Santa Monica Amateur Astronomy Club

August, 2018

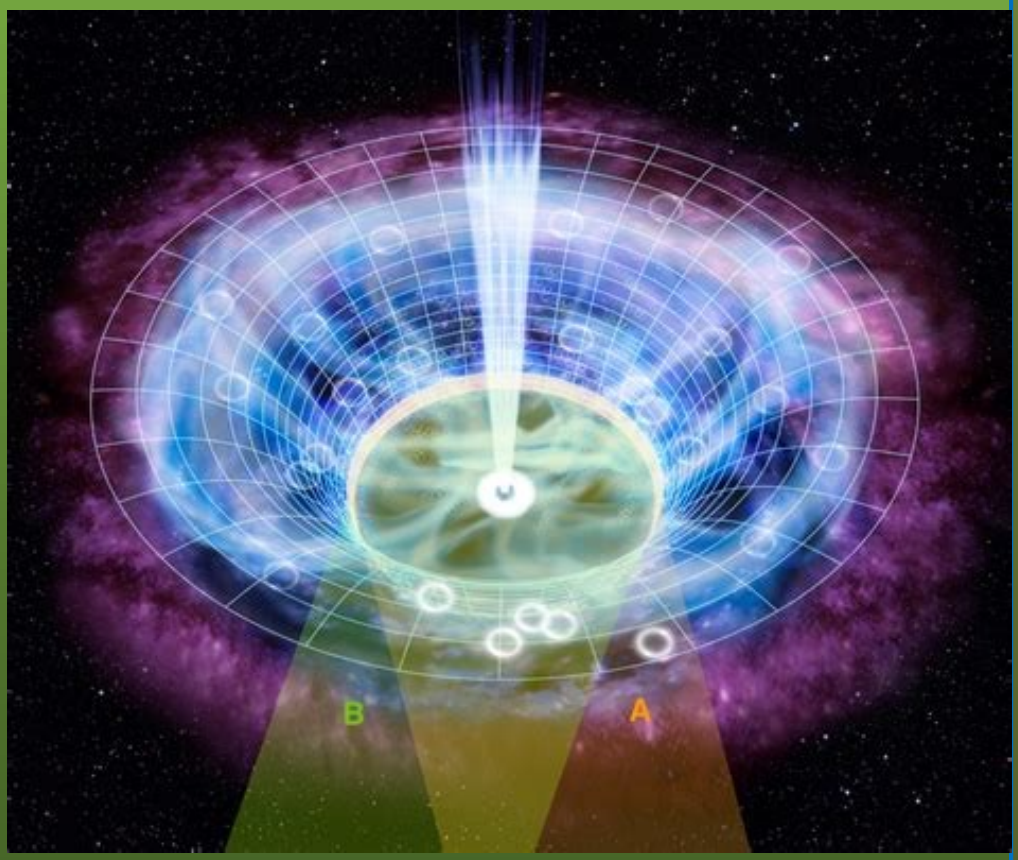
The Observer

Upcoming club meeting:
Friday, August 10, 7:00 pm

Our talk for August:

"Quasars and Their Extreme Outflows!"

Speaker:
Carla Quintero



INSIDE THIS ISSUE

OUR MEETING SITE

Wildwood School
11811 Olympic Blvd.
Los Angeles, CA 90064
Free parking:
Garage, SE corner of Mississippi & Westgate.

PICTURE AT LEFT:
Artist's conception of a quasar and its surroundings

August talk:

Quasars and Their Extreme Outflows!

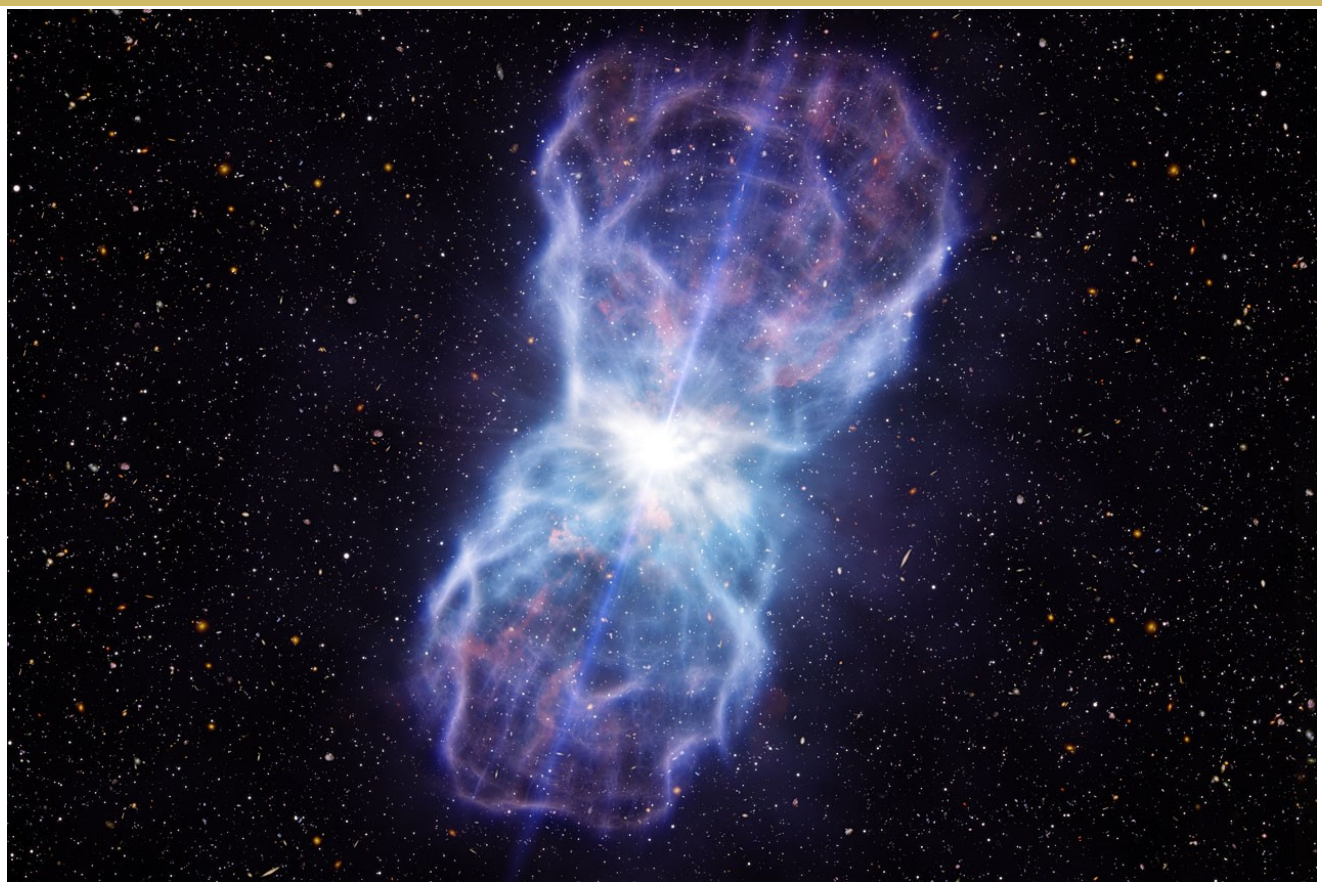
Quasars were one great mystery when discovered—they looked like stars, but had completely unfamiliar spectra. What could they be? The great breakthrough came when the spectral lines turned out to be ordinary hydrogen—but shifted so far to the red, that these objects must be moving away at thousands of kilometers per second.

This also meant that they must be extremely luminous—and the emitting area, star-like in appearance, had to be quite compact. Speculation finally settled on material falling into a supermassive black hole, a process previously relegated to science fiction stories.

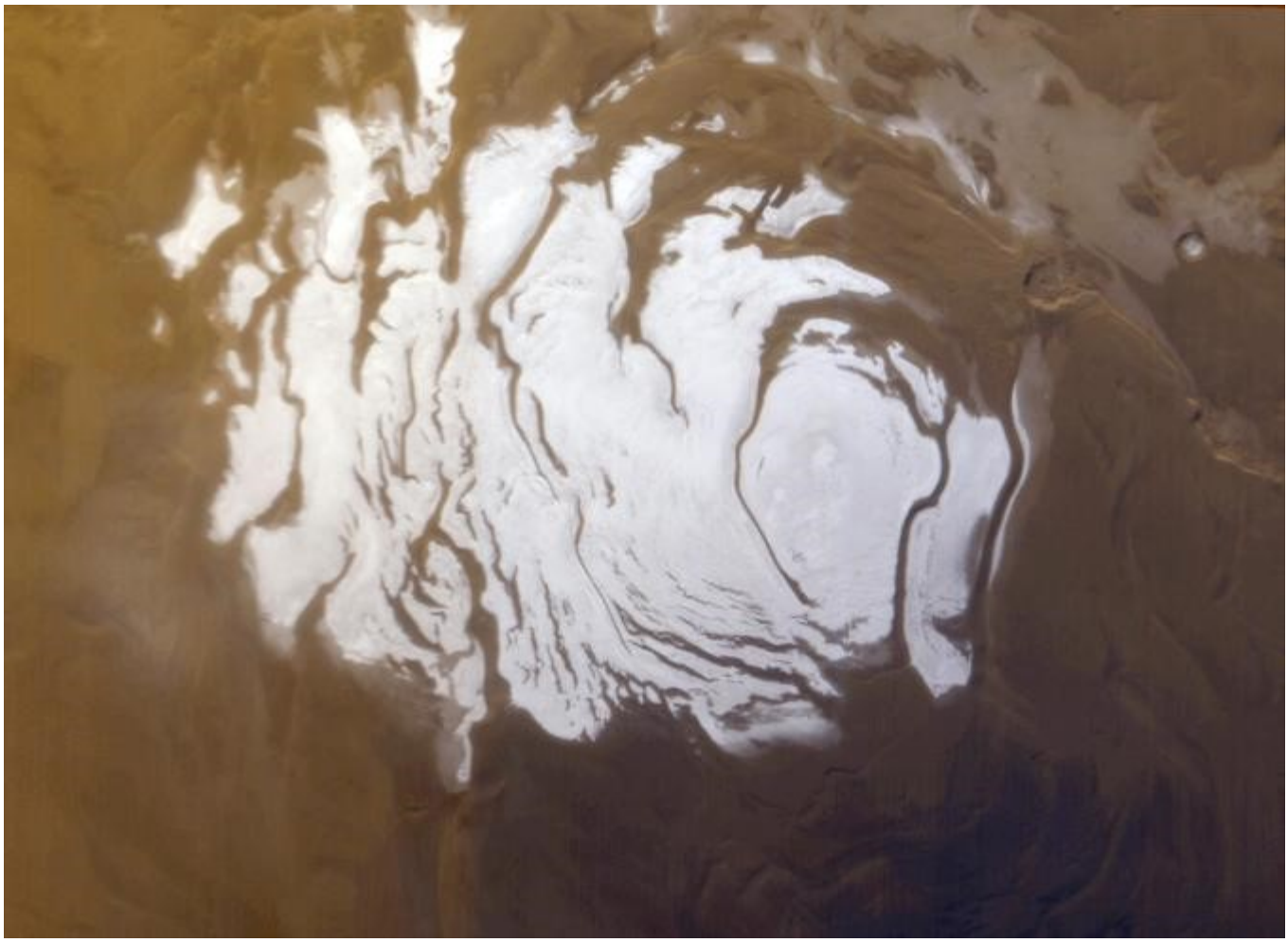
Quasars remain quite mysterious, despite the advances. While material falls in, some quasars also have superfast outflows. What characterizes these objects? What can they tell us about conditions out there—and the laws of physics themselves?

Carla Quintero, our speaker for August, will be familiar to a number of you—she was a member of our astronomy club a few years back (and still is, we always say). Now studying astronomy at Humboldt State College in Northern California, she has co-authored a few papers on quasars—and their extreme outflows!

Let's give Carla a wonderful welcome back, and enjoy what she has to say about quasars, and about her current work up north!



Martian Lake Below the Ice?



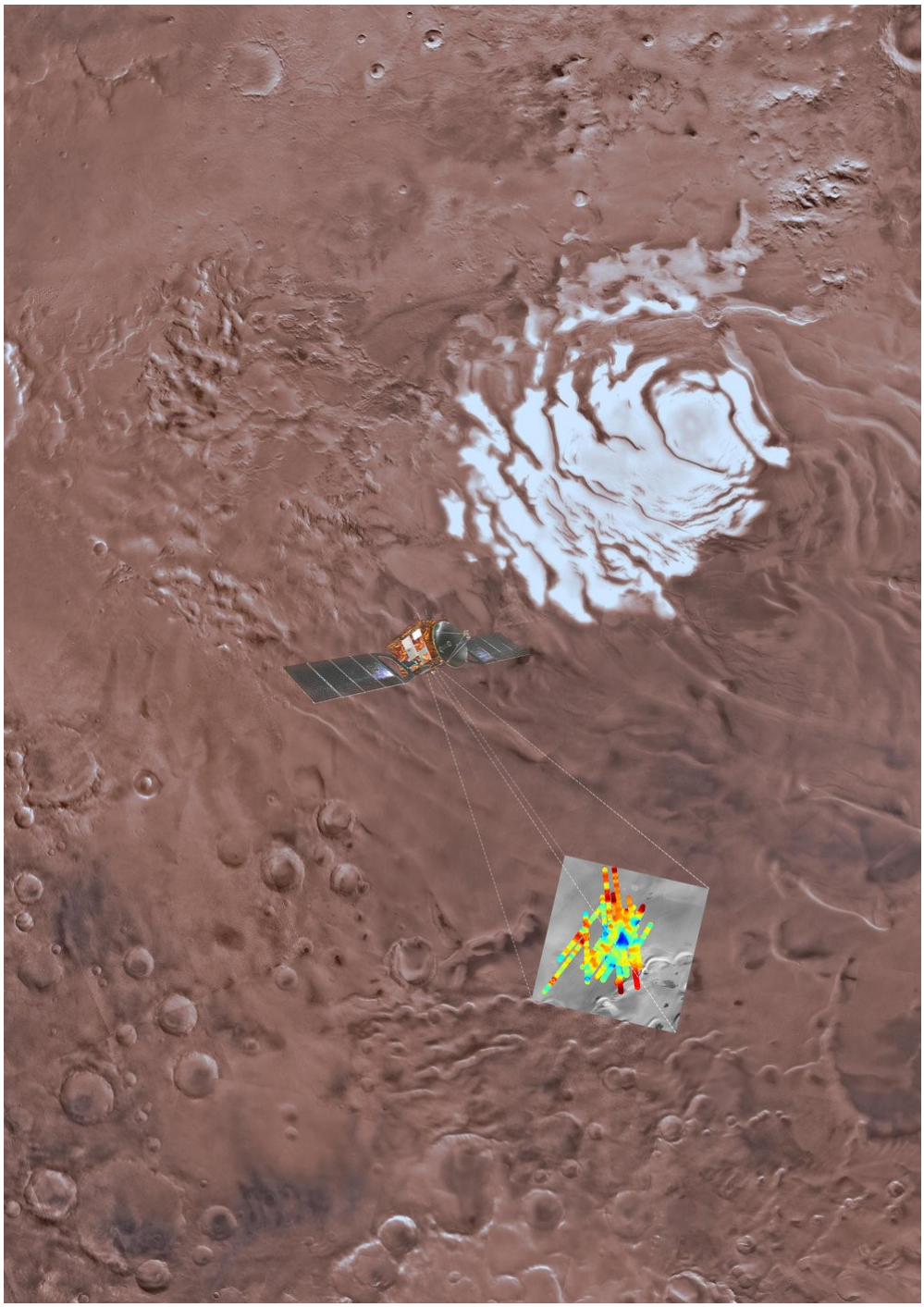
The European Space Agency's Mars Express probe has found possible evidence of a large lake a mile beneath the ice of the Martian South Polar Cap. This would put the 12-mile wide lake somewhere at the base of the ice. Temperatures down there are around –90°F, so only a very salty brine could avoid freezing.

All four Martian rovers (Pathfinder, Spirit, Opportunity and Curiosity) have confirmed the presence of ancient liquid water on Mars—in substantial quantity. Much smaller, seasonal features, called "recurring slope lineae", might indicate water on the surface *today*—possibly leaking brine from an underground aquifer (CO_2 and dry avalanches have also been proposed). The Phoenix lander even detected drops of briny, liquid condensation above its footpads. But if confirmed, this lake would be by far the largest identified supply of liquid water on present-day Mars.

The evidence? A bright reflection in the MARSIS instrument ground-penetrating radar. Brine comes close to metals in providing strong return signals. The depth of the lake is unknown, but would be at least a meter, and possibly much more than that. Either way, it's a lot of water.

More than the brightness of the radar signal was needed to make this announcement. The electric permittivity of the materials was one of the other factors involved. While some of the MARSIS radar signal bounces right off the Martian surface, other components can go down to 3 km (1.85 miles), and are sensitive to the boundary layer between different surfaces—for example, rock and salty water. The discovery of perchlorates on Mars certainly makes the case for salt in any subsurface water there. (see next page...)

Underground Lake on Mars? (continued)



Artist's conception of Mars Express scanning the South Polar region, with a swath of data depicted.

Not everyone is convinced, however. Other spacecraft radars haven't noticed any boosted signals in this region. However, they have used different wavelengths—and even the Mars Express data didn't seem to show anything, until it was reexamined. It turns out that the averaging of signal strengths across various pixels, to compress data, may have hidden the enhanced signal. Since then, data on 29 different passes (between 2012 and 2015) have all shown evidence of the boosted reflection.

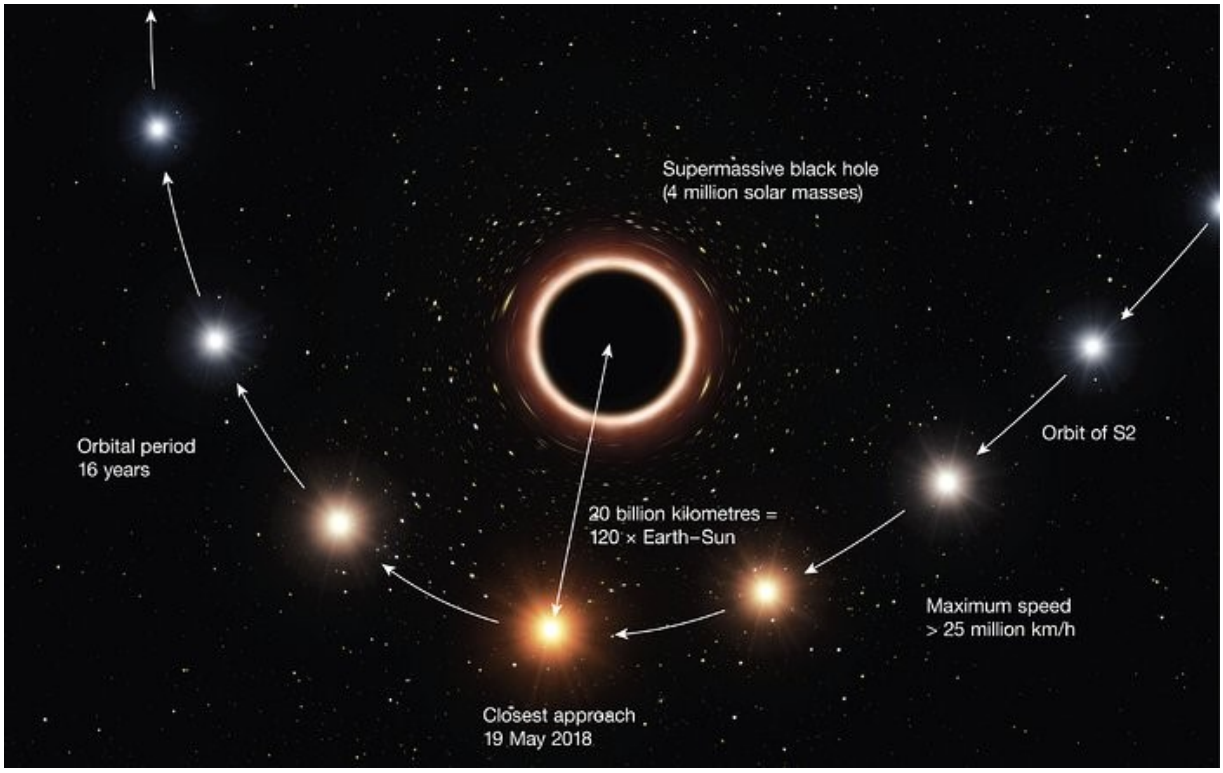
Others note that, while there are large lakes underneath the South Polar ice on Earth, these are kept warmer by heat flow from Earth's interior, and by the immense pressure of the overlying ice. With its less energized interior, Mars lacks similar heat flow. And its lower gravity doesn't produce the same pressure at the base of the ice cap. It is also possible that the water is more slurry than lake.

Still, the brightness of the signal does seem to match that of under-ice lakes on Earth. There may even be more of these bodies.

The brightest radar spot, still under the ice, is 9° offset from the South Pole.

Either way, the search is on—and now, scientists will be checking the data in more hospitable areas, in the long-held hope that the Red Planet is just a little bit—blue.

Gravitational Redshift Detected For a Star In the Grip of Our Galaxy's Central Black Hole



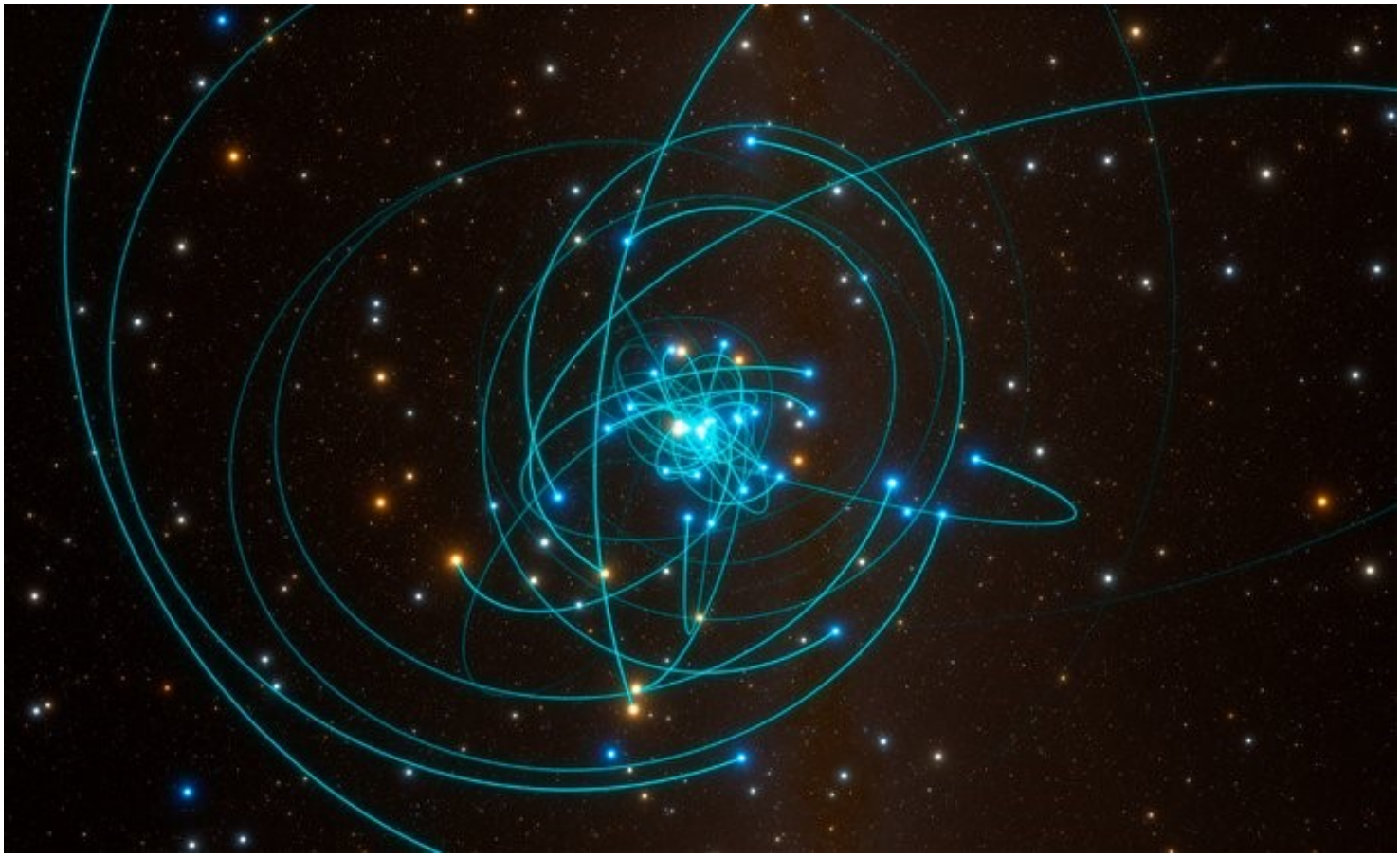
Our sun takes about 220 million years to orbit the center of the galaxy—give or take a few million, depending on which clouds and clusters we happen to encounter during our slightly erratic orbit. But "S2" takes only 15 years on its nearly-elliptical round trip.

S2 is a class B, main sequence star near the 4-million solar mass black hole at the center of our Milky Way. (Both young and old stars orbit near the center; this is one of the younger ones.) After a 26 year observing campaign, scientists got what they wanted: A test of Einstein's General Relativity—his theory of gravitation—in the most powerful gravity field in our galaxy.

This is the second time we've seen S2 at "pericenter"—its closest approach to the black hole. (Would 'peri-calamity' be more appropriate?) And this time, astronomers were waiting, with more advanced instrumentation. Using the four individual telescopes of the VLT (Very Large Telescope) in Chile as an interferometer, they were able to make the extraordinarily sensitive measurements needed to test Einstein's laws.

As S2 passed within 12 billion miles of the black hole (that's only 120 astronomical units, or 17 light hours, and it corresponds to a mere 14 milliarcseconds—less than 0.000004 degrees—on the sky), its speed around the black hole passed 25 million kilometers per hour. That's greater than 2% of the speed of light. (See next page.)

Star in Black Hole's Grip Confirms Einstein



Above: Stellar orbits around the central black hole.

During the star's passage, the VLT's GRAVITY beam combiner measured positional changes comparable to an astronaut moving a flashlight 10 cm on the moon. The SINFONI beam combiner measured redshifts, using (among other things) two absorption lines that it was able to detect in the spectrum of S2.*

The apparent redshift of 200 kilometers per second is a combination of special and general relativity effects, but the GR (gravitational) effects were a significant—and quite detectable—part of that. According to Einstein's theory, time intervals are stretched in a gravitational field, and the slower atomic oscillations give the appearance of a redshift.

The closest test to this current one has been of orbiting neutron stars; the recent detection of gravitational waves is another 'strong-field' test of general relativity. And, once again, Einstein has emerged unchallenged, albeit in a context that even he didn't allow himself to accept, 26,000 light years from the Earth.

Next, astronomers will be looking for an 0.2 degree 'kink' in the orbit as S2 leaves the vicinity of the black hole. This would reveal "Schwarzschild Precession", another prediction of Einstein's theory. Stay tuned!

Incidentally, one of our club members, Fabio Altenbach, contributed to research on the orbits of these stars around the 4 million solar mass black hole. Quite a feat!

*Brackett γ is a level 4 to level 7 jump for an electron in a hydrogen atom; it produces a feature at 2.1661 microns, in the near infrared. He I is an absorption line of helium, at 2.112 microns, also in the near infrared. Dust between us and the galactic center allows only one in a trillion visible light photons through, so infrared observations are required.

...And a Few Tributes

How time flies...

Phil Steffey, with a tie, is standing at right, in the back row. Anne Poe is third from the right, holding a pocketbook. Richard Reeve is the tall gentleman in the middle of the back row. You might (or might not!) recognize some of the other faces.

We recently learned of the passing of Phil and Anne, two of the earliest members of our club. Their contributions and their friendship will not be forgotten.

(Many thanks to Don and Lynne for providing this picture.)

Phillip C. Steffey was a member of our astronomy club from January 1983 to January 1987. In those few years, he was remarkably influential. Phil was the first Ph.D. astronomer to join the club (University of Arizona). His knowledge of the sky was unparalleled—he could give a lecture on the detailed properties and behavior of just about any star you could put in a telescope.

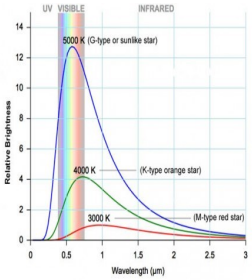
In addition to his professional interests in astronomy, Phil was an avid amateur astronomer, making thousands of variable star observations for AAVSO, the American Association of Variable Star Observers. Phil also had one most curious interest: The astronomy of the Dogon Tribe of Mali. There is a long lore about their sky stories. If Phil were around, we'd have him give one of his amazing talks, but as it is, you'll just have to look it up if you're intrigued!

Born in 1938, Phil grew up in Michigan. Phil worked in the aerospace industry here in California, and when that took a downturn, he moved to be near relatives, in Florida. He worked with the local astronomy club there, and taught some astronomy classes at the local community college. He also continued his meticulous observations of variable stars for AAVSO. We always hoped he'd come back for a visit, or we'd manage to catch him in Daytona Beach—sadly, it didn't work out that way. We often imagine what Phil would say or think about a particular issue. Some of our club members—notably Don and Lynne—kept in touch with him, and when their letters went unanswered for a while, we suspected that something had happened. A relative of Phil's was gracious enough to reply, and let us know of his passing, in October of 2017. Phil was one of those people whose personality and insight profoundly shaped the astronomy club. In so many ways, his influence is strongly felt today, despite all the years, by everybody who was fortunate enough to know him.

Why are there no bright, green stars, as there are visibly blue and red stars? Some claim that Zubeneschamali has a tinge of green-blue, and there are binary stars that appear green because of contrast effects when we interpret colors. But bright stars that are green, the way Betelgeuse is red?

Green is in the middle of the visible spectrum, and any star whose emission peaks there will have a whitish hue, because of the other colors you are seeing along with the green—but there's a lot more to it than that.

Phil Steffey's article "The Truth About Star Colors" in the September 1992 Sky & Telescope (p.266) is one of the most widely-cited articles ever published in that magazine. People still refer to it today as "definitive'—a testimonial to the knowledge and talent of this remarkable man.

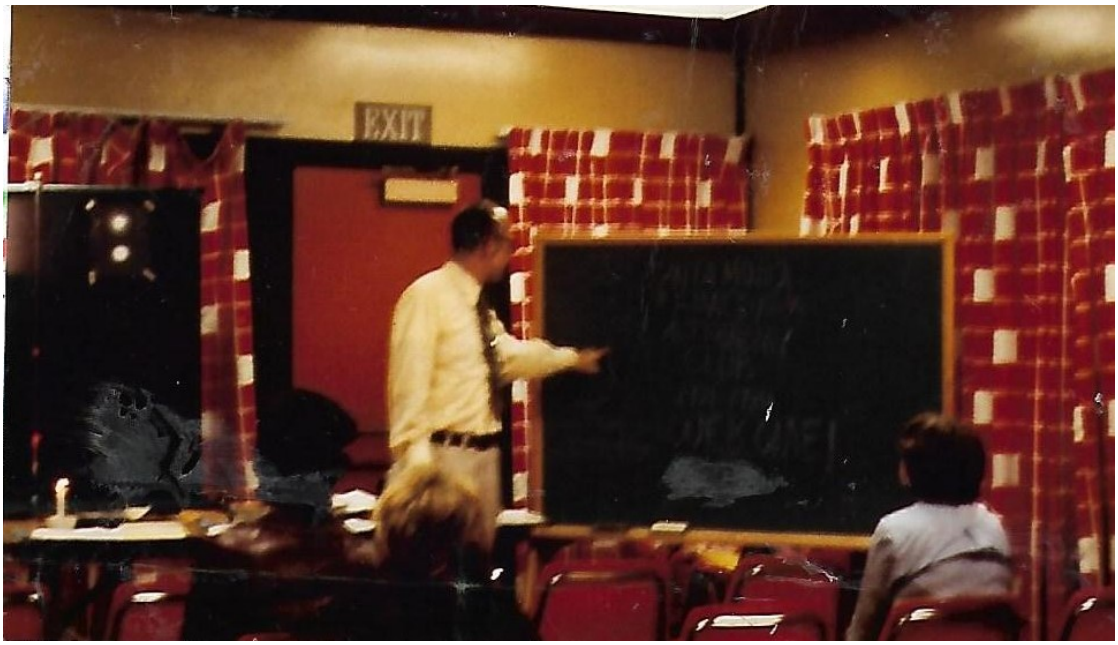


Anne Marie Poe was born in 1930, and grew up in Pennsylvania. She was a flight attendant, then a school teacher. Anne joined our astronomy club in May of 1982. She combined an interest in learning just about everything with an inquisitiveness about how the universe 'out there' informed our sensibilities about our own place in the universe.

She stayed with the club for many years, until illness prevented her from attending. Anne Poe passed away in 2016, but we had difficulty staying in touch, as she was under care for a while.

With the passing of Anne Poe, we have lost another memorable link to the early years of the club. She brought a unique perspective to the meetings, a blend of tradition and new learning.

Any of the long-time club members would undoubtedly be delighted to tell you more stories about Anne, and the other club members who have made this group such a memorable adventure—and who will be missed by those fortunate enough to have known them.



Phil lecturing to our group. It would be hard to find a more engaging speaker, or a more lively guest at our club dinners! Phil had something riveting to say on just about any topic—and it was always something thought-provoking. He also invited the club to rooftop viewings at his local apartment. We truly wish he could have remained in California just a while longer.

One evening in October 1946, just after dinner, my father called me out to the small yard behind our house. There he and another man whose identity I've forgotten were looking up at the just-dark and splendidly clear sky. As my eyes adapted I sensed flickering light, then its source. Everywhere in the sky, narrow, bright streaks appeared and quickly vanished as others appeared. My mother, June, who had followed me outside, said "Oh, look at the falling stars!" The men grumbled something critical, but as I knew nothing about real stars I just kept gawking at the aerial fireworks-like display.

—from "Starlight Memories" by Phil Steffey. This is still (as of August 2018) on the web. If you look at the rest of it, you might get a feel for Dr. Steffey's always-engaging character. You can also find one of Phil's classic letters to Sky and Telescope (unpublished!) and some other wonderful musings.