BLACKROCK CASTLE OBSERVATORY
The Space For Science

SKYMATTERS

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September 2020

Things to watch out for

September 2

The Full Moon will occur on this date. The Moon will be located on the opposite side of the Earth as the Sun and its face will be will be fully illuminated. The light of the Moon may make faint objects harder to observe.

September 11

Neptune will reach opposition on this date. The blue giant planet will be at its closest approach to Earth and its face will be fully illuminated by the Sun. This is the best time to attempt observations of Neptune, as it will be up all night long. However, Neptune will only appear as a blue dot through most telescopes and is not visible to the naked eye.

September 17

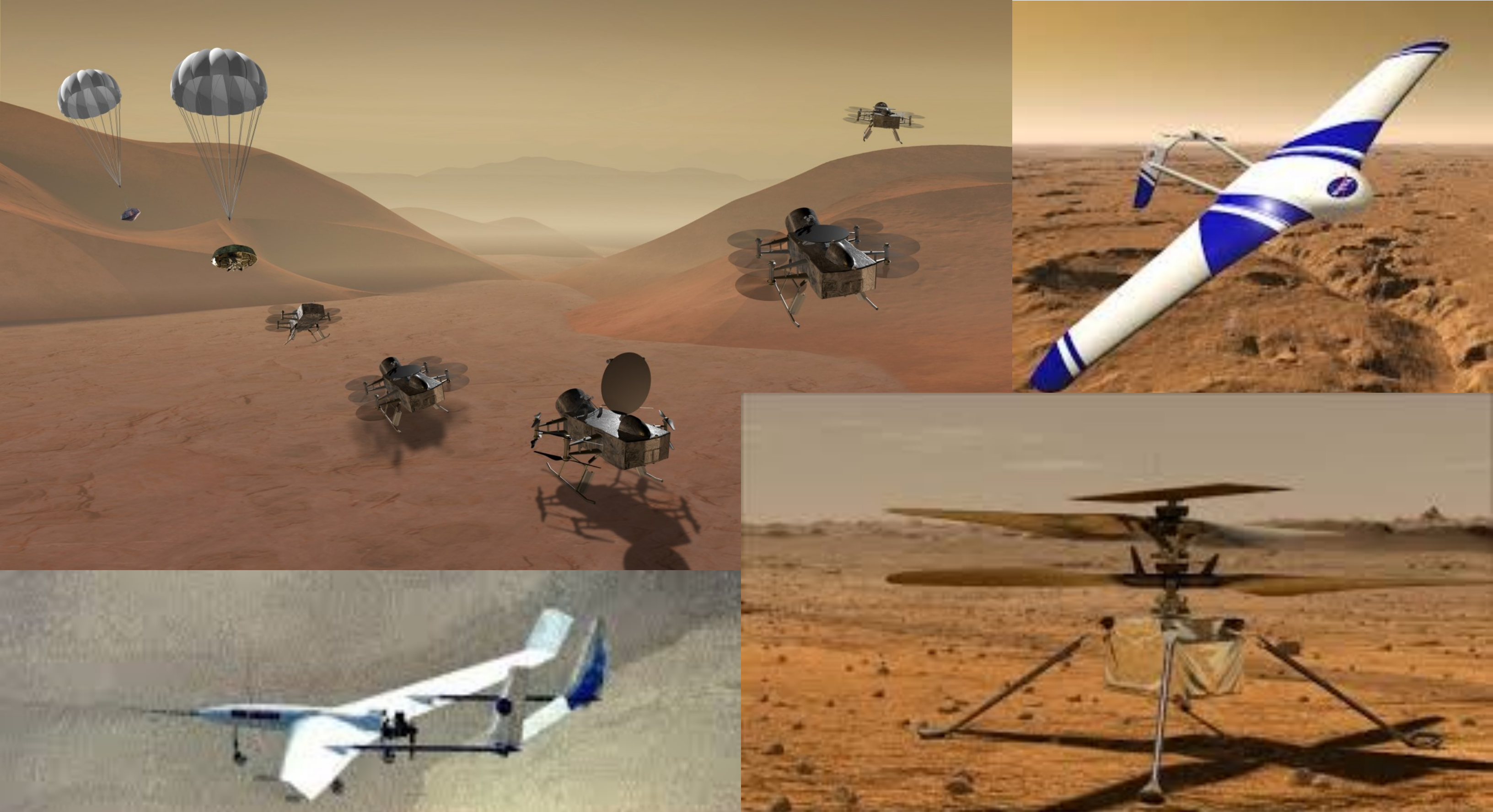
The New Moon will fall on this date. The Moon will located on the same side of the Earth as the Sun and will not be visible in the night sky. This means that there will be no moonlight to interfere with observations of faint objects.

September 22

The September Equinox will fall on this date this year. The Sun will shine directly on the equator and there will be nearly equal amounts of day and night throughout the world. This is known as the autumnal equinox in the northern hemisphere and the vernal (or spring) equinox in the southern hemisphere.

The bottom image shows sunrise on the 15th of this month at 6.45am. Venus will be visible towards the east-southeast all month, while Mars is visible to the southwest. The brightest star Sirius is also visible in the center of the image. The Moon, towards the east, will be a narrow crescent on this date.

In the image directly below we see the sky just after sunset on the 15th of this month, at 9.30pm. Mars is just rising low to the east, while both Jupiter and Saturn are visible due south. Saturn and Jupiter will be visible at sunset all month long, whereas Mars will rise a little later.



Clockwise from top left: The NASA Dragonfly, a proposed flying mission to Saturn's moon Titan. There are plans to launch this mission in 2026.
The ARES, a potential design for a Mars based aircraft. No prototype was made as another project was selected for the proposed launch window.
The Ingenuity Helicopter, launched this year with the Perseverance rover headed to Mars, it is set to be the first flying craft to operate on another planet.
The Mini Sniffer, a prototype hydrazine plane designed for use on Mars, has been successfully tested here on Earth.

Flight in Space

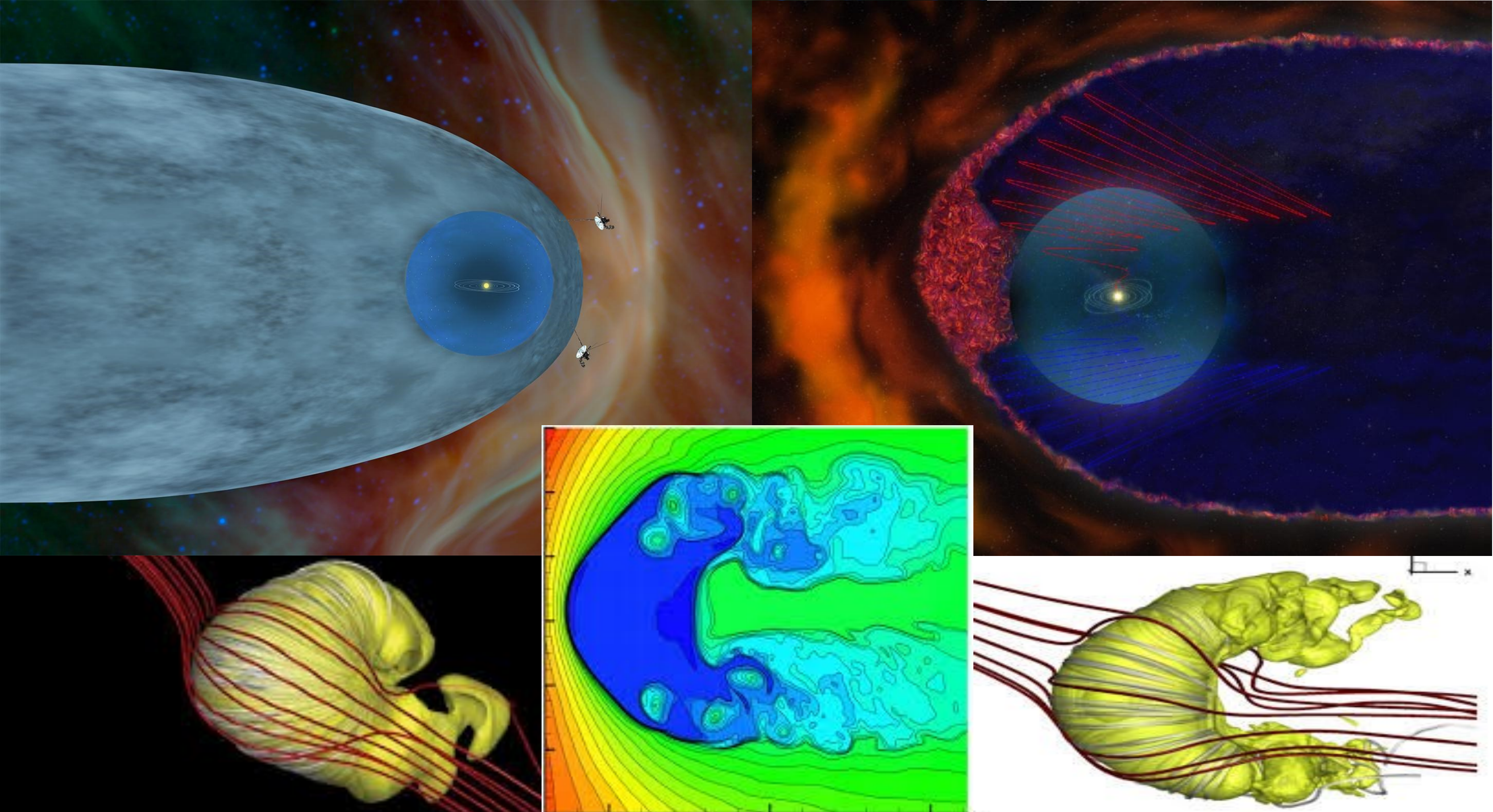
Spaceflight has become a common term over the past century. However, without air, what happens in space isn't really "flight". Flight is all about moving through a medium, generating enough lift to overcome drag and gravity. When a rocket launches, this occurs as the fuel exhaust creates thrust to lift the rocket against the force of gravity and through the air. However, once in space there is no drag, so no need to generate lift. Instead, momentum is generated as an equal and opposite reaction to thrust. This difference between flight as we know it and "spaceflight" is why rockets and space stations don't need wings. Wings (or rotors for helicopters and drones) have the all important task of generating lift in an atmosphere like ours. Of course, this overlap of terms doesn't matter too much. Spaceflight is in space, where there is no air, so the flight must be different to the flight of aircraft here on Earth. However, as we visit the atmospheres of other planets, another type of spaceflight may become more common.

Earlier this year, in July, NASA's Mars 2020 mission launched. As well as sending the Perseverance rover to the red planet, the mission includes the Ingenuity rotorcraft, Mars's first helicopter. A rotorcraft is anything that uses a rotor or rotors to generate lift, usually with sets of two to four spinning wings. This includes drones, but not propeller airplanes; it is still their wings that do the lifting. The Ingenuity rotorcraft will use a coaxial pair of rotors, two rotors that spin in opposite directions. This helps to prevent the craft's body from spinning and is used by some helicopters, though it is more common in toy helicopters. If Ingenuity manages to fly, it will be the first powered flight outside of the Earth's atmosphere. This will be quite hard, despite weaker gravity, due to the lower air density on Mars. Thinner air means there is less for the rotors to push against, meaning they would generate less lift.

A better location for flight may be Saturn's moon Titan. Titan is smaller than the Earth and Mars, meaning less gravity to fight against, but has a much thicker, mostly methane, atmosphere. A thick atmosphere coupled with weak gravity should make a perfect flying environment. A flying craft has been proposed for Titan: the Dragonfly rotorcraft. This craft is planned to have a more drone like layout, with four pairs of rotors arranged in a rectangle, rather than two stacked like Ingenuity, technically this makes it an *octocopter.* However, this craft will have to operate in temperatures well below -100 degrees Celsius, which could make it more brittle and susceptible to damage.

Balloons have also been proposed as a potential means of achieving flight on other worlds. But, filling the balloon (either with heated air or pressurised gases) and controlling its buoyancy are potential difficulties. And balloons tend to burst once they enter the vacuum of space. Fixed wing aircraft, more similar to planes have also been designed, some have even been tested here on Earth. However, thinner atmospheres require bigger wings, a real problem on Mars, and these craft normally need to build-up speed for take-off, therefore requiring some sort of runway or launcher.

It may be some time before spaceflight means flying on other planets, but the little Ingenuity rotorcraft may be our first step in that direction.



Clockwise from top left: First is a classic model of the heliosphere, with a long tail stretching behind, with both Voyager probes shown in front to the right.
Next we have a model which shows some of the turbulence at the front of the heliosheath, with two tails top and bottom.
The side-view model of the heliosphere better shows the croissant like shape, which is derived from the false color model in the center.
An oblique view of the model shows the round center of the heliosphere, with the two chaotic prongs stretching behind. Diagrams from Opher et al.

Our Solar Bubble

Here on Earth, our magnetic field protects us from high energy particles from the Sun. The magnetic field guides these particles towards our poles, where they light up the sky with beautiful auroras. However, the other stars further out in space can generate even greater dangers such as gamma rays. It is the Sun which protects us from these interstellar dangers, creating a safe bubble for us in space, the heliosphere.

The heliosphere is the area of space where we find particles leaving our Sun, the 'solar wind.' It ends as particles from the Sun collide with the interstellar medium, the sparse collection of particles and rays between stars. The force of the solar wind is enough to push back on the interstellar medium, creating a bubble around the entire solar system, protected from the threats of interstellar space. As the solar system orbits through the galaxy, this bubble deforms, with a rounder, smoother front and a more chaotic tail trailing behind. It was originally believed that the shape of the heliosphere would be similar to a comet, with a bulbous front and a long thin tail. However, it turns out the interaction between our Sun and the medium around it may be a little more complex.

Particles from the solar wind don't just passively deflect interstellar particles. They come into close contact and the interstellar medium pushes back on the solar wind, slowing it down. This region is known as the termination shock, where solar particles drop from speeds of over 400 km/s to just 100 km/s, less than the speed of sound. This compresses the solar wind, causing it to heat up. Electrical charge is exchanged between different particles, causing ions to form. This chaotic boundary zone is known as the heliosheath. Portions of the magnetic field that have broken off into their own system are thought to create a foamy magnetic structure at the head of the heliosheath. Although the Sun's magnetic field is much weaker out at the edge of the solar system, it still pulls on these energized particles, guiding them back towards the rear of the heliosphere. This gives an overall crescent shape, similar to a croissant.

After this, the solar wind slows down to nothing, and solar particles fall away. This is the heliopause, the last transition form our protected solar bubble, to the harsh irradiated world of interstellar space. Past this point, the magnetic field of our Sun no longer has much of an effect. At a distance of 121 AU, roughly 18 billion kilometres from the Sun, our solar system finally relents and gives way to the wider galaxy.

How do we know all this, about a structure so far away? Thanks to the spacecraft that have reached it. On the 25 August 2012, the Voyager 1 spacecraft passed the heliopause, becoming the first man made object to reach interstellar space. Followed by Voyager 2 in 2018, these probes have given us a first hand account, returning data from the edge of our solar system and pushing the boundaries of our knowledge with each fresh piece of data.

Leaving the protective bubble of our star may be one of the most difficult parts of any mission, especially a crewed mission, to another star. Even the power of a star like our Sun eventually bends to the pressure of the interstellar medium. Then again, the vacuum of space was a similar challenge just a few decades ago. Little by little, our final frontier gets pushed further and further out, as we learn more about our place in the universe.

Tips for Catching the Sunrise Due East

The Sun rises in the east and sets in the west. This is one of the most accepted generalizations in astronomy (solar astronomy is astronomy too!). But does it? In Ireland, the Sun doesn't always rise and set where you would expect.

Firstly, at sunrise or sunset, the Sun doesn't stray too far from east or west, but the Sun can rise north of northeast in the summer, when it will set north of northwest. In the winter, the Sun rises to the south of southeast and sets south of southwest. This is all down to the axial tilt of the Earth, the same phenomenon responsible for our seasons. This axial tilt is the reason the Sun gets higher in the summer and lower in the winter.

As the northern hemisphere tilts towards the Sun during the summer, the Sun reaches a higher point at midday. Really, the Sun will be higher at any given time in the summer compared to its height in the winter. This is why we see the Sun rising earlier. In winter, at 4 in the morning, the Sun is below the horizon. In summer, the Sun would be in the same direction at the same time, but higher; high enough to appear above the horizon. This means rises further and further north as we push closer to midsummer, and vice versa in the winter.

With all this variation, the truth is that the Sun will only rise due east and set due west at particular times of the year, close to the equinoxes. As the equinox is between summer and winter, the Sun reaches a median height in the sky, between the winter and summer extremes. In a similar way, it will rise between the winter extreme of southeast and the summer extreme of northeast, it will really rise exactly in the east.

We say the Sun rises in the east, but the truth can be a little more complicated.

Website of the month

bco.ie

Make sure to book your tickets in advance!

Quote of the month

The person who merely watches the flight of a bird gathers the impression that the bird has nothing to think of but the flapping of its wings. As a matter of fact this is a very small part of its mental labor . . . The bird has learned this art of equilibrium, and learned it so thoroughly that its skill is not apparent to our sight. We only learn to appreciate it when we try to imitate it.

Wilbur Wright, speech to the Western Society of Engineers (18 September 1901); published in the Journal of the Western Society of Engineers (December 1901); republished with revisions by the author for the Annual Report of the Board of Regents of the Smithsonian Institution (1902)

Some Upcoming Events at CIT Blackrock Castle Observatory

We are expanding our opening hours! Visits to the castle can now be booked on Wednesdays and thanks to huge demand, we have doubled the number of bookable spaces! Please see our website for details.

Join us on Culture night for a virtual tour of the night sky, as well as a tour of our historic fort. The astronomy experience will go into detail of the night sky as viewable on Culture Night, so you can step outside to put what you've learned to practical use.
Check our website on Fri 18 Sep 2020 to view the virtual tour and astronomy session.

Both experiences can be viewed in English or Irish.

PUBLIC OPENING Hours: 10am—5pm (Wed—Sun)* subject to change, please see www.bco.ie for the latest hours.

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Blackrock Castle Observatory is operated by Cork Institute of Technology and is a partnership with Cork City Council.

All Screenshots courtesy of Stellarium
Collated by Caoimhín de Bhailís and the Blackrock Castle Observatory team