The lighter side of gravity: How Swami Gurutwananda received enlightenment*

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When I was asked to deliver the after-dinner talk at this conference, I was very happy, thinking that this invitation indicated an appreciation of my wit and humour. I was, however, shaken when a colleague not noted for tact, pointed out that this meant that the organizers had consigned me to history. I am, however, approaching my assigned task with a positive frame of mind, and thus you will have to bear with my wit and humour.

A disclaimer

I should begin with a disclaimer. This is in the form of a quotation from the favmous Sanskrit play of Kalidasa, called *Abhijnana-Shakuntalam:*

> 'Parihasavijalpitam sakhe paramarthen na grihyatam madvachah',

which means: 'I spoke it all in jest, my dear friend, do not take it seriously'. Who said it, when and to whom? King Dushyanta had been narrating his escapades to his confidant the court jester, including how he had secretly met and married a damsel from the forest. Although in those days, polygamy was not frowned upon and the kings certainly practised it, Dushyanta became worried that his Head Queen may not take kindly to this bit of news. Yet, knowing the court jester, he was afraid that the gentleman would blurt it all out at the first opportunity. And so he said the above line to tell him that the narrated episode was entirely imaginary.

Definitive answers?

Having attended the various conferences in the ICGC series right from the first one in 1987, I am reminded of a Cambridge story. Since Ramesh Narayan from Harvard is here, I should clarify that I refer to the original Cambridge in England. The examiners in the mathematics and economics Tripos examinations (for the uninitiated, these are the final examinations for the Cambridge BA) were arguing. The mathematician said: 'In the Mathematical Tripos, we make sure that the candidates are given new, original questions to solve. There are no repetitions from previous years. Indeed the examiners take it as a challenge to invent new questions, which is why the Mathematical Tripos is considered so difficult. But when I look at the economics papers, they always have the same questions from year to year'. The economist paused before replying: 'But, you see, our answers change from year to year'.

Well, coming back to the ICGCs, I noticed that the cosmologists were discussing the same questions from one meeting to the next. 'What drives inflation?' 'What is the nature of dark matter?' 'Does the cosmological constant exist?' 'How does structure formation take place?' And so on, so forth. Only, the answers offered differ from conference to conference! This in itself is not to be derided, since science is supposed to have a pragmatic outlook with provision for mid-course corrections in the light of new facts. However, in each conference the speakers offer answers with a ring of finality and definitiveness (this is the way it happened, folks!) that does not leave room for any alternative viewpoints. Which brings to my mind Landau's statement that the cosmologists are always wrong but never in doubt.

Nevertheless, I will focus on a result reported in the proceedings of the first conference, which is reproduced in Figure 1 and accounts for the subtitle of this talk.

How was the law of gravitation discovered?

C. V. Vishveshwara (a.k.a. Vishu), the eminent historian of science and cartoonist *par excellance* is responsible for this important discovery. Since 1987, he has carried out further research which led him initially to name the unfortunate discoverer of the law of gravitation *Swami Gravitananda*. Subsequently he decided to appropriate the name for himself, since he felt that in modern times, being a *Swami* (that is, a 'holy master') is a more lucrative profession than being an academic. Respecting his wishes, I decided to name this person *Swami Gurutvananda*, which is in keeping with those times, since, as claimed by Vishu, this incident happened three centuries before Isaac Newton, that is in times when the English language had not reached our shores and Sanskrit still enjoyed the status of language of knowledge.

Now it so happened that the lineage of the original Swami continued to this day, each subsequent Swami Gurutvananda being numbered serially starting with the original one as number one. Keeping in view the fact that 600 years have passed and that each generation lasts for around 30 years, it is not surprising that the present incumbent of the position should be Swami Gurutvananda XXI. [I am not making the mistake currently being made by almost 90% of all people, of counting the third millennium from 1 January 2000. Like the years AD, the Swamis were counted from one and not zero.]

Now Swami Gurutvananda XXI is a physics graduate who, like Vishu turned Swami by compulsions of times. One of his missions in life has been to establish the priority of his ancestor as the discoverer of the law of gravitation. In this context he came to me for advice. How could he establish that the incident depicted in the picture actually took place? Even with Newton and his apple tree, he said, and rightly so that there are scholars who discount the incident of the fall of the apple serving as trigger for the law of gravitation. This, in spite of there being an authentic apple tree which has been cloned and planted in

*Based on the after-dinner talk at the International Conference on Gravitational and Cosmology (ICGC-2000 held at 11T Kharagpur, 4–7 January 2000).

Goa and gravitation

Many were the reasons for selecting Goa as the venue for a conference on gravitation. For instance, the natural beauty of the land with its emerald sea, the azure sky and the vast stretches of golden sand, the warm hospitality and the open friendliness of the people and a fascinating culture in which the East and the West have mingled together. In addition to all these, there was a historical reason as well. Legend has it that a sage belonging to this region discovered the universal law of gravitation some three hundred years before Isaac Newton. It so happens that there are hardly any apple trees in Goa, but one can find coconut groves all around. Consequently the discovery of the law of gravitation by our sage was occasioned by the fall of a coconut, as he sat in a contemplative mood. Needless to add, the world remained ignorant of his finding. This was indeed the first authentic case in unrecorded history of perishing without publishing.

many institutions including the IUCAA at Pune. He was well aware of the controversies Newton himself had to face with Hooke and Leibnitz, to establish the priority of his own work. So with such scanty evidence as the Goan folk tale, what chance did he have for his mission?

I suggested to him to go and talk to the present-day professionals such as those attending the ICGC. I told him that he will discover that he is being unnecessarily defensive and pessimistic. So the Swami button-holed a few dele-gates and here is how his interviews went.

The astroparticle physicist

The first person the Swami met was an expert in the particle physics of the very early universe. After hearing Gurutvananda's problem, he laughed and said: 'Look, let me tell you the positive way of approaching your problem. In our field we start with some hypothesis, call it *Hypothesis A*, which is used to predict a relic *R*. The Popperian way was to argue that if the relic *R* is not found, then the hypothesis is rejected. But that point of view is now out of date. No one ever rejects one's pet hypothesis. If the relic is not found, state a second hypothesis, call it *Hypothesis B*, which tells you *why* the relic is not found today. This way you do not lose your original hypothesis; but rather you get credit for two hypotheses'. Then he went on to explain how the grand unified theories (GUTs) had predicted the existence of massive magnetic monopoles whose present density would have exceeded the density of matter in the universe by several orders of magnitude. These theories were saved by the idea of inflation. So today you have both the GUTs and inflation.

Swami Gurutvananda felt that this very well suited his ancestor's case, where he could claim the latter's death by coconut as a supplementary hypothesis to explain why no one today knows about the original Swami's claim of discovering the law of gravitation. Aloud he said: 'That reminds me of a story where an artist exhibited a picture in the form of an empty frame entitled "a cow eating grass". When asked, why there is no grass, the artist said that it was all eaten by the cow. And why is there no cow in the picture? The artist said that having eaten all the grass, there was no reason for the cow to remain there'. For some unaccountable reason the astroparticle physicist turned cold and politely showed the Swami the door with the advice that he should go and talk to a cosmologist.

The cosmologist

The cosmologist was busy calculating on his computer when Swami Gurutvananda XXI dropped in. After greeting him, the cosmologist pointed out the state of the woollen carpet in his drawing room. 'See the rumples and wrinkles on the carpet? They contain a good deal of information about how the carpet was made. Here I am working on the spherical harmonics of the carpet: each harmonic carries information related to the size of the inhomogeneity of the carpet.'

'I beg your pardon, Sir!', said the Swami. 'But commonsense suggests that someone has disturbed the carpet recently, by running on it or dragging furniture across it. See for example, the frayed portion over there.'

'Nonsense! That is the famous Sack of Wool Effect', said the cosmologist. 'When you do cosmology, you get to learn the tricks of the trade. Postulate initial conditions and then work everything from it. The state of this rug today has to be related to the initial conditions, no matter how convoluted the reasoning may appear. That is the only way to know the past. Now, the solution to the fraying of the carpet is easy. Imagine that a sack of defective wool was around while the carpet was being woven. Naturally the carpet would fray soon.'

Gurutvananda was now getting the hang of how cosmologists function. Still his commonsense would not quit and he pointed to a spherical bump on the carpet. 'Can you explain that bump over there?' The cosmologist laughed at the naive query. 'That is called the Doppler peak! When the carpet was made, the loom was oscillating and the machine not being an imported one, had defects which caused local distortion. I have placed an order for an expensive machine called Map of Planck, to measure all the bumps and wrinkles like this one...'.

'I beg to differ, Sir!' said the Swami and before the cosmologist could react, he bent and put his hand under the carpet and pulled out a cricket ball.

'Good heavens!' said the cosmologist. 'This is the ball my kid was looking for... . Looks like despite my orders he has been practising his batting here.' As the cosmologist rushed out in search of his errant son and heir, the Swami quietly found his way to the door.

He was learning how science is practised at the turn of the century.

The GR-specialists

His next stop was at a group that was debating some mathematical details. Surely, he felt, these mathematical people will be more precise in what they conclude. He barged in and shared his concern with the group, saying: 'Everywhere, I notice that these physicists have let themselves go making unverifiable speculations. How do you people allow this?'

There was a hush and then one of the mathematicians spoke in a low tone. 'We work on exact solutions of Einstein's equations. Till the end of the seventies, we had nothing to complain. We solved Einstein's equations *exactly*, taking care that all boundary conditions like those of Synge or Lichnerowicz are fully satisfied. But then our subject was hijacked by the particle physicists.'

'Look at inflation!' said another. 'It is not an exact solution of the field equations, nor has anyone bothered to match the boundary conditions across the bubble that they talk about.'

'But why don't you protest?' asked the Swami. 'Well, we tried in the beginning, but the physicists with their big clout simply steamrollered us. They asked what use were our exact solutions when they were so unphysical. They would rather play with their physical but inexact solutions. 'We have been completely sidelined and are now facing a survival problem. Go and talk to the particle physicists if you like' advised one of them.

The particle physicist

'The GR (general relativity) is on its last legs; I can tell you that,' said the particle physicist, when Gurutvananda contacted him. 'We will soon have it tied up in strings.'

'What makes you so sure?' asked the Swami, since there was a ring of finality about the particle (string) physicist's words. 'So far as I am aware the GR best fits any evidence to date. Why replace it with another theory? And do you have any alternative to suggest which performs better?'

The particle physicist smiled patronizingly. Here was another classical fellow that needs to be educated in the niceties of quantum theory. He explained: 'The GR cannot be quantized. Even if it were quantized, it would be non-renormalizable. Besides, it does not fit into any unification scheme with other interactions.'

To the naive mind of the Swami, all these shortcomings seemed to be remote and insignificant compared to the observational evidence in favour of GR, classical though it may be. He was, however, intimidated by the strong personality of the particle physicist and meekly asked: 'Do you have a string theory that does all this and explains all the observed facts relating to gravity?'

'Of course, the string theory is free from fault on the theoretical front, and not far from being the theory of everything. Now as regards the trivial observational details...' coughed the string expert, pausing for a while. Then he resumed with renewed confidence: 'Although we do not yet have any observable result to predict, I am sure the theory will eventually get there. Which is why I feel that the days of GR are numbered. I do not think it will last a century... well before 2015, it will be consigned to the museum of defunct theories.'

'Do you mean to say that the GR has no power base left now? Are there no funds available for research in GR anymore?' asked the Swami.

The string physicist thought for a while and shook his head. 'No, there is a power base for GR which can still attract big money. Go and talk to the gravity wave wizards.'

The gravity wave wizards

The gravity wave wizard was working furiously on his work station, when the Swami accosted him. He had a tray piled up with lot of computer print-outs, and his screen was equally full with mathematical symbols. The Swami was duly impressed. Here was a scientist steeped in data and armed with sophisticated theory. 'Sir, the particle physicist sent me to talk to you. But why did he call you a wizard?' the Swamy asked after giving him the low-down on his ancestor.

The wizard smiled in good humour. 'The naughty man! You see he was referring to our ability to get huge funds and infrastructure despite an iota of data. If ever there was a huge output from nothing' he pointed to the paper pile and said: 'It is here.'

'But all this paperwork looks full of figures and tables.' To this remark of the Swami, the wizard replied: 'This is data analysis'.

'But you have no data yet!'

'Ha! Data, no. But data analysis, yes. It may sound paradoxical. But you see we are building all these huge detectors which will one day collect data. So we must be ready for it. Which is why we simulate and generate data on a computer and then figure out how best to extract it from the jumble and noise it is steeped in.' The wizard then showed him a stack of publications related to data analysis for data which was still to come.

'I am impressed, Sir. But can you tell me something about your detectors?' To this enquiry from the Swami, the wizard replied by giving him a small lecture, which he had prepared for the uninitiated, a commentary on the LIGO, VIRGO, AIGO, and so on. He gave a brief summary of the funds allotted to these projects. He also described even more ambitious projects, of putting *G*ravity *O*bservatories in space.

'But how could you persuade different governments to lay out so much money with no preliminary data?' asked the Swami. 'You people are truly wizards. You are literally GO-getters.'

The wizard beamed and said: 'It is a matter of writing proposals and mobilizing opinion with the threat of competition between rival teams. We emphasize that with this equipment we reach out to where light cannot reach and explore those final frontiers to which no astronomer has ever been before.' The Swami expressed curiosity as to how he and his colleagues in this exciting enterprise would react when real data begins to trickle in.

'Oh! That is all worked out,' said the wizard. 'You will recall that the COBE astronomers saw the face of God in 1992. We will begin by announcing to the media that God is smiling.'

The Swami recalled the message 'Buddha is smiling' with which the Indian scientists had announced the successful nuclear explosion to Prime Minister Indira Gandhi back in 1974. He asked the wizard about his long-term plans. The wizard pointed to a wall chart showing a futuristic picture and added: 'We plan well

ahead. Here is a proposal for any extremely sensitive project for the year 2050. It will have laser beams going between mirrors on Mars and a satellite of Jupiter.'

'How sensitive will that detector be?'

'Well, it may not be able to detect the drop of an apple... but it will detect the fall of a coconut' said the wizard. 'And if you are able to build four such interferometers in the solar system, you can even locate the particular coconut tree.'

'My! That would be wonderful.'

'There. Have I not sold you four detectors in place of one?' remarked the wizard triumphantly. 'We are professionals in this game.'

'Have you thought of a name for this gravity observatory of the future?' asked Gurutvananda. 'Not yet, have you any suggestions?' asked the wizard.

'Extraterrestrial Gravity Observatory sounds appropriate' said Swami Gurutvananda XXI, ready to step out as he delivered his parting shot: 'The acronym would be appropriate.'

The new technology camera

On his way back the Swami saw a shop advertising a new technology camera. 'Rs 1000 only for a light-less camera', said a bill-board outside. Intrigued and recalling that he needed a camera, the Swami went in. The smiling shop assistant looked more like a technician than a salesman. 'Here Sir is our model', he said producing a brochure. 'As you see we don't use light at all'. 'But where is the camera?' asked the Swami as the shelves contained no cameras. 'It is being made, Sir. The first pictures by our Mark I are expected in 2001. Here is simulated version.' The shop assistant showed a white blank wall-like picture. 'What is it? It has no details' rightly complained the Swami. 'Well Sir, with new technology, you proceed in stages. This is what we call 'White Noise'. For better definition you need our Mark II version shown here, expected out in 2004... costing Rs 5000'. The Swami could barely make out the outline of what looked like a tree. 'But I want to be able to photograph my friends as well as natural views when I am holidaying... this hardly comes up to what an ordinary light-using camera can produce.'

The shopkeeper who was watching these interchanges from a distance now stepped in. 'Sir, light or the electromagnetic radiation has reached the end of its technological capabilities. By investing in this new venture you are stepping right into the next millennium. Yes, in 2050 we will be able to generate a model, we call it Mark V, with the kind of capabilities you ask for. But for that we need funds for developmental research from patrons like you. Mark V is currently priced at Rs 50,000 if paid today'.

The Swami was shocked. 'Do you mean that people are already putting in money for your future cameras even though you have not produced a single picture?' He did not wait for an answer. He stepped out, went across the street and bought an ordinary camera for Rs 2000.

Conclusion

I received Swami Gurutvananda XXI in a thoughtful mood. How did it all go, I asked. 'Well, I am happy as well as sad, Sir!' he said. 'Happy, because I now see that establishing the claim of my ancestor is no problem. I have seen people selling less tangible items and ideas. Tomorrow I will approach the *New York Times*. For that is where all media blitz must begin.'

'Then what makes you sad?' I asked.

'The realization that I am not cut out to understand physics as it is practised today. In my student days, scientists went by concrete evidence... not elaborate consistency arguments. They asked for repeated experiments to confirm a hypothesis... not a sequence of conjectured events that were never observed nor were ever to be repeated. Yet they claim that they have solved everything and that the end of physics is round the corner. Even granting my ancestor's claim for priority, I have a deep respect for Isaac Newton. Did he not say 'I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me'? I wonder how he would have felt in today's scientific environment.'

'Swamiji, I can answer that! As my colleague said, he would have felt that he belongs to history. You and I are not Newton, but we too feel the same way.'

That is the saga of how Swami Gurutvananda XXI attained enlightenment.

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