• To entice you into taking Astronomy 1102/1104 – Our Solar System
• Spring 2013, MWF 11:15-12:05, Uris Hall G01
• Sun, Planets, Moons, Asteroids, Comets, and Exoplanets
• Emphasizes science from space missions and how this science affects our understanding of Earth
Awesome Profs!

Prof. Joe Burns

Prof. Steve Squyres
Bottom Line

• Some Overlapping Material -> GOOD GRADE!
Patterns and Differences
Terrestrial and Giant Planets
Terrestrial/Inner Planets

- Location: Nearer the Sun
  - Hotter
- Size: Smaller
- Density: Rock
  - Composition
- Rotation: Slower
- Moons: Fewer
  - No Rings
- Atmospheric Composition, Internal Heat, Revolution...

Credit: Calvin J. Hamilton
Giant/Outer Planets

- Location: Farther from the Sun
  - Colder
- Size: Bigger
- Density: Water
  - Composition
- Rotation: Faster
- Moons: Lots
  - Rings
- Atmospheric Composition, Internal Heat, Revolution...

Credit: Calvin J. Hamilton
Striking Differences

- Distance from the Sun: 72.3%
- Mass: 81.5%
- Radius: 94.9%
- Temperature: 737 vs. 288 K
- Pressure: 92 vs. 1 atm
- Surface Water: 0 vs. 71%
- Active Geology: Dead vs. Plate Tectonics
- Life: Dead vs. Abundant

Credit: NASA/JPL
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Credit: NASA/JPL
Patterns and Differences
Drastic Changes

• Water once flowed on Mars
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Credit: ESA

Credit: NASA/JPL/Cornell
Drastic Changes

• Water once flowed on Mars
• Venus probably used to have about one ocean’s worth of water as well
• Could Earth also lose its water?

Credit: www.deansweeklyblog.blogspot.com
Drastic Changes

• Water once flowed on Mars
• Venus probably used to have about one ocean’s worth of water as well
• **Could Earth also lose its water?**
• Rocks on the Moon and Mars suggest both bodies used to have a magnetic field
• Saturn’s moon Iapetus used to be spinning very fast
Four Major Geologic Processes

• Impact Cratering
• Volcanism
• Tectonism
• Erosion
Four Major Geologic Processes

- Impact Cratering
- Volcanism
- Tectonism
- Erosion
Understanding/Apppreciating Earth

We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S. Eliot
TITAN

• Most mysterious object in the solar system
• Saturn’s largest moon
  – Second largest moon in the solar system
• Christiaan Huygens
• 1655

Credit: NASA/ESA
Methane on Titan

- Voyager 1 1981 flyby
- Surface pressure of 1.5 bar, temperature of 90 K
- 95% Nitrogen and 5% Methane
- Only moon in the solar system to have a significant atmosphere
- Similar to Earth’s atmosphere

Credit: NASA/ESA
BUT WAIT...

• Methane is unstable in Titan’s atmosphere
• All of Titan’s atmospheric methane should be destroyed within $10^7 – 10^8$ years
• Where did the methane come from?
• Has Titan always had an atmosphere with methane?
Oceans on Titan?

- Photolysis of methane leads to the production of ethane
- Ethane is stable as a liquid at Titan’s surface conditions
- Titan’s surface is very near the triple points of both ethane and methane

1983 Lunine et al. proposed Titan has a global ethane-methane-nitrogen ocean
Atmospheric Windows

• Like Earth’s, Titan’s atmosphere is transparent to radio waves
• RADAR investigations from Earth based telescopes indicated that Titan’s surface is not uniform
  – No global ocean
Cassini-Huygens Mission

- First spacecraft to go into orbit around Saturn
- Largest and most expensive interplanetary spacecraft in history
- Launch: 1997
- Arrival: 2003
- End of Prime Mission: 2008
- End of Mission: 2017

Credit: NASA/ESA
Huygens Landing

- Huygen’s probe landed near Titan’s equator in 2005

Credit: NASA/ESA
Just For Fun...

• 2 are from Earth and 2 are from Titan
• Can you identify them?
• 2 are from Earth and 2 are from Titan
• Can you identify them?
• 2 are from Earth and 2 are from Titan
• Can you identify them?
Where is the liquid?

• Abundant evidence that Titan had liquids on its surface in the past and that it should still have liquids there today
Lakes on Titan!!

Titan’s North Pole

“Titan has hundreds of times more liquid hydrocarbons than all the known oil and natural gas reserves on Earth”

Credit: NASA/ESA
Titan’s South Pole

Credit: NASA/ESA

Credit: NASA/ESA
Lakes and Seas of Titan

- Titan has liquid ethane-methane seas at both its poles
  - Presence of liquid ethane was confirmed from spectra of Ontario Lacus
  - Specular reflection seen in the infrared
Review: Evidence for Liquids on Titan

1. Expect hydrocarbon liquids from atmospheric chemistry and thermodynamics
2. Evidence of past liquids
   – Rivers, lake beds, and rounded pebbles
3. Evidence of rain
4. RADAR dark spots at topographic lows
5. Spectroscopy
6. Mirror like surfaces
   – Specular reflections and altimetry

Our Solar System
Jason Hofgartner
Nov 26, 2012
Review: Evidence for Liquids on Titan

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Life?

• Titan is the only body aside from Earth that has stable liquids at its surface
• Could life survive in this environment?
  – Could it evolve into intelligent life?
  – This would double the number of life-suitable planets in the Drake equation
• Earth’s primordial atmosphere may have been very similar in composition to Titan’s current atmosphere
• There is evidence that Titan also has a water ocean beneath its solid surface
Future Exploration

• Scientists are working on the possibility of sailing on one of Titan’s seas
  – Climate and Meteorology, Composition, Depth, Currents...

• Challenges
  – Travel Time, Distance, Cold, Communication

YOU WILL LEARN LOTS OF INTERESTING THINGS ABOUT THE SOLAR SYSTEM IN ASTRONOMY 1102