

GOD'S GLORY

IN THE



HEAVENS.

BY

Prof. C. A. YOUNG, Ph.D., LL.D.,
PRINCETON.

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GOD'S GLORY IN THE HEAVENS.

IT is still as true as when the Psalmist wrote it first, that "the heavens declare the glory of God and the firmament showeth His handiwork. Day unto day uttereth speech, and night unto night showeth knowledge." In some ways it is even truer now than then, because to-day the words have a more impressive and a grander significance than they could have had to David. To him the heavens were not so very vast, nor so very far away; and for him they, and the sun and moon, were mere appendages of the earth, of no importance or significance except as beautiful and useful servants of mankind. Now we know an immeasurable universe, compared with which our great world itself is the merest speck—a drop in the ocean, a mote in the sunbeam.

"He that sitteth upon the heavens," "he whom the heavens of heavens cannot contain," was indeed, to the ancient Hebrew, very great as compared with any earthly potentate; but what shall we now say of Him who inhabits the immensity of space revealed by Science; who by His immediate, all-pervading presence, actuates and vivifies the universe of universes: of Him to whom we still, but with a clear understanding, address the adoring words of the prophet; "Of old, O Lord, hast thou laid the foundations of the earth, and the heavens are the work of thy hands: they shall perish, but Thou shalt endure: as a vesture shalt thou change them, and they shall be changed; but Thou art the same and thy years shall have no end."

I think it is unquestionable that, as men have come to know more of the material universe, they have had continually revealed to them something more of the glory and majesty of its Creator. Here, and for the present, we see, of course, only "through a glass darkly": but as time goes on we catch more frequent glimpses of the ineffable brightness and the majestic outlines: we recognize more and more distinctly the presence and the power of the Omnipotent; lying still beyond our vision and our touch indeed, but intimated, and to some extent manifested, in all the phenomena which we can apprehend.

Here, however, let me admit a limitation as to the extent of this natural revelation of God, so far, at least, as it appears in the science of astronomy. I dare not say that I am able to see in the phenomena of the starry heavens very much that bears on His moral attributes; very little, for instance that goes to demonstrate His holiness, His justice, or His mercy. For such evidence, apart from Revelation, we must look rather to the moral law written upon the human heart; and especially to the course of history, where we clearly recognize "the power, not ourselves, which makes for righteousness," and find evidence as to the character of Him who overrules the conflicts of the nations and directs the ever-ascending progress of the human race.

I may add, too, that one finds in the system of the stars less evidence, perhaps, of the Divine "ingenuity,"—if I may be allowed to use the expression reverently—fewer cases of obvious "contrivance" than in the world of organic nature. It is in the structure of living beings that the most striking instances of this sort occur. Such organs as the eye and ear and the human hand, and the wonderful arrangements by which the continuity and permanence of races are maintained, have few if any parallels among the stars. There are, it is true, numberless adaptations between the astronomical conditions of the earth, on the one hand, and on the other the characteristics and structure of its inhabitants, both animal and vegetable; and these adaptations may fairly be adduced, as Whewell and others have adduced them, in evidence of the Creator's intelligence, which has fitted together the habitation and its inmates. But the study and discussion of these adaptations belongs to the naturalist rather than to the astronomer, and I shall content myself with this mere allusion to them.

The really impressive lessons of the stars, it seems to me, relate to the greatness and eternity of God, His unity, His omnipresence, and all-pervading activity; and especially the wonderful manner in which, by a few simple laws, He has built and organized the sublimely glorious architecture of the heavens, radiant throughout with a clear intelligence, which we, His creatures, can recognize and measurably comprehend. I think that astronomy stands unrivalled among the sciences in the emphasis with which she teaches these lessons: no other science so forcibly, so overwhelmingly, impresses the thoughtful mind with the infiniteness of God, and the relative insignificance of man and the little globe on which we live. "What is man that Thou art mindful of him, and the son of man that Thou visitest him!" This the student of astronomy learns to say with a profounder and more intelligent humility than any other person can.

And, on the other hand, he too, I think, is likely to recognize more fully than other men the high dignity of our human nature, made in the image of God and partaking of the divine; able in a

most real sense to "comprehend" the whole material universe, to share the thoughts of God, and to think them after Him.

I do not forget, indeed, the "infinity of littleness" that lies, so to speak, below us—the world of microscopic organisms and structures, of molecules, and atoms, and light-waves; nor do I deny that here also is to be found a revelation of God, which, in its logical force and import, is as well worthy of consideration as that contained in the story of the stars. But it seems to me harder to read: the type is not so large, the sentences are more intricate, and the language is far less familiar. At any rate, that is not what we have to deal with at present.

And now let us, in the first place, consider the *vastness* of the material universe as in some sense a revelation of God's greatness. Clearly He is greater than any or all of the worlds that He has made; and so in contrasting the immensity of that portion of creation which we can see, with the littleness of our own sphere of action, we shall advance toward a true conception of the tremendous meaning of His omnipresence: advance towards it, I say, not reach it; for it is more than probable, nay it is certain, that our sensible universe is but an infinitesimal fraction of the mighty whole. The domain of astronomy is but a little corner of God's material kingdom; yet even this little corner is so vast that we can attain to some conception of its immensity only by degrees, beginning with the smaller and the nearer, and so ascending step by step through unimaginable heights until we reach the limits of our human observation.

Compared with ourselves, and with the region we can fairly see around us, the sphere upon which we live is certainly immense: he who has travelled much and made its circuit appreciates its greatness. When one has ridden weary days and nights to reach the coast of the Pacific, and then has steamed some three weeks or more across that great, lonely, sailless ocean to the islands of Japan, and spent another two months in coasting along the shores of China and Siam, and traversing the Indian Ocean, and the Red Sea, and the short-cut at Suez, and sailing over the blue Mediterranean and the rough Atlantic to his home again; such a man, I say, begins to know something of the magnitude of this world of ours. All the thousands of millions (probably about fifty thousand millions) of human beings who have inhabited the earth since its history began could be seated, as roomily as we are here, upon the surface of the single State of New Jersey. Compare a man even with mountains or lakes or rivers, not to speak of continents and oceans, and how small he is: how feeble as against the wild powers of wave and storm and earthquake. If we could have no knowledge of anything beyond the earth itself, we should rightly feel that a man, or even the whole human race, is as the small dust of the balance when weighed against the world.

But we are not so restricted in our knowledge. The heavens are full of objects that from the beginning must have riveted the attention and excited the curiosity of men. Nearest of them all, and most interesting, on account of her constant changes and rapid motion, is the Moon. How we ascertain her distance from us I have no occasion to explain: it is enough that astronomers can measure it with accuracy, and have done so, finding it to be a little more than thirty times the diameter of the earth, or nearly 239,000 miles. So remote is she that even our largest telescopes cannot bring her optically nearer than eighty miles. The great telescope of the Lick Observatory, the most powerful instrument in the world at present, will sometimes, when all the conditions of the air are kindly, bear a power of about 3,000; and then the observer sees the surface of our satellite about as a person in New York City would, with unassisted vision, look into Philadelphia, if he were raised high enough to bring the towers of the rival city above the horizon. As for the Moon herself, while we find that she is indeed much smaller than the earth, yet she is a real world, large enough to carry a population at least equal to that which now inhabits the earth. It is true, however, I may say in passing, that we find the condition of affairs there to be such that no inhabitants like those which dwell upon the earth could live upon her surface. This splendid orb that rules the night, and so beautifully brightens our hours of darkness, is an airless waste, frozen and lifeless, so far as we can ascertain. "God's ways are not our ways, nor His thoughts like ours;" at least this often turns out to be the case.

Let us in imagination leave the region of the earth and attempt the journey to the Sun. It is unnecessary and would be out of place to discuss this evening the methods by which astronomers have been able to stretch their measuring lines across the tremendous abyss and so to affix their scale of miles to the great map of the solar system: for this distance of the sun is now the unit of all human measures in the celestial spaces; like the golden reed with which the angel measured the walls of the New Jerusalem. The problem has not been an easy one, and its first approximate solution was attained only in the last century by means of the transits of Venus in 1761 and 1769. Since then various other methods have been devised and carried out, all of which practically agree in showing that the mean radius of the orbit of the earth is a little less than 93,000,000 miles—to be exact, 92,880,000 miles, with a possible uncertainty of perhaps 100,000 miles one way or the other. This is more than 3,700 times the circumference of the earth.

It is a distance so great that figures convey no adequate conception, and we are driven to all sorts of illustrations to make it in the least intelligible. We compare it with railway journeys, and find that the Empire State Express, on a schedule of sixty miles an hour, would occupy 174 years upon the trip, running day and night,

without a single stop or slackening of speed. We find that if sound could travel unimpeded through the celestial spaces it would require fourteen years for the boom of one of the great explosions on the sun to reach us ; and if, at the time, some meteoric mass were projected toward us, and should rush unretarded along its path with the speed of the swiftest cannon-ball, an interval of nearly seven years would elapse before the arrival of the missile. The flash of the light itself, darting 186,330 miles each second, is eight minutes and a third upon the way. It is a tremendous distance, and yet across the abyss the Sun exerts its power upon the Earth, and controls the motion of the huge mass as it whirls along its orbit, holding it to its course by bonds of attraction, invisible and impalpable indeed, but in strength equivalent to the breaking strain of ropes of steel attached to every square inch of the whole Earth's surface. Stated in cold figures, the mutual attraction between the Sun and Earth amounts to an unceasing pull of 3,600,000 millions of millions of tons (36 followed by 17 ciphers).

And not only does the Sun's attraction control the orbital motion of the Earth, but across the yawning gulf he pours the streams of radiance which we call light and heat, supplying all the energy that operates upon her surface. By sun power the winds blow and the waters run and engines drive their wheels — nay, even plants and animals grow and move and perform their varied functions only by virtue of the energy which is brought them in the solar rays. We cannot undertake at this time to follow out its Protean transformations and show exactly how to justify such statements : but they are strictly true,—and only a part of the truth ; for to all the planets of our system the Sun, from the material point of view, is the symbol and vice-gerent of the Deity Himself :—the most magnificently glorious of all created objects :—the single one whose removal would be a death-chill to every form of activity.

Compared with the Earth, the Sun is immense in magnitude ; so huge that if the earth were placed in the centre of his globe, the distant Moon would be but little more than half way to its surface, —so vast that its bulk is 1,300,000 times that of our own great globe, and its mass 330,000 times as great. If the intensest heat and most dazzling brilliance may be spoken of as " fire," then is the Sun a globe of fire, unmatched except among the stars : a fire, however, far too hot to " burn " in any such sense as the fires of our terrestrial furnaces :—no fuel is being consumed ; but for thousands and probably for millions of years the tremendous globe of elementary gases has, by its gradual condensation, maintained its blaze, and possibly even increased the fury of it. Every square foot of its enormous area still pours off continuously an amount of heat equivalent to more than ten thousand horse power of energy, and keeps up a temperature far higher than that of our fiercest furnace. It seems at first as if here we had repeated before us the miracle

of the burning bush, and on a scale as much grander as the heavens are vaster than the Earth. It is not so, however, — the end will come : but in such a process centuries and milleniums count only like minutes in our life.

The Earth and Moon are not the only attendants of the Sun. His domain is vastly more extensive. Four planets, which in scale of magnitude are of the same order as the Earth, are nearest to him. The Earth is third in distance, while Mercury and Venus revolve within her orbit, and Mars, attended by its two pigmy moons, pursues its course at a distance once and a-half as great as ours. And it is perhaps worth noting as we pass that this planet Mars is better situated for our observation than any other, and so is better known to us ; also, that in many of its conditions it is the most Earth-like of all the heavenly bodies within our range of observation ; and there, if anywhere, there may be life to some extent resembling that which inhabits the Earth. But of the actual existence of living beings upon it, we have no proof of any kind, nor any reasonable ground for either assertion or denial ; nor is there any reason to expect that we shall very soon come to knowledge more definite as to the fact.

Far beyond Mars revolve the so-called "major planets" — the giant Jupiter, with its five attendants ; the ringed Saturn, accompanied by eight ; Uranus, with its fairy retinue of Ariel, Umbriel, Titania, and Oberon ; and still beyond, and thirty times as far from the Sun as we are, the remote Neptune with its single moon. You do not need to be told now that half a century ago this planet was discovered by the computation of Leverrier and Adams before any human eye ever recognized it. Trusting implicitly in the dominance of law, they argued, from some slight but otherwise unaccountable peculiarities in the motion of Uranus, that such a planet must exist : they figured out its place in the heavens, and communicated their results to friends, who had access to telescopes ; and when the tube was duly pointed, there, like a little star, was found the great world, solemnly moving along its appointed path. They had followed out the thought of God, "the great Geometer," who works by rule and plummet in all the universe of matter, and "He gave them their heart's desire" in permitting them thus to find what he had hidden from all the generations of their predecessors.

These outer worlds are all immensely greater than the Earth : the bulk of Jupiter is 1200 times as great, and that of Saturn more than 700, while Uranus and Neptune are respectively about 75 and 90 times larger than the Earth. It is a great, an immense dominion, this of the Sun : no less than 5,000 millions of miles in diameter.

If this were all, if this were the whole of the universe revealed by astronomy, we might well say that the science had added much to the meaning of the Psalmist's song of praise. But vast as the solar system really is, it is hardly more than the merest speck as

compared with the universe of stars. For the stars which to the eye look like mere glimmering points of light, and even defy the power of the telescope to give them any apparent size, are really suns:—some of them certainly many times vaster than our own,—all shining, not like the planets with a borrowed light, but each with a special radiance of its own, and appearing small only because of their inconceivable remoteness. They are so far away, indeed, that it is possible to measure the distance of even the nearest of them only by processes and observations the most delicate and refined in all the range of instrumental science. Even now a half-page list of twenty-five or thirty would include all the star-distances which can be regarded as fairly known, though at present the catalogue is beginning to grow with some rapidity through the new resources of photography.

As the Earth describes its enormous orbit around the Sun, it is a necessary consequence that, to us upon the Earth, everything must seem as if we ourselves were at rest, while every other body in the heavens possessed, in addition to its own motion, our own reversed. Every star, therefore, must, and really does, appear to sweep out in the sky an annual so-called "parallaetic orbit" 186,000,000 miles in diameter, the precise counterpart of our own real motion around the Sun; and were the stars at any "reasonable" distance (say not more than two or three thousand times our distance from the Sun), this parallaetic motion would be conspicuous, and the inter-stellar spaces would have been bridged by Tycho 300 years ago.

In fact the parallaetic motion of the stars is so slight, so minute, that, as has been already said, it can be detected only by the most scrupulous precision of observation. In the case of our nearest neighbor, Alpha Centauri, the whole width of its apparent annual swing is less than the thickness of a human hair as seen across a lecture-room: small, however, as such an angle is, it can be measured now, and as a result we find that this next door neighbor of ours, this nearest of all our Sun's companions, is 275,000 times as far away as we are from the Sun: a distance so enormous that light itself is four years and four months on the way. As for our railway train at sixty miles an hour, it would require nearly forty-eight million years for it to make the journey. If the Earth could be released from the attraction of the Sun, and should travel straight on with its present speed of nearly nineteen miles a second, it would take it nearly 43,500 years to clear the distance. A whimsical illustration of John Herschel's (slightly modified to make it agree with the latest results) is that it would require nearly 4,000 vessels of 600 tons apiece to carry peas enough to mark the road, by dropping one each mile. Another, by Dr. Huggins, is that the railway fare to this nearest of all stars, at a cent a mile (a half-penny, of course, in the original), would be somewhat more than 250,000 millions of dollars; which, according to a recent estimate that I have some-

where seen, is at least five times as much as all the money in the world, counting all the gold and silver and every form of paper currency.

But Alpha Centauri is the nearest star. Of the rest whose distance has been measured, the three or four that come next (Bessel's or Cygni and Sirius, the primate of the stellar host, among them) are from two to three times as remote, and those that stand lowest on the list are at least ten times as far away;—from twenty to forty "light-years," to use the now usual way of expressing a stellar distance. At least twice as many other stars have been carefully observed, and show either no sensible parallax at all or a parallax so small that it is impossible to be quite sure of its reality; and among these unconquered stars are still some of the brightest of them all.

Our present means and methods do not permit us to measure with certainty any stellar distance much exceeding thirty or forty light years; but from the facts at hand it may be safely inferred that among the stars which the telescope reveals multitudes must be hundreds and even thousands of time as remote as the nearest; that we look upon stars so far away that the light by which we see them now must have started upon its journey before the pyramids were built. The visible universe of stars bears about the same relation to the dimensions of the solar system as the great globe of the earth to a gold dollar or a collar-button. I am not speaking at random, but stating the result of a serious calculation. According to Professor Newcomb, the stars visible with our present telescopes seem to be irregularly scattered through a disc-like space (shaped something like a watch), with a diameter of something like 30,000 light-years in the plane of the milky-way, and three or four thousand in thickness.

As for the nebulae and star-clusters, they are among the stars and form part of the stellar universe; at least this is unquestionably true of most of them. Forty or fifty years ago a different view prevailed, however, and is very prominent in the writings of Dick, Nicol, Mitchel and others of that period. It was then generally supposed that nebulae are only star-clusters, so remote that the separate stars cannot be seen, and that the star-clusters which the telescope resolves are composed of stars really as large as the sun. They thought that our sun and the conspicuous stars, together with the milky-way, form a cluster by themselves, and that the telescopic clusters and the nebulae are similar swarms of stars and suns far beyond the limits of our own galactic group. The association of large stars with small, in many of the clusters, the frequent and intimate connection of stars with nebulae, and especially the now-demonstrated gaseous nature of the nebulae, negative this view on the whole. At the same time it is by no means impossible that among the star clusters there may be here and there such a stellar

swarm as that view contemplates: it may be that here and there we catch glimpses of universes beyond the limits of our own.

I shall not raise the question of the absolute infinity of the universe of matter, or even of space itself. It is enough for me that thus far we find no evidence, no suggestion even, of a limit and a bound to the material dominion of the deity. However far we penetrate, there still seems to be an infinity beyond.

Some of you, no doubt, remember the dream of Richter, the German poet—a dream in form, perhaps, but after all only a shadow of the overwhelming reality. May I quote it to you in part?

“ God called up from dreams a man into the vestibule of heaven, saying, come thou hither and see the glory of my house. And to the servants that stood around his throne he said, take him, and undress him from his robes of flesh: cleanse his vision and put a new breath into his nostrils; only touch not with change his human heart, the heart that weeps and trembles. It was done: and with a mighty angel for his guide the man stood ready for his infinite voyage; and from the terrace of heaven, without sound or farewell, at once they wheeled away into endless space. Sometimes with the solemn flight of angel wing they flew through wastes of darkness, through wildernesses of death that divided the worlds of light: sometimes they swept over frontiers that were quickening under prophetic motions from God. Then from a distance that is counted only in heaven, light dawned for a time through a sleepy film: by unutterable pace the light swept to them, they by unutterable pace to the light. In a moment the rushing of planets was upon them; in a moment the blazing of suns was around them. Then came eternities of twilight that revealed, but were not revealed. On the right hand and on the left towered mighty constellations that by self-repetitions and answers from afar built up triumphal gates, whose architraves, whose archways, horizontal, upright, rested, rose, at altitudes, by spans that seem ghostly from infinitude. Without measure were the architraves, past number were the archways, beyond memory the gates. Within were stairs that scaled the eternities below,—below was above to man stripped of his gravitating body: depth was swallowed up in height immeasurable, height in depth unfathomable. Suddenly as thus they rode from infinite to infinite, suddenly as thus they swept over abysmal worlds, a mighty cry arose that systems more mysterious, that worlds more billowy, other heights and other depths were coming, were nearing, were at hand. Then the man sighed and stopped, shuddered and wept. His overladen heart uttered itself in tears; and he said, ‘Angel, I will go no farther: for the spirit of man acheth with this infinity. Insufferable is the glory of God. Let me lie down in the grave and hide me from the persecution of the infinite, for end I see there is none.’ And from all the listening stars that shone around issued a choral voice, ‘The man speaks truly: end there is none that ever yet we heard of.’ ‘End, is there none?’ the angel solemnly demanded: ‘Is there indeed no end? and is this the sorrow that overwhelmed you?’ But no voice answered. Then the angel threw up his glorious hands to the heaven of heavens, saying: ‘End there is none to the universe of God. Lo, also there is no beginning.’ ”

"O Lord, our God, Thou art very great! Heaven and Earth are full of the majesty of Thy Glory!"

And the *Time-Scale* of the universe matches its spatial extent. "Our little lives are bounded by a sleep." Not so with the life, the growth, maturity and decay of worlds and systems. As we study in the geological record the history of our small globe, we find that even after it became a world, ages upon ages, millions upon millions of years must have been occupied in fitting it for human habitation. It may not yet be possible to count with certainty the time consumed in each successive stage, and so to fix the length of the "creative days;" but it is clear beyond all questioning that the whole summed up duration of the earth bears some such ratio to a human life, as the earth's vast bulk to that of a human body.

And when we consider the present condition and peculiarities of the solar system, and note in it the evident traces of a formative process—an evolution from a pre-existing chaos, facts and phenomena which seem to mark it as a growth rather than a structure—and when we consider how slow and gradual such a process must have been, we are forced to conclude that the Earth's duration, as a habitable world, can be but a minute fraction of the time elapsed since the system itself took form and order. And in the heavens we seem to find bodies in all the various stages of our own history as a system. There are nebulae which are mere formless clouds of luminous gas; others that are more or less globular, and partly condensed around a star-like point in the centre: some are like spiral whirlpools, and there are some in which there seems to be a central globe, with whirling rings around it, like the strange appendages of Saturn, which suggested to La Place his famous theory of planetary evolution. There are stars with wisps of nebula attached to them, like those of the Pleiades. There are stars whose spectra seem to be intermediate between those of nebulae and finished suns: there are other stars whose spectra suggest an intenser heat and a more dazzling radiance than that of our own central orb, and also others that match its spectrum with precise exactitude. Others yet seem to be on the downward grade and verging towards extinction. And one of the most remarkable results of the work of the past few years is the certain demonstration of the existence of stars that in mass and bulk resemble the bright stars near them, but themselves are dark and utterly invisible. One cannot say for sure that they have lost their light, because we do not know with certainty that they ever shone; presumably they did, however; and now, their usefulness as suns outlived, they await the changes by which, as in all other departments of the creation, the remains of those that have perished are utilized in the building up of new forms and activities; or possibly some sort of stellar resurrection, by which they themselves shall be restored to the ranks of the shining ones.

As the elder Herschel expresses it in speaking of the sidereal

universe, the case is like that of a forest in which one finds all stages of arboreal life together: there are the seeds and saplings, young trees of rapid growth, and those that are in the full strength of their maturity—those also that have begun to fail, and over all the ground the prostrate trunks and decaying *debris* of those that have died and fallen. Though an observer cannot in any short time study the life-history of a single individual tree, yet by a few hours study of the forest he can form a fair idea of the successive stages of that history. So we can also conclude something as to the duration of the stellar universe, and we find it beyond all human conception. Individual stars and systems indeed give clear indications that they are by no means eternal; but the great whole,—it must be that its duration exceeds as much the countless ages of the life of any single system, as that of the entire human race surpasses that of any man. In *time*, as well as in *space*, the Divine presence and activity declares itself to us as transcending all limits we can fathom.

What now is to be said of the *Power* of God as revealed in the astronomical universe? Whether we consider the forces which act between the heavenly bodies, their tremendous masses, and the swiftness with which they move, the figures which express the so-called "molar energy" of the universe are utterly beyond conception;—on the same stupendous scale as the measures of space and time. Add to this "molar energy" the "molecular energy" of heat and light, of electric and magnetic activity, and that of chemical affinities—energies, acting within either the bodies themselves or radiating from world to world through the depths of space—and the total result is simply overwhelming. As the dimensions of the universe and its duration exceed all human powers of expression or conception, so also does its actuating energy.

Attempt, for instance, a comparison between the energy expended in driving across the ocean the largest vessel of the Atlantic steam fleet and that stored up in the revolution of the Moon upon its axis. We find that this stored-up energy of the slowly-turning little satellite, which occupies a month in each rotation, exceeds the other in the proportion of more than 50,000 millions to one. The Earth's energy of axial rotation is more than 800,000 times greater than that of the Moon, and the energy of the Earth's orbital motion, as she rushes on at the speed of nearly nineteen miles a second, exceeds the rotational energy by more than 11,000 times.

What shall we say, then, of the stored-up energy of such a planet as the swiftly-whirling giant Jupiter? Or that of the Sun and its attendant planets in the tremendous journey they are making through inter-stellar space with the velocity of about ten miles a second (that is at least twenty-five times as great as the speed of the swiftest cannon ball)? What, then, must be the total energy of all the whirling, rushing, flying universe of stars and systems!

Then as to the heat-energy of the universe (to consider no other form of molecular activity), recall that every square yard of the surface of the Sun is pouring off continuously about five times as much power as that exerted by the great engines of the Campania at her highest speed; and then remember the millions upon millions of other suns as great and fiercely hot as ours.

Consider, too, the forces, the pulls and pushes, that fill the universe: how, in some mysterious way, each separate atom of the mighty whole is urged toward every other by what we call "attraction"—a name to hide our ignorance. To one who has not thought much about it, it seems a very simple thing, this attraction; and in a sense it certainly is "simple," a fundamental fact as certain as the results of the most elementary mathematics, and no more to be called in question: and yet it is an inscrutable mystery so far; one that defies all explanation as obstinately as the kindred problem, how the indwelling spirit of man or animal calls into action and controls the power exerted by the muscles. Even if it should become clear hereafter that in some way these interatomic forces, this attraction of gravitation, and the electric and magnetic forces of the universe, are all but various consequences of the constitution of the mysterious space-filling "ether" of the physicist, the conclusion would still be untouched that, in the last analysis, we are compelled to recognize all the forces and energies of nature as manifestations of the power of the omnipotent, omnipresent, immanent deity. May I quote to you a passage from a suggestive paper by Sir John Herschel, published some thirty years ago, allowing myself some liberties of condensation and omission. It is a dialogue between one Hermogenes and his wife, Hermione. They have been talking about the atomic theory of matter, but have rather wandered off and now she says:

"(SHE): Do come back to our dear atoms: I love the delicate " little creatures. There is something so fairy-like about them.

"(HE): Well, they have their idiosyncrasies. I mean they obey " the law of their being. They comport themselves according to their " primary constitution. They conform to the fixed rule implanted " in them at the instant of their creation. They act and react upon " each other according to the rigorously exact, mathematically-deter- " mined relations laid down from the beginning. They work out " the preconceived scheme of the universe by their—their—col—

"(SHE): Their? Stop, stop! My dear Hermogenes, where will " you land us? Obey *laws*? Do they *know* them—can they *remem-* " *ber* them? How else *can* they obey them? Comport themselves " according to their primary constitution? Well, that is so far intel- " ligible: they are as they are, and not as they are not. Conform " to a fixed rule! But, then, they must be able to apply the rule " as the case arises. Act and react according to determinate rela- " tions! I suppose you mean relations with each other. But how " are they to know these relations? Here is your atom A, there " is your atom B (I speak as you have taught me to speak), and " a long interval between them and no link of connection. How

“ is A to know where B is, or in what relations it stands to B?
 “ Poor, dear little atoms! I pity them.

“ (HE): You may spare your sympathy; they are absolutely
 “ blind and passive.

“ (SHE): Blind and passive! The more the wonder how they
 “ come to perceive those same relations you talk about, and how
 “ they comport themselves (act, I should say) on that perception. I
 “ have a better theory of the universe.

“ (HE): Tell it me.

“ (SHE): In the beginning was the nebulous matter or Akaseh.
 “ Its boundless and tumultuous waves heaved in chaotic wildness,
 “ and all was oxygen, hydrogen, and electricity. Such a state of
 “ things could not continue, and as it could not be worse, altera-
 “ tion was necessarily improvement. Then came —

“ (HE): Now it is my turn to say, Stop! Stop! Let us be
 “ serious. Remember, it was you who began the conversation, and
 “ I only allowed myself to be drawn into it. The fact is I have
 “ so far only been trying you, and I see you are apt. There lies
 “ the real difficulty about these atoms. These same ‘relations in
 “ ‘which they stand to each other’ are anything but simple ones;
 “ they involve all the ‘ologies’ and all the ‘ometries.’ Their
 “ movements, their interchanges, their ‘hates and loves,’ their
 “ ‘attractions and repulsions,’ their ‘correlations,’ their what not,
 “ are all determined on the very instant. There is no hesitation, no
 “ blundering, no trial and error. A problem of dynamics which
 “ would drive Lagrange mad is solved instanter, so to speak, on the
 “ gallop. A differential equation which would belt the Earth is
 “ integrated in an eye-wink. In short, these atoms are most won-
 “ derful little creatures.

“ (SHE): Wonderful indeed! Anyhow, they must have not only
 “ good memories, but astonishing presence of mind to be always
 “ ready to act, and always to act without mistake in every compli-
 “ cation that occurs.

“ (HE): Thou hast said it. This is just the point. *The pres-
 “ ence of Mind* is what solves the whole difficulty; so far, at least,
 “ as it brings it within the sphere of our own consciousness, and
 “ into conformity with our own experience of what action is. When
 “ we know that we act, we are also conscious of will and effort;
 “ and *action without will or effort* is to us, constituted as we are,
 “ unrealizable and inconceivable.”

Yes, it is God himself who works in and through the whole stupendous mechanism, and his greatness appears to us in the relations of power as clearly as those of space and time.

Again, the whole astronomical universe manifests not only *power*, but *intelligence* and *wisdom*. Our planetary system is not a jumble, but an orderly organization, governed by laws of extreme simplicity and beauty—laws which our human intelligence delights to search out, recognize and apply in scientific prophecy. And while the stellar system is different and much more complicated, so that as yet we can only partly comprehend its plan, yet here also we catch glimpses of divine symmetries, and begin to make out the harmonies, intricate but exquisite, of the multitudinous chorus.

Surely it is one of the keenest pleasures possible to man, when at the appointed moment, fixed long ago as the result of laborious

calculations, the obedient stars come to some predetermined aspect, or Mercury keeps punctually his rendezvous with the Sun (as he will next November), or when at the very second of prediction the shadow of the Moon sweeps over the place where the observer has stationed himself; or when what seemed at first capricious errancies of some distant planet are recognized as the legitimate effect of an unknown attraction, and so become the demonstration of an unsuspected world, and the means of its discovery.

But let me add here, as something to be borne in mind from the philosophical point of view, that the astronomical prediction of events can never be *absolutely precise*. If our means of observation were delicate enough to note the million-millionths of a second of time or are as easily as now we note the single seconds themselves, an accurate almanac would be impossible; because the majestic course of even astronomical events is really (though at present only imperceptibly) swerved and disturbed by causes that are unpredictable—such as the actions of animals and men. One cannot build a house or even throw a stone without in fact, and to some extent, deranging the rotation of the Earth and changing the length of the day: to say nothing of the immensely greater disturbances due to such natural causes as storms, volcanoes and earthquakes. I think it is something more than merely “fortunate” that we and what we can do are so proportioned to the universe, and our powers of observation so limited, that we cannot perceive in the heavens any trace of these little ripples and quivers in the progress of astronomical phenomena. Otherwise we should be hopelessly confused. We are made so small in size and power that we can exercise our freedom and disturb the universe as much as we are able without obscuring the manifestation of the heavenly laws. We can do no more mischief than flies upon a locomotive, and may be allowed so to speak, to play with the universe as much as we please.

I have spoken of our system as a “*structure*” of sublime and beautiful simplicity, but I did not mean to intimate that it had been made by *building*. It appears much more likely that it has arrived at its present state by a process of growth and evolution. I do not propose to discuss the process here, but only to say that if this view is correct, it seems to me to evince a still more admirable and *adorable* intelligence,—I speak it reverently—than any mere “construction” from ready-made material: as much more wonderful as the evolution of a plant from its seed, or a bird from its egg; is more wonderful than the making of a watch or the erection of a house. The old-fashioned view that God made the Sun and planets one by one, and set them whirling upon their axes, and made them travel around the Sun in orbits nearly circles and nearly in one plane, because such a system would be the best and most stable possible,—this view, I say, seems to me far less honorable to the Divine intelligence and power than that which supposes Him so to have con-

trived and energized the matter out of which the worlds are made that from a chaotic nebula should have resulted the present stately cosmos by the simple operation of the laws and forces He first imposed:—never forgetting, however, that the power of God himself has all the time been immanent and operative in all these so-called "natural processes." It is true that as yet the exact course and methods of this evolution are only dimly understood; but one cannot doubt that, as we rise to clearer perception and fuller comprehension, we shall find in them still more wonderful revelations of the divine intelligence.

One other point remains to be noted briefly,—how the *Unity* of God declares itself in the revelations of Astronomy. Identity of substance and of law, similarity of plan and purpose run through the whole. As to material, the only astronomical "specimens," the only pieces of non-terrestrial matter upon which we can actually place our hands, are the meteorites which fall upon the Earth from time to time. It may not be perhaps quite certain that they all have had their origin outside our solar system, but the prevailing opinion is that they come from far beyond, from interstellar space. Now, we do not find in them a single chemical element unknown upon the Earth; nor any combination of elements disobedient to the laws of terrestrial chemistry, though we do find in them many minerals which are never met with elsewhere, and seem to have been formed under conditions very different from those that exist upon the Earth. Their whole testimony, not conclusive, perhaps, but relevant and weighty so far as it goes, tends to indicate a widespread identity of matter and of law.

The more recent evidence of the spectroscope also bears in the same direction with still more force, and with a far broader reach. It is hardly necessary for me here to enter into explanations how the light of every shining body carries with it a more or less satisfactory record of its constitution and condition. The lovely ribbon of color which we call its spectrum is marked with transverse lines and bands, sometimes bright and sometimes dark; and these are characters which, to those who can read them, tell more or less completely the story of its state and nature. Now, in the spectra of the heavenly bodies—of the Sun and stars and nebulae—we find the clear record of the presence of familiar elements. Here and there, it is true, we meet with characters which we cannot decipher, some of which possibly may indicate bodies unknown upon the Earth: but always, and still more strikingly, stand out the well-known lines of hydrogen and calcium, of sodium, magnesium and iron—the same which are the most conspicuous in the spectrum of the Sun (and Rowland says that if the Earth were heated to the solar temperature, its spectrum would be practically the same as that of the Sun itself). The names of many of our terrestrial metals are written upon some of the remotest stars as plainly as any monu-

mental inscription. Sirius and Vega, indeed a large majority of all the stars, exhibit hydrogen as distinctly as any bell-jar upon the laboratory table: and in its luminous properties the stellar hydrogen is identical with the solar, and the solar with the earthly. The sodium of Arcturus and the magnesium and iron of Capella ring out in perfect luminous unison with the same molecules upon the Earth. And it seems to me, notwithstanding certain adverse criticisms, that Herschel and Maxwell are quite justified in maintaining that the molecule of every element, say hydrogen or iron, bears all the marks of a "manufactured article," containing precisely a definite quantity of matter, put together in a definite way, and of definite dimensions and structure: as well-made and as accurately pitched as any tuning-fork;—and everywhere the same in all portions of the universe as yet open to human exploration.

So also the law of gravitation appears, with the highest probability, to be actually (though not *necessarily*) universal. The motions of the double stars are precisely what they ought to be if the same attractions which control the movements of the planets are also dominant in those distant regions. These "binaries," as they are called, move in oval orbits around a point between them, which is presumably their common centre of gravity; and when we compute their motion on the hypothesis of gravity, they follow obediently in the path described. It is true that the demonstration is not yet complete. Other laws of force are conceivable which would correspond to such an orbit: but they all involve the condition that the force, instead of depending solely upon the mass and distance of the bodies, must also be determined in part by the *direction* of the line that joins them, and that in a manner complicated and improbable. When spectroscopic observations have been longer carried on, it will be possible to decide the matter definitely, and I have not the slightest doubt that it will then appear that gravitation alone explains and rules the motions of the stars.

I might instance other ways in which the oneness of the starry heavens appears: the manner in which the stars classify themselves according to their spectra; the similarity of the forms and characteristics of the nebulae, and in many cases the curious connections between stars and nebulae. Here we have identical appearances and behaviors manifesting themselves in objects and regions separated by distances so vast that light must require milleniums to cross them. In short, the "Universe of Astronomy," immense as it is in space and time and energy, is not an aggregate of many differing and discordant and unrelated parts, but a single, magnificent whole, an orderly "cosmos" of organized activity; and its oneness illustrates and declares the Unity of the Creator, the one Eternal, Omnipresent, Omnipotent, All-wise GOD, glorious forever and ever.

And now, finally, let us for a moment emphasize one other

thought that has recurred continually to my own mind, as I presume it has to yours, while we have been considering the great universe of matter, law and energy, which the eye and the telescope reveals to us;—this, namely, that after all the human mind and soul is greater and more wonderful, higher and nobler than even the stars of heaven. We are made in the image of God, an expression the fullness of whose meaning I imagine we shall better understand hereafter: we share His nature,—I speak it reverently,—and his eternal life. Strange as it sometimes seems, when we measure our weakness and littleness against the immensities of the heavens, still it is true that God “*is* mindful of man, and visits the Son of man,” in whom is the breath of the Most High. I do not remember ever to have seen the thought more strikingly expressed than in a poem which appeared anonymously some dozen years ago, but is now known to have been written by the late Mr. R. A. Proctor. May I read it in closing, allowing myself a few slight changes from the original, the better to adapt it to my purpose.

VOICES OF THE STARS.

By “*VEGA*” (R. A. PROCTOR). From *Knowledge*, Oct. 12, 1883.

I watched the depths of darkness infinite,
 Bestrewn with stars, till dreaming I beheld,
 From out the mystic realms beyond my ken,
 A star come forth with even-gliding rush;
 Till sweeping ever onward shone its orb
 With all the mighty meaning of a Sun—
 A Sun girt round by many-peopled worlds,
 And worlds as yet not peopled, being young,
 And worlds long since unpeopled, being old
 And dead. Their ruling Sun shone on them—
 On the living, on the yet unfashioned,
 On the dead: on all it shone, though idly
 Where'er as yet life had not sprung from forth
 The teeming womb of Time: and idly too
 Where life had ceased to be. On all these worlds
 The mystic force which lives in matter worked
 Its mighty will. Dead worlds and worlds since born,
 And worlds astir with myriad forms of life
 Swept circling round the stately ruling orb.

As it swept past I heard its solemn voice
 Proclaiming through the realms of space the song—
 The everlasting song of Life and Death—
 Of wealth, of life and everlasting waste
 And dearth of life. It sang of present, past,
 And coming plenitudes of life; of past
 And coming wastes of death, infinitudes
 At once of Life and Death, each without end,
 Without beginning each.

“Along my path

“In front,” it said, “and backwards whence I came,

“And all around, above, below my course,

Lie millions such as I, through endless realms
 Of star-strown space. There is no end to God's
 " Domain of suns, and systems ruled by suns—
 " No end; and no beginning, through all space—
 " But everlasting, mystic, wonderful,
 " Our hymning song sounds ever round the throne
 " Of Him, who reigns supreme the life of all."

Then as the Psalmist sang of old I said—
 Because so moved I could not choose but speak—
 " What, Lord, is man that thou shouldst care
 " For him or for his kind,—the son of man that Thou
 " Shouldst mindful be of him or his?" Then rang
 A voice of solemn thunder through the spheres—
 Say, rather, What is space or time to Me
 " That thou shouldst deem mere mightiness of mass
 " Or plenitude of time can outweigh mind
 " And soul? Can worlds and suns have knowledge of my power?
 " Can .Eons after .Eons sing my praise as man
 " Gifted by me with power to know my power can tell
 " The meaning of the music of the spheres?"
 Then I replied—" Nay, Lord, but if the words
 " Of men are worth the utterance they are thine,
 " Lo we are but the creatures of Thy hand:
 " We see but part of all Thy wondrous work,
 " Could we but see the glory of Thy light,
 " Could we but hear the thunder of Thy power,
 " We should become both blind and deaf—
 " Deafened by pealing tones, made blind by light,
 " In Thee alone we live and move. In Thee
 " We have our being. But shall the finite hymn
 " The praises of the Infinite? Shall weak man
 " The creature, paint with erring brush the Sun
 " Of might and power and wisdom, evermore supreme?"

The answer came—" Shalt thou, my creature, doubt
 " Or hold my will in question? Learn that the least
 " Of all the countless minds My Will has made
 " Outweighs, not once, but many thousand times
 " The mightiest mere mass: the thoughts of human hearts
 " Outvie the movements of a million suns,
 " The rush of systems, infinite through space."

