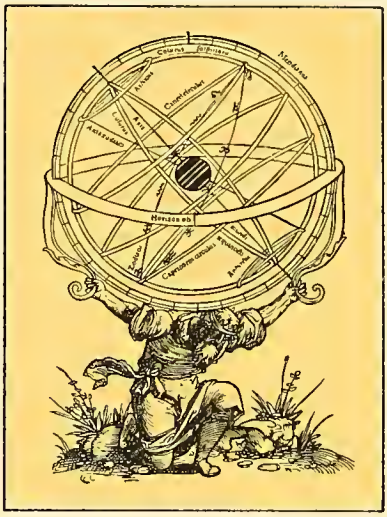

A SYNOPSIS OF THE ASTRONOMY OF COMETS.

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A

SYNOPSIS

OF THE

Aſtronomy of *Comets.*

THE ancient *Egyptians* and *Chaldeans* (if we may credit *Diodorus Siculus*) by a long Courſe of Obſervations, were able to predict the *Apparitions* of Comets. But ſince they are alſo ſaid, by the Help of the ſame Arts, to have prognoſticated Earthquakes and Tempeſts, 'tis paſt all Doubt, that their Knowledge in theſe Matters, was the Reſult rather of meer *Aſtrological Calculation*, than of any *Aſtronomical Theories* of the Cœleſtial Motions. And the *Greeks*, who were the Conquerors of both thoſe People, ſcarce found any other ſort of Learning amongſt them, than this. So that 'tis to the *Greeks* themſelves as the Inventors (and eſpecially to the Great *Hipparchus*) that we owe this *Aſtronomy*, which is now improv'd to ſuch a Heigth. But yet, amongſt theſe, the Opinion of *Ariſtotle* (who wou'd have Comets to be nothing elſe, but Sublunary Vapours, or Airy Meteors)

prevail'd ſo far, that this moſt difficult Part of the Aſtronomical Science lay altogether neglected; for no Body thought it worth while to take Notice of, or write about, the Wandring uncertain Motions of what they eſteemed Vapours floating in the *Æther*; whence it came to paſs, that nothing certain, concerning the Motion of Comets, can be found tranſmitted from them to us.

But *Seneca* the *Philoſopher*, having conſider'd the *Phænomena* of Two remarkable Comets of his Time, made no Scruple to place them amongſt the *Cœleſtial* Bodies; believing them to be *Stars* of equal Duration with the World, tho' he owns their Motions to be govern'd by Laws not as then known or found out. And at laſt (which was no untrue or vain Prediction) he foretells, that there ſhould be Ages ſometime hereafter, to whom Time and Diligence ſhou'd unfold all theſe Myſteries, and who ſhou'd wonder that the Ancients cou'd be ignorant of them, after ſome lucky Interpreter of Nature had ſhewn, *in what Parts of the Heavens the Comets wander'd, what, and how great they were.* Yet almoſt all the Aſtronomers differ'd from this Opinion of *Seneca*; neither did *Seneca* himſelf think fit to ſet down thoſe *Phænomena* of the Motion, by which he was enabled to maintain his Opinion: Nor the *Times* of thoſe Appearances, which might be of uſe to Poſterity, in order to the Determining theſe Things. And indeed, upon the Turning over very many Hiſtories of Comets, I find nothing at all that can be of Service in this Affair, before, *A. D.* 1337. at which time *Nicephorus Gregoras*, a *Conſtantinopolitan Hiſtorian* and *Aſtronomer*, did pretty

pretty accurately deſcribe the *Path* of a Comet amongſt the Fix'd Stars, but was too laxe as to the Account of the *Time*; ſo that this moſt doubtful and uncertain Comet, only deſerves to be inſerted in our Catalogue, for the ſake of its appearing near 400 Years ago.

Then the next of our Comets was in the Year 1472, which being the ſwifteſt of all, and neareſt to the Earth, was obſerv'd by *Regiomantanus*. This Comet (ſo frightful upon the Account both of the Magnitude of its Body, and the Tail) mov'd Forty Degrees of a great Circle in the Heavens, in the Space of one Day; and was the firſt, of which any proper Obſervations are come down to us. But all thoſe that conſider'd Comets, until the Time of *Tycho Brahe* (that great Reſtorer of Aſtronomy) believ'd them to be below the Moon, and ſo took but little Notice of them, reckoning them no other than Vapours.

But in the Year 1577, (*Tycho* ſeriouſly purſuing the Study of the Stars, and having gotten large Inſtruments for the Performing Cœleſtial Menſurations, with far greater Care and Certainty, than the Ancients cou'd ever hope for) there appear'd a very remarkable Comet; to the Obſervation of which, *Tycho* vigorouſly applied himſelf; and found by many juſt and faithful Trials, that it had not a *Diurnal Parallax* that was at all perceptible: And conſequently was not only no Aireal Vapour, but alſo much higher than the Moon; nay, might be plac'd amongſt the Planets for any thing that appear'd to the Contrary; the cavilling Oppoſition made by ſome of the

School-men in the mean time, being to no Purpose.

Next to *Ticho*, came the Sagacious *Kepler*. He having the Advantage of *Ticho*'s Labours and Observations, found out the *true Physical* System of the World, and vastly improv'd the Astronomical Science.

For he demonstrated that all the Planets perform their Revolutions in *Elliptick Orbits, whose Plains pass thro' the Center of the Sun*, observing this Law, That the *Area's (of the Elliptick Sectors, taken at the Center of the Sun, which he proved to be in the common Focus of these Ellipses) are always proportional to the Times, in which the correspondent Elliptical Arches are describ'd.* He discover'd also, That *the Distances of the Planets from the Sun are in the* Sesquialtera Ratio *of the Periodical Times*, or (which is all one) That *the Cubes of the Distances are as the Squares of the Times.* This great Astronomer had the Opportunity of observing Two Comets, one of which was a very remarkable one. And from the Observations of these (which afforded sufficient Indications of an *Annual Parallax*) he concluded, That *the Comets mov'd freely thro' the Planetary Orbs, with a Motion not much different from a Rectilinear one; but of what Kind he cou'd not then precisely determine.* Next, *Hevelius* (a Noble Emulator of *Ticho Brahe*) following in *Kepler*'s Steps, embraced the same Hypothesis of the *Rectilinear Motion of Comets*, himself accurately observing many of them. Yet, he complain'd, that his Calculations did not perfectly agree to the Matter of Fact in the Heavens: And was aware, that *the Path of a Comet was bent into a Curve Line towards the Sun.*

Sun. At length, came that prodigious Comet of the Year 1680. which descending (as it were) from an infinite Distance *Perpendicularly* towards the Sun, arose from him again with as great a Velocity.

This Comet, (which was seen for Four Months continually) by the very remarkable and peculiar Curvity of its Orbit (above all others) gave the fittest Occasion for investigating the *Theory of the Motion.* And the *Royal Observatories* at *Paris* and *Greenwich* having been for some time founded, and committed to the Care of most *excellent Astronomers*, the *apparent* Motion of this Comet was most accurately (perhaps as far as Humane Skill cou'd go) observ'd by Mrs. *Cassini* and *Flamsteed.*

Not long after, that *Great Geometrician*, the *Illustrious Newton*, writing his *Mathematical Principles of Natural Philosophy*, demonstrated not only that what *Kepler* had found, did necessarily obtain in the *Planetary System*; but also, that all the *Phænomena* of Comets wou'd naturally follow from the same Principles; which he abundantly illustrated by the Example of the aforesaid Comet of the Year 1680. shewing, at the same time, a Method of Delineating the Orbits of Comets Geometrically; wherein he (not without the highest Admiration of all Men) solv'd a Problem, whose Intricacy render'd it worthy of himself. This Comet he prov'd to move round the Sun in a Parabolical Orb, and to describe Area's (taken at the Center of the Sun) proportional to the Times.

Where-

Wherefore (following the Steps of ſo *Great a Man*) I have attempted to bring the ſame Method to *Arithmetical Calculation*; and that with deſired Succeſs. For, having collected all the Obſervations of Comets I could, I fram'd this Table, the Reſult of a prodigious deal of Calculation, which, tho' but ſmall in Bulk, will be no unacceptable Preſent to Aſtronomers. For theſe Numbers are capable of Repreſenting all that has been yet obſerv'd about the Motion of Comets, by the Help only of the following *General Table*; in the making of which I ſpar'd no Labour, that it might come forth perfect, as a Thing conſecrated to Poſterity, and to laſt as long as *Aſtronomy* it ſelf.

The

The Astronomical Elements of the Motions in a Parabolick Orb of all the Comets that have been hitherto duly observ'd.

Comet. An	Nodus Ascend.	Inclin. Orbitæ.	Perihelion.	Dist. an. Perihel. à Sole.	Log. Dist. Perihelia à Sole.	Temp equat. Perihelii.	Perihelion à Nodo.	
	gr. ′ ″	gr. ′ ″	gr. ′ ″			d. h. ′	gr. ′ ″	
1337	♊ 24.21. 0	32.11. 0	♂ 7.59. 0	40666	9.609236	June 2. 6.25	46.22. 0	Retrog.
1472	♍ 11 46.20	5.20. 0	♂ 15.33.30	54273	9.734584	Feb. 28.22.23	123.47.10	Retrog.
1531	♂ 19 25. 0	17.56. 0	♒ 1.39. 0	56700	9.753583	Aug. 24.21.18½	107.46. 0	Retrog.
1532	♊ 20.27. 0	12.36. 0	♋ 21. 7. 0	50910	9.706803	Oct. 19 22.12	30.40. 0	Direct.
1556	♍ 25.42. 0	32. 6.30	♍ 8.50. 0	.46390	9.666424	Apr. 21.20. 3	103. 8. 0	Direct
1577	♈ 25.52. 0	74 32.45	♎ 9.22. 0	18342	9.263447	Oct. 26.18 45	103 30. 0	Retrog.
1580	♈ 18.57.20	54.40. 0	♋ 19. 5.50	59628	9.775450	Nov 28 15.00	90. 8.30	Direct.
1585	♂ 7 42 30	6 4. 0	♈ 8 51. 0	109358	0.038850	Sept. 27.19.20	28.51.30	Direct
1590	♍ 15.30.40	29.40.40	♏ 6.54.30	57661	9.760882	Jun. 29. 3 45	51.23.50	Retrog
1596	♒ 12.12 30	55.12. 0	♏ 18.16. 0	51293	9.710058	Juli 31.19.55	83.56.30	Retrog
1607	♂ 20.21. 0	17. 2. 0	♒ 2.16. 0	58680	9.768490	Oct. 16. 3.50	108.05. 0	Retrog
1618	♊ 16. 1. 0	37 34 0	♈ 2.14. 0	37975	9.579498	Oct. 29.12 23	72.47. 0	Direct.
165	♊ 28.10. 0	79.28. 0	♈ 28.18 40	84750	9.928140	Nov. 2.15.40	59.51.20	Direct.
1661	♊ 22.30.30	32.35.50	♑ 25.58.40	44851	9.651772	Jan. 16 23 41	33.28.10	Direct.
1664	♊ 21.14. 0	21.18.30	♌ 10.41.25	102575½	0.011044	Nov 24.11.52	49.27 25	Retrog
1665	♏ 18.02. 0	76.05. 0	♊ 11 54.30	10649	9.027309	Apr. 14. 5.15½	156 7.30	Retrog
1672	♍ 27.30.30	83 22.10	♑ 16.59 30	69739	9.843476	Feb. 20. 8.37	109.29. 0	Direct.
1677	♏ 26.49.10	79 03 15	♌ 17.37. 5	28059	9.448072	Apr. 26.00.37½	99.12. 5	Retrog.
1680	♍ 2. 2. 0	60.56. 0	♑ 22 39.30	006121/2	7.787106	Dec. 8.00. 6	9.22.30	Direct.
1689	♂ 21.15.20	17.56. 0	♒ 2.52.45	18328	9.765877	Sept. 4.07.39	108.23 45	Retrog.
1683	♍ 23.23. 0	33.11. 0	♊ 25.29.30	56020	9.748343	Juli 3. 2 50	87.55.30	Retrog
1684	♑ 28.15. 0	55.48.40	♏ 28.52. 0	96015	9.982339	Mai 29.10.16	29 23 00	Direct.
1686	✶ 20. 34.40	11.21.40	♊ 17.00.30	32500	9.511883	Sept. 6.14.33	86.25.50	Direct.
1698	♑ 27.44.10	11 46 0	♈ 00 21.15	69129	9.839660	Oct. 8 16.57	2. 7. 0	Retrog.

This Table needs little Explication, since 'tis plain enough from the Titles, what the Numbers mean. Only it may be observ'd, that the *Perihelium* Distances, are estimated in such Parts, as the Middle Distance of the Earth from the Sun, contains 100000.

A General Table for Calculating the Motions of Comets in a Parabolical Orbit.

Med mot.	Ang. a perihelio.	Logar. pro dist. à Sole.	Mea. mot.	Ang. a perihelio.	Logar. pro dist. à Sole.
o	gr. ′ ″		o	gr. ′ ″	
1	1.31.40	0.000077	31	42.55.06	0.062400
2	3. 3.15	0.000309	32	44. 3.20	0.065838
3	4.34 43	0 000694	33	45.10.29	0.069319
4	6. 6. 0	0.001231	34	46.16.35	0.072839
5	7.37. 1	0.001921	35	47.21.36	0.076396
6	9. 7.43	0.002759	36	48.25.33	0.079984
7	10.38. 2	0.003745	37	49.28.27	0.083600
8	12. 7.54	0.004876	38	50.30.19	0.087244
9	13.37.17	0.006151	39	51.31. 8	0 090910
10	15. 6. 7	0.007564	40	52.30.56	0 094596
11	16.34.20	0.009115	41	53.29.44	0.098300
12	18. 1.54	0.010798	42	54.27.32	0.102019
13	19.28.47	0.012609	43	55.24 21	0.105752
14	20.54.54	0.014550	44	56.20.12	0.109490
15	22.20.14	0.016607	45	57.15. 6	0.113240
16	23.44.44	0.018783	46	58. 9. 3	0.116995
17	25. 8.22	0.021072	47	59. 2. 4	0.120756
18	26.31. 8	0.023470	48	59.54.11	0.124518
19	27.52.55	0.025969	49	60.45.25	0.128278
20	29.13.47	0.028570	50	61.35.45	0.132035
21	30.33.40	0.031263	51	62.25.14	0.135792
22	31.52.32	0.034045	52	63.13.52	0.139544
23	33.10.23	0.036916	53	64. 1.40	0.143291
24	34.27.12	0.039864	54	64.48.38	0.147029
25	35.42.59	0.042892	55	65.34.50	0.150762
26	36.57.41	0.045989	56	66.20 13	0,154482
27	38.11.20	0.049154	57	67.04.50	0.158192
28	39.23.54	0.052382	58	67.48.42	0.161890
29	40.35.23	0.055668	59	68.31.50	0.165578
30	41.45.47	0.059009	60	69.14.16	0.169254

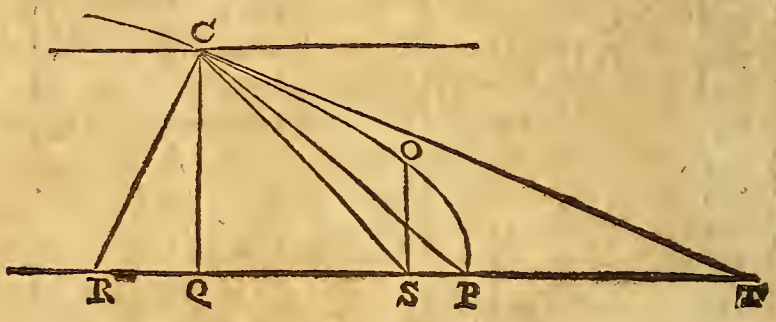
Med. mot.	Angul. à perihelio.	Logar. pro dist. à Sole.	Med. mot.	Ang. à perihelio.	Logar. pro dist. à Sole.
o	gr. ′ ″		o	gr. ′ ″	
61	69.55.58	0.172914	91	86.20.34	0.274176
62	70.36.56	0.176557	92	86.46.20	0.277239
63	71.17.16	0.180188	93	87.11.43	0.280284
64	71.56.56	0.183803	94	87.36.45	0.283306
65	72.35.57	0.187404	95	88.01.27	0.286308
66	73.14.15	0.190978	96	88.25.49	0.289293
67	73.51.59	0.194540	97	88.49.48	0.292252
68	74.29. 6	0.198085	98	89.13.32	0.295201
69	75.05.38	0.201614	99	89.36.54	0.298122
70	75.41.35	0.205122	100	90.00.00	0.301030
71	76.16.56	0.208612	102	90.45.14	0 306782
72	76.51.43	0.212080	104	91.29.18	0.312469
73	77.25.57	0.215529	106	92.12.14	0.318060
74	77.59.41	0.218963	108	92.54. 4	0.323587
75	78.32.54	0 222378	110	93.34.52	0 329042
76	79. 5.35	0.225769	112	94.14 40	0.334424
77	79.37.45	0.229142	114	94.53.30	0.339736
78	80. 9.23	0.232488	116	95.31.22	0.344979
79	80.40.34	0.235809	118	96. 8 22	0.350153
80	81.11.16	0.239127	120	96.44.30	0.355262
81	81.41.31	0.242416	122	97.19.48	0.360306
82	82.11.19	0.245684	124	97.54.17	0.365284
83	82.40.40	0.248933	126	98.28.00	0 370200
84	83. 9.34	0.252159	128	99.00.57	0.375052
85	83.38. 4	0.255366	130	99.33.11	0.379842
86	84. 6. 8	0.258552	132	100. 4.43	0.384576
87	84.33.49	0.261720	134	100.35.45	0 389252
88	85. 1. 5	0.264865	136	101. 5.48	0.393868
89	85.27.58	0.267989	138	101.35.22	0.398428
90	85.54.27	0.271092	140	102. 4.19	0.402930

Med. mot.	Ang. à peribelio.	Logar. pro. dist. à Sole.	Med. mot.	Ang. à peribelio	Logar. pro dist. à Sole.
o	gr. ′ ″		o	gr. ′ ″	
142	102.32.41	0.407380	204	113.37.25	0 523406
144	103.00.31	0.411784	208	114. 9.52	0.529705
146	103.27.47	0.416132	212	114.41.23	0.535886
148	103.54.31	0 420430	216	115.12.02	0.541958
150	104 20.43	0.424676	220	115.41.51	0.547922
152	104.46.22	0.428866	224	116.10.52	0.553782
154	105.11.33	0.433012	228	116.39. 7	0.559538
156	105.36.16	0.437110	232	117. 6.38	0.565199
158	106.00.32	0.441164	236	117.33.27	0.570762
160	106.24.23	0.445178	240	117.59.35	0.576233
162	106.47.47	0.449144	244	118.25. 5	0 581616
164	107.10.44	0 453060	248	118.49.57	0 586912
166	107.33.17	0.456936	252	119.14.14	0.592122
168	107.55.27	0.460772	256	119.37.56	0.597252
170	108.17.14	0.464208	260	120. 1. 6	0 602301
172	108.38.37	0.468318	264	120.23.44	0.607274
174	108.59.39	0.472030	268	120.45.52	0.612174
176	109.20.20	0.475705	272	121. 7.30	0.616998
178	109.40.40	0.479340	276	121.28.39	0.621750
180	110 00.40	0.482937	280	121.49.22	0.626438
182	110.20.20	0.486498	284	122. 9.38	0 631056
184	110.39.41	0.490022	288	122.29.28	0.635608
186	110.58.44	0 493512	292	122 48 54	0.640098
188	111.17.28	0.496965	296	123. 7.57	0 644525
190	111.35.55	0.500384	300	123.26.36	0 648893
192	111.54.05	0.503769	310	124.11.40	0.659559
194	112.11.58	0.507121	320	124.54 36	0.669880
196	112.29.34	0.510441	330	125.35 34	0.679876
198	112.46.55	0.513729	340	126.14.44	0.689568
200	113. 4.00	0.516984	350	126.52 12	0.698970

Med. mot.	Ang. à perihelio.	Logar. pro dist. à Sole.	Med. mot.	Ang. à perihelio	Logar. pro dist. à Sole.
o	gr. ′ ″		o	gr. ′ ″	
360	127.28. 6	0.708104	820	141.49.24	0.970836
370	128. 2.33	0.716976	840	142.10.00	0.978397
380	128.35.38	0.725606	860	142.29.56	0.985771
390	129. 7.27	0.734006	880	142.49.10	0.992970
400	129.38. 4	0.742186	900	143. 7.48	0.100000
410	130. 7.34	0.750160	920	143.25.51	1.006871
420	130.36. 2	0.757930	940	143.43 21	1.013586
430	131. 3.30	0.765516	960	144.00.18	1.020155
440	131.30. 2	0.772918	980	144.16.46	1.026583
450	131.55.41	0.780148	1000	144.32.46	1.032876
460	132.20.30	0.787216	1500	149.26. 8	1.158188
470	132.44.32	0.794122	2000	152.26.15	1.246058
480	133. 7.50	0.800882	2500	154.32.20	1.313703
490	133.30.25	0.807494	3000	156. 7.27	1.368678
500	133.52.20	0.813969	3500	157.22 49	1.414974
520	134.34.18	0.826522	4000	158.24.36	1.454950
540	135.14. 0	0.838600	4500	159 16 36	1 490125
560	135.51.28	0.850187	5000	160. 1 12	1.521521
580	136.27. 6	0.861369	5500	160.40. 5	1.549874
600	137.00.57	0.872155	6000	161.14 24	1.575718
620	137.33.13	0 882575	6500	161.45 00	1 599460
640	138. 3.58	0.892649	7000	162.12.34	1 621417
660	138.33.21	0 902401	7500	162.37.34	1.641838
680	139. 1.29	0.911866	8000	163.00.23	1 660922
700	139.28.25	0.921012	8500	163 21.20	1.678834
720	139.54.16	0.929907	9000	163 40.42	1 695708
740	140.19. 5	0.938549	9500	163.58.38	1 711662
760	140.42.56	0.946951	10000	164.15.20	1.726784
780	141.05.55	0 955124	50000	170.52. 0	2.197960
800	141.28. 3	0.963082	100000	172.45 44	2.399655

The Conſtruction and Uſe of the general Table.

As the Planets move in *Elliptick* Orbs, ſo do the Comets in *Parabolick* ones, having the Sun in their common *Focus*, and deſcribe equal *Area's* in equal *Times*. But now becauſe all *Parabola's* are *ſimilar* to one another, therefore if any determinate Part of the *Area* of a given *Parabola*, be divided into any Number of Parts at Liberty, there will be a *like* Diviſion made in all *Parabola's*, under the ſame Angles, and the Diſtances will be proportional: And conſequently this one Table of ours will ſerve for all Comets. Now, the Manner of the Calculation of this Table is thus: In the *Fig.*



Let S be the *Sun*, POC the Orbit of a Comet, P the *Perihelion*, O the Place where the Comet is 90 *gr.* diſtant from the Sun, C any other Place. Draw the Right Lines CP, CS, and make ST, SR, equal to CS; and then having drawn the Right Lines CR, CT, (whereof the one is a Tangent, and the other a Perpendicular to the Curve) let fall CQ perpendicular to the *Axis* PSR.

Now,

Now, any *Area*, as COPS, being given, 'tis requir'd to find the Angle CSP, and the Distance CS. From the Nature of the *Parabola* RQ is ever $= \frac{1}{2}$ the Parameter of the *Axis*, and consequently if the Parameter be put $= 2$, then RQ $= 1$. Let CQ $= z$; then PQ shall $= \frac{1}{2} zz$, and the Parabolick Segment COP $= \frac{1}{12} zzz$. But the Triangle CSP will $= \frac{1}{4} z$, and so the Mixtilineal *Area* COPS $= \frac{1}{12} z^3 + \frac{1}{4} z = a$, whence $z^3 + 3z = 12a$. Wherefore resolving this Cubical Equation, z or the Ordinate CQ will be known. Now, let the *Area* OPS be propos'd to be divided into 100 Parts; this *Area* is $\frac{1}{12}$ of the Square of the Parameter, and consequently $12a$ is $=$ that Square $= 4$. If therefore the Roots of these Equations $z^3 + 3z = 0,04 : 0,08 : 0,12 : 0,16$, *&c.* be successively extracted, there will be obtain'd so many z or Ordinates CQ respectively, and the *Area* SOP will be divided into 100 Parts. And in like manner is the *Calculus* to be continued beyond the Place O. Now the Root of this Equation (since RQ is $= 1$) is the Tabular Tangent of the Angle CRQ, or $\frac{1}{2}$ the Angle CSP, and so the Angle CSP is given. And RC, the Secant of the same Angle CRQ, is a mean Proportional between RQ or Unity, and RT, which is the Double of SC, as is plain from the *Conicks*. But if SP be put $= 1$, and so the *Latus Rectum* $= 4$ (as in our Table) then RT will be the Distance sought, *viz.* the Double of SC in the former *Parabola*. After this manner therefore, I compos'd the foregoing Table, which serves to represent the Motions of all Comets: For hitherto there has been none observ'd, but comes within the Laws of the *Parabola*.

It

It remains now, that we give the Rules for the Calculation, and ſhew the Way of determining the Place of a Comet ſeen, by theſe Numbers. *The Velocity of a Comet moving in a* Parabola, *is every where to the Velocity of a Planet deſcribing a Circle about the Sun, at the ſame Diſtance from the Sun,* as $\sqrt{2}$ to 1. as appears from *Cor.* 7. *Prop.* 16. *Lib.* 1. of the *Princip. Phil. Nat. Math.* If therefore a Comet in its *Perihelium* were ſuppos'd to be as far diſtant from the Sun as the Earth is, then the Diurnal *Area* which the Comet wou'd deſcribe, wou'd be to the Diurnal *Area* of the Earth, as $\sqrt{2}$ to 1. And conſequently, the Time of the Annual Revolution, is to the Time in which ſuch a Comet wou'd deſcribe a Quadrant of its Orbit from the *Perihelium*, as 3.14159, *&c.* (that is the *Area* of the Circle) to $\sqrt{\frac{8}{9}}$. Therefore the Comet wou'd deſcribe that Quadrant in 109 Days, 14 Hours, 46 Minutes; and ſo that Parabolick *Area* (Analogous to the *Area* POS) being divided into 100 Parts, to each Day there wou'd be alotted 0.912280. of thoſe Parts; the Log. of which, *viz.* 9.960128, is to be kept for continual Uſe. *But then the Times in which a Comet, at a greater or leſs Diſtance, wou'd* deſcribe ſimilar Quadrants, *are as the Times of the Revolutions in Circles,* that is, in the *Seſquiplicate Ratio* of the Diſtances: And ſo the *Diurnal Area's,* eſtimated in *Centeſimal* Parts of the Quadrant (which Parts we put for Meaſures of the mean Motion, like Degrees) are in each, in the *Subſeſquialtera* Proportion *of the Diſtance from the Sun in the* Perihelion.

Theſe

Theſe neceſſary Things premis'd, let it be propos'd to compute the *apparent Place* of any one of the mention'd Comets, for any *Given Time*. Therefore,

1. *Let the Sun's Place be had, and the Log. of its Diſtance from the Earth.*

2. *Let the Difference between the Time of the* Perihelion, *and the Time given, be gotten, in Days and Decimal Parts of Days. To the Log. of this Number, let there be added the conſtant Log.* 9.960128, *and the Complement Arithmetical of the* $\frac{3}{2}$ *of the Log. of the Diſtance in the* Perihelium *from the Sun: The Sum will be the Log. of the Mean Motion, to be ſought in the firſt Column of the General Table.*

3. *With the Mean Motion let there be taken the correſpondent Angle from the* Perihelium, *in the Table, and the Log. for the Diſtance from the Sun: Then in Comets that are Direct, add, and in Retrograde ones ſubſtract; if the Time be after the* Perihelium, *the Angle thus found, to or from the Place of the* Perihelion; *or in Direct Comets, ſubſtract; and in Retrograde ones, add; if the Time be before the* Perihelion, *the foreſaid Angle to or from the Place of the* Perihelion; *and ſo we ſhall have the Place of the Comet in its Orbit. And to the Log. found for the Diſtance, let there be added the Log. of the Diſtance in the* Perihelion, *and the Sum will be the Log. of the true Diſtance of the Comet from the Sun.*

4. *The Place of the Node, together with the Place of the Comet in its Orbit, being given, let the Diſtance of the Comet from the Node be found; then, the Inclination of the Plane being given, there will be given alſo (from the common Rules of Trigonometry) the Comet's Place reduced to the Ecliptick, the Inclination or Heliocentrick Latitude, and the Log. of the* curtate *Diſtance.*

5. *From*

5. *From these Things given (by the very same Rules that we find the Planets Places, from the Sun's Place and Distance given) we may obtain the* Apparent *or* Geocentrick *Place of the Comet, together with the Apparent Latitude.* And this it may be worth while to illustrate by an Example or two.

Example I.

Let it be requir'd to find the Place of the Comet of the Year $166\frac{4}{5}$, March 1^d, 7^h, $00'$, P. *M.* London. *That is.* 96^d, 19^h, $8'$, *after the* Perihelion, *which happen'd* Novemb. $24°$, 11^h, $52'$.

Log. Dist. Perihel.		0. 011044
Log. Sesquialt.		0 016566
Comp. Arith.		9 983434
		9. 960128
Log. Temp.		1. 985862
Log. Med. Mot.		1. 929424
Medius Motus		85.001
Perihel.	☊	10. 41. 25
Ang. Corresp.		83. 38. 05—
Comet. in Orb.	♉	17. 3. 20
Ascend. Nod.	♊	21. 14. 00
Com. à Nodo		34. 10. 40
Red. ad Eclip.		32 19. 05
Com. Helioc.	♉	18. 54. 55
Incl. Bor.		11. 46. 50
Log. pro dist.		0. 255369
Log. Perihel.		0. 011044
Co-sin. Incl.		9. 990754
Log. dist. Curt.		0. 257167
Log. dist.	☉	9. 997918
	☉ ♐	21. 44. 45
Com. Visus	♈	29. 18. 30
Lat. Visa		8. 36. 15

Exam-

Example II.

Let it be requir'd to find the Place of the Comet of the Year 1683, July 23°, 13^{h}, 35′, *P.M.* London: *Or*, 13^{h}, 40′ *Equat. Time. That is*, 21^{d}, 10^{h}, 50′ *after the* Perihelion.

Log. dist. Perihel.	9. 748343
Log. Sesquialt.	9. 622514
Comp. Arith.	0. 377486
	9. 960128
Log. Temp.	1. 310723
Log. Med. Mot.	1. 648337
Medius Motus	44. 498
Perihel. ♊	25. 29. 30
Ang. Corresp.	56. 47. 20
Comet. in Orb. ♈	28. 42. 10
Nod. Descend. ♓	23. 23. 00
Com. à Nodo	35. 19. 10
Red. ad Eclip.	4. 48. 30
Com. Helioc. ♓	28. 11. 30
Incl. Bor.	35. 2. 00
Log. pro dist.	0. 111336
Log. Perihel.	9. 748343
Co-fin. Incl.	9. 913187
Log. dist Curt.	9. 772866
Log. dist. ☉.	0. 006104
☉ Locus ♌	10. 41. 25
Com. Visus ♋	5. 11. 50
Lat. Bor.	28. 52. 00

At the Instant of Time specified in the first Example, 'twas observ'd (at *London*) that the Comet applied to the Second Star of *Aries*; so that it was found to be 9′ more Northerly,

and 3′ to the East, according to Mr. *Hook*'s Observation. But at that of the Second Example, I my self (near *London*, with the same Instruments whereby I formerly observ'd the Southern Constellations) found the Place of the Comet to be ♋, 5°, 11′ ½, and 28°, 52′ North Latitude, which agreed exactly with the Observation made at *Greenwich* almost the very same Moment.

As for the Comet of the Year 1680, which came almost to the very *Sun* it self (being in its *Perihelion*, not above ⅓ of the *Semi-Diameter* of the Sun distant from the Surface of it) since the *Latus Rectum* is so very small, could hardly be contained within the Limits of the General Table, because of the excessive Velocity of the *Mean Motion*. Therefore in this Comet, the best Way is (after the *Mean Motion* is found) to get from thence (by the Help of the foregoing Equation $z^3 + 3z = \frac{4}{100}$ of the *Mean Motion*) the Tangent of Half the Angle from the *Perihelion*, together with the Log. for the Distance from the Sun. Which Things being given, we are to proceed by the same Rules, as in the rest.

After this Manner therefore, the Astronomical Reader may examine these Numbers, which I have calculated, with all imaginable Care, from the Observations I have met with. And I have not thought fit to make them publick before they have been duly examin'd, and made as accurate as 'twas possible, by the Study of many Years. I have publish'd this Specimen of Cometical Astronomy, as a *Prodromus* of a designed future Work, lest, happening to

to die, these Papers might be lost, which every Man is not capable to retrieve, by reason of the great Difficulty of the Calculation. Now, it may not be amiss to put the Reader in mind, That our Five first Comets, (the Third and Fourth observ'd by *Peter Apian*, the Fifth by *Paulus Fabricius*) as also the Tenth seen by *Maestlin*, if I mistake not, in the Year 1596. are not so certain as the rest; for the Observations were made neither with fit Instruments, nor due Care, and upon that Account are disagreeing with themselves, and can by no means be reconcil'd with a regular Computation. The Comet which appear'd in the Year 1684. was only taken Notice of by *Blanchinus*, who observed at *Rome:* And the last, which appear'd in the Year 1698. was seen only by those at *Paris*, who determin'd its Course in a very uncommon Way. This Comet was very obscure; and, altho' it mov'd swift, and came near enough our Earth; yet we, who are wont to be curious enough in these Matters, saw nothing of it. For want of Observations I have left out of the foregoing Catalogue, those Two remarkable Comets which have appear'd in this our Age, one in *November*, in the Year 1689. the other in *February* in the Year 1702. For they directing their Courses towards the Southern Parts of the World, and being scarce conspicuous here in *Europe*, met with no Observers capable of the Business. But, if any one shall bring from *India*, or the Southern Parts, an accurate Series of requisite Observations, I will willingly fall to work again, and undergo the Fatigue of representing their Orbits in Numbers, as I have done the rest.

By comparing together the Accounts of the Motions of these Comets, 'tis apparent, their Orbits are dispos'd in no manner of Order; nor can they, as the Planets are, be comprehended within a *Zodiack*, but move indifferently every Way, as well Retrograde as Direct; from whence it is clear, they are not carry'd about or mov'd in *Vortices*. Moreover, the Distances in their *Perihelium's* are sometimes greater, sometimes less; which makes me suspect, there may be a far greater Number of them, which moving in Regions more remote from the Sun, become very obscure; and wanting Tails, pass by us unseen:

Hitherto I have consider'd the Orbits of Comets as exactly *Parabolick*; upon which Supposition it wou'd follow, that Comets being impell'd towards the Sun by a Centripetal Force, descend as from Spaces infinitely distant, and by their Falls acquire such a Velocity, as that they may again run off into the remotest Parts of the Universe, moving upwards with such a perpetual Tendency, as never to return again to the Sun. But since they appear frequently enough, and since none of them can be found to move with an Hyperbolick Motion, or a Motion swifter than what the a Comet might acquire by its Gravity to the Sun, 'tis highly probable they rather move in very Excentrick Orbits, and make their Returns after long Periods of Time: For so their Number will be determinate, and, perhaps, not so very great. Besides, the Space between the Sun and the fix'd Stars is so immense, that there is Room enough for a Comet to revolve, tho' the Period of its Revolution be vastly long.

Now,

Now, the *Latus Rectum* of an *Ellipsis*, is to the *Latus Rectum* of a *Parabola*, which has the same Distance in its *Perihelium*; as the Distance in the *Aphelium* in the *Ellipsis*, is to the whole *Axis* of the *Ellipsis*. And the Velocities are in a Subduplicate *Ratio* of the same: Wherefore in very Excentrick Orbits this *Ratio* comes very near to a *Ratio* of Equality; and the very small Difference which happens on Account of the greater Velocity in the *Parabola*, is easily compensated in determining the Situation of the Orbit. The principal Use therefore of this Table of the Elements of their Motions, and that which induced me to construct it, is, That whenever a new Comet shall appear, we may be able to know, by comparing together the Elements, whether it be any of those which has appear'd before, and consequently to determine its Period, and the *Axis* of its Orbit, and to foretell its Return. And, indeed, there are many Things which make me believe that the Comet which *Apian* observ'd in the Year 1531. was the same with that which *Kepler* and *Longomontanus* took Notice of and describ'd in the Year 1607. and which I my self have seen return, and observ'd in the Year 1682. All the Elements agree, and nothing seems to contradict thismy Opinion, besides the Inequality of the Periodick Revolutions: Which Inequality is not so great neither, as that it may not be owing to Physical Causes. For the Motion of *Saturn* is so disturbed by the rest of the Planets, especially *Jupiter*, that the Periodick Time of that Planet is uncertain for some whole Days together. How much more therefore will a Comet be subject to such like Errors, which rises al-

almoſt Four times higher than *Saturn*, and whoſe Velocity, tho' encreaſed but a very little, would be ſufficient to change its Orbit, from an Elliptical to a Parabolical one. This, moreover, confirms me in my Opinion of its being the ſame; that in the Year 1456. in the Summer time, a Comet was ſeen paſſing Retrograde between the Earth and the Sun, much after the ſame Manner: Which, tho' no Body made Obſervations upon it, yet from its Period, and the Manner of its Tranſit, I cannot think different from thoſe I have juſt now mention'd. Hence I dare venture to foretell, That it will return again in the Year 1758. And, if it ſhould then return, we ſhall have no Reaſon to doubt but the reſt muſt return too: Therefore Aſtronomers have a large Field to exerciſe themſelves in for many Ages, before they will be able to know the Number of theſe many and great Bodies revolving about the common Center of the Sun; and reduce their Motions to certain Rules. I thought, indeed, that the Comet which appear'd in the Year 1532. might be the ſame with that obſerv'd by *Hevelius* in the Year 1661. But *Apian*'s Obſervations, which are the only ones we have concerning the firſt of theſe Comets, are too rude and unskilful, for any thing of Certainty to be drawn from them, in ſo nice a Matter. I deſign to treat of all theſe Things in a larger Volume, and contribute my utmoſt for the Promotion of this Part of Aſtronomy, if it ſhall pleaſe God to continue my Life and Health.

In the mean time, thoſe that deſire to know how to conſtruct Geometrically the Orb of a Comet, by Three accurate Obſervations given, may

may find it at the End of the Third Book of Sir *Iſaac Newton*'s Principles of Natural Philoſophy, entituled *De Syſtemate Mundi*, in the Words of its renowned Inventor. Which have ſince been more fully explained by my very worthy Collegue Dr. *Gregory*, in his Learned Work of *Aſtronomia Phyſica & Geometrica*.

One Thing more perhaps it may not be improper or unpleaſant to advertiſe the Aſtronomical Reader; That ſome of theſe Comets have their Nodes ſo very near the Annual Orb of the Earth, that if it ſhall ſo happen, that the Earth be found in the Parts of her Orb next the Node of ſuch a Comet, whilſt the Comet paſſes by; as the apparent Motion of the Comet will be incredibly ſwift, ſo its *Parallax* will become very ſenſible; and the Proportion thereof to that of the Sun will be given. Wherefore ſuch Tranſits of Comets do afford us the very beſt Means, though they ſeldom happen, to determine the Diſtance of the Sun and Earth: Which hitherto has only been attempted by *Mars* in his Oppoſition to the Sun; or elſe *Venus* in *Perigæo*; whoſe *Parallaxes* though triple to that of the Sun, are ſcarce any ways to be perceived by our Inſtruments; whence we are ſtill in great Uncertainty in that Affair. This uſe of Comets was the ingenious Thought of that excellent Geometrician Mr. *Nicolas Facio*. Now the Comet of 1472, had a *Parallax* above Twenty times greater than the Sun's. And if the Comet of 1618, had come down, about the Middle of *March*, to his deſcending Node: Or if that of 1684, had arrived a little ſooner at its aſcending Node; they would have been yet much nearer the

Earth,

Earth, and consequently have had more notable *Parallaxes*. But hitherto none has threaten'd the Earth with a nearer Appulse, than that of 1680. For by Calculation I find, that *Novemb.* 11°, 1^{h}, 6′, *P. M.* that Comet was not above the Semi-diameter of the the Sun to the Northwards of the Way of the Earth. At which Time, had the Earth been there, the Comet would have had a *Parallax* equal to that of the Moon, as I take it. This is spoken to Astronomers: But what might be the Consequences of so near an Appulse; or of a Contact; or, lastly, of a Shock of the Cœlestial Bodies, (which is by no means impossible to come to pass) I leave to be discuss'd by the Studious of Physical Matters.

F I N I S.

Advertisement.

A

COMPENDIOUS VIEW

OF THE

ASTRONOMY of COMETS.

CONTAINING

Likewiſe an Accurate Calculation, in the Curve of an Ellipſis, of that whoſe Appearance is ſhortly expected.

WRITTEN in LATIN

By EDMUND HALLEY,

Late ROYAL ASTRONOMER.

And inſerted in the Quarto Edition of his ASTRONOMICAL TABLES, publiſhed by W. INNYS, 1749; which, as the Patent recites, were more than 30 Years in Printing.

Tranſlated by *G. T.* GENT.

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MDCCLVII.

TO THE

READER.

THE following Treatiſe having been tranſlated ſome time ſince, for the Information of a few Friends, was not intended to be made Public, but many ſuperficial pamphlets on the ſame Subject having lately made their appearance, which can give very little Information to their readers, and as many would be glad to know what Dr. *Halley* has really ſaid himſelf on the Subject, were not the book in which it is contained of a large price, and the Language in which it is wrote, not generally underſtood. Theſe conſiderations induced the Tranſlator to this publication, that every one might, at a ſmall price, and with little trouble in reading, have an inſight into a Subject, in itſelf extreamly curious, abſtracted from

any humdrum Reflections on the general Conflagration, or any vague Suppositions of the expected Comet's meeting the Earth on the 12th of *May*; which was never surmised by Dr. *Halley*, and inserted by Mr. *Martin* in his *Cometarium*, for no other purpose that I can conceive than to create a larger demand, many people searching eagerly after any thing strange or uncommon.

A Com-

EDMUND HALLEY was born in *London Nov.* 8, 1656, and brought up at St. *Paul's* School, under Dr. *Thomas Gale.* As the Stars at the South Pole are deficient in *Ptolomy* and *Tycho's* Catalogues, the Ancients ſeldom ſailing beyond the Equator, and *Tycho* living too far North to obſerve them, Mr. *Williamſon*, Secretary of State, and Sir *Jonas Moor*, grand Maſter of the Artillery, applied to King *Charles* II. to ſend him to St. *Helena*, to ſupply their Defects: Being furniſhed with every Thing neceſſary, he ſet out in *November*, 1676, and arrived at St. *Helena* in three Months, where he performed his Project, and returned to *London* about the Autumn 1678; in 1679 he publiſhed his Catalogue of Southern Stars; among other Novelties it contained the Royal Oak, in which King *Charles* II. hid himſelf after the Defeat at *Worceſter*, with this Inſcription, *Robur Carolinum, in perpetuam, ſub illius latebris ſervati Caroli Secundi Magnæ Britanniæ Regis memoriam, in Cælum meritò tranſlatum:* That is, *Charles's* Oak deſervedly tranſlated into Heaven, for ſheltring under its Branches *Charles* II. King of *Great Britain*; from which it has been inferred, that Aſtronomers as well as Poets can find opportunities of thanking their Benefactors; he died *Jan.* 25, 1742.

The

A Compendious View of the Astronomy of Comets.

THE antient *Egyptians* and *Chaldeans*, on the Teſtimony of *Diodorus Siculus* *, had learned, by a long Series of Obſervations, to foretel the appearing of Comets; but as they are mentioned foreſeeing Tempeſts and Earthquakes by the ſame Skill, it is beyond doubt, that their knowledge in theſe things might be more properly attributed to Aſtrology and Fortune-telling, than to any Aſtronomical Theory of their Motions; and in truth the *Greeks*, who ſubdued both † theſe Nations, ſcarce found any other literature among them, inſomuch that the Aſtronomy which the Moderns have ſo much improv'd, may be ſaid to have been invented by the *Greeks* themſelves, eſpecially the great *Hipparchus* ‡.

Yet

* *Diodorous* wrote in *Greek* 40 Books, containing the affairs of the *Egyptians*, *Aſſyrians*, *Medes*, *Perſians*, *Greeks*, *Romans*, *Carthagenians* and others, 15 of which have only come to our Hands; he was born at *Agyrium* in *Sicily*, and lived in the time of *Julius* and *Auguſtus Cæſar*, 60 Years before Chriſt.

† *Alexander* the Great ſubdued all *Aſia*, having defeated *Darius Codomannus*, about 325 Years before *Chriſt*, and about 60 Years before the firſt War between the *Romans* and *Carthagenians*.

‡ *Hipparchus*, a *Rhodian*, was the firſt among the *Greeks* who made a Catalogue of the Stars; he lived about 120 Years before *Chriſt*, and his Obſervations are preſerved by *Ptolomy*, in his

Yet the Opinion of *Ariſtotle* *, who would not allow Comets to be any thing but aerial Vapors, extending not ſo high as the Moon, prevailed ſo much among theſe very People, that this part of Aſtronomy, the moſt abſtruſe of any, remained entirely neglected; for no one thought it worth while to obſerve and commit to writing, the vague and uncertain Tracts of Vapors floating in the Air: And this has been the Reaſon that nothing certain has been tranſmitted to us concerning the Motion of Comets.

But *Seneca* † the Philoſopher having conſidered the Phænomena of two remarkable Comets of his own Time, makes no ſcruple to rank them among heavenly Bodies, affirming they are Planets which will endure as long as the Univerſe; tho' he ac-

his *Almageſt*, Book 7. This *Ptolomy*'s Name was *Claudius*, born at *Peluſium* in *Egypt*, and flouriſhed in the Reign of *Marcus Antoninus*, 140 Years after *Chriſt*, falſly taken by ſome for one of the Kings of *Egypt*; his Work was originally entituled Συνταξις Μεγιστη, that is, Greateſt Collection, it being a Collection of Problems in Geometry, Geography, &c. the *Arabians* tranſlated it about the Time of *Charlemagne*, *Anno* 800, and adding the Particle *al* to the Word Μεγιστη, called it in their own Language *Almagiſti*, ſince which it has bore that Name.

* *Ariſtotle*, Preceptor to *Alexander* the Great, born at *Stagyra*, a Town in *Macedonia*, 384 Years before *Chriſt*; his Works are extant both in *Greek*, and tranſlated into *Latin*; he is reported to have ſaid on his Death-bed, *Fœdè hunc mundum entravi, anxius vixi, perturbatus egredior cauſa cauſarum miſerere mei:* That is, I was conceived in Uncleanneſs, have lived in Anxiety, and die in greater: Supreme Cauſe of all Things have Mercy on me.

† *Lucius Annæus Seneca*, called the Philoſopher, to diſtinguiſh him from his Father the Rhetorician, born at *Corduba* in *Spain*, a little before the End of *Auguſtus*'s Death; he was Preceptor to *Nero*, who, hearing that he was privy to a Conſpiracy againſt him, ordered him to put himſelf to death, which he did by letting himſelf Blood in the Year of *Chriſt* 65.

know-

knowledges their Motions are regulated by Laws then unknown; and propheſies far from falſely, that the diligence and experience of ſome future Age would diſcover theſe Myſteries; and wonder that the Antients were ignorant of them: After that ſome Interpreter of Nature ſhould demonſtrate in what Regions of the Firmament Comets move, ſhewing both their Magnitudes and Qualities. Yet the greateſt part of Aſtronomers have thought differently from *Seneca*; and he himſelf has not tranſmitted to us the Phænomena of the Motions on which his Opinion is grounded, nor the Time when he obſerv'd them, all which would have been of Uſe to the Moderns to determine this Controverſy.

And after ſearching into many Hiſtories of Comets, I find none than can be of any Uſe in this affair before the year of Chriſt 1337, when *Nicephoras Gregoras*, an Hiſtorian and Aſtronomer at *Conſtantinople*, deſcribes to us accurately enough the Tract of a Comet among the fixt Stars, but he is very remiſs as to the time of its appearance, on which account it merits a place in the Catalogue we ſhall give hereafter, no otherwiſe than that it is very probable it appeared about 400 Years ago.

After this, in the year 1742, *Regiomontanus* * obſerved a Comet, the ſwifteſt and neareſt the Earth of any; which tho' large in bulk, and having a terrible Tail, in one day paſſed thro' 40 degrees of a great Circle of the Heavens; and this is the firſt Comet concerning which proper Obſervations

* *Regiomontanus*, a *German* Aſtronomer; he abridged *Ptolomy*'s *Almageſtum*, he found many material Errors in the Tranſlation of it, by *George* of *Trebizond*, and being made Archbiſhop of *Ratiſbon*, and coming to *Rome* to reform the Calendar, he was killed by *George* of *Trebizonde*'s Son, *Anno* 1476, others ſay he died of the Plague, aged 40.

have been tranſmitted us. However, all perſons who have conſidered Comets before the time of *Tycho Brahe*, the great Reſtorer of Aſtronomy, imagining they were nearer the Earth than the Moon, little regarded them, eſteeming them as Vapors.

But in 1577, *Tycho* * applying aſſiduouſly to the ſtudy of the Stars, and having collected large Inſtruments for meaſuring arcs of the Heavens with greater accuracy than the ancients could pretend to, there appeared a Comet conſpicuous enough, which *Tycho* obſerved ſtrictly, and found by many and juſt Experiments, that it had no ſenſible diurnal Parallax †, and conſequently was ſo

 far

* *Tycho Brahe*, born at *Knudſtorp* in *Denmark*, *December* 1546, died *Nov.* 1601, at *Prague*, aged 54 Years, 9 Months, 19 Days. He was a Knight, and made Obſervations on the Stars a long time at *Uraniberg*, in the Iſle of *Huen*, in the Sound, having fabricated curious inſtruments for that purpoſe at the expence of *Chriſtian* III. King of *Denmark*. When he left *Denmark* he was entertained at the Court of the Emperor *Rodolph*: He had great intimacy with *William* Prince of *Heſſe*: His works compleat were publiſh'd at *Frankfort*, 1648.

† What is meant by Parallax is, that ſuppoſing the Comet was obſerved from *Uraniberg*, and its diſtance from ſome fix'd Star noted: Again, ſuppoſe the ſame Comet was obſerved from *Prague*, and its diſtance from the ſame fix'd Star noted likewiſe; then if theſe two diſtances from the fix'd Star were the ſame in appearance, then would the Comet be ſaid to have no ſenſible Parallax, which Aſtronomers conclude to be a Demonſtration drawn from the Laws of Optics, that they are higher than the Moon; for that Planet, view'd from thoſe two places before-mentioned, wou'd appear to have two different diſtances from the ſame fix'd Star.

Sir *Iſaac Newton* takes another method of ſhewing that Comets are ſolid bodies, and not vapors; by inſtancing, that the Comet of 1680 came within a ſixth part of the Sun's Diameter to his Surface, and therefore might, if a ſolid body, have contracted a heat 2000 times greater than red-hot iron; now had the Comet been vapor alone, the whole muſt have

been

far from being a Vapor, that it was much higher than the Moon; and in ſhort, that no reaſon could be given that it might not be a Planet, notwithſtanding the contrary aſſertions of the Pretenders to Learning of thoſe Times.

The ſagacious *Kepler* * followed, and by the help of *Tycho*'s labours, found out the true and natural Syſtem of the World, and immenſely increaſed the Science of Aſtronomy: Shewing, that all the Planets revolv'd in Planes paſſing thro' the Center of the Sun, deſcribing elliptic Curves in ſuch manner, that equal Areæ of elliptical Segments (the Center of the Sun being plac'd in the Focus of the Ellipſis) are always deſcribed in equal times, in which the Areas are deſcribed. He alſo found, that the Cubes of the diſtances of Planets from the Sun were as the ſquares of their periodic times. Two Comets appeared to this ſkilful Artiſt one more remarkable than the other: And from the Obſervations *Kepler* made on theſe, and by many Diſcoveries of an annual Parallax, he concluded, that

been diſperſed by ſo intenſe a heat. He concludes therefore, that Comets are ſolid bodies, and that their tails are vapors, emitted from them by the great heat of the Sun, as ſteem is from water when heated by a great fire, and all the appearances agree perfectly with this ſentiment.

* *John Kepler*, born at *Wial*, in the country of *Wirtemberg*, in 1571. *Tycho Brahe* having ſettled in *Bohemia*, and obtained all manner of conveniences from the Emperor *Rodolph* for perfecting Aſtronomy, prevail'd on *Kepler* to leave the Univerſity of *Glatz* and to come to him, which he did with his family and library in 1600; but *Tycho* dying in 1601, *Kepler* enjoyed the title of Mathematician to the Emperor all his life, who ordered him to finiſh the Tables of *Tycho Brahe*, which were to be called *Rodolphine*, which he publiſh'd in 1627. He died at *Ratiſbon*, where he was ſolliciting the arrears of his penſion.

Comets

Comets were freely carry'd about between the Orbits of Planets, with a motion not very different from rectilinear, but which he could not then determine.

Hevelius *, alſo *Tycho*'s rival, following the tract of *Kepler*, embraced the hypotheſis of a rectilinear motion; but notwithſtanding he was an acute obſerver of many Comets, yet he complains that his calculation did not correſpond entirely with nature, and ſuſpected that Comets deſcribed a curve round the Sun.

At length the prodigious Comet of the year 1680 appeared in the heavens, ſeemingly deſcending perpendicularly towards the Sun, and afterwards aſcending with the ſame velocity therefrom; and having been ſeen for four months together, and diſcovering a peculiar and remarkable curvature of its Orbit, was more proper than any to give light to the theory of its motion. And the Royal Obſervatories of *Paris* and *Greenwich* having been long ſince erected, and intruſted to the care of the moſt eminent Aſtronomers, it ſo fell out, that the apparent motion of this Comet was obſerved by *Caſſini* † and *Flamſtead* §, with as much accuracy perhaps as mortals are capable of.

* *Hevelius*, Burgo Maſter of *Dantzic*, he diſcovered a great many Stars, which he calls *Sobieſki*'s Firmament, in honor of *John* III. king of *Poland:* He died in 1688, aged 76.

† *Caſſini John Dominic*, was born in the county of *Nice*, in 1625, and being taken notice of by *Colbert*, chief miniſter to *Lewis* XIV. became one of the greateſt Aſtronomers of his time: He died in 1712.

§ *John Flamſtead*, born at *Derby*, *Auguſt* 19, 1646; he went to *Cambridge*, entered a ſtudent of *Jeſus* College there, and became acquainted

Not long after which, *Newton* *, the chief of Geometers, having compoſed his Mathematical Principles of Natural Philoſophy, he not only demonſtrated, that the Diſcoveries of *Kepler* muſt neceſſarily have a place in the Planetary Syſtem, but that all the phœnomena of Comets muſt neceſſarily follow from the ſame principles, which he hath ſufficiently illuſtrated by an example from the aforeſaid Comet of the Year 1680, and ſhewed the manner of conſtructing Geometrically, or with exactneſs, the Orbits of Comets: To the wonder of all men ſolving a moſt difficult problem, and worthy of ſo great an *Oedipus* †. He proves

acquainted with Mr. *Newton*, Dr. *Barrow*, and Dr. *Wroe*: Sir *Jonas Moor* having ſtrongly recommended him to king *Charles* the Second, and the Duke of *York*. *March* the 4th, 1674, he brought Mr. *Flamſtead* a warrant to be king's Aſtronomer, with the ſalary of 100*l. per Anuum*, the *Eaſter* following he was ordained. In 1684 he was preſented to the living of *Burſtow* in *Surry*, which he enjoyed till he died, *Anno* 1719, aged 83; his *Hiſtoria Cæleſtis Britannica* was publiſhed *Anno* 1725.

* *Newton*, Sir *Iſaac*, was born at *Woolſtrop*, in the county of *Lincoln*, on *Chriſtmas*-day, *Anno* 1642: He was deſcended from the elder branch of Sir *John Newton*, Baronet. In 1696, Mr. *Montague*, then chancellor of the Exchequer, obtained of the king for him the office of warden of the Mint, and three years after he was appointed maſter of the Mint. In 1701 he was elected a ſecond time member of parliament for the Univerſity of *Cambridge*. In 1703, he was elected Preſident of the Royal Society, and continued in the chair 23 years, till his death. In 1705 he was knighted by queen *Anne*: He died *March* 20, 1726.

† *Oedipus*, according to the fabulous hiſtory, was the ſon of *Laius* and *Jocaſta*, king and queen of *Thebes*; his father being informed by the oracle that his ſon would kill him, gave him to his ſhepherd to be ſlain, but he being moved with pity, only left him in a deſert place, where he imagined he would die with hunger; but he was taken up by one *Phorbas*, belonging

proves this Comet to have moved round the Sun in an Orbit apparently parabolical in ſuch manner, that the areæ, reckoning from the center of the Sun, are proportionable to the times.

Purſuing the ſteps of ſo great a man, I have endeavoured to accommodate an arithmetical calculation thereto, and not without ſucceſs; for having collected from all parts the obſervations made on Comets, I obtained the following Table, the fruit of immenſe calculations, a ſmall but acceptable preſent to Aſtronomers; for theſe numbers are ſufficient to deſcribe accurately every thing that has hitherto been diſcovered concerning Comets, by the help alone of a General Table that accompanies it; in conſtructing which I have ſpared no pains to render it perfect, and I dedicate it to Poſterity, imagining it will laſt as long as the Science of Aſtronomy.

This Table, which was intended for no perſons unſkilled in the Mathematics, contains a Liſt of

ing to *Polybius*, king of *Corinth*, and brought to that place, where the queen brought him up as her own ſon; but he afterwards finding that he was not her child, went to ſeek his father at *Phocis*, and there being a ſedition in that city, he unwittingly ſlew his father; after which *Creon*, the ſucceeding king, proclaimed over all *Greece*, that any man who could expound the Sphynx's riddle, ſhould marry his ſiſter *Jocaſta*; the riddle was, What animal is that which in the morning goes on four feet, at noon with two, and at night with three? *Oedipus* undertook it, and ſaid it was a man, who in his infancy crawls on hands and feet or on all fours, in his middle age walks on two legs, and when he is old uſes a ſtaff, or goes on three; whereupon he obtained the prize, and had two children by his mother, *Eteocles* and *Polynices*, who ſlew one another, and ſhe ſlew herſelf. Hence unfortunate people are ſaid to be of the race of *Oedipus*, and the reſolvers of difficult problems to be an *Oedipus* himſelf.

24 Comets, beginning from the year 1337, and ending in the year 1698.

Now three only of this number have reference to the Comet expected to appear about the end of the year 1758, or beginning of the next, and are as follows.

The Comet of the year	had its Orbit inclined				Its nearest distance to the Sun was			
	deg.	min.	sec.		deg.	min.	sec.	
of 1531	17	56	0	Aquarius	1	39	0	
of 1607	17	2	0	Aquarius	2	16	0	
of 1608	17	56	0	Aquarius	2	52	45	

Having finished the above Table, I suspected from the similar situation of the Planes and Perihelions, that these three Comets were one and the same; having made its third revolution in the curve of an Ellipsis *; but as I found rather too much difference

* If a strait line of what length you please be a little bent, it will thereby become what Geometricians call part of an Hyperbola; bend it a little more, and it will thereby become part of a Parabola; bend it a third time, and it will become part of an Ellipsis; bend it still more, and in this last degree of curvature it will be part of a Circle: Now these crooked lines, according as they are more or less bent, serve for solving different Problems, for what you may perform by the help of one could never have been resolved by the other: For instance, a man who understands the properties of a Circle would easily make a square floor, or any other surface double or treble, &c. any other you please. Yet without the knowledge of the properties of a Parabola, he would never be able to increase or diminish, in any proportion, a solid stone pediment called a cube or die.

As

ference in ſome other reſpects, and eſteemed the Obſervations of *Apian* and *Kepler*, who made them too inaccurate for clearing up ſo ſubtil a point; I was content on firſt publiſhing this Compendium in the Year 1705, only to point out this as my opinion, ſupported by ſome degree of probability, and adviſed poſterity to be ſtrictly on the watch for its return, which I expected about the year 1758.

But he goes on and ſays, that ſince the firſt publiſhing the Compendium, he had found out a method of eaſily and accurately computing the motions of Comets in any Ellipſis whatever: And that in turning over the Catalogues of ancient Comets, he had found three more preceding the others in the ſame order and intervals; to wit, in 1305, about *Eaſter*; in 1380, the month uncertain; and another in 1456, in the month of *June*; and this made him reſume his former opinion with more confidence than formerly, ſo that in the whole he had obtained a catalogue of ſix Comets, which appeared in the years 1305, 1380, 1456, 1531, 1607, 1682; and being thus prepared, inſtead of the parabolic Orbit which he had

As to what Carpenters, Maſons, and other artificers perform without the knowledge of any properties of Lines at all, it is from the rules that thinking men have laid them down, and which they are content to uſe on their faith, without pretending or being capable to examine into the truth of the demonſtration, for many people can dexterouſly put in practice the inventions of others, if you will take the pains to inſtruct them, tho' they fall ſhort of a capacity to be inventors themſelves.

Now the computation of a Comet's motion in an Ellipſis was heretofore very difficult, which made Dr. *Halley* compute them as moving in the curves of Parabola's, therefore it was not ſtrictly accurate on that account.

had attributed in his former table to the Comet of 1682, he ſubſtituted new Tables of an Elliptic one, and then try'd if Mr. *Flamſtead*'s Obſervations on this very Comet, and which were taken with a very large and accurate ſextant, and duly cleared from refractions, would correſpond with his Theory.

Now it is manifeſt by the Catalogue, that two periods of this Comet amount to 151 years nearly, and that they are alternately greater and leſs, the one of 56, and the other of 55 years; afterwards applying this and other data, as directed by 15 Prop. 1ſt book of *Newton*'s *Principia*, by the help of his new Tables, he finds, that on the 30th of *Auguſt*, 1682,

The place of this Comet according to his Theory was,

		deg.	min.	ſec.
	Libra	15	35	58
and according to a real obſervation made by *Flamſtead* it was,	Libra	15	34	42

And its North Latitude according to his Theory was,

	deg.	min.	ſec.
	17	24	42
and by a real obſervation made by *Flamſtead*	17	24	46

Now the Difference between the computed and obſerved places, is but 1′ 16″, and that of their Latitudes only 45″, which difference he thinks deſerves

deſerves no regard, ſince they may as well be attributed to errors in the Obſervations, as well as to thoſe of the Calculations: And Aſtronomers ſeldom make leſs in their Theories of the primary Planets, which they have cultivated for ſo many years.

And in the ſame manner he found his Theory agree with every one of *Flamſtead*'s Obſervations, except ſuch trifling differences, of which he gives a Table.

Having thus far eſtabliſhed his Theory, he takes into conſideration the courſe of the Comet in 1607, which preceded that of 1682, which *Kepler* and *Longomontanus* ſay they obſerved; but though they were great Aſtronomers, they have tranſmitted too remiſs a deſcription, and not ſufficiently exact for the preſent enquiry: But ſuch as they have given are,

The Comet preceding that of 1682; to wit, in 1607, was obſerved by *Kepler* at *Prague*, the 16th of *September* that year, old ſtile, at nine o' clock at night,

		deg.	min.
and he eſtimates its place,	*Leo*	18	30
and North Latitude		35 ½	

But as the places of the fix'd Stars are falſely deſcribed in *Tycho*'s Tables by ſome miſtake; when they are ſet to rights, its apparent place at *London*, 51 minutes paſt 1 in the morning was,

		deg.	min.	ſec.
	Leo	21	49	00
and at the ſame time and place, according to *Halley*'s Computation its place was,	*Leo*	21	55	56

the difference of which places are but 6 minutes, 56 ſeconds.

And its North Latitude, as obſerved

	deg.	min.	ſec.
by *Kepler* was,	36	12	0
and by *Halley*'s Computation	36	20	4

the difference of which Latitudes are 8 minutes 4 ſeconds.

And out of 12 different obſervations made by *Kepler* and others, when the undoubted errors in their obſervations are ſet to rights, there is very little difference between them and *Halley*'s Computations, and that difference which there is, the candid reader will eaſily obſerve is to be attributed for the moſt part to the obſervations, which are not altogether congruous amongſt themſelves.

As to the period of one of the Comet's revolutions exceeding the other by more than a year, he reminds the reader, that it is no more than what he has demonſtrated in his Tables of the Planet *Saturn*, where one of that Planet's revolutions is 13 days longer than the other, and is the conſequence of one of the Laws of Gravity explained by *Newton*; and this irregularity he ſays, muſt be abundantly greater in a Comet which emerges 4 times higher than *Saturn*; and it is probable he ſays, this irregularity which is not accurately known, may make the next expected return of this Comet ſomething more than 76 years, and it may not be ſeen again till the end of the year 1758, or beginning of 1759; but this he leaves to the diſcuſſion of poſterity.

That the Comet obſerved by *Appian* in 1531, which is next preceding that of 1607, was the ſame

ſame as the other two, is pretty evident from the ſituation of the Nodes, its Perihelion and Inclination which are not very different from the other two; but the imperfect obſervations made by him with a ſmall azimuth inſtrument, whoſe only uſe was to ſhew the aſcent of the Comet's tail in the parts oppoſite the Sun, render all attempts to reduce thoſe obſervations to accuracy ineffectual. However, that he would omit nothing, he with great trouble procured *Appian*'s Book, intituled, *Aſtronomicon Cæſareum*, dedicated to the Emperor *Charles* V.

But as the Longitude of the fix'd Stars were very erroneouſly aſſign'd at that Time to what they are at preſent, if the true ones are ſubſtituted, as likewiſe allowance made for the refractions, the places of that Comet were thus,

True place of Comet.

		deg.	min.	ſec.
Auguſt 13, 1531,	*Leo*	20	16	0
23	*Libra*	3	49	0

But according to *Appian*'s obſervations.

		deg.	min.	ſec.
Auguſt 13, 1531,	*Leo*	19	15	0
23	*Libra*	1	23	0

Now tho' *Appian*'s places of the Comet differ from the true ones, on account of his uſing wrong Latitudes and Longitudes of the fixt Stars, and bad inſtruments; yet the differences are not equal in all, but greater in ſome, and leſs in others, which ſhews they were not all equally accurate, for on the 13th of *Auguſt* he differs but 1 degree, 1 minute from the truth, but on the 23d of *Auguſt* he differs from the true place 2 degrees 26 minutes,

ſo that they differ among themſelves more than from the true obſervations, which makes it impoſſible to reconcile ſuch inconſiſtences; however, tis ſufficient to ſhew that this Comet kept a tract very ſimilar to that of 1682, and if you make a little addition to the latitude, almoſt the very ſame.

As this Theory agrees with the real obſervations of three different Comets, made in 1531, 1607, and 1687, it would be next to a miracle if three different Comets ſhould three times keep the ſame tract, and more than a miracle if it were not the third revolution of the ſame Comet, in an elliptic curve: If therefore he ſays it appears again about the year 1758, impartial poſterity muſt needs allow this to be the diſcovery of an *Engliſhman*.

And this he ſays is as it were the Mercury of Comets revolving round the Sun in the ſmalleſt Orbit, whilſt others appear not again under the ſpace of a hundred, and ſome of many hundred years; at which time, arriving in the neighbourhood of the Sun, they ſhine with a greater luſtre, and ſend forth conſpicuous tails, which are nothing but ſubtle vapors exhaled from the body of the Comet by the intenſeneſs of the Sun's heat, as ſteam from water ſet over the fire; but concerning this he refers to *Newton* according to his cuſtom, arguing very forcibly at the end of the third book of his *Principia*, who therein, among other things, enters into the following ſpeculation; to wit, that the earth (by furniſhing ſuch a quantity of moiſture for the growth of vegetables, which when they wither become dry ſubſtances) would in a ſufficient length of time be exhauſted, and left a hard and dry body, unleſs ſupply'd by ſome means or other: Now the tails of Comets, like

other

other vapors, dilate themſelves as they aſcend, and conſequently are ſcattered through all the planetary regions, and from thence are gathered up by the Planets as they paſs thro' their Orbits, for they have a power to attract all bodies to them: Now theſe vapours, by entering into the atmoſphere of the earth, may well be ſuppoſed to contribute to the renovation of all things, and in particular to ſupply the diminution cauſed in the humid parts of the earth by putrefaction and vegetation. So far are they from portending any miſchief to us, which the natural fears of men are ſo apt to ſuggeſt, from the appearance of any thing ſtrange or uncommon.

And that the tails of Comets have ſome ſuch important uſe is very reaſonable, if we conſider, that theſe bodies ſeem to be framed of a texture which purpoſely diſpoſes them to fume in that ſort, and that they do not merely emit thoſe fumes or tails by their near approach to the Sun alone without any other conſideration; for the earth is more than half the year at a leſs diſtance from the Sun than either of the two Comets were, which appeared in the years 1664 and 1665, when they were neareſt thereto; and the Comet of 1682 never approached the Sun above half ſo near as *Mercury* did, and but very little nearer than *Venus*; yet all thoſe Comets emitted tails, whereas both the Earth, *Mercury* and *Venus* were free from any ſuch appearances.

The only objection that can be made againſt this opinion, is the difficulty of explaining how a ſufficient quantity of vapor can be raiſed from the body of a Comet, to fill thoſe vaſt ſpaces, through which their tails are ſometimes extended.

Which

Which Sir *Iſaac Newton* removes by the following computation; and he finds, that a Globe of ſuch air as we breath in, which ſhall be only one inch in diameter, if it were carried up to the height but of one Semidiameter of the earth, would thereby become ſo rarify'd, that it would fill all the planetary regions, even to the ſphere of *Saturn*, and far beyond: now as the tails of Comets are much higher, they may eaſily be conceived to fill all that ſpace they are ſeen to take up.

The only ſcruple left is, how theſe tails can reflect light enough as to appear bright and ſhining, if they are compoſed of ſo thin a vapor as this computation implies; for the removal of which, Sir *Iſaac Newton* obſerves, that the moſt refulgent of theſe tails, hardly appears brighter than a beam of the Sun's light tranſmitted into a dark room thro' a hole of a ſingle inch diameter, and that the ſmalleſt fix'd Stars are viſible thro' them without any ſenſible diminution of their luſtre.

All theſe conſiderations put it beyond doubt what is the true nature of the tails of Comets; and as to what has been reported of the ſtrange ſhapes in which thoſe tails have appeared, as no ſuch thing has been recorded by Aſtronomers, who, on the contrary, aſcribe the ſame likeneſs to the tails of all Comets; he refers all thoſe to accidental refractions, by intervening clouds, or to parts of the milky way contiguous to the Comets *.

And that the tails of Comets are vapors he further confirms from the following conſiderations: Firſt, the tails of Comets are but ſmall, while they are at a great diſtance from the Sun, but enlarge

* Theſe arguments are laid down Phil. Princip. of Natural Philoſophy, Page 509, to 517.

in

in proportion as they approach him, which ſhews that the tail depends upon the degree of heat which the Comet receives from the Sun. Secondly, the tails of Comets are always oppoſite the Sun, in the ſame manner as ſteam or ſmoke aſcends from the fire that produced it. Thirdly, the tails of Comets perfectly reſemble the ſmoke or vapor of a burning coal, for if the coal remains fixed, the ſmoke aſcends perpendicularly, but if the coal be in motion it aſcends obliquely, and the different appearances of the heads of Comets, greatly confirm this opinion of their tails; for ſmoke raiſed by a ſtrong heat is blacker and groſſer than when raiſed by a leſs; and accordingly the heads of Comets, having been more heated by the Sun, are leſs ſhining than when they were leſs heated, juſt as if they were then obſcured by ſuch groſs ſmoke.

Fourthly, theſe tails or vapors are likewiſe found to participate of another property of aſcending vapor, which is, that when it aſcends with the greateſt velocity, it is leaſt incurvated.

And laſtly, from the very near approach to the Sun of the Comet of 1680, Sir *Iſaac Newton* draws another Speculation; to wit, that ſome people have heretofore ſuggeſted, tho' it be very difficult to prove, that the Sun, by a conſtant emiſſion of light and heat, does really diminiſh; now ſhould that be the caſe, yet might a Comet approach ſo near its ſurface as to be attracted thereto, and thereby ſupply any decreaſe it may have hitherto undergone.

The reader will eaſily perceive, that entering farther into this ſubject would have engaged me in ſuch ſort of Calculations, as depend on principles the generality of people are unacquainted with, and

and which has been avoided as much as poſſible, thereby to render it intelligible to a greater number; I ſhall therefore take leave by obſerving, that Sir *Iſaac Newton* concludes his Mathematical Principles of Natural Philoſophy, by giving his thoughts concerning the Deity, wherein he remarks, that the Similitude and Symmetry found in all the parts of the univerſe, make it undoubted that the whole is governed by one Supream Being, to whom is owing the Original of the frame of Nature, which evidently is the effect of choice and deſign, and ſtating briefly the Metaphhyſical Notions of God, he concludes, that the Deity muſt neceſſarily be both immenſe and Eternal.

F I N I S.