of 1882" (when internal contacts are considered instead of passages of *Venus's* centre across the Sun's limb) "are less considerable than those" I had made in the case of the transit of 1874. This view is justified by the calculated positions of the places where ingress and egress are most affected by parallax. These I find to be as follows:—

		Lat.	Long.
(i.)	The place where first internal contact is most accelerated, lies in	51° 5' S.	86° 48' E.
(ii.)	The place where first internal contact is most retarded, lies in	53 16 N.	94 28 W.
(iii.)	The place where last internal contact is most accelerated, lies in	26 18 N.	40 1 W.
(iv.)	The place where last internal contact is most retarded, lies in	23 46 S.	137 11 E.

Not one of these places differs by much more than 300 miles from the corresponding place obtained by considering the passage of *Venus's* centre, with the position-angle for external contact,— the phase with reference to which these places had hitherto been calculated.

The transit of 1882 has an interest which that of 1874 wants, in being partially visible in England.

September 11, 1869.

Note on Atmospheric Chromatic Dispersion as affecting Telescopic Observation, and on the Mode of Correcting it. By George Biddell Airy, Astronomer Royal.

In my last communication to the Royal Astronomical Society on the Transits of *Venus*, I adverted to the injurious effect, on the observations, which might possibly arise from the chromatic dispersion produced by the atmosphere. I had carefully observed *Mercury* on the Sun's disk, and I was painfully struck with the colour and consequent indistinctness of the upper and lower limbs both of the Sun and of *Mercury*, and with the prospect of a total loss, in the observations of the Transits of *Venus*, of that delicacy on which the success of the observations will greatly depend: (it being remarked that, for the most valuable observations, the Sun must be low and the atmospheric refraction and dispersion must therefore be considerable; and that the planet must be near the highest or lowest part of the Sun's limb). And I suggested that probably an efficient corrective might be found, in the application of a glass prism of small refracting angle in the eye-piece of the telescope. It is my purpose now to give the numerical elements for the preparation of the necessary prism, and to state the success which attends its use.

The optical theory is exceedingly simple, but it may conduce to clearness that it be given here. Let θ be the angle of incidence when a ray of light falls on a refracting surface; $\theta + \psi$ the angle of refraction; then ψ is the angle of deviation. Also, if the refractive index be $1 + m$, m may be called the index of deviation; m is negative for the passage of light from vacuum to air, and for the passage from air to glass, but positive for the passage from glass to air. At each of these refractions we have the accurate equation,

$$\sin(\theta + \psi) = (1 + m)\sin\theta;$$

and, if θ remain invariable, but m be varied, and ψ be varied in consequence of the variation of m,

$$\cos(\theta + \psi) \times \delta\psi = \sin\theta \times \delta m.$$

Now when ψ is small, but in no other case, $\sin(\theta + \psi)$ is sensibly equal to $\sin\theta + \cos\theta \times \psi$; and in the second equation, the factor of the small quantity $\delta\psi$ may, without sensible error, be considered as $\cos\theta$. Thus, when ψ is small (whatever be the cause of that smallness), the following equations are sensibly accurate:

$$\sin\theta + \cos\theta \times \psi = \sin\theta + m\sin\theta, \quad \text{or } \cos\theta \times \psi = m\sin\theta;$$

$$\cos\theta \times \delta\psi = \sin\theta \times \delta m.$$

From which $\frac{\delta\psi}{\psi} = \frac{\delta m}{m}$; or, the proportion of the change of deviation (accompanying a variation in the colour of the light) to the whole deviation, is the same as the proportion of the change of the index of deviation to the whole index of deviation.

The two deviations which require consideration in the following investigation, namely, that produced by the atmosphere and that produced by a flint prism of small angle, are both small; the first because, though the angle of incidence is large, the index of deviation is very small; the second because, though the index of deviation is large, the angle of incidence is small. The theorem just found will, therefore, apply to both.

In collecting the numerical data to be employed for my calculation I have been referred by my friend Professor W. H. Miller to an account of Ketteler's observations on atmospheric refraction, given in the *Fortschritte der Physik*, 22nd Jahrgang, page 179. For the other media I use some well-known determinations by Fraunhofer. Although, in the practical construction, I use only flint glass, I have thought it interesting to insert the numbers for crown glass and water. The two rays of the spectrum by which I measure the dispersion are B and G.

Medium.		Index of Deviation for B.	Index of deviation for G.
Air	...	0·00029350	0·00029873
Water	...	0·0330977	0·0341261
Crown 13	...	0·0524312	0·0539908
Flint 30	...	0·0623570	0·0655406

Now dividing the difference of the indexes of deviation for B and G by half their sum, for each medium, we obtain the following values of $\frac{\delta m \text{ (B to G)}}{m}$:—

Air	...	0·017662,
Water	...	0·030596,
Crown 13	...	0·029310,
Flint 30	...	0·049784.

Air, therefore, is much less dispersive in proportion to its refraction than either of the other media.

I now proceed to apply these numbers to the estimation of the effect of atmospheric dispersion on telescopic vision, and to the construction for its correction.

Let R be the atmospheric refraction of the object viewed; p the power of the telescope. Then the atmospheric dispersion (B to G), as seen by the naked eye, is $R \times 0{\cdot}01766$; and, as seen in the telescope, it is $R \times p \times 0{\cdot}01766$. A prism of flint glass is to be introduced close to the eye, whose dispersion is to neutralize this magnified atmospheric dispersion. Therefore the dispersion of the flint prism (B to G) must be $R \times p \times 0{\cdot}01766$; its refraction must be $R \times p \times 0{\cdot}01766 \times \frac{1}{0{\cdot}04978}$; and, since the index of deviation of the flint glass for the mean rays is 0·6395 (estimated as for the passage from glass to air, which, it is easily seen, give the proportion of the aggregate of deviations at the two surfaces to the refracting-angle of the prism), the refracting angle of the prism must be $\frac{R \times p \times 0{\cdot}01766}{0{\cdot}04978 \times 0{\cdot}6395}$. Performing the numerical calculation, we find that the angle of the flint prism must be $\frac{R \times p}{1{\cdot}8}$, or the atmospheric refraction must be $\frac{1{\cdot}8 \times \text{angle of the flint prism}}{p}$, in order to produce perfect correction.

Suppose, then, that we have a series of flint prisms ground to the angles 2°, 4°, 6°, 8°, 12°, 16°. And suppose that we use a telescope with power 120 or with power 240. Then the following table, showing the zenith distance at which the atmospheric dispersion is corrected, is easily computed; the refraction being calculated by the formula just given, and the zenith-distance corresponding to the refraction being taken from a common table of refractions:—

	Telescopic power 120.		Telescopic power 240.	
Angle of Flint Prism.	Atmospheric Refraction.	Zenith Distance.	Atmospheric Refraction.	Zenith Distance.
°	′	° ′	′	° ′
2	1·8	61 58	0·9	43 7
4	3·6	75 16	1·8	61 58
6	5·4	80 15	2·7	70 32
8	7·2	82 52	3·6	75 16
12	10·8	85 34	5·4	80 15
16	14·4	87 3	7·2	82 52

For view with the naked eye it would be necessary to use a prism (of appropriate small angle) with its edge downwards; but, for view with an inverting telescope, the edge of its appropriate prism must be upwards.

Mr. Simms has prepared, under my instruction, a series of prisms of flint glass with the angles just mentioned; and Mr. Carpenter has made trial of them. The following are two of Mr. Carpenter's reports:—

1869, July 15, $11^h 50^m$ to $12^h 20^m$. *Saturn*, zenith-distance about 82°, viewed with the Great Equatoreal, power 245. Atmospheric dispersion very bad.

Prism 12° corrected the dispersion perfectly.
Prism 8° corrected it fairly.
Prism 6° corrected it partially.
Prism 4° and 2° produced no visible effect.
Prism 16° confused the image.

1869, July 21, 9^h. The Moon, zenith-distance about 78°, viewed with the Altazimuth, power about 100.

Prism 2° slightly diminished the colour.
Prism 4° better than the last.
Prism 6° destroyed the colour entirely. The definition of the details about the Moon's rugged edge was much improved.
Prisms 8°, 12°, 16°, gave an opposite dispersion.

It will be seen here that the object which I proposed to myself is completely attained. It is made possible, by this construction, to examine a celestial body with delicacy and accuracy, under circumstances which would, without this construction, have rendered nice observation impossible.

The series of angles of the prism which I have given appears to me well adapted to general wants. I propose to furnish each of the principal telescopes to be used for the Transit of *Venus* with a complete series of such prisms, arranged perhaps on a long slider. Care must be taken to make the thickness of the slider-frame as small as possible, inasmuch as it must be accompanied with another slider carrying dark glasses. It will probably be