sites studied, since the effects of local terrain cannot be ignored in describing turbulence and diffusion. In addition, Heinz Lettau presented a new hypothesis which relates eddy velocity and mean wind velocity by means of a three-dimensional vector expression. Application of proper boundary conditions to the problem leads to realistic wind profiles.

The greatest interest at the conference centered about turbulence and its relationship to the diffusion of aerosols. A theoretical approach to the problem of turbulence was offered by Hans Panofsky, who reviewed the principles of similarity theory and showed how some statistics of turbulence can be related to lapse rate, terrain, height, and mean wind speed.

F. N. Frenkiel pointed out that rigorous solutions of the complicated equations of fluid dynamics are becoming practical through the use of high-speed computing techniques. Computers are also valuable for processing the large amounts of experimental data involved in the microscale of turbulence. A large part of research on turbulence consists of statistical analysis of data obtained during field studies of wind. Several papers reported investigations of this type over various terrains. Measurements were made of vertical and horizontal wind fluctuations at several heights. Analysis included spectral energy distributions over ranges from small-scale mechanical turbulence to semidiurnal cycles. Many such studies are needed to increase our understanding of microscale processes.

Diffusion problems are currently studied directly by making measurements at grid points of tracer dosages from a known source. However, forecasting the dispersal of contaminants depends on ability to predict the fine structure of the winds. Several theoretical and empirical models are used to evaluate diffusion on the basis of turbulence statistics, which include terrain effects, source size and release time of the contaminants, and wind speed. Factors which are important in selecting the time and space scales to be used in various studies for the prediction of dosage levels and distributions were also the subject of many of the papers presented.

The conference was concluded with a panel discussion of the relation between turbulence and diffusion, chaired by Morton L. Barad. Members of the panel were S. Corrsin, H. E. Cramer, F. N. Frenkiel, F. A. Gifford, Jr., G. R. Hilst, and H. A. Panofsky. Much of the discussion revolved about the problems inherent in using Eulerian turbulence statistics to describe the basically LaGrangian process of diffusion. While data leading to Eulerian statistics are easily obtainable with current instrumentation, diffusion studies require data on moving "parcels" of turbulence which cannot be obtained with the sensing systems now available. Bubbles and balloons which simulate such parcels can be tracked but tend to influence the microscale system under study. A feasible approach in the future could include the use of lasers. Another suggestion was the greater use of high-speed electronic computers as experimental tools. Increased attention to and use of wind-tunnel modeling and testing by engineers and classical fluid dynamicists should be encouraged. In conclusion, the perennial request for increased communication among related disciplines was made during both the panel discussion and the discussion from the floor which followed.

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Relativistic Astrophysics

Quasi-stellar sources, commonly called "quasars," are the most distant observable objects in the universe; they are so vast and so brilliant that their very existence cannot be explained by present physical laws. Their ability to generate enormous amounts of energy is not understood. The second of a series of symposiums on the subject (sponsored by the University of Texas and the Southwest Center for Advanced Studies, Dallas, Texas) attracted about 500 participants from various disciplines and many countries to the university in Austin for 5 days in December 1964; present were physicists and astrophysicists, relativists and mathematicians, radio and optical astronomers.

At this second symposium much more information on many more quasars was presented, but no clear solutions to the questions posed by these observations emerged. The hypothesis of gravitational collapse, a process of implosion followed by explosion, that was favored at the first

symposium (Dallas, December 1963) seems to be losing ground; relativity theory may provide an answer. Formal talks and discussions were largely limited to presentation of data, with a properly tentative approach to their interpretation.

But theories were inescapable. One of the more outstanding performances was the opening talk by Geoffrey Burbidge (University of California, San Diego) on "Extragalactic effects of high-energy radiation." Estimates proposed at the first symposium have been increased something like 1000 times. Burbidge listed some of the factors contributing to these larger estimates: physicists had assumed that the fast-moving particles in these sources were accelerated by a mechanism working with 100-percent efficiency. Burbidge proposed instead that an efficiency of only 0.03 percent be assumed; if the observed values for the atomic particles in these radio sources are taken in conjunction with this revised estimate of efficiency, one can easily assume that the original energy input needed to produce these gigantic events is at least 3000 times larger.

This interpretation was challenged by John Bolton (Commonwealth Scientific and Industrial Research Organisation, Sydney, Australia), who, with the advantage of the 210-foot (64-m) radio telescope at Parkes Observatory, had found that strong radio sources have the appearance of huge clouds shaped like dumbbells. These dumbbells, Bolton believes, have a shell-like structure, with high-energy particles tending to concentrate in areas of much greater brightness at the outer edges. At these bright edges, which were also described by Thomas Matthews (California Institute of Technology), it is possible that the energy builds up to the point where the gas smashes its way through the perimeter of the "dumbbell" to form a new cloud or quasar. This theory, too, had its detractors; one of the many talking points was whether a large quasar is in process of expansion leading to reproduction in an amoeba-like fashion, or whether, in losing energy, it is in fact shrinking.

Another high point in the symposium was the talk on "Models of quasi-stellars" by Maarten Schmidt (Mount Wilson and Palomar Observatories). Schmidt took the trouble to convince his audience by a process of simple logic that the quasars are in fact more than 10^9 light years away,

and that they are enormous—several thousand light years across. He pictures their structure as resembling an onion, with several layers of skin. The outer skin is relatively thin, a cloud of high-energy atomic particles; the second skin is another thin shell of glowing, rarefied gas, which emits light predominantly at a few fixed frequencies. The inner core, much smaller, is thought of as a sort of hot superstar of perhaps 10^8 solar masses, with a temperature of over 10,000°C; its diameter may be as little as a light year.

Before the concept of a red-hot onion was served to the participants, they viewed the sky photographs presented by Allan Sandage (Mount Wilson and Palomar Observatories). The beauty and order of the pictures were reflected in the clarity and symmetry of Sandage's talk in which he gave the latest count (by now, doubtless, out of date) of 34 identified quasars. In the last few weeks before the conference, 15 new objects had been identified in a systematic search with the 48-inch (120-cm) Palomar Schmidt telescope. An enigmatic characteristic of these confusing objects is enormous variation in brightness of the quasars that Sandage had observed. The radio source known as 3C2 has varied in brightness by as much as a factor of 4 in the last 2 years—many times more than any other observed source. It is possible that 3C2 is the most distant object in the universe and is retreating from us at a speed very close to that of light.

Henry Palmer (Jodrell Bank Radio Observatory, England), who started the hunt for quasars nearly a decade ago, reported on the newly discovered sources. His observations had been made with the world's largest scientific instrument, a radio interferometer more than 100 miles (160 km) long.

H. Friedman (Naval Research Laboratory, Washington, D.C.) reported discovery of a number of new x-ray sources; one of them, Scorpio, may be only 30 light years away.

William Fowler (California Institute of Technology), in summing up the discussions of neutrinos, pointed out that our knowledge of the properties of neutrinos is minute. Attempts to increase such knowledge are being made in South Africa, near Johannesburg, where Frederick Reines (Case Institute of Technology) is installing a first crude neutrino telescope in a mine at a depth of 3450 m. The depth below Earth's surface represents an attempt to screen the instrument from cosmic radiation; one cosmic neutrino candidate has already been detected. Davis (Brookhaven) reported on a project to bury a tank filled with 400,000 liters of cleaning fluid in a deep mine; there, it is hoped, a few of the chlorine atoms in the tank will be transformed into argon atoms by neutrino radiation. If this experiment is successful, it will provide direct proof that neutrinos come from the sun, which will be established as a nuclear-fusion device; it will also have produced an instrument capable of "looking into" the sun's central region, hitherto an impossibility.

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Forthcoming Events

April

6–9. Royal **Aeronautical** Soc., conf., Nottingham, England. (H. Umpleby, Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1, England)

6–9. **Automatic Control**, conv., Nottingham, England. (H. Umpleby, Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1, England)

7–9. American Assoc. for **Cancer Research**, 56th annual, Philadelphia, Pa. (AACR, 7701 Burholme Ave., Fox Chase, Philadelphia 19111)

7–9. The **Chemical** Soc., anniversary meetings, Glasgow, Scotland. (CS, Burlington House, London, W.1, England)

7–9. **Nucleation Phenomena**, intern. symp., Cleveland, Ohio. (A. G. Walton, Dept. of Chemistry, Case Inst. of Technology, University Circle, Cleveland 6)

7–9. **Pesticides**, U.S.–Japan Cooperative Science program, Honolulu, Hawaii. (Office of Intern. Science Activities, Natl. Science Foundation, Washington, D.C.)

7–9. **Stress Analysis**, conf., Bristol, England. (Administration Asst., Inst. of Physics and the Physical Soc., 47 Belgrave Sq., London, S.W.1, England)

7–16. **Instrumentation for Hydraulic Research**, U.S.–Japan Cooperative Science Program seminar, Tokyo, Japan. (Office of Intern. Science Activities, Natl. Science Foundation, Washington, D.C.)

8–9. **Histochemical** Soc., 16th annual, Philadelphia, Pa. (S. S. Spicer, National Institute of Health, Bethesda, Md. 20014)

8–9. **Microbiological Deterioration in the Tropics**, symp., London, England. (Secretary, Soc. of Chemical Industry, 14 Belgrave Sq., London, S.W.1, England)

8–9. British Inst. of **Radiology**, annual congr., London, England. (BIR, 32 Welbeck St., London, W.1)

8–9. **X-ray Analysis**, Conf., Inst. of