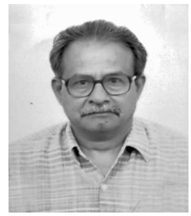
Editorial

Bala Iyer, Guest Editorial

The theory of general relativity is acknowledged universally as being the pinnacle of mathematical elegance riding on a remarkable, conceptual physical insight. Even while it was work in progress, Einstein left no stone unturned to look for its observational consequences and over the years, general relativity is also recognised for its phenomenal observational successes. Analogy with the electromagnetic case was an insight that Einstein used all along and hence it is no surprise that in 1916, a year after the creation of GR, Einstein predicted the possibility of gravitational waves by looking at the linearized version of his full equations. Biman's article provides a pedagogic introduction to the basic results on gravitational waves at this level.



Bala Iyer has worked in general relativity starting with his PhD. He worked at the Raman Research Institute till 2014, and particularly on the analytical approach to gravitational wave emission from inspiralling compact binaries from the year 1989. Currently, he is at the International Centre for Theoretical Sciences with the Astrophysical Relativity group. He is the Chair of the IndIGO collaboration, which coordinates the gravitational wave effort in India. One of his major other interests has been to add value to undergraduate science education in Bengaluru via regular lectures at the Jawaharlal Nehru Planetarium.
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The theoretical understanding of GW went through a chequered history in its early years with issues related to distinguishing physical and coordinate effects. Even Einstein ocassionally vacillated as recounted in the article (book review) by Rajaram and needed to be brought back to track by critical and sharp referees and editors who refused to be intimidated by him. Technical issues regarding choice of suitable coordinates, method to include non-linearities, imposition of no-incoming boundary conditions when working in the near-zone, matching exterior solutions to a source, created a babel for some years prompting Feynman at the Chapel Hill meeting in 1957 to quip, " Drive on... Make up your mind... Don't be so rigorous or you will not succeed". At the next meeting in Prague, in 1961, finding a day devoted to similar questions he wrote to his wife, " Not good for my blood pressure". Thus, the mathematical work of Bondi and the physical insight of Pirani to focus on the effect of the gravitational wave rather than the problem of production were important developments that merit the 'Back Cover' of this issue. Interestingly both these personalities figure in the famous

Chapel Hill meeting and proceedings which inspired Weber to build his bar detector and later provided Weiss insights to think about his laser interferometric GW detector.

Building on work by Trautman, in his own personal style in the sixties, Chandrasekhar solved the radiation reaction problem in the case of fluids. This gave astrophysicists confidence that in general relativity, emission of GW was corrrectly accounted by the loss in mechanical energy and angular momentum of the system. The discovery of the binary pulsar 1913+16 in 1974 and the possibility to test with it the radiation reaction predicted by GR revived issues related to the theoretical treatments then available. Finally, different approaches were shown to be consistent with each other and the observations put to end the theoretician's regress as described in the book by Kennefick.

The Nobel Prize to Hulse and Taylor brought to close this era and the start of another era towards a direct detection of GW by ground-based detectors like LIGO and Virgo. The first generation detectors achieved their design sensitivity and though they did not make any detection, allowed one to improve upper limits on a variety of potential GW sources. The upgrade to the second generation advanced detectors started in 2010, targetting eventally a 10-fold increase in sensitivity. The first detection of GW from a black hole binary almost at the start of the first science run of the Advanced LIGO is a dream debut for any endeavour. Its success is a tribute to a talented and determined team of experimenters making steady progress over almost four decades complemented by corresponding progress in the understanding of the two-body problem in general relativity and the setting up of reliable and efficient infrastructure for data analysis to detect and characterize the potential GW signals. It is indeed remarkable that almost all ideas explored over the last two decades to characterize GW and test GR by GW were implemented in the first discovery including the quasi-normal mode ringdown of the final black hole predicted by Vishveshwara in 1970.

Showing remarkable foresight, in parallel, LIGO Laboratory looked into the scientific merit for the geographical relocation of their third

Advanced LIGO detector to an observatory at intercontinental distance. How the collaboration of LIGO Laboratory and IndIGO led to LIGO-India is the story covered in Tarun's article.

The discovery of the first binary pulsar 1913+16 led to searches for binary pulsars and the subsequent discovery of other interesting systems. The discovery of the black hole binary GW150914 heralds a new class of binary GW sources and a subsequent revolution. LIGO-India is a critical element in the global GW network and has the potential to launch GW astronomy when it comes online by 2023. With possible spinoffs to impact precision experiments and cutting-edge technologies in India, LIGO-India could indeed be transformative with multiplicative effects arising from the symbiotic involvement of theory, experiment, engineering and computing communities in the endeavour.

Note from Chief Editor: Our plans for the March issue were overturned with the announcement on Feb 12 of the long-awaited direct detection of gravitational waves. I thank my colleagues Bala Iyer and Tarun Souradeep (both deeply involved in the field) who made this quick response by *Resonance* possible at short notice, in spite of being extremely busy in the last three weeks.