THE STAR DIAGONAL

THE JOURNAL OF THE OGDEN ASTRONOMICAL SOCIETY

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Meeting Announcement

The meeting this month will be a discussion about mirror grinding and telescope making.

Message from the President

Hello All,
First let me wish you all a merry winter solstice celebration and a happy new journey around the sun. At our meeting this month Dave and Lee will be discussing mirror grinding and telescope making. They are kind enough to be putting on a class this next year on telescope making so if you have a desire to make your own scope please contact them and join in.

The University of Utah has a new project that they are asking for help on this is to look for star clusters in the Andromeda galaxy. You can find their web site at http://www.andromedaproject.org/. I have helped classify galaxies on zooniverse and have found it to be interesting and a good killer of time that web site is https://www.zooniverse.org/. zooniverse also has different projects that you can help out with from classifying what is on the bottom of our oceans to classifying galaxies.

The executive committee will be getting together soon to schedule the coming year. We will get you the schedule as soon as possible to help you with planning the coming year. We will be changing our meeting day to the second Wednesday of the month starting in January. Weber State University had a scheduling conflict with our meeting day so we agreed to change our day. I cannot stress enough how lucky we are to have access to a planetarium as a club and we should be doing more for the Physics Department in appreciation for it.

I will be meeting with some folks coming up about doing a Utah star party it is not be associated with any one club and I think it’s long overdue. I feel a few days meeting new people and having some interesting speakers would be a good thing I am also thinking we could also do a swap meet with it.

Clear Skies
Craig

OAS Minutes – November 2012

Minutes for Ogden Astronomical society November 8, 2012

Meeting was called to order at 7:30 PM by Craig Browne.

Doug Say was taking dues and selling Calendars, Lee Priest was taking orders for the Year in space Calendars.

Announcements,
We have a Star Party November 19, 2012 at the Main Branch of the Weber County Library, David Dunn will be giving the Presentation inside and we will set up telescopes outside.

Craig announced that WSU has a class in the Planetarium for the Winter Semester on Thursday evenings so we won't be able to use it for our meetings January through March. The options are move the meetings to the second Wednesday, possibly find another classroom on Thursday, or find another location. After some discussion it was decided moving to Wednesday would be best.

Doug Say reported he was the only one that went to Curlew October 12, it was cloudy Friday but Saturday was clear.

We are still looking for people interested in grinding a telescope mirror, we will get together soon to work out the details and start grinding in January.

Meeting Presentation,
Ron Vanderhule showed a Youtube video of Carl Sagan demonstrating the Drake Equation and then conducted a discussion about the possibility of life on other planets.

Craig showed several "Physics in a Minute" Youtube videos including our 3D system and Size of Stars.

Meeting adjourned at 8:55 after which several members went to Village Inn.

Lee Priest

Star Party Schedule

Public Star Parties are as follows.

Our Requested Star Parties (Schools, etc).

Our Private Star Parties are as follows.
Feb 7-10 St. George

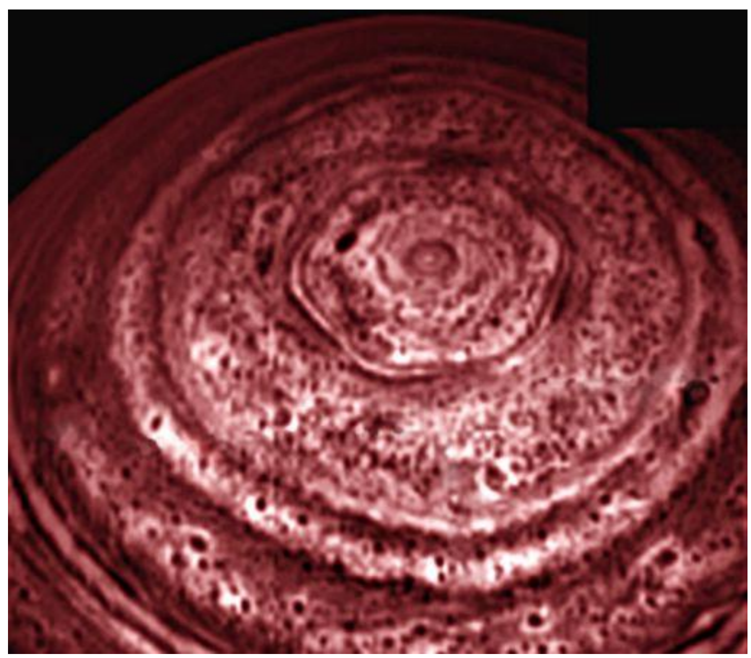
Year In Space Desk Calendars

For those that ordered Year In Space desk calendars, they will be available at the December meeting. Please contact me if you can't make it to the meeting and we can make arrangements.

Lee Priest

Saturn's hexagon recreated in the laboratory (part 2 from last month)

A lot of readers have expressed interest in the origin of Saturn's north polar hexagon. The hexagon is a long-lived pattern in the clouds surrounding Saturn's North Pole, which has been observed since the Voyagers passed by in 1980 and 1981. Unlike Jupiter, whose cloud bands are obvious in visible light, Saturn's cloud features are more subtle in visible wavelengths. The cloud features pop to life when viewed at longer, thermal wavelengths, as in this Cassini VIMS mosaic:



NASA / JPL / U. Arizona

Saturn's north polar hexagon

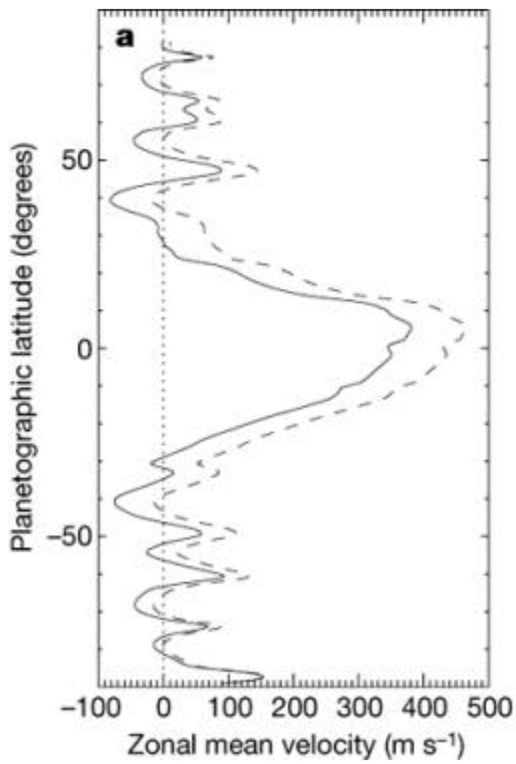
This image of Saturn's North Pole was taken by Cassini's VIMS spectrometer at a mid-infrared wavelength of 5 microns. It was winter at Saturn's North Pole; all illumination is thermal radiation (heat) welling up from Saturn's depths. Some of the heat radiation is blocked by clouds floating in Saturn's atmosphere at about 75 kilometers below the cloud tops that can be seen in visible wavelengths. The pressure at that level is about three times Earth's atmospheric pressure. The patterns in the image are created by alternating cloudy and clear areas. The image has been contrast-reversed so that the clouds show up as bright spots, while open areas appear dark.
There's an even cooler VIMS view of the hexagon, an animation:

http://planetary.s3.amazonaws.com/image/PIA09187.gif

Saturn's north polar hexagon

This movie (link above) of Saturn's North Pole was taken by Cassini's VIMS spectrometer at a mid-infrared wavelength of 5 microns. It was winter at Saturn's North Pole; all illumination is thermal radiation (heat) welling up from Saturn's depths. Some of the heat radiation is blocked by clouds floating in Saturn's atmosphere at about 75 kilometers below the cloud tops that can be seen in visible wavelengths. The pressure at that level is about three times Earth's atmospheric pressure. The patterns in the image are created by alternating cloudy and clear areas. The images have been contrast-reversed so that the clouds show up as bright spots, while open areas appear dark. The 37 frames in the animation (only 13 of which are shown in the thumbnail version) were taken over a period of about an hour, as Saturn rotated about 30 degrees.
The hexagon was first observed in Voyager images of Saturn, and immediately excited curiosity among scientists. In the years following Voyager, an oft-cited explanation for the origin of the hexagon was that it was a standing wave in Saturn's atmosphere. In order for it to be persistent, something needs to be driving it; that something was postulated to be a large, solitary storm observed in Voyager images at a latitude just south of the hexagonal feature. There were problems with this explanation, though, the chief one being that Cassini sees no such solitary storm, yet the hexagon is still there.

In an article published in the April issue of *Icarus*, Ana Aguiar and her coauthors advance an alternative explanation, and test it in the laboratory. The explanation has to do with the speeds of winds in Saturn's atmosphere. It begins with the following plot, showing how Saturn's wind speeds change with latitude.



NASA / JPL / University of Oxford

Wind speeds on Saturn

Wind speeds on Saturn were derived by tracking the motions of clouds observed by Voyager and Cassini. The fastest winds blow around Saturn's equator; at higher latitudes there are alternating eastward and westward jets. Exactly how fast the winds are blowing depends upon your choice of Saturn's rotation rate, which is generally measured from the rotation rate of its magnetic field. That rotation rate was measured to be slower by Cassini than by Voyager. If you use the Voyager reference rotation rate, most of Saturn's winds are prograde (the air moves eastward relative to Saturn's rotation), shown as the dashed line on this graph. If you use the Cassini reference rotation rate, shown as the solid

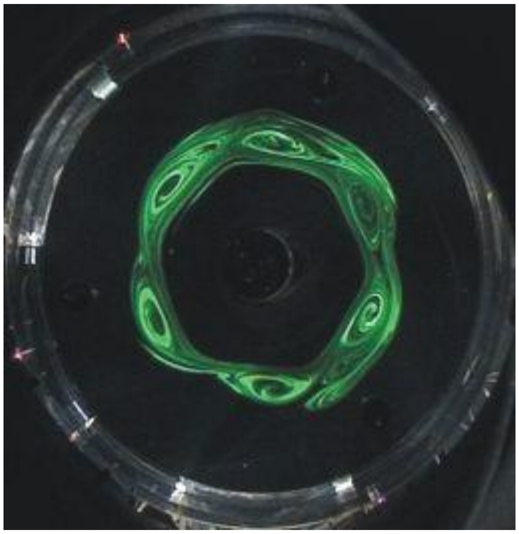
line, the winds alternate eastward and westward, as they do on Jupiter.
The hexagon corresponds to the latitude of the sharp, pointy, prograde peak at the very top of the above graph, about 78 degrees north. (There's another distinctively shaped band on Saturn, called the Ribbon Wave, that corresponds to the pointy peak at a latitude of about 48 degrees north). That pointy peak is actually one of the smaller ones on the plot, so you might not consider wind speed to be an important factor in driving a unique cloud feature.

Aguiar and her coauthors argue that it's not the wind speeds that are important per se; it's the *gradient* in wind speeds. Where there are steep contrasts in wind speeds -- adjacent parts of Saturn's atmosphere moving at very different speeds -- you can induce unstable behavior in a fluid, including waves, eddies, and swirls. That little prograde peak in wind speeds at around 78 degrees north is actually the narrowest peak on the graph, so that part of Saturn's atmosphere contains one of the steepest wind speed gradients to be found on the whole planet -- a good place to generate weird atmospheric features, including wavelike disturbances.

In the paper, Aguiar et al. run through a mathematical model that shows how the steep gradient in wind speed can set up a wavelike motion of this high-latitude jet, and that there are likely to be exactly six waves encircling the planet, setting up the hexagon (something that I explain in more detail here), and that wave propagates at about exactly the same speed as the jet flows (meaning that the hexagon will appear nearly stationary with respect to Saturn's rotation). Moreover, they show that the observed wind conditions near the South Pole are sufficiently different from those near the North Pole that the South Pole is *not* predicted to produce a similar wave, which is good, because there's no hexagon at Saturn's South Pole.

Having shown that the idea of wind speed gradients driving the formation of the hexagonal wave, they moved to the laboratory. Fun ensued, and science too.

They set up a cylindrical, rotatable tank 10 centimeters deep and 60 centimeters wide. The tank had a lid and base that were split into concentric sections. They could rotate the inner circle of the lid and floor of the tank at a different rate than they rotated the outer circle of the tank and floor, setting up a gradient in the flow speed of the liquid at the joint between the inner and outer circles. Depending on the relative speeds of the two disks, different things happened. At low relative speeds, there was nothing particularly unusual in the flow, just rotation of the water in the tank. But as the gradient between the two rotating sections was increased, wavelike instabilities started forming at the boundary between the two disks. Depending on conditions, the waves evolved chaotically or sometimes quite stably; there might be as few as two or as many as eight waves encircling the axis of rotation. But for a reasonably wide range of experimental parameters, they produced a wavenumber of 6: a hexagon.



Courtesy of Ana Aguiar

Creating Saturn's hexagon in the laboratory

This is a top-down view of a laboratory tank in an experiment designed to reproduce the wind conditions near Saturn's North Pole. The whole cylindrical tank is 60 centimeters wide. Its lid and base are split into two concentric sections, with the inner circle being 30 centimeters in diameter. The inner and outer circles are rotated at different rates, which sets up an instability at their boundary, producing a standing wave; the number of waves it takes to encircle the "pole" depends on various experimental parameters, including the rotation speed. In this particular case, the wavenumber is 6, producing a hexagon. Dye has been injected into the

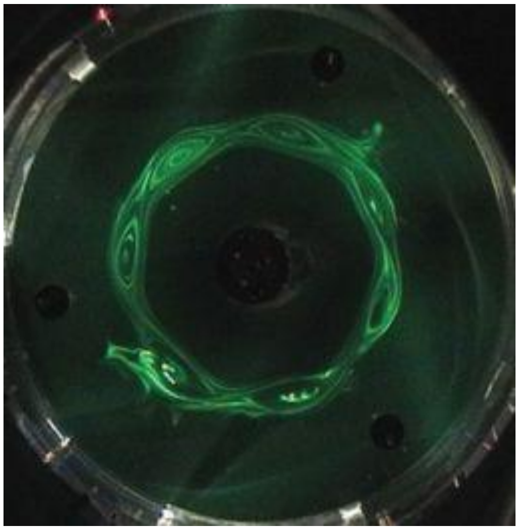
tank to make the form of the turbulent flow visible. Eddies are produced outside the wave.
Think that image is cool? I've got something even cooler: video. They documented the flow patterns in two ways. To get pretty photos that are analagous to spacecraft photos of Saturn, they injected fluorescent dye into the water in the tank:

To track the precise speed at different points within the fluid, they changed the fluid to a mixture of water and glycerol and seeded it with pellets of Pliolite (the glycerol was used so that the tracer particles would have neutral buoyancy within the fluid):

I should note here something that Aguiar wanted me to mention, which is that her work is not at all the first time that such patterns have been created in the laboratory; here, for instance, is another example. She and her coauthors were just first to publish a paper making a case for so explicit a connection between such laboratory experiments and conditions on Saturn.

They did manage to make a hexagon like the one that's seen on Saturn, but with slightly different choices of initial conditions (spin rates) they generated waves with other wavenumbers too, meaning they got polygons of different shapes. I want to thank Ana Aguiar very much for taking the time to dig these other cases out of her files for me, and especially for being willing to share data that *doesn't* look like the hexagon-near-Saturn's-pole situation she was trying to reproduce with her experiment. I asked to see them because we may see a hexagon near Saturn's pole, but different conditions around different planetary atmospheres could conceivably produce other shapes. And also because it's just so cool to see something as apparently chaotic and unpredictable as the turbulent flow of a liquid produce geometrical shapes like triangles, septagons, and ovals.

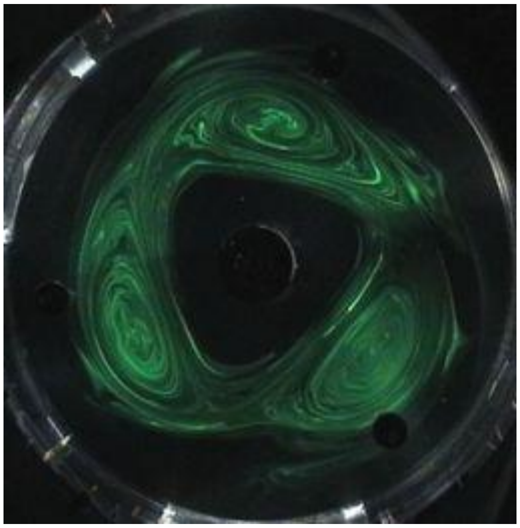
Want wavenumber = 7? Here's a septagon.



Courtesy of Ana Aguiar

Creating Saturn's...septagon(?) in the laboratory

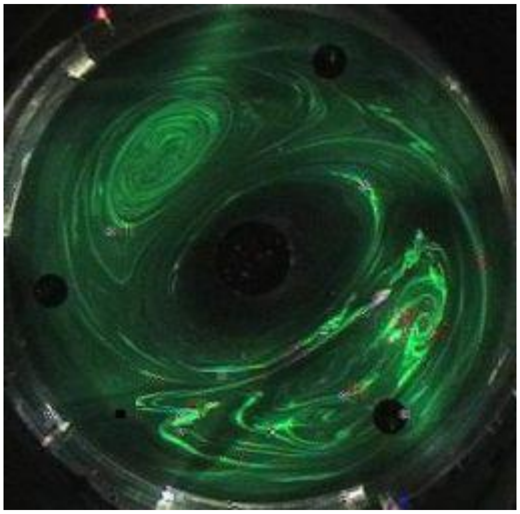
This is a top-down view of a laboratory tank in an experiment designed to reproduce the wind conditions near Saturn's north pole. The whole cylindrical tank is 60 centimeters wide. Its lid and base are split into two concentric sections, with the inner circle being 30 centimeters in diameter. The inner and outer circles are rotated at different rates, which sets up an instability at their boundary, producing a standing wave; the number of waves it takes to encircle the "pole" depends on various experimental parameters, including the rotation speed. In this particular case, the wavenumber is 7, producing a septagon -- one more "wave" than the number that surrounds Saturn's pole. Dye has been injected into the tank to make the form of the turbulent flow visible. Eddies are produced outside the wave.
How about "Saturn's triangle?" It doesn't exist, but if it ever does, we can explain that.



Courtesy of Ana Aguiar

Three eddies surrounding a pole

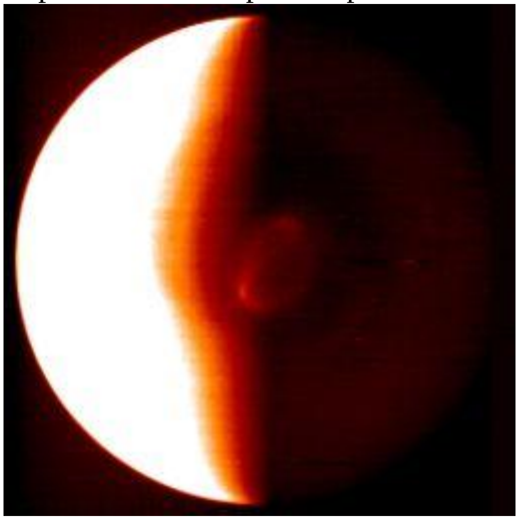
In an experiment designed to simulate the conditions near Saturn's North Pole, one experimental setup generated not a hexagon but a triangle.
How about wavenumber = 2? Here's an oval for you.



Courtesy of Ana Aguiar

Two eddies and a pole

With an experimental setup intended to produce Saturn's north polar hexagon, one choice of initial conditions produced two waves circling the pole, creating an oval shape bounded by two eddies. (Corrupt tape in the experiment's recording device caused the funky checkerboards in this image.)
Just to mess with you, here's the south pole of a planet that does have a polar oval, courtesy of ESA's Venus Express. I'm not saying it's caused by the same phenomenon Aguiar and her coauthors were exploring in the lab; I'm just saying you can get all kinds of polygonal shapes showing up near the poles of planets with deep atmospheres.



ESA / VIRTIS / INAF-IASF / Obs. de Paris-LESIA

Venus' south pole

A view of Venus in the thermal infrared, at a wavelength of 5 microns. The brightest part of the image is the uppermost atmosphere reflecting solar radiation on the dayside of Venus. On the nightside, subtle cloud features are visible, especially near the South Pole, as thermal radiation is emitted from Venus' upper atmosphere at an altitude of around 60 kilometers (36 miles). This image was captured on April 12, 2006 from a distance of 210,000 kilometers.
Finally, and just for fun: a video of a transition between a wavenumber=4 case and a wavenumber=3 case from Aguiar's lab. Can you imagine how fun it was to have this as a doctoral thesis project? I am sure that the experiments had their moments of tedium and frustration. But just imagine setting up an experiment, an apparently chaotic setup with fluid rotating in a tank, and see these bits of order emerge from that chaos. So cool!