A Dip into Space

Major Titus, #1

by Robert Duncan Milne, 1844-1899

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WHILE sauntering along Kearny Street one day last week I was approached by a gentleman of distinguished air, but an utter stranger to me, who said:

"Pardon me, but am I right in supposing that you are the transcriber of the account which appeared in the *Argonaut* not long ago, of the workings of the aerial cone reflector in Oakland? You were pointed out to me as such, and I have taken the liberty of addressing you in consequence."

Somewhat surprised I answered in the affirmative, and my interrogator went on:

"It is no idle curiosity which has prompted me to speak to you. I was deeply interested in the subject, and mean to evince that interest in a tangible form. Am I right in supposing that the gentleman referred to as having conducted the experiment is Doctor___?" at the same time mentioning the doctor's name. "If so, I have the pleasure of a slight acquaintance."

I replied that the doctor did not court publicity at present, but that as my questioner knew him, probably the best thing he could do would be to call on him, and explain his purpose.

"I entirely appreciate the motives which actuate his conduct, and am confident that he will in like manner appreciate mine when they are explained to him," said the stranger.

Not knowing what to say, I bowed assent and waited.

"Again I beg you will excuse me for introducing myself. Allow me to present you with my card. I think I can, perhaps, show you something which will compare not unfavorably with Dr.___'s discovery. If you will do me the favor to dine with me to-morrow at six—Sunday, I presume, is not a very busy day with you—I shall do my best to redeem my promise. I ask you unceremoniously, for literary-men are not usually in love with ceremony. Come if you can," and with a polite bow the stranger passed up the street.

I mechanically resumed my stroll, pondering upon the peculiar circumstances which seemed to make me the repository of extraordinary confidences, whether I desired them or not. Last week it was the doctor with his scientifically constructed magic mirror; this week it is—who? I pulled out the card that had been given me, and found him to be a retired army officer, whom I shall call Major Titus, residing in the western quarter of the city.

Certainly a gentleman, I mused; evidently well educated; probably rich; possibly a *bon vivant*; perhaps a *connoisseur* in wines. I should certainly go and eat his dinner, whether the Remainder of the promise was carried out or not.

With this selfish resolution, on Sunday afternoon I ascended the hill, rang the door-bell of an elegant mansion, was ushered in by the most decorous of servants, and sitting down to table did ample justice to the best of dinners, my host remarking that all his family were at the sea-side, his house virtually shut up, and himself merely in the city for a day or two on business. The conversation ran upon general topics, no allusion being made to the ostensible object of my visit, which, of course, I did not take the initiative in referring to. After dinner we went upon the piazza to smoke a cigar, and as the stars came out in the clear evening sky our conversation naturally turned upon astronomy.

"Do you know," said he, pointing to some stars in the constellation of Ophiuchus, "that I have succeeded in making these stars display a sensible orb? Even through the largest telescopes, hitherto, the fixed stars have indeed increased in brilliancy, but still remain mere twinkling points of flame."

"Indeed," said I, "you amaze me. With an optical power such as you speak of, even the remotest planets in our system might be brought comparatively to our door."

"They are," said be. "My new combination will create an enormous revolution in optical science. We have been running in old grooves too long, and have not taken advantage of the progress of the age."

"Will you show me your instrument?" I cried, eagerly. "I should be delighted to witness what you speak of."

"With pleasure," said he. "There are none of the planets visible in the evening sky at this moment, as you are aware, but if you will consent to wait till the bright galaxy heralds in the morning in the east, I will then convince you of the truth of my assertions."

"I shall certainly take the opportunity of doing so," replied I, "but meanwhile you perhaps would not be averse to explain the theory of your instrument, so that I may bring some prior knowledge to bear upon the subject But perhaps you wish to preserve its construction a secret?"

"On the contrary," answered the major, "I propose to relinquish all right to the possession of my discovery, and to make a present of it to the world. Such discoveries as mine are too vast to remain the monopoly and private property of an individual. They are useless unless disseminated among mankind. And more especially is this the case with astronomical discoveries. They are of no material benefit except in so far as they expand and enlarge our views of the sublimity of nature, and serve to convince us that we are not alone, or the only beings, in this vast and beautiful universe. Therefore I hold that all great discoveries are the property of all, and that it is criminal to selfishly withhold them from all. True, the men who make them are usually slighted, often forgotten, sometimes abused, rarely rewarded, but still it is their duty to make them public. They are not responsible for the treatment they may receive—they are for the manner in which they dispose of what they know.

"You are acquainted," he went on, after a pause, "with the construction of an ordinary telescope. All telescopes, whether refractors or reflectors, agree in this respect, that they project upon the air an image of any object within their field at a point beyond their focus, which is then examined through a magnifying eye-piece. Their strength depends upon the diameter and focal length of their object glasses, or reflectors, as the case may be, since it is a law of optics that the area of the image depends upon these conditions, and that the longer the focus the larger will be the image projected. Magnifying glasses of high power can not be used to indefinitely magnify a small image projected by an object glass of small area and short focus, any more than a one-horse-power engine making a thousand revolutions a minute can be made practically equivalent to a thousand-horse-power engine making one revolution in the same time; though, theoretically, it would be so, their length of stroke being equal. Certain proportions must be observed in all mechanical contrivances, and the telescope is no exception to this natural and inevitable law. But there is no reason why the small engine should not toil on at a less rate of speed, and for a correspondingly longer time, and store up as much energy as its larger brother, and such stored energy would be equally serviceable in either case. Now the reason that an image of small area, such as is projected by an object glass or reflector of small diameter and short focus, can not be indefinitely magnified by an eye-piece of high power, is less due to the spherical aberration which would ensue, and which can be rectified, than to the fact that the image itself is insignificant. The image of the moon, on the contrary, as projected by the six-foot speculum of Rosse, is too large in area to be examined by an eye-piece of high power, in its entirety, since the eye can grasp only a small

portion of its area at one time. It is, therefore, in the first place, to the enlargement of the image to be examined that we must look; and such enlargement has only been arrived at, hitherto, by using object glasses or reflectors of wide area and great focal length—the former quality collecting a maximum of light, and the latter providing an image sufficiently large to be examined by sections, so to speak. I presume you comprehend the line of argument?"

I signified assent, and he proceeded:

"I have hitherto," he said, "been explaining the simple laws of optics, which are as old as Kepler or Newton. I shall now, however, explain to you the nature of my discovery, to appreciate which it was necessary that you should distinctly understand the three great optical *desiderata* for telescopic observation—viz: area, luminosity, and sharp definition of the image to be examined. When I tell you that within a periphery of six feet diameter I can show you, if I please, not more than ten acres of the moon's surface, you will appreciate the extraordinary power of the combination I employ. When I further tell you that I can examine the ten acres thus projected with a magnifying power of one thousand diameters, if I please, just as if it were a chart, you will not be surprised when I make the further assertion that I can accurately determine the geological composition of a pebble lying on the surface of our satellite as well as if it lay the re upon the piazza before our eyes. You need not start as if such a thing were incredible. It is nothing but the simple, sober fact, and I would not assert it if I were not prepared to prove it. But the night is getting cold, and as it is impossible for me to complete my preparations till morning, let us go in. My butler is an adept in preparing a night-cap, and I shall give orders to have you called punctually at three. You will then witness the operation of my instrument, which I can explain more thoroughly while under actual inspection."

PUNCTUALLY at three a rap came at my door, and after hastily dressing, I descended to the dining-room, where my host was already awaiting my advent.

"I have been busy," he said, "for an hour already, preparing the material which I use to make my lenses. It is necessary that this material should be absolutely fresh to ensure perfect brilliancy and transparency; without which the experiment would be worthless. Help yourself to some coffee," he continued, pointing to the table. "I will not detain you five minutes longer. The ingredients require to be thoroughly mixed."

The thought flashed though my mind: Was I being made the victim of an innocent practical joke? or were the promises of the preceding night merely the vaporings and delusions of a monomaniac? The calmness and gravity of his conversation the evening before, and the methodical manner in which he talked and conducted his present operations, assured me that the first could not be the case. As to the second, I, of course, knew that persons may be mentally sound on all the practical affairs of life but one. This optical idea might be merely the harmless delusion of a wealthy gentleman, which could not possibly interest or affect his relations with others. So I resolved, at all events, to stay and see what would take place, humor him if occasion called for it, and—hold my tongue about it. While I sipped my coffee my host was engaged in mixing, in a large porcelain mortar which stood upon a side table, a quantity of some thick, glutinous

substance, which seemed to possess extraordinary tenacity by the apparent pressure requisite to force the pestle through it, adding, from time to time, now a portion of some fluid carefully measured in a graduated glass, and now a powder as scrupulously weighed on an apothecary's balance.

"The process requires much care," he remarked, as I approached the table where he was working, and manifested a silent interest in the proceedings. "Either too much or too little of any one ingredient I have found to seriously impair the refracting qualities of my composition. This has happened so frequently that I now take more trouble than during my first experiments, for the selfish reason that it saves me the trouble of doing everything over again. Besides, this morning I am taking extra pains," he added, smiling, "on your account. I wish the experiment to be made under the best possible conditions, so as to secure the best results."

"Surely," thought I, "this measured manner, this calm assurance, these sensible observations must proceed from a rational mind," and the reflection awakened new interest to observe every detail of the proceedings. I noticed that the substance undergoing triturition in the mortar was thick, glutinous, and perfectly pellucid. Besides transparency, it seemed to possess brilliancy, not dissimilar to those spurious imitations of diamonds known by the name of "paste." At length the process seemed to be completed. My host examined it critically, imparted a last tentative pressure to the pestle, and pronounced the result satisfactory.

"There, that will do," said he, with a gratified expression of countenance. "I think we can venture now on the manufacture of the lenses which are to reveal to us the mysterious secrets of space."

"It appears to me," said I, "that the lenses you doubtless intend to mould from this composition must be of limited diameter, as there does not seem to be more than a quart of the substance contained in the mortar."

"You are mistaken," he replied, "when you think that I mean to mould my lenses from that composition. To mould a lens at all, no matter how apparently perfect the matrix, would leave it subject to so many imperfections as to make it optically worthless unless subsequently ground. Besides, as you very justly observed, a single object lens framed from the entire composition which lies there would not compare favorably in size with those of the great refractors at Washington or Cincinnati, and accordingly I should be transgressing one of the primary postulates laid down last night, namely, the collection of light. The more parallel rays we can gather from a luminous object, the more light we shall necessarily have in our projected image when concentrated by lenticular action. The largest lens in existence is not three feet in diameter, and consequently has not a refracting area of seven square feet. I shall presently have the pleasure of showing you a lens faultless in curvature and absolutely achromatic, with a diameter of ten feet, a consequent area of seventy-eight and a half square feet, with more than three times the superficial area of Lord Rosse's speculum, utilizing nearly ten times the quantity of collected light that is done by that gigantic reflector, and utilizing it in such a fashion as to render the actual power of the combination many thousand times superior to that—the finest telescope on earth. I make the latter remark advisedly, since, as I told you before, my lens is not permanent, but necessitates refashioning every time I use it."

I felt it perfectly useless now to hazard any comment on my host's remarks. I determined to await events, and keep on the alert for any possible mischance. Still my experience of the week before had so utterly upset my ideas of physics as at present formulated by scientific dogmas, that I confess I was prepared for almost anything. My host pulled out his watch, remarking that it was already ten minutes past three, and that we must take advantage as much as possible of the darkness.

"If you will carry that spirit-lamp," said he, pointing to one on the table, "I will take the mortar, and we will go upstairs."

I did as desired, and followed him upstairs, and through a skylight, to the roof of the house, which was flat and ample, being, as far as I could judge, about fifty feet square. The heavens were as brilliant as those of California or Greece ever are, and, from the position of the house, presented a clear horizon in every quarter but the north. At one side, near the parapet, I noticed a cubical wooden structure, resembling a small house, movable on wheels, about ten feet in dimensions every way, from one side of which protruded a tube about two feet long by one in width, and from the centre of whose top rose a similar tube of about the same length and diameter, but terminating in a cup-shaped vessel of considerable size. Approaching this structure, I assisted the major to wheel it over to the eastern side of the roof, and opening a door in the side, we entered. A species of small stove was in the centre, connected by a pipe with the tube in the roof, opening the side of which the major asked me to place the spirit-lamp inside, light it, and close the door. At the side of the cabin opposite to that of the horizontal tube before mentioned there stood an upright circular frame, concealed by drapery; and at another point, a binocular instrument of a size I had never before seen, mounted on a tripod stand, and beside it a rocking-chair. There was no other aperture in the cabin but the door.

"If you will now come with me," said my host, "we will proceed to make the lens."

I accompanied him outside, and together we ascended to the roof of the cabin by means of a ladder, the major climbing in advance, and I handing the mortar up to him when he had reached the top.

"I think the cup is sufficiently hot now to dissolve the mixture," said he, feeling it with his hand, and proceeding to ladle some of the composition from the mortar into it.

I looked into the bowl and saw that it had a tiny perforation in the bottom not much larger than the orifice of a tobacco pipe. When about two-thirds of the substance had been put in the major paused.

"There," said he, "that is enough to construct a ten-foot lens, as large as we have any practical use for at present."

In two or three minutes the substance in the bowl began to seethe and bubble. The major observed it critically and requested me to descend and turn up the wick of the spirit lamp in the stove below. I did so, and on returning noticed that a bubble- shaped, vitreous sphere was now rising from the cup and gradually enlarging as it rose.

"Everything is perfectly satisfactory," remarked the major: "The composition is of the proper consistency, and in a few minutes more we shall have our object lens. I presume you understand the *raison d'être* of this globe," he continued as the bubble expanded and increased in size under the influence of the hot air inflation

from below. "You see it is formed on the same principle as an ordinary soap-bubble, and, when it attains a certain size, forms the most perfect sphere in nature."

The sphere kept on increasing in size until it reached a diameter of, as far as I could judge, ten feet, when the major turned a cock on the tube below the cup, remarking:

"The diameter is now as great as requisite, though I could, if necessary, increase it to nearly as much again. I would not, however, have room for a lens of greater focal length upon my roof, the globe which you now see having a focal length of eighty feet—greater than that of Lord Rosse's telescope."

"But your image will be projected into space," cried I, "where you will not be able to examine it, for your roof does not seem to be more than fifty feet in extent."

"Fifty-two feet is the extent of it," he returned, "but I re-reflect my rays back from a convex reflector at the distance of forty feet from my lens to this cabin, where they are received at focus by the tube you saw at the side, which contains a lens combination that projects the image upon a screen opposite, where you will examine it at your leisure by means of a powerful binocular microscope you saw standing inside."

By this time the crystalline sphere, which seemed beautifully brilliant and transparent, had apparently become hard, and looked like a globe of solid glass. The major now reached for a diaphragm of light metal resembling japanned tin, which I had not previously remarked, as it lay on the other side of the table, to which it was attached by trunnions just below the cap, and swung it from its horizontal position to a perpendicular one, where it formed a screen over the face of the sphere, practically transforming it into a convex lens of about nine feet aperture, by obscuring about ten degrees of its immediate top and bottom.

"I have found it necessary to use this diaphragm," he said, "since the unequal refrangibility of rays striking the sphere tangentially interfered with the distinctness of my image, their focus not coinciding with those which entered the lens at a lesser angle."

"But in any case," I remarked, "I do not see how you surmount two very serious optical defects in your object-glass—first, its want of refractive power, for it is evidently a mere shell, possibly not more than the hundredth of an inch thick; and, secondly, the chromatic dispersion of your refracted rays, for, with a focal length of eighty feet, as you claim to have, their unequal refrangibility will throw the focus of the red rays many feet nearer than that of the violet, and you will get no image at all, but a concentric rainbow spectrum."

The major smiled, and said: "My dear sir, you must remember that the science of optics has not been standing still since Hall and Dollond, in the middle of the last century, first framed the achromatic lens out of two kinds of glass of unequal refracting qualities, thus making the light passing through them homogeneous, and rendering it possible to construct a refracting telescope of high power, which, previous to their time, had been an impossibility. I have here simply gone a step further, having taken advantage of that quality of various substances known as their *florescence* and by a judicious combination of these substances I have absorbed the colors of the various rays entering my lens, thus bringing them all to a common focus of homogeneous light As I knew that a solution of aesculin

absorbs the violet rays, quinine and petroleum the blue, turmeric the yellow, uranium the green, napthalin the red, I experimented for a long time in framing a composite substance of all these materials to absorb color. My experiments with glass were not satisfactory, and I at last hit upon the device of combining the ingredients with a peculiar preparation of canada balsam, and producing a spherical lens by the ordinary process of inflation. In this I at length succeeded, and the result stands there before you. I also found that the refracting qualities of that hollow sphere, thin as it is, are perfectly sufficient to bring parallel rays to a focus. You will presently witness that what I say is correct. We shall now proceed to form my reflector."

I accompanied the major down the ladder, carrying the mortar with the remainder of the preparation, and re-entering the cabin he removed the spirit-lamp from the stove, placing it in another small stove, similarly surmounted by a tube and cup some five feet high, into which he put the rest of the glutinous substance, adding to it, however, a quantity of some sparkling powder, which he told me was an amalgam of quicksilver. In the course of a few minutes a similar bubble rose from the cup, which, however, instead of being transparent, shone like a polished silver mirror, or one of those Claude Lorraine glasses which one sometimes sees set up in gardens, having a diameter of about four feet. This was then wheeled outside upon its pedestal and set at the western extremity of the roof.

"I shall now proceed to collect the rays from any one of those four planets we now see over the eastern horizon," said the major, pointing to Venus, Jupiter, and Saturn, which shone at various altitudes and various degrees of brilliancy, "and focus them upon yonder receiving lens in the side of the cabin."

"Will it not be a matter of some difficulty," I asked, "to concentrate a focus directly upon that lens?"

"Not at all," he replied. "I wheel this reflecting globe backwards or forwards in a line with my refracting lens at a distance of about forty feet, and raise or depress it by screwing this tube up or down. You see it is made in two parts. Once I have ascertained the exact focal length of my object glass, I move this tiny windlass at the bottom of the pedestal, and tighten up that silken cord, this end of which is coiled round a drum, while the other is attached to the bottom of the cabin exactly beneath its centre. The drum is then held in its place by a ratchet, and by keeping the cord always tight while I wheel this pedestal, it is evident that my reflector moves on a radius of a circle, and always preserves its true distance from the object glass and the receiving lens below it. As the planet to be examined rises above the horizon, I depress my reflector and wheel it slightly northward, at the same time altering the inclination of my receiving lens, and the plane mirror which you see outside it, which moves upon a universal joint, and of the screen inside, If you will now go into the cabin, remove the covering from the screen inside, and help me to focus the image on the screen by the rack and pinion on the receiving lens, we shall not be three minutes in securing a picture of any one of the planets you may desire. Remember that only a small portion of the full orb of even the furthest of them will be projected upon the screen at a time, and the picture will keep moving over the screen slowly while you are gazing, its rate of motion being dependent upon the approximation of my adjustment of this reflector, and yours

of the receiving lens, to the apparent motion of the planet in the heavens. You will soon get experienced in the manipulation. Of course it would be an easy thing for one to adjust all portions of the combination accurately by clockwork motion, and a permanent line of circular rails for this pedestal, if my object glass were permanent, but as you know it is not, and as it is impossible for me to construct it of uniform size each time, I am compelled to have recourse to this somewhat primitive mode of procedure for the present, at all events. My object glass of course presents the true surface of a sphere from whatever direction the rays fall on it within the periphery of the diaphragm, and this fact therefore necessitates no change of position. Which planet would you rather view first?"

"I have always had a fancy," said I, "to know something about the one formerly known as the lather of the planets. I have always been curious to know the composition of those annular objects referred to by the poet in the lines—

"Still, as white Saturn whirls, his steadfast shade Sleeps on his luminous ring."

"It is now half-past three," observed my host, looking at his watch. "The planets are momentarily attaining an elevation which will not permit of my depressing this reflector to focus them on the screen for more than half an hour longer. Please go in and make the best of your time, while I attend to this reflector."

I did as desired, entered the cabin, closed the door, removed the covering from the circular screen opposite the receiving lenses, disclosing a concave surface of glistening white, seemingly made of the same substance as the spherical lens and mirror, sat down in the easy chair, moved the binocular glasses into convenient position, took hold of the rack and pinion which worked the receiving lenses, and opened a colloquy with the major outside. Presently a faint white light appeared on the surface of the screen. I hailed the major, who told me to focus the receiving lenses. I did so, the major meanwhile adjusting the reflector outside. As I focused the instrument the light dwindled in size, but increased in brilliancy, till it assumed the form of an intensely dazzling disc, about the size of a small silver coin, moving slowly across the screen in an upward direction. I told the major what I saw.

"That is one of the fixed stars in constellation Cancer, and only of the third magnitude. Focus still further back and forwards, till you reduce it to its least diameter. I told you that with my instrument the fixed stars displayed a sensible orb."

I moved the pinion back and forward, but only succeeded in increasing the diameter of the star. I therefore knew that my original focus was correct, and restored my instrument to it.

"That will do, then," exclaimed the major. "The receiving lens is now properly focused for the fixed stars. All further movement for the planets must be toward the screen. In a very few moments I shall bring Saturn upon the field."

As he spoke the bright disc moved rapidly across the screen, and was succeeded by other discs of various sizes and lustres, none of them, however, of more than half an inch in apparent diameter, when suddenly there appeared on the screen a brilliant white arc, forming a small segment of a circle of large radius, and I immediately apprised the major of the fact.

"That is either a portion of the body of the planet Saturn or its outside ring. Bring your binocular magnifier into play, and I will endeavor to keep the planet in focus," said he.

I then, having first of all focused the receiving lens until the outline on the screen was sharply defined, brought the binoculars to play upon the projected image. I remarked with surprise that while I still seemed to cover a field of vision six feet in diameter, the edge of the arc I was looking at had lost all curvature, and become a straight line. I at once concluded that I could now grasp only a very small portion of the image on the screen—a conclusion further strengthened by the fact that the white rim was speedily passing across my field of view. I followed it, at the same time readjusting the focus of the binocular and of the receiving lens to suit my vision, and presently had the satisfaction of witnessing a wondrous spectacle. The white body assumed distinctness, and became broken up into irregular, rough, grayish masses. Yes, there could be no doubt about it. I was gazing upon a frozen sea; upon barren fields of ice, covered with uncouth icebergs of every possible size and shape; upon dazzling and interminable wastes of snow. The scene seemed to pass angularly beneath my view, as though the bleak frozen panorama stretched hundreds upon hundreds of miles, and kept ever gliding away to a limitless horizon. I was awestruck at the spectacle, which, however, exercised such a fascination over me in its ghastly desolation that I could not remove my gaze from it. It was as if I were standing isolated upon some lone peak of awful altitude looking down upon a moving plain relegated to eternal cold, and night, and death. A weird glimmer, like that of moonlight, was shed from some unseen source upon the scene. I shuddered with an appreciation of unspeakable chillness as the icebergs and snowfields swept silently and majestically on. Suddenly a dark shadow began to move across the picture. It grew blacker and blacker, till I could barely distinguish the death-like landscape through it. The circumstance diverted my thoughts, and unchained the power of reason. This, I argued, must be the shadow of the ring; I shall presently gaze upon the ring itself, and solve the astronomical problem that has hitherto puzzled the ages. For perhaps a minute—though I was too preoccupied to note the time—the shadow landscape passed on. Then another apparition invaded the field of vision. A blurred and indistinct dark edge had succeeded the shadow. I felt that this must be the inner edge of the dusky ring whose nature had puzzled modern astronomers. I saw that my vision had leapt over a gap of many thousands of miles in a second, and that my receiving lenses were out of focus. I reached for the pinion, and readjusted the focus. The dusky mass became distinct. It resolved itself into myriads of isolated icebergs of all sizes and shapes, which careered onward, and clashed, and shocked, and rebounded through a sea of air, and gleamed against the darkened surface of the planet. "This, then," said I, "is the composition of that mysterious inner shadow-ring. It consists of nothing but a series of irregular ice-blocks, varying apparently from units to hundreds of miles in diameter, revolving, like independent satellites, around the body of the planet. While I looked the scene changed again. The icebergs and ice-masses got thicker, more connected, more numerous. Still they went moving horizontally, grinding and clashing among themselves. The disorderly procession passed on, and again came a black shadow, which I presumed was the shaded planet seen through the space dividing the

inner and outer luminous ring. I was right; for presently more changing and jostling fields of ice came into view, and proved that I was now inspecting the outer ring. Suddenly, and with a seeming start, the picture vanished. The surprise was broken by the major's voice as he opened the door.

"I have allowed you five minutes for Saturn," said he; "and have done my best to keep the planet well in the field of vision. Had I not done so, its image would have swept across the scene so rapidly as to be worthless for inspection. When I ceased moving the reflector I presume it vanished."

"I am astounded," I returned, "at what I have witnessed. A frozen planet, surrounded by rings of icebergs."

"Just so," said he. "Saturn has been dead for countless billions of years, ever since the limits of the sun contracted to a lesser diameter than the orbit of Mercury. Life upon Saturn was luxuriant when this earth was a sphere of vapor. The deprivation of heat and light froze him to death. The rings were once fluid, and their present resolution into myriads of independent masses, revolving at varying rates of speed around their primary, is the only dynamical condition under which they could continue to exist. You see, therefore, that practical observation merely bears out and corroborates theoretical law. Will you now inspect Jupiter, the next in order, and the largest of the mighty fraternity? You now understand how to focus the receiving lenses, fend I will attend to the reflector," he said, as he went out.

I lay back in the easy chair, wondering with what new development I was about to be presented, and presently I heard the major calling on me to depress the plane mirror, vary the altitude and inclination of the receiving lens a few degrees to the north and west, so as to receive the focal image of the new planet squarely, a thing which I had no difficulty in doing since the tube was hung upon a universal joint, and was also supplied with azimuth and meridian circles. An ingenious system of rods, which I had not before noticed, lying as they did upon the floor, caused the concave screen to likewise move upon a universal joint square to the axis of the receiving lens. At length, after numerous disks of light, which I now knew to be fixed stars, had passed over the surface of the screen, I perceived a luminous and nearly straight band of light rising from the southern border. I called to the major, who then began to adjust more carefully the movement of the reflector.

"That," said he, "is the northern limb of the planet. You will have to refocus your receiving lenses, as Jupiter is many millions of miles nearer us than Saturn. The latter planet, which is now in quadrature, and therefore some eight hundred and fifty millions of miles away, you saw projected upon the six-foot screen by sections, as if it were a globe of thirty feet diameter. Thus you could only see one-fifth part of its surface at a time, with the naked eye, upon the screen. Now, bearing in mind that the apparent angular diameter of Saturn upon the sky's face is only seventeen seconds of a degree, and that the six-foot screen subtends an arc of sixty degrees as seen from your chair which stands six feet off it, you can easily calculate the first power of my instrument by the following formula: As 3000 (5x60" being the angular measurement of the projected image of Saturn on the screen) is to 17", (the apparent angular measurement of the same planet on the sky,) so is 850,000,000 miles (Saturn's actual distance) to (about) 12,000 miles,

the distance at which the planet appears on the screen. But, through that powerful binocular microscope which you have been using, you can only examine one-half inch of the surface of the screen at a time, and this is magnified more than one hundred diameters, so that you have actually been inspecting Saturn at a distance of less than one hundred miles from his surface. Jupiter, being less than one- half this distance from our earth, will appear through the binocular, on the screen, as somewhat less than fifty miles off; while Mars, in his present position, will seem but twelve, and Venus, being now at her western elongation, somewhat less than five. The moon we shall inspect as if only a few hundred feet away, while—"

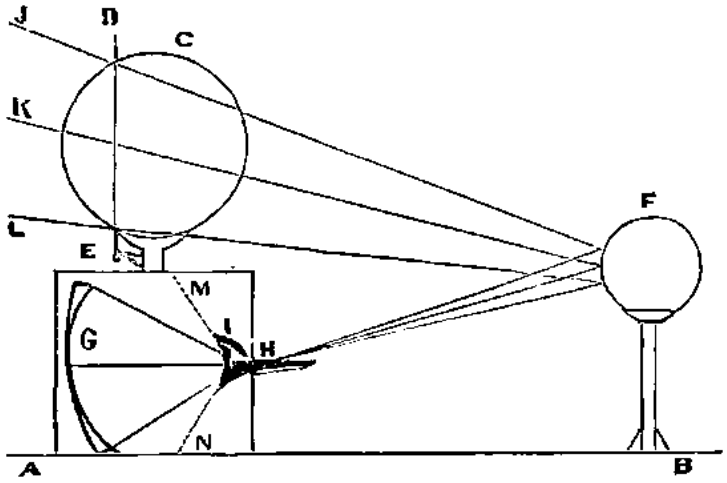
But what my host was going to say will be forever lost to mankind, as at this moment the fragile reflecting globe, at the base of which he had incautiously leaned in the forgetfulness of the moment, burst with a slight explosion, and instantly collapsed into a shapeless and wrinkled mass. The major looked ruefully at it for an instant, smiled, and regained his customary *sang froid.*

"N'importe." he remarked, "this is one of the disadvantages of employing optical *media* which are perishable. My sphere would, at any rate, have dissolved before the first rays of the morning sun. The result has been merely anticipated by a short space, for already I see the 'rosy- fingered dawn lifting the curtain from the east.' We should not have had very satisfactory results in any case. I am only sorry for the *contretemps* on your account. I should like you to have witnessed for yourself the seething cloud-atmosphere of Jupiter, the rose-colored vegetation of Mars, the picturesque woodland scenery of Venus, and the terrific and crater-scarred wastes of our ruined satellite, the moon. But you must come some other night and view them all. The experiment practically costs nothing hut time', and it is worth while to rob one's self of sleep for one night to witness such spectacles, is it not? Please put the covering on the screen and the cap on the receiving lens, while I wheel this pedestal inside. Then we will go down stairs and take some breakfast, for the night is cold and the sharp air bracing."

As we sat smoking a cigar after breakfast I remarked:

"Major, I do not perfectly understand the principle of your combination. Would you have the kindness to explain its proportions and effects more perfectly to me in detail."

"With pleasure," he replied, getting some paper and mathematical instruments, after which he proceeded to draw the following diagram:



"Here it is," said he, when he had finished: "The line A B represents the roof of my house, fifty feet long. C is the object lens I made first. D E the diaphragm you saw me swing up round the lens on the joint E. F is the spherical mirror I constructed next. G is the concave screen in the cabin. H is the plane mirror adjustable at the mouth of the receiving lens, J K L are parallel rays from any celestial object, and their course is plainly marked as they are converged by the spherical lens C, to the Cassegrainian reflector F, thence to the plane mirror H, and, through the receiving lens combination I. They are then thrown, greatly magnified, upon the concave screen G. The diverging rays M N, produced in dotted lines, show the extreme limits of the image if it were thrown *in toto* upon one screen, which you see would require to be five times the diameter of the screen I use."

"I perfectly understand," I answered, "the optical principle till the rays reach the receiving lens, but I cannot understand the *modus operandi* by which they are then diverged to such an extraordinary degree, and at the same time retained in focus."

The major smiled and said:

"My dear sir, you may have heard the remark that there are more things in heaven and earth than are dreamed of in our philosophy. Our *savants* and opticians are still children, fumbling in darkness, as regards the true nature of lenses. Within that receiving funnel are placed two concave lenses of extremely short focus, at a certain distance which is absolute, invariable, and the formula of whose distance is therefore easy to escape detection. The rays strike these lenses before they come to focus. The image which would otherwise he projected in the ordinary manner, inverted, at the distance of the screen, is thus prematurely caught by this concave lenticular action, and its rays diverged. But this does not mean that the image is distorted or lost. It is, in fact, projected in this thousandfold magnified form on the exact plane, or rather concave, surface where it would, under other circumstances, have assumed an insignificant and inverted shape."

"I am sorry," said I, "that the spherical lens burst before we had time to continue our investigations."

"It was unfortunate," assented the major, "but come some other night, and I will show you the remaining planets, including Uranus and Neptune, as they really are. They will astonish you. Take another cigar."

And, after promising to accept the major's invitation during the following week, I walked down the street pondering on the problem as to why unknown and private gentlemen frequently know more of a science than the professors of that science themselves.

—Robert Duncan Milne, San Francisco, August, 1881.