Our Solar System

A BRIEF INTRODUCTION TO OUR NEIGHBOURHOOD BY CHRIS SARA

FOREWORD

As much as we like to gaze into the Universe we are physically bound to our solar system. We have sent probes towards the outer regions and after many years of travel they are not even at the edge of our own neighbourhood. We are limited by our current technologies that allow us to travel at speeds that in universal terms are *"snail pace"*. Even if we could travel faster, we would be limited to the speed of light and that means for most of the things we observe outside our solar system they would take tens to thousands, if not millions, of years to reach.

We will have to resign ourselves, for now, with this reality, and take what opportunities we have to learn through observation and calculation. We have physically visited our Moon, and Mars. Venus has allowed us to probe her atmosphere ever so briefly, but what we have gleamed in those moments has provided great insight into our own world. Probes have reached Mercury and the Sun is in reach. We have data from Jupiter and Saturn that reveals what we once only surmised. Our latest technological advancements have delivered detailed images from Uranus and Neptune and even Pluto (once considered the 9th planet) has been within range of a close encounter. It is this knowledge that paves the way to a greater understanding of ourselves; the third rock in a string of 8, stretched out across a solar system, nested within a galaxy, orbiting with a billion other galaxies, in an ever-expanding Universe.

The rare and miraculous occurrence of life, dependent on so many factors, is evidenced by our study of our own neighbourhood. If we hope to one day venture to the stars then it will be the mastering of our solar system that will be the launching pad to that dream.

Introduction

If we were to consider the Milky Way as our entire world, then our solar system would be a single neighbourhood in that world. For millennia life on Earth was confined to its own little pond. As life evolved and grow ever more complex, its ability to move around increased. Fast forward billions of years and we are now at a point where human progress can outstrip evolution; no longer do we need to wait for nature to give us chances, we can create our own, only needing the courage to do so.

We are now capable of moving around our neighbourhood but in terms of the Universe we are still effectively stuck in the pond we were born in. This is fine, as it is not space travel that concerns us as astronomers, but observing. It is the advances in technology that comes from exploring off Earth that delivers us the tools to use in our modern-day astronomy.

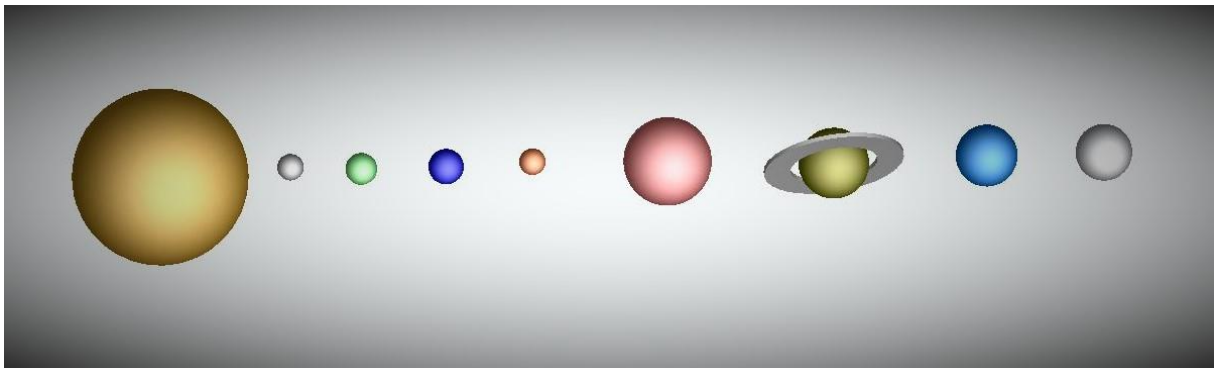
Solar system observations are different from looking at the stars. The stars are effectively fixed in the sky whereas our solar system companions are orbiting around the Sun at a speed that impacts these observations. We will one month be able to observe a planet and the next it will be passing by during the day. We drift from far away to really far away and in some cases will only be "close" once in a lifetime, or less. Nonetheless, our neighbours are still close in relative terms and we should not pass them by on the way to the stars.

When Rakiura became a dark skies sanctuary in 2019 I found my way into astronomy, but it was my first observation of Saturn, and the rings, that will always be my reference point to the moment I became an astronomer.

My first image of Saturn from my first telescope and iPhone

Our Solar System

It is within our own Solar System that we can observe objects with the most detail. Our Moon is the first stop on our journey through the solar system. Close and large this is the easiest body to observe. After that the planets Jupiter and Saturn offer the best observations. They are only reflecting light from the Sun, and are very large in relative terms, so details can be distinguished. Venus is bright, but small in the sky. With a gaseous atmosphere it reflects large amount of sunlight, and orbiting between us and the Sun means we have limited opportunities. Mercury, like Venus, orbits between us and the Sun, and also small, and therefore harder to see. On rare occasions they will past in front of the Sun and these transits are moments to be noted. Mars is also small, but closer than the gas giants of Jupiter and Saturn, and with a bit of patience and the right setup details can also be distinguished. Beyond Saturn orbit Uranus and Neptune. They are very far away and observations are limited.

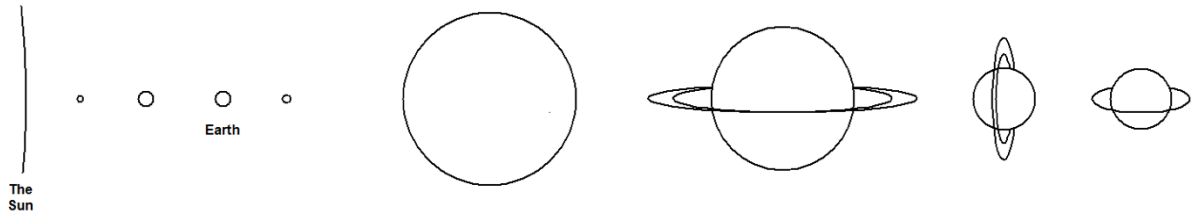


The Sun, Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune

Unlike the distance stars the objects in the Solar System are all in motion with us in an orbit around the Sun. This means that how and where they appear is dependent on where they are in their orbits. We need to be mindful of when alignments are best for viewing as sometimes the best observation conditions may only occur every 10-100 years.

Basic Facts

- A solar system is a sun with a number of orbiting celestial bodies that are bound by gravitation attraction.
- Our solar system is one of billions of solar systems in our galaxy, the Milky Way.
- Formed some 4.6billion years ago when a dust cloud, Nebula, collapsed.
    - The nebula started to spin and as it collapsed further it spun faster and faster, like a tornado forming in a storm. The forces are governed by the theory of “conservation of angular momentum”.
    - This forces of gravity and angular momentum eventually balanced.
    - Our sun ignited and lit up what was becoming our solar system.
    - Planet-forming clusters of matter swept the area and orbits stabilised.
    - As they grew in size their own gravitation forces acted to create stable masses that crushed themselves into round balls.
    - Most of the solar systems matter eventually resided in the sun and planets and our Solar System was born.
- There are 8 planets, Pluto (in the Kuiper Belt), the asteroid belt, comets and various other bodies in orbit around the Sun.
- The Sun comprises some 99% of the mass of the Solar System.
- Our Sun is in the mid phase of its life cycle and is of the right size to be stable enough not to burn itself out to fast; but still, one day it will burn out.



The planets to scale in size but not in distant from the Sun; that would require a very large piece of paper to show in scale.

The Sun

The stars that make up the night skies are suns. Our Sun is one of billions that reside within our galaxy, which in turn, is one of billions of galaxies that make up the Universe.

It requires specialised equipment to observe the Sun and it has its own unique features that make it interesting. It is fair to say that the Sun is a specialised object to observe and those wishing to make observations should firstly equip themselves with the knowledge to make it safe.

Basic Facts

- The Sun is at the centre of our Solar System and is 109 times larger than Earth.
- It contains over 99% of the mass of the Solar System.
- It is in its midlife phase.
- It is the source of energy for life on Earth.
- All of the elements in the periodic table are produced within the nuclear fusion process of suns.

The sun should never be observed directly by telescope, or any device, excepting those that have been specifically designed to make it safe.

Mercury

Viewing Mercury is very dependent on where it is and where we are in our orbits around the Sun. We are always looking towards the Sun when we are observing Mercury so it needs to be in front of the Sun or to the side. This means we need to plan our observations.

Basic Facts

- Closest planet in the Sun at an average distant of 58million kms.
- It orbits the Sun every 88 Earth days but only rotates on its axis every 176 days.
- Smallest planet in the Solar System and only 38% of the weight of Earth.
- Named for the Roman Messenger God.

Venus

Like Mercury Venus orbits the Sun inside Earths' orbit and therefore requires planning on when and where you can make observations. Venus was once Earth-like and could have been able to sustain life. It had liquid water and a friendlier atmosphere than it now has. With being closer to the Sun it gradually heated up and consequently lost its water and the greenhouse gas atmosphere that evolved meant it could never return to its Earth-like days.

Probes have entered the atmosphere with progressive missions gleaming more and more data about what lays beneath the thick glowing cloud we see from Earth. Like Mars it was once believed to be a Earth-like world. A place that harboured life, but sadly, the reality that we now understand leaves us in no doubt life would have been fleeting, at best, on the surface of Venus.

Facts

- Second planet in the Solar System, orbiting at a distance of 108million kms, every 225 Earth days.
- It rotates every 117 Earth days and is the only planet in our Solar system to orbit clockwise.
- It is almost the same size as Earth at 12,104kms. Earth is 12,756kms.
- It is the brightest object in the night sky, after the Moon.
- Named for the Roman Goddess of Love and Beauty.

Mars

Mars is the 4th planet in the solar system and probably the one we show the most interest in. It is the last of the inner planets before we reach the asteroid belt and the gas giants.

Mars has been the subject of many sci-fi movies with the existence of Martians being a long-held fascination. We have made significant scientific advancements towards exploring Mars and it looks set to be the first other planet we set foot on. Like Venus it was Earth-like in its early days of evolution. Being that bit further from the Sun it cooled and without a protecting magnetic field, as on Earth, the ravages of solar winds striped away it's atmosphere. It had liquid water, and still has water, but now trapped, frozen, by the coldness of the planet.

All the ingredients, bar one, existed for the evolution of life on Mars; that one thing was stability. It is Earths billions of years of constant temperature range and environment, presence of oxygen, carbon and nitrogen with other life-giving elements that has made life possible here.

Facts

- Fourth planet in the Solar System at 228million kms from the Sun.
- It is the second smallest planet.
- It orbits the Sun every 687 days and it rotates on its axis every 24.6 hours, almost the same as Earths 23.9 hours.
- Named for the Roman God of War, due to its red colour resembling blood.

Asteroid Belt

Between the rocky terrestrial worlds of the solar system and the gas giants lays the asteroid belt. Whenever you dismantle something and put it back together you often have spare parts. Parts that don't seem to hinder the operation of the thing you fixed, just spare bits. You could consider the asteroid belt a bit like that. The leftover bits from the formation of the solar system. As the sun and planets sweep the region to create their mass the asteroid belt fell in that zone between joining the Sun or being in a stable orbit about it. Held in place by Jupiter's immense gravity it is now a kind of ticking time bomb of debris that could one day wreak havoc, and more so to life on Earth, than any other thing in the solar system.

The individual objects within the belt are too small to see from Earth, even with a telescope, so we rely on images captured by passing probes heading off to the outer reaches of our solar system if we want to know what it looks like.

Jupiter

This is the big daddy of our Solar System and plays an important role in the composition of the planets and other objects in orbit around the Sun. Without Jupiter the Sun could have swallowed up the Earth or let us drift to close for life to have formed. It also holds the asteroid belt in place, but conversely it can also cause asteroids to be kicked into the path of Earth.

It's 4 Galilean moons make it a good object to observe, along with the colourful bands that rage about its atmosphere.

Facts

- Fifth and largest planet in the Solar System with a massive radius of 69,911 kms.
- All the other planets could fit within Jupiter.
- It has an average distant of 778.5 million kms from the Sun with a 12-year orbit.
- It has the fastest spin of all the planets at just under 10 hours per Jupiter day.
- As the biggest planet it was named for the King of the Roman Gods.
- Jupiter has 80 known moons and the four Galilean moons are easily viewed by telescope.

An image I captured with my iPhone held over the eyepiece of my telescope

Saturn

Seeing Saturn through my telescope for the first time truly reignited my interest in Astronomy**.** Focusing on the rings and observing the detail that was visible has now driven me to see more.

Facts

- Sixth planet in the Solar System
- Named for the Roman God of Agriculture and Wealth, the father of Jupiter
- Average distant of 1.48billion kms from the Sun with a 29-year orbit.
- Radius of 58232km, 9 times wider than Earth
- Saturn has 82 moons, 53 confirmed and 29 to be confirmed.
    - Titan is the biggest moon and the size of the planet Mercury.
    - Enceladus is the most reflective body in the solar system.
- The space craft Cassini orbits Saturn and sends back data about the rings.

The Rings of Saturn

- There are many rings orbiting Saturn.
- They are ice particles of varying size from microscopic to hundreds of meters. They are constantly colliding so their structure is ever changing; like ice fields that float on Earths polar regions.
- The rings are 100,000 kms wide but mere meters thick.
- They are visible from Earth using a reasonable telescope.
- The rings illustrate how the Solar System was formed by the conservation of angular momentum. This is a scientific principle that governs the way the planets orbit the Sun, how the stars orbit the centre of the Milky Way and even how the galaxies orbit each other.

Uranus

Being so far away this is not the easiest of objects to observe. As the planets get further from the Sun not only does their reflected light diminish, they also appear smaller and with extremely long orbits they are only in the right place to observe for a short period of time.

Facts

- Seventh planet in the Solar System
- Its name is a reference to the Greek God of the sky.
- Average distant of 2.87 billion kms from the Sun with an orbit of 84 years.
- It has a radius of 25,362kms and a day lasts 17.5 hours.
- It rotates on an axis that is almost parallel with the plane of the Solar System.
- It was the first planet discovered by the aid of a telescope.

Neptune
Visible by telescope under the right conditions, Neptune offers astronomers the last object of significant size to observe before getting to Pluto.

Facts
- Eighth planet in the Solar System
- Average distant of 4.5 billion kms from Sun and takes 165 years to journey once around the Sun.
- Named for the Roman God of the Sea due to its blue colouration.
- It has a day that is 16 hours long, and being so far from the Sun it is the coolest planet. It also has the strongest winds in the Solar System.
- It has a radius of 24,600kms.

Pluto
Pluto is a dwarf planet in the Kuiper belt and is a faint object that also requires the observer to be in the right place at the right time. It was once known as a planet but lost that title as it didn't meet the criteria of planet status. There are many objects like Pluto orbiting the Sun in the outer reaches of the solar system. Probes have now made close contact with Pluto and the data returned tells us much about the formation of the planets and solar system.

Facts
- Largest object in the Kuiper belt.
- Average distant of 5.9 billion kms from Sun and takes a crazy 248 years to journey once around the Sun.
- Named for the Roman God of the underworld.
- It has a day that is 6.4 Earth days long.
- It has a radius of 1,188kms; about the same as our moon.

Kuiper Belt
Not dissimilar to the asteroid belt the Kuiper belt is a much larger ring of space remnants orbiting the Sun. It is beyond the orbit of Neptune and home to Pluto.

The Oort Cloud
This is a theoretical cloud of matter that orbits the Sun at an extremely long distance. It is not anything we will be able to observe but if it does exist it would be the last thing we would encounter within the bounds of our solar system.

Transients
There are always objects that are passing into view as they travel through the solar system. They include comets, like Halley's, which orbits the Sun every 75-76 years. It is next due in our night sky in 2062.

Shooting stars and satellites will be seen as you observe the stars and may even be captured in the images of astrophotography.

Summary

We learn more and more every moment about our neighbourhood and can apply that knowledge to understanding our own world. We can see how our planets relate to the Sun and from those observations we can deduce how other planets, orbiting other suns, may be able to sustain life.

We once thought of the planets as we do the stars; distant bodies that were more like Gods than planets. The remnants of past suns, matter that escaped the fate of being consumed by our Sun. A family of bodies now balanced in a dance around the Sun, the Sun as isolated from deep space as much as we are. We need each other, but given our tenuous existence, based on our observations, maybe we need the other planets more than they need us.

I look forward to improving my abilities in astrophotography so I can get my own images of the planets, make my own observations and give me the feeling of a Universe, not so out of reach.

When it comes to life, we are at this time alone in a lot of space. But with a few different circumstances in our solar system things could have been quite different. One or more of the other planets could have been our home, or we could have had near neighbours, but as it stands Earth is it for us. We can view the solar system as astronomers, journey through it as astronauts but must learn to live within it as humans.