warded to the warehouses, the largest slabs are cut into pieces of about three and a half feet in length, eighteen inches in width and ranging from one half inch to three inches in thickness. Drying and packing in bales weighing one hundred and fifty pounds each follows, and the cork is ready for exportation.

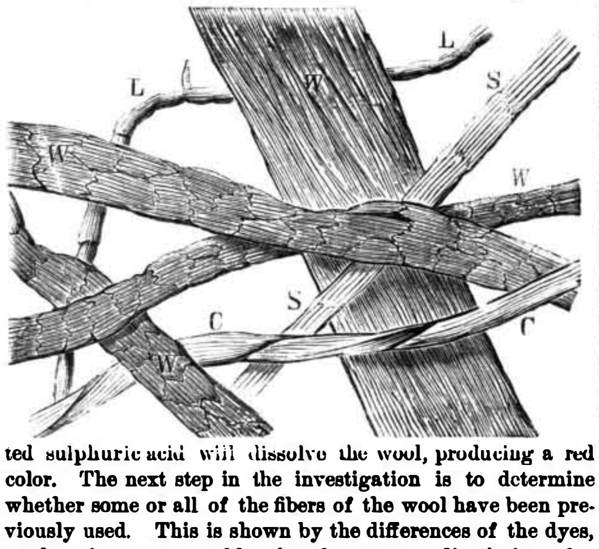
From five to twenty-five cents per pound is the usual price paid by the cork cutter in this country for the rough material as it arrives in the bale. It then undergoes another assorting, and a thorough steaming, in a chest designed for the purpose, the latter process softening the cork and rendering it easy to cut. To divide the substance special machinery is employed. Rapidly revolving circular knives are used, which cut by a drawing motion, as crushing strokes simply break the cork or cause it to crumble. The workman sitting in front of the machine places a piece of cork of suitable size in a revolving spindle by which it is firmly held. This spindle is raised a measured distance and the edges of the cork come in contact with the rotating knife, which smooths them off and leaves its work in a perfectly cylindrical form. Another method is to place the rough bits of cork in grooves on the circumference of a wheel which, working automatically, carries each piece to a point where its ends are received by a small lathe. The cork is then revolved slowly while a large circular knife removes a thin shaving, thus giving it the necessary taper, and a surface as true and smooth as if sand-papered. As fast as a cork is finished by the automatic lathe it is released and another substituted in its place.

Every portion of the material is utilized, either as stuffing for cushions or life preservers, or as a non-conducting substance for placing between walls or floors of buildings to deaden sound.

It has been estimated that it would require 4,000 men to be continually at work to supply New York alone with corks, if all had to be made by hand. There are at present 60 manufactories in the United States, cutting and supplying corks to the value of $2,250,000 per year.

TEXTILE FIBERS UNDER MICROSCOPE.

The present large demand for textile fabrics has led, not only to the discovery and application of new fibers, but also to several improved methods of disintegrating old rags that the fibers may be respun and used, either by themselves or in combination with new material. Wool thus treated is called shoddy, and its use has long been a common practice with makers of the lower qualities of woolen cloth. But as yarns are now spun for the making of mixed fabrics, wool, silk, cotton, and linen are so intimately blended that they all appear in the same thread, and a close examination with the microscope is necessary to detect the presence and the proportion of any of the four. Using a power of from 100 to 150 diameters, we observe, as in the engraving, the scaly hairs of wool, W, the smooth thread of silk, S, the cylindrical fiber of linen, L, or the spiral one of cotton, C, the colors of these varying considerably. When the presence of all or any of the four has been observed, a further test may be made by adding a drop of the ammoniate of peroxide of copper; by this salt, silk and cotton will be immediately destroyed, linen will gradually follow, and wool only will remain, its fibers being slightly increased in size. Concentra-



ted sulphuric acid will dissolve the wool, producing a red color. The next step in the investigation is to determine whether some or all of the fibers of the wool have been previously used. This is shown by the differences of the dyes, as the microscope enables the observer to discriminate between indigo, purpurine, madder, aniline, and any other dye-stuff that may have been used, and worn fibers show traces of the bleaching to which they were submitted before being treated for a second process of manufacture. Another test for old fibers is the irregularity of their diameters, and the disappearance, in places, of the surface scales. A still further method of detection is the application of a lye of potash or soda, which attacks old wool with a rapidity to which new material is inaccessible.

To ascertain the proportion of old fiber in any mixed fabric, the threads should be laid as nearly parallel as possible. A power of from 20 to 50 diameters is sufficient to enable the investigator to count the fibers, the relative number of each being shown by the appearances above described. The chemical tests already mentioned will reveal at once the composition of the fabric to a careful observer. But there is obviously room for an improved method of distinguishing the different materials, and the importance of the interests engaged in the manufacture will probably induce the scientific world to bestow some attention on the subject.

TURPENTINE to be good should be as clear and white as water, of a strong penetrating smell, and very inflammable.

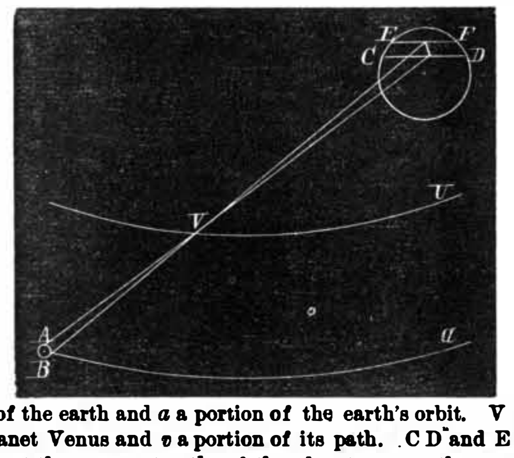
OUR PRESENT KNOWLEDGE OF THE SUN.

Professor C. A. Young concluded the annual course of lectures before the American Institute by an interesting and able discourse on the above topic. Modern science traces to the sun almost the whole range of terrestrial activity. We can easily follow out the solar action in our winds and no less easily in our waterfalls. The pumps that raise water to the hills are in the sun. The power that is expended in intercepting water in its downward flow is at the expense of solar fires. In a more remote way we may trace to the sun the steam power which is derived from fuel. The very force with which we move our limbs, the sound of our voices, even the power of mind, the impulses exerted in forming thought, in exciting emotions, are sun-derived, when traced to their ultimate source.

DISTANCE OF THE SUN.

The first point to be ascertained in relation to the sun, or indeed to any of the heavenly bodies, is its distance from the earth. The method of actually measuring the intervening space which can be most relied upon is by means of the transit of Venus. The planet will meet the eastern side of the sun's disk near the northern edge and will pass obliquely across. In Fig. 1, A and B represent stations on opposite

FIG. 1.



sides of the earth and *a* a portion of the earth's orbit. V is the planet Venus and *v* a portion of its path. C D and E F represent the apparent paths of the planet across the sun's disk. Fig. 2 shows the track of Venus more clearly. The upper and dark circle represents the planet as seen from the southern hemisphere, and the lower light circle, the planet as seen from the northern. The arrow shows the direction of the motion. The problem is to measure the distance between the center of the black dot on the great face of the sun to the edge of the latter with the utmost accuracy. An error of a hundredth part of a foot, at a distance of about 40 miles, would be fatal to any increase of the accuracy of our present knowledge.

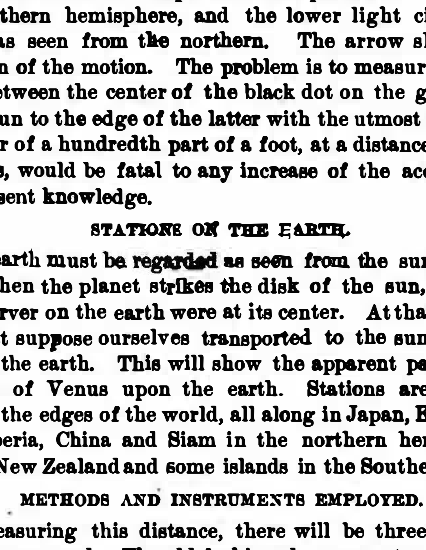
STATIONS ON THE EARTH.

The earth must be regarded as seen from the sun the moment when the planet strikes the disk of the sun, provided an observer on the earth were at its center. At that moment we must suppose ourselves transported to the sun, looking toward the earth. This will show the apparent path of the shadow of Venus upon the earth. Stations are selected around the edges of the world, all along in Japan, Kamschatka, Siberia, China and Siam in the northern hemisphere, and in New Zealand and some islands in the Southern Ocean.

METHODS AND INSTRUMENTS EMPLOYED.

In measuring this distance, there will be three different methods pursued. The old fashioned way was to note when the planet strikes the sun and when it leaves it, from which we may know the number of hours it takes to pass across the disk of the sun. Thus at the northern station we have the length of the chord which it passes over, and the same at the southern station; and knowing the length of the two chords it is not difficult to compute the distance between them. Sir George B. Airy, the Astronomer Royal of England, is disposed to rely mainly upon that method. But there are great difficulties with it. The main difficulty is this: A bright object looks to the eye larger than its real size; and a dark body projected upon it looks smaller than its real size, so that it is difficult to determine the precise moment when the planet enters upon the sun's disk.

FIG. 2.



Another method, which will be used mainly by the German astronomers, is to measure the position of this spot from time to time in reference to the edges of the sun's disk by means of the heliometer, an instrument by which we can measure very accurately the distance of the little round spot from the edge of the bright circle on which it will be shown. The other method, which will be used by all the nations, but will be mainly relied upon by the French and the Americans, is by photography. The English will use a common telescope, driven by clock work, with an eye piece to enlarge the image of the sun to about four inches in diameter. With this they will from moment to moment take photographs of the solar disk while the transit is going on, and they will afterward measure those photographs. The objection to this method is that the eye piece used to enlarge an otherwise too small image almost invariably produces a certain amount of distortion. The round image will not be round on the glass or paper, and it is very difficult to allow for that distortion. They propose to photograph with the same apparatus a scale of equal parts, putting up a board perhaps as long as this room, with laths nailed upon it at equal distances, to be photographed, and thus they propose to calculate, by comparison, the distortion of the different parts of the field of view. The Germans will use a telescope of the same kind and an eye piece of the same kind; but at the focus of their telescope they will place a piece of glass ruled with fine lines into squares. These will be measured beforehand very carefully, and the image of the sun and these ruled lines being photographed together, if there is any distortion it will affect these little squares precisely as it affects the sun; and they need only refer their measure to the nearest lines of this network to get an accurate result.

The best plan will be that pursued by the French and the Americans and by Lord Lindsay's party from England. The telescope will be 30 or 40 feet long—it need not be very large in diameter—and the image will be large enough not to require enlargement. Of course such a telescope would be very unwieldy if mounted in the usual way; and the method proposed is to put the telescope horizontally, perhaps in a tunnel underground to protect it from currents of air, though that is not essential, and to throw the image of the sun into the object glass by means of a flat mirror. In this case "flat" means a great deal. It is very difficult to make a mirror flat; and that is the difficulty in this method. The mirror must be so flat that at no point shall the curvature equal a radius of 18 miles.

NATIONAL EXPEDITIONS.

Russia will establish 25 stations in her Siberian dominions. France will send expeditions to Palestine, the Red Sea, Pekin and Japan, the island of St. Paul, New Caledonia, and possibly to the Sandwich Islands. The Germans will send to the Falkland islands, McDonnel's Island, and Kerguelen's Island, in the southern hemisphere. The English will send to Oahu, to Roderick's Island, to the Falkland islands, and to Alexandria, in northern India. Lord Lindsay will send a private expedition to Mauritius. The United States will

FIG. 3.

send out eight parties; four to Japan and China, and the other four to New Zealand, the Falkland islands, Van Diemen's Land and possibly Kerguelen's Island.

ILLUSTRATIONS OF THE SUN'S DISTANCE.

At present we consider the distance of the sun from the earth to be 92,000,000 of miles, with a margin of error of about 500,000 miles. It would take a railroad train 263 years to move from the sun to the earth; so that if the Pilgrim Fathers had started from the sun at the time they started from England, by a train whose only stopping places would be Mercury and Venus, they would not have arrived yet. It would take a cannon ball, going at full speed, about nine years to make the journey. Light takes eight minutes. Sound, if it could be carried over the celestial spaces, would be fourteen years on the way. You know, continued the lecturer, that if you touch a part of the body, one does not feel it instantly. If you touch the hand of any one with a pin, it will be an appreciable part of a second before he will feel it and draw his hand back. Now if I had an arm long enough to reach to the sun, and should put my fingers into the solar flame and burn them there, it would be one hundred years before I should find it out, and another hundred years before I could remove my hand.

DIMENSIONS AND DENSITY OF THE SUN.

Once having found out the distance of the sun, it is very easy to find out its diameter, which is about 860,000 miles. If the earth were represented by a ball $2\frac{1}{4}$ inches in diameter, the sun would require a ball of 18 feet in diameter, which would just about lie between this stage and the ceiling. If the earth were placed at the center of the sun, the moon would be so far inside the sun's surface that there would be almost room for another moon beyond, the distance of the moon from the earth being 240,000 miles, and of the surface of the sun from its center, 430,000 miles. In bulk, the sun is a million and a quarter times larger than the earth; that is, it would take that number of earths rolled into one to make up the bulk of the sun. It would not take that number to make up the weight of the sun, for the sun is lighter, bushel for bushel, than the earth. It weighs about 325,000 times as much as the earth. With that enormous mass, the force of gravity must be 28 times as great as on the surface of the earth; so that the weight of an ordinarily heavy man on its surface would be about two tuns.

THE HEAT OF THE SUN

is estimated by French physicists to not greatly exceed that of the electric arc, being, perhaps, once and a half or twice as great. Secchi, on the other hand, estimates it at 2,000,000° Fahr., and Ericsson at from 6,000,000° to 7,000,000°. Sir John Herschel illustrates the quantity of heat given out by the sun, as determined by his experiments, as follows: Suppose ice should be formed into a rod forty-five miles in diameter, and that rod of ice should be darted at the sun with the velocity of light: if all the heat of the sun could be concentrated upon the point of that advancing javelin of ice, it would never approach the sun, for the point would melt off as fast as it came. Or we may put it in another way: Suppose we should build a railroad from here to the sun, and should take to it two and one quarter miles square of solid ice, carrying it clear by the moon, Mercury, and Venus, and if we should concentrate upon that the heat of the sun, it would take just one second to melt it, and in seven seconds it would be volatilized, changed into steam, and invisible.

THE ORIGIN OF SOLAR HEAT

has been attributed by some to chemical combinations, but if the sun were of solid coal, it would have been completely burned out in 5,000 years, giving out heat at the present rate. The proper view is that its heat is maintained by the influx of matter. As meteors fall upon the earth, several millions in a day, so they fall into the sun, millions of millions per day, and contribute to the solar heat. But that does not account for it all. Another cause, I doubt not, is the contraction of its volume. If the sun were to contract one hundred and twenty feet in radius, or two hundred and forty feet in diameter, in a year, that would account for all the heat it gives off. Bodies may give off heat without growing colder. If we freeze a pail of water, it gives off heat while it is freezing, but the thermometer will indicate no fall of temperature until it is all frozen. So it is quite likely that the gases in the outer surface of the sun will enter into combinations with each other, dissociating and uniting in other forms, and emitting heat in the combination.

THE PHYSICAL APPEARANCE OF THE SUN

in the telescope is like a mass of clouds, or rather curdled milk or cotton wool. It is much darker on the edges, which is a very important point in explaining its constitution, and there are also numerous bright streaks, called faculæ, besides the solar spots. Mr. Nasmyth thinks that these irregular forms resemble willow leaves. I have not seen that, but I have seen in the sun what seemed irregular masses, dark spaces, and here and there apparently little holes.

The bright spots, called faculæ, are elevations on the solar surface. But the most remarkable objects on the surface of the sun are the spots; they are far more striking than the faculæ, and this before you (pointing to the diagram) may be taken as a good example or type of such spot, fairly formed and well established. In the center of it is a dark spot looking like a hole. The holes are not usually uniformly dark; there are usually little bays formed in the surrounding region; the edges of these are sharply defined, with no shading. Around this center, called the umbra, there is a wide border called the penumbra, almost invariably darker toward its outside edge, and striped radially. This hole—the umbra, if it be a hole—is so large that the earth might be dropped through into it without touching its edge. It is over 12,000 miles in diameter. The faculæ are always very numerous near the spot. Where the faculæ comes to the edge, there is a little projection. As to the nature of the

SUN SPOTS,

it is absolutely certain that the dark centers are depressed below the solar surface, but whether they are holes through to the body of the sun is another question, but they are cavities when the spot is first formed. You do not see the umbra, but the penumbra. To talk of temperate zones in a body as hot as the sun seems strange, but the spots are found in the temperate zones. They are not common in the sun's equator, or more than 30° from the equator. Rare examples have been found at 40° or 45° from it.

VARIATIONS OF SUN SPOTS.

The most curious thing about them is that they are not equally frequent in different years, and are regular in their irregularity or periodicity. After appearing in great force, they become infrequent for three years; then they gradually increase in number until, in about ten years from the first period or maximum frequency, they are again abundant. Sometimes as many as 400 or 500 separate groups of spots have been remarked upon the sun in a single year, and again there is a year when spots are few, and there may not be more than 80 or 100 in a year; so that in the year of maximum spot-frequency, the number is four times as great as on the year of minimum frequency. The cause of this is not yet known, but it is surmised that it is connected with the motions of Mercury, Venus and Jupiter, though it is probably due to a periodical boiling over of the vast caldron. When we examine the sun with the spectroscope, we find outward motion. Under the cloudy surface there is an ocean of liquid, and slags are formed in this ocean, and there is a blowing out of matter which gives rise to the penumbral phenomenon. There is undoubtedly an underfeed from the outside toward the center, but whether by a rush downward from the center of the spot, I cannot say. The English astronomers believe it is from the outside atmosphere to the center of the spot.

Professor Young then proceeded to explain and illustrate by diagrams on the screen, the solar prominences and their spectra. Fig. 3 is a representation of the sun with chromosphere and prominences, showing the relative magnitudes of the latter as compared with the sun, and also their number. The inner circular line is the boundary of the sun proper as distinguished from the chromosphere. The remainder of the lecture was devoted to the description of eclipses and the lecturer's observation of phenomena, the details of which have already appeared in our columns.

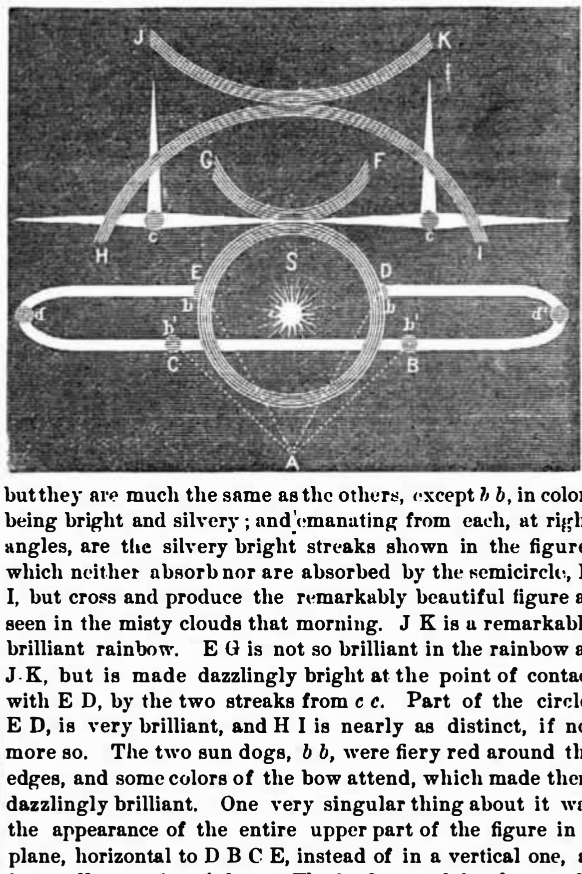
Correspondence.

Extraordinary Parhelia observed at Independence, Mo.

To the Editor of the Scientific American:

The inclosed diagram represents phenomena that occurred here on Saturday, January 25, at 9 o'clock A. M. In order that it may be better understood and more highly appreciated, it will be necessary to give some few points of description.

A is the place of observation; S the sun, E D a circle around the sun, or rainbow; F G is what we term the first reverse circle or rainbow; H I is a second circle or rainbow, whose brilliancy is cut short by the bright silvery belt, D B C E, which extends the whole heavens around, from east to west, in a plane, the hight of the sun, and parallel to the plane of the horizon, having its origin in the two dazzlingly brilliant sun dogs, or false suns, *b b*; J K is the second reverse rainbow, which was the most brilliant of all. The observations A B and A C, are west, and point to two very bright sun dogs, *b' b'*, which seem to correspond to D E in the east. *d* and *d'* are in the north and south, and quite bright also. But what is more singular, two more are at *c c*,



but they are much the same as the others, except *b b*, in color, being bright and silvery; and emanating from each, at right angles, are the silvery bright streaks shown in the figure, which neither absorb nor are absorbed by the semicircle, H I, but cross and produce the remarkably beautiful figure as seen in the misty clouds that morning. J K is a remarkably brilliant rainbow. E G is not so brilliant in the rainbow as J K, but is made dazzlingly bright at the point of contact with E D, by the two streaks from *c c*. Part of the circle, E D, is very brilliant, and H I is nearly as distinct, if not more so. The two sun dogs, *b b*, were fiery red around the edges, and some colors of the bow attend, which made them dazzlingly brilliant. One very singular thing about it was the appearance of the entire upper part of the figure in a plane, horizontal to D B C E, instead of in a vertical one, as is usually seen in rainbows. The background for the streaks proceeding from *c c* was a dark hazy blue, somewhat deeper than a sky blue.

The segment of the arc, J K, was apparently 90°; that of H I, 125°. Radius of H I seemed about 1,000 feet; J K, 750 feet; F G, 375 feet, and E D, 500 feet. The citizens here desire you to give or explain the philosophy of every part of the whole thing, either through your columns or by private letters. As we think it would be a very interesting matter to many of your readers, we hope you will insert the diagram and an explanation in your valuable paper.

The sky was, generally, slightly cloudy, hazy, and misty, and the earth was, and had been for some time, deeply covered with snow.

Will you please explain, particularly, the reversion of these rainbows? Some parts we understand, but what we want is an explanation of the whole thing as it was seen. The extreme upper part of the figure was east of a vertical line, and the whole was northwest of the sun's position.

D. M. WOODSON.

Independence, Mo.

REMARKS BY THE EDITOR.—When the sun is seen in a clear sky, the luminous disk is visible to us without any attendant phenomena; but if the air is loaded with moisture, or there are other favorable conditions, a great variety of phenomena present themselves and become the subject of investigation and study. The name halo is given indiscriminately to the circles which appear around the sun and the moon, and, for the purposes of precision, it has been proposed to call the rings about the sun "parhelia," and those about the moon, "paraselenæ." The parhelia witnessed at Independence were of rare occurrence, and we can only give the explanation of the phenomena that has been propounded by Newton and accepted by other philosophers. In cold weather, when particles of ice are floating in the higher regions, the sun is sometimes surrounded with the most complicated rings, circles, and mock suns, formed at the points where these circles intersect each other. Sir Isaac Newton considered the rings as produced by the light passing through very small drops of water, in the same manner as colors are produced by thin plates. Descartes supposed that the halos were due to refraction, through crystals of ice and snow floating in the air. The same view was taken by Mariotte, Young, Cavendish, and Brewster. In order to explain the larger halo. Dr. Young supposes that the rays which have been once refracted by the ice prisms fall on other prisms, and the effect is doubled by a second refraction, so as to produce a deviation of 90°. This explanation is not accepted by Brewster, who thinks that the external halo may be produced by the refraction of the rectangular terminations of crystals. All parties agree that such phenomena as were observed at Independence, Mo., are due to solid particles of ice floating in the higher regions of the air, and that refraction through ice prisms is the primitive cause. The air has been unusually charged with frozen water this winter, and an extraordinary number of halos, around the moon as well as around the sun, have been observed. On Lake Superior, the sun has been known to sink below the horizon and then to come up again to view, owing to a sudden change in the refracting medium through which the light passed. At Independence there was an unusual number of mock suns; but the other features of the parhelia were the same as have been pictured and described in works on natural philosophy. In fact, our correspondent will find in Brewster's "Treatise on Optics," two diagrams, one of parhelia and the other of paraselenæ, witnessed in 1630, which coincide very closely with the drawing shown by our engraving. The explanation of the whole set of phenomena is, therefore, resolvable into this, that the light was doubly refracted by ice prisms floating in the air, the sun being at a convenient hight above the horizon to produce the best effect. Experiments to prove the accuracy of this theory have been prepared and shown in the lecture rooms of professors of physics; and until a better explanation is offered, we prefer to abide by the above decision.

A Brilliant Meteor in Massachusetts.

To the Editor of the Scientific American:

I notice in your journal mention of meteors seen in Mason City, Ill., and in England, and the perusal calls to my mind a very sharp flash seen on the evening of January 11, 1873. It was caused by a large ball of fire, about the size of a bushel basket; it fell in Tyngsboro', Mass., some 6 or 7 miles from Lowell, on the Boston, Lowell, and Nashua Railroad. The flash was seen some twenty-five miles all around, and a dull rumbling sound was heard. It fell near or upon the railroad track, just in advance of an approaching passenger train, and caused quite a panic among the passengers, for a short time, until the conductor could satisfy them that there was no danger in proceeding. W. H. R.

Lowell, Mass.

Tree Transplantation.

To the Editor of the Scientific American:

On page 37 of your current volume some one says: "Most persons make a fatal mistake in trimming trees when transplanted. Never cut off a limb or a twig till they (the trees) have a secure foothold."

This advice, in the SCIENTIFIC AMERICAN, at once becomes a powerful influence. Whatever affects the tree-planting interest is of national importance; and I think I can show by reasons sufficient, as I could by the experience of all successful tree planters, that the advice referred to is radically wrong, and should read: "Always cut down the top of a tree transplanted, so that the relative proportion be preserved between roots and branches."

A tree to secure a foothold in its new bed must make a new growth of wood both at the top and root; otherwise death results in all cases after transplantation. Most trees lose, in transplanting, the larger portion of their roots; how does this operate when the top is left of full size and untrimmed? The leaves come out full with the advent of spring; and it takes all the nourishment supplied by the remaining roots to support the leaves, and no new wood is made.

If the top of the tree is cut down and the leaf buds destroyed, then, of necessity, in order to put forth leaves, there must be a new woody growth; when this occurs, there is always a corresponding root growth, and thus a foothold is secured. Many trees, like the sugar maple, only make wood during a brief period in spring; consequently, if transplanted with ever so much care after this season, they invariably die.

A tree which continues making wood during the entire season, like the willow and locust, can with care be transplanted at any time; but it may be set down as a rule, with but few exceptions, that deciduous trees should only be transplanted when bare of leaves, and then the top left must be proportioned to the root.

To further illustrate the fallacy of the no trimming theory, suppose that in putting out cuttings, as of the cotton wood or willow, a top was left. Does any one suppose that a new root would be formed? It is the growth of the new top that is accompanied by new root growth; in fact they are inseparable. The everywhere popular white elm and sugar maple, although exceedingly difficult to transplant successfully with large tops, will generally live and grow if every branch is cut off and the short bare poles only set. E.H.R.