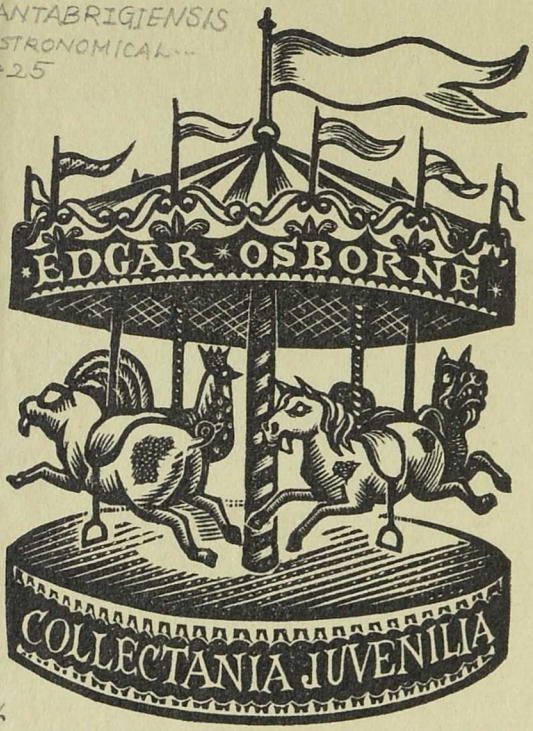
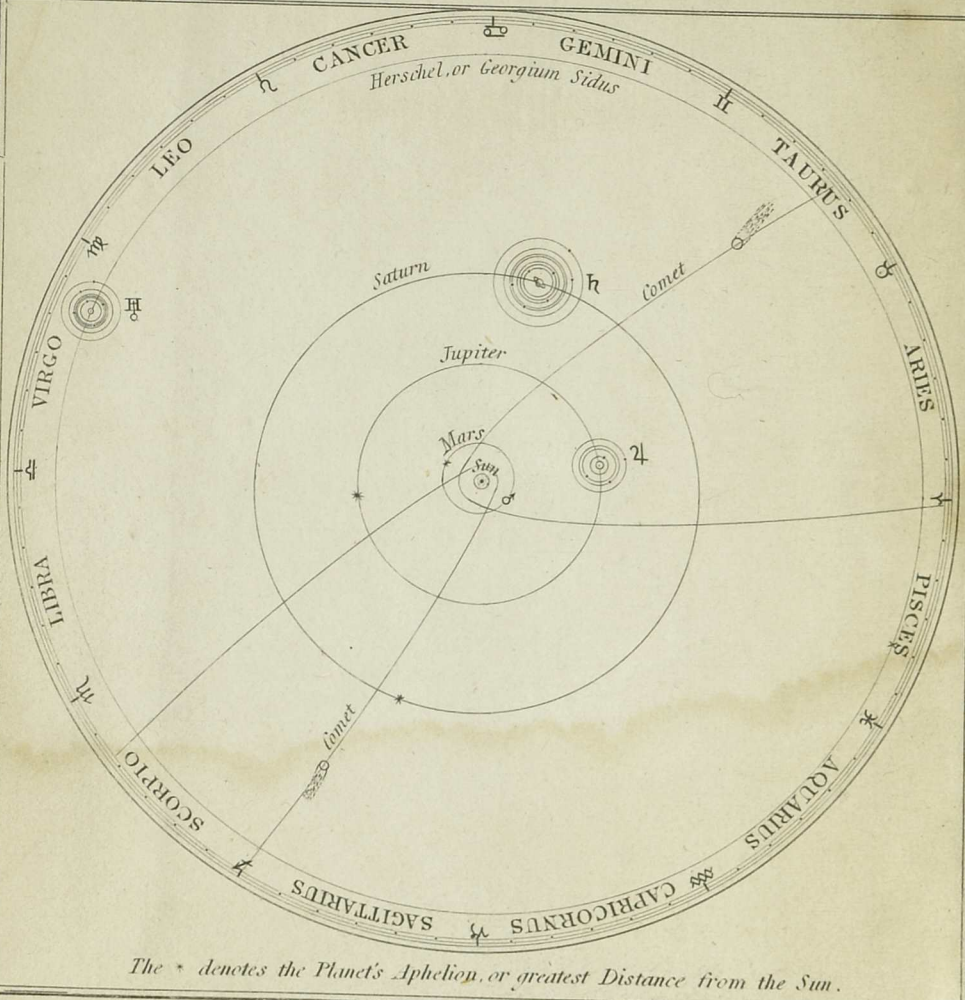
Conversations on Astronomy



PART OF THE SOLAR SYSTEM,

Exhibiting the Orbits of the Superior Planets & Comets.



*The * denotes the Planet's Aphelion, or greatest Distance from the Sun.*

Pub.d May 1.1825, by J. Harris, St. Pauls Ch. Yard.

ASTRONOMICAL

Conversations

FOR CHILDREN;

OR,

A FAMILIAR EXPLANATION OF SOME OF THE PRINCIPAL APPEARANCES OF THE HEAVENLY BODIES.

LONDON:
JOHN HARRIS,
CORNER OF ST. PAUL'S CHURCH-YARD.
1825.

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PREFACE.

THE Author of the following little Work recommends it to the attention of parents and others who are engaged in the instruction of children, as an easy method of bringing them acquainted with some of the principal phenomena with which they are surrounded, which daily strike their

imaginations, and call forth the enquiries of youthful curiosity.

He recommends it with the greater confidence, from the experience of its effect in his own family.

The questions introduced into the conversations were generally put to him in the course of his instructions by his own children; and by embodying them in the work, he hoped to make it more interesting to those for whose use

and benefit it is particularly designed.

The Author is not aware of having used any terms which he has not at the same time fully explained; and he has been careful that the expositions of the phenomena should be entirely within reach of his young reader's comprehension.

The religious and moral reflections, together with the quotations from Scripture, are introduced for

the purpose of leading the youthful mind, by degrees, to the contemplation of that Being, with whose glorious name and perfections a child cannot too soon be made acquainted, and whose goodness he cannot be taught too early to love and praise.

The questions which follow the conversations arise immediately from the work itself, and will there find ready answers in the order in which they are proposed.

To these questions the greatest attention is recommended.

With these observations the Author respectfully desires to commit his work to the public notice; and remains their very humble servant,

CANTABRIGIENSIS.

London,
April 20, 1825.

CONVERSATION THE FIRST.

My dear young friends, I promised to explain to you some of the principal appearances which we observe in the objects around us. And I desire you will ask me any questions you please, when you don't understand me.

We will begin with the earth, on which we live.

We read in the Bible, that this earth, the sun, the moon, and all the bright and magnificent stars, which we behold around us, were created by the Almighty power of God, who, in His infinite wisdom, made them, and all things in them: that when He had prepared the earth, and furnished it with every thing needful for the sustenance and comfort of mankind, He cre-

ated our first parents, and placed them in a state of happiness. He gave them the powers of reason and understanding, that they might know how great and glorious their Creator is, and might praise Him for his goodness.

By observing the objects around them, and applying their understanding to comprehend the wonderful effects which they behold, —how the sun warms and enlightens the earth; and the moon

and the stars shine by night;—how constantly the various seasons, the spring, the summer, the autumn, and the winter, follow each other in beautiful and orderly succession, supplying our bodies with food, and filling our hearts with gladness:—by applying their understanding to these things, men discovered that the earth we inhabit is an immense ball, or globe, about twenty-five thousand miles in circumference;

it is not perfectly round, but flattened like an orange; and a little broader from east to west than from north to south.

What is meant by east, west, north, and south?

The east is that part of the heavens where we see the sun rise in the morning; and the west is the opposite part, where he appears to go down in the evening. The south is the part where we see the sun at noon, or mid-

day; and the north is opposite to it.

When you turn your face to the north, the east is on your right hand, the west on your left, and the south behind you.

How do we know that the earth is round like an orange?

People have sailed round it, in ships. They have set out from a particular place; and, without changing their course, have returned to the same place, which

they could not have done if the earth were not round.

Make a mark with your pencil on this sheet of paper; now trace a line from this place, and try if you can get to it again without changing the direction of the pencil. You cannot. Now take your ball and make a mark upon it with the pencil; trace a line round the ball, and your pencil will return to the same place without having changed its direction.

If you stand upon the sea-shore, and observe a ship as it approaches the land, you first see the top of the mast; next, the sails become visible; and, last of all, the lower part of the ship.

But as we are not on the sea-shore, we will take another method of explaining this.—Stick a pin in your ball, on the under side of it; turn it slowly round in your hand. You first see the head of the pin, till by degrees,

as you turn the ball round, the whole pin becomes visible.

Does the sun move round the earth?

No; the earth itself turns round, from west to east, once in twenty-four hours. And this causes the sun to appear to move round the earth from east to west, in the same time.

Roll your ball along the floor; you see it turns round. Throw it up in the air; you observe it

turns round. Now the earth turns round as your ball does, only the earth turns much faster.

The earth, as I before observed, is about twenty-five thousand miles in circumference, and turns round once every twenty-four hours; so that we who live upon its surface, move at the rate of more than one thousand miles an hour.

Why do not we perceive the earth move?

You remember going over to France last year. When you were in the cabin of the ship, did you perceive it move?

No.

You were then going along at the rate of seven miles an hour, which is as fast as you travel in a carriage. But you did not perceive it, because every thing in the ship moved at the same time, and in the same direction with yourself.

For the same reason, we do not perceive the motion of the earth; because all the trees and houses, and every thing upon it, move together in the same direction.

I am now going to explain to you what causes day and night.

Suppose you could place an ant on the under side of your ball, and keep it there whilst you turn the ball round. The ant would first see the sun peeping

over one side of the ball; which, as the ball turns, would appear to move round it; and at length it would go out of sight, or disappear, behind the opposite side of the ball.

In like manner, as the earth turns round from west to east, we see the sun first peeping over the eastern side of it, appears to move round us; and in the evening it sets, or disappears, behind the western, or opposite side of the earth.

As you turn your ball round, every part receives the light and warmth of the sun in its turn: and so likewise as the earth moves round, every part of it, in its turn, receives light and warmth from the sun. And this causes the difference of day and night.

And as the earth turns round once every twenty-four hours, a day and a night make up that period, or the time of twenty-four hours.

But why do we not fall off from the earth as it turns round?

There is a property, peculiar to all bodies that we are acquainted with, whereby they attract one another. This property is called gravitation, or the force of gravity, and is always in proportion to the weight of the bodies; the heavier body attracting the lighter one, or drawing it to itself.

Now the earth being much heavier than any of the bodies

upon its surface, attracts them all to itself.

For this reason, if you throw up a stone, or let it fall from the top of the house, it returns, or falls down again to the earth.

And this is the cause why we do not fall off from the earth as it turns round.

When we say downwards, we mean *towards* the earth; and by upwards, we mean *from* the earth.

All the living creatures, and

every thing upon the surface of the earth, are kept upon it by the force of gravity. Their feet are opposite to each other, as flies upon a globe, which you sometimes see suspended from the ceiling.

And now, my dear children, we will pause a little, and contemplate the power, wisdom, and goodness of the Creator, who hath made such ample provision for the comfort and happiness of

all the creatures, which He hath made to live upon the earth.

How vast and incomprehensible is the power of that Being, by whose word the earth was created, with all its beautiful variety of land and water, trees and flowers, grass and corn—with all the living creatures sustained by its produce—all the beasts of the field, all the fowls of the air, and all the fishes in the waters!

How infinite His wisdom, who

could thus see and provide for all the wants of all the various and innumerable creatures which He hath made!

How immense and unbounded His goodness, who hath thus taken care for the comfort and happiness of all his creatures!

How wonderful is that delightful succession of day and night, which gives a season to labour and a season to repose!

In the sublime and affecting

language of Scripture—" Thou makest darkness that it may be night, wherein all the beasts of the forest do move.

" The lions, roaring after their prey, do seek their meat from God.

" The sun ariseth, and they get them away together, and lie down in their dens.

" Man goeth forth to his work, and to his labour, until the evening.

"O Lord, how manifold are Thy works! In wisdom hast Thou made them all!"

My dear children, before we begin another conversation, I will ask you some questions, that I may be sure you remember and understand perfectly what I have already explained to you.

1. Who created the earth, on which we live, with all things that we see upon it and around it, the sun, moon, and stars?

2. By what did God create them?

3. Where do we read this?

4. Why did God give man the powers of reason and understanding?

5. How did men come to comprehend the nature of the wonderful effects which they behold around them?

6. What did they discover with respect to the earth, which we inhabit?

7. What do you mean by east, west, north, and south?

8. How do you know that the earth is round?

9. How many miles is the earth in circumference?

10. Does the sun move round the earth?

11. What causes the sun to appear to move round the earth?

12. How long is the earth turning round upon itself?

13. How many miles do we move in an hour?

14. Why do we not perceive this motion?

15. What causes day and night?

16. How many hours make up one day and one night?

17. What is the power, whereby every thing upon the surface of the earth is kept from falling from it?

18. What do you mean by downwards and upwards?

19. What three attributes, or perfections of the Creator, does the consideration of His works lead us to contemplate?

20. How do these shew His power?

21. How His wisdom?

22. How His goodness?

23. In what part of Scripture do we find the words, with which we concluded our last conversation?

CONVERSATION

THE SECOND.

The first of the heavenly bodies, which attracts our notice, is the sun; that great and resplendent luminary, which, we are told in Scripture, "God made to rule over the day."

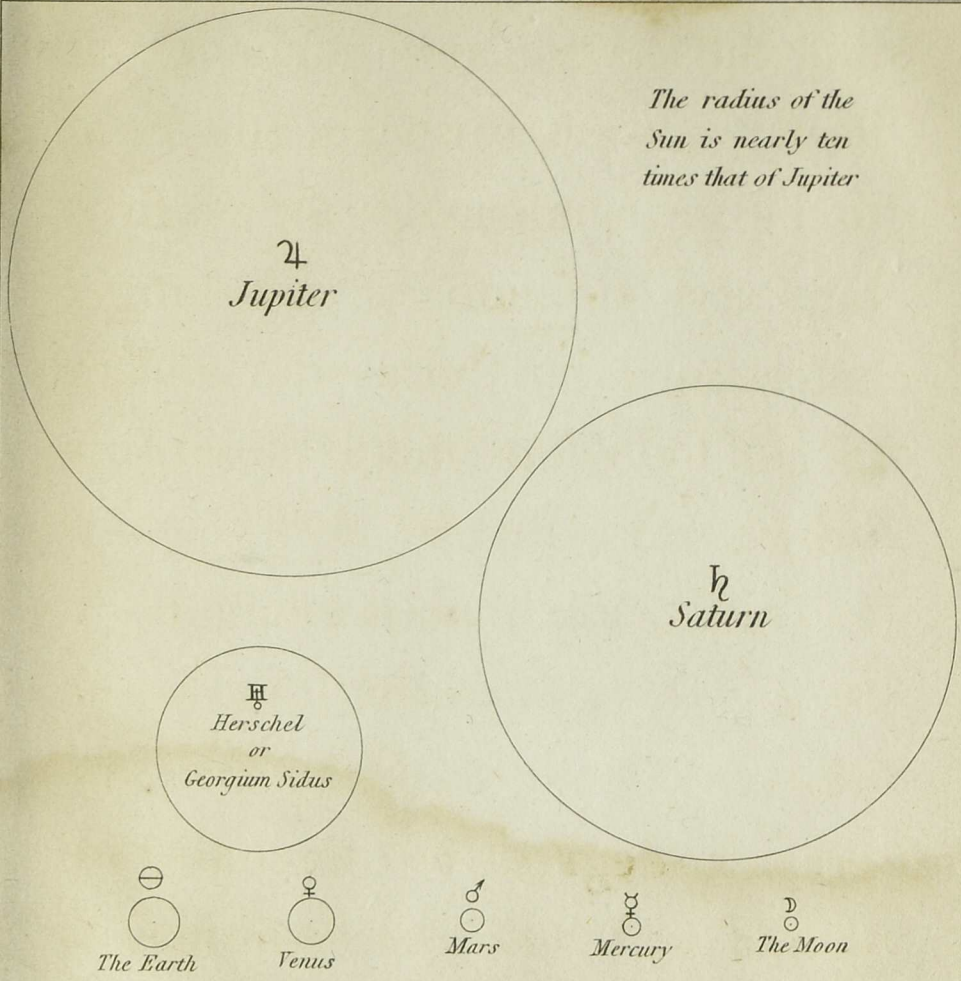
The sun is above a million times larger than the earth; and,

like the earth, turns round about itself. It was formerly supposed to be an immense body of fire; but this opinion is no longer entertained by those who appear to be best acquainted with the subject.

They think it cannot be a body of fire, because, in that case, the nearer we approached to it, the greater degree of warmth we should feel. But the contrary is the fact; it is ascertained, that

Relative Magnitudes of the Planets

The radius of the Sun is nearly ten times that of Jupiter



Pub.d May 1.1825. by J.Harris. St.Pauls Ch.Yard.

upon very high mountains the air is much colder than it is below. Besides, by looking at the sun through a glass made for the purpose, we perceive some dark spots upon it, which would not be the case if it were a body of fire. We conclude therefore that the sun is not a body of fire.

What then is the sun?

The sun is understood to be an immense ball, or globe, surrounded with an illumined atmosphere,

which, acting upon the air that encompasses the earth and other planets in a manner we are unacquainted with, produces light and heat.

You said, that the sun turns round upon itself, like the earth; how do we know this?

I have observed, that we can discover some dark spots upon its surface. By examining these attentively, we perceive them to move from one side to the other,

and then disappear; after a certain time, they appear again on the same part where we first perceived them. We observe also, that the time of their appearance is equal to the time of their disappearance; and that both make up the period, or time, of twenty-five days; and as this appearance is exactly what it would be if the sun turned round upon itself as the earth does, we conclude that it does so; and that it performs

one revolution, or turns once round upon itself, in twenty-five days.

You will take notice that we reckon a day and a night, or twenty-four hours, as one day.

How far is the sun from the earth?

About ninety-five millions of miles.

How can we know this?

Astronomers can calculate exactly both the size of the sun, and

its distance from the earth. You would not at present understand the method whereby they do this, should I explain it to you. When you are old enough to study mathematics, you will easily comprehend it.

Why are the days longer and warmer in summer than in winter?

Because the part of the earth on which we live is turned more to the sun in summer than in winter.

I will endeavour to explain this to you.

Your ball is too hard; fetch an orange.

Now ask for a knitting needle, and pass it through the orange, on the flattened sides: hold it opposite the lamp a little slanting, the lower end of the needle turned from you, or towards the lamp. The needle represents an imaginary line round which the earth turns, called *the axis*. The upper

end of it is called *the north pole*, and the lower end *the south pole*. Now this represents the position of the earth, supposing the lamp to represent the sun.

Supposing your orange to represent the earth, we will cut off a small piece of the peel to mark the situation of England, which is placed between the middle part of the earth, called *the equator*, and the north pole, but nearer to the pole than to the equator. You

observe now that the light of the lamp extends itself beyond the lower end of the needle, but does not reach so far as to the upper end of it.

This answers to our winter, when the light of the sun extends beyond the south pole, but does not reach to the north pole, which is left in darkness. The days with us are now shortest, and the nights longest.

Now walk round towards the

opposite side of the lamp, keeping the needle constantly in the same slanting position, the upper end pointing to the fire-place, and the lower end to the opposite side of the room. Stop half way between the place where you now stand and the opposite side of the room. You observe that the light now shines directly opposite to the middle part of the orange, between the two ends of the needle. Draw a line round the orange

exactly in the middle, between the upper and lower ends of the needle. This line represents that part of the earth which lies between the north and south poles, equally distant from each, and is called the *equator*.

When this line is exactly opposite to the sun, light is extended equally from pole to pole, and the days and nights are equal all over the earth.

This takes place on the twenty-

first of March, and is called the *vernal equinox;* the days from this time become gradually longer and warmer. Now proceed round the lamp as before, and stop when you come opposite to the part of the room from whence you set out.

You observe that the upper end of the needle now points to the lamp. The light extends beyond the upper end of the needle, but does not reach to the lower

end, which is turned away from it. This represents the position of the earth in our summer, when the light of the sun extends beyond the north pole, and leaves the south pole in darkness. The days with us are now longest and the nights shortest. Now continue your journey round the lamp, and stop when you come half way between the place where you now are, and the place from which you first set out. You

observe the light now shines again directly upon the middle line, between the two ends of the needle, extending equally to them both. In this position of the earth, the sun shines again directly upon the equator, extending its light equally to the two poles; and the days and nights are again equal all over the earth.

This takes place on the twenty-first of September, and is called the *autumnal equinox*. The days

from this time become gradually shorter and colder, until you return to the same place from which you first set out, when the days are again shortest and coldest.

Thus I have endeavoured to explain to you the cause of the variations of the seasons, made by the course of the earth round the sun, which course is called her *orbit*.

If you keep constantly turning the orange round the needle whilst you carry it round the

lamp, it will represent the two motions of the earth, one round its axis, producing day and night; the other round the sun, producing the different seasons of the year—winter, spring, summer, and autumn.

In this manner, the earth moves round the sun at the distance of ninety-five millions of miles from it, completing its revolution in three hundred and sixty-five days six hours, which is called a year,

producing the different seasons; and by constantly turning round upon its own axis at the same time, the necessary and agreeable change of day and night is produced.

You will observe, when I say the earth completes her revolution round the earth in one year, or three hundred and sixty-five days six hours, I reckon the day and night, or twenty-four hours as one day.

How do we know that the earth moves round the sun in three hundred and sixty-five days six hours?

Take the orange, and hold it opposite the lamp, as before. I will stick a piece of paper upon the opposite wall in a line with you and the lamp. Now walk round the lamp. You observe the lamp appears to move round you until it comes again into the same place opposite the piece of

paper. In like manner, by observing the sun in a line with some particular star, we find that in three hundred and sixty-five days six hours it returns to the same place again. And although the same appearance would take place whether the sun moved round the earth or the earth moved round the sun, yet, from observing some stars, that are called *planets*, and which in every respect, as far as we can discern their motions,

resemble the earth, move round the sun, we conclude that the earth resembles them in this respect also; and that it moves round the sun, as I have endeavoured to describe it to you.

And what makes it move round the sun?

You remember what I told you of a certain property, peculiar to all bodies that we are acquainted with, whereby they are attracted to each other in proportion to

their weights: the heavier body attracting the lighter one, or drawing it towards itself. Now the sun, being much larger and heavier than the earth, attracts the earth in such a manner, that if it were not prevented by another force, acting in another direction, it would move faster and faster towards the sun, until at length it would fall into it.

Now tie your ball to a string; —tie it quite fast;—take hold of

the other end of the string, and turn it round as quick as you can.

As the ball is turned round your hand, the string becomes stretched. Should the string break, or should you let it go, the ball would fly off to a distance; and the quicker it moved, the more the string becomes stretched, and the farther the ball would go, should you let it loose. Now, this gives you a tolerably correct idea of the two forces

which, constantly acting together upon the earth, cause it to move round the sun. The string which you hold in your hand represents the force of gravity, whereby the earth is attracted towards the sun; and the force which causes the string to become stretched, represents the force whereby it endeavours to fly off in another direction, and is called the *centrifugal force.*

But what keeps the earth up in the air?

What keeps your ball up in the air?

Why, the string I hold in my hand.

Well, the string you hold in your hand represents the attracting power of the sun, or the force of gravity; and the force by which the string is stretched, or the force which the ball exerts to fly off in another direction, represents the centrifugal force of the earth. Therefore, as the ball is kept up

by the string you hold in your hand, and the force whereby it endeavours to fly off, which becomes stronger as the ball moves faster—so the earth is kept in its orbit by the force of gravity and the centrifugal force acting constantly together.

Have you never observed, my dear children, that the year has sometimes one day more than usual?

Yes, February had twenty-nine

days this year, and last year it had only twenty-eight.

The reason is this. The earth completes her revolution round the sun in three hundred and sixty-five days six hours, that is, in three hundred and sixty-five days and one fourth part of a day.

Therefore by adding one day, or twenty-four hours, to every fourth year, we make up the exact time of four revolutions, or

complete four years. This fourth year is called *bisextile*, or *leap year*.

I have now finished, my dear children, for the present, what I proposed to tell you about the sun—that vast resplendent luminary, which "God made to rule the day, and to give light and warmth to the earth; producing food, cheerfulness, and comfort, to every living creature, which the Lord God hath made to dwell upon the face of it."

The air, the ground, and the water, all feel the vivifying stream of light and heat; and every creature, however minute, rejoices in the beneficence of its Creator.

To man alone, God hath given the superior faculties of reason and understanding. He created man in His own image, and put all things upon the earth in subjection under him; not thereby to make him the tyrant over His creation; but that, by imitating

his Maker in the mild and endearing qualities of kindness and compassion, man should be the means of communicating and multiplying happiness to every part of the great work of the Universal Father, which is capable of receiving and enjoying it.

How strongly does this consideration urge upon us, my dear children, the great duty of kindness and compassion to the inferior parts of the creation.

As this life is the whole of their existence, we should endeavour, by every act of humanity, to render it as happy as we can. The smallest insect is the creature of God; for it His sun that shines, and His rain that falls. He hath endowed each with the means of happiness adapted to its state and nature; and He hath declared that not a sparrow falls to the ground without His knowledge. We transgress therefore sadly

against His prerogative, when we wantonly misuse His creatures, or unnecessarily destroy that life, which we did not give, and which it is beyond our power to restore. We and they are all the work of His hand. He hath given them to us to use, not to abuse; and every act of rude oppression and inconsiderate cruelty will be placed to our account.

In the magnificent language of the Psalmist—" The heavens declare the glory of God, and the firmament sheweth His handy work.

" One day telleth another, and one night certifieth another.

" There is neither speech nor language, but their voices are heard among them.

" Their sound is gone out into all lands, and their words unto the ends of the world.

" In them hath He set a taber-

nacle for the sun; which cometh forth as a bridegroom out of his chamber, and rejoiceth as a giant to run his course.

"It goeth from the uttermost part of the heavens, and runneth about unto the end of it again; and there is nothing hid from the heat thereof."

QUESTIONS ON CONVERSATION II.

1. Which of the heavenly bodies first attracts our notice?

2. How much is the sun larger than the earth?

3. In what does the sun resemble the earth?

4. What was the sun formerly supposed to be?

5. What reason have we for thinking this opinion erroneous?

6. What is the opinion now entertained respecting the sun?

7. What reason have we for supposing that the sun turns round upon itself like the earth?

8. In what time does the sun turn round upon itself?

9. What period of time do we reckon as one day?

10. What distance is the sun from the earth?

11. Why are the days longer and warmer in summer than in winter?

12. Explain this.

13. When are the days and nights equal all over the earth?

14. What are these times called?

15. What do you mean by the axis of the earth?

16. What do you mean by the orbit of the earth?

17. How can you represent the two motions of the earth, one round her axis, the other in her orbit?

18. In what time does the earth perform her course round the sun?

19. How do you know this?

20. Explain this.

21. Would not the same appearance take place if the sun moved round the earth?

22. What reason then have we for supposing that the earth moves round the sun?

23. What causes the earth to move round the sun?

24. What are the two forces called which cause the earth to move round the sun?

25. What do you mean by the force of gravity?

26. What do you understand by the centrifugal force?

27. Explain this by means of your ball and a string.

28. What keeps the earth steady in her orbit?

29. Why is one day added to the month of February every fourth year?

30. What is this year called?

31. What are the beneficial effects which the sun produces on the earth?

32. What particular duty does this consideration suggest?

33. Where is the portion of Scripture with which we concluded our last conversation?

CONVERSATION THE THIRD.

The next object that claims our attention is the moon, the other "great light which God made, to rule the night."

"I will consider Thy heavens, even the works of Thy fingers, the moon and the stars which Thou hast ordained."

The moon, of all the heavenly bodies, is nearest to the earth. It is much less than the earth, and is carried along with it, in its orbit, round the sun; and, like the earth, receives its light from that grand luminary.

The moon also has two motions; one round her axis, which she performs in somewhat more than twenty-nine days; the other round the earth; about which she revolves in the same time, at the

distance of about two hundred and forty thousand miles. Her revolution round the earth is called her *orbit*.

In consequence of these two motions, in the same time, and in contrary directions, the moon always presents the same side to the earth.

I will endeavour to explain this to you.

Take your ball, and rub one side of it over with whiting.

Now stand in the middle of the room, and I will walk round you with the ball. Keep your face towards me. As I walk round you from right to left, I will turn the ball slowly round in my hand from left to right, and you will perceive that the same side of it is always turned towards you. This represents the two motions of the moon; one round the earth; the other upon her axis; in consequence of which she

always presents the same side to the earth.

What keeps the moon up in the air?

The moon is retained in her orbit, or, as you express it, kept up in the air, by the same means that the earth is retained in its orbit, by the force of gravity and the centrifugal force acting constantly at the same time.

The earth, being much larger and heavier than the moon, at-

tracts the moon in like manner as the sun attracts the earth, by the force of gravity; and the centrifugal force acting constantly at the same time, causes it to endeavour to fly off in another direction; as I explained to you in our last conversation respecting the sun and the earth; the earth being in this respect to the moon what the sun is to the earth.

Why does the moon appear

sometimes small and curved, and at other times large and round?

The moon, as I observed before, receives her light from the sun. Now, when the moon is between the sun and the earth she does not appear at all; for, as she receives light only from the sun, the side turned towards the sun will be perfectly light, and the other side, which is turned towards the earth, will then be perfectly dark, and therefore in-

visible to us. As she moves on in her orbit, from between the sun and the earth, a small part of her orb will become enlightened, which will appear as a very small curved line, and is called *the new moon;* and she is now said to be in her *first quarter.*

This curved line increases by little and little until she arrives half way towards the opposite side from whence she set out; she now appears as a half circle,

and this is called her *second quarter.* As she proceeds in her orbit, she becomes larger and larger, until she comes opposite to the sun; the whole of her side, which is now turned towards the earth and the sun, being opposite to them both, becomes enlightened, and appears full and round, and this is called the *full moon.* She is now said to be in her *third quarter.* As she proceeds in her orbit, her enlightened side is

turned more and more from the earth, and she decreases gradually, as before she increased, until she appears again as a half circle; and this is called her *fourth*, or *last quarter;* from this she proceeds, gradually becoming less and less until she comes into the same position as at first between the sun and the earth.

You have seen an eclipse of the moon. This takes place only at the full; when the moon is on the

side of the earth, opposite to the sun, and the earth is exactly in a line between the sun and moon. The earth's shadow now falling upon the moon intercepts the light of the sun, and renders her invisible to us. This is called an *eclipse of the moon;* and, as I observed, takes place only when the moon is at the full.

An *eclipse of the sun* takes place when the moon is exactly in a line between the earth and the sun,

so as to intercept his light from the earth. This takes place only at the new moon.

These eclipses do not occur every time the moon is full and new; because the sun and the moon are not always exactly in a line with the earth at those times.

You will have a correct notion of the comparative size of the earth, the sun and the moon, when I tell you that the earth is about eight thousand miles broad,

the sun above eight hundred thousand, and the moon two thousand.

The moon, being so much nearer to the earth than the other heavenly bodies, has a peculiar influence upon it.

By its attraction, the waters of the sea, as they pass under it, are a little raised; which causes the sea to swell, or rise, in those places. This takes place twice in twenty-four hours; and is called *the tide.*

Does any body live in the moon?

That, my dear, is what we cannot certainly know; the moon being at too great a distance for us to discover any living creatures upon it. But, judging from what we can discover, and from the general resemblance of the moon to the earth, we have reason to suppose that the moon may be inhabited by rational, intelligent creatures, capable of knowing and draising their Creator.

Can we distinguish any thing in the moon?

Yes; by the help of glasses, called *telescopes*, made for this purpose, we can plainly discern mountains in the moon: and what will surprise you more, we can measure them. We can discover also deep caverns and valleys in the moon.

How can we measure the mountains in the moon?

You would not understand me,

were I to explain this to you at present; as I said in our last conversation, respecting the distance and size of the sun; you will be able to comprehend how this is done, when you are old enough to study mathematics.

And how high are the mountains in the moon?

Astronomers have found one to be five miles in height; which is one mile higher than the highest yet discovered upon the earth.

Besides the sun and moon, God "made the stars also, and placed them in the firmament of heaven to give light upon the earth."

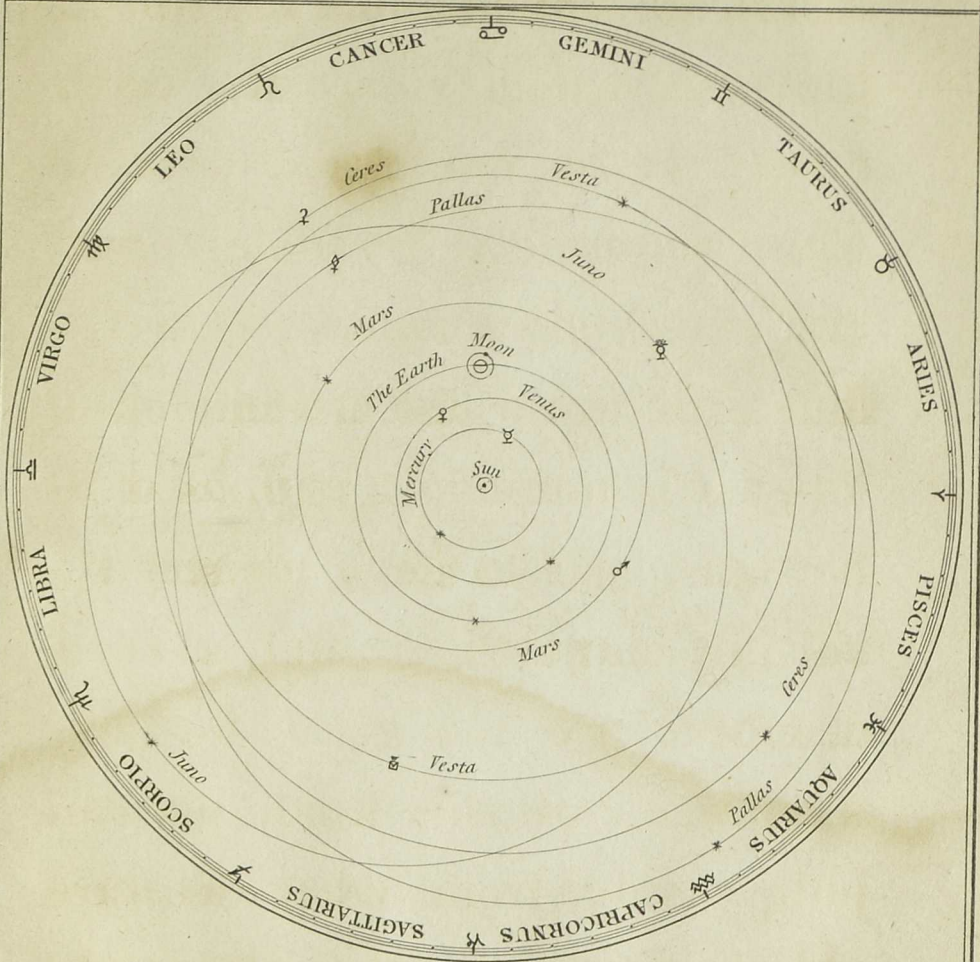
If you look through a telescope, you will see many more stars than can be seen by the naked eye. Not more than seven or eight hundred are visible to the naked eye; but by means of a telescope above one hundred thousand have been discovered.

Among these, some are ob-

served to move round the sun in the same manner that the earth does. These are called *planets*. The rest appear motionless, and are called *fixed stars*. The distances of these last are immense. They are commonly supposed to be suns, and to have planets revolving round them: but, as their distances are too great for any discoveries of this kind, we can judge only from what we are able to discover in those heavenly

PART OF THE SOLAR SYSTEM,

Exhibiting the Orbits of Mercury, Venus, the Earth, Mars, and the Asteroides.



*The * denotes the Planet's Aphelion, or greatest Distance from the Sun.*

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bodies which are within reach of our observations.

Of the moveable stars, or planets, there are eleven principal, which for the sake of distinction, are called by the following names :—*Mercury*, *Venus*, the *Earth*, *Mars*, *Vesta*, *Juno*, *Ceres*, *Pallas*, *Jupiter*, *Saturn*, and *Herschel*, or the *Georgium Sidus*. The last of these was discovered by Mr. Herschel, and received its latter name in compliment to

King George the Third, in whose reign it was first discovered.

Of these, *Mercury* and *Venus* are nearest to the sun, and perform their revolutions round that luminary within the orbit of the earth.

How do we know this?

These two planets, Mercury and Venus, are sometimes observed to pass between the sun and the earth, appearing like a small dark speck on his surface.

This passage between the sun and the earth is called their *transit*. This can be seen only by a telescope made for the purpose.

These planets all move round the sun, in the same manner as the earth does, in orbits nearly circular, or round; performing their revolutions in different times, according to their distances from the sun.

Mercury is about thirty-seven millions of miles from the sun;

and performs its revolution in somewhat less than three months.

Venus is nearly sixty-nine millions of miles from the sun; and completes her revolution in rather less than seven months.

Mars is almost one hundred and forty-five millions of miles from the sun; and performs his circuit in rather more than one year and eleven months.

Vesta is about two hundred and twenty-five millions of miles

from the sun; and goes through her revolution in rather more than three years.

Juno is about two hundred and fifty-three millions of miles from the sun; and performs her revolution in about four years and a half.

Ceres is about two hundred and sixty-three millions of miles from the sun; and completes her revolution in somewhat less than four years and eight months.

Pallas is about the same mean distance from the sun with Ceres, and performs her revolution in about the same time.

Vesta, Juno, Ceres, and Pallas, are called *Asteroides*, on account of their diminutive size: they can only be seen through a telescope.

Jupiter, the largest of all the planets, is upwards of four hundred and ninety-four millions of miles from the sun; and

occupies almost eleven years and eight months in completing his revolution.

Saturn is upwards of nine hundred and six millions of miles from the sun; and performs his revolution in about twenty-nine and a half of our years.

The *Georgium Sidus*, or Herschel, is upwards of one thousand eight hundred millions of miles from the sun; and performs its

revolution in one thousand and fifty-eight months, or rather more than eighty-four years.

These all receive light from the sun, which they transmit to the earth by reflection; in the same manner that horses, trees, and other objects, on which the sun shines, appear bright and luminous.

Some of the planets have satellites, or moons, accompanying them in their course round the

sun; as the moon accompanies the earth.

Jupiter has four moons, Saturn seven, and the Georgium Sidus six.

The planet Saturn is also surrounded by a double ring, or circle, of light, at the distance of more than thirty-four thousand miles from his body. Seen through a telescope, it appears like a shining atmosphere.

These vast bodies, which in all

their motions, as far as we can discover, resemble the earth, are probably the habitations of intelligent beings, receiving the bounty of the Creator, and praising Him for "his excellent greatness."

There are also other heavenly bodies, called *Comets*, which move round the sun; not in orbits like the planets, nearly circular, but long and narrow. They almost touch the sun in one part of their orbits, and go to an immense

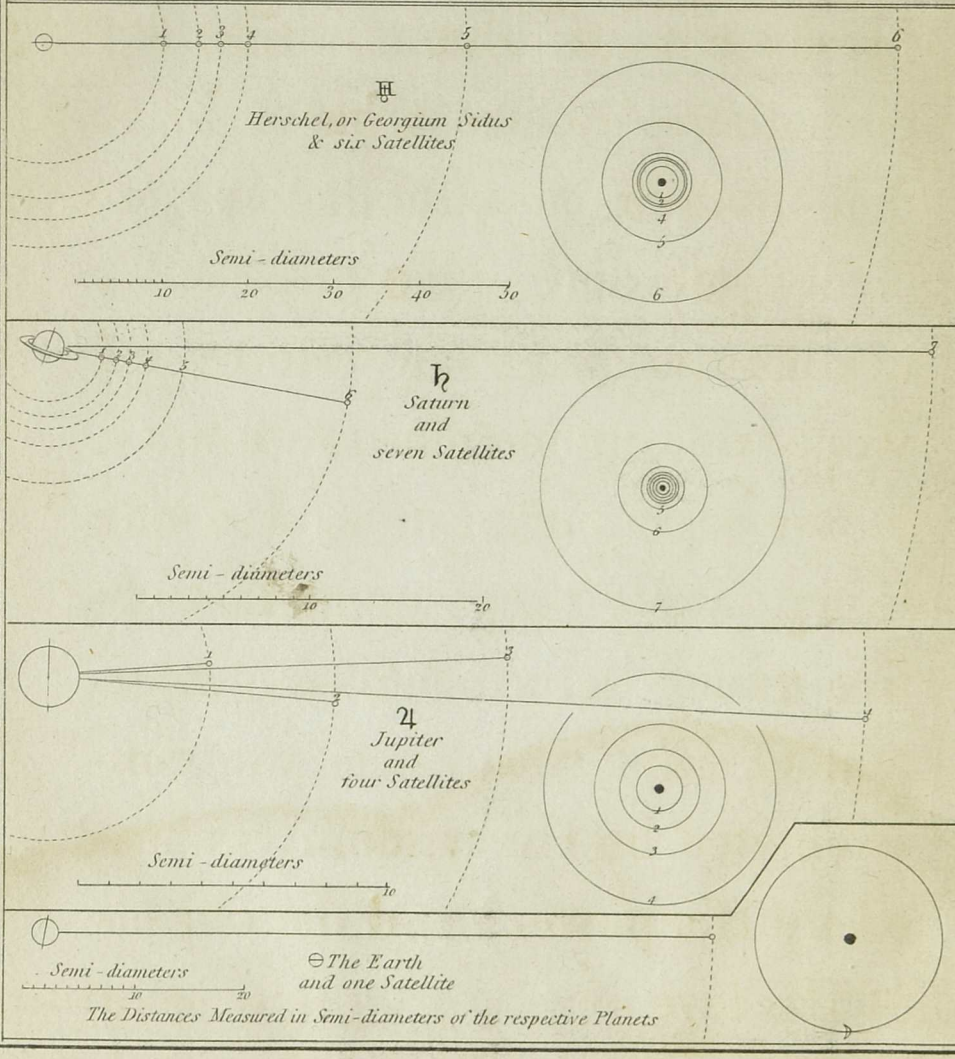
distance from him in the other part; carrying along with them a train of light many hundred thousand miles in length.

I shall here conclude our conversations respecting the appearances of the heavenly bodies, which we behold around us; concerning which, God hath permitted us to make such discoveries, as lead us to admire and adore that wisdom, which He hath thus bent down to our con-

templation; and to reverence and fear that power, so infinitely beyond our thoughts to apprehend; —but more especially, to love that unbounded goodness, which hath thus accommodated His creatures to our use and benefit; and who, although He dwelleth above the highest heavens, "humbleth Himself to behold the things in heaven and earth."

Contemplating the mighty works of the Creator, the Psalmist

Satellites



The Distances Measured in Semi-diameters of the respective Planets

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breaks out into this affecting exclamation—" Lord, what is man, that Thou art mindful of him!"

Insignificant as we appear, in comparison with the great and wonderful subjects of creation, it is our high prerogative, and our inexpressible consolation, that we live under the immediate protection of Him who made us; contemplated by His wisdom; guarded by His power; and the objects of His love.

Had we not been assured, by the unerring word of Truth, that there are mansions of eternal happiness prepared for us beyond the grave—yet when we reflect, that the highest perfections of the Deity are employed in our preservation and government, we could not but believe, that a being thus surrounded and guarded by its Creator, and endowed with faculties to conceive, though inadequately, and adore his in-

finite perfections, should have been made for higher purposes than to flutter for a moment in the sunshine of its little summer, and be seen no more.

Let then the great and glorious truth, that man was created for immortality, be ever present to your minds ; and at the same time, never forget the important fact, that if you hope to make that immortality a happy one, you must endeavour, under the guidance of

the Holy Spirit, to fit yourselves, by a life of purity and holiness, for the presence of that Being, "Who is of purer eyes than to behold iniquity;" who is too great to need our services, and too good not to reward them, however imperfect, when they proceed from an honest mind, solicitous to know His will, and careful to perform it.

" O praise the Lord of heaven! Praise Him in the height!

" Praise him, all ye angels of His! Praise Him all His hosts!

" Praise Him, sun and moon! Praise Him, all ye stars and light!

" Praise Him, all ye heavens; and ye waters that are above the heavens!

" Let them praise the name of the Lord! for He spake the word, and they were made; He commanded, and they were created.

" He hath made them fast for ever and ever; He hath given them a law, which shall not be broken.

" Praise the Lord upon earth, ye dragons and all deeps!

" Fire and hail, snow and vapours; wind and storm fulfilling his word;

" Mountains, and all hills; fruitful trees, and all cedars;

" Beasts, and all cattle; worms, and feathered fowl;

"Kings of the earth, and all people; princes, and all judges of the world;

"Young men and maidens, old men and children; praise the name of the Lord! For His name only is excellent, and His praise above heaven and earth!"

QUESTIONS ON CONVERSATION III.

1. Which of the heavenly bodies is nearest to the earth?

2. Is the moon smaller than the earth?

3. Does the moon accompany the earth in its orbit round the sun?

4. From what source does the moon receive light?

5. How many motions has the moon?

6. What are they?

7. What distance is the moon from the earth?

8. In what time does the moon revolve round her axis?

9. In what time does she perform her revolution in her orbit round the earth?

10. What takes place with regard to her appearance in consequence of those two motions?

11. Explain this.

12. What two forces, acting constantly together, retain the moon in her orbit?

13. Explain the cause of the different appearances of the moon, sometimes being curved

and small, at other times large and round.

14. What causes an eclipse of the moon?

15. What causes an eclipse of the sun?

16. When does an eclipse of the moon take place?

17. When an eclipse of the sun?

18. Why does this not take place at every full and new moon?

19. What are the respective

breadths of the earth, the sun, and the moon?

20. What particular effect has the moon upon the earth?

21. What is this called?

22. How often does this take place?

23. What reason have we for supposing the moon to be inhabited by intelligent beings?

24. What can we distinguish in the moon through a telescope?

25. What is a telescope?

26. Can we measure the mountains in the moon?

27. What is the height of one of them?

28. How much higher is this than the highest mountain at present known on the earth?

29. What other heavenly bodies do we see?

30. How many stars can be seen by the naked eye?

31. How many have been discovered by means of a telescope?

32. What difference do we observe in the stars?

33. What are the moveable stars called?

34. What are the others called?

35. What are the fixed stars supposed to be?

36. How many planets have been discovered?

37. By what names are these distinguished?

38. Which of these is nearest to the sun?

39. Name them in their order, according to their distances from the sun, beginning with the nearest.

40. How do we know that Mercury and Venus are nearer to the sun than the earth is?

41. What do we call their passage between the sun and the earth?

42. Why was the last planet which you named called the *Georgium Sidus*.

43. In what manner do these planets move round the sun?

44. From what source do they receive light?

45. How do they transmit it to the earth?

46. Which of them are accompanied by satellites or moons?

47. How many moons has each of them?

48. What particularly distinguishes the planet Saturn from the other planets?

49. What are the distances of the several planets from the sun?

50. In what times do they perform their revolutions round the sun?

51. What reason have we to suppose these bodies to be inhabited by intelligent beings?

52. What other heavenly bodies have been discovered?

53. What are they called?

54. Do they move round the

sun like the earth and other planets?

55. What peculiar appearance have these bodies in their course?

56. What important truth may we collect from a consideration of the works of God?

57. By what conduct must we endeavour to make ourselves fit for the presence of God?

58. Under whose guidance alone can we do this?

59. Where do you find the portion of Scripture with which we concluded our last conversation?

THE END.

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