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RESEARCH ARTICLE

Sonic Analysis of the Redlands UFO Tape Recording

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Abstract—The February 4, 1968, UFO sighting at Redlands, California, was accompanied by an intense, distinctive sound that was recorded as a background sound on a magnetic tape recording being made by Reverend Julian Vigh at the Bethel Christian Church. A rescue Emergency Vehicle (EV), with its siren operating, happened to be deployed in Redlands at the time of the UFO sightings. An inquiry by several Redlands University professors attributed the background sound on the Vigh recording to the EV siren. Reported here for the first time is an independent, comprehensive, detailed sonic analysis of the tape background sound and the EV siren, originally prepared in 1969, and intended for inclusion as an independent technical appendix in a book on the Redlands UFO sightings then in preparation. That book was never completed or published. The result of detailed tape analysis concurred with Professor Seff's conclusion that the EV siren was the source of background sound on the Vigh tape; however, a number of sonic anomalies in the time dependence of sound intensity and Doppler shift were identified and quantified.

Description of the Redlands Case

The Redlands UFO Sighting

On February 4, 1968, just before 7:30 p.m., a disk-shaped UFO was suddenly visible over Redlands, California. The object moved erratically, at one point hovering low over the ground. It was witnessed by more than one hundred people as it traveled overhead. Although it was dark outside, the UFO was visible because it had seven lights on its base, like jets, and also a row of lights on the top, alternating in color between red and green (see artist's conception based on witness interviews, Figure 1). After about five minutes it moved rapidly to the northwest and vanished. The UFO was visible long enough, and had sufficient apparent size, for the witnesses to provide consistent descriptions of its appearance.

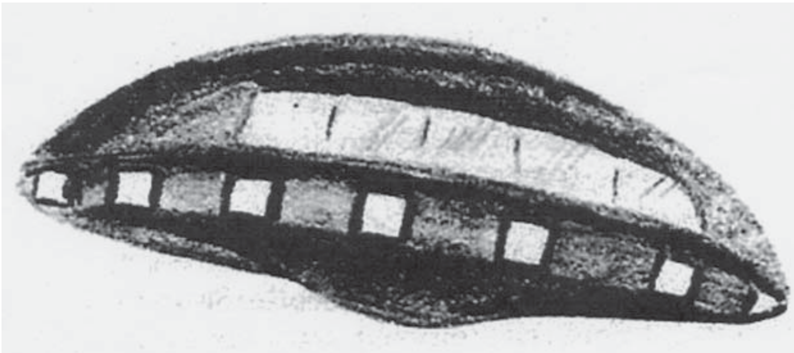

Figure 1. Artist's drawing based on witness interviews of the Redlands 1968 event. Credit: John Brownfield. Aerial Phenomena Research Organization.

During the sightings, animals were reportedly upset, and many witnesses also described a peculiar sound—characterized as high-pitched and modulated—coincident with the UFO. The odd sound was caught on tape by a minister who was recording his sermon during services in a church.

A group of four professors from the University of Redlands, who had agreed to assist the University of Colorado UFO study, then ongoing, immediately set about investigating the case, interviewing dozens of witnesses, gathering drawings, and looking into the recorded sound. They were Dr. Philip Seff (geology), Dr. Judson Sanderson (mathematics), Dr. Reinhold Krantz (chemistry), and John Brownfield (art). Altogether they devoted three months to their inquiry.

Witness descriptions were consistent enough to detail the object and its path. The team's calculations indicated that the object was about 50 feet in diameter, and at its closest approach was about 300 feet above the ground. They mapped the UFO's path across Redlands and its eventual departure to the northwest. They considered alternative explanations and searched for additional data, contacting the local Norton Air Force Base for any radar data. Nothing unusual was detected on radar, but they discovered that due to low altitude, neither a UFO nor a plane over Redlands would have been detectable at that distance from the radar site.

The team determined that the odd, recorded sound was from an emergency rescue vehicle that was driving in the same area of Redlands where the UFO was being observed. Regarding the UFO itself, their final conclusion was that the object could not be explained by any conventional, astronomical, or other natural source, and the case was categorized by them as "unidentified."

Sonic Analysis of the Redlands UFO Tape Recording

Introduction

This report deals with the sonic analysis of a number of sounds involved in the sighting of an unidentified flying object (UFO) in Redlands, California, at about 7:20 p.m., on February 4, 1968. Numerous witnesses reported that the UFO emitted an intense warbling sound with a quality unlike that of any sound within their previous personal experiences. At 7:17 p.m. on the same evening, an unusual warbling sound pervaded the main hall of the Bethel Christian Church of Redlands as Reverand Julian Vigh offered a prayer during his Sunday evening service: This warbling sound was recorded as a background sound on the magnetic tape used by Reverend Vigh to record his service. The voice of Reverend Vigh is the dominant sound source on the Vigh tape recording. The unidentified sound is a relatively weak background sound, which is prominent only during pauses in Reverend Vigh's prayer. This sound first becomes audible at the end of the phrase ". . . empowered by Thy spirit and together are led by Him . . . ", and time from perception is measured from this instant. The sound is audible for about 80 seconds, vanishing at the end of the phrase " . . . we deserve nothing because we . . .". During these 80 seconds, there are about 15 pauses in the prayer of one or two seconds duration and it was during these pauses that the characteristics of the unidentified sound were studied. Qualitatively, this sound can be described as a warble of moderate pitch (corresponding to the musical note "E" above standard "A"). The sound conveys a pronounced discordant quality suggesting the presence of slightly differing frequency components as well as some higher-frequency overtones. The sound seems to be the product of an electronic device, and while not simple in structure, it is clearly less complex than human speech. The relative simplicity of the sound waveform was expected to permit meaningful quantification of the characteristics of the sound using techniques of sonic analysis.

At approximately the same time that the aforementioned event was occurring, an emergency rescue vehicle was being called from Redlands to the scene of an accident north of Redlands. It is known that a warble type of siren was used on the emergency vehicle (EV) and that the EV passed along a known course in the immediate vicinity of the Bethel Christian Church. This siren can be operated in three standard modes, each of which is selected by positioning a rotary switch. The modes are l) wail, 2) whelp, and 3) wail burst. (These names are those of the owners of the siren). The wail mode is characterized by a pure sonorous tone with a slowly varying amplitude. The whelp mode is characterized by a rapid modulation of intensity and a complex pitch structure, qualitatively similar to the unidentified sound. The pitch of the whelp mode is considerably lower than that of the wail mode, and the auditory responses to these two modes are completely different. The third mode, wail burst, is essentially the wail mode issuing from the siren for only a brief interval when the horn ring is depressed. Because of the known activity of this acoustic source during the time interval of interest, this study sought the answers to three major questions:

1. Was the EV siren the acoustic source that produced the sound recorded on the Vigh tape?

2. Are the variations in time of the intensity and spectral power density of the unidentified sound on the Vigh tape those expected for the radiating siren moving along the known path of the EV?

3. Was the EV siren the acoustic source responsible for the intense sounds reported by at least two specific witnesses of the February 4, 1968, event?

To aid in this quest, the EV was put through a rerun that simulated the EV run made on July 12, 1969; recordings were made and analyzed of the sounds produced at the Bethel Christian Church and at two other locations in Redlands where extremely intense sound effects were reported the night of the UFO sightings. The rerun was deemed essential to the complete analysis of the Vigh tape because the acoustic environment in which the Vigh tape was recorded was complex. The intensity and frequency distributions recorded were shaped by the motion of the source relative to the recording location and by acoustic properties of the terrain between source and receiver. The rerun recording would serve as source material for direct comparison with the Vigh recording. Recordings of the siren with the EV stationary were also made to act as a source reference that was not subject to Doppler shift.

An answer to the first question was provided by characterizing both the unidentified sound and the siren warble with respect to the following parameters: 1) Average Carrier Frequency; 2) Amplitude Modulation Rate; 3) Frequency Modulation Rate; 4) Frequency Modulation Bandwidth; 5) Overtone and Harmonic Content.

The experimental methods and results of these detailed sets of measurements can be accessed in the report written by the author in 1969, published here as supplemental material online. Both the sound of the EV siren operating in the whelp mode and the Vigh tape unidentified sound are characterized by carriers of nominally the same frequency (700 Hz), the same AM and FM modulation rates, the same FM bandwidth, and, to the extent studied, a similar overtone structure. *On the basis of these correspondences, and on the relatively small variability of the EV siren signature, the acoustic source of the unidentified sound on the Vigh tape is determined to be the EV siren operating in the whelp mode, in agreement with Professor Seff's conclusion.*

The second question above was addressed by measuring sound intensity and average carrier frequency as a function of time for both the Vigh and EV rerun recordings. The rerun sound intensity distributions were used to verify the validity of a relatively simple model of sound propagation for a moving source; this model was then used to interpret the distributions obtained for the unidentified sound. The field recordings of the rerun made at sites occupied by two sets of witnesses permitted some quantitative comments on the answer to the third question above.

Unidentified Sound Recording

The upper panel of Figure 2 shows the average relative intensity of the unidentified sound on the Vigh tape as a function of time from perception. The lower panel of Figure 2 shows the average carrier frequency over the same time interval. The standard deviations of the measurements of intensity and average carrier frequency are included using error bars. The average carrier frequency is seen to decrease monotonically from about 714 Hz at perception to 590 Hz at extinction, a drop of more than 120 Hz. The carrier frequency is essentially constant for the first 18 seconds, and then decreases linearly for the next 11 seconds. The carrier remains nearly constant for an additional 9 seconds, and finally decreases rapidly for the remaining 30 seconds of audibility.

The intensity rises very rapidly to a peak 18 seconds after perception, drops rapidly for the next 7 seconds, and reaches a second lower peak at 32 seconds. The intensity drops only slightly during the next 20 seconds, finally passing through a third peak at 69 seconds. The sound is imperceptible 80 seconds after perception.

Rerun Simulation of the EV Rescue Run of February 4, 1968

At 9:20 p.m. on July 12, 1969, a rerun simulating the emergency rescue EV run of February 4, 1968, was made by the same operator using the same EV and siren. The prime purpose of the EV rerun was to make a tape recording in the Bethel Christian Church of the sound produced by the EV siren as it moved along the identical path driven on February 4, 1968. From this tape, quantitative studies of the sound intensity and average carrier frequency perceived at the Church could be made and compared

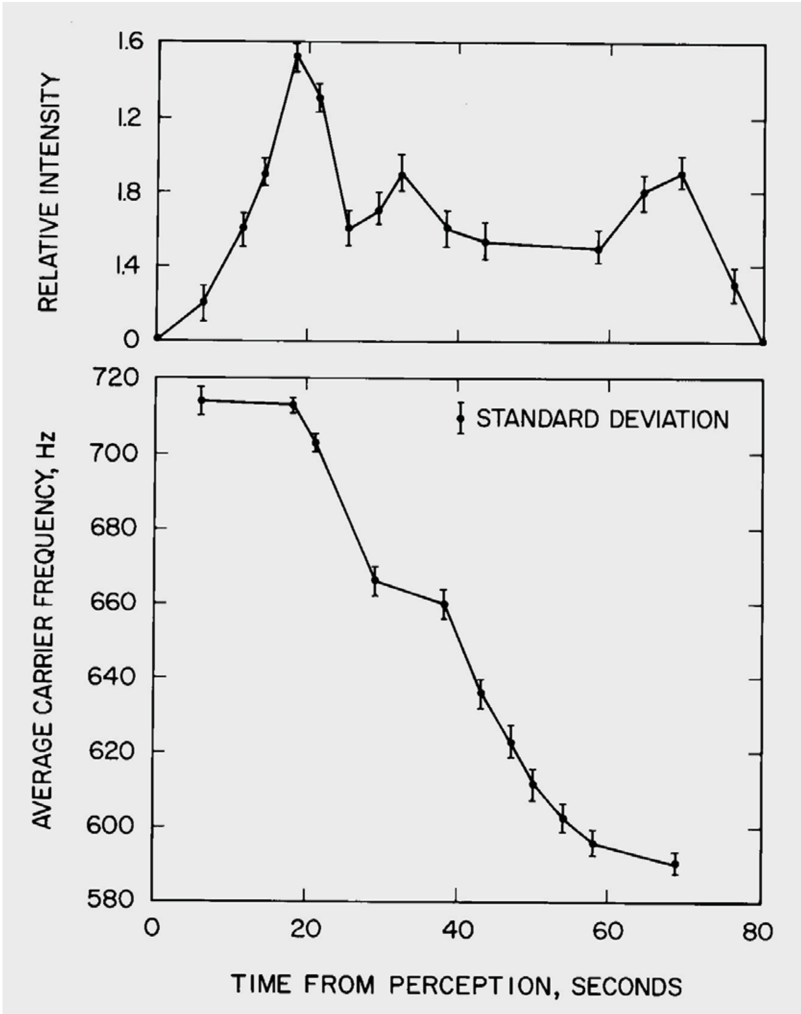

Figure 2. Intensity and average carrier frequency distributions of unidentified source.

with sound emitted from the EV siren. These recorded quantities depend on the geometry followed by the EV, the velocity and acceleration of the EV as a function of time, the acoustic properties of the terrain between the EV and the Church, and the acoustic properties of the Church hall itself. Since it was felt that the original run could be simulated to a high degree of approximation, it was fully expected that rerun distributions of intensity and frequency would bear marked similarity to those recorded on the Vigh tape. In this way, many factors affecting the recorded distributions, such as scattering and reflecting surfaces in the terrain, which cannot be easily accounted for in simple propagation models, can be appraised. Additional analysis was also performed based on the Doppler effect that describes the shift in frequency of a moving source as perceived by a stationary receiver. The shift in frequency from that emitted depends only on the component of velocity of the moving source along a line joining the source and receiver (e.g., the radial velocity). If the source emits a constant known frequency and moves along a known path with respect to the receiver, then the received frequency distribution in time is a *unique* record of the motion of the source giving both the position and the speed at every instant.

In order to fully document the rerun, nine tape recorders were used. A professional portable tape recorder was carried in the EV during the entire rerun to record the siren output. This tape recording was not subject to Doppler shifting of the siren carrier due to the motion of the EV, and could be used to measure any variation of the siren properties during the rerun. The true ground speed of the EV was noted and written down in a log every five seconds in order to provide an independent record of the motion of the EV. These speeds could later be compared with the speeds deduced for the EV from the Doppler measurements. Six recorders were deployed in and around the Church. Reverend Vigh's tape recorder was adjusted to record at the same level (a fixed level he always uses for recording services) as on February 4, 1968. The microphone originally used by Reverend Vigh was stolen sometime between February 4, 1968, and July 12, 1969, and replaced with a similar microphone, which was used during the rerun. Reverend Vigh gave a voice level sample prior to the rerun for approximate calibration of the absolute sound level. Two tape recorders were adjusted for maximum gain with microphones placed close to the pulpit microphone used by Reverend Vigh. Yet another recorder was operated at normal sensitivity with a similar microphone location. Two additional recorders were used to record the sound outside the Church. In one case the microphone was located on the eastern end of the Church facing east, and in the other case the microphone was located on the northern side of the Church facing east. Finally, two recorders were placed in locations away from the Church where witnesses reported having had intense acoustic experiences on the evening of February 4, 1968. One such location was at 1140 Columbia Street, and the other was at the corner of Texas Street and Pioneer Avenue. To synchronize the EV recorder with those at the Church, two stopwatches were started simultaneously before the rerun; one was retained at the Church and the other was taken on board the EV. Start marks were placed on all of the tapes at precisely 9:21 p.m., permitting temporal correlations among the tapes to about 0.5 seconds, the maximum transport speed error over 4 minutes.

Figure 3 shows the geometry of the EV motion path the evening of February 4, 1968, in relation to the Bethel Christian Church. The Bethel Christian Church is located on the southwest corner of Clay Street and W. Lugonia Avenue (Lugonia Avenue changes from W. Lugonia Avenue to E. Lugonia Avenue at Orange Street). The Church lies about 660 feet west of the major intersection of Orange Street and E. Lugonia Avenue. The EV proceeded due west along E. Lugonia Avenue, directly toward the Bethel Christian Church, slowed to make a right turn at Orange Street, and proceeded directly north for several miles on Orange Street. The four traffic lanes of W. and E. Lugonia Avenue provide an unobstructed channel along which the sound emitted from the siren coming along E. Lugonia Avenue can propagate without appreciable absorption or scattering. The terrain east of the Church and on the south side of E. Lugonia Avenue is open for the most part with a tennis court on the corner of Clay Street and E. Lugonia Avenue. Only one relatively large structure is situated between the Bethel Christian Church and Orange Street, a building on the south side of W. Lugonia Avenue between Washington and Orange Streets. On the north side of W. Lugonia Avenue between Clay and Washington Streets, there are four frame houses with tall trees in front of them on the tree belt. Between Washington and Orange Streets on the north side, there is a concrete building set back from W. Lugonia Avenue and extending 350 feet up Orange Street. The entire block from Clay to Orange Streets extending 1200 feet to the north is filled with frame structures, completely obscuring objects on Orange Street north of W. Lugonia Avenue from an observer at the Bethel Church.

The 1140 Columbia Street location (a witness location) is some 1800 feet from the intersection of Orange Street and E. Lugonia Avenue, and is acoustically shielded at ground level from this intersection by many homes.

Figure 4 shows the intensity and average carrier frequency of the EV siren recorded at the Church as a function of time from perception (note that the time scales used in Figures 2 and 4 are the same and may be directly compared). The error bars give the standard deviations of the measurements, and the solid curve joins the experimental points without smoothing. Contrary to expectations, *the rerun distributions of intensity and frequency are markedly different from those obtained from the Vigh tape.* In particular, the EV siren was audible at the Church for only 40 seconds during the rerun as compared with 80 seconds on the Vigh tape, despite the fact that both sounds had nominally the same maximum intensity, and that the rerun tape had a much better signal-to-noise ratio than the Vigh tape. There is also a

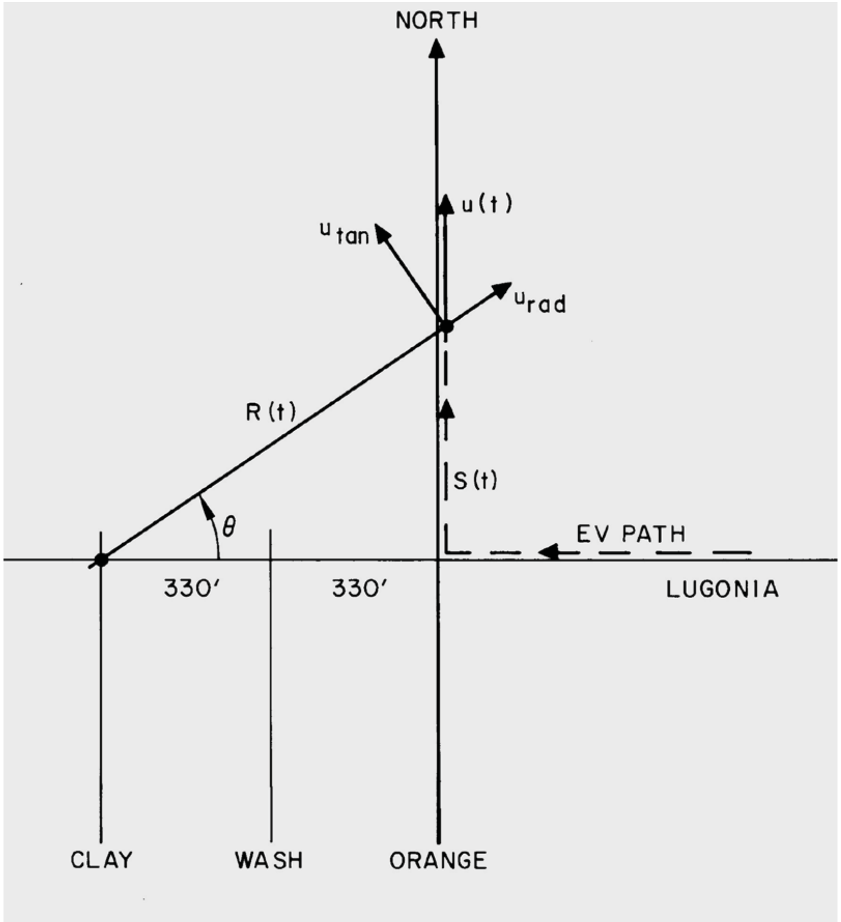

Figure 3. EV motion path in relation to the Bethel Christian Church the evening of February 4, 1968, and the geometry of intensity model parameters.

marked difference in the relationship of the carrier frequency distribution to the intensity distribution. In the EV rerun, the maximum intensity occurs near the lowest measured frequency, whereas in the Vigh distributions, the maximum intensity occurs near the *highest* measured frequency. In view of these anomalies, an analytic model was developed to describe the measured EV rerun distributions in terms of the known kinetic motion of the EV.

Consider first the qualitative features of the EV rerun distributions. The intensity rises to a maximum thirty seconds after perception and then drops

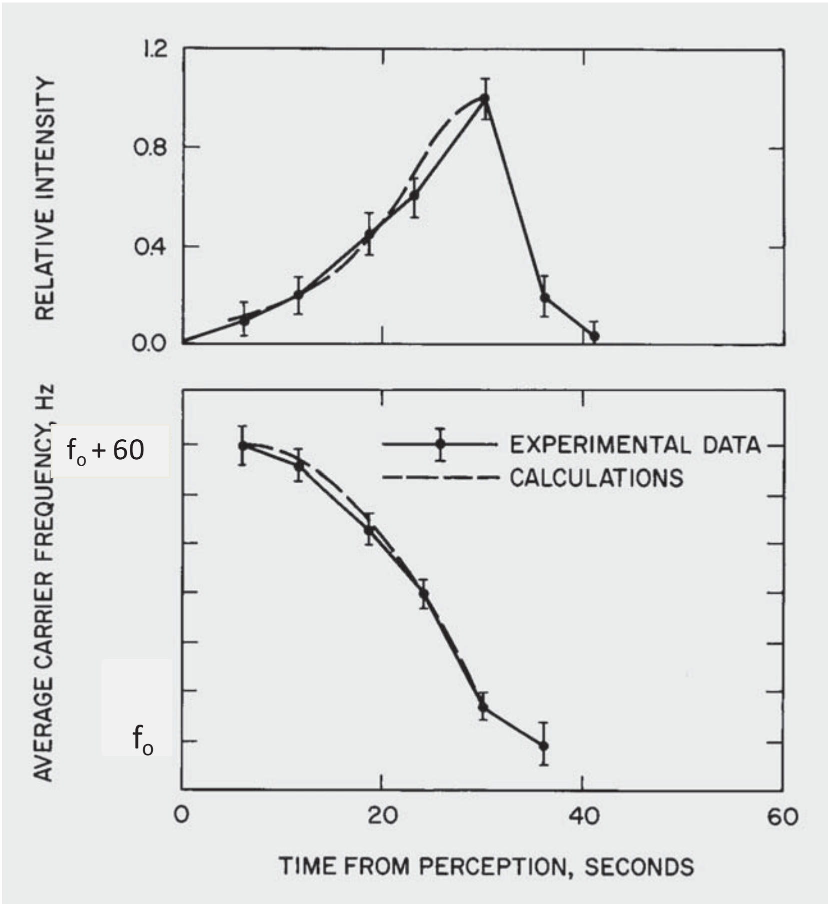

Figure 4. Measured intensity and average carrier frequency distributions of the EV siren during the rerun on July 12, 1969, and modeled intensity and Doppler carrier frequency distributions.

off much more rapidly than the rise during the next ten seconds. There are two main reasons for the more rapid fall than rise. First, the siren emits sound preferentially in the forward direction—it is mounted atop the EV facing toward. When the EV was approaching the Church along E. Lugonia Avenue, the sound emitted toward the Bethel Christian Church was constant in intensity, and the rate of increase in sound intensity at the Church was determined by the speed of the EV; as soon as the EV turned the corner at Orange Street, the actual intensity of sound emitted in the direction of the Church decreased due to the siren anisotropy, resulting in an immediate reduction in perceived intensity at the Church. Second, while the EV was on E. Lugonia Avenue, the emitted sound propagated directly down the street; upon turning north on Orange Street, the sound level dropped sharply in the time it took the EV to move from the corner into the sound shadow provided by the building on the corner of E. Lugonia Avenue and Orange Street.

The lower graph in Figure 4 shows average carrier frequency shift of the siren malfunction mode measured at the Bethel Church. The malfunction mode carrier was used for analysis here because its simple FM structure greatly facilitated the data reduction. Measurements on the tape recordings made in the EV showed that the siren emitted a constant average carrier frequency in this mode of 780 Hz. When first perceived at the Bethel Christian Church, the carrier frequency recorded at the Church was 840 Hz, a shift of 60 Hz above that emitted; it drops very smoothly to zero shift 29 seconds after perception, corresponding to the time when the EV turned north on Orange street. Thereafter, the received frequency shifted below that emitted, indicating that the source was then moving (radially) away from the Church. The intensity dropoff is so fast at this point that only two measurements of carrier frequency could be made for the EV directed northward on Orange Street. The EV was visually observed to reach the corner of E. Lugonia Avenue and Orange Street at 9:25:29 stopwatch time. The instant of zero Doppler shift on the Church recordings was determined to be 9:25:30, stopwatch time. Thus all of the measurements made during the rerun could be correlated to within one second.

Consider next the quantitative correlation of the intensity distribution with the carrier frequency distribution of the EV rerun. The Doppler shifted frequency, f, perceived by a stationary listener from a source emitting a frequency, f, and moving with velocity, u(t), is given by

$$f = f_o [1 - (u_{rad}/c)]^{-1} \qquad (1)$$

where c is the speed of sound (755 mph at 72 °F) and u_{rad} is the component of the source velocity, u(t), in the direction of the listener, e.g., the radial velocity (u_{rad} is taken as positive when the source moves toward the receiver). Since the Doppler shift depends only on the radial component of velocity, it is useful to break up the analysis into two parts: first, when the EV is on E. Lugonia Avenue, and second, when the EV is on Orange Street. In the first case, the motion of the EV is always directly toward the Church, so that the radial component of velocity is just the ground speed of the EV. Each of the measured Doppler frequencies shown in Figure 4 was inserted in Equation (l) and the corresponding speed of the source determined. For example, six seconds after perception the perceived frequency was shifted

60 Hz above the emitted frequency (to 840 Hz from 780 Hz). This shift corresponds to a ground speed of 54 mph toward the Church. The speed of the EV logged during the rerun at this same instant (counting from the start marks) was recorded as 55 mph. Each of the EV speeds computed from the measured Doppler shifts agreed with the entries in the log within accuracy of measurement. This result, of course, is at it should be; and it demonstrates the important result that the siren was sufficiently stable during the rerun to permit the state of motion of the EV to be described by Doppler measurements. Simple numerical calculations showed that the speed of the EV while on E. Lugonia Avenue can be expressed as the following analytic function of time:

$$u(t) = 78 - 0.1412\,(t)^2 \qquad 0 \le t \le 24 \qquad (2)$$

where u(t) is the ground speed of the EV in feet/second at the instant t, and the variable t has the value of zero six seconds after perception. This equation is valid from the time of the first Doppler measurement in Figure 4 until the EV reached the corner of E. Lugonia Avenue and Orange Street. The instantaneous EV acceleration during this interval, a(t), is found by differentiating u(t) with respect to time:

$$a(t) = -0.2824\,(t) \qquad 0 \le t \le 24 \qquad (3)$$

where a(t) is in feet/(second)^2. Equation (3) shows that the EV *deceleration increased linearly with time* as it approached the corner. The instantaneous distance of the EV from the Church, R(t), is the integral of u(t) with respect to time, with the constant of integration fixed by the requirement that R = 660 feet when u = 0.

$$R(t) = 1882 - 78\,(t) + 0.0471\,(t)^3 \quad 0 \le t \le 24 \qquad (4)$$

where R(t) is in feet. Equation (4) shows that the EV was 1882 feet from the Church when the first Doppler frequency measurement was made six seconds after perception; assuming that the EV speed was a constant 54 mph during the first six seconds of perception, the EV is computed to have been 2300 feet from the Church when first perceived. To show that these equations are an accurate representation of the kinetic motion of the EV on E. Lugonia Avenue, u(t) in Equation (2) was inserted into Equation (l) for $u_{rad}(t)$ and the Doppler profile f(t) was computed. The calculated Doppler distribution, shown by the dotted curve in the lower half of Figure 4, is an accurate replication of the measured Doppler distribution. Having established an analytic expression for the distance of the EV from the Church, the intensity distribution recorded at the Bethel Christian Church can now be computed. At a distance R(t), the intensity of an acoustic wave of carrier frequency f, propagating in a medium with a specific absorption coefficient β(f), at the frequency f, is

$$I(t) = k(\omega)\, I_o\, [R(t)]^{-2} \exp\,[-\beta(f)\, R(t)] \qquad (5)$$

where I_o is the emitted intensity and k(ω) is a parameter which describes the angular dependence of the radiated power (ω is the angle between the direction of motion of the EV and the receiver). While the EV was on E. Lugonia Avenue, the angle ω is a constant and equal to zero, so that k (0) = constant for $0 \leq t \leq 24$. The distance-dependent factors on the right side of Equation (5) were computed as a function of time, using β(700 Hz) = 0.045 db/100 feet, appropriate for the fundamental carrier wave propagating in air with 40% relative humidity and at a temperature of 72 °F (evening air conditions in Redlands on July 12, 1969). The results of the computation are shown in the upper panel of Figure 4 by the dotted curve. The distribution has been normalized to the maximum intensity perceived which occurs at the point of closest approach of the EV to the Church. Simple inspection of Figure 4 shows that the agreement between the measured distribution and the distribution computed using this simple model is excellent. It should be mentioned that the computed distribution is nearly independent of the exponential loss term (at f = 780 Hz) over the distances involved, and that the inverse square factor dominates the distribution.

The relatively weak intensity perceived when the EV was directed north on Orange Street precludes a detailed analysis of the type above. But, since it required several seconds for the EV to become acoustically shielded from the Church after reaching the corner, an estimate of the siren anisotropy can be made from the data in Figure 4. From the immediate drop in intensity near the point of zero Doppler shift, it is estimated that k(0) = 0.25 k(90), (i.e. a person listening to the siren from the side perceives about one fourth the intensity perceived by a listener head on).

Thus it has been shown that the frequency distribution recorded at the Church is an accurate record of the motion of the EV (since the geometric path of the EV is known) and that the propagation model expressed by Equation (5) correctly predicts the intensity distribution recorded at the Church when R(t) is derived from the Doppler distribution. In the next section, this same model is applied to the distributions recorded on the Vigh tape.

Analysis of the Vigh Tape Background Sound

As in the case of the rerun analysis, the carrier frequency distribution on the Vigh tape will first be assumed to be a Doppler distribution arising from a source constrained to move along the E. Lugonia Avenue–Orange Street path. To convert this assumed Doppler distribution into a velocity distribution for the EV, it is necessary to specify the average carrier frequency emitted by the EV siren. Since it is impossible to retrodict this frequency for February 4, 1968, some value must be assumed. The most probable frequency can be inferred from the following considerations. The spread of frequencies measured is 120 Hz, corresponding to a net change in radial velocity of 140 mph. Since the maximum ground speed of the EV is reported by the EV operator to have been less than 70 mph, it is reasonable to conclude that the emitted frequency was midway in the range of perceived frequencies. The flat region in the frequency distribution extending from 29 to 38 seconds occurs at a frequency of 662 Hz, or approximately mid-range. The stationary character of the carrier frequency at this value could then naturally be interpreted as the interval when the EV turned north on Orange Street. Making the assignment of 662 Hz for the average EV carrier frequency emitted, analytic expressions for the acceleration, velocity, and distance from the Church as a function of time can be deduced from the Doppler profile. For the first 29 seconds, the source moved on E. Lugonia Avenue directly toward the Church. As in the rerun analysis, the EV ground speed and the radial velocity $u_{rad}(t)$ of Equation (1) were equated. The calculation of the radial velocity of the EV moving along Orange Street as seen from the Bethel Church is somewhat more complicated. Referring again to Figure 4, define S(t) as the distance of the source north of E. Lugonia Avenue. Since the ground speed of the source at time t is u(t), then the radial velocity of the EV, $u_{rad}(t)$, can be expressed by:

$$u_{rad}(t) = u(t)\,\mathrm{Sin}(\theta) \qquad (6)$$

$$S(t) = \int_o^t u(t)\,dt \qquad (7)$$

$$\mathrm{Tan}(\theta) = S(t) / 660 \qquad (8)$$

The distance of the EV from the Church, R(t), is given by

$$R(t) = S(t) / \mathrm{Sin}(\theta) \qquad (9)$$

Assuming that the observed frequencies of the unidentified sound are Doppler shifts from the assumed carrier frequency of 662 HZ, and using

TABLE 1
EV Motion Scenario Based on Model Fit of Observed Doppler Shift

Time Interval (seconds)	Kinetic Parameter
0 to 19	u = constant = 54.5 mph = 80 ft/sec
19 to 30	a = constant = −7.0 ft/sec^2
30 to 56	a = constant = +5.2 ft/sec^2
56 to 90	u = constant = 92.2 mph = 135 ft/sec

Equations (l), (6), (7), and (8), the observed carrier frequency distribution of the unidentified sound could be reproduced for an EV motion according to the following scenario listed in Table 1.

According to this scenario, the sound source approached the Church along E. Lugonia Avenue with a constant ground speed of 54.5 mph and maintained this speed 19 seconds after perception. At 19 seconds the source began slowing with a *constant* deceleration of −7.0 feet/sec^2, or about 1/5 of the earth's gravitational pull. This magnitude deceleration is certainly reasonable for a motor vehicle. (In comparison, during the rerun the approach speed was 55 mph and the deceleration increased linearly with time reaching a maximum deceleration of −6.5 feet/sec^2). At 30 seconds, the source began to accelerate northward on Orange Street with constant acceleration of 5.2 feet/sec^2, again a very reasonable value. Fifty-six seconds after perception, the ground speed of the source reached 92.2 mph and was maintained there for at least another 20 seconds.

Figure 5 is a replication of Figure 2 (without the measurement error bars) showing model results for the EV motion scenario of Table 1. The Doppler frequency distribution generated at the Church by a source emitting 662 Hz and moving with this scenario is shown by the dashed curve in the lower panel of Figure 5. The solid curve gives the measured frequency distribution and is well-fitted by Doppler frequency time distribution for the assumed EV motion scenario of Table 1. Using the kinetic parameters for this scenario, the distance of the source from the Church, R(t), can be found. Insertion of R(t) into Equation (5) then gives the intensity distribution predicted at the Church for this scenario, shown as dashed curves in the upper panel of Figure 5. The calculated maximum intensity was arbitrarily equated to the maximum-recorded intensity. Two calculated intensity distributions are shown in Figure 5 for the source moving north on Orange Street, differing only by assuming in one case that the source is isotropic, and assuming in

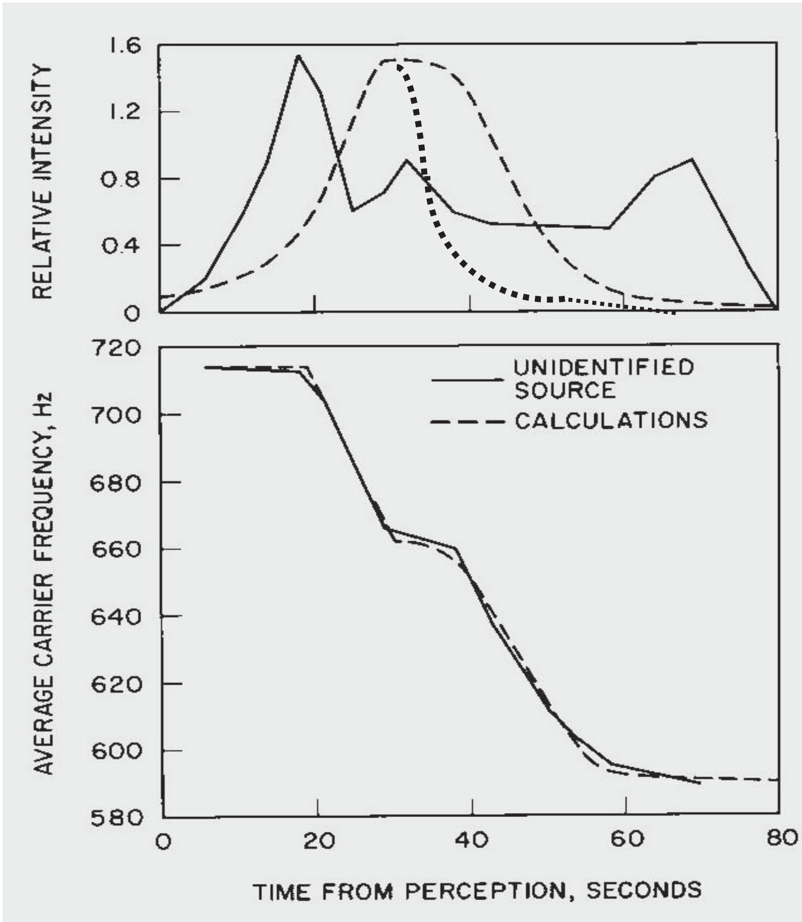

Figure 5. Measured intensity and average carrier frequency distributions of the unidentified source, and modeled intensity and Doppler carrier frequency distributions.

the second case that the source is anisotropic with k(90) = 0.25 k(0). These dashed curves are to be compared with the measured distribution shown by the solid curve. The predicted distributions do not take into account any acoustic shielding of the siren from the Church while it traveled north on Orange Street.

The gross dissimilarity of the measured and computed intensity distributions is striking, even during the time the EV was moving on E. Lugonia Avenue, for which the model expressed by ***Equation (5)*** *is highly* *accurate*, as verified by the EV rerun data analysis. The computed peak intensity occurs 30 seconds after perception, or 11 seconds after the measured peak intensity. The relatively strong intensity peak measured 69 seconds after perception is clearly anomalous; it is about 20 times too intense for an isotropic source and about 100 times too intense for an anisotropic source like the EV siren. The inclusion of acoustic shielding in the calculation would render the anomaly even worse. *These anomalies are well outside the limits of experimental error*, but before rejecting the propagation model, other kinetic scenarios should be examined. Because the siren carrier frequency for the evening of February 4, 1968, is not known a priori, the scenario discussed above is not unique. However, since it is known that the EV moved along the E. Lugonia Avenue–Orange Street geometric path, the possible number of scenarios is greatly limited. In particular, any successful scenario must predict the maximum intensity to occur at the instant of zero Doppler shift; this is because the radial velocity is zero at the point of closest approach for the E. Lugonia Avenue–Orange Street path. Inspection of Figure 5 shows that this requirement is met only if the emitted carrier frequency is assigned the value of 714 Hz. But this assignment implies that the EV approached the corner of E. Lugonia Avenue and Orange Street at virtually zero ground speed, and then accelerated rapidly to a ground speed of 140 mph. Even granting the unlikelihood of such a high ground speed (and disagreement with the EV operator's recollection of an EV top ground speed of ~70 mph), detailed calculations show that this scenario fails to account for the measured intensities beyond the first peak with even larger discrepancies than noted for the scenario based on a carrier frequency of 662 Hz. And so it is with all assignments of emitted carrier frequency for the evening of February 4, 1968. In view of this result, the validity of the assumptions implicit in Equation (5) must be examined. In particular:

1. The assumptions of constant intensity and/or constant average carrier frequency for the siren on February 4, 1968, are invalid (while being valid for July 12, 1969).

2. The acoustic environment on February 4, 1968, was radically different from that of July 12, 1969.

To assess these possibilities, first assume that the average carrier frequency emitted by the siren was very unstable during the 80 seconds of interest, but that the siren emitted a constant intensity. Under these conditions the frequency distribution recorded at the Bethel Church cannot be interpreted as a pure Doppler distribution reflecting the kinetic motion of the EV. Nonetheless, on the basis of the rerun recording, one would expect an intensity distribution with a single peak (with several plateaus possible) and lasting not longer than about 40 seconds. Thus, a pure frequency instability cannot account for the observed intensity anomaly. Next assume that the siren emitted a constant average carrier frequency but varied in emitted intensity. The frequency distribution can be interpreted as a pure Doppler distribution representing the kinetic motion of the EV. To compute the intensity distribution at the Church, one would have to know not only R(t) from the Doppler distribution, but the function $I_o = I_o(t)$ representing the time variation of the emitted intensity. In principle, any intensity distribution could be generated at the Church by such a source. On the basis of the treatment of the constant intensity source, the range of emitted intensities from the source to account for the observed intensity distribution would have to be about 50:1. It is very doubtful that the siren was that unstable on the basis of the performance of the siren on July 12, 1969, and on the (subjective) recollection of a member of the rescue team. In the case of both frequency and intensity instability, any intensity distribution could be generated but the same range of emitted intensities is required (50:1) to account for the observed distribution. Thus, within the known limits of the variability of the properties of the EV siren, and with the same level of confidence supporting the conclusion that the EV siren generated the sound recorded on the Vigh tape, *the model expressed by Equation (5) is inadequate with respect to factors other than siren stability.*

Analysis of the Rerun Field Recordings

In the interest of fully documenting the rerun, tape recorders were placed at two sites in Redlands where witnesses of the February 4, 1968, event perceived intense warbling sounds. One of the recorders was placed in the home of a witness at 1140 Columbia Street. His house is located 1800 feet from the corner of E. Lugonia Avenue and Orange Street, one and a half blocks south of W. Lugonia Avenue and three blocks west of the Church (five blocks west of Orange Street).

The terrain between the witness house and all positions taken by the EV siren is filled with wood frame houses and with trees; there was no unobstructed ground path between the two. The tape recorded at this location during the rerun failed to register *any* sound from the passing siren, and the witness who was present during the rerun perceived no sound from the EV siren. From the analysis of the rerun recording made at the Bethel Church, it was established that the EV siren is heard under normal conditions only at distances of 2300 feet or less (when the siren is facing the receiver and in open terrain). A simple computation shows that the maximum intensity expected at the Columbia Street location is about 0.2 of the maximum intensity at the Church (assuming open terrain). In actuality, the propagation of sound to the Columbia Street location is subject to substantial acoustic losses (houses and trees) not incurred by sound waves propagating to the Bethel Church, and the expected maximum intensity on Columbia Street is well below the threshold for perception.

The other field tape recorder was located at the intersection of Texas Street and Pioneer Avenue, 4200 feet northwest of the Bethel Church. Pioneer Avenue runs east/west and intersects Orange Street 3800 feet north of W. Lugonia Avenue. The corner of Texas Street and Pioneer Avenue lies 2500 feet west of Orange Street. The terrain between the recorder and the EV path is mixed, with some houses and trees and some open spaces. When the corresponding distances and siren orientations are examined for this location, it is concluded that the siren sound would be below the threshold for perception. And so it was, the tape recording of the rerun picking up no sound from the passing EV siren.

These unexpected null results are quite puzzling if the sounds heard by the witnesses on February 4, 1968, were indeed produced by the EV siren. One must conclude that some factor or factors associated with the EV siren and/or the acoustic environment were greatly different on February 4, 1968, and on July 12, 1969. Accepting that the EV siren was the source responsible for the reported sounds, the null results might be explained on the basis of some anomalous propagation effect, such as one arising from an atmospheric temperature inversion or a surface wind gradient.

Anomalous Atmospheric Propagation

The Redlands weather characteristics for February 4, 1968, were recorded at nearby Norton Air Force Base. Temperature/altitude data were not recorded at Norton AFB; the nearest source for such data is the U.S. Weather Bureau at Los Angeles International Airport, located some 70 miles west of Redlands. These data show that a moderate temperature inversion existed in the Los Angeles area on the morning of February 4, 1968, with a positive gradient of 2 °C per 100 feet, and with a temperature maximum at 380 feet. Such inversions are quite typical of the area just before sunrise and just after sunset, particularly on clear days like that of February 4, 1968. Thus, there is every possibility that just such an inversion was present in the environs of Redlands in the early evening of February 4, 1968. However, ascent balloon data taken the morning of July 12, 1969, also reveal a temperature inversion of 1 °C per 100 feet and a maximum temperature at 540 feet. As a general rule, temperature inversions tend to be less severe in summer than winter and this appears to be the case for the two days in question. If such an inversion was present in Redlands on July 12, 1969, the propagation model expressed by Equation (5) still was adequate to account for its effect, and one can assume this propagation model is also adequate to account for its effect on February 4, 1968.

The speed of sound is also a function of the temperature of the propagating medium, so that various portions of a spherical wavefront travel at different speeds in a medium with a thermal gradient. If the wave is propagating in a medium with a *linear* thermal gradient, a ray normally follows the arc of a circle. The temperature inversion data recorded at Los Angeles Airport for February 4, 1968, showed a thermal gradient of 2.5 °C per 100 feet and a temperature maximum of 17.5 °C at 300 feet. The temperature gradient above 300 feet follows the normal adiabatic lapse rate of −0.2 C per 100 feet. This overall temperature profile should approximate those encountered in Redlands during the winter. Such a positive thermal gradient below 300 feet causes all surface emitted rays at an angle less than the critical angle of 9.3 degrees to bend back toward the surface. A ray emitted at the critical angle just grazes the level of maximum temperature and returns to the surface at the maximum range, R_{max}. For the critical angle of 9.3 degrees, R_{max} = 7200 feet. Rays emitted at angles greater than the critical angle are not trapped below the 300 foot level and curve away from the surface, creating a sound shadow.

Thus, such a temperature inversion limits the horizontal range for perception of a source, and also results in an increase in the intensity of the sound at any point not in the shadow region over the sound intensity, which would have been generated at that point in the absence of the temperature inversion. Simple calculation shows that the maximum distance for perception of the siren with such a temperature inversion present is increased by a factor of 1.4 over the maximum range in the absence of the inversion. Assuming the no-inversion maximum range of 2300 feet found from the rerun analysis, the new maximum range for perception becomes R_{max} = 3220 feet. Even with this extended range, the estimated intensities produced at the two Redlands field locations are still well below the threshold for perception. It is interesting to note that the presence of a temperature inversion causes the sound to approach the receiver at ground level from slightly above, but never at an angle greater than the critical angle, here 9.3 degrees.

These simple computations show that while the temperature inversion that was most likely present on February 4, 1968, in Redlands could alter the intensities of perceived sound somewhat, its presence is essentially irrelevant in contributing to the cause(s) giving rise to the large intensity and frequency distribution anomalies discussed here. A detailed analysis of the effects of wind gradients on sound propagation was also carried out; it showed that the existing wind gradients were too small to have resulted in any appreciable propagation anomaly. Thus, one must assume that *the acoustic environment on February 4, 1968, was radically different from that of July 12, 1969*.

Summary and Conclusions

The unidentified sound on the Vigh tape and the whelp sound produced by the EV siren have been analyzed in detail with respect to average carrier frequency, amplitude modulation rate, frequency modulation rate, frequency modulation bandwidth, and overtone content. It was determined that these characteristics of the siren are not strictly invariant but vary between fairly well-defined limits in both the long term and short term. It was also determined that the wave train of the unidentified sound could be characterized by the same qualities with values that fall within the limits of variability characteristic of the EV siren. *It is therefore concluded with virtual certainty that the EV siren operating in the whelp mode was the acoustic source generating the sound recorded on the Vigh tape.* Given this conclusion and the knowledge of the course followed by the EV, it was anticipated that the intensity and frequency distributions on the Vigh tape could be simply correlated with the kinetic motion of the EV. This expectation was *not* fulfilled; it was found that no scenario of EV motion along the Lugonia/Orange path would account for the recorded distributions. To investigate this anomaly and to check the validity of the acoustic propagation model being used, the EV was put through a rerun simulating the events of February 4, 1968. The intensity and frequency distributions recorded at the Bethel Christian Church during the rerun were readily accounted for using the same model, which failed to account for the distributions on the Vigh tape. To compound the anomaly, no sound from the siren was perceived or recorded during the rerun at the two locations where witnesses claimed intense acoustic experiences on February 4, 1968. An attempt was made to resolve the anomaly by appeal to atmospheric propagation phenomena. Using the best available data for specifying the temperature inversion and wind gradients most likely present in Redlands on February 4, 1968, it was shown that neither effect was sufficiently large to account for the observed anomalies. One is left with the conclusion that the acoustic environment present in Redlands on February 4, 1968, was greatly different from that present on July 12, 1969, and that its description requires the inclusion of one or more time-dependent factors in Equation (5). The physical origin of such factors cannot be inferred from the information extracted from the Vigh tape, but the available information implies that the sounds recorded on the Vigh tape propagated from source to microphone by multiple paths, some of which were time varying independent of the motion of the EV.

There is as yet un-retrieved information contained on the Vigh tape, which might provide some additional support for this speculation; but the limited instrumentation available in 1969 precluded its study. Specifically, the overtone intensity as a function of time should be measured and compared with the time distribution of intensity in the fundamental carrier. The loss coefficient, β, of Equation (5) for the spectral overtone near 2000 Hz is computed to be 0.5 db/100 ft for the Redlands conditions on February 4, 1968, or an order of magnitude greater than the coefficient for the fundamental carrier. Because of this difference, the Vigh tape recorded intensity of the overtone will depend strongly on the exponential factor in Equation (5) for the ranges of concern here, whereas the intensity of the fundamental carrier will be essentially independent of this factor. If the total energy of the sound recorded at Bethel Christian Church is the sum of energies reaching the microphone by two or more paths, one of which is changing rapidly in time essentially independent of the EV motion, then the time-dependent partial contributions should show up in a comparison of fundamental and overtone intensity distributions.

Given the intensity and closeness of the multiple witness sightings at Redlands, and the existence of some physical evidence in the form of the Vigh tape recording, it is disappointing that a more intensive investigation into these sightings was not undertaken by and discussed in the UFO Condon Report of 1969, as pointed out by James E. McDonald (McDonald 1968) in his Redlands UFO testimony to the U.S. Congress in 1968. While the present investigation of the Vigh tape recording concurs with Professor Seff's conclusion "that the sound heard was that of the emergency rescue vehicle" (Story 1980), it also identifies significant sonic anomalies proving that the unidentified sound recorded on the Vigh tape cannot be attributed to the sound from the EV siren propagating directly along Lugonia Avenue to the Vigh tape recorder. According to the Story account of the Redlands UFO sightings,

> the unidentified object apparently came down just west of Columbia Street and north of Colton Avenue, then proceeded slowly in a northwestern direction for about a mile or less, at an altitude of about 300 feet. Coming to a stop, it hovered briefly, jerked forward, hovered again, then shot straight up with a burst of speed. . . . The object seemed (if at 300 feet altitude) to be around 50 feet in diameter. (Story 1990)

Note that this close approach of the unidentified object is in the immediate neighborhood of the witness at 1140 Columbia Street and only some 1800 feet from Bethel Christian Church. Though highly speculative, a large, solid, possibly metallic, disc 50 feet in diameter, situated some 300 feet above Columbia Street just south of W. Lugonia Avenue might have served as an effective sound reflector/scatterer in the acoustic environment on February 4, 1968, contributing to the frequency and intensity anomalies identified on the Vigh tape recording, and possibly causing some witnesses to report that the intense unusual sounds they heard were coming from the unidentified object.

The Redlands UFO sighting is, from one viewpoint, just one of many such reports that have been recorded by both official government projects and by civilian UFO groups. An unknown object was sighted low overhead by a large number of witnesses. It didn't land or cause any unusual effects on equipment or people, and it left after a short time in view.

Of course, there are differences from other such events. For one, it was investigated rapidly, competently, and thoroughly by a group of college professors, an exceedingly uncommon situation. As a result, this report was such a good exemplar of why UFOs are not so easily explained that James McDonald used it extensively in his testimony to the U.S. House of Representatives "Symposium on Unidentified Flying Objects." And, there was the recorded sound, now thoroughly studied in this article.

The case also importantly allows us to emphasize several key points about the UFO phenomenon and its investigation that are worth remembering. First, UFO reports can be investigated scientifically, with only witness testimony at hand. The University of Redlands team of professors did so with the witness reports and drawings, and even then had concluded that the intriguing sound came from the emergency vehicle. And when we are fortunate to have physical evidence, as in the Reverend Vigh recording, science can be methodically applied, as has been done here. UFO reports, even today, still elicit chuckles and derision, with UFO evidence often disparaged as "nothing but" witness testimony, as if this was some fatal flaw.

Second, witnesses to something substantial usually agree closely and are reasonably accurate in their testimony about the key details of an experience. Sure, they were confused about the sound and whether it was that unusual or connected to the UFO sighting, but even during an exciting, once-in-a-lifetime event of seeing a UFO, witnesses were consistent enough on the appearance of the UFO and the description of the sound that it was clear they were describing the same phenomenon.

Finally, and astounding to only those unfamiliar with the methods of the Air Force's Project Blue Book, the Redlands UFO was classified as "probable aircraft" by the project. This was based on the flimsiest of evidence, the key piece being that a single-engine propeller aircraft had landed at 7:15 p.m. at the nearby Tri-City Airport. The fact that the plane had landed before the sighting began and that its path of approach never brought it closer than six miles to Redlands, or that a small plane doesn't have the complex set of lights reported, didn't trouble the Blue Book investigators. In late 1968, J. Allen Hynek wrote a long letter to Colonel Raymond S. Sleeper of the Air Force, reflecting on the Air Force's UFO investigation and where it had failed, and then what could be a way forward for the study of UFOs. The letter is included as Appendix 4 in Hynek's seminal book *The UFO Experience*. It should be read completely by all those who want to fully understand why UFOs were not investigated honestly and scientifically by the government. With regard to Redlands, Hynek lists all the errors of reasoning and analysis made by Project Blue Book, with this to say about the University of Redlands team:

> Finally . . . [Blue Book] assumed that the professors involved had not the intelligence to recognize for themselves (having been over the ground and having 'reenacted the crime' so to speak), the possibility of the witnesses having misinterpreted a plane in a landing pattern, and have been individually wrong on the time, the place, the motion, the brightness, and the number of lights. And, over and above this is another tacit assumption, however politely hidden, that not only the witnesses but the professors were demented or incompetent, for only under such an assumption could one seriously advance the evaluation of "probable aircraft." (Hynek 1977)

That's straight talk from the leading scientist in the history of the field, and affirms the unidentified nature of the Redlands sighting.

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