

PHILOSOPHICAL
TRANSACTIONS:

On the Proper Motion of the Sun and Solar System; With an Account of Several Changes That Have Happened among the Fixed Stars since the Time of Mr. Flamsteed. By William Herschel, Esq. F. R. S.

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PHILOSOPHICAL
TRANSACTIONS.

XVII. *On the proper Motion of the Sun and Solar System ; with an Account of several Changes that have happened among the fixed Stars since the Time of Mr. Flamsteed. By William Herchel, Esq. F. R. S.*

Read March 6, 1783.

THE new lights that modern observations have thrown upon several interesting parts of astronomy begin to lead us now to a subject that cannot but claim the serious attention of every one who wishes to cultivate this noble science. That several of the fixed stars have a proper motion is now already so well confirmed, that it will admit of no further doubt. From the time this was first suspected by Dr. HALLEY we have had continued observations that shew Arcturus, Sirius,
VOL. LXXIII. L 1 Aldebaran,

Aldebaran, Procyon, Castor, Rigel, Altair, and many more, to be actually in motion; and considering the shortness of the time we have had observations accurate enough for the purpose, we may rather wonder that we have already been able to find the motions of so many, than that we have not discovered the like alterations in all the rest. Besides, we are well prepared to find numbers of them apparently at rest, as, on account of **their** immense distance, a change of place cannot be expected to become visible to us till after many ages of careful attention and close observation, though every one of them should have a motion of the same importance with Arcturus. This consideration alone would lead us strongly to suspect, that there is not, in strictness of speaking, one *fixed* star in the heavens; but many other reasons, which I shall presently adduce, will render this so obvious, that there can hardly remain a doubt of the general motion of all the stary systems, and consequently of the solar one among the rest.

I might begin with principles drawn from the theory of attraction, which evidently oppose every idea of absolute rest in any one of the stars, when once it is known that some of them are in motion: for the change that must arise by such motion, in the value of a power which acts inversely as the squares of the distances, must be felt in all the neighbouring stars; and if these be influenced by the motion of the former, they will again affect those that are next to them, and so on till all are in motion. Now as we know several stars, in divers parts of the heavens, do actually change their place, it will follow, that the motion of our solar system is not a mere hypothesis; and what will give additional weight to this consideration is, that we have the greatest reason to suppose most of those very stars, which have been observed to move, to be
such

such as are nearest to us; and, therefore, their influence on our situation would alone prove a powerful argument in favour of the proper motion of the sun, had it actually been originally at rest. But I shall waive every view of this subject which is not chiefly derived from experience.

To begin with my own, I will give a short but general account of the most striking changes I have found to have happened in the heavens since FLAMSTEAD's time. I have now almost finished my third review. The first was made with a Newtonian telescope, something less than 7 feet focal length, a power of 222, and an aperture of $4\frac{1}{2}$ inches. It extended only to the stars of the first, second, third, and fourth magnitudes. Of my second review I have already given some account*: it was made with an instrument much superior to the former, of 85,2 inches focus, 6,2 inches aperture, and power 227. It extended to all the stars in HARRIS's maps, and the telescopic ones near them, as far as the eighth magnitude. The catalogue of double stars, which I have had the honour of communicating to the Royal Society, and the discovery of the Georgium Sidus, were the result of that review. My third review was with the same instrument and aperture, but with a very distinct power of 460, which I had already experienced to be much superior to 227, in detecting excessively small stars, and such as are very close to large ones. At the same time I had ready at hand smaller powers to be used occasionally after any particularity had been observed with the higher powers, in order to see the different effects of the several degrees of magnifying such objects. I had also 18 higher magnifiers, which gave me a gradual variety of powers from 460 to upwards of 6000, in order to pursue particular objects to the full extent of

* Phil. Transf. vol. LXX. LXXI. LXXII.

my telescope, whenever a favourable interval of remarkably fine weather presented me with a proper opportunity for making use of them. This review extended to all the stars in FLAMSTEAD'S catalogue, together with every small star about them, as far as the tenth, eleventh, or twelfth magnitudes, and occasionally much farther, to the amount of a great many thousands of stars. To shew the practicability of what I have here advanced, it may be proper to mention, that the convenient apparatus of my telescope is such, that I have many a night, in the course of eleven or twelve hours of observation, carefully and singly examined not less than 400 celestial objects, besides taking measures of angles and positions of some of them with proper micrometers, and sometimes viewing a particular star for half an hour together, with all the various powers of my telescope. The particularities I attended to in this last review were, 1. The existence of the star itself, such as it is given in the British catalogue. 2. To observe well whether it was double or single, well defined or hazy. 3. To view and mark down its particular colour, whenever the altitude and situation of the star would permit it to be done with certainty. 4. To examine all the small stars in the neighbourhood, as far at least as the twelfth magnitude, and note the same particulars concerning them, except the colours, which would have taken up too much time in committing to paper, and be of no very material use. The result of these observations I shall collect under a few general heads in the following articles.

I.

Stars that are lost, or have undergone some capital change, since FLAMSTEAD'S time.

In the British catalogue we find two remarkable stars of the fourth magnitude in the constellation of Hercules, *viz.* the
 Both

80th and 81st. They are no more to be seen. I looked for them in October, 1781, but could not find them; and have since frequently examined that part of the heavens with no better success, though the small stars α , β , γ , of the sixth magnitude, not far from the place where the former should be, appear very plainly in a fine evening. On referring to my preceding review in August, 1780, I find, that I then also examined the left foot of Hercules, and had these stars been there at that time I must have seen them; for not only α of the fourth magnitude, but γ of the sixth, is in the list of stars examined; and the place of the 80th and 81st is very near directly between them.

In the northern claw of Cancer FLAMSTEAD has placed three stars of the sixth magnitude; they are the 53d, 55th, and 56th of his catalogue. The latter of them is vanished. Its place and magnitude are so well pointed out by the other two stars, that there can remain no doubt of this remarkable change. We find a very small telescopic star near the place where the 56th should be: this may possibly be the remains of that vanishing star; but that may be ascertained by those astronomical gentlemen, who, having fixed instruments, can determine the place of this small star, and compare it with the 56th of Cancer, when it will appear how far their places agree. I missed it first in February, 1782, and have since looked often for it in vain.

The 19th Persei, a star of the 6th magnitude, is either lost, or so considerably removed from its place in FLAMSTEAD'S time, that it is no longer to be known. What gives occasion for a suspicion of its having been removed is, that we find no star of the sixth magnitude in the place where this should be; whereas, about a degree following that situation, there is one of that, or the fifth magnitude, not taken notice of by FLAM-

STEAD, who could not overlook so considerable a star if it had been there in his time; because, being not far from the parallel of τ and ν , both which he has given us, it must have passed the field of view of his telescope whenever he observed them.

The 108th Piscium, a star of the sixth magnitude, near the head of Aries is lost. The 107th and 109th, both marked as smaller stars in FLAMSTEAD's catalogue, and near the place of the 108th, are easily discovered.

Two stars of the sixth magnitude, the 73d and 74th Cancri, in the southern claw, are either both lost, or at least have undergone such a remarkable change of magnitude, and one of them of place, that it is hardly possible to know them any longer. The alteration must evidently appear when we compare them to the 81st and 82d Cancri; the former of which, though only marked of the 7th magnitude, far outshines the brightest of those which may be supposed to be the two stars in question.

The 8th Hydræ is lost. There is a star just by, which I take to be the 31st Monocerotis. If this should be the 8th Hydræ, and a small star near the latter should agree with the place of the 31st Monocerotis, then the magnitudes will be quite contrary to what FLAMSTEAD makes them. There must, at all events, have been a very remarkable change.

The 26th Cancri is lost. Near this star is placed the 22d of the same constellation, and, as their distance is not much more than a quarter of a degree, it requires fixed instruments to determine which of the two is the star wanting: from the magnitude, however, I surmise, that the remaining star is the 22d rather than the 26th.

The 62d Orionis is lost; and a star near the 54th and 51st is not taken notice of by FLAMSTEAD. Perhaps the 62d has changed place; if this should be the case, it must have a very considerable motion.

The 71st Herculis, a star of the 5th magnitude, is lost. The 70th and 71st are so near each other by FLAMSTEAD'S catalogue, that it cannot be determined without fixed instruments, which is the star wanting. There is a small telescopic star, within about 30 minutes north following, in a direction towards μ Lyræ; if that should be the 71st, it is wonderfully changed both in place and size. The 40th star in Mr. MAYER'S collection of double stars * seems to be the 70th Herculis of FLAMSTEAD. Now, as that star is perfectly single in my telescope, with every power I have tried upon it, we may surmise that one of the stars which is now vanished was still visible in the year 1778, when Mr. MAYER observed it, though then already diminished from the 5th to the 8th magnitude.

The 34th Comæ Berenices is lost: FLAMSTEAD has marked it as a star of the 5th magnitude.

The 19th of the same constellation is also lost, or moved and changed in magnitude.

The 40th and 41st Draconis have undergone so great an alteration of place that we cannot possibly mistake it; for in FLAMSTEAD'S time they were above three minutes asunder, whereas now their distance is much less than half a minute. A more particular account of these two stars will be given in a second collection of more than 400 new double stars, observed in my third review, which I hope soon to have the honour of presenting to the Royal Society.

There seems to be an alteration in the place of the 65th, 64th, 54th, and 57th Orionis; but without fixed instruments I cannot ascertain in which of the stars it is. Their situation in the heaven does not agree with that which is delineated in FLAMSTEAD'S Atlas Cœlestis, for these two pair of stars are

* De novis in Cœlo sidereo phænomenis.

much nearer now than they should be, according to that account.

II.

Stars that have changed their magnitude since FLAMSTEAD'S time.

α Draconis is so much less than β , which is set down as a smaller star in FLAMSTEAD'S catalogue, that the change of magnitude cannot be doubted.

β Ceti marked of the 3d, and α Ceti of the 2d, are evidently the reverse, β being by much the larger star. I have mentioned this circumstance in my observations on the periodical star in Collo Ceti*, and it seems now as if the difference between the magnitudes of these two stars was still increasing.

ζ Serpentis is not near so large as η , and yet we find FLAMSTEAD has placed them in the same class: however, we cannot intirely confide in the marks of the magnitudes when two stars are placed in the same class, since every order admits of a considerable variety; but when the marks contradict experience so far as to describe one star, for instance, of the third, and another of the 4th magnitude, when observation shews the latter to be of the 3d and the former of the 4th, I think we can hardly doubt but that there must have been a change.

η Cygni is a brighter star than χ , though marked by FLAMSTEAD of a less magnitude.

The 2d Ursæ minoris is marked of the 6th magnitude, but is certainly intitled to the 5th.

η Bootis is much larger than ζ .

ι Delphini is much larger than κ .

β Trianguli is much larger than α .

γ Aquilæ is much larger than β .

* Phil. Transf. vol, LXX. numb. xxxi.

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σ Sagittarii is larger than δ , γ , and ϵ , though marked of an inferior magnitude.

δ Canis majoris is larger than β , and yet is marked to be less.

η Serpentis is so much larger than ζ , that they certainly should not have been put in the same order of magnitude.

α Serpentarii is larger than γ and ϵ , though marked to be of a less magnitude than either.

β Equulei is so much less than α that it could hardly deserve to be put in the same class.

δ Delphini is larger than ϵ , though placed in an inferior order.

ϵ Bootis is so much larger than ζ that it should not be put into the same order.

δ Sagittæ is larger than α and β , though placed in a lower order of magnitude.

δ Urfæ majoris is less than either ϵ , ζ , or η , though it is marked of a superior order of magnitude. Besides, it is evidently visible, that δ cannot be intitled to more than the 4th magnitude, or at most to between the 4th and 3d: on the contrary, ϵ , ζ and η , should be of the 2d, or at least between the 2d and 3d; all which is very different from FLAMSTEAD's account of those remarkable stars.

α Urfæ majoris is less than any star marked of the same magnitude, and cannot have the least pretension to be called a star of between the 1st and 2d, as FLAMSTEAD has marked it, and as I make no doubt it was in his time.

The 1st and 2d Hydræ are noted by FLAMSTEAD as being of the 4th magnitude, whereas they now are only of the 8th or 9th. It is remarkable, that the 30th Monocerotis, which is situated between them, has retained the order assigned to it

by FLAMSTEAD, and being of the 6th ferves to point out the change of the other two in a very evident manner.

γ Lyræ is much larger than β .

The change in the magnitudes of the 31st and 34th Draconis is very striking, these two stars being just the contrary of what they are marked in FLAMSTEAD'S catalogue. The 31st from the 7th is increased to the 4th; and the 34th, from being a star between the 4th and 5th, is reduced to one of the 6th, if not 7th magnitude.

The 44th Cancræ is much too small for the 6th magnitude. As ϵ and others are marked of the 6th, this, on being compared to them, can be intitled to no more than the 8th or 9th order.

The 96th Tauri is small enough to be of the 8th magnitude, though marked as one of the 6th.

The 62d Arietis is of the 5th magnitude, though only marked of the 6th.

The magnitudes of the 12th and 14th Lyncis are just the reverse in the heavens to what FLAMSTEAD has marked them. This denotes a double change of a star from the 5th to the 7th, and from the 7th to the 5th magnitude.

The 38th Persei, marked of the 6th magnitude, is increased so as to be equal to θ and κ of the 4th. Also, θ is less than \dagger contrary to FLAMSTEAD.

The 8th Monocerotis is less than the 76th Orionis, though the former should be of the 4th, and the latter only of the 6th magnitude.

The 23d Geminorum, though marked of the 5th, is less than the 21st of between the 6th and 7th magnitude.

The 26th Orionis is much too small for the magnitude of which it is marked to be, or rather is lost; for I can hardly take any one of the remaining telescopic stars for it.

ξ Leonis in FLAMSTEAD's time was of the 4th; but is now less than a star of the 5th magnitude.

III.

Stars newly come to be visible.

Near Lacerta's tail-end is a star of between the 4th and 5th magnitude, not mentioned in FLAMSTEAD's catalogue, though the 1st Lacertæ, not far from that place, is recorded. It is so easy to be seen with the naked eye, and in a spot where but few stars of that magnitude are near, that we can hardly account for its being omitted if it had been visible to FLAMSTEAD. Its colour is pale red.

The star of the 5th magnitude following τ Persei, supposed to be *v* removed, is most likely new, unless future observations were to favour the supposed motion of this star. It is among the double stars of my 4th class, so that it will be easy to detect its proper motion.

A very considerable star, not marked by FLAMSTEAD, will be found near the head of Cepheus. Its right ascension in time, is about 2' 19" preceding FLAMSTEAD's 10th Cephei, and it is about 2° 20' 3" more south than the same star. It is of a very fine deep garnet colour, such as the periodical star *o* Ceti was formerly, and a most beautiful object, especially if we look for some time at a white star before we turn our telescope to it, such as α Cephei, which is near at hand.

A considerable star in a direction from the 68th Geminorum towards the 61st is not to be found in FLAMSTEAD, its colour is red.

A star of a considerable magnitude preceding the 1st Equulei is not contained in FLAMSTEAD's catalogue. It is a double star of the first class, the 61st of my second collection, where measures of it will be found.

A considerable star following the 1st Sextantis, and another following the 7th, are not inserted.

Between β Cancri and δ Hydræ is a very considerable star not marked by FLAMSTEAD, though its situation is very remarkable. As the constellation of Cancer contains so rich a collection of very small stars, it is to be wondered how a star of such consequence could be omitted, if it had been visible in FLAMSTEAD's time.

Nearly $1\frac{1}{2}$ degree north following δ Herculis, almost in the direction of δ and ν , is a star of the 5th, or between the 4th and 5th magnitude, very visible to the naked eye. We can hardly think FLAMSTEAD could have overlooked it, had it been there in his time.

About 3 degrees south preceding γ Bootis, a considerable star not in FLAMSTEAD's catalogue of the 6th magnitude; and south preceding λ , another, almost as large.

Here we ought to observe, that it is not easy to prove a star to be newly come; for though it should not be contained in any catalogue whatsoever, yet the argument for its former non-appearance, which is taken from its not having been observed, is only so far to be regarded as it can be made probable, or almost certain, that a star would have been observed had it been visible. For these reasons I will lay no particular stress on the new appearance of the above stars; they are, however, such as do well deserve to have their places settled, while I shall leave it to others to determine how far they may think them to be new visitors to those starry regions that fall within the reach of our sight.

To return to the principal subject of this paper, which is the proper motion of the sun and solar system: does it not seem very natural, that so many changes among the stars,—many increasing their magnitude, while numbers seem gradually to vanish;—several of them strongly suspected to be new-comers, while we are sure that others are lost out of our sight;—the distance of many actually changing, while many more are suspected to have a considerable motion:—I say, does it not seem natural that these observations should cause a strong suspicion that most probably every star in the heaven is more or less in motion? And though we have no reason to think, that the disappearance of some stars, or new appearance of others, nor indeed the frequent changes in the magnitudes of so many of them are owing to their change of distance from us by proper motions, which could not occasion these phenomena without being inconceivably quick; yet we may well suppose, that motion is some way or other concerned in producing these effects. A slow motion, for instance, in an orbit round some large opaque body, where the star, which is lost or diminished in magnitude, might undergo occasional occultations, would account for some of those changes, while others might perhaps be owing to the periodical return of large spots on that side of the surface which is alternately turned towards us by a rotatory motion of the star. The idea also of a body much flattened by a quick rotation, and having a motion similar to the moon's orbit by a change of the place of its nodes, whereby more of the luminous surface would one time be exposed to us than another, tends to the same end; for we cannot help thinking with Mr. DE LA LANDE (Mem. 1776), that the same force which gave such rotations, would probably also

also occasion motions of a different kind by a translation of the center *. Now, if the proper motion of the stars in general be once admitted, who can refuse to allow that our sun, with all its planets and comets, that is, the solar system, is no less liable to such a general agitation as we find to obtain among all the rest of the celestial bodies †.

Admitting this for granted, the greatest difficulty will be how to discern the proper motion of the sun between so many other (and variously compounded) motions of the stars. This is an arduous task indeed, which we must not hope to see accomplished in a little time; but we are not to be discouraged from the attempt. Let us, at all events, endeavour to lay a good foundation for those who are to come after us. I shall therefore now point out the method of detecting the direction and quantity of the supposed proper motion of the sun by a few geometrical deductions, and at the same time shew by an application of them to some known facts, that we have already some reasons to guess which way the solar system is probably tending its course.

Suppose the sun to be at S, fig. 1.; the fixed stars to be dispersed in all possible directions and distances around at s, s, s, s, &c. Now, setting aside the proper motion of the stars, let us first consider what will be the consequence of a proper motion in the sun; and let it move in a direction from A towards B.

* Relating to the motion of the fixed stars, the Astronomer Royal has an expression in the second page of the explanation and use of the tables published in his *Astronomical Observations*, which seems to favour this idea, where he mentions the “peculiar but small motions, which many, IF NOT ALL OF THEM, have among themselves, which have been called their *proper motions*, the causes and laws of which are hid for the present in almost equal obscurity.”

† See Mr. MICHELL's note, *Phil. Trans.* vol. LVII. p. 252.

Suppose it now arrived at C. Here, by a mere inspection of the figure, it will be evident, that the stars s, s, s , which were before seen at a, a, a , will now, by the motion of the sun from S to C, appear to have gone in a contrary direction, and be seen at b, b, b ; that is to say, every star will appear more or less to have receded from the point B, in the order of the letters ab, ab, ab . The converse of this proposition is equally true; for if the stars should all appear to have had a retrograde motion, with respect to the point B, it is plain, on a supposition of their being at rest, the sun must have a direct motion towards the point B, to occasion all these appearances. From a due consideration of what has been said, we may draw the following inferences.

1. The greatest or total systematical parallax of the fixed stars, fig. 2. will fall upon those that are in the line DE, at rectangles to the direction AB of the sun's motion.

2. The partial systematical parallax of every other star, s, s, s , not in the line DE, will be to the total parallax as the sine of the angle BSa , being the stars distance from that point towards which the sun moves, to radius.

3. The parallax of stars at different distances will be inversely as those distances; that is, one half at double the distance, one third at three times, and so on; for the subtense SC remaining the same, and the parallactic angle being very small, we may admit the angle SsC , to be inversely as the side Ss , which is the stars distance.

4. Every star at rest, to a system in motion, will appear to move in a direction contrary to that in which the system is moving.

Corollary. Hence it follows, that if the solar system be carried towards any star situated in the ecliptic: every star, whose angular

angular distance *in antecedentia* (reckoned upon the ecliptic from the star towards which the system moves) is less than 180 degrees, will decrease in longitude. And that, on the contrary, every star, whose distance from the same star (reckoned upon the ecliptic but *in consequentia*) is less than 180 degrees, will increase in longitude, in both cases without alteration of latitude.

From these principles it would be easy to draw general theorems for every possible direction of the motion of the solar system, by which we might find what alteration of longitude or latitude would take place in any given star; but it will be time enough for those investigations when we shall have more immediate occasion for them. What we are now chiefly to endeavour at is, the speedy method of obtaining sufficient facts to proceed upon.

The immense regions of the fixed stars may be considered as an infinitely expanded globe, having the solar system for its center. With this idea it will occur to us, that no method can be so proper for finding out the direction of the motion of the sun as to divide our observations on the systematical parallax of the fixed stars into three principal zones. These, for the convenience of fixed instruments, may be assumed so as to let them pass around the equator and the equinoctial and solstitial colures, every one being at rectangles to the other two, according to the three dimensions of solids. And since no observations can be so conveniently made to ascertain small relative proper motions among the fixed stars as those on double stars, I have continued my researches in that line with great application, and can now furnish out these three zones, with a very complete set of double stars for such observations. We have the greatest reason to hope for success in this attempt; for,

if

if I am not mistaken, there will be found a secular systematical parallax of some considerable value; nay, possibly, so short a space of time as ten years may suffice to bring us acquainted with many hitherto unknown celestial motions.

The equatorial zone, extending 10 degrees on each side of the equator, will contain about 150 stars which I have found to be double, *viz.*

Piscium 38. 51. 77. 86. north of 110. 113.

Ceti south of 13. foll. 25. 26. 37. north of 37. foll. 54. 61. 66.

Eridani 32. near 48. 62. 69.

Tauri near 10. 45. foll. 66. 88.

Orionis foll. 1. near 10. foll. 10. 19. pre. 20. 20. 23. near 26. 28. near 28. pre. 29. near 30. between 30 and 33. 32. 33. 34. foll. 34. pre. 36. 39. 41. near 42. 44. another 44. pre. 46. north of 46. foll. 47. 48. 50. 52. pre. 58. 58. 59.

Monocerotis 8. 11. near 11. In naribus. Sub genam. Inter pedes. near 12. foll. 15. pre. 25. foll. 25. 29. 31. near 31.

Canis minoris near 10. foll. 10. 14.

Cancri 17.

Hydræ pre. 4. pre. 4. foll. 4. 15. 17. pre. 22. 22. foll. 22. 27. 30. 31.

Leonis 3. foll. 3. pre. 43. south of 43. 57. foll. 63. 74. pre. 75. 83. 84.

Virginis 4. 17. 25. 29. pre. 44. 44. 51. 51. 84. pre. 93. 93.

Libræ 17. near 31.

Serpentis 58. 59. 63.

Serpentarii near 11. 53. 61. 67. south of 67. 70.

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Aquilæ

Aquilæ 2. near 6. near 6. pre. 7 and 8. 15. 24. pre. 30
near 35. near 35. 49. 53. near 54. 57. near 63. 64. near
65. near 65.

Delphini 1.

Aquarii 4. 4. 22. 24. 51. 55. south of 72.

Equulei 1. pre. 1. south of 2. south of 6. 7.

Pegasi 3. near 3. 8. near 18.

Piscium near 7. 8. south of 10. 35.

Ceti south of 4.

The zone of the equinoctial colure, extending 10 degrees of
a great circle on each side, will contain, as far as it is visible in
our hemisphere, about 70 double stars, *viz.*

Ceti foll. 4. near 13.

Aquarii 107.

Piscium 51. 38. 35. 76.

Andromedæ 21. Supra caput. 29. pre. 23. near 27. near
16. near 17.

Cassiopeæ pre. 25. prec. 25. 8. 24. 18. 6. 9. south of 11.

55. 34. 31. 4. 3. 2. near 33. 35. 36. near 3. 44. 47.

Cephei 1. foll. 32. foll. 32. foll. 31.

Ursæ minoris 1. 18.

Draconis 40 and 41. between 10 and 11. near 77.

Ursæ majoris 79. between 50 and 38. foll. 42. 65. 57. near
58. south of 69.

Canum venaticorum 12. 2.

Comæ Berenices 24. from 36 to 26. 2. 12.

Leonis 95. 90. 93. pre. 95.

Virginis 29. pre. 44. between 4 and 6. 17. 25. 27. south
of 12. 4.

Corvi 7.

Crateris 17. foll. 21.

The zone of the folstitial colure, of the same extent, will include about 120 double stars, *viz.*

Canis majoris north of 13. 17. foll. 5. foll. 2. foll. 5.

Monocerotis 11. 8. 12. near 11. In naribus. foll. 15. Inter pedes. Sub genam.

Leporis 13.

Orionis 48. near 42. 41. 44. 44. 50. foll. 72. 58. In fuste. 59. pre. 70 and 76. pre. 58. pre. 69.

Geminorum 43. 38. pre. 1. between 13 and 18. 21. 15. north of 19. 12. near 34. 27. 37. near 24. near 24. south of 18. foll. 13 and 18.

Tauri north of 123.

Aurigæ 29. 13. 37. 34. 32. south of 34. 56. near 59. pre. 58. pre. Nebulam. 41.

Lyncis 12. In naribus. 5. 13. In pectore. 19.

Camelopardali. In aure.

Ursæ minoris 1. near 18. near 12.

Draconis 39. 63. 19. 21. 56. 31. 47. 24 and 25. 69. 46. near 31. 40 and 41. 48. near 23. near 77.

Cephei 1. 8.

Herculis 75. 95. over 85. near 87. 100. 86. near 94. near 103.

Lyræ 4. 5. 6. 10. 3. 8. 11. near 3. near 6 and 7. foll. 5. foll. 10. pre. 10. pre. 14 and 15.

Serpentarii 70. 54. 61. 53. 67. near 67. north of 72. north of 72.

Serpentis 59. 63. 58.

Aquilæ near 7 and 8. 2. near 6. near 6.

Sagittarii 13. 38.

It will not be amiss to add a zone of the ecliptic, which will contain, among others, a great many double stars that may

undergo occultations by the moon or planets. This is of the same extent, and includes about 120 double stars.

Arietis north of 3. 5. pre. 6. north of 6. pre. 17. 30. 42.

pre. 54. foll. 62. pre. 63. foll. 63. foll. 63. foll. 63.

Tauri near 4. 7. pre. 8. foll. 11. 30. 52. 59. 62. 68. foll.

68. pre. 74. 87. 94. 103. north of 103. 105. 111. foll.

112. 114. foll. 117. 118. north of 123. κ .

Orionis 68. pre. 69. pre. 70 and 76.

Aurigæ 14. 26. pre. Nebulam.

Geminorum pre. 1. 4. 12. foll. 13 and 18. 15. 18. 21.

pre. 24. near 24. near 24. 27. 37. 38. 54. foll. 55. pre.

61. 63. north of 63. 66. 78. foll. 78. foll. 81.

Cancri 11. 16. foll. 16. 22. 23. 24. 30. 48. 54. pre. 77.

ω foll. ι .

Leonis 2. 3. foll. 3. 6. 7. 14. 25. 32. 41. south of 43.

pre. 43. foll. 44. 57. foll. 63. 74. pre. 75. 83. 84.

Virginis 4. foll. 4. pre. 4. 17. 25. 44. 51.

Hydræ 54.

Libræ pre. 12. 18. 24. 31. 51.

Scorpii 8. 14.

Serpentarii 5. 38. 39.

Sagittarii 13. 38. foll. 43. 64. near 65.

Capricorni north of 1. 5. 7. 9. 11. 12. near 29. 29. 39.

Aquarii 14. 22. foll. 43. 51. 55. 57. 70. 71. 72. 91. 94.

Pisicium near 7. south of 8. 35. 38. 51. 77. 86. 110. 113.

Ceti foll. 4. near 13. 26. 54.

An account of each of these double stars, not already in my first catalogue, will be contained in the second collection. It remains now only for me to make an application of this theory to some of the facts we are already acquainted with, relating to the proper motion of the stars. And first let me observe, that
the

the rules of philosophizing direct us to refer all phenomena to as few and simple principles as are sufficient to explain them. Thus, for instance, we see the stars and planets rise and set every day: now, as it is much more simple to admit the earth to turn once in 24 hours, than to suppose every single star to revolve round the earth in that time, we very justly ascribe a diurnal motion to the earth; but yet, since we find that the planets do not every night exactly retain their relative places among the stars, we next admit that such deviations from the law, which all the rest seem to obey, are owing to a proper motion of their own. To apply this to the solar system.—Astronomers have already observed what they call a proper motion in several of the fixed stars, and the same may be supposed of them all. We ought, therefore, to resolve that which is common to all the stars, which are found to have what has been called a proper motion, into a single real motion of the solar system, as far as that will answer the known facts, and only to attribute to the proper motion of each particular star the deviations from the general law the stars seem to follow in those movements.

By Dr. MASKELYNE's account of the proper motion of some principal stars*, we find that Sirius, Castor, Procyon, Pollux, Regulus, Arcturus, and α Aquilæ, appear to have respectively the following proper motions in right ascension. $-0''\text{,}63$; $-0''\text{,}28$; $-0''\text{,}80$; $-0''\text{,}93$; $-0''\text{,}41$; $-1''\text{,}40$; and $+0''\text{,}57$; and two of them, Sirius and Arcturus, in declination, *viz.* $1'\text{,}20$ and $2''\text{,}01$, both southward. Let fig. 3. represent an equatorial zone, with the above mentioned stars referred to it, according to their respective right ascensions,

* Astronomical Observations made at the Royal Observatory at Greenwich.

having the solar system in its center. Assume the direction AB from a point somewhere not far from the 77th degree of right ascension to its opposite 257th degree, and suppose the sun to move in that direction from S towards B; then will that one motion answer that of all the stars together: for if the supposition be true, Arcturus, Regulus, Pollux, Procyon, Castor, and Sirius, should appear to decrease in right ascension, while α Aquilæ, on the contrary, should appear to increase. Moreover, suppose the sun to ascend at the same time in the same direction towards some point in the northern hemisphere, for instance, towards the constellation of Hercules; then will also the observed change of declination of Sirius and Arcturus be resolved into the single motion of the solar system. I am well aware of the many yet remaining difficulties, such as the correspondence of the exact quantity of each star's observed proper motion with the quantity that will be assigned to it by this hypothesis; but we ought to remember, that the very different and still unknown relative distances of the fixed stars must, for a good while yet, leave us in the dark about the particular and strict application of the theory; and that any deviation from it may easily be accounted for by the still unknown *real* proper motion of the stars: for if the solar system have the motion I ascribe to it, then what astronomers have already observed concerning the change of place of the stars, and have called their proper motion, will become only an *apparent* motion; and it will still be left to future observations to point out, by the deviations from the general law which the stars will follow in those apparent motions, what may be their real proper motions as well as relative distances. But lest I should be censured for admitting so new and capital a motion upon too slight a foundation,

dition, I must observe, that the concurrence of those seven principal stars cannot but give some value to an hypothesis that will simplify the celestial motions in general. We know that the sun, at the distance of a fixed star, would appear like one of them; and from analogy we conclude the stars to be suns. Now, since the apparent motions of these seven stars may be accounted for, either by supposing them to move just in the manner they appear to do, or else by supposing the sun alone to have a motion in a direction, somehow not far from that which I have assigned to it, I think we are no more authorized to suppose the sun at rest than we should be to deny the diurnal motion of the earth, except in this respect, that the proofs of the latter are very numerous, whereas the former rests only on a few though capital testimonies. But to proceed: I have only mentioned the motions of those seven principal stars, as being the most noticed and best ascertained of all; I will now adduce a farther confirmation of the same from other stars.

M. DE LA LANDE gives us the following table of the proper motion of 12 stars, both in right ascension and declination, in 50 years*.

* *Ast. par M. DE LA LANDE, tom. IV. p. 685.*

Étoiles,	Chang. d'asc. droite,	Chang. de déclinaison.
Arcturus	- 1 11	- 1 55
Sirius	- 37	- 52
β Cygni	- 3	+ 49
Procyon	- 33	- 47
ϵ Cygni	+ 20	+ 34
γ Arietis	- 14	- 29
γ Gemin.	- 8	- 24
Aldébaran	+ 3	- 18
β Gemin.	- 48	- 16
γ Piscium	+ 53	+ 7
α Aquilæ	+ 32	- 4
α Gemin.	- 24	- 1

Fig. 4. represents them projected on the plane of the equator. They are all in the northern hemisphere, except Sirius, which must be supposed to be viewed in the concave part of the opposite half of the globe, while the rest are drawn on the convex surface. Regulus being added to that number, and Castor being double, we have 14 stars. Every star's motion, except Regulus, is assigned in declination as well as in right ascension, so that we have no less than 27 motions given to account for. Now, by assuming a point somewhere near λ Herculis, and supposing the sun to have a proper motion towards that part of the heaven, we shall satisfy 22 of these motions. For β Cygni, α Aquilæ, ϵ Cygni, γ Piscium, γ Arietis, and Aldebaran, ought, upon the supposed motion of the sun, to have an apparent progression, according to the hour circle XVIII, XIX, XX, &c. or to increase in right ascension, while Arcturus, Regulus, the two stars of α Geminorum, Pollux, Procyon, Sirius, and γ Geminorum, should apparently

go back in the order XVI, XV, XIV, &c. of the hour circle, so as to decrease in right ascension; but according to M. DE LA LANDE'S table, excepting β Cygni and γ Arietis, all these motions really take place. With regard to the change of declination, we see that every star in the table should go towards the south; and here we find but three exceptions in β and ϵ Cygni, and γ Piscium; so that upon the whole we have but five deviations out of 27 known motions which this hypothesis will not account for. And these exceptions must be resolved into the real proper motion of the stars.

There are also some very striking circumstances in the quantities of these motions that deserve our notice. First, Arcturus and Sirius being the largest of the stars, and therefore probably the nearest, ought to have the most apparent motion, both in right ascension and declination, which is agreeable to observation, as we find by the table. Next, in regard to the right ascension only, Arcturus being better situated to shew its motion, by theorem II. p. 261. ought to have it much larger, which we find it has. Aldebaran, both badly situated and considerably smaller than the two former, by the same theorem ought to shew but little motion. Procyon, better situated than Sirius, though not quite so large, should have almost as much motion; for by the third theorem, on supposing it farther off because it appears smaller, the effect of the sun's motion will be lessened upon it; whereas, on the other hand, by the second theorem, its better situation will partly compensate for its greater distance. This again is conformable to the table. ϵ Cygni very favourably situated, though but a small star, should shew it considerably as well as α Aquilæ; whereas β Cygni should have but little motion: and γ Piscium, best

situated of all, should have a great increase of right ascension, and these deductions also agree with the table.

In the last place, a very striking agreement with the hypothesis is displayed in Castor and Pollux. They are both pretty well situated, and we accordingly find that Pollux, for the size of the star, shews as much motion in right ascension as we could expect; but it is remarkable, and seemingly contrary to our hypothesis, that Castor, equally well placed, shews by the table no more than one half of the motion of Pollux. Now, if we recollect that the former is a double star, consisting of two stars not much different in size, we can allow but about half the light to each of them, which affords a strong presumption of their being at a greater distance, and therefore their partial systematical parallax, by the third theorem, ought to be so much less than that of Pollux, which agrees wonderfully with observation*. Not to mention the great difficulty in which we should be involved, were we to suppose the motion of Castor to be really in the star: for how extraordinary must appear the concurrence, that two stars, namely those that make up this apparently single star, should both have a proper motion so exactly alike, that in all our observations hitherto they have not been found to disagree a single second, either in right ascension or declination, for fifty years together! Does not this seem strongly to point out the common cause, the motion of the solar system?

* If the light of Castor was exactly equal to that of Pollux, and the two stars, which make up the former star, were perfectly of the same size, we might, on that account, suppose the distance of Castor from us to be to that of Pollux as $\sqrt{2} : 1$; but Castor is in fact something less bright; and this consideration, added to the former, will make it probable enough that its distance may perhaps be double that of Pollux.

With respect to the change of declination I would observe, that the point of λ Herculis, which in fig. 4. is assumed as the Apex * of the solar motion is not perhaps the best selected. A somewhat more northern situation may agree better with the changes of declination of Arcturus and Sirius, which capital stars may perhaps be the most proper to lead us in this hypothesis; but as we should be guided by facts in researches of this nature, it may be as well to expect the assistance of future observations before we are too particular in determining this point †.

It may be expected I should also mention something concerning the quantity of the solar motion; but here I can only offer a few distant hints. From the annual parallax of the fixed stars, which, from my own observations, I find much less than it has hitherto been proved to be, we may certainly admit (without entering into a subject which I reserve for a future opportunity) that the diameter of the earth's orbit, at the distance of Sirius or Arcturus, would not nearly subtend an angle of one second; but the apparent motion of Arcturus, if owing to a translation of the solar system, amounts to no less than $2''.7$ a year, as will appear if we compound the two motions of $1' 11''$ in right ascension, and $1' 55''$ in declination, into one single motion, and reduce it to an annual quantity.

* I use the term Apex here to denote that point of fig. 4. wherein all great circles, drawn through the supposed direction of the motion of the solar system, intersect, and which, in other stereographic projections, is generally a pole, either of the ecliptic or equator. As this point is in the northern or elevated hemisphere, the sun, by tending to it, may be said to ascend, and the term Apex may perhaps not be an improper one.

† From the additional testimony of other capital stars considered in the postscript it now appears, that the point of λ Herculis is probably as well chosen as any we can fix upon in that part of the heavens.

Hence we may in a general way estimate, that the solar motion can certainly not be less than that which the earth has in her annual orbit.

I have now only to add, that it is to be expected future observations will soon throw more light upon this interesting subject, and either fully establish or overturn the hypothesis of the motion of the whole solar system. To this end I have already begun a series of observation upon several zones of double stars; and should the result of them be against these conjectures, I shall be the first to endeavour to point out the fallacy of them.

Datchet near Windsor,

Feb. 1, 1783.

Postscript to the Paper on the Motion of the Solar System.

In my paper on the Motion of the Solar System, I used a table of the proper motion of some fixed stars, which M. DE LA LANDE has given us as an extract from TOB. MAYER'S Opera inedita. By the favour of my astronomical friend Mr. AUBERT, I am now furnished with the scarce edition of the original. This work contains a catalogue of the place of 80 stars, observed by Mr. MAYER in 1756, and compared with the same stars as given by ROEMER in 1706. From the goodness of the instrument with which the observations to which Mr. MAYER has compared his own were made, he gives it as his opinion, that where the disagreement in the place of a star is but small, it
may

may be attributed to the imperfection of the instrument; but that when it amounts to 10 or 15'', it is a very probable indication of a proper motion of such a star. He adds, that when the disagreement is so much as in some stars which he names, (among which is FOMAHAND, where the difference is 21'' in 50 years) he has not the least doubt of a proper motion*.

By this extensive table I thought it highly necessary immediately to examine the hypothesis of the motion of the solar system, that it might receive an early check from observations, if they should be unfavourable; or that, on the other hand, it might be supported by the additional evidence of more stars, if their apparent proper motions should coincide with the idea I have pointed out in my paper on this subject.

I have followed Mr. MAYER's judgement of his own and ROEMER's observations, and left out of the list all the stars that do not shew a disagreement amounting to 10'' in the places which are given for them in 1706 and 1756. I have also left out those 13, or rather 14 stars, which have already been examined in my paper, and have been shewn to support the hypothesis I have advanced: the rest are here drawn up in two tables. The first contains the stars that agree with my assigned motion of the solar system; or rather which are thereby resolved into apparent, or partly apparent, and partly proper motions. The second table contains those stars whose motions cannot be accounted for by my hypothesis, and must therefore be ascribed to a real motion in the stars themselves, or to some *still more hidden* cause of a *still remoter* parallax †.

* De motu fixarum proprio Commentatio. Op. ined. Vol. I. p. 79.

† That I may not be obscure, it will be proper to mention what I allude to, especially as it claims a distant connection with our subject, and may hereafter become of sufficient moment to engage our attention. Mr. MICHELL's admirable idea

idea of the stars being collected into systems (Phil. Transf. vol. LI, p. 249.) appears to be extremely well-founded, and is every day more confirmed by observations: though this does not, in my opinion, take away the probability of many stars being still as it were *solitary*, or, if I may use the expression, *intersystematical*. It occurs then naturally, that by the principle of gravitation, which is never at rest, and which we have no reason to doubt extends to all possible distances, one system of stars will act on another as if the stars of each system were all collected into the center of gravity of each respective system. Hence then will arise this evident consequence, that a star, or sun, such as ours, may have a proper motion within its own system of stars, while at the same time the whole starry system to which it belongs may have another proper motion, totally different in quantity and direction. It will require no little abstract consideration to conceive the possibility of what may be thus surmised; therefore an instance or two, to elucidate the matter, may not be improper. If an inhabitant of the 5th satellite of Saturn should have discovered, that his little world revolves at a great distance round a planet, and to his great astonishment should also have found, that this planet again revolves round the sun;—if, farther, our hypothesis of the solar motion should prove to be well-founded (which, in some of the stars, supposing them to be suns surrounded with planets and satellites, must certainly be the case); then a third capital motion will be introduced to this inhabitant of Saturn's satellite; and he will experience, in a narrow compass, what we now surmise may possibly be our case upon a more extended scale, by the motion of the whole system of stars to which our sun may belong. Another view may, perhaps, still better throw a light upon the subject. Let us admit that a very small nebula may be a collection of a thousand stars: and if Mr. MICHELL's opinion of our system of stars, which he assumes to be about a thousand (Phil. Transf. vol. LVII. p. 255.) has any foundation, all these stars taken together will only subtend an angle of barely a minute to an eye placed 3438 times as far from the center of the system as the two farthest stars in it are from each other. Now as I have found some of these nebulae that are so small, that a tolerably good telescope cannot distinguish them from a single star, whole systems of stars, when presented to our imagination under this diminutive shape of nebulae, will easily, I believe, be admitted among the number of those celestial bodies that may have a proper motion. I ought to carry this hint a little farther, just to shew that it may possibly be applied to the subject of resolving a number of concurrent proper motions of the fixed stars into apparent ones; and thereby, in process of time, to arrive at the knowledge of all the real complicated motions of the planet we inhabit; of the solar system

T A B L E I.

Names of stars.	Motion in R. A.	Motion in Decl.	Names of stars.	Motion in R. A.	Motion in Decl.
β Ceti	+ 32		ζ Hydræ	- 23	
α Arietis	+ 10		γ Leporis		- 10
δ Ceti	+ 15		ϵ Urfæ majoris	- 33	+ 10
α Ceti	+ 16		α Serpentarii	infern.	
α Persei	+ 16		γ Draconis	+ 12	
η Pleiadum		- 16	α Lyræ	infern.	+ 14
γ Eridani	+ 14		γ Aquilæ		- 20
ϵ Tauri		- 11	γ Capricorni	+ 19	
α Aurigæ	+ 11	- 11	ϵ Pegasi		- 28
β Orionis	infern.	infern.	δ Capricorni	+ 24	- 17
β Tauri	- 11	- 13	α Aquarii	+ 13	
α Orionis	infern.	- 11	ζ Pegasi		- 13
μ Geminorum	- 16		ϵ Comæ	+ 21	
ρ Navis	- 13	- 11	β Pegasi	+ 12	
β Cancri		- 14	α Andromedæ		- 21
ϵ Urfæ majoris	- 54		β Cassiopeæ	+ 34	

to which it belongs; and even of the sidereal system, of which this sun may possibly be a member. We see then, that while the sun, by a proper motion, is going towards a certain point of the heavens, each of the stars belonging to the sidereal system, of which the sun is one, supposing them to be relatively at rest, with respect to each other, will be affected in the manner I have shewn (p. 261, &c. of the Paper on the proper Motion of the Sun) notwithstanding the whole system should have a real motion in absolute space, and change its situation with respect to other systems or intersystematical stars. We see also, that with respect to stars not belonging to our system, no parallax can appear but what is compounded of the proper motion of the sun, and of the whole system to which it belongs. And should there ever be found, in any particular part of the heavens, a concurrence of proper motions of quite a different direction, we shall then, perhaps, begin to form some conjectures besides those already mentioned by Mr. MICHELL (p. 253. of the same volume of Transactions) which stars may possibly belong to ours, and which to other systems.

T A B L E II.

Polaris		+ 13	ζ Hydræ		+ 24
γ Ceti	- 14		α Hydræ		+ 13
β Persei	- 10		β Herculis	+ 14	
α Leporis		+ 11	γ Cygni	- 13	
μ Geminorum		+ 15	ε Pegasi	- 14	
ε Canis majoris		+ 10	ζ Pegasi	- 20	

From the first table we gather, that the principal stars, *Lucida Lyræ*, *Capella*, *α Orionis*, *Rigel*, *Fomahand*, *α Serpentarii*, *α Aquarii*, *α Arietis*, *α Persei*, *α Andromedæ*, *β Tauri*, *β Ceti*, and twenty more of the most distinguished of the second and third rank of stars, agree with our proposed solar motion; when, on the contrary, the second table contains but a few stars, and not a single one of the first magnitude amongst them to oppose it. It is also remarkable, that many stars of the first table agree both in right ascension and declination with the supposition of a solar motion, whereas there is not one among those of the second table which opposes it in both directions. This seems to indicate that the solar motion, in some of them at least, has counter-acted, and thereby destroyed the effect of their own proper motion in one direction, so as to render it insensible; otherwise it would appear improbable, that eight stars out of twelve, contained in the latter table, should only have a motion at rectangles, or in opposition to any one given direction. The same may also be said of nineteen stars among those of the former table, that only agree with the solar motion one way, and are as to sense at rest in the other direction; but these singularities will not be near so remarkable when we have the motion of the sun to compound with their

own proper motions. However, I forbear entering too much into refined consideration; what we are chiefly to determine, at present is, an outline or sketch of what many repeated, and farther extended, observations must ripen so far as in time to enable us to apply more particular calculations.

The motions of α Lyrae and ϵ Urfæ majoris towards the north are placed in the first table; it will, therefore, be proper to shew the general law by which the apparent declinations of the stars, at present under consideration, are governed. Let an arch of 90 degrees be applied to a sphere representing the fixed stars, so as always to pass through the apex of the solar motion: then, while one end of it is drawn along the equator, the other will describe, on the spherical surface, a curve which will pass through the pole of the equator, and return into itself at the apex. This curve, to borrow a term from natural history, is a *non-descript* as far as I can find at present, and may be called a spherical conchoid from the manner of its generation. The law then is, that all the stars in the northern hemisphere, situated within the nodated part of the conchoid, will seem to go to the north by the motion of the solar system towards its apex; the rest will appear to go southwards. A similar curve is to be delineated in the southern hemisphere, in the nodated part of which the same appearances will take place. It will require but little attention to see the truth of this construction.

Suppose the great circle *Acam*, fig. 5. of which the generating quadrant *mn* is a part, compleated; then will it intersect the equator *EQT* in two opposite points *me*. Now, since the apex *A*, by the hypothesis, is somewhere north of the equator, the great circle will always make some angle *AmQ* with it; and the point *n*, which is 90 degrees from the intersection *m*

with the equator, will be the most northern part of the semi-circle mmc . From what has been said (p. 261. of the paper on the Motion, &c.) it follows, that the apparent motion of any star sS will always be in an arch of a great circle $AsSc$ drawn through the apex A and star sS : therefore, if the star be less than 90 degrees of the generating circle distant from its intersection with the equator (having more northern declination than the apex) as at s , its northern declination will increase, and it will also fall within the nodated part of the conchoid $AxPy$; but when its distance from the intersection m is more than 90 degrees, as at S , the motion will be towards the south, and the star will be situated without the nodated part of the curve. That the star s will fall within the nodated part appears because ms being less than mn by supposition, if m be drawn towards E , to describe the conchoid the angle AmQ will decrease, and therefore the describing point n will be depressed below s as it approaches A . For the same reason S will fall without; since, by drawing m towards Q , the angle AmQ will become greater than SmQ , and the describing point n will pass above the star S . The application of this theory is very simple; for instance, let it be required to find whether any given star will fall within or without the conchoid. Then, in fig. 6, there will be given Ps , the polar distance of the star; and QPc , the difference of right ascension between the star and the apex of the sun's motion A ; also, the polar distance PA , and declination cA of the point A . Then, by trigonometry, the sides sP , PA , and the included angle being given, we find the side As and angle $PA s$. Again, the side cA , and angle $cAm = PA s$ of the right-angled triangle $Ac m$ being given, we find the hypotenuse Am ; and if $Am + As$ be less than 90 degrees, the star falls within the conchoid, otherwise without.

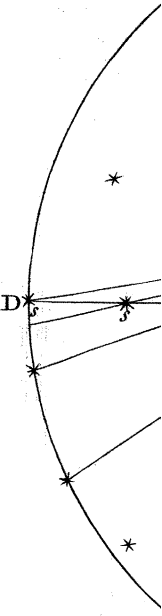
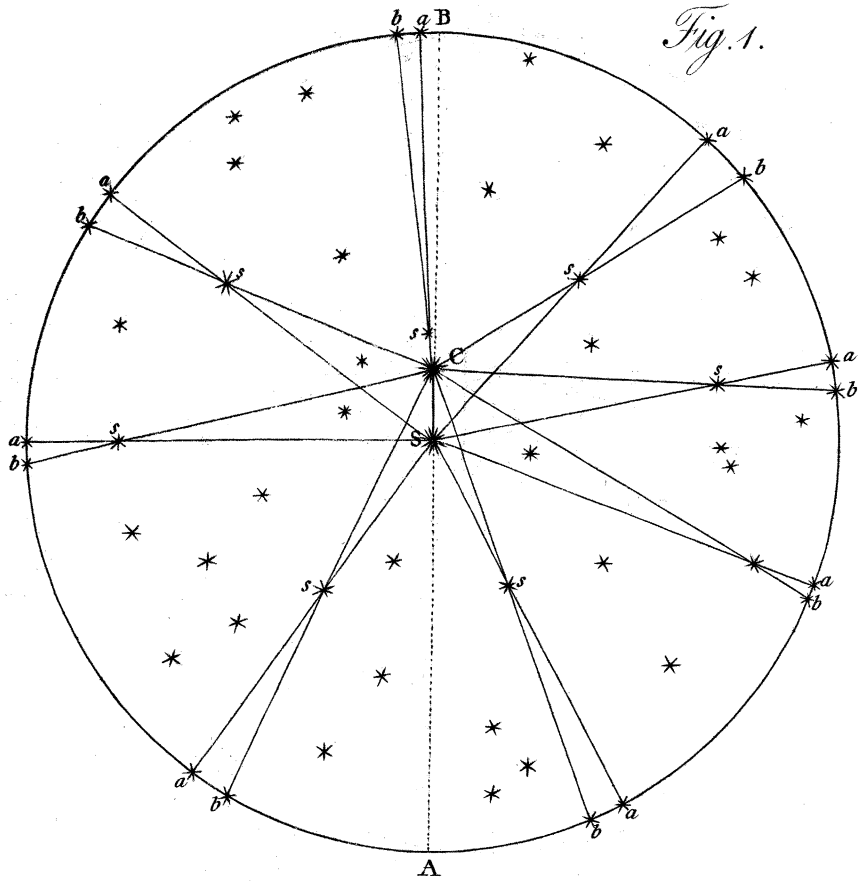
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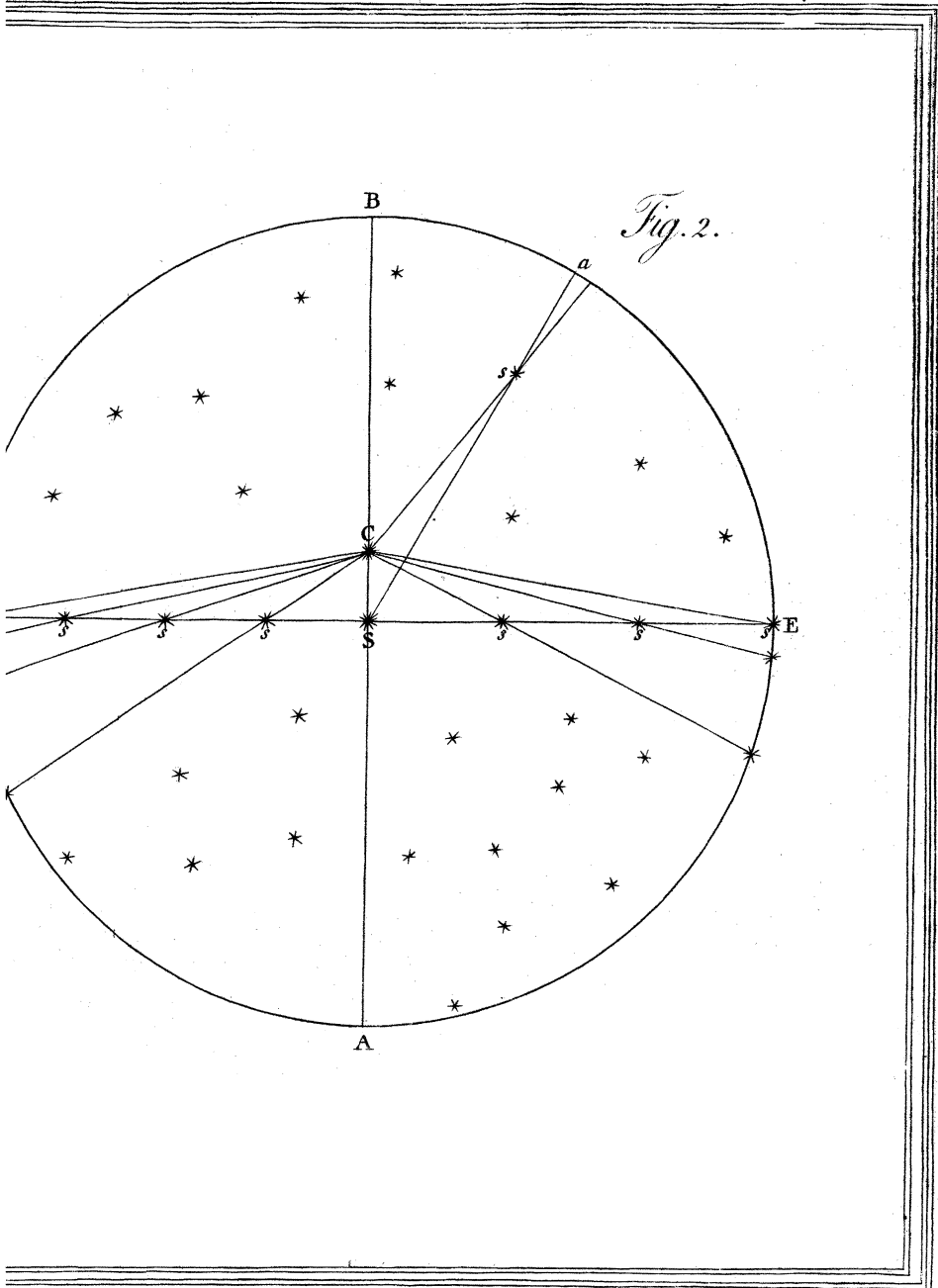
It will be found, that I have placed the want of sensible motion of α Lyræ and α Orionis in right ascension, and of Rigel both in right ascension and declination to the account of those stars that are in favour. These stars are so bright, that we may reasonably suppose them to be among those that are nearest to us; and if they had any considerable motion, it would most likely have been discovered, since the variations of Sirius, Arcturus, Procyon, Castor, Pollux, &c. have not escaped our notice. Now, from the same principle of the motion of the solar system, by which we have accounted for the apparent *motion* of the latter stars, we may account for the apparent *rest* of the former. Those two bright stars, α Lyræ and α Orionis, are placed so near the direction of the assigned solar motion, that from the application of my second theorem (p. 261. of the paper on the Motion of the Solar System) their motion ought to be insensible in right ascension, and not very considerable in declination, all which we find is confirmed by observation. With respect to Rigel and α Serpentarii, admitting them both as stars large enough to have shewn a proper motion, were their situation otherwise than it is, we find that they also should be apparently at rest in right ascension; and Rigel having southern declination, and being a less considerable star than α Orionis, which shews but 11" motion towards the south in 50 years, its apparent motion in declination may, on that account, be also too small to become visible.

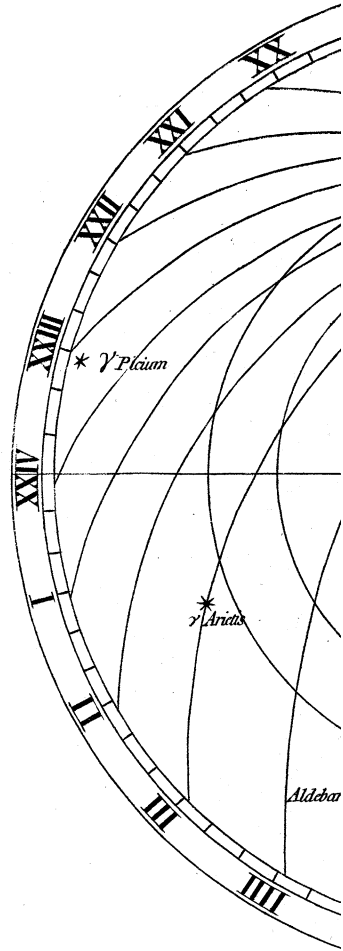
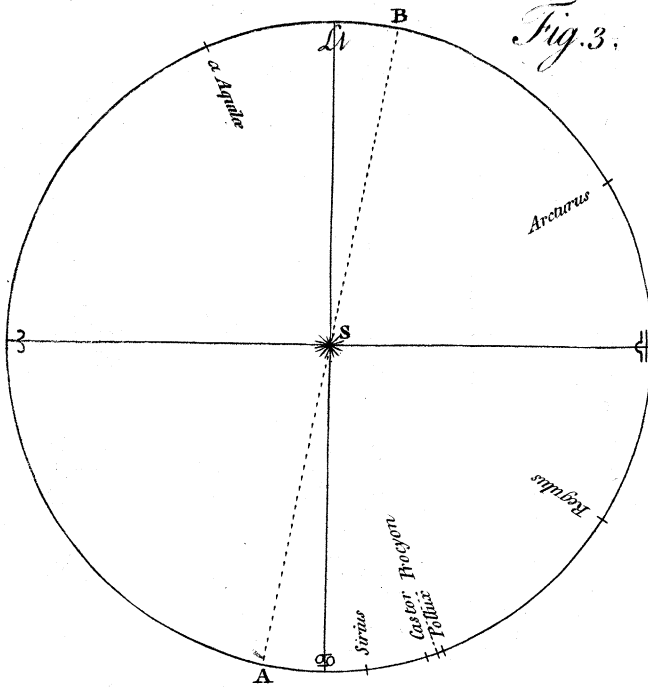
I should not omit to take notice of a very remarkable paragraph of MAYER'S, which seems to contain a strong objection against the motion of the solar system, while indeed it may be shewn to be a very good argument in its favour. At the end of his tract, *De Motu Fixarum*, he says: " Tandem, quum et quæri

“ illum explicare non posse per motum totius systematis so-
 “ laris, et si nec impossibile sit, solem, ut ejusdem cum fixis
 “ naturæ, instar harum quarundam in spatio mundano pro-
 “ moveri. Nam si sol et cum ipso planetæ omnes nostrumque
 “ domicilium terra, recta tenderent versus plagam aliquam, uni-
 “ versæ fixæ, quæ in ea plaga adparent paullatim a se invicem
 “ discedere, et quæ sunt in opposita parte coeli coire viderentur;
 “ non fecus ac per silvam ambulanti arbores, quæ ante viam
 “ sunt, disjungi videntur, quæ a tergo, congregari.” Now, if
 we recollect what has been said of the motion of the stars, we
 find, that those, towards which I suppose the solar system to
 move, do really recede from each other: for instance, Arcturus
 from α Lyræ; α Aquilæ and α Aquarii from α Serpentarii and ϵ
 Ursæ majoris; and, on the contrary, those in the opposite part
 of the heavens do really come nearer to each other; as Sirius
 to Aldebaran; Procyon to α Arietis; Castor, Pollux, Regulus,
 &c. to α Ceti, α Persei, α Andromedæ, &c. All this agrees
 with what MAYER says ought to happen, if the solar system
 was to have a motion towards a certain part of the heavens;
 which, by the bye, I find this admirable astronomer mentions
 as a very possible thing*. However, when he says that *all*
the stars in those parts towards which the sun might be sup-
 posed to move, should recede from each other, and *vice versa*;
 I must add, that this would only take place under the restric-
 tions of my first, second, and third theorems, and therefore it
 is not to be expected, that we should immediately see the effect
 of this parallax in any but the stars that are nearest to us. But
 as we have at present no other method of judging of the rela-
 tive distance of the fixed stars than from their apparent bright-

* This paper, *De Motu Fixarum*, was read at Gottingen in January 1760.







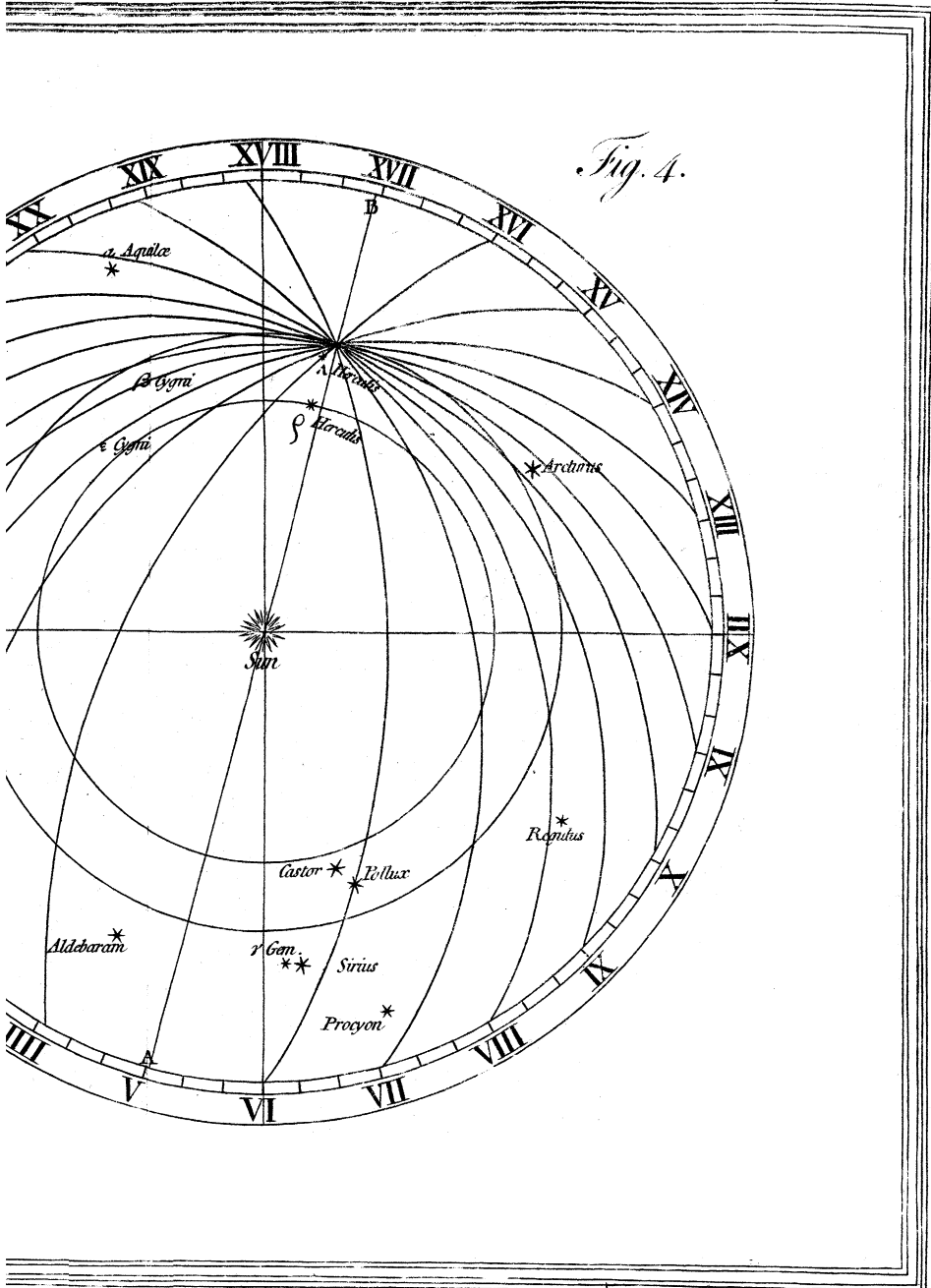
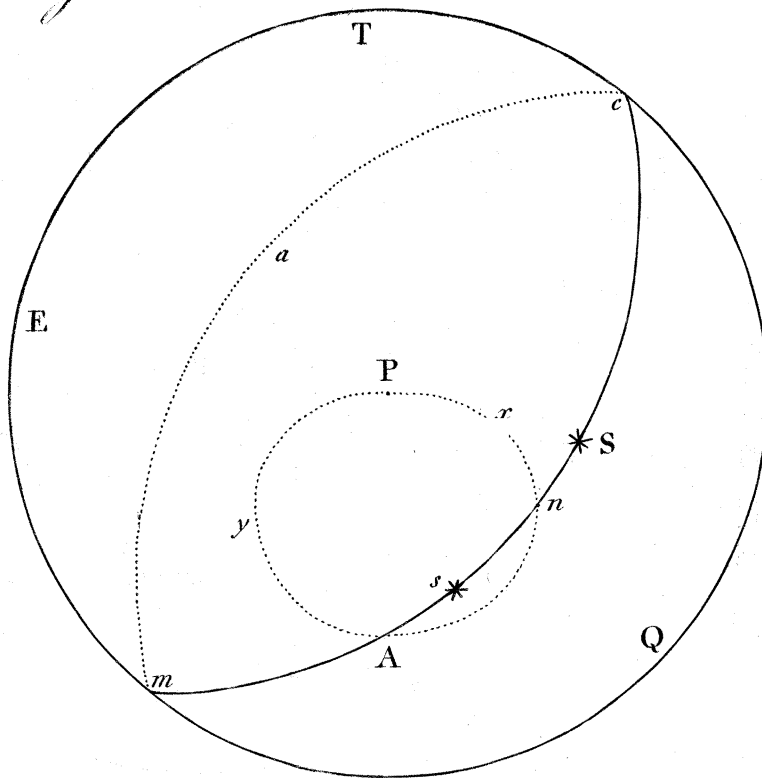


Fig. 4.

Bayle sc.

Fig. 5.



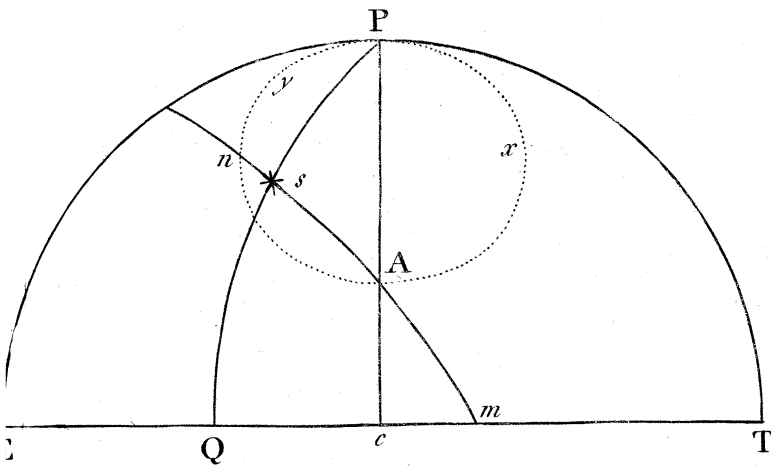


Fig. 6.

of the Sun and Solar System.

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ness, those that are most likely, on that account, to be affected by a parallax arising from the motion of the solar system, are the very stars which, by MAYER's own table, I have made use of to point it out to us*.

Datchet, March 13, 1783.

* I have lately been favoured by Dr. WILSON, Professor of Astronomy at Glasgow, with a short tract, called, "Thoughts on general Gravitation, and Views thence arising as to the state of the Universe;" wherein the possibility of a Solar Motion is also shewn. It was printed in 1777. Mr. DE LA LANDE, in the Memoirs for 1776, with his usual felicity of thought, has inferred the probable motion of the system from the sun having a rotation round his axis, when he says, p. 513. "Une force quelconque imprimée à un corps, et capable de le faire tourner autour de son centre, ne peut manquer aussi de déplacer le centre, et l'on ne sauroit concevoir l'un sans l'autre. Il paroît donc très-vraisemblable que le soleil a un mouvement réel dans l'espace absolu," &c.



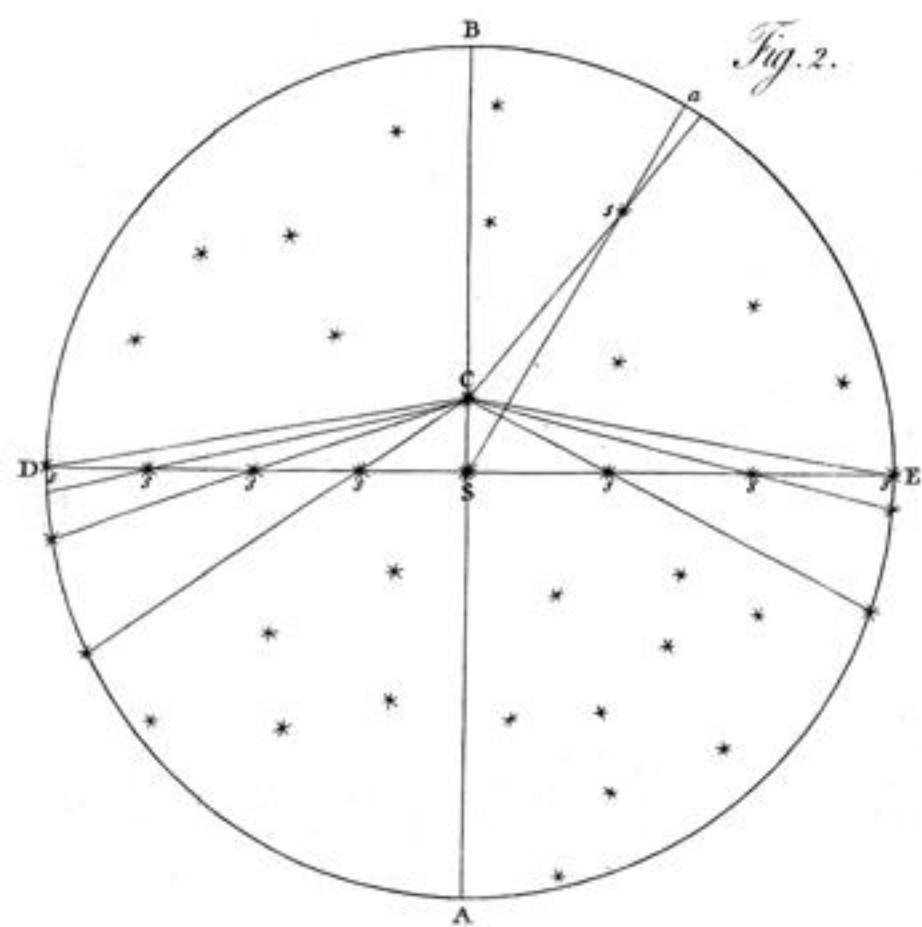
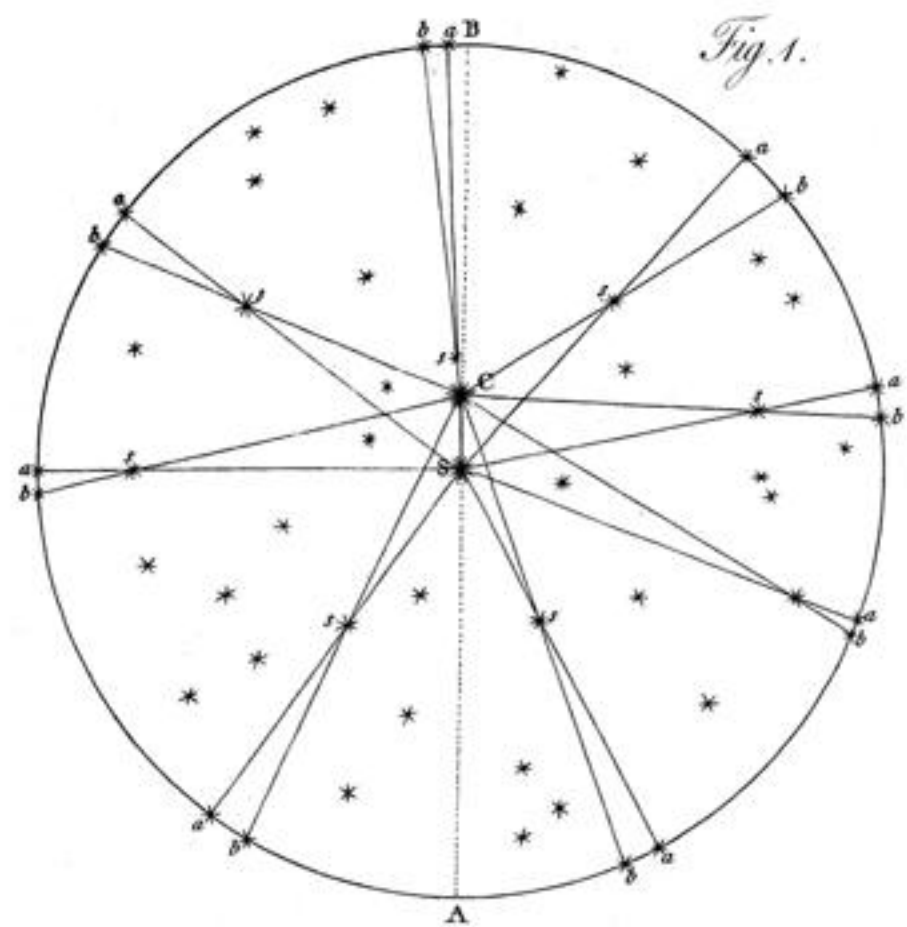


Fig. 5.

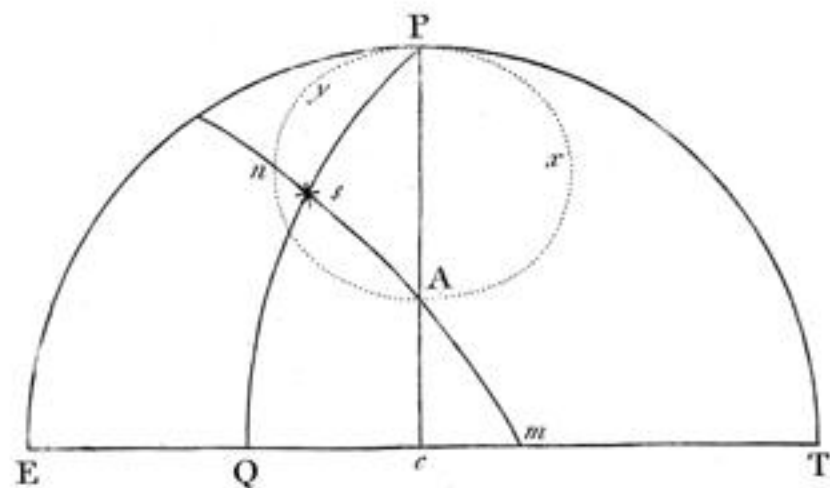
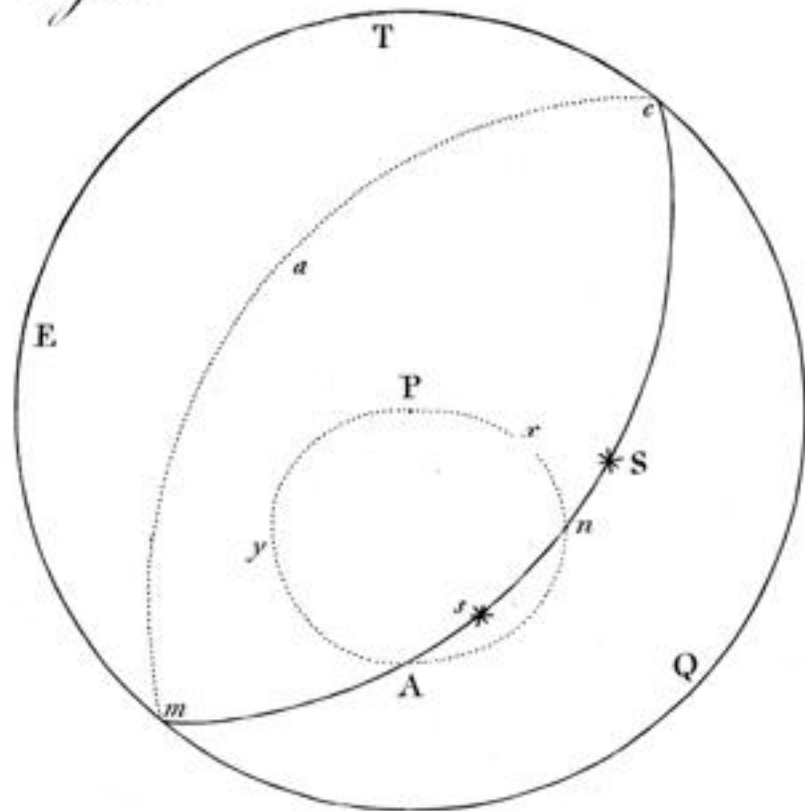


Fig. 6.