**Annual Review of Nuclear and Particle Science, 2017.** Barry R. Holstein, Wick C. Haxton and Abolhassan Jawahery (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 67, v + 274 pages. Price: US$ 107.

It gives me great pleasure to once again write a review of what is an important collection of review articles published year after year in the fields of elementary particles and nuclear physics, and indeed more recently in the field of astro-particle physics as well. This year, the volume is significantly slimmer than in previous years with 11 articles which is significantly smaller than the typical 20 or so articles that appeared earlier. However, what is lacking in quantity is easily compensated for in quality as each of the articles is a precious little gem in the field.

The fields of nuclear, elementary particle and astro-particle physics are extremely mature ones and a lot of information is collected on two frontiers. One is the high energy and the other is the high intensity frontier. Whereas new phenomena may be directly discovered by, for example the production of particles not seen so far if there is enough energy available for their production, they could also be indirectly inferred by deviations from the predictions of the presently accepted theory of elementary particle physics, which has come to be known as the Standard Model (SM), the theory of quarks and leptons, which participate in the strong, and electroweak (electromagnetic and weak) interactions with regard to quarks, and electroweak with regard to leptons. Hadrons are particles which are strongly interacting, and their spectrum contains mesons and baryons. The strong interactions are mediated by gluons, while the electroweak by the charged W, neutral Z bosons and the photon. Neutrons and protons are examples of baryons and are the constituents of nuclei and the basic building blocks of all matter, even though they are composite and made up of quarks of the u- and d-type. Other unstable quarks are the strange, charm, b and top quarks which are sequentially heavier than the u- and d-type quarks.

On the other hand, the electron, for instance, is the lightest charged lepton and is accompanied by a very light neutral partner, viz. the electron-type neutrino. There are heavier counterparts known as muons which are about 200 times heavier than the electron and an even heavier counterparts known as tau leptons which are nearly 3600 times heavier than the electrons. Tau leptons were discovered in the 1970s and their discovery was recognized by the award of the Nobel prize for physics in 1995 to Martin Perl. This volume begins with a biography of Martin Perl, a fitting tribute to a great experimental scientist, who carried out experiments at Stanford University, USA. The *Annual Reviews* Series has enriched the literature by doing its best to include such biographical material, thereby lending a human touch to what is otherwise an austere and impersonal subject. This biography by Gary Feldman *et al.* begins with a warm description of Perl's childhood, schooling, and higher education. The story of his thesis work under the supervision of the legendary I. I. Rabi is worth reading again and again, where it is pointed out that research is an extraordinarily difficult enterprise with '...no answers in the back of the book...', and that 'you are on your own'. After years at the University of Michigan, USA, the denouement comes with the discovery of the tau lepton using the Mark-I detector at the Stanford Positron Electron Asymmetric Rings at SLAC. By studying the sequential decay of the products of decay of the hitherto unknown tau-lepton, Perl was able to pinpoint the existence of this fundamental particle, which later fetched him the Nobel prize. Today, we know that the tau-lepton is accompanied by its 'third-generation' partners, the b-quark and top-quark, as well as its neutral leptonic counterpart, the tau-type neutrino. The rest of the article also describes to the interested reader Perl's other experimental interests, his engagement with community-related issues, his mentoring legacy and also his family. Thus, there emerges the picture of a scientist and human being, a lasting touchstone to those engaged in the pursuit of science as a profession.

Indeed, today, we live in the age that is defined by the Large Hadron Collider (LHC) at CERN, Geneva, which has dominated the elementary particle physics landscape. At the LHC protons are collided against proton at very high energies in one of the modes, and lead ions are collided against lead ions in a different mode. The former is a probe of elementary particle physics and the interactions that fit in their rubric, while the latter creates conditions akin to the big bang where the nuclear collisions mimic conditions of very high densities and temperature, and where the quarks and gluons which are bound in normal matter become 'de-confined' and produce a quark–gluon plasma. It may be noted that the precursor to the LHC was the Large Electron Positron (LEP) collider which eponymously collided electrons and positrons in the same tunnel for over a decade in the last decade of the previous century and carried out precision measurements of the properties of the Z boson, the force carrier of the weak interactions. The LEP experiments carried out precise measurements of the coupling of quarks and leptons to the boson, and the 'mixing-angle' which determines the strengths when the weak interactions and electromagnetic interactions go their separate ways from a unified electro-weak theory. de Monchenault in the article 'Electroweak measurements at the LHC' reviews the state-of-the-art coming from the various LHC experiments in this sector. This is a spin-off from the vast physics potential at the LHC which so far has not detected any interactions and particles that do not fit into the SM, and is an important by-product.

As mentioned earlier in this review, many of the quarks are unstable and the rates at which they decay are determined by how they couple to the force carrier of the weak interactions, the W bosons. These couplings are determined by the elements of a matrix named after their discovers – Cabibbo, Kobayashi and Maskawa – where the latter two were awarded the Nobel Prize, for they also predicted that with three generations in the quark sector, one could have violation of the combined effect of charge conjugation symmetry (C) and mirror reflection symmetry or parity (P). Descotes-Genon and Patrick Koppenburg review the status of these parameters in 'The CKM parameters'. As mentioned earlier, neutrons and protons are the building blocks of all stable matter, but a lasting puzzle has been where the heavier elements, heavier than iron, could have been born in the Universe as they could not have been produced in stellar interiors. Supernovae and neutron star mergers have been the primary objects where conditions exist for the production of such nucleosynthesis. F.-K. Thielemann *et al.* in 'Neutron star mergers and nucleosynthesis of heavy elements' provide an overview of the latter. With the recent multi-messenger astrophysics due to Laser Interferometer Gravitational-wave Observatory (LIGO) which observed a neutron star merger, this article is bound to become a gold standard for investigations in this field.

Whereas elementary particle physics relies on man-made machines and detectors for its advance, astrophysics remains primarily an observational field as this is the domain where celestial objects produce radiation and particles that remain to be observed by humans. An ingenious experiment that relies on Antarctic ice which is very clear, in which a large number of photomultiplier tubes are embedded and observe light coming from the interactions of particles of cosmic origin which produce light in the ice is called IceCube. P. Mészáros in 'Astrophysical sources of high-energy neutrinos in the IceCube era' shows how the cubic kilometre of ice has helped establish that the very high energy neutrinos have an extra-galactic origin in cosmic-ray interactions along with co-production of high-energy photons. Low-energy neutrinos are a by-product of nuclear power stations and could also hold clues to our understanding of the masses and mixings between neutrinos. A large effort has been made from the earliest days to harvest these neutrinos and probe them. L. J. Wen, J. Cao and Y. F. Wang review our understanding in 'Reactor neutrino experiments: present and future'.

The nucleon–nucleon interaction remains one of the great unsolved problems of theoretical nuclear physics. There is a whole host of low-energy bound states of the strong interaction, all of which contribute to the forces between two nucleons. Separating out their contributions remains a great challenge. Nature has been kind and has provided other probes such as electromagnetism as well as the neutral current due to the Z boson. The latter leads to parity violation, an intrinsic feature of the weak interactions. New experiments that study the effects due to such hadron parity non-conservation and their theoretical understanding is one of the goals of future studies. The state-of-the-art in this subject is captured in 'A new paradigm for hadronic parity nonconservation and its experimental implications' by Susan Gardner *et al.*

In 'New results on short-range correlations in nuclei', Nadia Fomin *et al.* provide a review on recent theoretical and experimental progress in the studies of short-range correlations in the nuclei which are crucial in understanding the dynamics of nuclear interactions at very short distances. O. A. Hurricane and M. C. Herrmann in 'High-energy-density physics at the National Ignition Facility' (at the Lawrence Livermore Laboratory in California, USA) describe the advances in this field and the underlying physical principles when matter is subjected to extraordinarily high pressures, even if for very short periods of time.

Behind many dramatic discoveries in elementary particles lie advances in technology. These advances could well be in the quantum world, or in ultra-low temperature technology, or in massive advances in vacuum technology. Whereas it is known that the Universe must contain dark matter, matter rendered dark because of its very weak coupling to known matter, it may yet be that an occasional collision may be made by such particles with known matter leading to a deposition of large amounts of energy. Such energy could, for instance, raise the temperature of a sample from a superconducting to an ordinary phase. Other detection challenges lie in observing the photons from the cosmic microwave background, the ethereal remnant of the big bang that is ubiquitous and bathes all parts of the Universe, when the photons of that era decoupled from the 'surface of last scattering'. These photons may be polarized and their detection is crucial to our understanding of primordial inhomogeneities. S. Pirro and P. Mauskopf review these topics in 'Advances in bolometer technology for fundamental physics'. Other dark matter detection experiments are in the offing, and an example is the first phase in 'The China underground laboratory and its early science' by J-P. Cheng *et al*. The experiments are a natural sequel to the landmark Reno and Daya Bay experiments.

This volume presents a set of wonderfully written articles by world experts on several frontiers of elementary particle physics, nuclear physics and astrophysics, theory and experiment and application. In conclusion, this volume is a pleasure to read and an invaluable addition to the library of researchers as well as of institutions.

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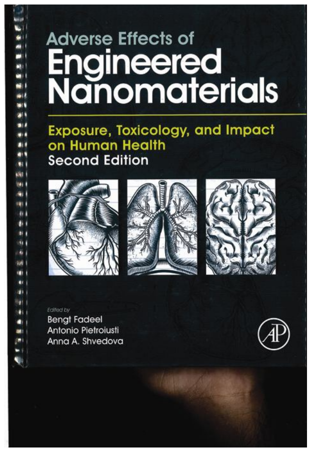


**Adverse Effects of Engineered Nanomaterials: Exposure, Toxicology, and Impact on Human Health.** Bengt Fadeel, Antonio Pietroiusti and Anna A. Shvedova (eds). Academic Press, an Imprint of Elsevier, 125 London Wall, London EC2Y 5AS, United Kingdom, 2017. Second Edition. xvii + 468 pages. Price: US$ 160.00.

Nanomaterials have garnered significant attention over the last few decades for their potential applications in multiple fields such as electronics, energy generation and storage, industrial catalysis, clinical medicine and new consumer products. These applications are beginning to bring humans in close contact with nanomaterials on a day-to-day basis, leading to important questions regarding their effect on our health. In this context, the book under review is timely.

Understanding the effect of nanomaterials on human health requires basic knowledge of both materials science and physiology. While providing sufficient background on these two different topics is difficult, the editors have done a remarkable job by dividing the book into two broad sections, one dealing with