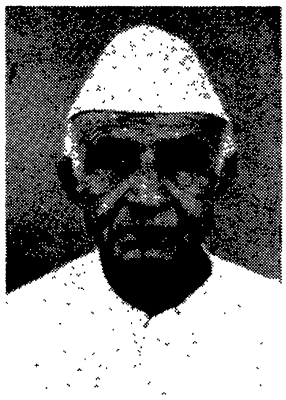
Bull. Astr. Soc. India (1997) **25**, 209–212

Silver Jubilee Article



Me, an Astronomer?

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I was faced with the query indicated in the title, when I received a letter from the editor of BASI wherein she described me as an astronomer. I have all along been regarding myself as a teacher and I earned my livelihood by teaching mathematics all these years. But to be a teacher one has to keep in touch with various related subjects and astronomy is, of course, one such subject. When the premier astronomical society of the country considers me as an astronomer of repute I felt proud and started some introspection to find out how this mathematics teacher was moulded into an astronomer.

It all began in 1937, when as an undergraduate student of mathematics I attended a course of lectures on General Relativity delivered by Professor V.V. Narlikar* at Bombay University. Not that I could follow much of what Prof. Narlikar talked, but today when I think in retrospect, I realise the profound influence these lectures had, at the subconscious level on the mind of a young student. I distinctly remember two turning points in my career when this subconscious impact might have led me to take the turn I did take.

Following traditions in my family, after graduation I opted for M.Sc. in pure mathematics. At the end of the first semester, in a casual discussion with a friend I found that both of us were feeling a little lack of excitement at studying the same old subjects like Calculus, Analysis, Algebra, Geometry etc. and we decided that if rules permit, we would change to applied mathematics. Rules permitted it and so we made the change and in applied mathematics I selected the special paper on Electromagnetic Theory and Theory of Relativity. This was the first turning point.

After my M.Sc. in 1940, I worked as a lecturer in mathematics in a college for one year. But then I decided to leave academic profession and to devote full time to what Gandhiji in those days called the constructive programme. With blessings of Gandhiji we started an institute of physical education called Ahimsak Vyayam Sangh (AVS) at Bombay in 1941.

* Father of the well known astronomer Prof. J.V. Narlikar. In this article the name Narlikar stands for Prof. V.V. Narlikar.

Baba Prithvi Singh Azad, a one time revolutionary was the director of the Sangh and I was working as the principal for the training programme of youths for non-violent struggle. In April 1942, Gandhiji was already planning for the freedom struggle (The Quit India Movement) and he wanted that our institute AVS should play a leading role in the struggle he was planning. We were all very happy at this idea but our director Prithvi Singh's response was lukewarm. As a revolutionary he had communist leanings. By 1942, Hitler had already invaded Soviet Union and so the Communist Party was set against any activity in India that would hamper the war efforts of the British (who were allies of Russia!) As a result, Prithivi Singh refused to undertake the responsibility which Gandhiji wanted to give him and in which we, younger members were all ready to help him. Because of his reluctance, on the advice of Gandhiji, it was decided to wind up AVS. As a young man of 24, I felt much disappointment. But I had an immediate problem to face. Without any activity, without any job, what to do, which way to turn? At this cross-roads, perhaps the subconscious impact reminded me of Prof. V.V. Narlikar. I wrote a letter to him at Banaras putting before him the facts and requesting him to take me as a research student. Pat came the reply by return of post and on 27 June 1942, I reached Banaras with my wife, a 6 month old child and with 500 rupees in my pocket (all my savings) to last us through a year.

I stayed at Banaras from July 1942 through March 1943. I started my research career not as a student of Banaras Hindu University but as a private student of Professor Narlikar, seeing him at his residence on two days every week. I began in the same way in which every young man begins his research career in Relativity in a mathematics department - by trying to solve the differential equation implying isotropy of pressure for a static sphere of perfect fluid. But ultimately we again turned to Bombay University lectures of 1937 referred to earlier. In these lectures Prof. Narlikar had mentioned two outstanding unsolved problems in General Relativity - the gravitational field of a radiating star and the field of a rotating star. He referred these two problems to me and further added that a rotating star must also radiate energy so we decided to concentrate on the field of a radiating star. And by early March 1943 a note was dispatched to Current Science giving essential steps in the derivation of the gravitational field of a radiating star. This note was published in the Current Science of June 1943. However those were war days and publication of detailed papers requiring intricate mathematical printing was a big problem.

But a still bigger problem awaited me. By March 1943, all the money I had brought with me was used up except the amount I had set aside to cover our return journey to Gujarat. So I returned to Gujarat in April and started searching for a teaching job which I got within a couple of months. Thus ended by nine months long career as a full time research student! And what a pleasant time it was!! We have a belief that people go to Kashi to earn a better life in the next birth. Well, I went to Kashi to learn how to lead a better scientific life in this birth.

The fact that I worked out an exact solution of Einstein's equations which represented the gravitational field of a radiating star did not qualify me to be called an astronomer; it only qualified me as a good mathematics teacher. Any new mathematical result which predicts a new astronomical situation or explains a hitherto unexplained observed phenomena gets a place in Astronomy. Otherwise it remains a beautiful piece of mathematics. And my solution came

under the latter category. Solution of Einstein's equations which represented the gravitational field of a cold dark (non-radiating) star was found by Schwarzschild in 1915. And that solution could explain all observed gravitational phenomena of stellar astronomy. My solution, in a sense, added a term of the order of the luminosity of a star to corresponding Schwarzschild solution. And for all known stars this additional term turned out to be of the order of 10^{-20} much below the range of observation.

Thus my research work qualified me to be a good mathematics teacher and I got full advantage of this additional qualification. Starting in 1943 as a lecturer in mathematics in a college, I became Professor, Vice Principal and Principal in colleges and ultimately became Professor and Head of the Department of Mathematics in the Gujarat University. I was also invited by a university in U.S.A. to be a visiting Professor of Mathematics in 1964. But by that time certain new astronomical observations gave an astronomical colour to the mathematical work of this successful maths-teacher.

It all began with the discovery of Quasars (Quasi Stellar Radio Sources). Quasars are the first gifts of the radio telescopes to Astronomy. Electro-magnetic waves of radio frequencies were being recorded on radio telescopes and the prevalent view was that these radio waves must be originating in far-off galaxies. I distinctly remember attending a lecture on this topic by Professor Vainu Bappu in the early sixties at Physical Research Laboratory. Discussing various possible theories of origin of these radio waves, in passing, he also mentioned the theory of collision of galaxies but added that except for a handful of 'die-hard relativists", no one believed in this theory. After the meeting was over, Prof. K.G. Ramanathan, director of P.R.L. introduced me to Prof. Bappu as "one of our live-hard relativists".

Observations of occultation of radio source 3C273 by the moon using the large radio telescope at Sidney, falsified the assumption that these radio waves originate in large galaxies. Australian astronomers found 3C273 to be a point like source. Since positions of the moon are precisely known, it was easy to locate the position of 3C273. So the 200-inch optical telescope was aimed towards this location and a star like object was observed. Thus, the first quasar was discovered and with it a new area in Astronomy developed - the area of High Energy Astrophysics. Newton's theory was found inadequate to describe the highly intense gravitational field of these objects and one needed the General Relativity of Einstein. Again quasars and pulsars not only have highly intense gravitational fields, they are point like sources emitting strong radiations. So the solution of a radiating star in General Relativity which I had derived in my papers of 1943, 1951 and 1953 found an application in 1964 in understanding the high energy outputs from these sources. So my solution of Einstein' Equations of Gravitation which remained a good piece of mathematics all these years, was found to be useful in understanding astronomical phenomena in 1964 and thus qualified to a place in Astronomy.

I shall end this introspection with an interesting episode. In early 1965, I had studied the gravitational contraction of a heavy star which is radiating energy and communicated that paper to Astrophysical Journal for publication. Prof. S. Chandrashekhar was the editor then. In July 1965 I attended the International Conference on General Relativity and Gravitation at London. There I had an occasion to meet Prof. Chandra. I introduced myself to him giving my name.

He immediately said, "Yes, I know you. You have communicated a paper to us. Did you receive my reply"? On my saying that I had not received it he said, "you will get it when you go back". And added, "By the way, where were you trained"? On my reply that I was a Deshi Doctor, completely made in India, he said, "Looks like it". And the interview ended.

On reaching home I found that a three-page letter from him had already arrived. The letter began something like this : The paper contains very interesting results and must be published, but ..... And after this "but" there followed 3 pages of instructions on how to write a readable paper - readable to Astronomers and Astrophysicists. It took me three weeks to rewrite my paper following those instructions and ultimately the paper was published.

So this Eklavya learnt how to write a readable paper from Prof. Chandrashekhar and he learnt it quite well. In 1973 I worked out a very general solution of Einstein's equations which represents the gravitational field of a heavy star which rotates about an axis as well as radiates energy. This work was communicated in a paper to Cambridge Philosophical Society for publication. The reply from the editor was, "This well-written paper will be published"!!

The net result of all this was that Professor Vainu Bappu suggested my name for membership of the IAU and so this mathematics teacher became an Astronomer!