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Reflector

LEAGUE AWARDS FOR 2023

THE DEER LICK GALAXY GROUP

THE CASE OF THE MISSING MATTER

DWARF NOVAE

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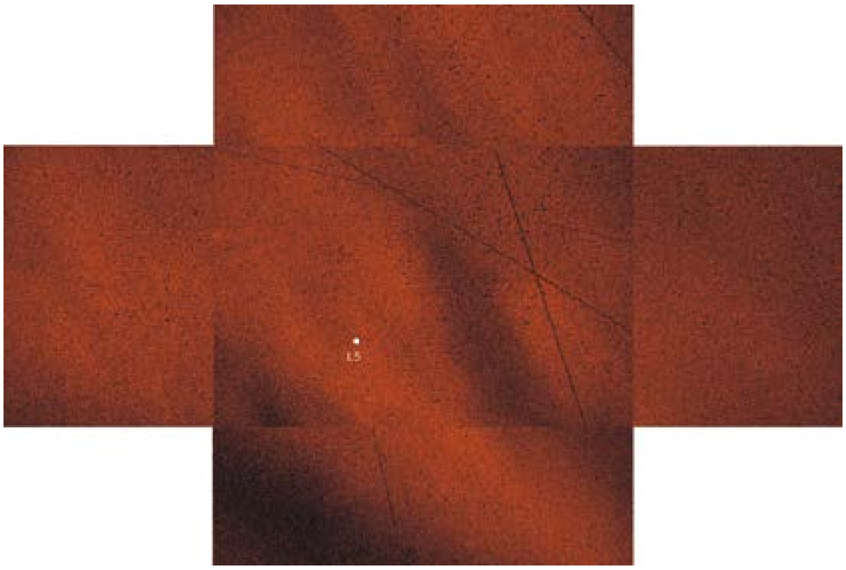

The polarization pattern of dust around the L5 point (white dot) of the Earth–Moon system. The polarized light scattered by the dust clouds is represented as red pixels in these images. The imaging polarimeter took data in the green (550 nm) spectral range on August 19, 2017. The five panels of the mosaic represent an area about ten degrees high and fifteen degrees across. The dark straight lines are artificial satellite trails. Image Credit: J. Slíz-Balogh

primary mission. The extended mission may visit more of these Trojans.

Most of the planets of the Solar System have trojan asteroids at L4, L5, or both. The exceptions are Mercury and Saturn. Jupiter has the most, with over eleven thousand Trojans sharing its orbit. Earth has two known trojans, both at L4. They are minor planets 2010 TK_7 and (614689) 2020 XL_5. The first was discovered by the WISE spacecraft and it is about a quarter-mile across. The second was discovered by the Pan-STARRS 1 telescope and it is almost three-quarters of a mile across. Other asteroids may have passed through Earth's L4 and L5 points, but they were travelling too fast to be captured.

The Earth–Moon system also has Lagrangian points, with the Earth taking the role of the Sun and the Moon taking the role of the Earth. This puts an L4 point sixty degrees ahead of the Moon in its orbit and an L5 point sixty degrees behind the Moon. While these two Lagrangian points have not captured an asteroid, there may be dust trapped in these equilibrium points.

Dust in our Solar System generally collects in a pancake along the ecliptic. Sunlight is scattered by this dust and under very dark, clear skies, it can be seen hugging the ecliptic. Near the Sun, the dust reflects more sunlight, forming the zodiacal light, which appears along the ecliptic shortly after evening twilight ends and shortly before morning twilight begins. Another bright spot along the ecliptic is in the area on the opposite side of the Earth from the Sun. The dust there reflects more sunlight due to the backscatter effect to form the gegenschein or counterglow.

Over 230 years ago, it was theorized that with all of this dust in the Solar System, some of it could become trapped in the Earth–Moon L4 and L5 points, forming dust cloud moons orbiting the Earth. Unfortunately, they are very faint and astronomers did not prioritize observing them, so they were not observed. Polish astronomer Kazimierz Kordylewski started a search for them in 1956 and between March 6 and April 6, 1961, he photographed two bright patches that were virtually stationary relative to L5. These dusty regions were dubbed the Kordylewski clouds. Even so, some astronomers still doubted the existence of these dust cloud moons (see Kuligowska reference). They were observed again in 1967 by J. Wesley Simpson using the Kuiper Airborne Observatory. He made infrared observations of the clouds at L4 and L5 over a three-year period to determine the behavior of the dust particles at these libration points.

Visual observations of the Kordylewski clouds have been reported from time to time, always from very dark sites like deserts, oceans, or mountains. The clouds appear to be about six degrees in diameter with the brightness of the gegenschein, but they have a redder color. They can drift as much as ten degrees away from the Lagrangian points. Some observations have placed the clouds in an orbit around these points in ellipses of six by two degrees. The Japanese Hiten spacecraft passed through both L4 and L5 in 1992 on its way to lunar orbit. It did not find enhanced dust levels, but it only made one pass through each point, so it may have missed the dust clouds if they are orbiting the Lagrangian points.

In 2018, a Hungarian team, led by Gábor Horváth of Eötvös Loránd University, developed a model of the clouds' reflectance in polarized light, which was tested by imaging the area around the L5 point with camera lens and CCD camera at Judit Slíz-Balogh's private observatory in Hungary (Badacsonytördemic). As reported in the *Monthly Notices of the Royal Astronomical Society*, the team showed that their images recorded dust-reflected polarized light extending to the edges of the image and beyond. The observed pattern matched the predictions they had previously made. The results were also consistent with the original observations of the clouds made by Kordylewski in 1961. The new observations confirmed the existence of the clouds (see Massey reference).

Searches for additional solid moons of the Earth have not turned up any new candidates. Nevertheless, the Earth has more than one moon. The Moon that we all know is accompanied by two or more dust cloud moons keeping the Earth company as it orbits the Sun.

—Berton Stevens

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Deep-Sky Objects

JEWELS FOR THE QUEEN

Cassiopeia is a northerly constellation that is best viewed in the fall. In Greek mythology, Queen Cassiopeia is the wife of King Cepheus and the mother of Andromeda. Cepheus ruled over Aethiopia, the upper Nile region of Sudan.

Both Cepheus and Andromeda are constellations adjacent to Cassiopeia, so the entire mythological family is honored in the constellations. For Europe and most of North America, Cassiopeia is circumpolar – it never sets.

The Milky Way runs through the southern regions of Cassiopeia. This means the constellation is filled with myriad star clusters, double stars, and colorful nebulae. The brightest stars in the constellation are, from west to east, Caph, Shedar, Navi, Ruchbah, and Segin. These stars form the easily recognized W asterism.

One of the best galactic star clusters in Cassiopeia is M103. Charles Messier's colleague Pierre Mechain discovered M103 in 1781. M103 was the last object Messier added to his original catalog. An avid comet hunter, Messier created this catalog of fixed objects (that is, not moving against the background stars) he did not want to confuse with possible comets. Messier identified faint comets by their motion over the course of hours or days with respect to the stars. At the eyepiece of Messier's primitive 18th-century telescopes, Messier objects and faint comets all appeared as fuzzy patches.

M103 is easy to find. The star cluster is 1.5 degrees northeast of the star Ruchbah. With a combined magnitude of 7.4, the cluster can easily be seen in binoculars and 30–50 mm finderscopes from dark sites. In these small instruments, the cluster appears as a tiny fan-shaped patch. The cluster is about six arcminutes in size. M103 is thought to be 8,500 light-years away.

In larger telescopes, M103 is a loose collection of approximately 40 stars between magnitudes 8 and 12. The brightest star in the cluster is Struve 131 (HD9311 or SAO11822). This is a double star with components that are magnitudes 7.3 and 10.5 separated by 13 arcseconds. This pair is at the apex of the fan-shaped patch on the northern edge of the cluster. Despite its appearance, Struve 131 is not a physical member of the M103 star cluster. It is a foreground star, 1,700 light-years away. Similarly, all the stars brighter than magnitude 10 apparently in the cluster are also foreground stars.

The two brightest cluster members are both magnitude 10.5. One is a spectral class B5 supergiant and the other is a B5 giant star. They are both blue-white in color. The cluster also contains a magnitude 10.8 red giant star of spectral class M6.

M103 is also known as NGC 581. The cluster has a true diameter around 15 light-years and is thought to be 25 million years old. The cluster may contain up to 172 stars, most too faint to see with an 8-inch telescope.

The accompanying image of M103 shows how the cluster might appear in a 6- to 8-inch telescope from a dark site. The image was taken with an 8-inch f/8 Ritchey–Chrétien Cassegrain with a 0.8× focal reducer/field flattener using an SBIG STF-8300C CCD camera. The exposure was 60 minutes.

The brightest star in the image, near the center of the image at left, is Struve 131. The bright blue star near the bottom of the image is HD9303, a magnitude 7.6 spectral class A0 star. The bright orange star on the upper right side of the image is HD9146, a magnitude 8.1 K1 giant star. None of these stars are members of M103. The image captures stars down to magnitude 16.

M103 is one of many fascinating open star clusters in Cassiopeia. Because of Charles Messier, it has a richer history of observation than most. This fall, everyone needs to visit this star cluster while exploring the nighttime sky with binoculars and telescopes.

—Dr. James Dire