



Einstein's Enigma or Black Holes in my Bubble Bath. C. V. Vishveshwara. Copernicus Books (An imprint of Springer Science + Business Media), 233 Springer Street, NY 10013, USA. 2006. 360 pp. Price: US\$ 27.50 (not given in the book, from the internet); Euro 19.95.

Black holes are fascinating objects to study and they have excited the curiosity of common man in recent times. The black hole has a strong gravitational field and that field does not allow anything to escape. The escape velocity needed is greater than the velocity of light, which is not permitted by the laws of physics. For a given mass of an object, the radius has to be smaller than a critical value to be a black hole. Black holes can be rotating, in which case they have an angular momentum. They can also have a charge, but these are not expected to occur in nature as objects in nature are neutral. However, charged black holes are of theoretical interest. In 1916, Schwarzschild obtained the first solution of Einstein's general theory of relativity, which describes a black hole for suitable values of the parameters. Einstein himself did not take black holes seriously. His lack of interest has been called an enigma. The book under review emphasizes this aspect in its title. In 1960s, interest in black holes increased sharply, helped strongly by John Wheeler and his group at Princeton, USA.

Several Indians (and persons of Indian origin) have worked on black holes. However, two names stand out. Subrahmanyan Chandrasekhar and C. V. Vishveshwara. Chandrasekhar's authoritative book on *Mathematical Theory of Black Holes* came out in 1982. Reviewing it, Roger Penrose commented that nothing in that book would be out of date for at least 50 years. Now Vishveshwara has written a popular book on the subject

about which Roger Penrose says '... provides an authoritative but distinctly original approach...'. When I was requested to review the book I agreed immediately, being curious to see it. When a copy of the book arrived, my heart sank. There were three highly complimentary comments on the jacket by Roger Penrose, Charles Misner and Anthony Leggett, all eminent scientists. What can one say after lavish praise by such dignitaries? Talk of 'fools rushing in where angels fear to tread'!

While discussing the intricate and detailed properties of black holes, Chandrasekhar used the term 'rococo': 'splendorous, joyful, immensely ornate'. Fortuitously these terms describe the book under review also. The book is not just a skeletal framework but a fully fleshed-out ornate creation. The whole book is largely in the form of dialogues between the narrator (Alfie) and George (a professor of astrophysics, based on the author himself), his students and Mike (an astronomer). The book places the subject of black holes in a broad setting. It starts with a description of the evolution of stars, their birth and death, and the three end-points after death; white dwarfs, neutron stars and black holes. The stars, the constellations in which they are located and the stories, legends, and myths about the constellations are then related. It is all Western mythology, mostly Greek (no pun intended).

The chapter on Newton reads beautifully and provides interesting information about *Principia* for persons not familiar with the book (most of us probably). Newtonian dynamics is discussed as a topic already familiar to the reader. Special and general relativity are then introduced. This is followed by a discussion of black holes, non-rotating, rotating, with and without charge. Then the observational methods and the presently available evidence for black holes are carefully discussed. Chandrasekhar once explained to me that observation of radiation scattered by a black hole and comparing with theoretical predictions, like the results in his book, would be one of the ideal ways of detecting a black hole. He was aware that these are likely only in the distant future. At present, the methods are indirect. Observers, however, are coming up with methods which are more direct and hence more convincing. Discussions in the book are lucid and no mathematics is used, except in the diagrams. Cartoons or

diagrams supplement the discussion and are often tinged with humour, well known to friends and admirers of the author. The presentation is, at times, quite catchy. Describing how an accelerated twin ages slowly compared to the non-accelerated twin, the author writes 'the faster you run, the later you arrive' (p. 263).

There are, in addition a large number of interludes with imaginary characters. There is Casanova, there are Alice and her friends in Wonderland, Sherlock Homes and Watson, and Einstein in two different personalities as Bert and Stone. Dante and his inferno also find a place in the book. All these characters talk about black holes and its fascinating properties in their own settings. In addition, in almost every chapter there are references to food and exquisite dishes (all Italian though; no wonder there are rumours of an Italian translation). Mozarella de Bufala, Fiori di Zucca Fritti, Risotto alla Trevisana are some of them. As Professor Misner puts it, it is a '... sauce of philosophy, history, literature, gastronomy... from an entertaining personality who... (displays) all the different ways he can think about his subject'. There is much that will be new or different even for the expert. The absence of an index is a serious drawback though.

But who is the book addressed to? Difficult to say. It has to be a sophisticated layperson familiar with Western literature and food. He or she must be also fond of alliterations and puns. Just when the puns are getting on your nerves, one of the characters is made to say that 'pun is the lowest form of humour'. The author seems to be highly self-conscious, but has decided that this is the best way to present the subject.

The subject of black holes in general relativity has quite a few aspects, which are puzzling even to the experts. Some of these are: (1) A black hole needs infinite time (in the asymptotic observer's frame) to get formed fully. (2) The Kruskal form of time coordinate, which avoids coordinate singularity at the event horizon, can be analytically extended. This leads to effects which may seem unrealistic or even bizarre, like the whole past history of one's life passing before one's eyes. (3) Black hole thermodynamics and the third law of thermodynamics, in the form of Nernst theorem seem incompatible. (4) A black hole is characterized only by mass, charge and angular momentum. Other information carried into a black

hole by matter falling into it, is not available to external observers. If a black hole evaporates totally due to emission of Hawking radiation, this information inside the black hole is lost. This is a serious violation of the laws of physics.

The author discusses such problems and in most cases gives his opinion also. In the case of the first problem, a direct answer is evaded in the book. George (the scientist in the book) says that the questioner already knows the answer. In answer to the second problem, George says that all these other universes will be covered up and go out of consideration, if a black hole is created by the physical collapse of a star. Chandrasekhar in his book also describes these bizarre predictions. He does not express any direct misgivings, but says that Cauchy horizon (through which one has to go) can be dangerous! To deal with the third problem, the author formulates the third law as non-attainability of absolute zero temperature in a finite number of operations (p. 251), which is satisfied by the black holes. This was originally suggested by Robert Wald in his book on black hole thermodynamics. Wald is a bit doubtful about the independence of this formulation of the third law from the second law. Wald, however, feels that the third law is not a fundamental aspect of thermodynamics and need not be satisfied in the form of Nernst theorem. The fourth problem, loss of information, is not discussed in the book, but the exposure of a naked singularity, it is pointed out can only be discussed after a quantum theory of gravity emerges. This holds for the information puzzle also, but is still in the distant future.

On the whole this book is highly informative, enjoyable and a beautiful piece of work. It should be specially attractive to laypersons with some sophistication and a love for Italian food. And yet, one hopes that the author will consider writing a book with an Indian audience in mind. Hopefully the book will have descriptions of Bisi bela holi, Biryani, Padhir poli, Badam Khir and such delicious dishes. It could also discuss stories of Arundhati, Saptarishis and others. Am I being chauvinistic?

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This volume consists of 21 chapters covering a wide variety of topics of plant pathological interest. The first chapter by Seiji Ouchi sets the tone of the volume, by tracing the evolution of plant pathology from a descriptive science to molecular understanding of pathogenesis to biotechnology-led development of disease-resistant crops. It also highlights the need for further understanding of molecular plant-pathogen interactions for developing rational strategies for breeding disease-resistant crops. In recent years, there has been considerable thrust to unravel the biochemical and molecular mechanisms of plant-pathogen interactions. Other areas gaining interest are molecular characterization, ecology and emergence of plant pathogens, epidemiology, modelling, understanding the effects of global climate change on pathogens and the diseases they cause, judicious management of plant pathogens, biosafety concerns related to field release of GMOs, plant pathogens as non-tariff barriers in world trade of agricultural produce and food-borne diseases. These trends are amply highlighted in the present volume.

Kamoun has reviewed the complexities and functions of the effector secretome of plant pathogenic Oomycetes. Effector proteins play a key role in the pathogenesis of Oomycetes. An attempt has been made to classify and catalogue the major apoplastic and cytoplasmic effectors of Oomycetes. van Loon *et al.* have comprehensively reviewed the role of PR proteins in helping plants adjust to constantly changing environment. A large number of genes are up- or down-regulated in plants under biotic and abiotic stresses, but only a limited number of inducible defense-related proteins have been characterized. Broekaert *et al.* while discussing the role of ethylene in host-pathogen interactions, provide insight of cross-communication between ethylene signalling and other defence mechanisms of plants; ethylene increases resistance to some necrotrophic but not to biotrophic pathogens. This is just a beginning; more efforts are required to get a full picture of the role of ethylene in pathogenesis.

Xu *et al.* highlight the potential role of fungal genomic studies in improving understanding of the molecular basis of host-pathogen interactions. So far, eight plant pathogenic fungi have been sequenced and many more are being sequenced. The reviewers rightly point out the need to build comprehensive genome database for fungal pathogens, and to develop efficient bioinformatics tools for genome profiling and functional analysis. Loria *et al.* have traced the evolution of plant pathogenicity in *Streptomyces*, which are mostly free-living soil saprophytes. Some *Streptomyces* like *S. scabies* are plant pathogens. These have emerged in agricultural systems through the natural transfer of pathogenicity island (PAI), consisting of genes coding for thaxtomin and other virulence determinants. Further characterization of diversity of PAI will show the role of horizontal gene transfer in the evolution of pathogenicity in *Streptomyces* and identification of plant cell targets of virulence determinants.

Carris *et al.* have given well-illustrated biology of *Tilletia indica* and *T. horrida*, which cause minor losses in yield and quality, but have severe economic impact. Karnal bunt, caused by *T. indica*, is a major non-tariff barrier in the export of wheat, and kernel bunt of rice caused by *T. horrida*, is a constraint in the production of certified hybrid rice seed due to low tolerance levels. Turf-grass has emerged as the fastest growing agricultural business. Bonos *et al.* discuss the developments in turf-grass breeding for resistance to a variety of diseases. Ngugi and Scherm have attempted to classify flower-infecting fungi, by drawing parallel with the venereal diseases of animals, into three groups based on the mode of infection and whether the fungus also infects other parts of the plants. This grouping has left many open questions due to the limited information available on the subject.

Enterobacteria are not only human and animal pathogens, but also cause some serious plant diseases. Toth *et al.* have compared the genome of animal pathogenic enterobacteria with the plant pathogenic *Erwinia carotovora* subsp. *atroseptica* (*Eca*), which is the first plant pathogenic enterobacterium to be sequenced. These pathogens share a 'backbone' of common enterobacterial genes; *Eca* seems to have acquired several genes by horizontal gene transfer for interactions with plants. These include secretion systems, phyto-toxins and cell-wall degrading enzymes,