

**XIII. Account of an Iconantidiptic Telescope, invented by  
Mr. Jeaurat, of the Academy of Sciences of Paris. Com-  
municated by John Hyacinth de Magellans, F. R. S.**

Read January 19, 1778.

**M**R. JEAURAT, of the Royal Academy of Sciences of Paris, having discovered a construction of the Iconantidiptic Telescope, thought proper to communicate to the Royal Society of London a short description of this new invention.

This Telescope is called the Iconantidiptic Heliometer, because it produces two images of the objects, the one in a direct position, and the other reversed. These two  
images,

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*Construction d'une lunette Iconantidyptique inventée par Mr. Jeaurat, de l'Academie Royale des Sciences de Paris.*

**M**. JEAURAT, de l'Academie Royale de Paris, ayant imaginé une construction de lunette Iconantidyptique, croit devoir communiquer à la Société Royale de Londres l'exposition succinte de cette nouvelle invention.

La lunette est appelée Heliometre Iconantidyptique parce qu'elle represente deux images des objets, l'une dans une situation droite et l'autre dans une situa-  
tion

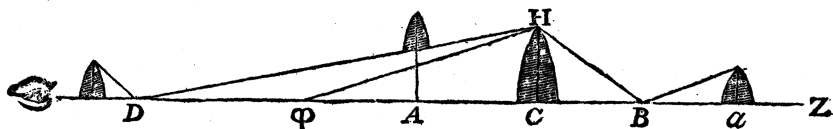
images, of opposite situation to each other, are exactly of the same size, and produce the effect of shewing the stars as entering at once both on the right and left sides of the Telescope. The first coincidence of the two images on the side of each other gives the passage of the first limb; the exact coincidence of the two images upon one another gives the passage of the center of the star; and the last coincidence of the two images at the side of each other gives the passage of the second edge: from whence it follows, that we not only observe as usual the passage of the two sides of the disk of a star, but also the direct passage of the center of the star: an observation which could not before be made in a direct manner. Besides, it may be observed, that this invention obviates the difficulty of illuminating the threads of the Telescope in observing  
very

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tion renversée. Ces deux images de situation opposée l'une à l'autre sont exactement de la même grandeur et produisent l'effet de voir tout à la fois entrer les astres par la droite et par la gauche de la lunette. La première coincidence des deux images à côté l'une de l'autre donne le passage du premier bord, la coincidence exacte des deux images l'une sur l'autre donne le passage du centre de l'astre, et la dernière coincidence des deux images l'une à côté de l'autre donne le passage du second bord, d'où il suit que non seulement on observe comme à l'ordinaire le passage des deux bord du disque d'un astre, mais aussi le passage direct du centre de l'astre: observation qui n'a jusqu'à présent pu se faire d'une manière directe. D'ailleurs on remarquera que cette invention supplée à la difficulté d'éclairer les fils de la lunette lorsqu'il est question d'observer de très petites étoiles, car avec cette

very small stars, for in this construction there is no occasion to see the threads.

The following is the construction of this Iconanti-diptic Telescope, which I have already made use of, and which appears to be proper for observations made in the plane of the Meridian.



That the solution may be applicable to Telescopes, it is proper that  $AD = AZ$ ,  $AB = aZ$ .

Then put  $AD = F$  the focal distance of the lens  $A$ ,

$aB = f$  the focal distance of the lens  $a$ ,

$aA = F - f$ ,

$AB = aA - aB = F - 2f$ ,

BC

construction on n'a pas besoin de voir les fils.

Voici la construction de cette lunette Iconantidypique dont je me suis déjà servi et qui me paroît commode pour les observations faites dans le plan du Meridien.

Pour que la solution soit aussi applicable aux oculaires il convient que  $AD = AZ$ ,  $aB = aZ$ .

Alors on fera  $AD = F$  foyer de la lentille  $A$ ,

$aB = f$  foyer de la lentille  $a$ ,

$aA = F - f$ ,

$AB = aA - aB = F - 2f$ ,

$$BC = x,$$

$$CD = y,$$

$\phi$  the focal distance of the lens c.

$$\text{Hence } \begin{cases} BD = AD + AB = 2 \times \overline{F-f}, \\ BD = BC + CD = x + y. \end{cases}$$

The two values of BD evidently give, 1<sup>st</sup>,  $x + y = 2 \times \overline{F-f}$ .

That the image B, given by the lens a, be seen at the distance BC: and that the direction of the ray BHD may form a relative focus in D, whose distance may be equivalent to AD, it is necessary that  $AB \times CD = AD \times BC$ , namely, 2<sup>dly</sup>,  $fy = Fx$ :

That the object B, seen in the direction BH, may form a focus in D, it is necessary that the focal distance of the lens:

$$BC = x,$$

$$CD = y,$$

$\phi$  foyer de la lentille c.

$$\begin{cases} BD = AD + AB = 2(F-f), \\ BD = BC + CD = x + y. \end{cases}$$

Les deux valeurs de BD donnent évidemment, 1<sup>o</sup>,  $x + y = 2(F-f)$ .

Pour que l'image B, donnée par la lentille a, soit vue à la distance BC: et pour que la direction du rayon BHD forme un foyer relatif en D, dont le foyer équivalent soit AD; il faut (voyez l'optique de SMITH de la Traduction de l'Abbé ROCHON, p. 278. art. 245.) dis-je que  $AB \times CD = AD \times BC$  savoir, 2<sup>o</sup>,  $fy = Fx$ .

Pour que l'objet B vu selon la direction BH, forme un foyer en D, il faut que-

lens c (namely, the distance  $\phi$ ) have this condition,  
 $\phi \times BD = BC \times CD$ , viz. 3dly,  $2\phi \times \overline{F-f} = xy$ .

From these  $\left\{ \begin{array}{l} 1^\circ \quad x+y = 2 \times \overline{F-f}, \\ 2^\circ \quad fy = Fx, \\ 3^\circ \quad 2\phi \times \overline{F-f} = xy, \end{array} \right\}$  we easily and incon-  
 three condi- testably find what  
 ons, viz. follows:

$BC = x = \frac{2f \times \overline{F-f}}{F+f}$  the dist. from the focus B to the lens c,

$CD = y = \frac{2F \times \overline{F-f}}{F+f}$  the dist. of the relative focus D, with re-  
 spect to the two lenses a and c,

$\phi = \frac{2Ff \times \overline{F-f}}{(F+f)^2}$  the focal distance of the lens c.

This solution just found is general; but to adapt it to  
 a particular case, which may be proper for practice, I  
 shall investigate what relation ought to take place be-  
 tween the distances  $F$  and  $f$  when  $\phi$  is  $= f$ . This suppo-  
 sition

le foyer de la lentille c (savoir le foyer  $\phi$ ) ait cette condition ci  $\phi \times BD = BC \times CD$   
 savoir, 3°,  $2\phi(F-f) = xy$ .

Avec ces trois con-  $\left\{ \begin{array}{l} 1^\circ \quad x+y = 2(F-f), \\ 2^\circ \quad fy = Fx, \\ 3^\circ \quad 2\phi(F-f) = xy, \end{array} \right\}$  on trouve facile et incontestable-  
 ditions, savoir, ment ce qui suit.

$BC = x = \frac{2f(F-f)}{F+f}$  distance du foyer B à la lentille c,

$CD = y = \frac{2f(F-f)}{F+f}$  le foyer relatif D, à l'égard des deux lentilles a et c.

$\phi = \frac{2Ff(F-f)}{(F+f)^2}$  foyer de la lentille c.

Cette solution qu'on vient de trouver est generale. Mais afin d'adopter un  
 cas particulier, qui soit commode à pratiquer, je vais chercher les rapports, que  
 doivent

fition gives  $\phi = \frac{2Ff \times \overline{F-f}}{F-f} = f$ ; from which we easily and incontestably extract the relation sought, *videlicet*,  $F = \sqrt{5+2} \times f$ ; or this, which comes to the same thing,  $f = (\sqrt{5-2}) \times F$ .

But  $\left\{ \begin{array}{l} \sqrt{5+2} = 4,2361 \\ \sqrt{5-2} = 0,2361 \end{array} \right\} \left\{ \begin{array}{l} \text{Therefore for the} \\ \text{case in which} \\ \phi = f, \text{ we have} \end{array} \right\} \left\{ \begin{array}{l} F = 4,2361 f \\ f = 0,2361 F \end{array} \right\} \left\{ \begin{array}{l} \text{The relation of} \\ \text{the focal dist.} \end{array} \right.$

*The*

doivent avoir entre eux les foyers  $F$  et  $f$  dans le cas où l'on auroit  $\phi = f$ . Cette supposition donne  $\phi = \frac{2Ff(F-f)}{(F+f)^2} = f$ ; d'où l'on tire facilement et incontestablement le rapport cherché que voici  $F = (\sqrt{5+2})f$ ; ou bien celui ci qui revient au même que le précédent  $f = (\sqrt{5-2})F$ .

Mais  $\left\{ \begin{array}{l} \sqrt{5+2} = 4,2361 \\ \sqrt{5-2} = 0,2361 \end{array} \right\} \left\{ \begin{array}{l} \text{donc pour les cas} \\ \text{où } \phi = f, \text{ on a} \end{array} \right\} \left\{ \begin{array}{l} F = 4,2361 f \\ f = 0,2361 F \end{array} \right\} \left\{ \begin{array}{l} \text{rapport des} \\ \text{foyers.} \end{array} \right.$

*Application*

*The Application of the general Formula to the particular case of the equal lenses a and c.*

Let  $AD = F$ , the focal distance of the lens A,

The relation  $f = 0,2361 F$ , found for the focal distances, gives

$$\left\{ \begin{array}{l} AB = f = 0,2361 F, \text{ the focal dist. of the lenses } a \text{ and } c, \\ AA = F - f = 0,7639 F, \text{ the dist. between these lenses,} \\ AB = F - 2f = 0,5278 F, \text{ distance,} \\ BD = 2 \times \overline{F - f} = 1,5278 F, \text{ distance,} \\ BC = \frac{2f \times \overline{F - f}}{F + f} = 0,2918 F, \text{ distance,} \\ CD = \frac{2F \times \overline{F - f}}{F + f} = 1,2360 F, \text{ distance,} \end{array} \right.$$

*The*

*Application de la formule generale au cas particulier des lentilles egales a and c.*

Soit  $AD = F$ , foyer de la lentille A,

Le rapport trouvé des foyers  $f = 0,2361 F$ , donne

$$\left\{ \begin{array}{l} AB = f = 0,2361 F, \text{ foyer des lentilles } a \text{ and } c. \\ AA = F - f = 0,7639 F, \text{ distance entre ces lentilles,} \\ AB = F - 2f = 0,5278 F, \text{ distance,} \\ BD = 2(F - f) = 1,5278 F, \text{ distance,} \\ BC = \frac{2f(F - f)}{F + f} = 0,2918 F, \text{ distance,} \\ CD = \frac{2F(F - f)}{F + f} = 1,2360 F, \text{ distance,} \end{array} \right.$$

*Application*

*The numerical application of the particular case of the equal lenses a and c.*

|                       |   | Ft. | In.                        |
|-----------------------|---|-----|----------------------------|
| Let                   | $AD = F = 1728 \text{ lines,}$  | =   | 12 0                       |
| Then we<br>shall have | $\left\{ \begin{array}{l} AB = 0,2361 F = 408 \text{ lines,} \\ AB = 0,5278 F = 912 \text{ lines,} \\ AA = 0,7639 F = 1320 \text{ lines,} \\ AD = AB + BD = 1,7639 F = 3048 \text{ lines,} \end{array} \right.$ |     | 2 10<br>6 4<br>9 2<br>21 2 |

It is from this particular case, in which  $\phi = f$ , and  $f = F \times \sqrt{5-2} = 0,23607 F$ , that the following table is constructed.

*Application numerique du cas particulier des lentilles égales a et c.*

|               |   | P. | P.                         |
|---------------|---|----|----------------------------|
| Soit          | $AD = F = 1728 \text{ lignes}$  | =  | 12 0                       |
| Alors on aura | $\left\{ \begin{array}{l} AB = 0,2361 F = 408 \text{ lignes,} \\ AB = 0,5278 F = 912 \text{ lignes,} \\ AA = 0,7639 F = 1320 \text{ lignes,} \\ AD = AB + BD = 1,7639 F = 3048 \text{ lignes,} \end{array} \right.$ |    | 2 10<br>6 4<br>9 2<br>21 2 |

C'est d'après ce cas particulier, où l'on suppose  $\phi = f$ , et que  $f = F(\sqrt{5-2}) = 0,23607 F$ , qu'est construite la table qui suit.



| Focal distance of the lens A and the equivalent AD. | Focal distances of the lenses A and C, and distance CA from the 2d lens C to the third A. | Distance AC from the first lens A to the second C. | Distance AA from the first lens A to third A. | Whole distance AD. | Distance CD from the 2d lens C to the focus A. |
|---|---|--|---|--------------------|--|
| Fr. ft. In.   | Fr. ft. In. Lin.  | Fr. ft. In. Lin.                                   | Fr. ft. In. Lin.                              | Fr. ft. In. Lin.   | Fr. ft. In. Lin.                               |
| 0 1   | 0 0 3   | 0 0 6  | 0 0 9   | 0 1 9              | 0 1 3  |
| 0 2   | 0 0 6   | 0 1 1  | 0 1 6   | 0 3 6              | 0 2 6  |
| 0 3   | 0 0 8   | 0 1 7  | 0 2 3   | 0 5 3              | 0 3 8½   |
| 0 4   | 0 0 11  | 0 2 1  | 0 3 1   | 0 7 1              | 0 4 11   |
| 0 5   | 0 1 2   | 0 2 8  | 0 3 10  | 0 8 10             | 0 6 2  |
| 0 6   | 0 1 5   | 0 3 2  | 0 4 7   | 0 10 7             | 0 7 5  |
| 0 7   | 0 1 8   | 0 3 8  | 0 5 4   | 1 0 4              | 0 8 8  |
| 0 8   | 0 1 11  | 0 4 3  | 0 6 1   | 1 2 1              | 0 9 11   |
| 0 9   | 0 2 1½  | 0 4 9  | 0 6 10½                                       | 1 3 10½            | 0 11 1   |
| 0 10  | 0 2 4½  | 0 5 3  | 0 7 8   | 1 5 8              | 1 0 4  |
| 0 11  | 0 2 7   | 0 5 10   | 0 8 5   | 1 7 5              | 1 1 7  |
| 1 0   | 0 2 10  | 0 6 4  | 0 9 2   | 1 9 2              | 1 2 10   |
| 2 0   | 0 5 8   | 1 0 8  | 1 6 4   | 3 6 4              | 2 5 8  |
| 3 0   | 0 8 6   | 1 7 0  | 2 3 6   | 5 3 6              | 3 8 6  |
| 4 0   | 0 11 4  | 2 1 4  | 3 0 8   | 7 0 8              | 4 11 4   |
| 5 0   | 1 2 2   | 2 7 8  | 3 9 10  | 8 9 10             | 6 2 2  |
| 6 0   | 1 5 0   | 3 2 0  | 4 7 0   | 10 7 0             | 7 5 0  |
| 7 0   | 1 7 10  | 3 8 4  | 5 4 2   | 12 4 2             | 8 7 10   |
| 8 0   | 1 10 8  | 4 2 8  | 6 1 4   | 14 1 4             | 9 10 8   |
| 9 0   | 2 1 6   | 4 9 0  | 6 10 6  | 15 10 6            | 11 1 6   |
| 10 0  | 2 4 4   | 5 3 4  | 7 7 8   | 17 7 8             | 12 4 4   |
| 11 0  | 2 7 2   | 5 9 8  | 8 4 10  | 19 4 10            | 13 7 2   |
| 12 0  | 2 10 0  | 6 4 0  | 9 2 0   | 21 2 0             | 14 10 0  |

