recall something of the kind, but I took it for an extravagant speculation of some *savant* who possessed more imagination than solid knowledge.”

“The *savant* who originally demonstrated the earthly origin of the moon,” I replied, “is not one to be easily led into extravagance by his imagination. It is Prof. George Darwin, the son of the famous author of the ‘Origin of Species.’ I shall not mention his mathematics, which are troublesome, but allow me to tell you, in a word, that his investigations have satisfied astronomers that the earth and the moon once composed a single body. How many million years ago that was we can only guess. The causes of the separation which eventually occurred were the plastic condition of the original body while it was yet hot and molten, its swift axial rotation producing an immense centrifugal force at its equator, and the attraction of the sun raising huge tides which affected its entire mass instead of affecting only the waters of the ocean as the tides do at present. At last there came a time when an enormous portion of the swiftly rotating globe was torn loose. That portion included about one-eightieth of the entire mass of the earth. Some astronomers and geologists think that the ‘wound’ left in the side of the earth by this stupendous excision is yet traceable in the basin of the Pacific Ocean.

“The separation being once effected, the material that had escaped gradually assumed a globular form under the influence of the

gravitation of its own particles; and, at the same time, by virtue of a curious reaction of the tidal attractions of the two bodies upon each other, the new-born globe was slowly forced away from its mother earth, becoming, in fact, its satellite. Thus, by a process which certainly does seem extravagantly imaginative, but which, nevertheless, is approved by strict mathematical deductions from known physical facts, the moon is believed to have had her birth.”

“Surely,” said my companion, “my imagination would never have dared to form such a picture, even if it had been capable of so extraordinary a flight.”

“No,” I replied, “nor the imagination of the most learned astronomer. You perceive that in things celestial as in things terrestrial fact is far more strange than fiction. We shall have occasion to refer to some of the consequences of the earthly origin of the moon later on, but just now in order that the knowledge you seek may not be too fragmentary, I must tell you some other, more commonly known, facts about our satellite.”

“Judging by myself I doubt if there are many such facts *commonly* known.”

“Perhaps you are right, but do not judge too severely the authors of astronomical books. Such books are written primarily for those who wish to study, not for those who desire to be intellectually entertained. But let me get through with my preliminaries, and then, under the guidance of science and photography, we shall try to visit the moon. One of the first questions that naturally arise concerning the objects that we see in the heavens relates to their distance from us. The average, or mean, distance of the moon from the earth is 238,840 miles. For the sake of a round number we

usually call it 240,000 miles. But the orbit, or path, of the moon in her monthly journey around the earth, is so far from being a true circle that the distance is variable to the extent of 31,000 miles. Even the form of the moon's path in space is not constant. Owing to the varying effects of the attraction of the earth and the sun, her elliptical orbit becomes now a little more and now a little less eccentric, the consequence being that the moon's distance from the earth is continually changing. When she is at her greatest possible distance she is 253,000 miles away, but this distance at certain times, may be reduced to only 221,600 miles. As a result of these changes of distance the moon sometimes appears noticeably larger to our eyes than at other times.

“This leads us next to inquire, ‘What is the actual size of the moon?’ When we know the distance of any body from the eye it is not difficult to determine its size. The diameter of the moon is 2,163 miles. The face of the full moon contains 7,300,000 square miles. It is a little larger than the continent of South America. For a reason that we will speak of presently, the moon always keeps the same side toward us no matter in what part of its orbit it may be. Consequently we always see the same features of her surface and, except through inference, we do not know what exists on the other side of the lunar globe. Of the 7,300,000 square miles of surface which the moon presents to us, about 2,900,000 are occupied by those dark gray patches which you see so plainly spotting her face, and which were once supposed to be seas. The remaining 4,400,000 square miles consist of a very rough, broken country, ridged with gigantic mountains and containing hundreds of enormous craters, and mountain-ringed valleys, which are so vast that one hesitates to call them, what many of them seem evidently to be, extinct volcanoes. A single explosion of a volcano of the

dimensions of some of these lunar monsters would shake the whole earth to its center!”

“Please stop a moment,” my friend laughingly interrupted. “So many merciless facts, chasing one at the heels of another, are as bad as the books on your science that I have tried to read. Give my imagination time to overtake you.”

“Very well,” I said, “then relieve your attention a little while by regarding the face of the moon. Do you perceive the portrait of the Moon Maiden there?”

“I believe I do, although I never noticed it before. It is in profile, is it not?”

“Yes, and it occupies all the central portion of the western half of the disk. Take the opera glass and you will see it more clearly.”

“Really, I find her quite charming,” said my companion, after gazing for a minute through the glass. “But what a coquette! Look at the magnificent jewel she wears at her throat, and the *parure* of pearls that binds her hair!”

“Yes,” I replied, “and no terrestrial coquette ever wore gems so unpurchasable as those with which the Moon Maiden has decked herself. That flaming jewel on her breast is a *volcano*, with a crater more than fifty miles across! Tycho, astronomers call it. Observe with the glass how broad rays shoot out from it in all directions. They are among the greatest mysteries of lunar scenery. And the string of brilliants in her hair consists of a *chain of mountains* greater than the Alps—the lunar Apennines. They extend more than 450 miles, and have peaks 20,000 feet high, which gleam like polished facets.”

“Truly,” said my companion, smiling, “these gigantesque facts of yours rather tend to dissipate the romantic impression that I had conceived of the Moon Maiden.”

“No doubt,” I replied. “It is only distance that lends her enchantment. But we must not disregard the facts. Her hair, you perceive, is formed by some of the vast gray plains of which I spoke a few minutes ago. She is like a face in the clouds—approach her, or change the point of view and she disappears or dissolves into something else.

“Now, to return to my preliminaries, upon which I must insist. Knowing the distance and the size of the moon, the next question relates to her motions. You are aware that she travels around the earth about once every month. There are two ways in which we measure the length of time that the moon takes for each revolution. First, regarding the face of the sky as a great dial, with the stars for marks upon it, we notice the time that elapses between two successive conjunctions of the moon with the same star. In the interval she has gone completely around the earth and come back to the starting point. This is called the moon’s sidereal revolution, and it occupies, on the average, twenty-seven days, seven hours, forty-three minutes, twelve seconds. Every twenty-four hours the moon advances among the stars, from west to east, about $13^{\circ} 11'$.

“But there is another, more usual way of measuring the orbital period of the moon. This way is connected with her phases, or changes of shape, from the sickle of the New Moon to the round disk of the Full Moon, and back again to the reversed sickle of the waning moon. It is the time that elapses from one New Moon to the next, or from one Full Moon to the next which now concerns us, and it amounts, on the average, to twenty-nine days, twelve hours,

forty-four minutes. This is called the moon's synodic revolution, and it is equivalent to the ordinary lunar month. It is variable to the amount of about thirteen hours. The reason why the synodic revolution is more than two days longer than the sidereal revolution is because the continual advance of the earth in its orbit around the sun causes the latter to move eastward among the stars, and before the moon's monthly phases, which depend upon her position with regard to the sun, can recommence, she must overtake the sun."

"What a hopeless task to try to remember all that!"

"At any rate, if you cannot remember these things my conscience will be clear, for I am simply doing my duty in telling you of them. If you forget, go to the books on astronomy and refresh your memory. But do not persuade yourself that the preliminaries are now finished. You are going to think that my story of the moon resembles Walter Scott's novels in the length of its introduction; but if, in the end, I can interest you half as much as he finally interests his readers I shall thank the stars for my good fortune.

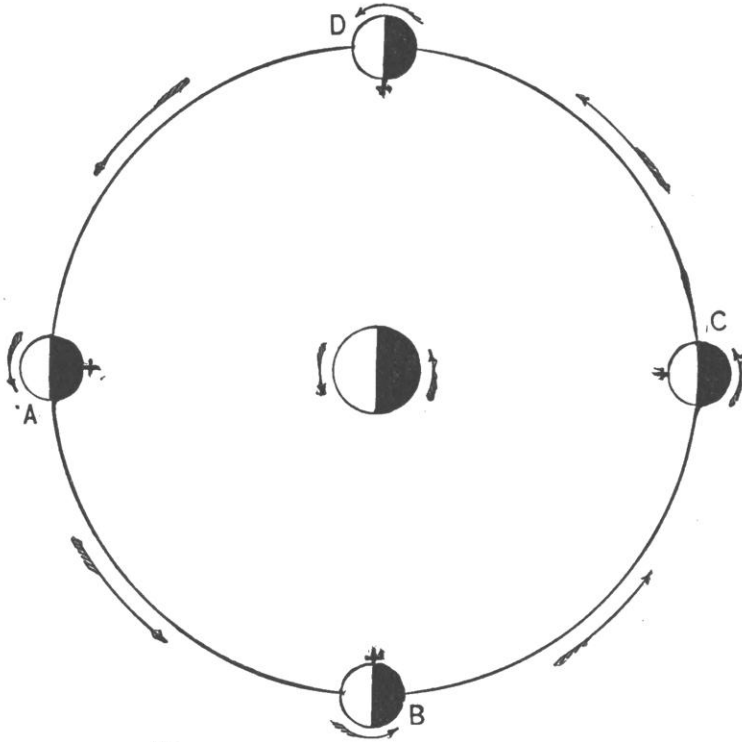
"The next thing that I must try to explain," I continued, "is the cause of the moon's phases, or her continual changes of form. You know that the New Moon is shaped like a thin crescent, and always appears in the west immediately after sundown, with the convex side facing the setting sun. The moon at First Quarter is a half circle and is visible in the southern part of the sky just after sunset. The Full Moon, which we have at present, is a complete round disk, and is always seen directly opposite to the place of the sun, so that she rises when the sun sets. The moon at last quarter is again a half circle, and appears on the meridian in the south at sunrise. The waning moon is like the new moon, crescent-shaped, but the

convexity of the bow faces the rising sun, and she is visible only in the morning sky just as dawn begins. To explain the reasons for these changes of shape, which the moon regularly undergoes every month, I must ask you to go indoors and examine a little diagram which I have made.”

“Oh!” said my companion, “it is too bad to abandon this charming spectacle, illuminated by rays so fascinating, for the sake of looking at mathematical lines drawn on paper! But I suppose that this is one of the sacrifices demanded by your inexorable science, and must be made.”

“Yes,” I said, “but if science sometimes demands sacrifices, at least she always rewards them most generously.”

When we had returned to the house I placed upon the drawing-room table this diagram.



Phases and Rotation of the Moon.

As I spread it out, my companion, after a regretful glance through the open door at the silvery lawn, on which the moon, having cleared the obstructing branches of the bordering trees, was now pouring down the full splendor of her rays, put her elbows on the table to follow my explanation.

“The globe, half bright and half black, in the center,” I said, “represents the earth. The large circle surrounding the earth we will call the moon’s orbit, which she traverses once every month.

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