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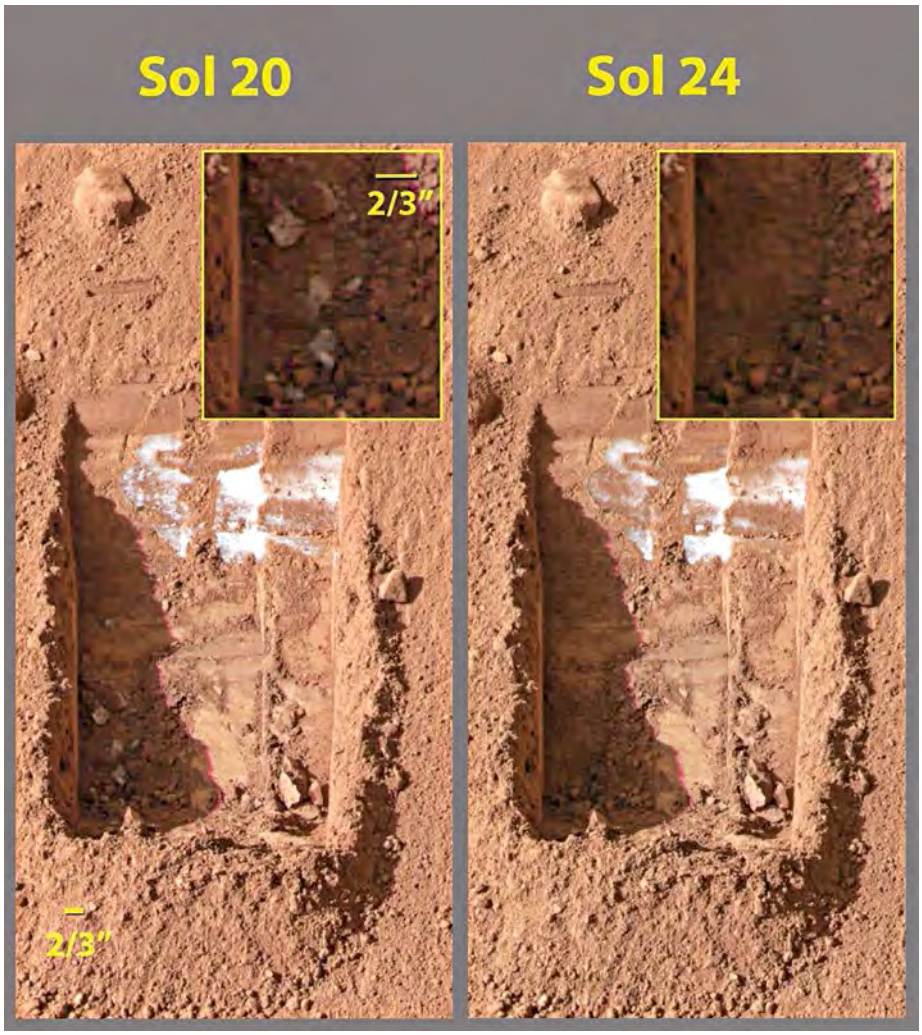
Reflector

MARTIAN ICE

HOW ONE NEUTRINO CHANGED ASTROPHYSICS

REMEMBERING TWO FORMER LEAGUE PRESIDENTS



NASA's Phoenix lander was the first spacecraft to directly image water ice on the martian surface. The spacecraft's claw dug this shallow trench uncovering the ice just below the surface. The trench, informally called "Do-do-Goldilocks," not only revealed the ice, but some lumps in the lower left corner of the left image sublimated (changed state from ice directly to water vapor) over the four days between images (June 15 and 19, 2008). Image credit: NASA/JPL-Caltech/University of Arizona/Texas A&M University.

These outburst floods appear to be episodic but rare. When they occur, huge volumes of liquid water are released to flow across the surface. These are comparable to the largest floods here on Earth. The water came from subsurface aquifers sealed by ice that were ruptured by a meteor impact or volcanic activity.

These outflow channels are different than the valley networks, which are more like terrestrial rivers. Drainage basins where smaller channels merge into larger channels which then merge into a large channel mimic terrestrial river basins. There are also river deltas and lakebeds visible from orbit. In addition, surface studies by landers have found minerals that could only have formed in the presence of water.

Other features on the surface suggest that ground ice is still just below the surface. Gullies and slope lineae (long, straight marks) along cliffs and crater walls are more recent, which suggest that water flowing on the surface still alters the martian surface, but much less than in the ancient past.

While the polar caps on Earth are made of frozen water, on Mars, where the temperature can get as low as –226 °F, they are mostly frozen carbon dioxide. However, fifteen percent of the visible polar caps are water ice. The martian poles become larger in winter as carbon dioxide from the atmosphere freezes onto the surface; it then sublimates (changes directly from solid to gas) back into the atmosphere in the summer.

Underlying the visible polar caps is a layer of ice. At the south pole it has been measured to be 2.3 miles thick – this may be the remains of an ancient ice sheet that covered the pole. Near the north polar cap, the Phoenix lander was able to scrape away dirt on the ground surface to reveal the top of an ice layer, providing the first visible proof of water on Mars. There may even still be liquid water below the ice layer of the polar cap. If all the water in both polar ice sheets melted, it would cover the surface of Mars to a depth of 29 feet.

Colonization of Mars would be a difficult and dangerous undertaking. The environmental factors that prevent life on the surface would also kill any human inadvertently exposed to them. Nevertheless, one of the most critical factors for establishing a colony – water – is available in abundance on Mars. Maybe one day we will see some of those science fiction tales become science fact.

—Berton Stevens

Deep Sky Objects

HARP ON NGC 6791

Lyra is one of the smaller boreal constellations of the 88 that adorn the heavens. However, it is vastly more recognizable than other nearby small constellations such as Sagitta and Vulpecula. Sagitta and Vulpecula lie within the milky swath that is the plane of our home galaxy. Their brighter stars are all but lost in our galactic glow. Lyra, on the other hand, lies just above the Milky Way's main glow. This gives its brighter stars greater contrast against a darker background.

Lyra is also well known because it contains the fifth brightest star in the nighttime sky, Vega, which shines at zero magnitude. The stars Vega, Epsilon Lyrae, and Zeta Lyrae form a equilateral triangle. The four stars Zeta, Delta, Gamma, and Beta Lyrae form a distinct naked-eye parallelogram. These geometric formations aid star hoppers finding two popular objects in Lyra: the Ring Nebula, a.k.a. M57, located almost midway between Gamma and Beta, and the double-double star, Epsilon Lyrae. M57 is one of the most viewed planetary nebulae in the northern hemisphere. Epsilon Lyrae is a fantastic quadruple star system that can be resolved by a 3-inch refractor at 100x if seeing conditions are excellent. Lyra is also home to a small globular star cluster, M56. But in this column, instead of featuring the globular star cluster, I want to concentrate on Lyra's best open star cluster, NGC 6791.

NGC 6791 is located approximately 8.5 degrees east and slightly south of Vega. It is also one degree east-southeast of the fourth-magnitude star Theta Lyrae. The outer Milky Way crosses the eastern edge of Lyra. In skies free of moonlight and light pollution, NGC 6791 appears within the Milky Way's chalky glow.

My image of NGC 6791 was taken with a Stellarvue 102 mm f/7.9 refractor with a 0.8x focal reducer and field flattener to yield f/6.3. The exposure was 40 minutes using an SBIG ST-2000XCM CCD camera. In the image north is up and east is to the left. The brightest star in the image is 6.2-magnitude SAO 68129 located in the lower right corner. The faintest stars in the image are dimmer than magnitude 18.

NGC 6791 lies 13,000 light-years away. The cluster is thought to contain a mass equal to 5000 suns. The cluster orbits the center of the galaxy at a radial distance of 26,000 light-years, placing it about the same distance from the galactic center as us. Visually, the cluster is magnitude 9.5 and spans a diameter of nearly 16 arcminutes. The cluster is easily resolved into hundreds of stars with an 8-inch telescope. The main part of the cluster is contained within a ten-arcminute area. Outside that area, it is visually difficult to distinguish the cluster's stars from foreground or background stars.

At first glance in a small telescope, NGC 6791 might appear to be a sparse globular cluster, but it is not. A few summers ago, I viewed this cluster on Kauai with Paul Jardin and Bob Kuzy using Paul's 20-inch Dobsonian reflector. This behemoth Dob resolved the cluster into what appeared to be thousands of stars down to nearly 17th magnitude. But the cluster contained neither the dense core nor the glow of hundreds of thousands of unresolved stars seen in globular star clusters. I cannot recall ever seeing an open star cluster with so many stars!

Based on studies of its stars, NGC 6791 is estimated to be eight billion years old. This is extremely old for an open star cluster. The stars in the cluster have about twice the iron to hydrogen ratio as our Sun, another oddity for a star cluster of that age. NGC 6791 is indeed a unique open star cluster and should be on everyone's list of objects to view this summer while exploring the constellation Lyra.

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

HELP WANTED

After 12 years, our **IT MANAGER** is retiring. We have immediate openings for people with experience in:

- Unix and the Ubuntu operating system
- Configuring firewalls and host intrusion detection system (HIDS) software
- Apache web server configuration and SSL certificates
- Administration of a Drupal content management system and programming Drupal modules

HELP WANTED

In addition, we have a new volunteer position: **GRANT WRITER.** The qualified person will have experience in successfully writing and securing financial grants at the local, regional, corporate, and national levels. These grants will enable your League to develop additional programs in outreach, observing programs, expansion of the *Reflector,* STEAM, and a host of other projects. The League does many great things with an annual budget of about $100,000. Imagine what we could do with an additional $25,000 or $50,000 per year. Literally, the sky is the limit.

NOTE: THESE ARE VOLUNTEER POSITIONS. Contact *president@astroleague.org* if you are willing to take on either challenge.