

November 26, 1951  
212 W. Seminary Ave.  
Wheaton, Illinois

Mr. H. R. Villarreal  
Cerrada de Vallarta No 1  
Mexico, D.F.

Dear Mr. Villarreal:

While I am no longer associated with NBS, your memorandum on the refraction in the solar atmosphere has reached me here. What you say is perfectly true. Unfortunately the magnitude of the effect is insignificant. This is because most of the solar atmosphere is of very low density, near that of a good vacuum by laboratory standards. Thus the refraction is exceedingly small. When put to mathematical test the refraction turns out to be of same order of magnitude as the refraction in earth's atmosphere. I suggest you consult the library of one of the large observatories near your city for quantitative formulas. The astronomers of these institutions, I feel sure, will assist in helping <sup>you get</sup> the necessary details.

P.T.O.

It is interesting to note that the solar atmosphere is ionized. Thus the index of refraction is negative and of large value for wavelengths near  $\frac{1}{2}$  meter long. Using your concepts this causes the sun to appear much smaller than it should be when observed at  $\frac{1}{2}$  meter wavelengths. For confirmation of this please see my data on 480 mc solar radiation published in the Proceedings of the Institute of Radio Engrs, January, 1948. You will notice that radiation is only observed from the great spot when it was near the center of the solar disk. This is because the negative index of refraction focus the energy to a small cone above the spot. This energy cone rapidly sweeps across the sun to earth line in a few days instead of appearing for 14 days as in the visible region of the spectrum.

Yours very truly,  
Grote Reber

April 1951

## OUR SUN IS NOT AS BIG AS IT LOOKS

By Humberto Ramirez Villarreal

Our old acquaintance, the sun, has been fooling us for ages about its size, which is not so great as it shows.

In connection with this question please allow me a short digression, before presenting the final proof of my contention: Einstein predicted that a ray of light passing near the sun would be deflected - as depicted in Fig. 1 - due to the gravitational attraction of the sun. Said scientist advanced that the deviation of such ray would be 1.75 seconds of an arc.

Photographs made during the solar eclipse of May 29, 1919, revealed a deviation of 1.64 arc seconds. In my concept, this figure was lesser than the predicted one because the rays of light coming from stars visually close to the apparent sun's disc actually passed far away from the surface of the sun, away from the maximum gravitation that it was thought of. The reason of this effect is that the sun is swelled or magnified by its own refraction, as will be demonstrated in this paper. But, before proceeding to do it, let us point out that Einstein is right, anyhow, in his theory of light being attracted by gravitation. Some scientists are not willing to accept as complete proof of that theory the slight deviation recorded by the mentioned photographs, nevertheless, there is the unanimously accepted proof of the gravitational shift observed in spectral lines in the light emitted by high gravitation stars.

Now, I proceed with my own theories. Most of the readers scarcely need to remind optical laws which are well known; anyway, let me be totally explicit and permit me to recall that when a ray of light from a star passes obliquely through our atmosphere such ray is curved downward by refraction as it gets into denser air; then, the eye of an observer on the earth receiving the ray will see the star higher than it really is over the horizon. If instead of an eye we place a mirror normal to the already refracted ray this will be reflected back through the same curved path it took when coming in within our atmosphere.

By the same token, if we use a lamp in the place of said mirror we can send out a ray of lamp light following the same curved path taken by the mirror reflected ray.

Now, let us extinguish for a moment all the light of the sun and transport our lamp to any point on the surface of the same sun; there, a ray of light emitted by the lamp toward the sun's horizon will meet considerable refraction

forcing its way through the thick gaseous envelope of the sun beyond the photosphere; thus, the ray will have to take a curved path; probably with a greater directional change than in the earth's atmosphere, for the solar gravitation is 27 times that of the earth, which means a much higher solar capacity to retain and compress a larger gaseous envelope or corona - an enormous replica of our atmosphere -, considered several miles thick, as the extent of the observed streamers proves; in other words, the ray of lamp light will be suffering refraction - or bending - during millions of miles, not just during hundreds, as in the earth's atmosphere.

Please concede now your kind attention to Fig. 2, showing the sun all darkened except a lighted ring or strip around the face opposed to our earth. Broken line a is a solar ray of light originating from a point in the lighted strip toward the sun's horizon; this broken line is straight as it should be without refraction, but a gaseous medium of changing density is in the way and the ray is refracted into the curved path represented by solid line b. As a result of this simple optical action an observer on earth would see the origin of said ray in the direction of a tangent to line b, indicated by broken line c of Fig. 3. A similar explanation belongs to lines a', b' and c', so that Fig. 3 becomes self explanatory.

Do I mean that the edge we see of the sun is actually a ring behind the sun? Yes, absolutely.

Maybe the optical swelling of our sun has been exaggerated in my drawings - for the sake of clearness -, but all the effects used in my demonstration have been worked out step by step according to scientific facts, so that the visual enlargement may be open to discussion only about its magnitude.

We all know that the correct size of the sun is really a crucial point for the astrophysicists; and since they have overlooked the actual size they will have to revise most of the solar calculations and rearrange all data regarding age, density, material composition, surface and inner temperatures, etc.

Perhaps my revelation is going to cause a shock in the scientific world. Anyway, it will be a salutary and enlightening shock, I hope.

*H. Ramirez*  
Humberto Ramirez Villarreal  
Cerrada de Vallarta No. 1  
Mexico, D. F.

This fellow has right idea but effect is insignificant at optical wavelengths, at radio waves the effect is reverse because the ionized solar atmosphere has a negative index of refraction.