Storytelling with Uniview #8:
Scale in the Milky Way Galaxy

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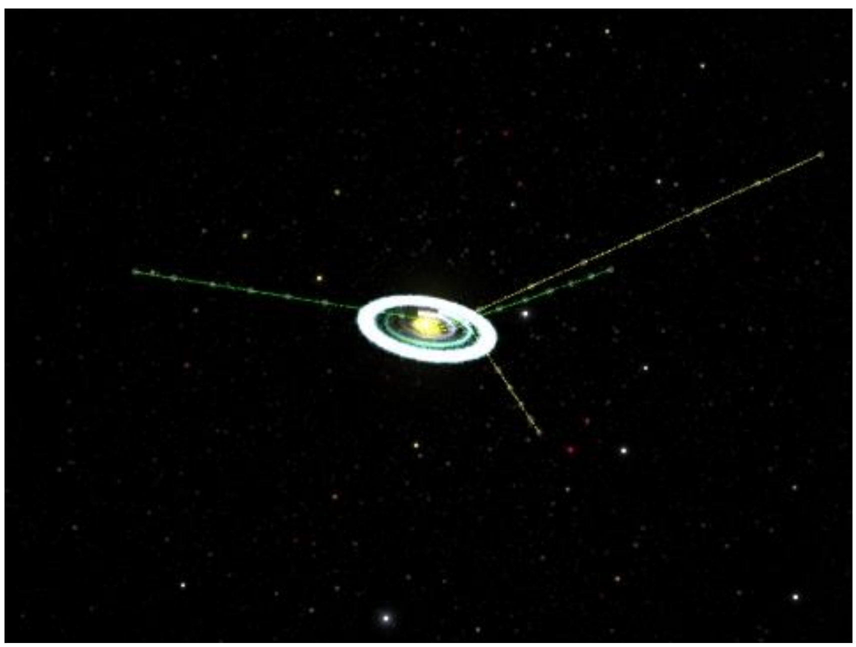
Ka Chun Yu
kcyu@dmns.org

In *Storytelling with Uniview #01*, we discussed ways to get visitors thinking about distances in the Solar System. The second column dealt with the structure of our Milky Way Galaxy. Now let us expand on both of these topics by considering how to get visitors to think about distance scales in the Milky Way Galaxy.

We had a hint of how much larger distances between stars are versus the separation between Solar System bodies in the first column, with the following table showing the light travel time from Earth to four man-made spacecraft in the year 2050:

Spacecraft	Light Travel Time
Voyager I	35 lh
Voyager II	30 lh
Pioneer 10	28 lh
Pioneer 11	24 lh

After traveling a human lifetime, these emissaries from Earth will have only gone roughly one light day. This is a powerful metaphor since it connects a highly abstract distance (far removed from everyday experience) to a measurement of time that your audience should have some familiarity with. And yet a light day is a very small distance compared to the light years to come, which will be necessary when talking about scale in the Galaxy.

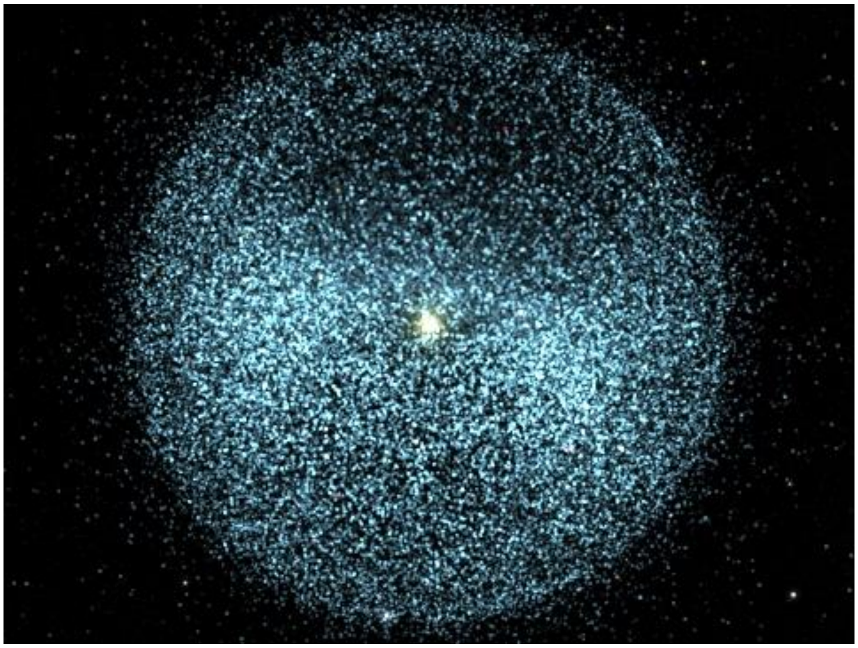


If I tell a story of scale and am starting inside the Solar System, I like to use the Voyager and Pioneer trajectories to partially boot-strap from Solar System to interstellar scales. The Milky Way→Kuiper Belt gives another good indicator for marking the outer edges of the Solar System, so I like to leave that on as well.

As you translate the camera out from the Solar System, we go to a view where the orbits of the outer planets are visible and are bounded on the outside by the Kuiper Belt (*Right*).

As we continue to zoom, the Kuiper Belt becomes lost in the glow of the Sun, with only the sticks of the spacecraft trajectories poking through (*Below*).

As you continue to pull away, remember that the spacecraft trajectories are only about 170-250 astronomical units (AUs) long (or equivalent to 24-35 light hours). As we zoom even further out, they quickly disappear into the solar glow as well, so it is a good time to toggle on Milky Way→Oort Cloud→Particle Systems. Without the comets in this spherical halo flying past as we continue to zoom, we would be hard-pressed to notice anything changing visually since the stars are even more distant. We have to travel out to 0.80 light years (=50,000 AUs) before we come to the edge of the Oort Cloud.

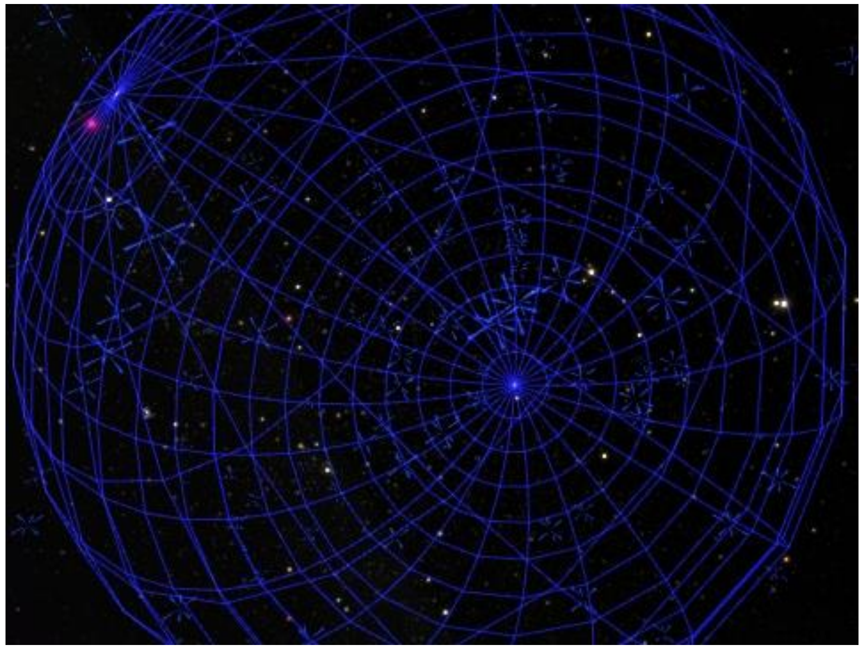


The Oort Cloud model is 1.6 light years in diameter. Notice this is more than a third of the distance to the nearest star, Proxima Centauri (4.243 light years) in the Alpha Centauri system. In our part of the Milky Way, the distance from one star to the next is on average about 6 light years. As stars drift relative to one another as they orbit the galaxy, it isn't too difficult to imagine that neighboring Oort clouds would occasionally overlap, making it easier to transfer cometary matter from the gravitational grasp of one star to the next.

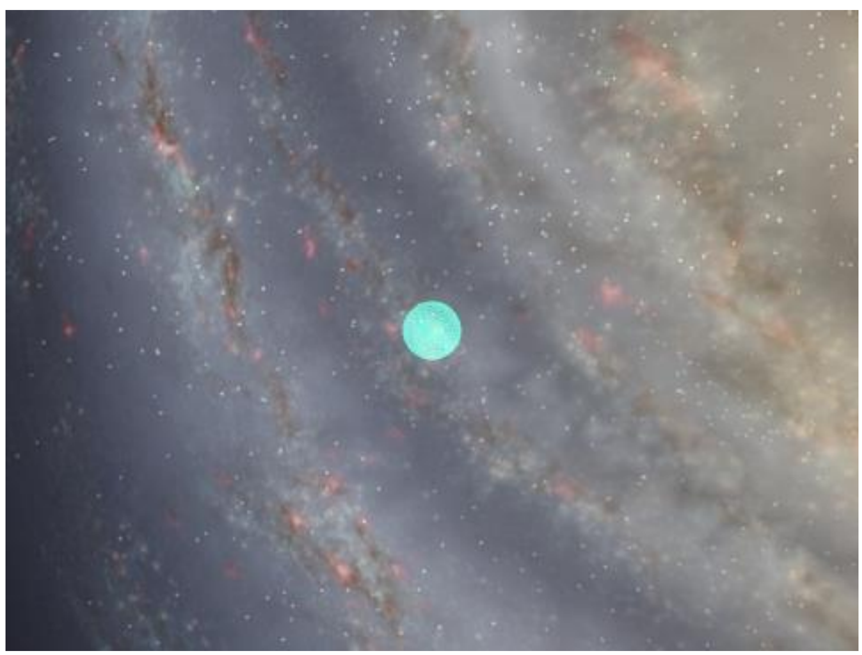
If you can find it, it's fun to pull the camera right up to the Alpha Centauri system, which actually consists of three stars. As mentioned earlier, Proxima Centauri is the closest to the Sun (and hence its name). Alpha Centauri proper is a binary pair, consisting of Alpha Centauri A and Alpha Centauri B. However these two orbit each other so close together—between 30-35 AUs—that the individuals in the binary are not visible in Uniview.

As we move further out into the Galaxy, there are several useful grids that can be turned on to help you step through ever increasing scales. The first is Grids→Celestial Coordinates (Radio Sphere, R=70 ly). As the name implies, this is a vector grid 70 light years in radius, or 140 light years in diameter, and it represents the distance traveled by man-made radio transmissions. This Uniview module was developed in the first decade of the 21st century, so it has become increasingly out-of-date. But if you assume that the first radio signals to leave the Solar System were the TV broadcasts from the 1936 Berlin Olympics (whose discovery by aliens is a plot point from Carl Sagan's novel and the movie *Contact*), then we see the **Radio Sphere** as it was in 2006.[1]

With the Radio Sphere still toggled on, turn on the Milky Way →Extrasolar Planets. This dataset is also likely to be out of date, considering how many new exoplanets are being discovered from month to month. But point out how many exoplanetary systems are found inside the boundaries of the **Radio Sphere**. If an advanced alien civilization existed on one of those worlds, the electromagnetic leakage coming from our Solar System would have announced our presence to them by now.



The next grid out past the **Radio Sphere** is only slightly bigger: Grids→Ecliptic Coordinates (R=100 ly).[2] The largest spherical grid is Grids→Galactic Coordinates (R=1000 ly). When you have flown out far enough to see this shell, the gross features of the Milky Way—the disk, bulge, and spiral arms—are readily apparent. Even though it is 2000 light years across, this final sphere is only 2% of the diameter of the Milky Way disk, which is estimated to be 100,000 light years across.



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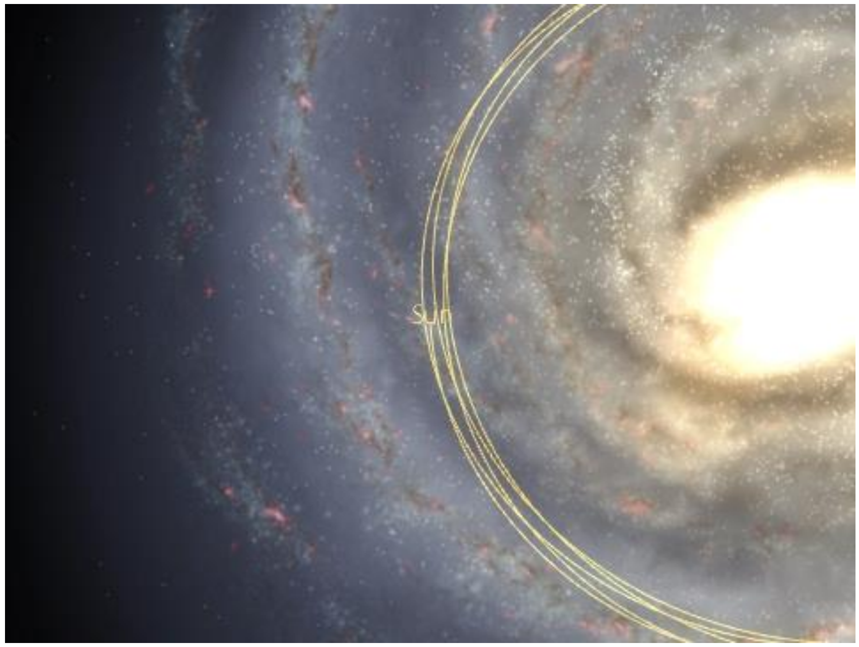
[1] The Radio Sphere is constructed in equatorial celestial coordinates. That is, it is an extension of Earth's latitude-longitude grid into the sky, which is equivalent to the Right Ascension and Declination coordinate system. You can therefore use it to help explain one way in which astronomers map fixed objects in the sky.

[2] It doesn't help you much beyond what the Radio Sphere already can show, but it can be used—as the name implies—to review ecliptic coordinates.

One final module can be used to convey the concepts of deep space and deep time, which are so essential in astronomy. Milky Way→Stars→Star Orbits→Sun shows the orbital path of the Sun around the Galactic Center, as calculated by astronomer Sebastien Lepine. The Milky Way's net gravity field is due to all of the stars, gas, and dust inside the Galaxy, and is not concentrated at the center, unlike the Sun dominating the gravitational potential inside the Solar System. Therefore the Sun's orbital trajectory does not close back on itself. Instead its orbit loops to create a pattern reminiscent of the ones produced by the spirograph drawing toy.



The important point here is that the Sun, even traveling at 230 km/sec, takes about 225-250 million years to orbit once around the Galactic Center. Therefore the last time that the Sun was in the neighborhood of where we are today, the Earth was coming out of the Permian-Triassic extinction event, which killed off more than 90% of all life on Earth. By the beginning of the Triassic, the Pangaea super-continent was starting to break up, and early dinosaurs had evolved onto the scene. It is not often that you can connect Uniview visualizations in the *Space Odyssey* exhibit with dinosaurs in *Prehistoric Journey*, but this is one way!

Reference

Henbest, N., & Couper, H. 1994, *The Guide to the Galaxy*, New York, NY: University of Cambridge.