

THE MEDITERRANEAN SOLAR ECLIPSE.

WHEN the astronomers came home to Cambridge from Kentucky after the total solar eclipse of 1869, so full of the great phenomenon and its tantalizing yet beckoning mysteries, that they were determined, if it were a possible thing, to see the one which was to take place in Spain and Sicily in a year from the following December, I thought to myself that to take such a journey for the chance of a moment was indeed the very wildness of scientific enthusiasm.

Sicily, in particular, had always seemed to me an "ultimate dim Thule"—one of the jumping-off places of the world, where, if indeed the morning sun of civilization had ever shone, it had faded so long ago that it was all one as though the island had never emerged from the midnight of barbarism. It is true I was dimly conscious that in the palmy days of Greece Athens had begun her own ruin by the siege of Syracuse in Sicily; also that in the golden age of Rome Sicily was her granary, and that the white slaves who raised the splendid harvests were so frightfully treated that they rose against their masters in the most desperate insurrections; that in the feudal ages both the Normans and the German Emperors had had something to do with Sicily, and that once there was a massacre there called the "Sicilian Vespers." But its history was all utterly vague and misty to me; and as for its geography, had any one asked me whether its inhabitants wandered about Mount Etna with one shoulder draped in skins, or walked paved streets in the clothes of the nineteenth century, I should probably have answered, "I'm sure I don't know"; and yet, dear reader, I *did* attend "public school" in my youth, and was often at the head of my class too!

When, therefore, the destinies of things had actually brought it about that the United States granted its Coast Survey \$29,000 wherewith to go and observe the eclipse, and I all suddenly found myself a member of Professor Peirce's own division of the expedition, the very last thing present to my thoughts was that I should find any pleasure in visiting Sicily. What I should see on my way thither and back was the great anticipation to me, and Sicily I classed with the voyage across the Atlantic, as the inevitable bore that in some shape or other dogs all human enjoyment, and is endured for its sake. I supposed that beautiful Naples would be our last stage of civilization, and there nerved myself up for indefinite dirt, fleas, and bad dinners, until we should see once more its heavenly bay and hear again the delightful hurly-burly of its streets.

It is a truly Italian fact that there is as yet no railway from Naples to the end of the peninsula—the toe of the boot—so that instead of being able to cross from Italy to Sicily by ferry in an hour, you have to take a little steamer at Naples and coast down the Italian shore for a day and a night, more or less, as it happens, until you get to Messina. And it is an equally peculiar Italian fact that there is no wharf in the Bay of Naples for the said steamer to lie at, but you and your luggage are rowed out to her in an open boat in the dark, and have to climb into her by a narrow ladder; and if this happens to be in a drenching rain, as was the case with us, one is very apt to think fondly on one's native land, where covered piers and broad gangways are natural rights just as much as the ballot! We unluckily had taken the Peirano instead of the Florio line, and found ourselves next morning, after not a bad night, on

board a boat whose deck was grimy beyond conception, and full of Italian soldiers or opera bravos, I am not sure which. However, a nice little English library had been bought, probably with the steamer, and as the Mediterranean was smooth to glassiness, I preferred to ensconce myself on a sofa in the cabin and while away the day with Mrs. Piozzi's "Reminiscences of Dr. Johnson," to spending it up stairs staring at the Apennines that lined the shore, for they are the most repellent mountains I ever saw, gray, bald, and bare, without anything grand to redeem them—much like the backbone of the modern Italian character.

We arrived at Messina about nine o'clock at night—a soft, exquisite, star-light night—and were rowed ashore in the same primitive fashion in which we had embarked. The back windows of our hotel looked out on the quay, so we were soon in it; and, with its barn-door entrance into an inner court round which its stone pillars and galleries and staircase were built, the Hotel Vittoria, if not "Sicilian," was certainly unlike any other I had seen. I was shown up to the third story into just the room for a summer land—large, dusky, with a stone floor and a deep grated window set in the thick wall, and looking out upon the bay with its lights and the sky with its stars in so romantic a fashion, that as I leaned back in the old casement to dream, I could not help hoping that many tender lovers had breathed their vows to each other "on such a night as this" and in that very spot.

The next morning we were up very early to take the first train for Catania, that city of our destination which in America I had thought of as probably a straggling village with nothing fit to eat in it. The railway carriage was new and quite elegant with its drab brocade cushions, and the four hours' journey along the seashore certainly one of the most beautiful I ever took. On one side the Mediterranean glittered like silver in the sunshine between the bold shore near us and the blue Italian heights across the straits; and on the other was the Sicilian landscape, with its wild hills covered with the gross and savage cactus, crowned here and there by castle, monastery, or ruin, and cut by the wide beds of immense torrents, at whose shrunken rill women would perhaps be washing; with its lemon and orange orchards laden with fruit, and its vineyards pruned for the winter; with its wayside villages, whose loungers and whose workers alike sit out in the sun, some of them so dark as to remind one that Africa in truth was not far off; and with nowhere any trees—the guide-book says, because two hundred years ago or so the inhabitants thought that the birds injured their splendid grain crops, and so they cut down the great forests that until then had characterized Sicily; and now the whole island suffers every year more for want of water. Such is "popular" wisdom, and, judging from the senseless passion for fence-making which is devouring the forests in this country, drying up the land before its time, and plotting it out in short, straight lines like a patch-quilt, it is a very good example too. Looking out of the car window at the resources of this wondrous island and compared with its development, one of our party said, in the American vernacular, "If the Italians could only be cleaned out of Italy, what a splendid country it would be." "What a splendid country it would be if the Italians could only be cleaned *in* Italy," suggested some one else; and amid a general laugh the amendment was agreed to.

I think we were about half-way to Catania when we caught our first glimpse of Etna, and a very disappointing one it was, and I suppose generally is, particularly if one has just left Naples. It is nearly three times as high as Vesuvius, but Vesuvius has the advantage of rising steeply from the plain very

near you without intervening hills, so that the whole height is apparent; whereas the base of Etna is 120 miles round, and the slope so gradual that, though it bears many Vesuvii, like pigmies upon its mighty bosom, its snowy top is too distant and too dwarfed by its other proportions to affect one at first with its true grandeur. Here we were, however, in the land of classic story, and actually beholding that Etna beneath which the Cyclops were imprisoned by Zeus, while soon after we were whirled by the very rocks that the "one-eyed Polypheme" had hurled after Ulysses into the sea! Sicily is indeed enchanted ground, and I thought so none the less when at ten o'clock we reached Catania, and were met at the station by the advance guard of the party, who informed Professor Peirce that the authorities of the city had placed the empty Benedictine monastery at the service of the American and English eclipse expeditions, and that the hotel was "excellent." We soon drove to it, and found it large and new, set in a garden, and kept by the ubiquitous German with the honest face, who gives one most of the comfort one gets on the Continent. Everything was fresh, clean, and airy; and though there were no fireplaces, the carpets on the floors (things almost unknown in Sicily) supplied the extra warmth required by the season. It was the 12th of December, yet my long window was wide open, the curtains fluttering in a balmy breeze, and from my balcony I could either look down on a blossoming rose-tree in the garden below, or across the housetops to stately, snow-capped Etna, which in all its majesty filled the northern horizon and seemed to upheave the whole surrounding country with it. The cup of our contentment fairly overflowed when, having found Sicily, Catania, our hotel, and our rooms all delightful, we were called down to "fork-breakfast," as we freely translated it, and were served with delicious fish, and with as nice steak, fried potatoes, coffee, and *vin ordinaire* as one could desire.

But the day that had begun so auspiciously was destined to end in gloom. Just before dinner came the startling news that the English party, which was to come to Sicily from Naples by the Government yacht *Psyche*, had been wrecked outside the harbor of Catania, and that they were all at the hotel. In the evening we learned the particulars, and they were indeed of the most aggravating description. It seemed that this yacht was the Admiral's own despatch boat—the pet messenger of the British navy—lined throughout with mahogany and finished in the most beautiful manner; being in fact the same one that took the Prince and Princess of Wales to Egypt. She had been put at the service of the eclipse expedition, and was to take different observers to various points, as should be decided after they all reached Catania. They had nearly made the harbor that morning, and were running a little nearer inshore than the usual course, in order to give the party a better view of the beautiful coast, when the captain was called away from the helm for a moment, and while he was absent the lieutenant changed the course of the ship. Alas! in bright sunshine, and on a sea like glass, she struck a rock not down in the chart, and was completely impaled in a moment. There was just time to get the observers, with their instruments and luggage, safely off, but the officers and crew lost everything. The young captain who was in command had only been in charge of her three months, and she was his first ship, while the terrible rule of the British navy is that a captain who once loses a vessel is never given another, but is put on half-pay for life. Moreover, the eclipse expedition itself, we understood, was not popular in England. When Professor Peirce reached London he found an almost perfect apathy upon the subject,

and was fearful that the English were not going to send out any expedition at all—so much so that he did not hesitate to appeal in the strongest manner to scientific men, and even to the Government, not to let the Americans and the Italians be the only nations interested in the great phenomenon.^{*} His enthusiasm at last communicated itself; the scientific men made their arrangements to go, and the Government granted them £2,000 and the use of the *Psyche*. But still, as one of themselves told us, they had left behind them a good deal of opposition and heartburning in England, and to have this dreadful misfortune come upon them the very first thing, and through them upon the young captain who seemed to have won all their hearts, was crushing. It took all mirth completely out of both expeditions from the beginning.*

Catania was founded by Greeks twenty-six hundred years ago, but it has been destroyed so many times by wars and earthquakes that it presents no traces of an ancient town, and what Greek and Roman remains there are, are mostly underground. It is a cheerful city of 64,000 inhabitants, built upon the seashore, and possessing a public promenade, a public garden, a university, a cathedral, and other churches, I should say, by the hundred (for it seemed to me as if we passed one every few steps), all of them in that base and inverted architecture that seems to have developed itself in the Roman Church since the Reformation. The façade of the modern Italian church is as utterly devoid of beauty, and, no matter what its cost, wears as degraded an expression as anything my eyes have ever gazed upon. In Rome I think the façades are, as a rule, peculiarly distressing; but in Catania many of them have a touch of the grandiose that redeems them a little. By the time I had got to Naples, I was very tired of bronze horses and marble lions, and began to wonder why no other animals were ever chosen to adorn the public places, when, the very first thing in Catania, in the middle of the cathedral square, I saw an elephant standing with an obelisk on his back, and looking so old that I was afraid to inquire his age lest I should learn he was modern. The elephant is the device of Catania, and I thought it so original to have gone all the way over to the East, perhaps, or all the way back to Pyrrhus and Hannibal for an inspiration, that it endeared the city to me at once. And, indeed, I have a high respect for its people on account of their industry. Drive through any street you will, and, in great contrast to any other Italian city I remember, you will see the men, women, and children, even quite little ones, clustered within their doors and as busy as they can be. Nor are there nearly so many degraded and wretched objects lounging about as in other places.

But the glory of Catania is the Benedictine monastery, now empty, and said to be, with a single exception, the most imposing in Europe. The church belonging to it is as large as a cathedral, and contains an immense organ unsurpassed in the world. The monastery itself is built around two gardens, and has a beautiful great hall for its library, with tiled floor and frescoed ceiling, and a similar one for its refectory. At the back is a large open garden made entirely of soil carted there upon the black lava rocks, and as beautiful as a dream, with its walks among lemons and oranges and roses, and at the very end a great stone terrace commanding the most superb view of stateliest Etna possible to imagine. The monks were "knowing ones" in their day, and the monastery in any town is very apt to be in the finest situation in it. So it was here. There was room enough in it to accommodate a thousand monks, all nobles. They had dwindled down to about forty, and four years ago, along with

* The captain was acquitted, however, but the lieutenant was not.

all the other monks in Italy, they were "suppressed." Now their wide and indeed magnificent home is going to decay; the great corridors and staircases are dirty; the marble and sculptured entrance-hall cobwebbed and dusty; their church desolate; their library deserted; their frescoed dining-hall profaned and ruined by the scene-painters of the theatre; their exquisite gardens neglected and fast running to weeds; even the rich organ is silent, for the monk who plays it will not exhibit his beloved instrument for money, and there are services in the church now only a few times a year. It is such a terrible waste! These monasteries would make the most splendid schools and colleges in the world, would the Italians only use them for such purposes; but it is said that there are so many all over Italy that the authorities know not what to do with them, so they let them go to decay, as the English did theirs at the time of the Reformation; and some day, like them, they will regret that they would not spend a few hundreds to repair what it cost tens of thousands to build, and once gone, will never be replaced.

It was nothing less than this grand place that the city had courteously placed at the service of the observers, and thither on the day after our arrival they all repaired to unpack their instruments. Our party experienced a reverse the first thing. In arranging for the expedition Professor Winlock of the Cambridge Observatory had invented for the spectroscopes he and his assistant, Mr. C. S. Peirce, had used in the eclipse of the previous year, an adjustment he called an "achromatic recorder," by which during the eclipse the observer could himself count the spectrum lines he saw, instead of having some other person do it for him. Mr. Peirce was looking forward to using it with great interest, but case after case was opened and it was not forthcoming. It was not there! Great dismay and much telegraphing; but the instrument had gone hopelessly to Spain, through some misunderstanding that Mr. Peirce was to join Professor Winlock's party there instead of going to Sicily with his father. Fortunately the English had more polariscopes than they needed, and they very kindly furnished him with one, or he would have been without any instrument at all. As for me, I had expected to be put on "general observations," but to my consternation was told that I must sketch the corona. Now I believe I can draw a very faithful outline of an object if I have time enough, but I am not very rapid with the pencil, and do not dare to trust my memory of objects, just as some persons cannot trust their memory of music away from notes. I decided that the only drawing I could *vouch* for would be simply what I should succeed in putting down at the moment of the eclipse. So I followed Mr. Lockyer's advice and took a dashing picture of Secchi's of a former corona—full of rays and long streamers, but the only one I had—and pinning it upon the hanging of my bed, I practised from it diligently all the week, until I could draw it several times in a minute. I also sketched often the steam-cloud that rolls out of Etna, changing from moment to moment, and any other object that my eye lighted upon suddenly. Meantime the other observers were at the monastery, setting up their instruments and practising with them. And so the ten days wore away and the eventful 22d drew near.

The whole interest of the solar eclipse of 1870 centred in the corona. Up to this eclipse, other and minor phenomena had divided the attention of astronomers. The changes of color in the sky, clouds, and landscape; the approach and retreat of the dark shadow at the rate of a mile a second; the beads into which the sun's crescent breaks up just before totality; the degree of darkness during totality; the shining out of the stars; the red flames or "promi-

nences" round the moon's disc—all these had been as interesting to the observer as the size, shape, color, and structure of the corona. But all of these were now settled and understood, while the corona, though indeed the most striking feature of an eclipse to the eye, was still a mystery, and had therefore come to be the most absorbing problem engaging solar scientific attention.

"Imagine, at the departure of the last ray of the sun in its retreat behind the moon, an awful gloom diffused over the face of Nature; and round a dark circle near the zenith, an immense radiated *glory* like a new creation in a moment bursting on the sight, and for several minutes fixing the gaze of man in silent astonishment." The solar eclipse here so beautifully described is the one seen at Albany in 1806, and the "glory" spoken of is that corona to investigate which so much time, money, and thought has since been expended.

Astronomy has been strangely fortunate in having three solar eclipses follow each other in three successive years in accessible places. The first was in India in 1868, where for the first time in a solar eclipse the wonderful powers of the spectroscope were brought into play. With its aid, the English observers hoped to discover of what elements both the red prominences and the corona were composed. With the latter they were not successful, only one observer, Major Tennant, obtaining an indefinite result of "a faint continuous spectrum, without lines either dark or bright"—that is, with nothing to show whether the corona shone by its own light or by light reflected from the sun. But the prominences they discovered to be immense flame-tongues or whorls of intensely heated hydrogen, which burst up from the sun to a height of from 50,000 to 150,000 miles, or play around him in lower flame billows. Moreover, Janssen found that with the spectroscope he could continue to observe the prominence he had been looking at during totality long after it was over; and simultaneously Lockyer in England discovered that prominences could be studied on any clear day, and that they belonged to a complete hydrogen atmosphere that enveloped the sun, and which he called the "chromosphere." Observers, however, did not find *all* the lines that had been seen during the eclipse, and they did see others which had not been noticed during it at all. Much of the precious time of our own magnificently clear eclipse in 1869, therefore, had to be given to verifying these conflicting observations. Professor Winlock gave his attention to counting the spectrum lines of the prominences, and his assistant, Mr. C. S. Peirce, to determining whether the prominences were identical in constitution by observing the differences in the relative intensity of the same lines in those of different shapes. Professors Young, Harkness, and Pickering, however, observed the corona, and gave to astronomy the first definite knowledge of its constitution. Judging from the incredulity with which their observations were received in England, the triumph for American science was worth having. "Upon the faint, continuous, rainbow-tinted spectrum seen by Major Tennant in India, Professor Harkness saw one bright green line; Professor Young recognized the same line and suspected the existence of two others; and Professor Pickering saw three bright lines." These observations told the scientific world in unmistakable spectroscopic language that the corona contains some substance that shines by its own light. What is this substance? Its place in the spectrum is or very nearly corresponds with that of a green line (1474 of Kirchhoff's scale), which belongs to the spectrum of glowing vapor of iron. The conclusion of Professor Harkness therefore was, that "the corona is a highly rarefied self-luminous atmosphere surrounding the sun, and perhaps principally composed of the incandescent vapor of iron."

But in the aurora borealis there is a green line which also corresponds to 1474 Kirchhoff. Hence arose the very natural theory that the corona is a perpetual solar aurora, and it is that adopted by Professor Young. Professor Winlock was at first struck by this view, but on returning to Cambridge after the eclipse and going over the observations, he formed a different hypothesis. For the photographs taken on this occasion had also something to say. Hitherto, photographs of total eclipses had been taken through a telescope, first small and afterwards enlarged. Professor Winlock arranged to have photographs taken through a telescope of the size desired in the first place, and this was found much more successful in giving the true proportions of the corona. But it did not take all of the corona that is visible to the naked eye. Only the inner and brighter portions showed on the negative, the long outside "radiations," as some call them, being entirely absent. What did that mean? As interpreted by Professor Winlock, it meant that the corona is two-fold, and consists first of an inner luminous envelope of gas, markedly quadrilateral in shape, which is the *true solar atmosphere*;* and second of outer streamers or radiations formed from the vapors or gases of our own upper atmosphere, and varying with its own variable conditions. Professor Winlock stated these as his conclusions in a letter to Mr. Lockyer after the eclipse of 1869, but the letter was not published in "Nature," and neither it nor the communications of the other American astronomers made any impression on the great solar spectroscopist, his theory being that the sun had no envelope outside the chromosphere or hydrogen envelope, and that the corona therefore was simply "a terrestrial phenomenon due to the passage of the sun's rays through our own atmosphere."

In 1870 then the corona problem stood thus:

The great luminous orb of the sun is called the "photosphere"; his hydrogen envelope is called the "chromosphere." Now *was* there still another sun-envelope beyond this (whether a glowing iron vapor or an aurora), which in an eclipse appears as the *whole corona*, as Professor Young supposed? Or was the corona nothing but an effect of our own atmosphere, as Mr. Lockyer maintained? Or was it, according to Professor Winlock's view, partly solar and partly terrestrial?

It may easily be imagined how anxiously, during the ten days previous to the eclipse, the astronomers watched that weather which might so easily prevent an answer to these questions. Professor Peirce's observers in Sicily were about twelve, but the English party was much more numerous. At its head was Mr. Lockyer himself, the most eminent solar spectroscopist in England, and with him were the distinguished chemist Professor Roscoe of Owens College, Manchester, Professor Adams of King's College, Mr. Vignolles, a famous engineer and contemporary of Robert Stephenson, and a crowd of clever and educated young men, fully armed and equipped with instruments, instructions, and enthusiasm.

Mr. Lockyer strikes one at once as a man of genius. He is very small and compact, with a pleasant and almost vivid face and frank impulsive manner, and with so much nervous energy that he resembles the typical American rather than his own calmer countrymen. He was evidently so eager to see with his own eyes whether indeed the corona *were* anything more than the continuation of his "chromosphere," and from his mastery of the subject he had such a *right* to see it. (to speak à l'Américaine), that I confess I hoped that whoever else were disappointed he would not be. He was accompanied by

* See "Silliman's Journal," November, 1870.

Mrs. Lockyer as his own assistant, a lady as tranquil as her husband is excitable, but who pursues his science, and has written several books upon it, so that together they seem to lead that double life devoted to one end of which we hear not unfrequently in England, but of which in this country, so far as I know, Professor and Mrs. Agassiz are the only examples. Professor Roscoe I fancied not only to be the typical, but the ideal Englishman—the fair-haired Viking translated into modern man, gentleman, and *savant*, and with a certain sweetness, a serene and broad and gracious kindliness of mien, that I never saw in an American; for in our drive and fret of life it is impossible.

The great day broke at last in splendor, after wind and clouds the previous afternoon, and a rain in the night which made our hearts quake lest it should last. It had only washed the atmosphere into perfect clearness, however, and we were all exultant, though somewhat uneasy about the observers who had gone up Mount Etna, for the whole mountain was wrapped in a white mantle of snow. The Marquis of San Giuliano, a leading nobleman of Catania and a member of the Italian Senate, had offered to the observers the use of two villas as different posts of observation. Mr. Lockyer, however, decided to remain at the monastery with one division of his observers. Professor Peirce stationed there also our photographers and our time-observer, Mr. Schott. Professor Roscoe and his party took Mount Etna, where we were represented by Dr. Peters of Hamilton College, New York (who had in past years surveyed the whole of Etna), and by General Abbot of the U. S. Engineers, who was to sketch the corona from the highest point possible. Professor Adams took a large party, principally polariscopists, to Agosta and Villamonda, and two English photographers went to Syracuse, where also Professors Harkness, Newcomb, Hall, and Eastman were stationed on the part of the U. S. Navy. Professor Watson of Ann Arbor, Michigan, took up his station at Carlentini to sketch the corona, while Professor Peirce accepted the invitation of the Marquis for his own party, and with his son, myself, and some American friends drove out to the Villa San Giuliano, which is two or three miles north of Catania, on the road to Etna and up-hill nearly all the way. We arrived about two hours before totality, which was to take place at two o'clock, and found the villa a sort of earthly paradise. The first thing we saw on alighting was a bed of scarlet geraniums in full bloom, and a wall close by was covered with a great vine full of purple blossoms. The Marquis and his son courteously received us on the steps of the villa, and introduced us to a party of friends who had also come up to behold the great event. The terrace in front of the house commanded the most enchanting view of the valley below, with Catania and its harbor in the centre, and the Mediterranean stretching broadly beyond, while above it all hung the bright sun, yet unconscious of the dark enemy that was lurking in his beams in order soon to cover his "glorious face" from the world. We all chose our posts of observation: Professor Peirce on an elevation behind the house, Mr. C. S. Peirce in the garden with his polariscope, the Marquis and his guests on the terrace, and I and another lady in a room of the villa just over it. A table was arranged for me in a window commanding the landscape just spoken of, and at a quarter past one, with my drawing materials before me, I sat down to wait for totality with a beating heart. I had been copying rays all the week, and if there were any rays in the corona rays I was determined to see; for I could not bear the idea of accepting so much pleasure from the United States and making no return. A strong wind blew in upon me and chilled my fingers, but in the excitement I neither felt it much nor took any cold. For some time the

sun reigned supreme, and until about half an hour before totality kept all clouds at a distance in spite of the foe that was now closing with him. But then they suddenly came upon his diminished crescent and hemmed him round, now serrying, now breaking, until, when he was but a shrinking silver rim, they united in a dense storm-wall, solid from the very horizon, and blotted him completely from our sight. I had no watch with me. The gentlemen walked in almost dead silence up and down the terrace, and as I sat watching that relentless gray veil the rain began to fall. The landscape was very dark (though not more so, nor more peculiar in its tint, than I have often observed just before sudden storms), and as the long seconds rolled on I felt sure that totality was being enacted behind that intolerable pall, and that all hope was over.

Dear reader, if you have a weakness, and ever undertake to observe a total eclipse, where coolness and presence of mind are the *first* requisites, be sure that weakness will find you out. I have no less than two—two small but intense impulses, remnants of original sin, I suppose, not to indulge which is always an effort with me, and which have often caused me serious annoyance, and I suppose often will again. One of them is, as soon as all apparent use is over for a thing, to get rid of it. As soon as I have read a letter I long to put it in the fire. Whenever my husband has got through with a coat (as I think), I wish to give it away, etc. The other is, that when I am in a tremendous hurry with anything and much agitated with the thought that I haven't time enough to do it in, instead of simply driving through the main point, I am very apt to try to accomplish also some non-essential connected with it, which of course gives me every chance of being behind time altogether, and sometimes in fact has made me so. Now, why of all moments in my life should these two impulses combine against me as they did? For, lest it should be too dark for me to see to sketch during totality, as is sometimes the case, I had been provided with a dark lantern. I had lit it with difficulty in the strong wind, and had had it burning for some time. It was but a small bit of candle that was in it. I should never use it again. Why, then, could I not have let it burn on even supposing totality *was* over? But no. If totality were over, as I was sure it was, the occupation of the burning candle was gone; indeed, its flame was a mockery if not an insult. At any rate, impulse No. 1 came strongly upon me, and in my heartache I blew it out! Some hundred seconds after a gentleman came up stairs with a watch, from whom I learned the time. It wanted yet five minutes of totality, and the cloud had begun to look thinner. Shocked at my own rashness, I tried to light my lantern again, but the wind and my agitation both together were too much for me. I gave it up and looked up at the sun. He was *there*. The clouds had broken and totality had not yet begun, for there was a thread of him, though but a thread, left. Of course I should have let all thoughts of the lantern go, and given my whole attention to the great spectacle and its accessories. But my demon of the impossible, or impulse No. 2, goaded me once more to try and light the paltry thing, and I made another effort, which was soon cut short by a bright red light as from a fire falling upon my paper, and I looked up just in time to see the horizon-clouds that bordered the sea transformed by it into dancing witches, and to catch sight of the beads that the sun's crescent breaks up into as it disappears. In another second, in a little lake of clear sky, almost as by a miracle, was the totality we had come so far to see—the black moon-disc, the white corona around it, a bright star near it; and simultaneously the Sicilians on the terrace burst into the most tremendous excitement, shouting and cheering and calling out “*Stel-la! stel-la!*”

(The star! the star!), and keeping it up through the whole hundred seconds of totality.

But how different was the corona from what I had expected! All the drawings I had seen gave one the idea of bright beams streaming out on all sides from the moon's disc, as they seem to do from the sun himself if one tries to look at him with the naked eye; whereas to me it looked like a soft, yellowish white halo or aurora, bright and well defined for a narrow distance all round the moon, then changing into so indistinct an outline that I thought there was a cloud over it; and in fact the whole corona looked pale and watery to my wrought-up imagination. I began to sketch the bright inner rim, which was crossed by dark lines, and then said to myself, "It will do no good for me to try and get the outline of the corona, for evidently there is a cloud over it. I had better first look for my rays and put *those* in their exact places." I found no rays in the upper half of the corona, only the dark lines which I had first jotted down, and then looking at the lower half, found instead of bright rays, to my intense surprise, pale gray or steel-colored spaces or channels, three of them, where the corona-light was interrupted as if from a shadow falling across it, and which I put down in the exact places and proportions as they appeared to me, beginning with No. 1, and then totality was over, and I had had no time to go back and give the outline of the whole. Therefore I only say that my whole sketch is but the general idea or impression made upon me in the first momentary glance before beginning to draw, but the three lower spaces I can most positively certify to, for they are all that I fairly allowed myself to look at during the eclipse. They are all that I can vividly recall; and in short, I most certainly saw them, and with an eye not unaccustomed to careful and minute observation of general things—thanks to Mr. Ruskin's books first and to Mr. Agassiz's lectures afterward. It is my belief, however, that cloud was either over them or light shining through them, for they were so pale as very easily to be lost to the casual observer in the general brightness of the halo. (See illustration, p. 192.)

After the eclipse I was in no hurry to go down stairs, for my paper had nothing to show on it but those rays and a few other marks, and I felt that I had acquitted myself even worse than I had feared I should. However, some one came to call me to a collation that the Marquis had hospitably prepared for us; so I hid my sketch and went down into the drawing-room to be served by footmen in livery for the only time in my life. The Sicilians and the Americans made a very triumphant and happy party, drinking the Marquis's wonderful old Etna wine, exchanging congratulations in broken French, and otherwise playing the agreeable to each other. After the collation we walked round the lovely grounds; some one gathered me a beautiful bouquet, and then it was time to bid adieu to the charming villa and the courteous Marquis, and go down to Catania to learn the fate of the other observers.

Alas! the cloud that had so nearly ruined our prospects had ruined theirs completely. A second and a half was all the view of totality vouchsafed them at the monastery; our photographers had taken nothing, and *Mr. Lockyer had not seen the corona!* It was dreadful, and in the evening the Etna party came home with the same sad tale. In spite of the snow-storm of the previous night, they had got their instruments safely set up, even Professor Roscoe's very delicate and complicated one, over which I had seen his assistant Mr. Bowen shake his head gloomily and ominously more than once as he was adjusting it at the monastery. Our General Abbot had actually climbed 8,400 feet up Mount Etna,

and flattered himself that he at least would have a perfectly clear view, when he, as well as the observers below him, was suddenly enveloped in a hail-storm, which lasted through totality. Of all the Catania observers, then, we had been the only fortunate ones; and though of course we should have felt very badly, since Uncle Sam had given us the money to come out with, to have gone home without any report to make him, yet when the spectroscopic observations were of such high importance, and when such very eminent men with splendid instruments were there to make them, I felt as if on this occasion it would have been better to have had the race to the swift and the battle to the strong, seeing we at the villa only had one borrowed polariscope among us.

However, the English observers at the other Sicilian stations were more fortunate; their polariscopist at Villamonda had clear weather; their spectroscopist, Mr. Burton, at Agosta, detected the green coronal line observed by the Americans in 1869; while at Syracuse their photographer, Mr. Brothers, obtained with a common camera a negative, showing not only the inner but also the whole of the outer corona; a novel and brilliant achievement, and one which an enthusiast in the "Spectator" declares to be "alone worth all the cost of all the expeditions put together."

At Carlentini, Professor Watson of our party had splendid weather, and from his observations made two valuable drawings, which will be referred to later in the article. At the monastery, Mr. Schott, to whom was intrusted the noting of the moments of the four contacts, recorded a great triumph for American science in the fact that the American's time of the first contact of the moon's disc with the sun's, as computed by Professor Peirce's Tables of the Moon, was right to within five seconds; while the English computation of the same contact, made after Hannsen's celebrated Tables, was out by fifty seconds. Professor Peirce himself, at the villa, had noticed the corona visible before totality began, and upon the outer corona he saw pink reflections from the red protuberances, which would be one proof that the outer corona is terrestrial. Mr. C. S. Peirce, observing with a polariscope, found "polarization radial to the sun, showing that light was reflected from the sun"; which observation agreed with that of Mr. Ranyard, the English polariscopist at Villamonda, and with those of Professor Pickering in Spain; but other instruments gave a different result, and Professor Pickering is now endeavoring to reconcile them in hopes of getting a uniform one. In Syracuse, Professor Harkness of the U. S. Navy observed the green corona line that he had seen in the preceding year, and followed it out as far as 10 min. (300,000 miles) from the sun. In Spain the observers generally had clear weather. Professors Winlock and Young followed the green line out to 20 min. (600,000 miles) from the sun, observing nearer to the sun other lines in it that belong to the chromosphere. Two young Englishmen, Mr. Abbay and Mr. Pye, who observed under their direction, obtained similar results. Professor Young and Mr. Pye also got an observation which is said "to close satisfactorily a discussion as to the existence of a thin shell of vapors dividing the photosphere from the chromosphere, which has occupied many pages of the scientific publications during the past year."* Two photographs were taken by Professor Winlock's photographer, which, if they show less of the external corona than those of Mr. Brothers (from having been taken with a telescope), are perfectly accurate in the details of the inner one, and therefore of equal scientific importance. One of the English parties observing under Father S. J. Perry, at San Antonio, found in the corona "no streamers

* Rev. S. J. Perry, Monthly Notices, Royal Astronomical Society, March 10.

or curves, but only a uniform glow of light, fading off as it receded from the sun, and broken by *four or five darker gaps*." Capt. McClear of the British Navy saw bright spectrum lines on the dark body of the moon, which, as Father Perry remarks, "show that we must receive with great caution any observations of bright lines in the corona which are coincident with those of the chromosphere, especially when the bright lines of the prominences are dispersed by intervening clouds and atmosphere." At Lord Lindsay's station "streamers" were seen in the outer corona.

This, I believe, is a summary of all the observations bearing on the corona. I did not learn them at the time in Catania, but since from scientific publications; and I have been rather surprised to find that though the English have written more articles, favorable weather had given the Americans the majority of the observations. Immediately after the eclipse the Catania parties broke up and went their ways—perhaps I should say endeavored to go them, for Sicily is a siren, who, when she has once got you, will not let you go for the asking. There was a five days' storm on the Mediterranean, which kept us all in Messina, waiting for a boat, from Sunday night until Friday afternoon; and when we did get off at last, it was at the price of a far more agonizing night than any we spent on the Atlantic. So it is no wonder that, as modes of communication are, travellers so seldom penetrate to Sicily. But how beautiful, how captivating she is! and we only saw a small part of her fascinations. Would that I could stop to tell more even of that little, but I must end with trying to state how the problem of the corona stands now.

The first result was, as Mr. Lockyer telegraphed to London immediately after the eclipse, that "the American observations of 1869 were confirmed." All astronomers now agree that there really is "surrounding the sun a mass of self-luminous gaseous matter, whose spectrum is characterized by the green 1474 line."*

The problems remaining are, how far does this sun-envelope extend, and of what is it composed?

The sun or "photosphere," as we see it, is 850,000 miles in diameter. Outside of this, as Professor Young proved in the eclipse, is a thin shell of many commingling glowing vapors, about 1,000 miles thick. Outside of this again is the narrow red hydrogen ring less than 7,000 miles thick, but that rushes up into prominences that are occasionally 150,000 miles high. Finally, outside of all these is the corona as seen in an eclipse, pearl-white and very bright near the sun, and fading gradually off to a distance equal to or greater than his diameter; that is, it extends apparently for a *million miles* more or less all round him! Now in 1869, when Professor Young saw this in perfectly clear weather, he thought it was all solar, and possibly a perpetual solar aurora. Professor Winlock thought that only the inner portion that showed on his photograph, and which ranged from 90,000 to 250,000 miles in width, was solar, and that the outer portion was due to "atmospheric glare," as astronomers say. He has not published anything on the eclipse of 1870, but I have his permission to say that his opinion of 1869 remains unchanged. His photographs of 1870 have a wider margin than those of 1869 (though not so wide as that of Mr. Brothers), and on giving the negatives to an artist who had never seen an eclipse or a picture of one, and requesting him to copy for him merely the brightest parts of the corona, the artist produced an outline almost identical with the corona-outline of the 1869 photograph, except that it has a rift where

* Professor Young, in "Nature," February 23.

the latter has only a deep indentation. This coincidence Professor Winlock values as tending to confirm his original view, that the solar corona should be limited to the bright inner ring, whose average width is one-quarter of that of the visible corona.

Mr. Lockyer started with the theory that there was no corona outside of the chromosphere, and I fear I may not get his opinions without mistake, for these seem to change while his term does not. By "chromosphere" I believe he originally meant the same thing that Mr. Airy had previously called "sierra," viz., the red hydrogen ring from which the prominences rise, and which is less than 7,000 miles wide. But the tops of the prominences are sometimes 150,000 miles high; and influenced perhaps by the American observations of 1869, though he did not accept them, Mr. Lockyer decided before the eclipse to enlarge the theoretical chromosphere to the height of the prominences at least, since its last layers might consist of cool hydrogen which would give a different spectrum from the heated hydrogen near the sun, and thus possibly account for the green line the Americans had seen in 1869. Since the eclipse he has expressed himself willing to add to the elements already constituting the chromosphere (hydrogen with a little iron, sodium, etc.) a new green-line-giving element sufficiently lighter than hydrogen to float above it, and thus to carry the boundary of the chromosphere "to six, eight, ten minutes" (200,000 to 300,000 miles)—he "cares not which"—beyond the sun's disc; just twice, that is, what he at first allowed. The outer corona he regards still as terrestrial, as nothing more than a halo; and thus in truth, to use his own laughing expression after the eclipse, he has "annihilated the corona"—there is none left—it is all "chromosphere" and atmospheric halo. Various astronomers of eminence agree with Mr. Lockyer in this his extension of the chromosphere to the whole region that gives bright spectrum lines. Professor Young and others, however, though willing to admit a portion of the outermost visible corona to be certainly due in cloudy weather, and probably always, to atmospheric glare, still think that the wide green-line-giving stratum may be a solar aurora having no definite outer limit, but quite distinct from the narrow red-prominence stratum below it. Therefore he is in favor (if I understand him) of limiting the word chromosphere to the latter as originally intended, and of giving to the former the new term "leucosphere" that has lately been proposed for it in England.

As far as I can make out, then, Professor Winlock and Mr. Lockyer are practically at one; for Mr. Lockyer's enlarged "chromosphere" has about the limit of Professor Winlock's "solar atmosphere" or "true corona," and all beyond that they are disposed to think terrestrial. The next eclipse battle will therefore perhaps be fought between them and their adherents on the one side, and Professor Young and his on the other; for he gives to the true corona or "leucosphere" an average extension of 250,000 or 500,000 miles, "with occasional horns of twice that height, and perhaps even no upper limit at all."*

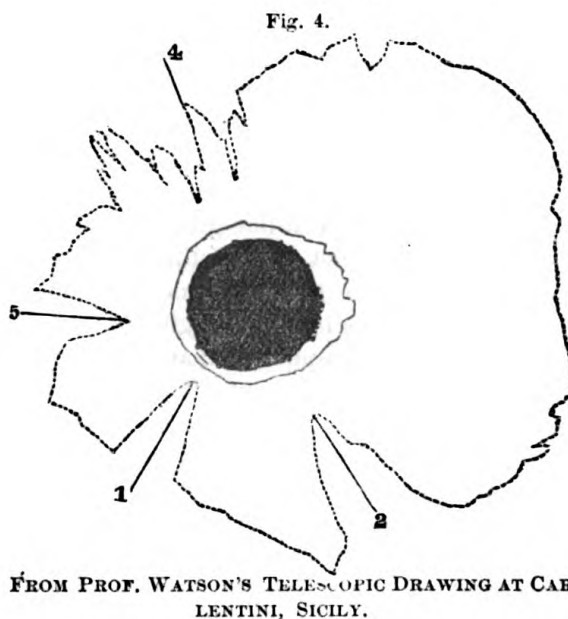
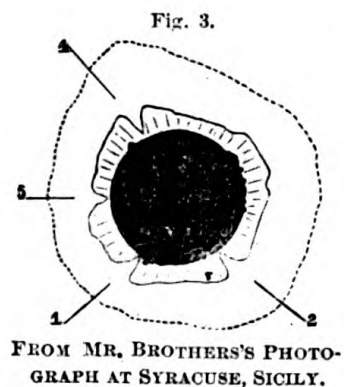
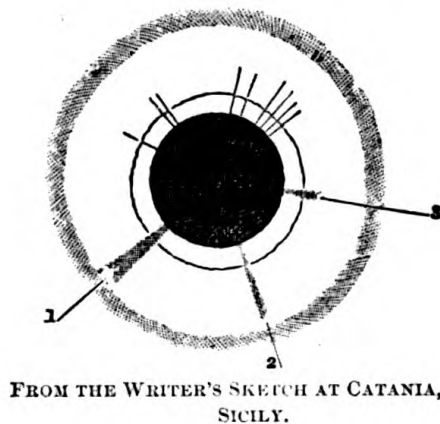
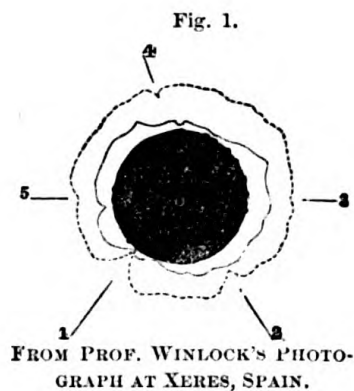
We come then to our last question, viz., whether there are any grounds for this theory; and I am sure the dear reader will be glad to know that here my poor little observation may perhaps lift up its timid voice, for the "rifts" in the corona are exciting interest as possible proof that *more* than the bright inner ring is solar.

Professor Winlock's Spanish photographs show one very sharp rift starting from the disc and going beyond the inner corona, and decided indications of several others. The cut given in "Nature" (March 9) of Mr. Brothers's pho-

* "Nature," February 23. There is even an opinion that the zodiacal light may be an extension of the corona: also, that the corona may be a ring of meteoric dust revolving round the sun.

tograph taken at Syracuse, shows four very wide rifts or gaps in the outer corona, but none in the inner. Professor Watson's water color drawing, taken through a telescope at Carlentini, shows four rifts in the inner corona, two of which agree well with two of Mr. Brothers's in the outer corona, but the others less well. Professor Winlock's photograph on glass is almost precisely the same size as my sketch, and when the former is superposed upon the latter his distinct rift coincides precisely with my No. 1, and two of his indentations with my Nos. 2 and 3. Here are all the witnesses in outline. The reader will per-

Fig. 2.



ceive for himself the above correspondences, and also that in the position of No. 1 *all* seem to agree, and that this most important of the rifts *seems to belong equally to the inner and outer coronas*.* Of the others, some belong to one corona and some to the other, and the different observers have placed them in slightly different positions, so that the correspondences can only be said to be general. The black dots indicate the prominences.

Mr. Lockyer says in "Nature," February 23, "that if in the two photographs taken at stations so wide apart as Spain and Sicily (1,100 miles), the rift had been in the same positions, the presumptive evidence in favor of the solar

* Mr. Gordon's drawing in Spain gives also the great rift, but no other.

nature of the corona for a distance outside the sun equal to its diameter would have been overwhelming." He concluded, however, that "the two cameras had *not* photographed the same phenomenon," and states that "the sketches in Sicily had not recorded a single rift," and that in Professor Watson's drawing there "is no indication whatever of them." Now, as to my drawing, no one at Catania had thought it worth while to ask what *I* had seen (being a woman, I suppose), and Professor Watson shall speak for himself, since I have just had the honor to receive from him (May 2) photographs of his drawings, with a recapitulation of his report to the United States Coast Survey. He says: "Where the naked-eye view shows indentations in the corona, the telescopic view exhibits well-defined cusps (*i. e.* rifts), the points of which reached almost to the moon's limb. These cusps were bounded by regular curved outlines, as shown in the drawing, and were delicately shaded in respect to light, having been darkest at the apex, and gradually becoming brighter and brighter, until at the limit of the inner or solar corona they were considerably brighter than the exterior halo."

Now, can any of the discrepancies between these photograph sketches be accounted for so as to make it probable that the rifts or cusps when shown on all our pictures are the same? No one will deny that we all saw the same *inner* corona, yet our representations of that differ even more than those of the rifts. Professor Young says that "even skilled observers, standing side by side, describe phenomena differing in very essential points." The last scientific opinion given by the late venerable Sir John Herschel in answer to a letter written him by Mr. Brothers upon the subject of the rifts, was in favor of the rifts being identical in the two photographs, and if in those, then they probably are so in the drawings. At any rate, several scientific men in Cambridge have compared the four pictures, and their verdict is that the balance of the evidence seems to be in favor of the three lower rifts or indentations being identical and common to both coronas, in which case they are *solar*; the true corona may turn out to be as extensive as Professor Young thinks, and Mr. Lockyer will have to double his "chromosphere" again.*

I will close by quoting the words of Professor Watson upon a new and most important observation, which may change the study of the corona into an every-day matter, as Mr. Lockyer and Mr. Jannsen changed that of the prominences. "I saw the corona beautifully," he writes, "many seconds before the eclipse became total; and having been convinced of its being a direct appendage of the sun, possibly an extension of what has been called the chromosphere, I concluded to observe carefully whether it might not be visible during a partial eclipse, and I was able to see it distinctly by the visibility of the limb of the moon beyond the limb of the sun, until only a few minutes before the end of the eclipse. Hence I have ventured the prediction that a careful scrutiny will show the corona during any partial eclipse of the sun, and that it is possible even to observe it in the spectrum as the prominences are now observed."

Should this possibility be realized, "eclipse expeditions," with all their pains and pleasures, their triumphs and disappointments, will be things of the past; but if not, since American science has so honorably distinguished itself

* There is no theory as yet as to what the dark rifts or cusps may be, but Mr. C. S. Peirce has suggested that if the solar spots are caused by down rushes of colder currents, the rift may be the whorl of such down-rush through the solar envelopes. He says he cannot remember, however, whether he or some one in Catania first thought of this explanation; but if it has any weight, it would be interesting to see whether there were any relation between the position of the great rift and any of the sun-spots of the 22d of December.

upon this difficult question, it is my private advice to our beloved and liberal Uncle, that he organize a permanent eclipse party of a few skilful observers—if they will go—to follow eclipses all round the world until they have got out all their secrets. For though we know, from this last one, that the corona is largely, and perhaps wholly solar, yet the question as to what it is made of—what element it is that gives the green spectrum line—still remains. In fine, science so far has but collected a mass of facts; the hypothesis to fit and account for them all has yet to be found; and therefore this article cannot conclude with a conclusion.

Z. F. P.

MARGUERITE.

FROM dawn to nightfall, at her window sitting,
She waits, while drift the heavy hours away;
And like the swallows all her thoughts go flitting
To that sweet South wherein they fain would stay.

Up from the street there comes the lazy laughter
Of girls who linger by the fountain's fall;
She heeds them not—her gaze still follows after
The clouds that roll beyond the city wall.

She vaguely hears her mother's fretful chiding,
Her idle wheel grows dusty at her side;
Listless, she wonders where her Love is biding,
Where'er he be there must her heart abide.

All the day long she listens for his coming,
All the long day she dreams of one dear face;
She hears his whisper in the bees' low humming,
She feels his kisses in the wind's embrace.

Lonely she dreams while the warm sunshine lingers
Upon the carven angels of her chair—
Alone sits sobbing, while with silver fingers
The moonbeams thread her soft, unbraided hair.

Ah, heavy heart! so passionate its yearning,
She needs must know that all her peace is o'er;
That eager pain 'neath her white bosom burning
Tells her 'tis gone, to enter there no more.

But once to feel, unchecked, his fond caressing!
One wild, sweet hour close to his heart to press!
There her thought stops; what else of bliss or blessing
The great world holds she does not care to guess.

Still at her window, dreaming, longing, weeping,
While to their mates the gray doves coo and call,
She leans and watches the slow clouds go creeping
Far down the blue, beyond the city wall.

NELLY HUTCHINSON.