Balu Turning Sixty

R. Thangadurai

Sikkal is the land of Jasmine flowers and the land of Lord Subramanian called Sikkal Singaravelan'. Ramachandran Balasubramanian was born at Sikkal on 15th March, 1951 to the couple Mr. Ramachandran and Mrs. Jembaga Lakshmi. In the mathematical community, he is known as 'Balu'.

Balu began his primary schooling at a small town called Vadapathimagalam in Tanjore District (currently Thiruvarur district) where his father worked in a Sugar Mills and his mother was a school teacher. Then he moved to a place called Ammapet, Tanjore district, for his secondary schooling. He joined Pushpam College, Poondy, Tanjore, district for his undergraduation (1967-70) and the postgraduation (1970-72), where he met an inspiring teacher Professor V. Krishnamurty.

After his successful postgraduate degree in Mathematics, he joined the premiere research institute, namely, Tata Institute of Fundamental Research (TIFR), Mumbai to do research in Mathematics in 1972, where he developed more interest in '*Numbers*'. It is noteworthy to mention a few of his batch mates at TIFR, some of which were, *Madhav Nori (University of Chicago), Adimurthi (TIFR, Bangalore)* and *N. S. N. Sastry (Indian Statistical Institute, Bangalore) who* are among the leading scholars in their areas of research in Mathematics. After the successful

completion of his first year course work at TIFR, he joined the leading Number Theorist '*Professor K. Ramachandra*' (1933-2011) to work towards his Ph. D. thesis in Analytic Number Theory. He chose Analytic Number Theory for his topic of research, as he felt most at home in this subject.

His Ph. D. Thesis dealt with an improvement of *a theorem of Titchmarsh (1934)* on the mean square of *Riemann Zeta function* and a *theorem of Hardy (1914)* on the gaps between the zeros of the *Riemann Zeta function* on the critical lines, which led to *'Young Scientist'* award by Indian National Science Academy (INSA), New Delhi in 1978.

He continued to work at TIFR. In 1980, he got an offer to visit the Institute for Advanced Study (IAS), Princeton, USA, where he had fruitful interactions with many great mathematicians, including, the Field's medalist `Atle Selberg'. During this visit, he had collaborated with another number theorist, M. Ram Murty on the oscillations of the values of Ramanujan Tau Function. A year later, he moved to the University of Illinois, Urbana-Champaign and spent a year there. During this visit, along with J. B. Conrey and D. R. Heath-Brown, he derived an asymptotic formula for the mean square of the product of the Riemann zeta-function and a Dirichlet polynomial. Moreover, their method led to an improvement of the lower estimate for the density of zeros of the zeta function on the critical line.

Along with K. Ramachandra, he has contributed many important papers to the theory of Riemann zeta function. Indeed, he continued to collaborate with K. Ramachandra till recently and wrote about fifty joint papers together.

He came back to TIFR in 1983-84 and continued his work there for another year or so. During this period, *Professor C. S. Seshadri* was setting up a pure mathematics group the *Institute of Mathematical Sciences (IMSc)* at *Chennai*, where Balu was offered the position `Associate Professor'. He accepted the offer and moved to IMSc in the year 1985.

During his Ph. D. days, he had developed an interest in one of the 300 year old classical problems in Number Theory, namely, the Waring's Problem which is: for a given natural number k more than 1, let the integer $g(k)$ denote the least positive integer s such that every natural number can be written as a sum of s, k^{th} powers of integers. Then Waring conjectured that *g(2) = 4, g(3) = 9, g(4) = 19 and so on*. Another Indian Number Theorist, Sivasankaranarayana Pillai (1901-50) solved this problem for all $6 \leq k \leq 100$, and, under a certain Diophantine condition, Pillai gave a complete formula for $g(k)$. In 1957, Mahler verified the Diophantine condition of Pillai for all large values of k. The case $k \leq 3$ was solved in 18th and early 19th century and the case $k = 5$ was proved by Chen in 1964. During Balu's Ph. D. days, the case $k = 4$ was a difficult open problem and he started working on this problem from his student days. Indeed, in 1978, he was close to the truth as he proved that $g(4) \leq 21$, whereas, conjecturally, $g(4)=19$. In 1986, he settled this 300 year old conjecture with the French collaborators (J-M. Deshouillers and F. Dress). Balu was elected as *a Fellow of the Indian Academy of Sciences (IAS), Bangalore* In 1987.

The year 1990 was the starting point of his glorious years to come. In that year, he has received *Shanti Swarup Bhatnagar Award* (CSIR, India) and *B. M. Birla Award* for his notable contributions to '*Number Theory*' and, in the same year, he became `*Professor*' at *IMSc*. Also, he was elected as a *Fellow of INSA*, New Delhi and *National Academy of Sciences (NASI), Allahabad*. Thus he became the member of all the three science academies in India.

During the period *1990-2000*, many important contributions came from him. Notably, with *V. Kumar Murty*, he proved that for any sufficiently large prime q a positive proportion of the characters χ *mod q* has *non-zero value of the Dirichlet L function* attached to the character χ at the value $\frac{1}{2}$.

He was a member of *INSA* council from *1994* till *1996*. During this period, with *K. Soundararajan*, he completely settled the Conjecture of Graham which is: If A is a set of N integers, then there exist integers a, b ϵ A with *a/(a,b)* is at least N. In fact, they proved the above conjecture for all $N >$ *(2.22)* 10^{12} and for the range $N <$ *(2.22)* 10^{12}, they had used computer calculations on gaps between primes to prove the assertion. Around the same time, he was promoted to `Senior Professor' at IMSc.

In *1996,* with *N. Koblitz*, he proved that the *Menezes-Okamoto-Vanstone algorithm* for reducing Elliptic curve *Discrete Log problem (DLP)* to classical *DLP* over finite fields is not in polynomial time, in general. This work guarantee that Elliptic curve based cryptography is more secure than the one based on the classical *DLP*.

In 2000-01, in the Indian Science Congress, he was honored with *'Ramanujan Centenary Award'*. He was one of the main academicians in India to establish the scientific collaborations between Indian and France. Indeed, in *2004-05, Institut Franco-Indien de Mathématiques (IFIM)* was established which enable the scientists to spent some time to do collaborative work in both the countries with the funding of Department of Science and Technology (DST), India and the French government. He is now the coordinator of *IFIM* in the Indian side. For his contributions, French government awarded him *'Chevlier de lordre National du Mérite'*.

Apart from his busy academic schedule, unlike many other researchers, he never shies away from the academic administrative responsibilities. In 2000, he became the Director of IMSc and after his successful two full-term directorship, he continues to be in that position even today. He has been simultaneously managing *Society for Electronic Transactions and Security' (SETS),* as an ***honorary director,*** since 2010. The Indian government awarded him *Padmashree* in *2006* for his contributions to Mathematics. In *2010*, he gave the prestigious plenary talk at the *International Congress of Mathematicians (ICM)* held at *Hyderabad* . Also, he has been quite involved with the Indian funding agencies like DST, and *National Board of Higher Mathematics (NBHM)*. For a long time he has been a member of both the funding agencies. He is slated to take over the *Chairman of NBHM* from April, 2011.

He has written about 135 research articles in internationally reputed journals and has collaborated with more than fifty Indian and non-Indian scientists. Apart from various branches of Number Theory, he has collaborated with many Analysts in India and abroad. Also, he has guided one theoretical computer science student's thesis and has written some research articles with other theoretical computer science colleagues. He has been President of *Cryptology Research Society of India*, Kolkata. He guided about ten number theory theses (the list is given below) and many post-doctoral fellows, including myself.

He has been an inspiration for many youngsters in India to pursue Number Theory as a research career. He delivers lectures with ease and makes the subject clear to even the non-expert

audience. Also, he is easily accessible and approachable. He is a very simple and kind hearted human being. He has a very lovable family. He is married to *Ms. Lakshmi*, has a daughter *Ms. Aruna* and a son *Mr. Ravi*. Though he became academic grand-father several years back, recently he became a grand-father in the family life too. His other interests include Tamil Literature and playing Bridge. Occasionally, he writes Tamil stories under the name `Ila Murugu'.

He is turning sixty on 15th March, 2011 and we pray the almighty to offer him good health, and continued success in the forthcoming days   in both the academic and family life.

List of Ph. D Students of Professor R. Balasubramanian and their current affiliation

1. S. D. Adhikari (Harish-Chandra Research Institute, Allahabad)

2. C. S. Yogananda (Sri Jayachamarajendra College of Engineering, Mysore)

3. M. Velammal (Meenakshi College for Women, Madurai)

4. R. Padma (Vellore Institute of Technology, Vellore)

5. N. Amora (Allahabad)

6. R. Venkatraman (IGNOU, New Delhi)

7. M. Kulkarni (Indian Statistical Institute, Bangalore)

8. S. V. Nagaraj (Hadramout University, Mukalla, Yemen)

9. D. S. Ramana (Harish-Chandra Research Institute, Allahabad)

10. G. Prakash (Harish-Chandra Research Institute, Allahabad)

11. P. P. Pandey (Currently, writing his Thesis)

Harish-Chandra Research Institute
Chhatnag Road, Jhunsi, Allahabad 211019.
thanga@hri.res.in