Our Oasis in Space

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This is a ball, the sphere of our birth; its home to us all, our blue planet Earth.

It spins once a day on an axis with tilt. Sun towards and away is how seasons are built...

As it orbits our star, at a distance that's honed, not too near, not too far, in the Goldilocks zone.

Mars freezes in ice. Venus bakes in dry steam. But here it's so nice, liquid water can stream.

But it wasn't so mild four billion years past, when together rocks piled, our molten planet to cast.

In a final big crash, a companion was hewn, from the ash of the smash that formed to our moon.

This made a big dent, but with gravity's snare, the hot gas that did vent trapped a layer of air.

Even after this slaughter, icy comets hit still, adding ever more water, deep caverns to fill.

Thus oceans of blue came to cover Earth's surface, to give it its hue, and salve for its purpose.

For this was the soup that cooked the first gels, that in time came to group into billions of cells.

These crawled onto land, once they grew a hard spine, to walk upright and stand, then evolve to our mind.

So treasure this home, life's oasis in space; but let your gaze skyward roam, its past faces to trace.
This is a ball, the sphere of our birth;
it’s home to us all, our blue planet Earth.
Pictures like this, taken from space, show clearly the ball-like, spherical shape of our home world, the “blue-planet” Earth.

The blue color comes from Earth’s expansive oceans, which cover more than 2/3 of our planet’s surface. Their water is itself nearly colorless, but it reflects the blue color of the sky, which comes from the fact that shorter-wavelength, bluer light from the Sun is more easily scattered by tiny air molecules and dust than longer-wavelength, redder light. The white, wispy clouds form when water vapor in the air condenses into small droplets, which directly reflect the full spectrum of the sun’s white light.

The spherical nature of our world was first deduced by the Greek astronomer Erasthosthenes. He noted that at noon on the Summer Solstice the Sun made an angle of 7 degrees to the vertical in Alexandria, Egypt, but was straight above in Syene, which lies on the Tropic of Cancer. He paid a runner to pace off the distance between, about 800 km. Since 7 degrees is about 1/50 of the 360 degrees around a circle, he correctly deduced that the Earth is a sphere with a circumference of about 50*800=40,000 km.
It spins once a day on an axis with tilt;

Sun towards and away is how seasons are built…
The Earth spins with a rotation period of one day, leading to the daily rising and setting of the Sun.

The Earth also orbits the Sun once a year.

The axis of Earth’s rotation is tilted such that the Earth’s equator makes an angle of 23.5 degree with the “Ecliptic” plane, defined by Earth’s orbit around the Sun.

Over its annual orbit, this means the northern and southern halves of the Earth alternately tilt toward and away from the Sun, leading respectively to their summer and winter.

The respective “solstices” mark the time when the tilt toward or away is maximal; the “equinoxes” mark the time when the Sun’s light is equally divided between north and south, during the spring or autumn transition between summer and winter.
As it orbits our star at a distance that’s honed,
not too near, not too far, in the Goldilocks zone.
A key feature about Earth’s orbit is that it is nearly circular, and at a distance to the Sun that is neither too close to be too hot, nor too far to be too cold, but is “just right”, in a kind of “Goldilocks zone”.

Current searches for other, “extra-solar” planets that might harbor life often focus on those that lie in this Goldilocks zone for habitability.
Mars freezes in ice.

Venus bakes in dry steam.

But here it’s so nice, liquid water can stream.
Our two nearest planetary neighbors in the Solar System are Mars and Venus.

Mars orbits the Sun at a distance of 1.66 au, meaning that is 5/3 times further than Earth’s distance of 1 au. Because the solar flux declines with inverse square of distance, this means a surface patch on Mars receive only $1/1.66^2 = 0.36$ as much light as an equal size patch would on Earth. Moreover, because Mars is also smaller, with gravity only 38% of Earth, its atmosphere is much weaker, < 1% the surface pressure of Earth; it thus has little “greenhouse” effect to block heat loss to space. As such Mars’ average temperature (-50 C) is well below freezing, and so any water is frozen as ice. Indeed, over the poles the carbon dioxide that makes up the Martian atmosphere also freezes out to form “dry ice” polar caps. (There is, however, substantial evidence that Mars was warmer and wetter in the distant past).


By contrast, Venus orbits 0.72 au from the Sun, with each patch of area thus receiving nearly twice as much solar energy flux. Though it’s size and gravity are comparable to the Earth, its atmosphere has a surface pressure nearly 100 times higher, leading to an extreme, runaway greenhouse effect, with surface temperature of 465 C! This has caused any initial water to boil away into space, with today’s atmosphere made mostly of carbon dioxide, in the form of a kind of “dry steam”.


Earth lies nicely between these extremes, with water cycling among ice, vapor and liquid phases, forming snow and rain, which melts and flows into our idyllic streams.

But it wasn’t so mild
four billion years past,
when together rocks piled,
our molten planet to cast.
Our Sun and the whole solar system formed from gravitational contraction of an interstellar cloud of gas and dust about 4.6 Gyr ago.

Most of this material collapsed to the center to form the sun. But due to conservation of angular momentum, even a slow rotation of the original cloud was amplified in the collapse, much like a skater who spins up as she pulls in her arms.

Some small amount of the collapsing cloud was spinning too fast to keep falling inward, and ended up in a swirling disk of dusty debris. Over time, the dust particles collected into larger size, forming rocks and boulders, which eventually started to attract each other by gravity to form molten planet-size bodies, including the proto-Earth.

Thus the matter of the planets, including Earth and indeed our own bodies, is here today because it was spinning too fast to fall into the sun.
In a final big crash
a companion was hewn,
from the ash of the smash
that formed to our moon.
The initially large number of smaller proto-planets were crowded into orbits so close together that they often collided, gradually leading to a fewer number of larger planets.

The Earth was almost fully formed, with heavy elements like iron sunken into a molten core, when a Mars-size body made a glancing collision, knocking off a fraction of Earth’s mantle and crust into a close-in, orbital ring. Once this cooled, it collected together to form our Moon, initially orbiting much closer to a much more rapidly spinning Earth, with a “day” just ~6 hours.

But the tidal pull of the Moon gradually stole this spinning momentum of Earth’s rotation, causing that to slow, and allowing the Moon to drift further away.

This “Giant Impact” theory for the formation of our moon was actually one outcome of the Apollo missions. Analysis of the samples of lunar soil brought back to Earth showed that it has an isotopic signature that matches that from Earth’s crust and mantle, indicating that the moon once was part of the Earth.
This made a big dent but with gravity’s snare,

the hot gas that did vent trapped a layer of air.
The dent in the Earth’s crust quickly healed with molten material from its interior.

But over time the gas vented from volcanoes became trapped by Earth’s gravity, and so formed an early atmosphere.

The composition of this atmosphere was likely quite different than ours today, a combination of methane and carbon dioxide, with little or no oxygen.

Because the heat of impact vaporized and dissociated volatile molecules like water, the immediate post-impact Earth likely was quite depleted in water.
Even after this slaughter, icy comets hit still,

adding ever more water, deep caverns to fill.
But in this early phase of the solar system, the interactions of icy asteroids and comets in the outer solar system with the giant planets there sent many of them hurtling inward toward the Sun.

This “Late Heavy Bombardment” of the inner solar system created many of the craters seen on today’s moon.

On Earth these early craters have been erased by weathering and geologic actions.

On the airless moon, the water from these icy impact was mostly lost to space, though it seems some retained in perpetually shadowed craters near the poles could provide a key resource for future lunar exploration.

On the Earth, this water was retained as water vapor in the atmosphere, and liquid water on the surface, which steadily filled the lowest lying canyon and caverns.
Thus oceans of blue came to cover Earth’s surface, to give it its hue, and salve for its purpose.
This ice from such asteroids and comets is thus the source of most of all the water that make up Earth’s deep oceans.

These oceans eventually attained the blue color that marks Earth today. But as noted before, this blue comes from reflection of our blue sky, which itself is largely due to scattering of bluer, shorter wavelengths of sunlight by molecules in our atmosphere.

Actually, the Earth’s early atmosphere was likely mostly methane and other hydrocarbons, which was transformed by the Sun’s UV light into smog, making the early sky more of a orange or even brown color, like a polluted city today.

But these hydrocarbons also dissolved into Earth’s early oceans, providing the raw materials to form more complex organic molecules like amino acids, which are the building blocks of the proteins that form the ‘backbone’ for life.

https://www2.gwu.edu/~darwin/BiSc151/Origin/origin.html
For this was the soup that cooked the first gels, that in time came to group into billions of cells.
Over time these complex molecules of carbon formed a soup of concentrated gels, leading then to the first simple, but self-replicating cells.

As these cells combined to ever more complex forms, they gradually collected into multi-cellular organisms, like the jellyfish pictured here.

For protection, some fish formed hard outer shells, while others developed bones to give them structure and strength.
These crawled onto land, once they grew a hard spine, to walk upright and stand, then evolve to our mind.
Our own fish ancestors were those with a hard spine (vertebrates), which gave them the internal strength to crawl around shallow tidal pools, eventually developing legs to crawl onto land and lungs to breath in oxygen from the air.

One branch evolved into apes with arms in place of legs, allowing them to hang from trees, and eventually walk upright. This freed hands to develop tools and drive development of an evermore complex brain that became the seat of our mind and consciousness.
So treasure this home, life’s oasis in space.

But let your gaze skyward roam, its past faces to trace.
So this "pale blue dot" known as Earth is the home to everyone, indeed every living thing, that we have ever known.

It is truly an oasis in space that we should treasure and protect.

But to learn about its past history — its origin and evolution — we must study not just its composition and geology and life.

Because it is also a planet, a body in space, we can also learn about Earth and its past phases by studying other planets, both in our solar system, and around other stars.

By comparing it to our frozen outer neighbor Mars, and our baking inner twin Venus, we can better appreciate the delicate balance that keeps it just right for life, and perhaps learn better how not to upset that balance.

The Earth is our hometown bridge to the cosmos, and possibly to other worlds where the majesty of life may have taken foothold.

https://www.youtube.com/watch?v=GO5FwsblpT8
Neil deGrasse Tyson - Best2 - 21:12

Dawkins-Why the universe seems so strange - 22:42
The text in the verse and annotations here was written by Stan Owocki.

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