446 MEMORANDA BY DAVID GREGORY
5, 6, 7 MAY 1694
From the original[1] in the Library of the Royal Society of London

44. Adnotata Phys: Math: et Theol: ex Neutono. 5. 6. 7. Maij 1694.[2] .

[44]   Cantabrigiæ 5. 6. 7. Maij 1694.

Continuo opus esse miraculo ne Sol et fixæ per gravitatem coeant. Magnam in Cometis excentricitatem et ad diversas et contrarias partes cum planetis divinam denotare manum, ac Cometas ad alium (a planetis) usum destinatos arguunt. Possunt satellites Jovis et Saturni in locum succedere ☿, ♀, ♂ destructorum, et ad novam Creationem reservari. Mars multo minor quam vulgo ponitur. id evincitur ex inde quod, in situ Achronychio multo minus lucidus quam ♃ non obstante majore distantia tum a Sole illustrante tum a ☿ vidente. Observationes Flamstedij cum Tychonis[3] et Longomontani[4] observationibus comparatæ ostendunt mutuam attractionem ♃ et ♄ in conjunctione proxime preterita 1683.

Si Corpus quodvis in orbita PQ revolvat viribus ad S tendentibus, vis qua tendit ad S est ad vim qua tendit ad R eodem tempore periodico ut $SP \times RP^2$ ad PT^3 posita ST parallela ad tangentem APB. demonstratur non ita difficilè.[5] Examinetur hoc theorema transferendo vim a Centro ellipsis ad focum, ab uno foco ad alium, a Centro circuli ad punctum infinite distans.
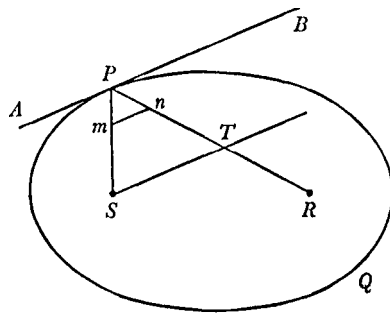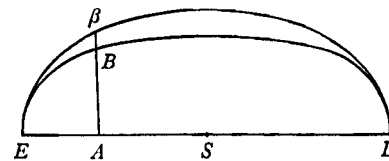

Fig. 1   Fig. 2

Si Ordinatæ AB proportionaliter augeantur ubiquæ fiantque $A\beta$ ex data vi ad S in orbita EBD, dabitur vis ad idem S in orbita EBD, etiam dato quocunque angulo applicationis $EA\beta$ diverso ab EAB. Hinc a[b] Equabili vi ad circuli Centrum transibitur ad vim ad Ellipseos Centrum. hic est facillimus modus pro Motu planetarum in Sectionibus Conicis.[6] Talem tractatum habet Newtonus.[7]

In curvis considerandæ omnes conjugatæ (quæ pro una eademque habendæ) Cycloidis Conjugatæ infinite sunt, primariæ in hunc modum ⌒⌒⌒, protractæ in hunc modum ⌒⌒⌒⌒, con-
tractæ in hunc ⌒⌒⌒⌒. Nulla enim est suppositio quæ rotam describentem sistat. Quadratricis item infinitæ sunt conjugatæ. Nam punctum Q est intersectio rectæ δq progredientis ab A et rectæ AD progredientis a B cum velocitatibus ut AC et arcus quad-rantalis BC. Nec ulla est suppositio quæ sistat hunc motum cum $\delta\delta$ et D ad primum C pervenerint et continuato motu in infinitum producuntur infinitæ conjugatæ. Quod si Catenariæ productio per motum esset nota, infinitæ conjugatæ innotescerent. Hinc harum Curvarum ad æquationes constru-endas vires.

Fig. 3

Virtus[8] magnetica per flammam interrumpitur, per Calorem inter-rumpitur; virga ferrea, vel diuturno situ perpendiculari, vel frigescendo in situ erecto, virtutem Magneticam acquivit a Terra. Sed etiam Mallei ictu forti ad alterum extremum magneticam Virtutem concipit: si fortiter feriatur ad alterum extremum, poli virgæ ferreæ permutantur: si fortiter in medio percutiatur (puta Malleo ad incudem) magnetismum prorsus amittit. Unde Mechanice produci videtur hæc virtus.

Sulci in limatura ferro Magneti circumposita, non fiunt ab effluviis sed quod ipsa ramenta limaturæ, magnetice excitata, se secundum longitudinem et per polos disponant.

Ang Reflectionis est plerumque non semper, æqualis angulo incidentiæ. prima de Coloribus experimenta instituit et primo theoriam Condidit dum Senior Sophista vel Baccalaureus artium esset, professor Lucasianus est factus dum Magister in Artibus esset per duos Annos.[9]

Cantabrigiæ 5 6 7 Maij. 1694

Duo aut 3 habet folia quibus proprietates coni sectionum (quatenus sint Orbitæ planetorum vel Cometarum) facillime ex facilibus prop: Generalibus deducuntur.

Congruentiam Hujus philosophiæ cum veterum precipue Thaletis philo-sophia fuse est ostensurus.[10] Epicuri et Lucretij philosophia est vera et antiqua, perperam ab illis ad Atheismum detorta. Problema de semita projecti dum resistentia est in duplicata velocitatis ratione Novit. Quæ de

335

luna facturus est die 4 scripsi.[11] Tractatum Conscripsit de Originatione gentium. Religio Omni tempore eadem, sed quam a Noha primisque hominibus puram acceperunt, Ethnici inventis propriis deturparunt; Unde Moses reformationem instituit retentis adiaphoris Egyptiacis (Ægypti fuere qui omnium maxime religionem superstitione deturparunt et ab illis in reliquas gentes fluxit). Christus Mosis Religionem reformavit.

Ex nominibus planetarum a Thoth (Mercurio Ægyptiaco) [datis] (nomina vero indidit predecessorum quos deos credi volebat) patet eum Copernicani Systematis Cultorem. Diversi Saturni, Joves &c (quæque enim Natio suos fundatores et reges pro diis colebat) Confusionem pariunt. Sectionem IV et V cum Quadraturis Curvarum tractatu[12] (quem vidi) 3 aut 4 foliorum (si ab utraque parte scriberetur) simul in uno libello at post principia editurus est.[13] Tractatus de Quadraturis, istam rem mire et ultra quam credi facile potest promovet, per series abrumpentes[14] procedit. Cum simplicissimis Comparat. Vidi etiam Three Books of Opticks. si imprimeretur princ Math: adæquaret. Catoptrica et Dioptrica, Nostra fere Methodo[15] ast Compendiose et Eleganter prosequitur. De Coloribus Mira et inaudita profert. Hæc editurus est post Academiam abdicatam intra 5 annos. si dum in Academia, in latinum versa quam operam æque ferret. De Coloribus Rerum Naturalium Schedulam Regiæ Societati obtulit. Tractatus hic absolutus est, de quadam Colorum specie et modo producendi nondum plene satisfactus. Sed prior pars satisfaciet. Radius lucis paraxysmos reflectendi aut refringendi habent et quidem incertos. Omnis Colorum varietas in Corporibus naturalibus est a magnitudine particularum sive attomorum componentium. Nihil coloratum cujus attomi non sunt pellucidi, Nigrorum attomi sunt Minimi. Tabula in aere aqua et vitro definitur attomorum horum magnitudo. Bullis Aqueis puerilibus experimenta facta, in aere distantia inter lentem convexam et planam, in vitro ex analogia.[16]

Ad Religionem non requiritur Status animæ separatus sed resurrectio cum memoria continuata.

Translation

[44]   *Cambridge 5, 6, 7 May 1694*

Annotations Physical, Mathematical and Theological from Newton. 5, 6, 7 May 1694. [Newton says] that a continual miracle is needed to prevent the Sun and the fixed stars from rushing together through gravity: that the great eccentricity in Comets in directions both different from and contrary to the planets indicates a divine hand: and implies that the Comets are destined for a use other than that of the planets. The Satellites of Jupiter and Saturn can take the places of the Earth, Venus, Mars if they are destroyed, and be held in reserve for a new Creation. Mars is much smaller than is commonly

supposed. This is proved from the fact that when it rises in the evening it is much less brilliant than Jupiter notwithstanding the greater distance both from the Sun that illumines it and from the Earth that views it. Flamsteed's observations when compared with those of Tycho [3] and Longomontanus [4] prove the mutual attraction of Jupiter and Saturn in their most recent past conjunction in 1683.

If any body revolve in an orbit PQ with forces tending to S, the force which tends to S is to the force which tends to R in the same periodic time as $SP \times RP^2$ to PT^3, supposing ST to be parallel to the tangent APB. The proof is not so difficult. [5] Let this theorem be examined by transferring the force from the centre of the ellipse to a focus, from one focus to the other, [or] from the centre of a circle to an infinitely distant point.
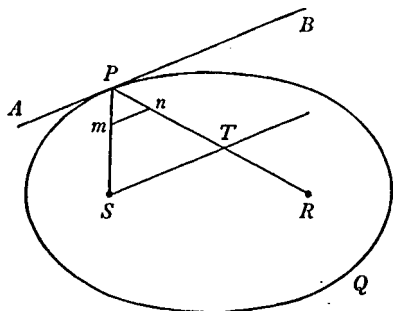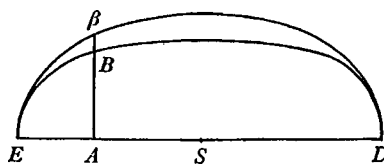

Fig. 1   Fig. 2

If ordinates AB be increased proportionally everywhere and become $A\beta$, from a given force towards S in the orbit EBD will be given a force towards the same S in the orbit $E\beta D$ even when the angle of application however given for $E\beta D$ differs from that for EBD. [6] Hence there will be a transformation from a constant force towards the centre of a circle to a force towards the centre of an ellipse. This is the easiest way for the motion of the planets in conic sections. Newton has such a tract. [7]

Among curves all conjugates are to be considered (and it is to be reckoned as one and the same curve): of cycloids there are an infinity of conjugates, the primary like this ⌒⌒⌒⌒, the extended like this ⋀⋀⋀⋀, and the contracted like ⌒⌒⌒⌒. For there is no limitation imposed upon the wheel that describes the curve. The conjugates of the quadratrix also are infinite in number. For the point Q is the intersection of the right line δq progressing from A and the right line AD progressing from B with velocities as AC and as the quadrantal arc BC. And there is not any other supposition that may be imposed on this motion when δ and D have arrived [together] at the first C, and by continuing the motion indefinitely an infinite number of conjugates are produced. But if the generation of a
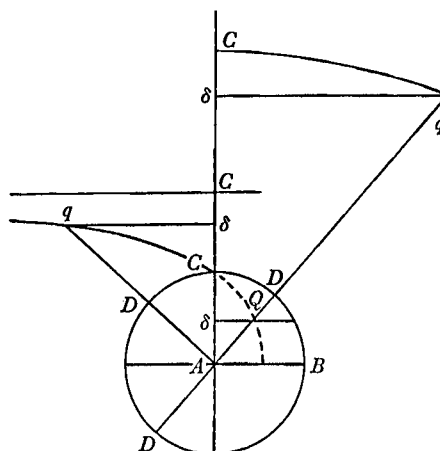

Fig. 3

catenary through motion were known an infinite number of conjugates would be recognized. Hence the power of these curves for constructing equations.

Magnetic virtue [8] is destroyed by a flame, and by heat: a rod of iron, either by standing long in a perpendicular position, or by cooling in an erect position, acquires magnetic virtue from the Earth. But it gets magnetic virtue too with a strong blow of a hammer at either extremity. If it is struck hard at one or other end the poles of the iron rod are interchanged: if it is struck in the middle (say with hammering at an anvil) it quite loses its magnetism. And so this virtue seems to be produced by mechanical means.

Furrows among filings placed around an iron magnet are not made by effluvia but because the bits of the filings are themselves magnetically excited and arrange themselves longitudinally and through the poles.

The angle of reflexion, though generally, is not always equal to the angle of incidence. He began his first experiments on colours and first established the theory while he was Senior Sophist or Bachelor of Arts. He was made Lucasian Professor after being Master of Arts for two years. [9]

Cambridge 5, 6, 7 May 1694

He has two or three sheets in which the properties of conic sections (in so far as they form the orbits of planets and of comets) are very easily deduced from easy general propositions.

He will spread himself in exhibiting the agreement of this philosophy with that of the Ancients and principally with that of Thales. [10] The philosophy of Epicurus and Lucretius is true and old, but was wrongly interpreted by the ancients as atheism. He [Newton] knows the problem of the path of a projectile when the resistance is in the duplicate ratio of the velocity. What he intends to do about the Moon I wrote down on the 4th. [11] He has composed a tract on the origin of nations. Religion is the same at all times, but religion which they received pure from Noah and the first men, the nations debased by their own inventions. Moses began a reformation but retained the indifferent elements of the Egyptians (it was the Egyptians who most of all debased religion with superstition and from them it spread to the other peoples). Christ reformed the religion of Moses.

It is clear from the names of the planets given by Thoth (the Egyptian Mercury)— he gave them, in fact, the names of his predecessors whom he wished to be accepted as gods—that he was a believer in the Copernican system. Various Saturns, Joves etc. (for each nation worshipped its own founders and kings as gods) beget confusion. He intends to publish Sections IV and V with the Quadratures of Curves, a tract (which I have seen) of three or four sheets (if it were written on both sides) together in one small book [12]— but after publishing the *Principia*. [13] The tract on Quadratures—he develops that matter astonishingly and beyond what can readily be believed—proceeds by means of terminating [14] series (series that break off). He compares them with the simplest.

I also saw 'Three Books of Opticks': if it were printed it would rival the *Principia Mathematica*. He pursues Catoptrics and Dioptrics almost by my method, [15] concisely

338

and with elegance. He sets forth unheard-of wonders about colours. These he intends to publish within five years after retiring from the University. If [they are published] while [he is still] at the University [they will be] translated into Latin, a work which he would undertake with equanimity. He has offered a small paper on the Colours of natural objects to the Royal Society. This tract is complete, though not yet to his full satisfaction about some aspect of colours and about the way to produce them. But the earlier part will satisfy him. A ray of light has paroxysms of reflexion or refraction, and indeterminate ones at that. All variety of colours in natural bodies arises from the size of the component particles or atoms. Nothing is coloured of which atoms are not transparent: atoms of black things are the smallest. The size of these atoms in air, water and glass is defined in a table. He has made experiments with children's bubbles, by the distance between a convex and a plane lens, in air, and analogously, in glass.[16]

Not a separate existence of the soul, but a resurrection with a continuation of memory is the requirement of religion.

NOTES

(1) R.S. Greg. MS. fos. 68, 69 (=U.L.E. Greg C 44).

(2) The title is taken from Gregory's Index to Folio C (U.L.E.).

(3) Tycho Brahe (1546–1601).

(4) Christian Longomontanus (1562–1647), born in Denmark, was mathematician and astronomer; he collaborated with Tycho Brahe for eight years, giving good service with his observations and calculations. From 1605 he was Professor of Mathematics at Copenhagen.

(5) See Memoranda 441, 12°, p. 312. The points R and S are any given points within the orbit.

(6) This property is proved by Horsley (II, 67).

(7) No such treatise has been found.

(8) Newton uses this term 'magnetic virtue' in the *Opticks*.

(9) Newton graduated as Bachelor of Arts in January 1664/5; he became Master of Arts in March 1667/8; and was appointed Lucasian Professor in the autumn of 1669.

(10) There is an autograph manuscript by Newton containing nine sheets devoted to this subject, in the Library of the Royal Society (R.S. Greg. MS. fos. 6–14v). Newton, it would appear, handed it over to David Gregory either as a gift or a loan, for there is a copy of it, in Gregory's hand, at the end of his manuscript book 'Notæ Principiorum' (the book was written throughout a period ending in 1697: see note (14), p. 338); and it is printed in part in the preface to Gregory's *Astronomiæ Physicæ et Geometricæ Elementa* (1702), although there is no mention of Newton there.

The manuscript is cast in a form that suggests that Newton intended it as a commentary upon Propositions 4–9 of the third book of the *Principia*. It ends with three paragraphs, the first and third of which appear to be an early draft of the general Scholium at the end of the second edition of the *Principia* (1713), while the second paragraph formed the substance of a passage which is found only in the third edition (1726). See the notice of the manuscript by Dr James Craufurd Gregory (*Transactions of the Royal Society of Edinburgh*, 12 (1834), 64–76).

(11) See Memoranda 441, sections 18–20.

(12) *Principia*, Book I, sections IV and V (see Memoranda 441, section 26, and 461 at reference (3), p. 384). The *De Quadratura* was first published with the *Opticks* in 1704 as one of two appendices, the other being the *Enumeratio*.

(13) See Memoranda 461 for particulars of the projected second edition.

(14) Cf. Letter 374, note (5), p. 179.

(15) See vol. II, note (1), p. 397.

(16) The renewed interest of Wallis and others in Newton's still unpublished optical work may well have been the sequel to what Gregory told them of these conversations with Newton. The following extract is taken from the Journal Book of the Royal Society, 1694: 'July 4, 1694. Ordered that a Letter be written to Mr Isaac Newton, praying that he will please to Communicate to the Society in order to be Published his Treatise of Light and Colours, and what other Mathematicall or Physicall Treatises he has ready by him.' Presumably he would derive the size of atoms in water from bubbles and their size in air from Newton's rings.

447 MEMORANDA BY DAVID GREGORY
[? MAY 1694]
From the original [1] in the Library of the Royal Society of London

$$\boxed{45}$$

Problema.
Invenire circulum equicurvum cum Sectione Conica
ad datum punctum.

Ut circulus *APG* eandem habeat Curvaturam cum Sectione Conica ad datum punctum *A*, patet primo circuli diametrum eandem esse debere quoad positionem cum recta *AG* curvæ (sive rectæ *AT* tangenti curvam) ad *A* perpendiculari, et preterea oportere *BC* ordinatam in circulo equalem [2] esse *BD* eadem ordinatæ ad Conisectionem productæ. Sed

$$BCq = GB \times BA = GA \times BA - BAq = (\text{evanescente } BAq \text{ ob } AB \text{ minimam})$$
$$GA \times BA.$$

Rursus $BDq = DEq$ (evanescente quippe *AB* evanescit et *EB* huic in data ratione) $= AE \times R$ (*R* est latus rectum ad diametrum *AK* pertinens) [3]

$$\pm \frac{AE \times R}{KA} \times AE$$

hoc est $AE \times R \mp \dfrac{R \times AEq}{KA}$ (est quippe $-\dfrac{R \times AEq}{KA}$ in ellipsi, $+\dfrac{R \times AEq}{KA}$ in