

**Scientific Study of Unidentified Flying Objects: Final Report of Research Conducted by the University of Colorado for the Air Force Office of Scientific Research under the Direction of Edward U. Condon**

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extent from its extreme readability, as well as its relevance to current research in high-energy physics.

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**Scientific Study of Unidentified Flying Objects: Final Report of Research Conducted by the University of Colorado for the Air Force Office of Scientific Research under the Direction of Edward U. Condon.** Pp. 965+xxiv, Bantam Books, 1969. Price: \$1.95, paperback. (Reviewed by Thornton Page.)

Most reviewers of this book have an advantage over Condon and his Colorado Project Staff in that we write for a more homogeneous audience. I assume that readers of *Amer. J. Phys.* are mostly physicists, many of whom view "flying saucers" with amusement or disdain, and I hasten to add that I had that reaction in 1953 when I served on the first (secret) UFO panel chaired by the late H. P. Robertson (Cal. Tech. physicist). He recognized our responsibility better than I, and reprimanded me severely for my excessive levity (though he included my warning in our brief report that UFO reports might clog the U. S. communications system during a true military emergency).

The Condon Report is not brief (989 pages), nor very humorous, and I cannot say that I have read every word of its 24 chapters and 24 appendices ranging over such physical topics as optics, radar, zodiacal light, plasma, and sonic boom, to history, perception, and psychology. This edition starts with an 8-page introduction by Walter Sullivan of the New York Times, and ends with an excellent 23-page index. Whether or not you agree that the subject is worth all this, the 56 detailed case studies make interesting reading, and a good deal of physics is brought to bear on a popular problem. In fact, we have offered *Flying Saucers* as a 1-semester course at Wesleyan University for the past two years, with some success. (It attracted students who would not otherwise have had any science.)

In one sense, the Condon Report lives up to its title, *Scientific Study*, because physical principles and available data are applied meticulously to more than 56 selected, well-documented "cases" (UFO sightings), with the result that 33 cases are explained. However, as several other reviewers have noted, this leaves unexplained a larger proportion than the 10% or so which caused all the ruckus and forced the Air Force to fund the Colorado Project in the first place. Hence, it may be argued that Condon's carefully written conclusions (the first five pages of the Report) do not logically follow from the case studies. He recommends, in effect, that there be no further government records or study of UFO sightings, a recommendation that makes the "UFO logists" see red. Those of us concerned with the AAAS Symposium on

UFO's (scheduled for 27 December 1969 in Boston) find it important not to take sides on this controversial issue. (We have discovered how emotional the reaction is on both sides, a fact hinted at in Sullivan's introduction.) So I will outline three separate views: Condon's, as expressed in this report, his critics' (the more sensible ones), and a "middle" position.

Condon argues that his Colorado Project explained the majority of cases as normal phenomena, examined the "far-out" hypothesis of extraterrestrial visitors, and found no direct evidence favoring it. In fact, use of the extraterrestrial hypothesis to explain more cases would clearly violate laws of physics and/or require materials with properties we think are impossible. It seems likely to Condon that, if more complete observations had been made, all UFO sightings would be explained by normal phenomena. Twenty-one years of investigation have developed no evidence of new scientific phenomena, hence further study is of no scientific value, and should not be maintained as a load on the scientific community.

The sensible critics, one of whom is J. Allen Hynek, who recently reviewed the Condon Report [*Bull. At. Scientists* 85, 39 (1969)], admit that 90 to 95% of UFO sightings are easily explained, but find a few well-documented cases among the other 5 or 10% that may be highly significant. These may indicate new atmospheric phenomena, or extraterrestrial visitors with technology far superior to ours. As in many important discoveries (supernovae, quasars, pulsars), the significant "cases" may be swamped by non-significant ones, and vast amounts of "messy data" (ancient observations of bright stars, rough locations of small radio sources, and UFO sightings) must be carefully studied. Therefore, Air Force records and periodic reviews, the critics say, should be continued.

The "middle position" is based on the fact, mentioned in the psychology section of the Report but ignored in Condon's conclusions, that a large fraction of the U. S. public (30 to 40%) believe that UFO's are extraterrestrial visitors. This is not only of political significance (it probably accounts for the \$500 000 grant to the University of Colorado for preparing the Report); it raises further questions about public education and the public image of science and scientists. Certainly educators (particularly science educators) should be concerned when the public is grossly misinformed. (The AAAS Symposium will discuss several aspects of the UFO problem for that reason.) But it does not help the public image of science when the scientists shrug off sightings and interpretation accepted by so many tax-paying citizens simply because "UFO's don't appeal to us." In fact, the scientists' general refusal to take UFO's seriously may strengthen the "new left" view that science is based more on authority than on observation and reason. Intelligent laymen can (and do) point out the logical flaw in Condon's conclusion based on a statistically small (and selected) sample. Even in this sample a consistent pattern can be recognized; it is ignored by the "authorities," who then compound their "felony" by recommending that no further observational data be collected. Actually, the Colorado Project introduced one

new set of data with higher statistical reliability than visual UFO sightings—the sky photos of the Prairie (meteor) Network. It had been noted [Science 160, 1258 (June 1968)] that this is a valuable source of UFO data not costing millions of dollars, but the Report scarcely does it justice in a brief section [(pp. 770–774) garbled by poor definitions and misprints.]

In my opinion, this “middle position” leads to the philosophical question: “What is the proper evidence for physical reality?” Following the “operational” definition of P. W. Bridgeman (*Logic of Modern Physics*, The Macmillan Co., New York, 1927), UFO’s have certainly been “measured” (detected) in a definable way, unlike the luminiferous ether, or the 20 000 000°K central temperatures of stars, for instance. In more modern terms, the UFO sightings show some statistical patterns that can be fitted to a theory based on the hypothesis of “extra-terrestrial civilizations which know far more physics than we do, and have developed materials, energy sources, and field devices that we have not yet invented.” How can we logically reject this theory when we accept theories of rotating neutron stars to explain pulsars? Of course, a better theory might be devised if more data were collected, and the present data examined in broader terms. For instance, there is a definite trend in the shapes reported, from “saucers” in 1947 to “sickles” in 1960 to “cigars” in 1966, and also the eastward travel of “flaps” (maxima in UFO activity) circling the earth in about 15 years. This latter empirical fact, which I like to call “Page’s Law,” may fit a sociological theory that settles the UFO problem and allows physical scientists to regain their sense of humor (though it is “outside the scope” of the Condon Report).

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**Practical Physics.** G. L. SQUIRES. Pp. 224. McGraw-Hill Book Co., Ltd., Maidenhead, England, 1968. Price: \$6.50. (Reviewed by Clyde R. Burnett.)

Physics laboratory instruction in most institutions in the United States is a directed study of selected experiments utilizing a published laboratory manual or notes prepared by the instructor. Emphasis varies from laboratory techniques to demonstrations of principles introduced in the classroom. *Practical Physics*, a publication in McGraw-Hill’s European Physics Series, is *not* another laboratory manual of selected experiments for undergraduate physics. It does not furnish detailed instructions for specifically instrumented experiments. According to

the author, it is intended, rather, as a “companion to any undergraduate course in practical work.”

This is a book which should be read leisurely outside the laboratory, not so much for its application to the experiment of the day, but for its general philosophy of attack on experimental problems, and for interesting pointers in a variety of measurement situations. In the latter respect, Part II, “Experimental Methods,” is suggestive of a collection of tried-and-true recipes handed down through generations of experimental workers. The author provides examples taken from a variety of problems, ranging from experiments in viscosity, which are rarely performed in United States physics labs today, to measurements of the electron  $g$  factor after the method of Wilkinson and Crane. Some of these examples, such as the order of measurements in an experiment to find how the terminal velocity of a sphere falling in a liquid depends on its diameter, make interesting exercises in logic, suitable for coffee-room discussions and oral examinations. About thirty pages of Part II are devoted to detailed discussions of three experiments which are treated with emphasis on reduction and elimination of errors. Such a discussion of errors in the context of complete experiments is highly appropriate when available for direct application by the student. Its inclusion in this book seems out of place, however, because the experiments that are treated are not the popular ones which students are assigned, as in the case of the electron  $g$  factor which is unlikely to be developed generally as an instructional experiment. This part of the book especially, is written with an informality that invites learning. In a few instances, the author’s professional background in British educational and research institutions has enlivened the terminology with local expressions which may be unfamiliar to American students. Some examples are his reference to “frequency to the carrier wave of Radio 2 of the BBC,” an assumption that “the accumulators are reasonably well-charged,” and a cautionary remark about “faulty valves.”

A “companion book” for laboratory courses might reasonably be expected to contain some working arrangement for data reduction and error analysis. This topic is handled in a fairly conventional manner in Part I, “Statistical Treatment of Data,” and other useful information on statistical distributions, units, and physical constants is contained in the 22 pages of appendices.

The discussion in Part III, “Record and Calculations,” should be scanned periodically by every undergraduate (and graduate) student. These 40 pages cover all of the criticisms which we teachers often have to write on students’ laboratory reports. However, I suspect that this well-organized and readable discussion will, as usual, be studied by only the exceptionally eager student. He will find much excellent advice here on first principles of data recording, analysis, and report writing.

The author has provided end-of-chapter exercises concerning experimental methods or data analysis for further consideration by the student. Detailed solutions and references are given at the back of the book. An instructor could profitably relax the schedule of laboratory experiments in an undergraduate course and use this book to give