21cm Quantum Amplifier

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Hydrogen being the most common element in the universe is almost invisible in atomic form though it is common as a as minor contaminating component in most terrestrial compounds. Atomic hydrogen and its isotopes are the only chemically active atoms whose valence electron is not screened from the nucleus. This unique property leads to a rich spectroscopic behavior when weakly bonded to other molecules, surfaces, or embedded within solids. The spectra's origin lie in rotational nuclear degrees of freedom that become active when the atoms are polarization bonded to other structures. Free neutral atomic hydrogen is difficult to detect by its 1420.4 MHz emission even in objects as large as the local Virgo cluster of galaxies. Our surprise was in detecting intense signals with an inexpensive receiver near 1420.4 MHz in the spectral band reserved for radio astronomy where broadcasting is forbidden. These signals behaved like emissions from slightly perturbed $1S$ atomic hydrogen possessing rotational states with very small energy shifts. These signals are ubiquitous when there is any low level electromagnetic noise present. 20 January 2023.

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I. BACKGROUND

In trying to learn something about the magnetic fields the earth sweeps up on its travels a survey was started in the low frequency range, ~ 1 milliHertz where there

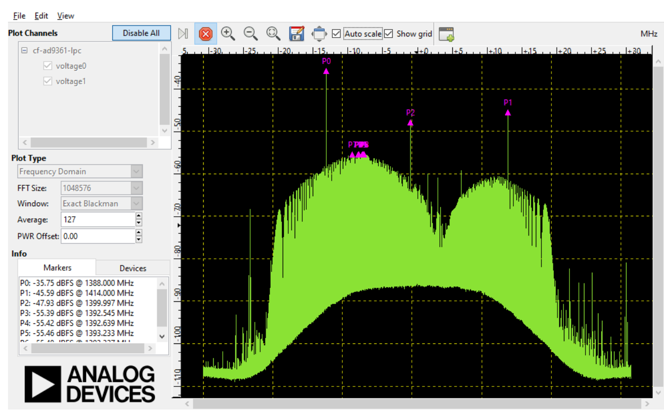


Figure 1 **Emission bands spanning 1380-1420 MHz with spectrum of a few thousand lines taken with 1 meter parabolic antenna pointed towards the zenith. The signal level at the peak is 30 db above the noise floor. Center frequency of the scan was 1401 MHz with a band pass set at 20 MHz. 127 FFTs of 1,048,576 samples were averaged and taken at a rate of 60 Mega samples per second. The energy sources creating these bands comes from a large flat panel TV monitor within a nearby building that is exciting materials in the building and in the area surrounding the antenna.**

is significant activity. Weak magnetic fields unlike electric fields because of their dipole source can form long range structures snaking through low density matter connecting unpaired spins on a scale that will compete with gravity in terms of range and strength. One form of these time dependent long range magnetic fields can even possess mass (Wallace, 2009) (Wallace and Wallace, 2014b).

It is usually assumed the atmosphere is not an active magnetic medium, however, for weak fields that assumption cannot be ruled out by current time dependent magnetic field measurement. Weakly bound atomic hydrogen either to gaseous molecules or coupled to atmospheric dust could produce an active magnetic medium affecting low frequency fields. To explore this possibility a second survey of the high frequency field was started searching the low background noise regions of the UHF band that is not strongly attenuated by the earth's atmosphere to check if there were magnetically active atoms/molecules that would affect these low frequency fields. We knew from the measurements made by Swartz (Swartz, 2020) that deuterium dissolved in the solid state was active in the RF region and was magnetically active in a way we did not understand. We thought the same maybe true for hydrogen.

Both the magnetic and the RF studies of these low energy fields operate far below thermal equilibrium of both the laboratory and deep space. Standard thermodynamics does a poor job of describing these regions far from equilibrium that are dominated by quantum behavior that function over large scales. Energy reservoirs can exist that can go completely unnoticed by thermal measurements.

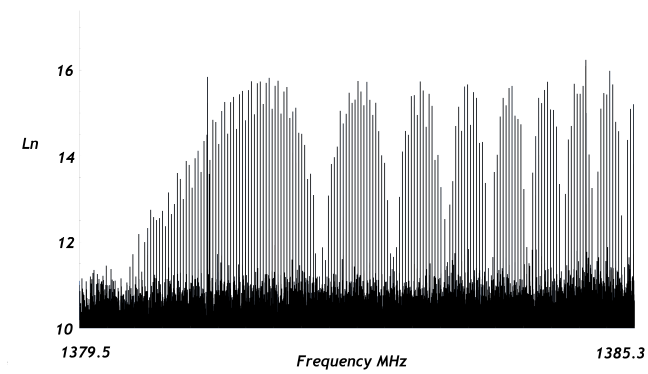


Figure 2 **An expanded region from Figure 1 showing the dense states. The entire 40 Mhz signal band from 1380 to 1420 MHz is made up of approximately 2600 states with a full width half maximum half-width of less than 4 Hz.**

II. HYDROGEN

Hydrogen's makes up 74 atomic per cent of the matter in the universe and is not under represented in the earth as a whole. It has the ability to to embedding itself into all forms of matter. It is very difficult to purge from metals as it finds both interstitial and defect sites as good low energy homes that makes the metal composition of the mantle a good reservoir for hydrogen (Toulhoat and Zgonnik, 2022) (Wallace and Wallace, 2014a). This atomic hydrogen is normally difficult to detect. Hydrogen and its isotopes has another property not shared with elements with a greater nuclear charge and that is the nucleus is not shielded from its active valence electron as are the nuclei of lithium and the heavier elements. Helium which does not commonly bond because of a completely filled 1S state that also does not couple to the nuclear spin of ^3He. This feature of hydrogen and its isotopes is unique and important when considering the source of these spectra.

Hydrogen can easily be hidden in a wide variety of materials and its nucleus faces a coupling competition between its screening *1S* electron and some freedom from that electron when the electron is bonding with matter. The atomic component with the minimum total inertia will then sprout active quantum states. When bonded this competition between attractors introduces an extra degree of freedom for the nucleus. For a free atom of hydrogen the electron's density is centered on the nucleus making the nucleus a passive component. If the electron is even weakly bonded by polarization to another structure and partially occupied then the nucleus may take on a local motion of its own about the electrons maximum density.

III. SPECTRAL PROBLEM

Mitchel Swartz in 2020 first reported these very sharp and prolific set of states in the vicinity of 327 Mhz when studying cold fusion within a Faraday cage where in the active volume there was considerable concentration of deuterium bound in the solid state (Swartz, 2020).

In setting up to reproduce Swartz's results first a calibration run was done for hydrogen at 1420 MHz. Simply by turning on a receiver in the laboratory and finding a complex spectra in the region of 1420.4 MHz of the magnetic transition for 1S hydrogen was a surprise. As no apparent effort was made to produce what was found in Figures 1 and 2: a complex spectra centered at about 1400 MHz that extended from 1380 MHz to slightly beyond 1420 MHz. Solid state spectra usually do not show a sharp transition and gas phase spectra typically have much greater spacing between states. These spacing are well below any hyper-fine structure in the Mhz range with these spectra having spacing $\sim$ 50 kHz and below. This implies for rotary motion extremely small moments of inertia and for vibrational motion very low effective elastic constants. Neither of these properties are compatible with results from standard molecular spectroscopic.

Any bonding of hydrogen will reducing the symmetry of the *1S* state allowing nuclear motion relative to the bound electronic state to automatically induce a dynamic electric dipole that has an average mean value of zero. However, this dynamic dipole enables strong electromagnetic interactions with the local low frequency EM noise to drive transitions and spreading of energy between available states to create the bands.

IV. APPARATUS

Observations were made using two instruments: a software defined radio receiver that is part of the Analog Devices ADALM-PLUTO training device operating from .325 to 3.5 GHz for the high frequency measurements operating with a hardware gain of +71db with the transmit mode turned off and a SR865 lock-in-amplifier operated as a low frequency spectrum analyzer to monitor low frequency background noise and inter-band transitions. For the RF measurements maximum down converted detection bandwidth is 20 MHz. The receiver antenna was a Southwest Antennas half wave dipole 1.34-2.5 GHz with a gain of 2.4 dbi. Principal software used was the I/O oscilloscope supplied by Analog Devices which gave the most control over the instrument and could be operated from a Raspberry Pi computer that was a minimal noise source. Frequency calibration for the SDR receiver was accomplished with a Bonard miniGPS receiver that could synthesize a calibrated output signal to 800 MHz. The second harmonic generated from the GPS clock source was a sufficient frequency calibration source accurate to 1 KHz if located within a few hundred meters of the receiver.

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 that were fast Fourier transformed (FFT). 127 FFT spectrum were taken then averaged to generate the final spectrum in all examples.

To make material measurements a leaky Faraday cage was constructed. Leaky because both an external low frequency noise source and some high frequency noise is required that can penetrate the cage. Activated high frequency signal from the surrounding structure were the principal high frequency noise source that penetrated the cage and were attenuated by ∼12 db. Even under these conditions measurements allow contributions from specific materials to be differentiated when placed at empty focus in the cage.

Low frequency noise source was 21 inch *Onn* flat panel monitor located 10 meters from the Faraday cage and rotated with its rear facing the cage. Antenna is shielded in a Faraday cage located at one focus. 5 frequency bands were scanned 1250, 1380, 1400, 1420, & 1433 MHz with a 12 MHz window for each frequency. Aluminum is not the ideal material to use because of its oxide which can absorb hydrogen (Wallace, 1978) (Wallace, 2011). Thin aluminum sheet 8.5 mil ($2.159 10^{-4}$ m) thick was used for the walls of an elliptical Faraday cage with two layers of 1 mil ($2.54 10^{-5}$m) aluminum foils for the top and bottom. The nominal attenuation at 1400 MHz was -12 db. Attenuation below 100 kHz is minimal in this leaky Faraday cage. Materials selected represent some common sources found within the surrounding structure. When the monitor was reversed or turned off removing the low frequency noise source there were no bands generated within the Faraday cage.

A second geometry used for detecting gain properties where small material samples were placed in front and then to the rear of the antenna in close proximity at 4 meters from the computer and receiver. In one way it is similar to the Faraday cage measurement in that the region around the noise sources activated materials and these signal then actively interact with the gain medium at the antenna location. The samples small size much less than the RF wavelength allows a measure of the forward propagating gain.

V. NOISE

There are two principal local noise sources that drive band formation and these are independent of natural sources. High frequency noise in the 1.4 GHz range that is most commonly from the computer and low frequency noise that is generated by flat panel monitors and power supplies. The low frequency monitor noise is detectable with a spectrum analyzer to a maximum of 10 db above the instruments noise floor when its antenna is placed against the source meaning these are very weak signals. An example of a broad response from the Raspberry Pi 4 computer in the 1.4 GHz range is found in figure 3. Other natural source maybe driven by sun heating the atmosphere and structures that shows up in the amplitude of the bands at 1420 MHz increasing in strength during the day by as much as 12 db. These will play a role in material studies if the low and high frequency noise sources saturate the available active spins. Saturation is a common problem in the study of low energy magnetic excitation (Wallace, 2009) (Wallace and Wallace, 2014a) where the result of too strong a signal source drives the generation of comb frequency bands to distribute the input energy. That is not very different than what is seen in the current measurements though the base states are very different.

The weak noise sources below 400 MHz with their most intense output below 4 MHz only 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. The active measured transitions acted as noise scavengers taking low frequency energy and moving it into the microwave band. This behavior is not unusual as it has been seen in magnetic materials (Wallace, 2009).

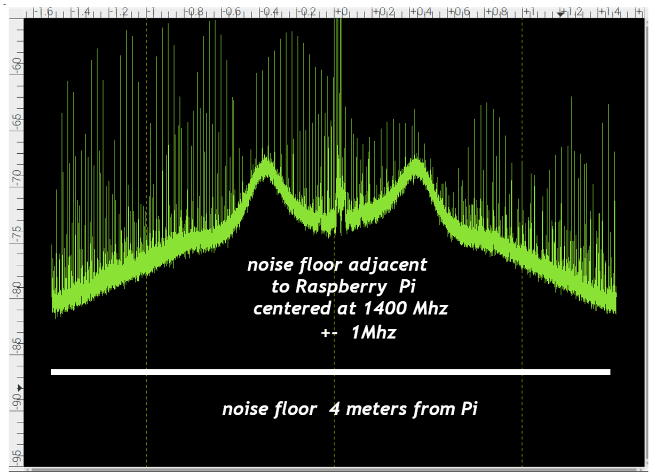


Figure 3 **Principal local RF noise source is the Raspberry Pi computer which has a clock running at 1400 MHz. The electronic noise the base line continuum with the two peaks. The array of sharp peaks are material in the vicinity of computer being excited. This signal falls off rapidly, however, it does excite at least two different types of band formation in its local vicinity. The noise floor a maximum of +18 db over the value when the antenna is displace 4 meters. At 1420 MHz there is a flat noise floor that is raised uniformly when measured at the Raspberry Pi by +8 db.**

VI. MEASUREMENT

In both indoor and outdoor measurements the signals from 1200 to 1500 MHz cannot be easily controlled unless done in a well constructed Faraday cage with careful material selection because embedded hydrogen is common in most materials. That limits the goal of the measurements to what can be differentiated. Our first task is to show how common these signals are and then to show specific sensitivities for generating these signals in a few common materials. As a zero point measurement in a thick wall, 14 mm, steel chamber that could be pumped to vacuum there was no measurable response above the noise floor over the entire frequency range. Even when brought to atmospheric pressure with injected water vapor no signals were detected.

A. Outdoor Measurements

The measurements shown in the first two figures were taken with the Southwest antenna mounted at the focus of a 1 meter parabolic reflector aimed toward the zenith. At times it was also oriented pointing downwards to the ground. Measurements also were taken at different altitudes far from any close structures. Polarization measurements were made by rotating the antenna. The vertically pointing parabolic reduced signals generated from the ground and surrounding structures. No microwave hydroxol lines were found in the outdoor measurements from 1612 to 1720 Mhz. Measurements at different altitudes were taken when the receiver was set up on the rear of a car with a battery powered Pi computer having the parabolic antenna 10 meters away to minimize local noise pickup.

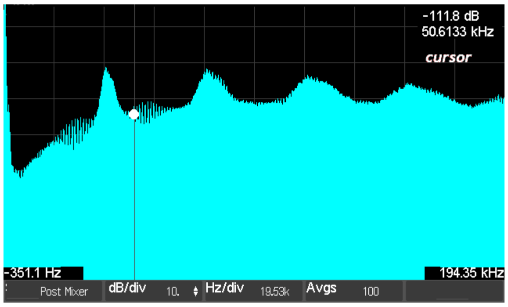
1. Generating Bands

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. The lock-in-amplifier operating as a spectrum analyzer from 0-194 KHz monitored the vector amplitude of the received signal from a coil centered on the .075 meter long RF antenna of the RF receiver. The sensitivity was set at 100 micro volts with max 10 millivolt input range. These noise levels were quite low and can be seen if Figures 4 and 5 with the ambient peaks not reaching -100db. It was also useful in observing the energy being drained over time from the background fields and being transferred into the dense set of bound states.

What is shown in Figure 4 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 5, the ambient noise is drain from regions between the enhanced peaks of the active states energy differences found in the RF spectra. That energy transfer from the noise spectra is the low frequency source for populating the high frequency bands.

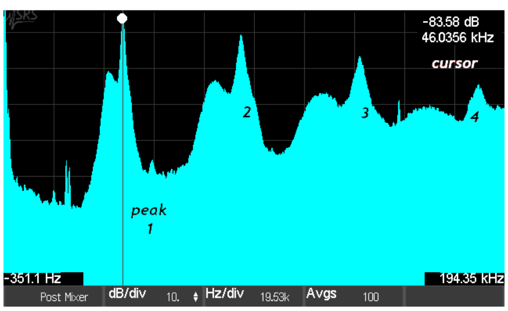
B. 1400 and 1250 MHz Band Comparison

The high altitude site selected was in a radio quite zone miles from any structures. The low altitude site was well away from power lines and habitation. This band starting around 1240 MHz in figures 6 and 7 is very different from the 1400 MHz set of bands found in Figures 1 and 2. First it is single sided and does not have a matching upper band. The 1250 MHz RF noise source maybe the commercial radio traffic seen at 1261 MHz where the noise baseline is raised. The ground band signal for the downward pointing antenna is 11 db down at 1250 MHz at 4397 ft compared to the signal from the zenith. The difference is less than 1 db down for the 1400 MHz signals. The 1250 MHz bands that was found is highly polarized +10 db E-W verses +2 db N-S



FFT ambient background noise

Figure 4 **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. Vertical scale 10 db/div**



FFT with noise source on

Figure 5 **With the same settings and 24" flat panel monitor now being turned on 1 meter from the coil, two features standout. Four new peaks appear starting at 46 kHertz spaced by the same amount. The noise band between the peaks are significantly reduced by as much as 20 dB. This represents a transfer 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.**

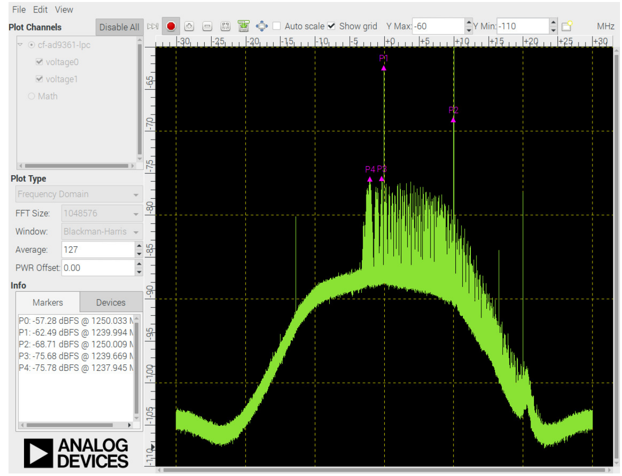


Figure 6 **Parabolic antenna pointed to the zenith with the dipole oriented on the East West axis at an altitude of 4397 ft. at Reddish Knob, Augusta County, VA. There is commercial traffic at 1261 MHz. Bandwidth of 20 MHz at 60 MSP centered at 1240 MHz.**

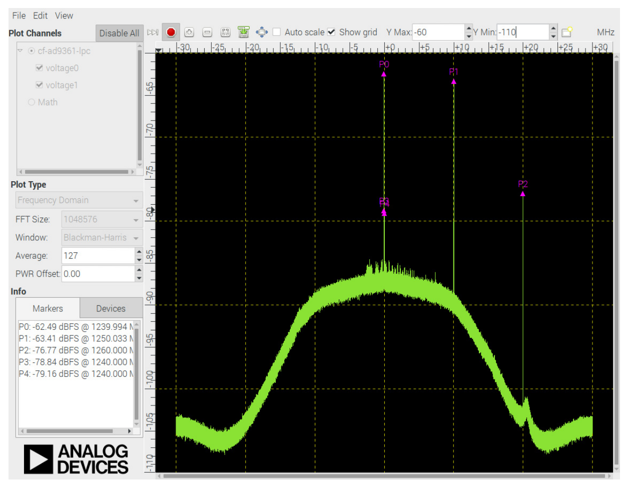


Figure 7 **Parabolic antenna pointed to the zenith with the dipole oriented on the North-South axis at an altitude of 4397 ft. at Reddish Knob, Augusta County, VA. The band is strongly polarized with respect to the magnetic orientation of the earths field. Bandwidth of 20 MHz at 60 MSP centered at 1240 MHz.**

relative to the noise floor. This is totally unlike the bands centered at 1400 MHz in Figure 8 that are not strongly polarized rather it is sparse and not dense indicating a different origin.

C. Ground Signals

Ground signals are complex because of very different chemistry of items such as cellulose, clay, limestone, silica, and other minerals that are in contact with water. At high altitude well above a water table the ground signals are minimized in Figure 9. However, where the water table is near the surface presented in Figures 10 and 11, the

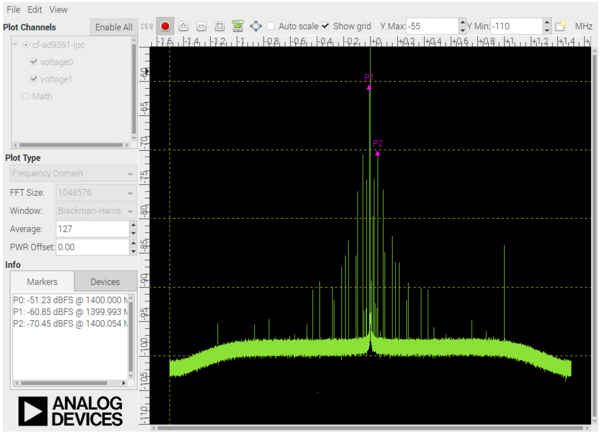
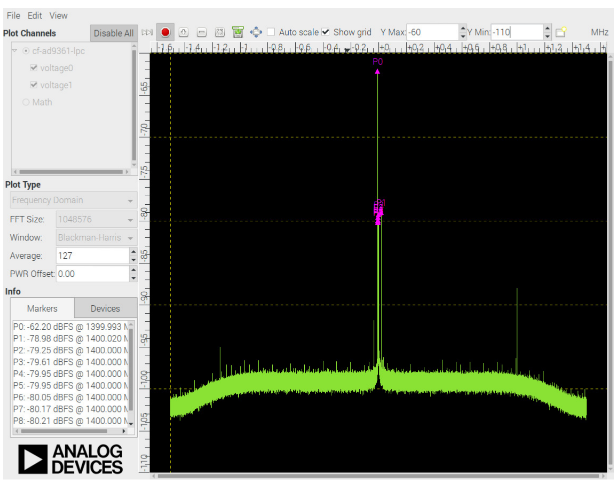


Figure 8 **Strong pump source for band above and below 1400 MHz, showing a Raman type spectra. Parabolic antenna pointed to the zenith with an EW polarization. Frequency resolution is 2.8 Hz/bin, with a center frequency of 1400 MHz an 20 MHz down-converted band width. This figure was taken at an altitude of 1150 ft above sea level and the next figure 4397 ft.**



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 any atmospheric signals.

VII. MATERIAL SPECTRA

Measurements were made indoors to isolate the larger signal sources that generated the dense band structures. There are three complicating sources in the structure that have significant volume: gypsum, fiber glass, and cellulose. An elevated room was used to put some distance between ground sources.

These measurements were taken in a long room that serves as a library 4 meters above grade in a wood frame

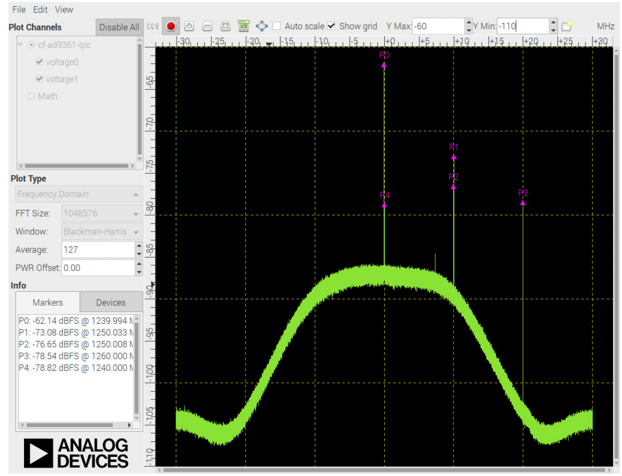


Figure 9 **Calibration for a band with the parabolic antenna point downward into the earth at an altitude of 4397 ft. Bandwidth of 20 MHz at 60 MSP centered at 1240 MHz.**

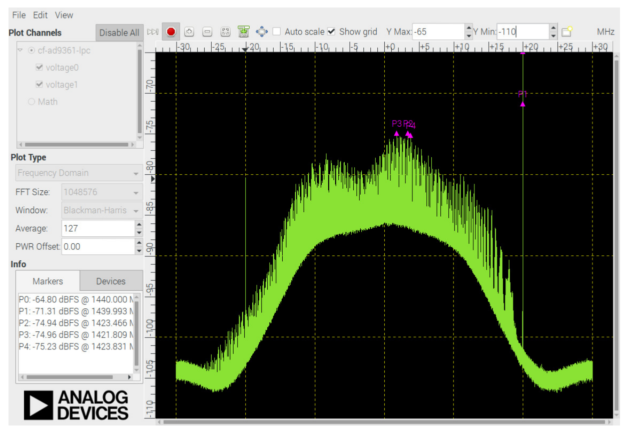


Figure 10 **Calibration for a band with the parabolic antenna point downward into the earth at an altitude of 1150 ft in a deep sand-clay bottom land. Bandwidth of 20 MHz at 60 MSP centered at 1420 MHz. The ground signal appears in a band above the center frequency.**

building with gypsum dry wall and fiber glass insulation. The 24 inch flat panel monitor was used as the low frequency noise source that is highly directional from the rear of the screen and was aimed at a target 10 meters away that used the Southwest antenna at one focus in the elliptical Faraday cage with the target material located at the other focus. Sample signals detected in the empty but leaky Faraday cage are shown in Figure 12 at five different frequencies spanning 12 MHz about the central frequency. The in-room measurement with the Faraday cage had the the monitor positioned to maximize the low frequency noise at the antenna and when the monitor was reversed to minimize the low frequency noise the bands were no longer present. Because humans have a significant effect on the noise spectrum in the room mea-

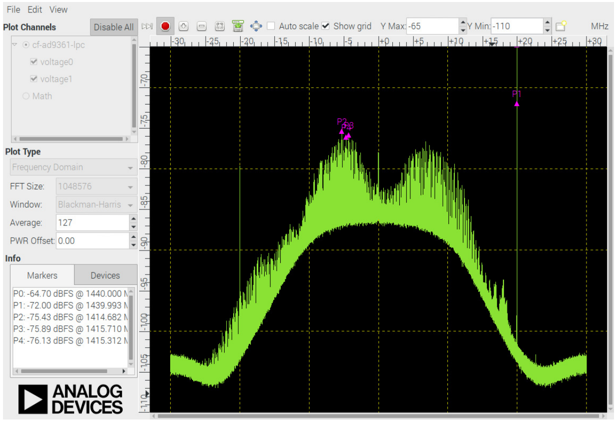


Figure 11 **Parabolic antenna pointed to the zenith with the dipole oriented on the East West axis at an altitude of 1150 ft. The ground signal is slightly attenuated with the change in orientation of the antenna.**

surements were taken from behind the low noise source to minimize any contribution.

Also at the location of the Faraday cage the parabolic antenna was aimed vertically to monitor external noise entering the room. No bands were found at 1250, 1380, and 1400 MHz. However, at 1420 and 1433 there were barely resolved bands forming between .5 and 3 db above the noise floor. These bands became enhanced towards the late afternoon. During a light rain they increased to 10 db above the noise floor. This indicates that the books, wood structure, fiber glass insulation, and dry wall in the directly line of the noise sources produced the bulk of the signals in the vicinity of the Faraday cage.

The only spectra that are dealt with here are those appearing when a low frequency noise source is applied and these form the dense bands like shown in Figures 1 and 2. When the low frequency noise source was off these bands were sometimes partially visible just a couple of db above the noise floor and when the noise source was on as much as 30 db above the noise floor. These bands are not simple as they can be made up of overlapping sets.

A. Faraday Cage Spectra

The varied nature of the data over the different frequencies indicates there are a number of different active sites within each sample. Even though the gross spectra are different from material to material there is close relation in some of the line spacing within the spectra indicating a common mechanism is controlling the spacing between states.

Al_2O_3 is different than the other materials with an emission band 1380 MHz. The niobium accelerator cavity responses are also very different because it is active at all the test frequencies. The activity of the niobium cavity is not a surprise as the electro-polishing process used on the cavity leaves a considerable amount of hydrogen in the metal, particularly at the near surface region and in the oxide. So there are many possible configuration for hydrogen occupation in the surface layers. The other point to be made is the signals from just these surfaces layers are just as strong as the signal changes found in the other bulk samples having much greater active volumes.

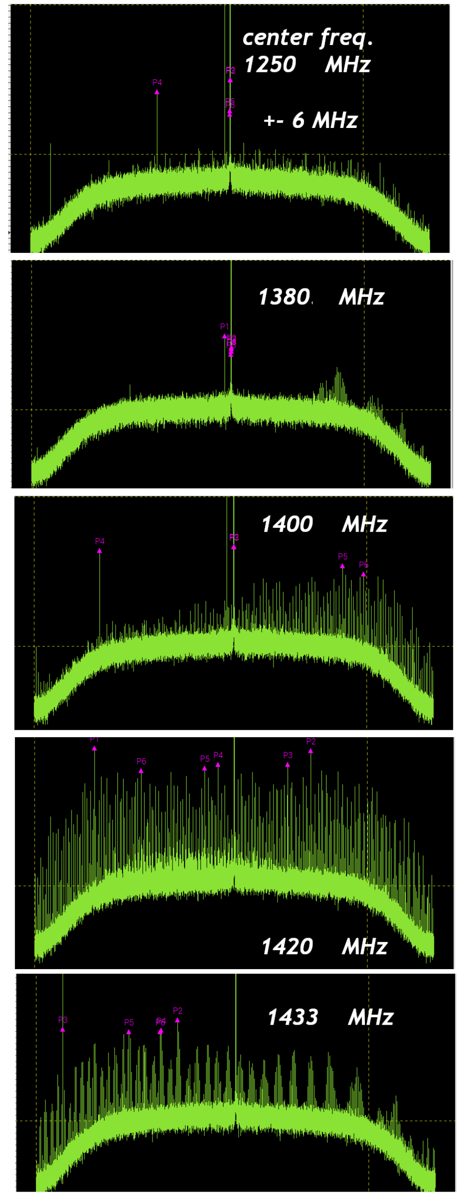


Figure 12 **Empty Faraday cage data where the broken horizontal scale is -80db and the top of each graph is at -70db. The band pass is 12 MHz, with 127 FFT scans averaged of 65k samples, with a sampling rate of 12 MPS. If the monitor is reversed reducing the low frequency noise from propagating towards the Faraday cage all the sharp peaks above the noise floor vanish.**

Water, paper and gypsum are not very different showing nearly common responses. One surprise is that sil-

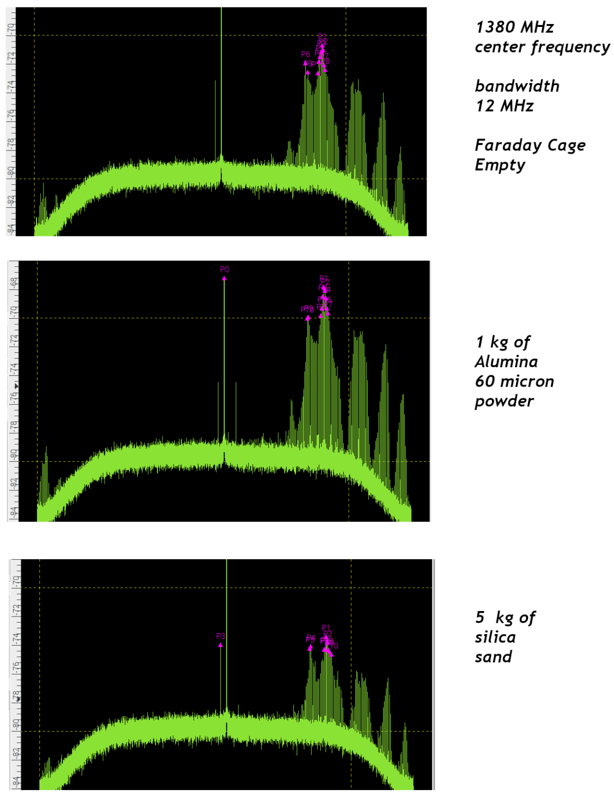


Figure 13 **The aluminum constructed Faraday cage has a great deal of surface and that surface of Al_2O_3 will absorb hydrogen from water. This comparison of the behavior at 1383 MHz indicates the effect with a +3 db gain over the empty chamber with 1 kg of 60μ powder of Al_2O_3. Silica absorbs at these frequencies and registers a drop in signal level of -3 db. Not only silica absorbs at this frequency but water, cellulose, and cement are absorbers. The strongest absorber was an electropolished 1.4 GHz resonant cavity made of niobium where the surface known to be is rich in hydrogen completely wiped out the signals in this 1380 MHz band. It is not so much the volume of the material but the activity in the site that hydrogen can occupy.**

Table I **Leaky Faraday cage survey measurements of some common materials sources found within the local structure along with an oxide and a metal with an oxide surface.**

Species	**Characteristic Band Features**
Al_2O_3 1kg 60μ	absorbs 1433 emits 1380 & 1420
H_2O 2 liters	absorbs 1380 & 1433 emits 1250 & 1420
800 sht. paper cellulose	absorbs 1380 & 1433 emits 1250 & 1420
sand SiO_2 5kg	absorbs 1380 emits 1420 & 1433
Nb EP cavity	absorbs 1380, 1400, & 1433 emits 1250, 1400, & 1420
gypsum 2 kg dry wall	absorbs 1380, 1400, & 1433 emits 1250 & 1420
cement 18th cent. 12 kg	absorbs 1380, 1400, & 1433 emits 1250 & 1420

ica and cement are different in their behavior as they have two frequencies where the responses are reversed. A number of these components can be found locally where measurements are made and they will interact with each other creating a complex electromagnetic noise environment that makes isolating particular sources difficult.

B. Active Gain Media

To isolate material contributions to the spectra two of the active materials at 1420 MHz cellulose and silica were tested as gain media. The meaning of gain medium is simple. If the material is presented with an activating noise source will the signal be enhanced on passing through the small sample that is much smaller than the wavelength of the fields passing through it in the forward direction. This was done with the Pi computer and receiver 4 meters from the Southwest antenna oriented in the horizontal plane perpendicular to the source direction. The data for the silica sample is shown in Figure 14. Small .1 meter long samples approximately .04 meters in diameter of silica (glass bottle with sand) and cellulose a piece of black walnut wood where first place in front of the antenna and then to the rear of the antenna within .01 meters also perpendicular to the signal source. The 1420 MHz bands showed a gain of 3 db when the sample is placed in front and a loss of 3 db when placed at the rear of the antenna. A similar result with a slightly smaller spread was found for the wood sample. In the presence of a weak magnetic field from a ceramic magnet of a few hundred Gauss the responses were suppressed but not eliminated. This measurement is in a higher noise environment compared to the Faraday cage measurement where there was some restriction on the total noise level.

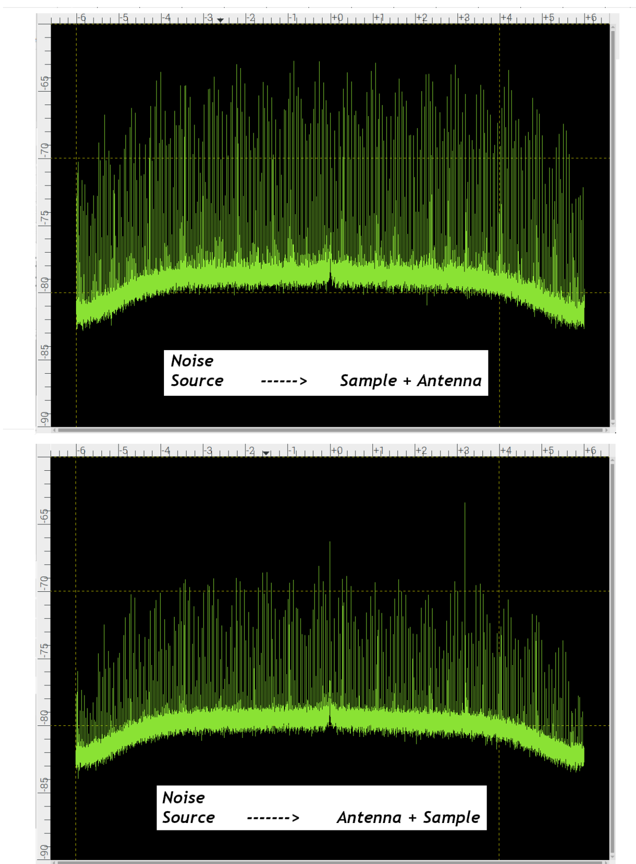


Figure 14 **A +3db forward scattering gain from silica sample about the size of the antenna place in front of the antenna for gain and behind the antenna for loss with respect to the noise source. With no sample the response was midway between the two. The sample placement and size are well below the wave length of the propagating field so there was a minimum of geometrical optical effects. The same effect though not as great is seen for a wooden obstacle and gypsum. Note also that the noise floor is increased by almost 1 db with the sample placed in front of the antenna. In the upper figure it is possible to observe three overlapping band sets. Measurements were take with a center frequency of 1420 MHz and a band width of 12 MHz.**

VIII. ATMOSPHERIC SOURCES

Our first guess after starting to take data was 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, particularly in hydronium. This bonded structure appears to have both rotational and vibrational modes. However, it is not apparent these gas phase components in a simple hydrogen bond could support such a well defined set of compact quantum states. The problem in measuring these states is 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 will not be visible. The lowest energy states only mechanism of emission is through the very slow magnetic dipole transition.

The spectra appears to be from perturbed atomic hydrogen. The sharp emission lines we initially thought imply a gas phase source as broadening would be expected in a solid. 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 was that hydronium H_3O was responsible where the extra hydrogen was slightly polarized by water's dipole moment and formed a weak bond. 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. The additional problem was the multitude of states whose numbers are far in excess of what is found in complex molecular rotational spectra.

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-orient-able unlike the linear carbon dioxide molecule that can be polarized by the earths magnetic field. The other molecule of interest is H_5O_2 where the middle hydrogen could have be active nucleus.

The atmosphere only contains three active molecules that can 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. These can both bond with other molecules. More promising is the dust and pollen in the atmosphere that can absorb water vapor on surfaces or interiors and become an active source with low and high frequency noise.

IX. POLARIZATION BOND

From the great number of available states, over 1000, that showing modulation patterns that indicate more than one dynamic process is active. Because the energies measured in the transition are so close to 1420.4 MHz the perturbation of the electronic 1S is minimal. The small energy separation between states indicates a weak coupling that allows so many physically accessible states.

Any model will have to explain both the sources as well as the bands that are non-traditional because their low frequencies implying both low moments of inertia for rotation and weak coupling constants for vibration that can only be satisfied by a radially polarized atomic hydrogen. Bands in both the 1250 MHz and 1400 MHz frequency ranges have approximately the same spacing indicating the same active species 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.

The question becomes how is a weak bond described? For that answer one has to look at the basic model of an elementary particle. That is a model of a lowest energy structure that defines the particle in its own self-reference frame (Wallace and Wallace, 2014a). There is only one spatial degree of freedom in this frame of reference and that is the radial density distribution. Any change can only be accomplished by changing the radial structure. In the case of weak hydrogen bonding the source of the binding energy is the polarized structure first suffers a scale expansion. If the hydrogen is found in a compact site it can also suffer a squeezed contraction (Dolmatov and King, 2012). These spectra provide a major hint in that these signals are very close to being like free hydrogen because of their small frequency displacement from the 21 cm transition. The structure of the bonded hydrogen is only slightly radially polarized. The binding energies of the weakly bonded states can be computed from the spectral data by just considering a small scaled expansion of the electronic wave function to lower the energy of the atom so it can bind. This makes a strong case for trapped hydrogen within a solid of fluid structure.

The variation in scale due to the polarization bond will slightly alters the Bohr radius, a_o. The normalization condition determines the constant A for a wave function of the ground state, $\psi(r)$ and the binding energy can then be computed.

$$\begin{aligned} \psi(r) &= A \;\; e^{-\frac{r}{a}} \\ 1 &= A^2 \int e^{-\frac{2r}{a}} \; r^2 dr d\theta d\phi \end{aligned} \tag{1}$$

$$A = \sqrt{\frac{2}{\pi \; a^3}} \tag{2}$$

The density at the origin, $\rho(a) = \psi^*(0)\psi(0) = A^2$ and can be computed as a increases from the Bohr radius value, a_o. The density change is proportional to the measured frequency shift, Δf from $f_o = 1420.4$ MHz for the ground state.

$$\frac{\Delta f}{f_o} = \frac{\Delta \rho}{\rho_o} \tag{3}$$

$$\frac{\Delta f}{f_o} \sim \frac{\rho(a) - \rho(a_o)}{\rho(a_o)} = \frac{a_o^3}{a^3} - 1 \tag{4}$$

From the shift in frequency the binding energy, ΔE of the altered state can be computed from the difference between the ground state energy (Bethe and Salpeter, 1957).

$$E_o(a) = -13.605693 \;\; \frac{a_o}{a} \;\; eV \tag{5}$$

$$\Delta E(a) = E(a) - E(a_o) = \;\; 13.605693 \; (1 - (1 + \frac{\Delta f}{f_o})^{\frac{1}{3}} \;\; eV \tag{6}$$

This form of bonding isolates the nucleus from its former environment giving the neutron some freedom where the electron density is now fixed to a larger structure. The sharpness of the transition is determined by the direct interaction of the atom as a whole that is coupled into a molecule or solid structure that limits the line broadening by absorbing the linear momentum of the transition. It is the nuclear spin transition coupled with the ability of the surrounding structure to absorb or supply the energy and momenta to complete the transition. As the nuclear spin is isolated from the lattice this transition will have the character of a narrow transition similar to Mossbaürer emission.

Table II ΔE **shift from band locations**

Band Frequency	**Shift in Mhz**	ΔE eV
1250	-170	+.56602
1400	-20	+.06416
1433	+13	-.04138

In a bound quantum system the component that has the minimum inertia will be the component that will take on quantize state behavior. The prime example is the electrons of the free hydrogen atom. When the atom is bound either in a lattice or to a molecule then the unshielded low inertia component becomes the proton in the case of hydrogen and it can take on the role of having a set of quantize states. The proton's leisurely activity sees a long term time averaged electron density locally which will allow well defined states to form.

A. Electron's Potential

The potential the proton sees will be very different than that of the electron if it is displaced from the center of symmetry. The electron's density function is $\rho(r) = \psi^*(r)\ \psi(r)\ r^2$ and the potential, $V_{elec}(r)$ that it generates as a function of r is:

$$V_{elec}(r) = -\frac{e^2}{4\pi\epsilon_o r}\frac{\int_0^r \psi^*(r)\ \psi(r)\ r^2 dr}{\int_0^\infty \psi^*(r)\ \psi(r)\ r^2 dr} = -\frac{e^2}{8\pi\epsilon_o r}\{2 - (\frac{4r^2}{a^2} + \frac{4r}{a} + 2)e^{-\frac{2r}{a}}\} \tag{7}$$

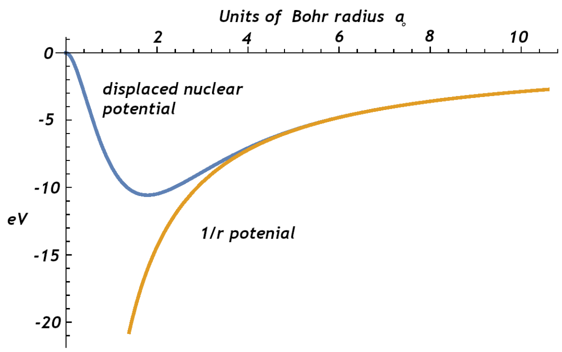


Figure 15 **In blue is the potential experienced by a proton displaced from the electron densities center of symmetry. Note the origin is an unstable equilibrium point for the nucleus as the electron is inhibited from tracking the nucleus. The nucleus' natural tendency will be to move away from this unstable point.**

The reduced symmetry of hydrogen bonding coupled with the external fields generated by surrounding matter determine the breaking of the degeneracy of the active rotational states about the potential protuberance. So that there can be as many as three different principal rotational spectra generated by the same occupied site. This might be the principal source of the complexity producing the multiple bands.

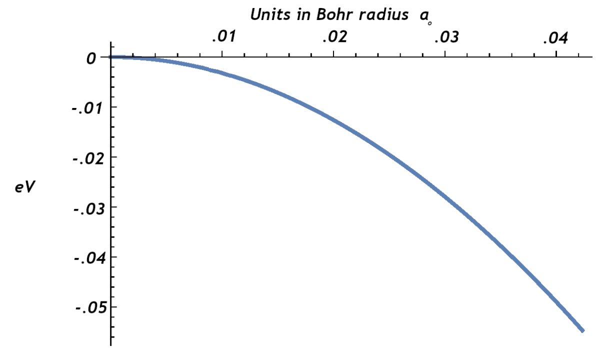


Figure 16 **Greater magnification around the origin for the potential seen by the nucleus if displaced. It is not vibrational states that will be activated by this possibly spherical potential but an array of rotational states.**

X. DISCUSSION

Interference with the weak bonding of the single valence electron of the hydrogen atom appears to be sufficient to allow the nuclei in hydrogen and its isotopes to take on a variety of mechanical motion relative to the bound electron. The change in behavior from free atomic hydrogen which is practically invisible because of the very slow transition rates from the triplet to singlet state now are completely reversed in these weakly bonded state.

By the process of elimination and considering the structure of the hydrogen atom and how it can weakly bond there was nothing from traditional spectroscopic processes that can explain the complex and dense spectra at such low energies other than nuclear motion that removes the nucleus from the center of symmetry of the electronic density function. In particular, the modulation of the bands indicated there are active spectra that overlap and in regions where they are degenerate thus forming gaps. In addition, there were a number of overlapping active spectra that implied either different binding locations or broken spherical symmetry or both for the adsorbed hydrogen. This is something that would be expected for hydrogen absorbed into any solid state structures. These emission modes may complicate the interpretation of some astrophysical signal.

The initial detection of these lines in Swartz's very efficient cold fusion reactor was no accident. Even though it is driven with a small DC current we expect significant currents to naturally form at the reaction sites generating the broadband noise to active these RF transitions (Wallace and Wallace, 2019). Also the continuous line shifting to higher frequencies as the reaction run indicate there is the expected spectral dependence on the thermally driven lattice expansion.

Broad band radiometer scanning of the earth surface for both ocean salinity and soil moisture measurement have been made from satellites for two decades in the 1400-1427 frequency band. Surveys encounter interference with these measurements from other sources (Daganzo-Eusebio *et al.*, 2013) (Uranga *et al.*, 2021). 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 might indicated that the high density of flat panel TV displays housed in a variety of structures might be a more important source of interference for signals spreading from these source into the forbidden transmission band.

In our low frequency magnetic measurements at 1 millihertz occasionally we noticed phase locking for periods of up to an hour. This is an indication of randomly time varying low frequency fields encountering a gain medium where they begin to absorb energy fixing the instantaneous frequency that is stabilized as energy is absorbed. The question is whether there is a link between hydrogen that is activated by local noise sources to such a transfer of energy into the time varying magnetic field. Longitudinal spin waves possess mass, however, there are few mechanisms for energy to be transferred to these long lived time varying fields. The gravitational measure of dark matter just maybe the measure of these low energy dynamic magnetic sinks operating as large scale populated quantum states that have been ignored.

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