Episode 36: **Titan's Truths**

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Pamela: Welcome to show number thirty-six of Slacker Astronomy; a podcast about astronomy and just about anything else that floats over our heads.

Travis: Each week we bring you a recent news event from the world of astronomy. And when there is nothing new to report we'll instead review this week's blockbuster hits from Hollywood.

Pamela: But although King Kong and the Chronicals of Narnia both taunt us with their CGI greatness, this week there is more than enough news to keep us out of the theaters.

<audience boo hiss boo hiss>

Travis: Now, while we may not be rich with Weta Workshop graphics, this show does feature space craft, alien vistas, and the potential for life and death.

<audience applause>

Pamela: Last January, in the days before Slacker Astronomy, the European Space Agency deposited the Huygens probe onto the surface of Saturn's largest moon, Titan. At the time there was much excitement, much data, and much anticipation about what scientists would learn from that data.

Travis: And guess what folks, this past month scientists have started to publish a plethora of papers on the Huygens results, and we're here to take you on a whirlwind ride through 5 press releases in roughly 8 minutes.

Pamela: But first, a bit of background. The Huygens probe was an atmospheric entry probe that rode to Saturn on the back of the European Space Agency's Cassini Orbiter. Its mission was simple: explore the atmosphere of Saturn's largest moon Titan. On December 25, 2004 the Huygens separated from Cassini, and on January 14, 2005 this little probe-that-could plunged through the atmosphere of Titan, landed on the surface of Titan, and transmitted data for about 90 minutes.

Travis: It's that data we're here to discuss today. Start your clocks. 5 releases in 8 minutes, here we go.

<stop watch beep>

Pamela: Press Release 1: The University of Arizona announces they know exactly where the Huygen's probe landed.

Travis: This may seem like something that should be easy to figure out, but when you try and land a small probe on a rotating moving moon that has a thick atmosphere that has winds, well… knowing exactly where it landed can be a challenge.

Pamela: During its ascent through Titan's atmosphere, the Huygen's probe took a series of images of Titan's surface.

Travis: These images, taken with the Descent Imager / Spectral Radiometer, or DISR, showed that Titan is very similar in geology to our own Earth, possessing rivers, deltas, and other features you might see while flying cross-country.

Pamela: Members of the DISR team matched these geologic features with radar data taken by Cassini. This was not an easy job. Imagine trying to match a bunch of random satellite images with a large topographic hiking map of the gulf coast region, and you begin to understand what they went through.

Travis: After much staring at images, they have determined the probe landed just 7 km or 4 mi from its predicted landing site. This is remarkably accurate considering this is the most remote spacecraft landing ever achieved. Pictures of the landing site and a link to a really cool descent video can be found on our website.

Pamela: Press Release 2: ESA states all the highlights of the Huygens Mission in 395 words

Travis: And we sum up their summary in 195 words.

Pamela: According to their press release, Huygens imaged Titan from an altitude of 40 km and saw a world that was similar to earth in terms of meteorology, geomorphology, and fluvial activity.

Travis: In other words, Titan has weather, rocks, and rivers.

Pamela: After being buffeted by winds gusting at 450 km/hr at altitudes of 120 km, the probe fell through decreasing winds and encountered an ionosphere with electrical conductivity between altitudes of 140 and 40 km. Below this ionsphere, at about 40 km altitude, the thick atmosphere thinned out enough for imaging, although haze was encountered all the way down to the surface.

Travis: The Huygen's probe landed in loose wet sand that contained Water-ice pebbles that were up to the size of large gumballs. Samples of the air at the surface contained Argon 40, indicating past and possibly present geological activity, like volcanoes.

Pamela: Put together this means that Titan, as we all had hoped, is a promising place to study the chemistry of molecules like those that formed the building blocks of life here on Earth. Titan, like it or not, you are cool, and so we're going to throw spacecraft at you as budgets allow.

Travis: Press Release 3: NASA Goddard announces that Titan's Methane originates inside the moon, not on the moon.

Pamela: Methane is a molecule of 4 hydrogen atoms. It breaks apart in direct sunlight and is produced regularly by cows and bean burrito eating humans.

Travis: Early in Earth's past, methane may have been abundant in our atmosphere. This methane was produced by bacteria call methanogens that constantly restocked the atmospheric methane that was destroyed by the Sun.

Pamela: The Huygens Probe proved there are no friendly little bacteria producing methane on Titan. Specifically, the probe looked for carbon isotope ratios indicative of life.

Travis: For reasons we can't explain, life prefers the isotope carbon-12 over the heavier carbon 13 isotope. If there is life present in an atmosphere than there will be a

specific ratio of carbon 12 to carbon 13.

Pamela: And Titan doesn't have that ratio, and thus doesn't have life.

Travis: In other words - there are no methanogens producing methane on Titan. Without something to produce methane, it is estimated that all the methane on Titan would be destroyed by sunlight in just 100 million years.

Pamela: Since the solar system, and most likely Titan as well, have been around for 4.5 billion years, something must be resupplying the methane, and that something appears to be the inside of the moon.

Travis: According to Dr. Hasso Niemann of Goddard, the gas may have been trapped in the moon during its formation and is now leaking out through vents. Now that is what I call a gasy gut!

<cartoon boing>

Pamela: Press Release 4: The University of Illinois announces that River's on Titan resemble those on Earth

Travis: We've already hinted at this several times, but somethings are worth repeating.

Pamela: Titan's rivers are made of liquid methane and they flow through continents of ice and contain river stone shaped pieces of water ice.

Travis: Without any industrial pollution, Titan's rivers still manage to smell worse than anything here on Earth.

Pamela: While they may smell bad, they look appetizing to scientists.

Travis: Understanding the rivers is a complex multi-variable problem – the type that drives an engineer a little crazy and makes a scientist salivate. The ingredients of the problem include: the viscosity of the flowing fluid, the specific gravity (which is related to density) of the sediment the fluid is flowing over, and the strength of gravity where the fluid is flowing.

Pamela: All of these parameters change when you go from flowing water on Earth to flowing methane on Titan.

Travis: But they change in precisely the way needed to keep the characteristics of rivers here very similar to rivers there.

Pamela: The viscosity of liquid methane is lower than the viscosity of water, but the specific gravity of the sediment it is flowing over is also lower, as is the acceleration of gravity. Mother Nature conveniently turned down all the parameters on Titan in just the right ways to get similar landscapes.

Travis: It may be an alien world, but it sure looks like home.

Pamela: But if you try to go skinny-dipping, you will die of asphyxiation, hyperthermia, poisoning, or internal hemorrhaging. All these things will happen to you – we just don't know which will kill you first.

Travis: Ahh, so there's that death you promised…

Pamela: Press Release 5: The University of Michigan announces that Titan provides Clues to Earth's Early Days

Travis: In a paper titled "The Abundances of Constituents of Titan's Atmosphere From the GCMS Instrument on the Huygens Probe" …

Pamela: Which we link to on-line, for any of you still awake after hearing the title

Travis: … scientists discuss the results of measurements made by Huygens' Gas Chromatograph Mass Spectrometer.

Pamela: This instrument measured the mass of materials in Titan's atmosphere, and was sensitive enough to sort isotopes of atoms.

Travis: Scientists discovered that Titan's atmosphere does not contain the primordial noble gases that Titan formed with. Instead, nitrogen on Titan formed from ammonia, just as the nitrogen in Earth's atmosphere did. This means that organic chemical reactions have reshaped the atmosphere of Titan.

Pamela: It's important to understand that living organic critters aren't required for organic reactions to occur. An organic reaction is just a reaction involving carbon.

Travis: Titan's atmosphere, like Earth's, is primarily nitrogen. Coming in second is methane, which makes up 5% of Titan's atmosphere.

Pamela: Methane on Titan plays a similar role to water here on Earth, with liquid methane existing in Titan's atmosphere just as liquid water exists in our atmosphere. Both form clouds, cause rain, and then evaporate from the ground back into the sky.

Travis: The combination of nitrogen and methane in sunlight provides just the right environment for the formation of complex organic molecules that may be the precursors to life.

Pamela: While there are no indications that life exists on Titan, understanding the formation of complex organic molecules there may help us understand the steps leading up to the formation of life here.

Travis: And now you've done it. You've brought up the potential for life. Everyone stop you clocks…

<Cartoon Boing>

Travis: That was for the record, 5 press releases in not 8 but 7 fast paced minutes, covering (as promised) space craft, alien vistas, and the potential for life and death. We hope you enjoyed this weeks experiment in providing too much information. I am now going to cleanse my mind with a mindless movie.

Pamela: In the next few months, thanks to the support of Travis and Aaron's employer, the American Association of Variable Star Observers, and the generous financial backing of Oceanside Photo and Telescope, the three of us are going to be traveling.

Travis: Yes folks, Pamela and Aaron are traveling, and for once they're taking me with them. Tour stop 1 is the American Astronomical Society's winter meeting in Washington DC from January 8-12. All three of us will be there, mics on and podcast ready. If you're going to be there, let us know. We'd love to meet you.

Pamela: A couple weeks later, Jan 21-25, I'll be in Anchorage, Alaska for the American Association of Physics Teachers Winter meeting…

Travis: Anchorage in January… Yea – Aaron and I are going to stay here in Boston …

Pamela: … and in May, some combination of the three of us will be at the American Association of Variable Star Observers Spring Meeting in Rockford, IL. Again, we'd love to see you. All are welcome.

Travis: We hope that these trips will allow us to bring you more interviews, more chat shows, and that they will provide us a place to talk to you face to face and learn what you want to hear.

Pamela: So we'll see you this winter. Thanks for listening. For Travis and Aaron, this is Pamela Gay.

Travis: Clear Skies and Clear Bandwidth. This has been Slacker Astronomy, a volunteer collaboration for you, for fun, for the voices in our heads.