

*A Letter from Mr. Anthony Leewenhoeck Fellow
of the Royal Society, dat. Apr. 14. 1684. contain-
ing Observations about the Cristallin humor of
the Eye, &c.*

IN mine of *September* the 7th, 1674. I communicated my Observations concerning the *Cristallin humour* of the *Eye*; which I find to have been inserted by Mr. *Oldenburg*, in the *Phil. Transactions* Num. 108. p. 178. where I say, that the *Cristallin Body* (or *humour*) of the *Eye*, is in hardness much like a preserved *Nutmeg*; which with a *Razor* I cut in too, and so observed the same in parcels, and found it to consist of many *Orbicular scaly parts*, lying one on the other, which had their beginnings from the *Center*; all which parts consisted again of *Cristallin Globules*: And having suffered the said *Cristallin humor* to dry for 3 dayes, it became so hard, that in the cutting, it broke in pieces: as if it had been hard *Rozin*. And observing again, these parts, I found therein, not only the aforesaid *Orbicular scaly substance*; but further, that each scale, was again composed, of other Ring-like parts, and that these second were contrary posited to the other: Thus much I observed, on the *Cristallin* part of the *Eye*; to which, I add, that I compared the scaly parts to a *Globe*, made out of a number of thin papers, lay'd the one on the other, and that every paper or *scale*, was again constituted out of so many parts, as there may be lines drawn upon a *Globe*, reaching from one *Pole* to the other.

I have sometime since, again made several observations, concerning the *Eyes* of *Oxen* and *Cows*; for that often since my first observations, I have thought, that I had not yet discovered the make of the *Cristallin humor* of the *Eye*, so thoroughly as I might have done.

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I therefore first examined the *Film* or *Membrane* which encloses it, and separates it, from the other *humors* of the *Eye*; and conceived that it was constituted of *Threads*; but at another time, tho there were great diligence used, I could observe none at all.

In these *Inquiries*, I have seen (though seldom) the impressions of the thred-like substance, of the outermost *scales*, of the *Cristallin humor*, in the forementioned *Membrane*; whence I concluded, that one use thereof might be, to fill up all the unevennesses caused by the *threads* in the *superficies* of the *Cristal*, and so to constitute a perfect *Round*.

Another use of it, may be, by compressing the *Cristallin humor* to alter its figure, and make it part of a greater or lesser *Circle*: and this being so, it may not improperly be called a *Muscle*.

Although (as before is said) it did not plainly appear, that the *Film* is constituted of *threads* woven together; I notwithstanding, make but little doubt thereof; because formerly, in the thinnest *Membranes* I have seen these thred-like appearances, and also for that I examined the parts thereabout and found a great many streakes or *Lines*, seeming to be *Lymphatick Vessels*, designed for the nourishment of the *humours* of the *Eye*; these I traced till they entred into the coat of the *Cristallin humor*, and then they grew so small that I lost the sight of them.

I further observed, that the aforesaid *Cristallin body*, was compounded of thin *scales*, placed upon one another: These seem'd about 2000 thick, for the *Axis*, where it was longest, was $\frac{2}{3}$ of an *Inch*, so that the distance from the *Center* to the *Circumference* is as $\frac{1}{3}$ of an *Inch*: now the length of an *Inch* being six hundred hairs breadth, (as I have often said) $\frac{1}{3}$ must be 200 hairs breadth, which being multiplied by 10. (the number of *Scales* equal to the breadth of a *hair*) make 2000. *Scales*, the thickness of this *Cristallin body*. I have further observed, that each of these

these *scales*, is constituted of *threads*, which in a very neat order, lye by one another, so that each of these *scales*, is the thickness of one of the *threads*, the appearance hereof to view, I have represented, as well as I could, by Lines drawn in a Circle, *Fig. 1.* ABC. is the *Cristallin Body*, of the bigness it appeareth to the naked Eye, B, is the part lying next the *Cornea Tunica*; but these I have magnified, that I might the better represent the *threads* constituting every *scale*. *Fig. 2.* KEFGHIL is represented, as if the aforementioned *Fig. Num. 1.* lay with the round B next the *Eye*: and altho I have here drawn many Lines, which represent as many *threads*, yet is their number nothing to those, in the Circumference of the *Chrifallin humor* of an *Oxe*, which are above 12000. For 10 *threads* lying close together side by side, making not out one *Diameter* of an haire bredth, now if the whole *Axis* (as before is said) is 400 haire bredth long, then is it long 4000 of those *threads*. And this computed by the common Rules, amounteth to 12571 $\frac{3}{4}$. the number of the *threads* lying side by side, and which make out the whole circumference of the *Cristallin Body*.

Hence may be perceived how thin these *threads* are, and how wonderfully they run not through the *Axis*, as I heretofore conceived, but taking 3 several wayes out of the point L, (the imagined *Axis*.) These *threads* do not approach the *Axis*, on the other side of the *Cristallin body*, as they do on this, but turne back, with a small bent making there the shortest *threads*. For example, the shortest *threads* here, *viz.* MK. HN. and OF. reach up to the *Axis* on the other side, and fill up the place; (as is here represented at L,) now the *threads* MK, having filled up their place, in the *Axis* of the other side, (as the *threads* ELI doe here) they returne from thence back, and are here the shortest *threads* HN. These HN place themselves again, on the other side near the *Axis*, and returning back again, are then OF. and OF coming from the
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other side nigh the *Axis*, is here again KM. To conclude, those which are here the shortest *threads*, are on the other side the longest; and the longest on the other side, are here the shortest. To present this yet clearer to view, I have drawn with lines, the *threads* composing one of the scales of the *Cristallin body*, seen on one side, as *Fig. 2.* R T P S W Q, and notwithstanding it is a *flattish* round, I have here made it *Globular*, with consideration, that in this Representation, the *threads* constituting each *scale*, may be the better discerned. P and Q are the middle points or *Axes*, of which P in the foregoing *Fig. 2.* is denoted by L, the *threads* issuing out of the point P, in the foregoing *Figure 2.* L extend to V, where they are the shortest *threads*, from whence they again extend back to P, where again they are the longest, and from P they again extend to W, where they are again the shortest; and thus also are extended the *threads* from T to Q, and from thence again to X, and from X to Q, and thus half the course of every one of the *threads* (since we must suppose this for an half round) is demonstrated. In short the *threads* LI, in the foregoing *Fig. 2.* are here PS; and the *threads* between L and M in the foregoing figure 2. are here the *threads* between P and X; and the *threads* between L and O in the foregoing *Fig. 2.* are here, the *threads* between P and T. So that the *threads* in the foregoing *Fig. 2.* between F O L I K E, are here in *Fig. 3.* the same with R T P S. Here is further to be observed, that the *threads* constituting the *Cristallin Body*, are thickest about R and S, and the nearer they approach to P or Q, they are the thinner. To conclude, when we view the fore-said *Cristallin body* with attention, as it cometh fresh out of the *Eye*, we find it to excel in transparency the purest *Glass*, notwithstanding it is composed of so many thousand *threads*, and that they lye very close compact together, so that one might justly wonder, how the light can pass through them in right lines, which is absolutely ne-

cessary; for if it were otherwise, the *Cristallin body* would appear white, but not transparent. To please some curious persons, and to represent this *Cristallin body*, yet plainer to their sight, I have taken a small *Tennis Ball*, and wound the same about, with a very fine *Cord*, having before stuck in many small *pins*, in the places where it was to be kept from slipping; then I smear'd the *Ball* over with strong *Glem*, and when it was well dryed, took out all the *Pins*, and this *Ball*, with the *cord* wound about it, representeth the *Cristallin Body* of the *Eye*.

I have heretofore said, that the parts, which I now plainly perceive as threds; are again constituted of *Globules*; which now in some of the *threds* I clearly discern. But, for that I alwayes discern it not, I conceived, that as the *threds* (as here before is said) are very small, and clotted one to the other, that so in the separating of them, some parts of one thred remain fastned to the other, which may appear to my sight *Globules*: I conceived it might better agree with their *Fabrick*, to suppose that each *thred*, was again composed of many other smaller *threds* joyned together, as I have heretofore said, that the *Flesh threds* although 9. times thinner then a hair of our head, are again constituted of other *threds*.

I further took out of the *Eyes* of *Sheep*, *Hogs*, *Dogs*, and *Cats*, the *Cristallin bodies*, and ordered them, as I had done those of an *Ox*; but have found not the least variation, either in the *scaly parts*, or in the course of the *threds*, composing each of those *scales*.

The same agreement I found also, in the *Eyes* of *Hares*, and *Rabbets*; except that whereas the *threds* constituting the before-mentioned *Cristallin bodies*, spread themselves from the *Center*, in three distant *courses*; here the *threds* of each *scale*, spread themselves but in two *courses*. *Fig. 4.* A B C D representeth half the round of the *Cristallin body* of the *Eye* of a *Hare* or a *Rabbit*; E is the *Center*, which lyeth extended to the *Apple* of the *Eye*; these

these *threads* constituting each *scale*, which run as through the *Center* E, are on the other side, the shortest, and appear like unto F or G. likewise F and G, on the other side run through the *center*. I have also caused the foregoing *Figure* to be drawn side-wise, the better to represent the thred-like appearance of each *scale*. I suppose then, that the threds, which in *fig.* 4. are represented between E and F, are the same with those in *Fig.* 5. represented by I O. so that the *threads*, which come from the point I (the same with E in the former figure.) end here, in N and L; where they are the shortest; and those which extend to O, through, or close to the *center* M, where they are the longest, end there, or bend again on the other side, as the same do here. In short those which here approach the *center* I, are on the other side furthest from the *center*.

In the aforementioned *Observations*, I have for the most part, endeavoured also to discover the nature of the *Vitreous humour* of the *Eye*; and which surroundeth for the most part the said *Cristallin humor*, for that I concluded, it was no watry matter, but rather a transparent *Muscle*; But notwithstanding all the means I thereto used, I could not make the least discovery thereof, for that this matter always changed into a watery substance.

I further examined the *Cristallin body* of the *Eyes* of *Fishes*, which are perfect *Globes*; and found them also constituted of like thin *scales*, lying one upon the other, as in those other *Animals* before noted: and each *scale* also composed of *threads*, but these *threads* run not in the same manner, as those of other *Animals*; yet, notwithstanding all the industry by me used, I could not discover the true course of them, for when the *threads* approach the *center*, they appear so thin, and so close joynd together, that the sight cannot trace them, and cause such a confusion, that I cannot be certain, whether they end in the *center*, or return again from thence. By *Fig.* 6.

ABCD. I represent the *Cristallin body* of the *Eye* of a *Cod-fish*, and although the circular lines representing the *threads* constituting each *scale*, be only drawn by a pair of *Compasses*, from the *center* A, to the *center* C, and therefore lye more distant one from the other, then in the foregoing *figures*; yet are the *threads* composing each *scale*, not thicker, except in the middle, as here B and D they are somewhat thicker; and the nearer they approach to A and C, they are the thinner. *Fig. 7.* is the true bigness of the *Cristallin body* of the *Eye* of a *Cod-fish*.

I have also examined, the *Cristallin* bodies out of the *Eyes* of *Birds*, only to view how the *threads* of the *scales*, constituting also the *Cristallin body*, run; and after many *observations*, I have discerned, that the *threads* constituting the *Cristallin body* of a *Turky-cock*, are extended like those in *Fish*; but as the *Cristallin body* of a *Fish's Eye* is perfectly *Globular*, those of *Birds* are a flattish round: as *Fig. 8.* posited with its flattish side D towards the *Cornea Tunica*. And when from without the *Cristallin body* of the *Eye* of a *Turky-cock*, I had with a very sharp knife, taken off many of the *scaly* parts, to bring it to a smaller *Globe*, it changed its *Figure*, and became an *Oval*; as *Fig. 9.* where E, is the same point with D, in *fig. 8.* the *threads* being, where they meet, so thin and small, that at last they are not distinguishable. From whence we may conclude, that the *threads* of the *scales*, which lye nearest the *center*, are in the midst thin; as in *Fig. 6.* at B and D is shewed, and make thus an *Oval figure*: and that when the *Cristallin body* increaseth in magnitude, the *threads* become then in the midst thicker; and thus constitute a flat round; as I have perceived it, for the *threads* in the *Cristallin body* of a *Turky cock*, in their thickest part, were thicker than those in an *Oxe, Hog, Sheep, &c.*

Before I leave this *discourse*, I cannot but mention, that I have by several ways and means, seen with my naked
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Eye, a threddy substance, like that whereof the *Cristallin humor* consists: I shall only mention two of them, *viz.* I take a clean wine Glass, and hold the Rim thereof close against the *Pupil* of one of my *Eyes*, while my other *Eye* is closed; and looking thus, firmly through the *Rim* of the Glass, against the flame of a Candle, or other light, I perceive the *thred-like* appearance above named; as if through a *Microscope*, I had beheld a piece of a *scale* of the *Cristallin Body* of the *Eye*. Or closing one *Eye*, I hold the fingers of my hand, before the other *Eye*, so close together, that they leave but a small opening between them: this small space between the fingers, through which the *Eye* receiveth the light of the Candle, will represent a like thred-like appearance, as in the former instance.

I have often been aware, of a moisture lying on the outside of the *Pupil* of the *Eye*, containing some few very small *Globules*; which as oft as we close our *Eye Lids*, change place: From hence may be learnt, the necessity of the *Eye Lids* in us; and why *Fishes* which continually live under water, need them not, but should *Men* and other *Animals*, that live out of the water, not have them, they would soon be blind: For if the *Eye Lids* by their closing, did not constantly moisten the *Eye*, the *superficies* thereof, would dry up and Rumble: and that chiefly in the *Sun*, or before a hot fire. Also it is not improbable, that from the inner part of the *Eye* a moisture continually issueth through the *Cornea Tunica*, which by *Eye lids* is cleansed off; for when I had examined several *Hogs Eyes*, which had been scalded with hot water, to get of the hair, I for the most part observed, that a thin Film, which was on the *Cornea Tunica* of the *Eye*, was somewhat singed; whereby it was easily separated, from that film, that was immediatly under it; and when I then pressed the *Eye*, a little, between my *fingers*, I perceived in several places, a thin watry matter to soak through

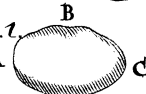
through the Horny film, and lye like a watry damp on a *Glass*; and when I continued this pressing for some time, this *watry damp* encreased into small *Drops*, and at length run like water in a stream. This ought not to seem strange, considering the parts of the Horny Coat to be made of hollow vessels, like *veins*; very thin, and spread about in *Branches*.

I have lately taken the Horny coat of an *Oxe's Eye*, and have separated from it, seven *films*, extremely thin, in each of which, were a number of interwoven, very clear, and transparent *streakes*; which I judge to be, many of them, *blood Vessels*; but so small, that they contain none of the *Globules*, which cause the redness in the blood. By the rubbing of our Eyes, with our hand, we may so press these blood vessels, until they become so stretched out, that some of these bloody *Globules*, may get in, and remain there, for some time, which may cause that redness in our Eyes; which comes by our rubbing of them.

But to return again, to the *Eye lids*. As our *Muscles* and other parts of our bodies rest not, unless posited as they lay, when we were yet in the *Womb*; (as I formerly said) in like manner, the *Eye lids*, are not at rest, till the *Eyes* are closed, and therefore we cannot long continue the *Eye lids* open, but with force; and, that the same might not be wearied, we often close them, although we mind it not. I have seen People, that listning with attention, to a *Discourse*, have closed their *Eye lids* according to my *Calculation* 6000. times in an *hour*; whereas others, standing by them, closed them not, above 2000. times in the same time.

Since I wrote unto Mr. *Oldenburg*, in the year 1673. that the matter, causing the redness of our *Blood*, was constituted of *Globules*; I examined the blood of *Oxen*, *Sheep*, and *Rabbets*; and observed no difference in *magnitude*, between the *Globules* of those *Animals*, and those of *Men*: so that I conceived, that that matter which in
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general made all *blood* red, was *Globules*. But, after I had tryed the *blood* of a *Salmon*, a *Cod*, of *Frogs*, &c. and found that the matter, which caused the *redness* therein, was made of parts oval, and flattish, (as I have before said) I examined the *blood* of several *Birds*; and have also observed, that the matter causing the *redness* of their *blood*, was also composed of like *Oval* flattish parts, with those of *Fishes*: so that I now concluded, that all *Animals*, whether *Birds*, *Fish*, or other *Creatures* that live in the water; have the parts causing the *redness* of their *blood*, consisting of the said *Oval* flattish parts, and if hereafter I chance to find the contrary, I will advise you thereof.

Fig. 1. 

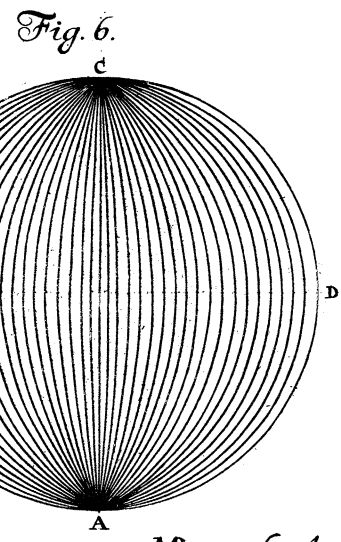
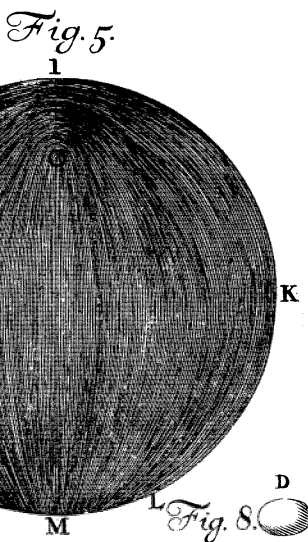
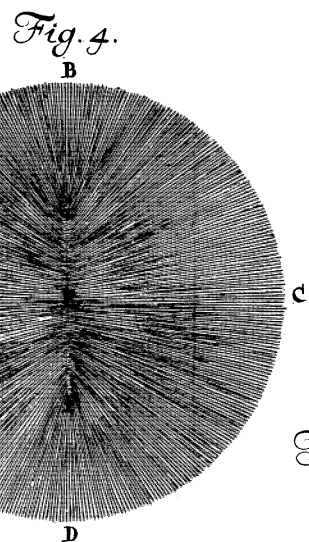
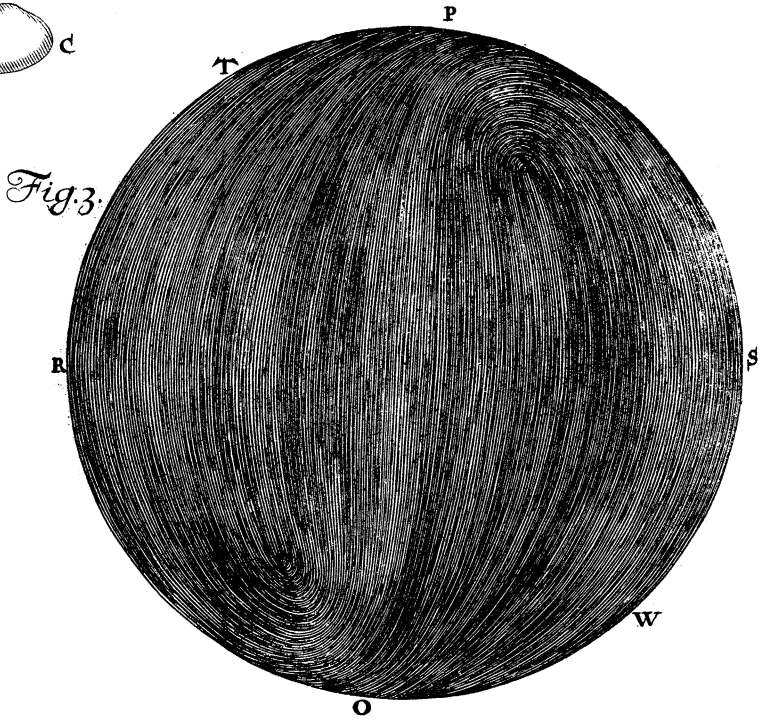
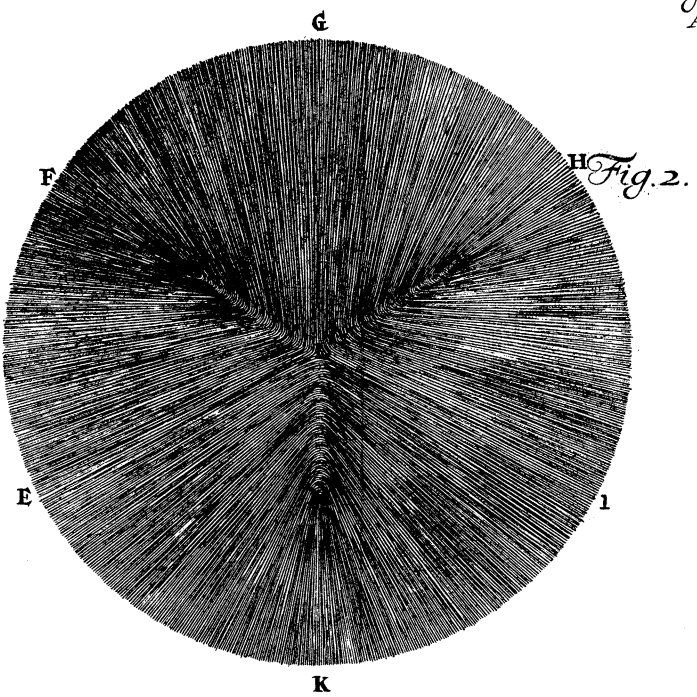


Fig. 7. 

Fig. 8. 

Fig. 9. 