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HISTORICAL NOTES

Rabindranath's Thoughts on Science : An Overview (A Tribute in his 150th Birth Anniversary)

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A close study of the intellectual renaissance which occurred in India during the second half of the nineteenth century flowing into the twentieth is vital in order to understand Rabindranath Tagore (1861-1941), one of the makers of modern India. It was within this renaissance that a creative synthesis of the best of the East and the West took place in science, art, literature and culture. Rabindranath was the symbol of that great synthesis. Rabindranath is the personification of supreme intellect, his name being synonymous with genius. The first Nobel Laureate in Asia and Africa in 1913 (in Literature for his book : "*Gîtāñjali*" – 'Offering of Songs') was not only a poet, a philosopher, an artist, but also an ardent propagator of popular science in order to eradicate age-old irrational superstition among his people.

Rabindranath is India's greatest modern poet and the most brilliant creative genius produced by the Indian Renaissance. In addition to poetry, he wrote songs, stories and novels, plays, essays, memoirs and travelogues. He was both a restless innovator and a superb craftsman. His poetry has an impressive wholeness : a magnificent loving warmth, a compassionate universal humanism, a delicate sensuousness, an intense kinship with nature and a burning awareness of man's place in the universe. He moves with effortless ease from the literal to the symbolic, from the part to the whole, from a tiny detail to the vast cosmos. His sense of science and its spirit is thematically reflected in his writings.

At the very dawn of the Indian Renaissance, Rabindranath came in close contact with the rising scientists of India [Acharya Jagadish Chandra Bose (1858-

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1937), Acharya Prafulla Chandra Ray (1861-1944), Chandrasekhara Venkata Raman (1888-1970)- the first Asian to win the Nobel Prize in Physics in 1930 for his Raman Effect and also Professor of Physics in the University of Calcutta, Meghnad Saha (1893-1956), Acharya Satyendranath Bose (1894-1974), Dr. Mohammed Kudrot-e-Khuda, Professor of Chemistry, Presidency College, Calcutta, and so on].

Rabindranath's interest in science can be traced to his early teens. He loved astronomy, and when in England many years later, visited the Greenwich observatory. Eminent astrophysicist, Meghnad Saha, persuaded him to write a book – rather a booklet – in Bengali ("*Vishvaparichaya*"- 'Introducing the Universe', 1937) which he dedicated to Satyaendranath Bose, Father of Boson and of Bose- Einstein Statistics- Bose- Einstein Condensate (BEC) fame. He collaborated with one of his very close family friends – Prashanta Chandra Mahalanobis, Professor of Physics and Statistics, Presidency College, Calcutta, who became general secretary of Vishva-Bharati University in 1921. He had encounters with European scientists and scientifically minded philosophers, such as Bertrand Russell (1872-1970), Nobel Laureate in Literature, 1950. The German physicist, Arnold Johannes Wilhelm Sommerfeld (1868-1951), met him in Calcutta in 1928. The famous German physicist and philosopher, Werner Karl Heisenberg (1901-1976), Nobel Laureate in Physics 1932 (for his Uncertainty Principle) met him in Calcutta at his Jorasanko-house in 1928. He is reported to have said in 1972 that Rabindranath's philosophical ideas had been of help to him as a physicist. Heisenberg (the young scientist of 27 then) had several conversations with the mature poet (then 67) about relativity, incommensurability, interconnectedness and impermanence as fundamental aspects of physical reality. After the conversations he said: "Some of the ideas that had seemed so crazy, suddenly made much sense. That was of great help to me." His enduring fascination with the relationship between Man and Nature, notably in his Hibbert Lectures- "The Religion of Man" at Manchester College, Oxford University on May 19, 21, & 26, 1930, - brought him close to Albert Einstein (1879-1955), Nobel Laureate in Physics, 1921. The Russian-Belgian scientist- Ilya Prigogine- (1917-), Nobel Laureate in Chemistry, 1977, remarked in 1984 that "Curiously enough, the present evolution of science is running in the direction stated by the great Indian poet." A magnificent tribute indeed!

In India Santiniketan School (Established 1901- first as *Brahma-Carya* School) is the first institution where learning of science by direct practical

experimentation was introduced at primary school level. In one of his essays- "*Shiksha*" (1906) he wrote: "In order to teach science to youngsters, their eyes need to be opened up first and power of observation enriched" (Translation by this author). Thanks to Rabindranath for his foresight!

Allusions and references of things scientific and medical fascinated both William Shakespeare (1564-1616) and Rabindranath. There are plenty of them in their writings. Shakespeare was interested in health and sickness in his time (allusions in King Lear, Macbeth, Julius Caesar, *Twelfth Night*, and so on). Rabindranath's interest was in contemporary sciences- astronomy, astrophysics biology, etc.- allusions are spread in his novels, short stories, poems, essays, etc., written from his teens to almost the end of his life.

Eminent Bengali writer and linguist, Syed Mustaba Ali, one of the closest students (1921-1926) of Rabindranath at his Santiniketan School recorded in one of his articles that he used to read books on science, physics, anthropology, chemistry, astronomy regularly, and sent them to the school library.

All of Rabindranath's writings containing references to things scientific are in his mother tongue- Bengali (this author's mother tongue as well). This is a serious limitation to non-Bengali readers. Bengali, in terms of numbers of speakers, is the seventh most-spoken language in the world (about 200 million in India, Bangladesh and in several countries outside India (United Kingdom, United States of America, Germany, France and Gulf countries). In order to get the real flavour and beauty of Rabindranath's writings, one needs to read them in original; translations in other languages are no substitute. Bertrand Russell appreciated Rabindranath's poems, but wished he could have read them in Bengali.

First Writing on Science

It was written at the age of 13. It was about planets and their inhabitants (its Bengali title: "*Grahagan Jiber Ābāshbhūmi*- Planets are the home of things living). It was published in their family periodical – "*Tattuabodhini Patrika*" in 1874. The periodical was established and edited by his father- Debendranath Tagore (1817-1905). This article shows his keen interest in astronomy, which stayed with him till the end of his life.

In 1885 a children's journal- "*Bālakā*"- was started in the Tagore family at Jorasanko by Jñānadanandinī Devī, wife of Rabindranath's elder brother,

Satyaendranath Tagore. It was short-lasting- only eleven issues were published. Rabindranath also took an active part in its editing and publication. The aim was to encourage literary activities among the children of the family. Rabindranath himself wrote in the 6th issue [on '*Barafparā*' (Snowfall) p. 34-44; '*Vijñān Saṃbād*' (Science News), pp. 351-354]. In fact, he wrote in Science News from the very first issue.

Rabindranath edited five periodicals (*Sādhanā*, *Bhāratî*, *Bangadarśan*, *Bhāndār*, *Tattuabodhinî*) at different times of his life. News and articles on science got prominence in all those periodicals.

Rabindranath edited "*Bangadarśan*" [established by Bankim Chandra Chatterjee (1838-1894)] for five years (1901-1905), when it came out again after Bankim's death. Bankim also wrote a book on popular science- ("*Vijñān Rahasya*"- Mystery of Science'); also got prominence in his journal- *Bangadarśan*. Rabindranath, during his editorship, encouraged people to regularly write on science in *Bangadarśan*. He himself wrote on Acharya Jagadish Bose's research in *Bangadarśan* ('*Acharya Jagadisher Joybārtā*'-Victory Message of Acharya Jagadish, 1901).

Rabindranath was primarily in charge of the science section of *Sādhanā* (1901). He himself wrote many articles on science [*Gatinirnayaner Indrīya* (Indicators of Motion), *Icchā Mṛtyu* (Suicide), *Uṭpākhîr Lāthi* (Kick of Camel bird), *Bhugarvastha Jal* (Underground Water), *Vāyupravaha* (Force of Wind) 1894].

Inquisitiveness for scientific knowledge and information made him a prolific reader and thinker- their reflection is scattered limitlessly in his literary works. He meant what he thought and put them into words wherever relevant.

The Poet and Copernicus

European Renaissance (1500-1700 AD) threw off many myths concerning Nature. With the publication of "*De Revolutionibus Orbium Coelestium*" (On the Revolution of Celestial Spheres) by the Polish astronomer, Nicolus Copernicus (1473-1543) in 1543, the myth of geocentric universe (earth is the center of the universe) was shattered and was replaced by the concept of heliocentric universe (the sun is the center of the universe, around which our planet earth moves). It was against the Biblical preaching (same as in other religions — Hinduism, Islam,

etc.). The Vatican rejected it. Galileo Galilei (1564-1642), the Italian astronomer, was a staunch supporter of the Copernican concept and was condemned by the Vatican in 1616 and 1633, and was put in house arrest in Florence for the rest of his life. The poet, John Milton (1608-1674), though blind since 1652, went to see Galileo at Florence. Geordano Bruno (1548-1600) extended the concepts of Copernicus by suggesting that the universe was infinite and thus paved the way for Galileo, Johann Kepler (1571-1630), Tycho Brahe (1546-1601), and Isaac Newton (1642-1727). Bruno was a churchman, but still he was burnt at the stake as a heretic for supporting the ideas of Copernicus.

Heliocentric universe of Copernicus did not escape the attention of the poet. He expressed the whole concept of Copernicus in a beautiful way in his poem – "*Vasundharā*" (1893) in his book of poems- "*Sonārtarî*" (1894):

"You, my earth are many years old

Taking me on your lap, aligning with the infinite sky

Going round and round with your untiring legs

Around the solar system- innumerable days and nights through the ages.

(Prose translation by this author.)

Rabindranath was totally free from superstitions- religious or otherwise. In his poem "*Vasundharā*" he totally rejected the geocentric concept of the universe postulated by the Egyptian astronomer and geographer of the Antiquity- Claudius Ptolemaeus (c. AD 100-c. 170) in his "*Almagest*". According to his theory, the Earth is the center of the universe with the Sun, Moon and Stars revolving around it. The poet poetically accepted in the above poem the idea of heliocentric concept of the universe proposed by Copernicus, Galileo and Bruno. He eloquently wrote about the fight of Bruno against religious superstition, for which he gave his life.

The Poet and The Sun

In his poem- "*Sāvitrî*" (1924), written on the ship to Buenos Aires (Argentina) – Haruna-Maru- on Sept. 26, 1924, the poet described how the Sun has kept his darling daughter- the mother Earth- alive and kicking with the gift of his enormous rays. In the preamble to the poem, he gave and account of how different elements- Hydrogen, Helium, etc.- are constantly burning generating profuse heat and high temperature. In that gaseous melee, the poet imagined the presence of "Saraswatî" – the goddess of learning with violin in her hand. He felt the influence of solar power within himself and introduced himself to the reader:

"....This life is a torn tune of your flute,
A trail of tunes in the confluence of our existence,
Smilingly floating in the stream in a game,
The mother earth amusingly embraced it.
Who knows what you gave me from the storage of glow and glare"
(Prose translation by this author.)

This was the poet's very personal way of expressing his profound gratitude, acute appreciation and indebtedness to the mighty Sun, donor of all energy and power to the mother earth. What an astonishing sense of science!

In another poem- "*Āhvān*" (1924) written on the ship – Haruna-Maru- on October 1, 1924, the poet admitted the influence of solar power in the very core of his mindset.

".....In this darkness of mother earth who is that enlightened composing sons,
Inviting others in every shade of light with burning and glowing eyes,
That is why romance arises in the deep darkness of the soil, in the excited grasses,
The earth rises with cries, ray of life spreads in all directions "
(Prose translation by this author.)

He was familiar with the famous physics textbooks of Adoiphe Ganot (1804-1887) that ruled European schools and undergraduate classes for many decades, and on which all Bengali physics text-books were modelled till 1898. Tagore's acquaintance with Ganot is apparent from a passing reference to Ganot and the German physicist- Herman Ludwig Ferdinand von Helmholtz (1821-1894)- the inventor of ophthalmoscope, in the famous satirical poem- "*Unnatirlakṣan*" ('Signs of Progress') included in his book of poems- "*Kalpanā*" (1900). Shortly after his return from the momentous tour of Europe and the USA in 1914, the poet wrote a delightful essay- "*Āmārjagat*" ('My World'), the theme of which is a mock debate between a poet and his scientist friend.

Science in Satires

Intellectual satires in his works are very well-informed and based on facts and not fiction. In one of his classic novels- "*Śeṣer-kavitā*"(1928) the hero Amit Ray, while addressing the Lābanya as Banya in her maternal anut- Jogamay's

house, insisted that the same person may be addressed in different names in different places and in different contexts, and this is relativity of names. He tells Labanya that he wants to be famous by preaching "Relativity of Names"; he also mentions time-space relation and time dilation as thought by Einstein. (*Śeṣer Kavitā*, Viśvabhāratî, 1929, pp. 53-54.) It was a time when the Special Teheory of Relativity by Albert Einstein (1879-1955) was a talk of the day in science, arts, philosophy, sociology, theology and so on. It stole people's hearts; it spoke the song of their souls and it played the music of their minds. Such an epoch-making event- the Special Theory of Relativity- cannot and did not escape the attention of Rabindranath.

In another context in *Śeṣer Kavitā*, Lābanya (Banya) is sitting alone under a tree and is tearing grass; suddenly Amit (Mita) appeared on the scene and commented "Lābanya's study of the Botany of grass did not proceed any further."

In another conversation, the very basic concept of the relationship of man, universe and velocity ($E= MC^2$: E= energy, M= mass, C= velocity of light) found literary expression in the shortening and lengthening of names. He made the complex Theory of Relativity easy for all of us. Einstein's Theory of Relativity got a new popular dimension in the poet's classic – "*Śeṣer Kavitā*" (p. 54, q.v.).

> "Time should not mean the same to everybody. Conventional clock gives one time relative to space, but personal clock which controls the Universe, gives another. This is what Einstein thinks."

There are many such scientific satires in his works.

Tagore, Thermodynamics and Entropy

Rabindranath had a wide and diverse interest in science. In his "*Panchā Diary*" (1895), he mentions if heat is the source of motion, then matter exists only when there is heat, matter moves and wind blows; if heat is exhausted, then everything comes to a standstill. The idea has a touch of the second law of thermodynamics which can be interpreted to mean that the entropy of a closed system tends towards a maximum and its available energy tends towards a minimum. It has been held that the universe constitutes a thermodynamically closed system, and if this were true, it would mean that a time must finally come when the universe unwinds itself, no energy being available for use. Heat and energy are convertible both ways. This state is referred to as the "Heat death of the Universe". In his statement Rabindranath considers this aspect and expressed apprehension.

It is by no means certain, however, that the universe can be considered as a closed system in that sense. The universe is still expanding. There might be many a universe-multiverse should be the right expression.

Rabindranath and the Universe

The evidence of Rabindranath's inquisitiveness about the planets, stars, etc. of the universe is scattered in his writings over 40 years, starting from "*Naivedya*" (1901) to "*Janmadin*" (1941). The cosmos and the universe always roamed in the corridor of his mind:

> "....What we mean by words like body, soul, mind: I don't fathom,
> but I shall always observe the universe quietly,
> without words..... .
>
> The current of the cosmos's awareness flows towards you".
>
> ("*Naivedya*"- Poem No. 88 : Translation by Ketaki Kushari Dyson- "Rabindranath Tagore : I Won't Let You Go" Bloodaxe Books Ltd., Newcastle upon Tyne, 1991, p. 125).

The discovery of the power source of the vast universe and the changing structure of atoms in 1900 revolutionized our perception about things around us. There are reflections of this phenomenon in other poems of "*Naivedya*" :

> "....Body, mind and soul in unison-
> what a beautiful display in my body
> What a glow- what a burning light
> In the eternal theatre of day and night.
>
> "....In the veins and arteries of my body
> Flow the waves of life day and night,
> That life is rushing to win the universe
> That soul is dancing on the planet in beautiful tunes."
> (Translation by this author.)

In his youth Rabindranath read about gravitation, life sciences, astronomy and mechanics of atoms. Protons and electrons are the foundation of all characteristics of the biological world, a wonderful display in our own body. The poet imagined the main scientific entity between the cycles of creation and destruction, which are flowing eternally. He wrote in his poem "*Naṭarāj*" in "*Banabanî*" (1931)- how electron rebels against the proton-circling the proton and enriching itself rushes again to the center of another proton:

> "....the rebel atom becomes beautiful in its dancing spree
> Around the feet of the moonlight"
> (Translation by this author.)

The poet contemplated on the uniqueness of the Grand/ Intelligent Designer. In his classic novel – "*Gorā*" (1909) dedicated to his son, Rathindranath Thakur, Gorā – the hero – enumerated different aspects of uniqueness of the Grand Designer in His/ Her Uni/ Multi/ verse pointing out science is breaking its head to explore the mystery (*Gorā*, *Rabindra Racanābalî*, Collected Works of Rabindranath, Viśvābharatî Kolkata, Vol. 3, p. 459, 1986).

Rabindranath, in fact, thought of an assimilation of reality with scientific truth. This is an echo of his understanding about the nature of the elements creating the Uni/ Multi/ verse – a problem yet to be solved by science.

There are pertinent questions about the origin of the Universe and our place in it. When and how did it begin? Why are we here? Why is there something rather than nothing? What is the nature of reality? Why are the laws of nature so finely tuned as to allow for the existence of beings like ourselves? And, finally, is the apparent 'grand design' of our universe evidence for a benevolent creator who set things in motion? Or does science offer another explanation? The most fundamental questions about the origin of the universe and of life itself, once the province of philosophy, now occupy the territory where scientists, philosophers and theologians meet- if only to disagree. It seems there is no one universe. There is now multiverse concept of reality, in which there are many universes.

Rabindranath- the science conscious poet- philosopher- symbolically alluded to the universe and our position in it in a myriad ways in his poems, songs, dramas, novels and in popular science writings.

Who is the Inelligent/Grand Designer of the Uni/Multi/verse? A million dollar question! In the odyssey of "His/Her" discovery, the caravan of scientists, poet-philosophers, theologians, and so on, starting from Newton, Rabindranath, Einstein to Stephen Hawking (1942-) stopped abruptly at the periphery and did not proceed any further to the center of the question.

Tagore and Einstein: Philosophy of Science

Albert Einstein and Rabindranath are legendary figures, whose reputation endures into the twenty-first century. Einstein and Tagore met four times- the first time in 1926 in Germany. Their first conversation about the nature of reality took place on July 14, 1930 during his second visit at Einstein's home at Kaputh, Potsdam, near Berlin (Appendix A). It was reported in the *New York Times* by

the journalist Dmitri Marianoff (Einstein's step-son-in-law) : "It was interesting to see them together; Tagore-the poet-with the head of a thinker, and Einstein-the thinker-with the head of a poet. It seemed to an observer as though two planets were engaged in a chat." On Science, the Poet told the Scientist during the conversation : "Science is concerned with that which is not confined to individuals; it is the impersonal human world of truth". [See Tagore "*Farewell To the West*"(1930-1931), pp. 294-295; Tagore "*The Religion of Man*", New York, Macmillan, 1931, Appendix 2, pp. 221-225.]

Courtesy: Science and the Indian Tradition, when Einstein met Tagore (Berlin, 1930)*

They met again for the third time at Einstein's home at Kaputh on August 19, 1930, and had a lengthy conversation on science and music. (Appendix – B: Science part only). On the Nature of Reality, *New York Times Magazine*, August 10, 1930, published an article entitled "Einstein and Tagore plumb the truth".

Tagore again met Einstein in mid-December, 1930, in New York for the fourth and last time. They shared a deep mutual respect. Einstein alluded to Tagore affectionately as "Rabbi" (Teacher) and Tagore turned down the offer of an Honorary Doctorate from Berlin University as a protest against the Nazi treatment of Einstein. The conversation on science made a great impact on several Indian scientists of the day. There was a progressive encounter between western science and educated Indians during the last two centuries, and the development of science in Indian society.

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The year 1905 is not only the "*Annus Mirabilis*" (Miraculous Year) of Albert Einstein (1879-1955), "the Copernicus and Newton" of the twentieth century- "Person of the Century" (*Time Magazine*, Dec. 31, 1999) but also of the world of Modern Science, when five epoch-making papers were published in *Annalen Der Physik*, Vol. 17, 1905. Einstein was then a second division Clerk at the Patent Office at Berne, Switzerland. His Special Theory of Relativity proposed in two of the 1905 papers (see Sisir K. Majumdar: *A Tribute To Einstein*, Germinal Publication, Kolkata, 2006, pp. 23-32) sent ripples in the world of science. It stunned every thinking person- scientist, theologian, philosopher, sociologist, artist and so on. It postulated that space and time were not independent and the world is a four-dimensional metrical continuum with three-dimensional space.

The Poet accepted the time-space continuum, and in appreciative hymnic adoration, he "sang the song of praise for light emanating from the source of darkness". The only witness is the limitless unknown. What a height of poetic imagination!

The new philosophy of time-space continuum- fourth dimensional world is reflected in several poems of his book- "*Śeṣ Saptak*"(1935):

> "....In the new theory, the boundary of time was drawn in the limitless sky at the beginning of creation.
>
> The largest space is measured in the scale over crores of years.
>
> On the planet boundary of human era is drawn but in a small measure in the form of light and darkness behind the eye of the stars secretly....
>
> In the twinkle of their eyes, the cycle of creation and destruction continues here on earth."
>
> (Translation by this author.)

This is how the Poet shows his respect and salutes the science of astrophysics.

He did appreciate the philosophical problems of science, as well as its relationship with the other creative areas of humans. He wrote in 1932:

> " Modern science analyses reality with a detached mind; modern poetry should also do the same, for that is what is eternally modern". (*Rabindra Racanāvalî*, Vol. 14, p. 348, West Bengal Govt. Edition, Calcutta, 1961).

Rabindranath seemed to be ambivalent with a bit of concern about the apparent incompatibility, conflict and contradiction between objectivity in science and literary/ artistic imagination or innovation. Literature, he said, was characterized essentially by the prejudices and caprices of the individual, which was in direct opposition to the impersonal and rational objectivity of science. He cites a beautiful example from his own lyrical dance-drama- "*Citrāṅgadā*" (1891). The hero-Arjun- is indulging in voyeurism (one who obtains sexual gratification looking at others' sexual actions or organs), when he stealthily looks at young narcissistic (youth who pined away from love of his own reflected imagemorbid self-love or self admiration) *Citrāṅgadā* undressing before bathing in a pond rapt at the exquisiteness of her own form. Arjun is excited and overwhelmed. This, Rabindranath appears to be saying, can be treated in two ways: one is the interpretation of Sigmund Freud (1856-1939), Father of Psycho-analysis which dominates modern psychiatry, which is perfectly in order in science. However, the moment that interpretation interferes with and dominates over artistic presentation, it kills art. Rabindranath felt that Western literature of the modern period had fallen victim to just such an aggression from reductionist modern science.

In later life, he seemed to have reconciled. He says that poetry should also look at the world with an objective clinical detachment. He brings in mathematics to solve the riddle when he says in 1932:

> "The mathematician no doubt engrosses himself in the profound symmetry permeating high-level mathematics, in the unity of forms. The fact of its orderliness is not only epistemic, it belongs also to the sphere of deep feelings: there you get pure bliss. It finds expression at the apex of knowledge, where it is free of any utilitarian concern. There knowledge attains liberty. One naturally wonders why this has not been the subject of poetry. The reason, of course, is that its experience is esoteric (not generally intelligible), its access denied to the common person".
>
> (*Rabindra Racanāvalī*, op.cit. p. 348.)

Rabindranath and Theory of Evolution

The Poet was immensely influenced by the Theory of Evolution by Charles Robert Darwin (1809-1882): While reading life sciences he was very much moved by Darwinism. There are references and allusions to the Theory of Evolution scattered in his various writings. In one letter in "*Chinnyapatra*" (*Torn Letters*) he said: "I can clearly remember that many thousand years ago I was born as a

tree on this planet earth and on that day in the morning rays from the new sun were flashing on my body". There are many such descriptions in many of his letters. His ideas and thoughts on human evolution were mostly expressed in his letters.

At the age of 22 in 1883, the poet commented in his essays- "*Vividha Prasaṅga*" and *Jagatpîḍā*" on what Evolution Theory teaches us. He wrote in "*Jagatpîḍā*":

> "Every inert atom is trying to attain life; tiniest life is trying to attain full life; every full being (for instance, man) is trying hard to avoid the clutches of unfulfillment. In the vast Universe, every atom is constantly trying to evolve."

Rabindranath and Jagadish Chandra

Jagadish Chandra Bose (1858-1937) experimented with wireless communication in Presidency College, Calcutta; he was the real inventor of Gugliemo Marconi's (1874-1937, Nobel Laureated in Physics, 1909), wireless detector (coherer) used for the trans-Atlantic wireless signal reception. Rabindranath and Jagadish were very close friends; both were in constant touch with each other at home and abroad — a union of two minds — poetic and scientific. Jagadish always looked to Rabindranath for inspiration and guidance in moments of despair in his odyssey of scientific research at home and abroad.

Rabindranath, while Editor (1901-1905) of '*Bangadarśan*' congratulated Jagadish Chandra in one article in 1901 (q.v.). He wrote a congratulatory poem-thematic of his research work under the title –"*Jagadish*" (1928) in his book of poems- "*Vanabānî*".

"Jagadish (Addressed to Sri Jagadish Chandra Bose)

Dear friend,

The day when the world was painless wordless desert,

Plants appeared with pleasure, apprehension and

Sadness in dangerous loneliness.....

.....

Today with thousands, I proclaim:

"Blessed you are, blessed are your friends, blessed is the holy land of your birth."

Later, Jagadish moved his research interest from physics to botany, particularly electro-physiology in plants; he believed plants have life. Rabindranath also found echo in support of his philosophy of universal humanism in the research of Jagadish involving both living and non-living world. He wrote:

> "European science is following the way of our philosophy. This is the way of unity. One of the major obstacles which science had faced in forging this unity of experience is the differences between the living and non-living. Even after detailed research and experimentation, scholars like Huxley could not transcend this barrier. Venturing this excuse biology has been maintaining a wide distance from physics. Acharya Jagadish has discovered the unifying bridge between the living and the non-living with the help of electrical waves".
>
> (Rabindranath Tagore, "Acharya Jagadisher Jaivārtā" [Message of Victory of Acharya Jagadish], *Vasundhara*, Vol. 2, p. 107, 1957.)

It may be mentioned that when Gugliemo Marconi (1874-1937) of Italy and Karl Ferdinand Braun (1850-1918) were jointly awarded the Nobel Prize for Physics in 1909 for development of wireless telegraphy and Jagadish Chandra was excluded, Indians all over the world were sentimentally and emotionally wounded, and this pathos still today pains Indian minds.

Rabindranath was an active patron of scientific research; he always encouraged Jagadish Chandra in his research at home and abroad. He helped Jagadis Chandra in raising funds to establish the Bose Institute in 1917. A seed sown by Jagadis Chandra in 1917 has now grown into a big tree. The Bose Institute (*Basu Vignān Mandir*) in Kolkata is now a leading center of scientific research in India.

Rittle- Rattles on Science

Rabindranath had no formal education. He resisted formal schooling. But he received an incredibly comprehensive education at home from tutors and under the supervision of his elder brothers, an education which was quite comparable to that purveyed by a British public school and which covered practically everything from languages, mathematics, drawing, music, to the natural sciences, anatomy and gymnastics. At the age of 17, he attended a school in Brighton, while staying with his eldest brother, Satyendranath, the first Indian I.C.S. of the day. At 18, he enrolled at University College, London, and for three months enjoyed studying English literature under the guidance of an inspiring teacher named Henry Morley.

He was an alumnus of the Presidency College, Calcutta, for just one day as an external student. (Mentioned by himself in his convocation address (in Bengali) of the University of Calcutta held on the lawns of the College in February, 1937).

Throughout his life, he read books on astronomy, life sciences, agriculture, etc., available at the time, and took copious notes, sometimes not very systematically. He read "*Hand Book of Stars*" by Proctor, "*Origin of Species* by means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life" (1859) by Charles Darwin, and books by Huxley and so on.

In his article- "*Monogaṇit*" he gave a pen-picture of what mathematics is all about in a very systematic imagination. "Zero" is an Indian contribution to the world of mathematics, and he used this truth in a wonderful way in his writings. Mathematics is the queen of sciences. "*The Book of Nature*" is written in Mathematical Characters – so said Galileo Galilie (1564-1642). Rabindranath was very original in his poetic imagination. In his article – "*Jagatsatya*" he deciphered the alphabet of Nature in mathematical terms.

He was always interested in things natural like agriculture, life sciences. He sold the ornaments of his wife and used the money to send his son, Rathindranath, to Illinois University in the USA to study agricultural science and son-in-law, Nagendranath, to England to study life sciences. Of course, the main aim was to engage them to teaching at his Santiniketan school.

His only Book on Popular Science: *Viśvaparicay* (1937)

It is rather a booklet in Bengali in 98 pages. Very articulate description indeed ! Dedicatee is the eminent scientist, Achariya Satyendranath Bose, who was a pioneer in propagating science in vernacular. Himself a flawless speaker on science in Bengali, Satyendranath established *Bangîya Vijñān Pariṣad* in Calcutta in 1948 for propagating science in Bengali. A worthy dedicatee indeed!

The poet wrote this booklet in 1937 at the ripe age of 76 years — 63 years after the publication of his debut article ("*Graha Jîbder Vāsbhūmi*") in 1874 at the immature age of 13. All these years he read extensively, on and about things scientific, observed acutely, analysed critically, interpreted creatively, predicted poetically and concluded meaningfully in his vast literary works.

A friend one day took him to the Anatomy Dissection Hall of the Medical College; he was ' shocked' to see the dissected parts of body lying on the floor.

But this sight did not diminish his interest in life sciences. He had a tremendous power of acute observation. In his novel – "*Mālañca*" (1934), in his dialogue with 'Saralā', 'Ramen' pointed out that in the world of birds only male birds have the capacity to sing and female birds only listen. This simple fact of observation is confirmed by biologist-bird experts; the silence of Saralā in the novel (later revised, altered and extended in drama form by the Poet himself- of course never staged during his life time) is only symbolic with a scientific sense at the core.

> "**Saralā:** I do not have the expertise to play a war of words with you.
>
> **Ramen:** No need for that! Male birds only sing, you female birds silently listen and that is your answer. Now let me sit by your side."
>
> (Translation of the dialogue by this author.)

What a theatrical expression of love! sentiments, science and romance- all three in one crucible!

The booklet is divided into six chapters- Atomic World, Galaxy of Stars, Solar System, Planets and Mother Earth. Enlightened with basic facts and figures along with vibrant, dynamic and yet easily understandable interpretation, it is a unique creation. In the concluding chapter, while discussing life on Mother Earth, he has made an extraordinary statement. He said: Without the heat and light of the Sun, life on earth is impossible; in our brain there are crores of nerve cells (neurons) which constantly secrete chemicals (neurotransmitters and neuromodulators); these chemicals generate electro chemical phenomenon which constantly flow through our nerve cells and fibres — that is the basis of our thought processes, intellect and wisdom.

> "We can imagine a fundamental unity between the material and mental world in the all-pervading ray and energy of the matter. Over the ages, science has discovered that even in apparently ray-less matter, they are constantly generating rays and heat, but indirectly. The fine expression of this great ray is in our soul and still finer expression in our consciousness".

What an imaginative interpretation!

Science and Society

Rabindranath always thought that science education and its propagation at the popular level are the only means to eradicate superstition. His views on the scientific superiority of the West over the East in the contemporary world was a

testimony to his courage and frankness in accepting the reality. A conversation which took place between the eminent British author and historian Herbert George Wells (1866-1946) and Rabindranath is an eloquent expression of the latter's views on the scientific and intellectual interaction between the East and the West (Appendix-C).

Rabindranath always believed that science education and science in practice must serve the society at the grass root level. He had his son, Rathindranath, trained in agricultural science at Illinois, USA, and in the village of Surul, renamed Sriniketan, adjacent to Santiniketan, he started an Institute of Rural Reconstruction with the help of his friend- Cornell — trained, English agricultural expert, Leonard Elmhirst. We need to remember that the Aryan civilization was mainly agrarian in its basic characteristics. He was interested to initiate the application of modern scientific agricultural methods in a creative and harmonious way with the age-old, experience-tested tradition. To him, science was reason and truth should always bring conciliation and not confrontation, cooperation and not conflict, with any indigenous system. It is mutual synthesis of creative and prospective nature and not suicidal souring of mutual relationship.

Epilogue

In all humility, Rabindranath said about himself: "I am not a worshiper of science nor a writer on science". But the truth was exactly opposite. Einstein once said: "Experimentation with instruments only does not make one a scientist, to me scientific mind makes one a real scientist." Rabindranath fits this definition of a scientist. It seems he had his "Rabbi" (Einstein affectionately addressed him so) when he made the above comments. The Poet met the Scientist four times-three times in Berlin and once in New York in 1930. In the study of things scientific, he knew his limitations and that is well expressed in the Introduction of his only book on popular science- "*Viśvaparicay*". He was a wise man with multi-faceted talents. "Wisest is he who knows what he does not know"- so said Plato (427-347 BC).

While William Shakespeare (1565-1616) did not meet Isaac Newton (1642-1726) born 26 years after his death, Rabindranath did meet Albert Einstein- "the Newton of the Twentieth Century" several times. Both Shakespeare and Rabindranath had a surprising similarity; the two giants of world literature had abiding interest in matters medical and scientific respectively, which was reflected and alluded to in their literary works.

The greatest recognition of his thoughts on science came from the greatest Indian scientist of that era-Acharya Jagadish Chandra Bose. He said in a letter to Rabindranath:

"If you would not be a poet, you could have been a great scientist."

Appendix A

The Nature of Reality

A Conversation between Rabindranath Tagore and Albert Einstein in the afternoon of 14 July 1930, at the latter's residence in Kaputh:

Einstein (E.) : Do you believe in the Divine as isolated from the world?

Tagore (T.) : Not isolated. The infinite personality of Man comprehends the Universe. There cannot be anything that cannot be subsumed by the human personality, and this proves that the truth of the Universe is human truth. I have taken a scientific fact to illustrate this. Matter is composed of protons and electrons, with gaps between them; but matter may seem to be solid. Similarly humanity is composed of individuals, yet they have their interconnection of human relationship, which gives living solidarity to man's world. The entire universe is linked up with us in a similar manner, it is a human universe. I have pursued this thought through art, literature and the religious consciousness of man.

E. : There are two different conceptions about the nature of the universe: (1) The world as a unity dependent on humanity. (2) The world as a reality independent of the human factor.

T. : When our universe is in harmony with Man, the eternal, we know it as truth, we feel it as beauty.

E. : This is a purely human conception of the universe.

T. : There can be no other conception. This world is a human world — the scientific view of it is also that of the scientific man. There is some standard of reason and enjoyment which gives it truth, the standard of the Eternal Man whose experiences are through our experiences.

E. : This is a realization of the human entity.

T. : Yes, one eternal entity. We have to realize it through our emotions and activities. We realize the Supreme Man who has no individual limitations through our limitations. Science is concerned with that which is not confined to individuals; it is the impersonal human world of truths. Religion realizes these truths and links them up with our deeper needs; our individual

consciousness of truth gains universal significance. Religion applies values to truth, and we know truth as good through our own harmony with it.

E. : Truth, then, or Beauty, is not independent of Man?

T. : No.

E. : If there would be no human beings any more, the Apollo of Belvedere would no longer be beautiful?

T. : No.

E. : I agree with regard to this conception of Beauty, but not with regard to Truth.

T. : Why not? Truth is realized through man.

E. : I cannot prove that my conception is right, but that is my religion.

T. : Beauty is in the ideal of perfect harmony which is in the Universal Being; truth the perfect comprehension of the Universal Mind. We individuals approach it through our own mistakes and blunders, through our accumulated experience, through our illumined consciousness—how, otherwise, can we know Truth?

E. : I cannot prove scientifically that truth must be conceived as a truth that is valid independent of humanity; but I believe it firmly. I believe, for instance that the Pythagorean theorem in geometry states something that is approximately true, independent of the existence of man. Anyway, if there is a *reality* independent of man there is also a truth relative to this reality; and in the same way the negation of the first engenders a negation of the existence of the latter.

T. : Truth, which is one with the Universal Being, must essentially be human, otherwise whatever we individuals realize as true can never be called truth- at least the truth which is described as scientific and can only be reached thought the process of logic, in other words, by an organ of thoughts which is human. According to Indian Philosophy there is *Brahman*, the absolute truth, which cannot be conceived by the isolation of the individual mind or described by words, but can only be realized by completely merging the individual in its infinity. But such a truth cannot belong to Science. The nature of truth which we are discussing is an appearance- that is to say what appears to be true to the human mind and therefore is human, and may be called *māyā* or illusion.

E. : So according to your conception, which may be the Indian conception, it is not the illusion of the individual, but of humanity as a whole.

T. : In science we go through the discipline of eliminating the personal limitations of our individual minds and thus reach that comprehension of truth which is in the mind of the Universal Man.

E. : The problem begins whether truth is independent of our consciousness.

T. : What we call truth lies in the rational harmony between the subjective and objective aspects of reality, both of which belong to the super-personal man.

E. : Even in our everyday life we feel compelled to ascribe a reality independent of man to the objects we use. We do this to connect the experiences of our senses in a reasonable way. For instance, if nobody is in this house, yet that table remains where it is.

T. : Yes, it remains outside the individual mind, but not outside the universal mind. The table which I perceive is perceptible by the same kind of consciousness which I possess.

E. : Our natural point of view in regard to the existence of truth apart from humanity cannot be explained or proved, but it is a belief which nobody can lack—no primitive beings even. We attribute to Truth a super-human objectivity; it is indispensable for us, the reality which is independent of our existence and our experience and our mind — though we cannot say what it means.

T. : Science has proved that the table as a solid object is an appearance, and therefore that which the human mind perceives as a table would not exist if that mind were naught. At the same time it must be admitted that the fact, that the ultimate physical reality of the table is nothing but a multitude of separate revolving centers fo electric forces, also belongs to the human mind.

In the apprehension of truth there is an eternal conflict between the universal human mind and the same mind confined in the individual. The perpetual process of reconciliation is being carried on in our science and philosophy, and in our ethics. In any case, if there be any truth absolutely unrelated to humanity then for us it is absolutely non-existing.

It is not difficult to imagine a mind to which the sequence of things happens not in space, but only in time like the sequence of notes in music. For such a mind its conception of reality is akin to the musical reality in which Pythagorean geometry can have no meaning. There is the reality of paper, infinitely different from the reality of literature. For the kind of mind possessed by the moth, which eats that paper, literature is absolutely non-existent, yet for Man’s mind literature has a greater value of truth than the paper itself. In a similar manner, if there be some truth which has no sensuous or rational relation to the human mind it will ever remain as nothing so long as we remain human beings.

E. : Then I am more religious than you are!

T. : My religion is in the reconciliation of the super-personal Man, the Universal human spirit, in my own individual being. This has been the subject of my Hibbert Lectures, which I have called 'The Religion of Man'.

[Rabindranath Tagore, *The Religion of Man,* Appendix II, London: George Allen & Unwin Ltd., 1931, pp. 222-25].

Appendix B

The following is an extract from his conversation on 19 August 1930, also at Kaputh:

T. : I was discussing today the new mathematical discoveries which tell us that in the realm of infinitesimal atoms chance has its play; the drama of existence is not absolutely predestined in character.

E. : The facts that make science tend towards this view do not say goodbye to causality.

T. : Maybe not; but it appears that the idea of causality is not in the elements, that some other force builds up with them an organized universe.

E. : One tries to understand how the order is on the higher plane. The order is there, where the big elements combine and guide existence; but in minute elements this order is not perceptible.

T. : This duality is in the depths of existence — the contradiction of free impulse and directive will, which works upon it evolves, an orderly scheme of things.

E. : Modern physics would not say they are contradictory. Clouds look one from a distance, but if you see them near, they show themselves in disorderly drops of water.

T. : I find a parallel in human psychology. Our passions and desires are unruly, but our character subdues these elements into a harmonious whole. Are the elements rebellious, dynamic with individual impulse? And is there a principle in the physical world which dominates them and puts them into an orderly organisation?

E. : Even the elements are not without statistical order; elements of radium will always maintain their specific order, now and ever onwards, just as they have done all along. There is, then, a statistical order in the elements.

T. : Otherwise the drama of existence would be too desultory. It is the constant harmony of chance and determination which makes it eternally new and living.

E. : I believe that whatever we do or live for has its causality; it is good, however, that we cannot look through it.

[Krishna Dutta and Andrew Robinson (eds) *Selected Letters of Rabindranath Tagore*, Cambridge: Cambridge University press, 1997, p. 533].

Appendix C

Conversation which took place between H. G. Wells and Rabindranath Tagore, the Nobel Laureate:

Tagore : Physical science of the nineteenth century probably has created this spirit of race superiority in the West. When the East assimilates this physical science, the tide may turn and take a normal course.

Wells : Modern science is not exactly European. A series of accidents and peculiar circumstances prevented some of the eastern countries from applying the discoveries made by humanists in other parts of the world. They themselves had once originated and developed a great many of the sciences that were later on taken up by the West and given greater perfection. Today, Japanese, Chinese and Indian names in the world of science are gaining due recognition.

Tagore : India has been in a bad situation.

Wells : When Macaulay imposed a third-rate literature and a poor system of education on India, Indians naturally resented it. No human being can live on Scott's poetry. I believe that things are now changing. But remain assured, we English were not better off. We were no less badly educated than the average Indian, probably even worse.

[*A Tagore Reader*, Boston, Beacon Press, p. 108]