21cm Quantum Amplifier

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Neutral atomic hydrogen is normally difficult to detect even in objects as large as the local Virgo cluster of galaxies because its magnetic dipole transition is glacial in generating the 1420.4 MHz emission. Detecting intense signals near the 1420.4 MHz in the spectral band reserved for radio astronomy where broadcasting is forbidden was a surprise. It appears there is a large collection hydrogen atoms polarization bonded to molecules that are then acting as high gain antennae to actively drive a normal glacial triple to singlet transition $^3S_1 \rightharpoonup {}^1S_0$ of the bound hydrogen that now possess both rotational and vibrational modes with exceeding low moments of inertia and small longitudinal vibrational coupling constants. These dense closely spaced states within the forbidden transmission band are exposed by the absorption of low frequency noise in the environment. The bands at $\sim 1380 - 1400 MHz$ are supported by a polarized hydrogen bonded to H_2O by its electric dipole moment and the second band found at $\sim 1250 - 1270 MHz$ by polarized hydrogen bonded by the electric quadrapole moment of CO_2. *4 July 2022*

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I. BACKGROUND

Magnetic fields unlike electric fields because of their dipole source can form long range structures. These fields winding through low density matter can support longitudinal oscillations with long wavelengths. Longitudinal magnetic excitons on these fields even though very low energy have mass (Wallace, 2009) (Wallace and Wallace, 2014). In trying to learn something about the fields the earth sweeps up on its travels a survey was started in the low frequency range, ~ 1 milli Hertz. Normally it is assumed that the atmosphere is not a particularly active magnetic medium, however, in this study of weak fields that assumption cannot be made. So in conjunction with

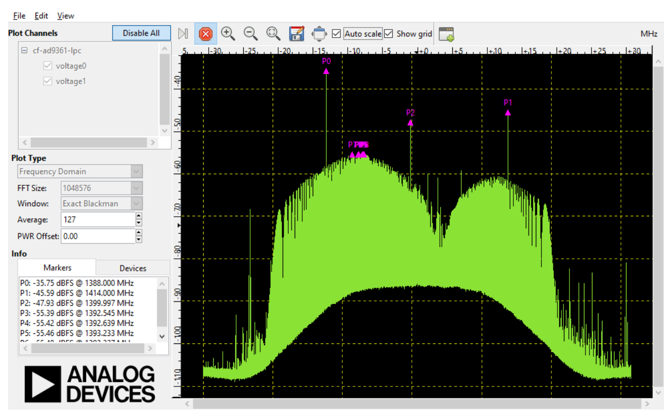


Figure 1 **Pair of bands spanning 1380-1420 MHz with the spectrum taken with an EW polarization with a 1 meter parabolic antenna pointed towards the zenith. The signal level at the peak is 30 db above the noise floor. Center frequency of the scan was 1401 MHz with a band pass set at 20 MHz. 127 FFTs of 1,048,576 samples were averaged and taken at a rate of 60 Mega samples per second. At first glance this appears to be a Raman like spectrum centered at 1400 MHz (1399.997 MHz peak P1) with two superimposed excitions. Atomic hydrogen is not a common isolated component in our atmosphere as it only occurs in compounds. The main energy source is the emission at 1399.997 MHz that then spread into the bands low frequency noise in the 50 KHz range.**

the magnetic measurements a second survey of the high frequency field behavior in the low background noise regions of the UHF band that is not strongly attenuated by the earth's atmosphere was also started to check if there were any correlated effects with magnetically active molecules.

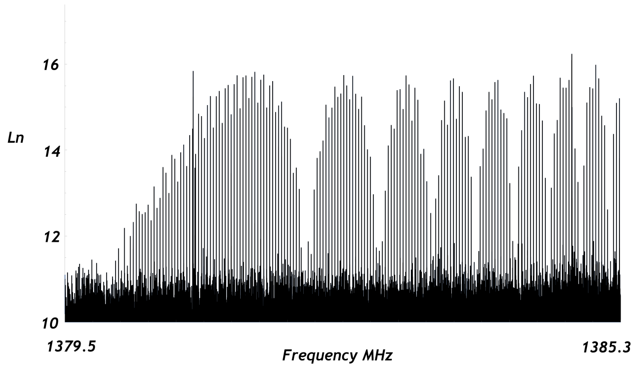


Figure 2 **An expanded region from Figure 1 showing the dense states. The entire 40 Mhz signal band from 1380 to 1420 MHz is made up of approximately 2600 states with a full width half maximum half-width of less than 4 Hz.**

It was noticed that there was a slight drop in the magnetic signal amplitudes and phase locking when high density bands of states with very narrow line widths less than 4 Hz appeared at frequencies below the 1420.4 MHz of the 1S hydrogen triplet to singlet transition $^3S_1 \rightharpoonup {}^1S_0$. This region of the UHF spectra is normally thought to be barren of molecular emissions, especially rotational state like emissions.

Two types of spectra were eventually found: individual lines that were always present with one very intense emission close to 1.400 MHz and a second near 1250 MHz. The second type emissions were bands of dense lines. When in the off state these bands were sometimes partially visible just a couple of db above the noise floor and when on as much as 30 db above the noise floor. These bands were not simple as they appeared to be at least three overlapping sets. These intense bands appear when there is a low frequency noise source: flat panel monitor, power supplies, drives of LED lighting, etc. These are weak noise sources below 400 MHz with their most intense output below 4 MHz detectable on a spectrum analyzer with an antenna .1 meters from a flat panel screen at the highest gain setting. At this setting these noise levels were well below the AM and FM signals from commercial stations.

II. PRODUCING A COMPLEX SPECTRA

The atmosphere contains hydrogen atoms bonded to molecules that are polarized with a dipole moment enabling them to function as high gain antennae actively driving a normally glacial triplet to singlet transition. This bonded structure appears to have both rotational

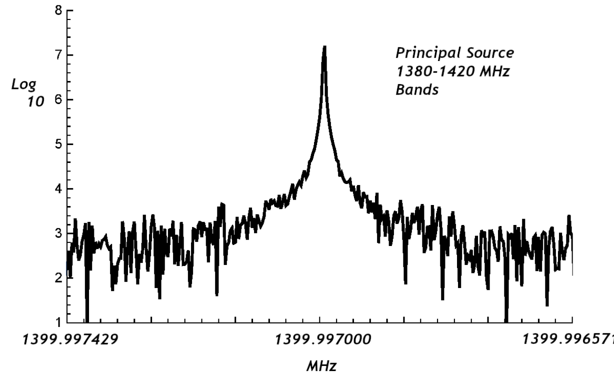


Figure 3 **Principal source for the 1380-1420 dense band of lines found in Figures 1 and 2. The energy from this source is then spread to other near by states with the aid low frequency noise local to the antenna. Unlike the other spectra that are average FFT this represent only a single FFT of 1,048,578 samples taken at a rate 3 million samples per second. Each point in the scan represents a frequency window of 2.86 Hertz which is on the order of the full width half maximum of the power spectrum. This peak shows a maximum at night and a minimum around noon varying less than 1 db typically .3 db in a 24 hour period.**

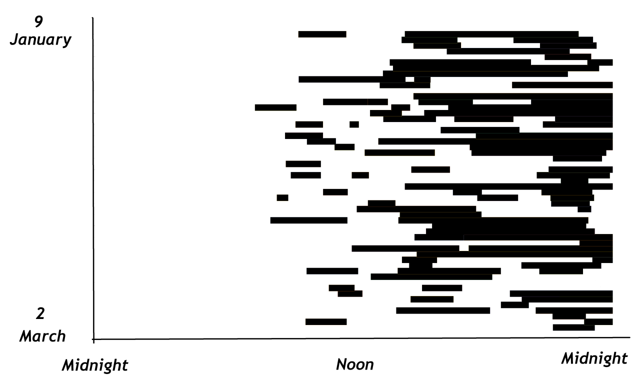


Figure 4 **Plot of when the strong 1380-1420 MHz emission bands were active in black. The data was taken with a vertical dipole antenna. The pattern conforms to two possible sources of radiation to pump these emission. First is the solar heating of the earth's atmosphere by the sun where there is a flux of protons driven upwards and the earth is left with a negative charge. Secondly when there is a low frequency noise source such as local flat panel TVs are operating. The problem is that in the morning and sometimes even later with a flat panel operating near the antenna the bands will often be absent.**

and vibrational modes with exceeding low moment of inertia and a weak longitudinal vibrational coupling constants. These dense closely spaced states were first exposed by the absorption of low frequency noise from flat panel monitors. The problem in measuring these states are that they are normally unoccupied because the efficiency of their transitions to their ground state. Unless they are continually fed energy to occupy the higher angular momentum and vibrational states only the lowest energy states will be visible.

The spectra appears to be from perturbed atomic hydrogen. The sharp emission lines imply a gas phase. How does an atomic species exist in a bond and not lose the characteristics of a free atomic species is the question? Our initial assumption when seeing the spectra this was a hydronium radical, H_3O^+ or H_3O where the extra hydrogen was slightly polarized with a dipole moment. These signals were also puzzling because of their rotational like molecular response at frequencies orders of magnitude below where such activity is normally found in molecules.

A. Passive 1400-1427 MHz Remote Sensing

Broad band radiometer scanning of the earth surface for both ocean salinity and soil moisture measurement have been made from satellites for two decades. Both surveys encounter interference with these measurements from other sources (Daganzo-Eusebio *et al.*, 2013) (Uranga *et al.*). The principal deduction made from the interference was improper cabling and connection of TV down-converters causing interference in the passive band. However, their most recent data from Japan in particular might indicated that the high density of flat panel TV displays might be a more important source of interference for signals spreading from a natural source into the forbidden transmission band.

This passive monitoring of the soil moisture in an area with a shallow water table is evident in the comparison of figures 12 and 13. Whereas, the measurements at 4397 ft on top of a mountain showed no strong ground signal sources in the 1400-1427 MHz band.

B. Apparatus and Experimental Details

Observations were done using using two instruments a software defined radio receiver that is part of the Analog Devices ADALM-PLUTO training device that operates from .325 to 3.5 GHz for the high frequency measurements and a SR865 lock in amplifier operated as a low frequency spectrum analyzer to monitor low frequency background noise that will excite band formation. For the RF measurements maximum down converted detection bandwidth is 20 MHz. Surveys for a few months were performed with the short broad band antenna supplied with the unit that could detect the on state of the bands from 1380-1420 MHz. The receiver antenna was replaced with Southwest Antennas half wave dipole 1.34-2.5 GHz with a gain of 2.4 dbi. Software used was the I/O oscilloscope supplied by Analog Devices. GNU radio an open source program was used occasionally to watch the development of band formation after a noise source was activated.

The RF receiver was operated as a spectrum analyzer with a sample rate between 3 and 60 million samples a second (Mps) with a sample length up to 1,048,576 which were fast Fourier transformed (FFT). Averaging spectra does two things: it helps identify man made sources by detecting baseline elevation in the spectra, and artifacts from the down conversion process. The averaging allows detection of infrequent molecular emissions that would normally be lost in the noise. The most interesting features are very narrow emission line typically less that 6 Hertz full width half maximum (FWHM), and some of these could be lost in the noise if the frequency interval sampled in the FFT was greater.

Initially, the Southwest antenna was mounted vertical on a pole 7 ft above the ground on the edge of precipice. The data were monitored periodically a number of times each day for a number of months in a wide range of weather and wind conditions. The measurements occurred in a radio quiet zone far from signal source also the 1400 to 1427 MHz frequency range is reserved for radio astronomy. Eventually this antenna was placed at the focus of a 1 meter parabolic reflector aimed toward the zenith or the ground and located 12 meters from the nearest structure. It was also possible to make polarization measurements of the emission by rotating the antenna. This reduced signals from the ground and surrounding structures that also produced outputs along with the hydroxol lines at 1612, 1665, 1667, and 1720 MHz. No hydroxol lines were found in the outdoor measurements.

The advantages in using a software defined receiver with a large sample set that allow very narrow atomic emissions to be detected in noise where a traditional detector with a band pass of a few kilo Hertz may not resolve the signal. Averaging the FFT transforms exposes data that is normally buried in the noise. In Figure 5-6 1,048,576 samples are taken for each of 127 FFTs that are averaged. The output data for 16,384 scans has a resolution of 3.72 kHz while the 1,048,576 has a resolution of 57.22 Hertz at a sample rate of 60 Mps. When the sample rate is reduced to 3 Mps the frequency resolution is increased to a width per sample of 190 and 3 hertz respectively.

Because of the narrow line widths the origin of these signals was thought to come from the gas phase. The sources of the bands could be local to the detector and the individual strong source emissions from the colder low density region of our atmosphere. Weak energy collecting activities are not uncommon in quantum systems. The implications of these active processes is that a form of atomic hydrogen slightly modified in a bond with an induced electric dipole moment that both readily absorbs and emits below the 1420.4 MHz hydrogen line is operating.

Table I **Two active atmospheric sources are studied because they were able to generate dense bands indicating a molecular origin. There were many more lines in this region that may not be artifacts from either commercial broadcasting or down conversion that can also be of molecular origin. By taking the ratio of the electron density at the proton as a function of the displacement of the electron to the ratio of the shifted frequency from 1420.4 MHz.**

Source MHz	Induced Electric Dipole Moment Bohr radius a_o	Relative Strength
1400	.00709 a_o	-51 db
1250	.0637 a_o	-58 db

$$\frac{\Psi(r')\Psi^*(r')}{\Psi(r=0)\Psi^*(r=0)} = e^{-2\frac{r'}{a_o}} = \frac{1400}{1420.4} \tag{1}$$

$$r' = -\frac{1}{2}Ln(\frac{1400}{1420.4})\ a_o$$

Normally inexpensive receivers that are used as teaching tools for implementing software defined radio are not ideally suited for radio astronomy when using the most primitive 3” long broad band dipole antenna. Even with this simple tool, strong signals were detected in the regions of the 1420 MHz emission of neutral hydrogen. This work was following earlier work by Swartz who found detectable emissions from from atomic deuterium from a various sources by an even more primitive receiver (Swartz, 2020). However, most of the spread band activity is very local to the receiver where the strong natural external pump sources are spread by the local low frequency noise sources. The strong pump sources at 1400 and 1250 MHz may very well be high altitude sources as they show little day to night variations. There is a short term time dependence in minutes and seconds in activity in the narrow range from 1420 to 1421 MHz that overlap the interesting astrophysical sources. There are a few band lines that fall within this narrow range that maybe sensitive to fields generated beyond our solar system. This time dependence is not seen in the band lines outside of this range. As these states would be very sensitive to external fields driving stimulated emission from these states.

We operated two RF receivers and their ability to measure the absolute frequency accurately is probably limit to 10 KHz as they were not calibrated with a frequency standard. The measured frequency offset between the two receivers was 4 KHz on monitoring the same source.

III. GENERATING BANDS WITH A LOCAL NOISE SOURCE

The low frequency spectrum analysis using the SR865A lock-in-amplifier used .25 meter diameter 11 turn coil of #18 copper wire that was terminated with a 50 ohm resistor. This was sufficiently large to accommodate the entire RF receiver and antenna. This configuration was used to monitor the ambient background noise below 200 KHz from power supplies but more specifically to monitor the pixel and line switching noise from local flat panel displays. These noise levels were quite low and can be seen if Figures 7 and 8. It was also useful in watching the energy being drained over time from the background fields and being transferred into the dense set of molecular states.

The noise sources that partially correlate with these signals were flat panel TV displays and flat panel computer monitors. Part of that has been cleared up when observing a parametric transfer of low energy field noise, $< 100kHz$ to populate states that became visible by a higher energy transitions $\sim 1400MHz$. We could not find noise sources in the $1400MHz$ range but we did have noise sources below $4MHz$ One high energy spectra appeared to be a Raman spectra that was generated from a strong natural pump source found at $1399.997MHz$ in Figure 5.

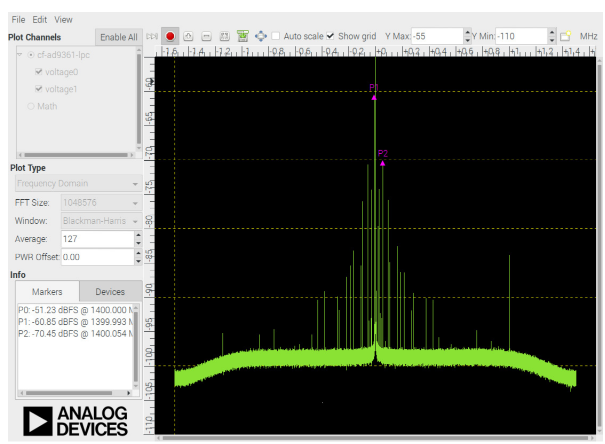


Figure 5 **Strong pump source for band above and below 1400 MHz, showing a Raman type spectra. Parabolic antenna pointed to the zenith with an EW polarization. Frequency resolution is 2.8 Hz/bin, with a center frequency of 1400 MHz an 20 MHz down-converted band width. This figure was taken at an altitude of 1150 ft above sea level and the next figure 4397 ft.**

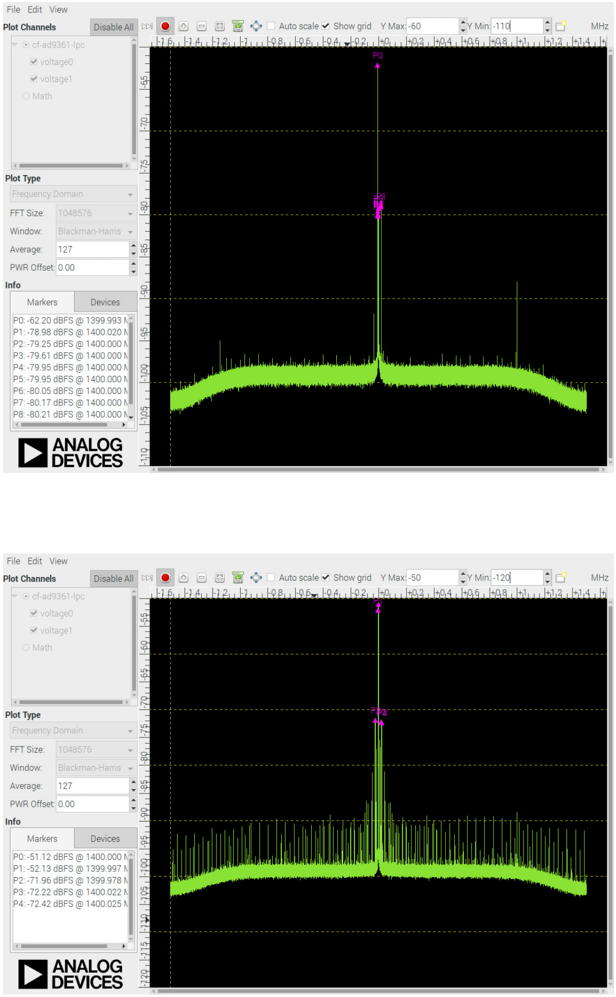
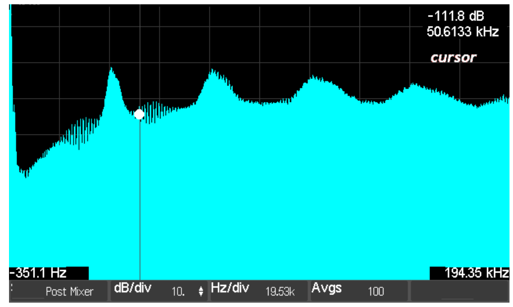


Figure 6 **Bands excited around 1400 MHz with a local flat panel display. Antenna prolarization E-W pointing to zenith with no line of sight to panel source.**

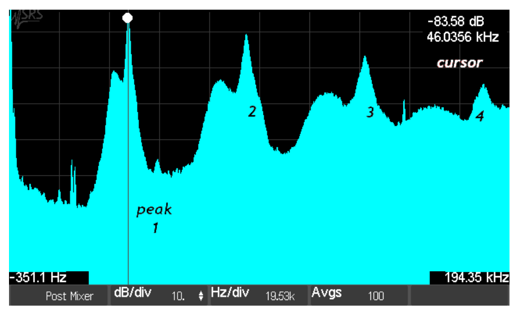
Because of the narrow line spacing and if the these lines are due to rotational states there should be emission transitions $J \rightarrow J \pm 1$ depending on the relative energy of the states. These signal were monitored with a lock-in-amplifier SR865A operated as a spectrum analyzer from 0-194 KHz monitoring the amplitude of the received signal from a coil centered on the .075 meter long RF antenna of the RF receiver. The filter setting of 24db per octave synchronous, sensitivity 100 micro volts with max 10 millivolt input range, and a 1 millisecond time constant.

What is shown in Figure 7 is the ambient low frequency RF noise with a small flat panel computer monitor 1 meter away from both antennas turned off. When the monitor is turned on shown in Figure 8 the ambient noise is drain from regions between the frequency difference between the active molecular states found in the RF spectra. That energy transfer from the noise spectra is what transfers energy from the strong source emissions into the available molecular states of the bound hydrogen atom.



FFT ambient background noise

Figure 7 **100 FFT's averaged for the ambient noise detected by a SR865 lock-in-amplifier whose local oscillator is set at 97.5kHz and the post mixer signal is converted to a spectrum covering the range of -351.1 Hertz to 194.35 kHertz. The signal level detected across the band is less that -100 dB.**



FFT with noise source on

Figure 8 **With the same settings and 24" flat panel monitor now being turned 1 meter from the coil, two features standout. Four new peaks appear starting at 46 kHerz spaced by the same amount. The noise band between the peaks are significantly reduced by as much as 20 dB. This represents a transference of energy from the noise band into states with this characteristic frequency. The lowest frequency peak match the separation of states found in the lower spectrum of states in Figure 2.**

IV. 1250.029 MHZ BAND

This band is very different from the 1400 MHz set of bands. First it is single sided and does not have a matching upper band that has Raman characteristic. The 1400 MHz center bands appears to source from a population of the same molecules but not in same vicinity where there is little external noise causing the bands to form. The 1250 MHz source is not found at the beginning of the band that is formed but inside the band and it maybe an entirely different collection of molecules acting as the source. The ground signal is 11 db down for the 1250 MHz pump source at 4397 ft. compared to less than 1 db down for the 1400 MHz source. The 1250 MHz bands that is formed is highly polarized +10 db E-W verses +2 db N-S relative to the noise floor. This is totally unlike the bands centered at 1400 MHz that are not strongly polarized.

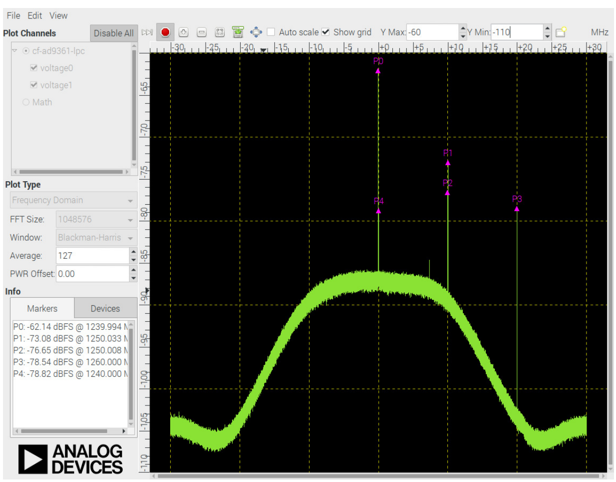


Figure 9 **Calibration for a band with the parabolic antenna point downward into the earth at an altitude of 4397 ft. Bandwidth of 20 MHz at 60 MSP centered at 1240 MHz.**

1. Competition Between States

There are secondary periodic structures associated with these dense emission bands that imply there are points of degeneracy where energy is bled from the primary emission bands. As there are a number of vibrational and rotational states available. The dips in the band structure indicates there are near-degenerate and degenerate states overlapping and only those that can sustain a substantial number of molecules over time will be those that are more strongly detected.

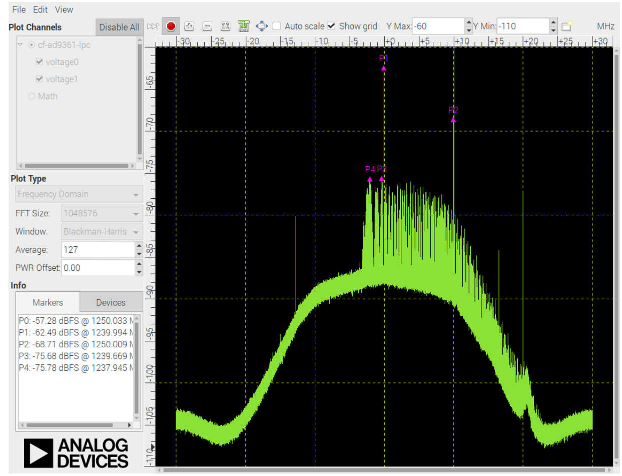


Figure 10 **Parabolic antenna pointed to the zenith with the dipole oriented on the East West axis at an altitude of 4397 ft. at Reddish Knob, Augusta County, VA. The band appears to be generated by an emission in the region 1250 MHz. There is commercial traffic at 1261 MHz. Bandwidth of 20 MHz at 60 MSP centered at 1240 MHz.**

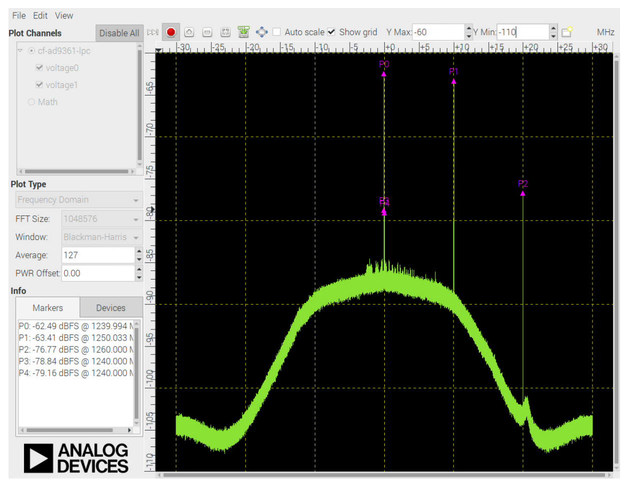


Figure 11 **Parabolic antenna pointed to the zenith with the dipole oriented on the North-South axis at an altitude of 4397 ft. at Reddish Knob, Augusta County, VA. The band appears to be generated by an emission in the region 1250 MHz. The band is strongly polarized with respect to the magnetic orientation of the earths field. Bandwidth of 20 MHz at 60 MSP centered at 1240 MHz.**

A. Ground Signals

Ground signals are complex because of very different chemistry of items such as cellulose, clay, limestone, and other minerals that contain water and carbon. At high altitude well above a water table the ground signals are minimized. However, where the water table is near the surface and in the particular case presented in figures 7 and 8, the water table is composed of many stratified bands of water in sand approximately .5 meters thick separated by the same amount of clay. This produces not only sources but a complex reflector and attenuator of atmospheric signals.

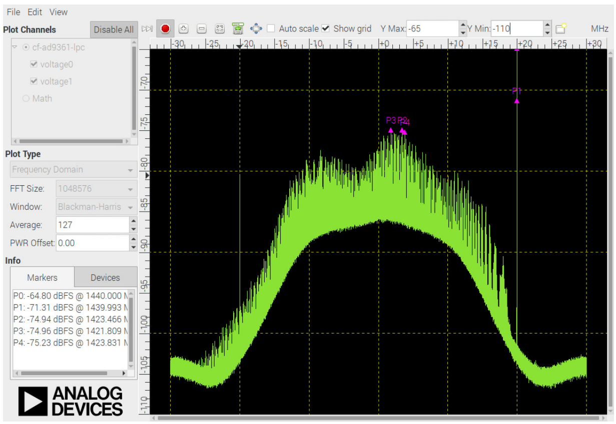


Figure 12 **Calibration for a band with the parabolic antenna point downward into the earth at an altitude of 1150 ft in a deep sand-clay bottom land. Bandwidth of 20 MHz at 60 MSP centered at 1420 MHz. The ground signal appears in a band above the center frequency.**

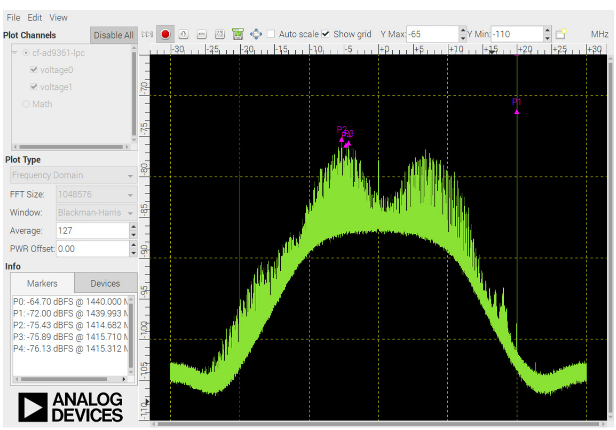


Figure 13 **Parabolic antenna pointed to the zenith with the dipole oriented on the East West axis at an altitude of 1150 ft. The ground signal is slightly attenuated with the change in orientation of the antenna.**

B. Active Molecules

The atmosphere only contains two active molecules that can both induce an electric dipole moment in hydrogen and also induce a polarization bond with hydrogen: water vapor and carbon dioxide. The water molecule has a weak electric dipole moment and carbon dioxide has a strong electric quadrapole moment.

Any model will have to explain both the sources as well as the band that are non-traditional because their

Table II

Species	**Conc.**	**Bond**	$^3S_1 \rightharpoonup {}^1S_0$
$H\searrow$ O ←-- H $H\nearrow$	high $\sim$ .25%	weak .007 a_o	$\sim$ 1400MHz -51 db
OCO ←-- H	low $\sim$ .041%	strong .06 a_o	$\sim$ 1250MHz -57 db

low frequencies implying both low moments of inertia for rotation and weak coupling constants for vibration that can only be satisfied by polarized atomic hydrogen. Bands in both frequency ranges have approximately the same state spacing indicating the same active species that are affected even with the differing bond strengths. We are assuming these are polarization bonds and the energy of the bond can be estimate from the frequency shift in the principal source lines from 14020.4 MHz. One feature of the polarization bond is the bound hydrogen now has an electric dipole moment that facilitates the triplet to singlet transition no longer depending on a magnetic transition.

A hint of the chemistry that occurs is the timing of the saturation of approximately 2400 states associated with the 1400 MHz version of the species that occurs in the late afternoon through the evening and then usually shuts down before midnight. During the day through evaporation with the solar input the earth develops a negative charge and hydronium H_3O^+ is pumped into the atmosphere (Pollack, 2013).

Structurally H_3O is interesting because there are degenerate orientation of where the hydrogen bond can be placed. This makes the molecule non-orientable unlike the linear carbon dioxide molecule that can be polarized by the earths magnetic field.

V. DISCUSSION

What is being measured here is the result of an intense flux at a few well defined frequencies exciting many molecular bounds state levels by tapping into low frequency noise sources to spread that energy between molecular rotational and vibrational states. These energy levels are orders of magnitude below their traditional molecular energy levels of covalently bond structures. In part this is due to the nature of the weak polarization hydrogen bonds that form and the lack of axial constraints on the light hydrogen atom. These results have implication for atmospheric chemistry in terms of the activity of these states in the upper atmosphere as they may be more chemically active in such process as ozone reduction. These data may complicate interpretation of astrophysical data from regions that may contain water and carbon dioxide. These spectra tell us a great deal about the hydrogen bond and how it is maintained. We have only looked at a very limited data set in this frequency domain that was thought to be barren of molecular spectra.

VI. ACKNOWLEGEMENTS

To Glen Westphal who was a great help when we first found these spectra. To Mitchell Swartz for introducing us to the use of software defined radios to investigate the spectrum of hydrogen and its isotopes (Swartz, 2020). Brian Ahern for making us aware of some practical techniques in monitoring low frequency magnetic fields that started this survey. Peter Hagelstein whose calculations lead to a more realistic method of dealing with the quantum mechanical bound state problem (Wallace and Wallace, 2021). Hervé Toulhoat for his discussion on planetary hydrogen on the underestimation of the hydrogen trapped during the earth's formation (Toulhoat and Zgonnik, 2022). Also to Brooks Pate for his background discussion on molecular spectra.

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