PHILOSOPHICAL TRANSACTIONS.

Januar 16. 16$\frac{7}{1}$0

The CONTENTS.

An Accompt of sundry Experiments made and communicated by that Learn'd Mathematician, Dr. Erasmus Bartholin, *upon a Chrystal-like Body, sent to him out of* Island.

BEfore we come to the Relation it self of these Experiments, we cannot but premise an *Extract* of the Obliging Letter,

written to the Publisher, by the said Doctor *Bartholin* from *Copenhagen* Febr. 27. 1670; English't as follows;

—I Know the many Excellencies of the English Nation, and that innumerable new things in the matter of knowledge issue thence, and diffuse themselves through *Europe*; though they arrive somewhat slowly hither. We are here pressed with so many cares, that though we want no will to contribute something to the advancement of knowledge; yet being destitute of the leisure necessary for it, and diverted by two difficult Professions, the Medical and Mathematical, we can rather admire the performances of others, than engage for any thing of our own. But yet, not altogether to frustrate your expectation, and to give you some Testimony of my affection and endeavors, I here send you some Experiments made with a certain Chrystal-like Stone, sent me out of *Island*, together with a piece of that Stone, to make the Tryals your self. Farewell.

For the rest, we are now labouring to publish a more corrected and better digested Edition of *Tycho Brahe's* Works; a business of much time and exceeding great labour: Which care while I am engaged in, I must lay aside other matters. Yet I hope, that my part in this work will shortly be over; there remaining almost nothing, but to provide the charges necessary for the Impression; which all true Lovers of Astronomy cannot but have a great concern for.

This Letter being sent to *Hamborough* to that Ingenious Physitian, Dr. *Matthias Paisenius*, with a desire to transmit it to *London*, this worthy Person was pleased to inclose it in one of his, written to the Publisher; which, since it treateth of the same argument (I mean, the *Islandian* Stone,) will not be amiss to subjoyn here the Breviate of.

——*The Observations of the Excellent* Bartholin *upon the* Island-Chrystal *are indeed considerable as well as painfull. We have here also made some Tryals of it upon a piece, he presented me with; which confirm his observations. Mean time, we found it somewhat scissile and reducible by a knife into thin* lamina's

or

or plates, which, when single, shew'd the Object single, but laid upon one another, shew'd it double; the two images appearing the more distant from one another, the greater the number was of those thin plates laid on one another. With submission to better judgements, I think it to be a kind of Selenites. *Some of our curious men here were of opinion, that the* Rhomboid *figure, proper to this Stone, was the cause of the appearances doubled thereby. But having tryed, whether in other Transparent Bodies, of the like Figure, the like would happen, we found no such thing in them; which made us suspect some peculiarity in the very Body of this Stone.*

These Letters being thus premised, we now come to relate the Brief of the Observations and Experiments themselves; referring the more Curious Reader to the larger Accompt of them, and their Mathematical Demonstrations, as they are to be found in the Printed Book, entitul'd *Erasmi Bartholini Experimenta Chrystalli Islandici Dis-Diaclastici; quibus mira & Insolita* REFRACTIO *detegitur.* Hafniæ A. 1669.

1. The Inhabitants of *Island* and our own Merchants inform us, *that* this kind of Chrystal is found in divers places of that Country; but chiefly digg'd out of a very high mountain, not far from the Bay of *Roerfiord*, which lies in 65. degr. *Latitude*; *that* that Mountain reacheth Southward, and hath its whole outside made up of this substance, without a necessity of digging deep for it; *that* it is cut out by Iron-tooles, in bigness of a Cubick foot, or somewhat better: and *that* out of its corners there is sometimes found grown out a harder matter, not unfit to cut glass, of a figure different from that of the whole mass, and approaching to that of Diamonds.

2. The Figure of this Chrystal-stone is like a *Rhombick* or *Rhomboid Prisme*. Nor hath the whole Body that Figure only, but all the parts of it, when broken into small pieces, keep the same; except that in some cases the ground, whence 'tis digged, yields such as are of a Triangular Pyramid-figure.

3. This Substance is Electrical, attracting (to speak with the Vulgar,) when heated, straw, Feathers, &c.

4. It is not so hard, as to endure polishing: Nor is it easily consumed; nor reduced into a *calx* but by a strong fire, by which it will turn into a substance like unslaked lime, which will heat a wet finger, and, when sprinkled with fountain-water, will buble up, and become like common lime.

5. *Aqua fortis* being by me dropp'd upon it, it was corroded, and the superficial parts were put into a motion with some noise. And when I pulverized it in a mortar, Aqua fortis, powred on it, made it boyle, till all was dissolved, and the *Monstruum* tinged with a yellowish colour. Then putting it into a Thermometer furnisht with a hollow glass ball, it considerably shew'd the difference of Heat and Cold. The powder being dissolv'd in *Aqua fortis*, I dropp'd some Spirit of *Vitriol* upon it, to separate the thick from the thin, and to precipitate the white *calx* to the bottom.

6. The sides of this Body are exceeding smooth; which is then easily obtained, if a thinner piece be nimbly broke asunder with your finger. But if you strike it with a hammer, the percussion hath not the same effect upon, nor is equally resisted from every part; whence the smooth sides of this Mineral become often scabrous. The whole Body is rather clear than bright, of the colour of limpid water; but that colour, when it hath been immersed in water and dryed again, becomes dull. Hence it is, that in its native place the upper surface is darkish; because of the Rains and Snows fallen upon it. Sometimes there appear also some reflections of colours, as in the Rain-bow. The Angles are not pointed alike, all the flat sides being obliquely inclined to one another. The opposite plains are parallel.

7. In this Chrystallin Prisme, two of the plain Angles are always acute, and the two other obtuse; and never any of them is equal to the collateral Angles of the Inclinations.

8. The Objects seen through it, appear sometimes, and in certain positions of the Prisme, double: Where 'tis to be noted, that the distance between the two images is greater or less, according to the different bigness of the Prisme; insomuch that in thinner pieces this difference of the double image almost vanisheth.

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9. The Object appearing double, both images appear with a fainter colour; and sometimes one part of the same *species* is obscurer than the other.

10. To an attentive Eye, one of these Images will appear higher than the other.

11. In a certain position the Image of an Object, seen through this Body, appears but single, like as through any other Transparent Body.

12. We have also found a position, wherein the Object appears sixfold.

13. If any of the obtuse Angles of this Prisme be divided into two equal parts by a line, and the visual rays do pass from the Eye to the Object through that line, or its parallel, both Images will meet in that line, or in another parallel to it.

14. Whereas Objects, seen through Diaphanous Bodies, are wont to remain constantly in the same place, in what manner soever the transparent Body be moved, nor the Image on the Surface move except the Object be moved; we have observed here, that one of the Images is moveable, the other remaining fix; although there be a way also, to make the fixed image moveable, and the moveable fix in the same Chrystal; and another, to make both moveable.

15. The *Moveable* Image doth not move at random, but always *about* the *Fixed*, which while it turneth about, it never describeth a perfect Circle but in one case.

16. *Dioptricks* teach, that a Diaphanous Body, having one only surface, sends from one Object but one Image refracted to the Eye; and having more Surfaces than one, it represents one Image in each; But whereas in our substance there occurs but one plain superficies to the Eye and yet a double image of one Object; it concern'd us to consider, whence this double image might be caused. *Two* ways offer'd themselves to us, *Reflection* and *Refraction*. How *Reflection* could perform it, was difficult to find. For, having dulled the clearness of the two plain sides of our Chrystallin Prisme, thereby to make them unfit for Reflecting the light; the Rays being directed through its upper and lowermost superficies, the image

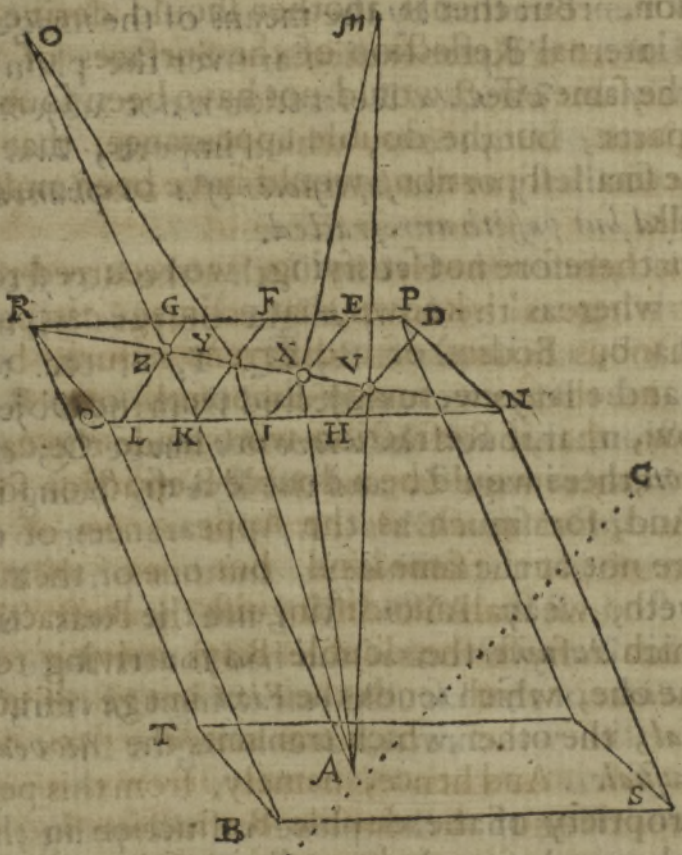
still

ſtill appear'd double. Again, two *ſpecies* appearing through a great Priſme, upon breaking of the ſame into pieces and ſo reducing it into divers ſmaller ones, it came to paſs, that through each of theſe leſſer portions the ſame object was ſeen always double. Whence I Collected, that if it ſhould be ſaid, that *one* of the images proceeded from the Reflection of the plain *ſides*; the former of theſe Experiments would diſcountenance that aſſertion. But then if another ſhould derive the cauſe from ſome internal Reflection of the Surfaces of this Body, certainly the ſame effect would not have been found in every one of its parts, but the double appearance, that was exhibited in the ſmalleſt portion, would have been multiplied in a greater bulk.

Reflection therefore not ſatisfying, we recurred to *Refraction*. But, whereas 'tis known, that no image can paſs through two Diaphanous Bodies of a different nature, but by Refraction, and that one image ſuppoſeth one Refraction; it did follow, that, if Refraction were made the cauſe of this *Phœnomenon*, there would be a double Refraction for a double image. And, foraſmuch as the Appearances of our *Iſland*-Chryſtal are not of the ſame kind, but one of them is fixt, the other moveth, we ſhall alſo diſtinguiſh the Refractions themſelves, which refract the double Rays arriving to the Eye, and call the one, which ſends the *Fixt* image refracted to our ſight, *Uſual*; the other, which tranſmits the *Moveable* to the Eye, *Un-uſual*. And hence, namely, from this peculiar and notable propriety of the double Refraction in this Iſland-ſtone, we have not ſcrupled to call it *Diſ-diaclaſtick*.

This being ſuppoſed, it will not be irrational to ſuſpect, that theſe two Refractions proceed from different principles. For, ſince it is commonly known from *Dioptricks*, that an Object, by viſual rays affecting the Eye, exhibits ſome Image on the *Superficies* of the Diaphanous Body, which Image is but one, as long as the *Superficies* is one, and the upper plain parallel to the lower; as alſo, that if, the Eye remaining ſteady, the Diaphanous Body be moved, that image remains always fixt, as long as the Object, whence it comes, remains

remains unmoved. Wherefore in this Transparent substance, the Image which appears fixt, may proceed according to the ordinary Laws of *Usual* Refraction; but that, which moveth, and is carried about according to the motion of the Diaphanous Body, while the Object remains un-stirr'd, sheweth an *Un usual* kind of Refraction, hitherto un-observed by *Dioptricians*.



Hence, that I might examine the nature and difference of both, I put, upon some Object, as the point A, the Prisme of my Double-refracting Chrystal N, P, R, Q, T, B, S; and the Eye M, being perpendicularly posited over the upper plain of the Prisme N, P, R, Q, I noted, whether there was any Refraction of the point A, (for the *usual* Laws of Refraction teach, that there is none.) But the Perpendicu-

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lar Ray of the Eye was obſerved to paſs not through the *Moveable* but the *Fixed* Image; thereby being conformable to the Rules of *Vſual* Refraction, as ſtriking the Eye unrefracted, ſo that the Eye, the Image, and the Object, were ſeen in the ſame Line. But, when in the ſame ſcite of the Eye, the Object A, did alſo exhibit the other Image X, at no ſmall diſtance from the former; I took notice, that this Object A, was not ſeen unrefracted by the means of the image X, though the Eye M, remain'd perpendicular over the plain; and that conſequently this *Vn uſual* Refraction is not ſubject to the received Axiome of *Dioptricks*, which imports, *That a Ray falling* perpendicularly *on the ſuperficies of a Diaphanous Body, is not refracted, but paſſeth unrefracted.*

Next, I ſo placed the Eye in O, that the Ray from the Object A, arriving to the Eye, might be parallel to the lines RT and Q B, of the plane R, Q, T, B, &c. then it appear'd, that the Rays were trajected from the Object A, without Refraction, through the *Moveable* image Q; the Object A, the moveable image Z, and the Eye O, being in the ſame line; and that the ſame Object A, did tranſmit to the Eye O, remaining in the ſame poſition, yet another *ſpecies* Y; through the Refracted Ray AYO Whence it was manifeſt to me, that this *Vn uſual* Refraction had for its Rule the *Parallel* of the *Sides* of this Double-refracting Chryſtal, while the *Vſual* Refraction was directed according to the *Perpendicular* of the *Superficies*.

But conſidering that the place of the point, appearing through our Diaphanous Body, cannot eaſily be determin'd, as being only obvious in the uppermoſt part; we ſhall add the way, whereby we have found its diverſity, by drawing, on the ſubjacent table, a ſtraight line through that point; the place of which line will be determined by the one Eye *through* this Chryſtal, and by the other Eye *without the* Chryſtal. For, in the ſame *Figure*, let through the Object A, be drawn upon the Table, a ſtrait line BC. The Eye being in M, that double line H D, and I E, will appear, the *ſpecies's* being caſt on the upper ſurface: And if you attend well, you will obſerve

obſerve one of the Images, *viz.* the Fixt H D to be congruent to the ſubjacent line B C, whil'ſt the other, namely the Moveable E I, tendeth towards R. But, if afterwards the Eye be poſited in O, the ſame Object, I mean the line B C, will not only be repreſented double by the images K F, and L G; but alſo the Movable Image G L be congruent to the inferiour line B C; while the Fixed F K is not ſo, but tends towards N.

After the Author hath given us theſe Experiments, he undertaketh to determine the *Quantity* of the Refractions in this Double-refracting Body; and haveing firſt given the *Demonſtration* of the Method of Meaſuring the Refraction of *Glaſs*, (omitted by *Des-Cartes* in his *Dioptricks*,) he finds, after ſeveral Tryals, the Angle of Inclination to the Angle of Refraction in this *Iſland*-Chryſtal to be as 5 to 3.

But this Ingenious Perſon doth not ſtop here, but proceeds to *demonſtrate* all the recited Experiments; obſerving firſt, that the Teachers of the *Corpuſcularian* Hypotheſis, which includeth that of *Figures* and *Pores*, could not wiſh for a fitter Body, than this, to aſſert their Doctrine; in regard that it appears, firſt, that this Double-refracting Body hath its Pores according to the *Ductus* of the ſides, and parallel thereto; ſince it may be obſerv'd, that, according to this diſpoſition of the ſides, it is broken, and the parts ſever'd from one another; and that one of the Images, namely the *Moveable*, paſſeth through them. Next, beſides theſe Pores, lying according to the Paralleliſme of the ſides, it hath others, ſuch as Glaſs, Water, and right Chryſtals have, through which the *Fixt* Image is tranſmitted.

But paſſing by theſe, our Author aſſumeth two *Hypotheſes*, as neceſſary to his deſign, not ſo much found out by Ratiocination, as by the above related Experiments. The one is, that there are ſome Lines, by which the Rays paſs through the tranſparent Body un-refracted; which Lines though they have been held to be Perpendicular in Diaphanous Bodies hitherto known, yet this Author requireth not, that they ſhould be always ſuppoſed ſuch, ſince they may perhaps in

some case be not such. The *other* is, that it may be supposed, that half the light or appearance, diffused from the Object, is refracted according to the *Usual* Refraction; but the other half according to the *Un-usual* Refraction; or, which is all one, that the Usual and Un-usual Refraction have the same power to refract the Rays of the Objects. The former of these Suppositions he collects from Exper. 14; the latter from Exp. 8. But, how he proceeds in these *Deductions*, and the thereon grounded *Demonstrations*, may be more fully and more plainly seen in the above-mentioned *Tract* it self, than can be conveniently deliver'd in this *Epitome*.

An Extract of a Letter from a Learned French Gentleman, concerning a way of making Sea-water sweet.

—MOnsieur *Hauton* hath now declared his secret of making Sea water sweet. It consists *first* in a *Precipitation*, made with Oyl of Tartar, which he knows to draw with small charges. *Next*, he *distills* the Sea-water; in which work the Furnace taketh up but little room, and is so made, that with a very little wood or coal he can distill 24 pots of water in a day: For the cooling of which, he hath this new invention, that instead of making the *Worm* pass through a Vessel full of water (as is the ordinary practise,) he maketh it pass through one hole, made on purpose out of the Ship, and to enter in again through another: So that the Water of the Sea performeth the cooling part: By which means he saveth the room, which the common *Refrigerium* would take up; as also the labour of changing the Water, when the *Worm* hath heated it. But then *thirdly*, he joyns the two precedent Operations, *Filtration*, thereby perfectly to correct the malignity of the Water. This Filtration is made by means of a peculiar Earth, which he mixeth and stirrs with the distilled water, and at length suffers to settle at the bottom. *Paris* Febr. 22. 1670.

An