ALICE: Where does the Solar System end and inter-stellar space begin? – by Lee Russell

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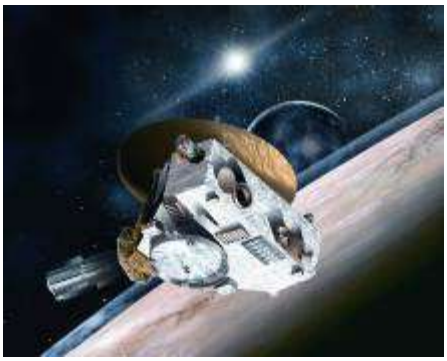
One of the interesting questions in Astronomy is where does the Solar System end and inter-stellar space begin? There's a nice result being shared by NASA from the ALICE instrument on the 'New Horizons' spacecraft that is helping with that question and confirming observations from the Voyager spacecraft.



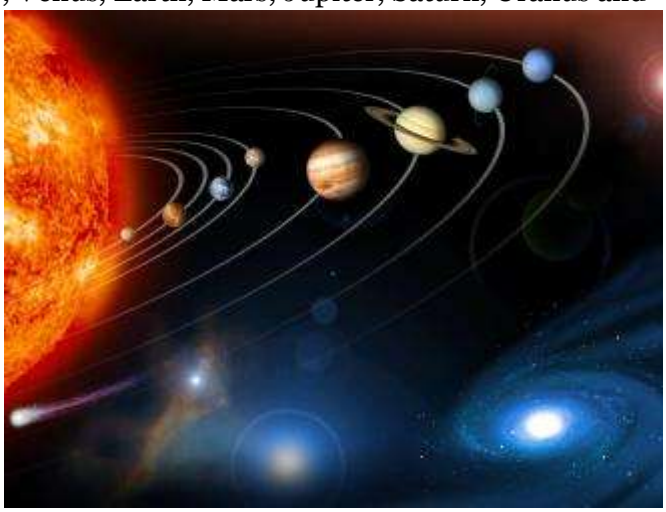
New Horizons' (right) is the spacecraft that flew past Pluto (left) on 14th July 2015 and was then sent onwards towards the Kuiper belt object (486958) 2014 MU69 (nicknamed 'Ultima Thule' by the New Horizons team), which it should reach on 1st Jan 2019.

'Voyager' (right) was actually two probes, launched in 1977 to study the outer Solar System.

So, where does the solar system end? It depends…

Based on the standard structural model (see below) we'd say somewhere near 50,000 to 200,000AU, at the far edge of the Oort Cloud. Based on the distribution of solar system hydrogen (see below), and taking Voyager 1's results to be correct (more below), we'd say it was around 121AU, with the result to be further verified by Voyager 2 and ongoing measurements from ALICE.

In the Standard Model of the Solar System the part we are most familiar with is the inner-most region containing the Sun and the eight major planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. There is a gap between Mars and Jupiter where a planet should be which actually contains the 'asteroid belt', an area of rocky asteroids that are probably material that never managed to accrete into a planet. This inner-most region extends out to around 4.5 billion km (or 30AU, as astronomers term it) from the Sun.



The next area beyond that, extending to about 50AU is the Kuiper Belt, which contains left-over material from the formation of the inner solar system, predominantly frozen volatiles like methane, ammonia and water. That is not to say that the objects in the Kuiper Belt are all 'small' as it contains three officially recognized dwarf planets: Pluto, Haumea and Makemake.

Overlapping the Kuiper Belt and extending beyond 100AU is the Scattered Disk, which is sparsely populated with small icy bodies like asteroids and comets. But the solar system doesn't end there… There is then also the Oort Cloud lying at around 50,000 to 200,000AU, which is believed to contain icy planetesimals and be the source region for some comets.

So somewhere beyond the region around 200,000AU we should no longer find any solid constituents of our solar system, and that would denote one boundary to our solar system. Anything beyond that point will not be bound by our Sun's gravity.

But what about gas? The main gas found in stars and the inter-stellar medium is hydrogen. Within our solar system these hydrogen atoms are pushed outwards by radiation pressure from solar photons. There will also be a radiation pressure applying inwards from the interstellar wind, and at some point those pressures will balance, causing solar system hydrogen atoms to bunch up in a 'wall' – this ***'heliosphere'*** will also mark another boundary to our solar system… and this is where the latest results from the ultraviolet spectrometer **ALICE** (named after the Alice Kramden in 'The Honeymooners') on **New Horizons** comes in.

NASA has already reported that Voyager 1 was about 121AU from the Sun when it passed through the heliopause (outer boundary of the heliosphere) on 25th August 2012 and entered inter-stellar space. Voyager 2 has a different trajectory and has not yet crossed that boundary.

Long-term observations made with ALICE have confirmed measurements made by the Voyager spacecraft. NASA scientists are reporting that both sets of data are best explained if the observed ultraviolet light results from BOTH the scattering of sunlight by hydrogen atoms within the solar system, AND a substantial contribution from a distant source, which could be the 'wall of hydrogen' at the heliosphere.

It could also be that the additional source of UV light is more distant, and more twice-yearly observations are being planned for New Horizons/ALICE. — here is a link to the abstract for NASA's paper, which is due to be published in the journal 'Geophysical Research Letters':

https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018GL078808

There's more from Lee Russell at www.russellweb.org.uk and @LeeJ_Russell

All pictures from NASA.gov