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Reflector

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VOIDS: SOME PARTS OF THE UNIVERSE ARE EMPTIER THAN OTHERS

ORBITAL TILTS AND HIGH-FLYING MOONS

the top contributors of mass being transferred to the oceans, causing sea level to rise and, consequently, a drift in Earth's spin axis.

While ice melt is occurring in other places (like Antarctica), Greenland's location makes it a more significant contributor to polar motion.

"There is a geometrical effect that if you have a mass that is 45 degrees from the North Pole – which Greenland is – or from the South Pole (like Patagonian glaciers), it will have bigger impact on shifting Earth's spin axis than a mass that is right near the Pole," said coauthor Eric Ivins, also of JPL.

Previous studies identified glacial rebound as the key contributor to long-term polar motion. And what is glacial rebound? During the last ice age, heavy glaciers depressed Earth's surface much like a mattress depresses when you sit on it. As that ice melts, or is removed, the land slowly rises back to its original position. In the new study, which relied heavily on a statistical analysis of such rebound, scientists figured out that glacial rebound is likely to be responsible for only about a third of the polar drift in the 20th century.

The authors argue that mantle convection makes up the final third. Mantle convection is responsible for the movement of tectonic plates on Earth's surface. It is basically the circulation of material in the mantle caused by heat from Earth's core. Ivins describes it as similar to a pot of soup placed on the stove. As the pot, or mantle, heats, the pieces of the soup begin to rise and fall, essentially forming a vertical circulation pattern – just like the rocks moving through Earth's mantle.

With these three broad contributors identified, scientists can distinguish mass changes and polar motion caused by long-term Earth processes over which we have little control from those caused by climate change. They now know that if Greenland's ice loss accelerates, polar motion likely will, too.

The paper in *Earth and Planetary Science Letters* is titled "What drives 20th century polar motion?" Besides JPL, coauthor institutions include the German Research Centre for Geosciences, Potsdam; the University of Oslo, Norway; Technical University of Denmark, Kongens Lyngby; the Geological Survey of Denmark and Greenland, Copenhagen, Denmark; and the University of Bremen, Germany. An interactive simulation of how multiple processes contribute to the wobbles in Earth's spin axis is available at *vesl.jpl.nasa.gov/sea-level/polar-motion/.*

— Esprit Smith

Deep-Sky Objects

PERSEUS'S BRIGHTEST GALAXY

The constellation Perseus was named after the Greek hero known for slaying Medusa, the Gorgon, whose head he is pictured holding on classical constellation charts. The variable star Algol depicts one of Medusa's eyes. Perseus is also the hero who rescued Andromeda from the sea monster Cetus.

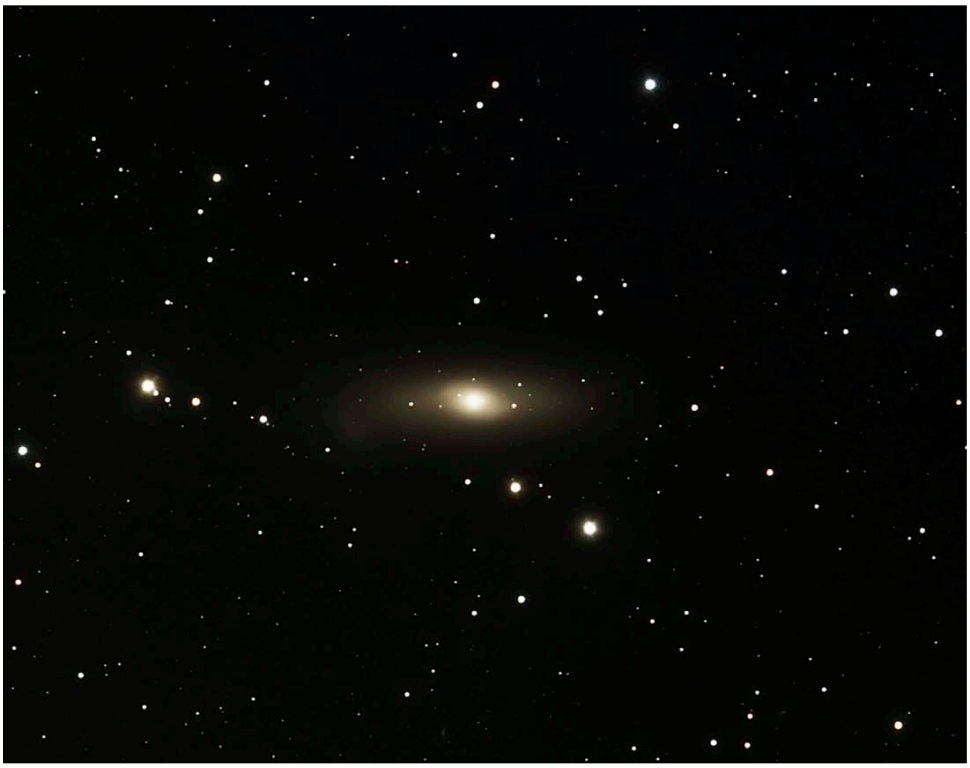
The constellation Perseus is contained within the plane of the galaxy, so visually its stars lie along the swath we commonly call the Milky Way. Besides the intriguing variable star Algol, the constellation is known for the bright star Mirfak, the California Nebula (NGC 1499), myriad double stars, and a multitude of open star clusters. The best open star clusters are the bright, wide cluster M34 and the famous Double Cluster (NGC 869 and NGC 884).

Perseus lies between the constellations Auriga and Cassiopeia, but it also borders Andromeda, Triangulum, Taurus, and Camelopardalis (my favorite constellation name!). The constellation culminates at 8:00 p.m. in early January, well after the end of astronomical twilight for North American observers.

With the plethora of star clusters in this Milky Way constellation, one might expect a majority of the New General Catalog (NGC) entries for Perseus to be galactic star clusters. But they are not. Of the 95 NGC objects located in Perseus, 71 of them are listed as galaxies! Unfortunately, the gas and dust in the plane of our home galaxy substantially dims these galaxies. Of the 71, only one is brighter than magnitude 10. That galaxy is NGC 1023. NGC 1023 lies 5.75 degrees west-southwest of the star Algol. It resides on the border of Perseus and Andromeda, just north of Triangulum. The galaxy is cataloged at magnitude 9.5 and is roughly 8 by 3 arcminutes in size. Brightness estimates for galaxies vary considerably, not because the galaxy varies in brightness, but because different astronomers use different techniques to estimate galaxy brightnesses. Some estimate NGC 1023 to be as bright as magnitude 8.7, while dimmer estimates are near 10.35. Likewise, distance estimates to galaxies vary considerably, too. The best estimate for the distance to NGC 1023 is 20 million light-years, but this estimate varies by a factor of 2.

Like the Milky Way Galaxy, which is a member of a group of galaxies located together in space (conveniently called the Local Group), NGC 1023 is a member of a group of galaxies located together in space. The NGC 1023 group contains NGC 891, NGC 925, NGC 1058, and NGC 1239. The two galaxy groups are next-door neighbors and both part of the Virgo Supercluster.

Most galaxies are classified as elliptical, spiral, or irregular in shape. In an 8-inch telescope, NGC 1023 appears to be elliptical. Many citations of NGC 1023 list it as an elliptical galaxy. Howev-



er, larger instruments reveal that NGC 1023 has an elongated disk, thus it is sometimes classified as a spiral galaxy. In reality, NGC 1023 is a barred lenticular galaxy of Hubble classification SB0. Lenticular galaxies are a category of galaxies in between spiral and elliptical. They have disks and central bulges. Some even have dust lanes or bars, but they lack spiral arms. Lenticular galaxies may have been spiral galaxies at one time, but they have used up all the material for star formation and contain very old stars, like most elliptical galaxies.

My accompanying image of NGC 1023 was taken with a Discovery 10-inch f/6 Newtonian with a Tele Vue Paracorr Type 2 coma corrector using an SBIG ST-2000XCM CCD camera. The telescope uses a Paramount ME German equatorial mount. The exposure was 60 minutes. North is up and west to the right. The diffuse galactic bar extends from upper left to lower right while the major axis of the galaxy runs east-west. The asymmetry is a consequence of the tilt of the plane of the galaxy to our line of sight. The brightest star in the field lies to the east (left) of the galaxy and is magnitude 9. The second brightest star located southwest of the galaxy is magnitude 10. Both are easily visible in 6- to 8-inch telescopes, framing this unique celestial island of stars.

This winter, when exploring the magnificent star clusters in the constellation Perseus, take a quick detour to spy Perseus's brightest galaxy, NGC 1023. Test your own eyes as to whether the galaxy appears more like an elliptical galaxy or a spiral galaxy.

— Dr. James R. Dire
Kauai Educational Association for Science and Astronomy

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