ISSN : 2454-2423

Glocal Colloquies

An International Journal of World Literatures and Cultures

Vol. 3 April 2017

Glocal Colloquies
An International Journal of World Literatures and Cultures
Vol. 3; April 2017. ISSN : 2454-2423

Translation across Disciplines: The Bodanis and Gamow Unconventional Physics Narratives

Shreya Bhattacharji[*]
Amitabha Bhattacharyya[**]

Abstract: Fascination for science in the non-scientist never developed due to the absence of interesting literature. The commonly available books and films belong either to the genre of science fiction which does not explain the science properly, or to popular science which explains the science in the terse language of the specialist, although without the mathematics. Neither has been able to draw the attention of the non-specialist, who wishes to feel the excitement of science without being trapped in the technical nitty-gritty.

In this dismal scene, there are two bright sparks. The first are the Mr. Tompkins stories by George Gamow later rewritten by Russel Stannard.[1] Gamow describes these stories as "Scientifically Fantastic Stories (Not Science Fiction Stories)." He uses the dreams of Mr. C. G. H. Tompkins, a bank clerk, to paint a make-believe world where minute physical effects are heavily exaggerated. The initials of Mr Tompkins are C (speed of light), G (gravitational constant) and H (quantum constant), values which are drastically changed to exaggerate the effects. The reader is thus invited to directly experience certain scientific phenomena which otherwise would need elaborate study and the use of sophisticated equipment. The situation is later explained by a learned professor of the university.

The second bright spark is "The Biography of the World's Most Famous Equation, E = mc squared"[2] by David Bodanis. Here Bodanis explains Einstein's famous equation through the history of the concepts, going back to the times of Michael Faraday and Antoine Lavoisier who developed the various terms that make up the equation. The excitement is sustained by the use of historical

facts to describe the situation, both in everyday world and in the world of science. Thus the importance of the equation and its tremendous impact become clear to the reader. The book delves deep into human nature, revealing the positive and negative traits of various players in the game of science. The book was made into a TV serial in 2005 by Gary Johnstone for Nova Channel. This docu-drama lucidly explains the concepts in the book, both through enacted scenes and explanations by leading science popularisers. The whole serial is available as a film in YouTube.
This paper attempts to highlight these novel modes of communication, which may be interpreted as translation across two far flung disciplines - theoretical physics and literature. It is hoped that this approach may break the barriers between the practitioners of these two diverse disciplines and make them understand and appreciate the lives and excitements of each other.

Keywords: *Translations, Physics narratives, Scientifically fantastic stories, David Bodanis, George Gamow*

The non-scientists' desire to feel the excitement of modern science remains largely unfulfilled, primarily due to the non-availability of good books. A visit to any good bookshop shows essentially two science genres for the non-specialist, science fiction and popular science. Science fiction books focus heavily on entertaining the reader, and the concepts of science, even when authentic, are relegated to the background. It is very rare to find a science fiction story that is actually able to take the reader on a virtual tour of science and explain its excitement and intricacies. The Ghanada books by Premendra Mitra may be considered to be an exception.

Popular science, which claims to explain the wonders of science to the lay person, usually fails for a different reason. The books are mostly written by scientists, and tend to use the terse language of scientific literature. The only difference is that the mathematical equations are removed and replaced by verbal explanations – the assumption being that if the equations are explained in words, the conceptions automatically become easy to comprehend. Obviously, this assumption is totally wrong. Also, the books use the same language and vocabulary that technical books use. Hence, with very few exceptions, such attempts are doomed to fail.

Against this backdrop, we introduce two somewhat unconventional authors, silver linings on an otherwise dark cloud. The first is George

Gamow, who classifies his works as “scientifically fantastic stories (not science fiction stories)” (Gamow and Stannard xi). In this series, he uses Mr. C. G. H. Tompkins, a mild mannered bank clerk, who loves to attend lectures by a learned physics professor. Each lecture isfollowed by a dreamsequence in which the subtle scientific effectdescribed in the lecture is highly exaggerated and can be seen and felt easily. The initials of Tompkins are the very basic constants of physics, namely C (velocity of light), G (gravitational constant) and h (Planck’s constant) which are changed heavily to make the effects gigantic.

The second attempt is by David Bodanis, who has, very interestingly, written what he calls $E = mc^2$, *A Biography of the World’s Most Famous Equation.* The preface to the book presents a very interesting anecdote, detailing why the book was written.

> …I was reading an interview with the actress Cameron Diaz ... At the end the interviewer asked her if there was anything she wanted to know, and she said she’d like to know what $E=mc^2$ really means. They both laughed, then Diaz mumbled that she’d meant it ….
>
> “You think she did mean it?” one of my friends asked…. I shrugged, but everyone else in the room—architects, two programmers, and even one historian (my wife!)—was adamant. They knew exactly what she intended: They wouldn’t mind understanding what the … equation meant too. It got me thinking. Everyone knows that $E=mc^2$ is … important, but they usually don’t know what it means, and that’s frustrating, because the equation is so short that you’d think it would be understandable. (Bodanis vii)

In the book, instead of conventional physics descriptions, Bodanis begins with the different components of the famous equation. He describes both, the concept involved as also the players who created it. Finally, he comes to Einstein and how the theory of relativity connects tocertain conceptions of physics, *e.g.* mass, energy, velocity of light, which were already known at that time.

Introduction to Authors and Texts

Since the authors and texts presented are somewhat unknown, perhaps it would help to have a little introduction.

George Gamow (1904-1968) was born in Odessa under "dangerous" circumstances. In his own words,

> I was too big and was wrongly located in my mother's womb … doctors decided that … I should be cut to pieces and extracted to save my mother's life. Fortunately for me, a woman … next door (… my godmother) knew that a well-known surgeon … was vacationing in a beach house … fifteen miles out of town. So in …the night she got a horse and buggy, roused the surgeon … and brought him with his black bag …. The Caesarean section was performed on the writing desk in my father's study, where all the walls were lined with bookshelves. (This may be why I write so many books myself.) (Gamow 9)

Apart from his considerable scientific work, he is famous for his science writings for the general public, a venture richly deserving the UNESCO Kalinga award, 1956. In his own words,

> Do I enjoy writing books on popular science? Yes, I do. Do I consider it my major vocation? No, I do not. My major interest is to attack … problems of nature… But to "get going"… one needs an inspiration, an idea… When I do not have any new ideas … I write a book; when some fruitful idea… comes, writing lags… The popular books earned me the 1956 Kalinga Prize … resulted in a very interesting … lecture trip to India and Japan … I do not plan to write any more books. … I have written about practically everything I know. But there is a remote chance that I may publish a cook-book…
>
> People often ask me how I write books that are so successful… it is a deep secret, so deep that I do not know the answer myself! (Gamow: 160)

Gamow was a linguist and a photographer and hasillustrated many of his popular books which include

i. *Mr. Tompkins in Wonderland* (1939)
ii. *The Birth and Death of the Sun* (1940)
iii. *The Biography of the Earth* (1941)
iv. *Mr. Tompkins Explores the Atom* (1944)

v. *One, Two, Three…Infinity: Facts and Speculations of Science* (1947) (according to Gamow, the book is "...of atoms, stars, and nebulae, of entropy and genes; and whether we can bend space, and why the rockets shrink")

vi. *The Moon* (1953)

vii. *Mr. Tompkins Learns the Facts of Life* (1953)

viii. *Puzzle-Math* (1958)

ix. *Biography of Physics* (1961)

x. *Gravity* (1962)

xi. *A Planet Called Earth* (1963)

xii. *A Star Called the Sun* (1964)

xiii. *Thirty Years that Shook Physics: The Story of Quantum Theory* (1966)

xiv. *Mr. Tompkins Inside Himself* (1967)

Russel Stannard (1931-) is a retired high-energy particle physicist who has written many science books, including the *Uncle Albert Trilogy* (*The Time and Space of Uncle Albert* (1989), *Black Holes and Uncle Albert* (1991), and *Uncle Albert and the Quantum Quest* (1994)) for readers above eleven. His books have been translated into 15 languages and have earned him the Whitbread Children's Novel of the Year, and the American Science Writing Award. He was awarded the Order of British Empire for "contributions to physics, the Open University, and the popularisation of science" (1998) and the Bragg Medal and Prize of the Institute of Physics for "distinguished contributions to the teaching of physics" (1999).He has re-written Gamow's Tompkins books with an eye on the contemporary reader. He has modernized the characters in the books and updated the content in tune with modern ideas of physics.

David Bodanis (1956-), in contrast, is an elusive author.None of his books carry an author introduction. Originally from Chicago, he studied mathematics, physics and economics at the University of Chicago. He is now based in London. He taught Intellectual Tool-Kit courses at Oxford from which the idea of the book *E = mc squared*emerged. His first commercial success *The Secret House: 24 hours in the strange & wonderful world in which we spend our nights and days* established him within the literary genre of "microphotography", employing an unusual perspective in the form of a detailed worm's-eye view of human life, featuring complex and obscure explanations of everyday phenomena. He has been translated into 26 languages.His other writings include

i. *The Body Book* (1984)
ii. *The Secret House: The Extraordinary Science of an Ordinary Day*(1986)
iii. *Web of Words* (1988)
iv. *The Secret Garden* (1992)
v. *The Secret Family* (1997)
vi. *Electric Universe: How Electricity Switched On the Modern World* (2005), winner of the Aventis Prize for Science Books in 2006
vii. *Passionate Minds*(2006)

The books are remarkable; they convey lucidly the meaning of very involved theories of physics to non-scientists. In order to appreciate the books better, a bit on the scientific details would not be out of place.

Theories presented:

Gamow has presented two distinctly different theories, namely (1) the theory of relativity, the world of the very fast and (2) quantum mechanics, the world of the very small. Incidentally, both the theories were developed at the turn of the last century, at a time when the end of physics seemed inevitable. Bodanis deals only with the theory of relativity, though he does make some glancing remarks on quantum mechanics. The viewpoints of different authors are described one by one.

Theory of Relativity

Towards the turn of the last century, two major experimental results, Stellar Aberrationand the Michelson Morley Experiment contradicted the universally accepted Newtonian or classical physics. The special theory of relativity, proposed by Albert Einstein in 1905, explained these results and described the world of very fast moving objects. The theory explained several experimental findings including the two listed above, using just two basic postulates

i. *All laws of nature are the same in all frames of reference moving uniformly, relative to each other.*
ii. *The velocity of light in vacuum is the same in all frames of reference (for all observers) moving uniformly, relative to each other.*

The special theory of relativity was soon to be followed by the General Theory of Relativity in 1916.This paper, however, would concentrate on the various takes on the Special Theory of Relativity. The theory addresses the concepts of motion and rest which are relative. The measurement of quantities like length, time, mass etc. depends on the relative motion of the observer with respect to the system undergoing measurement. Two important measurements dealt with here are length and time.

Length Contraction:

An object appears shorter to the moving observer, the reduction depending on the relative speed of the object and observer. A typical physicist would present the problem as a body moving with a speed *v* with respect to another body, with two observers on the two bodies, also called frames of reference. Their way of expressing length contraction would be in the form of an equation

$$x' = \frac{x - vt}{\sqrt{1 - v^2/c^2}}$$

{x' = length of the moving body as seen by observer in non moving body and x = length of moving body as seen by observer in moving body, c = speed of light, t = time}

A typical popular science writer would describe this as "A moving object appears to contract in its direction of motion and become shorter as its velocity increases until, at the speed of light, it disappears altogether" (Zukav 139). This sentence is almost as terse as the equation, which expresses the same thing in mathematical terms. In fact, the sentence loses in detail without gaining much in understandability.

Gamow's take is very different. In one dream, Mr. Tompkins wakes up on a bench in a street-side.

> The street was nearly empty-except for a single cyclist coming slowly towards him. As he approached, Mr Tompkins's eyes opened wide with astonishment. The bicycle and the young man … were unbelievably shortened in the direction of their motion, as if seen through a cylindrical lens. The clock on the tower struck five, and the cyclist, evidently in a hurry, stepped harder …Mr Tompkins did not notice that he gained much in

> speed, but, as a result of his effort, he shortened still further and went down the street looking rather like a flat picture cut out of cardboard. … Mr Tompkins understood what was happening… it was the contraction of moving bodies…(Gamow and Stannard: 2)

The fact that moving bodies appear shorter in the direction of movement is described graphically through the dream of Mr. Tompkins.

In the concept of relativity, the effect of movement is felt equally by each observer on the other, irrespective of who is actually moving. Hence it becomes impossible to decide which body is moving and which one is at rest. This concept is again expressed differently in the different versions. The popular science version would perhaps read something like this:"… the astronaut sees himself as stationary and his cigarettes as normal He also sees us as traveling … relative to him, and our cigarettes as shorter than his …" (Zukav 140).

Gamow's take is again unusual. The same dream continues, as Mr. Tompkins, on another bicycle, pursues the cyclist.

> …he mounted the bike and sped down the street in pursuit of the other cyclist. He fully expected that his newly acquired motion would … shorten him, and looked forward to this as his increasing girth had lately caused him some anxiety. To his surprise, however, nothing happened; both he and his cycle remained the same size and shape. On the other hand, the scene around him completely changed. The streets grew shorter, the windows of the shops became narrow slits, and the pedestrians were the thinnest people ….
>
> 'Ah!' exclaimed Mr Tompkins excitedly. 'I get it now. This is where the word relativity comes in. Everything that moves relative to me looks shorter for me — whoever works the pedals!'(Gamow and Stannard: 4)

The explanation is very vivid and clear. One cannot determine who is moving and who is at rest, so long as the two are moving relative to each other. This indicates the absence of an absolute rest frame (a special platform or measuring arrangement which is not moving). Gamow leaves no space for any confusion, and draws the reader's attention with his sardonic humour.

Time Dilation:

Time runs slower on a body to an observer moving relative to it with velocity *v*. The physicist expresses it as

$$t' = \frac{t - \left(v/_{c^2}\right)x}{\sqrt{1 - v^2/_{c^2}}}$$

{t' = time as seen by observer in non moving body and t = time as seen by observer in moving body, c = speed of light, x = position}

The popular science writer would perhaps express it in this way. A moving clock runs more slowly than a clock at rest, and continues to slow its rhythm as its velocity increases until, at the speed of light, it stops running altogether. The language is again very terse, losing in detail but gaining virtually nothing in lucidity as compared to the equation.

Gamow presents this equation in his own unconventional way. In the dream, Mr. Tompkins has followed the afore-mentioned cyclist to the post-office.

> Mr Tompkins … looked at the post office clock; it showed half past five. 'Hah!' he exclaimed triumphantly. 'What did I tell you? You were going slow. It took you all of half an hour to go those ten blocks. It was exactly five o'clock by the college clock when you first passed me, and now it's half past!'
> 'Did you notice this half hour?' asked his companion. 'Did it seem like half an hour?'
> Mr Tompkins had to admit that it hadn't really seemed all that long — no more than a few minutes. Moreover, looking at his wrist watch he saw that it was showing only five minutes past five. 'Oh!' he murmured, 'Are you saying the post office clock is fast?'
> 'You could say that,' replied the young man…[or] your watch running slow. It's been moving relative to those clocks, right? What more do you expect?' He looked at Mr Tompkins with some exasperation. 'What's the matter with you, anyway? You sound like you're from some other planet.' (Gamow and Stannard 6)

Again time dilation comes across in a very simple way. The mock sardonic humour is unmistakable.

David Bodanis approaches the problem of special relativity in a very different manner.As the title of the book suggests, he talks about the history of the equation $E = mc^2$. He begins with Michael Faraday, the British scientist, who brought in the concept of E, the energy. This connected different branches of physics, namely electricity, magnetism and later light, which were till then understood to be independent phenomena. He also describes Faraday's life and struggle and the state of physics at that time. The battery had just been invented and electricity was the happening topic of research. Highlighting Faraday's genius, Bodanis also offers the reader a guided tour into the minds of the leading physicists of the day; Humphry Davy, Hans Christian Oersted, William Hyde Wollaston, James Clerk Maxwell etc.Faraday showed that every phenomenon of nature depends on energy.His experiments introducedthe theory of conservation of energy; energy could neither be created nor destroyed in any process.

Bodanis then moves on to Antoine-Laurent Lavoisier, the French scientist, who studied chemical processes in painstaking detail. His experiments showed that m, the total mass remained a constant in all phenomena. This is the theory of conservation of massin contemporary physics. In his experiments, Lavoisier was helped very ably by his wife Mary-Anne, who learnt English and drawing, to help in translating literature from across the channel and to record all the experimental workin detail. The 1770-1780s French Revolutionadds a very interesting backdrop to the story, with Lavoisieras the tax collector of Paris. Lavoisier walled up the city to tax every commodity that came in or went out. This led to his eventual denunciation and execution, which lends a sad undertone to the story.

Bodanis next introduces the concept of c, the speed of light which comes from *celeritas*, the Latin word for swiftness. He details the history of the measurement of the speed of light, starting from Galileo and the Florentines down to Cassini, Roemer and finally to the work of James Clerk Maxwell. Faraday had already conjectured that light should be an electromagnetic wave, caused by an interweaving of electricity and magnetism, but he did not have the sound mathematical knowledge to prove that. It was Maxwell who provided the necessary formal mathematics. The combined work of Faraday and Maxwell showed that the speed of light is more fundamental than any other speed as it connects the phenomena of electricity, magnetism and light. This also goes to show light always travels at *c*, irrespective of the speed of the source or the measuring apparatus.

One interesting component which would normally escape attention is the square on c. Bodanis connects it to the controversy regarding the total motion in a moving body.Newton conjectured that the total motion of a moving body is its momentum, the mass times the speed. This was challenged by a twenty something woman, born in the beginning of the 18th century, who enjoyed reading Descartes'*Analytical Geometry*, and about whom her father said "…flaunts her mind, and frightens away the suitors. . . .don't know what to do with her" (Bodanis 58). Emilie du Chatelet settled in a chateau at Cirey and soon converted it into a base for genuine scientific research in France. Emilie was aware of the work of Gottfried Leibniz, German diplomat, mathematician and natural philosopher, who had concluded that the total motion (vis viva or life force) of a body should be mass times the speed squared. In the words of Leibniz, "According to [Newton's] doctrine, God Almighty wants to wind up his watch from time to time: otherwise it would cease to move. He had not, it seems, sufficient foresight to make it a perpetual motion" (qtd in Bodanis 63). Since the merit of this argument could only be judged by a person like du Chatelet, it was collecting dust over the decades. Also there was an absence of objective proof. Willem 'sGravesande performed experiments where he dropped weights into a soft clay floor at different velocities and measured the depth to which they sank. A weight that came at twice the velocity sank to four times the depth, providing the necessary proof in support of Leibniz's work. Combining the theoretical insight of Leibniz, the experimental work of 'sGravesande, and her own work, du Chatelet showed the world that energy of a body is indeed m times v squared. However, the final understanding had to go through a long debate with the English supporting Newton and the Germans supporting Leibniz. This may be taken as the first equation that used the square in physics. Voltaire wrote about du Chatelet, "She was a great man whose only fault was being a woman" (Bodanis 65).

In today's physics, mass times velocity is called momentum and half mass times velocity squared is called kinetic energy. Both quantities have their own importance. While momentum describes the actual motion of a body, kinetic energy is used to understand the consequences of the motion on other immobile objects in the vicinity.

Setting this background, the book moves onto Einstein and describes his life and work. Einstein questioned the basic conceptions of physics of his time, the conservations of mass and energy, and came out with a remarkable result. Einstein's question, "What happens when a body moves at the speed of light?" becomes important only at this point. The fact that light travels at the same speed for all observers, irrespective of their relative speeds, is Einstein'sremarkable theoretical advancement. From here comes the result that nothing can move faster than light. What would happen if more energy is pumped into a fast moving body in an attempt to make it move faster? The energy goes into the body in the form of an increase in mass, the conversion given by the formula $E = mc^2$.

The importance of the equation and its consequences are also illustrated by Bodanis. Otto Hahn, a chemist and Lisa Meitner, a physicist bombarded the uranium nucleus with neutrons. The idea was to create a nucleus heavier than the uranium nucleus, the heaviest natural nucleus. However, on analyzing the target, the scientists detected the surprising presence of smaller nuclei like those of barium and radium. The genius of Meitner explained this surprising result, later termed nuclear fission. According to her, the nucleus broke into two fragments and released a few neutrons and an enormous amount of energy. Also, the mass of the nuclei and neutrons produced after fission was less than that of the bombarded nucleus and the bombarding neutron. The amount of energy released can be calculated from this mass difference according to the equation $E = mc^2$.This phenomenon was later used to make the atom bomb and to extract nuclear energy. Once again, Bodanis goes into painstaking details to reveal the human angle to the tale, a tragic story of deceit and betrayal. A Jewish woman, Meitner, had devoted 30 long years of dedicated research in Germany, only to find the Second World War and Hahn usurp her lifelong passion in a matter of seconds. She was denied the recognition of the Nobel Prize.

The book was made into a TV serial for the Nova channel in US by Gary Johnstone in 2005. It is available in YouTube compiled as a movie. The whole concept, including its history, is explained through enacted scenes and discourses by science popularisers like Michelle Kaku, Patricia Fara, Judith Zinsser, the biographer of Emilie du Chatelet and Bodanis himself.

Quantum Mechanics

Quantum mechanics is the physics of very small objects, where again conventional physics fails. This concept developed through the work of many great scientists over almost three decades from 1900 to 1930. We will just look at the concepts of uncertainty and tunneling. Uncertainty states that it is impossible to measure the position and motion of a body at the same time with unlimited accuracy.Quantum tunneling tells that bodies can escape an energy barrier if they possess enough energy to move after the barrier is crossed.

Uncertainty: Expressing Δp as the uncertainty in p, the momentum and Δq as the uncertainty in q, the position, the physicist would describe the uncertainty principle in the form of an equation $\Delta p \Delta q \geq h/2\pi$. These uncertainties are not the experimental errors, these are more fundamental in nature. There is a fundamental limit in the accuracy with which these two quantities can be measured simultaneously. Here h is a very small constant called the Planck's constant.

The popular science writer would write, "The more certain we are of the position of a particle, the less certain we can be about its momentum, and the other way round. We can determine its position precisely but … we cannot determine its momentum at all. If we choose to measure its momentum precisely, then we will not be able to know where it is located" (Zukav 223).

Once again let us take a look at Gamow's take on the problem. In another dream, Mr. Tompkins and a professor of physics are at a billiards room.

> There was something very strange about it! A player put a ball on the table and hit it …Mr Tompkins noticed to his great surprise that the ball began to 'spread out'. This was the only expression he could find for the … ball … seemed to become more and more washed out, losing its sharp contours. It looked as… a great number of balls,

> all partially penetrating …Mr Tompkins had often observed analogous phenomena before, but not [on]…less than one drink. (Gamow and Stannard 100)

The uncertainty in measurement has been introduced here, through an exaggeration of the Planck's constant *h*. The position and momentum of the ball is not definite anymore.

> … the moving ball hit theother head on… there was a loud sound of impact just like … two ordinary balls. Then both the ball that had been moving and the one that had been stationary (… could not positively say which was which) sped off 'in all different directions at once'. Very peculiar. There were no longer two balls looking only somewhat fuzzy, but … innumerable balls, all of them very vague and fuzzy, were rushing about within an angle of 180° round the direction of the original impact. It resembled a wave spreading from the point of collision, with a maximum flow of balls in the direction of the original impact. (Gamow and Stannard 102)

After the collision, when the two balls are moving, their position and direction of motion are uncertain, though the maximum probability should be in the direction of classical billiard balls.

> 'That's a nice example of probability waves they've got there,' said a familiar voice behind him. Mr Tompkins swung round to find the professor at his shoulder.'… Perhaps you could explain what's going on here.'
>
> '…balls suffering from "quantum elephantism"…. nature… are subject to quantum laws. But Planck's constant … is very, very small ... for these balls … constant seems much larger — about ONE... actually quite useful; here you can see everything happening with your very own eyes. Normally you can only infer this …behaviour…[using] sensitive and sophisticated methods….'
>
> …Mr Tompkins. 'But tell me, why do the balls spread out like this?'
>
> 'Oh, that's all to do with the fact that their position … is not quite definite. You cannot indicate the position of a

ball exactly; the best… is "mostly here" but "partially somewhere else".'

'It actually, physically is in all these different places at once?' asked Mr Tompkins incredulously.

The professor hesitated. 'Maybe, maybe not. That's certainly how some people would say it was. Others would say … the ball's position [is]… uncertain. The interpretation of quantum physics …[is] a subject for debate.' (Gamow and Stannard102)

This debate is still continuing. The only thing known is that both position and momentum cannot be measured simultaneously with unlimited accuracy.

Mr Tompkins continued to gaze in wonder at the fuzzy snooker balls. 'This is all very unusual''…it happens all the time, to every material object in the Universe. It's simplythat h, the Planck's constant is so very small. Our ordinary methods of observation are too crude;they mask this… indeterminacy… that misleadspeople into thinking that position and velocity are … definitequantities… in purely practical terms you're never going tobe able to determine … position and velocity… but this they put down to nothing more than theclumsiness of their measuring techniques. But in truth, both quantities arefundamentally indefinite to some extent.'

'Actually it is possible to alter the balance of uncertainties… on improving the accuracy of your determination ofposition. OK you can do that, but the price … is an increase inthe uncertainty of the velocity… you can go for precision ofvelocity… you have to sacrifice precision of position. Planck's constantgoverns the relation between these two uncertainties.'(Gamow and Stannard 103)

The concept of experimenting has also been shown here. On reducing the uncertainty in one quantity, the uncertainty on the other one increases.

'… I am going toput definite limits on the position of this ball.'

> The fuzzylooking ball he spoke of was lazily rolling over the table. He (professor) reachedacross and trapped it inside the wooden triangle [used]… at the start of a game. Immediately the ball seemed to go berserk. Thewhole of the inside of the triangle became filled up with a blur of ivory.
>
> 'You see!' said the professor, 'I have now defined the position of the ball to the extent of the … triangle. Previously all we could say for certainwas that it was on the table — somewhere. But look… uncertainty in the velocity has shot up.'
>
> 'Can't you stop it rushing about like that?' asked Mr Tompkins.
>
> 'No — it's physically impossible. Any object in an enclosed space has to possess a certain motion … zeropoint motion. If it did stay still then we would know for certain what its velocity was… zero. But we are not allowed to know the velocity if we have a pretty good fix on its position — as we do here with the ball confined to lie within the … triangle.'(Gamow and Stannard 104)

Quantum Tunneling: A body can cross a barrier with a certain probability if it has enough energy to move after the barrier has been crossed. This has been explained elegantly in the same dream.

> While Mr Tompkins was watching the ball dashing to and fro in its enclosure — like a tiger in a cage — something very odd happened. The ball got out! It was now on the outside of the triangle … It wasn't that it jumped over the wall … it had sort of 'leaked' through the barrier.
>
> 'Hah!' exclaimed the professor excitedly, 'Did you see that? One of the most interesting consequences of quantum theory: It is impossible to hold anything inside an enclosure indefinitely — provided there is enough energy for the object to run away once it has crossed the barrier. Sooner or later the object will "leak through" and get away.'(Gamow and Stannard 105)

Why are people not aware of such phenomenon? Why do things kept inside boxes not leak out? The world market of locks, safes etc. is large and booming! The answer follows.

> 'Good grief!' declared Mr Tompkins. 'Then I'll never go to the zoo again.' His vivid imagination … conjured up a picture of lions and tigers 'leaking through' the walls of their cages. Then his thoughts took a somewhat different turn: … his car leaked out of its locked garage… passing through the garage wall, like the proverbial ghost … and careering off down the street… whether his car insurance covered such eventualities.
>
> He… asked, 'How long would I have to wait for that to happen?'
>
> …the professor came back with: 'It will take about 1,000,000,000 . . . 000,000 years.'
>
> …Mr Tompkins was accustomed to large numbers in the bank's accounts, he lost count of the number of noughts in the professor's answer… a reassuringly long period of time ….(Gamow and Stannard 105)

So once again through a big change in the value of a fundamental constant (this time increasing it by a factor containing 34 zeroes), Gamow explains a subtle quantum mechanical phenomenon. This phenomenon of tunneling is used heavily in modern electronics. Gamow's approach remains inimitable and his reasoning perfectly clear. The realistic portrayal of the characters of Mr. Tompkins and the professor keeps the reader attached to the story.

Views of non-specialists

Unfortunately the proliferation of terse literature in sciences makes the common man very skeptical about any science writing. On being shown a book on science, the typical comment is, "This is for science people" or "Will it enter my head?" While these comments are only to be expected so far as technical books are concerned, a similar fear is seen when "popular science" books are shown. The only book on popular science which made its presence felt in recent times was *A Brief History of Time* by Stephen Hawking, and the debates over its success are never ending.

The film version of *$E=mc^2$* has been seen by many individuals, who are intelligent, educated and nurture a healthy curiosity in everything. However, they are not trained in physics. Mittal, a well-read businessman said that the film made the theory of relativity and the background of the work easily accessible. Dasgupta, a bureaucrat with the state government said, "I never thought I will understand these things. This film did it." Mayank and Saxena, Assistant Professors of Law in Sikkim University, agree that the film has successfully explained a difficult topic almost effortlessly. An engineer and a chemist also agreed that it is a very interesting way of explaining something very abstract. The film has been shown to students of science and other subjects in colleges with great success.

Very few non-scientists known to the authors have read Gamow's books. However, undergraduate and high school students, both from sciences and humanities have enjoyed the books and commented favourably. Some have even claimed that the stories later helped them grasp the concepts. In fact the authors have personally used Gamow's stories to explain theory of relativity in undergraduate classes.

Conclusions

Even though the scene of science for the non-specialist is grim and discouraging, we have at our disposal the work of geniuses who have brought the complicated and abstract ideas of theoretical physics to the level of the common man in a very lucid manner. The fact that a man of the stature of Russel Stannard has updated the Tompkins stories to better explain the theories to the contemporary audience or that David Bodanis has written on theory of relativity gives us reason to hope that more such texts would arrive in the future, thereby bridging the gap between disciplines.

END NOTES

1. George Gamow and Russel Stannard, The New World of Mr Tompkins, Cambridge University Press, Cambridge, 1999.
2. David Bodanis , A Biography of the World's Most Famous Equation E=mc2, Walker Publishing Company, Inc., New York, 2000.

WORKS CITED

Bodanis, David. *$E=mc^2$, A Biography of the World's Most Famous Equation*. New York: Berkley Books, 2000.

Gamow, George. *My World Line: An Informal Autobiography*. New York: Viking Press, 1970.

Gamow, George and Stannard, Russel. *The New World of Mr. Tompkins*. Cambridge: Cambridge University Press, 1999.

Mitra, Premendra. *Adventures of Ghanada*. Translated by Lila Majumdar. New Delhi: National Book Trust, 2010

Zukav, Gary. *The Dancing Wu Li Masters: An Overview of the New Physics*. New York: A Bantam New Age Book, Bantam Books, 1978.

** Associate Professor*
Department of English Studies, Central University of Jharkhand
Ranchi, Jharkhand, INDIA

*** Associate Professor*
Department of Physics, Sikkim University
Gangtok, Sikkim INDIA