Answer to What's Up! October 2021's Challenge – York Astronomical Society

The challenge was to identify where we are and what the date is.

Firstly, the "Where"

Well, we're certainly in an ocean (or sea) as opposed to a lake because there are no whales in lakes, but which ocean? You may notice there's something odd about the position of the stars. We see Regulus, Procyon, Betelgeuse and the lower two stars of the Square of Pegasus all not that far above the horizon. But we can never see them like that from England; they should arch across the sky, with Betelgeuse, Aldebaran and the two planets being much higher than in the image. The only explanation is that we have landed much further north than England. How far north? If we look in Wikipedia, the declination of the three stars named in the text are:

Regulus	12°
Arcturus	19°
Altair	9°

These declinations are almost the same as our sextant readings, which means that the celestial equator must coincide with our horizon, which in turn means that **we must be at or near the north pole**. The fact that there's no ice can be explained because we know the date is at least 11 years after 2050, by which time the Arctic icecap could have melted.

Now for the "When"

Clearly, the only things we can use to determine this are the positions of the planets, which are obviously in Taurus; this may allow us to determine the year. The position and phase of the Moon may give us the month. We also know of course that the date cannot be earlier than 2061, and is likely to be well past that.

1. If all we know are the orbital periods of Jupiter (11.86 yrs) and Saturn (29.46 yrs):

From Saturn's position now, in Capricorn, we can estimate that it will next be in Taurus in about 1/3rd of its orbital period. i.e. in about 10 years – 2031. And from that, we can project forward 29½ yrs at a time to see in which years Saturn returns to that position. So, the return years are 2060.5, 2090, 2119.5, 2149 etc. etc. The year 2060 is too early but the others are candidates.

From Jupiter's position now, on the Capricorn-Aquarius border, we can estimate that it will next be in Taurus in about 1/4 of its orbital period. i.e. in about 3 years – 2024. We can project forward as we did with Saturn, but in say 11.9 yr steps and see if one of those years corresponds with one of Saturn's. And it does! 2119.2 to be precise, which is very close to Saturn's 2119.5. One could go on, but there isn't a better correspondence for many decades. If I were doing the quiz, with only these orbital periods, I'd stop at 2119. And if you did this, and given the orbital periods were all you had to go on, **congratulations, 2119 is a perfectly acceptable answer!**

2. If we also know about Ecliptic Longitude and Great Conjunctions:

Then all we need to do is look down the list of Great Conjunctions to find one that took place when the two planets were in or near to their positions as shown in the image. The ecliptic longitude of that location (just to the east of Aldebaran) is about 75°. And there it is!

The Great Conjunction of 15th July 2119 is at longitude 73.2°. Does that mean this is the date we're looking for? Unfortunately, not. If it was, the Sun would be in Gemini and above the horizon as seen from the north pole. In the sky image, it's obviously night time. So, is the sky image from before the Great Conjunction or after it? Jupiter moves eastwards along the ecliptic faster than Saturn, and is to the east of Saturn in the image, so it must be after the conjunction. Further, we read that the Moon is waxing gibbous. That means that the Sun is somewhere between around 170° to 100° to its west, so between longitude 265° and 335°, so the date must be between mid-December and late February. That in turn means **the date we're looking for must be in the range Dec 2119 – Feb 2120**. Even heartier congratulations if the date you came up with was within this range.

3. If we also have a decent Planetarium Software program:
We can set our latitude to be 90° and the time to midday (the centre of the day as it were, because it's dark for the whole day) then run the program between Dec 2119 and Feb 2120 looking for when the Moon is roughly where it should be. If we do that, there are three dates that fit: Dec 16th, Jan 12th and Feb 8th. If we look very carefully at the positions of the Moon and also the two planets and at the same time tweak the time of day, the moment that fits the sky image best is **8th Feb 2120 at about 1500 hrs. And that is the accurate answer**. If you got any of those three dates, excellent. And if you got the right one, BRILLIANT! The relevant section of the Stellarium sky image is shown below, this time with the date and time revealed.

Finally, if you're wondering about the challenge text's, "an 11-year (spacecraft time) mission", actually taking 70 years, that's quite feasible because of *time dilation*. See "**Time Dilation and Interstellar Space Flight**" in this link.