Scientific Study of Unidentified Flying Objects

Introduction

Michael Shermer

The *Scientific Study of Unidentified Flying Objects* was conducted at the University of Colorado between 1966 and 1968, with physics professor Edward U. Condon as its primary investigator. It is commonly known as the "Condon Report" or the "Colorado Project Report." The publication represents the largest single scientific project ever undertaken in relation to the UFO question. The *Scientific Study of Unidentified Flying Objects* was originally copyrighted in 1968 by the Regents of the University of Colorado, a body corporate. It was subsequently published in reports of the United States Air Force and other governmental agencies and was published commercially by Bantam Books, but is currently out of print.

Because of the historical importance of this document, the National Capital Area Skeptics, with the permission of the Regents of the University of Colorado, republished the *Scientific Study of Unidentified Flying Objects* on their web page. Under the direction of Jim Giglio, who worked for more than a year to bring this document to the web, and with the permission of the National Capital Area Skeptics, we present these excerpts—the first two sections of the publication—as a slice of twentieth-century history related to UFOs.

My own skepticism about the UFO phenomenon stems from a simple observation involving evolutionary biology: the extra-terrestrial inhabitants of UFOs are invariably described as remarkably similar to terrestrial primates—bilaterally symmetrical with two legs, two arms, two eyes, two ears, fingers and toes, a nose and a mouth. The probability of such creatures being anything like primates, let alone humans, is so remote as to not be worthy of further consideration. Of the hundreds of millions of species to have roamed the earth over the past three billion years, only gorillas, orangutans, chimps, bonobos, and humans have survived as living great apes, and only one species—us—has reached a level of intelligence and culture to achieve space flight. Is it really possible that the evolution of life on some other planet would so resemble ours as to produce another primate-like creature? No.

There is an additional problem, and that is the question of technological evolution. I first addressed this question in my January 2002 column in *Scientific American*, in an essay entitled "Shermer's Last Law." It is based on the famous three "laws" of the science fiction writer Arthur C. Clarke:

> *Clarke's First Law:* "When a distinguished but elderly scientist states that something is possible he is almost certainly right. When he states that something is impossible, he is very probably wrong."
> *Clarke's Second Law:* "The only way of discovering the limits of the possible is

to venture a little way past them into the impossible."

Clarke's Third Law: "Any sufficiently advanced technology is indistinguishable from magic."

This last observation stimulated me to think more on the impact the discovery of an Extra-Terrestrial Intelligence (ETI) would have on civilization. To that end I have immodestly proposed Shermer's Last Law (I don't believe in naming laws after oneself, so as the good book warns, the last shall be first and the first shall be last): *Any sufficiently advanced ETI is indistinguishable from God.*

God is typically described by Western religions as omniscient and omnipotent. Since we are far from the mark on these traits, how could we possibly distinguish a God who has them absolutely, from an ETI who has them in relatively (to us) copious amounts? Thus, we would be unable to distinguish between absolute and relative omniscience and omnipotence. But if God were only relatively more knowing and powerful than us, then by definition it *would* be an ETI! Consider two observations and one deduction:

1. Biological evolution operates at a snail's pace compared to technological evolution (the former is Darwinian and requires generations of differential reproductive success, the latter is Lamarckian and can be implemented within a single generation). 2. The cosmos is very big and space is very empty (*Voyager I*, our most distant spacecraft, hurtling along at over 38,000 mph, will not reach the distance of even our sun's nearest neighbor, the Alpha Centauri system that it is *not* even headed toward, for over 75,000 years). Ergo, the probability of an ETI who is only slightly more advanced than us and also makes contact is virtually nil. If we ever do find ETI it will be as if a million-year-old *Homo erectus* were dropped into the middle of Manhattan, given a computer and cell phone, and instructed to communicate with us. ETI would be to us as we would be to this early hominid—godlike.

Science and technology have changed our world more in the past century than it changed in the previous hundred centuries. It took 10,000 years to get from the cart to the airplane, but only 66 years to get from powered flight to a lunar landing. Moore's Law of computer power doubling every eighteen months continues unabated and is now down to about a year. Ray Kurzweil, in *The Age of Spiritual Machines*, calculates that there have been thirty-two doublings since World War II, and that the Singularity point may be upon us as early as 2030. The Singularity (as in the center of a black hole where matter is so dense that its gravity is infinite) is the point at which total computational power will rise to levels that are so far beyond anything that we can imagine that they will appear near infinite and thus, relatively speaking, be indistinguishable from omniscience (note the suffix!).

When this happens the world will change more in a decade than it did in the previous thousand decades. Extrapolate that out a hundred thousand years, or a million years (an eye blink on an evolutionary time scale and thus a realistic estimate of how far advanced ETI will be, unless we happen to be the first space-faring species, which is unlikely), and we get a gut-wrenching, mind-warping feel for just how godlike these creatures would seem.

In Clarke's 1953 novel *Childhood's End*, humanity reaches something like a Singularity (with help from ETIs) and must make the transition to a higher state of consciousness in order to grow out of childhood. One character early in the novel opines that "science can destroy religion by ignoring it as well as by disproving its tenets. No one ever demonstrated, so far as I am aware, the nonexistence of Zeus or Thor, but they have few followers now."

Although science has not even remotely destroyed religion, Shermer's Last Law predicts that the relationship between the two will be

profoundly affected by contact with ETI. To find out how we must follow Clarke's Second Law, venturing courageously past the limits of the possible and into the unknown. Ad astra!

This is best done, in my opinion, through the SETI program, the Search for Extra-Terrestrial Intelligence using radio telescopes in the hopes of detecting a signal from an ETI, rather than a close encounter of the third kind. Thus, I agree with the final conclusion of the Condon report, as summarized in "Section I Conclusions and Recommendations":

> We believe that the existing record and the results of the Scientific Study of Unidentified Flying Objects of the University of Colorado, which are presented in detail in subsequent sections of this report, support the conclusions and recommendations which follow.
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> As indicated by its title, the emphasis of this study has been on attempting to learn from UFO reports anything that could be considered as adding to scientific knowledge. Our general conclusion is that nothing has come from the study of UFOs in the past 21 years that has added to scientific knowledge. Careful consideration of the record as it is available to us leads us to conclude that further extensive study of UFOs probably cannot be justified in the expectation that science will be advanced thereby.
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> It has been argued that this lack of contribution to science is due to the fact that very little scientific effort has been put on the subject. We do not agree. We feel that the reason that there has been very little scientific study of the subject is that those scientists who are most directly concerned, astronomers, atmospheric physicists, chemists, and psychologists, having had ample opportunity to look into the matter, have individually decided that UFO phenomena do not offer a fruitful field in which to look for major scientific discoveries.
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> The question remains as to what, if anything, the federal government should do about the UFO reports it receives from the general public. We are inclined to think that nothing should be done with them in the expectation that they are going to contribute to the advance of science.
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> This question is inseparable from the question of the national defense interest of these reports. The history of the past 21 years has repeatedly led Air Force officers to the conclusion that none of the things seen, or thought to have been seen, which pass by the name of UFO reports, constituted any hazard or threat to national security.
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> It has been contended that the subject has been shrouded in official secrecy. We conclude otherwise. We have no evidence of secrecy concerning UFO reports. What has been miscalled secrecy has been no more than an intelligent policy of delay in releasing data so that the public does not become confused by premature publication of incomplete studies of reports.
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> The subject of UFOs has been widely misrepresented to the public by a small number of individuals who have given sensationalized presentations in writings and public lectures. So far as we can judge, not many people have been misled by such irresponsible behavior, but whatever effect there has been has been bad.

Scientific Study of Unidentified Flying Objects

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Conducted by the University of Colorado under contract No. 44620-67-C-0035 with the United States Air Force

Section II Summary of the Study

1. Origin of the Colorado Project. The decision to establish this project for the Scientific Study of Unidentified Flying Objects stems from recommendations in a report dated March 1966 of an Ad Hoc Committee of the Air Force Scientific Advisory Board set up under the chairmanship of Dr. Brian O'Brien to review the work of Project Blue Book. Details of the history of work on UFOs are set forth in Section V, Chapter 2. (See also Appendix A.)

The recommendation was:

It is the opinion of the Committee that the present Air Force program dealing with UFO sightings has been well organized, although the resources assigned to it (only one officer, a sergeant, and a secretary) have been quite limited. In 19 years and more than 10,000 sightings recorded and classified, there appears to be no verified and fully satisfactory evidence of any case that is clearly outside the framework of presently known science and technology. Nevertheless, there is always the possibility that analysis of new sightings may provide some additions to scientific knowledge of value to the Air Force. Moreover, some of the case records at which the Committee looked that were listed as "identified" were sightings where the evidence collected was too meager or too indefinite to permit positive listing in the identified category. Because of this the Committee recommends that the present program be strengthened to provide opportunity for scientific investigation of selected sightings in more detail than has been possible to date.

To accomplish this it is recommended that:

A. Contracts be negotiated with a few selected universities to provide scientific teams to investigate promptly and in depth certain selected sightings of UFO's. Each team should include at least one psychologist, preferably one interested in clinical psychology, and at least one physical scientist, preferably an astronomer or geophysicist familiar with atmospheric physics. The universities should be chosen to provide good geographical distribution, and should be within convenient distance of a base of the Air Force Systems Command (AFSC).

B. At each AFSC base an officer skilled in investigation (but not necessarily with scientific training) should be designated to work with the corresponding university team for that geographical section. The local representative of the Air Force Office of Special Investigations (OSI) might be a logical choice for this.

C. One university or one not-for-profit organization should be selected to coordinate the work of the teams mentioned under A above, and also to make certain of very close communication and coordination with the office of Project Blue Book.

It is thought that perhaps 100 sightings a year might be subjected to this close study, and that possibly an average of 10 man days might be required per sighting so studied. The information provided by such a program might bring to light new facts of scientific value, and would almost certainly provide a far better basis than we have today for decision on a long term UFO program.

These recommendations were referred by the Secretary of the Air Force to the Air Force Office of Scientific Research for implementation, which, after study, decided to combine recommendations A and C so as to have a single contracting university with authority to subcontract with other research groups as needed. Recommendation B was implemented by the issuance of Air Force Regulation 80-17 (Appendix B) which establishes procedures for handling UFO reports at the Air Force bases.

In setting up the Colorado project, as already stated in Section I, the emphasis was on whether deeper study of unidentified flying objects might provide some "additions to scientific knowledge."

After considering various possibilities, the AFOSR staff decided to ask the University of

Colorado to undertake the project (see Preface). Dr. J. Thomas Ratchford visited Boulder in late July 1966 to learn whether the University would be willing to undertake the task. A second meeting was held on 10 August 1966 in which the scope of the proposed study was outlined to an interested group of the administrative staff and faculty of the University by Dr. Ratchford and Dr. William Price, executive director of AFOSR. After due deliberation, University officials decided to undertake the project.

The contract provided that the planning, direction and conclusions of the Colorado project were to be conducted wholly independently of the Air Force. To avoid duplication of effort, the Air Force was ordered to furnish the project with the records of its own earlier work and to provide the support of personnel at AF bases when requested by our field teams.

We were assured that the federal government would withhold no information on the subject, and that all essential information about UFOs could be included in this report. Where UFO sightings involve classified missile launchings or involve the use of classified radar systems, this fact is merely stated as to do more would involve violation of security on these military subjects. In our actual experience these reservations have affected a negligible fraction of the total material and have not affected the conclusions (Section I) which we draw from our work.

The first research contract with AFOSR provided $313,000 for the first 15 months from 1 November 1966 to 31 January 1968. The contract was publicly announced on 7 October 1966. It then became our task to investigate those curious entities distinguished by lack of knowledge of what they are, rather than in terms of what they are known to be, namely, unidentified flying objects.

2. Definition of an UFO. An unidentified flying object (UFO, pronounced OOFO) is here defined as the stimulus for a report made by one or more individuals of something seen in the sky (or an object thought to be capable of flight but when landed on the earth) which the observer could not identify as having an ordinary natural origin, and which seemed to him sufficiently puzzling that he undertook to make a report of it to police, to government officials, to the press, or perhaps to a representative of a private organization devoted to the study of such objects.

Defined in this way, there is no question as to the existence of UFOs, because UFO reports exist in fairly large numbers, and the stimulus for each report is, by this definition, an UFO. The problem then becomes that of learning to recognize the various kinds of stimuli that give rise to UFO reports.

The UFO is "the stimulus for a report . . ." This language refrains from saying whether the reported object was a real, physical, material thing, or a visual impression of an ordinary physical thing distorted by atmospheric conditions or by faulty vision so as to be unrecognizable, or whether it was a purely mental delusion existing in the mind of the observer without an accompanying visual stimulus.

The definition includes insincere reports in which the alleged sighter undertakes for whatever reason to deceive. In the case of a delusion, the reporter is not aware of the lack of a visual stimulus. In the case of a deception, the reporter knows that he is not telling the truth about his alleged experience.

The words "which he could not identify" are of crucial importance. The stimulus gives rise to an UFO report precisely because the observer could not identify the thing seen. A woman and her husband reported a strange thing seen flying in the sky and reported quite correctly that she knew "it was unidentified because neither of us knew what it was."

The thing seen and reported may have been an object as commonplace as the planet Venus, but it became an UFO because the observer did

not know what it was. With this usage it is clear that less well informed individuals are more likely to see an UFO than those who are more knowledgeable because the latter are better able to make direct identification of what they see. A related complication is that less well informed persons are often inaccurate observers who are unable to give an accurate account of what they believe that they have seen.

If additional study of a report later provides an ordinary interpretation of what was seen, some have suggested that we should change its name to IFO, for identified flying object. But we have elected to go on calling it an UFO because some identifications are tentative or controversial, due to lack of sufficient data on which to base a definite identification. A wide variety of ordinary objects have through misinterpretation given rise to UFO reports. This topic is discussed in detail in Section VI, Chapter 2. (The Air Force has published a pamphlet entitled, "Aids to Identification of Flying Objects" [USAF, 1968] which is a useful aid in the interpretation of something seen which might otherwise be an UFO.)

The words "sufficiently puzzling that they undertook to make a report" are essential. As a practical matter, we can not study something that is not reported, so a puzzling thing seen but not reported is not here classed as an UFO.

3. UFO Reports. In our experience, the persons making reports seem in nearly all cases to be normal, responsible individuals. In most cases they are quite calm, at least by the time they make a report. They are simply puzzled about what they saw and hope that they can be helped to a better understanding of it. Only a very few are obviously quite emotionally disturbed, their minds being filled with pseudo-scientific, pseudo-religious or other fantasies. Cases of this kind range from slight disturbance to those who are manifestly in need of psychiatric care. The latter form an extremely small minority of all the persons encountered in this study. While the existence of a few mentally unbalanced persons among UFO observers is part of the total situation, it is completely incorrect and unfair to imply that all who report UFOs are "crazy kooks," just as it is equally incorrect to ignore the fact that there are mentally disturbed persons among them.

Individuals differ greatly as to their tendency to make reports. Among the reasons for not reporting UFOs are apathy, lack of awareness of public interest, fear of ridicule, lack of knowledge as to where to report and the time and cost of making a report.

We found that reports are not useful unless they are made promptly. Even so, because of the short duration of most UFO stimuli, the report usually can not be made until after the UFO has disappeared. A few people telephoned to us from great distances to describe something seen a year or two earlier. Such reports are of little value.

Early in the study we tried to estimate the fraction of all of the sightings that are reported. In social conversations many persons could tell us about some remarkable and puzzling thing that they had seen at some time in the past which would sound just as remarkable as many of the things that are to be found in UFO report files. Then we would ask whether they had made a report and in most cases would be told that they had not. As a rough guess based on this uncontrolled sample, we estimate that perhaps 10% of the sightings that people are willing to talk about later are all that get reported at the time. This point was later covered in a more formal public attitude survey (Section III, Chapter 7) made for this study in which only 7% of those who said they had seen an UFO had reported it previously. Thus if all people reported sightings that are like those that some people do report, the number of reports that would be received would be at least ten times greater than the number actually received.

At first we thought it would be desirable to undertake an extensive publicity campaign to try to get more complete reporting from the public. It was decided not to do this, because about 90% of all UFO reports prove to be quite plausibly related to ordinary objects. A tenfold increase in the number of reports would have multiplied by ten the task of eliminating the ordinary cases which would have to be analyzed. Our available resources for field study enabled us to deal only with a small fraction of the reports coming in. No useful purpose would have been served under these circumstances by stimulating the receipt of an even greater number.

Study of records of some UFO reports from other parts of the world gave us the strong impression that these were made up of a mix of cases of similar kind to those being reported in the United States. For example, in August 1967 Prof. James McDonald of Arizona made a 20-day trip to Australia, Tasmania and New Zealand in the course of which he interviewed some 80 persons who had made UFO reports there at various times. On his return he gave us an account of these experiences that confirmed our impression that the reports from these other parts of the world were, as a class, similar to those being received in the United States. Therefore we decided to restrict our field studies to the United States and to one or two cases in Canada. (See Section III, Chapter 1.) This was done on the practical grounds of reducing travel expense and of avoiding diplomatic and language difficulties. The policy was decided on after preliminary study had indicated that in broad generality the spectrum of kinds of UFO reports being received in other countries was very similar to our own.

4. Prologue to the Project. Official interest in UFOs, or "flying saucers" as they were called at first dates from June 1947. On 24 June, Kenneth Arnold, a business man of Boise, Idaho was flying a private airplane near Mt. Rainier, Washington. He reported seeing a group of objects flying along in a line which he said looked "like pie plates skipping over the water." The newspaper reports called the things seen "flying saucers" and they have been so termed ever since, although not all UFOs are described as being of this shape.

Soon reports of flying saucers were coming in from various parts of the country. Many received prominent press coverage (Bloecher, 1967). UFOs were also reported from other countries; in fact, more than a thousand such reports were made in Sweden in 1946.

The details of reports vary so greatly that it is impossible to relate them all to any single explanation. The broad range of things reported is much the same in different countries. This means that a general explanation peculiar to any one country has to be ruled out, since it is utterly improbable that the secret military aircraft of any one country would be undergoing test flights in different countries. Similarly it is most unlikely that military forces of different countries would be testing similar developments all over the world at the same time in secrecy from each other.

Defense authorities had to reckon with the possibility that UFOs might represent flights of a novel military aircraft of some foreign power. Private citizens speculated that the UFOs were test flights of secret American aircraft. Cognizance of the UFO problem was naturally assumed by the Department of the Air Force in the then newly established Department of Defense. Early investigations were carried on in secrecy by the Air Force, and also by the governments of other nations.

Such studies in the period 1947–52 convinced the responsible authorities of the Air Force that the UFOs, as observed up to that time, do not constitute a threat to national security. In consequence, ever since that time, a minimal amount of attention has been given to them.

The year 1952 brought an unusually large

number of UFO reports, including many in the vicinity of the Washington National Airport, during a period of several days in July. Such a concentration of reports in a small region in a short time is called a "flap." The Washington flap of 1952 received a great deal of attention at the time (Section III, Chapters).

At times in 1952, UFO reports were coming in to the Air Force from the general public in such numbers as to produce some clogging of military communications channels. It was thought that an enemy planning a sneak attack might deliberately stimulate a great wave of UFO reports for the very purpose of clogging communication facilities. This consideration was in the forefront of a study that was made in January 1953 by a panel of scientists under the chairmanship of the late H. P. Robertson, professor of mathematical physics at the California Institute of Technology (Section V, Chapter 2). This panel recommended that efforts be made to remove the aura of mystery surrounding the subject and to conduct a campaign of public education designed to produce a better understanding of the situation. This group also concluded that there was no evidence in the available data of any real threat to national security.

Since 1953 the results of UFO study have been unclassified, except where tangential reasons exist for withholding details, as, for example, where sightings are related to launchings of classified missiles, or to the use of classified radar systems.

During the period from March 1952 to the present, the structure for handling UFO reports in the Air Force has been called Project Blue Book. As already mentioned the work of Project Blue Book was reviewed in early 1966 by the committee headed by Dr. Brian O'Brien. This review led to the reaffirmation that no security threat is posed by the existence of a few unexplained UFO reports, but the committee suggested a study of the possibility that something of scientific value might come from a more detailed study of some of the reports than was considered necessary from a strictly military viewpoint. This recommendation eventuated in the setting up of the Colorado project.

The story of Air Force interest, presented in Section V, Chapter 2, shows that from the beginning the possibility that some UFOs might be manned vehicles from outer space was considered, but naturally no publicity was given to this idea because of the total lack of evidence for it.

Paralleling the official government interest, was a burgeoning of amateur interest stimulated by newspaper and magazine reports. By 1950 popular books on the subject began to appear on the newsstands. In January 1950 the idea that UFOs were extraterrestrial vehicles was put forward as a reality in an article entitled "Flying Saucers are Real" in *True* magazine written by Donald B. Keyhoe, a retired Marine Corps major. Thereafter a steady stream of sensational writing about UFOs has aroused a considerable amount of interest among laymen in studying the subject.

Many amateur organizations exist, some of them rather transiently, so that it would be difficult to compile an accurate listing of them. Two such organizations in the United States have a national structure. These are the Aerial Phenomena Research Organization (APRO), with headquarters in Tucson, Arizona, claiming about 8000 members; and the National Investigations Committee for Aerial Phenomena (NICAP) with headquarters in Washington, D.C., and claiming some 12,000 members. James and Coral Lorenzen head APRO, while Keyhoe is the director of NICAP, which, despite the name and Washington address is not a government agency. Many other smaller groups exist, among them Saucers and Unexplained Celestial Events Research Society (SAUCERS) operated by James Moseley.

Of these organizations, NICAP devotes a considerable amount of its attention to attack-

ing the Air Force and to trying to influence members of Congress to hold hearings and in other ways to join in these attacks. It maintained a friendly relation to the Colorado project during about the first year, while warning its members to be on guard lest the project turn out to have been "hired to whitewash the Air Force." During this period NICAP made several efforts to influence the course of our study. When it became clear that these would fail, NICAP attacked the Colorado project as "biased" and therefore without merit.

The organizations mentioned espouse a scientific approach to the study of the subject. In addition there are a number of others that have a primarily religious orientation.

From 1947 to 1966 almost no attention was paid to the UFO problem by well qualified scientists. Some of the reasons for this lack of interest have been clearly stated by Prof. Gerard P. Kuiper of the University of Arizona (Appendix C). Concerning the difficulty of establishing that some UFOs may come from outer space, he makes the following cogent observation: "The problem is more difficult than finding a needle in a haystack; it is finding a piece of extraterrestrial hay in a terrestrial haystack, often on the basis of reports of believers in extra-terrestrial hay."

5. Initial Planning. A scientific approach to the UFO phenomenon must embrace a wide range of disciplines. It involves such physical sciences as physics, chemistry, aerodynamics, and meteorology. Since the primary material consists mostly of reports of individual observers, the psychology of perception, the physiology of defects of vision, and the study of mental states are also involved.

Social psychology and social psychiatry are likewise involved in seeking to understand group motivations which act to induce belief in extraordinary hypotheses on the basis of what most scientists and indeed most laymen would regard as little or no evidence. These problems of medical and social psychology deserve more attention than we were able to give them. They fell distinctly outside of the field of expertise of our staff, which concentrated more on the study of the UFOs themselves than on the personal and social problems generated by them.

Among those who write and speak on the subject, some strongly espouse the view that the federal government really knows a great deal more about UFOs than is made public. Some have gone so far as to assert that the government has actually captured extraterrestrial flying saucers and has their crews in secret captivity, if not in the Pentagon, then at some secret military base. We believe that such teachings are fantastic nonsense, that it would be impossible to keep a secret of such enormity over two decades, and that no useful purpose would be served by engaging in such an alleged conspiracy of silence. One person with whom we have dealt actually maintains that the Air Force has nothing to do with UFOs, claiming that this super-secret matter is in the hands of the Central Intelligence Agency which, he says, installed one of its own agents as scientific director of the Colorado study. This story, if true, is indeed a well kept secret. These allegations of a conspiracy on the part of our own government to conceal knowledge of the existence of "flying saucers" have, so far as any evidence that has come to our attention, no factual basis whatever.

The project's first attention was given to becoming familiar with past work in the subject. This was more difficult than in more orthodox fields because almost none of the many books and magazine articles dealing with UFOs could be regarded as scientifically reliable. There were the two books of Donald H. Menzel, director emeritus of the Harvard College Observatory and now a member of the staff of the Smithsonian Astrophysical Observatory (Menzel, 1952 and Boyd, 1963). Two other useful books were *The UFO Evidence* (1964), a

compilation of UFO cases by Richard Hall, and *The Report on Unidentified Flying Objects* by E. J. Ruppelt (1956), the first head of Project Blue Book. In this initial stage we were also helped by "briefings" given by Lt. Col. Hector Quintanilla, the present head of Project Blue Book, Dr. J. Allen Hynek, astronomical consultant to Project Blue Book, and by Donald Keyhoe and Richard Hall of NICAP.

Out of this preliminary study came the recognition of a variety of topics that would require detailed attention. These included the effects of optical mirages, the analogous anomalies of radio wave propagation as they affect radar, critical analysis of alleged UFO photographs, problems of statistical analysis of UFO reports, chemical analysis of alleged material from UFOs, and reports of disturbances to automobile ignition and to headlights from the presence of UFOs. Results of the project's study of these and other topics are presented in this section and in Sections III and VI of this report.

6. Field Investigations. Early attention was given to the question of investigation of individual cases, either by detailed critical study of old records or by field trip investigation of current cases. From this study we concluded that there was little to be gained from the study of old cases, except perhaps to get ideas on mistakes to be avoided in studies of new cases. We therefore decided not to make field trips to investigate cases that were more than a year old, although in a few cases we did do some work on such cases when their study could be combined with a field investigation of a new case.

At first we hoped that field teams could respond to early warning so quickly that they would be able to get to the site while the UFO was still there, and that our teams would not only get their own photographs, but even obtain spectrograms of the light of the UFO, and make radioactive, magnetic, and sound measurements while the UFO was still present.

Such expectations were found to be in vain. Nearly all UFO sightings are of very short duration, seldom lasting as long as an hour and usually lasting for a few minutes. The observers often become so excited that they do not report at all until the UFO has gone away. With communication and travel delays, the field team was unable to get to the scene until long after the UFO had vanished.

This was, of course, a highly unsatisfactory situation. We gave much thought to how it could be overcome and concluded that this could only be done by a great publicity campaign designed to get the public to report sightings much more promptly than it does, coupled with a nationwide scheme of having many trained field teams scattered at many points across the nation. These teams would have had to be ready to respond at a moment's notice. Even so, in the vast majority of the cases, they would not have arrived in time for direct observation of the reported UFO. Moreover, the national publicity designed to insure more prompt reporting would have had the effect of arousing exaggerated public concern over the subject, and certainly would have vastly increased the number of nonsense reports to which response would have had to be made. In recruiting the large number of field teams, great care would have had to be exercised to make sure that they were staffed with people of adequate scientific training, rather than with persons emotionally committed to extreme pro or con views on the subject.

Clearly this was quite beyond the means of our study. Such a program to cover the entire United States would cost many millions of dollars a year, and even then there would have been little likelihood that anything of importance would have been uncovered.

In a few cases some physical evidence could be gathered by examination of a site where an UFO was reported to have landed. In such a case it did not matter that the field team arrived after the UFO had gone. But in no case did we

obtain any convincing evidence of this kind although every effort was made to do so. (See below and in Section III, Chapters 3 and 4.)

Thus most of the field investigation, as it turned out, consisted in the interviewing of persons who made the report. By all odds the most used piece of physical equipment was the tape recorder.

The question of a number of investigators on a field team was an important one. In most work done in the past by the Air Force, UFO observers were interviewed by a single Air Force officer, who usually had no special training and whose freedom to devote much time to the study was limited by the fact that he also had other responsibilities. When field studies are made by amateur organizations like APRO or NICAP, there are often several members present on a team, but usually they are persons without technical training, and often with a strong bias toward the sensational aspects of the subject.

Prof. Hynek strongly believes that the teams should have four or more members. He recommends giving each report what he calls the "FBI treatment," by which he means not only thorough interviewing of the persons who made the report, but in addition an active quest in the neighborhood where the sighting occurred to try to discover additional witnesses. Against such thoroughness must be balanced the consideration that the cost per case goes up proportionately to the number of persons in a team, so that the larger the team, the fewer the cases that can be studied.

The detailed discussions in Section III, Chapter 1 and in Section IV make it clear that the field work is associated with many frustrations. Many of the trips turn out to be wild goose chases and the team members often feel as if they are members of a fire department that mostly answers false alarms.

We found that it was always worthwhile to do a great deal of initial interviewing by long distance telephone. A great many reports that seem at first to be worthy of full field investigation could be disposed of in this way with comparatively little trouble and expense. Each case presented its own special problems. No hard-and-fast rule was found by which to decide in advance whether a particular report was worth the trouble of a field trip.

After careful consideration of these various factors, we decided to operate with two-man teams, composed whenever possible of one person with training in physical science and one with training in psychology. When the study became fully operational in 1967 we had three such teams. Dr. Roy Craig describes the work of these teams in Section III, Chapters 1, 3, and 4. Reports of field investigations are presented in Section IV.

7. Explaining UFO Reports. By definition UFOs exist because UFO reports exist. What makes the whole subject intriguing is the possibility that some of these reports cannot be reconciled with ordinary explanations, so that some extraordinarily sensational explanation for them might have to be invoked. A fuller discussion of some misinterpretations of ordinary events by Dr. W. K. Hartmann is given in Section VI, Chapter 2.

A great many reports are readily identified with ordinary phenomena seen under unusual circumstances, or noted by someone who is an inexperienced, inept, or unduly excited observer. Because such reports are vague and inaccurate, it is often impossible to make an identification with certainty.

This gives rise to controversy. In some cases, an identification that the UFO was "probably" an aircraft is all that can be made from the available data. After the event no amount of further interviewing of one or more witnesses can usually change such a probable into a certain identification. Field workers who would like to identify as many as possible are naturally disposed to claim certainty when this is at all possible, but others who desire to have a

residue of unexplained cases in order to add mystery and importance to the UFO problem incline to set impossibly high standards of certainty in the evidence before they are willing to accept a simple explanation for a report.

This dilemma is nicely illustrated by a question asked in the House of Commons of Prime Minister Harold Wilson, as reported in *Hansard* for 19 December 1967:

> Unidentified Flying Objects. Question 14. Sir J. Langford-Holt asked the Prime Minister whether he is satisfied that all sightings of unidentified flying objects which are reported from service sources are explainable, what inquiries he has authorized into these objects outside the defense aspect, and whether he will now appoint one Minister to look into all aspects of reports.
>
> The Prime Minister: The answers are "Yes, except when the information given is insufficient," "None" and "No."

Obviously there is a nice bit of semantics here in that the definition of "when the information is sufficient" is that it is sufficient when an explanation can be given.

Discussions of whether a marginal case should be regarded for statistical purposes as having been explained or not have proved to be futile. Some investigators take the position that, where a plausible interpretation in terms of commonplace events can be made, then the UFO is regarded as having been identified. Others take the opposite view that an UFO cannot be regarded as having been given an ordinary identification unless there is complete and binding evidence amounting to certainty about the proposed identification.

For example, in January 1968 near Castle Rock, Colo., some 30 persons reported UFOs, including spacecraft with flashing lights, fantastic maneuverability, and even with occupants presumed to be from outer space. Two days later it was more modestly reported that two high school boys had launched a polyethylene hot-air balloon.

Locally that was the end of the story. But there is a sequel. A man in Florida makes a practice of collecting newspaper stories about UFOs and sending them out in a mimeographed UFO news letter which he mails to various UFO journals and local clubs. He gave currency to the Castle Rock reports but not to the explanation that followed. When he was chided for not having done so, he declared that no one could be *absolutely* sure that *all* the Castle Rock reports arose from sightings of the balloon. There might also have been an UFO from outer space among the sightings. No one would dispute his logic, but one may with propriety wonder why he neglected to tell his readers that at least *some* of the reports were actually misidentifications of a hot-air balloon.

As a practical matter, we take the position that if an UFO report can be plausibly explained in ordinary terms, then we accept that explanation even though not enough evidence may be available to prove it beyond all doubt. This point is so important that perhaps an analogy is needed to make it clear. Several centuries ago, the most generally accepted theory of human disease was that it was caused by the patient's being possessed or inhabited by a devil or evil spirit. Different diseases were supposed to be caused by different devils. The guiding principle for medical research was then the study and classification of different kinds of devils, and progress in therapy was sought in the search for and discovery of means for exorcising each kind of devil.

Gradually medical research discovered bacteria; toxins and viruses, and their causative relation to various diseases. More and more diseases came to be described by their causes.

Suppose now that instead, medicine had clung to the devil theory of disease. As long as there exists one human illness that is not yet fully understood in modern terms such a theory cannot be disproved. It is always possible,

while granting that some diseases are caused by viruses, etc. to maintain that those that are not yet understood are the ones that are really caused by devils.

In some instances the same sort of UFO is observed night after night under similar circumstances. In our experience this has been a sure sign that the UFO could be correlated with some ordinary phenomenon.

For example, rather early in our work, a Colorado farmer reported seeing an UFO land west of his farm nearly every evening about 6:00 p.m. A field team went to see him and quickly and unambiguously identified the UFO as the planet Saturn. The nights on which he did not see it land were those in which the western sky was cloudy.

But the farmer did not easily accept our identification of his UFO as Saturn. He contended that, while his UFO had landed behind the mountains on the particular evening that we visited him, on most nights, he insisted, it landed in front of the mountains, and therefore could not be a planet. The identification with Saturn from the ephemeris was so precise that we did not visit his farm night after night in order to see for ourselves whether his UFO ever landed in front of the mountains. We did not regard it as part of our duty to persuade observers of the correctness of our interpretations. In most cases observers readily accepted our explanation, and some expressed relief at having an everyday explanation available to them.

We sought to hold to a minimum delays in arriving at the site of an UFO report, even where it was clear that it was going to be impossible to get there in time actually to see the reported UFO. Once an observer made a report, the fact of his having done so usually becomes known to friends and neighbors, local newspapermen, and local UFO enthusiasts. The witness becomes the center of attention and will usually have told his story over and over again to such listeners, before the field team can arrive. With each telling of the story it is apt to be varied and embellished a little. This need not be from dishonest motives. We all like to tell an interesting story. We would rather not bore our listeners if we can help it, so embellishment is sometimes added to maximize the interest value of the narration.

It is not easy to detect how a story has grown under retelling in this way. Listeners usually will have asked leading questions and the story will have developed in response to such suggestions, so that it soon becomes impossible for the field team to hear the witness's story as he told it the first time. In some cases when the witness had been interviewed in this way by local UFO enthusiasts, his story was larded with vivid language about visitors from outer space that was probably not there in the first telling.

Another kind of difficulty arises in interviewing multiple associated witnesses, that is, witnesses who were together at the time that all of them saw the UFO. Whenever several individuals go through an exciting experience together, they are apt to spend a good deal of time discussing it afterward among themselves, telling and retelling it to each other, unconsciously ironing out discrepancies between their various recollections, and gradually converging on a single uniform account of the experience. Dominant personalities will have contributed more to the final version than the less dominant. Thus the story told by a group of associated witnesses who have had ample opportunity to "compare notes" will be more uniform than the accounts these individuals would have given if interviewed separately before they had talked the matter over together.

One of the earliest of our field trips (December 1966) was made to Washington, D.C. to interview separately two air traffic control operators who had been involved in the great UFO flap there in the summer of 1952. Fourteen years later, these two men were still quite annoyed at the newspaper publicity they had re-

ceived, because it had tended to ridicule their reports. Our conclusion from this trip was that these men were telling in 1966 stories that were thoroughly consistent with the main points of their stories as told in 1952. Possibly this was due to the fact that because of their strong emotional involvement they had recounted the incident to many persons at many times over the intervening years. Although it was true that the stories had not changed appreciably in 14 years, it was also true for this very reason that we acquired no new material by interviewing these men again. (See Section III, Chapter 5.)

On the basis of this experience we decided that it was not profitable to devote much effort to re-interviewing persons who had already been interviewed rather thoroughly at a previous time. We do not say that nothing can be gained in this way, but merely that it did not seem to us that this would be a profitable way to spend our effort in this study.

In our experience those who report UFOs are often very articulate, but not necessarily reliable. One evening in 1967 a most articulate gentleman told us with calm good manners all of the circumstances of a number of UFOs he had seen that had come from outer space, and in particular went into some detail about how his wife's grandfather had immigrated to America from the Andromeda nebula, a galaxy located 2,000,000 light years from the earth.

In a few cases study of old reports may give the investigator a clue to a possible interpretation that had not occurred to the original investigator. In such a case, a later interview of the witness may elicit new information that was not brought out in the earlier interview. But we found that such interviews need to be conducted with great care as it is easily possible that the "new" information may have been generated through the unconscious use of leading questions pointing toward the new interpretation, and so may not be reliable for that reason.

8. Sources of UFO Reports. Usually the first report of an UFO is made to a local police officer or to a local news reporter. In some cases, members of UFO study organizations are sufficiently well known in the community that reports are made directly to them. In spite of the very considerable publicity that has been given to this subject, a large part of the public still does not know of the official Air Force interest.

Even some policemen and newsmen do not know of it and so do not pass on the UFO report. In other cases, we found that the anti–Air Force publicity efforts of some UFO enthusiasts had persuaded observers, who would otherwise have done so, not to report to the Air Force. We have already commented on the fact that for a variety of reasons many persons who do have UFO experiences do not report promptly.

Ideally the entire public would have known that each Air Force base must, according to AFR 80-17, have an UFO officer and would have reported promptly any extraordinary thing seen in the sky. Or, if this were too much to expect, then all police and news agencies would ideally have known of Air Force interest and would have passed information along to the nearest Air Force base. But none of these ideal things were true, and as a result our collection of UFO reports is extremely haphazard and incomplete.

When a report is made to an Air Force base, it is handled by an UFO officer whose form of investigation and report is prescribed by APR 80-17 (Appendix A). If the explanation of the report is immediately obvious and trivial—some persons will telephone a base to report a contrail from a high-flying jet that is particularly bright in the light of the setting sun—the UFO officer tells the person what it was he saw, and there the matter ends. No permanent record of such calls is made. As a result there is no record of the total number of UFO reports made to AF bases. Only those that require

more than cursory consideration are reported to Project Blue Book. Air Force officers are human, and therefore interpret their duty quite differently. Some went to great lengths not to submit a report. Others took special delight in reporting all of the "easy" ones out of a zealous loyalty to their service, because the more "identifieds" they turned in, the higher would be the over-all percentage of UFO reports explained. When in June 1967 Air Force UFO officers from the various bases convened in Boulder some of them quite vigorously debated the relative merits of these two different extreme views of their duty.

Many people have from time to time tried to learn something significant about UFOs by studying statistically the distribution of UFO reports geographically, in time, and both factors together. In our opinion these efforts have proved to be quite fruitless. The difficulties are discussed in Section VI, Chapter 10.

The geographical distribution of reports correlates roughly with population density of the non-urban population. Very few reports come from the densely populated urban areas. Whether this is due to urban sophistication or to the scattering of city lights is not known, but it is more probably the latter.

There apparently exists no single complete collection of UFO reports. The largest file is that maintained by Project Blue Book at Wright-Patterson Air Force Base, Ohio. Other files are maintained by APRO in Tucson and NICAP in Washington. The files of Project Blue Book are arranged by date and place of occurrence of the report, so that one must know these data in order to find a particular case. Proposals have been made from time to time for a computer-indexing of these reports by various categories but this has not been carried out. Two publications are available which partially supply this lack: one is *The UFO Evidence* (Hall, 1964) and the other is a collection of reports called *The Reference for Outstanding UFO Reports* (Olsen, n.d.).

We have already mentioned the existence of flaps, that is, the tendency of reports to come in clusters at certain times in certain areas. No quantitative study of this is available, but we believe that the clustering tendency is partly due to changing amounts of attention devoted to the subject by the news media. Publicity for some reports stimulates more reports, both because people pay more attention to the sky at such a time, and because they are more likely to make a report of something which attracts their attention.

In the summer of 1967 there was a large UFO flap in the neighborhood of Harrisburg, Pa. This may have been in part produced by the efforts of a local NICAP member working in close association with a reporter for the local afternoon newspaper who wrote an exciting UFO story for his paper almost daily. Curiously enough, the morning paper scarcely ever had an UFO story from which we conclude that one editor's news is another's filler. We stationed one of our investigators there during August with results that are described in Case 27.

Many UFO reports were made by the public to Olmsted Air Force Base a few miles south of Harrisburg, but when this base was deactivated during the summer UFO reports had to be made to McGuire Air Force Base near Trenton, N.J. This required a toll call, and the frequency of receipt of UFO reports from the Harrisburg area dropped abruptly.

For all of these various reasons, we feel that the fluctuations geographically and in time of UFO reports are so greatly influenced by sociological factors, that any variations due to changes in underlying physical phenomena are completely masked.

In sensational UFO journalism the statement is often made that UFOs show a marked tendency to be seen more often near military installations. There is no statistically significant evidence that this is true. For sensational writers, this alleged but unproven concentration of UFO sightings is taken as evidence that extra-

terrestrial visitors are reconnoitering our military defenses, preparatory to launching a military attack at some time in the future. Even if a slight effect of this kind were to be established by careful statistical studies, we feel that it could be easily accounted for by the fact that at every base men stand all night guard duty and so unusual things in the sky are more likely to be seen. Moreover civilians living near a military base are more likely to make a report to the base than those living at some distance from it.

AFR 80-17a directed UFO officers at each base to send to the Colorado project a duplicate of each report sent to Project Blue Book. This enabled us to keep track of the quality of the investigations and to be informed about puzzling uninterpreted cases. Such reporting was useful in cases whose study extended over a long period, but the slowness of receipt of such reports made this arrangement not completely satisfactory as a source of reports on the basis of which to direct the activity of our own field teams. A few reports that seemed quite interesting to Air Force personnel caused them to notify us by teletype or telephone. Some of our field studies arose from reports received in this way.

To supplement Air Force reporting, we set up our own Early Warning Network, a group of about 60 active volunteer field reporters, most of whom were connected with APRO or NICAP. They telephoned or telegraphed to us intelligence of UFO sightings in their own territory and conducted some preliminary investigation for us while our team was en route. Some of this cooperation was quite valuable. In the spring of 1968, Donald Keyhoe, director of NICAP, ordered discontinuation of this arrangement, but many NICAP field teams continued to cooperate.

All of these sources provided many more quickly reported, fresh cases than our field teams could study in detail. In consequence we had to develop criteria for quickly selecting which of the cases reported to us would be handled with a field trip (See Section III, Chapter 1.)

9. Extra-terrestrial Hypothesis. The idea that some UFOs may be spacecraft sent to Earth from another civilization, residing on another planet of the solar system, or on a planet associated with a more distant star than the Sun, is called the Extra-terrestrial Hypothesis (ETH). Some few persons profess to hold a stronger level of belief in the *actuality* of UFOs being visitors from outer space, controlled by intelligent beings, rather than merely of the *possibility*, not yet fully established as an observational fact. We shall call this level of belief ETA, for extraterrestrial actuality.

It is often difficult to be sure just what level of belief is held by various persons, because of the vagueness with which they state their ideas.

For example, addressing the American Society of Newspaper Editors in Washington on 22 April 1967, Dr. McDonald declared: "There is, in my present opinion, no sensible alternative to the utterly shocking hypothesis that the UFOs are extraterrestrial probes from somewhere else." Then in an Australian broadcast on 20 August 1967 McDonald said: ". . . you find yourself ending up with the seemingly absurd, seemingly improbable hypothesis that these things may come from somewhere else."

A number of other scientists have also expressed themselves as believers in ETH, if not ETA, but usually in more cautious terms.

The general idea of space travel by humans from Earth and visitors to Earth from other civilizations is an old one and has been the subject of many works of fiction. In the past 250 years the topic has been widely developed in science fiction. A fascinating account of the development of this literary form is given in *Pilgrims through Space and Time—Trends and Patterns in Scientific and Utopian Fiction* (Bailey, 1947).

The first published suggestion that some UFOs are visitors from other civilizations is contained in an article in *True*, entitled "Flying Saucers are Real" by Donald E. Keyhoe (1950).

Direct, convincing and unequivocal evidence of the truth of ETA would be the greatest single scientific discovery in the history of mankind. Going beyond its interest for science, it would undoubtedly have consequences of surpassing significance for every phase of human life. Some persons who have written speculatively on this subject, profess to believe that the supposed extraterrestrial visitors come with beneficent motives, to help humanity clean up the terrible mess that it has made. Others say they believe that the visitors are hostile. Whether their coming would be favorable or unfavorable to mankind, it is almost certain that they would make great changes in the conditions of human existence.

It is characteristic of most reports of actual visitors from outer space that there is no corroborating witness to the alleged incident, so that the story must be accepted, if at all, solely on the basis of belief in the veracity of the one person who claims to have had the experience. In the cases which we studied, there was only one in which the observer claimed to have had contact with a visitor from outer space. On the basis of our experience with that one, and our own unwillingness to believe the literal truth of the Villas-Boas incident, or the one from Truckee, Calif. reported by Prof. James Harder (see Section V, Chapter 2), we found that no direct evidence whatever of a convincing nature now exists for the claim that any UFOs represent spacecraft visiting Earth from another civilization.

Some persons are temperamentally ready, even eager, to accept ETA without clear observational evidence. One lady remarked, "It would be so wonderfully exciting if it were true!" It certainly would be exciting, but that does not make it true. When confronted with a proposition of such great import, responsible scientists adopt a cautiously critical attitude toward whatever evidence is adduced to support it. Persons without scientific training, often confuse this with basic opposition to the idea, with a biased desire or hope, or even of willingness to distort the evidence in order to conclude that ETA is not true.

The scientists' caution in such a situation does not represent opposition to the idea. It represents a determination not to accept the proposition as true in the absence of evidence that clearly, unambiguously and with certainty establishes its truth or falsity.

Scientifically it is not necessary—it is not even desirable—to adopt a position about the truth or falsity of ETA in order to investigate the question. There is a widespread misconception that scientific inquiry represents some kind of debate in which the truth is adjudged to be on the side of the team that has scored the most points. Scientists investigate an undecided proposition by seeking to find ways to get decisive observational material. Sometimes the ways to get such data are difficult to conceive, difficult to carry out, and so indirect that the rest of the scientific world remains uncertain of the probative value of the results for a long time. Progress in science can be painfully slow—at other times it can be sudden and dramatic. The question of ETA would be settled in a few minutes if a flying saucer were to land on the lawn of a hotel where a convention of the American Physical Society was in progress, and its occupants were to emerge and present a special paper to the assembled physicists, revealing where they came from, and the technology of how their craft operates. Searching questions from the audience would follow.

In saying that thus far no convincing evidence exists for the truth of ETA, no prediction is made about the future. If evidence appears soon after this report is published, that will not alter the truth of the statement that we do not *now* have such evidence. If new evidence ap-

pears later, this report can be appropriately revised in a second printing.

10. Intelligent Life Elsewhere. Whether there is intelligent life elsewhere (ILE) in the Universe is a question that has received a great deal of serious speculative attention in recent years. A good popular review of thinking on the subject is *We Are Not Alone* by Walter Sullivan (1964). More advanced discussions are *Interstellar Communications*, a collection of papers edited by A. G. W. Cameron (1963), and *Intelligent Life in the Universe* (Shklovskii and Sagan, 1966). Thus far we have no observational evidence whatever on the question, so therefore it remains open. An early unpublished discussion is a letter of 13 December 1948 of J. E. Lipp to Gen. Donald Putt (Appendix D). This letter is Appendix D of the Project Sign report dated February 1949 from Air Materiel Command Headquarters No. F-TR-2274-IA.

The ILE question has some relation to the ETH or ETA for UFOs as discussed in the preceding section. Clearly, if ETH is true, then ILE must also be true because some UFOs have then to come from some unearthly civilization. Conversely, if we could know conclusively that ILE does not exist, then ETH could not be true. But even if ILE exists, it does not follow that the ETH is true.

For it could be that the ILE, though existent, might not have reached a stage of development in which the beings have the technical capacity or the desire to visit the Earth's surface. Much speculative writing assumes implicitly that intelligent life progresses steadily both in intellectual and in its technological development. Life began on Earth more than a billion years ago, whereas the known geological age of the Earth is some five billion years, so that life in any form has only existed for the most recent one-fifth of the Earth's life as a solid ball orbiting the Sun. Man as an intelligent being has only lived on Earth for some 5,000 years, or about one-millionth of the Earth's age. Technological development is even more recent. Moreover the greater part of what we think of as advanced technology has only been developed in the last 100 years. Even today we do not yet have a technology capable of putting men on other planets of the solar system. Travel of men over interstellar distances in the foreseeable future seems now to be quite out of the question (Purcell, 1960; Markowitz, 1967).

The dimensions of the universe are hard for the mind of man to conceive. A light-year is the distance light travels in one year of 31.56 million seconds, at the rate of 186,000 miles per second, that is, a distance of 5.88 million million miles. The nearest known star is at a distance of 4.2 light-years.

Fifteen stars are known to be within 11.5 light-years of the Sun. Our own galaxy, the Milky Way, is a vast flattened distribution of some 10^{11} stars about 80,000 light-years in diameter, with the Sun located about 26,000 light-years from the center. To gain a little perspective on the meaning of such distances relative to human affairs, we may observe that the news of Christ's life on Earth could not yet have reached as much as a tenth of the distance from the Earth to the center of our galaxy.

Other galaxies are inconceivably remote. The faintest observable galaxies are at a distance of some two billion light-years. There are some 100 million such galaxies within that distance, the average distance between galaxies being some eight million light-years.

Authors of UFO fantasy literature casually set all of the laws of physics aside in order to try to evade this conclusion, but serious consideration of their ideas hardly belongs in a report on the scientific study of UFOs.

Even assuming that difficulties of this sort could be overcome, we have no right to assume that in life communities everywhere there is a steady evolution in the directions of

both greater intelligence and greater technological competence. Human beings now know enough to destroy all life on Earth, and they may lack the intelligence to work out social controls to keep themselves from doing so. If other civilizations have the same limitation then it might be that they develop to the point where they destroy themselves utterly before they have developed the technology needed to enable them to make long space voyages.

Another possibility is that the growth of intelligence precedes the growth of technology in such a way that by the time a society would be technically capable of interstellar space travel, it would have reached a level of intelligence at which it had not the slightest interest in interstellar travel. We must not assume that we are capable of imagining now the scope and extent of future technological development of our own or any other civilization, and so we must guard against assuming that we have any capacity to imagine what a more advanced society would regard as intelligent conduct.

In addition to the great distances involved, and the difficulties which they present to interstellar space travel, there is still another problem: If we assume that civilizations annihilate themselves in such a way that their effective intelligent life span is less than, say, 100,000 years, then such a short time span also works against the likelihood of successful interstellar communication. The different civilizations would probably reach the culmination of their development at different epochs in cosmic history. Moreover, according to present views, stars are being formed constantly by the condensation of interstellar dust and gases. They exist for perhaps 10 billion years, of which a civilization lasting 100,000 years is only 1/100,000 of the life span of the star. It follows that there is an extremely small likelihood that two nearby civilizations would be in a state of high development at the same epoch.

Astronomers now generally agree that a fairly large number of all main-sequence stars are probably accompanied by planets at the right distance from their Sun to provide for habitable conditions for life as we know it. That is, where stars are, there are probably habitable planets. This belief favors the possibility of interstellar communication, but it must be remembered that even this view is entirely speculation: we are quite unable directly to observe any planets associated with stars other than the Sun.

In view of the foregoing, we consider that it is safe to assume that no ILE outside of our solar system has any possibility of visiting Earth in the next 10,000 years.

This conclusion does not rule out the possibility of the existence of ILE, as contrasted with the ability of such civilizations to visit Earth. It is estimated that 10^{21} stars can be seen using the 200-inch Hale telescope on Mount Palomar. Astronomers surmise that possibly as few as one in a million or as many as one in ten of these has a planet in which physical and chemical conditions are such as to make them habitable by life based on the same kind of biochemistry as the life we know on Earth. Even if the lower figure is taken, this would mean there are 10^{15} stars in the visible universe which have planets suitable for an abode of life. In our own galaxy there are 10^{11} stars, so perhaps as many as 10^{8} have habitable planets in orbit around them.

Biologists feel confident that wherever physical and chemical conditions are right, life will actually emerge. In short, astronomers tell us that there are a vast number of stars in the universe accompanied by planets where the physical and chemical conditions are suitable, and biologists tell us that habitable places are sure to become inhabited (Rush, 1957).

An important advance was made when Stanley L. Miller (1955) showed experimentally that electrical discharges such as those in natural lightning when passed through a mixture of methane and ammonia, such as may have been present in the Earth's primitive atmo-

sphere, will initiate chemical reactions which yield various amino acids. These are the raw materials from which are constructed the proteins that are essential to life. Miller's work has been followed up and extended by many others, particularly P. H. Abelson of the Carnegie Institution of Washington.

The story is by no means fully worked out. The evidence in hand seems to convince biochemists that natural processes, such as lightning, or the absorption of solar ultraviolet light, could generate the necessary starting materials from which life could evolve. On this basis they generally hold the belief that where conditions make it possible that life could appear, there life actually will appear.

It is regarded by scientists today as essentially certain that ILE exists, but with essentially no possibility of contact between the communities on planets associated with different stars. We therefore conclude that there is no relation between ILE at other solar systems and the UFO phenomenon as observed on Earth.

There remains the question of ILE within our solar system. Here only the planets Venus and Mars need be given consideration as possible abodes of life.

Mercury, the planet nearest the Sun, is certainly too hot to support life. The side of Mercury that is turned toward the Sun has an average temperature of 660°F. (Mercury rotates in 59 days and the orbital period is 88 days, so there is a slow relative motion.) Since the orbit is rather eccentric this temperature becomes as high as 770°F, hot enough to melt lead, when Mercury is closest to the Sun. The opposite side is extremely cold, its temperature not being known. Gravity on Mercury is about one-fourth that on Earth. This fact combined with the high temperature makes it certain that Mercury has no atmosphere, which is consistent with observational data on this point. It is quite impossible that life as found on Earth could exist on Mercury.

Jupiter, Saturn, Uranus, Neptune and Pluto are so far from the Sun that they are too cold for life to exist there.

Although it has long been thought that Venus might provide a suitable abode for life, it is now known that the surface of Venus is also too hot for advanced forms of life, although it is possible that some primitive forms may exist. Some uncertainty and controversy exist about the interpretation of observations of Venus because the planet is always enveloped in dense clouds so that the solid surface is never seen. The absorption spectrum of sunlight coming from Venus indicates that the principal constituent of the atmosphere is carbon dioxide. There is no evidence of oxygen or water vapor. With so little oxygen in the atmosphere there could not be animal life there resembling that on Earth.

Although it is safe to conclude that there is no intelligent life on Venus, the contrary idea is held quite tenaciously by certain groups in America. There are small religious groups who maintain that Jesus Christ now sojourns on Venus, and that some of their members have traveled there by flying saucers supplied by the Venusians and have been greatly refreshed spiritually by visiting Him. There is no observational evidence in support of this teaching.

In the fantasy literature of believers in ETH, some attention is given to a purely hypothetical planet named Clarion. Not only is there no direct evidence for its existence, but there is conclusive indirect evidence for its non-existence. Those UFO writers who try not to be totally inconsistent with scientific findings, recognizing that Venus and Mars are unsuitable as abodes of life, have invented Clarion to meet the need for a home for the visitors who they believe come on some UFOs.

They postulate that Clarion moves in an orbit exactly like that of the Earth around the Sun, but with the orbit rotated through half a revolution in its plane so that the two orbits have the same line of apsides, but with Clar-

ion's perihelion in the same direction from the Sun as the Earth's aphelion. The two planets, Earth and Clarion, are postulated to move in their orbits in such a way that they are always opposite each other, so that the line Earth-Sun-Clarion is a straight line. Thus persons on Earth would never see Clarion because it is permanently eclipsed by the Sun.

If the two orbits were exactly circular, the two planets would move along their common orbit at the same speed and so would remain exactly opposite each other. But even if the orbits are elliptical, so that the speed in the orbit is variable, the two planets would vary in speed during the year in just such a way as always to remain Opposite each other and thus continue to be permanently eclipsed.

However, this tidy arrangement would not occur in actuality because the motion of each of these two planets would be perturbed by the gravitational attractions between them and the other planets of the solar system, principally Venus and Mars. It is a quite complicated and difficult problem to calculate the way in which these perturbations would affect the motion of Earth and Clarion.

At the request of the Colorado project, Dr. R. L. Duncombe, director of the Nautical Almanac office at U.S. Naval Observatory in Washington, D.C., kindly arranged to calculate the effect of the introduction of the hypothetical planet Clarion into the solar system. The exact result depends to some extent on the location of the Earth-Sun-Clarion line relative to the line of apsides and the computations were carried out merely for one case (see Appendix E).

These calculations show that the effect of the perturbations would be to make Clarion become visible from Earth beyond the Sun's limb after about thirty years. In other words, Clarion would long since have become visible from Earth if many years ago it were started out in such a special way as has been postulated.

The computations revealed further that if Clarion were there it would reveal its presence indirectly in a much shorter time. Its attraction on Venus would cause Venus to move in a different way than if Clarion were not there. Calculation shows that Venus would pull away from its otherwise correct motion by about 1 second of arc in about three months' time. Venus is routinely kept under observation to this accuracy, and therefore if Clarion were there it would reveal its presence by its effect on the motion of Venus. No such effect is observed, that is, the motion of Venus as actually observed is accurately in accord with the absence of Clarion, so therefore we may safely conclude that Clarion is nonexistent. (These calculations assume Clarion's mass roughly equal to that of the Earth.)

In his letter of transmittal Dr. Duncombe comments "I feel this is definite proof that the presence of such a body could not remain undetected for long. However, I am afraid it will not change the minds of those people who believe in the existence of Clarion."

We first heard about Clarion from a lady who is prominent in American political life who was intrigued with the idea that this is where UFOS come from. When the results of the Naval Observatory computations were told to her she exclaimed, "That's what I don't like about computers! They are always dealing death blows to our fondest notions."

[So we need consider Clarion no further.]

Mars has long been considered as a possible abode of life in the solar system. There is still no direct evidence that life exists there, but the question is being actively studied in the space research programs of both the United States and Soviet Russia, so it may well be clarified within the coming decade.

At present all indications are that Mars could not be the habitation of an advanced civilization capable of sending spacecraft to visit the Earth. Conditions for life there are so harsh that it is generally believed that at best

Mars could only support the simpler forms of plant life.

An excellent recent survey of the rapidly increasing knowledge of Mars is *Handbook of the Physical Properties of the Planet Mars* compiled by C. M. Michaux (NASA publication SP-3030, 1967). A brief discussion of American research programs for study of life on Mars is given in *Biology and Exploration of Mars*, a 19-page pamphlet prepared by the Space Science Board of the National Academy of Sciences, published in April 1965.

The orbit of Mars is considerably more eccentric than that of the Earth. Consequently the distance of Mars from the Sun varies from 128 to 155 million miles during the year of 687 days. The synodic period, or mean time between successive oppositions, is 800 days.

The most favorable time for observation of Mars is at opposition, when Mars is opposite the Sun from Earth. These distances of closest approach of Mars and Earth vary from 35 to 60 million miles. The most recent favorable time of closest approach was the opposition of 10 September 1956, and the next favorable opposition will be that of 10 August 1971. At that time undoubtedly great efforts will be made to study Mars in the space programs of the U.S.S.R. and the United States.

Some of the UFO literature has contended that a larger than usual number of UFO reports occur at the times of Martian oppositions. The contention is that this indicates that some UFOs come from Mars at these particularly favorable times. The claimed correlation is quite unfounded; the idea is not supported by observational data (Vallee and Vallee, 1966, 138).

Mars is much smaller than Earth, having a diameter of 4,200 miles, in comparison with 8,000 miles. Mars' mass is about one-tenth the Earth's, and gravity at Mars' surface is about 0.38 that of Earth. The Martian escape velocity is 3.1 mile/sec.

At the favorable opposition of 1877, C. V. Schiaparelli, an Italian astronomer, observed and mapped some surface markings on Mars which he called "canali," meaning "channels" in Italian. The word was mistranslated as "canals" in English and the idea was put forward, particularly vigorously by Percival Lowell, founder of the Lowell Observatory of Flagstaff, Arizona, that the canals on Mars were evidence of a gigantic planetary irrigation scheme, developed by the supposed inhabitants of Mars (Lowell, 1908). These markings have been the subject of a great deal of study since their discovery. Astronomers generally now reject the idea that they afford any kind of indication that Mars is inhabited by intelligent beings.

Mars has two moons named Phobos and Deimos. These are exceedingly small, Phobos being estimated at ten miles in diameter and Deimos at five miles, based on their brightness, assuming the reflecting power of their material to be the same as that of the planet. The periods are 7h39m for Phobos and 30h18m for Deimos. They were discovered in August 1877 by Asaph Hall using the then new 26-inch refractor of the U.S. Naval Observatory in Washington. An unsuccessful search for moons of Mars was made with a 48-inch mirror during the opposition of 1862.

I. S. Shklovskii (1959) published a sensational suggestion in a Moscow newspaper that these moons were really artificial satellites which had been put up by supposed inhabitants of Mars as a place of refuge when the supposed oceans of several million years ago began to dry up (Sullivan, 1966, 169). There is no observational evidence to support this idea. Continuing the same line of speculation Salisbury (1962), after pointing out that the satellites were looked for in 1862 but not found until 1877, then asks, "Should we attribute the failure of 1862 to imperfections in existing telescopes, or may we imagine that the satellites were launched between 1862 and 1877?" This is a slender reed indeed with

which to prop up so sensational an inference, and we reject it.

11. Light Propagation and Visual Perception. Most UFO reports refer to things seen by an observer. Seeing is a complicated process. It involves the emission or scattering of light by the thing seen, the propagation of that light through the atmosphere to the eye of the observer, the formation of an image on the retina of the eye by the lens of the eye, the generation there of a stimulus in the optic nerve, and the perceptual process in the brain which enables the mind to make judgments about the nature of the thing seen.

Under ordinary circumstances all of these steps are in fairly good working order with the result that our eyes give reasonably accurate information about the objects in their field of view. However, each step in the process is capable of malfunctioning, often in unsuspected ways. It is therefore essential to understand these physical and psychological processes in order to be able to interpret all things seen, including those reported as UFOs.

The study of propagation of light through the atmosphere is included in atmospheric optics or meteorological optics. Although a great deal is known about the physical principles involved, in practice it is usually difficult to make specific statements about an UFO report because not enough has been observed and recorded about the condition of the atmosphere at the time and place named in the report.

Application of the knowledge of atmospheric optics to the interpretation of UFO reports has been especially stressed by Menzel (1952; Menzel and Boyd, 1963). A valuable treatise on atmospheric effects on seeing is Middleton's *Vision through the Atmosphere* (1952). A survey of the literature of atmospheric optics with emphasis on topics relevant to understanding UFO reports was prepared for the Colorado project by Dr. William Viezee of the Stanford Research Institute (Section VI, Chapter 4).

Coming to the observer himself, Menzel stressed in consulting visits to the Colorado project that more ought to be known about defects of vision of the observer. He urged careful interviews to determine the observers' defects of vision, how well they are corrected, and whether spectacles were being worn at the time the UFO sighting was made. Besides the defects of vision that can be corrected by spectacles, inquiry ought to be made where relevant into the degree of color blindness of the observer, since this visual defect is more common than is generally appreciated.

Problems connected with the psychology of perception were studied for the Colorado project by Prof. Michael Wertheimer of the Department of Psychology of the University of Colorado. He prepared an elementary presentation of the main points of interest for the use of the project staff (Section VI, Chapter 1).

Perhaps the commonest difficulty is the lack of appreciation of size-distance relations in the description of an unknown object. When we see an airplane in the sky, especially if it is one of a particular model with which we are familiar, we know from prior experience approximately what its size really is. Then from its apparent size as we see it, we have some basis for estimating its distance. Conversely, when we know something about the distance of an unknown object, we can say something about its size. Although not usually expressed this way, what is really "seen" is the size of the image on the retina of the eye, which may be produced by a smaller object that is nearer or a larger object that is farther away. Despite this elementary fact, many people persist in saying that the full moon looks the same size as a quarter or as a washtub. The statement means nothing. Statements such as that an object looks to be of the same size as a coin *held at arm's length* do, however, convey some meaningful information.

Another limitation of normal vision that is often not appreciated is the color blindness of the dark-adapted eye. The human eye really has two different mechanisms in the retina for the conversion of light energy into nerve stimulus. Photopic vision is the kind that applies in the daytime or at moderate levels of artificial illumination. It involves the cones of the retina, and is involved in color vision. Scotopic vision is the kind that comes into play at low levels of illumination. It involves the rods of the retina which are unable to distinguish colors, hence the saying that in the dark all cats are gray. The transition from photopic to scotopic vision normally takes place at about the level of illumination that corresponds to the light of the full moon high in the sky. When one goes from a brightly lighted area into a dark room he is blind at first but gradually dark adaptation occurs and a transition is made from photopic to scotopic vision. The ability to see, but without color discrimination, then returns. Nyctalopia is the name of a deficiency of vision whereby dark adaptation does not occur and is often connected with a Vitamin A dietary deficiency.

If one stares directly at a bright light which is then turned off, an afterimage will be seen; that is, the image of the light, but less bright and usually out of focus, continues to be seen and gradually fades away. Positive afterimages are those in which the image looks bright like the original stimulus, but this may reverse to a negative afterimage which looks darker than the surrounding field of view. Afterimages have undoubtedly given rise to some UFO reports.

The afterimage is the result of a temporary change in the retina and so remains at a fixed point on the retina. When one then moves his eyes to look in a different direction, the afterimage seems to move relative to the surroundings. If it is believed by the observer to be a real object it will seem to him to have moved at an enormous velocity. A light going out will seem to shrink and move away from the observer as it does so. If one light goes on while another is going off, it may appear as if the light that is going off is moving to the place where the other light is going on.

Autokinesis is another property of the eye which needs to be understood by persons who are interested in looking for UFOs. A bright light in a field of view which has no reference objects in it, such as a single star in a part of the sky which has very few other stars in it, will appear to move when stared at, even though it is in reality stationary. This effect has given rise to UFO reports in which observers were looking at a bright star and believed that it was rapidly moving, usually in an erratic way.

12. Study of UFO Photographs. The popular UFO literature abounds with photographs of alleged strange objects in the sky, many of which are clearly in the form of flying saucers. Some of these have been published in magazines of wide circulation. The editors of *Look*, in collaboration with the editors of United Press International and Cowles Communications, Inc. published a *Look* "Special" in 1967 that is entirely devoted to "Flying Saucers," which contains many examples of UFO pictures.

Photographic evidence has a particularly strong appeal to many people. The Colorado study therefore undertook to look into the available photographs with great care. Chapter 2 of Section III gives the story of most of this work and Chapter 3 of Section IV gives the detailed reports on individual cases.

It is important to distinguish between photographic prints and the negatives from which they are made. There are many ways in which an image can be added to a print, for example, by double-printing from two negatives. Negatives, on the other hand, are somewhat more difficult to alter without leaving evidence of the fact. We therefore decided wherever possi-

ble to concentrate our study of photographic case upon the negatives. This was not, of course, possible in every instance examined.

A barber whose shop is in Zanesville, Ohio, but whose home is in the suburb of Roseville, has made a widely publicized pair of UFO photographs. He did not attempt to exploit them in a big way. He merely exhibited them for local interest (and stimulation of his barbering business) in the window of his shop. There they remained for more than two months until they were discovered by a big city newspaperman from Columbus, Ohio, who arranged to sell them to the Associated Press. They were distributed in February 1967 and have been often printed in various magazines after their original presentation in many newspapers.

Early in the project we became acquainted with Everitt Merritt, photogrammetrist on the staff of the Autometrics Division of the Raytheon Company of Alexandria, Virginia. He undertook to do an analysis of the photographs. A pair of prints was supplied to Merritt by NICAP.

Each of the pair shows the home of the photographer, a small bungalow, with a flying saucer flying over it. The flying saucer looks like it might be almost as large as the house in its horizontal dimension. The photographer says that he was leaving home with a camera when he chanced to look back and see the saucer flying over his home. He says he quickly snapped what we call picture A. Thinking the UFO was about to disappear behind a tree, he ran to the left about 30 feet and snapped picture B, having spoiled one exposure in between. He estimated that there was less than a two minute interval between the two pictures, with A followed by B.

Merritt studied the negatives themselves by quantitative photogrammetric methods, and also did some surveying in the front yard of the Roseville home, as a check on the calculations based on the photographs. From a study of the shadows appearing in the picture, he could show conclusively that actually picture B was taken earlier than picture A, and that the time interval between the two pictures was more than an hour, rather than being less than two minutes as claimed.

The photographic evidence contained in the negatives themselves is therefore in disagreement with the story told by the man who took the pictures. Two letters written to him by the Colorado project requesting his clarification of the discrepancy remain unanswered.

We made arrangements with Merritt for his services to be available for photogrammetric analysis of other cases. These methods require a pair of pictures showing substantially the same scene taken from two different camera locations. Unfortunately this condition is seldom met in UFO photographs. Only one other pair came to our attention which met this criterion. These were the much publicized pictures taken on 11 May 1950 near McMinnville, Ore. (Case 46). But in this case the UFO images turned out to be too fuzzy to allow worthwhile photogrammetric analysis.

Other photographic studies were made for the Colorado project by Dr. William K. Hartmann (Section III, Chapter 2).

Hartmann made a detailed study of 35 photographic cases (Section IV, Chapter 3) referring to the period 1966–68, and a selection of 18 older cases, some of which have been widely acclaimed in the UFO literature. This photographic study led to the identification of a number of widely publicized photographs as being ordinary objects, others as fabrications, and others as innocent misidentifications of things photographed under unusual conditions.

On p. 43 of the *Look* Special on "Flying Saucers" there is a picture of an allegedly "claw-shaped" marking on the dry sand of a beach. Some of the dark colored moist sand making up the "claw mark" was shipped to Wright-Patterson AFB and analyzed. The liq-

uid was found to be urine. Some person or animal had performed an act of micturition there.

A report by Staff Sergeant Earl Schroeder which says "Being a native of this area and having spent a good share of my life hunting and fishing this area, I believe that the so-called 'monster' (if there was such) could very well have been a large black bear." His report also notes that "during the week of July 26 the local TV stations showed a program called *Lost in Space*. In this program there were two monsters fitting their description controlled by a human being."

Summarizing, the investigation report says, "There was food missing from the picnic table which leads to the belief that some animal was responsible for the black shape portion of the total sighting. There are numerous bears and raccoons in the area."

Another photograph presented in the *Look* Special is of a pentagonal image, though called hexagonal. Photographic images of this kind arise from a malfunctioning of the iris of the camera and are quite commonplace. It is hard to understand how the editors of a national illustrated magazine could be unfamiliar with this kind of camera defect.

13. Direct and Indirect Physical Evidence. A wide variety of physical effects of UFOs have been claimed in the UFO literature. The most direct physical evidence, of course, would be the actual discovery of a flying saucer, with or without occupants, living or dead. None were found. Claims which we studied as direct evidence are those of the finding of pieces of material which allegedly came from outer space because it is a product of a different technology, so it is said, than any known on earth. Another kind of direct evidence studied was allegations that disturbance of vegetation on the ground, or of the soil was due to an UFO having landed at the place in question.

The claimed indirect physical evidence of the presence of an UFO is of the nature of effects produced at a distance by the UFO. Accounts of sounds, or the lack of sounds, associated with UFOs, even though reports of visual observation indicated speeds of the UFO far in excess of the velocity of sound were common. Whenever a terrestrial solid object travels through the atmosphere faster than the speed of sound, a sonic boom is generated. The argument has been advanced that the absence of a sonic boom associated with UFOs moving faster than cutoff Mach (see Section VI, Chapter 6) is an indication of their being a product of a technology more advanced than our own because we do not know how to avoid the generation of sonic booms. Another category of indirect physical effects is those associated with claims that UFOs possess strong magnetic fields, vastly stronger than those that would be produced by the strongest magnets that we know how to make.

There are many UFO reports in which it is claimed that an automobile's ignition failed and the motor stopped, and in some cases that the headlights failed also, and that after this happened, an UFO was seen nearby. Usually such reports are discussed on the supposition that this is an indication that the UFO had been the source of a strong magnetic field.

Reports of both direct and indirect physical evidence were studied by various staff members of the Colorado project, principally by Dr. Roy Craig, whose account of these studies is contained in Chapters 3 and 4 of Section III.

These studies resulted mostly in lack of substantiation of the claims that have been made. Claims of terrestrial magnetic disturbances at various Antarctic bases were either unconfirmed or seemed to be closely related to a practical joke that was played on a base commander.

During the period of field study of this project only one case of automobile engine malfunction came to our attention. There was

some ground for skepticism about the report in that it was made by a diabetic patient who had been drinking and was returning home alone from a party at 3:00 a.m.

Some laboratory tests showed that engine failure due to the action of an external magnetic field on the car's ignition coil would require fields in excess of 20,000 gauss, at the coil. Owing to the magnetic shielding action of the sheet steel in the car body, the strength of the field outside the car would have to be considerably greater than this. But magnetic fields of such intensity would alter the state of magnetization of the car itself.

The process of forming car bodies by cold-forming the sheet steel introduces some quasi-permanent magnetization into all car bodies. Since all of the bodies of a given make in a given year are usually made with the same molds on the same presses they are all magnetized in the same pattern.

In the case in question we found that the car body that had been subjected to the presence of the UFO was magnetized. The pattern of magnetization quite closely resembled that of a car of the same make and year that was found a thousand miles away in a used car lot in Boulder, Colo. From this we can infer that the car that was supposedly near the UFO, had not been subjected to a strong magnetic field, otherwise this would have permanently changed the state of magnetization of the body of the exposed car.

In the area of direct physical evidence, probably the most interesting result of investigation was the analysis of a piece of metallic magnesium which was alleged to have come from an UFO that exploded over a stretch of tidal water at Ubatuba, São Paulo, Brazil in 1957. This was one of several pieces of magnesium from the same source that had been sent to the society editor of a Rio de Janeiro newspaper at the time.

Later one of the pieces was subjected to elaborate chemical analysis in government laboratories in Brazil. The results of the analysis are given in great detail in the first of the Lorenzen books (1962), the full account occupying some forty pages. The claimed result of these studies was that the laboratory work showed the metallic magnesium to be purer than any ever made by man on Earth. Therefore it could not have been a product of earthly technology, therefore it came from an extraterrestrial source.

Mrs. Lorenzen kindly supplied one of the magnesium specimens to the Colorado project. We arranged to have it studied by the method of neutron activation analysis in a laboratory in Washington, D.C. The result, which is presented in detail in Chapter 3 of Section III, was that the magnesium metal was found to be much less pure than the regular commercial metal produced in 1957 by the Dow Chemical Company at Midland, Michigan. Therefore it need not have come from an extraterrestrial source, leaving us with no basis for rational belief that it did.

14. Radar Sightings of UFOs. The public became generally aware of radar at the end of World War II when the story of its important use in that war was told, after having been kept secret for some 12 years. A good nontechnical account of this development is given in R. M. Page, *The Origin of Radar* (1962).

The word radar is an acronym for *RA*dio *D*etection *A*nd *R*anging. Basically, most radar systems operate in the following way. A transmitter sends out short pulses of electromagnetic energy at regular intervals. These are sent out through an antenna designed to radiate a narrow beam within a small angle of its main direction. This beam of pulses travels outward at the speed of light. If it encounters an obstacle, which may be a metallic object like an airplane, a rain storm, or a bird or a flock of birds, it is partially scattered in all directions from the obstacle. In particular a part of the beam is scattered back toward the trans-

mitter. When it arrives back at the transmitter it is received and indicated or displayed in various ways, depending on the special purpose for which the system was designed. By the fact of there being a returned signal at all, the function of detection is accomplished. By the time delay involved between the transmission of the outgoing signal and the return of the back-scattered signal, the distance of the scattering object is inferred, thus accomplishing the function of ranging.

To get a beam of sufficiently narrow distribution in angle as to enable inferring from what direction the scattered signal was returned, the antenna must have a diameter of the order of ten times the wavelength of the radio waves which it uses.

In the period since 1945 the technology has had an enormous development so that nowadays there are elaborate networks of land and ship based radar systems, as well as radar systems carried by most airplanes, which have become vitally necessary to the safe operation of civil and military aircraft. In addition to the use of radar in connection with navigation, it has become a valuable tool in meteorological work in that distant rain storms can be detected by radar. Also the trails of ionized air left by meteors can be detected and studied by radar, providing for the first time the means for observing meteors in the daytime.

There are many popular misconceptions about radar. It is important at the outset to realize that the returned radar signal does *not* give a sharply focused image or picture of the obstacle that has been detected. What one gets when it is displayed on a cathode-ray screen is simply a diffuse blob of light indicating that *something* is there, in the direction the antenna is pointed (with some exceptions) and at the distance indicated by the time delay between transmission and reception of the back-scattered pulse. Of course, a large airplane gives a more intense signal than a flock of small birds at the same range, and skilled operators learn to make valid inferences about the nature of the object detected from other things that they know about the general situation together with the magnitude of the returned signal.

It is important also to recognize that the propagation of the outgoing and the back-scattered pulses is ordinarily assumed to be rectilinear and at the normal speed of light. But the actual propagation is affected by temperature and humidity difference in the air path along which the radio pulse travels. This can give rise to anomalous propagation that is analogous to but in detail not identical with the effects which give rise to mirages in the propagation of light through such an atmosphere. Usually the radar set operator does not know enough about the actual atmospheric conditions to make allowance for effects of this kind and, if they happen to be pronounced, can be led to make erroneous decisions. Another point is that, although the antenna sends out most of its energy in a single narrow beam, small amounts of energy go out in several other directions, known as sidelobes, so that a large or a nearby object in the direction of a sidelobe can give rise to a received signal that is indistinguishable from a small or distant object in the direction of the main beam.

The overall radar system is a rather complicated set of electronic equipment which can malfunction in various ways giving rise to internally generated signals which the operator will tend to regard as reflections made by outside obstacles which are in reality not there.

Usually the returned radar signals are displayed on the screen of a cathode ray tube and observed visually by the operator. On this account, subjective judgments of the operator enter into the final determination of what is seen, how it is interpreted and how it is reported. The data obtained from radar systems are thus not as completely objective as is often assumed. In some few instances subjectiveness is somewhat reduced by the fact that the cath-

ode ray screen is photographed, but even when this is done there is a subjective element introduced at the stage where a human observer has to interpret the photograph of the radar screen.

Radar operators do report unidentified targets from time to time and so there exists a category of UFO cases in which the unidentified flying object was seen on a radar screen. In a few cases there is a close correlation between an unknown thing in the sky seen visually and something also displayed on radar.

However in view of the many difficulties associated with unambiguous interpretation of all blobs of light on a radar screen it does not follow directly and easily that the radar reports support or "prove" that UFOs exist as moving vehicles scattering the radio pulses as would a metallic object. The Colorado project engaged the services of the Stanford Research Institute to make a general study of the functioning of radar systems from the point of view of the relation of their indications to UFOs. The study which was carried out resulted in the production of Section VI, Chapter 5, by Dr. Roy H. Blackmer, Jr. and his associates, R. J. Allen, R. T. S. Collis, C. Herold and R. I. Presnell.

Studies of specific UFO radar reports and their interpretation are presented in Section III, Chapter 5 by Gordon Thayer. Thayer is a radio propagation specialist on the staff of the Environmental Science Services Administration in Boulder. In his chapter, Thayer presents a detailed analysis of some 35 cases, some of which are visual, others radar, and some are both. Both optical and radar phenomena are treated together because of the similarity in the wave propagation problems involved.

In his summary of results he says: ". . . there was no case where the meteorological data available tended to negate the anomalous propagation hypothesis . . ." However, Thayer points out that adequate meteorological data for a thorough interpretation is often lacking so that a great deal more observational material of this kind would be needed in order to deal with a larger proportion of all of the reported UFO radar cases.

In view of the importance of radar to the safe operation of all aircraft, it is essential that further research be done leading to the more precise knowledge possible of anomalous propagation of radar signals. However, it is felt that this can best be done by a direct attack on the problem itself rather than by detailed field investigation of UFO cases.

15. Visual Observation made by U.S. Astronauts. The popular UFO literature makes occasional reference to UFOs seen by the U.S. astronauts in the space program operated by the National Aeronautics and Space Administration. We do not know of similar reports by Soviet astronauts but they may well have seen similar things.

In flights conducted between 12 April 1961 and 15 November 1966, thirty U.S. and Russian astronauts spent a total of 2,503 hours in orbit. The Colorado project was fortunate in that Dr. Franklin Roach, one of the principal investigators, has worked closely with the astronaut program in connection with their visual observations and so was already quite familiar with what they had seen and also was able to conduct further interviews with several of them on the basis of close personal acquaintances already established.

Roach presents a detailed account of what they saw as related to the UFO question in Section III, Chapter 6. Nothing was seen that could be construed as a "flying saucer" or manned vehicle from outer space. Some things were seen that were identified as debris from previous space experiments. Three sightings that are described in detail remain quite unidentified and are, Roach says, "a challenge to the analyst."

Roach emphasizes that the conditions for simple visual observation of objects near the satellite are not as good as might be naively

supposed. As he describes them, "The conditions under which astronauts made their observations are similar to those which would be encountered by one or two persons in the front seat of a small car having no side or rear windows and a partially covered, very smudged windshield." Moreover, the astronauts were kept occupied with other observations and activities during their flight and so did not have extended periods of time in which to concentrate on visual observation of their surroundings. Most of the available visual observations therefore have to be regarded as a by product rather than a primary purpose of the program in which they were engaged.

The conclusion is that nothing definite relating to the ETH aspect of UFOs has been established as a result of these rather sporadic observations.

16. Public Attitudes Toward UFOs. Opinion polls are widely employed nowadays to measure public attitudes on various important and trivial issues. It is natural therefore to apply the same method to a determination of public attitudes toward various phases of the UFO question.

Studies of this sort are not studies of the UFOs themselves, but an attempt at determination of what the American public thinks about UFOs. Some UFOs either do or do not come from outer space, and the fact of the matter would not be determined by finding out what the opinion of the American people about it may be. Nevertheless we considered that public attitudes do play a role in policy formation in America, and therefore it was appropriate to carry on some work in this area.

In 1947, 1950 and 1966 brief surveys of public attitudes on UFOs or flying saucers were conducted by the American Institute of Public Opinion, popularly known as the Gallup poll. Arrangements were made by the Colorado project for a more detailed study to be made during the spring of 1968. This was done for us by the Opinion Research Corporation. Findings of the earlier studies and of the study made for us are presented in Chapter 7 of Section III.

The first two studies indicated respectively that 90% and 94% of the American adult public had heard of flying saucers. The first of these results, taken within months of the original June 1947 sightings at Mt. Rainier indicates the extraordinary interest which the subject aroused from the outset. The 1966 survey indicated that 96% of the adult public had heard of flying saucers.

In the 1966 poll people were asked,

"Have you, yourself, ever seen anything you thought was a 'flying saucer'?"

The result was that 5% of the 96% who had heard of them answered yes to this question. The sample was designed to be representative of the American population, 21 years of age and older, of whom there are some 100 million. This is the basis of the oft-quoted statistic that five million Americans have said that they think they have seen a flying saucer.

In the same 1966 poll, 48% said they thought the things called flying saucers were "something real," and 31% said that they were "just people's imagination." The question does not distinguish between various kinds of "real" things, such as weather balloons, aircraft, planets, mirages, etc., so the result by no means indicated that 48% believe they are visitors from outer space. That question was not included in the 1966 poll.

The 1966 poll asked whether the person interviewed thinks "there are people somewhat like ourselves living on other planets in the universe." The question thus bears solely on ILE, not on whether such intelligences do in fact visit the Earth. Of the 1,575 interviewed 34% thought yes, 45% thought no, and 21% had no opinion.

There were no statistically significant regional differences between East, Midwest, South and West with regard to the proportion

of the population which had heard of, had seen, or believed in the reality of flying saucers. However, as to belief in ILE, the existence of people on other planets, this belief was held by only 27% of southerners, as compared with 36% of easterners, 37% of midwesterners and 36% of westerners. The lower proportion of southerners who believe in ILE is statistically significant, that is, outside the range of chance variation due to finite size of sample. Although statistically significant, it is causally unexplained.

Significant variation with age is shown in responses to belief in the reality of flying saucers, and to belief in intelligent life on other planets. About 50% of persons under 60 believe in the reality of flying saucers as compared with about 33% of persons over 60. On the other hand, a significantly smaller proportion of those under 50 believe in ILE, than do those over 50. On both of these points, the decline in the number of "believers" among older people is mostly due to the increase of those having "no opinion" rather than to an increase of the number of "non-believers." Here again the poll gives no basis for conclusions as to the reasons for these differences.

As to dependence on sex, 22% of men or women have no opinion as to the "reality" of flying saucers. Significantly more women than men believe in their reality:

	% Real	*% Imaginary*
Men	43	35
Women	52	26

The poll showed that increased amount of formal education is associated with an increased tendency to believe in the reality of flying saucers. Perhaps this result says something about how the school system trains students in critical thinking.

An interesting correlation is found between tendency to believe in UFO reality, and to believe in ILE with having had a personal experience of having seen an UFO. The results are:

	% Believing UFOs Are Real	*% Believing in ILE*
Sighters	76	51
Non-sighters	46	34

As before, causal relations are unexplored; we do not know whether seeing is believing, or believing is seeing.

In the 1968 study conducted for the Colorado project by the Opinion Research Corporation, 2,050 adults over 17 years of age, living in private households in the continental United States were interviewed. In addition teenagers in the same household with an adult who was interviewed were also interviewed to give a sample of their views. Separate studies of opinions held by college students were conducted. These are reported in Section III, Chapter 7.

In the 1968 survey, 3% of adults replied affirmatively to "Have you, yourself, ever seen an UFO?" This parallels the 5% who answered affirmatively in the 1966 Gallup poll to the similar question, "Have you ever seen anything that you thought was a 'flying saucer'?" One might think that the smaller number in 1968 could be explained by perhaps less familiarity of the public with the term UFO than with the term flying saucer. This seems hardly likely, however, in that the question was part of a total interview in which the meaning of the term UFO would have become clear from the general context of other questions in the interview. It seems to us therefore that this poll actually indicated a smaller percentage of sighters than the earlier one.

An important finding is that 87% of those who said that they had seen an UFO, also declared that they had reported it to no one, other than to family or friends, that is, to no one by which it would have received official

attention. Thus only about one-eighth of sightings were reported anywhere, and not all of these were reported to the Air Force. Hence if all sightings were reported to the Air Force, this result indicates that the number of reports received would be more than eight times as many as are now being received. From the small fraction who did report to the Air Force, it seems a fair inference that most of these non-reporting sighters did not think that what they saw constituted a security hazard.

In contrast, 56% of the non-sighters declared that they would report it to the police if they saw an UFO. We find this rather large discrepancy between the promised reporting behavior of the non-sighters and the actual reporting behavior of the sighters quite puzzling.

17. Other Psychological Studies. Consideration was given to a variety of modes of conducting psychological and psychiatric research into the UFO phenomenon. The possibility that an "experimental UFO" might be launched and reports of its sighting studied was given serious consideration and rejected on three grounds: In view of the fact that this was a government-sponsored, university-based study, it was felt that experiments in which the public might regard itself as having been victimized by what amounted to a hoax were unwise. Such experiments also might give rise, we thought, to the erroneous notion that the study regarded UFO phenomena *solely* as the result of misinterpretation of natural or man-made phenomena. Finally, we were advised by some of our experts in the psychological disciplines, that a "mock-up" UFO would introduce unknown variables that would render inconclusive any results derived from the conduct of experiments with it (see Section VI, Chapter 10).

Turning to the realm of psychiatry, we decided to refrain from mounting a major effort in this area on the ground that such a study could not be given priority over other investigations. This decision was buttressed by the evidence that we rapidly gathered, pointing to the fact that only a very small proportion of sighters can be categorized as exhibiting psychopathology and that, therefore, there is no reason to consider them any more suitable for study than psychotic or psychoneurotic individuals who belong to any other statistical class of the population as a whole (see Section VI, Chapter 3).

18. Instrumentation for UFO Searches. As remarked earlier, the short duration of most UFO sightings, the delays in reporting them and the delays caused by communication and travel, make it essentially impossible that investigators can bring physical observing equipment to a report site quickly enough to make UFO observations in that way. There is another way that is often proposed for getting better observational data than is now available; namely, to set up a permanently manned network of observing stations at various places in the country to observe such UFOs as might come within their range.

Such a network of stations might be set up solely for the purpose of UFO study, or it might be established in conjunction with one of the networks of stations which exist for other astronomical or meteorological purposes. This latter alternative, of course, would be much less expensive than the former, or could give a greater coverage for the same expenditure.

We gave considerable attention to the possibilities and difficulties in this direction (Section VI, Chapter 9). At first we hoped that some definite results could be obtained by such cooperation with existing stations in a way that would make results available for this report.

An all-sky camera was operated during most of August 1967 at Harrisburg, Penna. during

an UFO flap in that locality (Case 25) but no interesting results were found on some 9,000 photographs. It would be quite expensive to operate a network of such cameras on a routine basis all over the United States. The likelihood of interesting images being recorded would be very small. Because of the short duration of an UFO appearance a proper plan for use of the all-sky camera would involve frequent processing and examination of the film, otherwise the presence of an UFO would not be recognized until long after it had disappeared. This would greatly increase the cost of operation of such a network.

Another suggestion that is often made is to make UFO studies in connection with the radar networks operating in this country for air traffic control under auspices of the Federal Aviation Agency. Consideration was given to this possibility and it was concluded that it is quite out of the question to burden this network with additional duties of any kind. The air traffic control operators are now heavily burdened with the work of safely guiding civil and military aviation. During the summer of 1968 especially, the heavy overloads that sometimes exist on the system were emphasized by troublesome traffic delays in the neighborhood of several of the nation's major airports. It would be quite out of the question to ask the air traffic controllers to assume the responsibility of watching for UFOs in addition to their primary responsibilities. It would likewise be impracticable for a separate group of personnel to be installed at these stations to watch the same radars for UFOs.

The Prairie Network is a group of camera stations operated in the mid-west by the Smithsonian Institution in connection with the Harvard Meteor Program. Its primary purpose is to detect and record meteor trails in such a way as to guide a search for actual meteoritic bodies that strike the earth's surface. The field headquarters of this network is at Lincoln, Nebraska.

We prepared a listing of reported UFO sightings since 1965 that fell within the geographic limits of this network and through the kind cooperation of the Smithsonian Institution obtained the records of the network for the times and locations of these sightings. About half of the sightings were so lacking in specific information that, Frederick Ayer reports (1229) "even if an object had been recorded by the film it would have been impossible to correlate it with the sighting." About one-third of the sightings could not be traced on the film because of overcast skies. Some 18% of all the UFO sightings were identified on the network's records with a fair degree of probability. Nearly all of these were identified as astronomical objects. Some consideration was given to the costs and likelihood of success of adapting the Prairie Network instruments to UFO searches without interfering with their primary purpose. We think that something might be done along this line at reasonable expense, but we do not make a positive recommendation that such a program be undertaken because of the inconclusiveness of the information that we believe would be gathered.

Another existing program that was studied for unrecognized UFO records was that of scanning the night sky for study of air glow from the upper atmosphere, and of zodiacal light. Detailed study was made of two records obtained from a station on the Hawaiian Islands. One of these remains unidentified but is thought to be related to an artificial satellite for which no information is readily available. The other was definitely identified as a suborbital missile launched from Vandenberg AFB on the coast of southern California. Mr. Ayer concludes that "because of their relatively extensive sky coverage, scanning photometers can be considered useful instruments in the conduct of UFO searches." This, however, is not to be construed as a recommendation that a network of scanning photometer stations be established for this purpose.

Consideration was also given to the adaptability to UFO search purposes of radars of the type used by the Weather Bureau, and the radar station of the Radar Meteor Project of the Smithsonian Institution located near Havana, Illinois.

Although frequent claims are made in the UFO popular literature of magnetic disturbances due to the presence of UFOs, a consideration of various official magnetometer records produced no evidence of an effect of this kind that, in our judgment would warrant the setting up of an observational program to look for UFOs by their alleged magnetic effects.

19. Conclusion. In our study we gave consideration to every possibility that we could think of for getting objective scientific data about the kind of thing that is the subject of UFO reports. As the preceding summary shows, and as is fully documented in the detailed chapters which follow, all such efforts are beset with great difficulties. We place very little value for scientific purposes on the past accumulation of anecdotal records, most of which have been explained as arising from sightings of ordinary objects. Accordingly in Section I we have recommended against the mounting of a major effort for continuing UFO study for scientific reasons.

This conclusion is controversial. It will not be accepted without much dispute by the UFO amateurs, by the authors of popular UFO books and magazine articles, or even by a small number of academic scientists whose public statements indicate that they feel that this is a subject of great scientific promise.

We trust that out of the clash of opinions among scientists a policy decision will emerge. Current policy must be based on current knowledge and estimates of the probability that further efforts are likely to produce further additions to that knowledge. Additions to knowledge in the future may alter policy judgments either in the direction of greater, or of less attention being paid to UFO phenomena than is being done at present.

We hope that the critical analysis of the UFO situation among scientists and government officials that must precede the determination of official policy can be carried out on a strictly objective basis.

Attacks on the integrity of various individuals on either side of this controversy ought to be avoided. The question of an individual's integrity is wholly distinct from the issue of what science should do in the future about UFOs.

In the Congress of the United States concern about the UFO problem from a defense viewpoint is the province of the House Committee on Armed Services. Concern about it from the point of view of the nation's scientific research program comes under the House Committee on Science and Astronautics. Here there seems to be a valid situation of overlapping jurisdictions because the UFO problem can be approached from both viewpoints.

A particular interest in the UFO problem has been shown by Congressman J. Edward Roush of Indiana, who is a member of the House Committee on Science and Astronautics. He performed a valuable service by arranging for the holding of a "Symposium on Unidentified Flying Objects" in Washington on 29 July 1968 (see references). As pointed out by one of the symposium participants, Prof. Carl Sagan of the department of astronomy of Cornell University, the presentations made in that symposium incline rather strongly to the side of belief that large-scale investigations of the UFO phenomenon ought to be supported in the expectation that they would be justified by what some speakers called "scientific paydirt."

We studied the transcript of this symposium with great care to see whether we would be led thereby to any new material related to this study. We did not find any new data.

Several of the contributors to that symposium have become trenchant advocates in the

past several years of a continuing major government investment in an UFO program. Several have long urged a greater degree of congressional interest in this subject. The symposium of 29 July afforded them an occasion on which with the utmost seriousness they could put before the Congress and the public the best possible data and the most favorable arguments for larger government activity in this field.

Hence it is fair to assume that the statements presented in that symposium represent the maximum case that this group feels could be made. We welcome the fact that this symposium is available to the public and expect that its data and arguments will be compared with those in their report of this study by those whose duty it is to make responsible decisions in this area.

We have studied this symposium record with great care and find nothing in it which requires that we alter the conclusions and recommendations that we have presented in Section I, nor that we modify any presentation of the specific data contained in other sections of this report.

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