# Newton's Color Theory

Newton's theory of color was that the sun's light, or any other white light, was a mixture of rays of light, each with its own refrangibility, by which he meant characteristic angle of refraction in a prism. "Homogeneal" light (which modern writers would call monochromatic) would always bend at its characteristic angle in a prism, but the "differently refrangible" rays that make up white light are separated out into the rainbow by refracting to different degrees in the prism.

This certainly is consistent with what we see when we put white light into a prism at just the right angle: the spectrum forms at a predictable angle, with its red end bending least from the path the light was taking before entering the prism, and the violet, the least. In our lab, we set up an optical bench where we used a bright line light to simulate the sun coming through Newton's window "shut", made the rays parallel with a collimating lens, shined it on a prism, then focused the spectrum (using a lens) on a little screen.

However, at the time Newton was working on his "Opticks" experiments, there were other explanations being proffered as to how the prism produced the rainbow. Hooke, for example, thought that white light was simple (presumably uniform, or pure) and that the prism somehow brought the colors into being by "distorting" the simple white light. Just by looking at the spectrum, we can't distinguish which of these two explanations is closest to the truth.

In addition to producing the spectrum on the optical bench, we simulated Newton's two-prism experiment, and directed the spectrum into a second prism, which turned the mixed light white. Newton's theory explains this result by saying that the second prism is recombining the separate rays so that they get to the observer's eye mixed together in the way that we perceive as white. Also, according to Newton's theory, we should only see the recombined light as white if all the parts of the spectrum are mixed together. When we inserted a little post in the spectrum so that the part of it falling on the post was not entered into the mix at the second prism, the recombined light was a color, not white. For example, if we blocked the middle part of the spectrum (the green) with the post, the recombined light was magenta! In fact, all of modern color mixing theory could be demonstrated this way.

Newton said that "homogeneal" (monochromatic, in modern terms) light is not changed by passage through a prism or lens, or by reflection off a mirror. For example, when we put a green filter in the path of the light, the screen was dark where the red and blue light of the spectrum had been, and bright green just in the narrow middle. This is consistent with Newton's claim.

Newton said that white, black, and all the grays in between, were compounded of all the colors of the spectrum, mixed "in due proportion." I would restate that as meaning "in equal amounts". When we placed a gray item in the spectrum, it reflected all the colors of the spectrum, albeit less brightly than the white background. Even something we would call black reflected uniformly across the spectrum, just not very much. In fact, as our instructor showed us, a "true" black, which does not reflect any of the light falling on it, is hard to come by. She made a small hole in a piece of "black" construction paper, and used that as a window into a box. The hole was much blacker than the construction paper. Even the truly black object is on the same scale as white and gray, since it reflects uniformly across the spectrum, except that the amount of reflection for all parts of the spectrum is zero.

Newton thought that colors were a sensory experience, rather than a property of light. Insofar as the light had a physical property, it was the refrangibility of the ray, which we saw remained constant whether the color was “made” by a filter or by the prism. Lights of different refrangibility tend to cause us to experience different colors. (So far as I know, Newton made no claim as to how the light caused the sensation, or whether this had anything to do with refrangibility.) The property of objects, on the other hand, which causes us to call them colored, is their propensity to reflect this or that part of the spectrum more than another. This claim predicts that a colored object only reflects certain parts of the spectrum, and when placed in the spectrum, should either look the same color as the part of the spectrum shining on it, or black. If you can make a bright spectrum in a dark room, you can test this. We put variously colored objects into the different parts of the spectrum, and all of them either were the same color as that part of the spectrum shining on the white background, or were dark. For example, a saturated red object reflected the red part of the spectrum very strongly, but was dark everywhere else. Orange objects strongly reflected the red, orange, and yellow part of the spectrum, but were dark elsewhere, and so on.