EYEPIECE

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Webb Telescope Will Go Where None Have Gone Before

By Edward J. Fox

The upcoming James Webb Space Telescope (JWST) will be an ultimate science mission, designed to look back to the post-natal early period of the universe--the very early galaxies that formed after the Big Bang—attendees at a February 8 Hayden lecture heard.

The status of the JWST was discussed by Jon Arenberg, deputy systems engineer of Northrop-Grumman, a major JWST contractor. Key to Webb's great look-back capabilities will be that it will probe the early universe in the infrared, he noted.

Arenberg observed that all parts of the universe are moving away from us and the more distant from us an object is, the faster it is moving away. As objects move away at high speeds, the light from them is shifted into the infrared. So to see the most distant objects--those first galaxies--it's necessary to see in the infrared. According to Arenberg, "The JWST will see small faint objects in the infrared anywhere in the sky." It will also be used to study exoplanets and the solar system, and will be able to look through dust clouds.

Arenberg is the design integration lead on the telescope. His team must make sure that various systems, which have been in development since 1989, work together. The JWST is a joint development of NASA, the European Space Agency, Canada and numerous other participants.

Because it's being designed to see very faint distant objects, the JWST must be very stable. Since, at 1 million miles, it will be too far from Earth to be serviced, there will be no service calls as with the Hubble.

The team will design and build so JSTW is "affordable and long lived, the best possible deal for the taxpayer." It will save significant weight.

According to Arenberg, the design "has to be buildable, with no reinvention of the wheel."

The JWST will be a very large space telescope. The larger the light-collecting surface, the fainter the objects it can see. The telescope will fold out. It will have individual mirror segments, each with 7 degrees of freedom of movement and able to be reconfigured in degree of curvature. They'll be made of gold-coated beryllium, which will maintain shape at operational temperatures.

The telescope will operate just degrees above absolute zero. It will be "passively cooled," without a main cooling system. Rather, it's designed to radiate heat into space and to shade the telescope side from the Sun. This sunshade is provided by a five-layer shield that will unfold after launch. It will allow the telescope to get cold and to stay cold.

The JWST will operate at the Lagrange 2 point, on the side of Earth away from the Sun. Even at this point of stability of gravitation, the telescope will be actively held in orbit, and thus will require some fuel. It also will require fuel for maintaining its orientation to shield itself from the Sun. The fuel requirement will limit its life to some five years. Developers hope that as much as 10 years of operation may be possible since after the design is complete, the telescope's final weight will determine how much fuel can be loaded.

The current schedule calls for a 2014 launch. As the JWST speeds toward L2, the sunshade will open and the mirrors will unfold to be a light-collecting source about six times the size of the Hubble's. The JWST will speed

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What's Up

By Tony Hoffman

The Sky for March 2010

Saturn's Equinoctial Opposition. This year, the spring equinox falls on March 20. The following day, Saturn reaches opposition in Virgo, and is at its closest and brightest of the year. Still, at magnitude 0.5 it's not particularly bright. That's because Saturn's rings are still nearly edge-on to our line of sight, tilted a mere 3 degrees. Titan, Saturn's largest moon, should be visible in even a 2-inch telescope, and I can see several more moons in my 4-inch refractor.

Two constellations over, in Cancer, Mars is still brilliant at magnitude -0.6 as the month opens. Its disk spans 12 arc-seconds. By month's end, it will have shrunk to 9, meaning that you'll need a 8-inch or larger scope to hope to resolve much detail on the surface.

Minor planet 4 Vesta, which last month "threaded the needle" between Gamma Leonis and the star's 4th-magnitude companion, remains in the vicinity of Gamma Leonis for most of March. By month's end the asteroid, which at magnitude 6.8 is still an easy binocular object, moves to within a degree of Epsilon Leonis.

Venus continues its slow climb out of the evening twilight. By month's end it shines at magnitude -3.9 and sets an hour and a half after the Sun. In the last week of the month, Venus is joined by Mercury, at the start of its best evening apparition of the year. On March 31, Mercury lies just 3 degrees from Venus and will shine at magnitude -1.0.

March 2 Moon lies near Saturn.
March 7 Last-quarter Moon at 10:42 a.m.
March 15 New Moon at 5:01 a.m.
March 17 Moon lies 7 degrees from Venus.
March 20 Vernal equinox at 1:32 p.m.
March 21 Saturn at opposition.
March 23 First-quarter Moon at 7 a.m.
March 25 Moon lies near Mars.
March 28 Moon at perigee, 224,859 miles from Earth, 12:59 a.m.
March 29 Moon lies near Saturn; full Moon at 10:25 p.m.

Mars and Moon Shone Bright

By Joseph A. Fedrick

During the nights of January and the first half of February, Mars and the Moon shone bright, although the frost was cruel. Mars was gleaming bright in my 60mm refractor at 100x when I glimpsed a large, fairly well defined dark gray triangular area, Syrtis Major on the coral pink Martian disk, on the mornings of January 20 and 21 from 6:30 a. m. to 7 a. m. The north polar cap was also visible.

On the evening of January 29, an unusually bright and large full Moon shone about 7 degrees to the right of Mars. The 100x eyepiece of my 600 refractor revealed faint gray vague markings on the Martian surface. The image of Mars shimmered in the turbulent, chilly night air. Mars was especially bright because it was at opposition from the Sun and closer than it would subsequently be during the rest of the year. The Moon was especially bright and loomed large in the night sky because it was at perigee, the closest part of its elliptical orbit around the Earth.

The turbulent, often cloudy winter sky has yielded few views of the Moon and planets so far this year because stormy weather continued almost unabated. ■

Martin Rees to Speak in New York

Sir Martin Rees, one of the world's most noted cosmologists and astrophysicists, and astronomer royal of the United Kingdom, will speak on "From Big Bang to Biosphere" Monday, April 26 at the Caspary Auditorium of Rockefeller University, 1230 York Avenue (66th Street). The 5:30 talk is free and open to the public.

Sir Martin, professor of cosmology and astrophysics at Cambridge, is giving the university's Lewis Thomas Prize for Writing about Science lecture. He received the prize last year. It honors those who bridge the worlds of science and literature with a vision that speaks to science's aesthetic and philosophical dimensions.

Sir Martin, whose research helped challenge the Steady State theory of the universe's origin in favor of the Big Bang, is also controversial. He's given humanity a 50% chance of surviving this century. ■

A Message from AAA President Richard Rosenberg

Hello, members:

As you may have seen on the back page, if you don't renew your membership this will be your last issue of *Eyepiece*. At only $25 per year, with the opportunity to get subscriptions to *Sky & Telescope* and *Astronomy* magazines at substantially reduced rates and *Eyepiece* for free, I'd say this is quite a bargain. We will be sending a mailing to non-renewed members shortly, but I hope you'll respond now with a check or money order sent to Amateur Astronomers Association, P.O. Box 383, Gracie Station, New York, NY 10028. Use the stamped return envelope we sent.

The spring AAA astronomy class has been tentatively scheduled for Wednesdays April 7 through May 12. A few of us are working on the syllabus. Expect an announcement in a few weeks.

"The Pluto Files" will air on PBS on Tuesday, March 2 at 8 p. m. Based on Neil Tyson's book of the same name, the show will no doubt be a mixture of science and humor (Jon Stewart and Stephen Colbert will appear).

Shoba Bandi Rao has resigned from our board of directors, as she has taken on added responsibilities at NYU. Shoba made it possible for our seminar to move to NYU, with participants from both organizations. We'll miss her on the board, but she will remain an active member.

Fittingly, she will be replaced by Gerceida Jones. Gerceida is also a faculty member at NYU, teaching astronomy in the Global Liberal Studies program. Her group will now host our seminar. Gerceida has a Ph.D. in fluid dynamics from NYU. We're looking forward to working with her.

Rich Rosenberg, AAA President, president @aaa.org, (718) 522-5014

AAA Lecture March 5: The Contributions of Galileo

John S. Gianforte, owner-director of the Blue Sky Observatory in Durham, N. H., will address the AAA Friday, March 5 on "In the Footsteps of the Master: Discovering the Contributions of Galileo." The free public lecture begins at 6:15 p. m. in the Kaufmann Theater of the AMNH.

Gianforte will explore Galileo's contributions and some lesser-known motivations for his scientific pursuits that ultimately led to the accomplishments with which amateur astronomers are most familiar. He'll also cover some astronomical history to illustrate how the stage was set for Galileo to make the contributions he did, when he did.

In 2008, Gianforte and his wife, Doris, went to Italy to follow in Galileo's footsteps. They visited many places where Galileo lived and sought to get an idea of what it was like in the 17th Century and the influences on Galileo that led to his contributions to astronomy and to science in general.

Gianforte is also a physics instructor at the University of New Hampshire and an astronomy instructor at Granite State College. His main astronomical-research interests are transits of extrasolar planets, cataclysmic variable stars, comets and supernovae. He writes on astronomy on his web site, www.theskyguy.org.

The two remaining lectures in the AAA's 2009-10 series are April 9 and May 7. In April, Glynnis Farrar of NYU will discuss "High-Energy Astrophysics with a Neutrino Telescope in New York City." In May, Ruben Kier of Advanced Radiology Consultants will speak on "Best Targets for Amateur Astrophotography and What They Reveal about Our Universe." ■

The AAA's Annual Meeting

Is on Wednesday, May 19.

Plan on coming!

The Multiple Advantages of Liquid-Mirror Telescopes

By Lynn Darsh

Why spin a giant vat of mercury with a circumference of 20 meters at eight revolutions a second in a British Columbia rain forest?

To demonstrate an inexpensive large survey telescope can be built with no sacrifice of scientific benefits, that's why, as Dr. Arlin Crotts, professor of astronomy at Columbia University, outlined in an AAA lecture February 5 at the AMNH, "Liquid Mirror Telescopes are Looking Up." What's more, this design is well-suited to gather data needed to refine understanding of the expansion rate of the universe and elusive dark energy.

Crotts explained that liquid mercury spinning in a uniform gravitational field will rise up on the sides of its container into a parabolic shape, creating a "Newton's Bucket," similar in design but not in materials to the mirror (or "light bucket") of the classic reflecting telescope designed by Isaac Newton.

The spinning 6-meter dish is the only substantial moving part of the Large Zenith Telescope (LZT). At a cost of $900,000 for the building, mount and instruments, the LZT was designed and built by scientists from different universities, many of whom live in British Columbia near this largest of "backyard telescopes."

Crotts described plans to build an 8-meter version of this inexpensive 6-meter prototype, if $25 million in additional funding can be obtained. The "ALPACA" (Advanced Liquid-mirror Probe of Astrophysics, Cosmology and Asteroids) would be placed at Cerro Telolo in the Chilean Atacama desert.

A zenith telescope at Cerro Telolo would be well-positioned to survey the sky and discover hundreds of thousands of Type IA Supernovae (SN Ia) in distant galaxies, as well as asteroids in our solar system. The study of more of these exploding stars is key to refining their use as "standard candles" in mapping the expansion rate of the universe to better understand dark energy. SN Ias could become a reliable equivalent of the Cepheid variables on a larger distance scale.

The advantages of a liquid-mirror telescope are huge. A zenith survey telescope requires a building with a hole in the roof and a stable floor to sit on instead of a complex observatory and rotating mount. Neither filter wheels, shutters or dome are required, although steady rotation of the liquid-mercury mirror is a must. (The focal length of the mirror is affected by changes in rotational speed, degrading the image.) CCDs for the ALPACA would be scientific quality, off-the-shelf components; 240 of them can be obtained for about $5 million.

Comparative telescopes using more traditional mirrors can easily be 20 times more costly. While the Large Synoptic Survey Telescope (LSST) could do the work planned for a liquid-mirror scope, as well as much else, it would cost $500 million. Plans have been frozen for three years as part of a budget cut.

The ALPACA would not be able to compete with the Keck or the upcoming Webb telescopes in the detail of its images, Crotts observed. But it will be a large telescope built at a fraction of the cost, tailored to an observing program of supernovas and asteroids well-suited to its capabilities.

Crotts outlined technical challenges overcome in building the LZT. Since vibration from mirror-cell movement caused waves in the mercury, scientists built a "giant air bearing" to hold the mirror cell, eliminating vibration. The rotating liquid mirror created turbulence in the air above the circumference, affecting viewing. Designers reduced turbulence by placing Mylar with a low incidence of refraction over the mercury, trapping the air under it to rotate along with the mirror.

The proposed telescope will use "drift scanning," like the Sloan Digital Sky Survey. The scope will match sidereal motion of the sky above the zenith-pointing telescope exactly, with the CCD sensor collection sequencing data into each storage area. Thus, all photons coming from a single source will be captured by different CCDs as the Earth rotates the telescope under the sky, until the object "drifts" out of the field of view.

Using mercury this way doesn't pose a safety threat, Crotts told the audience. ■

Mars Society President Says Go to the Planet First

By John Delaney

What does Dr. Robert Zubrin, president of the Mars Society, think of plans for human spaceflights to the Moon and Mars? The originator of the Mars Direct plan to reach Mars spoke in September at the Hayden on the topic. *Eyepiece* caught up with Zubrin, who's on this month's Asimov panel at the AMNH (see *page 11)*, for his opinions on the significance of Mars and the future of humans in space.

Eyepiece: Regarding the [now cancelled] Constellation program and its mission to return to the Moon and then Mars, [did] you see such a mission as a logical step in eventually reaching Mars?

Zubrin: I disagree with the entire logic. If you want to go to Mars, that's where you should go, because that's where the science is, it's where the challenge is, it's where the future is. There are an infinite number of potentially useful precursor activities one could propose to do before you send humans to Mars. If you do all of them or even a small fraction of them, you never get to Mars. It's like the space station. Trust us [they said], it will be useful when you actually decide to go somewhere. Well, lo and behold, it has nothing to do with going to the Moon.

Eyepiece: What would be an effective way to present or sell a Mars mission in the current political and economic climate?

Zubrin: Any number of ways. As a stimulus to the economy and education. Also, if one wants to deal with the threat of irrationalism in the world, one way to counter it is to show what a civilization based on science, progress and freedom can accomplish. It could also be viewed as a way for America to reassert its spirit of cultural optimism as a nation that can take on any challenge.

Eyepiece: What would be the philosophical benefits of a trip to Mars?

Zubrin: There are three reasons to go to Mars. First, Mars is the Rosetta Stone in terms of the prevalence of life in the universe. We now know that Mars had liquid water on its surface for substantial periods of time, and the conjecture, generally accepted although not proven, is a process that emerges wherever you have appropriate physical and chemical conditions. If that's correct, life should have emerged on Mars and we'd be able to at least find fossils on the surface. Not only that, there's almost certainly liquid groundwater underground. If we could bring that up and examine it we could see what Martian life is like.

Second, the challenge. I believe civilizations are like individuals. We grow by challenging ourselves. Embracing the challenge of a Mars mission for exploration would be a great challenge. Among youth, it would be an invitation to adventure. Learn the science and you can be a part of pioneering and exploring a new world. We had that with Apollo.

Finally, there's the future, which is the hardest for us to appreciate but which will ultimately be why this is understood to be a great thing. If we do what we can in our time, which is establish the first human foothold on Mars, 500 years from now there will be several new branches of civilization on Mars.

Eyepiece: Do you think you will see humans on Mars in your lifetime?

Zubrin: Yes I do [Zubrin is 57], because we're ready to do it. This thing is available and it waits for someone to seize the moment, and sooner or later, we will.

Eyepiece: When a human mission to Mars finally happens, where should we go based on our current knowledge of the planet gathered from orbiters and rovers?

Zubrin: My favorite area is north of the Valles Marineris. Because it's in an equatorial region, you have lots of sunlight, a warmer climate and lots of interesting geology within a short distance. You get the canyon, run-off channels and dried-up lakes. You want to go where there's a variety of things to explore, including obviously the search for life and water. Another way to direct a search: There's evidence of methane vents on Mars. Go there, because that methane is coming from underground and there are only two possible sources. One is biological, the other hydrothermal. If we go [to the vents], that's an excellent place to look for extant life. ■

Going Under The Dome and Out of This World

By Evan Schneider

Nothing goes faster than the speed of light--except my recent experience and thorough enjoyment of the February 2 program at the Hayden Planetarium, "Virtual Universe--The Farthest Reaches of the Cosmic Ocean," presented by AAA board member Jason Kendall. I was treated to an insider's perspective, invited to observe Jason and his electronic sky pilot, the AMNH's Jackie Faherty, as they prepared for 100 attendees to join them on a digital trip across the universe.

I've been to many planetarium events, but never behind the scenes. So when I reached the doors of the dome, I was filled with excitement, knowing I was about to enter a world of endless perspective and wonderment. I opened the door slowly, not wanting to disturb Jason as he prepared, entered a room of total silence and darkness, and craned my neck skyward. Hovering above me was a huge image of Earth, slowing rotating on its axis. I stood still, transfixed by this image, savoring my moment alone in space. I saw Jason and Jackie in the control booth, preparing their digital world for the audience that would soon follow me through the door.

I blended into the darkness, watching our NASA JPL solar-system ambassador work through the largest dataset of any U. S. planetarium, formulating his approach on how and where to fly. His goal was rationalizing the vastness of the universe and having us leave knowing much more than before.

At last, he determined his direction: start with the astrological and mythological world by displaying Scorpio, Pisces, Taurus and Leo; show the stars behind these images; perceive distances; display the Magellanic Clouds, and small and large satellite galaxies near the Milky Way. Talk about how fast light travels: less than a second and a half from us to the Moon, four hours from Neptune. Then the Voyager 1 and 2 missions, the farthest we've gone at 17 miles per second yet now only 14 light-hours from Earth. Pull out to 100,000 light-years away. Then look back from our Sun to the center of the Milky Way, separated by only 26,000 light-years.

Let's fly through our galactic neighborhood. Andromeda so close at 2.2 million light-years. Then M33, the Triangulum Galaxy, at 2.4 million light-years. But Jason wanted us to go even farther, so we travel to the remote Virgo Cluster, a massive collection of 2,000 galaxies 60 million light-years away. Now, distances approach the incomprehensible, and overwhelm. We accept the fact that stretching our imagination to align with complexities of the data takes us to places we've never visited by probe or will ever visit in person.

Jason's voice was filled with excitement. We need to go farther, he tells Jackie. I looked toward the dome ceiling and was surrounded by an image of the cosmic microwave background radiation, The age of the universe is 13.7 billion years, but due to expansion of space we can observe objects considerably farther away. The edge of the observable universe is now about 46.5 billion light-years away. There are no galaxies here, no stars, no solar systems, only gas and dust in blurs of ancient invisible light. We can go no farther. Jason takes us back through billions of light-years to our familiar spiral Milky Way, then home to Earth.

Mesmerized by Jason's voice and the dome above, I suddenly realized two hours had passed. The auditorium was still empty. I had flown to the edge of the observable universe and back, and the presentation had yet to begin. The moment had come for Jason to share our private universe with those waiting to come in.

The dome lights came up slightly. The doors opened and people pressed into their seats. Expectation filled the room, this time by looking upward at the Earth, now rotating again on its axis for all to see. I sat in my seat and smiled, still in darkness, knowing that those around me were about to embark on the ride of their lives, to share with Jason his energy and vision of the universe, to fill themselves with the knowledge that we are but a small part of a wonderful, dynamic cosmos. ■

Geoffrey Burbidge Dies at 84

Geoffrey Burbidge, the renowned astronomer who sought to explain how everything derived from stardust, and who was a critic of the Big Bang theory, died January 26 at 84.

AMNH Marks Rose Center's 10th Anniversary

The AMNH is holding a year-long celebration of the 10th anniversary of the Rose Center for Earth and Space. It will include special space-show screenings, a star-themed sleepover, lectures by scientists from the museum's Division of Physical Sciences and elsewhere, and programs in cooperation with NASA, culminating in a 10th anniversary bash October 10.

This year also marks the 75th anniversary of the opening of the Hayden Planetarium. A celebration will be held in September.

Plans to usher the Rose Center into its second decade include a new Astro Bulletin using cutting-edge display technology, an overhauled Black Hole Theater presentation in the Hall of the Universe and a revitalized Big Bang presentation in the lower half of the Hayden dome featuring imagery and narration that take visitors on a trip back to the birth of the universe and reveal modern cosmology's understanding of the nature of the cosmos.

There will also be a "From the Edge of the Universe" lecture series highlighting the latest cutting-edge astrophysics research at the museum. "Tweet-Up to the Stars" will allow visitors to use tweet live with astronauts in the International Space Station. A summer solstice celebration June 20 on the Arthur Ross Terrace will feature hands-on activities including solar-powered car races, solar print making and solar telescope observations.

Special programming will commemorate the signing of the historic agreement between the museum and the Confederated Tribes of the Grand Ronde Community of Oregon 10 years ago. This ensured access to the 15.5-ton Willamette Meteorite, the largest meteorite ever found in the U. S. and a centerpiece of the Cullman Hall of the Universe, by the Grand Ronde for religious, historical, and cultural purposes.

The 73rd annual meeting of the Meteoritical Society in New York will include a pre-meeting workshop at the museum July 24-25 to explore the link between understanding of protoplanetary disks and evidence from extraterrestrial materials. ■

Speaker Discusses Trends in Astrophotography

Astrophotographers are stacking longer exposures, bringing out details never before seen, a Westchester audience recently heard.

Douglas Baum, president of Pound Ridge, N. Y.-based Night Vision Astronomy, who spoke as part of a panel at the Rye Arts Center in conjunction with a Hubble photo exhibit, also noted that new large-format chips in cooled CCD cameras have transformed amateur imagers' ability to reach new levels since chips keep getting bigger.

Baum explained the concept of stacking exposures and tried to convey the excitement and success experienced by astronomy imagers as they bring out details in their images during image software processing.

Baum explained the types of cameras used by amateur astronomers, such as digital single-lens reflex (DSLR) vs. CCD, as well as techniques of real vs. false color. DSLR is the digital version of the old standard single-lens reflex (SLR) camera people use all the time.

Baum outlined the differences between luminance red, green and blue (LRGB) color versus narrow-band filtered images, with colors assigned to molecular and chemical compositions selectively filtered using H-alpha, OIII and SII filters at various band passes.

There are four separate filters used in a black-and-white astronomy CCD camera, he noted. "You can take a monochromatic (black and white) exposure through each filter and combine them to produce a full-color image. It has an advantage over one-shot color cameras, which take a single-color exposure without any filters. The advantage is that the black-and-white camera will reach deeper and produce more details, although it must be used with the filters to combine all four exposures into a final color image."

Baum also asserted that narrowband is coming into the mainstream. "It allows us to image in light-polluted environments and we can image when a full Moon is up,

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Life Faces a Dangerous Future if Steps Aren't Taken

By Katherine Avakian

Two fundamentally different theories of how life functions on Earth are the subject of Peter Ward's book "The Medea Hypothesis." In a January 11th Hayden lecture on the subject, he explained why he believes Medean rather than more benevolent Gaiaian effects have shaped the course of life on Earth since its inception, and he warned of very real dangers to life in the near future if drastic steps aren't taken.

Ward, professor of biology, and Earth and space sciences at the University of Washington, and an astrobiologist with NASA, chose Medea, the Greek mythological figure who killed her children, as a destructive symbol, saying, "…a characteristic of evolution is that its basic unit is the species, not the biosphere, and from this accrues a vicious...lethality toward other species…."

This view is countered by James Lovelock's Gaia hypothesis, named for the Greek goddess of the Earth, which espouses the view, "Earth is a complex, self-regulating system, and living things carry out this regulation." Ward contradicted this view, pointing out examples where living things caused destruction of other life.

The rise of oxygen 2.5 billion years ago by appearance of photosynthetic microbes caused near-extinction of the organisms which had been living in an anaerobic world until then. These photosynthetic organisms, which greatly increased in number, caused the first snowball Earth 2.3 billion years ago by using up the carbon dioxide in the atmosphere, causing Earth's temperature to plunge, freezing the planet "from pole to pole."

In his book, Ward declares this episode "was perhaps as close to planetary sterilization as we have ever gotten." He writes about an especially insidious event which he thinks will happen when global warming inexorably produces "global stagnation…no heat gradient from equator to pole, no currents or wind. Without currents, a warmed ocean loses its oxygen, from the bottom up."

In these conditions, certain bacteria in the sea which metabolize sulfur can multiply greatly. The byproduct they give off is the poisonous gas hydrogen sulfide: "Two hundred ppm will kill you, 50 ppm will make you very sick." If this gas enters the atmosphere from the sea, it will "gruesomely kill off most land life, especially plant life." Ward says this has already happened at least eight times.

Ward points out that the amount of atmospheric carbon dioxide plays a crucial role in regulating Earth's temperature. This amount has trended downward from the time vascular plants evolved 400 million years ago to the present-day level of 380 ppm. This happened due to photosynthesis and "through removal of carbon dioxide from the atmosphere to carbonate reservoirs on continents," such as the Rockies or the Alps.

In the long run, for plants to survive, carbon will have to be returned to the atmosphere, perhaps, says Ward, through "some kind of heating of limestones on a massive scale." Paradoxically, at present, the amount of carbon dioxide is increasing and the threat of runaway global warming looms due to burgeoning human populations and a lifestyle dependent on fossil fuels.

Ward lists severe conservation measures: "Simply by replacing the entire fleet of the world's automobiles with Toyota hybrids, replacing all light bulbs with low-energy fluorescents, and banning all air travel would rather quickly stabilize atmospheric carbon dioxide values…." Knowing that these measures won't willingly be undertaken, he appears to underscore a colleague's belief that "it will take a mass mortality of humans before our species gets its act together…."

In his talk, he warned of a coming downward spiral of events. "Atmospheric carbon dioxide levels are rising toward Eocene levels (800-1,000 ppm), when there were no ice caps and continental ice sheets melted." He predicted if nothing is done, sea level will rise one meter by 2100. This would intersect with a population increase of 9 billion-11 billion. A one-meter rise would remove 25% of current agricultural land. There would be an additional rise of two to five meters by 2200. A flooded Earth would be our future.

Avakian continued on page 13

Review: How Celestial Phenomena Affect Life on Earth

By Luis Marcelo Cabrera

"Heaven's Touch" by James B. Kaler (Princeton, $24.95) presents how the diversity of life on Earth is affected by astronomical objects beyond their visual appearance in the sky. The effects of gravity, gamma-ray bursts, asteroid and comet impacts, radiation, solar flares, cosmic rays and supernovae are profound. They've altered life on Earth and will continue to do so.

The book explains the subtle but important variations in the shape and motion of Earth as it cruises through space, variations caused by gravity and the constant dance of bodies within the solar system. Detailed descriptions of the movements and their implications are easy to read, although the author chose not to exemplify these principles with mathematical formulas, instead using written explanations which became unnecessarily lengthy. Other topics discussed are the icy nature of comets, lunar and solar tides, and the source of cosmic rays, solar storms and exploding stars.

Kaler's writing is clear and straightforward, but inclusion of math and simple charts would have made things more concise, especially on topics such as Earth's wobble, multiple definitions of time units, relative distances to other planets in the solar system and star comparisons.

In general, Kaler stresses that although Earth may be separated from other bodies by astronomical distances, we're not alone and are part of the same solar and galactic system. Life itself, he says, may not have been possible without intervention of our cosmic environment.

"Heaven's Touch" reminds us of how connected with our dynamic universe we really are. While maintaining an informative and entertaining style, the author touches on history, mythology, and science's triumphs and misconceptions. Don't expect this book to go deeply into the science behind the natural phenomena discussed, but you'll get a plain-language explanation. ■

Obama Budget Whacks Constellation Moon Program

President Obama's proposed budget for fiscal 2011, released last month, cancels NASA's plan to build new spaceships to send astronauts back to the Moon. This means the end of the agency's Constellation program. The budget, if OKd by Congress, also scraps plans for Orion spaceships and Ares rockets that were envisioned to replace NASA's aging space shuttles and for new manned Moon missions, a $9 billion investment to date.

NASA Administrator Charles Bolden, a former space-shuttle commander, said that while the budget cancels the program building the space-shuttle replacement, the Orion crew vehicle, it's not trading away safety to embrace new, privately built spaceships to fly astronauts. NASA has already reached agreements with several commercial spaceflight companies to spur their efforts.

The budget request would set aside $369 million for vital technology development and test programs, with $183 million earmarked to support the International Space Station through 2020. The station was slated to be decommissioned in 2016, a year before it was believed the new Orion ship would be ready to ferry astronauts to it. The new budget would set aside $3.1 billion in funding to develop better heavy-lift rockets and more advanced space propulsion technology to explore faster and farther into the solar system. The agency is hoping commercially built space ferries could be ready to fly astronauts by 2016. ■

Corrections

An article last month on an AAA lecture by NASA's Jerry Bonnell neglected to mention that he's co-founder of the Astronomy Picture of the Day website (http://apod.nasa.gov/apod/astropix.html).

A January item on publication of the seventh edition of AAA member Dinah Moche's "Astronomy: A Self-Teaching Guide" omitted information about the author. She's professor of physics and astronomy at City University of New York and an award-winning author and lecturer. Her books have sold more than 10 million copies in seven languages. ■

Briefs: Hubble Takes Most Detailed Images of Pluto Ever

The Hubble has returned the most detailed images of Pluto ever. They reveal the mini-world in near true-life color, close to what the dwarf planet would look like to an observer traveling toward it. The surface appears reddish, yellowish and grayish in places, with a mysterious bright spot that's particularly puzzling to scientists. Some colors are thought to result from ultraviolet radiation from the Sun interacting with methane. The bright spot apparent near the equator was found in other observations to be unusually rich in carbon monoxide frost. When compared to data from 1994, the photos reveal a surprising amount of change in Pluto's appearance. It's gotten redder, while its northern polar region has gotten brighter and its southern hemisphere darker. One reason for variability is Pluto's highly eccentric, oblong orbit, causing strong temperature variations.

A preview of what's in store for the Sun is in view across the galaxy, as a similar star balloons in its dying throes. Chi Cygni lies about 550 light-years away from Earth. As it nears the end of its life, it's bloated in size and begun to pulse in and out. These are signs of a star running out of fuel. Chi Cygni is at red-giant stage. It's inflated so much that, were it in our solar system, it would engulf every planet out to Mars. Chi Cygni's pulsations occur every 408 days. As the star begins to run out of hydrogen fuel for fusion burning in its core, it cycles through contraction and expansion, causing it to brighten and dim. These pulsations allow it to jettison its outer gaseous layers, which will eventually become a planetary nebula. At its smallest, Chi Cygni's diameter is 300 million miles. At this stage, it's at its hottest, with giant plumes of hot plasma on its surface. When it expands, it cools and dims, reaching a maximum diameter of 480 million miles.

While nothing with mass can move faster than the speed of light, scientists now think some weird, faster-than-light currents may be the powerhouse for fast-spinning stars. A faster-than-light current would pass through certain rapidly spinning stars. This would cause positively charged atoms in the star to move in one direction and negatively charged atoms in another. Each particle would move slower than the speed of light, but the wave of movement would pass through the star faster than light speed. Scientists proposed this process to explain how certain pulsars shine. These stars are very dense and rapidly spinning, and emit a beam of light. Exactly how pulsars do this has been a mystery. Researchers believe pulsars' rotating magnetic fields create this current, which pushes the charged particles in a variety of directions, resulting in a focused burst of light.

New photographs taken by NASA's Lunar Reconnaissance Orbiter have revealed one of the Moon's most prominent craters in a new light. Tycho Crater appears to have formed relatively recently. It looks pristine in the images, while older craters have been slowly covered by newer impacts since their features are obscured. Rays of material ejected during the impact are still visible around Tycho, as is the central heap of debris that resulted when melted material flowed back down the slopes and solidified in the middle. Because it's so well preserved, Tycho, 53 miles wide, offers a unique chance to study the mechanics of how craters form.

A mysterious ribbon on the edge of the solar system has turned out to be a reflection of particles streaming off the Sun. The ribbon is where solar-wind particles heading into interstellar space are reflected back into the solar system by a galactic magnetic field. They travel to the edge of the solar system, where they encounter a strong magnetic field coming from the rest of the galaxy that slingshots them towards where they came from. The ribbon stretches almost across the sky, suggesting the magnetic field behind it must be equally huge. The structure emits no light, but discharges energetic neutral particles.

Scientists have observed a peculiar type of star death that may help explain supernovae. It didn't behave as most such explosions do. In some ways it seemed similar to a gamma-ray burst. But instead of a vast amount of high-energy gamma-ray light pouring from the star, scientists saw the supernova's explosion in lower-energy radio waves. Observations showed material expelled from the supernova explosion at speeds approaching light's. This characterized the blast as the type thought to produce one kind of gamma-ray burst. Meanwhile, the rest of the star's material was blown into space in a massive explosion. Only about one of 100 of this type of supernova produce gamma-ray bursts, though. Until now, no such "engine-driven" supernova had been found any

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Briefs: Stellar-Mass Black Hole Most Distant Discovered

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way other than by detecting gamma rays emitted by it. Discovering such a supernova by observing its radio emission, not gamma rays, is a breakthrough.

A newly found stellar-mass black hole left over from explosion of a star is the most distant to be discovered by astronomers. About 15 times the mass of our Sun, it's the second most massive on record. It's entwined with a star that will soon become a black hole. Until now, the only star-mass black holes known were found within our local cluster of nearby galaxies, the Local Group. These black holes are up to 10 times the mass of the Sun. The newly found black hole is the first seen outside the Local Group. Stellar-mass black holes are the final remnants of very massive stars but are much smaller than supermassive black holes. The new black hole was spotted in the spiral galaxy NGC 300 6 million light-years away. The black hole and a Wolf-Rayet star, which has a mass 20 times the Sun's, orbit each other every 32 hours. As they circle, the black hole siphons off matter from the star. But how the two wound up together isn't known.

NASA's Opportunity rover has discovered a peculiar rock on Mars that scientists think originated deep within the planet and could reveal new info about the makeup of Mars' interior. Dubbed Marquette Island, the rock is different in composition and character from any known rock on Mars or meteorite from Mars. In its 11 miles of traveling, Opportunity has found only one other rock of comparable size to Marquette Island and scientists think it was ejected from a distant crater. Called Bounce Rock, it closely matched the composition of a meteorite that landed on Earth, but was thought to have originated on Mars. The coarse-grained texture and basalt of Marquette Island indicates it cooled slowly from molten rock, allowing crystals time to grow. That means it likely originated deep in the crust, not at the surface where it would cool quicker and have finer-grained texture. Most basalt rocks Spirit and Opportunity have encountered have different textures and composition. Marquette Island appears to have much less nickel than other meteorites Opportunity has found. And its interior contains more magnesium than typical Martian basalt rocks.

NASA's latest sky-mapping space telescope has found an asteroid never before seen from Earth, the first of hundreds of objects the scope is expected to find. The asteroid was discovered by the Wide-field Infrared Survey Explorer (WISE) in mid-January. It's currently 98 million miles from Earth, with an estimated diameter of 0.6 miles. Because it circles the Sun in an elliptical orbit tilted with respect to the Earth's orbital plane, the asteroid isn't thought to come near enough to us to pose a hazard. WISE picked out the object moving against a background of stationary stars. WISE is expected to find 100-1,000 previously undiscovered asteroids in the belt between Mars and Jupiter, as well as hundreds of new near-Earth asteroids during its all-sky survey, which began in January. A report in January asserted that NASA's efforts at finding near-Earth asteroids that could potentially pose a threat are insufficient. In addition, WISE will detect millions of new stars and galaxies as it scans the sky in the infrared every 11 seconds as it orbits Earth.

A new study might have found an explanation for the disparate features of Ganymede and Callisto: Ganymede was pummeled by more and faster comet impacts than its sister moon billions of years ago. While the moons are similar in size and ice-rock composition, they sport different looks inside and outside. Ganymede's surface shows evidence of resurfacing by tectonic processes. It also has a large rock/metal core, showing its materials separated over time, with heavier materials settling to the interior. Callisto's surface shows no signs of resurfacing, and separation of rock and ice within it seems to be incomplete. A model found the moons' evolutionary paths diverged 3.8 billion years ago. Because Ganymede is closer to Jupiter, it was hit by twice the number of impactors. Proximity to Jupiter meant comets colliding with Ganymede were going faster than those hitting Callisto.

The icy crust of Enceladus appears to occasionally belch up blobs of warm ice, which helps explain the mysterious heat seen there, scientists suggest. Cassini appears to have caught Enceladus in the middle of a burp. Researchers suggest answers behind the mysterious heat and argon seen in the southern part of Enceladus could come from deep inside the moon. A computer model showed heat building up from the interior could periodically be released in blobs of warm, light ice rising

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Briefs: Some Binary Systems Could Host Earth-sized Planets

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to the surface. The rise of the warm blobs would drive cold, heavier ice into the interior, continuously renewing the surface. The blobs are probably just below freezing, whereas the surface is -316 degrees.

Turbulent binary star systems such as Alpha Centauri could host Earth-sized planets, computer modeling indicates. Scientists have been unsure whether planets could form amid the tug-of-war between binary stars. Now researchers have probed whether the necessary precursor to planet formation, a protoplanetary disk of planet building blocks, could survive in this environment. The answer appears to be yes, at least under certain conditions, such as a specific range of gas densities and star orientations. In the case of Alpha Centauri B, one of two binaries in Alpha Centauri, these conditions are right. Scientists built a computer model to test the birth of baby solar systems around binaries. They were able to alter starting conditions such as arrangement of parent stars and amount of gas in the system. They then ran simulations over many conditions to discover which factors would lead to a disk of planetary embryos forming 0.5-2.5 times the distance between Earth and the Sun.

A new group of spots is traversing the face of the Sun. Sunspot group 1045 is an active region that's produced moderate solar flares. The spots could unleash a major flare, though that probability is low, says the U.S. Space Weather Prediction Center. Each new spot in the group is about twice the diameter of Earth. Backyard astronomers with properly outfitted telescopes can easily see the spots. The Sun's at the low point in an 11-year cycle of activity. The next peak of activity is expected in 2013. NASA's Solar Dynamics Observatory, launched last month on a five-year mission, will study the Sun in greater detail than before. High-definition observation of the Sun's coronal atmosphere will help scientists track changing patterns in the corona that could indicate imminent flares and provide better ways of forecasting solar weather, including violent flares of charged particles that sometimes erupt and can disrupt satellites and power grids on Earth. Scientists would like to view the magnetic field to predict what will happen in solar activity.

The glow of methane has been detected in the atmosphere of a Jupiter-sized planet orbiting close to its star. Because the methane signature is so strong, it could help scientists better understand exoplanets' atmospheres, if it's a common feature among them. Water vapor, carbon dioxide and methane have been detected in HD 189733b's atmosphere. The first methane detection had a different signature than the new one. The new detection seems to be from the fluorescence of methane in the atmosphere. For atmospheric signatures for exoplanets so far, astronomers have assumed that heat is what's causing emission of various atmospheric constituents, as most are hot Jupiters. But heat can't explain the fluorescence of methane. The energy source driving the emission is presently a mystery. Two possible sources are collisions with photons or charged particles from the stellar wind. It's possible the signature of methane fluorescence from HD 189733b comes from a different part of the atmosphere than the previous methane signature.

New images and observations of the Orion Nebula have revealed normally hidden dusty regions and the odd behavior of very young active stars within them. This penetrating view was made in the infrared. A highlight: the four bright stars forming the Trapezium, a group of very hot young stars pumping out fierce ultraviolet radiation that's clearing the surrounding region and making the gas glow. Observing in the infrared reveals many other young stars in this central region that can't be seen in visible light. In the region above the center of the picture, curious red features appear that are completely invisible except in the infrared. Many of these are very young stars that are still growing and are seen through the dusty clouds from which they form. These youthful stars eject streams of gas with typical speeds of 450,000 mph. Many red features highlight the places where these gas streams collide with the surrounding gas, causing emission from excited molecules and atoms in the gas.

CERN's Large Hadron Collider was due to begin regular operation late last month, but will operate at only half power for two years and then shut down for a year-long repair. It has taken 15 years and $9 billion to get to this problem-riddled point. The collider will be operated at 3.5 trillion electron volts. Shutdown for repairs will be in 2012, startup will be in 2013. During a month-long break this fall, lead ions will be collided to try to produce a state of matter that existed just after the Big Bang. ■

Events on the Horizon
March 2010

M: members; P: open to the public; T: bring your telescopes, binoculars, etc.;
C: cancelled if cloudy;
HQ: at AAA headquarters, Downtown Community Center, 120 Warren St.
AMNH: For ticket information, call (212) 769-5200

For directions to AAA observing events, check the club's website, www.aaa.org.

Tuesday, March 2, 8-9 p. m.
"The Pluto Files" on PBS
Hayden director and AAA member Neil deGrasse Tyson will host a program based on his book of the same title.

Friday, March 5, 6:15 p. m.
AAA lecture, FREE, P
John S. Gianforte, owner-director of the Blue Sky Observatory in Durham, N. H., will speak on "In the Footsteps of the Master: Discovering the Contributions of Galileo" in the Kaufmann Theater of the AMNH. Prior to the lecture, Donna Stearns and fellow singers will perform "Up, Up, Up and Away," one of the IYA songs she composed. "Each verse describes the relevance of the sky to different people: First, Galileo. Second, All cultures and worshippers. Third, lovers: Romeo and Juliet, with "Herd Boy and Weaver Girl" representing Altair and Vega." Next lecture: April 9.

Saturdays March 6, 13, 20, 27, 8 p. m.
Observing at Inwood Hill Park, Manhattan, P, T, C
Next dates: Saturdays in April.

Wednesday, March 10, 8:30-10 p. m.
Observing at Fort Tryon Park, Manhattan.
Next date: April 14.

Thursday, March 11, 6:30-8:30 p. m.
Recent Advances in Astronomy Seminar, M
At NYU conference room, 726 Broadway, two blocks below 8th Street, 6th floor. Next date: April 8.

Monday, March 15, 7:30 p. m.
Annual Isaac Asimov Panel Debate, P, AMNH
"Moon, Mars and Beyond: Where Next for the Manned Space Program?" is the theme of the annual Isaac Asimov Panel Debate in the LeFrak Theater of the AMNH. Tickets are required. Hayden Planetarium director and AAA member Dr. Neil DeGrasse Tyson will moderate remarks by five experts on space exploration: Kenneth Ford, founder-ceo of the Institute for Human & Machine Cognition; Lester Lyles, U. S. Air Force (ret.); Paul Spudis, Lunar and Planetary Institute; Stephen Squyres, Cornell University; and Robert Zubrin, The Mars Society.

Friday, March 19, 8-10 p. m.
Observing at Floyd Bennett Field, Brooklyn, P, T, C
On the model airplane flying field. Next date: April 23.

Saturday, March 20,
Observing at Great Kills Gateway National Park,
Staten Island, P, T, C Next date: April 17.

Saturday, March 27, 10-noon
Solar Observing, Central Park, P, T, C
At the Conservatory Waters. Next date: April 24.

Tuesday, March 30, 6:30-8:30 p. m.
Observers' Group, M, HQ
Pre-meeting dinner at 5:15 at the Gee Whiz Diner, Warren and Greenwich streets. Next date: April 27.

AAA class: Wednesdays, April 7 to May 12.

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Ward advocates use of nuclear power, banning the burning of coal and reducing carbon emissions from all modes of transportation. But that's not enough. "We must engineer our world," he said. One proposal would be placement of large mirrors in space. Another would cover "large areas of the land, or sea, with reflective material. With a higher albedo, the temperature of the planet should drop." ■

Astrophotography continued from page 7

vastly increasing the amount of available imaging time each month, and opening up new locations where we can image. Narrowband filters also exhibit much more detail in the nebulas, not previously seen in LRGB images, completely changing the initial appearance of the target."

Baum showed an animation by California amateur astronomer Wes Stauffer, who completed an animation of the Crab Nebula in both LRGB and tri-color Narrowband (H-a, OIII & SII). The animation showed the nebula in both formats, cycling between them, thus showing differences in detail and color through both techniques.

Baum's company (www.nightvisionastronomy.com) designed and sells an eyepiece which uses military night-vision technology in the form of an image intensifier (a high-voltage vacuum tube in the eyepiece housing) to amplify light 50,000 times. It allows viewing of deeper, dim targets that couldn't be seen with a conventional glass eyepiece, effectively tripling the aperture of existing scopes. "It also allows you to use two eyes when viewing, which produces a 3D-type effect and gives you a sense of depth." ■

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toward its final location for about 100 days. After 167 days, it will have cooled to operating temperature. The JWST will be supervised by the same team that operates Hubble.

The lecture was a personal milestone for Arenberg. Fifty years ago, his father participated in a presentation program on the Viking rocket at the museum. The senior Arenberg carried a key chain that commemorated the event. That memento is now possessed by his son.

The JWST is named in honor of James Webb, NASA's director from 1961 to 1968. He was responsible for NASA starting science missions. The home page for the JWST is http://www.jwst.nasa.gov/. ■

Contacting the AAA

If you want to join, volunteer, participate in events, have a question or change your address: members @aaa.org, or (212) 535-2922. Visit us online at www.aaa.org. If you want to write for *Eyepiece*, contact Dan Harrison: editor@aaa.org or (914) 762-0358. ■

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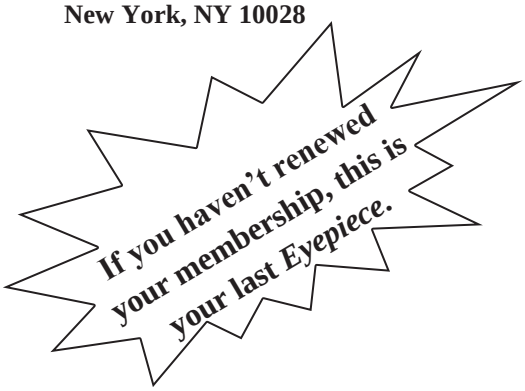

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