VIEW
PISGAH ASTRONOMICAL RESEARCH INSTITUTE
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New executive director joins PARI

Stephen F. (Steve) Saucier has been selected to serve as PARI's new executive director. Ken Steiner, who served as interim director for the past year, has returned to his role as a key volunteer for special projects and is currently working on the 12m radio telescope restoration.

Saucier comes to PARI from the NC Grassroots Science Museums Collaborative, where he served as Executive Director for the past four years. The Collaborative is a statewide network of 35 science centers, museums and children's museums dedicated to advancing STEM education. During his tenure at the Collaborative, Saucier developed a new advocacy system and annual advocacy plans that resulted in $13.6 million in funding with an additional $4.9 million pending for the next two years. He also spearheaded a new strategic plan to guide the Collaborative into greater economic development-based roles throughout the state.

"PARI is an active member of the NC Grassroots Science Museums Collaborative," said Saucier, "so I've worked closely with the PARI team for several years. I am very much aware of PARI's deep, rich history in the sciences of space flight, astronomy and science and technology education. Building on this platform, we are embarking on a planning process to create a robust vision for PARI's future focusing on cultivating a new generation of science learners and doers."

PARI Calendar

January 26	SciGirls
January 30-31	Astronomy Days - NCMNS
February 6	Volunteer Training
February 9-13	3D Planets - Salisbury, NC
February 12	Evening at PARI
February 16-17	Western Regional Science Fair
February 23	SciGirls
March 4	Volunteer Training

Smithsonian loans satellite for PARI Exhibit Gallery

Alex Alexander and Ken Steiner stand with the newest addition to the Space Artifacts wing of PARI's Exhibit Gallery, an ATS-6 satellite on loan from the Smithsonian Institution. The loan is a homecoming of sorts for the historic ATS. PARI's predecessor, NASA's Rosman Tracking Station, was the primary data collection facility for the series of Application Technology Satellites (ATS) that culminated with the ATS-6.

From the ATS satellite transmissions, the Rosman Station received the first full-disk Earth images from geosynchronous orbit and the first full-Earth cloud cover images. An ATS-6, like the one on display at PARI, was the first satellite to broadcast TV directly to small community antennas.

PARI's Exhibit Gallery is open to visitors from 9-4, Monday through Saturday.

From intern to employee, Tim DeLisle is a PARI success story

Tim DeLisle spent the past two summers on the PARI campus as an undergraduate intern. He is now our newest fulltime employee, having joined the staff as manager of software development. In 2014, Tim was the EMC intern and rebuilt the Smiley control system. Last summer he was the Ron Kelly intern and created a similar control system for the 12m telescope.

As a fulltime staffer, Tim will create and maintain software packages that allow the local and remote control of telescopes and other equipment. He will aid in the collection, storage and analysis of data from those instruments, as well as assisting with computer science educational programs.

Tim is originally from Maine but has lived in NC for nine years. He is currently completing a degree in computer science from UNC-Greensboro and will finish his last class online this semester.

PARI's 3D Planets program receives additional corporate support

Red Hat employees Felicia Akers and Mary Hall are shown with some of the laptops being donated to PARI's 3D Planet program.

Two major corporations, Red Hat and Oceanside Photo & Telescope (OPT), have made significant donations to further expand PARI's 3D Planets program.

3D Planets is a series of weeklong workshops for girls between the ages of 9 and 13. The girls learn about lunar and planetary altimeter data, 3D design and 3D printing, then apply their knowledge to design new tools for educators in North Carolina's science museums to use for people with visual impairments. The program is funded by a grant from the Burroughs Wellcome Fund and is intended for workshops within North Carolina.

The program has gained national attention that prompted OPT to raise $8650 through a raffle at the Southern California Astronomy Expo. The donation will be used to expand the 3D Planets program outside North Carolina. OPT is one of the top telescope retailers in the world and is located in Oceanside, CA.

Based in Raleigh, Red Hat is the world's leading provider of open source enterprise software and provides IT solutions to more than 90% of Fortune 500 companies. A Red Hat software engineer, Austin McDonald, assisted with a 3D Planets workshop last summer and was so impressed with the program he organized a donation of 16 laptops.

PARI Profile - Donnie Curto

Donnie Curto has been a mainstay of the PARI staff for 15 years and is largely responsible for all the behind-the-scenes maintenance that keeps PARI operational 24/7. Currently Facilities Coordinator, Donnie is responsible for installing new plumbing and electrical systems, maintaining vehicles and assisting with a host of buildings and grounds maintenance tasks.

Donnie and his wife Marina live in Lake Toxaway. Their family includes two grown children and one grandchild.

Planets explored during PARI Fall Homeschool Day

With the appearance of Venus, Mars and Jupiter in the fall morning sky “What is a Planet” was an especially relevant topic for PARI’s annual Fall Homeschool Day.

Students being schooled at home and their parents or chaperones spent a day on campus exploring the many different kinds of objects in our solar system, their characteristics and how they move through and around the solar system.

PARI educators and astronomers designed grade appropriate (K-2, 3-5, 6-12) modules so the students could learn to develop their own ideas about the definition of planets and discuss the categories of solar system objects with critical thinking.

PARI conducts two Homeschool Days, spring and fall, each year. And, as these photos indicate, they are always days of fun-filled, hands-on learning.

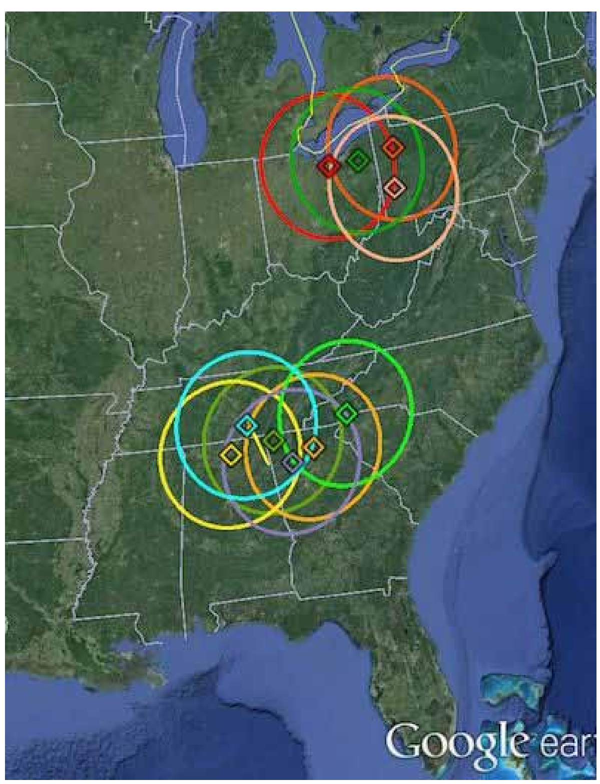
RESEARCH UPDATE

Michael Castelaz, Director of Science

External Research at PARI

In this newsletter, we bring you up-to-date on research projects at PARI brought in by visiting scientists. The image of the PARI campus (credit: Don Cline) pinpoints the locations of each of the projects, and descriptions follow the image.

A. NASA Marshall Space Flight Center (MSFC) All-Sky Fireball Network. The MSFC Fireball Network, led by Dr. Bill Cooke, operates multiple all-sky cameras throughout the United Starts. The objective is to measure the speeds and masses of bright meteors by observing their trajectories from several different all-sky cameras. An explanation of the data and current data can be found at http://fireballs.ndc.nasa.gov/helpme.html. The map below shows the location of the Fireball camera at PARI with respect to others in the Eastern U.S.



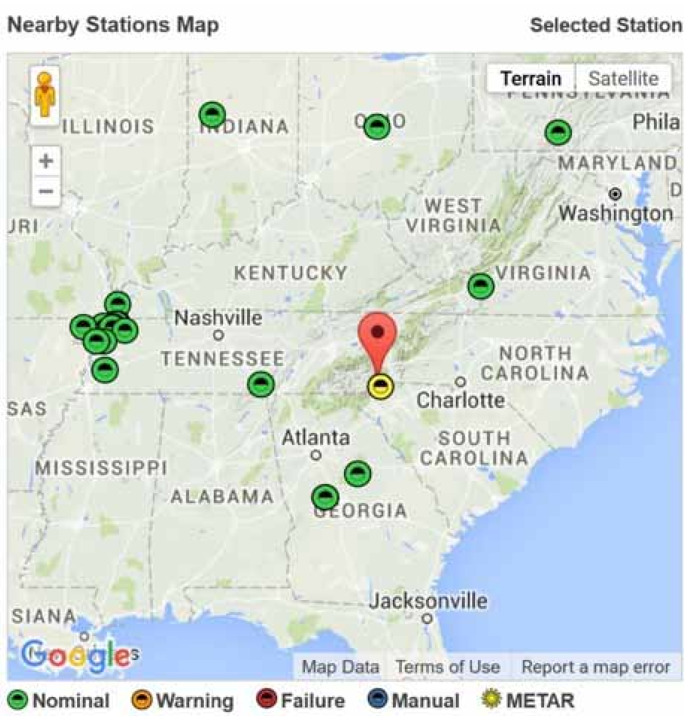
RESEARCH UPDATE continued

B. Geomagnetometer. This study is being conducted by Ron Speer, non-affiliated, to determine the effect of solar flares on the Earth's magnetic field. Ron's instrument measures the earth's magnetic field vector at PARI's location. The instrument uses 3 flux-gate type magnetometer sensors oriented 90 degrees to each other and aligned with respect to geographic north, east and zenith. The instrument is entirely solar powered and raw data from the sensors is transmitted via fiber optics to a desktop computer in the Cline Administration Building for processing. One-minute averages are displayed and published on the PARI website. The data is also archived to the PARI data center. Current data is accessible at http://www.pari.edu/telescopes/geoscience/geomagnetometer/

C. Research using APDA, the Astronomical Photographic Data Archive. The 250,000 astronomical photographic plates and films continue to generate interest. We are currently digitizing a series of films with ultraviolet spectra of stars taken during the SkyLab Mission, America' first space station that orbited the Earth from 1973 to 1979. Other current projects include the search for novae and the digitizing of a series of plates with images representative of data that is currently being obtained by the Gaia space-based telescope.

D. Clemson University Fabry-Perot interferometer. The experiment conducted with the Clemson Fabry Perot Interferometer (FPI) at PARI, led by Dr. John Meriwether, detects airglow from neutral oxygen in the thermosphere at an altitude of 100-200 km. The airglow passes through a 630 nm interference filter to the etalon of the FPI. The etalon produces an interference image on a CCD detector and appears as a series of concentric rings. The radius of a ring and the thickness of a ring are the Doppler broadening and Doppler shift of the neutral oxygen along the line of sight. The data from the FPI fills a critical role in measuring mid-latitude winds and temperatures in the thermosphere. The instrument has now been in operation for more than 8 years.

E. EarthScope Plate Boundary Observatory. The Plate Boundary Observatory at PARI is one of 16 detectors located east of the Mississippi, shown in the map below.



RESEARCH UPDATE continued

The detectors measure tectonic plate motion using GPS millimeter measurements. The data can be found at http://pbo.unavco.org/station/overview/P779/ and includes raw data, quality checked data, processed data, and both static and interactive plots of the data. Visiting PARI, the detector shown below is located on the road to the PARI Nature Center.

F. Radio Frequency Meteor Detection Instrument. David Olday, non-affiliated, has set up a detector that reads radio frequency reflections from meteors. The instrument is found in the Cline Administration Building Control Room. This instrument is relatively new, being in operation since the Summer 2015.

G. Atmospheric Weather Electromagnetic System for Observation Modeling and Education (AWESOME). This research is led by Dr. Morris Cohen and his grad student, Jackson McCormick, from Georgia Tech. The research is focused on measuring distant lightning by picking up the radio signal given off by lightning strikes in the very low frequency range. The antenna is shown in the image below with an image of the AWESOME console located in the Cline Administration Building Control Room. The antenna is very long to pick up those low frequency (long wavelength) signals.

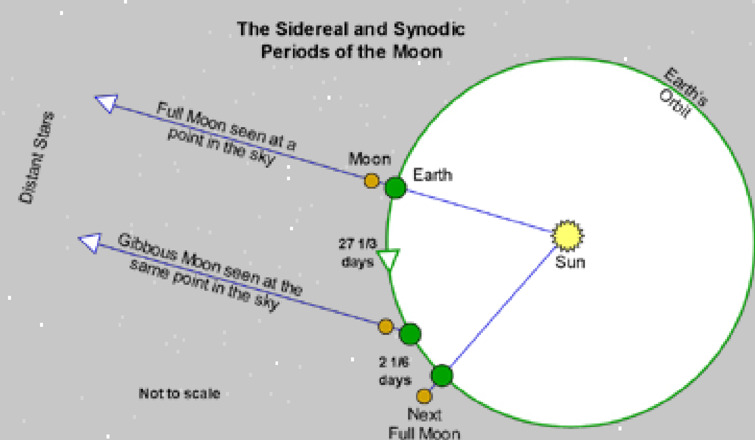
Calendars and Leap Year

astronomer's corner
Dr. Bob Hayward, Astronomer/Educator

Introduction: Not too long after reading this article you will be getting up at 2 a.m. to set your clock forward, i.e., “spring forward,” as we in the United States change over from Standard Time to Daylight Time. Well, whether you cheat like I do and set your clocks forward before you go to bed Saturday or get up at 2 a.m., you lose an hour of sleep that night. If you forget to do it, you will be an hour late to church or your tee time the next morning.

If you think losing an hour is bad, how would you like to been living somewhere in continental Europe in 1582? On October 4 of that year you would have gone to bed as usual; but, when you woke up the next morning, you would find it was October 15! Whoa! You would have been missing ten days, not merely a single hour. For those people living in the Roman Catholic countries of the world, this occurrence was the result of a change in the calendar decreed by Pope Gregory XIII. It was an effort to once again synchronize the calendar with the seasons of the year. When I say “once again” I’m implying that it had been done before. So, let’s take a brief look at the calendar through the ages. First, a little astronomy as background…

The Moon: Until very modern times timekeeping has depended on the motions of astronomical objects, in particular, the sun and the moon. As observations of these two objects became more precise, calendars needed to follow suit. The word “month” comes from the same root as the word “moon.” Actually, we use this connection to try to get students in our classes to remember that it takes a month for the moon to orbit around the earth one time. In actuality, it takes about 29½ days for the moon to orbit the earth if we measure it with respect to the phases of the moon, e.g., full moon to full moon or new moon to new moon. This period is called the synodic month. We could also measure the length of the month by timing how long it takes the moon to go from one point in its orbit as viewed against the background stars to the next time it reaches the same point on the celestial sphere. This is called the sidereal month and is 27⅓ days long. The difference is due to the motion of the earth-moon system around the sun during the intervening month.



The Babylonians: The ancient Babylonians used the synodic month to set their calendar. They had a calendar that consisted of 12 months of 29½ days each for a total of 354 days. There’s just one problem with this; the year is closer to 365 days in length. Thus, the year on their calendar started 11 days earlier from year to year and very quickly got out of synchronization with the seasons. The Islamic calendar still is a lunar calendar (In practice, alternate months have 29 or 30 days.) and, thus, their religious holidays shift through the secular calendar used in international date keeping.

The Egyptians: The ancient Egyptians tied their calendar to the flooding of the Nile River. They watched the stars in the morning sky and when they spotted the star Sothis (known to us as Sirius or the Dog Star) rising with the morning sun (a heliacal rising), they knew the Nile was about to experience its annual flooding that was so important to those living along its banks. Records show, however, that the Egyptians did recognize that the year is approximately 365¼ days long, not 354 or even 365. However, we have no records that indicate they adjusted their calendar accordingly.

Calendars and Leap Year (continued)

The Romans: In the early years of the Roman Empire, the Romans were using a lunar calendar like the Babylonians and Egyptians before them. The Roman calendar was ten months long with the months being named after various gods or just numbers. We have the remnants of their system in our modern calendar. For example, the seventh month of the year on their calendar was September after the Latin word for seven, i.e., septem. And the last month of their year was December after the Latin decem for the number ten. Later, they added two months to the end of the calendar, Januarius and Februarius. Thus, they had a calendar of twelve months starting in Martius and ending in Februarius.

Julius Caesar

The Julian Calendar: By 47 BC the calendar was out of synchronization with the seasons and spring was occurring in June. Julius Caesar tasked the Greek astronomer Sosigenes of Alexandria to come up with a solution to this problem. Sosigines developed what is known as the Julian calendar named, of course, after his emperor. The months alternated 30 and 31 days with 29 in February, still the end of the year. Every fourth year February had 30 days to make the average length of the year 365¼ days.

Following the death of Julius Caesar, Quintillis, the fifth month of the year, was renamed Julius (July) in his honor. Later, his successor Augustus Caesar renamed Sextillis, the sixth month of the year, in his own honor. Now, the newly renamed sixth month Augustus had a mere 30 days while July had 31. That was unacceptable to Augustus so he "stole" a day from the end of the year and made August 31 days long just like July. Thus, poor February remains only 28 days long, 29 in leap years, to this day!

The Julian calendar was used throughout the western world for centuries to follow. In 1563 King Charles IX of France became concerned that the now Christian celebration of Christmas was embedded well into the end of the year instead of near the beginning. So he had the calendar changed such that January was made the first month of the year. Thus, September, named after the Latin for the number seven, became the ninth month of the year, October named after the Latin for eight became the tenth month, etc.

Our Gregorian Calendar: So, the calendar was now 365¼ days long, i.e., 365.2500 days long. But, there's a problem with that. The earth is not quite that cooperative and the length of the year in the real astronomical world is actually 365.2422 days long. This is known as the tropical year and it's a whole eleven minutes shorter than the average length of the year in the Julian calendar. Curses! By 1500 this eleven minutes per year had accumulated to ten days and the first day of spring was occurring on March 11 instead of March 21. The Roman Catholic Church used (and still does) the beginning of spring along with the phases of the moon to calculate the dates of Easter. So, this situation was totally unacceptable.

Following a study by a committee Pope Gregory XIII fixed this by eliminating ten days from the calendar year. He decreed that March 4, 1582 would be followed by March 15. People rioted since they thought that would chop ten days off their lifetimes.

Pope Gregory XIII

Calendars and Leap Year (continued)

Tradition says tenants opposed paying a month's rent for the month of March since it had only 21 days and bankers did not want to pay a full month's interest. But, things gradually settled down.

Rules for Leap Year: The other part of the pope's decree, in order to avoid this happening again, was to change the rules for leap years. Here are the rules for leap year under the Gregorian Calendar which we now follow…

- Every year has 365 days except leap years in which poor February gets one of its lost days back making it 29 days long. Leap years are years that are evenly divisible by 4. However,….
- Century years, those evenly divisible by 100, are not leap years and February doesn't get an extra day. Unless….
- If the Century year is evenly divisible by 400, then it is a leap year.

So, where does that leave us? 2016 is a leap year since it is evenly divisible by 4. 2000 was a leap year since it was a century year evenly divisible by 400. But, 2100 will not be a leap year even though it is evenly divisible by 4 and is a century year evenly divisible by 100; it is not evenly divisible by 400. Thus, 2096 will be a leap year followed by seven years that are not leap years until the year 2104. Put a reminder on your calendar.

When will these rules require another calendar correction? This correction makes the average length of the year under the Gregorian Calendar 365.2425 days long. That is 0.0003 day longer than the true length of the tropical year. That error amounts to one day in 3226 years! We will need to correct the Gregorian Calendar by one day about the year 5000 AD. Don't let it worry you!

The Protestant Countries: Okay! You would think things could not get more complicated. But, they did. Remember that by 1582 the Reformation had occurred. There was no way the Protestant countries were going to abide by a decree from the pope. England, which was mainly Protestant, did not change its calendar nor did its colonies including the American colonies. It was not until September 2, 1752 that the Protestant countries finally got in step with the rest of the world. By that time the error in the Julian calendar had accumulated an additional day to eleven days. Other countries were even slower in making the change. For example, Russia didn't change to the Gregorian Calendar until 1918 when the error had accumulated to thirteen days. In Russia January 31, 1918 was followed by February 14, 1918.

George Washington's Birthdate: An interesting footnote to this has to do with the birthdate of our first President. When George Washington was born in 1732 (or 1731, bear with me) the colonies were still under the Julian Calendar and he was born on February 11. However, those of you who are as old as I am, remember that before Congress established the Presidents Day holiday, we used to celebrate Abraham Lincoln's birthday on February 12 and George Washington's on February 22. You see, of course, that his birthday of February 11 under the Julian Calendar translates into February 22 under the Gregorian Calendar when one takes into account the eleven days the two calendars were apart.

But, wait a minute. Wasn't George Washington born in 1731, not 1732? Well, yes….and, no. Here's the additional complication. In England prior to 1752 the year still ran through March 24; the new year began on March 25 each year. So, George Washington was born on February 11, 1731 in what has become known as "old style." Under the Gregorian Calendar our first President was born on February 22, 1732.

Calendars and Leap Year (continued)

Double Dating (not what you think): Those of you who are involved in the very popular hobby of genealogy like I am will be familiar with what is known as "double dating." Double dating occurs for ancestral events (births, deaths, etc.) which occurred January 1 through March 24 in a year before the changeover to the Gregorian Calendar. For example, in double dating George Washington's birthday would be listed as February 22, 1731/32 meaning that the year was 1731 under the Julian Calendar in use at the time of the event but is 1732 in the calendar we now use. It was recorded in contemporary records as 1731 but would be 1732 in the Gregorian Calendar. Clear? That's okay; I have to look up how it goes each time I encounter such an event in my genealogy research.

The World Calendar: So, here we are with a calendar used almost worldwide that works pretty well but still has some flaws. Do you remember "Thirty days has September.." etc.? The lengths of the months vary from 28 through 31 days. Why? And the lengths of the quarters are different. And each quarter begins on a different day. And one year is different from the last even if they have the same number of days. This is great for the companies that print calendars. But, isn't there a better way?

Some people have suggested a change to what has been called the World Calendar. This has even been considered by the United Nations Economic and Social Council. Here's the general outline of the proposed World Calendar:

THE WORLD CALENDAR

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

MARCH

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

APRIL

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

MAY

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

JUNE

S	M	T	W	T	F	S	
					1	2	
3	4	5	6	7	8	9	
10	11	12	13	14	15	16	
17	18	19	20	21	22	23	
24	25	26	27	28	29	30	W

JULY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

AUGUST

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			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

SEPTEMBER

S	M	T	W	T	F	S
					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCTOBER

S	M	T	W	T	F	S
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

NOVEMBER

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30		

DECEMBER

S	M	T	W	T	F	S	
					1	2	
3	4	5	6	7	8	9	
10	11	12	13	14	15	16	
17	18	19	20	21	22	23	
24	25	26	27	28	29	30	W

- Each quarter would consist of three months of 31, 30 and 30 days for a total of 91 days, exactly 13 weeks.
- Each quarter would be identical. You would need only one calendar of three months and that calendar would apply four times per year, year after year. Holidays and remembered events would occur on the same day of the week in the same month of the quarter, year after year after year.
- Since four quarters of 91 days each would total to 364 days, there would be an extra day inserted between December 30 and January 1. It would be called Worldsday and would not count as any day of the week. It would be a worldwide holiday! In other words Saturday, December 30 would be followed by Worldsday which would be followed by Sunday, January 1… every year!
- Leap year rules would be the same as for the Gregorian Calendar making the average year 365.2425 days long. In leap years an additional Worldsday would be inserted between Saturday, June 30 and Sunday July 1.
- And poor February would have 30 days permanently!

Calendars and Leap Year (continued)

There are lots of conveniences and economic reasons to change to a World Calendar worldwide. There are social and religious objections to doing so.

Summary: So, the Gregorian Calendar we now use and which gives us a leap day February 29, 2016 is the result of much trial and error over the past millennia. It is the result of more precise measurements of the revolution period of the earth around the sun, i.e., the length of the year. But, don't worry, scientists have known for a long time that the gravitational pull of the moon on the earth is causing the earth's rotation to slow down. Gradually, the lengthening of the length of the day will affect just how many days there are in a year.

Just recently a team of researchers at Harvard University have modeled the earth's spin as glaciers melt and sea levels rise with global warming, more water moves towards the poles. This will change the gravitational inertia of the earth enough to contribute to the slowing of its rotation, thus changing the length of the day and, thus, the number of days in a year.

However, these effects are extremely slow, amounting to about 4½ hours since 500 BC due to a combination of all causes. So, neither the Gregorian nor the World Calendar will need to be changed accordingly any time soon and I'll wait a couple of centuries before I write a sequel to this "Astronomer's Corner." Please be patient!

PS: Don't forget to set you clocks forward an hour at 2 a.m., Sunday, March 6, 2016.

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PARI needs your help!

PARI is a public not-for-profit foundation. Financially, we are dependent upon contributions and grants for our educational and research programs, and for the many operating expenses associated with maintaining the campus and our facilities.

If you have recently contributed, we thank you for your support. If not, please help support PARI and our mission with a contribution. PARI is a
501 c(3) organization and all donations are tax deductible to the full amount allowed by law.
PARI recognizes donors with various "Friends of PARI" membership levels and benefits. Individuals, couples and groups can also obtain annual membership benefits with contributions ranging from $100 to $300. Complete information for all giving levels and benefits can be found at www.pari.edu.

Jo Cline Memorial Fund

The Jo Cline Memorial Fund has been established at PARI to honor "The First Lady of PARI," who passed away in July. Jo was a loving partner with her husband, Don, in business, ballooning, education and philanthropy. Together, they founded PARI and Jo served as Chairman of the Board for most of the years of PARI's existence. She is memorialized at PARI with a scenic park in the heart of the campus, Jo's Cove.

Tax deductible contributions can be sent to PARI, 1 PARI Drive, Rosman, NC 28772. Please specifically designate your donation to the Jo Cline Memorial Fund.

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The Pisgah Astronomical Research Institute (PARI) is a public not-for-profit 501 (c)(3) foundation established in 1998. Located in the Pisgah Forest 30 miles southwest of Asheville, NC, the PARI campus is a dark sky location for astronomy and was selected in 1962 by NASA as the site for one of the first U.S. satellite tracking facilities. Today, the 200 acre campus houses radio and optical telescopes, earth science instruments, 30 buildings, a fulltime staff and all the infrastructure necessary to support STEM (science, technology, engineering and math) education and research. PARI offers educational programs at all levels, from K-12 through post-graduate research. PARI is home to the Astronomical Photographic Data Archive and a member of the NC Grassroots Science Museums Collaborative.
PARI's Exhibit Gallerydisplays a collection of rare meteorites as well as NASA Space Shuttle artifacts, many of which have flown in space. For more information about PARI and its programs, visit www.pari.edu. Follow PARI on Twitter at http://twitter.com/Astronomy_PARI. "Like" PARI on Facebook at www.facebook.com/Pisgah.Astronomical.Research.Institute.