Editorial

Govind S Krishnaswami, Editor

Email: govind@cmi.ac.in

Our personality for this issue of *Resonance* is William Rowan Hamilton, a 'larger-than-life' Irish physicist and mathematician of the mid 19th century. Even as a young boy, Hamilton had a way with words and a precocious talent for languages. He fancied becoming a poet, but was persuaded by William Wordsworth to tread "the path of Science". By age 22, while still an undergraduate, he was appointed Professor of Astronomy at Dublin, a job he had not even applied for!

Hamilton's early work was in optics. We learn that his characteristic function was an analytical way of describing Huygens' wave fronts, which implement Fermat's principle of 'least' travel time for light rays. His prediction of conical refraction (based on his way of thinking of optics) and its spectacular experimental verification evokes great admiration to this day. Having brought "harmony and unity into the contemplations and reasonings of optics", Hamilton used an analogy between light rays and particle trajectories to reformulate Newtonian mechanics! His viewpoint and equations turned out to be just what was needed for Heisenberg, Schrödinger and Dirac to take the step from classical to quantum mechanics nearly a century later. The connection between Hamiltonian dynamics and quantum theory is particularly striking in the semi-classical regime, and finds its expression in Bohr's correspondence principle. We get to see an example of this, with circular orbits emerging among highly excited states of the hydrogen atom. Remarkably, the Hamiltonian formulation also plays an essential role in the other physical framework dealing with randomness: the inclusion of thermal fluctuations in statistical mechanics.

The latter half of Hamilton's life was devoted to an attempt to do for three-dimensional geometry, what the algebra of complex numbers does for the plane. In fact, it was Hamilton who conceived of complex numbers as ordered pairs of real numbers. Unable to find a way of multiplying and dividing ordered triples, he leapt into a fourth dimension! He discovered that many properties of three-dimensional space (such as rotations), could be encoded in a non-commutative algebra of quadruples, the quaternions.

It turns out that there is a lot more to ordered pairs! In another article, we learn how to think about ordered pairs, Cartesian products of sets and the subtleties that can arise with unordered pairs or infinite products. This month's Think It Over features a puzzle on the motion of a charged particle in an electromagnetic field, viewed from two reference frames. In our final article, we move from the dynamics of particles to the locomotion of animals and plants. We learn of the remarkable adaptations wetland creatures have developed to counter (or even take advantage of) buoyancy, gravitational and drag forces.