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Gregory on the sun illusion

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"Some people are surprised that the sun looks larger at the horizon even though its observed diameter is actually smaller when viewed with an astronomical instrument. It is obvious why the observed diameter is usually smaller near the horizon than at a higher position in the sky: as every astronomer knows, the cause is refraction, which is greater for the lower than for the upper margin (*limbus*) of the sun[1]. However, what we shall try to explain here is why, in that case, it should look larger to us. The basic premise is that the perceptual faculty (*sensus communis*) judges the size of a visible object in the same way as do geometers, namely from a knowledge of its distance and of its visual angle. Hence, provided other factors are constant,

Figure 1. The oblate appearance of the rising sun. Grantchester, 4.50 a m, 28 May 1974. The valley of the Granta, lying between the observer and the horizon, was filled with a heavy layer of mist. A Wratten 59 filter has been used to preserve the contrast of the Ektachrome original.

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[1] The fact and the explanation are correct: v Scheiner C, 1617 *Refractiones coelestes, sive solis elliptici phaenomenon illustratum* (Ingolstadt); O'Connell D J K, 1958 "The green flash and other low sun phenomena" *Ricerche Astronomiche, Specola Astronomica Vaticana* 4 1–192; and figure 1 of the present paper.

GEOMETRIÆ
PARS VNIVERSALIS,
Inſerviens

Quantitatum Curvarum tranſmutationi & menſuræ.

AVTHORE

IACOBO GREGORIO
ABREDONENSI
SCOTO.

PATAVII, MDCLXVIII.

Typis Heredum Pauli Frambotti, *Superiorum Perm.*
CVM PRIVILEGIO.

DE SOLIS HVMILIS ET SVBLIMIS magnitudine apparente.

ADmirantur nonnulli Solem humilem maiorem apparere etiamsi instrumento astronomico observatus, e contra minor sit eius diameter apparens: quare minor plerumque sit eius diameter apparens prope horizontem quam in loco cœli elevatiore causa in promptu est, quę à nullo astronomo ignoratur, nempe refractio quæ maior est inferioris limbi quam superioris; sed quare tunc nobis maior appareat conabimur hic explicare. Primo itaque sciendum est sensum communem iudicare de visibilis magnitudine, sicuti faciunt geometræ, nempe ex cognitis distantia & angulo visorio, & ideo quo maiorem percipit sensus communis visibilis distantiam, eo cæteris paribus maiorem iudicat visibilis magnitudinem; sed dum Sol existit prope horizontem, iudicat sensus communis maiorem esse solis distantiam quam in loco Cœli elevatiore ob multa corpora interiecta; & ideo prope horizontem iudicat etiam eius magnitudinem maiorem quam alibi, vbi corpora interiecta non videntur, & proinde de eius magna distantia iudicare non potest. Aliquando tamen ob nubes conuexas inter nos & solem interiectas apparet Sol etiam instrumento observatus, multo maior quam ordinario videtur, atque hoc euenit etiam quando Sol est sublimis, sed sæpius quando est humilis ob maiorem nubium frequentium. quæ hic diximus de Sole eodem modo intelliguntur de reliquis corporibus cælestibus.

Figure 2. Left: title-page of Gregory's *Geometriae Pars Universalis.* Above: text of the passage "On the apparent size of the horizon and zenith sun". Most of the book is devoted to a systematic introduction to the calculus; the passage translated here occurs in an appendix.

the greater the perceptual faculty conceives the distance of the object to be, the greater it judges the size of the object. But, when the sun lies near the horizon, the perceptual faculty judges its distance to be greater than in a more elevated part of the sky, because of the many intervening objects. Therefore the perceptual faculty judges the sun's size, also, to be larger near the horizon than in other positions, where no intervening objects are seen and where therefore its great distance cannot be appreciated. Sometimes, however, owing to the arching (*convexas*) clouds interposed between us and the sun, the sun looks much bigger than usual, even when observed with an instrument. This happens even when the sun is high, but more often when it is low because of the greater frequency[2] of clouds. These remarks about the sun apply in the same way to the other celestial bodies."

J Gregory, 1668
Geometriae Pars Universalis
Padua pp 141-142

James Gregory, member of a family that has held fourteen British chairs[3], celebrated for his reflecting telescope and for his contributions to the calculus and considered in his day second only to Newton, died at the age of thirty-seven in 1675.

[2] By *frequentium* Gregory most probably refers to number of clouds within a given visual angle. Alternatively, he is possibly referring to a supposed diurnal variation in the frequency or kind of clouds; but, insofar as there is any general rule at all, it would seem contrary to his hypothesis: cumulus clouds are most common in the afternoon in most areas (Humphreys W J, 1940 *Physics of the Air* New York: McGraw-Hill). One possibility is that this passage refers not to a perceptual effect but to the apparent elongations of the diameter of the sun sometimes produced physically by layers of atmospheric discontinuity (v Scheiner C, 1617 p 58; O'Connell D J K, 1958 p 23, p 101 ff); this last interpretation is suggested by the phrase "etiam instrumento observatus".
[3] Grainger Stewart A, 1901 *The Academic Gregories* (Edinburgh: Oliphant, Anderson and Ferrier). The family is descended from the Macgregors of Roro and the nativist reader will be interested to note that it includes the Editor of this journal.