Vår Rastlösa Värld

M.Born

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I remember the book from my childhood. What fascinated me were the illustrations in the margins, which when rapidly flipped, produced the effect of a film, i.e. moving images. In my childhood it was common with those small packets you could flip producing the effects of mobility which at the time was rather fascinating. The book is a Swedish translation of the original 'The Restless Universe' which was published in 1938[1]. The translation includes a foreword by the Swedish physicist Oskar Klein, who lauds the author as a distinguished physicist and popularizator but begs to differ from him on a few points and provides in footnotes some more specific criticism as well as hopefully illuminating comments. My father received it as a prize at school in the spring of 1941 the last term of his attendence at 'Realskolan' prior to his attending the 'Gymnasium'. He must have read it, if not at the time, as there are two penciled remarks by his hand. One refers to the author's remark that matter is not so accommodating as to allow us to convert it into energy, in which my father notes that by 1945 this is no longer true, the other is just a small calculation.

The book is written in a leisurely style, allowing the author to digress on anecdotes and extended similes, with an effort to minimize on mathematics, which may enhance the appeal to the general reader at the expense of intelligibility. Mathematics is, however, not totally excluded, as it would be in a more modern version, the author does not want to be inarticulate after all, and any theoretical physicist invariably breathes mathematics. One cautionary tale the author relates is that of the lady who at a dinner party asks her companion at dinner to brief her on relativity theory. Her companion, one suspects a professor of physics (maybe Born himself), abstains and instead tells her about two men who arrive at a farm. Being thirsty one of them suggests to buy some milk, but his companion does not know what milk is. The other man refers to a white liquid, but his slow-witted friend does not know what 'white' is. Undaunted he is told that white is the color of a swan, but to no avail, and an attempt to describe a swan as a big bird with a bent neck is made, but the dense companion does not know what 'bent' means. Finally out of exasperation the man bends his arm, and then finally the ignorant companion explains, now I know what milk is. Obviously this is the result of many an attempt to explain science, when stymied by the abysmal ignorance of the audience, being reduced to try to explain basic terminology.

Now the book is divided into five chapters. The first starts with a leisurely discussion of the kinetic theory of gases, with digressions on dispersion of light and the color of the sky, to end up with Avogadro's number and a presentation of the basic elements. Then there follows a chapter on electrons in which the reader is presented with quantization, in

[1] The English version, which turns out to be a translation from the original German, was published in 1935 and illustrated by a nephew of the author.

particular the measurement of the charge of a single electron and relativity theory, specifically the conversion between mass and energy, in which he laments the above mentioned fact that nature is not accommodating when it comes to supply us with free energy. Interesting is the discussion how to make individual electrons visible, after all this is something that puzzled me as a child. Were the traces to be seen in a Wilson cloud chamber actually traces of individual electrons (or ions)? Or the result of some statistical fact that many small particles worked in union? Obviously the traces, to be visible on a macro scale, must involve many particles, but the origin of that communal effort can be traced back to individual ones. In fact the events witnessed are exceedingly rare, in view of the hugeness of the Avogadro number, otherwise there would be too much confusion. To Born, and many of his generation, those traces, along with the earlier explanation of Brownian motion, provide incontestable evidence of the palpable existence of atomic particles rebutting the instrumentalist view of late 19th century physicists such as Mach, that they are merely convenient fictions.

The third chapter is crucial in which he presents the dual notion of waves and particles when you consider electrons. Newton's theory of light as particles, the so called corpuscles, seemed obvious at the time, as light seems to travel in straight lines, and shadows are sharply delineated. Huygens, however, introduced the wave theory at the same time, due to phenomena such as interference, and the fact that narrow slits actually disperse light, by the early 19th century the corpuscular theory of light was totally discarded and it was instead given a unified treatment by Maxwell as electromagnetic oscillations (in which its speed occurred naturally). However, it would lead to a digression into the ether, because something had to vibrate, a confusion which lies at the origin of relativity theory. With quantum theory the old Newtonian conception of light was revived now in the form of photons. So the chapter turns on quantum theory and the Planck constant and the beginnings of Bohr's model for the atom and its take-off from Einstein's photo-electrical effect. It continues with the presentation of de Broglie's theory and the apparent contradiction that the electron waves travel faster than light. They may, the author concedes, but they cannot convey information faster than light being just idealized and formal. Instead what is interesting are groups of waves giving rise to the notion of group velocity which is indeed slower than that of light. It concludes with the statistical interpretation of the wave function and Heisenberg's uncertainty principle, matters which made Einstein very uncomfortable, but where Born was to make his main contributions. In fact he mentions in an aside that he had encountered matrices during mathematical lectures but not paid any attention to them, until he realized that they could be useful. This is a case of coquetry, Born was a star mathematical student when he came to Göttingen catching the attention of Hilbert whose assistant he was to become, and his thesis was really mathematics, if rather applied[2].

The fourth chapter discusses in some detail the electron structure of the atom involving the notion of spin and the Pauli exclusion principle. This advance is crucial as it subsumes chemistry under physics, in the sense of making the fundamentals of chemistry amenable

[2] Apparently he wrote a very good paper on elasticity but incurred the disapproval of Felix Klein as he would not like to become an applied mathematician. Klein was powerful and in order to appease him he submitted the paper to a competition at which it won a prize.

to a physical explanation. The spectra of various elements had been known since the 19th century and put to very good use, with Bohr's model it all could be explained by some simple principles. The final chapter discusses the atomic nucleus and the discovery of the neutron which was very recent at the time the book was written. Positrons and negative protons, and hence the existence of anti-matter is touched upon, but basically it is a presentation of radioactive decay and the production of isotopes which presents a species of nuclear chemistry. It is noted that one may not speak about individual electrons when two are present, to a mathematician it brings to mind the case of a connected and unramified double covering when one may locally distinguish between different sheets but not globally.

The author, in the spirit of a cultured and educated German, concludes by a quotation from Goethe's Faust[3], after having extolled the human spirit in its disinterested passion to try to understand as much as possible, aiming at truth. It finds that nothing is at rest, nothing endures, that not everything is knowable, even less is predictable. But yet in the middle of the ephemeral world of mere phenomena the laws of nature stand firm.

You cannot read through a book on science, not even a popular one, as you do a novel or a book on history and expect that you will understand, you have to work it through. Invariably, even as a mathematician, you tend to skip through the light mathematical parts, thinking it is routine after all, and thus miss some essentials. Yet the presentation is lively and motivational encouraging you to return to the material at some future date. It is here the master distinguishes himself, as opposed to the mere pedagogue, there is no substitute for deep understanding and intimate familiarity when it comes to presenting s subject.

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[3] So schaffe ich am sausenden Webstuhl der Zeit/Und wirke der Gottheit lebendiges Kleid.