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By VH NARA Date 2/14/94

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Incident #217 -- near Pittsburgh, Pennsylvania -- 9 December 1948

There is no astronomical explanation for this incident.

The object seen could easily have been a balloon, for apparent speed could have been a result of the observers' own motion. Even if an object were standing still, observers in an airplane would not see it for much longer than the time reported here (7 minutes).

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Incident #218 -- near Martinsburg, West Virginia -- 11 December 1948

As described, the object seen in this incident could have been a parachute flare. Under circumstances of a head-on approach, a meteor can appear stationary; however, the time in sight (one minute), if accurate, argues against the object's being a meteor. Therefore, while it is possible that the incident has an astronomical explanation, it is more probable that a flare was being observed.

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Incident #219 -- Newburgh, New York -- 29 November 1948

The object reported in this incident is clearly a slow-moving fireball. Time of day, length of time in sight, and all other data check with the bolide hypothesis.

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APPENDIX D

Dr. G. E. Valley

Some Considerations Affecting the Interpretation of Reports
of Unidentified Flying Objects

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By VH NARA Date 2/14/98

SOME CONSIDERATIONS AFFECTING THE INTERPRETATION OF REPORTS OF UNIDENTIFIED
FLYING OBJECTS.

By

G. E. Valley, Member Scientific Advisory Board,
Office of the Chief of Staff, United States Air Force.

The writer has studied summary abstracts and comments pertaining to unidentified flying objects, which were forwarded by Air Force Intelligence. These remarks are divided into three main parts: The first part is a short summary of the reports; the second part consists of a general survey of various possibilities of accounting for the reports; the third part contains certain recommendations for future action.

PART 1 SHORT SUMMARY OF OBSERVATIONS.

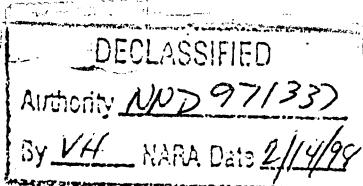
The reports can be grouped as follows:

Group 1. The most numerous reports indicate the daytime observation of metallic disk-like objects, roughly in diameter ten times their thickness. There is some suggestion that the cross section is asymmetrical and rather like a turtle shell. Reports agree that these objects are capable of high acceleration and velocity; they often are sighted in groups, sometimes in formation. Sometimes they flutter.

Group 2. The second group consists of reports of lights observed at night. These are also capable of high speed and acceleration. They are less commonly seen in groups. They usually appear to be sharply defined luminous objects.

Group 3. The third group consists of reports of various kinds of rockets, in general appearing somewhat like V-2 rockets.

Group 4. The fourth group contains reports of various devices which, in the writer's opinion, are sounding balloons of unusual shape such as are made by the General Mills Company to Navy Contract.



- 2 -

Group 5. The fifth group includes reports of objects in which little credence can be placed.

General Remarks.

In general it is noted that few if any reports indicate that the observed objects make any noise or radio interference. Nor are there many indications of any material effects or physical damage attributable to the observed objects.

SUMMARY, PART 1.

This report will consider mainly the reports of Groups 1 and 2.

PART 2. ON POSSIBLE EXPLANATIONS OF THE REPORTS.

Section A. What can be deduced concerning the nature of an unknown aerial object from a single sighting.

Here there are two problems: first, how much can be deduced concerning the nature of the objects from geometrical calculations alone; second, how much more can be deduced if, in addition, it is assumed that the objects obey the laws of nature as we know them.

Concerning the first problem it can be stated that only ratios of lengths, and rates of change of such ratios can be accurately determined. Thus the range and size of such objects cannot be determined; and it is noticeable that reports of size of the observed objects are widely at variance. However, angles, such as the angle subtended by the object, can be observed. Likewise there is fair agreement among several observers that the diameter of the objects of Group 1 is about ten times their thickness. Although velocity cannot be determined, angular velocity can be, and in particular the flutter frequency could, in principle, be determined.

All that can be concluded about the range and size of the objects, from geometrical considerations alone, is: 1) from the fact that estimated

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sizes vary so widely, the objects were actually either of different sizes, or more likely, that they were far enough from the observers so that binocular vision produced no stereoscopic effect; this only means that they were farther off than about thirty feet; 2) since objects were seen to disappear behind trees, buildings, clouds etc, they are large enough to be visible at the ranges of those recognizable objects.

Now it is obviously of prime importance to estimate the size and mass of the observed objects. This may be possible to some extent if it is permissible to assume that they obey the laws of physics. Since the objects have not been observed to produce any physical effects, other than the one case in which a cloud was evaporated along the trajectory, it is not certain that the laws of mechanics, for instance, would be sufficient.

But suppose that mechanical laws alone are sufficient. Then the following example is sufficient proof that at least a length could, in principle, be determined: suppose a simple pendulum were observed suspended in the sky; then after observing its frequency of oscillation, we could deduce from the laws of mechanics its precise length.

This suggests that something could be deduced from the observed fluttering motion of some of the objects of Group 1. Assume that we know the angular frequency and angular amplitude of this fluttering motion (they can be measured in principle from a motion picture). Then for purposes of calculation assume the object to be thirty feet in diameter, to be as rigid as a normal aircraft wing of 30 foot span, to be constructed of material of the optimum weight-strength ratio and to be a structure of most efficient design. It is now possible to calculate how heavy the object must be merely to remain rigid under the observed angular motion. Let the calculation be made for a plurality of assumed sizes 1, 2, 4, 8, 16, 32, 64 ----- up to say

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200 feet, and let calculated mass be plotted versus assumed size. The non-linear character of the curve should indicate an approximate upper limit to the size of the object.

If in addition, it is assumed that the flutter is due to aerodynamic forces, it is possible that more precise information could be obtained.

The required angular data can probably be extracted from witnesses most reliably by the use of a demonstration model which can be made to oscillate or flutter in a known way.

SUMMARY, PART 2, SECTION A.

Geometrical calculations alone cannot yield the size of objects observed from a single station; such observation, together with the assumption that the objects are essentially aircraft, can be used to set reasonable limits of size.

PART II, SECTION B. THE POSSIBILITY OF SUPPORTING AND PROPELLING A SOLID OBJECT BY UNUSUAL MEANS.

Since some observers have obviously colored their reports with talk of rays, jets, beams, space-ships, and the like, it is well to examine what possibilities exist along these lines. This is also important in view of the conclusions of Part II, Section A. of this report.

METHOD I. Propulsion and support by means of "rays" or "beams".

By "rays" or "beams" are meant either purely electromagnetic radiation or else radiation which is largely corpuscular like cathode-rays or cosmic-rays or cyclotron-beams.

Now it is obvious that any device propelled or supported by such means is fundamentally a reaction device. It is fundamental in the theory of such devices that a given amount of energy is most efficiently spent if the momentum thrown back or down is large. This means that a large mass should

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be given a small acceleration - a theorem well understood by helicopter designers.

The beams or rays mentioned do the contrary - a small mass is given a very high velocity - consequently enormous powers - greater than the total world's power capacity - would be needed to support even the smallest object by such means.

METHOD II. Direct use of Earth's Magnetic Field.

One observer (incident 68) noticed a violent motion of a hand-held compass. If we assume from this that the objects produced a magnetic field, comparable with the Earth's field, namely 0.1 gauss, and that the observer found that the object subtended an angle θ at his position, then the ampereturns of the required electromagnet is given by

$$ni = \frac{30 R}{\theta^2} \quad \text{where } R \text{ is the range of the object.}$$

For instance, if R is one kilometer and the object is 10 meters in diameter, then $ni = 1$ billion ampere-turns.

Now if the object were actually only 10 meters away and were correspondingly smaller, namely 10 cm in diameter, it would still require 10 million ampere-turns.

These figures are a little in excess of what can be conveniently done on the ground. They make it seem unlikely that the effect was actually observed.

Now the Earth's magnetic field would react on such a magnet to produce not only a torque but also a force. This force depends not directly on the Earth's field intensity but on its irregularity or gradient. This force is obviously minute since the change in field over a distance of 10 meters (assumed diameter of the object) is scarcely measurable - moreover the gradient is not predictable but changes due to local ore deposits.

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Thus even if the effect were large enough to use it would still be unreliable and unpredictable.

METHOD III. Support of an Electrically Charged Object by Causing It to Move Transverse to the Earth's Magnetic Field.

A positively charged body moving from West to East, or a negatively charged body moving from East to West will experience an upward force due to the Earth's magnetic field.

A sphere 10 meters diameter moving at a speed of one kilometer/second would experience an upward force of one pound at the equator if charged to a potential of 5×10^{12} volts. This is obviously ridiculous.

SECTION D. THE ANTI GRAVITY SHIELD.

It has been proposed, by various writers, perhaps first by H. G. Wells, that it might be possible to construct a means of shielding a massive body from the influence of gravity. Such an object would then float. Recently there appeared in the press a notice that a prominent economist has offered to support research on such an enterprise.

Obviously, conservation of energy demands that considerable energy be given the supported object in order to place it on the shield. However this amount of energy is in no way prohibitive, and furthermore it can be gotten back when the object lands.

Aside from the fact that we have no suggestions as to how such a device is to be made, the various theories of general relativity all agree in assuming that gravitational force and force due to acceleration are indistinguishable, and from this assumption the theories predict certain effects which are in fact observed. The assumption therefore is probably correct, and a corollary of it is essentially that only by means of an acceleration can gravity be counteracted. This we can successfully do

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for instance by making an artificial satellite - but this presumably is not what has been observed.

SUMMARY, PART II, SECTION B.

Several unorthodox means of supporting or propelling a solid object have been considered - all are impracticable. This finding lends credence to the tentative proposed assumption of Part II, that the objects are supported and propelled by some normal means, or else that they are not solids. No discussion of the type of Part II, Section B can, in principle, of course, be complete.

PART II, SECTION C. POSSIBLE CAUSES FOR THE REPORTS.

CLASSIFICATION I. NATURAL TERRESTRIAL PHENOMENA.

- 1) The observations may be due to some effect such as ball lightning. The writer has no suggestions on this essentially meteorological subject.
- 2) The objects may be some kind of animal.

Even in the celebrated case of incident 172 where the light was chased by a P51 for half an hour and which was reported by the pilot to be intelligently directed, we can make this remark. For consider that an intelligence capable of making so remarkable device would not be likely to play around in so idle a manner as described by the pilot.

In this connection it would be well to examine if some of the lights observed at night were not fire-flies.

- 3) The observed objects may be hallucinatory or psychological in origin.

It is of prime importance to study this possibility because we can learn from it something of the character of the population; its response under attack; and also something about the reliability of visual observation.

One would like to assume that the positions held by many of the re-

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ported observers guarantee their observations. Unfortunately there were many reports of curious phenomena by pilots during the war - the incident of the fire-ball fighters comes to mind. Further, mariners have been reporting sea-serpents for hundreds of years yet no one has yet produced a photograph.

It would be interesting to tabulate the responses to see how reliable were the reports on the Japanese balloons during the war. There we had a phenomenon proven to be real.

It is interesting that the reports swiftly reach a maximum frequency during the end of June 1947 and then slowly taper off. We can assume that this is actually an indication of how many objects were actually about, or, quite differently, we can take this frequency curve as indicating something about mass psychology.

This point can be tested. Suppose the population is momentarily excited; how does the frequency of reports vary with time? A study of crank letters received after the recent publicity given to the satellite program should give the required frequency distribution.

It is probably necessary but certainly not sufficient that the unidentified object curve and the crank-letter curve should be similar in order for the flying disks to be classed as hallucinations.

A large scale experiment was made at the time of Orson Welles's "Martian" broadcast. Some records of this must persist in newspaper files.

CLASSIFICATION II. MAN-MADE TERRESTRIAL PHENOMENA.

1) The objects may be Russian aircraft. If this were so, then the considerations of Sections A and B indicate that we would have plenty to worry about. It is the author's opinion that only an accidental discovery

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of a degree of novelty never before achieved could suffice to explain such devices. It is doubtful whether a potential enemy would arouse our curiosity in so idle a fashion.

CLASSIFICATION III. EXTRA TERRESTRIAL OBJECTS.

1) Meteors: It is noteworthy that the British physicist Lovell writing in "Physics Today" mentions the radar discovery of a new daytime meteorite stream which reached its maximum during June 1947. The reported objects lose little of their interest however if they are of meteoritic origin.

2) Animals. Although the objects as described act more like animals than anything else, there are few reliable reports on extra-terrestrial animals.

3) Space Ships. The following considerations pertain:

a) If there is an extra terrestrial civilization which can make such objects as are reported then it is most probable that its development is far in advance of ours. This argument can be supported on probability arguments alone without recourse to astronomical hypotheses.

b) Such a civilization might observe that on Earth we now have atomic bombs and are fast developing rockets. In view of the past history of mankind they should be alarmed. We should therefore expect at this time above all to behold such visitations.

Since the acts of mankind most easily observed from a distance are A-bomb explosions we should expect some relation to obtain between the time of A-bomb explosions, the time at which the space ships are seen, and the time required for such ships to arrive from and return to home-base.

PART III. RECOMMENDATIONS.

1) The file should be continued.

2) A meteorologist should compute the approximate energy required to

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evaporate as much cloud as shown in the incident 26 photographs. Together with an aerodynamicist he should examine whether a meteorite of unusual shape could move as observed.

3) The calculations suggested in Part II, Section A, should be estimated by an aerodynamicist with such changes as his more detailed knowledge may suggest.

4) The mass-psychology studies outlined in Part II, Section C, Classification I 3 should be carried out by a competent staff of statisticians and mass-psychologists.

5) Interviewing agents should carry objects or moving pictures for comparison with reporter's memories. These devices should be properly designed by a psychologist experienced in problems pertaining to aircraft and design of aircraft control equipment so that he shall have some grasp of what it is that is to be found out. If the Air Force has reason to be seriously interested in these reports it should take immediate steps to interrogate the reporters more precisely.

6) A person skilled in the optics of the eye and of the atmosphere should investigate the particular point that several reports agree in describing the objects as being about ten times as wide as they are thick; the point being to see if there is a plurality of actual shapes which appear so under conditions approaching limiting resolution or detectable contrast.

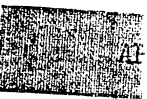
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APPENDIX E-1

Rand Corporation

Letter, dated 29 March 1947



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By VH NARA Date 2/14/98

The RAND Corporation

1500 Fourth St - Santa Monica - California

29 March 1949

L-2563

Lieutenant Colonel A. J. Hemstreet
Technical Intelligence Division
Air Materiel Command
Wright-Patterson Field
Dayton, Ohio

Dear Colonel Hemstreet:

In reply to your inquiry of March 24th, we had not planned to issue a formal report on Project Grudge until or unless our study leads to some unusual or unexpected finding which would throw new light on Grudge.

We are now working through the data in search of significant consistencies or other indirect bits of evidence. It is expected that we shall have explored all our various avenues of attack in about two months. To date we have found nothing which would seriously controvert simple rational explanations of the various phenomena in terms of balloons, conventional aircraft, planets, meteors, bits of paper, optical illusions, practical jokers, psychopathological reporters, and the like.

We should like to take this opportunity to raise a few questions: (1) The file on incident 50 contains a photograph which apparently belongs with incident 40. Is this surmise correct? (2) The file on incident 162 was omitted from the data. Why? (3) We have heard from a reliable source of an incident in which fishermen observed flying objects which dropped hot material which they collected and subsequently gave to official investigators. The investigators' plane crashed but there was a survivor. We do not seem to have a file on this incident - certainly not a complete file. May we have one?

Sincerely yours,

/s/ A. J. Hood
A. M. Hood

AMM:rb

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APPENDIX B-2

Rand Corporation (J. E. Lipp)

Space Ship Considerations



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By VH NARA Date 2/14/98

13 December 1948

AI-1009

Brigadier General Putt
United States Air Force
Director of Research and Development
Office, Deputy Chief of Staff, Materiel
Washington 25, D. C.

Dear General Putt:

Please refer to your letter of 18 November 1948 relative to the "flying object" problem and to Mr. Collbohm's reply dated 24 November 1948. In paragraph (b) of the reply, Mr. Collbohm promised (among other things) to send a discussion of the "special design and performance characteristics that are believed to distinguish space ships."

This present letter gives, in very general terms, a description of the likelihood of a visit from other worlds as an engineering problem and some points regarding the use of space vehicles as compared with descriptions of the flying objects. Mr. Collbohm will deliver copies to Colonel McCoy at Wright-Patterson Air Base during the RAND briefing there within the next few days.

A good beginning is to discuss some possible places of origin of visiting space ships. Astronomers are largely in agreement that only one member of the Solar system (besides Earth) can support higher forms of life. It is the planet Mars. Even Mars appears quite desolate and inhospitable so that a race would be more occupied with survival than we are on Earth. Reference 1 gives adequate descriptions of conditions on the various planets and satellites. A quotation from Ref. 1 (p. 229) can well be included here.

"Whether intelligent beings exist to appreciate these splendors of the Martian landscape is pure speculation. If we have correctly reconstructed the history of Mars, there is little reason to believe that the life processes may not have followed a course similar to terrestrial evolution. With this assumption, three general possibilities emerge. Intelligent beings may have protected themselves against the excessively slow loss of atmosphere, oxygen and water, by constructing homes and cities* with the physical conditions scientifically con-

*"Not too large or they might be visible. Perhaps underground, where the atmospheric pressure would be greater and where the temperature extremes would be reduced."

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trolled. As a second possibility, evolution may have developed a being who can withstand the rigors of the Martian climate. Or the race may have perished.

"These possibilities have been sufficiently expanded in the pseudo-scientific literature to make further amplification superfluous. However, there may exist some interesting restrictions to the anatomy and physiology of a Martian. Rarity of the atmosphere, for example, may require a completely altered respiratory system for warm-blooded creatures. If the atmospheric pressure is much below the vapor pressure of water at the body temperature of the individual, the process of breathing with our type of lungs becomes impossible. On Mars the critical pressure for a body temperature of 98.6°F. occurs when a column of the atmosphere contains one sixth the mass of a similar column on the Earth. For a body temperature of 77°F. the critical mass ratio is reduced to about one twelfth, and at 60°F. to about one twenty-fourth. These critical values are of the same order as the values estimated for the Martian atmosphere. Accordingly the anatomy and physiology of a Martian may be radically different from ours - but this is all conjecture.

"We do not know the origin of life, even on the Earth. We are unable to observe any signs of intelligent life on Mars. The reader may form his own opinion. If he believes that the life force is universal and that intelligent beings may have once developed on Mars, he has only to imagine that they persisted for countless generations in a rare atmosphere which is nearly devoid of oxygen and water, and on a planet where the nights are much colder than our arctic winters. The existence of intelligent life on Mars is not impossible but it is completely unproven."

It is not too unreasonable to go a step further and consider Venus as a possible home for intelligent life. The atmosphere, to be sure, apparently consists mostly of carbon dioxide with deep clouds of formaldehyde droplets, and there seems to be little or no water. Yet living organisms might develop in chemical environments that are strange to us: the vegetable kingdom, for example, operates on a fundamentally different energy cycle from Man. Bodies might be constructed and operated with different chemicals and other physical principles than any of the creatures we know. One thing is evident: fishes, insects, and mammals all manufacture within their own bodies complex chemical compounds that do not exist as minerals. To this extent, life is self-sufficient and might well adapt itself to any environment within certain limits of temperature (and size of creature).

Venus has two handicaps relative to Mars. Her mass, and gravity, are nearly as large as for the Earth (Mars is smaller) and her

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cloudy atmosphere would discourage astronomy, hence space travel. The remaining Solar planets are such poor prospects that they can be ignored.

In the next few paragraphs, we shall speak of Mars. It should be understood that most of the remarks apply equally well to Venus.

Various people have suggested that an advanced race may have been visiting Earth from Mars or Venus at intervals from decades to eons. Reports of objects in the sky seem to have been handed down through the generations. If this were true, a race of such knowledge and power would have established some form of direct contact. They could see that Earth's inhabitants would be helpless to do interplanetary harm. If afraid of carrying diseases home, they would at least try to communicate. It is hard to believe that any technically accomplished race would come here, flaunt its ability in mysterious ways and then simply go away. To this writer, long-time practice of space travel implies advanced engineering and science, weapons and ways of thinking. It is not plausible (as many fiction writers do) to mix space ships with broadswords. Furthermore, a race which had enough initiative to explore among the planets would hardly be too timid to follow through when the job was accomplished.

One other hypothesis needs to be discussed. It is that the Martians have kept a long-term routine watch on Earth and have been alarmed by the sight of our A-bomb shots as evidence that we are warlike and on the threshold of space travel. (Venus is eliminated here because her cloudy atmosphere would make such a survey impractical). The first flying objects were sighted in the Spring of 1947, after a total 5 atomic bomb explosions, i.e., Alamogordo, Hiroshima, Nagasaki, Crossroads A and Crossroads B. Of these, the first two were in positions to be seen from Mars, the third was very doubtful (at the edge of Earth's disc in daylight) and the last two were on the wrong side of Earth. It is likely that Martian astronomers, with their thin atmosphere, could build telescopes big enough to see A-bomb explosions on Earth, even though we were 165 and 153 million miles away, respectively, on the Alamogordo and Hiroshima dates. The weakest point in the hypothesis is that a continual, defensive watch of Earth for long periods of time (perhaps thousands of years) would be dull sport, and no race that even remotely resembled Man would undertake it. We haven't even considered the idea for Venus or Mars, for example.

The sum and substance of this discussion is that if Martians are now visiting us without contact, it can be assumed that they have just recently succeeded in space travel and that their civilization would be practically abreast of ours.

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The chance that Martians, under such widely divergent conditions, would have a civilization resembling our own is extremely remote. It is particularly unlikely that their civilization would be within a half century of our own state of advancement. Yet in the last 50 years we have just started to use aircraft and in the next 50 years we will almost certainly start exploring space.

Thus it appears that space travel from another point within the Solar system is possible but very unlikely. Odds are at least a thousand-to-one against it.

This leaves the totality of planets of other stars in the Galaxy as possible sources. Many modern astronomers believe that planets are fairly normal and logical affairs in the life history of a star (rather than cataclysmic oddities) so that many planets can be expected to exist in space.

To narrow the field a little, some loose specifications can be written for the star about which the home base planet would revolve. Let us say that the star should bear a family resemblance to the Sun, which is a member of the so-called "main-sequence" of stars, i.e., we eliminate white dwarfs, red giants and supergiants. For a description of these types, see reference 2, chapter 5. There is no specific reason for making this assumption except to simplify discussion: we are still considering the majority of stars.

Next, true variable stars can be eliminated, since conditions on a planet attached to a variable star would fluctuate too wildly to permit life. The number of stars deleted here is negligibly small. Reference 3, pages 76 and 85 indicate that the most common types are too bright to be in nearby space unnoticed. Lastly, we shall omit binary or multiple stars, since the conditions for stable planet orbits are obscure in such cases. About a third of the stars are eliminated by this restriction.

As our best known sample of space we can take a volume with the Sun at the center and a radius of 16 light years. A compilation of the 47 known stars, including the Sun, within this volume is given in reference 4, pages 52 to 57. Eliminating according to the above discussion: Three are white dwarfs, eight binaries account for 16 stars and two trinomies account for 6 more. The remainder, 22 stars, can be considered as eligible for habitable planets.

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Assuming the above volume to be typical, the contents of any other reasonable volume can be found by varying the number of stars proportionately with the volume, or with the radius cubed, $S_e = 22 \times \left(\frac{r}{16}\right)^3$, where S_e is number of eligible stars and r is the radius of the volume in light years. (This formula should only be used for radii greater than 16 light years. For smaller samples we call for a recount. For example, only one known eligible star other than the Sun lies within eight light years).

Having an estimate of the number of useable stars, it is now necessary to make a guess as to the number of habitable planets. We have only one observed sample, the Solar System, and the guess must be made with low confidence, since intelligent life may not be randomly distributed at all.

The Sun has nine planets, arranged in a fairly regular progression of orbits (see reference 1, Appendix I) that lends credence to theories that many stars have planets. Of the nine planets, (one, the Earth) is completely suitable for life. Two more (in adjacent orbits) are near misses: Mars has extremely rigorous living conditions and Venus has an unsuitable atmosphere. Viewed very broadly indeed, this could mean that each star would have a series of planets so spaced that one, or possibly two, would have correct temperatures, correct moisture content and atmosphere to support civilized life. Let us assume that there is, on the average, one habitable planet per eligible star.

There is no line of reasoning or evidence which can indicate whether life will actually develop on a planet where the conditions are suitable. Here again, the Earth may be unique rather than a random sample. This writer can only inject some personal intuition into the discussion with the view that life is not unique on Earth, or even the random result of a low probability, but is practically inevitable in the right conditions. This is to say, the number of inhabited planets is equal to those that are suitable!

One more item needs to be considered. Knowing nothing at all about other races, we must assume that Man is average as to technical advancement, environmental difficulties, etc. That is, one half of the other planets are behind us and have no space travel and the other half are ahead and have various levels of space travel. We can thus imagine that in our sample volume there are 11 races of beings who have begun space explorations. The formula on page 3 above now becomes

$$R = 11 \times \left(\frac{r}{16}\right)^3$$

where R is the number of races exploring space in a spherical volume of radius $r \geq 16$ light years.

Arguments like those applied to Martians on page 2 need not apply to races from other star systems. Instead of being a first port of call, Earth would possibly be reached only after many centuries of development and exploration with space ships, so that a visiting race would be expected to be far in advance of Man.

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To summarize the discussion thus far: the change of space travelers existing at planets attached to neighboring stars is very much greater than the change of space-traveling Martians. The one can be viewed almost as a certainty (if the assumptions are accepted), whereas the other is very slight indeed.

In order to estimate the relative chances that visitors from Mars or star X could come to the Earth and act like "flying objects", some discussion of characteristics of space ships is necessary.

To handle the simple case first, a trip from Mars to Earth should be feasible using a rocket-powered vehicle. Once here, the rocket would probably use more fuel in slowing down for a landing than it did in initial takeoff, due to Earth's higher gravitational force.

A rough estimate of one-way performance can be found by adding the so-called "escape velocity" of Mars to that of the Earth plus the total energy change (kinetic and potential) used in changing from one planetary orbit to the other. These are 3.1, 7.0, and 10.7 miles per second, respectively, giving a total required performance of 20.8 miles per second for a one-way flight. Barring a suicide mission, the vehicle would have to land and replenish or else carry a 100% reserve for the trip home.

Let us assume the Martians have developed a nuclear, hydrogen-propelled vehicle (the most efficient basic arrangement that has been conceived here on Earth) which uses half its stages to get here and the remaining stages to return to Mars, thus completing a round trip without refueling, but slowing down enough in our atmosphere to be easily visible (i.e., practically making a landing). Since it is nuclear powered, gas temperatures will be limited to the maximum operating temperatures that materials can withstand (heat must transfer from the pile to the gas, so cooling can't be used in the pile). The highest melting point compound of uranium which we can find is uranium carbide. It has a melting point of 4560°R. Assume the Martians are capable of realizing a gas temperature of 4500°R (= 2500°K), and that they also have alloys which make high motor pressures (3000 psi) economical. Then the specific impulse will be $I = 1035$ seconds and the exhaust velocity will be $c = 33,400$ ft/sec (reference 5). Calculation shows that using a single stage for each leg of the journey would require a fuel/gross weight ratio of 0.96 (for each stage) too high to be practical. Using two stages each way (four altogether) brings the required fuel ratio down to 0.81, a value that can be realized.

If, by the development of strong alloys, the basic weight could be kept to 10% of the total weight for each stage, a residue of 9% could be used for payload. A four stage vehicle would then have a gross weight $\frac{(100)^4}{9} = 15,000$ times as great as the payload: thus, if the payload were 2,000 pounds, the gross weight would be 30 million pounds at initial takeoff (Earth pounds).

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Of course, if we allow the Martians to refuel, the vehicle could have only two stages* and the gross weight would be only $(\frac{100}{9})^2 = 123$ times the payload, i.e., 250,000 pounds. This would

require bringing electrolytic and refrigerating equipment and sitting at the South Pole long enough to extract fuel for the journey home, since they have not asked us for supplies. Our oceans (electrolysis to make H_2) would be obvious to Martian telescopes and they might conceivably follow such a plan, particularly if they came here without foreknowledge that Earth has a civilization.

Requirements for a trip from a planet attached to some star other than the Sun can be calculated in a similar manner. Here the energy (or velocity) required has more parts: (a) escape from the planet (b) escape from the star (c) enough velocity to traverse a few light years of space in reasonable time (d) deceleration toward the Sun (e) deceleration toward the Earth. The nearest "eligible" star is an object called Wolf 359 (see reference 4, p 52), at a distance of 8.0 light years. It is small, having an absolute magnitude of 16.6 and is typical of "red dwarfs" which make up more than half of the eligible populations. By comparison with similar stars of known mass, this star is estimated to have a mass roughly 0.03 as great as the sun. Since the star has a low luminosity (being much cooler and smaller than the Sun) a habitable planet would need to be in a small orbit for warmth.

Of the changes of energy required as listed in the preceding paragraph, item (c), velocity to traverse intervening space, is so large as to make the others completely negligible. If the visitors were long lived and could "hibernate" for 80 years both coming and going, then 1/10 the speed of light would be required, i.e., the enormous velocity of 18,000 miles per second. This is completely beyond the reach of any predicted level of rocket propulsion.

If a race were far enough advanced to make really efficient use of nuclear energy, then a large part of the mass of the nuclear material might be converted into jet energy. We have no idea how to do this, in fact reference 6 indicates that the materials required to withstand the temperatures, etc., may be fundamentally unattainable. Let us start from a jet-propellant-to-gross-weight ratio of 0.75. If the total amount of expended material (nuclear plus propellant) can be 0.85 of the gross weight, then the nuclear material expended can be 0.10 of the gross. Using an efficiency of 0.5 for converting nuclear energy to jet energy and neglecting relativistic mass corrections, then a rocket velocity of half the velocity of light could be attained. This would mean a transit time of 16 years each way from the star Wolf 359, or longer times from other eligible stars. To try to go much faster would mean spending much energy on relativistic change in mass and therefore operating at lowered efficiency.

* Actually three stages. On the trip to Earth, the first stage would be filled with fuel, the second stage would contain partial fuel, the third would be empty. The first stage would be thrown away during flight. On the trip back to Mars, the second and third stages would be filled with fuel. The gross weight of the initial vehicle would be of the order of magnitude of a two-stage rocket.

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To summarize this section of the discussion, it can be said that a trip from Mars is a logical engineering advance over our own present technical status, but that a trip from another star system requires improvements of propulsion that we have not yet conceived.

Combining the efforts of all the science-fiction writers, we could conjure up a large number of hypothetical methods of transportation like gravity shields, space overdrives, teleports, simulators, energy beams and so on. Conceivably, among the myriads of stellar systems in the Galaxy, one or more races have discovered methods of travel that would be fantastic by our standards. Yet the larger the volume of space that must be included in order to strengthen this possibility, the lower will be the chance that the race involved would ever find the earth. The Galaxy has a diameter of roughly 100,000 light years and a total mass about two hundred billion times that of the Sun (reference 4). Other galaxies have been photographed and estimated in numbers of several hundred million (reference 2, p. 4) at distances up to billions of light years (reference 7, p 158). The number of stars in the known universe is enormous, yet so are the distances involved. A super-race (unless they occur frequently) would not be likely to stumble upon Planet III of Sol, a fifth-magnitude star in the rarefied outskirts of the Galaxy. - *deck*

A description of the probable operating characteristics of space ships must be based on the assumption that they will be rockets, since this is the only form of propulsion that we know will function in outer space. Below are listed a few of the significant factors of rocketry in relation to the "flying objects".

(a) Maneuverability. A special-purpose rocket can be made as maneuverable as we like, with very high accelerations either along or normal to the flight path. However, a high-performance space ship will certainly be large and unwieldy and could hardly be designed to maneuver frivolously around in the Earth's atmosphere. The only economical maneuver would be to come down and go up more or less vertically.

(b) Fuel reserves. It is hard to see how a single rocket ship could carry enough extra fuel to make repeated descents into the Earth's atmosphere. The large number of flying objects reported in quick succession could only mean a large number of visiting craft.

Two possibilities thus are presented. First, a number of space ships could have come as a group. This would only be done if full-dress contact were to be established. Second, numerous small craft might descend from a mother ship which coasts around the Earth in a satellite orbit. But this could mean that the smaller craft would have to be rockets of satellite performance, and to contain them the mother ship would have to be truly enormous.

(c) Appearance. A vertically descending rocket might well appear as a luminous disk to a person directly below. Observers at a distance, however, would surely identify the rocket for what it really is. There would probably be more reports of oblique views than of end-on views. Of course, the shape need not be typical of our rockets; yet the exhaust should be easy to see.

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One or two additional general remarks may be relevant to space ships as "flying objects". The distribution of flying objects is peculiar, to say the least. As far as this writer knows, all incidents have occurred within the United States, whereas visiting space-men could be expected to scatter their visits more or less uniformly over the globe. The small area covered indicates strongly that the flying objects are of Earthly origin, whether physical or psychological.

The lack of purpose apparent in the various episodes is also puzzling. Only one motive can be assigned; that the space-men are "feeling out" our defenses without wanting to be belligerent. If so, they must have been satisfied long ago that we can't catch them. It seems fruitless for them to keep repeating the same experiment.

Conclusions:

Although visits from outer space are believed to be possible, they are believed to be very improbable. In particular, the actions attributed to the "flying objects" reported during 1947 and 1948 seem inconsistent with the requirements for space travel.

Very truly yours,

J. E. Lipp
Missiles Division

JEL:sp

References

1. "Earth, Moon and Planets", by F.L. Whipple, Harvard Books on Astronomy, Blakiston, 1941.
2. "Atoms, Stars and Nebulae", by Goldberg, Alter; Harvard Books on Astronomy, Blakiston, 1943.
3. "The Story of Variable Stars", by Campbell and Jacchia, Harvard Books on Astronomy, Blakiston, 1945.
4. "The Milky Way", by Bok and Bok, Harvard Books on Astronomy, Blakiston 1941.
5. Calculated Properties of Hydrogen Propellant at High Temperatures. Data provided to RAND by Dr. Altman, then at JPL. Unpublished.
6. "The Use of Atomic Power for Rockets", by R. Serber, Appendix IV Second Quarterly Report, RA-15004, Douglas Aircraft Co., Inc., Project Rand.
7. "Galaxies", by Shapley, Harlow; Harvard Books on Astronomy, Blakiston 1943.

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APPENDIX F

3610th Electronics Station

Analysis of Project Grudge Reports

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By VH NARA Date 2/14/98

AIR MATERIEL COMMAND
3160 Electronics Station
Cambridge Field Station
230 Albany Street
Cambridge 39, Mass.

ACT/Bs

000.92
In reply address
both communication
and envelope to the
Commanding Officer
and attention of
following office
symbol. ERH

April 18, 1949

SUBJECT: Analysis of Project "Grudge" Reported Incidents

TO: Commanding General
Air Materiel Command
Wright-Patterson Air Force Base
Dayton, Ohio
ATTN: MCIAXO

1. Reference is made to the letters from your Headquarters to this station of 22 November 1948, 6 December 1948, and 14 January 1949, Subjects: "Project 'Sign' ", requesting that reported incidents 1 through 172 be analyzed to determine whether or not these might have been caused by balloons launched by these laboratories.

2. A listing has been compiled of all balloons launched by these laboratories and its contractors for special atmospheric research purposes, from the first such launching to No. 101 on 17 November 1948. Each of these launchings has been compared with the reported incidents 1 through 172. Factors of comparison were date of launching and date of recovery with respect to date of reported incidents; place of launching and place of recovery with respect to the place of reported incidents, and possible deviations from the known flight path with respect to the place of reported incidents. So that your office may make an independent analysis, three copies of the launching list are inclosed.

a. Incidents No. 5 through No. 16 reported on 4 July 1947 throughout Oregon, Idaho and Washington gave, in general, descriptions of clusters or groups of objects. The 3 July 1947 balloon launching No. 8 at Alamogordo was a cluster of balloons and was not recovered, and so might be suspected of being the cause of these reports. However, although not recovered, this flight was terminated in the New Mexico Tularosa Valley only a few miles northwest of Alamogordo. That the balloons were downed was determined both by airplane spotting and by radio direction finding upon the balloon telemetering instruments. Recovery of the balloons and instruments was prevented by the impassability of the terrain.

b. Balloon release No. 11 of 7 July 1947 could compare with respect to date with incident No. 1 through No. 4, and again with incident No. 40. This balloon flight was again a cluster.

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Ltr, ERH, to CG, AMC, Subj: Analysis of Proj. "Grudge" Reported Incidents

The description of incident No. 40 is inconsistent with the appearance of balloon flight No. 11. Also, in consideration of the prevailing upper winds, it is very unlikely that the balloons would have gone more than a few miles westward of Alamogordo, although it must be admitted that a long flight west of the launching point could not be ruled out as impossible.

c. Incident No. 47 compares somewhat in time with balloon Launching No. 10 of 5 July 1947. However, balloon No. 10 although not recovered was known to have been downed northeast of Albuquerque, New Mexico. It was not recovered due to impassability of terrain. Incident No. 113 is a reasonable description of the 20 ft. plastic balloon and instruments used by these Laboratories. This incident was on the date of balloon release No. 46 of 9 April 1948 at Alamogordo. However, the time of the reported incident (1506 CST) is about 1/2 hour before the time of balloon release (1432 MST), thus the incident could not have been that balloon.

d. It is of interest to note that incident No. 122 was reported by an employee of these Laboratories who had considerable experience in the use of balloons of all kinds, and could have been depended upon to know the appearance and behavior of a balloon if it was this he saw.

e. Incident No. 163 bears a fair description of the appearance of a large plastic balloon in sunset light. The object's disappearance could be accounted for either by its movement into the earth's sunset shadow or by natural defocusing of the observer's eyes. This incident could possibly have been balloon release No. 75 or No. 76 or 20 and 21 July 48 from Alamogordo. Balloon No. 75 was recovered at Hollister, California, which is in the Monterey Bay area, on 22 July 1948 and could have easily had a trajectory which would have been within sight of the Los Angeles area. Balloon No. 76 was never recovered. It is possible that it had a trajectory similar to No. 75.

f. All other reported incidents from 1 to 172 do not seem to have reasonable comparison with balloons launched by these Laboratories.

3. The balloons used by these Laboratories are now somewhat standardized. They are 20 feet long, plastic, white in color, and hemisphere-on-cone in shape. Nearly all launchings are made at the Holloman AFB at Alamogordo, New Mexico. Two photograph prints are enclosed showing the appearance and size of these balloons. The larger photograph shows the typical flight appearance at any altitudes where it would be visible. It is hoped that this information may be of some use to you in identifying future reports of incidents.

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4. It is believed that certain of the items in the questionnaire "Checklist-Unidentified Flying Objects" produce insignificant and unreliable data from an observer. These are; 9. Distance of object from observer; 11. Altitude; 12. Speed; and 16. Size. For any unfamiliar object beyond the focal range of the human eyes (about 60 ft.), these four factors are mutually inter-dependent and therefore indeterminate unless at least one of them (and some observed angles) are known. Directly asking an observer about these indeterminants not only gets unreliable data but induces wild answers because the observer is led into making a statement about quantities for which he has no basis in fact. He will unconsciously assume knowledge of some one of these factors and so give incorrect information on all. That people (many of whom should know better) will arbitrarily give answers to two significant figures on these questions, which really cannot be answered at all, is proof of the unreliability of their information.

5. It is suggested that these four items on the questionnaire be replaced by questions which will yield answers possible of being independent facts in terms of the observer's best estimates of angles and time. From such data given by observers of the same object at two different places, a reliable calculated estimate could be made of the object's size, altitude, speed and path. These data should include;

a. An estimate of the angular size of the object. A quick but reasonable estimate can be made by comparing the angle subtended by the index finger held at arms length. The finger ($7/8$ " wide) of an average man held at 26" to 30" (arms length) will subtend an angle of approximately two degrees. In this way angular size from about $1/2^\circ$ to about 8° can be estimated.

b. The range of the object's flight in terms of the angle subtended by the observed path. If the object moves in a reasonably straight course it is important to observe the position at the beginning and the end of its course. After the flight has been completed a person can extend his arms toward the two points and also at 90° or 180° and by comparison estimate the angular extent of the flight. It is also important that information which will determine those directions relative to a compass point be given. If the angular course is associated with objects on the horizon, with roads, with the sun (if the time of day is also noted) or by the north star, the orientation can be rechecked at any later time.

c. The time required for the object to traverse the observed course. This is probably the most difficult estimate to make. Timing with a watch is the most satisfactory, but an observer is seldom prepared to do so. Seconds can be counted with good accuracy by saying,

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"one flying saucer; two flying saucers, three flying saucers" ---etc. At a normal speaking speed. On the other hand it is not easy to count seconds and at the same time make all the other desirable observations. It must be remembered that when a person is excited his estimates of time are apt to be rather inaccurate.

d. Estimation of the elevation angle of the object. Almost all persons will overestimate elevation angles. This tendency can be reduced by the observer extending one arm vertically and the other horizontally to observe a 90° angle. The vertical arm can then be lowered to point to the observed object. In this way the observed angle can be compared with a 90° angle and a more accurate estimate obtained.

6. It is realized that it might not be possible for an observer to perform the operations suggested in the preceding paragraph, during the period the object is sighted. If he would immediately reconsider what he saw and then estimate such measurements, he should be able to give quantitative answers accurate to at least 25%. In interrogating observers, they should also be asked to reconstruct their observations and then estimate these same factors. It is suggested that instructions for making such quick and estimated observations be given to weather observers, control tower operators, civil police, forest and fire rangers, and other such people who might have good chance of seeing unidentified flying objects. If any information concerning unidentified flying objects is given to the public, instructions for reliable observation should be included.

7. This organization will be pleased to be of any further assistance required in connection with this matter.

FOR THE COMMANDING OFFICER:

3 Incls

1. List of balloons launched (in trip)
2. 8" X 10" photo print of plastic balloon
3. 4" X 5" photo print of plastic balloon

/s/ A. C. Trakowski, Jr.
A. C. TRAKOWSKI, JR.
Captain, USAF
Director, Base Directorate
for Geophysical Research

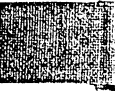
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APPENDIX G

Dr. Paul M. Fitts

Psychological Analysis of Reports of Unidentified Aerial Objects



C O N F I D E N T I A L

U. S. AIR FORCE
HEADQUARTERS, AIR MATERIEL COMMAND
ENGINEERING DIVISION

No. of pages - 15

MCREXD9/PMF/maf

MEMORANDUM REPORT ON

28 April 1949

SUBJECT: Psychological Analysis of Reports of Unidentified
Aerial Objects

SECTION: Aero Medical Laboratory

SERIAL NO.: MCREXD-694-18D

Expenditure Order No. 694-38

A. PURPOSE:

1. At the request of the Technical Intelligence Division, Intelligence Department, AMC, an analysis has been made, from a psychological point of view, of 212 investigations of persons reporting sightings of unidentified aerial objects.

B. FACTUAL DATA:

2. A report of this analysis is attached as Appendix A.

C. CONCLUSIONS:

3. It is concluded by the writer that there are sufficient psychological explanations for the reports of unidentified flying objects to provide plausible explanations for reports not otherwise explainable. These errors in identifying real stimuli result chiefly from inability to estimate speed, distance and size.

D. RECOMMENDATIONS:

4. Test the ability of pilots to estimate the course of a small lighted balloon while doing acrobatics with it at night. It is suggested that several pilots try to fly pursuit curves and collision courses on such targets at night and report accurately their sensations. It would be desirable, but probably impossible, to keep them from knowing the nature of the light source.

5. In all future reports of unidentified objects specify the location of object with reference to polar coordinates (direction and degrees above the horizon) rather than asking individuals to estimate distance. If possible, obtain an estimate of size in terms of the visual angle subtended by the object.

6. In all future investigations determine the angular position of the sun with respect to the unidentified object and the observer.

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Engineering Division

Memorandum Report No. MCREXD-694-18D

28 April 1949

Also determine the approximate time during which the object was in sight
(this information was not available for more than half the reports).

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PAUL M. FITTS, Ph.D.
Chief, Psychology Branch

Prepared by: Shirley C. Connell
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Psychology Branch

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Engineering Division
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28 April 1949

APPENDIX A

PSYCHOLOGICAL ANALYSIS OF REPORTS OF
UNIDENTIFIED AERIAL OBJECTS

The Inaccuracy of Human Observation

Psychologists have long known that human perception is fallible. In fact, part of the science of psychology is concerned with the measurement of errors of observation, and with the discovery of the conditions and laws that govern such phenomena.

Errors of observation may be classified as variable or constant. Variable errors are those in which a number of separate observations are found to differ from one another. The distribution of such errors often follows the normal probability curve. Constant errors are those in which observations are consistently biased in one or another direction. For example, individuals often are guilty of a constant error, in the direction of underestimation, in reporting their ages.

Errors of observation may be classified further as precision errors and identification errors. Inaccuracy in estimating the speed of an aircraft is an example of the former. Mistaking an aircraft for a "flying saucer" is an example of the latter.

It is the purpose of the present report to analyze 212 reports of observations of unidentified flying objects in order to see to what extent these reports can be explained in terms of known psychological facts and principles.

Scientific Method and a Posteriori Data

A word of caution must be injected at the outset of this report. Certain conditions are necessary for drawing valid scientific conclusions.

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These conditions are largely lacking in the case of the data available on unidentified flying objects. It is impossible to say with any assurance what any particular individual in this series of 212 reports was actually observing at any particular time. It is only possible to examine the accumulation of available evidence or the accumulation of all reports of a given class (e.g., all reports from supposedly competent observers) and to consider them in a statistical sense. If certain characteristics appear repeatedly in reports from different people it may be possible to infer causal factors.

It will never be possible, on the other hand, to say with certainty that any given observer could not have seen a space ship or an enemy missile, or some other object. It will only be possible to estimate the probability that he could have seen such things.

The principal hypothesis to be examined in the following discussion is that reports of unidentified flying objects have the characteristics that would be expected if they were cases of failure, on the part of typical normal individuals, to identify common or familiar phenomena.

Possible Sources of Inaccurate Reports of Flying Objects

There are three broad classes of mistakes in human observations. These are the following: 1. Misinterpreting the nature of real stimuli, 2. Mistaking unreal (imaginary) stimuli for real ones, and 3. Deliberate falsifications. Each of these are considered briefly below.

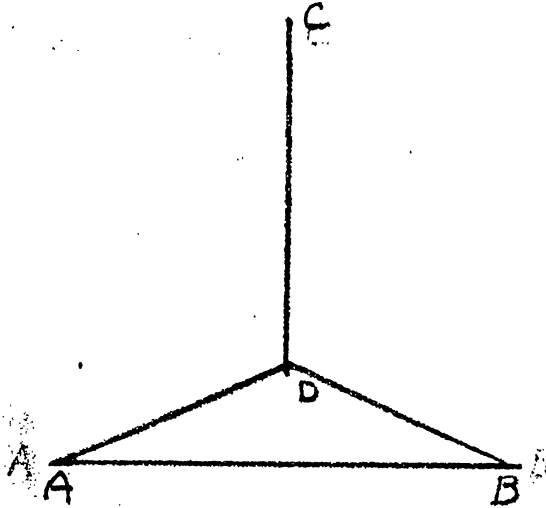
(1) Errors in Identifying Real Stimuli. All normal, intelligent people experience certain errors of observation. The moon appears much larger on the horizon than when it is high in the sky. A stick looks bent when one end is in water. Distant objects appear relatively close in clear, desert atmosphere. A small point-source of light, if viewed in a dark room, will appear to move about in strange gyrations, even though it is actually motionless. This is called

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the autokinetic illusion (see Guilford, J. P., 1928). In the accompanying figure the line AB looks approximately as long as the line CD, but when you measure them the two will be found to be of quite different lengths.



Visual stimuli originating within the eye itself also give rise to mistaken observations. *Muscae volitantes* or "flying gnats" are small solid particles that float about in the fluids of the eye and cast shadows on the retina. They often can be seen when you look up at the clear sky, or when you are reading. They move as your eyes move. It is sometimes possible also to see corpuscles or other objects that are circulating within the fluids in the retina of the eye.

Then, of course, everyone from time to time mistakes some more or less familiar object for another object. A probable explanation for many reports of unidentified aerial phenomena is that the object is really something quite familiar, such as an aircraft, a light, or a bird. The observer simply fails to identify it correctly. These errors arise chiefly as a result of inability to estimate speed and distance.

(2) Mistaking Imaginary for Real Events. This error of observation is usually made ~~not~~ by children, by individuals of low intelligence (people who are very suggestible), by people who see visions, or by the mentally ill. It usually is not difficult for an

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expert to spot this type of person. Reports will be received ^{from} ~~by~~ such persons especially at times when the radio and newspapers carry accounts of strange phenomena. Relatively few of the 212 investigations considered in this report are of this nature, probably because investigators interviewed only the more reliable type of witness.

(3) Deliberate Falsifications. It is always possible that some persons will give false reports. Circulation of false reports has been a standard psychological warfare technique from earliest times. This procedure might have some utility in wartime, but it hardly seems likely that it would be resorted to at this time. Probably, however, some individuals start false reports of "flying saucers" for the same reason that they turn in false fire alarms.

Some Consistent Points in the Reports of Unidentified Objects.

The following section summarizes some significant facts that come out of a tabulation of 212 reports of interrogations, by USAF Intelligence Officer, of some of the individuals who reported seeing unidentified flying objects. It is understood that these interrogations covered primarily persons that were judged to be reliable. Most of the 212 reports were made by pilots, non-flying officers, professional men, government employees, housewives and other supposedly dependable people.

1. Number of objects. About 75% of the people who reported on the number of objects seen said that they saw only one object.
2. Time the object remained in sight. About half of the persons specifying time in sight saw the object for 60 seconds or less.
3. Altitude and distance of the object. Of those who estimated the distance of the object, two-thirds judged it to be more than a mile away. Ninety percent also thought that it was more than 1,000 feet high.

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4. Speed. About half judged that the speed was less than 500 miles an hour. The other half of the judgments varied from 500 miles an hour all the way to "terrific", "tremendous", "inconceivable" and "blue blazes".

5. Background against which viewed. The great majority of observers saw the object against a clear day or night sky.

6. Time of day sighted. About two-thirds as many observations were reported at night as in the day. There are, of course, many more opportunities for observing things during the day. The most popular hours were from 12 noon to 5:00 P.M. and from 7:00 P.M. to 11:00 P.M. at night. Very few (6 only) observations were made from 5:00 to 7:00 P.M., the usual hours of sunset.

7. Color. Observers almost universally reported seeing a light-colored object. Thirty observers reported "white" and twenty-five said "silver". Over 70 percent described glittering, shiny, luminescent, mirror-like, ^{flame-like} or other very bright objects. Only six individuals said black or dark.

8. Shape. Over half described the object as either "round", "disc-shaped", "spherical" or "circular". Other descriptions were similar. Very few observers saw any distinctive shape.

9. Size. The majority of observers did not specify the objects' size. Of those who did over half said it was less than 10 feet in its largest dimension. Many compared it with a dime, a lamp, a dot, a weather ballon, a baseball, etc.

Interpretation of the Common Points of All Reports

The words used by observers to describe the appearances of the unidentified objects fall into a surprisingly uniform pattern. The objects were usually reported as being far away, small, bright and without a distinctive shape. They were usually seen against a clear sky

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and were frequently seen for less than a minute.

First of all, it is obvious that it would usually be impossible for observers to make reliable estimates of the speed, distance, or size of such stimulus objects. It is not possible to estimate accurately the distance of small bright objects viewed against a clear sky, unless the object is identified first. If you know beforehand that an object is a weather balloon, an F-80, or a dirigible you can estimate its speed and distance with some degree of accuracy. In such situations distance is judged on the basis of known size, and speed on the basis of an estimate of distance plus the angular change in position. It must be concluded, therefore, that most of the statements of speed, distance, altitude and size are entirely unreliable and should be disregarded. This is doubly true of observations made at night. The objects seen may actually have been at very great distances, or they may have been relatively close by. In the latter case, of course, they could also have been quite small.

Secondly, it is probable that individuals who saw objects in daylight were in many cases observing either the reflection of the sun on a shiny surface or else looking directly at a light source of high intensity. Aircraft themselves, when viewed against a clear sky, are seen as dark objects against a lighter background unless they are reflecting the sun's rays directly. This fact was recognized during the recent war by camouflage experts who placed bright lights on the leading edges of the wings of aircraft on anti-submarine patrol in order to conceal them from the eyes of submarine lookouts. If observers, during daylight hours, were actually seeing lights, or reflections of the sun, this would account in large measure for their inability to identify the objects. On the other hand, if they were actually seeing enemy missiles, for example, the majority of reports

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of daylight sightings should have been of dark objects. It is possible, of course, that they may have thought the objects were bright because they expected all aerial objects to be bright.

On the basis of the evidence thus far considered, the best guess as to the nature of a visual stimulus that would elicit reports of unidentified flying objects is that in the daytime it would be the reflection of the sun from an aircraft, a wind-blown object, etc., and at night some direct light source, such as an engine exhaust, the light on a weather balloon, a running light on an aircraft, a meteor, etc., or light from the ground or the moon reflected back by birds or other objects in the air.

Discussion of Several Specific Reports

Discussion of a few specific reports will serve to illustrate some of the points brought up earlier, particularly some of the factors that make observations of aerial phenomena inaccurate.

Incidents No. 81 and 163.

In one case (Investigation No. 81) a civilian employee at Hickam Field at 0900 observed what looked like a balloon with a bright object suspended below it. It was estimated to be at about 6,000 ft. The bright object appeared to reflect the sun's rays at times. After a few minutes he looked away and then could not find the object again.

In another case (No. 163) a reserve officer at Van Nuys, California, about an hour before dark saw an object that looked somewhat like a weather balloon at about 2000 ft. He kept it in sight for about an hour. He later concluded that it was at a great height. At first it had the color of a fluorescent electric light but became orange as the sun went down and then rather suddenly became invisible.

Both of these objects could well have been just what they appeared to resemble most—balloons. The sun was low in the sky in both cases.

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Reflection of the sun's rays may have given an unusual appearance to the object. The second case illustrates the uncertainty of judgments of height or distance. The object looked near, but when it remained in view for an hour the observer decided that it must be very far away. Actually he probably had nothing on which to base an accurate estimate of distance.

Incidents 61 and 61a.

Two couples saw approximately 12 objects flying in formation at what they judged to be 2000 or 3000 foot altitude over Logan, Utah at 22:30. They were judged to be about the size of pigeons and looked white. All four observers agreed that these objects looked and acted somewhat like birds but all thought they were not birds because they appeared to travel much faster than birds.

As we have seen, it is not possible to judge speed accurately under the conditions of these observations, i.e., when looking at objects of unknown size and distance against a night sky. The objects may actually have been a flock of white birds, flying at a relatively low altitude and reflecting the lights of the city.

Incidents 30, 30b, 30c, and 48, 48a, 48b, 48c, 48d.

During the same space of time (about half an hour) on the night of 7 January 1948 observers at Lockbourne Air Force Base, observers at Clinton County AFB and the pilot of an aircraft flying from Dayton to Washington reported an unidentified object in the sky. All reports agreed as to the color and general appearance of the object, and as to the fact that its light at times ^{was} visible through a light overcast. All agreed also that it was seen to the southwest. However, persons at all three locations judged the object to be only a few miles away. To all of them it looked motionless at times, then appeared to gain and lose elevation. A very similar object was seen by numerous

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persons at Fort Knox and other towns in Kentucky a few hours earlier. All saw it in the southwest and many thought it was only a few miles away. The Commanding Officer at Goodman Field observed it for 1 1/2 hours, (beginning at 1145). During this time it seemingly remained stationary. It was "chased" by four National Guard pilots, one of whom crashed after having been up to 20,000 feet. It was also reported by persons in Lexington, Madisonville, and Elizabethtown.

The significant fact that emerges from these reports again is the inability to estimate distances. It appears possible that persons over parts of Kentucky and Ohio may have been seeing the same astronomical phenomena which was a great many miles away. Nevertheless each believed it to be relatively near his own location.

Incident No. 172.

A National Guard Pilot returning to Fargo, North Dakota, in a F-51 at approximately 2100 hours saw a small light in the air below him. He was then in the traffic pattern. He dived on the light. The light gained altitude. The pilot "chased" it up to 14,000 feet, making various passes at it and attempts to ram it as he climbed. He finally stalled out.

Several inferences can be drawn from the several reports about this incident. In the first place, when it is night, and a pilot is turning so steeply, and going such violent acrobatics, that he sometimes blacks out, as was the case here, it would be very difficult if not impossible to judge at the same time what another object was doing. In the second place, if the pilot kept his eyes intently on the object, as also was the case here, he would have great difficulty in knowing and reporting later what he himself was doing. The situation is very conducive to loss of orientation. In other words, it is impossible to infer from the pilot's report whether the light perceived by him was

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maneuvering or not maneuvering. It is quite possible that it was simply climbing steeply on a relatively straight course, such as would be taken by a lighted weather balloon.

As a matter of fact, a lighted weather balloon was released by the Fargo Weather Station within 10 minutes of the time the light was first sighted by the F-51 pilot. It is the opinion of the writer that this lighted balloon easily could have accounted for all of the pilot's observations. (It should be noted that the standard 30 inch and 65 inch weather balloons have a vertical speed of about 600 and 1100 ft./min. respectively.)

General Discussion and Summary

In the preceding section the hypothesis has been advanced that most reports of unidentified flying objects have been the result of persons failing to identify familiar phenomena, such as reflections from bright surfaces in the day or lights in a night sky. It is believed that this explanation will account for many of the reports. However, some reports undoubtedly have other explanation.

Vertigo. The term vertigo covers a large group of miscellaneous phenomena including air sickness, disbelief in one's instruments, and partial loss of orientation. The conditions under which some of the observations of flying objects were made were such that they could have produced loss of orientation on the part of an observer. This is especially true for those experiences occurring at night and those in which attempts were made to "chase" the object. Movement is always relative. If the only outside reference is a point of light, and both the observer and the object observed are moving, it would be practically impossible under certain conditions to tell which was moving and which was not, or to separate out the two motions. It is hard enough

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to fly a good pursuit curve on another aircraft in good daylight, for example, much less to close on a solitary light at night. The difficulty is due chiefly to the inability to judge distance or speed of a point source of light.

Suggestion. Suggestion works in various ways. Sensational radio and newspaper reports lead a few people to imagine they are seeing things they are not seeing. The effect on most people is to dampen their critical judgment. Under such conditions we are more likely to overlook certain factors, and find it easier to accept the suggested explanation uncritically. The expected result would be to make the reports of most observers slightly less accurate than if they had never heard reports of others seeing "flying saucers". Particularly when the stimulus object is fuzzy or ill-defined, persons tend to see it as resembling whatever is suggested to them. Carmichael et. al., for example (1932) showed individuals simple designs and gave them the name of an object. When the individuals drew the design from memory, they drew it to resemble whatever the object was that had been suggested to them.

Precedent. An historical precedent can be found for most errors of human observation. Although the writer has not tried to make an historical survey of reports of earlier unidentified aerial objects, he feels sure that there have been many such reports in years past, particularly during and after World War I.

Small Wind-borne Objects. It is possible that some observers may have seen small objects carried aloft by strong winds, or objects dropped from aircraft. Bits of paper, small cartons, etc., may occasionally be carried to a considerable height by strong winds. Aircraft may sometimes jettison small articles. It would be impossible to

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estimate the distance, size or speed of such objects, and it would be easy to fail to recognize them.

Conclusions

It is concluded by the writer that there are sufficient psychological explanations for the reports of unidentified flying objects to provide plausible explanations for reports not otherwise explainable. These errors in identifying real stimuli result chiefly from inability to estimate speed, distance and size.

Recommendations

The following recommendations are offered:

1. Test the ability of pilots to estimate the course of a small lighted balloon while doing acrobatics with it at night. It is suggested that several pilots try to fly pursuit curves and collision courses on such targets at night and report accurately their sensations. It would be desirable, but probably impossible, to keep them from knowing the nature of the light source.
2. In all future reports of unidentified objects specify the location of the object with reference to polar coordinates (direction and degrees above the horizon) rather than asking individuals to estimate distance. If possible, obtain an estimate of size in terms of the visual angle subtended by the object.
3. In all future investigations determine the angular position of the sun with respect to the unidentified object and the observer. Also determine the approximate time during which the object was in sight (this information was not available for more than half the reports).

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Authority NWD 971337

By VH NARA Date 2/14/98

HEADQUARTERS
AIR WEATHER SERVICE
Andrews Air Force Base
Washington 25, D. C.

In Reply
Refer To: AWS DSS

11 May 1949

SUBJECT: Unidentified Flying Objects

TO : Commanding General
Air Materiel Command
Wright-Patterson Air Force Base
Dayton, Ohio
ATTN: MCIAXO-3

1. Reference is made to letter from your headquarters, MCIAXS, dated 9 March 1949, subject "Unidentified Flying Objects," and first indorsement thereto by this headquarters, dated 31 March 1949.

2. The incident summaries 173 through 233 have been checked against routine weather-balloon ascents made by the Air Force, Navy and Weather Bureau. Comments based on this review are inclosed.

3. It is recommended that the "Guide To Investigation Of Unidentified Aerial Objects" be changed as follows: Item 13, "Direction of Flight of Object," should be clarified so that vertical and horizontal motions are distinguished if possible, and so that motion is specified as the direction towards which the object appears to move. "Relative to Radar Settings" should include a statement of the type of radar set used.

FOR THE CHIEF, AIR WEATHER SERVICE

2 Incls:

- 1 - Incident Summaries
- 2 - Comments 173 thru 233

/s/ W. A. West
W. A. WEST
Lt. Col., USAF
Adjutant General

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By VH NARA Date 2/14/98

No. 173: Rawinsonde released from Barksdale AFB at 1500 CST. Shreveport under influence of very tight low of a local nature which extended through the 500 mb. level. In all probability, rawinsonde balloon path was circular following isobar curvature around Shreveport, hence balloon was seen approximately two hours later in the same area. Assuming a balloon leak, not altogether uncommon, the rawinsonde could have remained low enough to be seen. Winds reported as high as 70K account for speed. Conclusion: Rawinsonde balloon.

No. 174: Nearest pilot balloon sounding release was at Lake Charles at 0300 CST. Wind flow WNW in lower levels, changing to SSW with altitude. No winds of high enough velocity to carry pilot balloon sounding from Lake Charles to New Orleans in time interval were reported. Only other release in the area was at Biloxi, North of New Orleans. Winds aloft were WSW. Speed stated by observer of 300 M.P.H. is approximately 15 times greater than any wind reported for that area. Conclusion: Not a balloon.

No. 175: Pilot balloon sounding released from Albuquerque at same time as observation. Upper winds show WNW flow hence could not have been the AB balloon. Great differences of opinion exist as to speed and shape of the object. One observer states that the object was not a weather balloon. All evidence indicates that this is true. Conclusion: Not a balloon.

No. 176: Navy rawinsonde and Weather Bureau pilot balloon sounding were released approximately one hour prior to sighting. Wind flow, however, was WNW at all levels from the surface to 15,000 feet which would seem to preclude the possibility of either balloon drifting North to the San Pablo area. Both witnesses also agree that the object was travelling at high speed. Winds for that region did not exceed 25 K. Conclusion: No balloon.

No. 177: Crack-pot report; insufficient information to evaluate.

No. 178: No weather balloons were released in the vicinity on the date mentioned.

No. 179: Crack-pot report; insufficient information to evaluate.

No. 180: No date given hence no analysis possible.

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No. 181: This obviously inaccurate report says in effect that the object was seen about 30 minutes after pilot balloon sounding and rawinsonde release time. From the known releast points, wind direction and speed at the level mentioned, this object or objects could not possibly have been a weather balloon.

No. 182: No balloons released within 120 miles of this position, but if wind were from west it could have been a leaking balloon from Norfolk or Hatteras which was not rising as it should. However, the date of incident cannot be read from the questionnaire, hence no definite conclusion can be drawn.

No. 183: Purely a radar report. If this report is accurate, couldn't possibly be a balloon.

No. 184 - 185: Very controversial accounts of speed (0 - 3 times that of a Jet); description sounds like burning pilot balloon sounding with lantern. However, nearest release was two hours earlier at St. Cloud. Could have been this pilot balloon sounding assuming a leaky balloon to keep it at a low altitude. Not at all probable, but possibly a balloon.

No. 186: Object reported moving directly into headwind of 20K. Only possible weather balloon would have been moving SE from Salt Lake City. If speed is any criterion, this was definitely not a balloon.

No. 187: A heavenly body, Venus.

No. 188: No actual sighting; a radar report, if accurate, definitely no weather balloon.

No. 189: Rawinsondes released at Montgomery and Atlanta 1 1/2 hours earlier and would have been blown into sighted area by upper winds. Only a faulty balloon, however, could have descended to that low altitude. From description, balloon is most unlikely.

No. 190: Every indication seems to point to this object being a rawinsonde balloon. Rawinsonde scheduled to be released from Munich approximately one hour previous to sighting. Very light winds in Munich area. Definitely a balloon.

No. 191: Only balloon released in wind pattern that would carry it over Junction City was released at Dodge City approximately one hour before sighting time. If reported direction and speed of object were at all accurate, balloon not possible.

No. 192: Balloons released from St. Cloud and Duluth just prior to sighting. Wind perfect for carrying balloon ~~xx~~ into observer's path. Wind

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reported at 30K at about 80° to 110° . Steadily rising is also indicative of weather balloon.

No. 193: No date given; very little information; cannot determine object.

No. 194: Definite identity established by M.I.T.

No. 195: Very little information, only radar pipe; cannot determine if weather balloon or not.

No. 196: Radar scope observation only; object travelling directly into wind. Cannot determine if balloon, but unlikely.

No. 197: Almost certainly the comet discovered by the Sydney astronomer. No balloon could have reached Richmond at the time the object was sighted inasmuch as the sighting time and release time were almost simultaneous.

No. 198: No visual observation; radar blip moving at high speed and constantly changing direction. If radar report is accurate, couldn't possibly be a balloon.

No. 199: Wind, time and number of objects sighted rule out possibility of weather balloons.

No. 200: Definitely not weather balloon. Course southerly, wind almost due North at all levels. Only station releasing balloon in this area is North of Crescent City.

No. 201: Pilot balloon sounding released from Azores station at 0300 H. Time of sight "about" that time. Description sounds very much like lighted pilot balloon sounding. Only discrepancy is speed which is reported from 25 M.P.H. to 800 M.P.H. If the lower speed is correct, object may be almost certainly assumed to be a weather balloon.

No. 202: Time of sighting was five hours after last scheduled release time for any rawin or pilot balloon sounding, thus discounting a balloon leak, would put it far too high for easy sighting. Definitely not a weather balloon.

No. 203: Again last scheduled release was over five hours prior to sighting. Only possibility, and a definitely unlikely one, is a lighted balloon falling in flames from an extremely high altitude.

No. 204: Venus.

No. 205: No date given on this, therefore, impossible to check wind flow pattern. Time, two hours after scheduled release time for Kansas City, Columbia, and St. Louis, Mo. balloons.