

IV

August

August is the month to explore the Milky Way, MW. You'll find it as a faint light band going almost straight N-S, 10 to 30 degrees East of the Meridian around 10 PM in August. We are in the MW and see it therefore edge-on. Billions of stars and lots of gases and dust making up the MW appear to us as a faint glow. Sit down comfortably with your binoculars and wander along the band. The glowing band will reveal many stars now, but still many more remain hidden. Only a few percent of the stars in our MW can be seen. The dust and gases limit our view, even with binoculars, to 10,000 l-y while MW is 100,000 l-y in diameter.

Galaxies and Distances

Earth and Moon rotate around the Sun. The Sun is part of the Milky Way. Visualize our galaxy as a swirling flat disc, a pinwheel.

Let's put distances in this picture. Moon is close, 300,000 mile away and goes around Earth in 28 days at 3/4 mile per SECOND. Earth circles the Sun in one year and the distance to the Sun is almost 100 million miles (Sun's diameter is about 1 million miles). Calculate Earth's speed going around the Sun and you get 20 ml/sec or over 70,000 mph! The distance Sun-Earth is defined as 1AU (astronomical unit). Mercury is at 0.4 AU and Mars at 1.5 AU; Pluto is at 40 AU.

Imagine a rocket leaving Earth at the escape velocity of 25,000 mph and going straight to the Moon It'll get there in 12 hours. To the Sun will take 4,000 hours, almost half a year, and to Pluto 20 years! Going as fast as a plane at Mach 1 and the trip to the Sun takes 17 years.

Light goes fast! Roemer estimated light's velocity from measurements of the eclipses of Jupiter's moons. His estimate was 25% slow, but he had to rely on someone's distance measurement from Paris to Rome. That distance was wrong; he would have been 1% off with the correct one! And that was in September of ... 1679.

Light travels at 700,000,000 mph; it takes light from the Sun 8 minutes to reach us.

Light traveling for one year (lots of minutes!) covers a distance of 63,000 AU or 6 trillion miles; 1 light-year = 6 10^{12} miles. In a sphere with a 20 l-y radius you'll encounter a dozen stars. This is a typical density for stars in galaxies.

Then there are the Parsec and MegaParsec. 1 Parsec = 3.2 l-y and has to do with a parallax of 1 arcsec when pinpointing a star and doing that again 6 months later when Earth has traveled half around the Sun (you have then a 'base line' of 2 AU! See that?). The MegaParsec equals 1 million Parsec. Our neighbor galaxy, Andromeda, member of the same Local Group as we are, is almost that far away from us. I noticed a sign near one of the observatories in New Mexico reading; "-> Andromeda 20,000,000,000,000,000 ml".

How large is our pinwheel-shaped Milky Way? 100,000 l-y in diameter and only a few thousand l-y thick except for its central bulge. Are we centrally located? Not at all, we are 25,000 l-y from center and 2/3 along the way in the Orion Arm. The Local Group is part of the Virgo Cluster of galaxies. "Cluster" is not a meaningful term, one thinks of a lot of 'stuff'. Every galaxy has billions of stars; 100 billion is an average. A cluster of galaxies contains thousands of galaxies, but... there is a lot of space. If we could even it all out as loose atoms and molecules (almost all hydrogen and helium) then it would

average only a dozen per cubic yard and that is much better vacuum that we can achieve in a laboratory!

How come then that such a super low-density gas can 'clump' into stars and galaxies? That's a fine question for a next time and for now we blame Gravity **and** a time-span of a few billion years.

However, the Sky is beautiful to look at, therefore: Clear Nightskies. GW