influence of the changing climate on evolution. Thus the reader is able to get a broad overview of the Universe rather than compartmentalised descriptions.

As far as our students are concerned, given the declining standards of English, I am not sure if they would be comfortable with this book, barring perhaps the IIT-types. Though it is supposed to be popular science, the reader has to think, absorb, and digest. If the student is accustomed to this sort of reading, then she or he would cetainly benefit from this book as it would promote a broad and comprehensive view of science, very necessary even if one wants to specialise.

In one important respect this book left me rather disappointed and that is the total absence of illustrations. I can understand a book on mathematics not carrying any figures but a book of this sort, especially in this day and age when one can do wonders with graphics? To sum up, the book is good and well written but it sort of lacks the sparkle of Gamow.

The production values are excellent and the publisher deserves to be complimented.

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Science and Hypothesis

N Mukunda

Science and Hypothesis
H Poincaré
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Jules Henri Poincaré was one of the most profound thinkers of the late 19th and very early 20th century. Apart from his path-breaking work in many areas of mathematics, he was also deeply involved with the physics of his day, and made lasting contributions to celestial mechanics, optics and electrodynamics. His collection of essays titled "*La science et l'hypothese*" was published in French in 1902, and its English translation appeared in 1905. It has long been a classic of the literature of science, covering some areas of mathematics and physics of that period.

Poincaré divides his thirteen chapters into four major parts respectively titled 'Number and Magnitude', 'Space', 'Force' and 'Nature'. While the first two parts devoted mainly to arithmetic and geometry retain their value to this day, the last two parts dealing with physics are understandably out of date on account of the great progress that has taken place over the past century. In his penetrating logical analysis of the arithmetical operations and the meaning of magnitude, Poincaré brings out the key role of the method of proof by induction. He expresses beautifully, as only a master can, the true spirit behind mathematical thinking: it is the form, not the matter, that is of the essence; and relations between objects, not the objects themselves, are of the greatest concern. His extremely close touch with physics seems reflected in the statement: "The mind only uses its creative faculty when experiment requires it".

When he turns to geometry the situation is rather different. As against the essentially unique structures in arithmetic, with geometry there are several distinct possibilities depending on the axioms one chooses. Poincaré's deep philosophical insight and grasp keep surfacing all the time in short profound statements such as: "... the word 'existence' has not the same meaning when it refers to a mathematical entity as when it refers to a natural object"; and "The geometrical axioms are therefore neither synthetic a priori intuitions nor experimental facts. They are conventions". He traces the development of the non Euclidean geometries of Bolyai and Lobachevsky; and in explaining our intuitive understanding of the properties of space he lays great stress on the interplay of the senses and of muscular effort in reaching out to and apprehending material objects. One sees how deep the unconscious processes of grasping space really are – we are actually totally unaware of them. Even the three-dimensional nature of space is traced to muscular experience. Poincaré's view that the geometry we attribute to physical space is basically a convention would appear hard to accept for a physicist familiar with the general theory of relativity – indeed one wonders how Poincaré would have assessed that theory.

Once Poincaré turns to an analysis of the foundations of physics, in particular mechanics, two points become especially clear – the great distinction he draws between the French and the English ways of thinking in science; and his systematic conclusion that so many of the laws held sacred within physics evaporate into thin air and reduce to mere definitions or conventions! Poincaré sees absolute space, time and geometry as part of, and not prior to, mechanics. While he does explore whether the laws of mechanics might have been otherwise than they are, he concludes that Newton's 1st Law can never be decisively tested, and even the 2nd and 3rd Laws become in his eyes (interdependent) conventions. Concerning the Galilean Principle of Inertia and of Relativity there is a seeming contradiction: at one point he asks "Is this a truth imposed on the mind *a priori*?" and soon concludes it is not; but somewhat later he declares "... it is imposed upon us for two reasons ... the consideration of the contrary hypothesis is singularly repugnant to the mind".

The later chapters on energy, principle of least action, optics, electricity and electrodynamics are clearly dated. The general discussion of the role of mathematics in physics is beautifully perceptive. Poincaré sometimes seems to affirm the need for an ether, and also to doubt the reality of molecules. There is much pride in and admiration for the 'immortal' work of Ampere, and of Fresnel and Carnot; and at the same time quite strong criticism of Maxwell's style in expressing his ideas and theories. The meaning of mechanical explanation of physical phenomena – the ideal in 19th century physics – is especially clearly outlined.

It needs a rather mature mind to read and understand Poincaré's writings. And then one cannot help wondering how he might have reacted to the revolutions in physics of the 20th century.

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