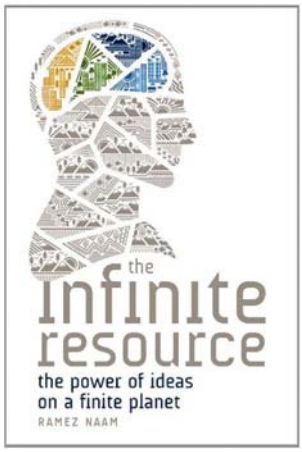

The Infinite Resource: The Power of Ideas on a Finite Planet. Ramez Naam. University Press of New England. 2013, 349 pp. Price: Rs 1460.

This book deals with contemporary global issues of development, inequality, resources of land, freshwater, energy and the growing population. The author reminds us that presently we are living in a 'period of unprecedented wealth and comfort undreamt of in previous ages'. At the same time, 'we are living in a world facing unprecedented global risks to our continued prosperity, to our survival, and to the health of the planet itself'. Optimists would accept the first, while pessimists the second. The take-home message of the book is 'that the force that propelled us to our present well-being is the most powerful resource we have to tackle our future challenges', and the resource is innovation, based on expanding scientific knowledge and technology. Human ingenuity can overcome the challenges and create greater wealth.

The author, Ramez Naam was born in Egypt and moved to the US in 1976, as a child, with his parents who initially intended to return to the old country, but later opted for American nationality. He considers growing up in the US as the most important event. Visits to Egypt, brought him back in time, as he found the present-day Egypt to be not very different from what the US was in the past.

The book is the outcome of broad, interdisciplinary research, as evident from extensive notes provided at the end. It includes 21 chapters in four parts – (1) The best of times; (2) The worst of times; (3) The power of ideas and (4) Unleashing innovation.

Part 1 includes two chapters – 'The rise of innovation' and 'The incredible present'. Rise of innovation is credited to the advance of humans from hunting and gathering to farming some 10,000 years back. Growing crops led to a more settled life in villages; the population densities as well as connectivity of minds increased. 'It took 90,000 years from the dawn of humanity to the invention of agriculture.' In the next less than 5000 years, 'the vastly increased brain power of humanity created wheel and sail, and not much later, the development of writing, arithmetic, bronze, steel, watermills, windmills, and far more'.

The new developments that led to Renaissance and Industrial Revolution in Europe are examined. Question why China, the largest and wealthiest empire in AD 1200, which was also scientifically advanced, and others such as the Ottoman and Eastern Roman Empires failed to make similar gains is raised. Absence of success is attributed to less diversity of ideas, lack of competition, and top-down approach in China, and the Emperors' absolute powers to approve or deny a new line of scientific enquiry. Even in Europe, Christopher Columbus could not find support for expedition to discover a western sea route to the Indies from the royalty of his native Genoa, and other kings. After many attempts, in 1492, he received the financial backing for his voyage from the king of Spain, which was considered a high-risk, high-reward investment. It is inferred that the rates of innovation depend upon the choices the societies make.

Chapter 2 – the incredible present, describes how Europe and North America raced ahead of the other nations. Clean water, sanitation, good nutrition, control of infectious diseases, wider access to improved health care and high literacy led to less of poverty and hunger. Economics of open competition and incentives played a significant role. The same factors are now contributing for increasing well-being in the developing countries. The number of hungry persons as per cent of the total population has declined rapidly, though the absolute number still remains a matter of concern. Mobile phones and internet have expanded rapidly in the last two decades. The message is that the present, though imperfect, is better than all previous times – 'Rich are getting richer, but poor are gaining in wealth much faster'.

Part 2, The worst of times, includes four chapters 'Running out of steam', 'Peak everything', 'Greenhouse earth' and 'End of party'. Chapter 3 – Running out of steam illustrates Tikal – one of the largest centres of Mayan civilization, which was at its peak in the 18th century AD. In a few decades the great civilization collapsed due to over use of the natural resources, causing infighting for the remaining. This led to rapid climate changes and further destruction of the available resources. Currently, we see similar inter-state conflicts for natural resources – oil and water, fishing rights. The economic laws suggest that with increased demand, supply is augmented. This is leading the present society to unconventional resources illustrated by current interest in oil sands. Predicting future and exploitation of new technologies are always associated with risks and uncertainty.

Chapter 4 – Peak everything, highlights the steep rise in global food prices in 2008, which is attributed to increased grain-intensive production of meat to satisfy the demand generated by rising incomes in China. FAO has projected 70% increase in food demand from the present by 2050. Every resource is finite – ocean fisheries, freshwater, copper, iron, aluminum, uranium, wood, wool, etc. Deforestation has been slowed down or stopped in the temperate regions of the rich countries, but not in the developing countries.

Chapter 5 – Green house Earth, tracks the human contribution to global warming and climate change. Four questions are raised: (I) Is the planet warming? (II) Are humans causing the warming? (III) Does the warming really matter? (IV) Is there anything worth doing about it? After considerable discussion on these, the question is raised – how much of the greenhouse gases, responsible for warming, can be safely released into the atmosphere? Historically, CO_2 stayed below 280 ppm level; the current levels are 390 ppm, and the target for 2050 is 450 ppm, in order to keep temperature increase under 2°C. This is considered a tall order in view of the rising human aspirations in the developing countries for cars, larger homes and other conveniences that demand energy. Worldwide energy demand is expected to double by 2050.

Chapter 6 – End of party, reiterates that currently we have unprecedented wealth, prosperity and well-being, but

have made large demands on natural resources and environment to reach there. Should we descend to lower levels of consumption for sustainability? However, growth for the poor means ability to access food. Can growth of affluence be stopped? At the end of this chapter the question of true limits of life, wealth and population on the planet Earth is raised.

Chapter 7 – The first energy technology, in Part 3 refers to the battle for feeding humanity. Paul Ehrlich's *Population Bomb* and Famina 1975! America's Decision! Who *Will Survive* by William and Paul Paddock had predicted large-scale starvation deaths. Four years later *Limits to Growth* (published by the Club of Rome – an International think tank) predicted that the increasing population was exceeding the world's ability to grow food. In the author's view, earlier Thomas Malthus, and subsequently these books underestimated the human ingenuity to increase food production; adding that knowledge works as a multiplier of physical resources. Agriculture is the first energy technology that harvests the Sun as food. Hunter-gatherers needed more than 3000 acres (700 ha) to feed one person; today the same food needs can be met from one-third of an acre (0.14 ha), indicating the rising carrying capacity of the planet. Discussing the well-known *IPAT* equation of Ehrlich ($I = P \times A \times T$), where I, the environmental impact is the product of P (population), A (affluence) and T (technology), the author stresses that technology has in fact worked in the opposite direction of what Ehrlich had predicted. However, many alarmed with the environmental changes may not agree. Agriculture is cited as an example of the power of ideas to multiply resources.

Chapter 8 – 'The transformer', reiterates the idea of economist Romer who assigned technological change as the key variable for economic growth, stressing that rearranging of resources to make them more valuable leads to economic growth. Obtaining more value from the same resource is shown by the design of bow and arrow. Sticks, stones and raw hide were transformed into tools that made hunting easier, less risky and provided more meat. Further, the example of modern drugs is cited which are 'almost pure distilled knowledge, barely material at all'.

Chapter 9 – 'The substitute', brings out that innovators flock to find substitutes when resources become scarce or too expensive. We have more innovative minds today than ever before for creating new ideas, stressing that innovation is the most important capability. Augmenting this capacity would be the best strategy for overcoming the constraints.

Chapter 10 – 'The reducer', stresses that more can be done using less. Knowledge can reduce the amount of any resource needed for a task. The amount of energy, raw materials and thus money can be reduced for the end-product. Learning curve which is the accumulation of knowledge brings about gradual reduction in the cost of manufactured products. The products can be manufactured with less of energy, labour and time. It is stressed that demand creates efficiencies. Tragedy of the commons, referring to the free resources without any charge, is elaborated. It is stated that even with the available technologies, there is plenty of headroom to enhance efficiencies and reduce pollution levels.

Chapter 11 – 'The recycler', emphasizes that while the world is a nearly closed system, the amount of raw materials with infinite possibilities of reuse makes the finite resources limitless. Chapter 12 – 'The multiplier', continues the discussion on the fallacy of finite resources using the illustration of energy received from the Sun amounting to 160,000 TW, while the present use from all different sources adds up only to 17 TW. Decreasing costs of solar photovoltaic panels, rising energy densities for storage batteries, and biofuels are covered. Boost in innovation is suggested as an insurance against all the challenges faced.

Part 4 – Unleashing innovation starts with 'Investing in ideas' (chapter 13) that emphasizes on education, higher education and increasing government support for research and development, and funnelling more students into science and engineering. Chapter 14, the flaw in 'The market', advocates that free markets are superior to any other systems for innovation, increasing productivity, reducing poverty and increasing wealth. Chapter 15, 'Market solutions', discusses the market-based solutions for reducing pollution, favouring the pollution tax, and incentives for using non-polluting technologies. Chapters 16 and 17 under the broad title, 'The unthinkable', cover the real and perceived risks of new technologies, particularly nuclear energy. Worldwide more people are killed each year in mining of coal, and per terawatt hour of coal-based energy compared to nuclear power. Chapter 17 deals with climate engineering. Two options for solving the increasing CO_2 are discussed: (i) to capture CO_2 from the source or from the air, and (ii) to reflect part of the impinging solar energy back into space.

Chapter 18 – 'Greener than green', cites the agricultural green revolution as a technology where innovation overcame the limits. The downside of green revolution is pointed out. An important question is raised – how to grow 70% more food in view of (i) the expected climatic changes; (ii) without cutting down the remaining forests and at the same time reducing carbon emissions, nitrogen runoff, pesticide use and freshwater depletion? Organic farming is ruled out. The possible advantages provided by genetically engineered crops are discussed. The chapter ends with, 'some times, new technology, even though it looks different or frightening, is exactly what we need to embrace in order to survive and thrive'.

Chapter 19 – 'The decoupler', highlights the need to understand growth of population, consumption of resources (with pollution on the flip side) and of wealth and well-being. The rich countries are cleaner, greener and use resources more efficiently. The message of prosperity, health and well-being can be decoupled from growth of resource consumption. Chapter 20, 'Of mouths and minds', brings out that the people are not only mouths to feed; they are minds also when they are educated, empowered and connected to each other.

Chapter 21 – 'Easy way, hard way', stresses that people should be open to new ideas and not reject new technologies. Both the market forces and democracy are innovative ideas and should play the decisive role. People are either optimists or pessimists with regard to the future. Optimism does not mean complacency; it means hope along with action to produce results. The easy way would be gradual, manageable changes, similar to ones that have driven us this far, now, or harder, more difficult and expensive changes later when disaster comes in.

The postscript titled 'Coda', restates that human mind is the ultimate source of wealth. What society needs to do for thriving in the 21st century is suggested. They are: (i) Fix the markets to account for the value of the commons. (ii) Invest

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.

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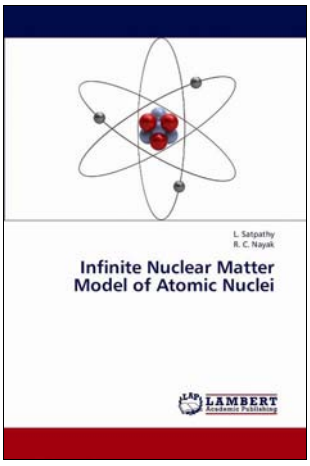

Infinite Nuclear Matter Model of Atomic Nuclei. L. Satpathy and R. C. Nayak. LAP Lambert Academic Publishing, Saarbrueken, Germany. 2013. 240 pp. Price: € 79.00.

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.