clear there at that time, it adds one more to the long list of wonders associated with that observatory.

In regard to the third matter, relating to the transmission of terrestrial radiation, I am quite unable to understand Mr. Very's logic. His mind seems to let through the consideration of rays that rise vertically from the earth's surface, but to abolish all thought of those which rise obliquely. Like every other surface, all parts of the earth's surface emit rays in all directions within a hemisphere, and tend to cool by the loss of the energy of all these rays which they emit. The loss is to some extent compensated by rays which reach the earth from every one of these directions, and which at night come mainly from the emission of the atmosphere itself. Mr. Ångström and others have measured at night the excess of the radiation emitted by a horizontal blackened surface, at terrestrial temperature, over the radiation received by such a surface from above. There is no great disagreement in the observation. All observers find the net loss of radiation at 20° C. to be from 0.12 to 0.20 calories per sq. cm. per minute, depending on the state of the atmosphere. But Mr. Very maintains that the whole of this loss represents energy that is transmitted entirely through the atmosphere in direct beams from the earth's surface to space. I see no reason to admit this at all. What is measured is a difference between the energy of two beams of rays, one leaving the surface, the other reaching it. If the atmosphere (taking its entire thickness) was totally opaque to these rays, there would still be a difference in these amounts of energy, because the atmospheric sources are at a lower temperature than the earth's surface.

To determine the transmission of the earth's surface-radiation through the atmosphere, as I define it, one must sum up the total of all radiant energy which, having been emitted by a horizontal fragment of the earth's surface, escapes outside the atmosphere into space, by whatever path, without having suffered true absorption and re-radiation. The sum total just described divided by the original quantity emitted by the same element of surface is the transmission. Perhaps Mr. Very has in mind the coefficient of vertical transmission. This is naturally larger than mine, but it does not serve to indicate the rate of loss of heat of the earth's surface by radiation. That depends on the rate of loss by oblique rays as well as that by normal ones.

C. G. Abbot

Mount Wilson, Calif.,
August 17, 1916

A REMARKABLE AURORAL DISPLAY

Between eight and nine o'clock on the evening of August 26 I stepped out on the porch of our cottage on the shore of Lake Douglass in northern Michigan and noticed what I at first mistook for an unusually bright twilight for that date and hour.

Looking up through the tree-tops I saw a curious flickering as of sheet lightning on a bit of cloud. But there was a peculiar streaming movement which at once suggested an auroral phenomenon, although I was looking towards the south! Passing around the house to an open field, I was fairly staggered with such a spectacle of light in motion as had never been dreamed of by any of our family group of eight which at once answered my cry of amazement.

Practically the whole vault of the heavens was alive with light. Light in patches, bands and arches; in streamers, sheets and delicate pencillings. Clear from the northern horizon to the zenith, and far beyond until the southern sky was invaded to within about four degrees of the horizon, and was utilized for the unfolding of the display.

I had seen what I thought to be fine auroras much farther to the north, but had never even heard of one which required almost the entire expanse of the heavens for its staging.

The focus of the spectacle was the zenith itself, and around this was a shifting and irregular zone of light below which almost the entire sky was set with masses of shifting, shimmering radiance constantly changing shape as if the sky were a vast kaleidoscope. It seemed, indeed, as if we stood beneath the

center of the dome of the firmament, whose vault was composed of bands and changing masses of streaming light, the quivering waves of which were surging upward toward the disk of blue at its apex. A brighter arch spanned the northern horizon, and this also was undergoing constant transformation.

It was not the light itself, marvellous as were its mass, zones, banners and steamers, that most thrilled the observers. Such a vast display of light in constant *movement* had never before been seen nor imagined by any of us. The whole heavens shuddered and staggered, shivered into a swirling chaos and reformed again and again in new and still more weird aggregates of shimmering light. Light streamed and wavered, rippled, flickered and pulsated. Now it was in broad waves reaching to the zenith, and now in vibrating bands. Here a broad cone shot up from the northern horizon until its apex pierced the very mid-heavens, and in the twinkling of an eye it was gone. There, from the shifting zones around the zenith, ripples of light passed upward to the blue apical disk. To the naturalist no more apt figure of this rippling motion could be suggested than the waves of light passing along the meridional bands of phosphorescent Ctenophora.

Again, a delicate fringe of pencil points would appear on the upper edge of one or more of the shifting zones and then shoot upward with inconceivable rapidity in sharp vibrating pencillings of light. As mentioned before, the focus of all these movements was the zenith itself, which seemed to be undergoing an intense bombardment of waves, ripples and searchlights from all sides, although subsidiary lateral movements were also in evidence.

Marvellous as was the rapidity of movement, the rapidity of change or kaleidoscopic effect was no less astonishing. Over and over again one of the observers would try to call attention to some particularly vivid display, only to find it utterly gone before the others could turn their eyes in the direction indicated. These changes were much more rapid than in other auroras seen by the writer. Nothing but electrical phenomena could approach their instantaneous shiftings.

At first the light was all pure white radiance, exactly that of electricity. Later certain areas took on a rose color, and still later the display more closely resembled that of ordinary auroras, being concentrated in the broad arch across the northern sky and showing more variety in colors.

So absorbed were the observers in this grand spectacle of light in motion that it was long before they noted the peculiar effect of the light upon themselves and their immediate surroundings. Then we saw that it was a perfectly diffused light, coming in practically equal intensity from all points of the sky. A more *unreal* scene could hardly be imagined. It was unlike moonlight, for there were no shadows nor shadings. On that account all objects seemed much less brilliantly illuminated than they really were. It was most like the light of early dawn; but still different, for in the dawn the light, although diffused, is all from one side. Objects were distinctly visible, but flat. Our companions' faces could be seen quite plainly, but lacked individuality. The opposite shore of the lake could be seen much more distinctly than in bright moonlight and objects inside the house were quite distinct, even if small.

How long the display lasted we do not know, although one of the party reported it as striking as ever well past midnight. Finally the chill of the night and the aching of our strained necks drove us indoors with the conviction that never again should we see such a stupendous spectacle of light in motion.

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INCREASING DEPTH OF FOCUS WITH THE SWING-BACK

TO THE EDITOR OF SCIENCE: The writer admits his membership in the not inconsiderable class of field workers who are never satisfied with their photographic results. A little discovery, however, recently enabled him to improve the focus on certain classes of deep-focus pictures and he excuses the description