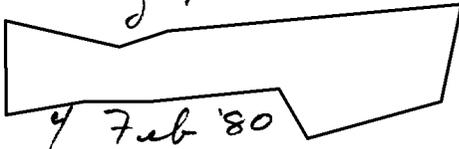SG1A

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Final Report

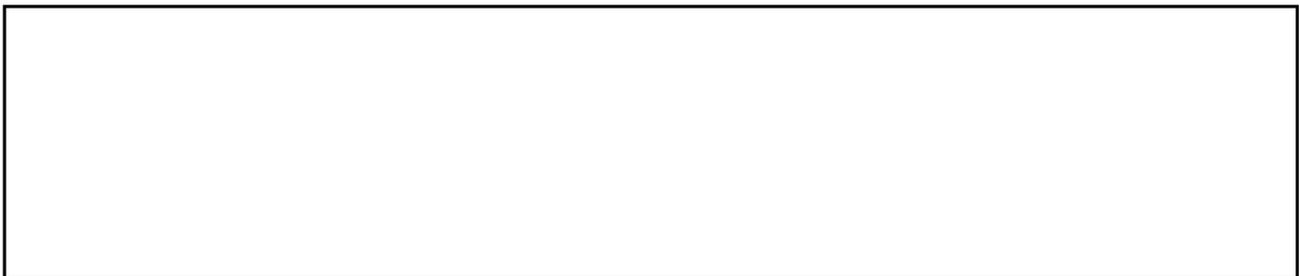# NOVEL BIOPHYSICAL INFORMATION TRANSFER MECHANISMS (NBIT)(U)

January 14, 1976

Document No. [ ]

SG1A

Contract No. XG-4208(54-20)75S

SG1A

AIRESEARCH MANUFACTURING COMPANY OF CALIFORNIA
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Final Report

NOVEL BIOPHYSICAL INFORMATION TRANSFER MECHANISMS (NBIT)(U)

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CONTENTS

SECTION 1

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SECTION 1

ABSTRACT (U)

(S) This report presents the results of a review of Soviet research on the biophysics of parapsychological processes. The reviewers centered their attention on novel biophysical information transfer (NBIT) mechanisms. The body of the report treats Soviet application of statistical theories, research done on electrostatics, the development of remote sensors, hypothesized carrier mechanisms, human sensitivity to magnetic fields, and performance training to improve NBIT. Speculations are made with respect to Soviet research organization and as to the direction of future R&D. Conclusions are drawn concerning Soviet progress in understanding and applying NBIT mechanisms.

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SECTION 2

SECTION 2

INTRODUCTION, OVERVIEW, AND CONCLUSIONS (U)

INTRODUCTION

(S) This document presents the results of a study effort conducted under
Contract No. XG-4208(54-20)75S. The purpose of the study was to review
Soviet research literature concerning the biophysical aspects of parapsychology.
The body of this report presents salient features of the study. It is assumed
that the readers have a background understanding of parapsychology. In
addition, it is assumed that the reader also is familiar with the questions
posed by physical, physiological, biological, psychological, and mathematical
approaches to this topic. A distillation of the relevant background material
can be obtained from a review of this field presented in Biophysical Aspects
of Parapsychology, AiResearch Report No. 75-11096, January 20, 1975, which
was prepared in response to the RFP for this study. The technical team
utilized in this study and their disciplines are listed below:

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>
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OVERVIEW

(S) The great bulk of the papers reviewed during this study were found to be
speculative, unscientific, and sensationalistic, much like the parapsychological
literature of the West. There is one big difference, however, between this
type of literature in the U.S.S.R and the U.S. The Soviet literature almost
invariably shows interest in the physical and physiological mechanisms. An
example is the interest in psychoenergetics, bioplasma, and psychotronics.
The term psychotronics was coined by a French journalist after the analogy
with electronics, bionics, nucleonics, and others. The Czechs have adopted
the term to replace parapsychology. The Russians have devised their own
term--psychoenergetics. These new names were chosen to give the field of
study an air of scientific or technological respectability.

(S) A fundamental question remains: does the name imply a basic difference
in the approach and, if so, what effects can be expected from it? Judging
from the available literature, the name does imply a difference in the

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(S) approach of the Russian and Czech investigators from that of most Western parapsychologists. Some of the differences are outlined below.

(1) The Russians do not undertake studies like those of J.B. Rhine, in which remote card reading or other simple telepathic tasks are carried out repeatedly to gather statistical evidence. The Russians assume the reality of thought transference. Their best experiments are designed to elucidate the physical basis of these novel biophysical information transfer (NBIT) mechanisms.

(2) Many of the Russian researchers that publish in open literature in this field pursue their studies on their own time and at their own personal expense. They lack the resources to carry out well designed or long statistical studies.

(3) Many Westerners remain convinced that parapsychology will never be explained in terms of physics. They cling to an undertone of a religious-like belief in transcendent mechanisms. The Russians, in contrast, reject such an approach; being doctrinaire materialists, everything has a physical, scientific explanation. Again, this line of reasoning reinforces the trend toward eliciting the physical mechanisms of NBIT.

(4) The Soviets would not hesitate to use secrecy or deception to try to gain even a small military or political advantage. This desire to gain a small advantage would undoubtedly lead them to try to develop NBIT means of communication if they assumed that it was technically feasible. Such attempts would obviously be cloaked in secrecy and camouflaged by false information.

(S) In reviewing Soviet and Western work on NBIT phenomena, it seems reasonable that serious interdisciplinary research and development is being carried on. Furthermore, there seems to be veridical indication that the Soviets have organized laboratories for just such programs. The work of these laboratories, is obviously secret. On the other hand, it is obvious that many Russian workers in this field pursue their research as extracurricular activity, with little or no funding. Thus, there are hints of secret work as well as indication that parapsychological research may be in disfavor. It may be that high quality, systematic research is officially approved, well-funded, and well-organized, whereas research in this field from "nonofficial" laboratories may be allowed to founder without funds, thus providing a smoke screen of poor quality work. If the Soviets did indeed establish laboratories for a systematic approach to this problem, in our opinion they are certainly capable of making good progress.

(S) The literature surveyed varies widely in degree of sophistication. Most experimental papers give rather vague descriptions and insufficient data to assess the accuracy and importance of claimed results. Upon completion of the review, we found the bulk of what was considered to be creditable work centers around the activities of three principal individuals--Kogan, Adamenko, and Sergeyev.

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(S) Of the theoretical papers, those by Kogan are undoubtedly the best and reflect the good thinking of an experienced physicist. Using physically acceptable arguments, Kogan demonstrates the possibility that ELF and VLF carrier waves might be part of NBIT mechanisms, and initiates an information theory approach to the study of NBIT. His ideas are much like those of Persinger and strike a resonant chord for all members of the team.

(S) The papers by Adamenko, on the other hand, are spotty with respect to knowledge of modern physics and physiology. He utilizes a number of poorly defined and unquantifiable concepts such as "bioplasma," "psi energy," etc. Nevertheless, significant contributions are made by him--particularly his study and explanation of telekinesis in terms of electrostatics.

(S) The papers by Sergeyev show the effectiveness of a radar signature expert turned to analyzing electrophysiological events. He shows some interesting new possibilities, taking into account that the noise in the signals not only contain statistical random variations, but that the carriers also may have non-stationary drifts. His work also seems to suffer from the lack of an interdisciplinary approach. Furthermore, he is probably responsible for the development of at least one and perhaps two remote physiological sensors.

CONCLUSIONS

(S) From the review of essentially open Soviet literature, the following conclusions are made:

(1) The Soviets have done significant work on signal extraction, statistical, and information theory approaches to novel biophysical information transfer mechanisms.

(2) The Soviets have done creditable work on the electrostatics of telekinesis and have probably now turned their attention to the psychophysiological aspects of the phenomenon.

(3) The Soviets have an interest in remote physiological monitors, have developed one or two new instruments, and are probably involved in R&D in this area.

(4) The Soviets had and probably still have an interest in the physics of NBIT transmission mechanisms and are probably doing research in this area.

(5) There is a developing interest in the Soviet Bloc to apply psycho-physiological training methods (similar to biofeedback) to develop control over NBIT mechanisms.

(6) All the Soviet research that has been reviewed suffers from the lack of an interdisciplinary approach.

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(S) (7) The Soviets are investigating the psychophysiology of multimodal, programmed stimulation as a method to entrain physiological rhythms and produce changes in states of consciousness.

       (8) A systematic, interdisciplinary approach to NBIT by the Soviets would require only a modest commitment of resources. A small number of key personnel with an adequate supporting staff of engineers and technicians could make substantial headway in this area. At this stage, in our opinion no unique technological breakthrough is required--only careful investigation. In addition, no unique features such as physical plant, facilities, services, or equipment would specifically identify an NBIT R&D laboratory from other types of laboratories.

(S) These conclusions are drawn in spite of the fact that most of the published material we have reviewed is confusing, inaccurate, and of little value from a scientific point of view. In this respect, the review team may have erred in the direction of trying to make too much sense from a small data base. The following sections of the report provide a critical review of Soviet research, by topic, in support of these conclusions.

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SECTION 3

APPLICATION OF STATISTICAL THEORIES TO NOVEL BIOPHYSICAL INFORMATION TRANSFER (NBIT) MECHANISMS (S)

RUSSIAN APPROACH

(U) In the field of theoretical statistics, the Russians are usually considered to be ahead of the Western countries. Kolmogorov and his contemporaries did a considerable amount of work in the 1920 to 1945 era, developed many new theories, and applied them to some classical problems, such as Kolmogorov's theory of isotropic turbulence. Directly before and during World War II, Rice, Shannon, and others in the West developed more advanced ideas that are now embedded within information theory and communication theory. However, the Soviets have been the first to apply these ideas and techniques to the field of parapsychology. I. M. Kogan seems to have been the leader in this venture and the papers that we have by him are good in that he demonstrates a knowledge of these advanced fields, correctly applies the techniques, and reaches some justifiable and creditable conclusions. Kogan seems to have started working on these ideas in the early 60's. Ryzl (Reference 3-1)* states that the Bio-information Section of the Scientific Technical Society of Radiotechnique and Electrocommunication was founded in 1965 and that Kogan was its first director, indicating that Kogan's ideas were viewed favorably at that time. Ryzl further reports that the Bioinformation Section seemed to flourish under Kogan. It organized meetings, seminars, and discussions; he embarked upon a publicity campaign in newspapers and magazines and was concerned with the use of para-psychology as a military weapon. Kogan also headed the section as it under-took some successful experiments involving transmission of images over short ranges.

(S) Kogan seems to have been at his peak when he visited the United States in 1969 and gave a presentation at U.C.L.A. on the application of information theory to the problem of telepathy. That paper (Reference 3-2) summarized his work and represents the most advanced work on this topic by anyone. Then publication of his work inexplicably stopped. Judging from the papers that we have, no one else in the U.S.S.R. has reported this line of endeavor.

(S) Although this work may have been completely stopped, it hardly seems likely. Considering that Kogan had successfully started to apply these new concepts to parapsychology and had obtained some new information, it is more plausible that this work did not abruptly stop, but is continuing secretly. Ryzl (Reference 3-1) indirectly lends credance to this idea by discussing the military work done at Kogan's institute.

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*References are presented at the end of this section.

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(S) It is significant that the Soviets pursued the application of non-stationary analysis to parapsychology, especially in the study of EEG signals. Sergeyev (References 3-3 and 3-4) has been the leader in this effort; he has used both correlation functions and spectral analysis. Under the more common assumption of stationarity, these statistical quantities are independent of time. Since parapsychological events are quite intermittent and occur rather randomly, their statistical functions, such as correlation, spectra, etc., may vary dramatically in time.

(U) Sergeyev thus defines a nonstationary auto-correlation function as:

$$R(t,\tau) = \frac{1}{T} \int_{t}^{t+T} [X(S) - \bar{X}(S)][X(S + \tau) - \bar{X}(S + \tau)] \, dS$$

where X is the stochastic variable, $\bar{X}$ is the average value of X (presumably over time T), τ is a time delay, and T is the averaging time. He does not specify the averaging time T, but T must be of the same order of magnitude as the time scale of the event being studied.

(U) Since $R(t,\tau)$ is a function of the time delay τ, Sergeyev suggests characterizing this correlation function by several time scales, which he defines as:

$$\tau^{(n)}(t) = \int_{0}^{T} \left| R(t,\tau) \right|^{n} \, d\tau.$$

Thus, $\tau^{(n)}$ are random functions of time and Sergeyev claims that $\tau^{(1)}/\tau^{(2)}$ is a measure of the nonlinear modulation by the stimuli received through extra-sensory channels. He does not justify nor substantiate this conclusion.

(S) Sergeyev has applied this type of analysis in at least two different modes. First, he compares the ratio $\tau^{(1)}/\tau^{(2)}$ from a "bioplasmagram" to that obtained from signals external to the body, such as the fluctuations in the earth's magnetic field (Reference 3-4). He claims to have obtained a well-defined relation between these two signals; however, the data shown in his paper do not support the statement that is given in the text. In spite of this discrepancy, Sergeyev's ideas are sound and in view of the intermittent nature of parapsychological phenomena, it seems reasonable to explore nonstationary analysis of the recorded data. Ryzl (1968) speaks highly of these new mathematical methods and goes on to say that Sergeyev can detect an incoming telepathic stimulus by analyzing EEG records.

(S) Secondly, Sergeyev (Reference 3-3) has applied these ideas in studying changes in the "bioplasmagram" during emotional stress. He used digital analysis and retained the high-frequency content (i.e., up to 30 kHz) of the EEG. It is obvious after studying the data in his previous paper (Reference 3-4) that he also retained the high-frequency content there as well. Although it is not obvious what type of information is obtained in these higher frequencies,

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(S) Sergeyev does believe that they are important in the dynamic functioning of the brain, it is conceivable that frequencies higher than the normal beta wave frequency may be present and would be instructive to study.

(S) Also, if a very low frequency (VLF) carrier wave is important in the parapsychological communication channel, a study of these frequencies would be beneficial.

SEQUENTIAL ANALYSIS

(U) Sequential analysis is a technique for analyzing data that are transmitted over a noisy channel. It was developed at about the same time that the foundations of communication theory and information theory were being laid and is described in the classical book by Wald (Reference 3-5). Since this technique has been used by Ryzl (Referernce 3-6), a brief description of the method is given, followed by a discussion of Ryzl's application.

(U) Quite often communication channels are very noisy, which decreases the reliability of the channel. Thus, a common problem is to attempt to improve the reliability by coding techniques. This is often accomplished by sending redundant information. For example, assuming a message consists of a set of binary bits, each bit may be sent several times instead of just once. The average number of times that a bit is sent will depend upon the signal-to-noise ratio of the channel. Thus, one wishes to maximize the reliability of the channel while minimizing the redundancy.

(U) Sequential analysis is one technique that will minimize the redundancy under a given set of conditions. This technique allows a bit of information to be sent continually until it is received. The amount of redundancy (e.g., the number of times a bit is sent) is a random variable and cannot be determined in advance. Thus, some additional information must be available in order to decide when to terminate transmission of that bit and proceed to send the next bit. It is the nature of this additional information that determines if sequential analysis can be used and how successful it will be.

(U) In practice, there are two different types of problems in which sequential analysis has been quite useful. The first utilizes an additional communication channel. This method assumes a nonpassive sender that continues to send a bit until instructed to proceed to the next one. The additional channel is utilized to send the instructions to the sender. In this case the sender is an active element in the transmission process in that he reacts to instructions sent over the second channel. Since there are two communication channels involved, sequential analysis is useful under these circumstances only if there are significant differences between the channels. Satellite communications is one example of this method where one channel is very weak and the other quite strong. If the channels were equal in quality and direction, only one would be required, assuming that it had sufficient capacity.

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(U) The second use of sequential analysis utilizes some additional information embedded within a predetermined probability distribution. With this additional knowledge, the receiver can decide with a predetermined probability when the correct bit has been received and then proceed on to the next bit. This presupposes that the message is fixed and available for viewing or reading at the will of the receiver; that is, the sender is completely passive and may have no knowledge that someone is attempting to read his message. This technique has been used in radar analysis to determine if a target is present in a given sector. The data received from that sector are continually sampled and compared with existing information. After the receiver has gathered sufficient data, he makes a decision and takes appropriate action, such as moving to another sector. A similar method is used in sampling products on an assembly line for quality control.

(U) Ryzl (Reference 3-6) has attempted to use the techniques from sequential analysis in order to explore the functioning of an extrasensory perception channel. The message he attempted to send was a three-digit number that was coded in binary. The binary representation was a unique sequence of ten white and green cards. The procedure was to select a three digit number at random, determine its equivalent representation in a binary base (0,1), and then use green cards to represent 1 and white cards to represent 0. To ensure that there was no color preference of the subject, a reverse color coding was used in a separate set of ten cards. Another set of ten index cards chosen completely at random was used as an exploratory device to determine apriori if an extrasensory perception channel was functioning. A total of 30 green and white cards were thus selected and hidden from normal sensory perception channels by enclosing them in opaque envelopes. These envelopes were then presented at random to the subject, S.P., who attempted to determine if the enclosed card was green or white. The envelopes were then reshuffled and this procedure was repeated 50 times.

(U) Ryzl first analyzed the results from the ten index cards. If he found clear evidence of an extrasensory perception channel existing, he proceeded to analyze the remaining 20 cards that had the encoded number. He does not state what criteria he used to determine if an extrasensory perception channel was operative or not. One can only assume that the subject must have scored relatively high in determining the colors of the initial index cards before the remainder of the cards was analyzed. It may be possible that the technique used to determine whether or not to proceed may have influenced his final results. Without further details, it is impossible to estimate this effect.

(S) The remaining 20 encoded cards were then analyzed according to criteria that are clearly specified in Ryzl's paper. In the terms of modern mathematical statistical theories, these criteria define a decision boundary. From the text of the paper, it is not clear how his decision boundary was determined. Ryzl fails to state whether the criteria were determined before any experiments were run, whether the criteria were determined after an initial set of experiments, or if the criteria were determined after an initial analysis of the data reported in his paper. It is well known in fields such as pattern recognition, decision theory, etc. that the conditions under which a decision boundary is determined are extremely important to the outcome of

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(S) the experiment. For example, given a set of data such as recorded by Ryzl, it is known that a decision boundary can be determined posteriori that will ensure a prescribed set of conclusions as long as those conclusions were arrived at by a unique process. Without this additional information, it is impossible to judge the quality of the results of Ryzl's experiments.

(S) Even if it is assumed that the decision boundaries were arrived at in a completely unbiased manner, the data presented by Ryzl do not agree with his stated boundary criteria. For example, the cards Aa and Cc do not indicate that they have crossed any of the stated decision boundaries (i.e., they do not satisfy the necessary conditions for making a decision as given by Ryzl). According to his criteria, it appears that he should have gone at least one more step in his sequential analysis and taken another set of data.

(S) As stated in his title, Ryzl seems to be offering this technique as a model of extrasensory perception. In actual fact, sequential analysis is not a model of any physical system, but merely offers a technique for analyzing messages and other information in the presence of noise. Its limitations in analyzing communication channels for extrasensory perception are even more restricted because of the requirement that additional information must be imposed upon the problem as discussed earlier. Thus, it is difficult to conceive why sequential analysis would be used in circumstances such as remote viewing if another channel is accessible to the viewer. That is, if conditions allowed two channels of communication as in Ryzl's experiment (such as an ESP and voice channel, say), then use of the voice channel exclusively would be preferable because of its higher efficiency. However, the method with feedback could be very useful in training subjects in extrasensory communications because it can provide immediate feedback of results to the receiver. Sequential analysis could be used in remote viewing in a "radar" context where the sender is completely passive and the receiver slowly scans the scene. In this case, an effort would have to be expended earlier in order to develop the underlying statistics necessary for determining the proper decision boundaries (i.e., the subject would require training to be able to determine when he had received a portion of the message and should proceed to the next).

(S) In terms of remote viewing as described by Puthoff and Targ (Reference 3-7), the methodology of sequential analysis can be a useful tool for both training and analyzing viewed results. In this context, the technique could initially be used as a means of analyzing data obtained in a training session. This would involve a sender at a site that was sending one item of information at a time (e.g., tree). After the receiver in the laboratory had made a decision, he could be informed of the correctness of his decision so that training would occur. The sender would then be instructed to proceed to the next item of the message. Simultaneously, a more mathematical version of this technique could possibly be tested by using some concepts from pattern recognition together with EEG signals. After a sufficient amount of data had been gathered in the training mode, this information would form the basis for making decisions in a mode with no active sender. Other than for use in a training mode, we fail to see how the ideas borrowed from sequential analysis by Puthoff and Targ can be applied to optimize the S/N ratio in remote viewing.

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POSSIBLE SOVIET DIRECTIONS

(S) It is purely speculative to guess what type of work the Russians are now doing in this area. Obviously, they have a great interest in para-psychology. Mutshall (Reference 3-8) says that they have opened seven new laboratories to study these phenomena since 1960. Kogan had just started to apply information theory to these problems and seems to have developed this technique to the point of usefulness before publication of his work ceased. Although information theory cannot explain the physical mechanism of the NBIT communication channel, it is a very useful tool to analyze the data quantitatively. Kogan had already used this to yield new information (e.g., the information rate dropped as distance traversed increased). More advances from this avenue of approach can be expected, such as (1) qualifying the information to be transferred, (2) designing experiments more amenable to analysis, and (3) studying coding and encoding techniques.

(S) Sergeyev's published work suggests that he is possibly continuing his study of nonstationary analysis of NBIT phenomena. In particular, it seems strange that he did not publish or even mention the use of his techniques for cross-correlations or cross-spectra. Since he almost always was comparing two different signals (EEG and the earth's magnetic field), a nonstationary analysis of the cross-correlation between these signals seems more appropriate than the single channel analysis he published.

(S) It also could be expected that Sergeyev has pursued nonlinear analysis and modeling of NBIT events. He reported (Reference 3-4) that he found a modulation of the EEG at a frequency f_1-f_2 when lights were flashing at frequencies f_1 and f_2. If only linear mechanisms were involved, there would be no energy or modulation of the spectra at a frequency of f_1-f_2, thus suggesting that nonlinear mechanisms may be responsible for this behavior. This phenomenon should be verified and explained, if possible.

(S) The Soviets should have a vested interest in remote viewing, which interestingly is never mentioned in the available literature. Based upon the experience of Puthoff and Targ (Reference 3-9), it is not too difficult to set up an experiment in this area, and it seems reasonable to assume that the Russians have probably successfully done so. The next step is obviously to improve the efficiency of the transmission process. Here, the ideas from information and communication theory become important tools because they can be used to determine the amount of information transferred, and thus represent a quantitative measure of success or failure. This tool can then be used to measure the effect of different variables such as distance (which Kogan has already done), directivity, shielding, and the type of information transferred. Mutshall says Kogan has studied this also. It is more reasonable to assume that this work has continued than that it was terminated at this level of development.

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SECTION 4

ELECTROSTATICS OF TELEKINESIS (S)

(U) According to the published reports, there are several investigations of telekinesis (i.e., moving material objects without touching them) that have occurred at various times and places in Communist Bloc countries. In work done in Leningrad by Vasil'yev and his associates, Mrs. Nina Kulagina (also called Nelja Mihailova) exhibited remarkable psychokinetic ability. Benson Herbert, Milan Ryzl, Zdenek Rejdak, and Viktor Adamenko, among others, have discussed or commented on Mrs. Kulagina'a feats. In Moscow, Adamenko worked with another subject, Alla Vinogradova, who is more skilled in telekinesis than Nina Kulagina. Benson Herbert and others also have reported some of the work of Julius Krmessky of Bratislava, who moves hanging mobiles. As tele-kinetic subjects, the women seem to be superior to the men: Vinogradova and Kulagina are said to be able to move objects on a table top weighing as much as 100 gm.

(S) Viktor Adamenko has advanced an explanation for observed phenomena of telekinesis that is more interesting psychologically than physically. In the article "Some Problems of Biological Electrodynamics and Psychoenergetics", he theorizes that the physical force causing the objects to move is due to static electric charges on the objects and electrical fields generated by the subject. It can be shown (as discussed subsequently) that electrostatic forces can indeed be strong enough to produce some of the effects reported. Anyone living in dry climates is quite familiar with electrostatic forces: static electricity discharges from the finger when one walks across the room to the light switch, and articles of clothing stick together and crackle with corona discharge when removed from the gas clothes drier.

(S) Dr. Adamenko's descriptions of the observed phenomena are easier to deal with than his theoretical expositions. An example is his article in The A.R.E. Journal, Vol. viii, No. 2, pp. 76 to 77, March 1973, cited on page 4 of the Annotated Bibliography of Selective Psychoenergetic Activites, July 1973. In the work with Ms. Vinogradova and others in Moscow, Adamenko used a dielectric cube, 50 cm on an edge, as a table. Various small objects were placed on the upper surface of the cube. Ms. Vinogradova was able to induce an electric charge on the cube, after which she could then move small objects on its sur-face. With biofeedback training, other subjects were able to duplicate Vinogradova's feats. There must have been some effect that reduced the coefficient of friction between the moved object and the cube, since Adamenko writes at some length about the reduced friction and theorizes that the electric field of the cube polarizes the air molecules and reduces their number of degrees of freedom from six to two. In addition, Adamenko states that the field is inhomogeneous and produces a net flow of the air molecules, which tends to buoy up the objects on the cube. Elsewhere he states that the electric field is as great as 10,000 v/cm. This value is approximately the maximum electric field that can exist in dry air because of corona discharge and ionization of the air molecules at higher field strengths. The explanation of air molecules providing the buoyant force to overcome sliding friction is necessary because

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(S) electrostatic forces alone could not, in the situation described by Adamenko, levitate objects weighing more than a gram or so, and because the coefficient of sliding friction is in the range 0.1 to 0.3 for nonlubricated surfaces.

(U) The concept of a conductor at ground potential near a charged dielectric surface as the mechanism for generating an electric field whose direction and magnitude can be altered is illustrated in simplified form in the Figures 4-1 and 4-2. In Figure 4-1, a plane conducting surface is placed parallel to the dielectric. The resulting electric field is uniform and normal to the two parallel surfaces. If the extent of each surface is much larger than the distance between them, the field is not changed by moving the plates closer together or farther apart. In Figure 4-2, the plates are not parallel. In this case, the electric field is nonuniform and has a component parallel to the dielectric slab.
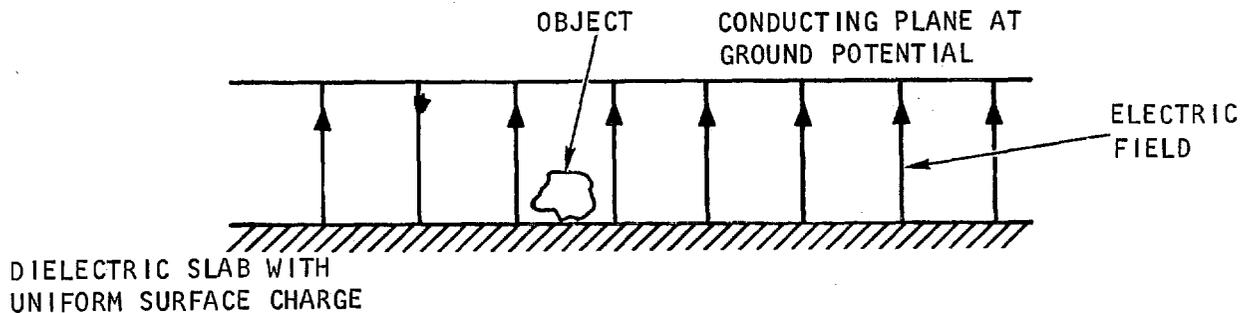

Figure 4-1. Electric Field Between Parallel Plates
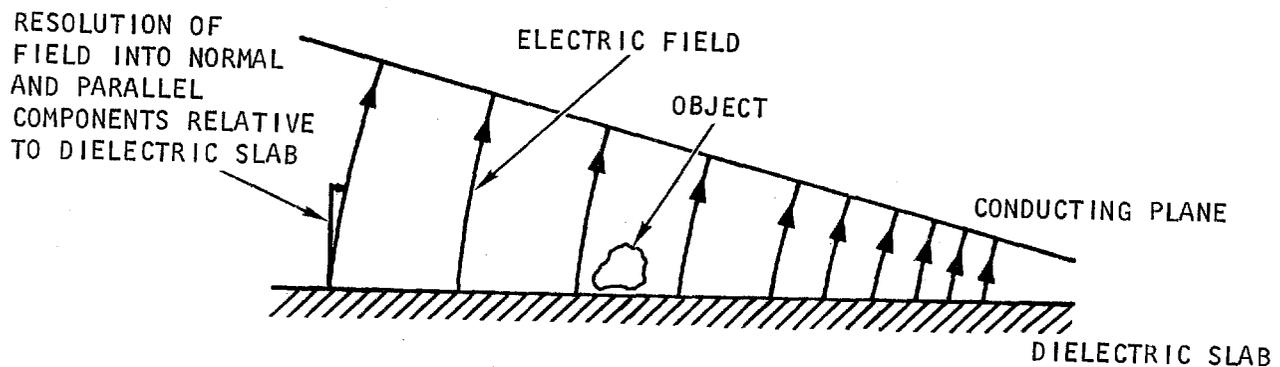(Title, U; Figure, U)

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Figure 4-2. Electric Field Between Non-parallel Plates
(Title, U: Figure, U)

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(U)   In the case illustrated in Figure 4-1, the object experiences no force
parallel to the surface of the slab. In the case shown in Figure 4-2, the
electric field is not normal to the slab. Hence, if the object has an
electrostatic charge, it will experience a force that tends to move it
parallel to the plate, either toward or away from the region of closest
approach between the dielectric slab and the conducting plate. It will
experience a force in the same direction, but weaker if the effect is due to
polarization of the object rather than an unbalanced charge.

(U)   The human body is a conductor. According to Adamenko, the conductivity
can be varied at will to affect the field. He does not try to explain in detail
the physiological mechanism involved. Even with constant conductivity, the
human subject can vary the field near the dielectric surface by positioning
his (her) body, arms, hands, etc.

(U)   There are two possible mechanisms whereby a small object on the dielectric
surface can be moved by the electric field--particularly a nonuniform field.
The first mechanism is that the small object is itself electrostatically charged.
The second is that it is electrically neutral but can be polarized. An electric
dipole in a nonuniform electric field experiences a force in the direction of
the field.

(S)   The work reported by Viktor Adamenko on telekinesis appears to be genuine
information and not disinformation. The experimental arrangement he describes
can be analyzed on the basis of electrostatic theory, with predicted results
in substantial agreement with the results reported. Adamenko's theoretical
explanation appears to be a mish-mash of classical electrostatics and para-
psychology. It appears probable that Adamenko himself is a believer in the
psi field because he tries to incorporate it into his theoretical framework.

(S)   In terms of application to the transmission of intelligence, the telekinetic
work of Adamenko does not seem to lead anywhere. However, it does point up the
ability of certain individuals to develop an ability to influence the ambient
electrical field, apparently by volitional control over physical and physiological
processes (e.g., electrical conductivity of the skin). In addition, we must
not overlook the possibility that the psychophysiology of this phenomena may have
relevance to NBIT transducer mechanisms.

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SECTION 5

REMOTE PHYSIOLOGICAL SENSORS (S)

(S) A remote sensor is an instrument for measuring a physiological response
of the human body without the use of electrodes or other means of contacting
the body. In the literature reviewed, there are references to one or more
remarkable remote sensors developed by Dr. Gennadij Aleksandrovic Sergeyev.*
It is claimed that one of these instruments will measure the electro-
encephalogram of a person at a distance of 5 m. The instrument is classified
and no credible description of it is available--only allusion to its existence.
One must keep in mind that there is reason to doubt the Russian claim. If the
instrument is to register the EEG, it must remotely sense the electromagnetic
field associated with the EEG potentials. These potentials are typically of
the order of tens of microvolts. American investigators have measured EEG
signals with electrodes placed a few centimeters from the head. These electrodes
sensed the electric field generated by the brain. David Cohen (Science,
Vol. 161, pp. 784 to 786) has measured the magnetic field associated with the
EEG by means of a search coil several centimeters from the head. At larger
distances from the head, the electric and magnetic EEG fields become drowned
in noise. The following discussion is a speculative attempt to guess the
operating principles of the instrument.

(S) It is possible that a sensitive electric or magnetic sensor, or some
combination of the two, would detect electrical signals from a human body at
a distance of 5m. Although it is unlikely that the output of such an instru-
ment would be a direct measure of the EEG, it would provide information of
interest to a police interrogator, such as the strength and rate of the heart
beat, the tensing and relaxation of muscles, the depth and rate of breathing,
and perhaps the electrical properties of the skin. The uses to which the
instrument would be put are reasons enough for official secrecy about its
operating principles. Moreover, the story that a remote sensor is a remote
EEG sensor would be a natural way of trying to hide the real purpose of
Dr. Sergeyev's invention. Some support to the speculation that the invention
is a remote lie detector is provided by the statement in the Ostrander and
Schroeder book (Psychic Discoveries behind the Iron Curtain, Prentice-Hall,
1970 p. 20) that Sergeyev is a mathematician at the Uktomskij Laboratory run
by the Soviet military.

(S) In reviewing the available literature, five references have been found that
may help shed some light on the Sergeyev invention(s). First, Ostrander and
Schroeder (Psychic Discoveries, pp. 73 to 74) report Sergeyev's assertion that
Nina Kulagina, who reportedly exhibits remarkable telekinetic ability,
generates a pulsating magnetic field whose amplitude is not much weaker than
the magnetic field of the earth, according to measurements made with his remote
sensor. Second, the reporter Anatolij Kongro, writing in the journal Znanije-
Sila, discusses work by Sergeyev and his students in measuring emotional states

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*Sergeyev also referenced as Sergeev in the literature.

(S) of a subject by a remote sensor. No description of the instrument is given in the article. Third, in an article entitled "Detection of Telekinesis by Semiconductors," there is a description of a remote sensor. The sensor consists of a metal disc suspended in a vessel of water. The disc is coated with a semiconductor and appears to be electrically connected to an EEG recorder. The patient is connected to the other (ground) input of the recorder.

(S) The fourth reference, a paper entitled "The Method of Registration and Statistical Processing of the Bioplasmogram" by Sergeyev, Shushkov,* and Griasnuhin, contains the intriguing statement that the sensitivity of the bioplasmagram detectors is increased by placing them in water. A doubling of the output is claimed. Although it is claimed that these detectors respond to electromagnetic radiation, this reviewer is unfamiliar with any simple detector whose sensitivity would be enhanced by immersing it in water, except possibly a proton resonance detector for the magnetic field. A small acoustic detector (such as a hydrophone) consisting of a piezoelectric or magneto-strictive material with appropriate electrical connections might exhibit greater sensitivities to sound when immersed in water. The greater sensitivity would be achieved because of the improved match of acoustic impedances between water and detector as compared with the poor match between air and detector. In addition, the physical size and shape of the water container might provide a larger sensitive area for detecting sound than the detector alone.

(S) A speculative conclusion from the previously cited literature, together with the known fact that Sergeyev is a mathematician who has published articles on the application of information theory to parapsychology (see, for example, G.A. Sergeyev, "Some Methodological Problems of Parapsychology" in the journal Telepatie a Jasnovidnost, Prague, 1970, pp. 79 to 87) is that the Sergeyev remote sensor does exist and is an instrument for measuring electric and magnetic fields generated by a human subject at a distance of a few meters. Because of background noise, sophisticated analysis of the signal generated by the instrument is required to extract useful information. The instrument is probably a research tool and apparently has been used with some success on subjects that generate strong electric or magnetic fields (e.g., Nina Kulagina). The coated disc in a vessel of water is probably mostly a Russian fairy tale if we discount the possibility of an acoustic sensor; however, the mention of water suggests that possibly magnetic fields are detected with a proton resonance magnetometer. Certainly water would be a poor medium for detecting electric fields because of its high dielectric constant. The instrument probably comprises several sets of electric and magnetic field detectors arranged such that the noise due to extraneous fields can be reduced by signal extraction techniques.

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*Also referenced as Suskov in the literature.

(S) In the fifth reference, an article entitled "A New Detector for
Registering the Physiological Functions of the Organism", by G. A. Sergeyev,
G.D. Shushkov, and E. G Griasnuhin, a set of noncontacting electrodes used
to measure changes in the dielectric properties of the patient is dis-
cribed. It may well be that this instrument is completely different from
the Sergeyev remote sensor. On the other hand, these noncontacting
electrodes may, in fact, be the Sergeyev sensor and the other published
information may be a complete fabrication. If it is assumed that the des-
cribed sensor is different from the Sergeyev remote sensor, it can be concluded
that the instrument comprises noncontacting electrodes arranged electrically
to sense small changes in the dielectric constant of the human body. The
electrodes are silver, probably formed by depositing silver on plates of
barium titanate. They are built into a rubber covering that insulates them
electrically from the body and holds them in a fixed geometric configura-
tion with respect to a portion of the body. The two terminals of a high-
voltage supply (e.g., a battery) are connected to the two silver electrodes,
with a large resistance in series with one electrode. A change in the
dielectric constant of the body causes a change in the capacitance between
the electrodes. The resulting flow of charge either to or from the
electrodes produces a measurable potential difference across the resistance.
This potential difference is amplified and constitutes the output of the
instrument.

(U) The resistance or other details of the signal conditioning and amplifying
system are not explicitly mentioned in the article. Instead, the theory of
the instrument based on the bioplasma hypothesis is described, as is the
notion that there are maser effects in living organisms which lead to the
emission of free electrons and protons, and thereby to changes in the elec-
trical properties of the surrounding air. An analysis also is presented to
show that the observed signal is not due merely to the piezoelectric effect
in barium titanate.

(S) The fact that barium titanate is used to support the silver electrodes
is irrelevant to the operation of the sensor, but relevant to the evaluation
of the paucity of the report. It is likely that silver-plated barium titanate
slabs happened to be available to the investigators. Because of its piezo-
electric properties, barium titanate has a variety of uses in military
weapons and instruments, such as hydrophones for underwater sound detection
and shock-actuated detonators for explosive devices. As previously noted,
Sergeyev works in a military research and development laboratory where barium
titanate would be available. It has been previously reported that much of
the Russian parapsychological work to which we have access is done as an
avocation by the investigators without official support or sanction. In such
circumstances, the use of silver-plated barium titanate as an inexpensive
and available substitute for solid silver electrodes is understandable.

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(S) Other types of remote sensors mentioned in the available literature seem quite simple and conventional. For example, V. Puskin (Pushkin) wrote (in an article published in the Moscow journal Znanije-Sila, "Knowledge-Strength", No. 10, 1972, pp. 4 to 49, about a sensor used to demonstrate that the power shown by Alla Vinogradova to move objects without touching them was due to the electrostatic charges induced on the objects. The sensor in this case was a simple neon glow lamp. When the object was discharged by means of the neon lamp, it could no longer be moved.

(S) A broader question regarding remote sensors is to determine or predict types of sensors that logically would have been or would be developed in the course of following the indicated lines of investigation. Perhaps the Russians have, in fact, developed such instruments; perhaps they are going to do so. Perhaps they have tried and have not been successful. Possible sensor developments discussed in the following paragraphs are not meant to be exhaustive; rather, they are speculative and offered as examples of what may or might be.

(S) A tunable antenna for detecting low-frequency, very-low-frequency, or extremely-low-frequency electromagnetic radiation could be used. The Russians believe both in mental telepathy and in a prosaic physical mechanism for it. The most probable mechanism is electromagnetic radiation. A tunable antenna could be used in two types of experiment: trying to detect the radiation from the telepathic agent and trying to generate radiation of the right frequency to interfere with telepathic reception.

(S) A neutrino detector may be used. Both the Russian Je. Parnov (Nauka i Religija, No. 3, pp. 48 to 49, 1966) and the American Martin Ruderfer ("Neutrino Theory of Extrasensory Perception" in Abstracts: 1st International Conference on Psychotronics, Vol. 2, Prague, pp. 9 to 13, June 1973) have suggested neutrinos as the means of transmitting thought from one mind to another. One of the collaborators in the present study, J. Eerkens, has a plausible hypothesis about the production and detection of neutrinos that could be experimentally tested by relatively modest expenditures for equipment and labor.

(S) A magnetic field or field gradient detector could be used. The Russians and other Eastern Europeans are greatly interested in dowsing, or finding ground water. A currently popular theory of dowsing is that the human body is sensitive to small changes (temporal or spatial) in the magnetic field of the earth, such as might be produced by water near the surface of the ground. If the human body can generate as well as sense magnetic fields, such human magnetism might be the basis of some form of thought transference or psychokinesis. It is reported that Nina Kulagina warms up her psychokinetic powers by causing a compass needle to move (Ostrander and Schroeder, "Psychic Discoveries behind the Iron Curtain" p. 68) and Dr. Sergeyev claims that Kulagina generates a pulsating magnetic field not much weaker than the magnetic field of the earth (ibid., pp. 73 to 74), according to measurements made with his remote sensor.

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(S) A noncontacting temperature detector may be used. V. Adamenko and others have shown interest in the properties of human skin in three separate lines of investigation. First, Adamenko ascribes some electrostatic properties to the skin to support his theories about telekinesis. Second, he has developed a tobioscope for investigating the electrical properties of the acupuncture points on the skin. Third, he has written joint articles with the Kirlians about photographing the skin with the Kirlian apparatus. It seems natural that eventually he or other workers in Russia will be curious about other properties of skin, such as temperature. Two American investigators, Barrett and Myers, have recently reported a technique of subcutaneous temperature measurement by measuring microwave radiation from the skin (Science, Vol. 190, pp. 669 to 671, November 14 1975). One might expect the Russians to develop remote temperature monitors, either on their own or by copying the American techniques. Such a monitor would be a useful adjunct to a remote lie detector, and its development would probably be supported by the Military or the Secret Police.

(S) In addition to work on the development or application of remote sensors, one can expect the Russians to try to develop data processing equipment to handle the signals from an assembly of several sensors. In their published work, the Russians have shown interest in various types of correlation analysis. For example, G. A. Sergeyev has published a paper dealing with nonstationary random functions and their application to parapsychological phenomena (Telepatie a JasNovidnost, Prague, Czechoslovakia, 1970, pp. 79 to 87). It would be natural for Dr. Sergeyev or others to attempt to mechanize his methods of statistical analysis by a special-purpose electronic signal processor. The difficulty may be that the Russians are not very advanced in electronics and would hesitate to develop such a piece of equipment. Nevertheless, it would seem to be a logical next step.

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SECTION 6

SENSITIVITY OF HUMAN SUBJECTS TO MAGNETIC FIELDS (U)

(S) An interesting facet of the present study is the fascination of Russian and Czechoslovakian parapsychologists with the effects of magnetic fields on human beings, as well as the presumed ability of human subjects to generate magnetic fields. Presman (A.S. Presman, "Electromagnetic Signaling in Animate Nature", Moscow, 1974) presents a survey of the effects of weak magnetic and electric fields on living organisms, such as the ability of birds to use the earth's magnetic field as a cue in navigation. There is, in fact, a respectable body of experimental evidence in reports published both in Iron-Curtain countries and in the West on the effects of magnetic fields on the growth of plants, the orientation of simple animals, and the like. Presman is mainly interested in the possibility that electric and magnetic fields can be used by complex animals for information transfer. He theorizes that humans have largely lost this ability through evolutionary disuse following the development of speech, a much more efficient method of communication. Those few individuals who have the ability to communicate by electromagnetic signaling are, in Presman's view, evolutionary throwbacks.

(S) There is some evidence that human subjects can detect small changes in a magnetic field. Harvalik (Z.V. Harvalik, "A Biophysical Magnetometer-Gradiometer," Virginia Jour. Sci., Vol. 21, No. 2, 1970, pp. 59 to 60) reports that about 80 percent of subjects tested were sensitive to magnetic field changes in tests where the field was generated by an ac or dc current passing through damp ground. Harvalik, a Czech-American, proposes that dowsers are able to sense changes in the earth's magnetic field due to moisture in the ground. The sensing organs are the muscles of the forearms. The dowsing rod is an amplifying and indicating device for the slight twitching of the muscles responding to the changes in magnetic field strength. Native Czech writers also are fascinated with dowsing, as evidenced by reports by the following authors cited in the Annotated Bibliography prepared by Skaidrite Maliks Fallah: Boleslav and Boleslav, p. 13; Bradna, p. 14; Drbal and Rejdak, p. 19; and Kaderavek, p. 36. We have seen only the abstract of the Harvalik paper in the Annotated Bibliography. It appears that the paper presents actual experimental data. Actual data on the sensitivity of humans to weak magnetic fields are scarce, a situation that should be remedied by research.

(S) A related question to magnetic field sensitivity is the ability of a human subject to generate a detectable magnetic field. Adamenko alleges that a Russian psychic (Nina Kulagina) generates a pulsating magnetic field when she is demonstrating telekinesis. Belief in the existence of such an ability is speculative at present. However, the concept of volitional human generation of a magnetic field is consistent with present knowledge of physics and biology.

(S) It is worthwhile to conclude this brief discussion of human magnetism
with a review of some of the better known magnetic effects. With regard to
generating a field, the two known mechanisms are current loops and ferro-
magnets. It is known that the body generates circulating currents; pre-
sumably these currents can be enhanced and controlled volitionally by bio-
feedback training. Several effects are known that might be used by the
body to detect a magnetic field or field gradient; some of these are
outlined below:

> Hall Effect--An ion moving in a magnetic field experiences a force
> perpendicular to its direction of motion and perpendicular to the
> direction of the field. The resulting displacement of the moving
> ion creates an electric field in the direction of its displace-
> ment. The Hall Effect is sensitive to the magnitude and direction
> of the magnetic field and not particularly to the field gradient.

> Force on Magnetic Dipole--A molecule having a magnetic dipole
> moment tends to align itself parallel to a uniform magnetic
> field. Molecules having this property would act as tiny compass
> needles. A second effect is that a dipole experiences a net force
> in the direction of a field gradient. Thus, an assembly of such
> molecules would experience two forces in a magnetic field: a
> twist or torque tending to align them with the field and a tension
> tending to pull them in the direction of increasing field strength.

> Zeeman Effect--A magnetic field changes the energy separation of a
> group of closely related quantum levels in a molecule. Usually the
> effect is to remove the energy degeneracy of a set of quantum
> states. Such states have identical energies in the absence of a
> magnetic field. The splitting of energy levels could have subtle
> chemical effects, inasmuch as many metabolic processes involve
> small changes in the total energy of a given molecule. Certain
> chemical reactions could proceed in the presence of weak magnetic
> fields, with small Zeeman splitting, but would be inhibited or
> altered by large fields due to the increase in energy level
> separation among the affected quantum states.

(S) One would expect to see Soviet research dealing with biological,
physiological, or psychological interactions of these three effects if they
are systematically engaged in research on NBIT.

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SECTION 7

SECTION 7

BIOPHYSICAL INFORMATION CARRIER MECHANISMS (S)

(S) In several papers, I. M. Kogan reports experiments and hypotheses
concerning telepathic information, and describes information theory aspects
of the observed phenomenon; he developed rationale for transmission mechanisms.
Essentially, his thesis is that the energy required is about 10^{-8} to 10^{-20}
joules. He hypothesizes that the transfer of information is advanced by ultra-
long electromagnetic waves in the spherical waveguides formed by the surface
of the earth and the ionosphere. In our opinion, the work of I. M. Kogan is
creditable and the best thought out of any of the work reviewed.

(S) Observing that experienced physicists such as Kogan took serious notice
of parapsychology from 1966 to 1969 and that almost nothing profound has
appeared on the subject in the Soviet literature in the last 5 yr suggests
that further theoretical and experimental developments along the lines out-
lined by Kogan are continuing underground in the Soviet Union. Kogan posed
too many interesting and challenging questions for himself and his colleagues
not to have delved into them further. Based on the well-known predilection
of Soviet physicists to solve difficult and challenging problems and their
excellent training in modern physics, the possibility that a team of Soviet
physicists is at work to systematically uncover and learn the physical mecha-
nisms of parapsychological events is highly probable. Had Kogan not presented
such a clear and sound proposal 6 yr ago, one might have wondered if Soviet
physicists have any interest at all in novel biophysical information transfer
(NBIT) mechanisms. Clearly, if one could find out where Kogan is working
and what he is doing, this question would be answered.

(S) Assuming that the U.S.S.R. started a special NBIT program some time in
1970, by now they should have developed some sensitive instruments to detect,
monitor, and analyze VLF and ELF radiations for possible information content,
as Kogan suggested should be done. Also, they must have been instrumental
in developing sensors to monitor fluctuations in the human body's electric
and magnetic fields, and they may have a team of scientists studying the
properties of bio-organic molecules and their response to electromagnetic
ELF/VLF radiation. In fact, the suggested experiments given in Section 10
may well be much like what was proposed 5 yr ago by such a group. The Russians
may now be implementing the next logical step, namely to reinforce, enhance,
or aid NBIT in certain trained or gifted individuals after having discovered
the basic communication carriers.

(S) If experiments which generate special ELF/VLF waves are being conducted,
it may be possible to intercept and analyze them because they will travel
across the world. Thus, an opportunity may exist during the initial test
phase to do some elint work. However, as discussed subsequently, these man-
manipulated VLF and ELF frequencies may be very monochromatic and undetectable
by the usual relatively broad-band radio frequency detectors. For example,
it would be like finding the red emission line of a 1-mw Helium-Neon laser

(S) emitted from a satellite to the earth and observed against a background full of bright direct sunlight. With the proper narrow-band filter, such a line can be observed, of course, but the frequency must be known.

(S) It is rational to assume that the Soviets pursued the investigation of various physical methods that might serve as novel biophysical information transmission mechanisms. Whether or not ELF/VLF mechanisms explain para-psychological events may be a moot question if these mechanisms can be utilized for human information transfer. In order to (1) evaluate the credit-ability of the hypothesis, (2) evaluate where the Soviets might logically have gone in their work, and (3) display the type of thinking involved to know what information to seek in other fields, a short speculative study on the possible carrier mechanisms for novel biophysical information transmission (NBIT) was undertaken. A review of possible NBIT transmission mechanisms that are compat-ible with current modern physics yields three schemes.

> (1) Very-low frequency (VLF) and extremely-low frequency (ELF) electromagnetic waves
>
> (2) Neutrinos, based on the photon theory of neutrinos
>
> (3) Quantum-mechanical (Ψ) waves, based on the schizo-physical interpretation of basic QM theory

Presently, most U.S. and Soviet experiments on NBIT and the use of the law of parsimony would point to ELF/VLF mechanisms, but the other two possibilities cannot be ruled out. In this section, these three possibilities are briefly examined.

SPECULATION ON VLF AND ELF MECHANISMS

(S) In the VLF or ELF transmission scheme for NBIT it is hypothesized that atmosphere-produced naturally occurring ELF electromagnetic waves in the 3-to-300 Hz region (so-called "Schumann" waves) or in the 3000-to-30,000 Hz (VLF) region propagate over the surface of the earth and interfere with the natural frequencies (alpha and other bio-organic oscillations) in the human brain or directly with objects. This results in an interference pattern that is either an amplified signal (by stimulated emission) or a scattered wave pattern that contains the information that was present in the brain wave oscillations or object. The atmospheric ELF and VLF carrier wave spreads the interference pattern over the surface of the earth (in two dimensions), and certain gifted people can pick off the interference patterns and reconstruct the originals.

(S) In this scheme, it is vital to know whether a second human is necessary to convert the viewed object into transmittable and decodable (by the viewer) information or whether the interference patterns of entire scenes (buildings, forests, etc.) are directly decodable by an NBIT receiver.*

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*The hypothesized processes bear some resemblance to holography. However, the wavelengths are much larger than the objects, while in holography the opposite is true.

(S) Another important feature in ELF/VLF transmission may be that the carrier frequency is not constant, but randomly floating (within a certain range) so that it is difficult to pick off the information waves for subsequent decoding by an instrument, unless special receiving circuits are built that can instantaneously search for and detect the floating value of the carrier frequency. At any rate, the interference pattern probably will be highly nonlinear, and although radio-receiving techniques should be a guide, much thought must be given to the many possible ways in which information can be imparted to and retrieved from an ELF/VLF wave with a floating base frequency.

(S) Because the frequency is so very low for natural ELF waves, it is difficult to see how significant quantities of information can be transmitted by them.* However, the VLF wave frequencies are high enough that reasonable rates of transmission are conceivable.

(S) Instead of the scattering interference scheme proposed or alluded to by most parapsychological researchers, considerable stronger carrier-wave utilization results from carrier-wave amplification and modulation by stimulated emission in resonant bio-organic liquid crystals. The latter scheme is discussed in a subsequent part of this section.

(U) For naturally occuring reservoirs of VLF and ELF radiation, some portions of the ELF and VLF region can exist in mode patterns that are trapped by the spherical annular waveguide bounded by the earth's surface and ionosphere (References 7-1 through 7-6). The ELF modes are three-dimensional, annular, spherical groundwaves whose characteristic wavelength is the earth's circumference, while the VLF waves are TM_{no} and TE_{no} earth-curvature that follow ribbon-like modes with open sides whose characteristic wavelength is the altitude of the ionosphere. The two different types of standing wave modes that the ionosphere can support are illustrated in Figure 7-1.

(U) The lowest frequency waveguide resonance in the ELF region is at 7.8 Hz, or at a wavelength of 38,462 km, which is approximately equal to the earth's circumference. The next waveguide resonances for spherical annular modes are at 14.1 Hz (λ = 21277 km), 20.3 Hz (λ = 14,778 km), 26.4 Hz (λ = 11,364 km), and 32.5 Hz (λ = 9231 Km). They have been called the Schumann waves (Reference 7-1) after Schumann, who first calculated the eigenvalues of these spherical annular eigenmodes of trapped waveguide radiation (see Figure 7-2). Under solar activity, Schumann waves with 1 mv/m field strength (= 2.65×10^{-9} w/m^2) have been observed (References 7-1 and 7-2).

(U) The other type of eigenmodes that the earth's surface and ionosphere can capture and support in a near-resonant manner are similar to those that are propagated in microwave waveguides (References 7-7 through 7-9). They are ribbon-like and have open sides, much like the eigenmodes in a laser, except that reflections occur between the earth's surface and the ionosphere, and the wave travels around the earth instead of being a standing wave. Since TE_{no} modes are less attenuated by the ionosphere than TM_{no} modes, trapped VLF radiation (noise) is probably mostly polarized horizontally.

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*The maximum bit rate dB/dt is equal to twice the frequency: dB/dt = 2ν.

7-4
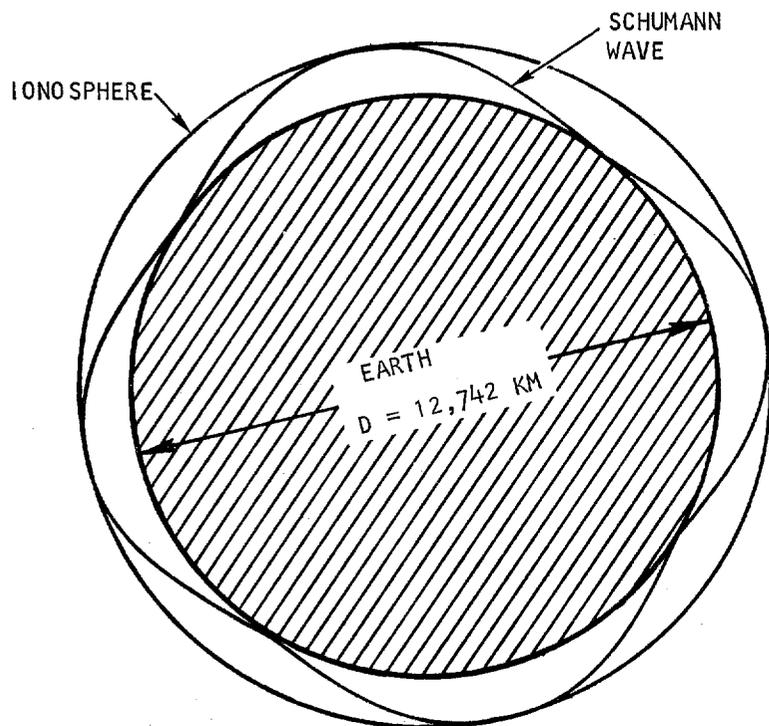
(a) THREE-DIMENSIONAL SPHERICAL
ANNULAR GROUND-WAVE MODE
AT 14.1 Hz IN THE ELF REGION
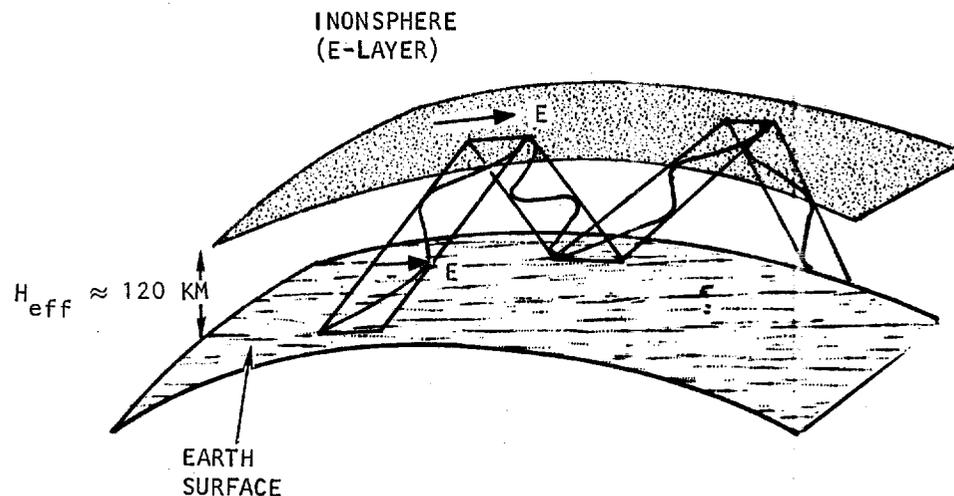
(b) RIBBON-LIKE TE_{no}
TRAPPED MODE IN
THE VLF REGION

S-1942

Figure 7-1.   Illustration of Two Types of Ionosphere-Supported Trapped
Electromagnetic Wave Modes
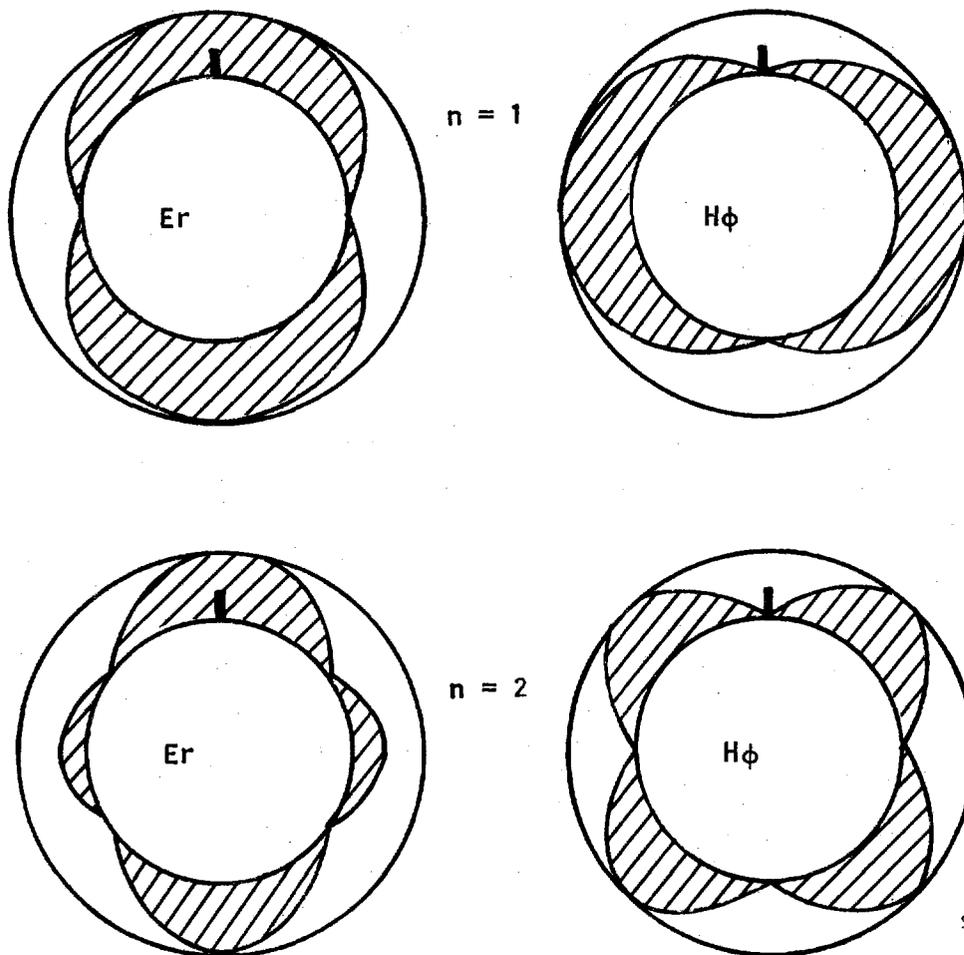
Figure 7-2.   Standing Waves of the Radial Electric and Horizontal Magnetic
Field in a Concentric Shell Cavity Excited by a Vertical
Electric Radiator at the Two Lowest Frequencies (after
Reference 7-2, p. 41). (These Waves are also Called
Schumann Waves.)

(U) The trapped frequencies with the strongest intensities in the VLF region
lie between 2000 and 20,000 Hz (References 7-1 through 7-7), or λ = 150 km and
λ = 15 km. Sharp increases in electron density in the ionosphere occur at
60-to-90 km (D-layer), 110-to-120 km (E-layer), and 200-to-350 km altitudes
(F-layer). The least attenuated, and thus most intense naturally trapped, VLF
radiation is found at 10,000 Hz ($\lambda \approx 30$ km), as shown in Figure 7-3, which
gives the observed pulse from a distant nuclear detonation.*

(S) The frequencies at which waveguide modes are least attenuated are
influenced by three factors: (1) the reflectivity of the waveguide boundaries
(which decreases with increasing frequency for the ionospheric layers),
(2) the low-frequency cutoff, which is the lowest frequency at which a fixed
waveguide geometry can support a given mode, and (3) the high-frequency mode
losses. For the spherical annular earth-ionosphere waveguide which gives rise
to the ELF resonant frequencies, a high-resolution spectrum is shown in Fig-
ure 7-4 (see Reference 7-2), while the measured VLF spectrum of ribbon modes
is shown in Figure 7-5.

(S) Since each waveguide mode has a minimum in its attenuation-versus-
frequency curve, the attenuation losses tend to suppress propagation at high
frequencies while at low frequencies the cutoff frequency prohibits support
of a propagating wave. Thus, an optimum frequency exists for each mode. If
a flat earth is assumed, the attenuation of mode TE_{no} (n = 1, 2, 3) for ribbon
modes is approximately given by Equation 7-1 (Reference 7-8).

$$\alpha = 1.088 \times 10^{-6} \, h_{(km)}^{-3/2} \left[\frac{n \left(\rho_{ion}^{1/2} \, \rho_{earth}^{1/2} \big/ \rho_{copper} \right)}{(f/f_c)^3 - (f/f_c)} \right]^{1/2}$$

$$\cdot \left[1 + \frac{h}{2w} \left(\frac{f}{f_c} \right)^2 \right] \, , \quad \frac{nepers}{km} \qquad\qquad (7-1)**$$

---

*Reference 7-2 calculates TM_{no} modes emitted from radio stations to be least
  attenuated at f = 18,000 Hz, if reflected by the D-layer at 70 km. Experi-
  ment gives 10,000 Hz for peak radiation, however.
**1 neper/km = 1 e-fold/km = $\dfrac{10}{\ln(10)}$ = 4.3433 db/km.

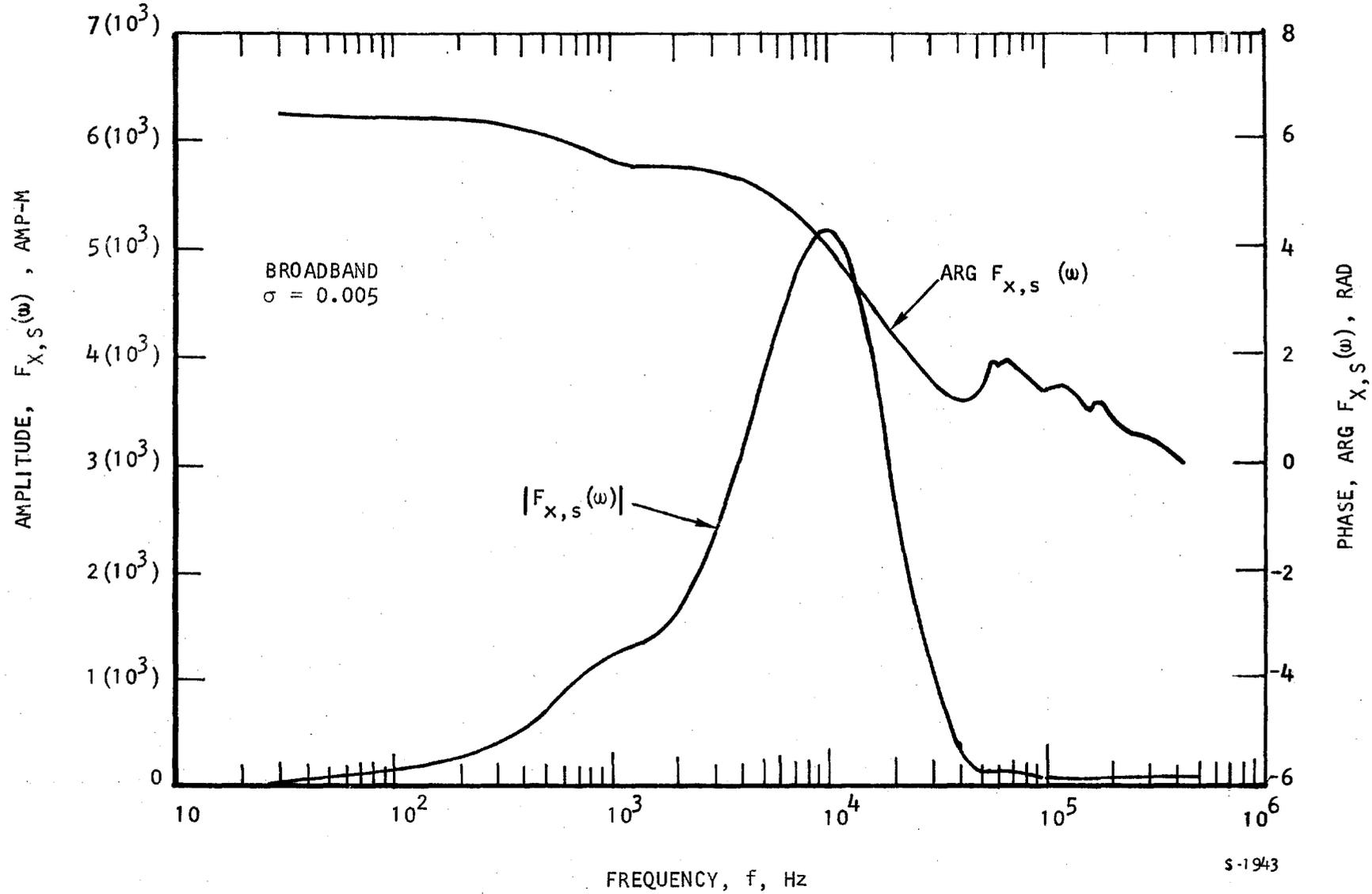Figure 7-3. Observed Pulse Waveform of a Distant Nuclear Detonation
(After Reference 7-6)
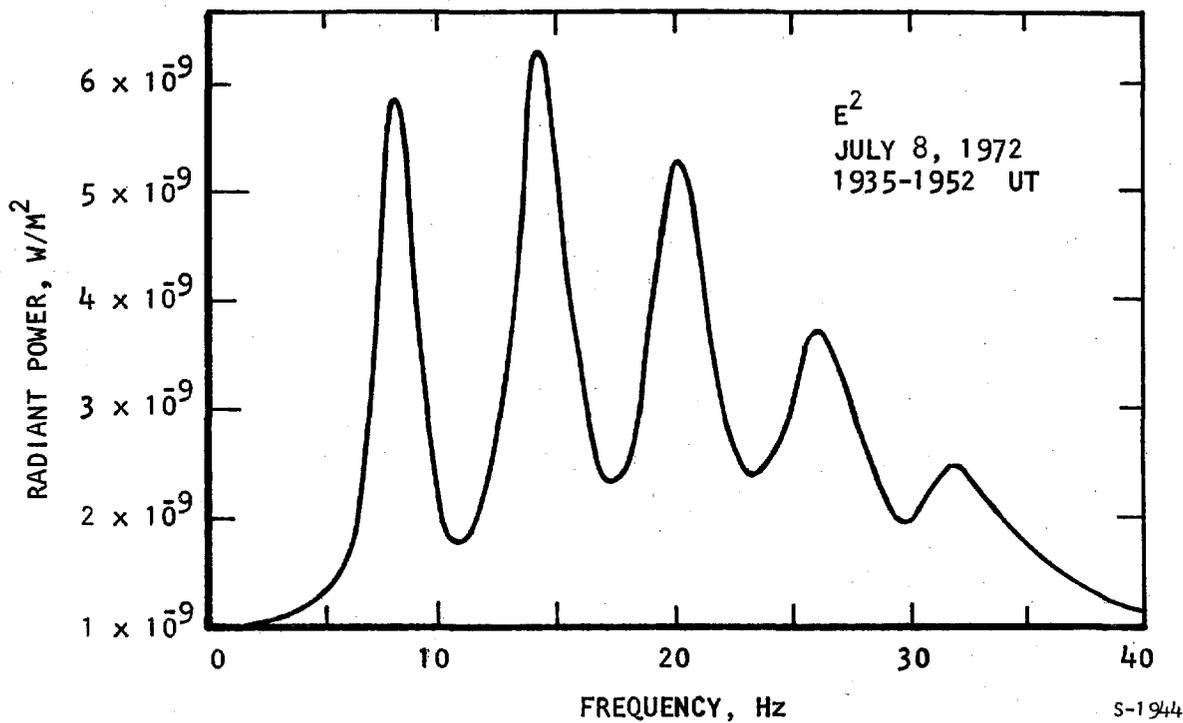
Figure 7-4. High-Resolution Measurement of Schumann-Wave Radiation Near Kingston, R.I. (After Reference 7-2, p. 40).

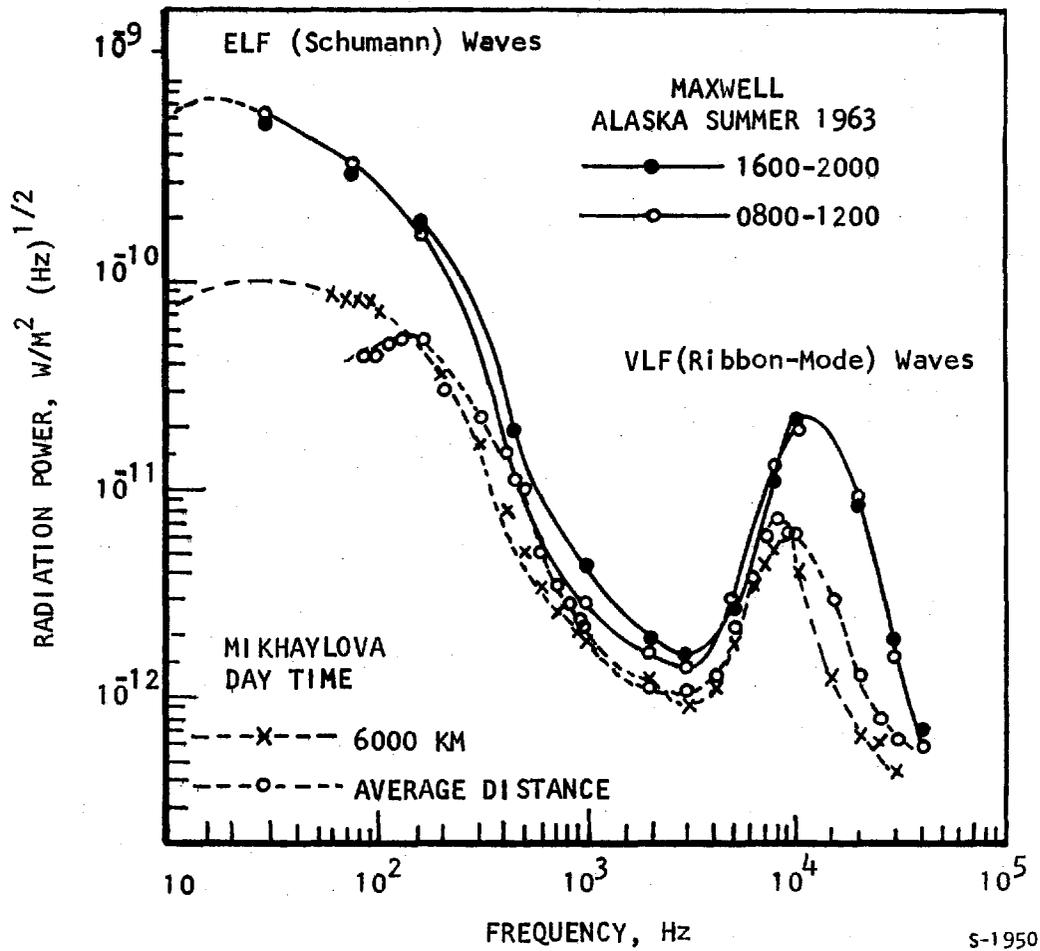Figure 7-5. Measured Atmospheric "Noise" in the ELF and VLF
Regions (After Reference 7-2, p. 42).

where h is the effective height of the waveguide, n is the mode number, $\rho_{ion}^{1/2} \rho_{earth}^{1/2} / \rho_{copper}$ is the effective resistivity ratio of the ionosphere/earth and that of copper, f is the frequency of interest, and f_c is the cutoff frequency given by:

$$f_{c(TE_{no})} = n \left(\frac{150,000}{h_{(km)}} \right) , \quad Hz \tag{7-2}$$

(S) The parameter w is the width of the waveguide, or since the sides of the ribbon-mode waveguide are open, the width of the source radiation. For thermal earth radiation from land masses or other random sources, a probability distribution of widths may be assumed, given by $p = \exp-(w/L_E)^2$, where L_E is the flatness scale of the land and is estimated to vary from $L_E = 0.01$ km for mountainous terrain to $L_E = 100$ km for flat deserts. The probability averaged expression for α is then still given by Equation 7-1, with w given by:

$$w_{(land)} = \bar{w} = L_E \sqrt{\pi} \tag{7-3a}$$

Over the oceans on the other hand, w can be quite large. It might appear that $w = \infty$ could be assumed, but this cannot be correct physically because the curvature of the ionosphere and earth put a limit on how wide a strip of earth might still be considered flat at the wavelength $\lambda = c/f$. Somewhat arbitrarily, it is assumed that the approximate rectangular cross-section formed by the earth's surface, the ionosphere layer, and two radial lines passing through the center of the earth should not deviate by more than 1/20 wavelength from an exact rectangular. Since $\lambda = \frac{2h}{n}$, this means $\Delta x \lesssim \frac{h}{10n}$. Thus, the arc section $S_{ion} = \theta (6371 + h)$ passing through the ionosphere layer should not exceed arc on the earth's surface $S_{earth} = \theta (6371)$ by more than 0.1 h/n. For w this yields the relation:

$$w_{(ocean)} \approx 6371 \frac{0.1}{n} = \frac{637.1}{n} , \quad km , \tag{7-3b}$$

where n is the mode number of the TE_{no} ribbon mode.

(U) If $(f/f_c) \gg 1$, a minimum attenuation (according to Equation 7-1) occurs at:

$$\left(f/f_c\right)_{\substack{\min. \\ \text{atten,}}} \approx \sqrt{6w/h} \quad , \tag{7-4a}$$

or above oceans:

$$f_{\substack{\min. \\ \text{atten.} \\ \text{(oceans)}}} = \left(\frac{n \times 150{,}000}{h}\right)\left(\frac{6 \times 637.1}{n\,h}\right)^{1/2} = n^{1/2}\left(\frac{44{,}141.5}{h}\right)^{3/2} , \text{ Hz} \tag{7-4b}$$

Thus, above oceans for the TE_{10} modes with $h = 70$ km, $f_{min} = 7.39\, f_c = 15{,}835$ Hz, while for $h = 120$ km, $f_{min} = 5.64\, f_c = 7055$ Hz, and for $h = 300$ Km, $f_{min} = 3.57\, f_c = 1784.8$ Hz.

The ratio $\rho^{1/2}_{ion.}\, \rho_{earth}/\rho_{copper}$ may be expressed by:

$$\frac{\rho^{1/2}_{ion.}\,\rho^{1/2}_{earth}}{\rho_{copper}} = \frac{\sigma_{copper}}{\sigma^{1/2}_{ion.}\,\sigma^{1/2}_{earth}} = \left(5.8 \times 10^3\right)\left(\frac{9.02 \times 10^{-12}}{5 \times 10^{-3}}\,\frac{\omega^2_N}{\nu_c}\right)^{\frac{1}{2}} = 0.1834\left(\frac{\omega^2_N}{\nu_c}\right)^{\frac{1}{2}} \tag{7-5}$$

For the D-layer of the ionosphere ($h = 70$ km), the following approximation can be made (Reference 7-2).

$$\left(\frac{\rho^{1/2}_{ion.}\,\rho^{1/2}_{earth}}{\rho_{copper}}\right)_{\left(\substack{\text{D-layer,} \\ h = 70 \text{ km}}\right)} \approx 100 \tag{7-6}$$

(U) Here, the conductivity of copper for RF frequencies is 5.8×10^3 mho/m (Reference 7-8); the average earth conductivity is taken as 0.005 mho/m;* the square of the plasma frequency equals $\omega_N^2 = 3.18 \times 10^3 \, N_e$ (m^{-3}), with N_e the electron density (m^{-3}); and the collision frequency $\nu_c = 1.38 \times 10^8$ $P_{(torr)}$, where p is the atmospheric pressure. It is assumed further that an exponential atmosphere exists such that in the D-layer (Reference 7-3) the following is true:

$$N_e = 4.717 \times 10^8 \, \exp\left\{0.15 \, (h-70)\right\} \quad , \quad \frac{electrons}{m^3} \tag{7-7}$$

$$\nu_c = 5 \times 10^6 \, \exp-\left\{0.15 \, (h-70)\right\} \quad , \quad Hz \tag{7-8}$$

With Equations 7-3 and 7-6, the attenuation relation (Equation 7-1) becomes:

$$\alpha_{TE_{no}} \; (D\text{-layer}) \approx 1.09 \times 10^{-5} \cdot \left[\frac{n/h^3 \, (km)}{(f/f_c)^3 - (f/f_c)}\right]^{\frac{1}{2}} \left[1 + \frac{h_{(km)}}{2w_{(km)}}\left(\frac{f}{f_c}\right)^2\right] \, , \quad \frac{nepers}{km} \tag{7-9}$$

For the other ionosphere layers, another constant in place of 1.09×10^{-5} must be used. However, the remainder of Equation 7-9 remains the same.

(U) The result (Equation (7-9), which was derived by fitting the rectangular waveguide relations of microwave theory to the ionosphere-earth ribbon-mode problem, is only approximate. More exact calculations have been made in References 7-3 through 7-6, which treat the ionosphere more realistically as a series of slabs.** The assumption of a sharp waveguide boundary inherent

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*Over oceans, $\sigma \sim 2$ mhos/m, while over lakes, $\sigma \sim 0.001$ mho/m and over dry desert sand, σ varies from 0.1 to 0.0001 mho/m. Over land masses, an average value of 0.005 mho/m may be assumed. (AIP Handbook, 2nd edition, pp. 5-284, McGraw-Hill.)

**Unfortunately, all calculations made in References 7-2 through 7-6 were done with h = 70 km and for a source with vertical polarization (TM_{no} waves from a vertical radio-station antenna); furthermore, all mode effects in the horizontal direction at the edges are ignored. For a horizontally polarized TE_{no} source, the attenuation is less than that calculated in these references. Many dependencies on frequency and earth magnetic field are similar, however.

(U) in Equation 7-9 cannot correctly predict all the VLF propagation features that have been observed. One of these features is that the earth's magnetic field rotates the incoming refracting/reflecting wave such that for TM_{no} waves, less attenuation occurs for waves traveling from West to East than for waves traveling from East to West.* For North-South and South-North polar travel, where the earth's magnetic field is perpendicular to the direction of travel, there is no difference in attenuation.

(U) In Figure 7-5, the measured frequency envelopes of the natural waveguide trapped radiations in the ELF and VLF regions are shown side by side. The intensity levels shown in Figure 7-5 depend strongly on such factors as thunderstorms, solar flares (ionospheric disturbances), and whether it is day or night. The VLF contour shown in Figure 7-5 agrees reasonably well with a sum of the various modes given by Equation 7-9. To obtain the relative intensities of the TE_{10}, TE_{20}, etc. modes, one must consider that during the travel of a wave around the circumference of the earth (40,000 km in 0.1333 sec), it is attenuated by exp-(40,000 α). If a source emits steadily R Watts/(m^2 . Hz) of energy at frequency f, the buildup in the atmosphere due to the guiding effect by the ionosphere will be:

$$I(f) = \frac{R \ f)}{1 - \exp(-40,000 \ \alpha(f))} , \frac{W}{m^2 \cdot Hz} \qquad (7\text{-}10a)$$

(U) From a comparison of calculations with Equations 7-9 and 7-10a, and the VLF curve in Figure 7-5, it appears that the assumption of reflections from the E-layer at h = 120 km by waves propagated over oceans give better agreement between observations and calculations than if supra-oceanic reflections from the D-layer (h = 70 km) are assumed.** With h = 120 km, a TE_{10} peak occurs at about 7055 Hz and a TE_{20} peak occurs at 9977.3 Hz, while with h = 70 km, the TE_{10} peak is at about 15,835 Hz and the TE_{20} peak at 22,394 Hz according to Equation 7-4b.*** Observations give a peak at 10,000 Hz. The D-layer at 70 km seems to disappear at night, during which only a weakened E-layer at 120 km remains (Reference 7-10). This may explain why the observer spectrum of Figures 7-3 and 7-5 peaks at 10 kHz and not at 18 kHz. Reference 7-6 does not indicate at what time of the day the data of Figure 7-3 were obtained, but even if the nuclear detonation occurred in daylight, the waves may well have traveled over a darkened portion of the earth before reaching the observers.

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*For the TE_{no} waves, this effect may be reversed (?)
**Of course, Equations 7-3b, 7-4, and 7-9, are only approximate, and it is not possible to deduce from them with certainty that the observed reflections actually occur primarily in the D-layer or E-layer.
***Reference 7-2 calculates 18,000 Hz for the peak of the envelope of TM reflections at h = 70 km with n = 1,2,3,4,.....

(S) Having determined that the earth's ionosphere can trap the portions of the ELF and VLF spectrum shown in Figure 7-5, it remains to determine from where such radiation may originate. When viewed as a black-body, the 290°K earth can be shown from the Rayleigh-Jeans law to provide:

$$\frac{dR}{d\nu} = 9.728 \times 10^{-40} \, \nu^2_{(Hz)} \; T_{(°K)} = 2.821 \times 10^{-37} \, \nu^2_{(Hz)} \quad , \quad \frac{w}{m^2 \cdot Hz} \qquad (7\text{-}10b)$$

which at $\nu = 10^4$ Hz yields $dR/d_\nu = 2.821 \times 10^{-29}$ w $\cdot$ m$^{-2}\cdot$ Hz^{-1}. Assuming a width of approximately 5000 Hz for the VLF peak, this amounts to 1.41 $\times$ 10^{-25} w/m^2. Similarly for the ELF trapped radiation, we find approximately 6.35 $\times$ 10^{-34} w/m^2.

(U) Normally, these radiations would be lost to space, but because of the trapping effect by the earth's ionosphere, they accumulate up to a level where the leak rate through the ionosphere equals the supply rate. For a leak rate of Tr = 0.01 through the ionosphere, for example, the level of trapped radiation will be (1/Tr) = 100 times the amount given by Equation 7-10, or 1.41 $\times$ 10^{-23} w/m^2 for the VLF region and 6.35 $\times$ 10^{-32} w/m^2 for the ELF region. Since this level is far below what has been observed, other sources must exist.

(S) In their review articles, Persinger, et. al. (Reference 7-1) mention that VLF waves with intensities on the order of 10^{-7} w/m^2 have been observed by Reiter in connection with unstable air masses, while both VLF and ELF waves appear to be created by ionospheric disturbances. However, even in the absence of such sources, VLF and ELF levels well above the levels that are predictable from earth black-body radiation and the ionospheric green-house-effect (with believable transmission (leak) fractions of 0.001 to 0.01 from the ionosphere) have apparently been observed (Reference 7-1); thus, other possible sources must be sought.

(S) One speculation is that large bio-organic molecules may possess quantum levels of excitation in the 10^4 Hz (VLF) or 30 Hz (ELF) regions. If such is the case, organisms (for example a forest) could be responsible for providing nearly monochromatic ELF and VLF radiation at levels that are far above that of Maxwell-Boltzman or Rayleigh-Jeans thermal earth radiation. Also, it is possible then that resonant amplifying interactions can take place between organisms and radiation in these frequency regions. Resonant interactions of radiation with matter are much more efficient than those due to scattering, and it appears more likely that a resonant interaction is responsible for NBIT transmissions than one based on scattering if VLF or ELF are indeed involved. These possibilities are considered in some detail in the next part of this section.

(S) In searching for possible quantum interaction resonances between matter and electromagnetic waves in the 10 or 10^4 Hz region, stimulated amplifica-tion of VLF and ELF waves by large bio-organic molecules in the liquid crystal state provides a model. One could consider the hyperfine transi-tions that are known in the kHz region (for example, for iodine due to nuclear magnetic octupole interactions (p. 142 of Reference 7-14), and in the 10 Hz

(S) region due to nuclear electric hexadecapole (16-pole) interactions (p. 133 of Reference 7-14). However, the interaction cross-sections are extremely small compared to the usual electric dipole interactions, and it is not too likely that these interactions play a role in the ESP phenomena under investigation.

(S) It is well known that in living organisms large organic molecules exist which are arranged in regular patterns and form liquid crystals (References 7-15 and 7-16). Also, from recent studies of nematic liquid crystals (Reference 7-17), it is known that many large organic molecules have appendages at an angle to the main chain which possess strong dipole moments. When an electric field is applied, the molecules align their long chains along the field and the appendages cause the scattering and refraction of light in preferential directions causing opaqueness in certain directions; this effect is utilized in display technology (Reference 7-18). When the applied field is lifted, the molecules become randomly oriented and the liquid becomes transparent again. When certain additives are added, however, the return of the liquid crystal to a random orientation is slowed considerably and may take hours (this is used in displays with memory). However, it has been found (Reference 7-18) that if radio frequency radiation in the kHz region is applied to the liquid, the hindered relaxation is overcome and instant random reorientation can be effected (this is used to wipe out memory). This is most likely due to the absorption of rotational quanta by the macromolecules which cause rotation of the appendage chain about the main chain as illustrated in Figure 7-6.

(S) The energy quanta associated with the rotation of large molecules (with or without appendages) can easily fall in the kHz range. The usually studied rotational levels of molecules are those of relatively simple ones such as CO, NH_3, SF_6, H_2O, etc. For these molecules, the fundamental rotational quantum is given by :

$$\nu_B = \frac{h}{8\pi^2 I} = \frac{h}{8\pi^2 \mu \bar{r}^2} \quad , \quad Hz \tag{7-11}$$

This has an energy or frequency value that falls in the microwave region ($gHz = 10^9$ Hz), since μ and $\bar{r}^2$, and thus the moment of inertia $I = \mu \bar{r}^2$, of such molecular rotors are relatively small. For a large bio-organic molecule, however, $\bar{r}$ can be 10 to 100 times larger than the value of a typical diatomic or simple polyatomic molecule, while μ can be 100 to 10,000 times larger. Thus, the product $\mu \bar{r}^2$ for such a large molecule can well be 10^3 to 10^7 times larger than the corresponding value of a simple molecule. Hence, the values of the rotational constants ν_B of some large bio-organic molecules lie between 10 and 10^6 Hz.

7-16

MAIN CHAIN
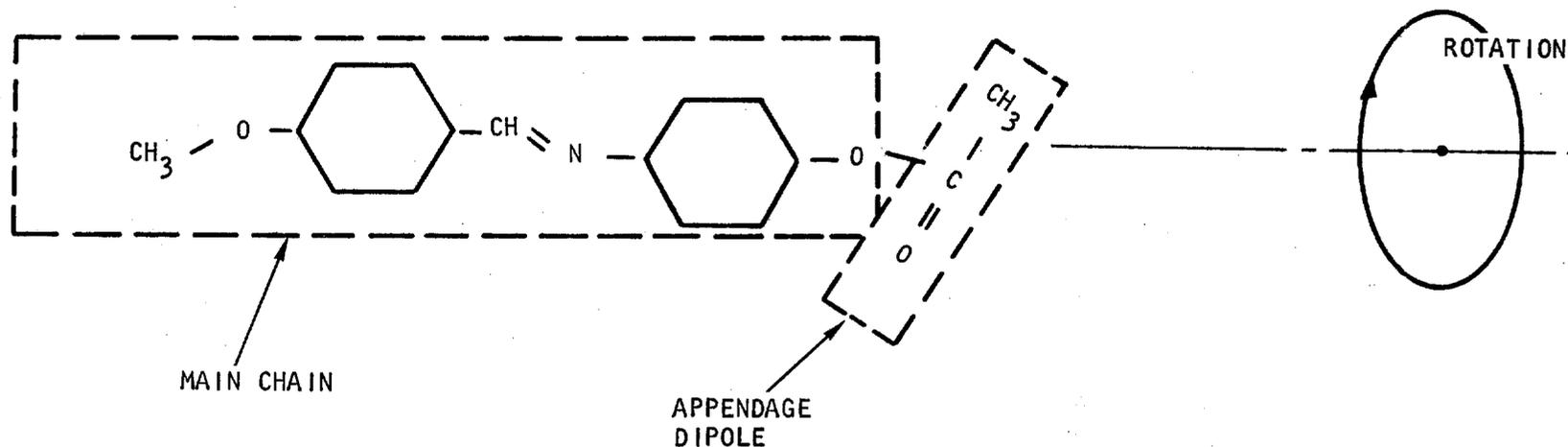
APPENDAGE
DIPOLE

ROTATION

ROTATION ENERGY LEVELS ARE:

$$E_{rot} = J \frac{h}{4\pi^2 I}$$

$$I = \mu \bar{r}^2$$

$$J = 1, 2, 3, \ldots$$

S-1940

Figure 7-6.   Illustration of a Non-aligned Appendage Dipole in a Macromolecule
(Reference 7-18) and its Rotational States

(U) The emission rate constant (Einstein coefficient), the absorption cross-section, and stimulated emission cross-section of rotational levels in molecules are as given below (from Reference 7-19).

$$\left(A_{mn}^{rot}\right)_{\substack{spont.\\emission}} = 2.6833 \times 10^{-21} \underset{(Hz)}{\nu_{mn}^3} \; w_n \underset{(cm^2)}{\left(R_{mn}^2\right)_{rot}} \; , \quad sec^{-1} \qquad (7\text{-}12)$$

$$\left(\sigma_{nm}^{rot}\right)_{absorption} = 0.0960 \underset{(Hz)}{\nu_{mn}} \; w_m \underset{(cm^2)}{\left(R_{mn}^2\right)_{rot}} \; \underset{(Hz^{-1})}{g(\nu,\nu_{mn},\Delta\nu_{mn})} \; , \quad cm^2 \qquad (7\text{-}13)$$

$$\left(\sigma_{mn}^{rot}\right)_{\substack{stimulated\\emission}} = 0.0960 \underset{(Hz)}{\nu_{mn}} \; w_n \underset{(cm^2)}{\left(R_{mn}^2\right)_{rot}} \; \underset{(Hz^{-1})}{g(\nu,\nu_{mn},\Delta\nu_{mn})} \; , \quad cm^2 \qquad (7\text{-}14)$$

where the upper level is labeled m and the lower level n. The function $g(\nu,\nu_{mn},\Delta\nu_{mn})$ is the line-broadening function to be discussed later, while the rotational transition matrix element R_{mn}^2 and statistical weights w_k are given by:

$$\left(R_{mn}^2\right)_{rot} = f(J,W) \; d_o^2 \; , \quad cm^2 \qquad (7\text{-}15)$$

$$w_k = 2J_k + 1 \; . \qquad (7\text{-}16)$$

Here, d_o is the permanent dipole moment length (Reference 7-19) of the molecule, and $f(J,W) = J_m$ for a simple diatomic rotor. However, for an asymmetric-top rotor with three different principal rotation axes, $f(J,W)$ is a function of the two quantum numbers J and W (W is a semi-quantum number with non-integer values).

(S) Assuming that the large bio-organic molecule under consideration is constrained to rotate only about its main axis (as is the case in a liquid crystal), it can be described by a diatomic-like rotation for which $f(J, W) = J_m$, even though it has three principal axes. Here, J_m is the quantum number of the upper level of the unhindered rotation, which transitions from level J_m to J_n. Also, d_o is the dipole moment length about the main axis. For such transitions, $\nu_{mn} \approx 2 J_m \nu_B$ to first-order, so Equations 7-12 through 7-14 become:

$$\left(A_{mn}^{rot}\right)_{\substack{spont. \\ emission}} = 2.15 \times 10^{-20} \underset{(Hz)}{\nu_B^3} \ J^4(2J - 1) \underset{(cm^2)}{d_o^2} \ , \ sec^{-1} \qquad (7-17)$$

$$\left(\sigma_{nm}^{rot}\right)_{absorption} = 0.192 \ \underset{(Hz)}{\nu_B} \ J^2(2J+ 1) \ \underset{(cm^2)}{d_o^2} \ \underset{(Hz^{-1})}{g(\nu,\nu_{mn},\Delta\nu_{mn})} \ , \ cm^2 \qquad (7-18)$$

$$\left(\sigma_{mn}^{rot}\right)_{\substack{stimulated \\ emission}} = 0.192 \ \underset{(Hz)}{\nu_B} \ J^2(2J - 1) \ \underset{(cm^2)}{d_o^2} \ \underset{(Hz^{-1})}{g(\nu,\nu_{mn},\Delta\nu_{mn})} \ , \ cm^2 \qquad (7-19)$$

In Equations 7-17 through 7-19 $J = J_m$ for brevity, that is, J is the rotational quantum number of the upper level of the transition.

(S) Taking typical values of $d_o = 3$ Angstrom $= 3 \times 10^{-8}$ cm, $\nu_B = 10^3$ Hz, and $J = 10$, we get values like:

$$A_{mn}^{rot} = \tau_{mn}^{rot^{-1}} = 3.6765 \times 10^{-21} \ , \ sec^{-1} \qquad (7-20)$$

$$\tau_{mn}^{rot} = 2.72 \times 10^{20} \ sec = 7.67 \times 10^{12} \ years \qquad (7-21)$$

$$\sigma_{absorption}^{rot} = 3.63 \times 10^{-10} \ \underset{(Hz^{-1})}{g(\nu,\nu_{mn},\Delta\nu_{mn})} \ , \ cm^2 \qquad (7-22)$$

(S)

$$\sigma^{rot}_{\substack{stim. \\ emission}} = 3.28 \times 10^{-10} \; g(\nu, \nu_{mn}, \Delta\nu_{mn}) \quad , \quad \frac{cm^2}{(Hz^{-1})} \qquad (7\text{-}23)$$

Clearly, the lifetimes of these rotational levels are infinite if they depend on spontaneous decay via emission of a photon. Thus, their population must be controlled by molecular collisions or crystal-field (electric or magnetic) excitation/deexcitation processes. Stimulated deexcitation and absorption by electromagnetic field radiation can be quite significant.

(S) If there is an incident flux of F_ϕ photons cm^{-2} sec^{-1} with frequencies in the vicinities of the resonant rotational transitions and there are N_n molecules/cm^3 in lower state n, and N_m molecules/cm^3 in upper state m in an organism, the absorption and stimulated emission rates in the organism will be as follows (Reference 7-19).

(S)
$$\left(Q^{rot}_{mn}\right)_{absorption} = \int_\nu \frac{dF_\phi}{d\nu} \; \sigma^{rot}_{abs}(\nu) \; N_n \; d\nu =$$

$$= 0.192 \; \nu_B \; J^2(2J+1) \; d_o^2 \; N_n \left(\frac{dF_\phi}{d\nu}\right)_{\nu=\nu_{mn}} \quad , \quad \frac{absorptions}{sec \cdot cm^3} \; , \qquad (7\text{-}24)$$

and similarly:

$$\left(D^{rot}_{mn}\right)_{\substack{stim. \\ emission}} = 0.192 \; \nu_B \; J^2(2J-1) \; d_o^2 \; N_m \left(\frac{dF_\phi}{d\nu}\right)_{\nu=\nu_{mn}} \quad , \quad \frac{emissions}{sec \cdot cm^3} \qquad (7\text{-}25)$$

Here $\int_\nu \frac{dF_\phi}{d\nu} \; g(\nu, \nu_{mn}, \Delta\nu_{mn}) \; d\nu = \left(\frac{dF_\phi}{d\nu}\right)_{\nu=\nu_{mn}}$ if $\frac{dF_\phi}{d\nu}$ is not monochromatic

(Reference 7-19). The net number of outgoing photons or gain will be:

$$G^{rot}_{mn} = \left(D^{rot}_{mn}\right)_{\substack{stim. \\ emission}} - \left(Q^{rot}_{nm}\right)_{abs} =$$

$$= 0.192 \; d_o^2 \; \nu_B \left(\frac{dF_\phi}{d\nu}\right)_{\nu=\nu_{mn}} J^2(2J+1)\left[\left(\frac{2J-1}{2J+1}\right) N_m - N_n\right] \quad , \quad \frac{photons}{sec \cdot cm^3} \qquad (7\text{-}26)$$

(S) The photons emitted from the organism according to Equation 7-26 are going in the same direction and are coherent with the incoming flux $dF_{\varphi}/d\upsilon$. If they are emitted from an area of A_T cm^2 at right angles to the beam $dF_{\varphi}/d\upsilon$ from a volume V_T in the organism, and if the resonance line-breadth is $\Delta\upsilon_{mn}$, the ratio of outgoing to incoming photons, or amplification by the organism, is:

(S)

$$\gamma = \frac{G_{mn}/(A_T\Delta\upsilon_{mn})}{(dF_{\varphi}/d\upsilon)_{\upsilon=\upsilon_{mn}}} = \frac{0.192 \, L_T\upsilon_B d_o^2 \, (2J+1)J^2}{\Delta\upsilon_{mn}}\left[\left(\frac{2J-1}{2J+1}\right) \, N_m - N_n\right] \quad (7\text{-}27)$$

where:

$$L_T = V_T/A_T \, , \quad cm \, , \quad\quad\quad (7\text{-}28)$$

and the frequency of the resonance was:

$$\upsilon \approx 2J \, \upsilon_B \, , \quad Hz \quad\quad\quad (7\text{-}29)$$

(S) Taking again typical values of:

$$\upsilon_B = 10^3 \text{ Hz}$$

$$d_o = 3 \times 10^{-8} \text{ cm}$$

$$J = 10$$

Equation 7-27 becomes:

$$\gamma = 2.1856 \times 10^{14} \, \frac{L_T(cm)}{\Delta\upsilon_{mn}(Hz)}\left(0.905 \, \mathfrak{m}_m - \mathfrak{m}_n\right) \quad\quad (7\text{-}30)$$

where $\mathfrak{m}_m$ and $\mathfrak{m}_n$ are the molar concentrations (moles/cm^3) of the upper excited (m) and lower excited (n) populations of resonant biomolecules in the organism. Taking further reasonable values of $L_T = 10$ cm and $\mathfrak{m}^* = (0.905 \, \mathfrak{m}_m - \mathfrak{m}_n) = 10$ moles/cm^3, we get:

$$\gamma = \frac{2.19 \times 10^9}{\Delta\upsilon_{mn}(Hz)} \quad\quad\quad (7\text{-}31)$$

which can be quite large if $\Delta\upsilon_{mn}$ is not too large.

(S) For the amplification to be possible, it is necessary that $\mathfrak{m}_m > \mathfrak{m}_n$ by at least 10 percent (if J = 10). Such inversions can easily exist with the very low quanta of energy that are needed (10,000 Hz $\approx$ 4.8 x 10^{-7} °K) for the rotational levels of a large molecule. If excited by random collisions, the most probable J-level for the rotation of a gaseous molecule is given by:

$$J_{\substack{most \\ probable}} \approx 0.589 \left(\frac{T \ (°K)}{\nu_B \ (cm^{-1})} \right)^{1/2} \qquad (7\text{-}32a)$$

which for T = 300°K and ν_B = 10^3 Hz = 3.33 x 10^{-8} cm^{-1} would give J = 55,877. Actually, for such a high value of J, stretching corrections would have to be added to the energy level expression ϵ_{rot} = J(J + 1) $h\nu_B$ used in driving, and this would make J_{max} much smaller. However, EquatioN 7-32a does not apply to a liquid crystal of large molecules aligned on and off by bioelectric fields. The rotations of appendaged long-chain species like the one shown In Figure 7-6 are not excited by random collisions in that case. In liquid crystals composed of aligned large bio-organic molecules, it is necessary that all molecules rotate with the same quantum number J for dissipation forces to be minimum. The minimum total energy, and thus most probable distribution of states, would in this case correspond to some constant value of J rather than a Boltzmann distribution*, and Equation 7-32a becomes instead:

$$J_{\substack{most \\ probable}} \approx \left(\frac{T \ (°K)}{N\nu_B \ (cm^{-1})} \right)^{1/2} \qquad (7\text{-}32b)$$

Here, N is the number of molecules in the liquid crystal. Taking N $\approx$ 10^7, T = 300°K, and ν_B = 10^3 Hz gives $J_{most \ prob.} \approx 18$ (according to Equation 7-32b), which is more reasonable.**

(U) Returning to Equation 7-31, the usual expressions for doppler, collision, and natural line-broadening of the rotational absorption emission lines of gaseous molecules are given below (Reference 7-19).

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*If one molecule rotated faster than its neighbor, its appendage would collide with the appendage of its neighbors. Only if all molecules rotate with the same frequency are such collisions avoided. Statistical mechanics allows precisely such a stationary minimum energy solution if the energy levels are constrained like this (see p. 277 of Reference 7-20). The Boltzmann distribution only results if the rotational energies are free to take on any quantum values.

**N = 10^7 molecules with molecular weight M = 10^6 amu, gives a total liquid crystal mass of 1.66 x 10^{-11} gram, which is still very little.

(U)

$$\left(\Delta\nu_{mn}\right)_{Doppler} = 7.6246 \times 10^{-7} \, \nu_{mn} \, T^{1/2} \, M^{-1/2} \, , \quad Hz \qquad (7\text{-}33)$$
$$\text{(Hz)} \quad (^{\circ}K) \quad \text{(amu)}$$

$$\left(\Delta\nu_{mn}\right)_{Collision} = 3.384 \times 10^{8} \left(\frac{\sigma_{ab} \, (\text{\AA}^2) \, p \, (atm)}{\sqrt{\mu_{ab} \, (amu) \, T \, (^{\circ}K)}}\right) \, , \quad Hz \qquad (7\text{-}34)$$

$$\left(\Delta\nu_{mn}\right)_{Natural} = \frac{A_{mn}^{rot}}{4} \, , \quad Hz \, , \qquad (7\text{-}35)$$

The largest of these three determines the line width of a gaseous molecule.

(S) For $\upsilon_{mn} = 10$ Hz, $T = 300^{\circ}K$, and $M = 10,000$ amu, we obtain $(\Delta\nu_{mn})_{Doppler}$ = 1.32×10^{-3} Hz, while $(\Delta\upsilon_{mn})_{Natural} = 9.2 \times 10^{-22}$ Hz according to Equations 7-20 and 7-35. Collision-broadening as given by Equation 7-34 would not apply to an assembly of aligned rotating biomolecules, but assuming that it did, we would have $(\Delta\upsilon_{mn})_{Collision} = 9.2 \times 10^{8}$ Hz, if $\sigma_{ab} \sim 1000 \text{ \AA}^2$, $\mu_{ab} = 10,000$ amu, $p = 1$ atm, and $T = 300^{\circ}K$. Thus, if random collisions could occur in the liquid crystal (for example, perpendicular to the crystal axis), $\gamma \sim 10$.

(U) In crystals, the main broadening effect is due to local crystal fields. For electronic transitions in solid luminescent crystals, the broadening effects have been studied theoretically, but no theory yet is available for the effect of the field on rotational transitions of aligned rotating biomolecules in liquid crystals. An educated guess would be that at most $\Delta\nu_{mn}/\nu_{mn} \sim 10^{-3}$, in analogy with electronic transitions in crystals for which $10^{-10} \lesssim \Delta\nu_{mn}/\nu_{mn} \lesssim 10^{-3}$. For $\nu_{mn} \approx 10^{4}$ Hz, $\Delta\nu_{mn} = 10$ Hz, and thus the following is obtained from Equation 7-30:

$$\gamma = 2 \times 10^{13} \, L_T (0.905 \, \mathfrak{m}_m - \mathfrak{m}_n) \qquad (7\text{-}36)$$

or from Equation 7-31, with $L_T = 10$ cm and $(0.905 \, \mathfrak{m}_m = \mathfrak{m}_n) \approx 10^{-6}$ moles/cm^3:

$$\gamma \sim 2 \times 10^{8} \qquad (7\text{-}37$$

(S) The result (Equation 7-37) is rather surprising and shows that if liquid-crystal-like assemblies of biomolecules exist in organisms, which we know is very likely the case (References 7-15 and 7-16), these organisms are capable of coherent and monochromatic amplification of incoming electromagnetic waves in the kHz region by more than a millionfold. Not only can the incoming waves be amplified, but if the liquid-crystal rotational levels are modulated by bioelectrochemical potential fluctuations induced by the brain of a man, for example, the outgoing field will carry this modulation information. A second person, gifted to perception and demodulation of this kHz wave-modulated information, could then conceivably "read" the first person's mind. Thus, NBIT could be explained.

(S) Aside from the possibility of explaining NBIT between men, the interesting picture that emerges from the above-given analysis is that for very large biological molecules, resonant interactions with low-frequency radiation fields occur primarily via absorption and stimulated emission. Spontaneous emission can be entirely ignored. This is completely opposite to the thinking of 40 yr ago, which indicated that atoms and molecules interacted with the radiation field mostly by spontaneous emission and absorption.

(S) In the 1930's, Einstein first introduced and showed the necessity of a stimulated emission process in addition to absorption and spontaneous emission, but it was considered small and negligible. Not until 15 yr ago, when masers and lasers proved to be feasible, did one realize that simulated emission can play a significant role. Of course, one was still dealing with well-known light molecules such as CO_2, N_2, CO , H_2O, etc. Now, by extending recent knowledge of the lasable and masable lighter molecules to heavy organic molecules, spontaneous emission may be almost entirely ignored. From the nanosecond lifetimes of excited electronic states, the milliseconds for vibrational states, and hours for the rotational states of small molecules, we have to consider relative lifetimes of billions of years for the rotational levels of biomolecules.

(S) To illustrate some possible consequences of these new notions, one could preferentially pump liquid crystals of macromolecules to some particular desired J-level, and as long as the liquid crystal properties remained intact and no mechanical or electromechanical deexcitation mechanism came into play, these levels would remain pumped up at the particular J-level indefinitely.

(S) A forest with trees possessing large biomolecules in a liquid crystal state may be "charged up" to some high J-level by the advancing kHz waves generated from a rain-front or storm. This might trigger a chain of physiological events in the tree to prepare itself for storing water.

(S) Although the resonant frequency is low (10 - 10^4 Hz ELF and VLF), the resonance is very sharp (very monochromatic) and must be exactly matched by $v = 2v_B J$ for a particular liquid crystal with quantum number J. With Δv_{mn} between 10^{-4} and 1 Hz, experimentally finding such a resonance may be very difficult with ordinary RF equipment.

(S) It is quite likely that many liquid crystal subdomains actually make up an organism or organ in a living thing, and that each domain can have a different J-value, there being a distribution of the domains over the J-values. Since a domain of aligned biomolecules with the same J may contain some 10^7 molecules, each with M = 10^6 amu, its weight is only 10^{-11} gm. Therefore, some 10^{12} domains may make up a 10-gm liquid crystal portion of an organ or organism. The total spectral coverage and resonance detectability of 10^{11} domains with a J distribution over say $1 \lesssim J \lesssim 1000$ would be considerably better than if only one liquid crystal with one J value existed. On the other hand, the gain Y will be lower, and the larger the spread in possible J values.

SPECULATION ON THE NEUTRINO MECHANISM FOR NBIT

(U) In the neutrino theory of photons (NTP), it is postulated that photons (i.e., electromagnetic waves) are composite quanta made up of one neutrino and one antineutrino (References 7-21 to 7-25). Absorption or emission of a single neutrino (or antineutrino) is not possible because of the requirement of spin conservation, and this enables neutrinos to traverse directly through the earth. A beam of neutrinos can stimulate the deexcitation of an excited state, however, without violating any of the conservation laws. Thus, they can leave signatures in excited matter or trigger the release of stored energy without being consumed themselves (Reference 7-21).

(S) Now the sun and the cosmos send immense quantities of neutrinos and antineutrinos at and through the earth over a very large spectrum of frequencies. Some of the lower frequency neutrinos (kHz to MHz) can stimulate the deexcitation of biophysical rotationally excited molecules in the brain according to the NTP hypothesis. A flux of these low-frequency (kHz to MHz) neutrinos could thus release "J-stored" VLF radiation from organisms as discussed in the previous part of this section, or set off the emission of brain-modulated low-frequency VLF electromagnetic waves directly. In the 10-kHz region, these VLF waves can propagate with little attenuation around the earth because they are trapped by the ionosphere. Thus, in this picture neutrinos aid the VLF/ELF mechanism discussed previously, being responsible for the release of coded thought waves as well as the mysterious enchancement of natural "noise" radiation in the ionosphere/earth-trapped VLF/ELF region. As discussed at the beginning of this section, the observed intensity of the latter cannot be explained by Planckian sources and only superficially by assuming the continuous presence of many world-wide thunderstorms (Reference 7-1).

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(S) The stimulated-deexcitation cross-section by neutrinos is much smaller than that by photons, but since the neutrino flux from the sun at a frequency of 10 kHz is much higher than that of 10-kHz photons produced via Planckian earth radiation, the deexcitation trigger rate can still be higher.

(S) In another NTP-involving scheme, it is conjectured that NBIT communication takes place directly via thought-modulated monochromatic neutrinos generated during maser-like VLF stimulated discharges of liquid organic crystals of the type discussed above.* An NBIT receiver can register the passage of such monochromatic neutrinos if it possesses near-threshold masable crystals that are in resonance with the neutrino frequencies (Reference 7-21).

(S) Since neutrinos can travel straight through the earth and NBIT has been observed to be independent of distance and magnetic shielding, the direct-neutrino scheme has some favorable arguments. On the other hand, it may be that neutrino flux levels are too weak to cause sufficient signal strength at the NBIT receiver unless the sender aimed a coherent beam of neutrinos at the receiver. Calculations for the NTP interactions described above are subject to several uncertainties (which can only be removed by some experimental data). If one set of assumptions is correct, the flux levels will be too low, while if another set is right, the above scheme may be possible.

(S) Both NTP schemes discussed above could be theorized further ad infinitum. However, such exercises would be a waste of time without the guidance of experiments to prove or disprove the basic assumptions of the NTP postulate. The NTP hypothesis is sufficiently plausible on theoretical grounds that one or more experiments, as suggested in Reference 7-21, seems well justified. If NTP proves to be correct, it will almost assuredly advance science by a magnitude comparable to the discovery of nuclear fission, nuclear fusion, or the laser, while in the field of communications (including NBIT), it would add an entirely new dimension.

SPECULATION ON QUANTUM-MECHANICAL ψ APPROACHES TO NBIT

(U) According to one school of quantum-mechanical theorists, actual matter and states of matter are indeterminate or "dispersed", and actual reality must be described by a wave function with an infinite set of eigenstates that extends over all space and time. The state of matter is not in any one particular state, but is dispersed over all possible eigenstates--that

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*According to the neutrino theory of photons, each generated maser photon is really an antineutrino-neutrino pair traveling in the same direction. This theory also predicts that occasionally (with lower probability), an antineutrino-neutrino pair is emitted in which each is traveling in exactly the opposite direction.

(U) is, it is in a state of schizophrenia (Reference 7-32). When an experimenter* observes certain matter (say the movement of an electron) either directly or via an apparatus, he performs an operation on the wave function of this matter or on the combined wave function of the apparatus plus matter, namely the act of bringing it from an unconscious state into a conscious state. This operation places the matter from its schizophysical state into one particular eigenstate (References 7-26 through 7-32). This assumption of physical reality is referred to as the schizophysics postulate (SPP).

(U) Another school of theorists led by David Bohm believes that matter (say an electron) still must be described by a multi-state wave function, but that this wave function represents the time and space average of certain hidden variables, much like pressure and temperature represent the statistical average of a subworld of molecules with different momenta and kinetic energies. If time and space intervals of observation are taken short enough, one would find, for example, an electron to be in a particular state specified by so-called hidden variables whose averages may take on any one of a series of possible discrete values inherent in the wave function. This hidden variables postulate (HVP) can be given a sound mathematical and physical foundation which is not in conflict with current quantum mechanical results (References 7-33 through 7-34), but suggests new experiments which may verify the postulate.

(U) Recent measurements by Freedman and Clauser (Reference 7-36) to test such HVP theoretical predictions indicate that at least a "local hidden variables postulate" is in conflict with experimental data. Many researchers therefore tend to give more credence to the SPP theory (References 7-36 through 7-38), which was originally considered to be too exotic. However, one should be cautioned that the HVP theory as constructed in Reference 7-34 is rather general and that only one particular possibility of how local hidden variables might play a role and might be observed has been disproven. Other possibilities still exist and the HVP theory can by no means be considered dead.

(U) Both the SPP and HVP theorists reject the belief of a third school of quantum mechanics practitioners, which is herein designated the "axiomatic collapse postulate" (ACP). According to SPP and HVP believers, the ACP group assumes ad hoc, without use of any physical rules, that the multi-state wave function, or "state vector," Ψ "collapses" to one of several possible states i of an observable E with eigenvalues e_i, with a probability given by $\left| \left| \int \Psi^* E \Psi \, d\tau \right| / e_i \right|^2$ when an observation is made. The ACP group, according to SSP and HVP believers, seems not to be concerned about such an unphysical "change of the rules" (References 7-32 and 7-34). Many ACP followers, however, consider the wave function Ψ of say an electron to be a parameter that represents the average state or probability distribution of many electrons, not of one electron. The observed measurement of a parameter is then also a probability, and the collapse described above is no longer artificial.

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*The word experimenter must be taken in its widest sense and includes, for example, a person who views another person and consciously perceives him. This viewing is considered to be experimenting.

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(U) On the other hand, the HVP and SPP believers state that Ψ must be attached to one system or particle and not to an ensemble because the famous Davisson-Germer electron scattering and double-slit electron diffraction experiments and variants thereof reject the possibility that Ψ is an ensemble parameter (Reference 7-34, P. 455). It is the writer's opinion (Reference 7-34) that the interpretation of the double-slit experimental results lies at the foundation of the conflict between the ACP followers and the HVP and SPP theorists.*

(S) Before presenting a personal view of the double-slit tests, let us first restate by another example the different viewpoints of the SPP, HVP, and ACP philosophies. Consider a polyatomic molecule such as CO_2, which has three normal vibrations (v_1, v_2, v_3), each one of which can be excited to various levels ($v_1 = 0,1,2,\ldots; v_2 = 0,1,2,\ldots; v_3 = 0,1,2,\ldots$), and for which v_2 is doubly degenerate, meaning that the v_2 bending vibration can occur in two possible planes that are perpendicular to each other. According to the ACP viewpoint, if CO_2 molecules are excited to say the $v_2 = 2$ level of the degenerate v_2 vibration, a particular CO_2 molecule is either doubly excited in one plane, doubly excited in the other plane, or once excited in one plane and simultaneously once excited in the other plane, all three cases requiring the same amount of energy (anharmonicity is neglected). According to the SPP viewpoint, the degenerate $v = 2$ vibration of one single CO molecule is a mixture of the three possibilities, and only when the "conscious observation operation" is performed does the molecule jump into one of these three possible states. Thus, SPP theory asserts that a particular state is only an imagination and that in reality the state is a schizophysical three-state. Bohm's HVP theory finally assumes that one CO_2 molecule in the $v_2 = 2$ state will jitter back and forth very rapidly and randomly between the three states, the details and rate of the jitter being determined by hidden variables.

(U) Returning to the double-slit test, which has compelled many to accept the SPP or HVP theory, the question appears still open as to whether the maxima- and minima-containing diffraction pattern formed on a screen by single electrons passing one at a time through the two slits is due only to an intrinsic Ψ-wave ascribed to each electron or due to the interaction forces between the electron field and the sum of the induced and permanent force field of the electrons and nuclei that make up the double-slit structure. Any real material, whether conductor or dielectric, must exert

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*Note that Bohm's motivation for the HVP theory is the same as of the ACP school, namely, the retention of determinism in physics. However, he starts with assuming that Ψ is a property of one electron (because of the double-slit experimental results) and starts from that point on to reformulate quantum mechanics so that determinism is still kept. The ACP school, on the other hand, assumes from the start that Ψ represents the statistical average of many electrons, and thus determinism is still not violated. They ignore or disbelieve the contention that the results of the double-slit experiment are necessary and sufficient proof that a single particle like an electron has wave properties expressed by Ψ.

(U) an induced and/or permanent asymmetric force on the electron which deflects it as it passes through slit 1, for example, because there are less electrons and nuclei on the side where slit 2 is and more on the other side.

(U) Gryzinski (References 7-39 through 7-41) has shown that the diffraction pattern produced by electrons scattered from molecules can be entirely explained by a three-dimensional consideration of the conservation-allowed exchanges of energy, momentum, and spin (and thus the forces) between the projectile electron and the electrons bound in the outer shell of an atom or molecule. A simpler alternative wave scattering analysis which assumes the electron particle to be a wave gives the same diffraction pattern, but if one believes in determinism, only Gryzinski's classical particle analysis makes any sense. It seems that an analysis similar to the one given by Gryzinski, in which surface atoms or molecules and a two-dimensional two-slit geometry replaces Gryzinski's single spherical molecular scatterers, may well give an interference pattern which is also identical to the one calculated by a simple particle-wave model. The recent work by Boyer, who has shown how several other quantum results can be replaced by a classical calculation (References 7-42 through 7-44), perhaps also may be useful and applicable in such a calculation.

(U) Bohm himself also admits that a classical interpretation of the Davisson-Germer and like experiments is possible, and in fact has been made by Duane (Reference 7-45, Sections 3.12 and 6.11). The additional counter-arguments given by Bohm in 1951 in favor of a wavy nature (ψ) for a single particle (Reference 7-45) over a possible classical interpretation with a statistics-produced effective ψ are not rigorous, particularly not in view of his invokement of a hypothetical "proton microscope" with certain limited electron-proton scattering angles. These angles, so he states, can only be explained on the basis of a wave theory. As mentioned above, Gryszinski has in the meantime (1965) shown that such limited scattering angles can indeed be explained classically.

(U) Of course, all the classical explanations of previously supposed pure quantum effects by Duane, Gryzinski, Boyer, and others do not suggest that the use of ψ and quantum mechanics for the description of microscopic system interactions should be abandoned. The quantum mechanical calculations are much quicker and easier to carry out, and therefore much to be preferred. The classical-calculations only suggest that the ACP theory, which considers ψ as the average property of a pure ensemble (Reference 7-34, p. 456) rather than the property of one single particle, appears physically more plausible than the SPP and HVP theories. Quantum mechanics is then seen as a shortcut to describe overall interactions and is made possible because of quantum restrictions inherent in these interactions, much like thermodynamics provides many shortcut calculations in the macroscopic world.

(S) In summary, though this writer is a believer of the deterministic ACP theory for the reasons given above, it is not possible at this time to say with certainty that the SPP and HVP theories are untenable. The SPP theory, which has been called upon by some to possibly explain NBIT, therefore cannot be ruled out. Its possible connection with NBIT phenomena is discussed in a following section.

(S) Time-reversed waves and precognition is another controversial subject. Whether or not "advanced waves" are admissible as really occurring phenomena in physics in addition to the usual "retarded waves" also has been pulled into NBIT theories in an attempt to explain precognitive NBIT events (References 7-26, 7-27 and 7-38). In contrast to the controversy surrounding the interpretation of ψ discussed in the previous section, which is of quantum-mechanical origin, advanced and retarded waves are both allowed by the classical Maxwell equations. However, certain boundary and initial conditions (usually present in classical physics) allow only the retarded wave solutions to exist in the macroscopic world. Retarded waves move forward in time and assure the irreversibility of a physical process. Contrary to the fundamental diffusion equation in classical physics, which is not symmetric with regard to time inversion (i.e., processes described by diffusion are irreversible), the equally fundamental wave equation is symmetric with respect to time and allows two possible solutions, one called the advanced wave (negative time) and the other the retarded wave (positive time).

(U) It should be emphasized that time irreversibility seems only to arise in the macroscopic world, but on a microscopic basis, a quantum-mechanical transition is symmetric in time (it obeys the wave equation), and for example, the probability of a particular excitation is equal to the probability of its deexcitation.* In other words, on the microscopic level at least both advanced and retarded waves are physically allowed.

(S) Costa de Beauregard, who appears to believe in SPP (Refererence 7-26), has considered coupling the SPP theory for ψ with an allowance of both advanced and retarded waves in the final consciousness operation procedure assumed in SPP theory. His general discussion could apply equally well to an ACP-based quantum theory with such "dual-time" waves because they are allowed in any quantum theory. Thus, a belief (Reference 7-38) that time-inverted interactions also require the SPP concept is not true.

(U) Costa de Beauregard gives physically plausible arguments which suggest that because of the finite values of the "thermal quantum" kT, time-reversed processes (such as the conscious "willing" that a certain event will happen) are not zero in probability, but have a finite value even though this value is usually very small. He states further that the probability for an interaction increases with time for retarded waves, but should decrease with time for advanced waves.

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*This result is often called the principle of microscopic reversibility.

(S) Both Costa de Beauregard and Walker (References 7-26 and 7-27) also cite experimental evidence that appears to indicate that will-influenced macroscopic events actually occur, for example, when pinballs are thrown and directed to follow a certain desired path. Walker states that influence on even one atom or molecule of the pinball at the beginning can affect its final position because of amplification by a multitude of interactions, as the pinball proceeds to its final location. He claims to have calculated these willed effects for the pinball case, though these calculations are not explicitly given (Reference 7-27), and that the experimental results agree well with his calculations.

(U) Costa de Beauregard's dissertation (Referrence 7-27), which is on a more fundamental level, does not provide an explicit example of how one can verify his assertions experimentally in a specific case using a particular expression. Without checking Costa de Beauregard's basic arguments, however, let us postulate that he is correct and review some specific situations in what follows.

(S) In considering the specific case of precognition,* a person imagines a certain event that actually occurs later.** First consider the simple event of a person viewing an automobile. According to the dual-time wave concept, it is equally possible (not violated by mathematical physics) that the interaction "seeing of automobile" in the observer, brought about by the observer's absorption of diverging visible light that traveled from the automobile to the observer, was preceded by the emission of a converging visible wave with the same automobile imagery from the observer to the automobile. Typically, a person can see only a distance of about 100 m, and since light travels at 300,000 km/sec, the time difference between the two events in the retina of the perceiver is $2 \times (0.1/300,000) = 0.67 \times 10^{-6}$ sec, or about 1 μsec. Since neurons have time constants on the order of milliseconds, it is doubtful that a person could distinguish the two events, assuming that the emission event was registered in the same manner as an absorption event and that the person had the capability of emitting visible light from his eyes. Clearly, there are at least two macroscopic constraints, and possibly a third, that prevent the physically allowed dual observation to be actually used by man: (1) eyes are not provided with a mechanism to emit light; (2) neuron time constants are too large; and (3) registration of absorbed light by the brain is not equal to registration of (hypothetically) emitted light.

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*It is quite possible that "deja-vu" experiences also can be fitted into the theory, but we shall not consider it to avoid unessential digressions.
**Instead of "willing" the event as Costa de Beauregard envisions, our feeling is that the event is not willed but already "established" (time is relative) so that the precognitor "perceives" it ahead of time via the advanced waves, but does not create the event.

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(S) However, let us now turn to NBIT communications via ELF or VLF waves
and let us assume for the sake of definiteness that the brain can sense such
waves via groups of certain bio-organic molecules that are in liquid crystal
aggregations as discussed previously. Because of the very small quantum
energies involved (microelectron volts), the brain can easily provide the
necessary microwatts of power for emission of ELF or VLF waves, as well as
register absorptions. In contrast, the emission of visible light requires eV
quanta, and consequently watts of power. Such large energy supply rates are
not (known to be) available in man. Thus, for ELF/VLF at least, the macro-
scopic energy source requirement for emission is in principle available,
while the registration (in the brain or consciousness) of an absorption
and emission event is most likely equally recordable. Therefore, macro-
scopic objections (1) and (3) listed above for visible light would most
likely be absent for the ELF/VLF sensing case.

(S) Whereas nearly all other electromagnetic waves of the spectrum are
highly attenuated and/or escape into space on an attempted trip around the
world, ELF and VLF waves have the unique property of being able to circle
the globe (in about 0.13 to 0.2 sec per revolution) with little attenuation,
perhaps a thousand to a million times. If they are amplified in some
fashion (say by other bio-organic assemblies), certain waves may even keep
circling the globe for a day before they lose most of their information
content if they possess any. The loss of information with time for an
organism-emitted (highly monochromatic) ELF or VLF wave circling the globe
would depend on the bit rate in the emitted pulse train, lower bit rate
signals generally surviving longer than higher bit rates.

(S) Returning to the automobile viewing situation, let us now assume that
instead of direct communications with visible light waves, another person
sits in or on the automobile and "communicates" with ELF/VLF waves of what
he sees to our subject. This person thus serves as a translator of high
bit-rate visible wave signals into low bit-rate ELF/VLF wave signals with
an inevitable loss of picture quality, but nevertheless some picture.*
Because of the globe-circling capacity of ELF/VLF waves, it is now possible
for our subject precognitor to emit an ELF/VLF wave that travels a minute
or more by making 450 or more orbits around the world before arriving at
the automobile scene.

(S) Many people have reported to have perceived a certain scene which
actually presented itself again a minute or so later (i.e., "deja-vu").
It is possible to explain such "double exposures" with the dual-time wave
proposition by assuming that an advanced ELF/VLF wave traveled a thousand

*As stated previously, it may well be possible that objects do implant their
own signal on ambient ELF/VLF waves so that an intermediate translator is
not needed.

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times or so around the earth before arriving at the scene, while the retarded ELF/VLF wave (and the visible wave) traveled directly to the individual. Cases of precognition of hours and days also are reported, but it appears that the frequency of their occurrence is less than those of the 1 or 2 minute variety.

(S) We next ask what the probability might be that one would perceive an advanced picture of a future scene communicated via ELF/VLF waves. Avoiding a rigorous derivation, a heuristically constructed expression for this probability is:

$$P_{\substack{relative \\ precogn}} = \frac{\text{"Pre-View" Probability}}{\text{"Direct-View" Probability}} = \eta_{dissip.} \; \exp-\left(\frac{\Delta t}{\overline{\Delta t}}\right) \qquad (7\text{-}38)$$

where Δt is the time into the future when the interaction event occurs and $\overline{\Delta t}$ is the mean time of travel for earth-orbiting ELF/VLF waves in going from a precognitor who emits these waves in random directions to the scene of the interaction event. The latter is given by:

$$\overline{\Delta t} = \frac{\overline{\Delta s}}{c} \qquad (7\text{-}39)$$

in which c is the velocity of light and $\overline{\Delta s}$ is the mean travel distance of the earth-orbiting ELF/VLF wave-front before "hitting" the event target.*

(U) The parameter η_{dissip} is an efficiency factor which gives the loss of wavefront information content with time due to wave attenuation, diffraction, and incoherency production. A heuristic expression for η_{dissip} is:

$$\eta_{dissip.} = \exp-\left(K_c \, \beta_c \, \Delta t\right) \qquad (7\text{-}40)$$

*Because of the geomagnetic field and the earth's rotation, plane waves that circumnavigate the globe will experience a lateral drift. Thus, a wave-front emitted in say the direction of the North- or South-pole will reappear after 0.15 sec near the location where it was emitted, but shifted to the West or East.

(U) where β_c is the original information bit rate carried by the wave ($\beta_c \lesssim 0.5 \, \nu_{wave}$) and K_c is a lumped constant dependent on the details of the attenuation, diffraction, and incoherency-generation processes experienced by the wave and on the original direction and constitution of the emitted wavefront. Clearly, there may be preferred directions of emission where these losses are a minimum.

(S) Typically, one may have $\overline{\Delta t} \sim 100$ sec (based on the anecdotal performance by precognitors), while for an optimum direction and wave constitution, we guess that $K_c \sim 10^{-2}$. According to Equation 7-38, the probability of a "pre-view" (via ELF/VLF sensing, not by visible seeing) is exp(-2) $\approx$ 10 percent for a bit rate of say 1 Hz. Of course, all this is extremely speculative since neither the probability expressions nor the assumed constants are at all established. This result shows that a precognitor cannot will an event, but rather he has an opportunity for a preview if he is lucky, and (1) turns on his right-hemisphere* ELF/VLF equipment and (2) optimizes the wave-front emission directed by orienting himself optimally.

(S) Since the advanced and retarded waves must be exact replicas of each other except for time reversal, it follows that if the retarded wave emitted from an interaction event diverges, as is usually the case when it goes from the event scene to the observer, the advanced wave must converge if it is to trace the retarded wave in going from the observer to the event scene backwards in time. Because of the diffraction properties of waves, an advanced wave emitted by a precognitor to hit the event target from the front would usually be divergent, and thus would not do. However, it would appear that replication of the process is only required during the interaction process at the scene, and therefore a diverging advanced wave coming from the rear may be substituted for a converging wave coming from the front. Thus, provided one can hit the event scene from the rear, there may still be a nature-allowed possibility to observe both waves.

(S) The "shadow requirement" alluded to above for a person to perceive both the advanced and retarded wave of an interaction event if we assume that nature only allows diverging waves and a convergent advanced wave from the front can replace a divergent advanced wave from the rear is illustrated in Figure 7-7. The ELF/VLF waves clearly can meet this requirement, while visible waves cannot, and therefore it may explain why dual waves have never been observed before in general. The shadow requirement is in addition to the macroscopic requirement of being able to emit, absorb, and record both processes equally in the brain, which test also was failed by visible waves (but not by ELF/VLF waves).

(S) It may be that advanced waves can be perfectly mirrored at an interaction event and that this allows diverging advanced or emitted waves to be registered as converging waves (after reflection) at the interaction site. The shadow problem does not exist then, and in that case the necessity of having waves that are able to circle the globe to hit the event location from the rear no longer exists. These and many other questions only can be answered after much more study, and more importantly, many more experimental tests.

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*See discussion on page 10-2.

7-34

A
Subject

B
Interaction Event

A′
Subject
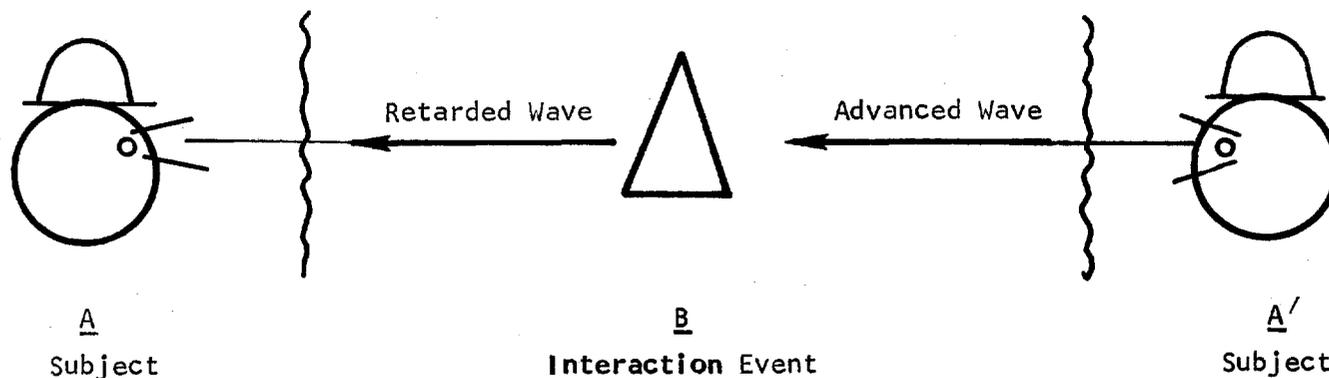
(a) Visible Communications. Subject cannot be simultaneously at location A and A′ to profit from the dual-wave preview possibility (besides that, he cannot emit visible waves and does not meet some other macroscopic requirements).

Advances Wave

Retarded Wave

Advanced Wave

Trip(s)
Around
The World

A = A′
Subject

B
Interaction Event

Trip(s)
Around
The World
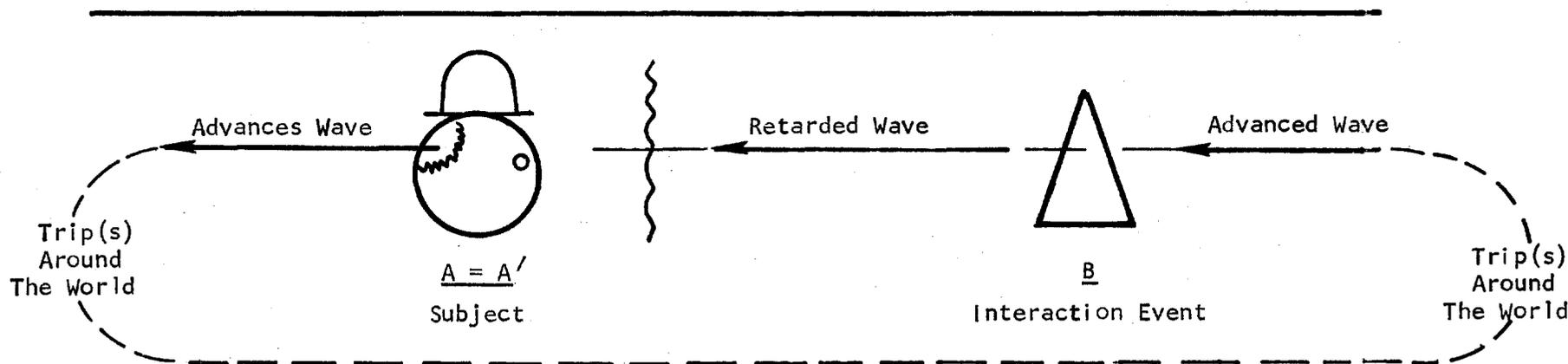
(b) ELF/VLF Communications. Subject can be simultaneously at receiver and emitter locations A and A′ because waves circle the globe.

Figure 7-7. Illustration of Possible Shadow Requirement and Fulfillment for Dual-Wave Perception

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(S) With regard to the SPP quantum waves model of NBIT, ordinary electromagnetic ELF/VLF waves for the dual-time wave concept have been considered earlier in this section. According to believers of the SPP quantum theory, however, the wave functions of quantum mechanics represent real matter waves, and some believe it is communication via these φ-waves which may explain NBIT and precognition. Nothing is known about the propagation of such φ-waves, but theoretically they should permeate all space and time, and according to SPP theory, it would only require one's will to perform an operation on them to perceive any scene one wishes in space and time. The reason why man thus far has nearly always been perceiving scenes and events near him, so the SPP believers say, is strictly physiological and evolved because of biological survival needs. They cite NBIT (remote viewing) as evidence that certain individuals are able to transcend the near and immediate and can operate on the φ-wave of features on, for instance, the other side of the world or the future.

(S) At present, one cannot reject this theory with certainty, but the most potent argument against the SPP theory, and therefore the communication with φ-waves concept, is that determinism and causality must be completely abandoned. Most physicists, including the writer, feel that there is almost no experimental evidence for this basic assumption, but a lot against it.

(U) Because the history of physics has been full of surprises, prudence dictates that one should consider the φ-wave communication concept until it has been definitely disproven. We therefore must include it in our suggestions for further research.

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SECTION 8

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MISCELLANEOUS OBSERVATIONS (U)

(S) The bulk of the Soviet papers on parapsychological events and novel biophysical information transfer (NBIT) demonstrate not only a poor understanding of physics, but also generally fail to deal with psychological and physiological processes that may underly NBIT. No interdisciplinary approach that would help alleviate these difficulties is described in the literature reviewed. For example, Sergeyev measures the bioplasmagram (presumably, electrical or electrostatic field) associated with heart action and the bioplasmagram associated with breathing. He states that under certain conditions the heart action and breathing can interfere with one another, apparently by inductive interference. Our guess is that he may not know exactly what he is measuring and probably does not understand the interaction of breathing rate and heart rate. From his background in signal analysis, he does know how to analyze the bioplasmagram for all its worth.

PERFORMANCE TRAINING AND VOLITIONAL CONTROL

(S) In the more creditable parameters reviewed in this study, the Soviets indicate an interest in volitional control of the phenomona observed. For example, Adamenko indicates that subjects are trained by hypnosis or using biofeedback procedures to control the conductance between acupuncture points in the skin. In another case, he refers to the use of self-induction, self-suggestion, and bioelectric induction to achieve the electromagnetic changes associated with psychic phenomena.

(U) His model for training in telekinesis is volition effort that leads to changes in skin conductivity that are simultaneous with telekinsis. During training, the subjects learn by volitional effort to charge a battery of condensors; the charge is roughly proportional to volitional effort. Once trained, the subjects can use a _similar_ volitional effort to electrostatically charge an object at a distance. In describing what may be a current Soviet position in training, Adamenko further states in his discussion on "...Electrodynamics and Psychoenergetics", "...Production of special states of consciousness and psychic training at the level of psychoenergetics using modern devices has just as great significance as the investigation of the psychic field of physically talented individuals."

(U) Another method of training in the literature reviewed on telepathy is described by Milan Ryzl. Ryzl claims that approximately 10 percent of the 500 subjects he trained demonstrated some ability as a consequence of the training. The six principal stages of Ryzl training procedure are outlined below:

    (1) Orient subject and improve his motivation.

    (2) Training in hypnosis--increase confidence of the subject, increase suggestability.

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(U) (3) Attempts to induce visual hallucination. Close off subjects to incoming stimuli other than hypnotists words. Perfect mastery and consistency of visual hallucination. Inhibit spontaneous mental processes.

(4) Induction of extraordinary perception. Simple assignments (simple discriminations). Suggestion is to be able to see, with eyes closed, objects in front of him; objects may be described in detail to facilitate hallucination.

(5) Training, including elaboration of procedures, removal of errors, training in use of skills, and development of sense to discriminate between correct and erroneous psychics.

(6) Auto-induction of the essential state of mind; on the razors edge between sleep and wakefulness.

(U) Ryzl goes to great lengths to prevent the occurrence of errors that are perceived by the subject as a mistake that has been made. For example, when the subject reads a license plate of a car, "if the subject reads OE-6333 instead of CF-6888, we interpret the result as successful and strengthen the subjects compliance."

(U) The training then may be characterized as "shaped" reinforcement learning utilizing hypnosis and the development of a special state of consciousness. The training is extremely extensive and time consuming (3-hr sessions, 3 times a week, over a period of months). If nothing else, the training can be conceived to be an elaborate screening process during which subjects with insufficient talent and motivation are weeded out.

(U) Ryzl's "essential state of mind" appears to be a semi-hypnogogic state usually accompanying low-frequency α and high-frequency θ brain rhythms of 7 to 5 Hz. Such a subject state could be more quickly developed utilizing biofeedback techniques.

(U) In view of the high-reward-frequency/no-failures-allowed aspects of the training procedure, it is suprising that Ryzl only claims that 10 percent of his subject population demonstrate psychic ability as a consequence of the training.

(S) Due to the dual Russian interest in both hypnosis and NBIT, we feel certain that the Soviets have probably done a thorough evaluation of Ryzl's procedure.

HYPNOTIZING MACHINES

(S) The Russian interest in hypnosis has lead to many attempts at automating hypnosis. Typical techniques are tape recordings, rotating discs in the visual field, and application of pulsating electrical current through the head. The latest Soviet attempt in this area is "LIDA" (apparently an acronym for remote control therapeutic apparatus); a U.S. patent (No. 3,773,049, Nov. 1973) by Rachichev et. al. has been issued for apparently the same device.

(S) This device, described by B. Belenkig, 1973, V. Rabichev, et. al., 1973, and Bragen and Petrov, 1974, is essentially different embodiments of an apparatus that subjects a patient to pulsating light, heat, sound, or very-high-frequency, electromagnetic radiation (VHF EMR), simultaneous or individually. The pulse repetition rates (PRR) are programmable. It is uncertain to the reviewer whether the pulse repetition rates suggested in the patent, 10 to 100 Hz, can be achieved for thermal sensations. At the correct PRR, the device may be effective at least in neuropsychiatric disorders. Nowlis has demonstrated that certain EEG biofeedback devices with PRR-like visual feedback causes alpha entrainment and enhancement, while Fehmi has demonstrated the same for auditory EEG biofeedback. EEG entrainment caused by strobe light sources is, of course, a well-known phenomenon. The range of PRR of the apparatus is 10 to 100 Hz. Apparently the inputs made to the subject in each sensory modality are synchronous and directed to the recipients head or face. The subjective consequences of the apparatus are difficult to imagine, especially for VHF EMR and thermal stimulation. The selection of appropriate stimulus intensities and PRR are not described. However, apparently the training of the subjects involves gradually lowering the PRR.

(U) The Soviets claim numerous therapeutic advantages of the LIDA apparatus as a consequence of "inducing the desired biorhythm". The "desired biorhythm" is unfortunately not described in the literature available to us.

(S) An alternative use for LIDA may be in changing the subjective psychological state of the subjects. For example, it is well known to biofeedback therapists in this country that EEG biofeedback promotes feelings of well being, openness, and transference to the therapist. One model for the use of LIDA to achieve these effects without monitoring the patient would be to gradually reduce the pulse repetition rates from 15 to 6 Hz over the course of 1 hr, thus entraining the individual's α at some frequency and shaping it to some lower frequency. The Soviets claim that the effectiveness of LIDA improves with use (i.e., training) of the subject. Being familiar with the subjective effects of biofeedback, it is still difficult to imagine the subjective consequence of pulsed VHF EMR either separately or in synchronous combination with the other ~~modulation~~ modes of stimulation.

(S) In summary, the device is considered veridical with probable unique subjectives consequences. At lower PRR's, the subjective experience may correlate to those of EEG biofeedback.

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THE R.F. ELECTROMAGNETIC RADIATION HYPOTHESIS

(S) In "Experimental Studies of Mental Suggestion" (JPRS 59163, May 31, 1963),
L.L. Vasilyev describes Soviet attempts, starting in the 1930's to replicate
the work of F. Cazamalli, an Italian researcher of the 1920 to 1930 period.
Cazamalli essentially assumed that the human brain produced EMR in the radio-
frequency spectrum and claimed to have measured the same. Vasilyev claims that
the Soviets conducted a systematic attempt to replicate Cazamalli's work to
no avail. In the rest of the article (approximately 170 pages), he puts down the
R.F. EMR hypothesis (see, for example,) pp. 110 and 160 to 171). In reviewing
Cazamalli's book El Cervanto Radiante, not much was achieved in the way of
enlightenment if the report is accepted from Cazamalli's perspective. His idea
was essentially that people doing parapsychological tricks would produce novel
and systematic RF EMR. If this hypothesis is ignored and the consequences
of the behavior of his subjects are examined, there is some indication that
he might have been actually getting something of which he was not aware. For
example, he indicates surprise that he received signals of greater amplitude
when his subjects didn't try. He also indicates that when there were 3 to
4 people in the shielded room with the subject, there were no signals detected.
Another observation that he frequently made was that physical activity of the
subjects reduced or eliminated the signals. Furthermore, he reports that when
"emoactive" tension is discharged through motor, vascular, and glandular
expression (passionate reactions, flushing of the face, cries, walls), the
phenomena of radiation stops abruptly."

(S) Based on Cazamalli's behavioral description of his subject, there may
have been a negative correlation between the level of cortical arousal of his
subject and the occurrence of whatever he was measuring with his primitive RF
antenna and receivers. If this is indeed the case, his primitive apparatus
may have, in some way, detected the higher cortical voltage of his resting
subjects or changes in their electromyographic levels. Consequently, Vasilyev's
effort to discredit Cazamalli could possibly be disinformation, although
such a position would be difficult to defend.

PSYCHOTRONICS

(U) At this writing, the only available source of information about psycho-
tronics is the Annotated Bibliography (AB). The Introduction to the Annotated
Bibliography states merely that the terms psychotronics, psychoenergetics,
and parapsychology are used to denote the same field of investigation by the
Czechs, the Russians, and the Anglo-Saxons, respectively. It is reported that
in Czechoslovakia, psychotronics is an offically recognized branch of science.
There is a conflict between the emphasis suggested by the word itself and
the brief descriptions presented in AB.

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(U)   The term itself suggests a blend of the concepts embraced by psychology and electronics.   In many portmanteau words of this type, the suffix -tronics suggests electrical or electronic instrumentation techniques applied to exper- imental investigations in the field.   One might conclude from the form of the word alone that the field of psychotronics is visualized as comprising elements of psychology combined with sophisticated instrumentation techniques to dis- cover new and useful properties of the human mind and central nervous system.

(U)   The AB presents a somewhat different view.   The introduction, as noted above, states that psychotronics is the Czech word for parapsychology.   An abstract on page 66 states that psychotronics embraces telepathy, telegnosis, rhabdomancy, psychokinesis, cosmic biology, and biological radiation.

(U)   Perhaps there is some truth in both views.   The Czechs have published serious papers on dowsing, or finding water by means of a divining rod.   For example, Bradna (AB, p. 14) presented a paper in Prague in 1973 relating dowsing to electromagnetism, myotransfer, electromyography, and the effect and influence of the seasons on these paranormal phenomena.   Drbal and Rejdak (AB, p. 19) have written a paper on "divining, dowsing, and radiesthesia."

(U)   Perhaps the most informative abstract on the theory of dowsing is that of Z.V. Harvalik, a Czech-American.   Dr. Harvalik points out that the human body can respond to minute changes in magnetic field.   It is suggested that ground water distorts the local terrestrial magnetic field and that successful dowsers exploit this effect.   The dowsing rod, held loosely in the hands, is merely a mechanical amplifier of a slight reaction of the forearm muscles to the changing magnetic field.   (AB, Pp. 25 to 26).   Mirko Kaderavek (AB, p. 36) also has a paper on dowsing rod reactions.

(U)   There appears to be a bias in the AB toward the occult and paranormal view of psychotronics and away from the physical and instrumental view.   Short shrift is given in the abstracts to papers that describe reasonably good experiments.   The work reported by Harvalik occupies about a third of a page. The paper of Kaderavek rates only a few lines.   However, a paper by Miloslav Loucka about a model of telepathic communication, which looks like pure fantasy, rates about one and two-thirds pages.   The compilers of AB seem to want to believe in the occult, the mysterious, and the unexplainable. Experimental attempts to provide rational explanations for certain phenomena classified as parapsychological receive little space.   The paper by Loucka reveals the attitude of many Czech scientists about psychotronics.   Loucka postulates the existence of an information field as the carrier of telepathic information.   Loucka considers that the same field provides the explanation of telekinesis; this is in contrast to the work of Adamenko and other Russians, who claim that telekinesis is a manifestation of the electrostatic field.

(U)   To summarize the field of psychotronics, from the point of view of its practitioners, the following can be postulated:

(1)   Mental telepathy, clairvoyance, telekinesis, and telegnosis, are real.   There is a lack of unambiguous experimental evidence concerning these phenomena; this lack must be remedied.

(U)   (2)   These phenomena do not conflict with physics and other sciences. In so far as possible, physical explanations will be sought for these phenomena.

(3)   Existing theories of physics are not adequate to explain all psychotronic phenomena. Therefore, there must exist some new physical principles to be discovered or elucidated.

In short, the theoretical basis of psychotronics is substantially the same as that advanced for parapsychology in this country.

BIOPLASMA

(U) The appropriate starting point for this discussion is to try to define or explain what is meant by the term bioplasma. In origin, the concept seems to be analogous to the "aura" of the Western parapsychologists. The Western concept is an old one, dating from the prescientific age ("The Age of Faith") when the soul or spiritual body of a human being was thought to be as real as the physical body. The aura was an emanation or radiation from the spiritual body. Saints in old paintings are depicted with halos or auras. Modern Western psychics still believe in the aura and in the ability of gifted individuals to see it.

(S) However, the Eastern (Bloc) term bioplasma, although used in a confusing fashion, appears to be frequently a generic term for all radiant phenomena associated with a living body (e.g., thermal, electrical, magnetic, electrostatic). Viktor Adamenko has used the bioplasma concept as supported by theoretical and empirical considerations. However, in his later papers, he does not mention bioplasma, but instead writes about the psi field, the biological electric field, and so forth. The strongest theoretical arguments for bioplasma seem to come from G.A. Sergeyev (see, for example, a paper by G.A. Sergeyev and V.V. Kulagin, "The Interaction of Bioplasmic Fields of Living Organisms with Light Photon Sources"). For Sergeyev, the bioplasmagram is a low frequency electrostatic field.

(S) The Russians assert correctly that plasma is a fourth state (or phase) of matter. Confusingly, Sergeyev and other Russian parapsychologists aver that living organisms generate a plasma that surrounds them. They get around the physical difficulties of maintaining a plasma at temperature and pressure conditions compatible with life by the hypothesis that living matter obeys different physical laws from inanimate matter.

(U) The classical physical objections to the bioplasma concept are summarized below. A plasma is a state of matter similar to a gas in which a large fraction of the molecules or atoms are ionized. A plasma can exist at high temperatures or at very low densities. At high temperatures, the individual particles have enough kinetic energy that ionization can result from collisions; the plasma is maintained by virtue of the high rate of production of ions, which balances the recombination rate. At low pressures or densities, the rate of ionization need not be high because the recombination rate, which depends on the rate of collision of ions with each other, is low. A physical plasma consists of approximately equal numbers of positive and negative ions.

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(U) Electrostatic attraction between the bodies of positively and negatively charged matter holds the plasma together, in a sense. The plasma can absorb and lose energy by electromagnetic radiation. A means of detecting the presence or absence of plasma is to look for the characteristic emission or absorption of radiation. If the Russians take the bioplasma concept seriously, they will probably try to detect it by virtue of these radiation characteristics. At temperature and pressure conditions consistent with the maintenance of life, a classical plasma cannot exist.

(S) The Russians must have done significant work in plasma physics as part of their program of developing nuclear weapons. This technology would be applied to a study of bioplasma. For several reasons, such studies probably would have been done secretly. First, the Russians might not wish to reveal their full capabilities in plasma physics. Second, not every Russian scientist is a parapsychologist and would not want to experience the expected ridicule for such a frivolous use of plasma physics terminology. Thus, in the available papers on Soviet parapsychology, the theory of bioplasma remains vague and unclear and at best is an attempt to employ analogous terminology from physics to NBIT.

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SECTION 9

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SPECULATION ON THE NATURE OF SOVIET LABORATORIES INVESTIGATING NBIT (S)

(S) Available published reports are contradictory or inconclusive regarding
whether (and to what extent) the Soviet government actively supports investi-
gative or speculative work in the field of NBIT, parapsychology, or psycho-
energetics. It appears that some of the older work in the field, before
the middle 1960's, was sponsored by the government. More recently, there is
conflicting evidence as to whether the field has fallen into official dis-
favor, with the result that most published work has been done without specific
funding or authorization. In Russia, scientific research work is done mostly
in institutes. Each institute is presided over by a senior scientist or
academician. Apparently in the Russian system, the presiding scientist of an
institute has a great deal of freedom and independence from bureaucratic
dictation as to the kind of work undertaken. This reviewer has seen nothing
about the organization of scientific work conducted by Russian military
organizations. One must presume that the organization parallels the civilian
institute, with a military officer in charge, assisted by a chief scientist.

(S) Parapsychological investigations in the Soviet Union are probably
conducted in two types of circumstance: first, work that is not officially
sanctioned or funded by the Russian government; and second, work that is
officially supported and is conducted in a military research laboratory or
in a laboratory that is an adjunct to another institution.

(S) In the first type of circumstance, the investigators themselves are
employed in research institutes to do other types of work. Their work on
parapsychology is conducted on the side, perhaps on their own time. Where
possible, they employ the facilities of the institutes in which they work.
For example, a shielded room used for testing electronic apparatus also may
be used for subjects and investigators in mental telepathy experiments.
Special test equipment has to be borrowed or bootlegged from other projects
in the institute, built on their own time, or purchased with money contri-
buted by the investigators themselves. The results of such work seem to be
published in the unclassified literature. Apparently, official government
disapproval of such work does not preclude publication results. As an
indication of this condition, we have commented elsewhere in this report
about the use of $BaTiO_3$ slabs coated with silver as electrodes, speculating
that the barium titanate with silver happened to be available, whereas pure
silver was not.

(S) In the second type of circumstance, government approval of the work
seems to imply the intent to use the results to the advantage of the
military or the secret police. The officially sanctioned work, if there is
any, seems to be classified. The laboratory itself would be camouflaged.
It would probably be part of another organization, such as a military research
laboratory or a psychiatric hospital. In any event, the camouflage would be
fairly difficult to penetrate, since a parapsychological laboratory would not

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(S) have unusual requirements for electrical power, material supplies, or test equipment. The staff would probably consist of psychologists, biologists, physicists, electrical engineers, mathematicians, technicians, and some "gifted" subjects.

(S) Much of the work of Vasil'ev (Vasil'yev) was conducted with subjects who had psychological or psychiatric problems. It would thus be logical to locate the secret parapsychological laboratory in a mental hospital. It is reported that the Russians tend to sentence political deviates to mental hospitals rather than prisons. It might be possible to learn from interviewing political deviates and other patients who have been released from Russian mental hospitals.

(S) Based on our review, attempts were made to envision organizational structures that may have been established by the Soviets to do systematic research on NBIT. These are depicted in Figure 9-1 and 9-2.

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NBIT RESEARCH INSTITUTE
Director
Asst, Director

COMPUTER SUPPORT DIVISION

— MATHEMATICIANS

— PROGRAMMERS

— OPTIMIZERS

TOTAL TECHNICAL STAFF OF ~ 25

THEORETICAL DIVISION

RESEARCH PLANNING GROUP (3)

VLF/ELF INTERACTIONS WITH BIOORGANIC MOLECULES (6)

NEUTRINO THEORY OF PHOTONS (5)

PHYSICAL INTERPRETATION OF QUANTUM MECHANICS (5)

INFORMATION THEORY (5)

WAVE PROPAGATION (5)

BIO-NEURAL SYSTEM: BRAIN: BIORECEIVING/ TRANSMISSION SYSTEM ANALYSES (15)

BASIC EXPERIMENTAL EXPLORATION DIVISION

PLANNING GROUP (5)

BIOELECTRICS AND BIOMAGNETICS GROUP (10)

VLF/ELF INTERACTIONS (STIM'D EMMISIONS, AMPL'N) WITH BIOORGANIC MOLECULES (10)

NEUTRINO EXPERIMENTS (10)

ADVANCED WAVE PROOF-OF-EXISTENCE TESTS (5)

OTHER BASIC EXPERIMENTS (25)

APPLICATIONS AND INTEGRATED SYSTEM TESTING DIVISION

OVERALL PLANNING GROUP (10)

REMOTE SENSING SYSTEMS (20)

REMOTE VIEWING FOR INTELLIGENCE APPLICATION (20)

SUBJECT TRAINING BY BIOFEEDBACK; ETC. (20)

WAVE PROPAGATION OPTIMIZATION AND FREQUENCY OPTIMIZATION TESTS (20)

COUNTERMEASURES (20)

SPECIAL EQUIPMENT AND INSTRUMENT MANUFACTURING SUPPORT DIVISION

— ELECTRONIC TECHNICIANS

— INSTRUMENTATION SPECIALISTS

— MACHINISTS

TOTAL STAFF OF SPECIAL SKILL TECHNICIANS IS APPROXIMATELY 35
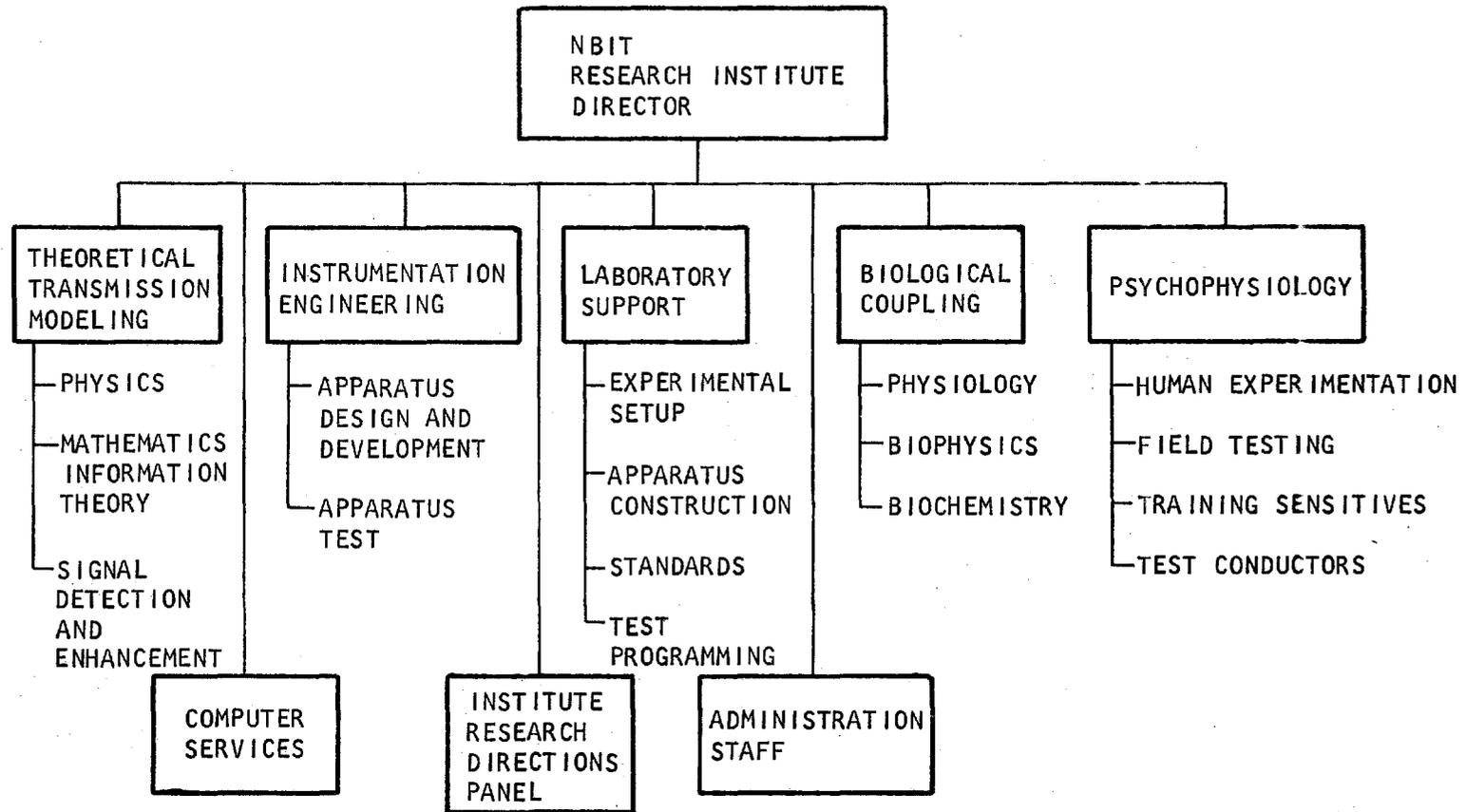
NOTE:

● Number in parenthesis indicates estimated technical staff. Total personnel is probably two to three times technical staff.

● Estimated total technical staff ≈ 300 (physicists, chemists, biochemists, E.E.'s, M.D.'s, etc.)

● Estimated total personnel ≈ 700

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Figure 9-1. Possible Organization and Staffing of a Heavy Commitment, Serious NBIT Research Effort

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                    ┌─────────────────────┐
                    │ NBIT                │
                    │ RESEARCH INSTITUTE  │
                    │ DIRECTOR            │
                    └─────────────────────┘
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| THEORETICAL TRANSMISSION MODELING | INSTRUMENTATION ENGINEERING | LABORATORY SUPPORT | BIOLOGICAL COUPLING | PSYCHOPHYSIOLOGY |

—PHYSICS

—MATHEMATICS INFORMATION THEORY

—SIGNAL DETECTION AND ENHANCEMENT

—APPARATUS DESIGN AND DEVELOPMENT

—APPARATUS TEST

—EXPERIMENTAL SETUP

—APPARATUS CONSTRUCTION

—STANDARDS

—TEST PROGRAMMING

—PHYSIOLOGY

—BIOPHYSICS

—BIOCHEMISTRY

—HUMAN EXPERIMENTATION

—FIELD TESTING

—TRAINING SENSITIVES

—TEST CONDUCTORS

COMPUTER SERVICES

INSTITUTE RESEARCH DIRECTIONS PANEL

ADMINISTRATION STAFF

S-1863

Figure 9-2. Alternative Possible Organization for Investigating NBIT

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SECTION 10

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RECOMMENDATIONS FOR FUTURE RESEARCH AND DEVELOPMENT (U)

(S) The following suggested lines of investigation are presented with two purposes in mind. First, it is hoped that they may serve as a guide as to what tell-tale signs to look for that indicate significant areas of research which the Russians may be undertaking. Second, they represent areas that seem promising in terms of directions that R&D on NBIT mechanisms should take in this country. It is our considered opinion that it is worthwhile for the United States government to initiate and support systematic research in this area. In addition, systematic interdisciplinary research is likely to reveal NBIT mechanisms that are functional even though they may have no relationship to common parapsychological phenomena.

(S) Because NBIT research crosses so many widely different scientific disciplines, it is important that one special task in the research program concern itself with continuously integrating, overviewing, and planning the various specialized research operations. This includes initiating periodic cross-disciplinary seminars. Thus, it is recommended that a system integration and research planning analysis team be formed to evaluate research work completed, update an overall NBIT research system model, identify and outline new areas of research, and organize interdisciplinary meetings between different research groups so that they are continuously updated and educated about the state of the art.

(S) The most fruitful lines of investigation can be categorized in terms of five major areas of interdisciplinary research. These are:

   (1) The Psychophysiology and Psychology of Awareness of NBIT--This area includes such questions as what are the modes of awareness that facilitate NBIT? How to select and train individuals for high resolution and reliable performance? Which of the possible transmission mechanisms can humans utilize for NBIT?

   (2) Transmission Mechanisms--This area includes such questions as what are possible NBIT transmission mechanisms? How is information transmitted from the source to the recipient?

   (3) The Physiology and Biochemistry of Human Transducer Mechanisms-- In this area, research would be conducted on physiology and bio- chemistry of reception and receptor mechanisms.

   (4) Statistical Development--This area includes non-stationary analysis of random data, deviation from normally distributed data, and new developments in communication and information theory with respect to noisy channels.

   (5) Development of Non-Contact Physiological Sensors--This area includes development of M.E.G., thermography, low-frequency electric field monitors, and other sensors.

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(U) Examples of typical research projects that might be conducted within each of these five areas are summarized below.

PHYCHOPHYSIOLOGY AND PSYCHOLOGY

(S) In the initial proposal submitted by AiResearch, it was hypothesized that NBIT mechanisms might be associated with right hemispheric functioning of the cerebral cortex. Discussions with colleagues during this study makes this hypothesis even more attractive. A simple and elegant test of this hypothesis would be to present information simultaneously and sequentially to both the right and left visual field during, for instance, a remote viewing experiment. Thus, the types and rate of information transmitted could be evaluated, and the relevance of participation by each cortical hemisphere could be determined.

(S) A similar experiment would be to repeat the various remote-strobe-induced cortical desynchronization experiments, allowing the strobe flash to be perceived by only one-half of the visual field of the sender while observing the occurrence of bihemispheric, ipsilateral, or contralateral desynchronization of the receiving subject.

(S) In still another typical approach, operant conditioning or biofeedback schemes would be utilized to attempt to ascertain the ability of subjects to respond to ELF and VLF EMR or other physical mechanisms for NBIT (e.g., ac and dc electric and magnetic fields).

(S) Whether one is a skeptic or a believer, it is evident that the important elements lacking in experimental research are reliable human detectors of NBIT. No instrument has yet been developed that unambiguously, even though noisily, monitors NBIT. As long as the physical nature of the process remains a mystery, there is little chance of developing such an instrument. As an alternative, it is proposed to develop reliable human observers (e.g., human receivers). The technique proposed would utilize biofeedback, coupled with training in introspection, to develop reliable observers equipped with a replicable ability to describe internal states and events.

TRANSMISSION MECHANISMS

Experimental Test of Weak Magnetic Field Hypothesis

(S) Credible reports suggest that gifted dowsers respond to small changes in the earth's magnetic field. This same physical effect may be one means of telepathic communication. Sensitive individuals of proven ability and trained NBIT subjects would be tested in the presence of a controllable magnetic field to determine whether the presence of the field could be detected and what its limits are as an NBIT mechanism.

Experimental Test of Weak Electric Field Hypothesis

(U) This test is analogous to the magnetic field test discussed above, except the effects of electric fields would be investigated.

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Neutrino Communications

(S) In this category, a proof-of-principle experiment should be conducted to prove or disprove the neutrino or "photino" theory of photons concept as formulated by J. W. Eerkens. A detailed description of this experiment is given in Section 7 of this report. Independent of whether or not all aspects of Eerkens photino theory are proven correct or not, the neutrino-catalyzed liberation of stored potential ELF/VLF radiation as rotational energy in bio-organic liquid crystals remains a possibility. Theoretical analyses followed by the formulation of experimental checkout tests and experimentation should be carried out under this task.

ψ-Wave Communications

(S) Testing of SPP against ACP and HVP theories of quantum mechanics is needed. Further in-depth theoretical studies of the three interpretations of ψ in quantum mechanics should be carried out, expanding on the concepts discussed in Section 7 of this report. Experimental tests (beyond those of Freedman and Clauser) should be formulated to prove or disprove the various hypotheses.

(S) Assuming that the SPP interpretation of ψ is correct, additional experiments on NBIT and ψ-waves could be conducted to determine details of the physical process whereby a distant event scene is perceived by a person, both precognitively and directly. Possible experiments that can prove or disprove these physical processes could be formulated.

ELF/VLF Mechanisms

(U) In this area, ELF/VLF propagation and natural generation in the atmosphere could be studied. Data should be gathered on the propagation of both horizontally and vertically (and of mixed) polarized narrow-beam ELF and VLF wave pulse trains, and revolution times and revolution drifts of waves that orbit the earth determined as a function of different azimuthal (up or down) and lateral (to the right or left) beam direction. Also, frequency spectrum changes and attenuations could be determined in these experiments.

(S) In addition, super-radiant ELF/VLF wave interaction with bio-organic molecules should be investigated as follows:

  (a) Construction of ELF/VLF wave generating equipment with horizontal, vertical, and randomly oriented polarization.

  (b) Study and identify large bio-organic molecules that can aggregate into liquid crystals; prepare and test cells containing such molecules (in vitro), and select and test animals or plants with such molecules (in vivo).

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(S) (c) Develop ultrasensitive electric and magnetic field detection equipment that can detect changes of the rotational state in the liquid crystal aggregates of the cells or organisms selected under (b) above.

(d) Place two large sets of cells (in vitro or in vivo) containing bio-organic molecules selected under (b) above some distance apart (10 m to 10 km), and direct ELF/VLF waves from the generator constructed under (a) above so that they pass first through one and then through the other. Observe whether any changes are detected in the liquid crystal states of the cells with the sensor developed under (c) and whether they correlate (that is, information is communicated between the cells).

(e) Investigate any other possible means of filtering and detecting narrow spectral lines ($\sim 10^{-6}$ to 10^{-1} Hz) in the ELF/VLF region of the spectrum, such as frequency beating, frequency mixing, etc.

STATISTICAL RESEARCH

(S) Research should be conducted in the area of deviations from normal distributions and non-stationary analysis of random data. Also, new developments in communication and information theory should be monitored, especially as related to noisy channels. In addition, the EEG signals in the previously proposed experiments should be explored for any information residing in the high frequencies in an attempt to ascertain what Sergeyev is exploring.

REMOTE SENSORS AND EQUIPMENT DEVELOPMENT

(S) In addition to the sensors identified in preceding paragraphs, it would seem relevant to develop reliable electrical, electrostatic, and capacitance field detectors and measuring apparatus and to develop a means for monitoring selected, naturally occurring VLF/ELF phenomena and to investigate methods of providing VLF/ELF shielding.

PHYSIOLOGY AND BIOCHEMISTRY

(S) Initially, existing work in this country should be followed, such as the current research in the influence of electrical forces in biogenisis, biological data transmission, and control systems (e.g., the work of Becker at the VA Hospital, Syracuse) for relevant "fall-out". Also, research on complex crystal-line physiological structures that possess semiconductive, photoconductive, and piezoconductive properties or sensitivity to EMR or electrical currents would be tracked. Monitoring this research would allow the discrimination of holes in the applicability of research in this area to NBIT. At that time, specific projects directed at elucidating NBIT mechanisms would be initiated.

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APPENDIX

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APPENDIX

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This appendix contains the unclassified sources that were reviewed and used in part to establish the existing knowledge base from which a meaningful and nonduplicative study effort could be conducted. The information is presented in two parts as follows:

Part 1: Unclassified Soviet and Communist-Bloc Literature (by author)

Part 2: Miscellaneous Sources

The sources are presented in alphabetical order by author. Where no author is listed, the sources are presented alphabetically by title. Where one author has several publications, they are presented with the most recent publication first, and when dates are not given, in alphabetical order by title.

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PART 1

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