

and was able to pick up at least five more of these objects. *Being skeptical, I did my best to see them as either dandelion seeds or other small particles close to the surface of the earth rather than large objects at extreme distance.* However, after keeping them in sight long enough to study their appearance they definitely seemed to be very high. *I won't make an estimate of the height since I did not know their size.* All of these appeared in

the west and proceeded east at what appeared to be an extremely high rate of speed."

I submit that this Air Force lieutenant was not incompetent, but rather that his manner of reporting—as far as it went—was commendable and that his report, made in good faith, is therefore entitled to a hearing without prejudice or ridicule, but also, without fanfare, hysteria, and fantastic newspaper publicity.

## Phantasmagoria or Unusual Observations in the Atmosphere\*

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For many eras in man's history, the sky has been occupied by various gods, or constellations, or birds, mythical or real. A new concept has arisen in the last few years, largely a product of aviation and balloony, and civil air defense spotters. In general the reports have more psychological than physical significance. However, certain optical phenomena are now gaining far wider interest than among research men in optics. Some "authentic reports" by "reliable, competent observers" are recounted and considered. While complete interpretation of all "reports" is impossible, due to lack of sufficient experimental data, NO evidence exists for any phenomena not explicable by standard physical concepts.

IT is most unfortunate that man's early activities are not properly recorded for posterity. Thus it is not known when man first became aware of unusual phenomena in the atmosphere. The fear of solar and lunar eclipses was almost universally prevalent until very modern times. Gods in general inhabited the atmosphere—but not in visible form. Unusual birds appear in various myths and may have had some basis for reality in pterodactyls and other large avia. Rainbows have played a prominent part in various stories. As well as we understand lightning today, it is not generally realized that this knowledge has been accepted by the people for only slightly over a hundred years. Benjamin Franklin was greatly exasperated by the loss of life and property which continued even after widespread publication of his experiments. In particular, many churches were being destroyed by fire caused by lightning hitting the steeple. In addition, the bell ringers were being killed by lightning traveling down the wet bell cord. A papal edict had previously been issued that church bells were to be tolled during thunderstorms. This edict was the result of a theory that thunder (and thus storms) could be warded off by countering the noise with the peal of the church bells. The edict was, of course, rescinded, but only about 150 years ago.

\* At the time this paper was prepared, the nation was in the throes of a flying saucer scare, apparently of greater magnitude than any previous one. Since the impact was so great, it was believed most worth while to take any action which might alleviate the hysteria. In this spirit, the invitation to present this paper was accepted.

The origin of the general concept now known as flying saucers is difficult to ascertain. It seems that the name was attached to a newspaper report of mysterious objects seen in 1947 and has continued in prevalent use. However, many unusual phenomena were noted in the atmosphere prior to this time. Perhaps the best known is the Star of Bethlehem. In very early American history, a great explorer, David Thompson, who preceded Lewis and Clarke, records in his narrative dated November, 1792, an occurrence on Landing Lake in the Northwest Territory. He observed something which appeared globular and which, he said, from its size must have had some weight. It had no tail and no luminous sparks came from it until dashed to pieces. He assumed that it was a meteor, since he wrote, "The next morning we went to see what marks the meteor had made on the ice but could not discover that a single particle was marked or removed."

Lieutenant Bassett, U. S. Navy, published a book in 1885 entitled *Legends and Superstitions of the Sea and of Sailors*. Even at this early date he stated: "There is an obvious tendency in the human mind to exaggerate wonders. This has been especially true with regard to those wonders found in the great ocean, where a limitless horizon sets no bounds to thought, and where the smallest object, often by atmospheric causes, will easily be magnified." Remember this was written 67 years ago!

He goes on to recount: "The occasional reflections of mountains, cities, or ships in mirage or fog-bank, the land-look of such banks themselves, coupled with

the superstition of the medieval mariner, doubtless gave rise to the many stories of mysterious lands at various places and times. The Chinese call the mirage the "Sea Market."

The quotation continues: "A particularly apt illustration of the effects of natural causes is given in a modern book of travels. One evening travelers in a ship approaching close to Port Danger, on the South African coast, beheld a well-known English man-of-war, a short distance away. The travelers saw faces on board, and a boat was lowered and manned from the English ship, in sight of everybody. All recognized 'Barracouta,' and they expected to find her at anchor when they arrived, a short time after. It was a week, however, before she arrived, and then it was learned that she was at least 300 miles from Port Danger at the time referred to. The image seen was doubtless due to reflection or refraction in some cloud or fog-bank. Arctic voyagers often speak of the very remarkable effects of refraction, and many of the nautical tales of phantom-ships are, beyond doubt, caused by the sight of images in cloud of fog-bank." This excerpt is quoted at great length since, if the incident had occurred today, it would undoubtedly have been headline material. Also, it shows that the physical explanation was obvious even sixty-seven years ago.

I cannot resist the comment that a great deal of the furor of flying saucers is due to the hucksters of science. Pseudo science, uninhibited by the discipline of organized thinking or experimental facts, has received great impetus in the last several years from increased public interest in science itself. This is a lucrative business. It is practiced not only among those who have had some (and, in rare instances, for amusement, among those who have had extensive) scientific training. Those who make a living by such means are the first and loudest to object to a rational scientific explanation of these phenomena. Reputable journalists, too, must feed the maw of our great public press. The dearth of news following the political conventions provided an excellent opportunity for the July epidemic of front page stories.

In trying to analyze the various reports of atmospheric phenomena, one is generally confronted in press reports with two classes of observers: "outstanding scientists" and "competent observers." No aviator wishes to be called an "incompetent observer." Some have been flying for more than 20 years and are most vehement in defense of their ability to observe. Aviation psychologists, however, are well aware of the difficulties pilots encounter in their activities. Many aviators with thousands of hours experience have confided to me some of their difficulties. In flight formation, they have wandered off course following a star instead of the plane in front. Ground lights appear in unusual configurations. The engineer's awareness of these difficulties is evidenced by the plethora of instruments on the pilot's panel. Self-hypnosis is not unique to

aviation; highway engineers are greatly concerned about it in the construction of super-highways.

Concerning "outstanding scientists" I am reluctant to comment. If correctly quoted, their statements have certainly been more "outstanding" than "scientific." I recall one "outstanding scientist," widely quoted in the press, who retained a plainly marked piece of Navy scientific cosmic-ray equipment for several days, then turned it over to the Federal Bureau of Investigation as a "mysterious object," after appropriate interviews with press representatives. Fortunately, the Navy's liaison with the FBI permitted immediate return of the apparatus to its owner.

Several reports have received more widespread interest than others and should be discussed. The "Mantell" case, the Air Force officer who flew to his death in pursuit of a "saucer," has been widely and variously reported. He could have been chasing Venus; he could have chased a cosmic-ray balloon at 100 000-foot elevation (thus visible perhaps for 200 miles). Since Mantell and the others were not familiar with large objects at such altitudes, it is understandable that they would think the object was traveling away from them since they could not close the range. Suffice it to say he was not killed by a mysterious object.

A more scientific report is the "Chiles-Whitted" incident. These Eastern Airline pilots were flying a DC-3 over Georgia at approximately 3:00 A.M. in July, 1948. They saw "a wingless aircraft," approximately 100 feet long, with lighted windows. They veered course and it followed, then it disappeared in the clouds above. With these meager experimental data, the following explanation is possible. It is seldom pointed out that this was a clear, bright, moonlit night. Reflection of moonlight from the aluminum of the plane, and brighter reflection from the plastic windows, provided ample illumination to give a source for reflection from adjacent incipient clouds. It has not been widely known that haze particles too small to appear as solid clouds can act as reflecting layers. To the dark-adapted eyes of the pilots, the reflection appeared brilliant. Being a side reflection, the aircraft appeared wingless. Since the reflecting surface was not plane, the apparent speed and size of the image could be anything. The bright orange object was the reflection of the red hot exhaust pipes of the engines.

Another widely publicized report was from Fargo, North Dakota. Here an experienced pilot in an Air Force fighter plane chased a mysterious lighted object for some time. The object performed variously, always eluding the pilot, but always rising. The report is entirely compatible with the statement that he was chasing a standard meteorological balloon regularly released from airports. In fact, it has been reported that another pilot has chased a weather balloon in daylight when it was fully visible and he duplicated entirely the phenomena reported.

The public press is continually asking for *the* answer to

flying saucers. The only singular answer possible is that they are the result of physical optical phenomena. But certainly more than one principle is applicable. Analysis of the myriad reports of "saucers" shows that they fall into several categories. One immediately discards the phantasies such as children burned by flying saucers in their own backyards. Many reports come under the category of range and identification errors. Typical of the identification errors was the gossamer debris of a supposed saucer found in southern California. It turned out, on analysis, to be spider web of unusual variety having considerable length and volume. The web had been wind blown a hundred miles or so from its origin in northern California.

People are reluctant to admit range errors. No sea-going sailor will admit he cannot guess range and speed of distant ships. He is usually right because he knows the *size* of the target ship and hence can guess by the stadimeter principle of triangulation. In other instances, he is lost. Typical of range errors are two examples cited in a recent article in *Life Magazine* (March, 1952). In one instance the reporter gives a dimension visually measured as 136 feet at a range of 20 miles; in another, the object was measured as 160 feet long and 65 feet wide, also at 20 miles. Since an object 100 feet long subtends roughly an angle of 4 minutes of arc at 20 miles, and since physiologists say the human eye can barely resolve  $\frac{1}{2}$  minute of arc, these estimates appear to be more precisely stated than warranted. In fact, if such estimates were possible, the Navy could save the taxpayers a great deal of money by eliminating range finders from their ships. Thousands of dollars are expended for even a fifteen-foot range finder such as goes on destroyers.

Another physiological principle often neglected is that bright objects appear larger than dark objects. Many reports at dusk or night of large objects could very well be small. It is often published that even physicists at Los Alamos have observed these unusual phenomena—implying *large* unknown objects. The Los Alamos fellows have told me that what they have seen are star-type lights, to be sure, sometimes of fractional magnitude and sometimes with large apparent velocities. But all can be explained as meteors, although they are reluctant to do so. One of the arguments advanced against the meteor theory is that the light lasts a long time and that meteors disappear rapidly. It is often forgotten that oxygen and nitrogen have metastable states and that meteor trails may be visible from the afterglow of the ionized air generated by the meteor, for considerable periods of time after the meteorite has disappeared.

Another phenomenon neglected by the layman in interpreting unusual sights is the mirage. It is too often assumed that these occur only over deserts and in the vicinity of oases. Thermal gradients occur in the atmosphere in widespread fashion. Meteorologists tell me there is a fairly abrupt change in character of the

atmosphere at that point in the thermal gradient where the temperature is 0°C, generally around 8000 feet elevation in the summer. This provides, then, a very good reflecting surface, so that, under proper conditions, one may see ground lights invisible by direct views. The other aspect of this is that the gradient may be in a vertical plane instead of a horizontal one—although this is admittedly much rarer. The presence of strong thermals is known to all aviators who fly over deserts. The "experienced observers" who saw a saucer chasing a Skyhook balloon in New Mexico were likely seeing reflections of the balloon on the vertical thermal gradient plane.

It is obvious, of course, that these boundary layers, so to speak, are fluid just as a surface of water. Minor changes in pressure or other disturbances can cause wave motion, which in turn gives an apparent motion to the image. This motion can have any velocity and hence cause the reports of speeds of thousands of miles per hour.

Rayleigh's law of scattering is familiar to all. This, however, applies to particles small compared to the wavelength of light. When particles are essentially equal in diameter to wavelengths in the visible region, it is possible to have considerable reflection and transmission, similar to the half-silvered mirror. Thus pilots or ground observers can see reflections of lights as well as transmission, and get the impression that some object intervenes. These partial "cloud" formations are sometimes short-lived, and may move with pressure gradients rather than as material—hence unusual motions may be observed. It is also obvious that if you penetrate this cloud the image will disappear. It is as futile to chase these images as to get to the bottom of the rainbow wherein lies the mythical pot of gold.

It is often surprising how slowly information travels. Many times during the war radar operators reported targets that pilots could not find—nor lookouts see. In one instance, for example, many thousands of rounds of ammunition were expended against a radar target consisting of thin air. The phenomenon has been re-discovered dozens of times—yet the general public and often "competent radar operators" are misled by these false targets. Because radar is supposed to show "real" targets, many news writers and pseudo scientists assume that a radar blip is proof of the presence of a *solid* object in the air. Much of the *Life Magazine* article last March (1952) contained glib assumptions that things seen were solid. I wonder what the same observers think of rainbows and sunbeams.

There was much excitement last July by reports from airport control operators that flying saucers were seen over Washington, D. C. Air Defense jet planes dispatched to intercept these targets failed to catch them. The excitement was heightened by visual sighting of targets contemporaneously with radar sighting. Finally, the peak of excitation occurred with the simultaneous visual sighting and radar detection of an apparent

object. Even the astute editor of the *Washington Post* drew the obvious conclusion that real objects were in the sky. It will take some time to educate the laymen to understand that the atmospheric condition which leads to radar reflection may also be appropriate for visual reflection of ground lights.

This education is now beginning. It was reported in the *New York Times*, September 3, 1952, that two pilots "flew through a target showing on the (radar) scope and there was nothing there—not even a cloud."

The austere and generally critical *New Yorker Magazine* has recently published an article signed by David Lang on "Something in the Sky." This is the longest article on a single subject that I have noted in their publication in some time. It is in general a critical article, but forcefully implies that there is still a "secret." It ends with the statement that: "Too many people are waiting for the answer." The only singular answer is that these are displays of natural phenomena not generally understood. Why don't we believe that the aurora borealis is a series of fantastic searchlights projected by an unknown enemy? The excitement over green fireballs displays an equal ignorance of meteors. To be sure, copper and nickel meteors are rare, but not unknown. The expenditure of a sizeable sum of money by the Air Force for special spectrographic cameras will resolve whether the meteors are nickel or copper, but little else. Theodolite measurements will, of course, continue to be important when properly used.

The notorious picture by a Coast Guardsman showing an "echelon" of flying disks was widely published by the press. Only the thorough *New York Times* pointed out that the picture was taken through a window screen—an elementary experiment in diffraction.

One is reminded of the excitement in the early 1900's generated by the N-ray. This was propounded by a Parisian "scientist" (by present press standards a world-renowned, outstanding scientist). These rays would penetrate all matter, yet could be diffracted by a special prism. This hoax, you will recall, was exposed by R. W. Wood, to the dismay of some people, but the delight of those who believed in the rationale of physical optics.

One recalls the incident of the two employees of the Empire State Building who were on the observation tower one evening. They were extremely frightened by an image of a large head and torso in the sky. Rational thinking prevailed and they soon observed that it was their own shadow cast on a cloud formation.

The United States, in acquiring its leadership in world affairs, has also acquired a virtual monopoly on flying saucers. In addition, the concentration of reports centers around areas involving Atomic Energy Commission activities. This implies intelligence on the part of the people controlling the saucers. It also contributes to the mass hysteria prevalent at this time. We are conditioned to be frightened of atomic weapons and the great secrecy surrounding them. Thus, just as ghosts are seldom seen outside cemeteries or haunted houses, so flying saucers are seen at points of greatest fear psychosis.

Gullibility of people works two ways. After the publication of an interview I gave a couple of years ago, I received a letter from southern France expressing great appreciation for the explanation of sights seen there. It contained a beautiful colored drawing of these objects—including landscape; they were balloons with drop lines and baskets of the type seen often in French illustrations. They could not have been skyhook balloons or similar objects.

I have no delusions that all "explanations" which may be given will stop the flood of saucer stories. They are but facets of the mythology of this stage of history. People believe what they want to believe—not necessarily what is true. The general public has not been able to keep pace with the advance of science. Since so many apparent miracles, such as radio and television and use of nuclear energy, have come to pass, the laymen will believe most any story. The success of various comic strips also bears witness to this.

It can, however, be categorically stated that I know of NO evidence which leads one to doubt the physical laws of motion and inertia or to believe in inter-planetary travel at this time. All reliably reported incidents can be fully explained when sufficient scientific data are provided. Most of the incidents are the result of one or more of the following: (1) reflection (visible or radar), (2) refraction, (3) meteors and meteor trails, and (4) diffraction. Pressure, temperature, and moisture gradients are widely prevalent in the atmosphere and provide interfaces for the action of these optical principles. Meteorologists readily admit how much they need to learn. The extensive effort now being expended on compiling data may be worth while after all, by providing information leading to a better knowledge of the atmosphere. It may indeed be important in our present defense effort for other reasons.