HUBBLE SPACE TELESCOPE AMATEUR ASTRONOMERS WORKING GROUP

PROPOSAL FOR
HUBBLE SPACE TELESCOPE OBSERVATIONS

**This complete proposal package including two 4" x 9½" (or larger) self-addressed stamped envelopes must be postmarked and sent to HST Proposal, AAVSO, 25 Birch St., Cambridge, MA 02138.

1. Proposal Title: Titan's Atmosphere and Evolution thru Disk Resolved Spectroscopy

2. Principal Investigator (PI): George R. Lewycky

3. Address: 7 Durst Drive

4. City: Milltown State NJ Zip Code 08850

5. Telephone: day (212) 236-3018 night (908) 846-1216

6. Co-investigator: _____ Telephone (___) _____

7. Scientific Category: (Select One)
   - xxx Solar System
   - ___ Variable Stars (including novae & supernovae)
   - ___ Interstellar Medium
   - ___ Stellar Astrophysics
   - ___ Stellar Populations
   - ___ Galaxies and Clusters of Galaxies
   - ___ Quasars and Active Galactic Nuclei
   - ___ Other (describe nature and characteristics of object below)

8. Abstract: (please confine to this space)

By using disk resolved spectroscopy, create a map of Titan's atmospheric constituents using the HRS to obtain the presence, temperature and volume of Titan's species (both gaseous and chemical). Highlighting the minor species with emphasis of the Aldehyde group (-CHO), most preferably Formaldehyde (CH2O), which is known to play a role as an oligomer to Hydrogen Cyanide (HCN), resulting in simple precursors (e.g., adenine, uracils) and ultimately purines and pyrimidines.

9. Scientific Keywords: Atmosphere, spectroscopy, evolution, formation

10. Estimated observing time: 1.5 hours (primary)
    _____ hours (parallel)

11. Number of targets: 1 (primary)
    _____ (parallel)

12. Circle instrument(s) requested: WF/PC FOC FOS (HRS) HSP FGS

13. Special Scheduling requests:
    - ___ Real-time observation
    - ___ Uninterrupted long exposure
    - ___ Time-critical observations
    - ___ Special orientations

14. Signed [signature] Date 7-27-91

Please answer the following questions. Continue on the reverse side of the question sheet if necessary. Try not to exceed the space available on both sides of the question sheets. We recommend you begin work first on the question you find most difficult.

Explain in detail what you are proposing to study and the significance of the investigation to the field of astronomy.

With Voyager I's findings over a decade ago of a unique atmosphere on Saturn's moon Titan, I propose disk spectroscopy of Titan's atmosphere using the HST's GHRS to map spectrographic data of Titan, and possibly determine the contents distribution based upon the species characteristics found thru the spectrum.

Though key compounds and elements are already discovered, questions remain as to how, why and where such compounds and elements exist as well as their origin. As well as searching for undetected constituents that went undetected or possibly have been formed since.

By mapping the satellite, areas with unique compositions or higher concentrations can be studied by their distribution content in order to understand what caused such compounds/elements to be present and to see if any unusual or unique activity is/was present among such areas. Also to see if such activity is spreading or if it is confined (and if so, why ?).

The mapping would also try to find if a "catalyst" or an oligomer (particularly Formaldehyde - or other aldehydes) are present in such areas where HCN has been found. As well as analyzing for expected and unexpected purines ($C_5H_4N_2$), various hydrocarbons, hydrates, nitriles, uracils and pyrimidines ($C_4H_4N_2$). This could determine if the catalyst's or oligomer's origin was internal or external or if it was inhibiting any activity. If so, then isolate it to determine its origin and content.

Using the spectral data a search could possibly find for breaks in Titan's hazy atmosphere. This could aid Cassini's arrival in December 2002 by dropping its Huygens probe in a prime location to crack Titan's atmosphere, something that Voyager I was unable to accomplish.

And finally, (1), with the data gathered generate a model (or control) to aid us in comparing other moons, planets, etc. We cannot resort to only Earth as a model for comparing other planets and moons against to determine if they could be habitable or life forming; (2), to explore whether or not Titan shows any evidence that it was once a planet itself or was in the process of becoming one. But instead, it became locked into Saturn's orbit making it one of its orbiting satellites (particularly one of its outermost satellites). It seems very odd that such a satellite in our Solar System contains an atmosphere and composition resembling that of a planet. Whether accidental, incidental or intended more data must be gathered of Titan's composition, atmosphere and evolution so that we can better hypothesize and analyze other satellites and planets and know what to look for (as well as where). All in order to learn more about DNA's evolution as well as Titan's; And, (3), possibly explain the origin or phenomenon of Titan's North polar hood, which is the sole visible feature that stands out of Titan's hazy atmosphere. With the spectra gathered a comparision of the North polar region versus the Equator and South polar regions could possibly explain the 'rings' composition and features. Such a comparison also could possibly expose a 'gap' or 'break' in Titan's hazy atmosphere by it exposing previously undetected constituents.

2. Give specific details of the targets to be studied and the HST instruments and their modes to be used. Explain how the data from the instrument/mode are required for your investigation. Provide a table with columns as follows: Target Name/ID, Target Position, Magnitude, Instrument/Mode, Filter or Spectral Range, Number of Exposures Needed, Comments. Provide a separate table listing only the targets you wish to study and the Exact Positions (either in Right Ascension and Declination (specify the epoch) or in offsets from a known target). In lieu of a table you can supply a chart or photograph indicating desired targets.

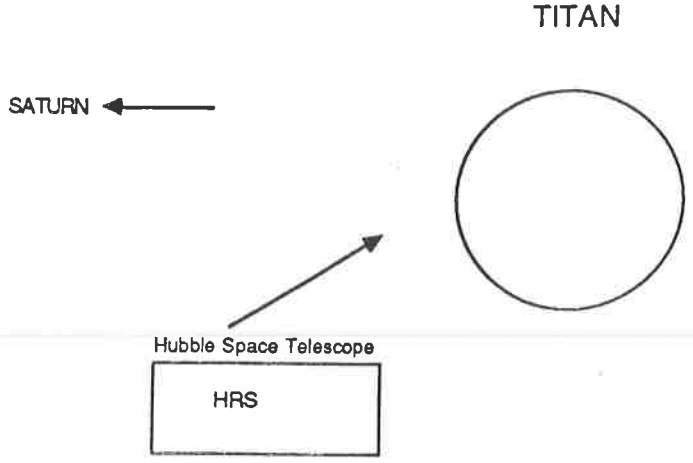
The sole target involved for this proposal is any hemisphere of Saturn's moon Titan covering the entire disk.

The HST instrument needed for this experiment is the HRS with the Large Science Aperture (LSA).

As for the mode of resolution of the HRS, the high resolution mode is desired. Because of the spectral range that Formaldehyde and other species fall in, the spectral data needs to be distinguishable to identify it. Especially if additional Aldehydes are discovered, segregating Formaldehyde with or without other aldehydes must be a capability to prove or disprove this proposal of Titan.

The filter required is the G270M, since it will cover the absorption spectrum of Formaldehyde which ranges from 2667 Angstroms thru 3288 Angstroms. Along with the detection of other compounds.

Target Name/ID	Target Position	Magnitude	Instrument/ Mode	Filter	Number of Exposures	Comments
TITAN	N/A	8.4	HRS & LSA/ High Resolution	G270M	6-8	Exposures are estimates



3. Given HST throughput and motion and pointing constraints, show not only that the HST can make the observations your investigation requires but that the data returned will be scientifically useful in answering the inquiry you propose.

Since I propose to acquire spectral data of Titan's entire disk (at any one time of any hemisphere), the HST has a large visible object for positioning and acquisition purposes. Also several GTO's of Titan have been performed and proposed.

The spectral data returned will indicate the presence, composition, distribution, migration and possible reactions of Titan's atmposphere and composition. Most important is the presence of Formaldehyde, known to play the role as an oligomer with Hydrogen Cyanide. Discovering formaldehyde could indicate that chemical activity and side reactions are occuring that can ultimately lead to purines and pyrimidines essential to DNA's evolution has occured or will ultimately occur.

Since the Voyager encounters and until Cassini (both a decade apart from the present), other minor species could have been formed or entered Titan's atmosphere. Therfore such spectral data could expose such species.

By analyzing Titan's spectral disc numerous questions could be answered, such as: (1) What is the possibility that Titan was ever a planet itself, and somewhow it became locked into Saturn's orbit making it one of its orbiting satellites, particularly one of its outermost. And the followup question is then Why only Titan ?; (2) A composition study of Titan's North polar hood feature could possibly determine whether this feature might be the result of a weather system, or magnetic field interaction with Saturn, or it may even be a 'break' into Titan's hazy atmosphere; (3) With the map created, comparisons of the spectra from Northern, Equatorial and Southern regions of Titan's disk could be performed. This would expose differences in composition, temperature and other variables, and possibly explain the latter.

4. Explain which of the HST-unique capabilities your investigation requires and show why your study cannot be made using a groundbased telescope.

Hubble's GHRS is required for my investigation of Titan's composition, most importantly for emphasizing its minor or secondary constituents. Both expected and unexpected species will be of extreme interest, especialy of the Aldehyde group (-CHO), with emphasis on Formaldehyde (CH_2O), therefore very fine resolution and specific wavelengths are critical to this proposal in order to distinquish Formaldehyde from other compounds. A groundbased observation might not be able to find trace amounts of Formaldehyde and other minor species, due to distance and interference of Earth's atmosphere. And this proposal requires spectroscopy, therefore a groundbased telescope observation could not return the data required.

Titan currently contains the elementary constituents (Carbon, Hydrogen and Oxygen) which are the components for Formaldehyde. Whether Formaldehyde exists is just as important as finding the reaction(s) to which it evolved (if possible).

Formaldehyde is known to be an Oligomer to Hydrogen Cyanide (HCN), which plays a vital role as a precursor for the chemical evolution of purines and pyrimidines. With the presence of Formaldehyde, or possibly some other catalyst and/or oligomer which has not been discovered reactions could be producing by-products ultimately leading to Adenine and Uracil.

5. Outline your plans for analyzing the data you obtain (help will be available from the ST ScI) and how/where you would like to publish your results.

I. From the Spectra acquired a data model is needed to map and visualize the presence and volume of species which are found.

A. Analyze the spectra for the presence of Formaldehyde.

B. A data model would be able to highlight areas of Titan's disk based upon its content, temperature, etc. (see attached diagram)

C. Minor and secondary constituents will be exposed.

D. Areas of activity could be determined (e.g., reactions, migrations, gases escaping and entering, etc).

II. Possible understanding and/or explaining the composition and phenomena of Titan's North Polar Ring feature.

A. Find what species were detected in that area of the disc spectra.

B. Compare the spectra of that area of the disc to other areas, to possibly rule out certain reasons or species that could explain such a unique feature of Titan's hazy atmosphere.

C. Also compare the spectra of that area of the disc to other areas for species that present a possible 'break' in the atmosphere.

III. Try to find a unique feature or characteristic of Titan to possibly understand more of its Evolution. Possibly to answer any of the following:

A. What gave it an atmosphere ?

B. Was it ever a planet itself ?
If so, what forced it into becoming an orbiting satellite ?

C. Why dont any neighboring satellites resemble Titan ?

IV. As for publishing my results, I would desire to write two versions of my findings, one more technical than the other, so that people interested regardless of their background would be able to understand the results.

The reasons for this are that since this project, I have encountered innumerable resources some too technical for people (like myself) with an interest but not experienced enough to fully understand its content and findings.
And since this is an Amateur project it should be directed to amateurs, hopefully to inspire other amateur astronomers.

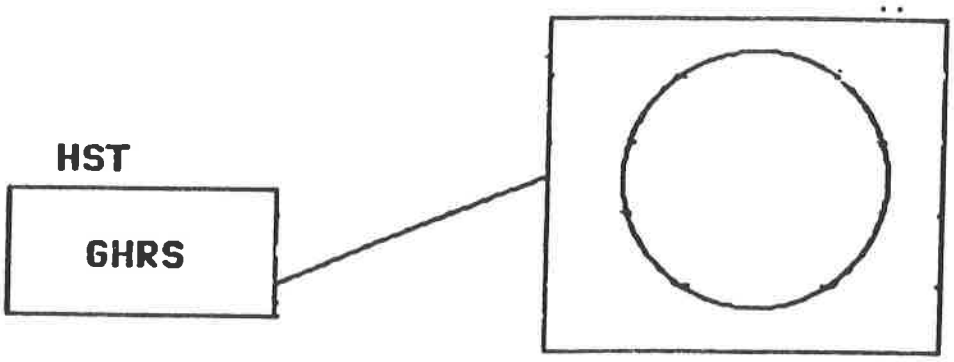
A. Desired publications for the Amateurs would be any of the following: Astronomy, Scientific American, Sky & Telescope, etc.

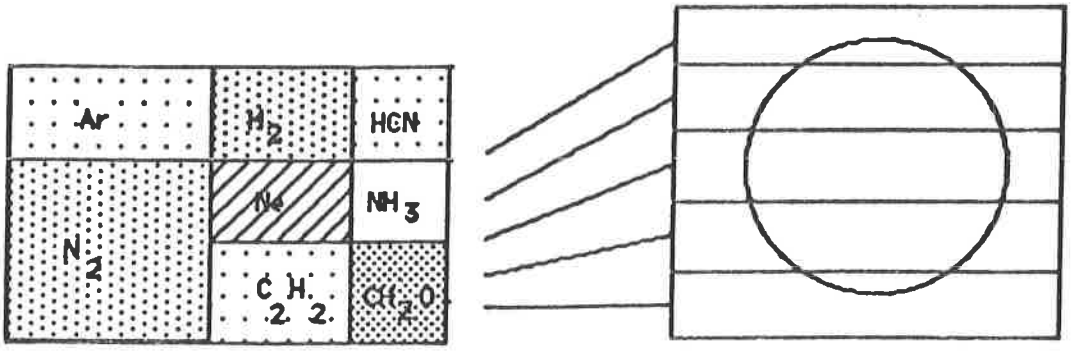
B. As for the more technically detailed publication a candidate could be: Icarus, Astronomical Journal, Science, Nature, etc.

Data Modeling Procedure

Using Spectral data, we are attempting to map Titan's atmospheric properties and subsequently its constituent compounds in regards to both temperature and characteristics.

Based on distribution, migration and temperature of its constituents, a three dimensional model may be hypothesized to include the upper, middle and lower atmospheres as well as surface temperature.





6. Supply a bibliography listing relevent scientific publications that describe your topic. Give the title, author, journal or book, volume number, page, and year of publication. Supply photocopies of one to three recent articles.

NOVA, 'Resolution on Saturn', transcript (Toby Owen) 8/25/81 pp. 12-15

Voyages to Saturn, David Morrison, 1982, NASA SP-451, pp. 3,7,9-11, 59,61,67,70,72,74,76,82-85,88,91,126,128,132,144-148,151-152

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The Identification of Molecular Spectra, R. Pearse & A. Gaydon, 1950, p. 84

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Science, 'Titan Continents in a Hydrocarbon Sea', M. Mitchell, Waldrop, vol. 245, July 14, 1989, pp. 129-130

Science, 'Was Adenine the First Purine ?', Alan W. Schwartz & C.G. Bakker, vol. 245, September 8, 1989, pp. 1102-1104

Science, 'Radar Reflectivity of Titan', Duane O. Muhleman, Arie W. Grossman, Bryan J. Butler & Martin A. Slade, vol. 248, May 25, 1990, pp. 975-980

Science News, 'Titan: Decoding the Atmosphere', vol. 118, December 13, 1980, p. 375

Science News, 'Voyager 1: Titan and other wonders', vol. 118, December 20 & 27, 1980, p. 391

Astronomy, 'Cassini', Donald Frederick Robertson, September 1987, pp. 20-24

Astronomy, 'Atmospheres', Edward J. Ciaccio, May 1984, pp. 14-22

Astronomy, 'Voyager: Science at Saturn', Richard Berry, February 1981, pp. 16-22

BIOGRAPHICAL SKETCH OF HST PROJECT PROPOSER

Name: George R. Lewycky

Date of Birth: 11-11-66 **Place of Birth** Elizabeth, New Jersey

Education: B.S. in Computer Information Systems, 1987
DeVry Technical Institute, Woodbridge, New Jersey
DeVry Institute of Technology, Chicago. Illinois

Occupation: Programmer/Analyst **Current Position:** Programmer/Analyst

Brief Career Summary:

Merrill Lynch, Manhattan, NY	9/90 to present	Programmer/Analyst
AT&T Communications, Piscataway, NJ	12/89 to 6/90	Consultant
J. Crew, Manhattan, NY	10/88 to 10/89	Programmer/Analyst
Syms, Secaucus, NJ	10/87 to 5/88	Programmer/Operator

Membership(s): National Space Society, Princeton Planetary Society, Smithsonian

Publications (if any): NONE

Interests: Music, Aerospace, Space Sciences, Astronomy and Computers