Contents

In the News

Story 1:
NASA's Hubble Shows Link between Stars' Ages and Their Orbits

Story 2:
Snow line in an infant solar system

Story 3:
Parmitano praised for 'grace under pressure' in aborted spacewalk

Departments

The Night Sky
ISS Sighting Opportunities
Space Calendar
NASA-TV Highlights
Food for Thought
Space Image of the Week
1. NASA's Hubble Shows Link between Stars' Ages and Their Orbits

Astronomers using NASA's Hubble Space Telescope have determined the orbital motion of two distinct populations of stars in an ancient globular star cluster, offering proof they formed at different times and providing a rare look back into the Milky Way galaxy's early days.

Researchers led by Harvey Richer of the University of British Columbia in Vancouver combined recent Hubble observations with eight years' worth of data from the telescope's archive to determine the motions of the stars in the globular cluster 47 Tucanae, which is located about 16,700 light-years away in the southern constellation Tucana.

The analysis enabled researchers, for the first time, to link the movement of stars in the clusters with the stars' ages. The two populations in 47 Tucanae differ in age by less than 100 million years.

"When analyzing the motions of stars, the longer the time baseline for observations, the more accurately we can measure their motion," said Richer. "These data are so good, we can actually see the individual motions of the stars in the cluster. The data offer detailed evidence to help us understand how various stellar populations formed in such clusters."

The Milky Way's globular clusters are the surviving relics from our galaxy's formation. They offer insights into the early history of our galaxy. 47 Tucanae is 10.5 billion years old and one of the brightest of our galaxy's more than 150 globular clusters. The cluster measures about 120 light-years wide.

Previous spectroscopic studies revealed many globular clusters contain stars of varying chemical compositions, suggesting multiple episodes of star birth. This Hubble analysis supports those studies, but adds the stars' orbital motion to the analysis.

Richer and his team used Hubble's Advanced Camera for Surveys to observe the cluster in 2010. They combined those observations with 754 archival images to measure the change in position of more than 30,000 stars. Using these data, they could discern how fast the stars move. The team also measured the stars' brightness and temperatures.
This stellar archaeology identified the two distinct populations of stars. The first population consists of redder stars, which are older, less chemically enriched, and orbiting in random circles. The second population consists of bluer stars, which are younger, more chemically enhanced, and moving in more elliptical orbits.

The lack of heavier elements in the redder stars reflects the initial composition of the gas that formed the cluster. After the most massive of these stars completed their stellar evolution, they expelled gas enriched with heavier elements back into the cluster. This gas collided with other gas and formed a second, more chemically enriched generation of stars that was concentrated toward the cluster center. Over time these stars moved slowly outward into more elliptical orbits.

This is not the first time Hubble has revealed multiple generations of stars in globular clusters. In 2007, Hubble researchers found three generations of stars in the massive globular cluster NGC 2808. But Richer's team is the first to link stellar dynamics to separate populations.


The Hubble Space Telescope is a cooperative project between NASA and the European Space Agency. NASA's Goddard Space Flight Center in Greenbelt, Md., manages the telescope. The Space Telescope Science Institute (STScI) in Baltimore, Md., conducts Hubble science operations. STScI is operated by the Association of Universities for Research in Astronomy Inc. in Washington.

For images and more information about 47 Tucanae, visit:  http://hubblesite.org/news/2013/25

Source: NASA  

Return to Contents
2. Snow line in an infant solar system

Astronomers using the Atacama Large Millimeter/submillimeter Array (ALMA - http://www.eso.org/alma) have taken the first ever image of the snow line in an infant solar system. On Earth, snow lines form at high altitudes where falling temperatures turn the moisture in the air into snow. This line is clearly visible on a mountain, where the snow-capped summit ends and the rocky face begins.

The snow lines around young stars form in a similar way, in the distant, colder reaches of the dusty discs from which solar systems form. Starting from the star and moving outwards, water (H$_2$O) is the first to freeze, forming the first snow line. Further out from the star, as temperatures drop, more exotic molecules can freeze and turn to snow, such as carbon dioxide (CO$_2$), methane (CH$_4$), and carbon monoxide (CO). These different snows give the dust grains a sticky outer coating and play an essential role in helping the grains to overcome their usual tendency to break up in collisions, allowing them to become the crucial building blocks of planets and comets. The snow also increases how much solid matter is available and may dramatically speed up the planetary formation process.

Each of these different snow lines -- for water, carbon dioxide, methane and carbon monoxide -- may be linked to the formation of particular kinds of planets [1]. Around a Sun-like star in a solar system like our own, the water snow line would correspond to a distance between the orbits of Mars and Jupiter, and the carbon monoxide snow line would correspond to the orbit of Neptune.

The snow line spotted by ALMA is the first glimpse of the carbon monoxide snow line, around TW Hydrae, a young star 175 light-years away from Earth. Astronomers believe this budding solar system shares many of the same characteristics of the Solar System when it was just a few million years old.

"ALMA has given us the first real picture of a snow line around a young star, which is extremely exciting because of what it tells us about the very early period in the history of the Solar System," said Chunhua "Charlie" Qi (Harvard-Smithsonian Center for Astrophysics, Cambridge, USA) one of the two lead authors of the paper. "We can now see previously hidden details about the frozen outer reaches of another solar system similar to our own."

But the presence of a carbon monoxide snow line could have greater consequences than just the formation of planets. Carbon monoxide ice is needed to form methanol, which is a building block of the more complex organic molecules that are essential for life. If comets ferried these molecules to newly forming Earth-like planets, these planets would then be equipped with the ingredients necessary for life.

Before now, snow lines had never been imaged directly because they always form in the relatively narrow central plane of a protoplanetary disc, so their precise location and extent could not be determined. Above and below the narrow region where snow lines exist, the star's radiation prevents ice formation. The dust and gas concentration in the central plane is necessary to insulate the area from the radiation so that carbon monoxide and other gases can cool and freeze.

This team of astronomers succeeded in peering inside this disc to where the snow has formed with the help of a clever trick. Instead of looking for the snow -- as it cannot be observed directly -- they searched for a molecule
known as diazenylium (N$_2$H$^+$), which shines brightly in the millimetre portion of the spectrum, and so is a perfect target for a telescope such as ALMA. The fragile molecule is easily destroyed in the presence of carbon monoxide gas, so would only appear in detectable amounts in regions where carbon monoxide had become snow and could no longer destroy it. In essence, the key to finding carbon monoxide snow lies in finding diazenylium.

ALMA's unique sensitivity and resolution has allowed the astronomers to trace the presence and distribution of diazenylium and find a clearly defined boundary approximately 30 astronomical units from the star (30 times the distance between the Earth and the Sun). This gives, in effect, a negative image of the carbon monoxide snow in the disc surrounding TW Hydrae, which can be used to see the carbon monoxide snow line precisely where theory predicts it should be -- the inner rim of the diazenylium ring.

"For these observations we used only 26 of ALMA’s eventual full complement of 66 antennas. Indications of snow lines around other stars are already showing up in other ALMA observations, and we are convinced that future observations with the full array will reveal many more of these and provide further, exciting insights into the formation and evolution of planets. Just wait and see," concludes Michiel Hogerheijde from Leiden Observatory, the Netherlands.
3. Parmitano praised for 'grace under pressure' in aborted spacewalk

A dangerous leak resulting in a large blob of water weightlessly sloshing inside Luca Parmitano's space helmet forced NASA to abort a planned six-and-a-half-hour spacewalk Tuesday, sending the Italian astronaut, struggling to hear and see clearly, back to the safety of the International Space Station's Quest airlock.

Fellow spacewalker Christopher Cassidy helped him along and within a little more than a half hour, the airlock was repressurized. Astronaut Karen Nyberg and cosmonauts Pavel Vinogradov and Fyodor Yurchikhin quickly opened the airlock's inner hatch and helped Parmitano get his helmet off, using towels to soak up the free water.

Flight director David Korth praised Parmitano, Italy's first spacewalker, for "grace under pressure."

"As he progressed back toward the airlock, the amount of water he was reporting started to increase and increase," Korth said. "You can imagine, you're in a fishbowl. So go stick your head in a fishbowl and go try to walk around. That's not anything you take lightly.

"Certainly, an EVA is dangerous already, and he did a great job of just keeping calm and cool and making his way back to the airlock."

It's not yet clear what caused the leak. NASA spacesuits feature a built-in 32-ounce drink bag filled with potable water and more than a gallon of water used in the suit's cooling system. Engineers do not believe the drink bag was the culprit, but they do not yet know exactly where the leak originated.

Wherever it came from, it was a serious issue. In the absence of gravity, water tends to pool in blobs and inside the cramped confines of a space helmet, a large amount of water could trigger uncontrolled coughing and, possibly, even drowning.

"Choking or drowning is definitely a possibility" if enough water is present, said Karina Eversley, the lead spacewalk officer at the Johnson Space Center in Houston.

The spacewalk, the second in seven days for Cassidy and Parmitano, began at 7:57 a.m. EDT (GMT-4). The work proceeded smoothly through the EVA's early stages as both men accomplished the initial tasks on their to-do lists.

Then Parmitano ran into a pair of problems. A carbon dioxide sensor in his spacesuit suddenly stopped working and shortly after, he noticed the back of his head felt unusually wet. Problems with CO2 sensors have cropped up in earlier spacewalks and don't normally pose a problem; flight controllers simply monitor suit telemetry on the ground and keep tabs on how the spacewalker feels.

But as Parmitano continued to work, routing cables on the outside of the International Space Station, he felt more and more water pooling in his helmet.

"I don't understand where it's coming from," he said.

"It has to be (your drink) bag," Cassidy replied. "Can you suck it dry?"
A few minutes later, Cassidy peered into his crewmate's helmet for a closeup look, saying "so that stuff on your forehead is not sweat?"

"No it's not."

A few minutes after that, Cassidy told flight controllers in Houston that Parmitano's drink bag almost certainly was empty "so there's something left, like a liter, at the back of his head."

"No, it's less than that," Parmitano corrected. "Half a liter."

"A half a liter at the back of his head," Cassidy called. "Half of a drink bag. That's just a guess on our part."

But the amount of water continued to increase and began to creep around the side of Parmitano's head into the forward part of the helmet.

"I can still hear perfectly, but my head is really wet and I feel it increasing," Parmitano said. A few minutes later, he wondered again, "where's it coming from? It's too much."

"I don't know, it's a lot," Cassidy agreed.

"Now it's in my eyes," Parmitano said.

By that point, flight controllers assessing the problem at the Johnson Space Center in Houston already knew the spacewalk could not continue. In fact, it needed to end as quickly as possible.

"He started reporting it was coming around his ears and getting on the front of his face and it was at that point, per the rules and guidelines, we judged it was in the best interest of the crew and the mission (to) terminate the EVA," Korth said. "It wasn't prudent to try to continue tasks with water accumulating around his ears and the discomfort he had at that point."

Astronaut Shane Kimbrough in mission control passed the decision up to the crew.

"Chris and Luca just for you guys, based on what we heard with Luca saying that water's in his eyes now and it seems to be increasing, we think we're going to terminate EVA case for EV-2," he said. "So Luca, we'll have you head back to the airlock. Chris, we'll get a plan for you to clean things up here and then join him in a minute."

"OK. copy all, Shane," Cassidy said.

And not a moment too soon. By the time the astronauts made it back to the Quest airlock, Parmitano was having trouble seeing, hearing and even talking. The spacewalk ended at 9:29 a.m. when valves were opened to begin repressurizing the outer airlock.

Eight minutes later, the airlock's inner hatch was opened and Vinogradov and Yurchikhin quickly removed Parmitano's helmet, using towels to sop up the excess water. Parmitano appeared in good spirits as he dried off and Eversley said he was none the worse for the scare.

"Luca's doing great," she said. "He's smiling and happy and all the crew is looking at the suits and reporting anything they can to help us investigate the source."

Korth said the carbo dioxide sensor failure may have been a result of the water leak. Parmitano initially
speculated the leak involved his drink bag, but there appeared to be more water in his helmet than the drink bag could account for. On top of that, the water didn't taste right.

"Luca says the water tastes really funny, not like our water from the PWD (potable water dispenser), which makes me think ... water out of the PWR (water reservoir)," Cassidy told flight controllers later. Water in the cooling system is laced with iodine to prevent bacteria from building up. "To him, the water clearly did not taste like normal drinking water.

"And the other important thing is when we took his LCVG (liquid cooling and ventilation garment) off, demated that connection, and felt his long underwear right by his belly button, that was all basically completely dry. Some little moisture from sweat, but not to the extent that it would have created the bubble up in his (helmet)."

He was referring to the location of a cooling line inside Parmitano's spacesuit.

Cassidy said the water was concentrated at the back of Parmitano's helmet, "kind of where the vent port is. That region seems to be the source of the water in the back of his head."

Cassidy and Parmitano carried out a spacewalk last Tuesday to begin working through a backlog of station maintenance and assembly tasks. Today's outing was the sixth for Cassidy and the second for Parmitano, the first Italian to walk in space.

The astronauts only accomplished the first two tasks on their spacewalk to-do list. Cassidy completed work at the Z1 truss atop the central Unity module to install a second set of jumper cables that will enable flight controllers to quickly reconfigure electrical loads in the wake of failures that otherwise would require a spacewalk.

Parmitano, meanwhile, began work to complete installation of wiring between the U.S. and Russian segments of the station. Shortly thereafter, the water problem developed and both spacewalkers were told to stand by while flight controllers assessed the problem. Within a few minutes, they were told to head back to the airlock.

None of the remaining items on the crew's spacewalk task list are time critical and flight controllers will assess the crew's timeline to figure out when another attempt can be made to get the work done.

The unfinished tasks include additional cable routing, work to move a wireless camera antenna on the station's power truss and replacement of a camera on the external deck of the Japanese Kibo lab module.

The astronauts also planned to reposition a balky door in a compartment on the power truss that houses electrical gear and to remove insulation blankets from a failed electrical switching unit that will be repaired later using the station's robot arm.

"As far as where we go from here, clearly we have a problem at this point that we don't quite understand," said Kenneth Todd, chairman of the ISS Mission Management Team. "And we're going to take the next day or two and sort through that ... trying to determine what kind of things we can do on orbit and here on the ground to try to get a better understanding of what's going on."

As for when NASA might attempt another spacewalk to complete the unfinished tasks, "we have no time clock that we're working to and certainly when you have an issue like this, you want to make sure you turn over every rock and make sure we've dealt with the issue completely."

Source: CBS News
The Night Sky

Friday, July 19
• Telescope users looking at the gibbous Moon from most of North America tonight can watch the Moon's invisible dark limb creep up to and occult the 4.4-magnitude star Xi Ophiuchi. Only Florida and the West miss out.

Some times of the star's disappearance: in western Massachusetts, 12:38 a.m. EDT; Atlanta, 12:32 a.m. EDT; Chicago, 11:10 p.m. CDT; Winnipeg, 10:50 p.m. CDT; Kansas City, 11:00 p.m. CDT; Austin, 11:07 p.m. CDT; Denver, 9:39 p.m. MDT. Start watching early.

Saturday, July 20
• Look upper left of the Moon after dusk, by roughly three fists at arm's length, for Altair, the bright eye of Aquila the Eagle. A little less far to the Moon's right is Antares, the fiery heart of Scorpius.

Sunday, July 21
• As twilight fades away, spot Venus low in the west-northwest. Look 1¼° to its lower left for much fainter Regulus. Bring binoculars.

Monday, July 22
• Twinkly Regulus is now 1¼° below Venus at dusk.

• Full Moon (exact at 2:16 p.m. EDT). The Moon travels across the sky tonight in western Capricornus.
ISS Sighting Opportunities

For Denver:

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<tr>
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Sighting information for other cities can be found at NASA’s Satellite Sighting Information

NASA-TV Highlights
(all times Eastern Daylight Time)

July 19, Friday
9:20 a.m. - ISS Expedition 36 In-Flight Event for the European Space Agency - JSC (Public and Education Channels)

Watch NASA TV online by going to the NASA website.
Space Calendar

- Jul 19 - [Jul 12] Cassini, Earth Photo
- Jul 19 - [Jul 17] MUOS 2 Atlas 5 Launch
- Jul 19 - [Jul 14] Comet P/2013 N3 (PANSTARRS) At Opposition (2.392 AU)
- Jul 19 - Asteroid 8 Flora At Opposition (8.6 Magnitude)
- Jul 19 - Asteroid 71885 Denning Closest Approach To Earth (1.524 AU)
- Jul 19 - Asteroid 7307 Takei Closest Approach To Earth (1.892 AU)
- Jul 20 - Cassini, Distant Flyby of Titan
- Jul 20 - Asteroid 2063 Bacchus Closest Approach To Earth (0.429 AU)
- Jul 20 - Asteroid 6032 Nobel Closest Approach To Earth (0.830 AU)
- Jul 20 - Asteroid 13208 Fraschetti Closest Approach To Earth (0.966 AU)
- Jul 20 - Asteroid 35978 Arlington Closest Approach To Earth (1.061 AU)
- Jul 20 - Asteroid 5748 Davebrin Closest Approach To Earth (1.866 AU)
- Jul 20 - Asteroid 6318 Cronkite Closest Approach To Earth (2.358 AU)
- Jul 21 - Moon Occults Pluto
- Jul 21 - Comet C/2012 V1 (PANSTARRS) Perihelion (2.090 AU)
- Jul 21 - Asteroid 4226 Damiaan Closest Approach To Earth (1.298 AU)
- Jul 21 - Asteroid 2620 Santana Closest Approach To Earth (1.833 AU)
- Jul 21 - Asteroid 10867 Lima Closest Approach To Earth (1.688 AU)
- Jul 21 - Asteroid 582 Olympia Closest Approach To Earth (2.260 AU)
- Jul 21 - 40th Anniversary (1973), Mars 4 Launch (Soviet Mars Mission)
- Jul 22 - Mars Passes 0.8 Degrees From Jupiter
- Jul 22 - Comet P/2012 G1 (PANSTARRS) At Opposition (2.572 AU)
- Jul 22 - Comet 231P/LINEAR-NEAT At Opposition (3.361 AU)
- Jul 22 - Asteroid 5103 Divis Occults HIP 100027 (4.2 Magnitude Star)
- Jul 22 - Asteroid 2013 BN18 Near-Earth Flyby (0.065 AU)
- Jul 22 - Asteroid 2007 XY9 Near-Earth Flyby (0.076 AU)
- Jul 22 - Asteroid 12002 Sues Closest Approach To Earth (1.696 AU)

Engineers at NASA's Jet Propulsion Laboratory pose with the completed Galileo orbiter and probe. The spacecraft would later be modified as a result of the 1986 Challenger disaster.

Source: JPL Space Calendar
Food for Thought

What’s the Best Design for a Flying Mars Robot?

Building a flying vehicle for Mars would have significant advantages for exploration of the surface. However, to date, all of our surface exploring vehicles and robotic units on Mars have been terrestrial rovers. The problem with flying on Mars is that the Red Planet doesn’t have much atmosphere to speak of. It is only 1.6% of Earth air density at sea level, give or take. This means conventional aircraft would have to fly very quickly on Mars to stay aloft. Your average Cessna would be in trouble.

But nature may provide an alternative way of looking at this problem.

The fluid regime of any flying (or swimming) animal, machine, etc. can be summarized by something called the Reynolds Number (Re). The Re is equal to the characteristic length x velocity x fluid density, divided by the dynamic viscosity. It is a measure of the ratio of inertial forces to viscous ones. Your average airplane flies at a high Re: lots of inertia relative to air stickiness. Because the Mars air density is low, the only way to get that inertia is to go really fast. However, not all flyers operate at high Re: most flying animals fly at much lower Re.

Insects, in particular, operate at quite small Reynolds numbers (relatively speaking). In fact, some insects are so small that they swim through the air, rather than fly. So, if we scale up a bug-like critter or small bird just a bit, we might get something that can move in the Martian atmosphere without having to go insanely fast.

We need a system of equations to constrain our little bot. Turns out that’s not too tough. As a rough approximation, we can use Colin Pennycuick’s average flapping frequency equation. Based on the flapping frequency expectations from Pennycuick (2008), flapping frequency varies roughly as body mass to the 3/8 power, gravitational acceleration to the 1/2 power, span to the -23/24 power, wing area to the -1/3 power, and fluid density to the -3/8 power. That’s handy, because we can adjust to match Martian gravity and air density. But we need to know if we are shedding vortices from the wings in a reasonable way. Thankfully, there is a known relationship, there, as well: the Strouhal number. Str (in this case) is flapping amplitude x flapping frequency divided by velocity. In cruising flight, it turns out to be pretty constrained.

Our bot should, therefore, end up with a Str between 0.2 and 0.4, while matching the Pennycuick equation. And then, finally, we need to get a Reynolds number in the range for a large living flying insect (tiny insects fly in a strange regime where much of propulsion is drag-based, so we will ignore them for now). Hawkmoths are well studied, so we have their Re range for a variety of speeds. Depending on speed, it ranges from about 3,500 to about 15,000. So somewhere in that ballpark will do.
There are a few ways of solving the system. The elegant way is to generate the curves and look for the intersection points, but a fast and easy method is to punch it into a matrix program and solve iteratively. I won’t give all the possible options, but here’s one that worked out pretty well to give an idea:

Mass: 500 grams  
Span: 1 meter  
Wing Aspect Ratio: 8.0

This gives an Str of 0.31 (right on the money) and Re of 13,900 (decent) at a lift coefficient of 0.5 (which is reasonable for cruising). To give an idea, this bot would have roughly bird-like proportions (similar to a duck), albeit a bit on the light side (not tough with good synthetic materials). It would, however, flap through a greater arc at higher frequency than a bird here on Earth, so it would look a bit like a giant moth at distance to our Earth-trained eyes. As an added bonus, because this bot is flying in a moth-ish Reynolds Regime, it is plausible that it might be able to jump to the very high lift coefficients of insects for brief periods using unsteady dynamics. At a CL of 4.0 (which has been measured for small bats and flycatchers, as well as some large bees), the stall speed is only 19.24 m/s. Max CL is most useful for landing and launching. So: can we launch our bot at 19.24 m/s?

For fun, let’s assume our bird/bug bot also launches like an animal. Animals don’t take off like airplanes; they use a ballistic initiation by pushing from the substrate. Now, insects and birds use walking limbs for this, but bats (and probably pterosaurs) use the wings to double as pushing systems. If we made our bots wings push-worthy, then we can use the same motor to launch as to fly, and it turns out that not much push is required. Thanks to the low Mars gravity, even a little leap goes a long way, and the wings can already beat near 19.24 m/s as it is. So just a little hop will do it. If we’re feeling fancy, we can put a bit more punch on it, and that’ll get out of craters, etc. Either way, our bot only needs to be about 4% as efficient a leaper as good biological jumpers to make it up to speed.

These numbers, of course, are just a rough illustration. There are many reasons that space programs have not yet launched robots of this type. Problems with deployment, power supply, and maintenance would make these systems very challenging to use effectively, but it may not be altogether impossible. Perhaps someday our rovers will deploy duck-sized moth bots for better reconnaissance on other worlds.

Source: Universe Today
Space Image of the Week

A Waterspout in Florida
Image Credit & Copyright: Joey Mole

Explanation: What's happening over the water? Pictured above is one of the better images yet recorded of a waterspout, a type of tornado that occurs over water. Waterspouts are spinning columns of rising moist air that typically form over warm water. Waterspouts can be as dangerous as tornadoes and can feature wind speeds over 200 kilometers per hour. Some waterspouts form away from thunderstorms and even during relatively fair weather. Waterspouts may be relatively transparent and initially visible only by an unusual pattern they create on the water. The above image was taken earlier this month near Tampa Bay, Florida. The Atlantic Ocean off the coast of Florida is arguably the most active area in the world for waterspouts, with hundreds forming each year. Some people speculate that waterspouts are responsible for some of the losses recorded in the Bermuda Triangle.

Source: APOD

Return to Contents