Editorial

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Resonance joins in the celebration of the World Year of Physics by presenting here a selection of articles from earlier issues; these articles connect us to the magical year, a hundred years ago, which changed profoundly the way we understand and describe the physical world. They also record the reverberating echoes of these discoveries and the many directions in which physics is moving.

It is a measure of the epoch making nature of Einstein's contributions in 1905, namely the special theory of relativity, the light quantum hypothesis, and the theory of Brownian motion, that the three generally perceived frontiers of physics today are the large, the small and the complex! Physics is not only alive and well at these frontiers, but is also reaching out to other fields such as chemistry, materials science, biology and chemical engineering as never before.

Both in the world of the small and the large, relativity has predicted spectacular consequences; examples are (respectively) the relation $E=mc^2$ between mass and energy which is the basis of our approach to the release of energy in nuclear fission and fusion, and black holes where gravitation curves light so much (Einstein's General Theory of relativity) that it cannot go in. Einstein's revolutionary hypothesis –that energy is quantized as exemplified in light, is the defining feature of the small. His establishing the link between random thermal motions of objects (Brown, 1828) and their atomic causes brought home the reality of atoms directly, and is perhaps the single most influential contribution of Einstein to science. It is essential not only for the understanding of the complex in physics, but also reaches out to apparently completely unrelated fields, eg. motion of aerosols in the atmosphere, and the dairy industry (milk is a colloidal suspension of 'Brownian' particles)!

This depth and variety is represented here first by three articles on the 1905 work of Einstein, namely those by Supurna Sinha, N Mukunda and Sriram Ramaswamy on the theory of relativity, the photon and Brownian motion respectively. Then there is a rich feast of themes ranging from the expanding universe to magnetic monopoles and Bose-Einstein condensation. There are also historical vignettes on Homi Bhabha and Cosmic Ray Research in India, and Wegener and his Theory of Continental Drift.

Some of the values that inform these journeys in physics, as also the original discoveries of Einstein, are perhaps worth pointing out. The distinguished physicist Abraham Pais, in his famous work on Einstein '*Subtle is the Lord*' said "Had I to compose a one-sentence scientific biography of Einstein, I would write: better than anyone before or after him, he knew how to invent invariance principles and make use of statistical fluctuations". This statement reflects the dual character of physics, namely the search for general, basic principles describing the physical world as well as the world of phenomena which is the ground from which such descriptions spring and to which they must return. All of physics provides illustrations of the varying degrees in which this duality is found. An example of the search for underlying basic principles at one extreme is the intense, nearly a generation old, effort to see if quantized fields living on strings 10^{-35} m or so in size can provide a final theory of matter, a unifying description of the four known basic forces namely gravitation, electromagnetism, strong and weak nuclear forces. In the realm of the large, the search for answers to questions such as the large scale structure of the universe, the preponderance of dark energy and of dark matter, is increasingly influenced by accurate observational data. The frontier of complexity is marked by our ability to make many worlds and to probe them, as well as existing ones, in novel ways. This has led to an explosion of new phenomena, systems and applications.

The variety of behaviour and the emergence of new patterns requires explanatory and predictive theories at different levels, in close correspondence and contact with experiments. These obviously have to be consistent with basic principles and sometimes can be directly connected with them. The opening to complexity thus enriches science through new phenomena, new materials and applications, through stronger interconnections between different branches, and through new examples of this organizing principles at several levels.

An early, inspiring example of this is the 1905 theory of Brownian motion which connects for the first time two consequences of statistical fluctuations, namely diffusion and fluid friction (viscosity), and then, the former to atomic motions. Einstein was manifestly, close to experiments to the extent necessary for a deep understanding of the workings of nature. For example, in his approach to Brownian motion, he aimed not only to provide a path which qualitatively demonstrates the reality of atoms, but one through which their number and size could be calculated. For this purpose, he analyzed the origin of the extra, solute caused, viscosity of dilute sugar solutions and compared them with experiment. (Having so close to experiment was clearly not possible when one tried to understand the relativity of space and time or the energy carried by light). Our remembering 1905 in physics thus suggests to us why and how the subject has grown in unexpected directions. This issue is a sampler.