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UNIVERSITY LECTURES.

ASTRONOMY.

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LECTURE V.

The Sun.—His Distance and Magnitude.—Trigonometrical terms defined.—Sun's Volume.—Weight of the Sun.—How determined.—Law Governing the Revolution of Bodies.—Density of the Sun.—Relative Weight of Materials on the Sun's Surface.—How ascertained.—Rotation of the Sun.—Determined by spots on his surface.—Inclination of the Sun's Equator to the Ecliptic.—Velocity of the Sun's Equator.—Distance through which a body will fall in one second at the Sun's Equator.—Rapid Vibrations of a Clock Pendulum on the Sun's Surface.—What Velocity of Rotation will Destroy the Weight of Bodies at the Sun's Equator.—Ellipticity of the Sun's Figure.

OUR inquires have hitherto been principally restricted to the form, magnitude, diurnal and annual motions of the earth—to the form, dimensions and positions of its orbit, and to the principal phenomena arising from its transition in space.

The next most important and interesting subject of inquiry is the Sun—the great central luminary, from which is received an inexhaustible supply of light and heat; and by which the countless species of organized beings which people our globe, are sustained in life.

We have already learned, by our former investigations, that the sun is situated in one of the foci of the elliptic orbit, described by the earth, as it wheels its annual course around that resplendent luminary.

It would certainly be a subject of great interest to learn the distance, magnitude, motions, weight, density, physical constitution and all other important features of the great centre of our system.

The distance of the sun is, as we have already observed, obtained by a simple trigonometrical computation from the observed horizontal parallax, and is in round numbers about 95,000,000 of miles. Let me here observe, that, though we have hitherto been somewhat particular in expressing magnitudes, distances, times and motions within a small fraction of their true numerical value, yet we shall hereafter abandon this strictness, as being, for general information, not only unnecessary, but inconvenient.

Round numbers are more easily remembered than others; and for conveying general information, they answer every purpose.

Where great accuracy or strictness is required, tables are constructed with the greatest of care, to which the astronomer can, at any time, refer for the numerical elements necessary to be used in his researches.

Knowing the distance of the sun, let us next inquire how its magnitude can be ascertained.

This problem, like that of the distance, is solved by the simplest principles of trigonometry.

As the magnitude of all the heavenly bodies which have been determined, have been obtained by the same principles, it may not be uninteresting to explain some of the principles of trigonometry. An angle is the inclination or opening between two straight lines; the angle is greater or less as the lines are more or less opened.

A right angle is the opening made when each line is perpendicular to the other; the opening of a right angle is equal to 1-4 of a circle; all angles less than a right angle are called acute angles; all angles greater than a right angle are called obtuse angles. The fences enclosing our city blocks are intended to stand at right angles to each other.

A triangle is a plane enclosed by three sides; to every triangle there are three angles, as well as three sides.

If, in a triangle, the three sides, or two sides and an angle, or one side and two angles, be known, the other angles or sides can be easily calculated.

Now if we conceive lines drawn from our eye to each side of the sun's disc, it is evident that the length of these lines will be known, each being equal to the sun's distance.

The angle, or opening of these two lines may be measured by a micrometer, or any accurate instrument. This angle is equal to the sun's apparent diameter, whose disc subtends or opens these two lines; hence, we shall have two sides and their included angle given or known, to find the other side of the triangle, which will be the real diameter of the sun. It is upon this simple principle that the real diameter of the sun is ascertained to be in round numbers equal to 888,000 miles.

Perhaps this may be simplified in another way, so as to be brought more fully within the comprehension of those who are not in the habit of reflecting upon these subjects. It is a fact well known by every one, that the sun and full moon appear to be of the same size. If their angular breadth be measured by instruments, they will on an average, be found to subtend about the same angle.

This is apparent to any one who will compare the breadths of the two discs in a solar eclipse; for then the moon is in a direct line between the earth and sun; and when their centres are in a direct line, it will be observed that the moon's disc sometimes entirely covers the disc of the sun, producing a total eclipse; at other times, a narrow circular ring of light will be seen, while the other portions of his disc will be hid by the central interposition of the dark body of the moon.

This is called an annular eclipse. This slight deviation in the apparent size of the two discs is owing to the variation of the relative distances of the sun, moon, and earth at different seasons of the year. Upon the whole, then, it may be safely asserted, that the average apparent dimensions of the sun and moon's discs are equal.

The distance of the moon from the earth is about 240,000 miles, or about 400 times nearer the earth than the sun; yet these two bodies appear to be of the same size.

Now suppose the moon to be removed as far from the earth as the sun, the apparent breadth of its disk would be 400 times less than the apparent breadth of the sun. If the moon were really of the same dimensions as the sun, it would have the same apparent size as the sun when removed at the same distance.

But as it has the same apparent dimensions only, when it is situated 400 times nearer, it follows of necessity that its real diameter must be 400 times less than the sun's.

Now the real diameter of the moon has been determined by the most careful observations and measurements to be a little over two thousand miles; let this be multiplied by 400, the product will be 800,000 miles.

Therefore the diameter of the sun must be 800,000 miles, or more accurately, as we observed before, 888,000 miles.

It is very difficult for us to form any conception of such stupendous magnitudes.

If the centre of the sun coincided with the centre of the earth, its surface would extend more than 200,000 miles beyond the moon's orbit.

The diameter of the earth is about 8,000 miles; but the sun's diameter is 111½ times greater.

Having once ascertained the diameter of a globe, it is an easy matter to calculate its volume, for the volumes or real bulks of globes are to each other as the cubes of their diameters.

Therefore, by multiplying 111½ into itself three times, we get the volume of the sun compared with the earth; which is equal to 1,386,196 times the volume of the earth; or in round numbers, the sun is about 1,400,000 times larger than the earth; in other words, if 1,400,000 globes of the size of the earth were united and moulded into one, they would form a globe of the dimensions of the sun.

If all the planets and satellites of our system were united in one, their bulk would not be the one-five hundredth part of that of the sun.

In some of our former lectures, we pointed out the method of weighing the earth; but the astronomer is required to perform still greater wonders than this.

It is his duty, not only to weigh the globe which we inhabit, but to soar aloft with his astronomical balances through the vast spaces which separate the planetary bodies, and accurately weigh those stupendous globes, and declare the quantity of matter which each contains.

Even the sun itself can be weighed with the most unerring certainty. But how can this be accomplished? Where can balances be found of sufficient magnitude to contain these vast bodies?

What astronomer is capable of winging his flight to those distant worlds to examine the materials of which they are composed; to place them in balances, or make experiments of any kind so as to form an accurate judgment as to their weights?

We reply that the astronomer has his balances on hand—balances too, of the most perfect kind; he is not under the necessity of leaving his native earth to explore the solar system, but can with the greatest of ease balance world with world, and determine which is the heaviest.

Every astronomer is in possession of such a balance.

The great astronomical Balance for weighing worlds, was not made by our American or London artists, but was constructed by the great Architect of nature; its use was entirely unknown until discovered by the gigantic mind of the immortal Newton; since whose time, astronomers have been as familiar with weighing worlds, as chemists are in weighing the proportional ingredients which enter into the various compounds which come under their investigation. But what is the nature of this balance?

We reply, that it is the amount of deflection which one body has towards another, which determines the quantity or weight of the matter towards which the deflections are made; for instance, the relative quantities of matter in the earth and sun are ascertained by comparing the moon's deflections towards the earth with the earth's deflections towards the sun.

The amount of these deflections can be calculated if we know the distances and periodic times.

Now the distances of the sun and moon from us are known, as also the periods of the moon's revolution around the earth, and of the earth's revolution around the sun, therefore, from these data, the deflections, and consequently the relative quantities of matter contained in the earth and sun can easily be deduced.

It may not be uninteresting to this audience if this principle should be illustrated by a reference to some of the most common and familiar experiments, with which we are all more or less acquainted.

We all know that when a body is made to revolve in a circle, it has a tendency to recede from the centre.

This tendency will be greater as the velocity of revolution becomes greater, and as the distance from the centre increases.

This fact is manifest by the whirling of a stone in a sling; the longer the string, or the greater the velocity with which it is whirled, the more will the string be stretched.

If the velocity be sufficiently augmented, the string will break and the stone will recede from the centre.

It is not the force of gravity which tightens the string; for if the stone be whirled in a horizontal instead of a vertical plane, the same tendency to recede from the centre will be manifested. If the string be lengthened or shortened while the time of revolution remains the same, the tendency to stretch the string will be proportionally increased or diminished.

On the other hand, if the string remain of the same length while the velocity of the stone in its revolution is increased or diminished, or (which amounts to the same thing) while the time of revolution is diminished or increased, the tendency to stretch the string will be proportionally increased or diminished.

Thus, it will be perceived, that there are two causes which increase or diminish the tendency of the whirling body to recede from the centre; one is the increased or decreased distance from the centre of motion—the other is the decreased or increased time of its period.

Now let us endeavor to ascertain the exact law of the force which stretches the string, as depending on each of these causes separately. 1st. What will be the force which stretches a string that is twice the length of another string, if they be attached to equal weights and be made to whirl round in a circle in equal times?

It is evident that the weight attached to the long string would have twice as far to move as the other weight—and the deflections from the tangent would be twice as great as in the smaller circle; therefore, the tension of the longer string will be twice that of the shorter. When the time of revolution is the same, if the string be three times longer, the tension will be three times greater; if it be four times the length, the tension will be four times greater, and so on.

Now the distance from the centre of the earth to the moon is about 240,000 miles, which is equal to 1,267,200,000 feet; hence, if a string equal in length to the moon's distance, with a weight attached, be made to whirl round in the same time as a string one foot in length, the tension, or the centrifugal force which stretches the longer string, will be 1,267,200,000 times greater than the tension or centrifugal force of the shorter one.

Again, if one string, equal in length to the distance of the sun, be made to whirl round in the same time as another string, equal in length to the distance of the moon, the tension, or centrifugal force of the longer string would be about 400 times greater than the tension of the shorter, for the distance of the sun is about 400 times greater than the distance of the moon.

In all these cases, it is supposed, that the weights or masses of matter attached to the ends of these several strings, are equal and that the periods or times of completing their respective revolutions, are also equal. Under these conditions, we easily perceive the law of the increased or decreased tension of the string; depending on the distance of the revolving weights, that is, the tension varies directly as the distance; this is the law.

2nd. What will be the force which stretches two strings of equal lengths, if the weights attached to them be equal and they be made to revolve in circles in unequal times? According to the mathematical principles of mechanics, the strings would be stretched inversely as the squares of the times of their respective revolutions; for instance, if one of the weights be made to revolve twice as quick as the other, the tension of the string will be 4 times greater than the one having the greater period. If one performs its revolutions 3 times as quick as the other, the tension of the string will be 9 times greater. If the period of one be 4 times sooner than the other, the tension or centrifugal force will be 16 times greater, and so on.

It makes no difference how long these strings are, provided they are of equal lengths; for at all equal distances at which the weights are made to whirl round, the inverse squares of the respective times of their revolutions will be proportional to the tension of the two strings.

Now let us suppose that each of the strings is 95,000,000 miles long, and one be whirled round in one year, and the other in 600 years; in what proportion will the two strings be stretched?

The string whose period is 600 times less than the other, will be stretched 360,000 times more than the one having the greater period. Therefore, the law of tension, governing strings of equal length, to which are attached equal weights, may be expressed in the following words:

The tension of the strings varies inversely as the squares of the times of their respective revolutions. It will be perceived that the law of force by which a string is stretched, as depending on the lengths when the times and weights are equal, and also as depending on the times of revolution when the lengths and weights are equal, has been investigated. From these two laws, it is evident that we can calculate the proportional tensions of strings, although their given lengths and periods of revolution are unequal; for instance, what will be the proportional tensions of two strings, one of which is one foot long, and the other four feet long, the time of the revolution of the shorter being one second, and that of the longer being two seconds. According to the law depending on the lengths, when the times are equal, the tension of the longer would be four times greater than the shorter one; but, according to the law depending on the inverse square of the times, when the lengths are equal, the tension of the longer would be four times less than the shorter; from both of these causes, combined, their tensions would be equal.

Again, what will be the proportional tensions of two strings, one of which is 240,000 miles long, and the other 95,000,000 of miles long; or in other words, whose lengths are as the respective distances of the moon and sun, the time of the revolution of the weight, attached to the shorter string being 27.322d. and the time of revolution of the longer 365.26d.

The tension of the longer string, according to the law, depending on the distance, when the times are equal, is 400 times greater than that of the shorter one, because the length of one is 400 times greater than the other, but the tension of the longer string is about 179 times less than the shorter, according to the law of the inverse squares of their periodic times, when the lengths are equal.

If 400 be divided by 179, the quotient will be about 2 1-4; therefore, from the law of the periodic times and distances, it is proved that the longer string has nearly 2 1-4 times more tension than the shorter one; that is, if the longer string connected the centres of the earth and sun, and the shorter string connected the centres of the earth and moon, the earth, in revolving round the sun in 365.26 d, would pull upon or stretch the string, by its tendency to recede from the centre of motion nearly 2 1-4 times more than the moon would stretch a string, connecting it with the earth, her period being 27.322 d.

This tendency of the earth to recede from the sun, and of the moon to recede from the earth in their respective revolutions, is called the centrifugal force; and the strings which we have supposed to connect these bodies and which prevent them from flying from their centres are called the forces of gravitation, or the centripetal forces.

In circles the centrifugal and centripetal forces are exactly equal; therefore, as we have shown above, that the centrifugal force of the earth, as it whirls around the sun, is about 2 1-4 times the centrifugal force of the moon, as it whirls around the earth, it follows that the gravitation of the earth towards the sun is 2 1-4 times greater than the gravitation of the moon towards the earth.

Thus, it will be seen, that the proportional forces of gravitation, exerted by the heavenly bodies at different distances, are calculated by the same law or rule, as the proportional tension of strings of different length, and which are whirled round by means of weights attached to their ends, with different degrees of velocity.

But, as will be shown more fully hereafter, gravitation increases as the square of the distance decreases; that is, at 1-2 the distance, gravitation is four times as great. At 1-3 the distance it is nine times as great. At 1-4 the distance it is sixteen times greater. At 1-400 part of the distance, it is 160,000 times greater. Therefore, if the earth were placed as near the sun as the moon is to the earth, the gravitation of the earth towards the sun would be 160,000 times greater than it is now; but it is now 2 1-4 times greater than the moon's gravitation to the earth; consequently, if we multiply 160,000 by 2 1-4 the product will be 360,000.

Therefore, at equal distances, the earth gravitates to the sun 360,000 times more than the moon does to the earth; that is, the sun contains 360,000 times more matter than the earth.

We have thus explained how to use the great astronomical balance for weighing worlds, and have given an example by weighing the sun, which we find to be about 360,000 times heavier than the earth. We now leave this balance in your hands; and if you will follow the simple rules which we have given, you will be enabled to weigh Jupiter, Saturn, and some of the other great bodies of our system.

We will here observe, that the numbers used in the above calculation are not as exact as would be requisite for computing the relative masses of the sun and earth for astronomical purposes, yet the principle being the same, they answer every purpose for scientific illustration.

The solution of this great problem may be ranked among the wonders, unfolded by the mathematical principles of mechanics.

Who could have supposed, that the revolution of planets in their orbits was a phenomenon precisely of the same kind, as the whirling of a stone in a sling.

Who could have believed, that by simply knowing the weight of the earth, its periodic time, the length of a string, the weight attached, and the time of its revolution, mathematicians could calculate the weight of the sun.

However great the disparity apparently existing at first view, between the phenomena, yet upon careful reflection, it is evident, that the centrifugal force generated by the whirling of a stone in a sling, is of the same nature as the centrifugal force generated by a revolving planet around the sun; and as that force can be calculated in the instance of the earth, it is further evident that it can be calculated for the sun; and it is still further evident, that as the centrifugal force in the one instance determines the force of tension of the string, so, in the other instance, it determines the force of gravity, or in other words, the relative amount of matter in the sun, compared with the weight in the sling; and if the weight of matter in the sling be known, the weight of matter in the sun will be known also. I am not aware, that any astronomer ever has calculated the sun's mass, by comparing it with the weight of bodies, attached to whirling strings, yet it is certain that this method is strictly true in theory, and might be resorted to in case we were not in possession of the better method already referred to.

In case our earth were destitute of a moon, the general method adopted by astronomers for determining the mass of the sun, founded on the periodic times and distances of the earth and moon, would be inapplicable and other methods would, doubtless, come into practice.

The weight and bulk of the sun being known, it is an easy matter to calculate its density, and thus arrive at some knowledge of the nature of the materials, as a whole, which enter into its constitution.

If the materials of the sun were as heavy as the materials of the earth, its weight would be much greater than it is now; for we have seen that the sun is about fourteen hundred thousand times larger than the earth, while it is only about 360,000 times heavier; consequently, if there should be taken a volume of matter from the sun, equal in bulk to our earth, it would weigh only about ¼ as much as the earth.

If the materials of the sun were as heavy as the materials of our globe, instead of the sun's weighing only 360,000 times as much, it would necessarily weigh as much more than the earth, as it is greater in bulk. The density of the sun is a little over 1¼ times the density of water; that is, if about 1,750,000 globes of water, each equal in size to the earth, were moulded into one, the united mass would weigh as much as the sun.

Having ascertained that the average density of the sun is but a trifle greater than water, let us next inquire, What is the relative weight of the materials on its surface?

Perhaps some of this audience may be startled when they are informed that the astronomer can not only weigh the sun and give its average density as a whole, but can also give the relative weight of the materials at its surface.

The solution of this problem was achieved by the discovery of the law of force which obtain between the particles of matter of which the worlds are made.

This law may be expressed as follows: Every particle of such matter has a tendency to approach every other particle with a force directly proportional to their respective masses, and inversely as the squares of the distances between them.

If the distances are equal, the approaching tendency is directly proportional to the masses towards which a particle gravitates, that is, one-half, one-third, one-fourth, or one-tenth the mass, will generate one-half, one-third, one-fourth, or one-tenth the force called weight.

But when the distances are unequal, these direct ratios of the masses must be multiplied by the inverse squares of the distances. These are the laws of particles. The same law holds good in the gravitation of particles to large masses in the form of spheres.

It can be demonstrated geometrically, that the gravitation to the surface of a sphere is precisely the same as if all the matter of the sphere were collected in its centre.

Now suppose that all the matter of the sun and earth was collected in their respective centres, what would be the gravitating tendency of bodies at the distances of their respective semi-diameters, namely 440,000 and 4,000 miles?

The earth is 1-360,000th part of the mass of the sun; therefore, at equal distances, bodies would have 360,000 times greater weight or tendency towards the centre of the sun than what they would have towards the centre of the earth; but as gravitation diminishes as the square of the distance increases, and as the surface of the sun is about 110 times as far from its centre, as what the surface of the earth is from its centre, it follows that the intensity of gravity, resulting from the consideration of the relative masses, must be diminished in the ratio of the squares of 110 to 1, or in the ratio of 12,100 to 1.

Therefore if 360,000 be divided by 12,100 the quotient will be 29.7.

Hence bodies at the surface of the sun are nearly 30 times heavier than at the surface of the earth.

If the above data had been taken in their true numerical value, instead of round numbers, the result would be 27.9; that is 1 lb. of terrestrial matter would, if carried to the surface of the sun, weigh 27.9 lbs.

An ordinary man who would weigh on the earth 160 lbs., would, if transported to the surface of the sun, weigh 4464 lbs., and therefore would literally crush to pieces under his own weight.

If the surface of the sun be composed of materials heavier than its mean density, that is, if the specific gravity of the surface strata be more than 1¼ times that of water, then the density will be uniform from the surface to the centre; if the specific gravity be less than 1¼ that of water, then the density will increase from the surface to the centre.

Has the sun an axial rotation, or is it at rest, is a question frequently asked by the inquisitive mind of man. We have already shown in our former lectures, that the apparent diurnal and annual revolutions of the sun are not equal, but arise from the real motions of the earth upon its axis, and in its orbit. So far as we have been able to extend our observations, the planetary bodies of this system have a rotation upon an axis; this seems to be indispensably necessary, in order that different sides of those bodies may alternately be exposed to the heat and light of the sun. But the sun being the great source of heat and light, does not apparently stand in need of either heat or light from any external source; and therefore, it would seem altogether unnecessary for it to have a rotation upon an axis; if no beneficial object is perceived to result from a rotation of the sun, we might be led to conclude, in the absence of any direct evidence, that the sun was really quiescent in the centre of the system.

But when we examine the sun by the aid of a telescope, we discover upon its disc many large spots which appear dark, and when watched from day to day, they appear to move across the disc from east to west.

When first discovered near the eastern limb, their velocity is very slow, but increases as they approach the middle of their paths, at which place, the velocity arrives at its maximum value, after which the velocity gradually decreases until near the western limb, when the spots disappear and remain invisible some twelve or thirteen days, and then again re-appear near the eastern limb, describing the same paths as before.

Were these appearances produced by dark bodies intervening between the earth and sun, having an orbitual motion independent of that luminary, then the velocity would be uniform; but the variable velocity, observed in the description of their apparent paths, is precisely the same as it would be if those spots were a part of the surface of the sun itself, rotating upon an axis from west to east. With such a rotation, it is evident that the side of the sun turned towards the earth would have a movement apparently from east to west; while the most distant hemisphere which is turned from us, and consequently invisible, would have a motion from west to east.

If these spots appertain to the surface of the sun, they will each describe a circle parallel to the sun's equator; and if this equator were coincident with the plane of the ecliptic, each of these circles would at all times appear like straight lines on the sun's disc; but if the plane of the sun's equator be inclined to the plane of the ecliptic, the circles described by these spots will, by the effect of perspective, appear elliptic.

One-half of the year these apparent semi-ellipses will present their convex sides towards the upper limb of the sun, and the other half of the year their convexity will be presented towards the lower limb. These appearances are produced by the relative positions of the sun's axis to the earth in different points of its orbit. These ellipses will, at certain seasons of the year, appear much more elongated than at other seasons; this also depends upon the relative position of the axis of the sun to the earth in different portions of its orbit.

There are two days in a year when the axis of the sun is at right angles to the line of vision, namely, the 11th of June and the 12th of December. At these two periods the spots on the sun appear to describe straight lines. After the 12th of December, the apparent paths of the spots begin to deviate from a straight line, the convexity being towards the north, or towards the upper limb of the sun. This deviation from a straight line will continue to increase more and more, until the 10th of March, when it will attain to its greatest value.

From the 10th of March, the curvature of these ellipses will begin to decrease, and continue decreasing until the 11th of June, when the spots will again apparently describe a straight line; after which they will again deviate, but in a contrary direction, the convexity being towards the south, or in other words, the sun's lower limb; the curvature will increase more and more, until the 13th of September, when it will become greatest; then again receding until the 12th of December, when their apparent paths will again be straight lines.

Thus it will be seen that on the 12th of December the earth passes from the northern to the southern side of the plane on the sun's equator; while a spot on the sun's equator, at the same time, appears to ascend from the southern to the northern side of the plane of the ecliptic; this is called the ascending node of the sun's equator. The heliocentric longitude of the ascending node is 80° 21'. On the 11th of June, the earth passes from the southern to the northern side of the plane of the sun's equator, while a spot on that equator appears to descend from the northern to the southern side of the plane of the ecliptic; this is called the descending node of the sun's equator, and is situated directly opposite the other node, 180° further east. The descending node, therefore, lies 260° 21' heliocentric longitude.

If the shorter semi-axis of these elliptic paths be accurately measured with a micrometer—say, for instance, when the earth is 90° distant from either of the aforementioned nodes, or on the 10th of March, or 13th of September—it will be an easy matter to determine from these measurements the inclination of the plane of the sun's equator to the plane of the ecliptic; this is found to be about 7° 20', and the period of rotation, 25 days, 7 hours and 48 minutes. This period does not bring the same spots into the same relative position, in regard to the sun and the earth, that they occupied at the commencement of such period; for the earth, during this period, advances in its orbit over a space equal to about 1-14 part of the whole circumference; consequently the sun has to perform more than one complete rotation before the same spots are brought round to the same relative position that they occupied at the commencement of the period; this period, which may be termed the apparent period, is two days longer than the real period of the rotation.

The distance around the sun being about 2,750,000 miles, a spot on the sun's equator must move with a velocity of about 4,580 miles per hour; this is over four times swifter than the earth's equator moves by its rotation.

The rotation of the sun generates a centrifugal force at its equator about 1-6 of the centrifugal force generated at the equator of the earth by its rotation.

In a former lecture, we proved that the centrifugal force at the earth's equator is about 1-289 part of the earth's gravity; hence, the centrifugal force at the sun's equator is only about one sixth of this fraction, or 1-1734 part of the earth's gravity; but in this lecture we have proved that the earth's gravity is 27.9 times less than the sun's gravity.

Therefore, the centrifugal force at the sun's equator is 1-48379 part of the sun's gravity.

A body will fall at the sun's equator about 5375.49 inches in a second, and if the sun had no rotation, it would fall about 1-9 of an inch further.

A clock pendulum which will vibrate seconds here on the earth would if carried to the surface of the sun, vibrate over five times more rapidly; that is, a pendulum of the same length would make 5282 vibrations at the surface of the sun at the same time that it would make 1,000 vibrations at the surface of the earth.

If the sun's rotatory velocity should become about 219 times more rapid than it is at the present, bodies would have no weight at the sun's equator, and a complete rotation would be accomplished in about 2 hours and 46 minutes.

It is probable that the sun is not a perfect sphere as it would be had it no rotation, but its deviation from the spherical form is very much less than that of the earth; for the centrifugal force of the sun's equator, compared with the force of gravity at his surface, is 167 times less than the centrifugal force of the earth's equator, compared with the force of gravity at its surface. Therefore, the force exerted to alter the spherical form of the sun is 167 times less than the force exerted upon the earth to alter its spherical form. Hence the spheroidal form of the earth is much more oblate than that of the sun.

If the mathematical students in the University, will solve these astronomical problems for themselves, it will have a tendency to make a more lasting impression upon their minds, and will make them more familiar with the grand mechanical forces of the universe, and will raise their thoughts to heights still more sublime—to glories still more resplendent—to powers Omnipotent, enthroned in everlasting light, creating, upholding and governing all things.

Correspondence.

CEDAR CITY, Feb. 6, '71.

Editor Deseret News: In traveling through these southern settlements, I find evidences of prosperity everywhere apparent, and general good feeling seems to prevail. With the prospect of an early opening of Spring the people are preparing for farming extensively, though the people of this county, have not, as yet, adopted the co-operative system of farming, they have, in the matter of caring for their horned stock and sheep. Their sheep herd, numbering nearly 3,000 head, is considered one of the best and most flourishing in the Territory. Every exertion is at present being made by the people of this place to raise the necessary cash to purchase from government their land, and I find rather more of the needful in circulation than farther north. The ground for the erection of a new meeting house, 40x80 feet, was broken here to-day and dedicated; the dedicatory prayer being offered by Elder E. Stevenson of Salt Lake City. The health of Bishop Lunt has of late been very poor, and he is at present suffering severely from sore eyes, but he was out at the dedication and was the first to break the ground. Elders Stevenson and N. T. Porter, the latter from Centerville, have held about twenty-five meetings on their trip between Salt Lake City and this point, and yesterday and this evening they preached in Cedar City. Their teachings cause a good feeling wherever they go. Yours respectfully,

G. C. L.

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AFTERNOON DISPATCHES.

WASHINGTON.

Confirmations.

WASHINGTON.—The Senate confirmed the following nominations: J. E. Black, of Wyoming, to be Surveyor General of Montana; J. A. Seward, to be Postmaster at Kit Carson; Col. Edward S. Stackpole, to be Postmaster at Deer Lodge, Montana.

FOREIGN NEWS.

GREAT BRITAIN.

Motion to aid France in securing terms of peace—Contributions reckoned in the indemnity—German propositions for peace.

LONDON, 17.—The Paris *Figaro* says it is reported that the German propositions for peace run thus: "The cession of Alsace and Lorraine and a portion of the department of Daubs and an indemnity of one and a half million thalers, and the Prussians to keep all the materials of war they have captured, and that the French fleet and the colonies remain intact.

Favre has left Paris again for Bordeaux, whence he will return, with the representatives of the Assembly, and negotiate a treaty of peace.

All the contributions which have been collected by the Germans in France, otherwise than as penalties, will be reckoned in the general war indemnity.

In the House of Commons, yesterday, Aubercon, liberal, moved to resolve that, in the opinion of the House, it is the duty of the neutral powers to interpose and procure such moderate terms of peace as may restore tranquility to Europe and independence to France. The resolve was opposed as inopportune and impolitic.

Peel and Fawcett, while they heartily sustain the government, could not help feeling that England's position was one of selfish isolation; and said that Prussia was already contemptuous in her tone toward England, and her philanthropy was her only redeeming feature.

FRANCE.

Presidency of the Assembly.

BORDEAUX, 17.—M. Grievy has assumed the presidency of he Assembly. All the elections, in the department of the Seine, were confirmed before the sitting was opened. A member of the Left remarked that, "to get here I have been obliged to pass through several lines of armed men. I shall, therefore, in future, come armed myself."

WEST INDIES.

The 'Tennessee."

HAVANA.—A vessel which has arrived at the east end of the Island, reports having seen, on the 2nd inst., a war steamer off the Haytien coast, with three masts, painted black, bark-rigged, about two thousand tons burthen, steaming slowly. She was supposed to be the *Tennessee*.

PANORAMIC VIEWS AND LECTURES.—On Monday and every day during next week there will be on exhibition, at the Deseret Museum, a series of panoramic views in China, Japan, South Africa, St Helena, Ceylon, &c. The exibition will be accompanied by an explanatory and descriptive lecture, the whole being very instructive to all, but especially to young folks and children. In order to give as many as possible a chance of attending, the prices, during the week, will be for adults fifty cents; under eighteen years, twenty-five cents; children up to ten, ten cents. The exhibition and lecture will be given three imes each day, at 12, 2, and 4 o'clock.

LECTURE.—The lecture yesterday afternoon by Professor Maeser, at the Deseret University, was unusually well attended. The subject was, "Footprints of Providence in the development of the human race, or God in History," and tracing the series of revolutions from the time of the ancient hieroglyphic and engraven Egyptian records, to the birth of printing, the lecturer showed, by a classical array of crowning events and revolutionary characters, in the apparently detached and broken threads of historical science, the divine planning and designing of Providence in the harmonious whole. In the birth and career of the Savior of the world, our ruling power and one intelligent language fitted most completely the event to the future development of christianity. In the possession of Constantinople by the enemies of christianity, Divine power was again manifested, as from one of the places where light still continued, the Grecian professors and cultivators of science, were obliged to flee, diffusing their light through Germany, France, Italy, etc.

By the doctrine of Galileo the impulse was given which led to the discovery of America.

Again the invention of gunpowder was one of the important factors of the Reformation of Martin Luther. The art of war had to assume more the garb of science, and the work of the brain the superiority over the work of the hands.

Classifications of society were forming new congregations for the reception of religious principles, and the art of printing crowns the Lutheran age in the universal diffusion of the Christian religion.

The whole spirit of the lecture was to represent that, in general history, events appear to us as certain *radii*, pointing to harmonious centres, which again are moving, radius like, to a universal centre, proving that we are fast approaching this common centre by the rapid development of general and important, inventive and eventful truths.

MIDLAND FREE PRESS.—There is a paper with the above title, addressed to Miss M. Jackson, care of Mr. Thos. T. Chamberlain, 8th Ward, at this office, which can be had upon application.

"CONGRESSIONAL GLOBE."—We acknowledge the receipt, from Hon. W. H. Hooper, of a file of the Washington *Daily Globe*, up to the 12th inst.