Correspondence.

The Physical Substratum of Mechanical Power in Nature.

To the Editor of the Scientific American:

If your correspondent in regard to the subject of planetary motion, on page 275, would turn to a communication on page 228, I think he would find a physical explanation, without either accepting or casting aside the nebular hypothesis. As the subject is theoretically of the greatest importance, I would request the favor of a further illustration of the principle there advanced.

In my former communication I intimated that every particle of matter was the nucleus of a ubiquitous substratum of mechanical power, constantly exercised in attaining and maintaining equilibrium with all others. This is fairly worthy of being rigorously tested, when we consider that Newton exercised his vast mathematical powers in endeavoring to demonstrate that every particle of matter attracted every other, and that the non-mathematical Faraday, from physical considerations only, in his electrical researches, was induced to utter the singular expression: "The atom is everywhere."

The only attempt to explain gravitation by a mechanical theory which has met with any favor, and that but little, is the one of Le Sage. This supposes space to be filled with self-repelling corpuscles, which impel bodies together through acting as screens to their motion. Herschel considered this theory as too grotesque for serious consideration, while Sir W. Thomson has shown it to be inconsistent with the principle of the conservation of energy, unless the *vis viva* lost by the resistance of matter be exactly compensated by a fresh force of impulsion continually coming from beyond the limits of the stellar universe. The same objection applies to Professor Challis' theory of impulsion by etherial wave motion. Other objections there are which we will not dwell upon, such as the non-accumulation of the corpuscles on the together impelled bodies; but we may safely say with Herbert Spencer that astronomers have as good as given up the mechanical explanation. Professor Maxwell, in his splendid attempt to generalize the radiant forces, acknowledges that he cannot conceive an etherial medium possessing the property of causing matter to gravitate, combined with that of manifested radiant motion. But now conceive the equilibrating power of all matter to be ubiquitous, and a universal consistency results. All bodies, by the equilibrating energies of all others, are continually in a state of stress; submitting when unbalanced to the predominating tensions or pressures. The tensional power exercised by any body in drawing others to a balancing condition with itself will of course be directly as its mass; that of all bodies inversely as the square of the distance. The static or attained position of balance will be stable when the pressures, perpendicular to the lines of tension, are in power inversely as the distance from the center of combination (gravity) or, we might call it, fulcrum. In cosmic systems, the energy of motion in revolving bodies must correspond to the force of pressure in a balance. I hazard nothing in saying that, if ever we have optical instruments powerful enough to examine minutely the rings of Saturn, we will find that the bodies at the interior of the dark ring, being rather more than half the distance of those on the exterior of the outer, will have rather less than double the energy of motion, the particles between being of intermediate velocities, according to their respective positions, or distances from the planet.

So palpable is this physical connection, by the native energies of distant bodies, that Professor Nichol pictured Jupiter and Saturn as nicely balancing on a lever of varying length throughout the great inequalities, the mean length, during the ever recurring cycles, the same. Herschel also, for greater definiteness, figured the planetary orbits during the varying inclinations as rigid rings (on which the planets were sliding like beads), tilting each other during their motion, while preserving the general plane or fulcrum unaltered. This plainly shows an unalterable amount of motive power centralized in the system by the individual tensions being there balanced by the pressures, or motions of the bodies perpendicular to their lines of traction. Even tidal phenomena are less the results of pure attraction than equilibrating oscillations during terrestrial and celestial motions. Now no universal plenum of self-repelling corpuscles could produce and sustain (of course as a secondary cause) the conservative harmony of cosmic systems, for their extraneous action could have nothing to do with masses balancing each other at a distance. Nor is an infinitude of attractions contending with an infinitude of tendencies to fly off at tangents (the results of primitive impulses) at all satisfactory as a theory.

S. E. Cowes, an American, published, in 1851, a treatise on "Mechanical Philosophy," in which he repudiated the physics of the schools, basing his own system on the principle of the indestructibility and identity of force, apparently ignorant of the agitation of this question by a few in Europe. His boldness in the application of the principle carried him out of the pale of scientific recognition. His application of it, however, to terrestrial gravitation will not be out of place here. A body involved in the earth's motion shares, according to its position, the diffused force of revolution and rotation. Projected upwards, it describes a wider area from the earth's center, which is equivalent to an increased force of motion. Consequently the force of projection decreases, with the increase of gravitation—potential. Being, by difference of density, not in equilibrium with the surrounding atmosphere, it takes the nearest path to equilibration, back again; the falling force by its acceleration being exactly equal to the force necessary to make it describe a wider orbit.

The desire of not encroaching too much upon your valuable space hinders me from a more thorough treatment of this subject, and also from showing how the radiant forces become, by the principle, consistently generalized. Like Faraday I would "dispense with the ether but not the vibrations." And I must record my conviction that Science never can advance to a generalization of all the forces of Nature until it recognizes the fact that the substratum of mechanical power, appertaining to every unit, is as infinite and eternal as space and time in the will of God—that the Great Mechanic presides over a universe, and not merely a cohering multiverse.

Philadelphia, Pa. WM. DENOVAN.

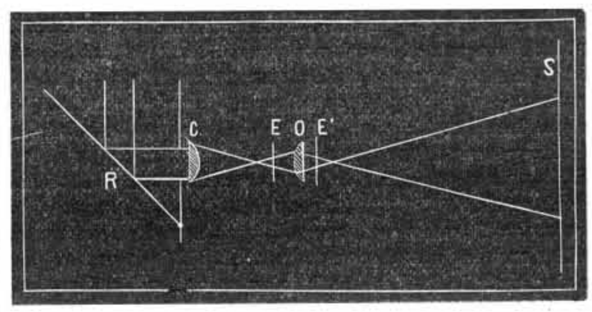
The Projection of Diffraction Phenomena.

To the Editor of the Scientific American:

As usually presented, the phenomenon of the diffraction of light is so obscure in effect that but a few can see it at a time, even when a powerful light is used. This answers well enough for one who is investigating the matter; but for presenting the phenomenon to a class or to a popular audience, there is no method that I know of to be found in any treatise. Therefore I hope the following description will meet the demand, as the spectacular effect is certainly very beautiful and striking:

For most of my projections, I use a *porte lumière*, and wait for the sun, if it is not shining at the time. The brilliancy and magnitude of the effects, and the trifling cost, render this method desirable in those institutions that are not well supplied with physical appliances; so I will describe the fixtures for that instrument:

The two large lenses, such as are usually combined for a condenser in the magic lantern, are used. The light is reflected from the mirror, R, through one of these lenses, C, used as a condenser. The other lens, O, is placed a little outside the focus of the condenser, at such a distance that the light is again converged and crosses between the line, O, and the screen; the size of the disk of light upon the screen will evidently depend upon the distance of this focus from it. I have found that, at the distance of twenty-five feet



from the lens, this disk can be utilized to the diameter of thirty feet or more for this experiment. Now bring a piece of wire gauze to the place marked E, not in the focus for ordinary projection. The meshes will not be distinct, but each one will be represented by the prismatic colors, so as to make a pretty show. If, in place of the gauze, a piece of perforated paper be used, the effect will be finer yet; and if still the eidotrope be placed there and the rotation be given to it, there will be a fine blending and distribution of the colors, interesting and novel. Now let the eidotrope be placed outside of the objective, O, at the place E', between the lens and its focus. I will not even try to describe the splendid effect which is thus produced, for it surpasses my power of description. It will be enough to say that it is not surpassed by the most gaudy exhibition of polarized light. If the eidotrope be used and made to revolve at this latter place, some of the appearances will be much like those from double refracting media. If the eidotrope has ever been thus used, I am not aware of it.

I might say in addition that, with the above lenses, a very brilliant rainbow of any size, up to thirty feet in diameter, can easily be projected. Move the lens, O, from within the focus of the condenser, C, outward; there will appear a disk with a strongly colored edge, which can be amplified to the desired size by the movement of the objective. The colors are arranged with the red outward, as in the primary bow. Bring a small paper screen with a rounded edge of such a curvature as to cut of all the light except the rim, when placed at E'. There will then be left a splendid bow upon the screen. A. E. DOLBEAR.

Bethany, W. Va.

Wooden Railroads.

To develope the resources of a country, facilities for transportation are indispensable. Iron ore could be mined and lumber manufactured only to a very limited extent if wagon transportation for any considerable distance over common roads were necessary to reach a market. Where the business is sufficiently extensive to warrant it and the capital can be secured, railroads, either narrow or ordinary gage, will afford the best facilities. But there are many localities in which ordinary railroads are impracticable, not from physical but from financial difficulties in the way of their construction. With a limited capital and a sparse population, railroads cannot be built in localities highly favored in natural resources for operations of quarrying, mining, and heavy manufacturing. In such cases, a substitute for the wagon road, less expensive than the railroad, becomes a desideratum.

This substitute has been proposed in a new style of wooden railroad, costing but little more to construct than an ordinary wagon road, yet affording transportation at less than one fifth the cost by wagon, and less also than the ordinary cost by rail, where interest on capital invested is considered. This road differs essentially from the ordinary tram road, which consisted of sawn rails about three inches wide, laid on cross ties, and used with narrow tread iron-wheeled cars. Such roads, although some improvement on the common wagon road, with its mud holes and deep ruts, have given very unsatisfactory results. The differences extend to the tracks, cars, and motive power.

The track is formed of heavy logs, hewn on the upper side to the width of eight inches, and on the inside at right angles, sufficiently deep to form a straight edge for the flange. These logs are buried so that the top, or rail surface, is almost level with the road surface, resting on stout sills at the end and middle, to which they are secured by wedged treenails. The rails therefore are solidly bedded, and not liable to warp or twist. Twenty feet would be a convenient length on curves, but on straight lines longer pieces could be used, the ties being ten feet apart. The grading, of a sufficient width, on a side hill with gentle slopes, would cost about $200 per mile for a three foot gage; but of course the cost of graduation will vary greatly with the locality. Ravines and small water courses would in general be crossed with rough trestles or timber cribs. Hewing the timber would cost about $200 per mile. In a wooded country, where timber can be obtained along the line of the road, where no large bridges are required and no rock has to be excavated, the cost of such a wooden railroad should be covered by from $500 to $2,000 per mile, depending upon the amount of earth work.

The cars proposed for such wooden railroads are simple frames placed on wheels, without springs, and covered with a floor of plank. The wheels are of wood, built up of pieces cut from two inch plank in the form of sectors, about 8 inches wide at the wide end. Four thicknesses of plank will build a wheel with a tread of eight inches, corresponding with the face of the rail. A cast iron hub is inserted in the center, through which an iron axle passes, and a cast iron flange is bolted on the inside. The timber should be of hard wood, well seasoned, the sectors laid so as to break joint and well bolted. Diameter of wheels, about thirty inches. Such cars, if used with horses, will cost $40 to $50, or about one third the price of a farm wagon. They will carry three tuns, and can be made by any rough hand who can use carpenter's tools. If designed for use with locomotives in trains, drawbars and springs must be used, and the cost per car increased

MOTIVE POWER.

Horse or mule power can be used; but if the tunnage is considerable, it will be preferable to adopt a light engine of six or seven tuns, with wide driving wheels, covered with vulcanized rubber tyres. Such engines can be manufactured at the Baldwin Locomotive Works for about $4,000. Passengers could be carried on the proposed roads with such engines at a speed of ten or twelve miles an hour, which would make a great improvement on the stage coach.

Such roads would rot out long before they would wear out, and the answer to the objection that they are not durable is simply that they will last just as long as the cross ties on an ordinary railroad, and it will cost less to renew them. Post oak ties in the South last from ten to fourteen years. The cost of transportation by wagons, for a distance of twenty-five miles, without return load, is fifty cents per 100 lbs., or ten dollars per tun of 2,000 lbs.

Assuming the tractive power on such a wooden road, for the purpose of an approximation, to be double that of an ordinary railroad, or 20 pounds per tun, the angle of friction would be forty-eight feet to the mile. And a horse exerting a power of 150 lbs. at 2½ miles per hour, or 4 horses doing 600 lbs., would haul, on a grade of 144 feet to the mile, one fourth of the gross load on a level, or 7½ tuns, giving 6 tuns of net load. As a trip of twenty-five miles, returning empty, could be made in two days, assuming a team to be worth $5 a day, the cost of the round trip would be $10, or $1.66 per tun, as against $10 per tun by wagon transportation; and this, too, on grades of 150 to the mile, nearly—tolls for use of road not being included in either case.

This illustration will show the great economy of such roads over wagon transportation, even when operated by horse power; but where the business will warrant it, the rubber-tyred locomotive should be used. If, after a few years, a business should be developed sufficiently to justify the expense, an iron railroad could be substituted, in which the original grading, as it would form apart, or the expenditure for it would not be lost. It is also to be observed that, the rails of the proposed wooden railroad, being even with the surface of the road bed, or nearly so, would permit the same road bed to be used for the ordinary vehicles.—*General Haupt, in Journal of the Farm.*

M. VIGNON has prepared mannitan by mixing mannit with half its weight of concentrated sulphuric acid, and keeping the mixture at 125° for two hours. Mannitan turns the plane of polarization to the right, and does not yield mannit even on boiling with baryta water for an hour. If mannit is heated to 280°, with a little water, a body is obtained which appears to be mannitan, but which turns the plane of polarization to the left, and yields mannit on boiling with water.

SEVERAL geese died in Mormon Island, Cal., a few days ago, and, upon dissection, gold dust was discovered "in fatal quantities" in their gizzards. And yet there was no suspicion that either of these was the golden goose we hear so much about.

DR. GATLING fired a quantity of the Mead-Meigs one inch caliber explosive bullets at the Gatling gun trial, at Fort Munroe, October 6, and reports the practice as very good.