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It is a pleasure to review the collection in the 2020 *Annual Reviews of Nuclear and Particle Science*, particularly because the first article captures the essence of this collection and of the enterprise. In ‘Why do we do physics? Because physics is fun!’ James D. Bjorken, one of the highly celebrated figures in Elementary Particle Physics tells us about his voyage in physics, a voyage that encompassed the era when the field burgeoned into a highly sophisticated one, both due to massive experimental efforts across the world, and in particular at the Stanford Linear Accelerator Centre in California and at the Fermi National Laboratory in Illinois, where he held positions. Bj as he came to the known tells the tale, as he followed experimental results closely all his life and was also someone who has actually participated in experimental work. Bjorken is known for having done pioneering work in uncovering the nature of the strong interactions, which today we known is a gauge theory of interactions which is asymptotically free. This theory is one of quarks and gluons that binds matter and confines quarks and gluons. His work was essential in establishing all these features. The above said, Bj talks about his long innings in physics, and finally talks about his most recent interest in gravitational physics. In terms of human interest aspects, he discusses the issue of prizes, which he considers as the work of the Devil! Although he has himself been richly decorated, he decries the deleterious effects of the Nobel Prize on science, but hastens to add that it is good for publicity for the particular field that is honoured in a given year. Among other things, the article is a pleasure to read for its simplicity, clarity and honesty. It would be a useful touchstone for everyone on how to take stock of one’s life in science.

Today the field of elementary particle physics, which is the study of matter at the most fundamental level, is a very rich and diverse one and makes contact with other fields. Composite particles such as nucleons, namely protons and neutrons are made of quarks and gluons, and nucleons are the constituents of atomic nuclei. Nuclei when surrounded by electrons form atoms and from thereon we make molecules, the stuff of which everything around us is made. In extreme environments, the electrons may get stripped off, and exist in ionized forms, and in even more extreme conditions, similar to those that prevailed at the time of the big bang, where temperatures were remarkably high and densities of unimaginable proportions, the quarks and gluons would be liberated and form a plasma, similar to the plasma that exists of electrons and protons in very hot stellar media. The problems of physics today are of two types: obtaining normal matter from their constituents, and seeing what kind of properties prevail in matter at extreme conditions. Besides the big bang, there are other settings in nature where extreme conditions prevail, such as in the collisions and mergers of black holes or of neutron stars some events now observed by the LIGO/Virgo collaborations. Neutron stars as the name suggest are an end stage of certain stars where electrons have collapsed into protons to form neutrons which are unable to decay because of the collective properties of the star, for otherwise a free neutron under normal circumstances would have decayed away. Today, we are in the era of multi-messenger astronomy where gravitational wave detectors have seen the mergers of neutron stars, and simultaneously the collisions have also been observed in many regions of the electromagnetic spectrum. Thus advances in technology and detection have rendered possible observational science to reach high precision. Furthermore, in terrestrial experiments such as the Large Hadron Collider at CERN which is often regarded as a proton on proton collider, one also has a highly extensive scientific programme of collisions of lead nuclei on lead nuclei, which aim to replicate the conditions of the big bang in order to study the properties of the quark gluon plasma. This latter is also studied at other experiments including at the Relativistic Heavy Ion Collider at the Brookhaven National Laboratory, USA. Whereas the quarks we are accustomed to, the up and down quarks which constitute normal nucleons, they are also accompanied by several heavier cousins, which are all unstable due to the weak interactions which lead to their decay. The heaviest amongst them is the top-quark which was experimentally discovered a little less than three decades ago, which is a laboratory to test our understanding of all the interactions. The LHC provides an opportunity to study this particle at great precision. The present collection of articles is one where we find a review of theory as well as a description of experimental methods and techniques that are at the forefront of such work.

In ‘Covariant density functional theory in nuclear physics and astrophysics’ Junjie Yang and J. Piekarewicz review the methods of modern day quantum mechanical techniques and modern astrophysics. The article highlights the importance of theoretical calculations to make sense of all the observational and experimental work that will probe neutron-rich matter. Such methods are required for probing the ‘...entire nuclear landscape by connecting finite nuclei to neutron stars’. An article that I am sure will be remembered for its thoroughness and depth.

As mentioned earlier, the work of Bjorken which paved the path to our understanding of the strong interactions involve the construction of the ‘Parton Model’ where today we understand that partons are the quarks and the gluons. In ‘Partond distributions in nucleons and nuclei’, Jacob J. Ethier and Emanuele R. Nocera review the state of knowledge of the parton distributions. It also offers a discussion on the future directions for progress.

David Radice *et al*. tell us about ‘The dynamics of binary neutron star mergers and GW170817’, where GW170817 is the first observed neutron star merger by the LIGO/Virgo collaboration. The article describes our understanding of the various phases of the phenomenon, namely the inspiral, merger and postmerger evolutions.

Of closely related interest is ‘Primordial black holes as dark matter: Recent developments’ by Bernard Carr and Florian Kühnel. The possibility that part of the dark matter in the Universe can be such black holes is not ruled out. The authors describe the possibility against the background of the detection of black hole mergers by LIGO/Virgo collaborations.

Amazingly enough today the cart is indeed ahead of the horse, as evidenced by the fact that the cosmos has now turned into a laboratory for nuclear physics, see ‘Nuclear reactions in astrophysics:

A review of useful probes for extracting reaction rates' by F. M. Nunes *et al*. A short article by the standards of the present collection, it reviews three types of reactions, namely, transfer, breakup and charge–exchange reactions.

Nuclear physics, needless to say, is the basis of so many human activities ranging from energy production to medical isotopes. In this collection we are presented with 'The nuclear legacy today of Fukushima' by Kai Vetter. The author sensitively looks at the failure of the reactor due to the earthquake in March 2011 and the response of the community and the implications to the future of nuclear energy. 'The shortage of Technetium-99m and possible solutions' has been written in response to the shortages of Molybdenum-99 and Technitium-99m isotope due to ageing facilities and the decommissioning of highly enriched uranium from medical isotope production, and instead to move towards production using accelerators.

Turning now to the issue of sub-nuclear physics, we now reach the constituents of nuclei which are nucleons. These in turn are made up of quarks and gluons which are trapped inside nucleons. However, at extreme conditions, natural and man-made one can see these degrees of freedom playing. One such phase is known as the quark–gluon plasma. The study and understanding of the properties of the quark–gluon plasma are well represented in this collection. 'Polarization and vorticity in the quark–gluon plasma' is an in which these eponymous properties are discussed by Francesco Becattini and Michael A. Lisa. Although there is broad agreement between theory and experiment in the issue of the spin polarization of produced hadrons in ultrarelativistic heavy nuclear collisions, a new field appears to have been opened. As regards the closely related topics of nuclear collisions, these are discussed in 'Chiral magnetic effects in nuclear collisions' by Wei Li and Gang Wang. These are pertinent to the observation of magnetic as well as vertical effects of import to measurements at the Relativistic Heavy Ion Collider at Brookhaven National Laboratory as well as at the LHC. 'Photonuclear and two-photon interactions at high-energy nuclear colliders' by Spencer R. Klein and Peter Steinberg takes us through a tour of what are called Ultraperipheral Collisions that throw open a window on nuclear shadowing, nuclear structure and possibly of physics beyond the Standard Model.

The Standard Model is what summarizes our present day understanding of electro-weak and strong interactions. It in reality is an engineering model where we do not know the answers to many basic questions. Answers to such questions are likely to arise from extensions of the Standard Model. For instance, the Higgs mechanism itself is only a phenomenological model. Is it so that there is only one Higgs Boson? In this volume, highly theoretical notions are discussed in 'Extended scalar sectors' by Jan Steggemann. A fascinating article in which the author shows how precision measurements of the known Higgs itself can give constraints on extensions of the Higgs sector.

Popular extensions of the Standard Model are those that are based on supersymmetry. A theoretically compelling scenario, which if true should be 'broken' and leave behind its imprint in the presence of additional particles few times heavier than, say, the Higgs boson. Such particles if discovered should have masses and other properties which are related to one another due to the structure of the symmetry breaking. Anadi Canepa *et al.* discuss the prospects of finding certain species of such particles in 'The search for electroweakino'.

In the Standard Model, the heaviest particle is the top-quark. Its direct observation came less than three decades ago and requires a variety of methods to determine its mass. Besides the experimental challenges, there are also challenges in theory to define its mass properly to the fact that it is constantly surrounded by gluons and decays very rapidly. André H. Hoang in his contribution presents the modern day answers 'What is the top quark mass?'

As we today celebrate the LHC and its discoveries, we also need to think about the future. In the future it will be having what is called a high luminosity model. At such luminosities there will be enormous challenges to the accelerator design as well as in detection. Anders Ryd and Louise Skinnari discuss the history of tracking in a variety of experiments and plans for the future in 'Tracking triggers for the HL-LHC'.

Continuing to accept that the cosmos itself presents us a variety of laboratories, we today can look at various environments to study properties at high precision of particles and also on the specific epoch in which they are produced. Whereas neutrinos produced in supernovae have now been with us for several decades, what of those before the star has exploded? In 'Theoretical prediction of presupernova neutrinos and their detection', Kato *et al*. explore such particles theoretically and plan an alarm system for their observation, since they would also provide a window into the properties of supernova neutrinos and properties of the star.

One particular area in which particle physics meets cosmology in a compelling manner is that of dark matter. Needless to say dark matter has not been observed so far, and in the effort to detect it, there have been many experiments. One such has been covered in 'The Fermi-LAT galactic center excess: Evidence of annihilating dark matter?' by Simona Murgia. The excess discussed is in the X-rays and could, of course, come from annihilating dark matter or also from millisecond pulars. This fascinating subject is well covered in this article.

This brings us to the end of this fascinating collection of articles. From the largest to the smallest scales, from highly sophisticated instruments on earth to gravitational waves, to quark–gluon plasma, no field of elementary particle physics has been left untouched. Besides being of interest to experts, the articles here provide a valuable reference to young people interested in catching up with the state of the art. I recommend this book to every library and every interested reader.

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