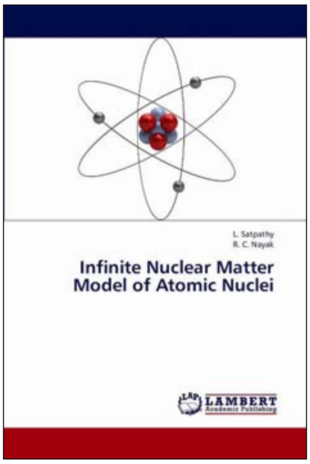
in R&D to fund long-range innovations. (iii) Embrace technologies that improve our lives and the planet. (iv) Empower each of the billion minds and turn them into assets producing new ideas.

The book presents a very optimistic outlook of the world, contrary to all the negative news, reflecting the views of pessimists, seen every day in the media. This book foresees that resource constraints can be overcome to enhance productivity through innovations. Social acceptance of the technologies, motivation and collective decisions will determine the future. Even with all the optimism shown in the book, controlling human numbers in India and many other countries will determine their overall progress. This book is recommended for all who worry about human progress, welfare and the environment.

C. R. BHATIA

17 Rohini, Plot 29–30,
Sector 9-A, Vashi,
Navi Mumbai 400 073, India
e-mail: crbhatia.bhatia@gmail.com



Infinite Nuclear Matter Model of Atomic Nuclei. L. Satpathy and R. C. Nayak. LAP Lambert Academic Publishing, Saarbrueken, Germany. 2013. 240 pp. Price: € 79.00.

It is often an unenviable task to write a book on a subject as vast – and as diffuse – as that of nuclear physics, especially because it is so hard to identify a central theme around which to build its description. (From that point of view, a book on, say, a subject like quantum mechanics – or even quantum field theory – does not perhaps suffer from a similar disadvantage, since its theme is generally well defined.) On the other hand, to carve out a theme from a vast descriptive field like nuclear physics, an author must have both the capacity as well as the willingness to operate the Occum's razor ruthlessly on the 'unwanted' topics so as to bring out the intended emphasis. For when one speaks of nuclear physics – or nuclear matter – certain traditional features like saturation showing up through the twin properties of optimum binding energy and incompressibility often cannot be disentangled from some specific issues occupying the author's mind.

In the present book the authors have defined their emphasis through its very title, 'Infinite nuclear matter', which filters out many inessential details bearing on a finite size for the nucleus. Apart from this aspect, their emphasis being on nuclear masses, a natural starting point would be the celebrated Bethe–Weiszacker (BW) mass formula whose 'classical' form would however need a 'minimal quantum correction' before being presented to undergraduate classes in nuclear physics. On the other hand, the precise nature and extent of the 'quantum correction' often remains undefined. In this respect, an important conceptual issue that cannot be neglected concerns the role of the Hugenholtz–Van Hove (HVH) theorem which states that for 'normal' Fermi systems in equilibrium at zero temperature, the average energy per particle must coincide with the Fermi energy. Hence any description of nuclear masses would be inadequate without paying obeissance to the HVH theorem – a typically quantum effect.

Now the traditional picture of the nucleus – since the emergence of nuclear physics in early 1930s – has been a classical liquid drop, adopted as the basis of the BW mass formula. After the discovery of shell structure in late 1940s, the 'shell' and 'liquid drop' were considered as the two main pillars of nuclear dynamics. The marriage of these two facets of the nucleus formed the basis for a macroscopic description of the nucleus. The fundamental question of why shell model works, necessitated the development of a many-body theory like that of Brueckner, once again requiring the introduction of the concept of infinite nuclear matter (INM). On the other hand, a fully quantum mechanical many-fermionic entity whose saturation properties are often linked to the BW-like mass formulae to nuclear masses (despite its classical basis), often presents us with a hybrid picture which in turn leads to ambiguities like the density of INM – measured from the direct electron scattering on heavy nuclei – not matching with that derived from the above mass formula.. More explicitly, a BW-like mass formula gives a nuclear radius which is higher (at the value $r_0 = 1.22$ fm) than that obtained from electron scattering, namely $r_0 =$ 1.12–1.13 fm, thus giving rise to a long standing 'r_0-paradox'. The latter ($r_0 =$ 1.12–1.13 fm) was adopted as the true INM density at the cost of the former ($r_0 = 1.22$ fm). On the other hand, for the empirical value of energy per nucleon of INM, the value given by the volume term of the BW-like mass formula-fit was adopted. Thus the two properties of INM were determined from two different sources, thus leading to a perennial inconsistency in nuclear physics. The continued effort of the celebrated authors of this book for more than 30 years, has been to resolve this issue through the establishment of a fresh nuclear model termed infinite nuclear matter model, wherein the classical liquid has been replaced by quantum mechanical many fermionic liquid, in conformity with the true nature of nuclear matter. Their model is based on the celebrated HVH theorem of many-body theory, one in which the single-particle property of the system – in particular the Fermi state and its relation to the average energy – plays the central role.

Now to a short summary of the contents. After an introduction, the book presents in chapters 2 and 3 the origin of the INM concept, followed by an account of the many-body theory of Brueckner–Bethe as well as the variational approach of Pandharipande (with specific reference to the saturation properties of INM). This aspect in turn brings out the inevitability of the 'three-body force' in the scenario, including the importance of the latter for nuclear physics as a whole. Then an extensive microscopic study of the liquid drop model (LDM) using Skyrme effective interaction is presented in chapter 4, showing the 'goodness' of the LDM expansion to be sure, but at the same time acknowledging its non-uniqueness in the sense that its coefficients do not necessarily pertain to the ground state – a fact later used to determine incompressibility.

In chapter 5, the authors extend the original HVH theorem to an asymmetric system and show its general validity for multi-component systems as well as for multi-body forces, especially the three-body force. The INM model is formally developed in chapter 6 using the generalized HVH theorem as would be appropriate for an asymmetric system consisting of both neutron and proton, consistently with the view that the nucleus incorporates both types of properties 'collective' as well as 'individualistic'. The model has been successful in separating the ground-state energy of a nucleus into a universal part represented by a sphere made up of INM common to all nuclei, and a characteristic part η, called local energy comprising contributions from specific features like 'shell', 'deformation', 'diffuseness', etc. which vary from nucleus to nucleus. The model has three distinct equations, the first two describe the INM sphere determining the universal part once for all; the third is a differential equation for determining the local energy η, with the input of the known nuclear masses and the derivatives (neutron and proton) of the corresponding energies in each case.

Chapter 7 addresses the saturation properties of INM. Solving the first two equations (see above), the saturation properties of INM are determined. The density so obtained yields $r_0 = 1.138$ fm in agreement with that of electron scattering and thereby resolving the longstanding 'r_0-paradox'. Chapters 8 and 9 deal with the perennial problem of nuclear incompressibility (K_∞). In the former, exhaustive discussion on the present status of its determination together with the associated defects is presented. A microscopic study using the Skyrme interaction is carried out here, to show that unlike the energy, the LDM expansion of finite nuclear incompressibility (K_A) does not converge, thus ruling out its possible use in the case of INM. Chapter 9 presents a new promising method for the determination of K_∞ called ab initio method – free of all existing drawbacks. This uses the energy and density of two states of INM and determines $K_\infty = 288 \pm 20$ MeV using its very definition in a more or less model-independent manner, making use of about 4500 data on nuclear masses and their corresponding energy derivatives. Nuclear equation of state is then obtained using this value.

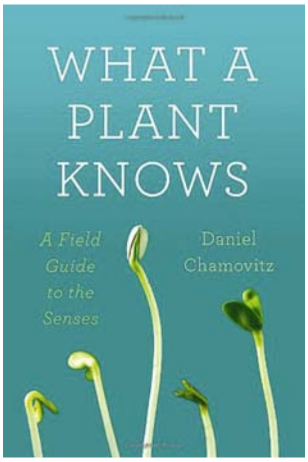
Chapter 10 presents the prediction of masses and other nuclear phenomena in the INM model. The latest mass predictions using 2198 known masses yields root mean square deviation of 342 keV, the lowest in the known literature. It predicts much expected shell quenching in $N = 82$ and 126 shells, and new islands of inversions showing that it is a general feature of nuclear landscape. Needless to say, the spectacular success of the INM model is due to its microscopic many-body basis, accounting of three-body force by the use of the HVH theorem, and repeated use of data pertaining to three properties of nuclei, while not using any nuclear interaction in any way (to avoid double counting).

Chapter 11 is devoted to a critical study on the predictive potential of the model in respect of the following two aspects. (1) The INM model has introduced in nuclear physics a new entity, the local energy η. It contains all the characteristic properties like shell, deformation, etc. hence uniquely defined, thus extending its scope beyond the Strutinsky shell effect. As a result, its systematics predicts new magic numbers and associated new islands of stability around Sm^{162}, Pt^{228} and Th^{254} in drip-line regions, corroborated by microscopic study in RMF theory. This reveals a new effect in nuclear physics wherein the 'shell' overcomes the instability due to repulsive components of nucleon–nucleon force (this is analogous to the phenomenon of superheavy elements in which repulsive Coulomb instability is stabilized by the same). While the latter effect elongates the stability-peninsula, the former broadens it. (2) Global analysis of the predictions of different mass formulae numbering about 15 has demonstrated the unique ability of the INM model to predict the masses of nuclei far from stability in unknown regions. It is interesting to note that the predictive power of the INM model stems directly from its non-trivial feature of a differential equation representation – in company with the 'greats' in physics – and not merely a set of (BW type) mass formulae whose predictive power is necessarily limited.

The INM model developed in this book has convincingly brought out the most important facet of the nucleus, viz. a quantum mechanical many-Fermionic nuclear matter, which is its true nature, in contrast to a (simplified) classical liquid drop or a weakly shell-manifested entity. Precisely for this reason the INM model is able to describe quantitatively thousands of data, and reveal many new phenomena, in addition to resolving some longstanding issues and thereby putting our understanding of nuclear physics on a firm footing. In this respect, while many-body theories like Brueckner–Bethe are based on equally firm foundations, they are generally considered to be rather complex – hence not of much practical use for teaching at universities by practitioners of nuclear physics. The present book in contrast, has succeeded considerably in dispelling this notion, and thus bringing many-body theory to the centre stage of nuclear physics as a first step towards integrating it to the main stream. Hope it will play a significant role in providing the necessary impetus for revamping the study of this subject on a wider scale. I feel this book is eminently suitable for a course in M Phil/Ph D preliminary classes, and as a special paper in advanced nuclear physics in an M Sc level programme.

A. N. Mitra

244, Tagore Park,
Delhi 110 009, India
e-mail: gargimitra@vsnl.com



What a Plant Knows – A Field Guide to the Senses. Daniel Chamovitz. Scientific American/Farar, New York, USA. 2012. 1st edn. 177 pp. Price: US$ 23.

Man has been enjoying intellectual supremacy since ages owing to his ability to make fullest use of the sensory inputs, information encoding, its storage and retrieval when needed.

This fascinating book by Daniel Chamovitz underlines the astonishing