Annual Review of Nuclear and Particle Science 2001. Chris Quigg, Vera Lüth and Peter Paul (eds). Annual Reviews, 4139 El Camino Way, P. O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 51. 501 pp. Price not mentioned.

Traditional nuclear physics dealt with the collection of structureless neutrons and protons, situated at the centre of an atom, and mostly in stable state. In modern nuclear physics, this situation has changed. The neutrons and protons, and for that matter all hadrons, are known to have a structure. They are made up of quarks (and anti-quarks), which interact through the exchange of gluons. The theory of this interaction is quantum chromodynamics (QCD), and, unlike quantum electrodynamics, is non-abelian in nature. Here the gluons interact among themselves, also the interaction becomes nil at asymptotically large momenta and infinite at the opposite end. Currently, the Standard Model (SM) is an accepted model for the description of matter at the fundamental level. It has three generations of quarks, leptons and massless neutrinos. A matrix known after Cabibbo–Kobayashi–Maskawa (CKM) gives the strength of transition between different quarks. According to the SM this matrix is unitary (i.e. the sum of the squares of the matrix elements in each row and column equals one). The SM has been extraordinarily successful so far in explaining the known experimental facts up to distances as close as 10^{-18} m. Its predictions have been confirmed experimentally, except the existence of the Higgs boson, which probably will be found at the advent of the Large Hadron Collider (LHC) at CERN. One article in the book, reviews the precision measurements and tests of the SM led by the e^+e^- collider at the Stanford Linear Accelerator (SLAC). These measurements are in the energy region of Z^0 resonance and use the unique combination of the longitudinally polarized electron beam, small beam size and a large CCD pixel vertex detector (called SLD). They test the electroweak physics in the SM to an extraordinarily high precision and establish beyond doubt that the SM is a successful milestone in the description of the ultimate structure of matter and its interaction. These measurements also constrain the mass of Higgs boson between 114 and 195 GeV at a 95% confidence level ('Highlights of the SLD physics programme at the SLAC linear collider' by P. C. Rowson, Dong Su and Stephane Willocq).

Presently, the observations, which seem to go beyond the SM, are the neutrino oscillations, indications of the deviation of CKM matrix from unitarity and indirect evidence from the CP violation experiments. This review volume has two articles pertaining to this subject. One gives a critical reading of the evidence for neutrinos having masses through neutrino oscillations in the experiments with the atmospheric neutrinos ('Oscillations of atmospheric neutrinos' by C. K. Jung *et al.*) and the other focuses on the potentialities to use CP violation as a probe on supersymmetric (SUSY) extensions of the SM ('New physics in CP violation experiments' by Antonio Masiero and Oscar Vives). The importance of the CP violating processes to go beyond the SM can be gauged from the single fact that starting with a baryon–antibaryon symmetric universe, the SM is unable to account for the observed baryon asymmetry in the universe. The presence of new CP-violating phenomena beyond the SM looks crucial to produce an efficient mechanism for the generation of a satisfactory ΔB asymmetry. Both the reviews are comprehensive.

While QCD calculations in the high-energy domain have been in good agreement with experiments, the task at lower energies is daunting. This is because the QCD in this region becomes non-perturbative. One important consequence of this non-perturbative character is that the structure of the hadron becomes much more complicated than that coming only from valence quarks. The proton, as revealed by several deep inelastic lepton scattering (DIS) data on protons and other targets, has only about 20% of the nucleon's momentum and spin carried by the valence quarks. This suggests that the vacuum, which is taken as passive in all valence-quark-inspired models, in fact, plays an active role. The strange quark sea (ssbar), for example, is indicated to have a significant contribution to the nucleon structure in DIS. One article in the book gives a detailed review of the parity violating component in DIS to determine the ssbar contribution to the static properties like mass, magnetic moment or spin of the nucleon. The article gives a detailed account of the formalism for the parity violating electron-scattering and future experimental programmes. It also discusses the contribution due to parity violating γ–Z mixing (anapole moment) in the electromagnetic interaction of nucleons. ('Parity violating electron scattering and nucleons' by D. H. Beck and R. D. McKeown).

Another consequence of the non-perturbative QCD is the violation of the chiral symmetry. This necessitates mathematical schemes/tools to solve the QCD interacting system with chirality in it. One review article describes the progress in this field realizing chiral symmetry in the lattice calculations. This article involves advanced mathematical technicalities, and thus should be of great use to practitioners in this field ('Exact chiral symmetry on the lattice' by Herbert Neuberger).

The quark composition of hadrons has extended the nuclear physics domain much beyond the cold assembly of neutrons and protons sitting at the centre of an atom. The scope of nuclear physics now encompasses a general system of hadrons composed of quarks, gluons, mesons, baryons and resonances in varied proportions and in different thermodynamic conditions like temperature and density. One article in the book discusses the possible phase diagrams of quarks at high density and low temperature. This has a possible relevance to compact astrophysical objects like neutron and quark stars. The article considers these systems as a Fermi system with correlations among quarks near the Fermi surface, generating BCS-type condensates in superconductors. Using one gluon exchange interaction and alternatively some phenomenological interaction (which has essentials of the QCD physics in the regime of interest), the article conjectures a rich structure of phases of u, d and strange quarks and gluons. Identifying possible signals in the real neutron/quark stars for such phases, however, is a challenging task. ('Color-superconducting quark matter' by Mark Alford).

Talking of astrophysical objects, neutrinos, which are trapped transiently in such matters, carry information about the properties of these sites. The neutrino interaction with such matter also sheds light on fundamental properties of neutrinos themselves. The physical sites of interest for these studies include the early universe, supernovae and newly born stars. Using the new generation neutrino detectors, detection of neutrinos from these vastly different eras promises a great wealth of information. One article gives an overall description of neutrino propagation in dense astrophysical systems, their transport and hydrodynamics, starting from various initial conditions. It also discusses the many-body interaction of neutrinos with matter. The results presented in the article are, however, indicative, not definitive, because of the complexity of the problem and the uncertainty in the input quantities ('Neutrino propagation in dense astrophysical systems' by M. Prakash *et al.*).

Many compelling questions in nature are addressed in nuclear astrophysics. They relate to nucleosynthesis at different astrophysical sites, stellar evolution, total density of matter in the universe, etc. Since at the stage of evolution of the universe the nuclear interaction time was considerably shorter than the lifetime of nuclei, critical quantities which enter in the astrophysical models of these environments are the rate and energy release of several nuclear reactions involving unstable (radioactive) nuclei. Rapid developments in accelerator technology and nuclear instrumentation have initiated a new era in nuclear physics where beams of radioactive nuclei with sufficient intensity, purity, and quality are being made available for experiments. This book carries an excellent review article on this subject. It identifies specific nuclear reactions entering in stellar dynamics, describes different techniques for producing radioactive ion beams (RIB) and summarizes different existing and upcoming RIB facilities worldwide. The RIB, in addition to being of fundamental importance in astrophysics, is also of much interest in nuclear physics currently. It opens up new horizons in nuclear physics for the study of structure of nuclei away from the stability line in general ('Nuclear astrophysics measurements with radioactive beams', Michael S. Smith and K. Ernst Rehm).

In traditional nuclear physics, the most challenging task had been the understanding of nuclear properties starting from the realistic nuclear forces. This requires the knowledge of nuclear forces and the availability of techniques to solve the many-body problems. We do have by now a tremendous amount of experimental data on nucleon–nucleon scattering that can be accurately described in terms of two-body potentials. These potentials, of course, are complicated, depending on the relative positions, spins, isospins and momenta of the nucleons. This makes finding accurate quantum mechanical solutions of the bound and scattering states of the nucleus a demanding task. In addition, such calculations, when carried out for three- and four-nucleon systems, reveal the existence of three nucleon forces, which makes the task even more difficult. Till recently, exact quantum mechanical calculations with the realistic potentials had been possible up to mass-4 systems only. In the shell-model framework 'no core' calculations have been done recently for *p*-shell nuclei using effective interaction derived from the realistic potential using the *G*-matrix method. One article in the volume goes beyond this. It focuses on recent developments in quantum Monte Carlo methods, which make it possible to access the *p*-shell nuclei at the level of accuracy close to that obtained in exact calculations for the *s*-shell ($A = 4$). The article presents the technical details of the calculations, which include the variational Monte Carlo and Green's function Monte Carlo techniques. Results for more than 30 states in $A < 9$ have been obtained with an excellent reproduction of the experimental energy spectrum. This is a landmark achievement. It encourages us to believe that the nuclear system can be understood quantum mechanically starting from a known two- and three-body force, provided we have techniques to solve the many-body systems accurately ('Quantum Monte Carlo calculations of light nuclei' by Steven C. Pieper and R. B. Wiringa).

Another many-body system which has been seen to have tremendous similarity in their properties with nuclear systems, are atomic clusters. They are the confined aggregates of atoms or molecules varying in numbers from a few to several tens of thousands. Thus they provide the paradigm for understanding how matter builds from its elementary constituents to the bulk matter. Clusters, like nuclei, lie between these two limits. Their properties show novel structures and thermodynamic properties not present in bulk matter. Like nuclei, these clusters show shell structure and associated magic number behaviour. Two systems show similar shape, dipole vibration mode and thermodynamic decay behaviour in excited states. One article in this volume discusses in detail the metal clusters. These clusters are composed of delocalized electrons from the metal atom and the resulting ions. The presence of ions, which are absent in nuclei, introduces difference in some properties like fission and particle decays. While many theoretical nuclear physicists have contributed to the atomic cluster studies, experimental nuclear physicists have not been forthcoming to the same extent. The article invites this community to join in the endeavour. ('Atomic clusters as a branch of nuclear physics' by S. G. Frauendorf and Claude Guet).

Gerald E. Brown has made several pioneering research contributions in many areas of theoretical physics. He has worked with many scientists like Gregory Breit, Rudolph Peierls and Hans Bethe, and had been associated with many international centers of pioneering physics research. The volume contains a brief autobiographical write-up by Brown, which starts with his observation about how his training in many areas of physics derived impetus from 'flying with eagles'. It is a revealing and an interesting article ('Fly with eagles' by G. E. Brown).

All in all, this volume of *Annual Review of Nuclear and Particle Science* gives an overview of several research areas of this subject, which are of current interest. It is good to have such a volume in one's library.

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Molecular Systematics and Evolution: Theory and Practice. R. DeSalle, G. Giribet and W. Wheeler (eds). Birkhauser Verlag, P. O. Box 133, CH-4010 Basel, Switzerland. 2002. 309 pp. Price not mentioned.

This is an interesting book, dealing with molecular techniques in systematics and evolutionary biology. It is a compilation of 18 papers by eminent scientists in their respective fields. The book is divided into three sections and contains an extensive list of references. The editors have done a great job in putting together recent advances in the areas of molecular systematics and evolution. It covers both computational and experimental developments.