

The background of the entire image is a deep blue and purple starry space. At the top left is a light blue planet with a ring system. To its right is a smaller, brown and white planet. Further right is a large, deep blue planet. In the middle left is a large planet with brown and white bands. To its right is a yellow planet with a ring system. Below these are several smaller planets: a grey one, a brown one, a blue and green one (Earth), and a reddish one. At the bottom is a large, bright yellow sun.

# Our Amazing Created Solar System

**Edited by Russell Grigg**

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# Foreword

How awe inspiring is the sight of the heavens on a dark night away from city lights! Of all the heavenly objects on display, those belonging to our own solar system are the brightest in the sky, from the moon, which dominates when visible, to the brilliance of Venus, Mars, Jupiter and Saturn. Turn even a modest telescope to the moon and the planets and you will be treated to a fascinating variety from the phases of Venus, the redness of Mars, the clearly visible Galilean moons orbiting Jupiter, and the stunning rings surrounding Saturn.

The more we learn about the system of planets, comets and asteroids that orbit our sun, the more it becomes evident, for those who will see, that there is a profound intellect behind the design of the solar system. The secularists have tried in vain to account for the existence of the solar system in naturalistic terms, but the observations stubbornly refuse to comply with such attempts.

This book provides compelling evidence confirming the Bible's account of God's creative activity on Day 4 of Creation Week which is an eye-witness account of

what actually happened when the sun, moon, and stars were created.

A prolific author in his own right, with many articles in *Creation* magazine over the years, Russell Grigg has edited this collection of articles from past issues of *Creation* and has brought them up to date with our rapidly expanding knowledge of the solar system.

You will be truly enriched by reading this book with its brilliant illustrations and lay-level explanations of the observations that experimental science has made. The evidence is overwhelming that the solar system has been created. As Sir Isaac Newton, perhaps the greatest scientist to have ever lived, observed: "This most beautiful system of the sun, planets, and comets could only proceed from the counsel and dominion of an intelligent Being."

Be inspired as you read and give God the glory!

A handwritten signature in black ink that reads "Mark Harwood". The signature is written in a cursive style with a long horizontal flourish extending to the right.

Mark Harwood, B.Sc., B.,E., Ph.D.: part-time scientist/  
speaker for *Creation Ministries International* (Australia).

# Introduction

## What is the solar system?

Our solar system consists principally of the star we call the sun; the four inner terrestrial (or rocky) planets Mercury, Venus, Earth, and Mars; the four outer giant gaseous planets Jupiter, Saturn, Uranus and Neptune; and many dwarf planets (as currently categorized) of which five are officially recognized: Pluto, Ceres, Haumea, Makemake, and Eris. The solar system also contains the moons of all these planets, plus numerous Trans-Neptunian objects (TNOs) that are sometimes called Kuiper Belt objects (KBOs), plus comets, asteroids, meteors and smaller bodies, all of which orbit the sun; plus dust, cosmic rays, and the solar wind.

The solar system's edge is where the solar wind drops off and interstellar radiation sharply increases. On 25 August 2021, the space probe *Voyager 1*, launched in 1977, crossed this boundary, 18.1 billion km from the sun, becoming the first man-made object to leave the heliosphere and enter interstellae space.

## Where did the solar system come from?

Either it formed all by itself as per the nebular hypothesis, as evolutionists claim, or it was created by God, as the Bible says. In this book we will tour the solar system and consider the evidence. Our purpose is two-fold: first, to provide accurate information about our solar system; second, to demonstrate how the record in Genesis of creation by God fits the data best.

Many of the planets and moons in the solar system appear to be young, and they also show evidence of design by an intelligent Creator. One chapter deals with the perennial question: "Did life come to Earth from outer space?"; another: "Did God create life on other planets?" These chapters detail the enormous problems involved in these ideas for evolutionists.

Facts and figures for the planets, supplied in each chapter, as well as being tabled in the Appendix, are based on the latest data supplied by NASA space probes, when this edition was published.

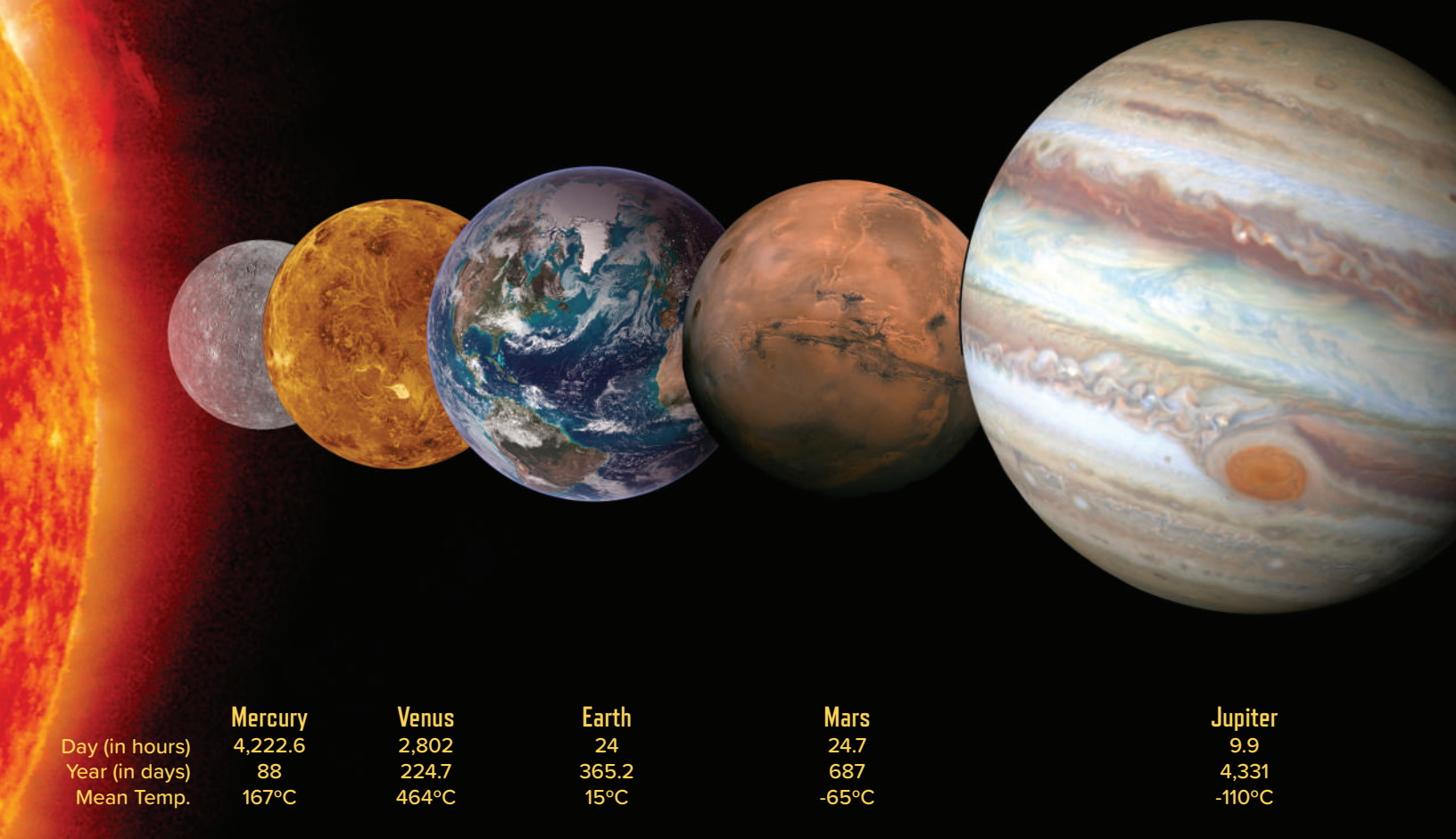


## Chapter 1

# Solar system origin: Nebular hypothesis

According to the eyewitness account in Genesis, God created the earth on Day 1 of Creation Week, and the sun and moon on Day 4, most likely along with the planets. However, evolutionists reject a Creator *a priori*, so they need to come up with another explanation. The leading candidate is called the *nebular hypothesis*. This proposes that the sun, the earth and the rest of the solar system formed from a *nebula*, or cloud of dust and gas that supposedly contracted or collapsed due to its own gravity.

Author: Jonathan Sarfati<sup>1</sup>



## Evolutionary problems

The best known pioneer of this was French atheistic mathematician Pierre-Simon Laplace (1749–1827).<sup>2</sup> The nebular hypothesis is now the most widely accepted model used to explain the formation of our solar system by the process of evolution. It was originally applied to our solar system only, but is now applied to the rest of the universe also.<sup>3</sup> Nevertheless, despite the dogmatic support given to this theory by evolutionary astronomers, it has a number of huge problems.

### Origin of stars

First of all, if the collapsing cloud theory can't even explain the sun alone, then it is doomed from the start. To form the sun, or any star, a cloud must be dense enough to collapse and compress the interior so that it becomes hot enough for nuclear fusion to start. But in a typical nebula, the outward gas pressure is far greater than the inward gravitation.

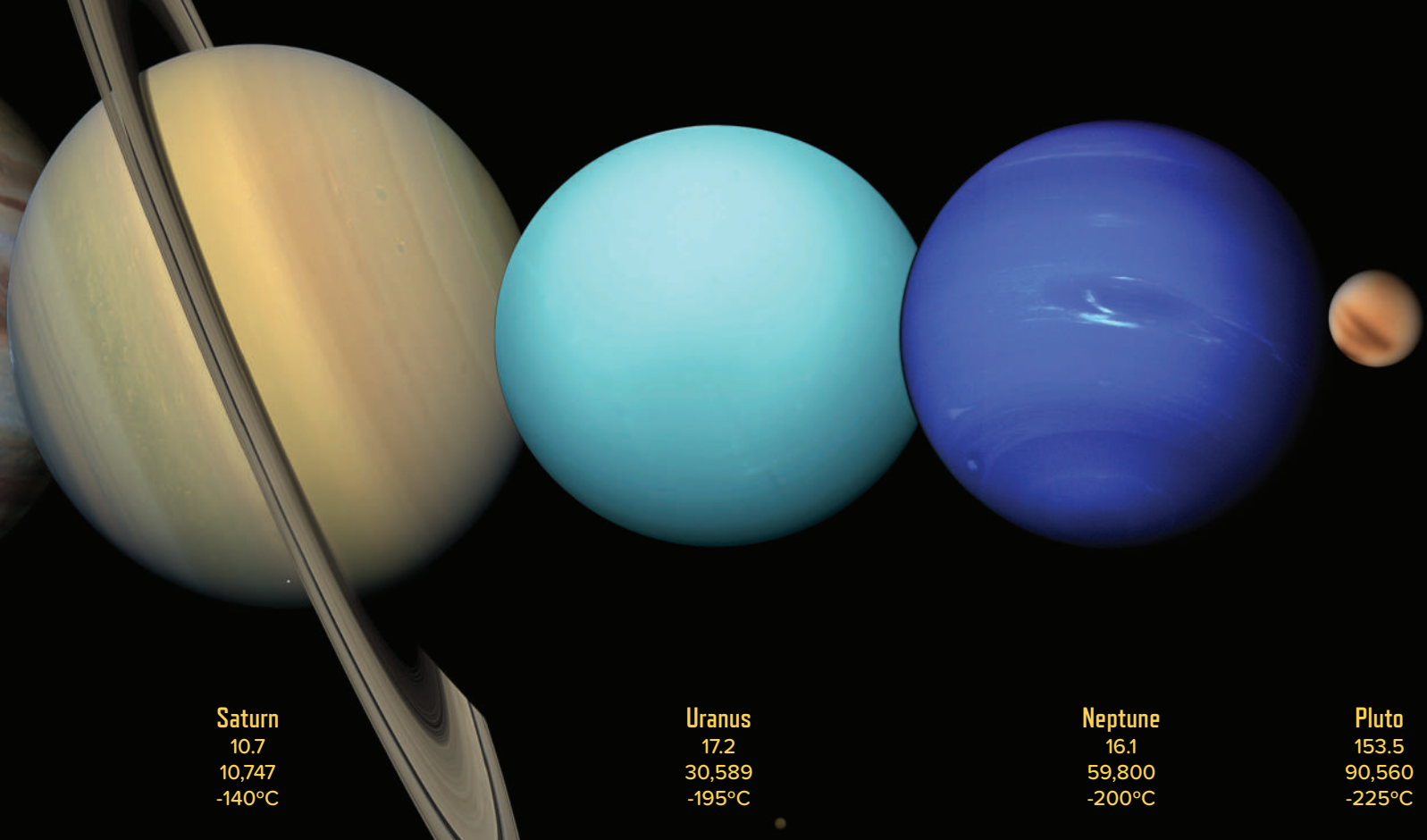
The British mathematician and astrophysicist James Jeans (1877–1946) calculated how massive a cloud must be so that gravity can overcome the tendency for gas to expand. The main points are: high density favours collapse, and high temperature favours expansion. The minimum mass he calculated relates to both of these, and is now called the *Jeans Mass* ( $M_J$ ).<sup>4</sup>

But according to the big bang theory, at the time the first stars were formed, the temperature was so high that the required Jeans Mass would be about 100,000 suns.<sup>5</sup> This is about the same mass as a globular cluster, i.e., no cloud less massive than this could have collapsed into a star, thus no star could have formed this way.<sup>6</sup>

All theories of star formation have problems.<sup>7</sup> Some include a shockwave from an exploding star, but this doesn't explain where *that* star came from. Ph.D. astrophysicist Jason Lisle points out another problem: "Even if we could compress the nebula sufficiently to the point that the force of gravity was strong enough to prevent the gas from expanding, other effects would kick in, thereby preventing the formation of a star. Clouds of gas always have a weak magnetic field, which would be concentrated if the cloud were compressed. This dramatically increases the field strength. The magnetic pressure would halt a shrinking cloud and drive it to re-expand. It's a bit like trying to push the like poles of two magnets together."<sup>8</sup>

Neil deGrasse Tyson, evolutionary astrophysicist and fanatical atheist, admits:

"Not all gas clouds in the Milky Way can form stars at all times. More often than not, the cloud is confused



about what to do next. Actually, astrophysicists are the confused ones here. We know the cloud wants to collapse under its own weight to make one or more stars. But rotation as well as turbulent motion

within the cloud work against that fate. So, too, does the ordinary gas pressure you learned about in high-school chemistry class. Galactic magnetic fields also fight collapse: they penetrate the cloud and latch onto any free-roaming charged particles contained therein, restricting the ways in which the cloud will respond to its self-gravity. The scary part is that if none of us knew in advance that stars exist, front line research would offer plenty of convincing reasons for why stars could never form.”<sup>9</sup>

### Origin of planets

So, stars alone can’t be explained by such naturalistic conjectures. However, the planets pose even more difficulties for evolutionists to explain, with several additional problems, as outlined below.

### Angular momentum

One major problem can be shown by accomplished skaters spinning on ice. As skaters pull their arms in, they spin faster. This effect is due to what physicists call the *Law of Conservation of Angular Momentum*.



Skater © iStockphoto/Technet and Nebula from NASA, JPL, Caltech, P.S. Teixeira (CfA)

Angular momentum = mass  $\times$  velocity  $\times$  distance from the centre of mass, and always stays constant in an isolated system. When the skaters pull their arms in, the distance from the centre decreases, so they spin faster or else angular momentum would not stay constant.

In the formation of our sun from a nebula in space, the same effect would have occurred as the gases allegedly contracted into the centre to form the sun. This would have caused the sun to spin very rapidly. But our sun spins very slowly, while the planets move very rapidly around the sun. In fact, although the sun has over 99% of the mass of the solar system, it has only 2% of the angular momentum. This pattern is directly *opposite* to the pattern predicted for the nebular hypothesis.

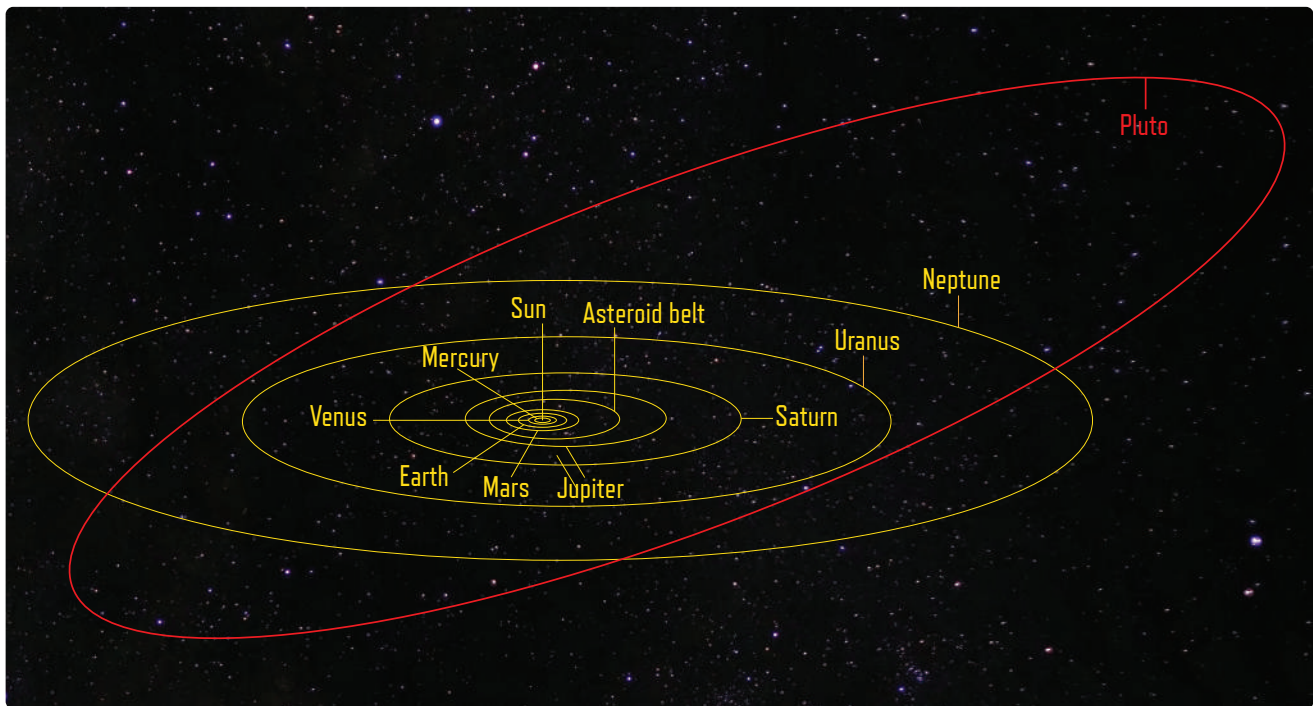
Evolutionists have tried hard to solve this problem. In a leading textbook, well-known solar system scientist Dr Stuart Ross Taylor notes “angular momentum must be transferred outwards ... and a wide variety of physical processes have been suggested.” He then gives details of some current favourites, including ‘gravitational torque’ in an asymmetrical disk,<sup>10</sup> before admitting “a predictive theory of nebular evolution is still lacking.”<sup>11</sup>

### Sun’s axial tilt

If the sun and the planets were formed by a collapsing nebula, then the sun should be spinning in the same plane as the planets. However, its axis is tilted 7.25° away from the ecliptic, which is defined by Earth’s orbit. A better comparison would be Jupiter’s orbital plane, since it has most of the planetary mass and angular momentum of the solar system. Jupiter’s orbital inclination is 1.308° from the ecliptic, so this still leaves almost 6° difference. The anomalous tilts of the planets are usually explained by invoking collisions, but this would not apply to the sun.

### Rocky planets

Evolutionary astronomers believe that the planets arose from collisions of dust particles which heated and stuck together to form larger accretions of welded rock. These blobs further accreted to form larger and larger blobs, at a certain stage melting into spheres, and thus the inner planets were formed: Mercury, Venus, Earth and Mars. However, research has shown that the rocks would not stick, but most likely “simply zoom past each other or collide and recoil like snooker balls.”<sup>12</sup>



The **plane of the earth’s orbit around the sun is called the plane of the ecliptic (or just the ecliptic)**. The sun’s apparent path through the sky lies in this plane. The other seven planets orbit the sun in nearly the same plane. However, Pluto orbits the sun with an inclination to the ecliptic of 17°.

## Gas giants

According to evolutionary models, the huge planets Jupiter and Saturn could have formed only if they were far enough away from the sun so that ice could condense. This would provide additional mass to draw in gas from the nebula, and the ice would help the rocks to bond. Jupiter's core would need to be about 20 Earth masses to do this, but models of Jupiter indicate that its core is actually only about 5 Earth masses at the most, if it even exists.<sup>13</sup>

And simulations indicate that the solar nebula would have dissipated before the core had a chance to grow big enough. Furthermore, the friction of the gas and dust in the nebular disk would slow the planets' orbits so they would spiral into the sun. When it comes to the 'Ice Giants', Uranus and Neptune (Chapters 12 and 13), the problems are even more acute, as one evolutionary astronomer admitted:

"Pssst ... astronomers who model the formation of the solar system have kept a dirty little secret: Uranus and Neptune don't exist. Or at least computer simulations have never explained how planets as big as the two gas giants could form so far from the sun. Bodies orbited so slowly in the outer parts of the solar system that the slow process of gravitational accretion would need more time than the age of the solar system to form bodies with 14.5 and 17.1 times the mass of Earth."<sup>14</sup>

To solve the problem of insufficient matter in the outer reaches of the solar system, some evolutionists have proposed that the gas giants formed closer to the sun and migrated outwards. This has been called the Nice model, after the city in France where the theory's developed at the observatory there.

However, the Nice model involves unrealistic fine tuning. For example, to form Uranus and Neptune, the model requires limiting the disk of nebular material to only 30 Astronomical Units in diameter. This makes it difficult for this model to account for the many even more distant objects in the solar system, such as Pluto (39 AU).

Furthermore, giant planets around other stars also confound the nebular hypothesis (see Chapter 16). Here, the problem is that they are too close to their star so that ice would never have condensed, as per the standard model. So evolutionists have proposed that they formed further out and migrated inwards. But

then the problem is halting this migration so they don't fall into their star in a 'death spiral'.<sup>15</sup>

## Retrograde motion

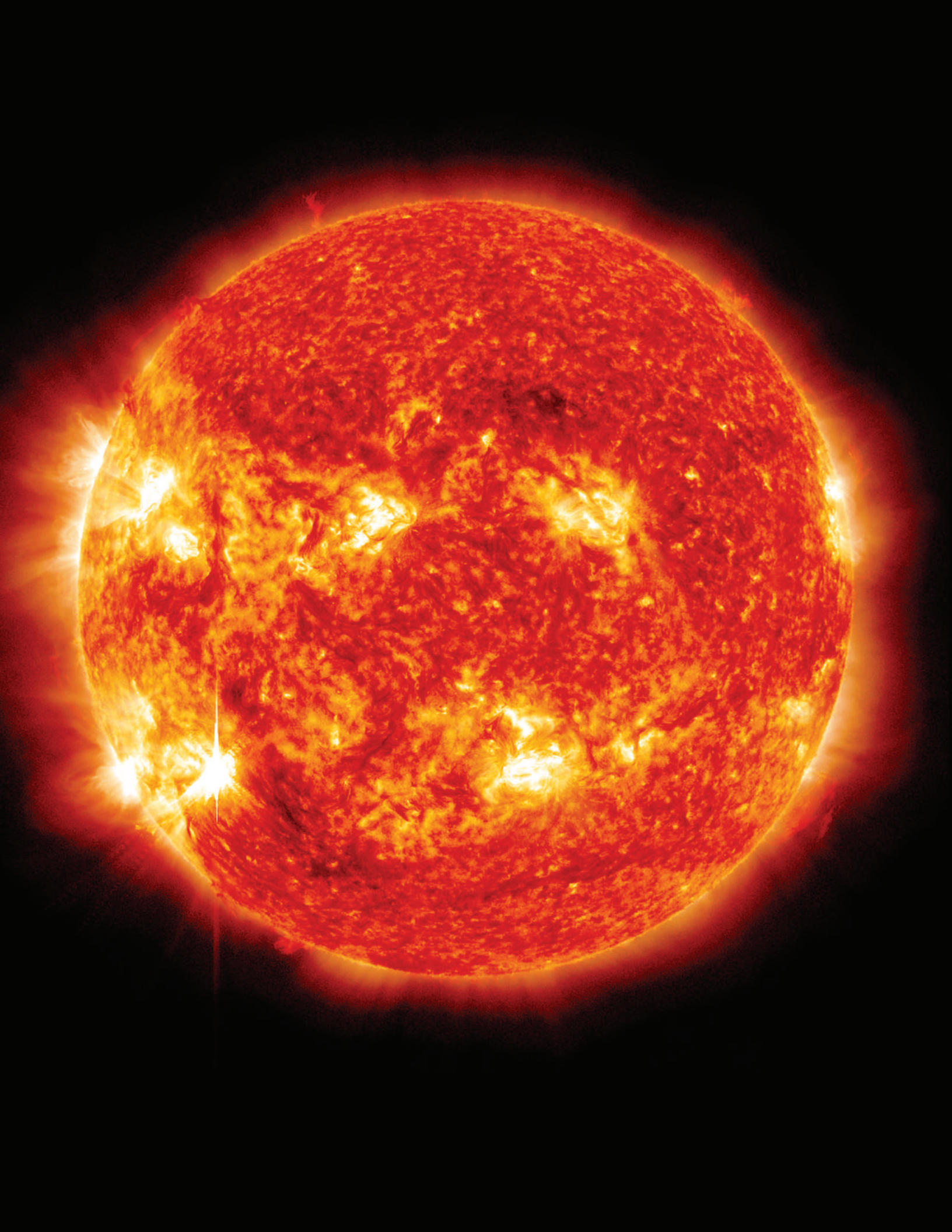
The nebular hypothesis predicts that as the nebula spiralled inwards, all the resulting planets and comets would rotate and orbit in the same direction (*prograde*). But Venus rotates in the opposite direction, called *retrograde* (see also Chapter 4). Furthermore, a comet and several exoplanets have been discovered with retrograde orbits (see Chapters 15 & 16).

## Conclusion

Although the nebular hypothesis is accepted uncritically by many evolutionists, there are severe problems with forming both the sun and the planets from a collapsing cloud. The best explanation is still, "By the word of the LORD the heavens were made, and by the breath of his mouth all their host" (Psalm 33:6).

## References and Notes

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2. Laplace, P., *Exposition du Système du Monde (Exposition of the System of the World)*, 1796.
3. The modern variant that is most accepted is the Solar Nebular Disk Model (SNDM), "universetoday.com."
4. Jeans Mass ( $M_J$ ) =  $K\rho^{-1/2}T^{3/2}$ , where  $K$  is a constant,  $\rho$  is the density, and  $T$  is the temperature. Alternatively, this can be expressed as  $M_J \approx 45M_\odot n^{-1/2}T^{3/2}$ , where  $M_\odot$  is the solar mass,  $n$  is the density of atoms per  $\text{cm}^3$ , and  $T$  is the temperature in Kelvins.
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## Chapter 2

# The Sun: our special star

The sun—this hot, bright ball of plasma—dominates the daytime sky, and is by far the most massive object in our solar system. Over 1 million Earths would fit inside the sun. It is exactly the right distance from Earth to provide the heat and light that our trees and plants need. It also evaporates water from our oceans, lakes, and rivers to form the clouds that provide the rain that sustains our crops and gives us fresh water to drink. For us, it is certainly no ordinary star.

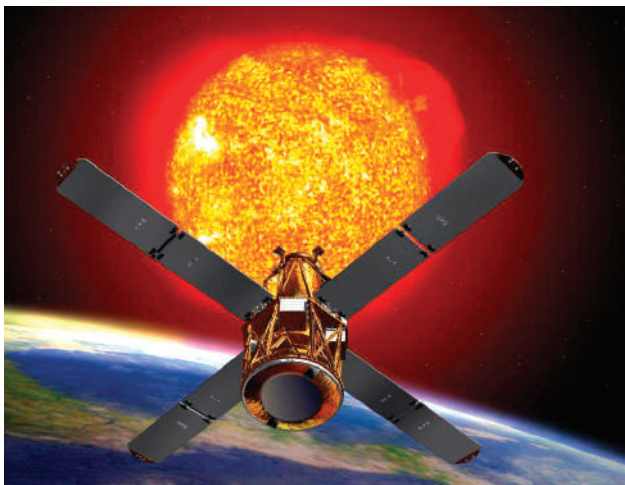
**Author: Jonathan Sarfati<sup>1</sup>**

### The sun's origin

According to God's Word, the Bible, the sun did not always light the earth. God didn't make it until Day 4 of Creation Week, while the earth was created on Day 1. This refutes ideas like 'God used evolution' and 'God created over billions of years', because they all assert that the sun arose before the earth.<sup>2</sup> For the first three days of its existence, the earth was lit by the light which God created on Day 1 (Genesis 1:3),<sup>3</sup> while the day/night cycle was caused by the earth's rotation relative to this directional light source. Then according to Genesis 1:14–19.

"And God said, 'Let there be lights in the expanse of the heavens to separate the day from the night. And let them be for signs and for seasons, and for days and years, and let them be lights in the expanse of the heavens to give light upon the earth.' And it was so. And God made the two great lights—the greater light to rule the day and the lesser light to rule the night—and the stars. And God set them in the expanse of the heavens to give light upon the earth, to rule over the day and over the night; and to separate the light from the darkness. And God saw that it was good. And there was evening and there was morning, the fourth day."

In the New Jerusalem of Revelation 21:23, there will also be no need for the sun, because God will provide the light once again. But meanwhile, we can appreciate the wonder of the star God has provided for us.



**An artistic impression of the NASA Solar Dynamics Observatory in orbit around the earth. The purpose is to study violent sun activity that can disrupt communications, knock out power stations, and disable satellites on the earth.**

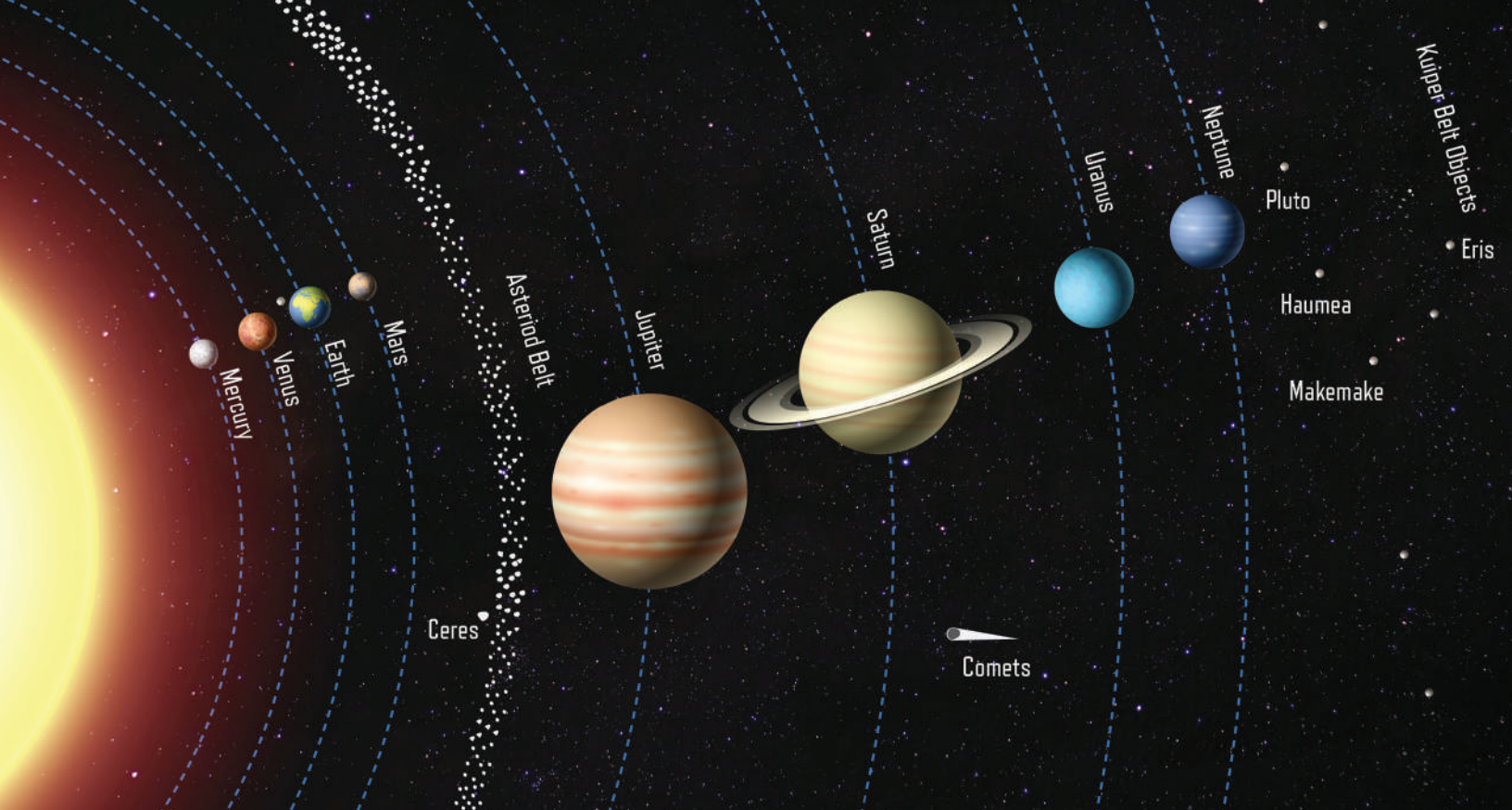
### How is the sun special?

Anti-theists are fond of dismissing the sun as a run-of-the-mill star in a not-too-special place in a spiral arm of the Milky Way Galaxy. It is true that many stars are far bigger and brighter than the sun. However, saying that bigger stars are more important is as illogical as saying that a 7-foot man is more important than a 5-foot woman.

Recent research has called the sun 'exceptional'. Our sun is among the top 10% (by mass) of stars in its neighbourhood (most stars are red dwarfs invisible to the naked eye). It is actually an ideal size to support life on Earth. There would be little point in having a red supergiant star like Betelgeuse, because it is so huge that it would engulf all the inner planets! Nor would we want a star like the blue-white supergiant Rigel, about 120,000 times as bright as the sun, and emitting too much high-frequency radiation. Conversely, a star much smaller than our sun would be too faint to support life, unless the planet was so close to the star that there would be dangerous gravitational tides.

The sun is in an ideal environment. It is a single star—most stars exist in multiple-star systems. A planet in such a system would suffer extreme temperature variations. The sun's position in our spiral Milky Way Galaxy is also ideal. Its orbit (within this galaxy) is fairly circular, meaning that it won't go too near the inner galaxy where supernovae, extremely energetic star explosions, are more common. It also orbits almost parallel to the plane of our galaxy—otherwise, crossing this plane would be very disruptive. Furthermore, the sun is at an ideal distance from the centre of our galaxy, called the *co-rotation radius*. Only here does a star's orbital speed match that of the spiral arms—otherwise the sun could cross an arm and be exposed to supernovae.<sup>4</sup>

Our sun is a powerful object, often throwing out flares, and every few years (usually around sunspot maximum—see below Sunspots, Galileo and heliocentrism) more violent eruptions called coronal mass ejections. These cause huge electric currents in Earth's upper atmosphere and disrupt power grids and satellites. In 1989, one disabled a power grid in northern Quebec. Nevertheless the sun is an 'exceptionally stable' star. Three astronomers recently



**The sun and everything that orbits it make up the solar system, including the eight planets, and five named dwarf planets. Distances are not to scale; Asteroid and Keiper Belts are mostly empty space.**

studied single stars of the same size, brightness and composition as the sun. Almost all of them erupt about once a century in *superflares* up to 100 million times more powerful than the one that blacked out Quebec. If the sun were to erupt in such a superflare, it would destroy Earth’s ozone layer, with catastrophic results for life.

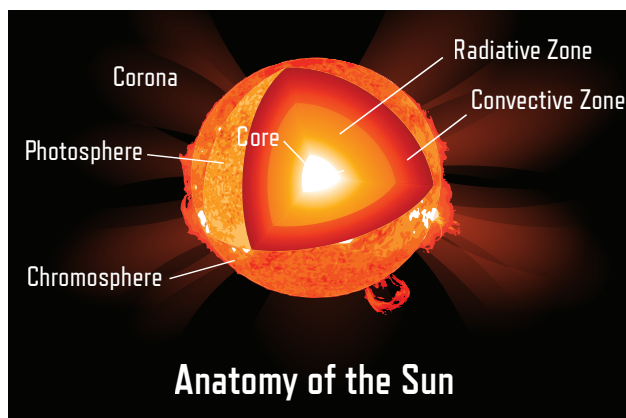
### How does the sun shine?

In 1939, Hans Bethe proposed that the sun and other stars are powered by *nuclear fusion*—this theory earned him the 1967 Nobel Prize for Physics.<sup>5</sup> In fusion, extremely fast-moving hydrogen nuclei join to form helium—this requires temperatures of millions of

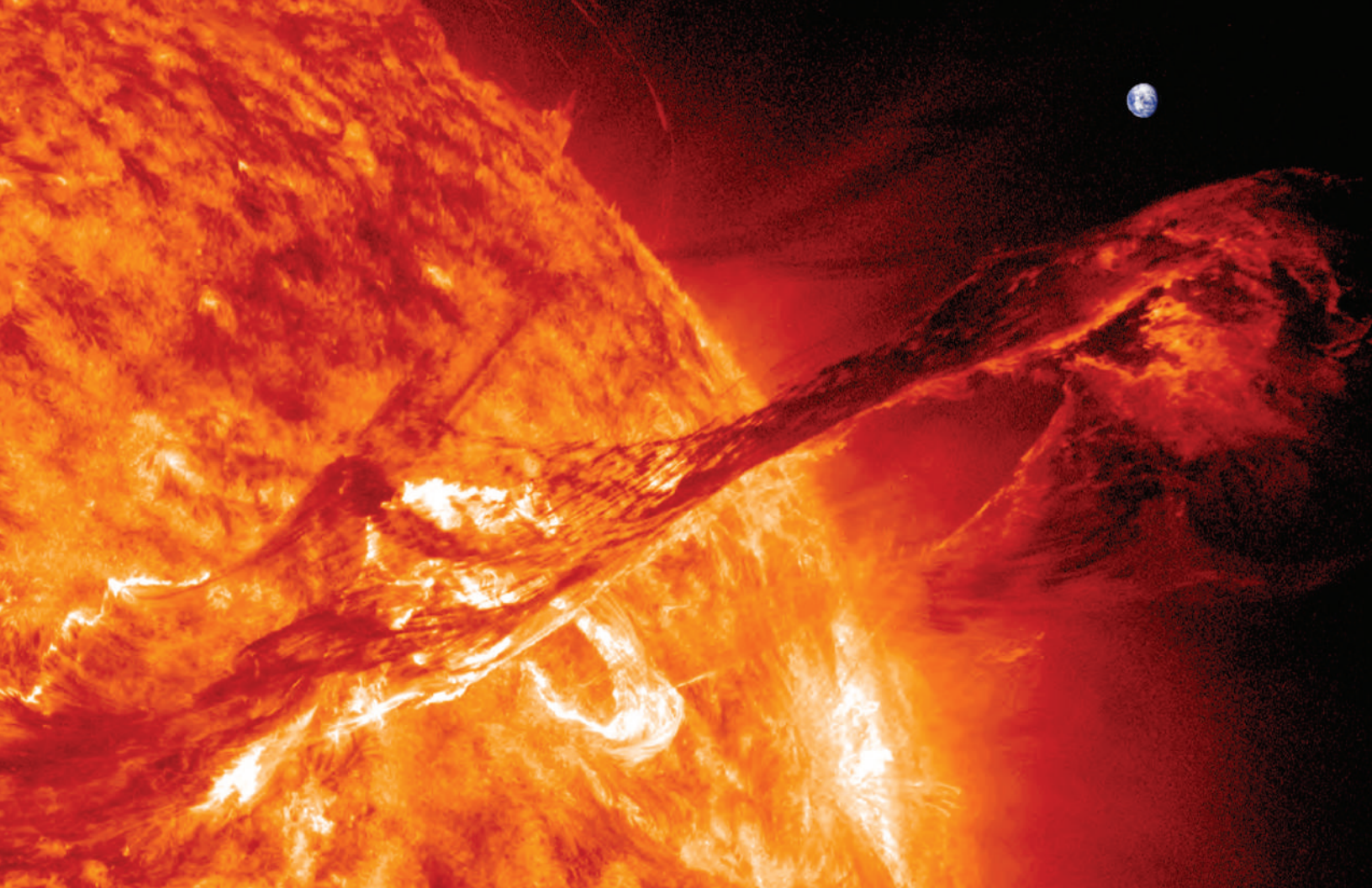
degrees. Some mass is lost and converted into a huge amount of energy as per Einstein’s famous formula  $E = mc^2$ .<sup>6</sup> Thus the sun is like a gigantic hydrogen bomb.<sup>7</sup> Four million tonnes of matter are converted into energy every second—this is huge, but negligible compared to the sun’s enormous total mass of  $1.99 \times 10^{30}$  (1,990,000,000,000,000,000,000,000,000) kg.

Fusion in stars generally combines four hydrogen nuclei into one helium nucleus.<sup>8</sup> This actually provides an upper limit to the sun’s age (see below Our steady sun: a problem for billions of years). Fusion also produces a vast number of extremely low-mass particles called neutrinos that travel almost as fast as light.<sup>9</sup> These ghostly particles can pass untouched through matter light-years in thickness. They are now known to switch between ‘flavours’ (types).<sup>10</sup>

“Concerning the alleged long age of the sun, a leading solar astronomer once commented: ‘I suspect ... that the Sun is 4.5 billion years old. However, given some new and unexpected results to the contrary, and some time for some frantic recalculations and theoretical readjustment, I suspect that we could live with Bishop Ussher’s value for the age of the Earth and Sun [about 6,000 years]. I don’t think there is much in the way of observational evidence to conflict with that.’”<sup>11</sup>



Credit: Kelvinsong/wikipedia



**Earth is dwarfed here in approximate relative size to the sun. The length of this eruption extends about 250,000 km out from the sun. Earth is about 12,750 km in diameter, so the eruption is about 20 times the diameter of our planet.**

### **Our steady sun: a problem for billions of years**

All living things on the earth ultimately obtain their energy from the sun, as do the wind and water cycles. And nuclear fusion reactions power the sun. In theory, as four hydrogen nuclei fuse to form one helium nucleus, they would take less room and the sun's core should shrink. This would make further fusion reactions occur more readily. Therefore, the sun should shine more brightly as it ages.

But this means that if billions of years were true, the sun would have been much fainter in the past. However, there is no evidence that the sun was fainter at any time in the earth's history. Astronomers call this the 'faint young sun paradox', but it is no paradox at all if the sun is only as old as the Bible says—about 6,000 years.<sup>12</sup>

Evolutionists and long-agers believe that life appeared on the earth about 3.8 billion years ago. But if that timescale were true, the sun would be

25% brighter today than it was back then. This implies that back then (with a cooler sun) the earth would have been frozen at an average temperature of  $-3^{\circ}$  C. However, most palaeontologists believe that, if anything, the earth was warmer in the past.<sup>13</sup> The only way around this is for them to make arbitrary and unrealistic assumptions of a far greater greenhouse effect at that time than exists today,<sup>17</sup> with about 1,000 times more CO<sub>2</sub> in the atmosphere than there is today.<sup>14</sup>

However, the scientific evidence is consistent with the sun having the age that we would expect from reading of the Bible. In 6,000 years or so, there would have been no significant increase in energy output from the sun. It is a problem only for old-age ideas.

### **Sunspots, Galileo and heliocentrism**

Sunspots look like dark patches on the sun. They can be seen to move, and analyzing them has shown that different parts of the sun rotate at different rates, unlike

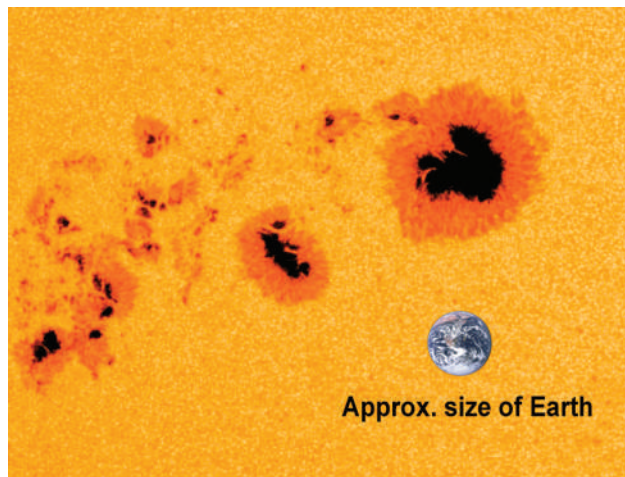
a solid body (see diagram). Sunspots come and go in cycles of about 11.2 years. Galileo Galilei (1564–1642) systematically studied sunspots in 1611 and realized that they upset the prevailing Aristotelian/Ptolemaic view that the heavenly bodies were ‘perfect spheres’.<sup>15</sup>

Today we realize that sunspots are vortices of gas on the sun’s surface, and appear dark because they are several thousand degrees cooler than the rest of the sun. Analysis of their light spectra shows that the sun’s magnetic field is especially strong in sunspots.<sup>16</sup> Galileo supported the theory of Nicolaus Copernicus (1473–1543) that the earth and other planets move around the sun. Anti-Christian propagandists make much of the conflict between Galileo and the Church, or ‘science vs religion’. But Galileo thought that the much simpler mathematics of the Copernican system compared to the unwieldy Ptolemaic system would best reflect God’s mathematical simplicity (i.e., God is not composed of parts but is Triune). The *Encyclopædia Britannica* identifies Galileo’s main opponents as the scientific establishment:

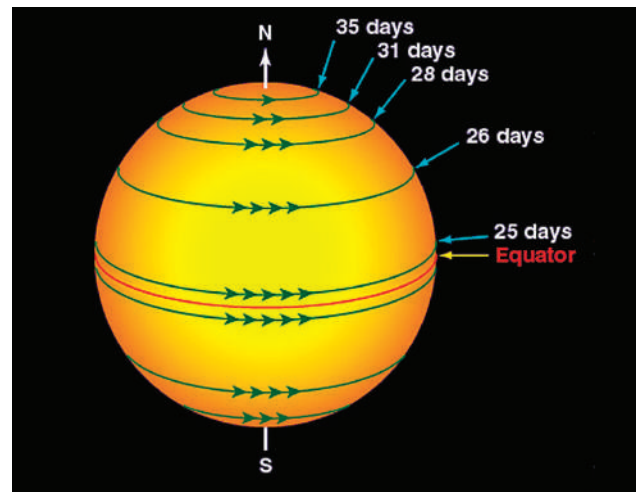
“The Aristotelian professors, seeing their vested interests threatened, united against him. They strove to cast suspicion on him in the eyes of the ecclesiastical authorities because of [alleged] contradictions between the Copernican theory and Scriptures.”<sup>17</sup>

Giorgio de Santillana (1902–1974), Professor of the History of Science at Massachusetts Institute of Technology, pointed out that contrary to myth:

“It has been known for a long time that a major part of the church’s intellectuals were on the side



Sunspots (shown) can be as large as the earth.



**Because the sun is made of plasma (ionized gas), it is fluid and so is able to rotate faster at its equator than at its poles. The sun’s equator takes about 25 days and the poles about 35 days to make one full sidereal rotation (i.e., in relation to the other stars), so the sun is continually changing shape.**

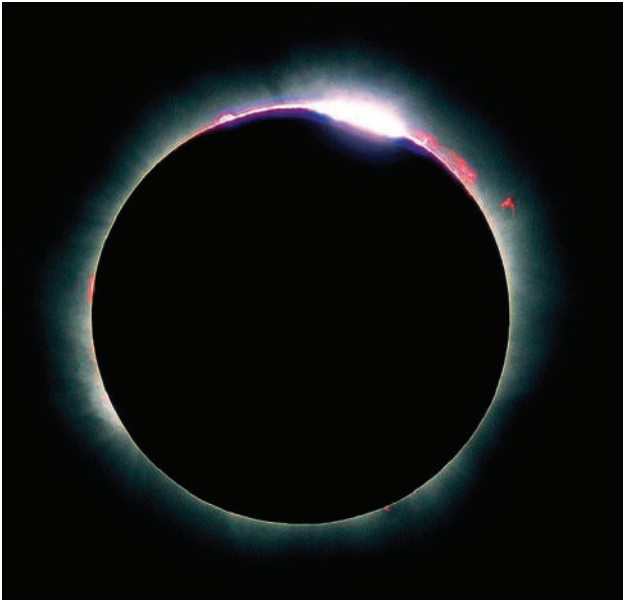
of Galileo, while the clearest opposition to him came from secular ideas.”<sup>18</sup>

Both sides should have realized that all movement must be described *in relation to something else*—a *reference frame*—and from a descriptive point of view, *all reference frames are equally valid*. The Bible writers used the *earth* as a convenient reference frame, as do modern astronomers talking about ‘sunset’; speed limit signs also depend on the earth as a reference frame. Using the sun (or the centre of mass of the solar system) is the most convenient for discussing planetary motions.<sup>19,20</sup>

## Eclipse!

A *solar eclipse* occurs when the moon passes between the sun and the earth so that the sun is totally or partially obscured. This happens during a new moon, when the sun and moon are in conjunction as seen from the earth. A total solar eclipse is a spectacular phenomenon, but **should never be viewed without special equipment to prevent eye damage**.

A total eclipse is possible because the moon is almost exactly the same angular size (half a degree) in the sky as the sun—it is both 400 times smaller and 400 times closer than the sun. This looks very much like design. The moon is gradually receding from the earth at 4 cm (1½ inches) per year. If this had really been going on for billions of years, and mankind had been

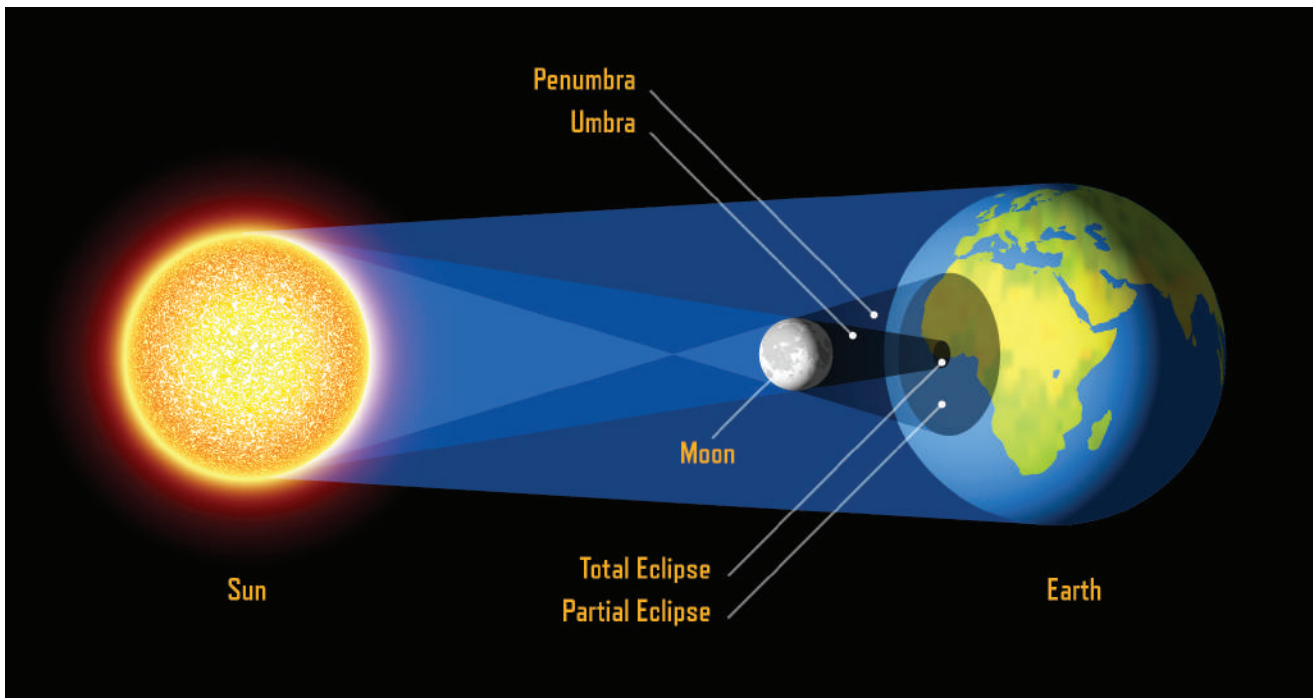


For a few seconds near the beginning and again at the end of a total solar eclipse the sun shines through valleys in the moon's mountainous surface causing beads of light to be seen; they are named after English astronomer Francis Baily (1774–1884) who first deduced what caused them. When just one Baily's bead is left or appears, it and the corona look like a diamond ring. This artist's impression combines these effects.

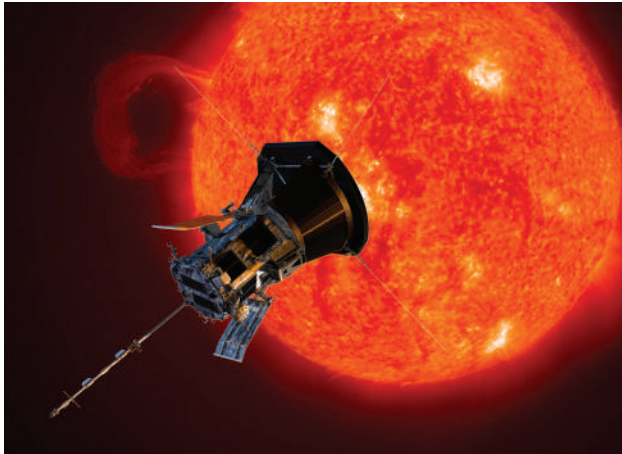
around for a tiny fraction of that time, the chance of mankind living at a time so they could observe this precise size matchup would be remote. (Actually, this recession puts an upper limit on the age of the earth/moon system at far less than the assumed 4.5 billion years—see Chapter 8).

Creationist astronomer Prof. Danny Faulkner<sup>21</sup> has shown that solar eclipses (as seen from the earth) are unique in the solar system—no other planet/moon combination comes close.<sup>22</sup>

During a total eclipse, the sun's outer atmosphere, the *corona*, is visible. This comprises extremely thin ionised gas, which is extremely hot. At 2 million °C, it is about 350 times hotter than the sun's surface. This has been a mystery, because heat normally flows from hot objects to cooler ones. One promising theory (which still needs work) involves the sun's strong magnetic field—reconnection of magnetic flux lines could release large amounts of energy into the corona.<sup>23,24</sup> This could have applications in fusion power research. Another theory involves magnetic fields 'whipping' coronal gas back and forth.<sup>25</sup>

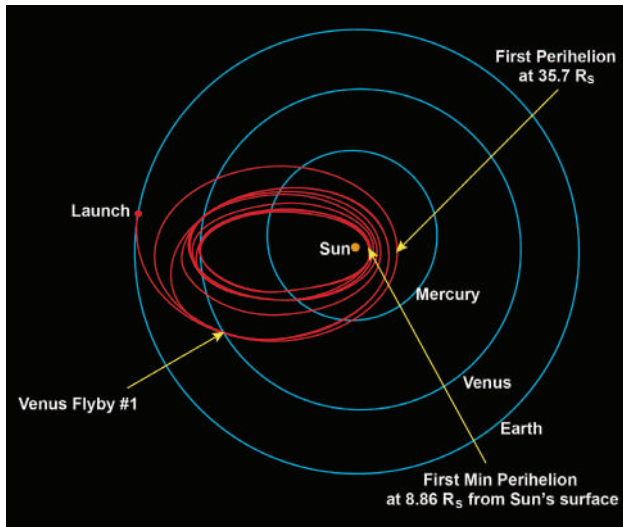


The region of complete shadow on Earth during a solar eclipse is called the moon's 'umbra' (from Latin for 'shadow'); observers within this area see a total eclipse of the sun. The region of partial shadow is called the penumbra (from Latin *paene* for 'almost' or 'nearly'); observers here see a partial eclipse. The earth's surface outside the penumbra is fully lit by the sun, so no eclipse is seen here.



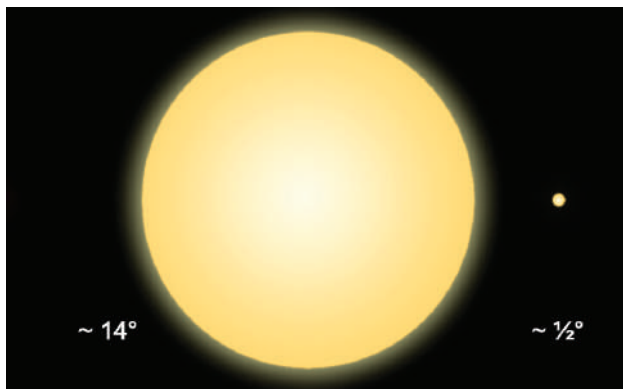
Credit: NASA/John Hopkins APL/Steve Gribben

**An artist's concept of the Parker Solar Probe observing the sun. The spacecraft flies more than seven times closer to the sun than any spacecraft before it.**



Credit: NASA/JHU/APL

**The Parker Solar Probe is orbiting the sun 24 times, seven of which involve flybys of Venus so as to gradually shrink the craft's orbit around the sun.  $R_s$  = sun's radius.**



Credit: Wikimedia Commons

**The sun's apparent size as the Parker Solar Probe sees it compared to how we see it from Earth.**

### **Parker Solar Probe to contact the sun**

On 12 August 2018, NASA launched a spacecraft called the Parker Solar Probe<sup>26</sup> to fly directly into the sun's atmosphere, called the corona. The purpose is to determine why the corona is several million degrees hotter than the sun's surface, and why it produces the solar wind, solar flares, and coronal mass ejections.

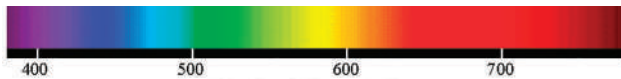
The probe is now in a Venus-sun elliptical orbit, which it will fly some 24 times, using gravity from flybys of Venus on seven of these orbits to slow the craft and remove the inherited Earth's angular momentum from its orbit. The Venus-sun orbital periods are decreasing from the 150 days it took for the first flyby, to 88 days it will take for the seventh. So this Venus-sun orbit is gradually shrinking. On its final orbit in 2024, at perihelion (the point nearest the sun) the probe will be about 6.1 million km (3.8 million miles) from the sun's surface.

All of this is a great example of 'real' or operational science—trying to find out more about the makeup and operation of the universe we live in. This is far removed from speculations about how it all is supposed to have come into being.

Such experimental science is firmly based on the confidence and knowledge that the universe operates by unchanging physical laws. These laws permit NASA's scientists to power, guide and control its solar probe, totally confident in the results of their calculations.



**NASA artist's impression of the Parker Solar Probe flying past Venus. The white heat shield is to protect the craft's instruments when the craft approaches the sun. The two extended solar panels provide power for the craft in orbit.**



Visible light spectrum; the wavelength is in nanometres (i.e., billionths of a metre).

### What colour is the sun?

If you ask people this question, most will say ‘yellow’. But this is not correct. If you shine yellow light on a white surface or through mist, it will appear yellow. Yet during the daylight, white objects look white, and fluffy clouds in a blue sky look white as well. This means that white light must be shining on them.

Thus, in reality, the sun is *white*. However, the sun is actually all colours mixed together, which we see as white, but which we can also see separated in a rainbow. The colours in a rainbow from outer (longest wavelength) to inner (shortest wavelength) are red, orange, yellow, green, blue, indigo, violet. When the sun is low in the sky, at sunrise or sunset, it may appear red, orange or yellow, because its other (shorter wavelength) colours are scattered by the earth’s

atmosphere and only the red, orange, or yellow get through the atmosphere for us to see.

So why are most of the images of the sun in this book red? This is an artefact of the imaging process. Most have been taken by extreme ultraviolet (EUV) imaging telescopes aboard spacecraft such as the Solar and Heliospheric Observatory (SOHO) of NASA and the European Space Agency. The EUV images come from the sun’s chromosphere, which is a layer of the sun sandwiched between the sun’s visible surface called the photosphere, and its atmosphere called the corona. Since UV light is invisible we need a false colour to see the features.

In the chromosphere, the temperature rises from 6000° C to about 30,000° C. At this higher temperature, hydrogen emits light that gives off a deep-red colour (called H-alpha emission). This is what gives the chromosphere its name (colour-sphere). When the sun is viewed through EUV filters that isolate the H-alpha emission, a wealth of new features can be seen, such as flares and coronal mass ejections.

## Sun Facts

Mean distance from Earth	150 million km or 93 million miles, More precisely 149,597,871,700 metres = 1 Astronomical Unit (AU) (= 8.317 light minutes, = 499 light seconds) As defined by the International Astronomical Union in 2012
Mean radius	695,700 km or 432,290 miles (109.2 × Earth)
Mass	$1,988,500 \times 10^{24}$ kg (333,000 × Earth)
Volume	$1,412,000 \times 10^{12}$ km <sup>3</sup> (1,304,000 × Earth)
Mean density	1,408 kg/m <sup>3</sup> (25.5% Earth)
Surface gravity	274 m/s <sup>2</sup> (28 × Earth)
Escape velocity	617.6 km/s or 383.76 miles/sec (55.2 × Earth)
Sidereal rotation period	~25 Earth days at equator; ~35 Earth days at poles
Power output (luminosity)	$382.8 \times 10^{24}$ J/s
Mass conversion rate	4,260 million kg/s
Temperature	~15 million °C core; ~5,500° C surface; ~2,000,000° C corona
Photosphere composition	H <sub>2</sub> 90.965%, He 8.889%, traces C, Ne, N, Fe, Mg, Si, S

Source: Sun Fact Sheet, NASA, updated 17 November 2022.

## References and Notes

1. This chapter adapted and updated from Sarfati, J., *Creation* **22**(1): 27–31, 1999; creation.com/sun.
2. Many Christians who compromise with billions of years assert that the sun and other heavenly bodies were not really ‘made’ on the fourth ‘day’ (millions of years long). Rather, they ‘appeared’ to a hypothetical observer on Earth when a dense cloud layer dissipated after millions of years. But this (mis)interpretation is not allowed by the Hebrew words used. The word *‘asah* means ‘make’ throughout Genesis 1, and is sometimes used interchangeably with ‘create’ (*bara’*), e.g., in Genesis 1:26–27. It is pure desperation to apply a different meaning to the same word in the same grammatical construction in the same passage, just to fit in with atheistic evolutionary ideas like the big bang. If God had *meant* ‘appeared’, then He presumably would have used the Hebrew word for appear (*ra’ah*), as when the dry land ‘appeared’ as the waters gathered in one place on Day 3 (Genesis 1:9). This is supported by Hebrew scholars who have translated the Bible into English. Over 20 major translations were checked, and all clearly teach that the sun, moon and stars were *made* on the fourth day.
3. See Grigg, R., Light, life and the glory of God, *Creation* **24**(1): 38–39, December 2001; creation.com/light and the related article “What does ‘God is light’ mean?” creation.com/bible-contradiction-claims#light, 2 June 2012.
4. Chown, M., What a star! *New Scientist* **162**(2192):17, 26 June 1999.
5. Bethe, Hans Albrecht, *The New Encyclopædia Britannica* **2**:173, 15<sup>th</sup> Ed. 1992.
6. Four hydrogen atoms (mass = 1.008) convert to helium (mass 4.0039) losing 0.0281 atomic mass units (1 AMU =  $1.66 \times 10^{-27}$  kg), releasing  $4.2 \times 10^{-12}$  joules of energy.
7. Man-made hydrogen bombs use the heavy hydrogen isotopes deuterium and tritium, plus some lithium. The sun uses ordinary hydrogen, which is much harder to fuse, but Bethe calculated that carbon-12 nuclei in the sun could catalyze the reaction.
8. The net fusion reaction is  $4 \text{ }^1\text{H} \rightarrow \text{}^4\text{He} + 2 \text{e}^+ + 2 \text{v}_e$  where  $\text{e}^+$  is a positron or anti-electron, and  $\text{v}_e$  is an electron-neutrino. If the sun were powered by nuclear fission (instead of fusion) or by radioactive decay of heavy elements, *antineutrinos* would be produced instead.
9. In 2011, researchers at CERN (Switzerland) claimed that neutrinos exceeded the speed of light, but this claim has largely been discounted. See Sarfati, J., Neutrinos faster than light? Will relativity need revising? creation.com/neutrino, 11 October 2011.
10. Before this neutrino oscillation was demonstrated, this was a huge problem for the fusion theory and thus for billions of years. Theoretical physicists taught that neutrinos had precisely zero rest-mass, which would make oscillation impossible. However, in 2001, oscillation was detected, so the theorists were proven wrong. See Newton, R. (pen name at the time for astrophysicist Dr Jason Lisle of ICR.org), ‘Missing’ neutrinos found! No longer an ‘age’ indicator, *J. Creation* **16**(3):123–125, 2002; creation.com/neutrinos.
11. Eddy, J.A., quoted by Kazmann, R.G., It’s about time: 4.5 billion years, *Geotimes* **23**:18–20, 1978.
12. Faulkner, D., The young faint sun paradox and the age of the solar system, *J. Creation* **15**(2):3–4, 2001; creation.com/faintsun.
13. As leading day-age defender Hugh Ross does in: The faint Sun paradox, *Facts for Faith* **10**, 2002.
14. However, analyses of acritarchs (eukaryotic algal microfossils) ‘dated’ to 1.4 billion years ago, when the sun would have been only 88% as bright as it is today, provide evidence for only 10–200 times today’s level of CO<sub>2</sub>. Still, the researchers continue to hope that this would have compensated for the fainter sun. Kaufman, A. and Xiao, S., High CO<sub>2</sub> levels in the Proterozoic atmosphere estimated from analyses of individual microfossils, *Nature* **425**(6955):279–282, 18 September 2003; comment by Mojzsis, S.J., Probing early atmospheres, same issue, pp. 249–251. See also Samec, R., The sun in time, *J. Creation* **18**(3):8–9, 2004.
15. Galileo, *Encyclopædia Britannica* **19**:638–640, 15<sup>th</sup> Ed., 1992.
16. Magnetic fields often split spectral lines—the Zeeman Effect—and this is detectable in sunspots.
17. See Carter, R. and Sarfati, J., Why the Universe does not revolve around the Earth: Refuting absolute geocentrism, creation.com/geocent, 12 February 2015.
18. de Santillana, G.D. *The Crime of Galileo* p. xii, University of Chicago Press, Chicago, 1955.
19. Grigg, R., The Galileo ‘twist’ *Creation* **19**(4):30–32, 1997; creation.com/gal-twist. See also creation.com/geocent.
20. Sarfati, J., *Refuting Evolution*, ch. 7, 5<sup>th</sup> ed., Creation Book Publishers, 2012.
21. See He made the stars also ..., *Interview with creationist astronomer Danny Faulkner*, *Creation* **19**(4):18–21, 1997; creation.com/stars-also.
22. Faulkner, D., The angular size of the Moon and other planetary satellites: an argument for design, *Creation Research Society Quarterly* **35**(1):23–26, June 1998; creationresearch.org/crsq/articles/35/astrodesign.html.
23. Weiss, P., The sun also writhes, *Science News* **153**(13):200–202, 1999. See also creation.com/geocent.
24. Irion, R., The great eclipse: crown of fire, *New Scientist* **162**(2188):30–33, 1999, discusses rapidly oscillating magnetic waves as a possible energy source.
25. Seeds, M.A., *The Solar System*, 5<sup>th</sup> edition, Thomson Brooks/Cole, p. 166, 2007.
26. So-named in honour of University of Chicago scientist Eugene Parker (b. 1927), who in the mid-1950s developed the theory of the supersonic solar wind and Parker spiral shape of the solar magnetic field in the outer solar system.