

## The Music of Relativity

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*It's a hundred years since Einstein laid out the fundamental landscape of the General Theory of Relativity and changed the human construct of our universe.*

The General Theory of Relativity, and quantum mechanics and Gödel's theorem are among many others the intellectual edifices of the 20th century and they seem to have bypassed the mass of humanity. This is unfortunate as there is no better pathway to the *longue durée* of life, the universe and everything.

As edifices go, the General Theory of Relativity is pure music, sheer elegance and a monumental tribute to the power of pure thinking of the human brain. It gives joy to those who are fortunate to follow the train of thought that leads to a glimpse of the beauty and symmetry behind it. It is Beethoven's Moonlight sonata, Bach's magical fugues, Bade Ghulam Ali Khan's Darbari Kanada and Thyagaraja's Pancharatnakritis rolled into one.

It was in November 1915, when Einstein laid out the fundamental landscape of the General Theory: it is the geometry of space-time that determines gravity, and the distribution of mass-energy; and importantly, vice-versa. Or as the physicist Wheeler put it wryly: "Spacetime tells matter how to move; matter tells spacetime how to curve".

"When old words die out on the tongue, new melodies break forth from the heart; and where the old tracks are lost, new country is revealed with its wonders." Rabindranath Tagore in *Gitanjali*

This is what Einstein must have felt when in 1907 he had the 'happiest thought' in his life: if a person falls freely he/she will not feel his/her own weight. The 'happiest thought' occurred to him, two years after 1905, Physics' *annus mirabilis*, the year of miracles, when Einstein published four path breaking papers. This happy thought gave him an insight that acceleration and gravity were basically facets of the same coin. And it was another eight years before Einstein felt confident enough to announce to the world, in November 1915, the General Theory of Relativity that worked out the implications of the 'happy thought' signifying the equivalence of inertial and gravitational mass.

Nothing in geometry and physics has since been the same. Our zeitgeist and weltanschauung changed forever. Einstein surpassed the other Master, the Master of the Mint, Isaac Newton. Newtonian physics with its warts and all was ironed out with Newton's Law of Gravitation, itself turning out to be a special

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case of General Theory of Relativity.

the General Theory. In addition predictions of the General Theory have been impressively confirmed experimentally even as General Theory of Relativity was and is the definitive predictive theory informing us about the structure of the universe, black holes, the bending of light by gravity (the original Eddington observation in 1919 vastly improved by quasar radio observations since 1969), the slowing of time in a gravitational field (pace the Pound Rebka experiment of 1960), the correction to the orbital precession of Mercury, the “time delay effect” confirmed by Shapiro (now called the Shapiro delay). And, of course, the fact that GPS timing devices would not have worked but for taking into account that clocks of hovering artificial satellites are faster by 38 microseconds than earth-based clocks, an effect predicted by the General (and Special) Theory of Relativity. The earliest predictions of stars collapsing into black holes or neutron stars were made by the Indian American physicist Subrahmanyan Chandrasekhar – a prediction famously ridiculed by Eddington. Even Einstein in the early 1930s did not show interest in the devastating prediction of black holes by General Theory of Relativity. Nor would he have of phenomena such as wormholes, parallel universes, time travel, event horizon, etc., all triggered, ironically, by his theory.

Any philosophy of time and space worth its name after General Relativity, and that goes beyond mere Bridgmanesque operationalism, or Popperian logical positivism, has to integrate in its discourse the nature of relativistic space time and matter and energy, and the bizarre behaviour of time in the presence of giant masses. Any Grand Unified Theory of Everything has to take into account relativity and quantum theory (for which there is no satisfactory unified theory at present); and has also to take into its stride complexity and chaos (as in chaos theory) in the universe; evolution from the first singularity; the Big Bang; to evolution from apes to human beings, and the onset of consciousness. How is it matter can think about itself if we all are a product of the primordial ylem? The physicist’s response to the question as to what happened before time started, as a meaningless question, is unsatisfactory. How do things get meaning if geometry defines time, mass and energy?

“Now,” said JBS Haldane in his *Possible Worlds*, “my own suspicion is that the universe is not only queerer than we suppose, but queerer than we can suppose. I have read and heard many attempts at a systematic account of it, from materialism and theosophy to the Christian system or that of Kant, and I have always felt that they were much too simple. I suspect that there are more things in heaven and earth than are dreamed of, or can be dreamed of, in any philosophy. That is the reason why I have no philosophy myself, and must be my excuse for dreaming.”

A good reason, indeed, for the human race not to self-destruct over fundamentalisms of any kind ...even if, Einstein’s  $E=mc^2$  led to the atom bomb, and Hiroshima and Nagasaki happened because of human frailty.