Titan - What Next?

Ralph D Lorenz

Lunar and Planetary Laboratory,
University of Arizona,
Tucson, AZ 85821, USA
rlorenz@lpl.arizona.edu
A new beginning....

Artwork by Mark Robertson-Tessi and Ralph Lorenz, LPL, University of Arizona (http://www.lpl.arizona.edu/~rlorenz)
Titan - What Next?

- The future on Titan - seasonal change
- Emerging Astronomical Capabilities
- Future Titan Exploration Instruments and Concepts
Titan’s seasons 7.5x longer than Earth’s, slightly stronger (higher obliquity), and asymmetric due to orbital eccentricity (c.f. Mars)

Figure courtesy of Tetsuya Tokano (Tokano et al 2000)
Emerging Capabilities

AO imaging/spectrographs on 10m-class telescopes - cloud monitoring.

High-resolution spectrographs (Geballe HCN; Roe - Propane etc.)

ALMA - Atacama Large Millimeter Array

Heterodyne IR spectroscopy on large telescopes (Kostiuk+)

HST ??

JWST
Cratering - interpolation among Saturnian satellites suggests ~200 craters (D>20km) per million km².

~20,000 total? (Atmospheric shielding cuts off population <10km) Craters fill with liquid ? (all to the same level?)

Canadian examples (Clearwater Lakes; 30,20km ; Manicouagan 70km)
Impact melt sheets are prime sites for organic synthesis on Titan - hydrolysis of tholin yields purines, amino acids etc...
Key Science Goals (mutatis mutandis post Cassini)

• Surface chemical sampling for Astrobiology - especially of frozen ice material in melt sheets etc; contains water-tholin interaction products such as amino acids

• Subsurface profiling - presence of near-surface melt, depth of methane lakes

• High-Resolution geomorphological studies (esp. fluvial, aeolian phenomena at scales too small for Cassini)

• Meteorological Investigations
Hotspot Chemistry

Tholin Hydrolysis Products

Amino Acids

Urea

NH₃

H₂O

Impact Melt from Icy Crust

From atmospheric photochemistry

Tholin (R-CN etc)

HCN

Strecker Synthesis

HCN oligomers

Purines, Pyrimidines

Cometary Material

Team “χMERA” (ChiMERA, or Chiral Measurements for Extraterrestrial Robotic Analyses)

A U of Arizona-Caltech-JPL Partnership

Team Lead:         Pat Beauchamp, Jet Propulsion Laboratory
University Lead:   Jonathan I. Lunine, Lunar and Planetary Laboratory, The University of Arizona

Team
Jack Beauchamp, Beckman Institute and Dept. of Chemistry, Caltech
Dennis Dougherty, Dept. of Chemistry, Caltech
Gene MacDonald, Jet Propulsion Laboratory
Mark Smith, Department of Chemistry, U of A
Chris Welch, Merck and Co.

The Chimera of Arezzo, 1553
(image of copy of original)
‘Vision’ Missions NRA - Proposals Selected Early 2004

Study mission concepts for 2010+ timeframe

$300K / 1 year study

- Joel Levine, NASA Langley. Titan Aeroplane?

- Jonathan Lunine (+Zimmerman/JPL, Lorenz) Titan concepts, especially Airship+deployable robot
Sun/Saturn position - autonomous location determination via near-IR imaging of sky (Earth always within ~6 degrees of sun)

Saturn visible too - provides additional navigation information via phase and ring shadow.
Airship concept - phased array antenna for direct-to-Earth communication. Deployable tethered sonde for surface sampling.
HCIPE - High Capability Instruments Program

- Study instrument concepts for post-JIMO Prometheus (nuclear) missions, to exploit high power and bandwidth capabilities, esp. leveraging on terrestrial experience

~ $1.5M/3 year

Probably to include SARs, Subsurface Sounding Radars, Laser Ablation Spectrometers etc.

At least one Titan-specific proposal selected. Eastwood Im, Steve Durden (JPL) and Ralph Lorenz - Titan Cloud and Precipitation Radar / Altimeter

Ka-band radar for 3-D cloud structure
Conclusions

Titan to change in next 6 years

Titan is on NASA’s radar screen

Work ongoing esp. at JPL - other centers waking up.
Instrument concepts evolving

Next New Frontiers AO to solicit Titan mission? ($700M+)

N Polar mission circa 2015?

Prometheus mission (a la JIMO?)

ESA ???