distance of the Sun ($=z$) at that point. Then from a known optical principle, the apparent brightness of the surface at P as seen from the Earth will be proportional to the real illumination. Consequently, the apparent brightness B of any point on *Venus* as seen from the Earth will be

$$B = A \cos z.$$

The point where the apparent brightness is greatest will be therefore that where the Sun is in the zenith.

Consequently, when *Venus* is crescent, or less than one half of the illuminated hemisphere of *Venus* is visible, the limb of the planet will be the brightest portion. This is what the observations of Capt. Noble (*Monthly Notices*, vol. xxxv. p. 350) have already indicated. When, however, the planet is gibbous, so that more than half the illuminated hemisphere can be seen, then the point of maximum illumination will be within the limb. Under these conditions, in fact, the region of maximum brightness will be an ellipse of great eccentricity.

This is in accord with the observations of Mr. Christie, communicated to the Society in November 1876.

These two series of observations are not therefore, discordant, as might be supposed, and neither confirm the hypothesis that the solar rays are specularly reflected from the surface of *Venus*.

Note on the Gradation of Light on the Disk of Venus.

By W. H. M. Christie, Esq.

Some months ago Mr. Brett pointed out that there was a gradation of brightness towards the limb of *Venus* as well as, in a more marked degree, towards the terminator, and he considered that this was due to specular reflexion modified by large atmospheric diffusion. As *Venus* was then becoming crescent-shaped, and therefore unfavourably situated for showing any effect of specular reflexion, I had no opportunity of testing the point till after inferior conjunction. When the planet became gibbous again, I examined the disk on several occasions in the forenoon with the direct-vision polarising eyepiece, described in the *Monthly Notices* for last January, applied to the Great Equatoreal of the Greenwich Observatory, and was thus enabled to reduce the brightness very gradually to the point of total disappearance. On October 12 the disk was reduced, on turning the Nicol prism, to an oblong patch, the edge of which was distant about one-sixth of the diameter of *Venus* from the limb, special attention being directed to this point. Afterwards, on November 28 and December 6, under more favourable circumstances, four distinct phases were remarked, corresponding to different readings of the position-circle attached to the Nicol, and indicating four different degrees of brightness:

(*a*) At the first phase the limb was just beginning to fade, the disk being then gibbous, though a small portion near the terminator had, as far as I could judge, already disappeared.

(*b*) The next phase was an oblong patch, from two-thirds to three-quarters of the planet's diameter in length, in the direction of the line of cusps, and about one-third as broad as it was long.

(*c*) On turning the Nicol further, the ends of this patch disappeared, and a nebulous spot, about one-third of the diameter of *Venus*, and condensed towards the centre, was seen.

(*d*) Finally, just before total disappearance, the disk was reduced to a nearly stellar point from one-sixth to one-tenth of the original diameter, and surrounded by an extremely faint haze, which was occasionally invisible, leaving nothing but a minute point of light to be seen. The appearance was exactly that of the nucleus of a small comet, or of a nebulous star. By the help of a pointer in the field of view, the position of this stellar point was found to be about the middle of the visible disk.

From several sets of closely accordant readings of the position-circle, taken with the eyepiece in various positions, the angles for the Nicol measured from the position for which its plane of polarisation is perpendicular, to the plane of reflexion in the eyepiece, were found as follows for the respective phases :—

(*a*) 30° (*b*) 24° (*c*) 13° (*d*) 11°

Since the intensities of light transmitted by the Nicol are as the squares of the sines of the above angles, we get, taking the faintest portion of phase *a* as standard:—brightness of $b=1\cdot5$, of $c=4\cdot8$, of $d=7\cdot0$. So that it would appear that the central portion of the disk is about seven times as bright as the part near the limb. It may be thought strange that so great a difference in brightness should not be more noticeable, but it would seem that a highly-trained eye is required to detect a gradation in bright objects, though when the brightness is reduced nearly to the vanishing point, there is no difficulty in seeing it. In the polarising eyepiece the light is reduced in the first instance to about 1–3000th part by the three reflexions, and with the Nicol at the reading for phase *d* it is further reduced to one-thirtieth of this amount, or 1–90,000th of the original brightness. Though the extinction method of photometry is liable to large error from variation in the sensitiveness of the eye, it may be trusted for comparative results, where, as in this case, there is an extremely faint background of scattered daylight, which gives a sort of standard for comparison.

Whatever uncertainty there may be in the actual values found for the brightness, there can, I think, be no doubt of the fact of a considerable gradation of light from a central, or nearly central spot; and it seems difficult to explain this on any other hypothesis than that of specular reflexion modified by atmospheric diffusion.

1876, *December* 7.