Copy of a letter to John Collins, dated 9 April 1672

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<46r>
< insertion from the top left of f 46r >

By M^{r} Newton to M^{r} Collins.

< text from f 46r resumes >
< insertion from the left margin of f 46r >

By M^{r} Newtons Answer to M^{r} Gregories Letter of March: 7: 1673.

< text from f 46r resumes >
< insertion from the top right of p 46a >

(Ent^{d} LB. 6. 71.)

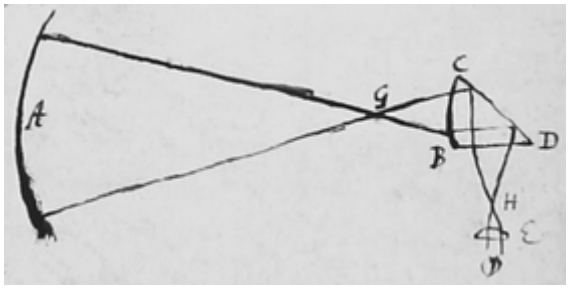
< text from f 46r resumes >

Cambridge Apr. 9. 1673.

Sir

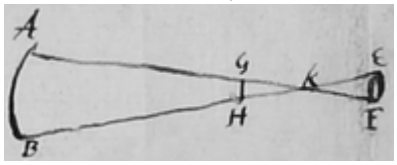
Having perused M^{r} Gregorys candid reply, I have thought good to send you these further considerations upon the differences that still are betweene us. And first that a well polishet plate reflects at the obliquity of 45 degrees more truly then direct ones seemes to me very certaine, For the flatt tubercula or shallow valleys, such as may be the remaines of scratches almost worne out, will cause the least errors in the obliquest rays which fall on all sides the hill, excepting on the midle of the foreside and backside of it, that is where the hill inclines directly towards or directly from the ray; For if the ray fall on that section of the hill, its error is in all obliquitys just double to the hills declivity: but if it fall on any other part of the hill its error is lesse then double, if it be an oblique ray, and that so much the lesse, by how much the ray is obliquer; but if it be a direct ray, its error is just double to the declivity and therefore **{**greater**}{**greatest**}** in that case. I presume M^{r}. Gregory, if you think it convenient to transmitt this to him, will easily apprehend me.

How the charge may be varied at pleasure in my Telescope, will appear by this figure, where A represents the great Concave, E the Eye-Glasse, and BCD a Prisme of Glasse or Crystall whose sides BC & BD are not flat but spherically convex, so that the rays which come from G the focus of the great concave A, may by the refraction of the first side BC be reduced into parallelism, and after reflection from the base CD be made by the refraction of the next side BD to converge to the focus of the Eye-Glass H.



The Telescop**{**e**}** being thus formed it appears how the charge may be altered by varying the distances of the glasses and speculum.

As for the objection that M^{r}. Gregorys Telescope will be <46v> either overcharged or have too small an Angle of vision &c I apprehend that the difference betweene us lyes in limiting the aperture of the Eye-glass. M^{r}. Gregory puts it equall to that of the little Concave, but I should rather determine it by this proportion; That if a midle point be taken between the Eye-glass and its focus, the apertures of the Eye-glasse and concave be proportionall to their distances from that point. That is, suppose AB the little concave, EF the eye-glass, GH their common focus or image, and K the meane distance between GH and EF; from the Extremitys of AB draw AK and BK butting on the Eye-Glass at F and E, and EF shall be its aperture. The reason of this limitation is, that the superfluous light, which comes on all sides of the speculum AB to the space GH in which the picture of the object is made, may fall besides the Eye-glass. For if it should passe through it to the Eye, it would exceedingly blend those parts of the picture with which ti's mixed; and such are those parts of it which extend themselves beyond the lines AK, BK. As I remember I said in my former letter that the scattering light which falls on the Eye-glass will disturb the vision; and this is to be understood of any straggling light which comes not from the picture; but if it come from the picture to the Eye-glass, the disturbance will be much greater so as not to be allowed of. Against the first I see no very convenient remedy, & against the last none but assigning a small aperture to the Eye-glasse; supposing the Telescope is used in the day-time or in twy-light, or to view the moon or any starr very near her or near the brighter planets. And if for this reason the aperture be limited by **{**m**}{**an**}**y rule, the Angle of vision will become very small as I affirmed; for instance in that case where M^{r}. Gregory in his Postscript puts it above 20 degrees, it will be reduced to lesse then halfe a <46ar> degree. Yet I confesse there is a way by which the angle of vision may be somthing inlarged, but it will not be very considerably, unless the Eye-glasse be also deeper charged.



Why I assign a concave with an Eye-glass to magnifie small objects (in Transact: pag. 3080.) and yet an Eye-glass without such a concave to magnifie the image of the great concave which is equivalent to a small object, is, because that image doth not require to be magnified so much as an object by a microscope, and further because the Angle of the penicill of rays which flow from any point of the small object, that the object may appear sufficiently luminous, ought to be as great as possible; and a concave will with equall distinctnesse reflect the rays at a greater angle of the penicill then in a Lens; but in the Telescope the Angles of those penicills are not so great as to transcend the limits at which an Eye-glasse may with suf**{**fi**}**cient distinctnesse refract them, and therefore in these Instruments I chose to lay all the stress of magnifying upon the Eye-glasses as it is well capable of, and the excesse only upon the concave.

Concerning my citation of M^{r}. Gregory against Mons Cassegrain the force of it lies only in the inference that Optique instruments most probably according to Mons Cassegrains design had been tryed by reflexion; which I thinke I might well inferr, without haveing regard to the specifick figure of the speculum which M^{r}. Gregory there spake of. And therefore I think it cannot be said, that I made him speake of spherick figures where his meaning was of hyperbolick and Elliptick ones: but if I should be so understood, because I put the figure <46av> of the great concave to be sphericall wherever I specifie it, I know not why I might not by way of consequence make that interpretation. For it is not probable, that any man would attempt Hyperbolick & Elliptick figures of speculums untill the event of sphericall ones had been first tryed.

And accordingly the tryall of M^{r}. Gregory with M^{r}. Reive was by a sphericall figure. Which trial although I am now satisfyed that it was made very rudely, yet by the information which I had of it when I wrote the letter # # about M. Cassegrains designe, I apprehended it to have beene made with great diligence and curiosity, as I signified in my former letter at large. And this I hope may excuse me for speakeing of it in the Transactions as if it had beene tryed with more accuracy then really it was. And thus much concerning the Telescope.

The design of the burning speculum appears to me very plausible and worthy of being put in practise: what Artists may thinke of it I know not, but the greatest difficultie in the practise that occurrs to me is to proportion the two surfaces so, that the force of both may be in the same point according to the Theory. But

perhaps it is not necessary to be so curious, for it seems to me that the effect would scarce be sensibly less if both sides should be ground to the concave and gage of the same tool. And this all at present from

Sir

Your humble servant

I Newton