

*Santa Monica Amateur
Astronomy Club*

July, 2015



The Observer

UPCOMING CLUB MEETING:
FRIDAY, JULY 10 7:30 PM

Topic:

“Multi-Wavelength Astronomy:
Ending the Tyranny of the Eye!”

Speaker:

Tim Thompson (JPL, Mt. Wilson)



Multi-wavelength Tim Thompson



INSIDE THIS ISSUE

Ceres, relativity
and more...

OUR MEETING SITE:

Wildwood School
11811 Olympic Blvd.
Los Angeles, CA 90064

Free parking in garage, SE
corner of Mississippi
& Westgate.

“The Observer” would be de-
lighted to accept submissions
from club members. Co-
editors would also be wel-
come. See one of our club
officers at the next meeting!

UPCOMING MEETINGS:

July 10—Tim Thompson (JPL, Mt. Wilson)

“Multi-wavelength Astronomy—Ending the Tyranny of the Eye!”

August 14—Jeremy Brightbill (UCLA)

September 11—Deborah Vane (JPL)

“Earth Climate Observations From Space”

ASTRONOMY EVENTS AND NOTES ABOUT TOWN:

PANEL DISCUSSION: “HOW EINSTEIN’S THEORY OF RELATIVITY CHANGED EVERYTHING”

Wednesday, July 22 at 8:30 pm

KPCC will sponsor a discussion on RELATIVITY with astronomer Jeffrey Bennett and Caltech physicist Sean Carroll, to honor the 100th birthday of the theory

[The Crawford Family Forum, 474 South Raymond Ave, Pasadena, CA 91105](#)

Admission is free, but you have to reserve tickets. Go to:

<http://www.scpr.org/events/list/forum> and scroll to $E = mc^2$, or head right to

<http://www.scpr.org/events/2015/07/22/1735/e--mc2/> or...

Simply search for “Crawford Family Forum” + relativity

JET PROPULSION LABORATORY TALK

“Discovery at Mars” Thursday, July 16, Von Karman Auditorium, 7pm

Repeated at Pasadena Community College the following day. See JPL website.



Extra! Extra! July “Observer” delayed by one second!

This month’s “Observer” was delayed by the 26th official leap second, which capped off June 30, producing unusual clock readings around the world.

Timekeeping is a messy business. Atomic clocks, along with certain pulsars, are our most consistent timekeepers. They are the basis for TAI, Temps Atomique International.

The earth’s rotation is a relatively poor timekeeper. Tides, convection currents below our crust and even earthquakes affect our planet’s spin—but it governs our lives, and defines UT1, Universal Time.

The link between the two systems is Coordinated Universal Time, UTC, which we commonly use for civil time. UTC matches the atomic clocks second for second, but a leap second is added when the difference between atomic and earth-rotational time approaches 1 second. UTC is consistent—and it keeps the world safe for sundials!

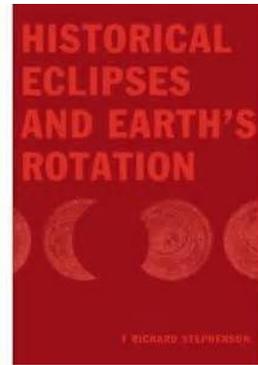
While scientists sweat through the details of “Barycentric Dynamical Time” and “Terrestrial Time”, which account for the varying time-distortion effects of gravity on our atomic clocks, we can safely negotiate Happy Hour and bus schedules without them.

Some experts want to eliminate leap seconds, and just let the day slide a tiny bit. If you thought Pluto got controversial...

Best recommendation: Relax and enjoy your leap seconds! With the continued slowing of the earth (see last page), they will be happening more often.



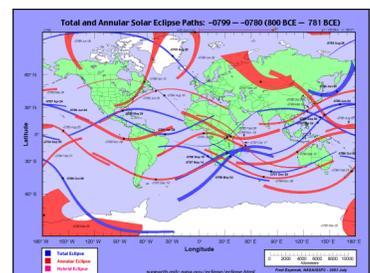
So—how did you spend your leap second?



The Babylonians and Assyrians may not have had atomic clocks, but we can use their records as a check on earth’s rotational slowing. The day is currently getting longer by 1.7 milliseconds each century. That doesn’t sound like much, but it really adds up over the millennia.

Just knowing whether or not an eclipse was seen over Babylon or Ninevah tells us a great deal. In these cities, we find records of eclipses that should never have been seen there—if earth’s rotation rate were constant.

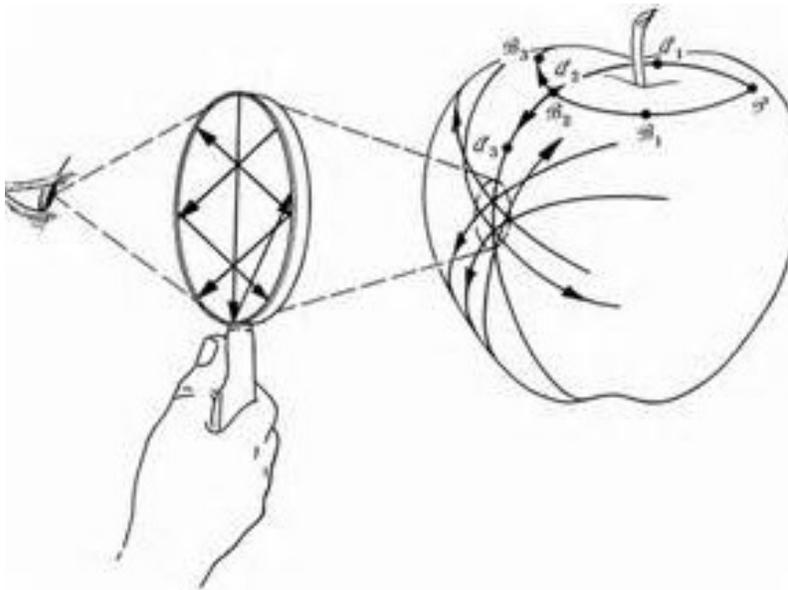
Some of these records show discrepancies of several hours. Interested readers can refer to the works of F. Richard Stephenson.





EINSTEIN'S THEORY TURNS 100!

2015 marks the 100th anniversary of Einstein's Theory of General Relativity. What we now call the "Special Theory" was published in 1905, and resolved some longstanding issues between Newton's mechanics and Maxwell's electrodynamics. Yet, its very assumption of constant-velocity observers limited its application to the accelerating universe of gravitation and cosmology.



A remarkable insight!

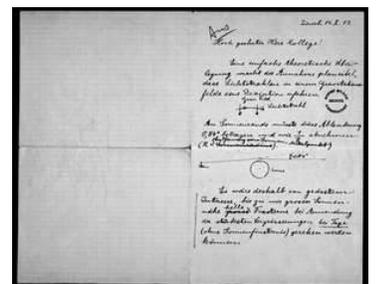
Illustration from Misner, Thorne, Wheeler
"Gravitation"

Ants on the apple follow curved trajectories—but they are really just taking the shortest paths on a warped surface. The earth's orbit is also a 'shortest path'—through a 'warped' spacetime.

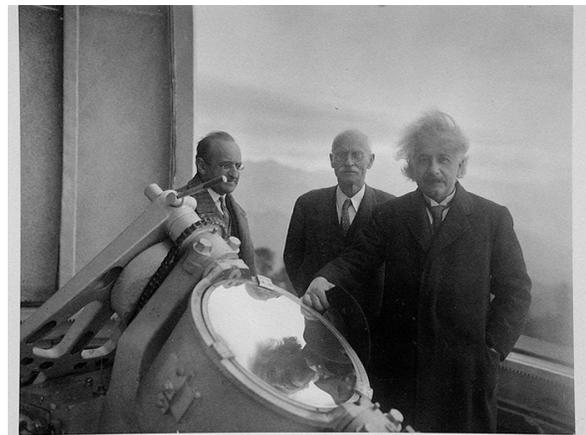
Einstein's 1915 Theory of General Relativity did away with Newton's 'action at a distance', which even Newton disliked. "All physics is local," ran the new paradigm. Objects don't instantly react to forces emanating at infinite speed from a distant object—they respond to the local warping of space, produced by the presence of mass, which sends its influence out at the speed of light.

But is "warped space" real? Space does not really behave like a substance in Einstein's theory—it is not "substantial". And now, physicists are trying to develop the theory strictly from the requirements of cause and ef-

ACTIVITY TIP: Einstein's famous 1913 letter to Hale on the bending of light around the sun is at the Huntington Library. At the time of writing, a facsimile is on display to protect the original—but the books at the Dibner Hall are all the real deal—and well worth a visit. See the Huntington Library website for information.



Einstein visited the Mount Wilson Observatory on January 29, 1931. He is shown looking through the 100" telescope with Hubble (right), standing by the 150' solar tower coelostat mirror (below right) with his mathematician-assistant Walther Mayer and solar astronomer Charles St. John (standing at center) and on the bridge (below) in front of the 100" telescope dome. Einstein, a former patent clerk and sometime-inventor, impressed the staff with his very down-to-earth knowledge of the mechanics of telescopes. He poses with luminaries at the Carnegie Observatory headquarters, Santa Barbara Street, Pasadena (bottom). Recognize any? (See next page.)



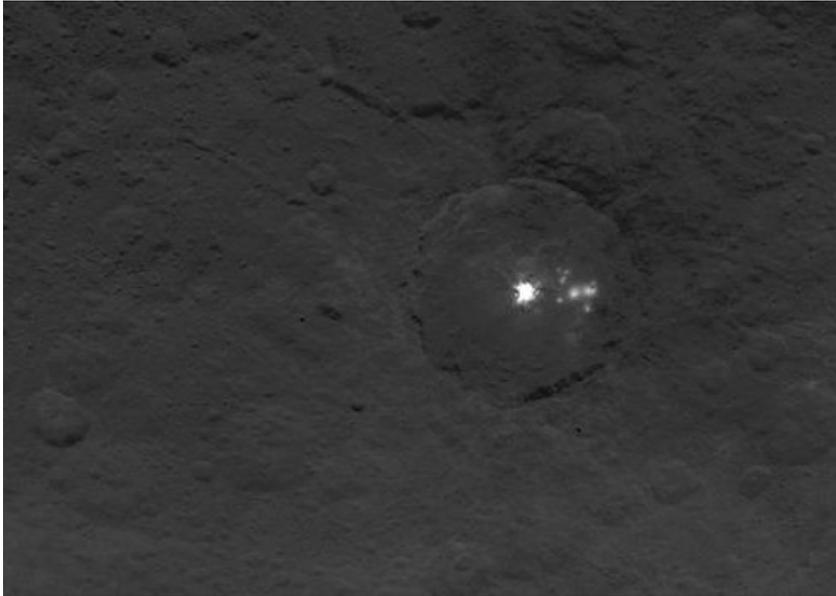
Learning of Hubble's work on the recession speeds of galaxies, and of Georges Lemaitre's theory of the expansion of the universe, Einstein revised his earlier, static model of cosmology, known as "Solution A".

Einstein had tied this theoretical model to observations made with the 60" telescope at Mt. Wilson. Now, Hubble's results on the 100", along with the theories of Lemaitre, Tolman and deSitter, led him to revise his thinking.

According to George Gamow, Einstein referred to his forced, unstable, static solution as his "greatest blunder". But, resistant to the idea of a beginning, he (and others) proposed that we could avoid a singular "Big Bang" by having galaxies fling around each other at the time of greatest density, and propel each other outward again. Mistake #2?

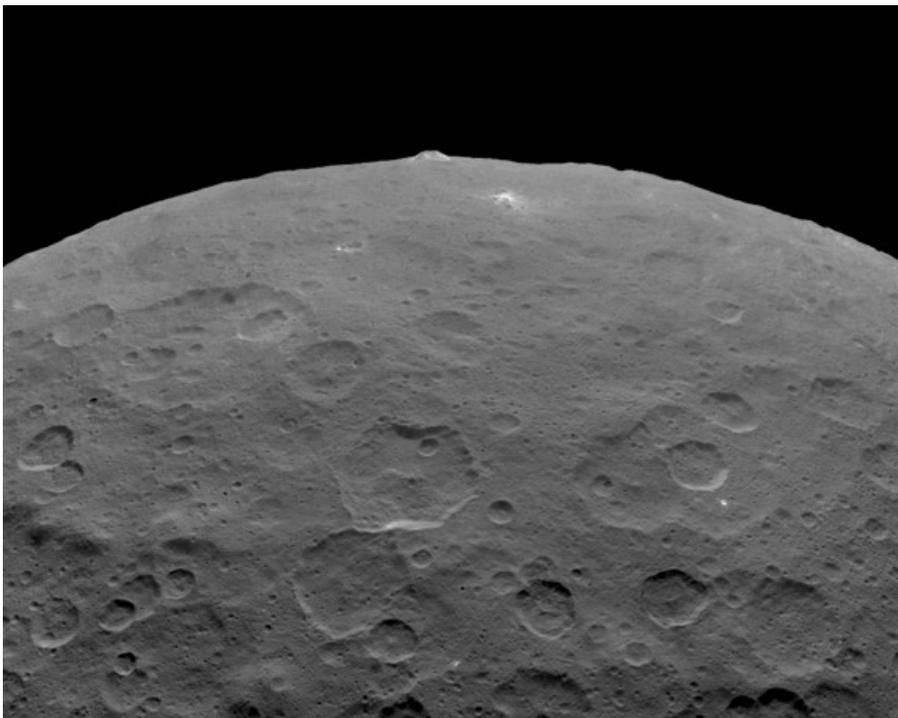
Einstein's work had consequences so profound—from black holes to quantum particles to an expanding universe—that it would take decades to verify them. Who wouldn't want to be able to make 'blunders' like that?

The Dawn Mission reveals ever more mysterious features on Ceres...



The "Eyes"

"The surface of Ceres has revealed many interesting and unique features. For example, icy moons in the outer solar system have craters with central pits, but on Ceres central pits in large craters are much more common. These and other features will allow us to understand the inner structure of Ceres that we cannot sense directly," said Carol Raymond, deputy principal investigator for the Dawn mission, based at NASA's Jet Propulsion Laboratory in Pasadena, California.



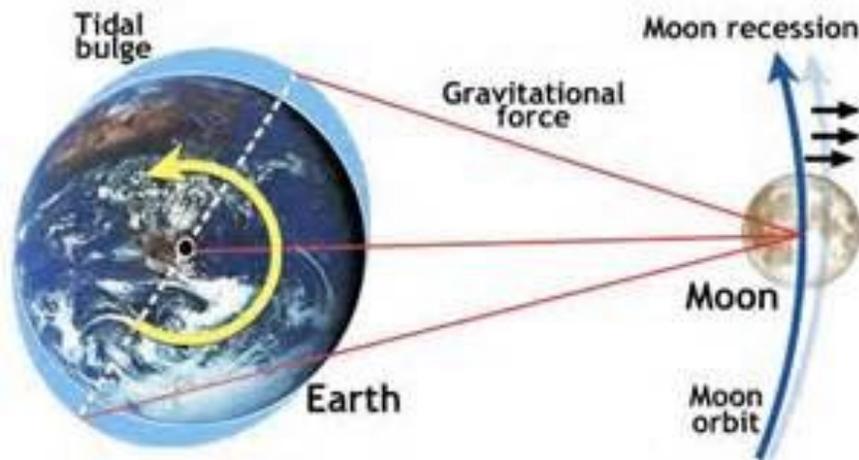
A surprising mountain...

Among the fascinating features on dwarf planet Ceres is an intriguing pyramid-shaped mountain protruding from a relatively smooth area. Scientists estimate that this structure rises about 3 miles (5 kilometers) above the surface. NASA's Dawn spacecraft took this image from an altitude of 2,700 miles (4,400 kilometers). The image, with a resolution of 1,400 feet (410 meters) per pixel, was taken on June 6, 2015.

—JPL

The feature is center top in the image. Volcano? Tectonic feature? Central peak of eroded crater? Other...?

Go to the Dawn Mission website!



What's slowing the earth's rotation, and lengthening the day? Mostly, it's the tides. The moon produces a tidal bulge on the earth, and earth's rotation—through friction—pulls that bulge ahead of the moon's position. The gravitational force between that bulge and the moon causes the earth to slow, and the moon to speed up—and move away from us by several centimeters a year.

If the moon orbited in *less* time than earth rotates, it would speed up the earth—but the moon would be doomed. “Doomed” moons, which orbit in less time than their planets rotate, include the Martian satellite Phobos, and Jupiter's innermost moons Metis and Adrastea.

Some have predicted that the moon and the earth will become locked, with the day and the month equaling each other—but it appears likely that the brightening sun will cause earth's oceans to boil away in 2 billion years or so, thus ending the ocean tides for good! (Land tides are a much smaller effect.)

How's that for good news?

At Carnegie, left to right in the picture: Milton Humason, Edwin Hubble, Charles St. John, Albert Michelson, Einstein, William Wallace Campbell (Lick Observatory), Walter Adams (Mt. Wilson). Humason measured galactic redshifts at Mt. Wilson; St. John checked for the sun's gravitational redshift. Michelson measured the speed of light, and became the first American to win a Nobel Prize (1907).



ABOUT OUR MULTI-TALENTED SPEAKER FOR JULY:

TIM THOMPSON: TIM THOMPSON RECEIVED HIS DEGREES IN PHYSICS FROM CALIFORNIA STATE UNIVERSITY AT LOS ANGELES; B.S. IN 1978 AND M.S. IN 1987. HE JOINED THE JET PROPULSION LABORATORY TECHNICAL STAFF IN JANUARY 1981, AND RETIRED FROM JPL IN NOVEMBER 2008. HE EARNED TWO NASA GROUP ACHIEVEMENT AWARDS FOR HIS PARTICIPATION IN THE NASA SEARCH FOR EXTRATERRESTRIAL INTELLIGENCE (SETI) PROJECT, AND HIS WORK AS A SCIENCE TEAM MEMBER FOR THE ADVANCED SPACEBORNE THERMAL EMISSION AND REFLECTION RADIOMETER (ASTER) PROJECT, AS WELL AS A NASA/JPL CENTER AWARD FOR HIS ROLE IN ESTABLISHING THE CENTER FOR LONG WAVELENGTH ASTROPHYSICS. AT JPL HE GAINED BROAD RESEARCH EXPERIENCE IN RADIO AND INFRARED ASTRONOMY, INFRARED GEOLOGICAL REMOTE SENSING, AND ATMOSPHERIC PHYSICS & CHEMISTRY. BUT TIM IS ALSO AN AMATEUR ASTRONOMER. A LONG TIME MEMBER AND FORMER PRESIDENT OF THE LOS ANGELES ASTRONOMICAL SOCIETY, HE RECEIVED THE SOCIETY'S LIFETIME ACHIEVEMENT AWARD IN 2004, AND IS THE RECIPIENT OF THE 2015 G. BRUCE BLAIR MEDAL FROM THE WESTERN AMATEUR ASTRONOMERS. TIM HAS BEEN A DOCENT & TOUR GUIDE AT MT. WILSON OBSERVATORY SINCE 1982, AND RESIDENT ASTRONOMER AT THE GARVEY RANCH OBSERVATORY, IN THE CITY OF MONTEREY PARK, SINCE 1975. IN OTHER AREAS, TIM HAS BEEN A REGULAR TOURNAMENT CHESS PLAYER SINCE 1968, AND IS A MINOR COLLECTOR OF RARE BOOKS ON SCIENCE & HISTORY.



Did you see the close conjunction (as advertised in the last “Observer”!) between Venus and Jupiter on June 30?

The two planets are still close to each other, and a beautiful sight.

The highest clouds, still shining in the background, are “noctilucent” clouds. These form at the astonishing altitude of 50 miles, far higher than even the wispy cirrus clouds seen at airplane-level.

Noctilucent clouds, when they form, inhabit the coldest layer of our atmosphere, the mesopause. This sits atop the mesosphere, which in turn lies above the ozone-containing stratosphere.

These mysterious clouds may be ‘seeded’ by meteoritic dust. The severe cold allows tiny ice crystals to form, even in this ultra-dry layer.

How cold is it? Temperatures approach -150°F , so it’s not exactly cozy. No high-altitude balloon skydiver has even approached this level of the atmosphere—the stratosphere is still the highest layer they have reached.

See “APOD” for more details.

Sky Events for July: A star map should appear as a separate pdf file with this month's "Observer". Education and outreach groups, such as our club, have full permission to use and reproduce up to 300 copies of this sky calendar, for free distribution only.

Enjoy!

