

"We cannot fail to connect the principle of free education with that weakening of parental influence and that perilous depreciation not to say contempt, of family responsibilities and duties, which are at this moment, the most painful and portentous symptoms in connection with the fast and ambitious social life of the States. This is a subject on which we dare not enlarge, but it cannot but be felt that for children to be educated not under any direction or responsibility of the parent, but solely at the charge and under the direction of the State, and for parents to shrink from family responsibilities, are two facts which well agree. Other points also may be noted. The youth whom the State has educated, *in loco parentis*, has scarcely left school before he becomes in most parts of the Union an independent citizen and voter, from whom an original and individual opinion on civil and political questions is due; and so, under his father's roof he becomes an independent political power. All matters go together and all tend to add intensity to the social evils over which the wise and good in the United States lament."

SCIENCE.

Two Astronomic Discoveries.

The year 1875 seems likely to be distinguished in the annals of astronomy for the new evidence it is perfecting of two important facts, both of which have been held probable but have hitherto lacked complete demonstration. The first of these facts is that we are some 4,000,000 or 5,000,000 of miles nearer to the sun than we had been taught by our old textbooks on astronomy to believe; and that consequently the distances of all the planets from the sun and from each other are to be calculated over again and set down at much lower figures. The evidence which the recent observations of the transit of Venus have contributed to this important subject is well known to our readers, and is brought forcibly to mind by the recent return of the *Swatara* to New-York with the transit expedition. The second of the demonstration we have referred to is that of the motive force of light. At a meeting of the Royal Society of Great Britain a few weeks ago, Mr. William Crookes, Fellow Royal Society, who had previously communicated some interesting facts on this subject, read a paper which may give rise to much more important discoveries perhaps than any contribution to Celestial mechanics since the law of gravitation was demonstrated by Newton. It has always been assumed, and Dr. Balfour Stewart and other authorities have affirmed that light, apart from heat, has no mechanical force whatever. This old theory is overthrown by Mr. Crookes, who for some years past has been making experiments, and has at last constructed an ingenious apparatus, by which he shows the power of luminous rays to drive round and round a little vane when the heat rays are excluded, being thoroughly sifted out by means of a screen of alum. We abridge from the London *Telegraph* the following account of one of the experiments, and regret that our space does not allow a more extended notice of the phenomena submitted to examination before the Royal Society. With an air pump Mr. Crookes first exhausts a tube with a bulb at its end and in the bulb he mounts upon a delicate pivot a little vane of glass or straw. This vane is made in the form of the letter X, and on each of its four arms is mounted a disc of pith blackened on one side. The use of this blackened surface is ingenious, as will be presently seen. As soon as the machine is ready, it is exposed to the sunshine, when its discs immediately become endued, as it were, with life. They revolve around their common axis just as the planets revolve about the sun in the orrery. What is the motive force in this beautiful experiment? It is not heat. For, as before observed, the heat rays can be sifted out by the alum screen without stopping the rotation of the machine. The atmosphere and its changes have nothing to do with producing the motion. Prof Osborne Reynolds some time ago suggested that the discs revolved because there was a latent moisture in them which, being evaporated in the experiment, gave a resilient impulse to the little orrery. To refute this theory and, at the same, to show that the sole motive force engaged in driving the orrery was the luminous rays of the sun, Mr. Crookes exhibited a machine made wholly of platinum which had been heated to redness while under continuous and absolute exhaustion. The discs

being made of platinum instead of pith, as before, revolved as obediently as the discs of pith; inasmuch as they could contain no appreciable amount of latent moisture, the theory of Prof Reynolds was, of course, exploded. The final result was that light is now acknowledged for the first time as one of the mechanical forces, and such eminent men as Profs Stokes and Huxley, Dr. Carpenter, Mr. Norman Lockyer, and others, agree that the demonstration was perfect.

Another point of importance is that the force which light delivers is not like the force of gravitation, but differs from it in several essential respects. One of these is, that while gravitation attracts and gives a centripetal impulse the force of light is centrifugal, and repels or pushes away the objects on which it is delivered. Thus the black side of the disc is pushed from the sun, and the orrery of Mr. Crookes is kept in constant rotation so long as the lightwaves dash themselves against the black surface and drive it before them. Shut out the light by covering the machine with a hat, and the rotation instantly stops, to be renewed again the moment the obstruction is taken away and the light readmitted. A green or blue screen diminishes the force of the rotation. Yellow or red glass quickens it into a much more lively activity. If a cloud passes over the face of the sun while this little orrery is working at full speed its movements are checked and somewhat slower, but the moment the sun is visible again the mechanism responds with alacrity, and its revolutions are as swift as ever.

Mr. Crookes is well known as the man to whom science owes the discovery of the metal thallium, and the complete establishment of its atomic weight. He has also invented the radiometer. But the little orrery we have described above is a much more remarkable contrivance. It contains the promise of further discoveries. It will perhaps raise its inventor to the front rank among the explorers of physical science. In this simple little machine one of the most occult forces of nature is for the first time revealed to the eye of man. In it, says the authority from which the foregoing facts are chiefly taken, "we see the subtlest of imponderables set like a willing slave to turn a wheel; while tiny as that wheel is in these experiments, we must remember that light pervades it, flashing perpetually from countless centres like our own sun, across the infinite ether, and it may be fairly imagined that the interplanetary ether resembles the vacuum in the bulb, so that the condition of these revolving disc is, perhaps, much the same as that of the planets in space. Strange, indeed, are the thoughts which must be started by this revelation that light, pouring upon bodies freed from atmospheric friction, is in itself an active and mighty force. That so remarkable a discovery solves at once the mystery of the comet's tail—which is always seen to be driven violently away from its natural line upon approaching the sun—is, we believe, affirmed by more than one high astronomical authority. But may it not also have something to do with the axial motion of the planets? May it not have something to do with the maintenance of centrifugal force, balancing, as it were, that of gravitation? Can it be for nothing in the celestial universe that this potency and stress of light sweeps from centre to circumference of each system, exercising a power which, in its totality must be something prodigious? It seems not impossible that our mathematicians, calculating from the surface of these disks the motive force of sunlight, may soon tell us pretty accurately what is the aggregate power which the luminous rays of the sun command; and nothing of this, by the law of forces, can be really wasted. 'Let there be light and there was light' seems to derive a new majesty of meaning from the discovery which shows us this subtle something, no more undulation nor 'mode of motion,' but a living force as well as the illumination of all life. It does appear as if a marvellous expansion of knowledge is about to open in these delicate experiments."

But there are no limits to the ingenious conjectures which may be advanced. To pursue them would be unprofitable in the present state of our knowledge. What is certain is that a great cosmic force has been discovered and submitted to experiment and investigation. But how long this force will be before it finds its Kepler and its Newton the future will show. "Why in the ranks of our American astronomers should we not look for the expected teacher to rise up?" Sir William Herschel, in his "Lectures on Astronomy," gives some interesting calculations as to the enormous waste of the rays of light in the solar system. He concludes that "taking all the planets together, great and small, the light and heat they receive is only 227 millionth part of the whole quantity thrown