Meetings

Theory and Practice of Classification in Diverse Disciplines

Workers in a given academic field frequently are "discipline-bound"; they are so busy keeping up with their own area that they have little time to survey other disciplines for methods and techniques that they could use profitably in their own work. The structure of institutions (for example, academic departments in a university) further reinforces the barrier to interdisciplinary communication. In the field of classification, which is a fundamental activity of most sciences, the Classification Society aims to overcome these barriers.

Founded in Great Britain in 1964, the Classification Society has as its main purpose the promotion of cooperation and interchange of views and information among those interested in the principles and practice of classification in any discipline that uses them. As a result, its membership includes anthropologists, biologists, computer and information specialists, geologists, librarians, linguists, psychologists, soil scientists, and others. The society seeks to provide unique services to its members. These include symposia on classification that are not limited to one discipline and a project under consideration that will result in a bibiography of current articles dealing with the theoretical and applied aspects of classification. Supplements to the original bibliography will be issued periodically.

Business of the society is conducted by a committee elected by the membership. The society has two branches, the European branch and the North American branch. Current membership numbers around 500, divided equally between the two branches. Annual dues are U.S. $3, and they entitle members to receive copies of the bulletin of the society, which contains contributions of both a formal and informal nature. (Membership applications may be obtained from the secretary, Dr. Theodore J. Crovello, Department of Biology, University of Notre Dame, Notre Dame, Indiana 46556, or from Dr. A. J. Willmott, Department of Computation, University of York, Heslington, York, England.)

The first annual meeting of the North American branch was held 8 to 9 April 1970 in Columbus, Ohio, at Battelle Memorial Institute. Both invited and contributed papers were presented. Some explored the common characteristics of classification, regardless of the discipline. For example, J. Kruskal (Bell Telephone Laboratories) provided explicit illustrations of the many kinds of classification (or clustering), considering such aspects as the purpose of the analysis, the kinds of data that can be utilized, and the use of classification in conjunction with other procedures to achieve a given goal.

The theory of classification and of particular classification algorithms was investigated by several speakers. These included a consideration of the synergistic value of the simultaneous use of cluster, network, and multidimensional scaling analysis by F. J. Rohlf (Biology, University of New York, Stony Brook). H. Chernoff (Statistics, Stanford) described metric considerations in the *k*-means method of cluster analysis. L. Orloci (Botany, Western Ontario) described information-type measures of diverence and their application in biological classifications. R. B. McCammon (Geology, University of Illinois at Chicago Circle) discussed the dendrograph as a graphical aid to classification.

Applications of classification were described from many fields. These included a presentation by H. Friedman and R. Goldwyn (IBM) on interactive data analysis, a case study of physiologic classification, and interpretation of the critically ill. T. Deeming (Astronomy, University of Texas, Austin) considered the classification of stars and galaxies. R. Christal and J. Ward (U.S. Air Force) described the use of hierarchial grouping in job analysis and personnel research. E. Gloye and R. J. Marcus (Office of Naval Research) discussed the role of classification to enhance a medical-chemical data base. R. E. Beschel and P. Y. Wong (Biology, Queen's University) presented a method for the classification of lichen communities.

The general feeling among those attending was that much could be gained if workers in diverse disciplines would routinely pause and analyze the activities of workers in other fields. This feeling was emphasized by D. Hull (Philosophy, University of Wisconsin at Milwaukee) who delivered the banquet address. Copies of the abstracts of all of the talks will be available for a limited time from the undersigned.

THEODORE J. CROVELLO
Department of Biology,
University of Notre Dame,
Notre Dame, Indiana 46556

Coulomb Energies in Nuclei

An informal meeting to discuss Coulomb energies in nuclei was held at the University of North Carolina at Chapel Hill on 1 and 2 May 1970. The available information on the charge and matter distributions in atomic nuclei, on Coulomb displacement energies, the progress in experimental techniques, and the interpretation of the data in terms of nuclear dynamics were summarized.

Because the electrostatic interaction is well known and because Coulomb interactions in nuclei occur only between protons, charge-dependent effects in nuclei may be used to give important information about nuclear structure. The Coulomb interaction is contained in the static part of the electromagnetic field, the dynamic part of which gives rise to gamma-ray transitions. The details of the energies of meson (μ^-, π^-, and K^-) states and electron states are sensitive to the Coulomb field of the nucleus.

A feature of the meeting was the bringing together of experts in meson physics, in high energy electron scattering, and in low energy nuclear structure. The advantages that would be gained if workers in these fields used the same models and parameterizations, drew upon each other's interpretations, and established a uniform notation were clearly brought out. The topics covered can be grouped roughly as follows: (i) spatial distribution of electric charge and nuclear matter in nuclei; (ii) measurement of Coulomb displacement energies (the increase in energy when a neutron is replaced by a proton to form an isobaric analog state); and (iii) theory of Coulomb displacement energies, including shell-structure effects, deformation terms, excess neutron dependence, and phenomenological Coulomb energy formulas.

The charge distribution in nuclei may be inferred from low energy interactions of nucleon and nucleus—for example, elastic scattering and single-particle bound states. It was emphasized that the most model-independent parameter characterizing the charge distribution is its root-mean-square (r.m.s.) radius. Data on x-rays from μ^- mesons, whose inner orbits penetrate the nucleus, were reviewed. The advent of high energy–resolution Ge(Li) detectors for gamma rays has greatly increased the accuracy of the data. The study of radiationless transitions, including μ^--induced fission and of x-ray emission in the field of the μ^--excited nucleus (to measure nuclear excited-state quadrupole moments) were discussed. Analysis of electron scattering from Stanford, involving high momentum transfer, shows that oscillatory charge-density variations occur over distances of less than 1 fermi (10^{-13} cm) and also that the charge density in heavy nuclei dips near the nuclear center, rather than being flat as assumed in the nucleon scattering and mesic x-ray analyses. However, the latter data can be well described with the use of the central dip. The three methods are in agreement on the surface behavior of the charge distribution.

The nuclear matter distribution will differ from the charge distribution if the neutron and proton distributions are different. The matter distribution can be measured with any probe which interacts strongly with nucleons. Results of nucleon and alpha particle scattering have recently been supplemented with intensity measurements of K^--mesic x-rays in competition with K^- nuclear capture. The latter has recently been found to be about three times as likely for capture by neutrons as for protons. This suggests that the neutron distribution extends much further than the proton distribuion. However, as emphasized in the meeting, there are probably important effects from the resonant process $K^- + p \rightarrow Y_0{}^*$, which has so far been ignored. It was suggested that comparison of π^+ and π^- scattering would enable the differences between neutron and proton distributions to be accurately estimated. Such a comparison is being carried out at the Rutherford laboratory in England with a range of targets and a range of pion energies from 500 Mev to 2 Gev. Measurements of the energies of electron K x-ray lines have recently been made at Caltech and enable the isotope shift (about 1 ppm) to be accurately determined. It was reported that in barium the addition of two neutrons acually reduces the r.m.s. radius—an anomaly which is not yet understood. A tentative conclusion from the analyses on charge and matter distribution, and from the Coulomb displacement energies discussed below, was that, in heavy nuclei, the neutron r.m.s. radius exceeds that of the proton by 0.2 ± 0.2 fermi on the average.

A dramatic increase in the accuracy of measurement of Coulomb displacement energies between isobaric analog states compared with previous typical uncertainties of 20 kev was reported. The work of the Minnesota–Princeton collaboration, in which Q values of (^{3}He,t) reactions were measured in a magnetic spectrometer to an accuracy of 4 kev, made it possible to observe fine structure in the energy levels of the residual nucleus states and thereby to estimate the isobaric spin impurities of these states. A report by the Duke University group on the fine structure of the isobaric analog resonances observed in proton elastic scattering in medium-weight nuclei indicated an accuracy of 5 kev in determining the centroids of fine structure resonances, although the separations between the latter could be determined to within 0.1 kev. These experiments therefore challenge the theorist, who must now calculate the Coulomb displacement energy, including contributions of only a few kilo-electron volts.

The theory of the Coulomb displacement energy (ΔE_C) occupied about one-half of the Coulomb energies meeting. Three major points were emphasized: (i) The analog state energy differs from ΔE_C by up to 500 kev in heavy nuclei, there being eight major correction terms of more than 10 kev each of which four are strongly state-dependent. These terms have been estimated in work done at M.I.T. It was pointed out that even the effect of atomic electrons could be larger than 10 kev. (ii) In heavy nuclei 99 percent of ΔE_C is accounted for by the uniform charge distribution formula, whereas the remaining 1 percent contains detailed information on nuclear structure and dynamics. (iii) The major contribution to ΔE_C depends essentially on the r.m.s. radii of the core protons and of the excess neutrons and is amazingly insensitive to the type of distribution assumed for each. This point reiterated the importance of meson, electron, and x-ray results for the measurement of r.m.s. radii.

Nuclear structure effects on Coulomb displacement energies were discussed in four interesting reports. Strong correlations between fluctuations in measured values of ΔE_C and calculated excess neutron binding energies as a function of neutron number N were shown near all closed shells. The charge polarization of the core when $N = Z$ (Z is the atomic number) was shown to be important for ΔE_C in the calcium region. For excited mirror nuclei, ΔE_C was shown to depend strongly on nuclear structure, systematic effects being most pronounced for rotational bands in light nuclei. A summary by the Saclay (France) group for ΔE_C values for $A = 130$ to $A = 210$ (where $A = N + Z$) showed strong deviations from the charged sphere formula in the region of the deformed rare earth nuclei. Within the experimental accuracy of about 50 kev, these deviations are now understood. A phenomenological Coulomb energy equation analogous to the liquid-drop model for nuclear masses was presented, and this promises to be very useful. It was pointed out that the small $T_Z{}^4$ term in the isobaric mass formula [T is the isobaric spin quantum number which describes the charge state of the nucleus and $T_Z = (N - Z)/2$] contains information on the charge dependence of the nucleon-nucleon interaction and therefore the search for the high T isobaric analog states in light nuclei is very important. Experimental possibilities for finding such states were reviewed.

The meeting was attended by about 50 persons, of whom about 20 were from the Triangle Universities Nuclear Laboratory, which is the research facility shared by Duke University, North Carolina State University, and the University of North Carolina at Chapel Hill.

A short reading list, a copy of the program, and a list of participants can be obtained on request.

A. A. Jaffe
S. M. Shafroth
W. J. Thompson
Department of Physics, University of North Carolina, Chapel Hill 27514