the great *integer;* as, by way of illustration, to quote the poet's words,

> The spider's touch, how exquisitely fine,
> Feels in each thread and lives along the line;

whilst of gravity it may be said, too, that it "extends through all extent; spreads *undivided*, operates *unspent*." "Kepler," writes Proctor, "possessed some very sound notions of the nature of gravity. . In his famous work de Stellâ Martis, he distinctly states that gravity is a corporeal affection reciprocal between two bodies of the same kind, which tends, like the action of the magnet, to bring them together, so that when the earth attracts a stone, the stone at the same time attracts the earth." And Clerk Maxwell's theory, as interpreted by Professor Chrystal, is to this effect, that "possibly magneto-electrical effects are due to the existence of matter, of ordinary matter," and it has been proved mathematically by Gauss, and it was held long before him by Gilbert, and after him by the famous Halley, that the whole earth acted as an enormous magnet. Becquerel, too, maintained that all matter is magnetic. Airy also showed that "terrestrial magnetism is not produced in any important degree by magnetic forces *external* to the earth."

Does matter attract matter? If we try by means of a crane to lift a hundred weight of iron to the height of a hundred feet, how unwilling, as we pull the rope, does the iron feel to be torn from the ground. As we pull and pull, the weight seems to pull against us, exactly as if some one on the ground was, with another rope attached to the same weight, pulling against us; and if at length, by the energy of our muscles lifted to the desired height, how taut the rope is, as if the weight strained it in its effort to get it back to where it was before it had been so forcibly lifted. Then, if we cut the rope which held it aloft, how speedily it flies again to the earth. Such is the pull of gravity (Tyndall). For though the gravity of a particle of matter is not the million-million-millionth part of the force of the chemical affinity of an affine particle, yet, when all the particles are combined that make the vast quantity of the mass of the earth, the force of the gravitation of the whole is enormous. Still, it is denied—indeed, what is not denied by some or other of the sceptic scientific class?—that matter does attract matter. But does not lime attract carbonic acid, or sulphuric acid copper? But why multiply instances? and are not these so tenaciously held in the compound that only by a most potent *energy* can they be separated—a double illustration of Grant Allen's theory—force combining and energy separating, the separated atoms having a very high energy, which they did not possess in their neutral form in combination. But it may be replied that this is chemical attraction. True. But do names alter things? Call it what you will, it is yet the attraction of matter for matter, and many million times more powerful than the force of the gravitation. Can we supply the cause of this affinity: and if not, why dispute gravitation because we cannot supply it? Why not take both as foundation facts with nothing behind them? As Professor Chrystal asks, "Where is the electromotive force which drives the electric current situated?" And he replies: "Unfortunately the answers, both experimental and theoretical, that have at different times been given, are not so concordant as could be desired." But the oneness of nature is absolute; everything—atom and world—is included in the undivided whole. In fact, the universe is a unit indivisible.

But what *is* this strange, many-sided thing, so patent yet so evasive, called matter? Matter! Why, everyone knows what matter is; but, when we come to close quarters, no one seems to know it really, so innumerable are the sides and shapes and transformations which it presents. Boscovich thought of it as so many points of force. Newton spoke of it as "brute," inert matter. So, between all force and no force we have come to a strange pass. But Grant Allen's theory (*i. e.*, one-half of it) is this, that force is an inherent property of all matter, and that the smallest part of it is held to the whole as an integral part of it. But, though a stone falls to the ground, and the moon is kept every moment from falling on it by the *energy* of its motion, it is objected that, according to this, the masses of matter will of themselves "have created energy, and yet, while creating it, will have *lost nothing* that they originally had possessed, because they will, after the operation is over, be as competent as ever to exert the force of attraction." But, if gravity be an ever-present, inherent force, it can no more be lost or diminished than can matter itself. The law of the conservation of energy is, in this respect, true equally; for the quantity of the energy of the universe is as surely a constant quantity as is the quantity of force; but, unlike *force*, which is always and in all circumstances always resident in and never separable from any particle of the matter of the indissoluble whole, energy may, on the contrary, move from point to point, from matter to matter, and from matter to the ether (as in the case of iron cooling), so that, while one substance may be the loser of it, another will be by so much the gainer; and hence nothing is ever lost to the whole universe. As Prof. Tait says, "do what we will, we cannot alter the mass or quantity of a portion of matter. We may change its form, dimensions, state of aggregation . . . but the quantity remains unchanged . . . and, if we receive this as evidence of the objective reality of matter," we must, by parity of reasoning, "consider *energy* as the other objective reality in the physical universe."

I now come to another point of warm debate. Prof. Tait, Balfour Stewart, and other able physicists very properly divide the energies of the universe into *two* classes—the potential and the kinetic, or energy ready to act (*in posse*) and energy in act (*in esse*). But some scientists not holding the doctrine of the persistence of force, while persuaded of the truth of the dogma of the conservation of energy, and trying to explain the kosmos by energy *alone*, seem to me to boggle fearfully. Thus, potential energy, they tell us, is *in its nature kinetic, i.e.*, is the equivalent of motion. Again, they tell us that a stone lifted from the earth, by the energy of human muscles, or steam, or any other energy, on to, say, a high overhanging ledge of rock, is in a state of potential energy, though neither the eye nor the hand nor any other test can discern any motion, molar or molecular, in it that was not in it when it rested on the ground; but if energy be the equivalent of motion—the kosmos being divided by *them* into "*matter and motion*"—is not this a paradox? The lifted stone is in a state of palpable inertia, and has no motion whatever. How, then, on *their* premises, not on ours, can this be explained? Can it be at the same moment energetic and inert? Let this be a *test-question*. Prof. Chrystal confesses that he cannot tell "how potential energy can exist in a body all whose powers are *at rest*." This is indeed frank. Prof. Tait, too, admits that it is "impossible to conceive a truly dormant state of energy whose magnitude should in any way depend on the unit of time; yet potential energy, like kinetic, depends in some unexplained or rather *unimagined* way upon motion . . . and the conclusion, which appears inevitable, is that, whatever matter may be, the other reality in the physical universe, energy, which is never found unassociated with matter, depends in all its widely varied forms upon *motion of matter* . . . but the question, in its generality, is of the most obscure . . the most profoundly difficult . . in the whole range of physics." Does it not seem a doleful conclusion—this potential paradox of *motion where no motion is?* But, on the hypothesis of the force of gravitation, the whole difficulty vanishes, and order reigns throughout. Thus, when the stone falls off its high ledge of rock, its potential energy (energy *in posse*), due to its separation from the lower earth, becomes kinetic, and when it strikes the ground its *molar* kinetic energy is not lost, but is only changed into *molecular* kinetic energy (the vibration of its several particles). Its physical aggregative longing (so to speak) is satisfied. Its potential energy of separation was *due to the energy that lifted it there*, and, in its fall, *that* energy, through its molar motion, was translated into molecular motion when it struck the ground, and there is no obscurity or mystery in the matter at all. But this must not be lost sight of, that motion *is* energy, *no matter what its cause*, and that, after all, the energy of the motion of a falling stone is only an *incident* of its position, and that whether it remained where it was or fell, the force of gravitation was always persistently acting on it, and that the motion-energy created by its fall, molar and molecular, was the exact equivalence of exchange, in units of energy, of the energy previously expended in lifting it there. The waves of the sea are lifted in mid-ocean to a ridge by the attractive force of the moon, and, were it not for the counter attractive force of the gravitation of the earth, would flood the moon itself. The late astronomer Royal, Sir George Airy, wrote that, "an eye at a great distance capable of observing the swells of the tide-waves might see one huge longitudinal ridge extending from the mouth of the Amazon to the sea beyond Iceland, making high water at one time from Cape Verd to the North Cape," and all this effected by the attraction of one great mass of matter upon another. But the earth's attractive force pulls down the wave to it again, as soon as it has reached its highest point. And Sir Robert Ball tells us that "a philosopher of the present day who had never seen the sea could still predict the necessity of tides, as a consequence of the law of universal gravitation"—a result owing to the relation "between the moon and the tides."

In a leading article in *Nature* we read that "the unimaginable vehemence of *heat* in the sun is balanced by an unimaginable urgency of *pressure* . . here gravity and molecular motion—*the two universal antagonists*—carry on a conflict intensified far beyond the control of laws derived from terrestrial observation;" and, again, "local excesses of temperature lead to what we may call *revolts against gravity*." And what is all this but a most emphatic affirmation of the truth, in the two aspects of it, of Grant Allen's theory. Again we are told in *Nature* (a leading article, too) that "some explain gravity as a push, not a pull." Central forces are replaced by the preponderant external impacts of mundane and ultramundane particles. Such theories *write their own sentence.* They include their own condemnation; for, as M. Isencrake points out, "the very form of the fundamental equation implies a contradiction of the law, that gravity varies with *the mass*." Again writes Nicola Tesla, "the forces or molecules keep up a ceaseless bombardment, but these being in *every* direction neutralize each other"; and it must not be lost sight of that action and reaction are equal and opposite. Writing on gravitation, says Taylor, "its direction is in a right line between the *centres* of the attracting masses . . it is incapable of *exhaustion* . . every body attracting every other in proportion to its *mass*," while Laplace tells us that in every part of the universe its action is "instantaneous," and, says Prof. Fitzgerald, "the instantaneous propagation of gravity" need not be "an essential difficulty." Oliver Lodge, too, says: "conceivably gravitation is transmitted by such longitudinal impulses or thrusts, and in that case it is nearly if not quite instantaneous." Like water in the ocean, matter is one and inseparable. A hole made in it with the finger closes up immediately. And Prof. Lodge, trying his hand at accounting for gravitation (which he by no means denies) says, "conduction does not go on except in the presence of ordinary matter, and is connected with *bound* ether; perhaps, matter *only strains the ether to it* . . . in this form gravitation may be held to be partially explained; for two bodies" (the earth, say, and the moon)—"two bodies, straining at the ether, will in this way tend to *pull themselves together* . . . We have learned from light and electricity that some such action between matter and ether actually occurs." And the same author speaking of "ether-vortices and atoms," indestructibly composed each of whirling ether, says, they have, "apparently, all the properties of atoms except gravitation," adding "but *this fundamental property of matter* cannot be left to be explained by an artificial battery of ultramundane corpuscles (La Sage's). We cannot go back to mere impact of hard bodies after having allowed ourselves a *continuous* medium. Vortex atoms must be shown to gravitate, but then," says he, "remember how *small* a force gravitation is . . . two pound-masses of lead *attract* one another, though they seem not to do so, yet is it the aggregate attraction of trillions upon trillions of atoms, the slightest effect of each *upon the other* being sufficient to account for gravitation." I quote this to show that the author of one of the latest works on electricity and the ether (Oliver Lodge), a fierce opponent of Grant Allen's book, only confirms—and on the most vital point, too—what he has written.

Prof. Lodge's book *is* a helpful one. I judge he is a careful and good experimenter, and himself above the ordinary intellectual standard. But, when a man of his calibre comes to speak of the giants of our race, he ought to show a becoming reverence. What, indeed, he says of Grant Allen, in the swell and storm of his indignation, matters little; but that he should seek to belittle such a power in the universe as Herbert Spencer—a man in whose ample brain a hundred Oliver Lodges might find room and to spare—is only to be accounted for on his own overestimate of his powers, stimulated by the mutual admiration of little coteries of specialists—very needful in their way—who collect little and even important facts, and sometimes group them into small generalizations; but here is one who binds the universe in one grand one. Yet, if in anything this man, whose pre-eminence *prægravat artes infra se positas*, seems to make a slip, with what a crowing they fall upon him. The little slip delights them. But,

> Why has not man a microscopic eye?
> For this plain reason, man is not a fly,
> What were the end, were finer optics given,
> To inspect a mite, not comprehend the heaven.

"Why, man, he doth bestride our narrow world like a colossus, and we petty men," etc. But to return. Grant Allen has given us what is so all-important, whether in physics or chemistry, or whatever it be, a *theory* of the dynamics of the universe, which meets, I think, every requirement, so far as theory is concerned, of science; and as the author of a leading article in *Nature* says, when speaking of chemistry, what "we need is a true theory to guide us, for the fact is, that as chemistry is taught too frequently to-day, *the facts obscure the view of the principles*. We pile up the deckload when we ought to jettison half the cargo. What we want is a stricter subordination of facts to *principles*." We need, in truth, a pilot-thought to steer us through the fog, where here and there some headlands only are visible. Many have done much in this direction. But there was need of a complete theory to light up the whole. Grant Allen, however, speaks of his attempt as simply "tentative." It is for the best unprejudiced judges to say if it is or is not thorough.

J. A. Allen.

QUESTIONING.

Should joy be cup-bearer to hearts that bleed?
And minstrel-chief to souls that walk in gloom?
Or may one, stumbling 'neath the weight of doom,
Pipe entertainment on a broken reed?

Rest from the striving. Let some happier throat
Swell with the music thy parched soul hath heard;
While in the thicket lonely a sad bird,
Droop-winged, shall list afar its own high note.

J. H. Brown.

TWO KNAPSACKS:

A Novel of Canadian Summer Life.

BY J. CAWDOR BELL.

CHAP. XIII.

Walk to the P. O.—Harding's Portrait—The Encampment Besieged—Wilkinson Wounded—Serlizer and Other Prisoners—No Underground Passage Found—Bangs and Guard Remain—The Constable's New Prisoners—Wilkinson a Hero—The Constable and Maguffin—Cards.

There was no room for twenty persons in two waggons, yet twenty proposed to go, seventeen to the seat of war, and three to the post-office. As those three were the young ladies of the house, all the warriors offered to surrender their seats to them. They refused to accept any surrender, preferring to walk, whereupon Messrs. Errol, Wilkinson and Coristine thought an after-dinner walk the