The Spectrogram

Newsletter for the Society of Telescopy, Astronomy, and Radio

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S*T*A*R
P.O. Box 863
Red Bank, NJ 07701
On the web at:
http://www.starastronomy.org

February Meeting

The next meeting of S*T*A*R will be held Thursday, March 5 at 8 p.m. at Monmouth Museum. The speaker will be Professor William Gutsch of St. Peter's University, who will describe the process by which solar flares and coronal mass ejections interact with earth's magnetic field to produce northern lights. He will also present images he took on a visit to the arctic.

Calendar

March 5, 2015 – S*T*A*R meeting

April 2, 2015 – S*T*A*R meeting

February Meeting Minutes

By Rob Nunn

STAR met Thursday, February 5, 2015 at Monmouth Museum. The meeting began at 8:10 p.m. and was chaired by vice president Rob Nunn. There were 18 attendees, including one first time attendee, the president of the physics and astronomy club at Brookdale Community College.

Rob presented the agenda for the evening, then introduced the speaker. Dave Britz serves on the STAR board as member-at-large, and has been a STAR member for about 25 years. Dave regularly attends STAR observing sessions with his 8-inch Celestron catadioptric scope with video display, and is working on a long-term project to build an observatory in his yard. In his professional work, he is investigating possible effects on telecom systems of an electromagnetic pulse associated with a solar flare.

Dave's topic for his presentation was his visit to the mirror lab at the University of Arizona. The lab was established by Roger Angel, who was responsible for many innovations in mirror technology, and is housed in the basement of the university's football stadium.

One of Angel's innovations was to cast mirrors on a honeycomb core of alumina silicate, thereby greatly reducing weight and cooling time. A mirror for an amateur scope might have a diameter to thickness ratio of 4. The mirror lab makes mirrors of diameter up to 8.4 meters with a glass thickness of about 2 inches. The honeycomb core contains tubing that provides cooling for the mirror.

Another innovation was to put the mirror and furnace on a turntable. After the glass has been melted, the table is rotated at a speed of 1 to 6 rpm. The rotation causes the surface of the glass to take the shape of a paraboloid, thereby greatly reducing the amount of glass needed to be ground. The resulting surface is correct to within about 1 mm.

The assembly of the honeycomb core requires about 1 year. Pyrex glass pieces are then carefully placed in position, a process that takes about half a year. With power consumption of a megawatt, melting the glass takes 4 days. The table is spun for 3 months as the glass cools.

The mirror is then moved to a Computer Numerically Controlled milling machine. In the milling machine the mirror is fixed while a lap whose shape is controlled by 18 actuators is moved over the glass. The first step is diamond grinding for 3 months, followed by a year of grit grinding. Polishing and figuring then take 2 years. During this process the mirror is moved back and forth between the milling machine and an 85-foot test tower that measures the shape of the surface. The result is a mirror with a surface accuracy of $1/20^{th}$ wavelength. The total time to complete a mirror is about 5 years, and the cost is about $100,000,000.

During Dave's visit work was proceeding on mirrors for 2 telescopes, both of which are destined for Chile. The Large Synoptic Survey Telescope has a single mirror of 8.4 meters, and a focal ratio of f/1.23. The mirror surface has two curves. The outer ring of the mirror acts as the telescope's primary mirror, while the more strongly curved inner section acts as a tertiary mirror.

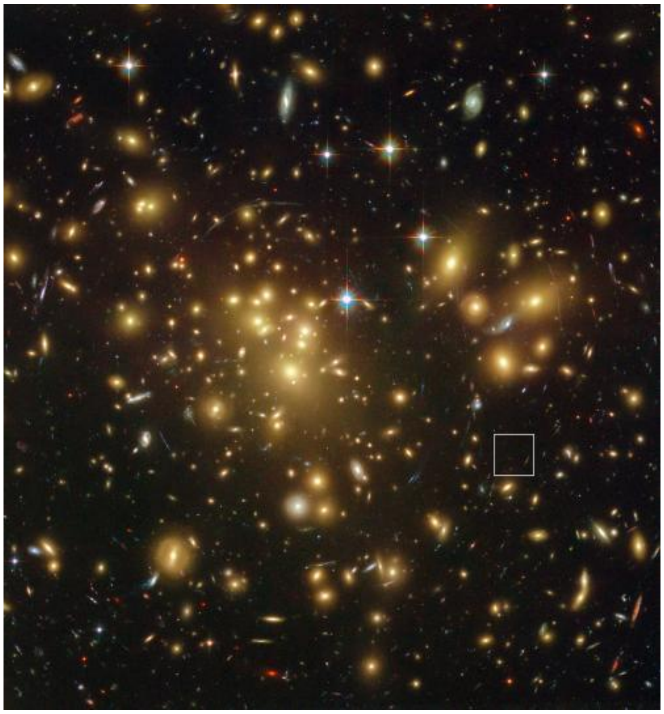
The Magellan telescope will employ 7 mirrors, each of diameter 8.4 meters. It will have an effective focal ratio of f/0.71. The 6 mirrors surrounding the central mirror will have no axis of symmetry, so special techniques are required for casting and figuring. Each primary mirror will have a 1 meter secondary with thickness about $1/8^{th}$ inch. Each secondary mirror will employ adaptive optics through use of 75 actuators. The actuators correct for atmospheric turbulence about 100 times per second.

Dave greatly enjoyed his visit to the lab, and communicated the thrill he experienced. The audience showed its fascination through a multitude of questions and comments.

Following a break, Rob presented a few night sky events to watch for this month. The meeting concluded with a short review of upcoming events, and adjourned about 10 p.m.

An old-looking galaxy in a young universe

Mar 02, 2015



This view from the NASA/ESA Hubble Space Telescope shows the rich galaxy cluster Abell 1689. The huge concentration of mass bends light coming from more distant objects and can increase their total apparent brightness and make them visible. One such object, A1689-zD1, is located in the box -- although it is still so faint that it is barely seen in this picture.New observations with ALMA and ESO's VLT have revealed that this object is a dusty galaxy seen when the Universe was just 700 million years old. Credit: NASA; ESA; L. Bradley (Johns Hopkins University); R. Bouwens (University of California, Santa Cruz); H. Ford (Johns Hopkins University); and G. Illingworth (University of California, Santa Cruz)

A team of astronomers, led by Darach Watson, from the University of Copenhagen used the Very Large Telescope's X-shooter instrument along with the Atacama Large Millimeter/submillimeter Array (ALMA) to observe one of the youngest and most remote galaxies ever found. They were surprised to discover a far more evolved system than expected. It had a fraction of dust similar to a very mature galaxy, such as the Milky Way. Such dust is vital to life, because it helps form planets, complex molecules and normal stars.

The target of their observations is called A1689-zD1. It is observable only by virtue of its brightness being amplified more than nine times by a gravitational lens in the form of the spectacular galaxy cluster, Abell 1689, which lies between the young galaxy and the Earth. Without the gravitational boost, the glow from this very faint galaxy would have been too weak to detect.

We are seeing A1689-zD1 when the Universe was only about 700 million years old—five percent of its present age. It is a relatively modest system—much less massive and luminous than many other objects that have been studied before at this stage in the early Universe and hence a more typical example of a galaxy at that time.

A1689-zD1 is being observed as it was during the period of reionisation, when the earliest stars brought with them a cosmic dawn, illuminating for the first time an immense and transparent Universe and ending the extended stagnation of the Dark Ages. Expected to look like a newly formed system, the galaxy surprised the observers with its rich chemical complexity and abundance of interstellar dust.

"After confirming the galaxy's distance using the VLT," said Darach Watson, "we realised it had previously been observed with ALMA. We didn't expect to find much, but I can tell you we were all quite excited when we realised that not only had ALMA observed it, but that there was a clear detection. One of the main goals of the ALMA Observatory was to find galaxies in the early Universe from their cold gas and dust emissions—and here we had it!"

This galaxy was a cosmic infant—but it proved to be precocious. At this age it would be expected to display a lack of heavier chemical elements—anything heavier than hydrogen and helium, defined in astronomy as metals. These are produced in the bellies of stars and scattered far and wide once the stars explode or otherwise perish. This process needs to be repeated for many stellar generations to produce a significant abundance of the heavier elements such as carbon, oxygen and nitrogen.

Surprisingly, the galaxy A1689-zD1 seemed to be emitting a lot of radiation in the far infrared, indicating that it had already produced many of its stars and significant quantities of metals, and revealed that it not only contained dust, but had a dust-to-gas ratio that was similar to that of much more mature galaxies.

"Although the exact origin of galactic dust remains obscure," explains Darach Watson, "our findings indicate that its production occurs very rapidly, within only 500 million years of the beginning of star formation in the Universe—a very short cosmological time frame, given that most stars live for billions of years."

The findings suggest A1689-zD1 to have been consistently forming stars at a moderate rate since 560 million years after the Big Bang, or else to have passed through its period of extreme starburst very rapidly before entering a declining state of star formation.

Prior to this result, there had been concerns among astronomers that such distant galaxies would not be detectable in this way, but A1689-zD1 was detected using only brief observations with ALMA.

Kirsten Knudsen (Chalmers University of Technology, Sweden), co-author of the paper, added, "This amazingly dusty galaxy seems to have been in a rush to make its first generations of stars. In the future, ALMA will be able to help us to find more galaxies like this, and learn just what makes them so keen to grow up

New technique allows analysis of clouds around exoplanets

Mar 03, 2015 by Helen Knight

Analysis of data from the Kepler space telescope has shown that roughly half of the dayside of the exoplanet Kepler-7b is covered by a large cloud mass. Statistical comparison of more than 1,000 atmospheric models show that these clouds are most likely made of Enstatite, a common Earth mineral that is in vapor form at the extreme temperature on Kepler-7b. These models varied the altitude, condensation, particle size, and chemical composition of the clouds to find the right reflectivity and color properties to match the observed signal from the exoplanet. Credit: NASA

In a paper to be published in the *Astrophysical Journal*, researchers in the Department of Earth, Atmospheric, and Planetary Sciences (EAPS) at MIT describe a technique that analyzes data from NASA's Kepler space observatory to determine the types of clouds on planets that orbit other stars, known as exoplanets.

The team, led by Kerri Cahoy, an assistant professor of aeronautics and astronautics at MIT, has already used the method to determine the properties of clouds on the exoplanet Kepler-7b. The planet, a gas giant more than 5.5 million miles from Earth, is known as a "hot Jupiter," as temperatures in its atmosphere hover at around 1,700 kelvins.

NASA's Kepler spacecraft was designed to search for Earth-like planets orbiting other stars. It was pointed at a fixed patch of space, constantly monitoring the brightness of 145,000 stars. An orbiting exoplanet crossing in front of one of these stars causes a temporary dimming of this brightness, allowing researchers to detect its presence.

Researchers have previously shown that by studying the variations in the amount of light coming from these star systems as a planet transits, or crosses in front or behind them, they can detect the presence of clouds in that planet's atmosphere. That is because particles within the clouds will scatter different wavelengths of light.

Modeling cloud formation

To find out if this data could be used to determine the composition of these clouds, the MIT researchers studied the light signal from Kepler-7b. They used models of the temperature and pressure of the planet's atmosphere to determine how different types of clouds would form within it, says lead author Matthew Webber, a graduate student in Cahoy's group at MIT.

"We then used those cloud models to determine how light would reflect off the atmosphere of the planet [for each type of cloud], and tried to match these possibilities to the actual observations from the Kepler mission itself," Webber says. "So we ran a large set of models, to see which models fit best statistically to the observations."

By working backward in this way, they were able to match the Kepler spacecraft data to a type of cloud made out of vaporized silicates and magnesium. The extremely high temperatures in the Kepler-7b atmosphere mean that some minerals that commonly exist as rocks on Earth's surface instead exist as vapors high up in the planet's atmosphere. These mineral vapors form small cloud particles as they cool and condense.

Kepler-7b is a tidally locked planet, meaning it always shows the same face to its star—just as the moon does to Earth. As a result, around half of the planet's day side—that which constantly faces the star—is covered by these magnesium silicate clouds, the team found.

"We are really doing nothing more complicated than putting a telescope into space and staring at a star with a camera," Cahoy says. "Then we can use what we know about the universe, in terms of temperatures and pressures, how things mix, how they stratify in an atmosphere, to try to figure out what mix of things would be causing the observations that we're seeing from these very basic instruments," she says.

A clue on exoplanet atmospheres

Understanding the properties of the clouds on Kepler-7b, such as their mineral composition and average particle size, tells us a lot about the underlying physical nature of the planet's atmosphere, says team member Nikole Lewis, a postdoc in EAPS. What's more, the method could be used to study the properties of clouds on different types of planet, Lewis says: "It's one of the few methods out there that can help you determine if a planet even has an atmosphere, for example."

A planet's cloud coverage and composition also has a significant impact on how much of the energy from its star it will reflect, which in turn affects its climate and ultimately its habitability, Lewis says. "So right now we are looking at these big gas-giant planets because they give us a stronger signal," she says. "But the same methodology could be applied to smaller planets, to help us determine if a planet is habitable or not."

The researchers hope to use the method to analyze data from NASA's follow-up to the Kepler mission, known as K2, which began studying different patches of space last June. They also hope to use it on data from MIT's planned Transiting Exoplanet Survey Satellite (TESS) mission, says Cahoy.

"TESS is the follow-up to Kepler, led by principal investigator George Ricker, a senior research scientist in the MIT Kavli Institute for Astrophysics and Space Research. It will essentially be taking similar measurements to Kepler, but of different types of stars," Cahoy says. "Kepler was tasked with staring at one group of stars, but there are a lot of stars, and TESS is going to be sampling the brightest stars across the whole sky," she says.

This paper is the first to take circulation models including clouds and compare them with the observed distribution of clouds on Kepler-7b, says Heather Knutson, an assistant professor of planetary science at Caltech who was not involved in the research.

"Their models indicate that the clouds on this planet are most likely made from liquid rock," Knutson says. "This may sound exotic, but this planet is a roasting hot gas-giant planet orbiting very close to its host star, and we should expect that it might look quite different than our own Jupiter."

Are you a S*T*A*R Member?

S*T*A*R meets the first Thursday of each month, except July and August, at 8:00 p.m. at Monmouth Museum on the campus of Brookdale Community College in Lincroft, NJ. Meetings usually include a presentation of about one hour by a guest speaker, a break for refreshments and socializing, a description of interesting objects to view, and a discussion of club business.

Memberships:
( )Individual...$35
( ) Family...$45
( ) Student…$15

Name____________________________

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Make checks payable to: STAR Astronomy Society, Inc. and mail to P.O. Box 863, Red Bank, NJ 07701

The club owns 8" f/8, and 13" f/4.5 Dobsonian telescopes which are available for use by members. To borrow a telescope, please contact the Vice President.

The officers of S*T*A*R are:
President Kevin Gallagher
Vice President Rob Nunn
Secretary Michelle Paci
Treasurer Arturo Cisneros
Member at Large Dave Britz

S*T*A*R members can join the Astronomical League (AL) for a small fee. Members receive the AL publication Reflector.

In the Eyepiece

Here is a list of objects for this month. This is reproduced from www.skyhound.com with the kind permission of its creator and author of SkyTools Greg Crinklaw.

Object(s)	Class	Con	RA	Dec	Mag
M 81 & M 82	Galaxies	Ursa Major	09h55m34.1s	+69°03'59"	7.8
NGC 3511	Galaxy	Crater	11h03m23.7s	-23°05'11"	11.5
The Spindle	Galaxy	Sextans	10h05m14.1s	-07°43'07"	10.1
Ghost of Jupiter/Eye	Planetary Nebula	Hydra	10h24m46.1s	-18°38'32"	8.6
NGC 2903	Galaxy	Leo	09h32m09.7s	+21°30'03"	9.6
M95	Galaxy	Leo	10h44m00.0s	+11°41'57"	10.5
M96	Galaxy	Leo	10h46m48.1s	+11°48'54"	10.1
The Leo I Dwarf	Galaxy	Leo	10h08m30.6s	+12°18'07"	11.2
Markarian 421	Galaxy	Ursa Major	11h04m27.4s	+38°12'34"	14.8
Arp 270	Galaxy Pair	Leo Minor	10h49m52.4s	+32°58'35"	12.4
NGC 2818	Planetary Nebula in Open Cluster	Pyxis	09h16m01.5s	-36°36'37"	13.0
The Twin Quasar	Quasar	Ursa Major	10h01m20.8s	+55°53'54"	17.0
Hickson 44	Galaxy Group	Leo	10h18m00.4s	+21°48'44"	10.0
Abell 33	Planetary Nebula	Hydra	09h39m09.2s	-02°48'35"	13.4

Coordinates are epoch 2000.0