gratitude to our late ingenious brother, Mr. Ramsden, to whom he says he is chiefly indebted, not only for the information which was necessary to enable him to prosecute his investigations upon the subject of vision, but also the zeal which influenced his early exertions in the philosophical career.

The opinion here alluded to was brought forward in Mr. Home's Lecture for the year 1794, and was founded upon experiments which seemed to prove that the removal *of the crystalline lens does not deprive the eye of the power of seeing distinctly at different distances.*

An additional case is here mentioned of a man who had a cataract extracted from each of his eyes, and yet preserved a considerable range of vision.

In the Bakerian Lecture of last year, Dr. Young, having entered minutely into the inquiry, thought himself authorized to doubt the above inference; and in order to insure the accuracy of the experiments he intended to make on the subject, he constructed an optometer upon the principle of that of Dr. Porterfield, by which he could ascertain the different focal lengths, and hence the power of adjustment of every eye. The result of his experiments was, that eyes deprived of the crystalline lens have lost their power of adjustment.

This difference of results induced Mr. Home to reconsider the subject, and having sent for the man from whose eyes he had last extracted the cataracts, he repeated the experiments with Dr. Young's optometer, somewhat simplified by leaving out the lens which was placed before the eye. With this instrument that man was unquestionably found to have distinct vision at different distances, the nearest focus being at only 8·3 inches, and the furthest at 13·3 inches, while with Dr. Young's optometer he could never observe any difference whatever.

Besides this individual, others, whose eyes had never been disordered, tried the effects of both optometers; and it should seem, from the various impressions produced upon them, that the contradiction in the above results depends chiefly, if not entirely, on the difference of the instruments.

The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, *M.D. F.R.S. Professor of Natural Philosophy in the Royal Institution.* Read November, 12, 1801. [*Phil. Trans.* 1802, *p.* 12.]

Although the mode, much practised by the ancients, of accounting for a variety of phænomena by a preconceived hypothesis, be, if not wholly exploded, at least greatly discountenanced by modern philosophers; yet it must be owned that when a number of facts have been collected and duly ascertained, it cannot but be conducive to the extension of knowledge, to arrange them under certain heads, and, if possible, to ascribe them to some general cause; and that with men who are candid and not over-tenacious, even an error in

such a proceeding may often be the means of eliciting some further information, which progressively may tend to the advancement of science. The immortal Newton has given us a striking example of this in his Theory of Light, which, should the principle he assumed prove ultimately erroneous, his investigation and mode of reasoning will yet remain an everlasting monument of acuteness and ingenuity, which it is likely will ever be found the best source of information to those who shall engage in this delicate branch of natural philosophy.

Under this impression, Dr. Young, having resolved to contemplate the subject of light and heat, in the present Lecture, proposes to take a general survey of what is extant, using the materials which, chiefly through Newton's means, are now at hand, and at the same time to add some new experiments of material importance in the investigation, in hopes thereby to establish a general principle which may apply to all the phænomena hitherto discovered.

The Newtonian system of emanation, though illustrated in so masterly a manner by its author, partly on account of the stupendous velocity it implies, has been ever thought liable to difficulties, which could not be satisfactorily obviated. Accordingly another hypothesis, namely, that of an ethereal fluid, producing its effects either by an undulatory motion or by a continued pressure, had been substituted by some, without however entering in a methodical manner into the abstruse disquisition necessary to establish their theories. This arduous disquisition our author engages in, in favour of the undulatory system; and it is no less curious than satisfactory, that, in carefully examining the writings of Newton, there are abundance of passages which prove that he was strongly impressed with ideas which singularly favour this theory.

In the first part of the Lecture, our author enumerates these passages, and adduces them in support of the three following hypotheses. 1. That a luminiferous ether, rare and elastic in a high degree, pervades the whole universe. 2. That undulations are excited in this ether whenever a body becomes luminous. And, 3. That the sensation of different colours depends on the frequency of vibrations excited by light in the retina. It is here to be observed that, speaking of the motion of this ether, Newton uses the term vibration instead of undulation, which two words manifestly convey different meanings, the one being the alternate motion of a pendulum, and the other that of waves which protrude each other. It is likewise obvious, as to the motion of the retina, that it must rather be of the vibratory than of the undulatory nature, the frequency of the vibrations depending on the constitution of the substance limited to the sensation of colours.

These three hypotheses, which may be called essential, are here shown to be literally parts of the more complicated Newtonian system. But a fourth is now advanced, which appears diametrically opposite to that of Newton, and differs in some measure from any that has been hitherto proposed by other writers, although the author does not consider this difference as affecting in any degree its ad-

missibility. It assumes that all material bodies have an attraction for the ethereal medium, by means of which it is accumulated within their substance, and for a small distance around them, in a state of greater density, but not of greater elasticity.

The whole theory is now applied to the phænomena, in Nine Propositions, together with several scholia and corollaries. As the arguments on which the doctrine rests cannot be abbreviated without impairing their evidence, we must content ourselves with merely enumerating the heads, adding, however, a few observations which may facilitate the understanding of the main object of the inquiry.

All impulses, says the author in the First Proposition, are propagated in a homogeneous elastic medium, with an equable velocity. The truth of this theorem has been mathematically demonstrated by various writers, the actual motion being considered as very minute. Prop. 2. An undulation conceived to originate from the vibration of a single particle must expand through a homogeneous medium in a spherical form, but with different quantities of motion in different parts. Prop. 3. A portion of a spherical undulation, admitted through an aperture into a quiescent medium, will proceed to be further propagated rectilineally in concentric superficies, terminated laterally by weak and irregular portions of newly-diverging undulations. The chief purport of this last Proposition is to obviate the objection, that if light were the effect of a widely-expanded fluid put in motion by an impulse, it would, like the waves of water, and air in the instance of sound, spread laterally from the original direction of the motion, and agitate the contiguous quiescent medium; by which means we ought to see objects as well as we hear sounds, behind an opaque body. It is here alleged that, according to Newton's own words, sounds diverge much less than the waves of water, the air being more rare and elastic; and that in the very rare luminous medium, after its undulations have passed by an opaque substance, they will indeed diverge a little from their first direction, but this in so small a degree as to be almost imperceptible; whereas the loss of even this small degree of impulse will make the progressive undulatory beam appear somewhat contracted. It is no small confirmation of the theory, that this effect perfectly agrees with the result of an experiment mentioned by Sir Isaac Newton; though, having adopted a different principle, he used it rather as an objection to the undulatory system. The subject of this Proposition having always been considered as the most difficult part of the last-mentioned system, the author has taken particular pains to clear it as much as possible from all objections.

The mere recital of the enunciations of the four next Propositions will probably enable those at all conversant with the science of optics, to perceive in what manner the author means to explain, according to his theory, the important phænomena of Refraction, Reflection, and Colours. They are stated in the following manner.—When an undulation arrives at a surface which is the limit of media of different densities, a partial reflection takes place, proportionate in force to

the difference of the densities. This, it is thought, may be well illustrated, if not demonstrated, by the analogy of elastic bodies of different sizes. When an undulation is transmitted through a surface terminating different media, it proceeds in such a direction that the sines of the angles of incidence and refraction are in the constant ratio of the velocity of propagation in the two media. When an undulation falls on the surface of a rarer medium so obliquely that it cannot be regularly refracted, it is totally reflected at an angle equal to that of its incidence. And if equidistant undulations be supposed to pass through a medium of which the parts are susceptible of permanent vibrations somewhat slower than the undulations, their velocity will be somewhat lessened by this vibratory tendency; and the more so in the same medium, the more frequent the undulations. If we ascribe the sensation of colours to the different velocities of the coloured beams or undulations, this last Proposition will afford a solution to the phænomena of dispersion according to the new system.

When two undulations from different origins coincide either perfectly or very nearly, in direction, their joint effect is a combination of the motions belonging to each. This is the Eighth Proposition, which, at first sight, appears so consistent with the most obvious mechanical principles, as scarcely to need any illustration; yet its extensive utility in explaining the phænomena of colours renders it perhaps the most important in the lecture. In a first corollary the author treats of the colours of striated surfaces, where, after showing in what manner these depend on the breadth of the undulations in proportion to the distance and position of minute surfaces, it is shown from original experiments in what manner this circumstance affords a very strong confirmation of the theory. But a still more interesting coincidence is shown in the second and third corollaries, which treat of the colours of thin plates, and of thick plates. It is here explained by what means the breadth and duration of the respective undulations may be deduced from Newton's measures of the thicknesses reflecting different colours; and the law of variation of colour, in consequence of the change of obliquity, which is very embarrassing on every other supposition, and had never been reduced to any analogy, is referred to a simple and necessary consequence of the author's theory.

The whole visible spectrum being estimated to be comprised within the ratio of 3 to 5, the undulations of red, yellow and blue appear to be related to each other in magnitude as the numbers 8, 7, and 6. On these data a table is constructed, showing for each primitive colour, and the intermediate ones between each pair of them; 1. The length of an undulation in parts of an inch in air. 2. The number of undulations in an inch. And 3. The number of undulations in a second. All these numbers agreeing accurately with the phænomena, will probably be considered as a strong evidence in favour of the theory. The appearances of colours in inflected light are likewise explained in a subsequent corollary.

The last Proposition may be considered as the general result of the whole investigation; in consequence of which, Dr. Young thinks him-

self authorized to assert, without hesitation, that radiant light consists in undulations of the luminiferous æther. The general inferences he draws from his arguments are, that it is clearly granted by Newton that there are undulations, although he denies that they constitute light; and that it being shown in the three first corollaries of the Eighth Proposition, that all cases of the increase or diminution of light are clearly referable to an increase or diminution of such undulations, and that all the affections to which the undulations would be liable are distinctly visible in the phænomena of light, it may therefore be very logically inferred that the undulations are light.

Dr. Young proceeds to attempt the removal of some apparent difficulties in the system which he has adopted; and concludes with a summary comparison of light with heat, which he supposes to differ from it only in the magnitude and frequency of its undulations or vibrations.

An Analysis of a mineral Substance from North America, containing a Metal hitherto unknown. By Charles Hatchett, *Esq. F.R.S.* Read November 26, 1801. [*Phil. Trans.* 1802, *p.* 49.]

This substance, which was lately found among the minerals in the British Museum, appears by an entry in Sir Hans Sloane's Catalogue, to have been sent to him with various specimens of iron ores, by Mr. Winthrop of Massachusetts, whence it is conjectured that it is the produce of that province. Its resemblance to the Siberian chromate of iron first attracted Mr. Hatchett's notice. It is of a dark brownish gray; its longitudinal fracture is imperfectly lamellated, and the cross fracture shows a fine grain. Its lustre is vitreous; it is moderately hard, and very brittle.

The analysis was conducted with all the chemical agents usually applied upon those occasions; and the whole process is minutely described in the paper. From these experiments we learn that this ore consists of about one quarter of iron, and three quarters of a substance hitherto unknown, but now proved to be of a metallic nature, both by the coloured precipitate which it forms with prussiate of potash and with tincture of galls, and by the colour which it communicates to phosphate of ammonia, or rather to concrete phosphoric acid when melted with it.

From the experiments made with the blowpipe, it seems to be one of those metallic substances which retain oxygen with great obstinacy, and are therefore of difficult solution. That it is an acidifiable metal appears from the circumstance of the oxide turning litmus paper red, expelling carbonic acid, and forming combinations with the fixed alkalies; but in many points which are enumerated, it is manifestly very different from the acidifiable metals hitherto known, such as arsenic, tungsten, molybdena, and chromium, and it appears to differ still more from the lately discovered metals known by the names of uranium, titanium, and tellurium.