Why Are Things the Way They Are? G. Venkataraman. University Press, Hyderabad, 1992. 112 pp. Price: Rs. 35.

G. Venkataraman, a vital figure in the Indian Physics world, and the author (among other things) of *Journey into Light*, a biography of C. V. Raman likely to become a classic, has turned his talents to writing a series of books on physics for the enjoyment of the young. These books attempt to communicate some of the interesting and fundamental concerns of physicists, emphasizing how, why and who. The author has an astonishing range, and a light touch that enlivens.

The present volume in the series seeks to explain the size of various things from basic and simple physical arguments. After a chapter where the main actors, namely the fundamental constants, are introduced, some of the plays in which they have roles are described. These are: the size of atoms, solids and liquids, the height of mountains, stellar facts, and cosmic numbers. The topics emphasize the wide range of application of physical principles, from the microscopic to the cosmic. This 'outward bound' tour is undertaken with great energy and cheer, with many an anecdote and aside on the way. It is an exhilarating journey.

Each theme is well presented, with arguments, stories, boxed-in digressions and a chatty style. The text is attractively printed and remarkably free from printer's errors. The only typographical quirk I found distracting was the consistent use of the symbol ν (mentally blocked for frequency!) for the velocity v. The line drawings are clear and plentiful; the cover design is really attractive.

The book is, as Venkataraman points out, a Bhashya (gloss) on a brief tract by Weisskopf, the well-known physicist. This circumstance is a source of many strengths as well as weaknesses as I illustrate with some examples.

Weisskopf estimates the size of atoms with up to ten electrons by adding the pairwise coulomb repulsion energy of electrons to the kinetic energy and the electron nuclear attraction energy. The first is evaluated by assuming all electron pairs to be at the same distance $0.6r$ (r being the radius of the atom) and to repel each other (without screening), adding this repulsion energy to the other contributions, and minimizing the total energy as a function of r. All this is done rather tersely by Weisskopf, and Venkataraman does an excellent job of explaining the processes and the results. But, where is the nub? Can the inner workings be laid out to give the reader a greater sense of ease and participation? Some contributory factors, such as the existence of a single length scale (the Bohr radius), the long range of coulomb interactions (imagine doing this for a liquid or a nucleus), absence of screening (and hence the restriction to light, few electron, atoms) could indeed have been brought out.

The chapter on solids and liquids has a gem, unearthed by Weisskopf from an old German chemistry textbook; the idea is that one can estimate an *atomic length* as a ratio of two *macroscopic* energies, namely surface tension (energy per unit area) and evaporation energy (per unit volume). This insight ought to be in every high school book. Again, this idea is very well explained by Venkataraman, with figures and words.

The chapter on stellar facts attractively raises and answers many basic questions which may not even occur to many of us, e.g. how big (or how small) a planet can be, how heavy a star can be and still be stable. Along the way, necessary physical ideas such as the Pauli exclusion principle, Fermi degeneracy pressure are introduced. The last chapter on cosmic numbers, emphasizing strangely coincident large dimensionless ratios leaves the reader wondering at the mystery of it all.

A major inaccuracy originating from Weisskopf's perceptions is to be found in the chapters on solids and liquids, and on the height of mountains. Weisskopf has the idea that melting is due to the disappearance of directionality in interatomic bonds. This is clearly not true in a large number of solids (metals, alloys, ionic crystals) where there is no directionality in bonding to begin with. Indeed, that modern paradigm of simplicity in solids, namely the hard sphere crystal, does not have any cohesion or bonding, and yet its melting is a very good model for many real systems. Weisskopf uses this bond directionality breaking idea and yet another hypothesis, namely that deformation and motion in rocks is due to local melting, to estimate the maximum height of a mountain. The stress due to the weight of a mountain is assumed to cause melting at the base, and the energy cost of melting is estimated by bond directionality arguments. The final estimate is reasonable, and illustrates how two wrongs can make some right! Most likely, the shear causes slip, i.e. atomic planes slide past each other or dislocation arrays move. In terrestrial silicate rocks, with some directionality in bonding, such a motion does require directionality to be broken and remade, so indeed the maximum mountain height *is* connected with bond directionality in this case. And if for these systems the energy of the latter can be connected with the melting temperature, the parity in energy scales can be rationalized, though physical melting of rocks at the mountain base may not occur at all. In a neutron star, another system alluded to by Venkataraman, there is no directionality in bonding and the maximum mountain height is determined by the rather small critical yield stress, related to the Peierls–Nabarro barrier for dislocation motion and totally unconnected with melting! These ideas and facts are all well known to Venkataraman, but either lack of time or belief in Weisskopf's insight, seem to have intervened.

There are some other statements reinforcing an impression of haste. For example, Venkataraman says, on page 26, that the earth is in a stable orbit under the balance of two forces, namely gravity and the centrifugal force. At the elementary Newton's law level familiar to the main readers of the book, this sounds wrong; there is one force, that of gravitational attraction and it causes inward acceleration according to the second law so that the planet is indeed continually falling in. In the noninertial rest frame of the planet, of course, what the author says is true. But from the context of the paragraph, this is not clear and a clarificatory sentence would have helped.

Another consequence of adherence to Weisskopf is a fifties flavour to the book. A number of basic, accessible and exciting recent phenomena as well as connected estimates are missed out. Venkataraman is, again, well aware of this, as some of his parting thoughts on page 111 suggest. Some examples are minimum metallic conductivity, Josephson relations, flux quantization, quanti-

zed Hall resistance, physical parameters of soft condensed matter systems such as membranes and polymers, etc. This book could have formed a good entry to these lively fields.

Two extreme but necessary stances in regard to the creation of such literature can be labelled bedazzlement and empowerment. Venkataraman uses a judicious mixture of the two. I would perhaps stress the latter, because I believe that we (especially in India) are already dazzled; there is an overwhelming need to enable all of us, starting young, to figure things out for ourselves. It is essential to instil the hope and confirm by practice that this can be done. For this reason, I worry a little about the occasional myth making overtones in Venkataraman's book. But unlike the rest of us, he has taken the plunge and has come up with a unique range of offerings for an age group which is intellectually hungry, but gets an unbalanced and unappetizing diet. This series of books will help in the growth of scientifically zestful and well nourished youth. Their style and the manifest need for them ensure continued popularity. With some further critical attention and about 10% change in future editions, these contributions will fulfil their purpose perfectly. I congratulate Venkataraman on this service, born out of his love for the subject, his talents as a writer, and his concern for the young.

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Superconductivity Today (An elementary introduction). T. V. Ramakrishnan and C. N. R. Rao. Wiley Eastern Ltd., 4835/24 Ansari Road, Daryaganj, New Delhi. 115 pp. Price: Rs. 55.

The announcement in 1987 of the discovery of new materials, which are superconducting above the boiling point of liquid nitrogen, generated an overenthusiastic belief that a revolution in technology would be caused very soon by this discovery. Such an expectation was generated when prominent scientists all over the world made extravagant statements about the possible applications of these new materials. With the realization that there are formidable technological problems yet to be solved before serious application could be realized, public euphoria has died down.

However, this discovery still excites the imagination of serious students of science. The problem of low temperature superconductivity was a hard one to understand. With the work of Bardeen, Cooper and Schreiffer, which was a culmination of decades of effort by first rate theoreticians, it was felt that a correct theoretical understanding of superconductivity has been achieved. The new discovery has shown that this belief is incorrect and we are still far from an understanding of the mechanism/ mechanisms responsible for this fascinating phenomenon.

The present book has been written by two eminent scientists of the Jawaharlal Nehru Centre to provide the student with an elementary introduction to the complex phenomenon and to put before him the new discoveries and the ongoing efforts to understand the problem. The effort is aimed at not only creating a general awareness of this new discovery among students of science but also to create an interest in some bright young minds to attract them to pursue serious research in this field. From this point of view this effort is to be commended.

The theory of superconductivity is very recondite and is clothed in complex mathematical formalism. It is very difficult to propound the ideas in simple language for a student at the Master's level to comprehend. Anyone attempting to take on such an onerous task needs a lot of courage. It is heartening to note that the physics aspects of the phenomenon have been presented very ably in this book. Elementary mathematics has been used to derive, the phenomenon of flux penetration in a type I superconductor and the phenomenon of flux quantization. The concept of pairing and coherence length has been explained adequately and the difference between type I and type II superconductors has been explained.

The description of the anomalous normal state properties in the cuprates is interesting. An attempt at evaluating the various mechanisms proposed for superconductivity has been made, though space limitations and the scope of the book do not permit the discussions from being anything more than cursory. A valiant attempt has been made to explain how the spin and charge degrees of freedom get decoupled to give the concept of holons and spinons in RVB theory. On the whole the coverage of the physics of superconductivity is reasonably adequate and interesting.

The materials aspect has been dealt with in Chapter 3. This chapter tries to cover too many aspects in too little space. It also assumes that the student is familiar with crystal systems and structure, the concept of twins and the concept of holes in the given context. The materials preparation part is very sketchy.

Chapter 6 on applications is, in my opinion, very unsatisfactory. The book would have stimulated greater interest if the important applications had been dealt with in some more detail. Perhaps the authors did not want to lay too much emphasis on the material preparation and application aspects in order to keep the book within manageable size.

In teaching superconductivity to students I have often found that students are puzzled by the two following questions: (i) how does pairing explain the absence of resistivity in superconductors? and (ii) if the electrons in a pair are moving with Fermi velocities in opposite directions, the distance between them will increase beyond the coherence length in a time of the order of 10^{-13} sec. What happens then? I feel that these questions will still remain in the minds of the students after reading the book.

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Blackbody radiation, i.e. radiation inside a cavity in thermal equilibrium with its walls, has been one of the most productive problems in physics. Its