

LV. *An Account of a Memoir read at the Royal Academy of Sciences at Paris, by M. de Barros, a Portuguese Gentleman, concerning certain Phænomena observed by him at Paris, in the last Transit of Mercury over the Sun: by J. Short, A.M. F.R.S.*

Read Dec. 13, 1753. **T**HE author says, he made use of an excellent Gregorian reflector of four feet in length, taking in the eye-piece, together with as much of the great tube, as exceeds the focal lengths of the two eye-glasses (*I suppose it should be the two speculums*): that the focus of the great speculum is 33 (*Paris*) inches; that of the small one four inches; the focus of the eye-glass next the eye 18 lines; the focus of the glass furthest from the eye 5 inches; and, lastly, that the combined power of these two glasses is nearly equal to that of a single eye-glass of 3 inches. This telescope, therefore, according to my computation, magnified about 130 times.

That he was placed in the most commodious situation for observing the egress; that his smoked glass was fixed perpendicular to the axis of his telescope within a close tube; and that he always made use of the same part of this glass.

He took notice, that the interior contact of Mercury's and the Sun's limbs * was very rapid, having observed it with a green-colour'd glass held over the

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* At 10^h 18' 41".

smoaked glass: immediately after which, looking thro' the smoaked glass only, he perceived, that a small thread of light was still visible between the limbs, before, what he calls, the second contact took place, which was not till four seconds after; that the exterior contact appeared stationary, or seemed to last 6 or 7 seconds; that having observed the total egress with the coloured glass upon the smoaked one, he brought Mercury upon the Sun's limb again, by removing the colour'd glass; and that the second total egress did not happen till 6 or 7 seconds after the first. When he observed him at the distance of about 3 of his diameters from the Sun's limb with both the glasses, he remarked, that the said distance seem'd diminished, and Mercury's diameter increased. That the part of the Sun's limb, where Mercury went off, to the extent of six degrees of circumference, seemed under much the same configuration, as the illuminate limb of the Moon about the quadrature, somewhat uneven and undulating. The same looked also redder than the rest of the disk. This was about 18 or 20 seconds before Mercury disappeared, and was seen thro' the smoaked glass alone: for when the green glass was applied, the appearance in a manner vanished.

The evening before the transit, he viewed the Sun with different-colour'd glasses, variously combined with one another, and with a smoaked glass; and found, that a green glass before the smoaked one did best: the Sun appearing of a silvery hue, like the Moon, and the spots and the limb exceedingly well defined.

M. de Barros, having thus described the particular phænomena, attempts, and indeed very ingeniously, to
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account for them all, from this single supposition; namely, that the disks of the Sun, and of Mercury seen thereon, are environed with a certain *corona* of light (like that which Sir Isaac Newton calls the circle of *aberration* or dissipation in refracting telescopes), whereby the apparent diameter of the Sun is enlarged, and that of Mercury contracted.

But, as this gentleman made use of a reflecting telescope, and as no such circle, from the known principle of reflexion, can take place in such a telescope, if well made, as Sir Isaac has proved long ago; I shall not take up the Society's time in pursuing him thro' all his particular suppositions; but shall endeavour to shew, that his hypothesis has really no foundation.

Sir Isaac, as I before hinted, in several of his writings, remarks, that the images of all objects seen in refracting telescopes are surrounded with a circle of aberration; which is always less, the longer the telescopes are. In his optics he tells us, that, to avoid the indistinctness arising from this circle, he would propose catadioptric telescopes, in which, if the speculums, under limited apertures, be justly figured, no such circle of aberration can confuse the image: but, if the speculums are of a spherical figure, with too large apertures, then indeed a circle of aberration will take place; as it also will, when the figure deviates from the circular towards the hyperbolic, even under a small aperture; and the same thing will happen, if the spherical figure be inaccurate.

About three days from the change of the Moon, her whole body is visible: that part of the limb, which is directly enlightened by the solar rays appearing

pearing to the naked eye, as an arc of a greater circle, than the other, which receives the reflex light from the earth. Look thro' a refracting telescope, and you will perceive the apparent difference of these circles very much diminished: and if they be view'd with a good reflector, they will be perfectly reduced to an equality, even if measured with a micrometer in the focus, as we have often found.

If a reflecting telescope, well constructed in all respects, be directed any considerable time to the sun, such a circle of aberration will be generated, from the little speculum's being heated, and thereby its figure alter'd, from the sun's rays falling condensed thereon from the great one; and if it continues long under this circumstance, the image will be render'd utterly indistinct and confused.

This we were thoroughly convinced of at the above-mention'd transit of Mercury: for the reflector, a very good one, which we used, in taking, with the the micrometer, the differences of right ascension and declination between the planet and the sun's limb, having been a good while exposed to the direct rays, was found at last to give a very indistinct image; but was restored to its former degree of perfection, by turning it from the sun, and screwing off the eye-piece, so as to admit the cool air into the great tube, whereby the over-heated small speculum soon recovered its due temper and figure. The last-mentioned effect is scarce sensible in the lesser reflectors of small apertures; but in those of large ones it is very considerable.

Dr. Bevis, Mr. Canton, and Mr. Bird, who viewed Mercury going off the sun, with very good reflectors of different lengths, assure me, they saw him quite
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distinct and free from any *corona*, or circle of aberration, and the sun's limb perfectly well defined. For my own part, he appeared to me, thro' a reflector of four feet focus, magnifying about 135 times, as truly defined as I could wish to see a black circle upon a white ground

I must, however, upon this occasion, take notice, that, during the whole time of this transit of Mercury, the air was perfectly calm with us; but that, in the two last transits of Mercury over the sun, *viz.* in the years 1736 and 1743, both the sun's and Mercury's limbs appeared to me indistinct, and surrounded with something like what this gentleman calls a luminous crown, or circle of aberration; tho' I, at both these times, made use of reflecting telescopes, which I had, by former trials, esteemed good. But it is to be observed, that, during both these transits, there was a constant hard gale of wind; and as I had, by other observations, formerly found, that the images of the planets, in the night-time, did not appear so distinct in windy weather, as when it was calm, I therefore imputed the indistinctness of the sun's and Mercury's limbs to the air's being agitated by the wind*. And of this we may be made sensible by a familiar instance:

Suppose a vessel full of water, having any thing lying at the bottom, such as a shilling, the water being at rest; you will then perceive the image of the shilling distinctly; but if you give any commotion to the water, the image of the shilling will then appear indistinct and confused.

* Since this paper was read, Mr. Short has been informed by M. Le Monnier, the French King's astronomer, that, during the last transit at Paris, they had a hard gale of wind from the N. E.

Somewhat analogous to this is this other appearance: If you look thro' a telescope at any of the planets, when the stars appear hazy, dim, and languid, you will see them distinctly: but look at them again, when the stars appear most bright and sparkling, you will then find their images less distinct. This may be accounted for by the just-mention'd instance of the vessel of water, by supposing air instead of water. And if we consider the infinite number of heterogeneous particles which continually float in the air, and suppose these to be at rest, or put into motion, we shall find, that it is not at all surprising, that we see the images of objects, placed beyond the medium of air, more or less distinct.

We are not so sensible of this indistinctness, arising from the agitation of the air, in refracting telescopes, as in reflectors: because the errors of reflexion, caused by any irregularity in their figure, or confusion in the air, are about five or six times greater than the same errors in refraction; even tho' both telescopes magnify the same number of times; as has long ago been demonstrated.

We also took notice of M. de Barros's first phenomenon; to wit, the seeming greater velocity of Mercury when he was near the egress: which we thus accounted for. When he was at a considerable distance from the limb, there being nothing near enough to refer his velocity to, he seemed in a manner stationary; but being advanced near the sun's edge, we could refer his motion to that, with ease; which thus becoming sensible, it might be esteemed rapid, in comparison of the former. I have often made the same remark on the gradual approach of two lumi-

nous bodies, as the appulse of the moon's lucid limb to a star or planet.

The expedition with which the author observed his second phænomenon, is truly somewhat extraordinary; namely, that he should first observe what he names the final contact; secondly, that he should take away his green glass; and then, thirdly, that he should be able suddenly to alter the conformation of his eye, so as to see distinctly with a much greater influx of light, and then take another observation, and all in the short space of four seconds! Messieurs Mairan and Bouguer take notice of this in their certificate, which follows this memoir; and own, that his observations were such, as seem to have required the attention of several persons.

Upon the whole, we may conclude, that the several phænomena, observed by this gentleman, in the transit and egress of Mercury, were owing to indistinctness of vision, arising either from the eye, the telescope, or the air; and that this alone may account for them all, without having recourse to supposed circles of aberration; which can never possibly exist in a well-constructed reflecting telescope.