proceedings

Editorial

Introduction–Symmetry 2017 †

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† Presented at Symmetry 2017—The First International Conference on Symmetry, Barcelona, Spain, 16–18 October 2017.

Published: 24 January 2018

Symmetry undergirds all of science. In fact, at the deepest level, the laws of nature are reflections of symmetry. The concept of energy, which may be the most important scientific construct, is a reflection of the symmetry that our fundamental description of nature is independent of time. Likewise, momentum conservation reflects the fact that observations made at different places, at different positions, yield the same laws of nature.

Symmetry 2017, the First International Conference on Symmetry, brought together many experts in different fields of science, biology, physics, chemistry, mathematics, and computer science, to explore the pervasive nature of symmetry in understanding natural phenomena.

In biology, it is often symmetry in its most transparent geometric aspect that plays a key role. Thus the symmetry of viruses and amino acids are crucial to understanding how living systems function. But symmetries beyond geometrical are clearly becoming more central as our understanding of biological systems matures.

Physics has long been founded on the notions of symmetry. Sometimes, these are quite subtle, such as the dual symmetry between electric and magnetic charges. The central role of space-time symmetries, such as Lorentz invariance, cannot be overemphasized. Noether's theorem codifies the duality between symmetries and conservation laws, already referred to above. It is remarkable, given the long history of the subject, that the form of the energy-momentum tensor in electromagnetism, which expresses the symmetry under general coordinate transformations, is still unsettled. Symmetry plays a key role in all scales of physics, from cosmology through condensed-matter physics, all the way down to subnuclear and particle physics.

Chemistry likewise largely rests on symmetry. For example, chirality—handedness—is critical in the biological functioning of complex molecules. At the atomic and molecular level, where ab initio calculations are often intractable, symmetry arguments often allow for crucial simplifications.

Mathematics seems to be nothing but symmetry. Lie groups lie at the basis of our understanding of the world. Symmetries are often not obvious, and emerge only after a problem has been studied for some time. And when we turn to numerical simulation of systems with high-performance computers, we would still be at a loss were it not for symmetries that permit drastic reduction of the number of independent variables. Lattice gauge theory is an obvious example, where great progress has been slowly won with the help of symmetry arguments.

All of this, and much more, was covered in 2.5 days of talks at Symmetry 2017. All of the presentations were plenary, that is, there were no parallel sessions. Consequently, talks were rather brief. But there was ample time for discussion, in coffee breaks, receptions, and over lunch and dinner, and the multidisciplinary format allowed for important cross-fertilization of ideas. In an era of ever-increasing specialization, it is refreshing to have a meeting where so many disparate fields, represented by leading experts, were presented. This Proceedings memorializes this very valuable conference, which we hope will have many successors.