

Robert Hooke, "Considerations upon Mr. NEWTON'S discourse on light and colours"

Philosophical Transactions of the Royal Society, 1672):

I have perused the discourse of Mr. NEWTON about colours and refractions, and I was not a little pleased with the niceness and curiosity of his observations. But, tho' I wholly agree with him as to the truth of those he hath alledged, <11> as having, by many hundreds of trials, found them so; yet as to his hypothesis of solving the phenomæna of colours thereby, I confess, I cannot see yet any undeniable argument to convince me of the certainty thereof. For all the experiments and observations I have hitherto made, nay, and even those very experiments, which he alledgeth, do seem to me to prove, that white is nothing but a pulse or motion, propagated through an homogeneous, uniform and transparent medium: and that colour is nothing but the disturbance of that light, by the communication of that pulse to other transparent mediums, that is, by the refraction thereof: that whiteness and blackness are nothing but the plenty or scarcity of the undisturbed rays of light: and that the two colours (than the which there are not more uncompounded in nature) are nothing but the effects of a compounded pulse, or disturbed propagation of motion caused by refraction....

....Nor would I be understood to have said all this against his theory, as it is an hypothesis; for I do most readily agree with them in every part thereof, and esteem it very subtil and ingenious, and capable of solving all the phænomena of colours: but I cannot think it to be the only hypothesis, nor so certain as mathematical demonstrations.

But grant his first proposition, that light is a body, and that as many colours as degrees thereof as there may be, so many sorts of bodies there may be, all which compounded together would make white; and grant further, that all luminous bodies are compounded of such substances condensed, and that whilst they shine, they do continually send out an indefinite quantity thereof, every way in orbem, which in a moment of time doth disperse itself to the utmost and most indefinite bounds of the universe; granting these, I say, I do suppose there will be no great difficulty to demonstrate all the rest of his curious theory: though yet, methinks, all the coloured bodies in the world compounded together should not make a white body, and I should be glad to see an experiment of that kind done on the other side.

Newton's reply:

....And first of the Hypothesis, which is ascribed to me in these words: *But grant his first supposition, that light is a body, and that as many colours or degrees as there may be, so many bodies there may be; all of which compounded together would make White, &c.* This, it seems, is taken for my Hypothesis. 'Tis true, that from my Theory I argue the Corporeity of Light; but I do it without any absolute positiveness, as the word "perhaps" intimates; and make it at most but a very plausible consequence of the Doctrine, and not a fundamental Supposition, nor so much as any part of it; which was wholly comprehended in the precedent Propositions. And I somewhat wonder, how the

Objector could imagine, that, when I had asserted the Theory with the greatest rigour, I should be so forgetful as afterwards to assert the fundamental supposition it self with no more than a “perhaps”. Had I intended any such Hypothesis, I should somewhere have explain'd it. But I knew, that the Properties, which I declar'd of Light, were in some measure capable of being explicated not only by that, but by many other Mechanical Hypotheses. And therefore I chose to decline them all, and to speak of Light in general terms, considering it abstractly, as something or other propagated every way in streight lines from luminous bodies, without determining, what that Thing is; whether a confused Mixture of difform qualities, or Modes of bodies, or of Bobies {sic} themselves, or of any Virtues, Powers, or Beings whatsoever. And for the same reason I chose to speak of Colours according to the information of our Senses, as if they were Qualities of Light without us. Whereas by that Hypothesis I must have considered them rather as Modes of Sensation, excited in the mind by various motions, figures, or sizes of the corpuscles of Light, making various Mechanical impressions on the Organ of Sense; as I expressed it in that place, where I spake of the Corporeity of Light.

But supposing I had propounded that Hypothesis, I understand not, why the Objector should so much endeavour to oppose it. For certainly it has a much greater affinity with his own Hypothesis, than he seems to be aware of; the Vibrations of the Æther being as useful and necessary in this, as in his. For, assuming the Rays of Light to be small bodies, emitted every way from Shining substances, those, when they impinge on any Refracting or Reflecting superficies, must as necessarily excite Vibrations in the æther, as Stones do in water when thrown into it. And supposing these Vibrations to be of several depths or thicknesses, accordingly as they are excited by the said corpuscular rays of various sizes and velocities; of what use they will be for explicating the manner of Reflection and Refraction, the production of Heat by the Sun-beams, the Emission of Light from burning putrifying, or other substances, whose parts are vehemently agitated, the Phænomena of thin transparent Plates and Bubles, and of all Natural bodies, the Manner of Vision, and the Difference of Colors, as also their Harmony and Discord; I shall leave to their consideration, who may think it worth their endeavor to apply this Hypothesis to the solution of phænomena.

[6] In the second place, I told you, that the Objectors Hypothesis, as to the fundamental part of it, is not against me. That fundamental Supposition is; That the parts of bodies, when briskly agitated, do excite Vibrations in the Æther, which are propagated every way from those bodies in streight lines, and cause a Sensation of Light by beating and dashing against the bottom of the Eye, something after the manner that Vibrations in the Air cause a Sensation of Sound by beating against the Organs of Hearing. Now, the most free and natural Application of this Hypothesis to the Solution of phænomena I take to be this: That the agitated parts of bodies, according to their several sizes, figures, and motions, do excite Vibrations in the æther of various depths or bignesses, which being promiscuously propagated through that Medium to our Eyes, effect in us a Sensation of Light of a White colour; but if by any means those of unequal bignesses be separated from one another, the largest beget a Sensation of a Red colour, the least or shortest, of a deep Violet, and the intermediat ones, of intermediat colors; much after the manner that bodies, according to their several sizes, shapes, and motions, excite

vibrations in the Air of various bignesses, which, according to those bignesses, make several Tones in Sound: That the largest Vibrations are best able to overcome the resistance of a Refracting superficies, and so break through it with least Refraction; whence the Vibrations of several bignesses, that is, the Rays of several Colors, which are blended together in Light, must be parted from one another by Refraction, and so cause the Phænomena of Prisms and other refracting substances: And that it depends on the thickness of a thin transparent Plate or Buble, whether a Vibration shall be reflected at its further superficies, or transmitted; so that, according to the number of vibrations, interceding the two superficies, they may be reflected or transmitted for many successive thicknesses. And since the Vibrations which make Blue and Violet, are supposed shorter than those which make Red and Yellow, they must be reflected at a less thickness of the Plate: Which is sufficient to explicate all the ordinary phænomena of those Plates or Bubbles, and also of all natural bodies, whose parts are like so many fragments of such Plates.

These seem to be the most plain, genuine and necessary conditions of this Hypothesis: And they agree so justly with my Theory, that if the Animadversor think fit to apply them, he need not, on that account, apprehend a divorce from it. But yet how he will defend it from other difficulties, I know not. For, to me, the Fundamental Supposition it self seems impossible; namely, That the Waves or Vibrations of any Fluid, can, like the Rays of Light, be propagated in Streight lines, without a continual and very extravagant spreading and bending every way into the quiescent Medium, where they are terminated by it. I mistake, if there be not both Experiment and Demonstration to the contrary. And as to the other two or three Hypotheses, which he mentions, I had rather believe them subject to the like difficulties, than suspect the Animadversor should select the worst for his own.

What I have said of this, may easily be applied to all other Mechanical Hypotheses, in which Light is supposed to be caused by any Pression or Motion whatsoever, excited in the æther by the agitated parts of Luminous bodies. For, it seems impossible, that any of those Motions or Pressions can be propagated in Streight lines without the like spreading every way into the shadow'd Medium, on which they border. But yet, if any man can think it possible, he must at least allow, that those Motions or Endeavors to motion, caused in the æther by the several parts of any Lucid body that differ in size, figure, and agitation, must necessarily be unequal: Which is enough to denominate Light an Aggregat of difform rays, according to any of those Hypotheses. And if those Original inequalities may suffice to difference the Rays in Colour and Refrangibility, I see no reason why they, that adhere to any of those hypotheses, should seek for other Causes of these Effects, unless (to use the Objectors argument) they will multiply entities without necessity....

[8] But whatever be the advantages or disadvantages of this Hypothesis, I hope I may be excused from taking it up, since I do not think it needful to explicate my Doctrine by any Hypothesis at all. For if Light be consider'd abstractly without respect to any Hypothesis, I can as easily conceive, that the several parts of a shining body may emit rays of differing colours and other qualities, of all which Light is constituted, as that the several parts of a false or uneven string, or of uneavenly agitated water in a Brook or Cataract, or the several Pipes of an Organ inspired all at once, or all the variety of

Sounding bodies in the world together, should produce sounds of several Tones, and propagate them through the Air confusedly intermixt. And, if there were any natural bodies that could reflect sounds of one tone, and stifle or transmit those of another; then, as the Echo of a confused Aggregat of all Tones would be that particular Tone, which the Echoing body is disposed to reflect; so, since (even by the Animadversor's concessions) there are bodies apt to reflect rays of one colour, and stifle or transmit those of another; I can as easily conceive, that those bodies, when illuminated by a mixture of all colours, must appear of that colour only which they reflect....

[To Hooke's assertion that Newton's theory is "not so certain as mathematical demonstrations: Here Hooke is alluding to a particular statement in Newton's paper introducing the "new theory," namely, that by Newton's new discovery the science of colours becomes "as mathematical and certain as any other part of Optiques."]

Newton: I said indeed that the Science of Colours was Mathematical & as certain as any other part of Optiques; but who does not know that Optiques and many other mathematical sciences depend as well on Physicall Principles as on Mathematicall Demonstrations: And the absolute certainty of a Science cannot exceed the absolute certainty of its Principles. Now the evidence by wch I asserted the propositions of Colours is in the next words expressed to be from Experiments & so but Physicall: Whence the Propositions themselves can be esteemed no more then Physicall Principles of a Science. And if those Principles be such that on them a Mathematician may determin all the Phænomena of colours that can be caused by refractions . . . I suppose the Science of Colours will be granted Mathematicall & as certain as any part of Optiques.