

# How Voyager 1, Formaldehyde and Titan changed my life

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## INTRODUCTION

December 1990's issue of Astronomy magazine announced an opportunity unique for amateur astronomers to submit proposals to use the newly orbited Hubble Space Telescope (HST). I requested for additional information not knowing what I would research or what it would entail. Or about the experience, and scientists I would meet and communicate with if I was accepted.

Three objects interested me: a) Oort Cloud, b) Beta Pictoris and c) Titan. 7 month deadline for a 9 page proposal so research began at my local library since this is before WWW, PDFs and Google evolved. I searched a magazine index database for recent publications. One caught my eye about a compound Voyager 1 discovered on Titan as Toby Owen explained in an episode of NOVA in 1981 that I remember vividly showing the IR spectra. The compound was Hydrogen Cyanide (HCN) and its relevance to DNA. This article in the journal Science titled "Was Adenine the First Purine?" about a lab experiment of Formaldehyde and HCN by Alan Schwartz.

Titan mirrored this lab experiment with the possibility of Adenine forming on another body in our own solar system being a pre-biologic Earth.

This became my proposal!

## WRITING THE HST PROPOSAL

Invasions at various technical and university libraries in the New Jersey and New York City region became my research venues as I scrambled to find formaldehyde in the ultraviolet spectrum which was critical for my proposal.

I think the librarians enjoyed me pronouncing spectroscopy as "spek-troh-scopey" until I eventually got it right. Rutgers University was my major research site and closest with its chemistry, physics and science libraries. Back when we still had card catalogs but the catalogs were also computer searchable.

Until I accidentally discovered *The Identification of Molecular Spectra* I was relieved because not only did it have the Formaldehyde UV absorption wavelength data I needed for the proposal, it also had a line list in ascending order identifying other species which I also found beneficial for the UV region I will decide to observe, becoming my holy grail.

I remember going back to the computer to see more information about this reference book to find other resources like it. I discovered the Library of Congress had **subject classifications** and **call numbers** to categorize these books which would make my research much easier since I am dealing with printed materials and older ultraviolet data and at other libraries.

I continued with more research about Titan, its atmosphere and chemistry, the HST's instruments, UV spectroscopy, electronic and molecular spectra together with spectrum analysis became my routine for 7 months.

In order to make the proposal as accurate as possible I was advised to request the instrument handbooks from Dr. Janet Mattei of AAVSO who was one of the 7 members of the Amateur Astronomers Working Group (AAWG) who managed and judged the proposals.

I even contacted my inspiration the late Toby Owen (who I met at JPL after my observation in October 1993 at a Cassini planning meeting).

## PREPARATION, COMMUNICATING W/SCIENTISTS

What lied ahead whether I was accepted or not would still be an amazing experience for any amateur astronomer.

My proposal was signed and mailed on 7/27/1991 and the acceptance letter arrived on 7/28/1992 with the observation occurring 9/21/1993.

Along the way the scientists and experts I met and communicated with and learned from would be an experience of its own. All were very cooperating, inspirational and generous of their time and resources, they were amazed of this opportunity, my proposal and that I was accepted.

I became a celebrity on local TV, newspapers, radio, Sky & Telescope, Astronomy and the Science journal. Even serving as ambassadors for the Hubble giving lectures about our research and the telescope and notifying others about the amateur program. It also faced me with unique questions like was I getting paid for this and did I ride the shuttle to use the telescope!

I even assisted some professional astronomers with their own proposals, and co-authored another proposal on Neptune in a future proposal with another amateur since I been through it. But, this time it was amazing!!!!

Harvard-CFA was visited for solar and molecular data; then JPL/Caltech for a Cassini planning meeting and even meet my inspiration the late Toby Owen; and even contacted Carl Sagan.

In 1992 we were invited to the Space Tel Institute(SpaceTel) in Baltimore meeting the other amateurs, and finalize and program our observations with instrument scientists and other technicians. I was very accurate except for time needed which they figured out for me and they were impressed.

Someone informed about Carl Sagan coming lecture titled *Water on Titan*, but I couldn't attend. So I wrote to Sagan explaining my proposal and hoping for a copy of his lecture let alone a reply. Watching COSMOS religiously back in 1980 I remembered his amazing program and even appearances on Johnny Carson and now this.

Sagan replied supporting my search for formaldehyde stating "*the major organic constituents are indigenous...produced from the principal constituents of the atmosphere by UV and charged particle radiation sources*". But hearing "*there might be small quantities of formaldehyde produced from CO and CO2*" made my jaw drop along with some notes and formulas with some of his published works and yes his autograph!

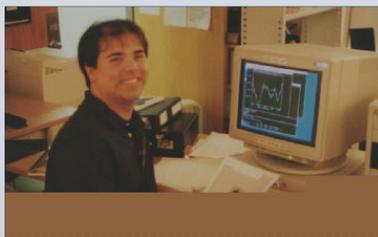
Alan Schwartz I then contacted in Holland, he published the experiment inspiring me to search for formaldehyde. He was ecstatic his lab work was being explored like this and mailed me his spectra and other information.

The best UV solar data I had ready for the observation was from Gail Anderson of the Air Force, but its resolution would cost me data until I found other sources.

Scheduling and re-scheduling my observation would happen many times, but my observation finally had a date Sept 20, 1993. I even had a travel budget for the observation, data analysis at SpaceTel, along with travel to JPL & Harvard-CFA

Big day was 9/20/1993, so I thought. I never expect to be bumped another day due to the Space Shuttle. Its mission extended a day, mission STS-51 to be exact since it had TDRSS satellite priority over me.

It gave me time with my assistants to prepare my solar data, CH2O data and learn the software I would be using with some test spectra.



## THE OBSERVATION AND ANALYSIS

On 9/21/1993 I was fortunate to witness in real-time my observation. Technicians were happy having me there I even wore my Hubble tie and took photos. They usually don't have the researchers present.

Listening to the communications with White Sands, GSFC and others on the speaker phone was cool, but what was wild was seeing the target image of Titan on one screen and a sample of my spectra on another and the reality hit me that this is really happening. Notice photo below with my Hubble tie. This image of Titan was nothing spectacular but it came from the original WF/PC with the spherical aberration which wasn't an issue for my observation. The whole observation with all the orbits took a few hours so I later ate and returned. The next day my assistant showed me where to sign for my data tape reel and we uploaded the files and started the process.

To my surprise another amateur from the first cycle, Peter Kandefer was also there processing his data and we became friends and I was invited to GSFC by Theodor (Ted) Kostniuk who spoke at one of my astronomy clubs and invited me for a tour when I was in MD. Peter came with me and I met one of Ted's associates Gordon Bjoraker who helped and guided me tremendously with my data processing and analysis and we became good friends, we would share our work over the years. We even watched together with others the Huygen's probe penetrating Titan at GSFC.

Another luxury of all this and the connections I made along the way would be the sites I would visit would be the special tours, all this prior to 9/11 of course. But still with all that came serious work and research where I continued with specialists and experts worldwide.

In early 1993 at the advice of Peter Smith of Harvard-CFA who specialized in astrophysical molecular spectra, who I met together with Robert Kurucz who has the best high-res solar UV data from the Solar Max satellite of which my data complemented his to his surprise.

Kurucz showed me how difficult it would be to identify true absorptions in the UV region I observed and I was believing it.

Peter Smith suggested I contact certain people for *unpublished line lists of ultraviolet data* in the region I'm researching to cover other possibilities once I get the solar out especially Gerhard Herzberg. Gordy Bjoraker also told me to collect UV absorption data specifically for atoms, molecules and now ions of the atoms C,H,N,O which I would pursue and collect in print and eventually electronically.

Herzberg, known as "Mr. Molecule" who I later found out to be a Nobel Prize winner in 1971, was very generous and energetic with our three letters and advice and references I didn't have.

But the best formaldehyde UV spectra came from an unlikely source - Jerry Rogers of General Motors (GM). Yes the car company in August of 1993 he also snail mailed me the data on a floppy.

Rutgers and Princeton University many of which I got to know with my astronomy clubs and my research allowed me to use their computers to work on my data locally. I even assisted a few with their HST proposals in return! I wish I was able to have a head start with the software and sample spectra locally before my observation to prepare me. We suggested this and other ideas to the Institute for future amateurs but unfortunately due to budget and other reasons the amateur program ended ~1997.



Obstacles such as very strong solar lines since Titan acted like a mirror to the sun and determining Titan's real atmospheric data would be a difficult task for years to come.

Different UV spectral data (Titan, Solar, etc.) and the different instruments and resolutions have made the data analysis difficult to finalize. I have collected solar, atomic and molecular line lists in the UV region observed to account for any feature in the spectra.

Worked with ~500 books in ~15 government and university libraries throughout the U.S. also.

I found out many tricks the professionals use but too late for my observation such as using the same observation parameters on a moon without an atmosphere to generate the solar spectra needed but straight from the Hubble.

Toby Owen suggested a G2V star like 16CygB which I was able to obtain and use for my data but, another UV expert A.L. Lane was against that idea.

## REFERENCES

- Pearse, R.W.B., and Gaydon, A.G.**, The Identification of Molecular Spectra, 1976, Chapman and Hall, pp. 21, 99, 255-263; 1950, Chapman and Hall, pp. 31-32, 84-85
- Rogers, J.D.**, Ultraviolet Absorption Cross Sections and Atmospheric Photodissociation Rate Constants of Formaldehyde, *J. Phys. Chem.*, 1990, 94, pp. 4011-4015
- Schlesinger, G. and Miller, S.L.**, Prebiotic Synthesis in Atmospheres Containing CH<sub>4</sub>, CO, and CO<sub>2</sub>: II. Hydrogen Cyanide, Formaldehyde and Ammonia, *J. Molec. Evolution*, 1983, 19, pp. 383-390
- Schwartz, A.W., and Bakker, C.G.**, Was Adenine the First Purine?, *Science*, 245, 1989, pp. 1102-1104
- Soderblom, D.**, Hubble Space Telescope Goddard High-Resolution Spectrograph Instrument Handbook (version 3.0), January 1992, Space Telescope Science Institute, Baltimore, MD
- Personal Communications and/or meetings with:** T. Owen, C. Sagan, A.L. Lane, R. Kurucz, Gerhard Herzberg, Peter L. Smith

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