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Electronic and Atomic Collisions

When activity in the field of atomic collision physics (along with extranuclear atomic physics generally) went into its decline three decades ago, it was widely felt that the field was completely understood in principle and that a limited number of then impossible experiments and calculations would tie up the entire matter. The 4th international conference on the physics of electronic and atomic collisions, held at Laval University in Quebec, Canada, 2-6 August 1965, disclosed that assessment to be far from adequate.

The "impossible" experiments have disclosed an incredible richness of phenomena in atomic and electronic collision physics, of importance to space, atmospheric, and plasma physics and to gas-phase chemistry; the computer-aided theoretical work has brought to light at least as many new problems as it has solved.

Typical of the new areas is the matter of "resonances" in scattering. As presently used, the term "resonance" refers to observation of energy-dependent structure in electron collision cross sections. This structure appears to be well fitted by the Breit-Wigner resonance formula much used in nuclear physics; moreover, theoretical calculations, especially in e-H scattering, have predicted the observed structure and the immature nervous system to disease. He offered a classification of developmental disorders based on two main variables, developmental stage of onset and disease agent. A classification, supported by experimental data, must precede comprehension of mental retardation, epilepsy, and other groups of diseases.

The conference was sponsored by the Jackson Laboratory. In lieu of published proceedings of the conference, a detailed checklist and bibliography of neurological mutants in the mouse will be published by the Harvard University Press, Cambridge, Massachusetts.

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have shown that it is associated with the rapid energy variation of individual phase shifts.

Papers on resonances, given by P. G. Burke (England), A. Herzenberg (England), and E. Holøien (Norway), made it clear that the techniques of predicting resonances have steadily improved since 1963. In particular, a means of projecting out the coupling to the continuum, and thereby of associating the complex energy eigenvalue responsible for a resonance with a real eigenvalue computable by the Rayleigh-Ritz minimum principle, has been developed. Moreover, a variational (nonminimal) principle for the complex eigenvalues has been shown to have great promise. Thus accurate predictions of resonances in not-too-complicated electron-molecule reactions (for example, $e + H^2$ collisions) soon should be forthcoming.

The theoretical advances in resonances have been well matched by advances in experiments. Particularly striking were the new measurements on the H atom resonance reported by H. Kleinpoppen (Germany); these measurements verify and are an improvement on the earlier measurements of G. J. Schulz (U.S.A.). Also noteworthy were the studies by H. Ehrhardt and G. Meister (Germany) on the angular distribution of electrons scattered by helium in the vicinity of the resonance first predicted by Gerjuoy and Baranger (U.S.A.) and previously observed by G. J. Schulz, J. Arol Simpson, and C. E. Kuyatt (U.S.A.).

Among the other experiments which employed high-resolution electron techniques and which were particularly interesting for development of theory were those of Kuyatt, Simpson, and Mielczarek. Their electron scattering experiment displayed the vibrational level structure in $H_2$. In the experiments of McGowan and Fineman (U.S.A.) the ionization of $H_2$ curves displayed structure due to rotational excitation.

The question of resonances in electron scattering is closely related to the existence of states of atoms and molecules with excitation energies in excess of the first ionization potential (so that autoionization can occur) and to the existence of unstable, compound negative ions. Techniques to map out the energy levels of these super-excited states have been developed.

Related to the question of these super-excited states is the matter of characteristic energy losses in ionizing collisions between ions and atoms.
 Such energy losses have been studied by coincidence methods in the laboratories of N. V. Fedorenko (U.S.S.R.) and E. Everhart (U.S.A.). It now appears that at small impact parameters any ionization process is correlated with the excitation of one of the characteristic energy losses and that these energy losses are evidently associated with ionization and excitation from the inner shells of the colliding heavy particles. The finding by M. E. Rudd and D. V. Lang (U.S.A.) that the energy spectrum of the electrons produced in ion-atom collisions show well-defined, sharp structure further supports the view that ionization in heavy particle collisions proceeds in part through excitation to super-excited states, followed by autoionization.

Classical (that is, nonquantum) methods for computing cross sections were discussed by a panel consisting of M. Gryzinski (Poland), A. Burgess (England), I. C. Percival (England) and L. Vriens (Netherlands) in perhaps the most spirited and controversial session of the conference. The use of classical theory to compute atomic cross sections dates back to J. J. Thomson in 1912. Recently, however, as a result of Gryzinski's demonstration that Thomson's formula for ionization of an atom by electron impact could be improved by taking into account the actual velocity distribution of the atomic electrons, the possibility of estimating atomic collision cross sections classically has attracted widespread interest. In general, the panelists thought that the remarkable successes of these classical calculations stem from the "accidents" that atomic interactions involve Coulomb forces and that scattering of a pair of otherwise isolated charged particles is independent of Planck's constant, that is, the scattering is the same whether calculated classically or quantum mechanically. Gryzinski appears to believe that atomic collision cross sections ultimately can be predicted accurately without reference to quantum concepts.

Among the outstanding of the 72 theoretical contributions was the work of F. T. Smith and R. P. Marchi (U.S.A.). They showed that the oscillations in the He+ + He charge-transfer cross sections could be accounted for in detail; indeed it should be possible to infer the He+ - He interaction potential from the oscillations observed. Also, G. F. Drukarev and Yu. M. Demkov (U.S.S.R.) contributed a very interesting and novel paper on the distribution of poles and zeros of the scattering...
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Turning to but a few of the "nonresonant" experimental highlights of the conference, one can point first to recent experimentation on the free hydrogen atom. S. J. Smith (U.S.A.) reported a new measurement for electron-impact excitation of Lyman alpha which confirms the earlier results of Fite (U.S.A.) that the "best" quantum theory as of present (the close coupling approximation) is indeed in error at lower energies. H. B. Gilbody (England) has extended the energy range for charge transfer between protons and hydrogen atoms by a factor of three over previous measurements.

H. Kleinpoppen (Germany) reported some beautiful results concerning the effect of nuclear spin on polarization of optical radiation. His work goes far toward testing the predictions of Percival and Seaton made in 1958. In the experiment, atoms of Li$^6$, Li$^7$, and Na$^{23}$ were excited by electron impact; the polarization of the first resonance line was measured as a function of electron energy. These three isotopes represent cases where the hyperfine separation compared to the level width of the excited state is small, comparable, and large, respectively. It was found that although the transitions are the same electronically, the polarization fractions near threshold were 40, 21, and 15 percent in good agreement with theoretical prediction.

The first experiment on two-photon absorption by negative ions, combining laser and crossed beam techniques, was reported by Hall, Robinson, and Branscomb (U.S.A.). Extremely elegant experiments on the interaction of electrons and ions, particularly enlightening for theory development and for plasma physics, were reported both by Dance, Harrison, and Smith (England) and by Dunn, van Zyl, and Zare (U.S.A.).

The question of the effect of internal excitation on measured cross sections in ion-neutral collisions has begun to be evaluated. Perhaps the most definitive experiments reported were those of Turner, Stebbings, and Fine

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studied. From such studies it seems clear that much of the disagreement between different laboratories in earlier measurements originated from differences in state population of beams from different ion sources.

In the thermal energy range, the methods involving flowing pulsed, afterglow, which were devised by E. E. Ferguson and his associates (U.S.A.), were particularly impressive. Also impressive was their tabulation of a large number of measured rates for processes occurring in the upper atmosphere.

Numerous experiments delved into less well-defined problem areas relating to excitation, ionization, and heavy particle collisions. The supply of entirely unexpected observations reported is ample to keep the theoreticians hard at work for a number of years.

The conference was invited by N. V. Fedorenko to meet next in Leningrad in 1967, a proposal which was accepted with great enthusiasm.

W. L. Fite
E. Gerjuoy

Department of Physics and
Space Research Coordination Center,
University of Pittsburgh,
Pittsburgh, Pennsylvania

Forthcoming Events

October


31–4. American Soc. of Agronomy. 57th annual, Columbus, Ohio. (ASA, 677 South Segoe Rd., Madison, Wis. 53711)

31–5. Society of Motion Picture and Television Engineers, 98th technical conf., Montreal, P.Q., Canada. (SMPTE, 9 E. 41 St., New York 10017)


November


1–3. Systems, intern. meeting, Chicago,

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This text is intended for science and engineering students and designed for a two-year or three-semester physics sequence with previous or concurrent study of the calculus. Taking the student well beyond the stage of the usual introductory college text, it prepares him for advanced courses in physics. To this end, the author presents subjects not usually included in basic courses, but which are important because of their applications in modern physics and their use in advanced courses. The result is a logically coherent text, not an encyclopedic one. Progressively sophisticated treatment of physics, particularly with regard to the necessary mathematical understanding, is the hallmark of this work. Optics is studied first, enabling the student to gain facility with the calculus and introducing him to the interplay of theory and experiment that is science. As the student's facility with the calculus increases, the author develops the kinematics, mechanics, and thermodynamics.

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4-5. Rheumatology, Czechoslovak-Polish meeting, Prague, Czechoslovakia. (F. Leoch, Na Slupi 4, Prague 2)

4-6. American Soc. of Cytology, 13th annual scientific, New York, N.Y. (W. R. Lang, 1012 Walnut St., Philadelphia, Pa. 19107)


4-6. Geological Soc. of America, Kansas City, Mo. (R. C. Becker, GSA, 231 E. 46 St., New York 10017)

4-6. National Assoc. of Geology Teachers, Kansas City, Mo. (M. B. Rosalsky, Dept. of Geology, City College of New York, New York 10031)

4-6. Southwestern Medical Assoc., 47th annual, El Paso, Tex. (S. Heinemann, 310 N. Stanton, El Paso)

4-6. Paleontological Soc., Kansas City, Mo. (R. L. Langenheim, Jr., Dept. of Geology, Univ. of Illinois, Urbana)

5-6. Cancer of the Gastrointestinal Tract, 10th annual clinical conf., Univ. of Texas M. D. Anderson Hospital and Tumor Clinic, Houston. (R. L. Clark, M. D. Anderson Hospital and Tumor Inst., Univ. of Texas, Houston 25)


6-7. International College of Dentists, Las Vegas, Nev. (H. O. Westerdaal, 4829 Minnetonka Blvd., Minneapolis, Minn. 55416)

6-20. International Federation of Thermalism and Climatism, Israel. (A. Schirm, Fédération Intern. du Thermalisme et du Climatisme, Fédération des Voyages thermales, 12, Baden, Switzerland)

7. American College of Dentists, Las Vegas, Nev. (O. W. Brandhorst, 4236 Lindell Blvd., St. Louis, Mo.)

7-9. American Science Film Assoc., annual, Washington, D.C. (ASFA, 1319 F St., NW, Washington 20004)


7-11. American Soc. of Mechanical Engineers, winter annual mtg., Chicago, Ill. (ASME, 345 East 47 St., New York)

7-12. Anatomical Pathology, 5th Latin American congr., Lima, Peru. (J. J. Andujar, P.O. Box 118, Fort Worth, Tex.)

7-9. Paediatric congress (5th intern. congr.), Tokyo, Japan. (K. Nakamura, Dept. of Pediatrics, Univ. of Tokyo, P.O. Box 18, Hongo, Tokyo)

7-14. Vienna Univ. of Technology, 150th anniversary celebration, Vienna, Austria. (Technische Hochschule, Guss- hausstr. 23, Vienna 4)

6-9. Engineering in the Practice of Medicine, Philadelphia, Pa. (S. Rosen,
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8-11. Insecticide and Fungicide, 3rd British conf., Brighton, England. (Secretary, 140 Bensham Lane, Thornton Heath, Surrey, England)
8-11. Quality Control, intern. congr., Tokyo, Japan. (Union of Japanese Scientists and Engineers, c/o Sakata Bldg., 3 Muromachi 4-chome, Nihombashi, Chuo-ku, Tokyo)
8-13. Austrian Medical Congr., 19th annual, Vienna. (M. Schnardt, Oesterreichische Artzetkammer, Referat für Arztliche Fortbildung, Weiburgasse 10-12, Vienna I)
10-13. Respiratory Therapy, 2nd New England conf., Boston, Mass. (D. Crocker, Children's Hospital Medical Center, 300 Longwood Ave., Boston 15)
10-20. Development of Petroleum Resources of Asia and the Far East, 3rd symp., Tokyo, Japan. (S. Santitham, Rajadamnern Ave., Bangkok, Thailand)
11-12. Kentucky Acad. of Science, Univ. of Kentucky, Lexington. (D. M. Lindsay, Georgetown College, Georgetown, Ky.)
11-13. Bases for Nuclear Spin-Parity Assignments, conf., Gatlingburg, Tenn. (F. K. McGowan, Oak Ridge Natl. Laboratory, P.O. Box X, Oak Ridge, Tenn. 37831)
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CONTENTS OF VOLUME 11, NUMBER 3, JUNE 1965:

THOMAS C. MAYER, The Development of Pheidole Songbing in Microcosm

Y. KURODA AND T. NAGATANI, Experimentally Induced Changes in Fructosamine, 6-diphosphatase Activity in Embryonic Chick Liver and Heart Cells in Vitro

GENTARO USUKU AND JEROME GROSS, Morphological Studies of Connective Tissue Resorption in the Toll Fin of Metamorphosing Bullfrog Tadpole

H. D. BERENDS, The Induction of Changes in Chromosomal Activity in Different Polyene Types of Cell in Drosophila hydei

LISETTE MEZGER-FREED and JANE M. OPPENHEIMER, Ribenoulcetic Acid Base Composition in the Developing Amphilipic Optic Cup-Lens System

M. H. MOSCONA and A. A. MOSCONA, Control of Differentiation in Aggregates of Embryonic Skin Cells: Suppression of Feather Morphogenesis by Cells from Other Tissues

ELIAS SHAAYA and PETER CARLSON, Der Ecdysionsfaktor während der Insektenentwicklung, IV. Die Entwicklung der Legidopteren Bombyx mori L. und Cerura vinula L

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STANLEY SHOSTAK, The Re-formation of the Epidermis of Embryonic Rana pipiens Following treatment with Ultrasound

SOFIA F. FABRO and L. M. RINALDINI, Loss of Ascorbic Acid Synthesis in Embryonic Development

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14-18. Mexican Dental Assoc., 1st intern. congr., Mexico City. (R. Espinosa de la Sierra, Asociación Dental Mexicana, Sinaloa no. 9, Mexico 7, D.F.)


14-19. American Acad. of Ophthalmology and Otolaryngology, Chicago, Ill. (W. L. Benedict, 15 Second St., SW, Rochester, Minn.)


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**INSTRUMENTS**

22 OCTOBER 1965


Mathematics, Physical Sciences, and Engineering


Annual Review of Astronomy and Astrophysics. vol. 3. Leo Goldberg, Armin J. Deutsch, and David Layzer, Eds. Annual Reviews, Palo Alto, Calif., 1965. 446 pp. Illus. $8.50. Thirteen papers: "Clustering of galaxies" by G. O. Abell; "Absolute spectral energy distributions in stars" by J. B. Oke; "The energy balance and dynamics of the interstellar medium" by F. D. Kahn and J. E. Dyson; "Spectral line broadening" by Henri Van Regemorter; "The system of astronomical constants" by G. M. Clemence; "Theory of stellar orbits in the galaxy" by A. Ollongren; "Model atmospheres" by Jean-Claude Pecker; "Chemical evidence bearing on the origin of the solar system" by Hans E. Suss; "Some observational aspects of stellar evolution" by Olin J. Eggen; "Radio radiation from the galactic nuclear region" by Bernard F. Burke; "Cosmic magnetobremstrahlung (synchrotron radiation)" by V. L. Ginzburg and S. I. Syrovatskii; "Spectra of comets and their interpretation" by Claude Arpigny; and "Radar astronomy" by Gordon H. Pettengill and Irwin I. Shapiro.


standards. California led the way in prescribing such standards, and other states were beginning to follow suit.

The journey through Congress of this year's Clean Air Act Amendments bill (which included the vehicle-emission standards) was relatively easy, even though some members objected to the provisions for research on disposal of solid wastes as an ill-advised federal venture into the garbage business. Success was assured (it may never have been much in doubt) after the straightening out of a mix-up which caused the Administration some embarrassment. This concerned its position on fixing standards for exhaust emission. HEW had appeared to support strongly the Muskie subcommittee's recommendations for standards; but then James M. Quigley, an assistant secretary of HEW, testified in April that the emission control methods to be used by the automobile manufacturers to meet California's requirements should be evaluated before being applied nationally.

This surprising testimony produced headlines such as "LBJ Scuttles Smog-Control Bill," and some observers were quick to suggest that President Johnson, the master of consensus, was snuggling up to the car manufacturers for political purposes. The turn-about defied logical explanation, and the Administration was soon back to an endorsement of the Muskie proposals.

In time, Congress may have to return again to the problem of automobile exhaust emissions. V. G. MacKenzie, the assistant surgeon general in charge of PHS's air pollution division, indicated recently that the application of controls on carbon monoxide and hydrocarbon emission to automobile engines of the kind now in use is no better than a holding action. By 1980 the number of automobiles will have so increased that, without controls, pollution from exhaust emissions will have grown worse. Moreover, for certain emissions, such as oxides of nitrogen, no technical means of control are yet available, MacKenzie said.

PHS is continuing its research on the control of pollutants resulting from fuel combustion. Meanwhile, MacKenzie and others already wonder whether the ultimate solution may not be to abandon the spark ignition engine and develop a radically different automobile propulsion system. Greater use of mass transit would help, too.

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SCIENCE, VOL. 150
Automobile exhaust emissions are, of course, only one source of air contamination in the rapidly growing urban areas. Sulfur oxides, principally from the burning of coal and fuel oil, also are major pollutants, and there are others. The mounting public concern over air pollution is easily understandable. Not everyone goes down to the river, to be repelled by the water's burden of indigestible wastes. But inhabitants of the increasingly numerous cities afflicted by smog become quickly offended. Poor visibility, smarting eyes, and the nagging thought that continuous exposure to contaminated air may bring on a chronic illness make ready converts to the antipollution cause.

Through the Clean Air Act of 1963 and this year's amendments, Congress has tried to give the federal government a meaningful role while, at the same time, holding to the philosophy that air pollution control is primarily a state and local responsibility. Eventual stringent controls seem assured, whether imposed by the states and localities or by a Congress grown impatient at a laggard performance in the statehouses and city halls.—LUTHER J. CARTER

Announcements

The Division of Mathematics of the National Academy of Sciences—National Research Council has established the Committee on Support of Research in the Mathematical Sciences. The committee's duties include preparing studies of current research in mathematical sciences and of mathematics education at the undergraduate, graduate, and postdoctoral levels; of current levels and forms of support of mathematical research by federal and private agencies; and an indication of support needed in the immediate future to maintain the present state of mathematical activity.

Lipman Bers, of Columbia University, is chairman. The other members are:

T. W. Anderson, Columbia University
R. H. Bing, University of Wisconsin
H. W. Bode, Bell Telephone Laboratories
R. P. Dilworth, California Institute of Technology
G. E. Forsythe, Stanford University
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Meeting Notes

The 29th national meeting of the Operations Research Society of America will be held in Los Angeles 18–20 May. The theme is “expanding horizons of operations research.” Papers in the field will be considered from members and nonmembers. Deadline for receipt of papers: 1 January. (J. E. Walsh, System Development Corp., 2500 Colorado Ave., Santa Monica, Calif. 90406)

Grants, Fellowships, and Awards

Fellowships are offered for a 2-year program of research training in psychiatry through the graduate educational program of the State University of New York Downstate Medical Center. The program includes courses on research methodology and current major concepts in psychiatry. Applicants must have completed at least 2 years of residency in psychiatry. Participants in the program may work toward the degree of doctor of medical science. Stipends are from $5000 to $7000 for the first year and $8000 the second year. Deadline for receipt of applications for the 1966–1967 academic year: 15 January. (Office of Admissions, Downstate Medical Center, 450 Clarkson Ave., Brooklyn 3, New York)

Scientists in the News

Louis T. Benezet, president of the Claremont Graduate School and University Center, has been elected chairman of the American Council on Education.

Edwin W. Niemi, coordinator of activities at the Keweenaw Field Station, Michigan Technological University, has been appointed director of the recently created Keweenaw Research Center at the school.

Charles Frankel, professor of philosophy at Columbia University, has been sworn in as Assistant Secretary of State for Educational and Cultural Affairs. He succeeds Harry C. McPherson, Jr., who now is a Special Assistant to the President.

The National Science Foundation has appointed Lyle W. Phillips director of the division of undergraduate education in science. He succeeds Leland Shanor, who is returning to the University of Florida as head of the botany department. Phillips had been an officer in the planning and evaluation unit of the office of NSF’s associate director for education.

Horace R. Byers, professor in the department of geophysical sciences at the University of Chicago, has been named dean of the college of geosciences at Texas A&M University.

Thomas P. Singer, formerly chief of the division of enzyme chemistry at the Edsel Ford Hospital and Research Institute, Detroit, has become professor of biochemistry, in residence, at the University of California San Francisco Medical Center.

The University of Michigan has appointed Allan F. Smith vice president for academic affairs. He had been dean of the law school since 1960. He succeeds Roger W. Heyns, who has been named chancellor of the University of California, Berkeley.

James R. Dixon, former associate professor in the department of animal range and wildlife sciences at New Mexico State University, has been appointed curator of herpetology at the Los Angeles County Museum.

Armand J. Gold has taken a 2-year leave of absence as head of the life support group in the research department, Martin Company, to head the environmental physiology department at the Negev Institute for Arid Zone Research, Beersheba, Israel.

The University of Miami has announced the appointment of Paul R. Halmos as visiting professor of mathematics during the 1965–66 academic year. He is a professor of mathematics at the University of Michigan.

Note: In the report “Actinomycin D and hydrocortisone: intercellular binding in rat liver” by C. W. Dingman and M. Sporn (149, 1251, 10 Sept. 1965), the heading of column 5, Table 3, should have read, “RNA/DNA ratio.” The last footnote to the table should have read, “The first ratio in each pair was determined on a sample of nuclei used for measuring in vivo incorporation of cytidine-H3; the second ratio in each pair was determined on a sample of nuclei used for measuring in vitro incorporation of CTP-H3.” In column 5, the ratios in each pair should have been separated by a semicolon. As printed, the table implies, incorrectly, that only one ratio, rather than two, is reported.

22 OCTOBER 1965
Anaphase: bivalents of homologous chromosome pairs moving to opposite poles during spermatogenesis in Pales ferruginea (Tipulidae).

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