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Indian Knowledge Systems: The Central Plank of the New Education Policy

Soumitro Banerjee*

The National Education Policy 2020 (NEP-2020), which was accepted by the Union Cabinet on 29 July 2020 in the middle of the COVID lock-down, declares upfront, "The rich heritage of ancient and eternal Indian knowledge and thought has been a guiding light for this Policy", and that this knowledge will be "put to new uses through our education system".

But in the 66-page policy document, there is very little elaboration of what the policy-makers mean by the term 'Indian Knowledge Systems'. In Clause 4.27, it says "Knowledge of India" will include knowledge from ancient India and its contributions to modern India and its successes and challenges". "Indian Knowledge Systems, including tribal knowledge and indigenous and traditional ways of learning, will be covered and included in mathematics, astronomy, philosophy, yoga, architecture, medicine, agriculture, engineering, linguistics, literature, sports, games, as well as in governance, polity, conservation". "An engaging course on Indian Knowledge Systems will also be available to students in secondary school as an elective". This is all the document says regarding the 'guiding light of the policy'.

Naturally, educationists who read the document had no clue of what was coming. But within months of the adoption of the policy, it became clear that the ruling dispensation has a specific notion of what they are calling the "Indian Knowledge System".

The first glimpse came in an International Webinar on Indian Knowledge Systems, which was organised by IIT Kharagpur from 6 to 8 November 2020. The inaugural programme was attended by many important government functionaries, including the Union Education Minister Mr Ramesh Pokhrival 'Nishank', the Union Minister of State for Education Mr Sanjay Dhotre, the Secretary of Education Mr Amit Khare, Mr Atul Kothari of the Shiksha Sanskriti Uthyan Nyas and the Director of IIT Kharagpur, Prof V K Tiwari. Their speeches, now available on YouTube [1], made it clear that the government is inclined to project an imaginary glorious past of India without bothering about what is supported by evidence.

In February 2021, all Institutions under the Ministry of Education received a letter from the Ministry instructing them to organise programmes for disseminating the NEP-2020 in collaboration with an entity called 'Bhartiya Shikshan Mandal'. In these programmes, the deliberations by the representatives of Bhartiya Shikshan Mandal focused almost exclusively on disseminating 'India's glorious past' through the education system: the knowledge produced in ancient India that remains hidden as great treasures. The task before us, according to them, is to rediscover these treasures

^{*}Dr Banerjee is a Professor of Physical Sciences at the IISER Kolkata and the General Secretary of *Breakthrough Science Society*.

and apply them in the present context. So they are advocating that all universities and research institutes take up the task of digging out those treasures.

For this purpose, the NEP-2020 proposes to mainstream Sanskrit in the education system. In Article 22.15 it states, "Due to its vast and significant contributions and literature across genres and subjects, its cultural significance, and its scientific nature, rather than being restricted to single-stream Sanskrit Pathshalas and Universities, Sanskrit will be mainstreamed with strong offerings in school - as well as in higher education. It will be taught not in isolation, but in interesting and innovative ways, and connected to other contemporary and relevant subjects such as mathematics, astronomy, philosophy, linguistics, dramatics, yoga, etc."

Not only that. "Departments of Sanskrit that conduct teaching and outstanding interdisciplinary research on Sanskrit and Sanskrit Knowledge Systems will be established/strengthened across the new multidisciplinary higher education system. Sanskrit will become a natural part of a holistic multidisciplinary higher education if a student so chooses." Plans are also in place for creating a body of teachers to make it happen. "Sanskrit teachers in large numbers will be professionalised across the country in mission mode through the offering of 4-year integrated multidisciplinary B.Ed. Dual degrees in education and Sanskrit."

So, something called a "Sanskrit Knowledge Systems" will be imparted as a part of regular education, including science and engineering subjects.

The Ministry of Education has created a special cell for 'Indian Knowledge System (IKS)' at the All India Council for Technical Education (AICTE), which oversees the entire technical education in the country.

With its help, the AICTE has launched a Faculty Development Programme on IKS and has instructed engineering colleges to introduce courses on it. It has also advised universities and engineering institutions to introduce courses like Sanskrit for Technical Knowledge, Value Education, Stress Management by Yoga, Personality Development through Life Enlightenment Skills, etc.

Therefore, it seems improving various areas of education is not a matter of importance to the people in political power. Influencing the mindset of students with a particular fundamentalist ideology appears to be the prime objective of the New Education Policy 2020.

What do they believe are "Indian Knowledge Systems"?

What do the proponents of IKS mean by the term? What do they mean to include in the school and college curricula as components of the knowledge that existed in ancient India? If the NEP document does not spell it out, we have to figure that out from the statements of the leaders of the government on different occasions.

On 25 October 2014, in a programme held at a private hospital in Mumbai, Prime Minister Narendra Modi claimed, "We can feel proud of what our country achieved in medical science at one point in time. We all read about Karna in the Mahabharata. If we think a little more, we realise that the Mahabharata says Karna was not born from his mother's womb. This means that stem cell technology was present at that time." He continued: "We worship Lord There must have been some Ganesha. plastic surgeon at that time who placed an elephant's head on the body of a human being." [2]

In the 102nd Indian Science Congress held on January 3–7, 2015, a 'paper' was presented by someone named Captain

Anand J Bodas claiming that there were aeroplanes in the Vedic age. According to him, in those days, aeroplanes were huge and could move left, right, and backwards, unlike modern planes that only fly forward. Not only that, he claimed that the Vedic aircraft could also fly between planets! [3]

You might think that people would ignore such ridiculous claims. But no! In the webinar mentioned above held at IIT Kharagpur from 6 to 8 November 2020, the Union Education Minister Mr Pokhriyal announced the creation of a Centre of Excellence on Indian Knowledge Systems at IIT Kharagpur, and the Director Prof. Tiwari said the Centre would conduct research to find out "if the stories about Pushpak Vimana in the Vedic Age are really stories or if there is truth behind it" [1]. This Centre of Excellence has now published a calendar for the year 2022, which spells out what they mean by Indian Knowledge Systems.

In April 2018, the Tripura Chief Minister Mr Biplab Deb claimed that there was internet and television in the days of the Mahabharata: How else could Sanjaya give a running commentary of the war to the blind king, Dhritarashtra? [4]

In 2016, a workshop was organised at IIT Delhi to initiate research on the health benefits of 'panchgavya' [5]. In July 2019, the Uttarakhand Chief Minister Mr Trivendra Singh Rawat claimed that the cow is the only animal that inhales and exhales oxygen [6]! As the COVID wave hit India in 2020, some quarters propagated the idea that drinking cow urine and dunking in cow dung would ward off the virus. Collective cow-urine drinking sessions were organised in many places!

In 2014, taking part in a Parliament debate, Mr Ramesh Pokhriyal 'Nishank' claimed that astrology is the biggest science, and modern science is a dwarf in front of astrology. "We speak about nuclear

science today, but Sage Kanad conducted nuclear test one lakh years ago", he said [7]. Nishankji went on to become the Union Minister of Education and was instrumental in tabling the NEP-2020. Therefore, it was expected that his ideas would find a place in the education system. In June 2021, the Indira Gandhi National Open University announced that they are starting a new MA programme in Jyotish (astrology).

The list can go on and on. But we see that the proponents of IKS believe that in the ancient Vedic age, there were aeroplanes, the internet, stem-cell technology, plastic surgery that can place an animal's head on a human torso, and so forth. This is what they plan to propagate through the education system.

Can the claims be true?

Isn't it possible that the above were truly there in ancient India? I would request the readers to consider four issues and draw their own conclusions.

Firstly, these claims have always been made *after* modern science invented something. There have been no claims on ancient aircraft before the Wright Brothers invented the aeroplane and they came to common use. Nobody claimed that Sanjaya gave a running commentary of the Mahabharata war using internet live steaming before the internet was invented in the 1980s. Nobody talked about Karna's birth as a result of stem cell technology before modern science started research on stem cells.

Secondly, if modern science and technology were truly there in ancient texts, one could have made inventions by following these texts. Not a single invention has happened that way.

Thirdly, any development of technology requires the prior development of basic sciences. Aircraft could be built only after

we acquired an adequate knowledge in aerodynamics, thermodynamics, engines, properties of materials, solid mechanics, navigational technologies, etc., and then combined these knowledges coming from different branches. In order to claim that there were aircraft in ancient India. one at least has to show that the laws of thermodynamics or Bernoulli's principle were known in that period. Internet could not have been invented before transistor switches, logic gates and digital technology were developed. That is why, to claim that there was internet in ancient India, one has to show that this knowledge existed in the first place. Apart from tall claims, no one bothers to back them with proof that such technologies existed back then.

Fourthly, no physical evidence of any such aeronautics technology has been found at any archaeological site. If aircraft really flew over the Vedic skies, some remnants should have been found in an archaeological site. If modern weapons were used in the Mahabharata war, some fragments should be found in the excavations in Kurukshetra. None has been found.

The 'Indian Knowledge Systems' calendar of IIT Kharagpur

IIT Kharagpur's 'Centre of Excellence for Indian Knowledge Systems' has published a 2022 calendar with the express purpose of promoting certain views. As stated at the outset, the purposes of this calendar are "recovery of the foundations of Indian Knowledge Systems, recognition of the secret of the Vedas, reinterpretation of the Indus Valley Civilization, and rebuttal to the Aryan invasion myth". More importantly, this calendar gives an insight into what the proponents of the IKS mean.

The storyline running through the calendar is an attempt to establish that Vedic



The front-page of the IIT Kharagpur calendar

India was the cradle of all civilisations They had to extrapolate the worldwide. Vedic period back in time by 10,000 years or more for that purpose. The thorn in this claim was that the timeline of the Harappan civilisation has been established scientifically by radiometric dating to be from about 7000 BCE to 1800 BCE (2600 BCE to 2000 BCE is considered the 'mature' phase). So, to push the Vedic culture's antiquity beyond this period, they had to establish that the Harappan civilisation was a part of the Vedic age, and the Harappan people were none other than the Vedic Aryans. That is why we see the claims that it must have taken 'a few 1000 years' to create the spiritual texts of the Vedas, that the image of a one-horned imaginary animal found in some Harappan seals was none other than the 'Ekashringa Rishi' mentioned in the Puranas, that the rivers Sindhu and Brahmaputra (and hence the Indus Valley and the Brahmaputra Valley civilisations) originate from Mount Kailash, that the

swastika symbol found in some Harappan seals was a Vedic icon, and so on.

It can be easily verified that the first two are wild claims, and the other two are factually incorrect. The Indus originates from the Bokhar Chu glacier located close to Mount Kailash, but the Brahmaputra originates from a different place: the Mansarovar lake region. The swastika symbol is found in practically all civilisations, including African, Native American, the Aztecs in South America, etc. (an internet search for 'Swastika' will yield a list, with pictures).

We could have ignored these claims as elements of personal belief. After all, a calendar is not considered a medium for disseminating serious, evidence-based studies and ideas, for which peer-reviewed scientific journals are more appropriate. However, we cannot ignore these ideas because we are staring at the possibility of these beliefs being introduced in schools and college curricula.

That is why we need to sift through the claims, assess them scientifically on the basis of verified historical facts.

Was the Harappan really a part of the Vedic Age?

According to most historians, the Harappan Civilization was a pre-Aryan civilisation. The Aryan-speaking people once entered India from the steppe highlands of Central Asia and gradually gave birth to a rich Vedic culture. The proponents of 'Indian Knowledge System' see it as a conspiracy of Western historians. So they want to rewrite history, and renaming is the first step. The recent history textbook brought out by the UGC calls the Harappan civilisation as the 'Saraswati Civilisation'.

When historians conclude something, they have to do it based on evidence. They have to present those evidence before sci-



A few typical Harappan seals showing animals and written text.

entists and historians by writing research papers. Others judge whether it is possible to draw that conclusion from what has been found. Only when recognised in this process, does it get a place as 'history'.

So, after the discovery of Harappa and Mohenjo-Daro in the early 1920s and subsequent finding of more than a hundred such ancient sites, what evidence was dug up that led historians to conclude that this civilisation was pre-Vedic? There are four pieces of evidence.

First, houses in the Harappan civilisation were made of burnt clay bricks. But for more than a thousand years after that, no brick house has been found on the Indian subcontinent. This implies that the Vedic Aryans did not make terracotta bricks, indicating that the Harappan Civilization could not have been part of the Vedic Age.

Second, the main animal in Vedic literature is the horse. But there has been no sign of horses in the wild in any forest on the Indian sub-continent. This means that horses came to India with men. Excava-

tions at hundreds of archaeological sites in the Harappan Civilization have uncovered many terracotta seals. These have pictures of various animals—bulls, tigers, rhinos, elephants, deer, pigs, and even a onehorned fictional animal with the body of a bull and the head of a deer. But there is no picture of a horse. In other words, the animal, the horse, could not have been there in the Harappan civilisation¹. That led historians to conclude that the horse came to the Indian subcontinent along with migrating humans from a place where there are wild horses.

Third, the Indus Valley Civilisation seals show that they had a written language. The writing has not yet been deciphered, as it bears no resemblance to any modern language. But it is certain that there was a written language. And we also know that in the early days of Vedic civilisation, the verses of the Vedas were propagated and preserved through shruti (what is said) and smriti (what is remembered). If the Harappan Civilization was to be a part of the Vedic culture, then the language of the Rigveda is supposed to be a continuation of the written language of the Indus Civilization, that is, there would be similarities between the two. That is not the case.

Fourth, nowhere in the Vedic literature like the Vedas, Vedanga, Vedanta, Upanishads, and Puranas is there any description of urban life like that found in the Indus civilisation: brick houses, paved roads, covered sewerage and drainage systems, public bath, elevated granaries, etc.

Based on these four clues, historians have concluded that there was no cultural connection between the Harappan Civilisation and the Vedic culture. Radiometric dating of the artefacts has shown that the Harappan cities were no longer inhabited from around 1800 BCE. Since there is an uninterrupted cultural history of the Vedic civilisation, historians concluded that the Vedic Age started only after the end of the Indus civilisation. The earliest horse fossils in the Indian subcontinent, found in the SWAT valley of Pakistan, and the history of the evolution of the Indo-Iranian language group (especially the striking similarity between the language and content of the Avesta and Rigveda), indicate the same timing of arrival of Aryan-speaking steppe people in India [8].

The strongest evidence of migration of the steppe population comes from genetic studies reported over the last five years. Earlier genetic studies had used a marker from the X-chromosome, which flows from mother to daughter, and these studies did not find evidence of the influx of new genes over the past 12,500 years. However, since 2016 many studies have been reported that used the haplogroup R1a found in the Y-chromosome (a haplogroup is a group of DNA sequences that share a common ancestor and hence can identify a line of descent). By sequencing the genes of 16,244 male subjects from 126 populations, a research paper reported that this haplogroup occurs in people living over a vast range in Europe, Central Asia and South Asia, including the Indian subcontinent [9]. Using modern techniques, it is possible to identify the region from which this specific genetic marker has radiated [10], and the study concluded that the focus is the Pontic-Caspian Steppe.

The fact that the evidence of large-scale migration is not found in studies that use chunks of the X-chromosome but does show up in the Y-chromosome studies implies a sex bias in the migrating population: the migrating people were predominantly

¹Historians believe that horses had not arrived in large numbers in the Indian subcontinent during the Harappan period. However, the Harappan cities had trade links with Central and West Asian people, and it is likely that they may have come across the animal.

male. Today, about 17.5% of Indian male lineage has been found to belong to haplogroup R1a. Further investigation revealed two sub-haplogroups: the subgroup Z282 is distributed only in Europe (96% of the R1a samples in Europe belonged to this sub-group), while another subgroup, Z93, is distributed only in parts of Central Asia and South Asia (98.4% of the Central and South Asian R1a lineages belonged to this sub-haplogroup). The two groups diverged from each other only about 5,800 years ago [11].

Therefore, there is strong evidence of the male-dominated influx of the steppe population into the Indian subcontinent some 4,000 to 3,500 years ago [12]. Recent gene sequencing studies of the Indus people have found striking dissimilarity with the ancestral North Indian population. The study of DNA samples of the skeletons found in Rakhigarhi, an Indus Valley Civilisation site in Haryana, has found no traces of the R1a haplogroup that is related to the Central Asian 'steppe' people, which is found in much of the Indian population today [13].

The authors of the calendar seem to be declaring war on what they call the "Aryan Invasion Myth". This is like fighting an imaginary enemy since no historian today says there was an Aryan invasion—simply because there are no signs of destruction by war in the Indus cities. The correct understanding is that there was a migration of people from the Asian steppes, and the timing of that migration was after the city-based Harappan civilisation disintegrated probably due to natural causes like drought, disease or famine.

Human history is a history of migrations. Almost all humans on Earth today are descendants of people who migrated from central Africa roughly 75000 years ago. Since then, people have constantly moved

from one place to another, settled, and have mixed with the local populations. That is why the people of no place can be said to be belonging to a pure race.

What was the true knowledge system in India?

Like any other civilisation in the world, we also have a rich history of cultivating knowledge. The Harappan civilisation distinguished itself in terms of the technological development necessary for urbanisation: brick-built houses, the grid pattern of roads, drainage system, public bath and granary etc. After this urban civilisation disintegrated, the Vedic age started, characterised by a high standard of literature: the Vedas, Vedanga, Vedanta, Puranas, Upanishad, etc. We see some development in geometry in this period, as evidenced in the Sulvasutras.

The major advancements in ancient India happened in the post-Vedic or Siddhantic period. In medical science, we see the work of Susruta and Charaka. Panini formalised the Sanskrit grammar and gave it a formal structure to make it easier to learn. Kautilva made important contributions to the political organisation of society. Zero and the place value system of writing numbers were introduced in the 2nd-3rd century CE, after which mathematics advanced in leaps and bounds. Aryabhata, Varahamihira, Brahmagupta, Sridhara, Bhaskara-II and many other mathematicians made seminal contributions to arithmetic, algebra and trigonometry. Ideas in astronomy developed hand-in-hand with the advancements in mathematics. Alchemy developed in the hands of Nagarjuna and others. Important developments happened in metallurgy, and the 'wootz' steel technique was perfected in this land. For a long time, Indian kingdoms exported steel to the Middle-East, where it was in great demand. For details of the

scientific developments in this period, see [14].

However, after the 9th century, science in India declined, and after the 11th century, very little science was left. In the book "History of Hindu Chemistry" [15], Acharya P C Ray attributed the decline and fall of science in India to three causative factors:

- 1. Due to the ascent of a rigid caste system, the doers and the thinkers no longer exchanged knowledge and experience.
- 2. The do's and don'ts of the shastras (in particular, the Manu Samhita) made it impossible for practitioners of medicine and surgery to teach the next generation because dissection of dead bodies became impossible (only shudras were allowed to touch cadavers).
- 3. A large section of the intelligentsia became influenced by the 'maya' philosophy of Shankara, which saw the material world as an illusion. Naturally, they were no longer inclined to probe the character of the material world.

After the 11th century, the light of science was practically extinguished, and India plunged into a Dark Age.

The great contributions made in ancient India should make us proud. But instead of researching these, if we claim that in ancient India, there were aeroplanes, the internet, stem cell technology, plastic surgery which could plant an animal head on a human torso, etc., it would effectively undermine the value of these real contributions.

There is another aspect. Knowledge develops through a cumulative process of interacting with different civilisations and cultures. Knowledge cannot be termed as Indian, Egyptian, Chinese or any other. Humanity has reached the present stage

through the cumulative process of cultivation of knowledge, assimilating and improving upon the knowledge obtained from different lands. For example, Newtonian mechanics, which was a path-breaking achievement in the history of humankind, was the result of the knowledge accumulated till the time of Newton by the thinkers and philosophers of different lands. Newton's famous quote, "If I have seen further it is by standing on the shoulders of giants", is a testimony of this.

The knowledge created in ancient India has been subsumed in the wealth of knowledge created by humanity. It is now an integral part of the knowledge available everywhere.

Should we teach our students ancient knowledge?

As we have seen earlier, what they understand by Indian Knowledge Systems or Sanskrit Knowledge Systems are just matters of fanciful imagination based on a blind belief that all modern science and technology existed in ancient India. The real danger in this is that it could lead to the emergence of a generation of students steeped in such blind belief.

Such a deliberate design at adulteration of science education with such myths in the name of glorifying the past with false claims will not only discredit the actual achievements that were made in different branches of knowledge in those times, but have dire consequences on the development of scientific temper and critical thought among students in their most impressionable years.

But we have seen that there were commendable developments in ancient India, especially in the post-Vedic or Siddhantic period, in different areas of science and technology. Can we not teach that knowledge? Can we not teach algebra and

trigonometry from Brahmagupta's writings, spherical geometry and positional astronomy from Bhaskaracharya's books, medical science from Charaka Samhita, linguistics from Panini, or economics from Kautilya?

These works surely have a lot of historical significance, and any historian of science should take cognisance of them as important milestones in humanity's quest for knowledge. But man's understanding of nature and society has advanced significantly since their time. Science and technology are cumulative processes in which each generation builds on the knowledge created by the earlier generations, and at any point in time, humanity has the advantage of the knowledge accumulated by all past generations, including the ones developed during the Vedic period and later. That is why the most advanced knowledge in every field should be imparted to the upcoming generation.

Notice that even though Newton was responsible for creating much of classical mechanics, we do not use his *Principia Mathematica* to teach mechanics to our students. That is because knowledge in classical mechanics has advanced since Newton's time, and we impart the latest knowledge. We do not teach chemistry using Lavoisier's writings for that same reason, even though he was a father figure in modern chemistry. This is true in all fields of human knowledge.

Moreover, creating knowledge and imparting that knowledge to students are two different things. A book written for a learned audience may not be the right material as a class textbook. Pedagogy demands specific treatments to develop, step by step, an integrated understanding of a subject. This is another reason why we do not teach mechanics from Newton, chemistry from Lavoisier, and mathematics from Fermat or Euler. Teachers in later

periods have devised better methods of imparting the knowledge created by these stalwarts. These are the books used by universities worldwide.

The same concept applies to the works of ancient authors like Charaka, Aryabhata, Varahamihira, Brahmagupta and Bhaskaracharya. Science has progressed; some of their ideas have become integrated into the available body of knowledge, and some of their ideas have been proved wrong in the light of further research. Moreover, they mostly did not write with classroom teaching in mind, and so these texts are not suitable for that purpose.

In the days of Ishwar Chandra Vidyasagar (1820–1891), mathematics used to be taught using Bhaskaracharya's Lilavati and Vijaganita. Vidyasagar felt that this practice was depriving students of the taste of modern mathematics and was rendering students weak in the subject. So he introduced the teaching of mathematics from modern textbooks. He wrote in justification: "These two works are very meagre. ... The examples are very few. The study of mathematics in Sanskrit should be discontinued. It is not to be understood from this that I undervalue a knowledge of Mathematics as an essential element of a complete education. Far from it. I wish to substitute the pursuit of it in English, whence in less than half the time now given to it an intelligent student will acquire more than double the amount of sound information that he could obtain by the most perfect acquaintance of all that exists in Sanskrit language in the subject."

Now the educational planners are claiming that the way forward is the stone wheel!

Pseudo-science in the name of Sanskrit Knowledge System

The NEP document also says, "In consonance with the rest of this policy, Sanskrit

Universities too will move towards becoming large multidisciplinary institutions of higher learning" (Article 22.15). Let us see what courses the Sanskrit universities are teaching now. The Kavikulaguru Kalidas Sanskrit University located in Nagpur is offering a BA course on Vedang Jyotish. Sri Lal Bahadur Shastri National Sanskrit University located in Delhi is teaching courses like Phalit Jyotish, Siddhant Jyotish, Vastushastra, etc. The Banaras Hindu University has an Astrology Department, which offers a two-year diploma course on Jyotish and Vastushastra.

The last issue of Breakthrough [16] had a very detailed exposition of astrology, and so we refrain from repeating it in this article. Suffice it to say that astrology and vastushastra are pseudo-sciences and should have no place in today's school, college and university classrooms.

In conclusion

The New Education Policy 2020 seeks to introduce unscientific ideas and pseudoscience in the school and college curricula in the name of Indian Knowledge Systems. It is an attempt to change the narrative of Indian history and its intellectual contributions. The protagonists of this policy want to establish that Vedic India is the cradle of all civilizations. That explains their attempt to push back the Vedic period by 10000 years or more.

The science-loving people in general and the scientific community in particular should launch a movement to save the education system from this attack. \Box

References:

- 1. The recording of the session can be found by searching YouTube with the keywords: 'Bharata-Tirtha' An International Webinar on Indian Knowledge Systems (IKS) – Day 1 (1st half)
- 2. The Guardian, 28 October 2014.
- 3. India Today, 6 January 2015.
- 4. Deccan Herald, 18 April 2018
- 5. India Today, 18 February, 2017
- 6. Indian Express, 28 July 2019
- 7. The Hindu, 4 December, 2014.
- David W. Anthony and Don Ringe, The Indo-European Homeland from Linguistic and Archaeological Perspectives, Annual Review of Linguistics, 1:199-219, 2015
- Poznik, G., Xue, Y., Mendez, F. et al. Punctuated bursts in human male demography inferred from 1,244 worldwide Y-chromosome sequences. Nature Genetics 48, 593–599 (2016).
- Partha P. Majumder, Understanding the Aryan debate: population genetic concepts and frameworks, Current Science, 114 (5), 971–975 (2018).
- Silva, M., Oliveira, M., Vieira, D. et al. A genetic chronology for the Indian Subcontinent points to heavily sex-biased dispersals. BMC Evolutionary Biology 17, 88 (2017).
- 12. Vagheesh M. Narasimhan et al. (118 authors), The formation of human populations in South and Central Asia, Science, 365 (6457), (2019)
- 13. Vasant Shinde et al., An Ancient Harappan Genome Lacks Ancestry from Steppe Pastoralists or Iranian Farmers, Cell, 179 (3), 729-735, (2019)
- 14. Science in Ancient India: Reality versus Myth, Breakthrough Science Society publication, 2016.
- Acharya P C Ray, History of Hindu Chemistry, Indian Chemical Society, 1956; and Cosmo Publications, 2010.
- Articles by J V Narlikar, Partha P Majumder, Sunil Mukhi, and Aniket Sule, Breakthrough, Vol.22, No.2, September 2021.

Science and Research in Union Budget 2022: A story of ever-increasing neglect

Arghya Das*

On 1 February 2022, the Union Finance Minister placed the central budget in the Parliament. It is well known that, despite repeated appeals from the entire academic community, education and research continue to take a back seat in the priority list of the Government of India. However, after the huge and perhaps irrecoverable adverse impact of the horrible pandemic for two years at a stretch, it was expected that the government would open its eyes and acknowledge the pressing need to improve the education and research ecosystem of the country with due priority and urgency. But the Union Budget once again showed that this is far from being the case. Let us deliberate briefly on how this year's budget goes with these sectors, in particular in the realm of research and science.

This year, the total budget declared for 2022-23 amounts to nearly Rs. 40 lakh crores. In this, the entire allotment for education is merely Rs. 1.04 lakh crores, a minuscule increase compared to 2020-21 and stands only at 2.6% of the budget. If we look at this in reference to the total GDP in 2021-22, the ratio of governmental educational allotment is as insignificant as 0.44%. Just 38% is kept for higher education out of the meagre total allotment.

If we look at where the policy focuses, we find several mentions of digital education, e-learning system, etc. In other words, the government is emphasising digital education and, at the same time, talks of inclusive education. Now, the government confessed that in the last two years of the ravaging pandemic, the education of crores of children suffered greatly. Why has education suffered that heavily when great emphasis has been placed on online learning? The answer can be found in the Government's own documents. The Economic Survey placed just before the budget announcements showed the acute digital divide throughout India, which divided the mass into a few haves and millions of havenots in terms of digital reach. Against this backdrop, it is incomprehensible how this budget envisions to merge two opposite realms of inclusiveness and digitisation.

Let us take note of one further point that, whereas the budget wants to dedicate 200 TV channels to provide supplementary education to the children who lost two years for learning because of the pandemic, only Rs. 1 lakh is allocated in this scheme (PM e-Vidya) for the whole year for the whole country! The assumption behind the 'solution' that this digitally and economically deprived country has access to TV and the piteous allotment for that is an irony with our children's future and at the same time a design for the profit of TV channel providers and digital businesses at the expense of inclusiveness and education.

We shall not discuss here the budget provisions for school and higher education

^{*}Dr Das is a Postdoctoral Fellow in the Department of Physics, TIFR Hyderabad

in detail. Instead, let us now focus on the picture of research and science in this year's budget.

The highest and most important body for India's research ecosystem is the UGC. And we keep hearing that the projects and fellowships of UGC are getting delayed or curtailed. Has anything improved in this year's budget? We find that the crisisridden UGC is allotted only Rs. 4900 crores, a mere increase of 4.5% compared to last year. Considering inflation, this is actually a decrease. The councils that lead the Social Science, Humanities and Philosophical research, viz ICSSR, ICHR, ICPR etc., have been allotted a total of Rs. 311 crores. Compared to last year's 256 crore rupees allotment, this is a 20% increase in terms of the ratio. But if we look according to the need, where does it We have seen that the amount stand? of fellowship given by these councils have been decreased recently, so much so that their Postdoctoral fellowship is now lower than the PhD-JRF stipend. So instead of a budgetary overhaul, pittances are being thrown to these important institutions. To add to the misery, the grants for the institutes for the promotion of Indian languages have been reduced from last year's Rs. 433 crores to Rs. 250 crores this year, i.e., by 42%.

The allotment for NITs, IISERs, Central Universities etc., has been increased nominally on pen and paper. The funding for IITs has been increased from Rs. 7686 crore last year to Rs. 8495 crore now. But in the past few years, there has been a large expansion in the number of IITs, and they have been directed to arrange their own funds! It only means that either the allotted money does not come, or the sanctioned amount is much less than what is actually required.

A very small fraction of the funding of the

Department of Atomic Energy (DAE) and Department of Space (DoS) is utilised for civil research. In the case of DAE, the allotment in this regard has been increased from Rs. 2300 crore to Rs. 2800 crore. But if we set aside the Heavy Water Facility centric R&D, we see that the allotment is actually reduced to Rs. 1845 crore this year from last year's Rs. 1961 crores¹. The allotment of DoS has come down to Rs. 13,700 crores this year from Rs. 13,949 crores last year. In this, five Institutes under DoS are alloted only Rs. 795 crore rupees, in which too most of the funds is used for strategic research.

Now let us come to the allotments for the Ministry of Science and Technology (MST). Under this Ministry, three major organisations play a pivotal role in India's science and technological research: DST, DBT, and DSIR (under which CSIR operates). This year the financial allotment for the MST has come down to Rs. 14,219 crores from last year's 14794 crores of rupees, i.e., the allotment has decreased by 4%. Compared to the previous year, the allotment for DSIR has increased a bit from Rs. 5224 crores to Rs. 5636 crores, but the allotment for DST has come down to 6000 crore rupees from 6067 crore rupees. The allotment for DBT has been cut sharply by 25%, i.e., from Rs. 3502 crores to Rs. 2581 crore in one stroke!

As it happens every year, we anticipate massive post-budgetary fund curtailment over whatever piteous sanction is done this year. Take arts, social sciences and humanities: from the last year's miserly allotment of Rs. 256 crore, merely Rs. 202 crores were finally utilised. For the institutes for promotion of Indian languages, out of Rs. 433 crores only Rs. 195 crores, that is

¹We have to keep in mind that, even in this amount, there is a significant part for project-based and strategic research. The research institutes under DAE had been allotted only Rs. 75 crores last year, which is now further reduced to Rs. 71 crores.

45% of the allotted money, was actually given. The DAE's allotment for research was curtailed from Rs. 1961 crores to Rs. 1550 crores, which is approximately 21% less. DST was provided 14% less from the budget allotment; for DBT, it was 15% less. For the Ministry of Science and Technology as a whole, the post-budgetary curtailment in the previous year was 9%. We have already seen that this year the budget allotment itself is lesser. On top of that, if there are further curtailments, one has to wonder whether any meaning would be left to research funding. If we keep in mind the 5-6% inflation rate, the actual picture would be even more pathetic.

The question is, what does all this signify? Why this continued and, in fact, conscious and ever-deepening neglect? Is this merely to demean the legitimate expectations and requirements of the education and research sector? What interests are served by these assaults that affect these sectors and put the present and future of the entire society at stake? These are some questions we need to think deeply about.

Seen in the backdrop of education and research policies over the past decades and in the context of the recent New Education Policy 2020, these are just the measures to destroy the country's remaining public

research and higher education ecosystem. The gradual but systematic financial starvation of the existing research bodies will cripple the entire sectors that, on the one hand, will pave the path of marketisation of the research sector and, on the other hand, will make the institutions and individuals slave to the ruling dispensation. This will eventually create the conditions to take these sectors under the control of centralised bodies like HECI and NRF. which then will become the sole centralised regulatory and funding bodies, which will dictate what research is done and who does it. This will become the death knell of remaining institutional independence and free and fundamental research in all realms of knowledge directed to social progress.

This year's budget must be seen as a giant step in that direction. We, the education and research loving people, must become aware of this nefarious design, and come together unitedly, and raise a strong, insistent voice against the implementation of the New Education Policy 2020. We should demand at least 10% of the public spending for education as a whole, and at least 3% for research in humanities, sciences and technology, out of which a significant fraction should be spent on curiosity-driven basic research. \Box

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Risk of Space Debris

Pradip K. Datta*

Abstract: Space is being polluted by space debris. As more and more satellites, space crafts etc. are sent to space the space crafts at the end of their useful life, abandoned satellites and launch vehicle stages, spent rocket stages, etc. as well as the fragments from their disintegration, erosion and collisions remain in the space as debris, The space debris can cause danger to a useful satellite, space craft etc. Space debris poses growing threats to the satellites and spacecrafts.

Introduction

One of the major problems mankind is facing today is pollution. We are encountered with different kinds of pollution, such as air, water, sound, electronic waste, etc. Even oceans have been polluted. Humans are polluting not only their own planet but also space, specially the earth orbit. The pollution in space which will be discussed in the present article is called space debris, also known as space junk, space pollution, space waste, space trash, or space garbage. According to Cambridge dictionary debris means "broken or torn pieces of something larger". According to the Oxford dictionary debris means "broken or torn pieces of something larger" and "Loose natural material consisting especially of broken pieces of rock." Space debris may be natural such as meteors, meteoroids, dust particles, etc. as well as artificial, such as defunct humanmade objects in space like nonfunctional spacecraft at the end of their useful life, abandoned satellites and launch vehicle stages, spent rocket stages, etc. as well as the fragments from their disintegration, erosion and collisions, such as paint flecks, solidified liquids from spacecraft breakups, etc. Natural space debris is ubiquitous throughout the universe. The problem of space debris started since 1957 with the advent of space age, when the space activities were initiated with the launch of the first artificial satellite Sputnik I. Since then the number of satellites in use has been steadily increasing; which in turn increases the space debris. This debris, left unchecked, eventually poses serious hazard to near earth, also causes danger to space vehicles, space stations, space shuttles and other space crafts with humans aboard. Space activities may cause serious environmental problem in earth orbit. Space debris poses growing threat to the satellites and spacecrafts¹.

In this article some of the relevant facts about space debris will be presented and the risk from orbital debris will be discussed. Some incidences of the hazards caused by space debris will be cited. Finally the steps taken to reduce the hazards and related matters will be briefly discussed.

Relevant facts about space debris 2,3,4,5,8

1. The number of space debris orbiting the earth is more than 5,00,000 pieces. Sizes of space debris range from microscopic particles to obsolete spacecraft

^{*}Dr. Datta is a former Head of the Department of Physics, Presidency College, Kolkata. e-mail : dattapradip@gmail.com

and rocket bodies that stand several stories tall. A few examples may be cited. (i) Softball size or larger ($\geq 10 \text{ cm}$): ~23,000 as tracked by U.S. Combined Space Operations Center, CSpOC, (ii) Marble size or larger ($\geq 1 \text{ cm}$): ~500,000, (iii) Dot or larger ($\geq 1 \text{ mm}$): >100,000,000. There are millions of pieces of debris that are so small that they even can't be tracked.

- 2. Orbital debris moves fast enough to damage a satellite or a space craft. Average impact speed in low Earth orbit (altitudes lower than 2,000 km) is ~35400 km/ hour, more than 10 times the speed of a bullet. Even a tiny particle in space can crack a space shuttle window. NASA often had to replace space shuttle orbiter windows because they were significantly damaged by these minuscule "speckles".
- 3. The natural space debris (meteoroids) orbits around the sun, while most artificial debris orbits the earth. Functioning satellites comprise only 7% of the objects in space while 93 per cent of the objects are space rocks, broken satellites and satellite parts—all of which present a major threat to the working spacecraft. Currently, more than 9000 Earth-orbiting man-made objects (including many breakup fragments), with a combined mass exceeding 5 million kg, are being tracked by the U.S. Space Surveillance Network.
- 4. A major part of the artificial space debris orbiting the earth is the residual fuel of rockets, explosion of over-heated batteries, etc., fragments of broken objects due to collision, breaking up of nonfunctional satellites, etc. Another factor which contributes to space debris is anti-missile tests to destroy or pacify spy satellites.

- 5. Some events cause space debris to increase. For example, in 2007 on 11 January China conducted an anti-satellite (ASAT) test in which a missile was used to destroy one of its derelict polarorbiting weather satellites, known as Feng Yun 1C, as a result of which more than 3,000 pieces of space debris was produced which is more than 20% of the existing debris. On February10, 2000 more than 2,000 pieces of debris were added to the inventory of space junk when a defunct Russian satellite (Cosmos 2251) collided with and destroyed a functioning Iridium 33 satellite operated by a private US Iridium company at about 760 km above Northern Siberia.
- 6. Most orbital debris is within 2000 km of earth surface. The greatest concentrations of debris are found at 750-800 km above the earth.

The risk from orbital debris 6,7,8

It has been mentioned earlier that even a tiny particle in low earth orbit can damage a space shuttle because the particles move with very high speeds (about 9.7 km/s). The debris causes serious damage to the windows of space shuttles of NASA; as a result NASA has to frequently change the windows of their space shuttles. The space environment is a harsh vacuum that is constantly swept by solar storms, naturally occurring micrometeoroids, and a hail of fast-moving space debris. Most satellites move at speeds ranging from 3.1 km/s to 7.8 km/s and the speed of the debris may be as high as 7.8 km/s. When satellites and space debris collide at such speeds, the results can be catastrophic. The speed of the small debris is sufficient to cause damage to an artificial satellite or a space craft. To give an idea about the destructive power of the debris it may be mentioned that an aluminum sphere of diameter 1.3

mm has destructive power similar to 0.22 caliber rifle bullet. However, debris smaller than 1 mm cannot cause any damage to the spacecraft but can damage the solar panel, the optics such as the telescope of the satellite, star tracker system, etc. The increasing amount of space debris orbiting the earth could lead to catastrophic collisions with the numerous billion dollar satellites in orbit and can affect the world economy. Space debris also could damage communications and intelligence-gathering satellites. The space vehicles are in great danger, especially the International Space Station and Space Shuttles and other space crafts with human beings on board. Since the launch of Sputnik I, the number of artificial satellites in the earth orbit is steadily increasing which in turn increases the space debris. In the last decade or so, as scientists came to agree that the number of objects in orbit had surpassed a critical mass — or, in their terms, the critical spatial density, the point at which a chain reaction becomes inevitable — they have grown more in number. This debris poses growing threat to the satellites and could prevent use of valuable orbits in future. According to Ben Greene, Head of Australia's Space Environment Research Centre⁸, "the space junk problem has been getting worse every year," "We're losing three or four satellites a year now to space debris collision ··· " It is estimated that collision between an active satellite and a piece of dangerous debris will occur on the average once every 2-3 years over the next decade. NASA simulations indicate that even if no new satellites were launched, collisions would continue to occur in low Earth orbit and increase debris6. Since additional spacecraft (and the rockets needed to deploy them) will continue to be launched, the actual situation is likely to become much worse.



An artist's impression of spece debris

objects of size greater than 10 cm and may avoid collision. But there are millions of debris of smaller size, such as solar panel pieces, paint strips in the earth orbit which may cause damage. Large spacedebris (e.g. spacecraft, rocket bodies or fragments thereof) that reenter into the atmosphere in an uncontrolled way can reach the ground and create risk to the population on ground.

Major accidents caused by space debris^{6,9}

Let us now mention a few major accidents caused by space debris. On 26 March, 2006 a Russian communication satellite Ekspress AM11 was hit by an unknown object and became inoperative. On 13 October. 2009 one of NASA's research satellites. Terra, was hit by a Micrometeoroid and its battery along with its heater controller got damaged. On March 12, 2010 a Micrometeoroid damaged about half of the eleven solar panels of a research satellite of NASA. On May 22, 2013 a weather data collection and research satellite, GOES (Geostationary Operational Environmental Satellite) of National Oceanic and Atmospheric Administration, USA was displaced from its position due to collision with a Micrometeoroid and it took about a month Space surveillance network can track to set the satellite back in its desired

position. On 22 January, 2013 BLITS (Ball Lens in the Space), a Russian laser-ranging satellite, experienced a sudden change in its orbit and its spin due to collision with space debris. As a result it was abandoned by Russian scientists. On August 23, 2016 Germany's earth observation satellite, Copernicus Sentinel 1A, was hit by a piece of space debris and underwent a slight change in orbit and orientation. The electric power also dropped and was not returning to normal.

Steps to prevent risks of accident from space debris $^{\!\!3,9}$

Since the number of space debris is increasing, it is apprehended that collisions may lead to chain reaction, known as the Kessler syndrome (after American scientist Donald Kessler) in which the resulting space debris would destroy other satellites and so on, with the result that low Earth orbit would become unusable.

Researcher Hugh Lewis predicted in the European Air and Space Conference held at University of Suthampton, UK during 26-29 October, 2009 that the risk of space debris will increase by 50% in the next decade and will be 4 times in the next 50 years. In 2011 NASA was warned by the US National Research Council that the amount of orbiting space debris was at a critical level. Some computer models show that there are enough debris in orbit to continually collide and create even more debris and increases the risk of spacecraft failures. The report called for international regulations for limiting debris and the need for research on disposal methods. To prevent chain reactions, space agencies have taken some measures, such as burning up all the fuel in a rocket stage so it does not explode later.

Awareness of the debris problem led to meetings being held between the Euro-

pean Space Agency, the National Space Development Agency of Japan, and the Russian Federal Space Agency. Later, the four agencies created the multilateral Inter-Agency Space Debris Coordination Committee (IADC). The primary objectives¹⁰ of the IADC are (1) to exchange information on space debris research activities between member space agencies; (2) to facilitate opportunities for cooperation in space debris research; (3) to review the progress of ongoing cooperative activities and (4) to identify debris mitigation options. Countries or national or international space organizations that carry out space activities. either through manufacturing, launching, and operating spacecraft or manufacturing and launching rockets can become member of IADC. IADC members should actively undertake space debris research activities and contribute to an increased understanding of space debris issues.

Later Space Agencies from 13 countries such as Britain, France, India, Germany, Italy, Ukraine, etc have joined IADC. Technical debris-mitigation guidelines were submitted to the UN Committee on the Peaceful Uses of Outer Space (COPUOS) in 2002 and were officially endorsed by the UN General Assembly in December 2007. However, this endorsement has no legal binding. Thus, implementation of debris-mitigation guidelines remains in the hands of governments. Again, it should be mentioned that in the absence of any rules for launching a satellite in any orbit, there is a chance that more satellites populate a particular orbit and increase the risk of collision. Further, destructive ASAT tests, each of which can create much debris, are addressed only tangentially by existing laws and can frustrate prevention of risks. Fortunately, some countries such as China, Russia, and others have expressed a desire for a legally binding agreement, a condition

that the European Union code does not Conclusion satisfy.

Many nations, including the United States, India, China, Germany and Canada, have rules concerning getting rid of old satellite and rockets, but everything depends on whether the satellite and rocket were designed for disposal or not. ISRO (Indian Space Research Organisation), being a member of the IADC, is involved in global mitigation measures which takes many forms including the prevention of new debris creation, designing satellites to withstand by the impact of small pieces of debris, improving operational procedures such as using orbital regimes with less debris, and predicting space debris collisions and avoiding them.

Under the leadership of Professor Craig Smith. the Chief Executive and Technical Director for the Australian aerospace technology company Electro Optic Systems, a team of scientists and engineers at the Space Environment Research Centre is trying to create a high-powered, high-precision laser that can push space debris out of the way to avoid a collision. There is also hope the lasers could eventually be used to destroy chunks of junk. His team, based at Mt Stromlo Observatory near Canberra, hopes to have an operational laser ready to demonstrate within the next three years, and is working closely with the US to build it.

Jason Held, who leads the company Saber Astronautics in Sydney, and his team have built there a device, called DragEN, which can be attached to spacecraft and satellites. He expects that DragEN is able to eliminate some of space junk and drag it back down into the atmosphere where it will combust.

When, in 1957, space expedition started none thought that one day we will have to face the risk of space debris. Fortunately, recognition of the space debris issue is now widespread, and many countries have expressed their willingness to take steps to address it. Development of cost-effective, innovative ways to remove space debris is required. We can only hope that the rules to safeguard the planet and the space from space debris are adhered to without which space becomes yet another dumping ground for humans.

References

- 1. Guide to Space Debris from spaceacademy.net.au. Archived from the original on 26 August, 2018. Retrieved 13 August, 2018.
- 2. https://www.indiatoday.in/education-today/gkcurrent-affairs/story/space-debris-facts-982322-2017-06-12#:
- 3. https://en.wikipedia.org/wiki/Space_debris
- 4. "Space Junk Threat Will Grow for Astronauts and Satellites" Archived 9 April, 2011 at the Wayback Machine, Fox News, 6 April 2011.
- 5. Bulletin of the Atomic Scientists. www.thebulletin.org. March/April 2010
- 6. J.C. Liou and N. L. Johnson, Science, Vol. 311, 20 Jan 2006, pp 340-341
- "Orbiting Junk, 7. William J. Broad, Once a Nuisance, Is Now a Threat," New York Times, February 6, 2007.Available at http://www.nytimes.com/2007/02/06/science/ space/06orbi.html?pagewanted=all
- 8. P. Venkata Ramu and Y. Sreekanth, "Status of Space Debris: What To Do? And What Not To Do?", International J, Engineering Science Invention (IJESI) ISSN (Online): 2319 - 6734, ISSN (Print): 2319 - 6726, www.ijesi.org, pp. 52-54
- 9. https://www.britannica.com/technology/spacedebris
- 10. https://www.icao.int/Meetings/SPACE2016/ Presentations/2%20-%20H.%20Krag%20-%20IADC.pdf

Military Emissions — The Missing Carbon Footprint

Dr Sudhansu Sekhar Senapati*

The streets of Glasgow, where the COP26 was held, had seen mammoth protests by students, youths, activists, scientists and researchers. An estimate shows about 100,000 activists marched together. The climate conference started way back in 1992 in Rio de Janeiro and the 26th conference is being held this year. But there have been very little concrete steps taken to mitigate greenhouse gas emissions. There have been many protocols, recommendations and agreements but no accountability. The protesters also claim that most of the militaries are under-reporting or not reporting their greenhouse emissions (Conflict and Environment Observatory, and Universities of Durham and Lancaster).

The signatories of the Paris Agreement do publish greenhouse gas emissions under different categories like transportation, shipping, manufacturing, agriculture, waste and construction. The one category that is missing is the carbon footprint of military emission. The data of greenhouse gas emission of military are rarely published on the plea of national security.

Are military emissions excluded from different climate conventions?

Kyoto Protocol 1997: In the first draft of the protocol, military emissions were a part of the list of emissions that countries would have to report, but in the final signed document this was left out. The exemption of military emissions from the protocol came because of the biggest military spending nation of the world, USA. The Defense Department of USA lobbied intensely to exclude military emissions from the protocol.

Ambassador Eizenstat, who represented the US in Kyoto, says "Yes, the military will be protected. We would not have wanted Kyoto to tell our military or anybody else what to do". The US did sign the protocol, but never ratified it (the only signatory not to do so). The US did not ratify it as it was seen as a threat to the US economy.

Eizenstat further states: "We took special pains, working with the Defense Department, to fully protect the unique position



Fig.1: The US military budget for 2020 which is more than the combined military budget of next 11 countries. The defence budget of USA was \$648.8 billion in 2018 but in 2020 it is \$761 billion, 17% rise in two years.

 $^{^{\}ast}\text{Dr}$ Senapati is a doctor, M.D. (Pediatrics) and lives in Bhubaneswar.



Fig.2: If we tabulate greenhouse emission of countries of the world and consider US military as a country and rank them from largest emitters to lowest one, US military would rank in between 45 to 51.

of the United States as the world's only super power \cdots we achieved everything they outlined as necessary to protect military operations \cdots At Kyoto the parties, for example, took a decision to exempt key overseas military activities from any emission targets, including exemption for bunker fuels that are used in international aviation and maritime transport and from emission resulting from military operations".

The Paris Climate Agreement of 2015 limits the carbon emission of all signatory nations but countries would not be obliged to cut their military emissions. Under the operating rules of the treaty, reporting of military carbon emissions may be excluded, but the decision is left to individual countries (voluntary reporting). It leaves it up to the nation states as to which national sectors should make emission cuts before 2030.

Military emission remained exempted from reporting in COP26 also and there was no discussion about reducing military emission at Glasgow.

How large are the military emissions?

Militaries are some of the biggest polluters. 'Fossil Fuel is the blood of military'. The countries with highest military budget are USA, Russia, China, Saudi Arabia, France, UK, India and Germany. The military budget of USA is roughly 700 million dollars yearly, which is more than the next 7 countries combined (see Fig. 1). 'The conversation' states in an article that "The US military is a bigger polluter than as many as 140 countries" (Fig. 2). The US military is one of the largest polluters in history, consuming fossil fuels and emitting greenhouse gasses.

The defense budgets of many countries of the world are increasing every year in the name of national security. The crisis ridden capitalist economy does not have significant domestic and international markets. The governments of these countries militarize their economies to give fillip to the crisisridden system where the buyer is the government machinery from the taxes collected

A :	Minning	Internal	Danas in nautical	Eucl	Matria Tana of
Aircraft	Mission	Internal	Range in nautical	Fuel	Metric Tons of
		Fuel	miles on internal	consumption,	CO2e Emissions,
		Capacity in	fuel	gallons per	without aerial
		pounds and		nautical mile	refueling.43
		gallons ⁴²			
B-2	Bomber	167,000 lbs/	6,000	4.28	251.4 Metric Tons
		25,692 gal		gallons/mile	
F-35A	Fighter	18,499 lbs/	1,199	2.37	27.8 Metric Tons
(CTO)	bomber	2,846 gal		gallons/mile	
A-10	Close	11,000 lbs/	500	3.38	17.5 Metric Tons
	Air	1,692 gal		gallons/mile	
	Support				
KC-135R	Refueling	50,000 lbs/	1,500 (loaded	4.9 gallons/mile	75.3 Metric Tons
	Tanker	7,692 gal	with 150,000 lbs	, i i i i i i i i i i i i i i i i i i i	
			of transfer fuel)		
KC-46A44	Refueling	Estimated	6,385 (loaded	Estimated 2.9	156.5 Metric Tons
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	Cargo	aal	of transfer fuel)		
	- Sungo	9			

Table 1: Examples of US military jet fuel consumption and CO₂ emission

from common men. So the greenhouse emissions from military will rise in future.

Military vehicles like tanks, fighter planes (see Table 1), and war ships are major consumers of fossil fuel, leading to emission of large amounts of greenhouse gasses. There were protests in Norway two years back over purchase of a squadron of F-35 fighter jets. The protesters discovered that each of these planes burn 5600 liters of fossil fuel for each hour of flight. An average car can run 61,600 kms on that amount of fuel.

What is the Carbon footprint of the US military?

Let us look at the carbon emission of world's largest military, the USA. "With an armed force of more than two million people, 11 nuclear aircraft carriers, and the world's most advanced nuclear aircraft, ... the US has been continuously at war since 2001, with the US military and State Department currently engaged in more than 80 countries in counter terror operations." The US operates about 800 military bases outside US and 300 inside US. We all know the history of engagement of US military in Vietnam, North Korea, Iraq, Afghanistan. This global war involvement needs a great amount of fossil fuel.

"According to the Department of Defense, the US Army emitted more than 70 million tons (tons or tonnes) of CO_2 equivalent per year in 2014. But the figure omits facilities including hundreds of military bases overseas as well as equipment, vehicles" (The Guardian). Activities like intelligence work, law enforcement, emergency response, tactical fleets and areas classified as national security interests are also exempted from reporting obligations.

The Iraq war was responsible for 141 million tons of carbon emission in the first 4 years of war. On an annual basis this was more than the emission from 149 countries in this period, or about the same as putting an extra 25 million cars on US roads for a year, according to *The Guardian*.

There is no published data on carbon emission but fuel consumption of military vehicles and energy consumption of military installations are available. Prof Neta Crawford of Brown University has estimated total carbon emission based on these data in her paper, "Pentagon fuel use,



Fig. 3: US Military emits more carbon dioxide than even some of the industrialized countries like Sweden and Switzerland.

Climate change, and the costs of war". Military operations were responsible for 60% of these emissions, while military bases that the US operate around the world were responsible for 40% of the total emissions. The quality of data from many of these bases is poor. Crawford concluded that the Pentagon was the largest institutional consumer of petroleum products in the world. If we compare US military emission with the emission by other nations, we find that it is the 47th biggest polluter in the world (see Table 2).

The emissions mentioned above are only a part of the story. We should also count the emissions from the arms industry which produce military equipment, extraction of raw materials used by the industry and the impact they produce when used in war or military exercise. The supply chain has to be taken into account also. The data on military operation is usually sparse, not published and unreliable. The total emission of the US military, calculated by some scientists, stands at 340 million tCO_2e which is roughly 6% of the total national emission of USA. (tCO_2e = tonnes (t) of carbon dioxide (CO_2) equivalent (e)). The greenhouse emission of US military

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is approximately 6 to 10% of the total greenhouse emission of USA. The total CO_2 emission of US military alone is more than that of some of the industrialized countries like Sweden and Switzerland. (See Fig. 3)

What about UK military emission?

Carbon emission data of the UK can be found in the annual publication, Sustainable Ministry of Defense. The issue for 2017-18 provides data of carbon emission of different components of UK military, but they do not provide a total figure. Dr Stuart Parkinson has calculated the total to be 3.2 million tCO_2e . He has further included the emissions from the arms industry and supply chain and arrived at a figure of 13 million tCO_2e which is 3% of the total carbon emission of UK.

What is the global military carbon footprint?

The largest military spenders of the world besides the USA and UK are China, Russia, India, Saudi Arabia, France and Germany. They are less transparent. These economies are based on fossil fuel and hence the carbon footprint of their military is quite significant.

Dr Stuart Parkinson estimates that the



Fig.4: A comparison of energy consumption of US civilian agencies and US military. The energy used and so the greenhouse gas emissions are much higher in case of US defense than the civilian use.

Greenhouse Gas Inventory: Department of Defense	FY 2018						
Scope and Category	GHG Emissions from Standard Operations (MT CO2e)	GHG Emissions from Non-Standard Operations* (Military Operations, Law Enforcement, and Other) (MT CO2e)	Total Quantity Emitted Biogenic (MT CO2e)				
Scope 1: On-Site Fuel Consumption at Federal Facilities	5,403,108.4	0.0	81,754.4				
Scope 1: Mobile EmissionsVehicles, Aircraft, Ships, and Equipment Scope 1: Mobile EmissionsPassenger Fleet Vehicles	1,159,348.4 420,289.1	33,804,424.0 71,354.2	10,194.2 33,654.2				
Scope 1: Fugitive EmissionsFugitive Fluorinated Gases and Other Fugitive Emissions	328,777.1	658,708.8					
Scope 1: Fugitive EmissionsOn-site Wastewater Treatment	5,636.9		1,274.0				
Scope 1: Fugitive EmissionsOn-site Landfills and Municipal Solid Waste Facilities	155,535.8		41,231.3				
Scope 1: Manufacturing and Industrial Process Emissions	0.0	0.0					
Subtotal Scope 1	7,472,695.6	34,534,487.1	168,108.2				
Scope 2: Purchased Electricity	13,019,180.1	0.0	0.0				
Scope 2: Purchased Biomass Energy	3,965.3		331,885.2				
Scope 2: Purchased Steam and Hot Water	573,203.7	0.0	0.0				
Scope 2: Purchased Chilled Water	2,300.8	0.0	0.0				
Scope 2: Purchased Combined Heat and Power Electricity, Steam & Hot Water	0.0	0.0	0.0				
Subtotal Scope 2	13,598,650.0	0.0	331,885.2				
Scope 2: Reductions from Renewable Energy Use	-199,188.5		0.0				
Subtotal Scope 1 & 2	20,872,157.1	34,534,487.1	499,993.3				
*Non-Standard Operations are vehicles, vessels, aircraft and other equipment used by Federal Government agencies in combat support, combat service support, tactical or relief operations, training for such operations, law enforcement, emergency response, or spaceflight (including associated ground-support equipment). Non-Standard operations also includes generation of electric power produced and sold commercially to other parties.							

Table 2: Greenhouse gas inventory of US military as calculated by Prof Neta Crawford for the year 2018.

carbon emission of the world's military and the industry that provide the equipment are in the region of 5% of global total. This does not include the carbon emission of the impacts of war like devastation caused by war, post conflict construction, fires, deforestation, health care for survivors etc.

The IPCC (Intergovernmental Panel on Climate Change), the UN's scientific advisory body has little to say on the subject of military emissions.

In many countries, militaries pollute more than any other institution but reporting of military emission to UN remains voluntary. Cyprus, Germany, Hungary, Norway and Slovakia currently follow the voluntary reporting standard, as published in the Military Emission Gap website. The Climate Convention and its actions will be futile if the significant military emissions, which are equal to the transport and shipping emissions added together, are not reduced.

"If we are going to win on climate, we have to make sure we are counting carbon completely, not exempting different things like military emissions because it is politically inconvenient to count them" Stephen Kretzmann, Oil Change International's Director told *The Guardian*. "The atmosphere counts the carbon from the military, therefore we must as well." \Box

Can We Kill Pathogenecity Instead of Pathogens?

N Sai Prashanthi*

The world has faced many diseases over the years and has seen them cause deaths of human beings all over the world. We have many techniques to diagnose disease and treat them too but they still continue to affect our lives. Why are we not able to escape diseases caused by bacteria and other agents? How can we stop them from causing disease?

These are some of the questions for which we have to find answers.

Pathogenecity

There are many types of diseases which affect humans, animals and plants, caused by different agents, like bacteria, fungi, virus and protozoa. Tuberculosis, leprosy, anthrax are diseases caused by bacteria; AIDS, influenza are diseases caused by viruses; and amoebiasis is caused by the protozoa Entamoeba Histolytica. The ability of an organism to cause disease is known as pathogenicity and such an organism is called a pathogen.

These pathogens have different ways of affecting the host cell. The pathogen enters the vector (any person, animal or microorganism that carries and transmits a disease) and transfers to the host cell by different routes such as the blood stream, nasopharyngeal pathways. It then multiplies in the host cell, till it ruptures it to cause the disease. Sometimes a

pathogen can enter directly into the host cell. To detect it, we have many laboratory methods such as blood smear, swab test, urine test, etc. and effective drugs have been invented by scientists for particular diseases. Discovery of medicines for many diseases are still under research because of novel transformations in disease causing agents.

What causes Pathogenecity?

Every living organism from bacteria to human beings will show some characteristics which will appear outside, called phenotypic characteristics. How do they make their appearance? What peculiarities will they have? What are all these characteristics based on? Scientists say they are based on genes which express themselves in a peculiar manner to show phenotypic effect. Viruses and bacteria also have genetic matetial - viruses have DNA or RNA as a genetic material, while bacteria have DNA only. The genes which are present in those agents express themselves and produce some protein compounds for their protection and if these are injected into the host cells, or if the agents themselves are transferred into the host cell, they will multiply, rupture the host cell and cause adverse affects in the body. There is a possibility that genes will form pathogenic compounds in disease-causing agents because each and every character in living beings is expressed by the genetic material

 $^{^{*}\}mbox{Student}$ of Microbiology, Osmania University, Hyderabad

Students' Section

they have, according to the environment they live in. A lot of research has to be done to understand the mechanisms of pathogenecity.

Can we remove Pathogenecity?

If it is possible that the genes can cause pathogenecity in the agents, is there any possibility to remove the pathogenecity by using laboratory techniques such as genetic engineering or CRISPR CAS 9 technology? This is the question in front of the science community and must be studied through different methods.

CRISPR CAS 9 is a technique which was taken from bacteria. A bacterium has a special mechanism to remove unwanted or harmful materials from its own genetic material. Nowadays this technique has been adapted and applied to produce disease-resistant plants, genetically engineered animals and so on. So there is a possibility of applying this technique to remove pathogenicity causing genes in bacteria, viruses, fungi, etc., under particular conditions.

If this type of research turns into successful technology, we can easily remove pathogenecity from the pathogenic agents and can make this world disease-free.

However, there are still some challenges to be met in this field:

- 1. We need to identify pathogenicity causing genes in organisms
- 2. The need to check the variabilities from species to species
- 3. There are ethical issues to be considered. If some people misuse this technology for the production of deadly disease causing agents and misuse them for bio-war, etc., applicability of this technique to all disease-causing agents will be a big challenge.

Since ages, diseases have been affecting lives and livelihoods of mankind. Today modern techniques are evolving because of discoveries in each and every field of science. This is a hope to remove pathogenecity from the world and make it disease-free for ever. \Box

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A new philosophy of life

Meghnad Saha*

The poet has in his own inimitable way often explained to you his ideal of life. The question is: Why should this ideal need explaining at all? Civilizations have come and gone; several have survived. If we go to the root of any civilization, we find that its working has been determined by some high ideal that shapes its course. An early understanding of the real worth of this ideal can eliminate a lot of misunderstandings and mistakes later. Many ancient philosophies and religions stem from the idea that the universe is the handiwork of some Creator, although the idea of this Creator is different in different religions. In the ancient Hebrew scripture, the Creator is the ultimate arbiter of law and order. It was his order that the ten commandments in the Bible be followed; any violation of them bringing down on people dire consequences. Several other religions basically derive from the Jewish

religion, their concepts of a Creator not very different from the Jewish one.

Intolerance in Religion

The followers of such philosophies are bound by codified laws that are taken to be the Word or the commands of God. The class of people who maintain and explain these commands enjoy a high position in society, and are not prepared to tolerate different points of view.

Ancient China in the farthest East had visualized the Maker as an artisan, who brought the world into being by the strokes of his chisel and hammer. No wonder China has produced such great craftsmen and sculptors, who enjoy an esteem in society much higher than that accorded to them in other societies. The social hierarchy in China is in the following downward order: mandarins, farmers and artisans, tradesmen and warriors. According to Hindu belief the Creator is a philosopher, out of whose meditation came the entire visible universe with its living and nonliving its animal world and its scriptures. This explains the great regard that Hindu society has had for speculative thinkers, those who waste time in idle speculation and specialize in mystification. Craftsmen, artists and builders have been traditionally placed quite low in the social hierarchy. There has been no connection between the hands and the brain in Hindu society. ...

None of the ideals on which these civilizations have based themselves has been faultless. All the ancient religious ideals

^{*}The great scientist Prof Meghnad Saha went to Santiniketan in November 1938 with the purpose of securing Rabindranath Tagore's support for the reelection of Netaji Subhas Chandra Bose as Congress President for a second term. While he was in Santiniketan, the poet requested him to deliver a talk before the students of Santiniketan. The talk, delivered on 13 November 1938, was published in the Bengali magazine Bharatbarsha, vol. 26, p 937. This article created quite a stir. Anilbaran Roy from Pondicherry wrote a criticism of the article and Dr Saha responded by writing three articles. There was another critical article by Mohinimohan Datta, and Dr Saha responed through two more articles. The entire debate was translated by Enakshi Chatterjee and Santimoy Chatterjee. Here we publish excerpts from Prof Saha's arguments as these have bearing with the current debate on Indian Knowledge System.

have now been proved to have been based on concepts of creation entirely fictional, hence they have all been discarded as imperfect. The ancients believed the Earth to be at the centre of the universe; the stars were taken to be the souls of holy people; the sun and the planets were supposed to determine the destiny of human beings. Almost all ancient religions tell us of an impossible utopia where everybody lived in peace and harmony, undisturbed by famine and pestilence. Nothing could be farther from the truth. It is common knowledge now that instead of being the best creation in the universe, the Earth is nothing but a spark of the sun.... In the beginning there were no living creatures on the Earth, leave alone human beings. A very primitive type of life had originated first, before man appeared on the scene through a process of evolution. This explodes the idea that God in meditation had created the world, men and beasts at one stroke.

A tradition of knowledge and experience acquired through thousands of years forms the basis of our present civilization. New methods in agriculture, trade and industry have been discovered during this period, often leading to revolution and reorganization in society. In other words, modern civilization stands on the accumulated wisdom of centuries. Equal use of hand and brain characterizes the present age.

In order to survive, we must extract and produce as much of energy, mineral and agricultural products as can be got from the Earth. For us in India this struggle for survival has not ended, it has just begun. For many people the solution of this problem of survival lies in a return to the village and in improving cottage industries and handicrafts. A little thinking is enough to show that it is not based on sound logic. A scientist is used to thinking in terms of figures. Let us compare the amount of

work done by an ordinary man in India with that done by a common man in Europe or America. It can be proved (as I have done elsewhere) that we in India do only onetwentieth of the work done by a person in any of the Western countries. The reason is that they have put to use most of the available sources of energy, e.g. water. coal. etc. Calculations have established that a horse can work ten times more than a human being. The mechanical power produced per capita in Europe and America is equal to the work done by a horse in 365 days working all through the day and night. In our country there is no dearth of sources of energy but only 2 per cent of it has been converted to work. Most of the work is done by hand, hence the people here work twenty times less. This is the reason why we are twenty times poorer than the Europeans or the Americans. A nation's prosperity depends on the full utilization of all the natural sources of energy in building up a machine-based culture.

I do not have any illusions about the sanctity of village life. In my opinion the villages are hardly ideal places for living. A return to the village by the urban population looking for a living will only aggravate the problems of the village. There will be competition and rivalry over the means of livelihood. Naturally the village people will resent our presence. What are the exact needs of the villagers? They need good houses, adequate food and clothing and leisure in plenty. All these can be achieved only through generation of more work. It will not only eliminate poverty and misery, it is also necessary for self-defence. At present we are threatened by invasion both from the East and the West. To resist this threat if it ever becomes a reality, and so that we are not subjected to foreign rule once again we have to excel in mechanical culture like Europe or America. Many

of our wellwishers insist that we should remain basically agricultural. I think this smacks of a conspiracy. If all of us return to the village it becomes easier for a handful of capitalists to exploit us. In the West all the key industries like power production, manufacture of machinery, transport and road construction are controlled by the State. No individual or community is given special favour to run these industries or allowed to acquire power greater than that of the state. The same policy should be adopted here. In 1923, Dr Sun Yat-Sen, the saviour of China, had adopted the same kind of planning. Our country can be prosperous like Europe or America only if we can develop industry and raise capital through state supervision ····

In the following sections, we excerpt from Prof Saha's responses to Anilbaran Roy's and Mohinimohan Datta's criticisms.

Rejoinder to the Rejoinder: $\mathbf{1}^1$

Last November I went to Santiniketan to pay my respect to the illustrious poet Rabindranath and at his request I addressed a gathering of students and teachers. The poet himself was present on the occasion for which I am much obliged to him. The text of the lecture was published in all the daily papers. Since then there has been a lot of criticism of that lecture in various dailies and periodicals. Bedridden following a surgery, I was not in a position then to answer the critiques. Recently, in the Baishakh issue of the monthly Bharatbarsha, Sri Anilbaran Roy of Pondicherry has, in an article, offered an elaborate criticism of my lecture. From a perusal of his article it seems that unfortunately he has not grasped the spirit of my lecture and has

imposed his own interpretations on it in an attempt to mislead the public, compelling me to offer this refutation.

This is what my critic has to say about my lecture: 'The comments that Dr Meghnad Saha has recently made on Hindu philosophy and religion in a lecture delivered at Santiniketan, are not based on any original research, on the contrary they are merely echoes of some of those clichés that ignorant and prejudiced Western critics throw about.'

To this I would like to reply that it is against my nature to echo somebody else's view without acknowledging it, no matter how eminent a person he may be. My lecture is entirely original from beginning till end.... He may not find my comments about the limitations of Hindu thought to his liking, but that does not entitle him to malign me as a mere echoer of others without providing ample proof. This is not an act befitting a gentleman.

Moreover, he has added, 'If Dr Saha had taken the slightest trouble to find out the real facts about Hindu religion, philosophy and the history of India instead of depending on second-hand sources, he would have realized how improper such comments were, coming from a scientist of his standing.'

Perhaps the particular critic and many others like him have assumed that I have not read any of the original texts of Hindu religion and philosophy. It would have been wiser on their part to enquire a little before forming such an impression. However, I hope my reply will clear his misconception.

What the critic seeks to claim is that Hindu religion and philosophy contain all the ideals that should go into the making of a great civilization, and even that of present-day Europe. According to the critic, several misguided and inexperienced people, the present writer included, are

¹Published in Bharatbarsha, vol 26, p. 937, 1939.

drawn towards modern civilization in a state of utter confusion. It is his firm conviction that all the fundamental theories of modern science, including the theory of evolution, the heliocentric theory of the solar system, even national planning, have all been either clearly stated or germinally present in Hindu thought. I am going to demonstrate in this article that this critic's ideas are not only erroneous but born out of profound ignorance....

In order to establish his contention, the critic begins by saying, 'Hindu religion and philosophy have their source in the Vedas.' Is the critic not aware of the discovery of the ruins of the two ancient cities of Harappa in the Punjab and Mohenjodaro in Sind by the late Rakhaldas Bandyopadhyay in 1923? This discovery has radically changed all the older theories regarding the origin of Indian religion, philosophy and civilization. All Western scholars and most Indian scholars (like Ramaprasad Chanda, Sunitikumar Chattopadhyay, Kshetreshchandra Chattopadhyay, Birajasankar Guha) agree that this civilization is pre-Vedic and pre-Aryan....

Let us leave aside the archaeological controversies; but is he not aware of the different schools of thought about the origins of civilization in India which were prevalent even before the discovery of the pre-Vedic and pre-Aryan Indus Valley Civilization? Is he not aware of the fact that Jainism and Buddhism, the two religions that gave India its most glorious era had rejected the Vedas as entirely and fundamentally wrong? Does he not know the Lokavata view of the propounders of the Vedas: trayah vedakarttārah bhanda dhārtta niśācarāh [The authors of the three Vedas are impostors, knaves, and shady characters].

In other words, shortly before the birth of Christ there were rationalists in India

who felt that while real meaning of the Vedas is difficult to comprehend, some impostors claiming to interpret it were only propagating wrong notions. We still do not have any dearth of such people....

He has attempted to trace the origin of the caste system to the *Purusha sukta* of the tenth chapter of the Rig Veda. All scholars are in agreement that these verses belong to a later period when the caste system was firmly established; and they only serve to provide a philosophical explanation for the system, and instead of outlining the history of the caste system, only churn out a story to justify it....

The author seems to think that the Purusha sukta of the Rig Veda contains a philosophical explanation of the caste system. In other words, the sukta takes recourse to rūpaka to suggest that priests and scholars will naturally occupy the top position in the social hierarchy. I have nothing to say to this. My point was that such a position upholding the caste system has had a pernicious effect on society. I am quoting the comment of a very great man on the subject: "When the Indians believed that some of them had sprung from the head, some from the arms, some from the thigh, others from the feet of their Creator and they arranged their society accordingly; they doomed themselves to an *immobility* from which they have not been able yet to recover" [Mazzini, in Duties of the People]. Sir Henry Maine, the famous jurist, has said, 'Caste is the most blighting institution ever invented by the human mind.'

To be charmed by the philosophical subtleties of the *Purusha sukta* verses is nothing but a pretence of futile erudition; what one has to see is the effect these have had on society, how the people have accepted them and what has been its consequences. Society at large has read the *sukta* in the following terms: since the Brahmans have

sprung from the head of the Creator, that gives them the right to trample on the Shudras who have sprung from the feet. If however the Shudra educates himself he will no longer accept the superiority of the Brahman, hence he should have no access to learning the scriptures. In the first or second century AD the great Manu was cited as having advised that molten lead should be poured into the throat of a Shudra if he dared to study the Vedas. Krishna in the Geeta has been made to say: cāturvarnyam mayā srstam gunakarmavibhāgaśah [I have created the four varnas, dividing according to virtue and vocation.]

All such later theories about the caste system have done nothing to abate the harmful influence of this system. The people of this country have taken the theory contained in the Purusha sukta only literally, which has led to a permanent institutionalization of the caste system offering all opportunities to self-seekers. The system in its turn has given rise to numerous social evils and evil notions like untouchability, and the fear of the mixing of varnas.

I have preferred to look at it from another angle. The way I look at it, this caste system has been responsible for the dissociation between the brain and the hand in India; hence, India has lagged far behind Europe and America in terms of material culture. The intellectual has always been content with his bookish knowledge, notes and annotations, and grammatical and philosophical disputes. In fact, in the Indian Middle Ages it was the mission of every Indian scholar to dazzle ordinary people by the extent of his learning. They had little to do with the practical problems of life. They never thought about ways to improve trade and industry. Probably they would have lost their caste if they did it. The warrior was happy to show off his powers in the

use of the conventional weapons. It never crossed his mind to improve upon them or try to learn what was being used in other countries...

For ages India has not invented any new process in weaving, ploughing, architecture, metallurgy and warfare. The reason is we have always looked down upon using the hand. Thinking was supposed to be superior, hence the hand and the head have lost all connection. I have been teaching physical science for the last twenty years and have direct knowledge about the methods of teaching in Europe and America. From my own experience I can say that our students are unwilling to use their hands. In America the students and professors are not ashamed to do the work of a carpenter or a blacksmith, and other mechanical jobs. But any Indian student of science would think it beneath his dignity to do such jobs. But unless an intellectual handles an instrument himself how can he devise ways to improve it? This is why Europe has gone so far ahead in mechanical culture. The experience gained by the intellectuals from using out-of-date devices and contact between the mechanics and those intellectuals have led to the invention of newer and better devices. This synthesis between the head and the hand lies at the root of the spectacular advances of a mechanical culture in Europe and America.

Let us take the textile industry. According to calculations made by a scholar there have been about 800 new inventions in weaving since the Vedic spinning wheel and loom, and these have gone to the making of the present gigantic textile industry. Amongst these inventors Hargreaves was an illiterate labourer, Arkwright was a penny-barber, Cartwright was a village priest. James Watt, the inventor of the steam engine, was a blacksmith, who repaired tools, till he came in contact with

Professor Black of the Glasgow University, and could invent the steam device.

My critic has remarked: "Excellence of the intellect is the ultimate measure of human excellence, no matter how important the physical body or even life might be. Neither Meghnad nor Rabindranath was an artisan. Does that mean a skilled weaver or cobbler will enjoy a social status higher than either of them?"

I would like to counter this with a question: Why should an illiterate priest who conducts wedding and funeral rites without understanding the mantras that he pronounces enjoy more social prestige than the weaver and the shoemaker? Both the weaver and the cobbler serve the society through hard labour, whereas the ignorant priest is for all practical purposes nothing but a cheat. If the 'son' of a butcher in Europe had enough talent he could have been a Shakespeare; but in this country according to traditional rules such a person could not have become a Rabindranath or Kalidasa, and if he had made any such attempt the great God Rama himself would have chopped off his head in order to preserve the sacred caste system....

The theory of incarnation and the theory of evolution

My critic has amazed us with his remarkable capacity for research when he tries to equate the Hindu Theory of Incarnation with the modern scientific Theory of Evolution. From time to time he has confused both with the Theory of the Transmigration of the Soul: Man has had to go through eight million births to be born human.

This fairly simple restatement of the Theory of the Transmigration of the Soul suggests that if a person commits a sin, he has an inferior birth and after going through millions of life cycles as a low-born creature he is absolved of his sins, and

can be born again as a human being and thus get the opportunity to attain salvation. The affinity of this theory with the Western theory of evolution is an original discovery of our critic, for even the late Shashadhar Tarkachudāmani, who gave a scientific explanation to Hindu religion, going to the extent of finding in the mythological story of Agastya's drinking up of the ocean an example of electrolysis, was not capable of such an astounding discovery.

What is even more surprising is the way our critic has in one great leap reached the theory of incarnation straight from his astounding discovery. In his view the basic idea of the Western Theory of Evolution is contained in the Hindu Theory of Reincarnation. If we are to accept this hypothesis presented by the critic, then poor Darwin loses all his claims to originality.

But any impartial reader would soon find out that the critic has little knowledge of the Theory of Evolution; this is excusable as he is probably not familiar with Western science. What I would like to show however is that his knowledge of the theory of Incarnation is equally erroneous.

Those who wish to believe in the theory of reincarnation are welcome to do so, but I myself cannot accept it because I do not think there is any scientific proof, direct or hypothetical, of this theory of re-birth. It is my conviction that this theory was one way of keeping people in the path of moralityconceived mostly by the Buddhist moralists just as the fictitious idea of heaven and hell was circulated in an earlier era by ancient preceptors to keep common people from straying from the moral path.

But the theory of evolution is based on well-observed facts and well proved notions. Discovery and collection by scientists of thousands of fossil specimens dating back to the very early ages of the Earth helped to form this theory. All these

findings have been classified in a scientific manner, through a process of elimination and analysis their chronological order has been established and every age has been determined through much tried methods of physical sciences. The gaps that were present in Darwin's conclusion, the inconsistencies it has with Mendelism, have more or less been solved. If anyone thinks this theory has any similarity with the theory of Incarnation, then he must be living in a fool's paradise.

The main principles of the theory of Incarnation have been expressed through Krishna in the Geeta: paritrānāya sādhunām vināśāya са duskrtām: dharmasamsthāpanārthāya ca sambhavāmi yuge yuge. In other words, God is born in this Earth in every age to save good people and to destroy the wicked. That this has any relation to Western evolutionary theory can only be established by force. The theory of evolution holds that very low forms of life appeared on Earth some 5000 million years ago. Then the fish, reptiles, birds, and mammals came in this order to be followed by the apes and finally man evolved. God does not appear in this chain at all. I do not know what books our learned critic has read on evolution or which of these books from the West acknowledges the presence of an animal as half-man and half-lion....

The Hindu scriptures have given different accounts of the incarnations. According to the Mahabharata (cf. Shanti Parva, Chapter 240), Buddha is not an avatāra. The list mentioned there is as follows: hamsa, kurma, matsya, varāha, narasimha, vāmana, Paraśurama, Rama Krishna and Kalki. Buddha is not mentioned there. We are nowhere told about the particular contribution of hamsa. Even in the Vishnu Purana, Buddha has only been indirectly referred to as the incarnation



Meghnad Saha (1893–1956)

of illusion. According to most Vaishnava puranas, Krishna is not an incarnation but the great Brahma himself, Balarama is the avatāra. Many scriptures proclaim the rise of the kalki avatāra after the Gupta Kings. Thus this avatāra is only a symbol of the decline of the Buddhists and Hindu ascendency. The explanation that the Ramayana is an allegory of the fight between animality and humanity is ludicrous. For all wars are, truly speaking, conflicts between animality and humanity.

In conclusion I am compelled to say that my critic is neither well versed in the theory of Incarnation or Rebirths nor in the Western theory of Evolution. In trying to cite examples of modern science from Hindu scriptures he has said things which amount to incoherent delirium.

Science and Consciousness²

According to my critic Anilbaran, 'the scientists of the twentieth century have recognized the pervasive presence of a consciousness behind the universe though the nineteenth century scientists did not think so.' Since Dr Saha does not recognize this presence (he has not pointed out where I have done this) he must be a nineteenth century scientist! In this connection he refers to an anecdote concerning Napoleon

²Excerpted from 'Rejoinder to Rejoinder: 2', Published in Bhāratbarsha, vol. 27, p. 37. (1939).

and Laplace.

Interestingly, the critic has not given us the names of those twentieth century scientists who are supposed to believe in this consciousness, nor has he mentioned the books written by them. So any argument with him will be quixotic and absurd. Evidently he has read the Napoleon-Laplace story in an English translation, and as it is bound to happen when one picks up things at second hand, he misreads the story having missed its very essence. For his information, the actual story goes Laplace in his famous book as follows. Mécanique céleste, gave a very simple explanation of the movement of the moon and the planets, proving that all such observed movements can be explained by the laws of dynamics and the gravitational force. When he sought the permission of Napoleon to dedicate the book to him, Napoleon made a light-hearted remark, 'Monsieur Laplace, you have so well described and explained the mechanics of heavenly bodies, but I find that you have nowhere mentioned the Creator.' Laplace replied, 'Monseigneur je n'avais pas besoin de tel hypothèse' ('Sire, I had not the necessity of such a hypothesis').

This comment has often been misunderstood. It might give the idea, unless the context is known, that Laplace was denying the existence of God. But the comment must be read in its context. There was a controversy at the time on whether the laws of dynamics and gravitation are adequate to explain planetary motions. In reality, observations made at the time gave an impression of the planetary motions so complicated that they defied complete explanation. Many scholars were of the opinion that the laws of dynamics and gravitation were not adequate to account for these motions in all their finer details. Some seemed to think that from time to time interference by some unknown agency set

the movement of the planets in order. But Laplace proved that the laws of dynamics and gravitation were adequate enough, and there is no need for the intervention of any unseen agency. This explains his answer to Napoleon. It will not be correct to assume that this was a categorical statement about the existence or non-existence of God.

In fact when scientists express any opinion beyond their domain of research, it has to be assessed through reason and argument. As Sir J J Thomson has said, if an eminent scientist expresses a particular opinion about religion, it should be taken to have come from his family and social background. Unless he provides enough scientific proof it should be taken as nothing but his personal opinion. It would be unfair to impose the weight of his scientific personality on such views. Hence if a twentieth century scientist believes in God, but cannot provide any accepted scientific proof beyond that of his own belief, then it would not be wise to attach any importance to such views....

My contention was that 'God is a subjective creation of the human mind,' i.e. people have conceived particular images of God in every country, every age. Naturally these imaginary Gods differ in nature, and merely reflect the attitudes of those races or particular individuals. I do not know of anyone who has formed an objective idea of God based on definite proof. '*Ī*svarāsiddheh pramanābhābat' (For lack of proof, the concept of God is irrational]. Perhaps this view of the Sankhya philosophers is applicable even to-day.

My critic seems to feel that religion is impossible without an unwavering faith in God. He has forgotten all about Jainism and Buddhism, The Creator or God has no place in these two religions. Yet for two thousand five hundred years Jainism and Buddhism formed the basis of the social

structure, customs and attitudes of a large section of mankind. Even now Buddhist ideas dominate in China and Japan. In India of course Buddhism has been swept away by Puranic Hinduism. According to many, this has been the main cause for India's downfall. Present day Russia is totally godless, but in the last twenty years they have set an example to the world by an overall material progress achieved in a spirit of confidence....

It's all in the 'Vedas' 3

It seems many of the readers are unhappy with the mockery in my first article of 'it is all in the Vedas'. Some have misinterpreted it as an expression of my uncalled for contempt for the Vedas. This is far from the truth. Actually the use of this phrase is related to a personal experience. It goes back to eighteen years ago when I had just returned from abroad, having earned a little fame in the scientific world. In my home town Dhaka a lawyer of repute expressed curiosity about my scientific work. With the enthusiasm of youth I started explaining to him my researches about the physical state of the sun and the stars and how it could be understood by the theory of ionization Every now and then he of elements. interrupted me, saying, 'But that is nothing new, it's all in the Vedas (Sabi byadé āché). After mildly protesting a couple of times, I asked him, 'Sir, would you kindly show me that part of the Vedas which contains these theories? He replied, 'I have never read the Vedas, but I am convinced that whatever modern science claims to have achieved are all contained in the Vedas.' Yet strangely enough this very gentleman had passed the highest examination of the University with distinction.

Scientists who believe in Chaitanya

The critic Mohinimohan Datta refers to Sir Arthur Eddington and Sir James Jeans as twentieth century scientists who believe in cosmic consciousness. Fortunately the present writer knows them very intimately. Since our fields of research are more of less similar I can claim to have a more thorough acquaintance with their work than anyone else in India.

Many people are not aware that Sir Arthur Eddington is a Quaker and a true believer in the message of Christ. He was a conscientious objector during the last war. This belief almost led him to the prison, but he was saved by the timely intervention of an influential friend. His book idea of Universal Mind or Logos, which expresses the faith of a Quaker, hardly contains any scientific argument.

The argument regarding Sir James Jeans is not very clear. Jeans has referred to the theory of Indeterminism posed by the famous German physicist, Professor Heisenberg. But this theory has nothing to do with God or Chaitanya. Driesch has only repeated it. Since the critic is not acquainted with physical sciences he has not understood the meaning of the excerpt.

The conscious spirit pervading the universe' as perceived by Western men of science like Eddington is obviously different from the way pseudo-philosophers of our country look at it. The religious fanatics and so called philosophers of this country squat in a posture of meditation as though to please that conscious spirit and extract some benefit out of it. They cheat the people by pretending that they have communion with the divine spirit, hence possess supernatural powers. They set up a business of spirituality. There is no need to give examples, the daily papers are full of news of such godmen, unscrupulous traders in the name of religion.

 $^{^{3}\}mathrm{Excerpted}$ from 'Rejoinder to Rejoinder: 4', published in Bharatbarsha, vol. 27, p. 407, 1940, pp. 160-169.

All India Programs

Breakthrough Science Society organised a webinar on 14 Nov 2021 in memory of Prof. Thanu Padmanabhan, the eminent physicist who passed away on 17 Sept 2021. Prof Tejinder Pal Singh, Department of Astronomy and Astrophysics, Tata Institute of Fundamental Research, Mumbai spoke on 'Gravitation: From Newton to Padmanabhan and Beyond'.



T Padmanabhan (1957-2021)

BSS-Abroad

There is a BSS chapter comprising students, researchers and faculty members who are now residing in various countries abroad. This chapter organized an webinar on the 'National Education Policy 2020 and the spread of pseudoscience in the name of Indian Knowledge System'. The speaker was Prof. Soumitro Banerjee, General Secretary, BSS. Nearly 120 scholars and science loving people participated online.

Delhi

A webinar was organized on 6 Feb 2022 A science lecture series was organized onon the topic 'The Higgs Boson particle—The line as part of the JRL Lakshmana Rao

building block of Reality'. Prof Soumitro Banerjee, IISER, Kolkata, and General Secretary of BSS was the speaker.

Jharkhand

A Webinar on the 'Origin of the Solar System' was held on 24 Oct, 2021. The speaker was Dr Radhakanta Konar, State Secretary, BSS West Bengal Chapter.

A discussion on the solar system and a sky-watch program was organized on 13 Dec. 2021 by BSS Ghatshila unit.

A discussion was held on the Solar system in the Tangerine School of Potka Block, East Singhbhum, on December 15, 2021. Mr Arvind Tiwari, Chandan Kundu, Uttam Bera and Jagdish Mahali conducted the discussion. 150 students including villagers participated in the program.

A sky watch program was organized by Stephen Hawking Club, Galudih, Ghatshila on 18 Dec. 2021. More than 200 students including villagers were present in the program.

A sky watch program was organized at Tata College, Chaibasa, Jharkhand on 21 Dec 2021.

Einstein Club, Ghatshila, organised a seminar on 27 December on the topic "What actually is science?". The speakers were Dr. Amitabh Bose and Mr Kanhai Barik. The program was presided over by Mr S.R Dutta.

Karnataka

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The discussion on 'What actually is science?' in progress in Ghatsila, Jharkhand, on 27 December

Centenary year celebration. Prof Harini Nagendra (Ecologist and Professor at Azim Premji University) gave a talk on "Ecologically Smart cities in India from ancient to modern times" and wildlife conservationists Kripakar and Senani presented an online talk on "Elephants, forest and us".

The Breakthrough Bengaluru Unit conducted the following programs at Vidyaniketan School as part of the year-long Affiliation. 'On Dance with Mathematics' by Mr. Krishnamurthy (Theoretical Physicist) followed by a hands-on session on the same; 'Scientific approach to tackle misinformation' by Ms. Namrata (BSS Gulbarga); 'Know the sky: An Introduction to Astronomy' by Mr. Anand Raj (BSS Karnataka); 'Movie and Discussion on Life of Louis Pasteur' by Mr Shivkumar (BSS Karnataka); 'Fascinating Aspects of Biology' by Mr Deenadalayan (Principal, SSK PU College).

Breakthrough Gulbarga unit held a Webinar on "Necessity of scientific thinking in times of CoVID-19". Dr. Ramesh Londonkar, Professor, Dept of Biotechnology, Gulbarga University, was the speaker.

Gujrat

A webinar was organised on 1 Sept 2021 Scientist, IGCAR, Kalpakkam and Dr R on the topic 'Why should we have scientific Venkatesan with a view to develop the

temperament?'. It was live streamed on the Facebook page of Universe Science Forum. Mr. Kishan Malaviya (MSc student, Saint Xavier's college) was the speaker.

As part of the 6th Nobel Prize lecture series–2021, the following webinars were conducted live on the Facebook page of Universe Science Forum.

'Nobel Prize in Medicine/Physiology' by Dr. Durgesh Modi on 8 October, 2021.

'Nobel Prize in Physics' by Kishan Malaviya (Member, Editorial board, Vigyan Chetna) and Vaibhav Trivedi (Member of USF) on 11 October, 2021.

'Nobel Prize in Chemistry' by Uttam Surapati (Convenor of USF) on 17 October, 2021.

Celebration of World Space Week: The 2021 theme of World Space Week (4-10 October) was "Women in Space". Universe Science Forum organised a program at Gogha High School, Ghogha, Bhavnagar on 12th October, 2021. Shri Prashantbhai Joshi (Adviser of USF) talked on "Women in science" and Dilip Satashiya demonstrated some simple science experiments and talked about the need for developing scientific approach in life. About 250 students and teachers participated in the program and enjoyed the whole event with great enthusiasm.

Tamilnadu

A series of online discussions under the title 'Art of learning Science' was conducted for students on Fridays over a period of several months. The discussions were on different topics in science and mathematics. The discussions were conducted by a team of resource persons: Prof Vijesh, Dept of Chemistry, Payyannur College, Kerala, Prof Joseph Prabhagar, Loyola college, Chennai, Mr Harikumar K S, Retd Safety Officer, FACT, Kochi, Dr T S Selvakumar, Retd Scientist, IGCAR, Kalpakkam and Dr R Venkatesan with a view to develop the



Science experiments being demonstrated before slum children in Dharavi, Mumbai

science learning centres in the state.

A lecture series on climate and weather was conducted in the period October to November 2021 beginning with a talk on the Nobel Prize in Physics. Dr B Amudha, Director, Airport Metrological Department, Chennai, spoke on "Can we predict the weather?". Dr R Venkatesan spoke on the topics "Science of weather—Basics for students" and "Why do weather predictions go wrong at times?"

A discussion on Indian Knowledge System (IKS) was conducted on 28 Jan 2022. Mr V P Nandakumar, All India Vice President, BSS presented the important aspects of the IKS and a discussion followed.

An online course in Quantum Mechanics by Prof Satyanarayana, Dept of Physics, Pondicherry University is in progress every Saturday.

Kerala

A state level webinar was organised on the much debated Silverline semi-high speed rail project on January 30. Dr C P Rajendran, Geoscientist and Adjunct Professor, NIAS, Bangalore spoke on 'Krail silver line project—Why is it unsafe to the environment'. Hundreds of people participated through Zoom and YouTube.

Another state level webinar was organized on "The Techno—economic feasibility of K-Rail Silverline project" on 6 Feb 2022. The speaker was Mr Alok Kumar Verma, Former Chief Engineer, Indian railways.

Thiruvanathapuram chapter

A talk on Nobel Prize in Physics 2021 was organised jointly with Science and Technology Museum in Priyadarshini Planetarium Hall on November 28. Dr. G P Padmakumar, Director of the planetarium presided over the function. Dr. M. Govindankutty, Associate Professor at IIST Thiruvanathapuram spoke on "Understanding the climate change through mathematical modeling" and Dr. Naveen Surendran, Associate Professor, IIST Thiruvanathapuram spoke on "Pattern in complex systems".

The International Day for women and

girls in science was observed on February 13 with an online panel discussion. The panelists were Prof. Hema Somanathan, IIST, Thiruvanathapuram, Dr. Manoj Puravankara, TIFR, Mumbai and Dr. Reshmi L, IIST Thiruvanathapuram. Around 300 students participated through Zoom and YouTube. Essay competition, online quiz competition and poster making competition were also organised on the occasion.

Alappuzha chapter

An online panel discussion to observe the International Day for women and girls in science was organized on February 13. The panelists were Dr. Sangeetha Joseph, Pediatrician, W&C Hospital Alappuzha, Dr. Bindu L, Dept. of Zoology, MSM college, Kayankulam and Dr. M A Bindu, President, Alappuzha District, AIMSS. Dr K. Hariprasad, State Secreariat member of BSS was the moderator. Kumari Shilpa also spoke on the occasion.

Kottayam chapter

An online panel discussion was conducted to observe the International Day for Women and Girls in Science on February 11. Dr. K Indulekha, SPAP, MG University, Kottayam, Dr. Keerthi T R, School of Biosciences, MG University, Kottayam, Dr. Mercy Mathews, Dept. of Physics, KE College Mannanam and Dr Jesty Thomas, Dept. of Chemistry, KE college Mannanam were the panelists. Around 90 students from various colleges took part online.

Ernakulam chapter

The BSS Ernakulam Astronomy club has been conducting weekly sessions on astronomy related topics on every Saturday. An astronomy course with the objective to train the trainers is in progress. Mr Sajeev Prabhakaran and Mr Harikumar K S are

conducting the course with the assistance of a team of faculty members.

Weekly science sessions for junior students and senior students are being conducted on every Sunday for the last 7 months. The junior students session is coordinated by Mr P P Abraham and Mr P C Thankachan. The senior students session is coordinated by Mr George Joseph and Ms Lasitha Sajeev.

Andhra Pradesh

A webinar on "Why we (Indians) are so sweet (Diabetic)?" was held on 21 Nov 2021. The speaker was Dr Parimal Misra, Senior Professor and Chief Scientist, Center for Innovation in Molecular and Pharmaceutical Sciences, Dr. Reddy's Institute of Life Sciences, University of Hyderabad Campus.

Telangana

Webinar on 'SARS CoV2 & COVID-19: Where from & Whither to?' was held on 21 Nov 2021. Dr Parimal Misra, Senior Professor and Chief Scientist, Center for Innovation in Molecular and Pharmaceutical Sciences, Dr. Reddy's Institute of Life Sciences, was the speaker.

BSS Telangana Chapter organized a one day Winter Science camp on 9th January, 2022 at Hyderabad. Science experiments, miracle-bursting shows and a session on the solar system were part Children particiof the science camp. pated enthusiastically. At the concluding session, a science drama on superstition also performed by children. The state in-charge Mr R.Gangadhar addressed the camp members. BSS activists Devarshi Gangaji, Sarath and Ushakiran with the help of several volunteers conducted the camp successfully.

An online Science experiments by children was held on January 14. Srinidhi and

Prashanthi performed the science experiments.

Webinar on 'Revisiting Charles Darwin' was held on Feb 12. Dr.Vikas Sarma, Asst. Professor, Biotechnology, Osmania University was the speaker.

A seminar on 'Global warming and its impact on Environment' was organized at G.Pulla Degree and PG College, Osmania University on 8 Dec, 2021.



A webinar was held on 17 February, 2022 to observe the death anniversary of Giordano Bruno, the first Martyr of science. The webinar was organised by the BSS Sonitpur Chapter. Mr. K. Das, Assistant Professor, Mizoram University and Mr. Diptojyoti Mondal, science activist, spoke on the occasion.

Tripura

A BSS book stall was organized at Agartala during the festival time in October 2021

Maharashtra

Mumbai

A science experiment demonstration for school students was organized in Dharavi (slum area), Mumbai, on 21 December 2021. Ms. Karuna Game and Mr. Dibyashankar Das, members of BSS Mumbai unit conducted the program. Nearly 50 students participated from various schools.

On 22nd December 2021, a science experiment demonstration program was organised in Chuna Bhatti (near Dharavi). Ms. Karuna Game and Mr. Dibyashankar Das, members of BSS Mumbai unit, conducted the program, and nearly 60 students participated in the program.



The science camp in progress in Guna, Madhya Pradesh

Nagpur

During 24 to 26 December, several science programs were organised in Nagpur. On the 24th, a webinar was organised on 'Life Cycle of Stars' in Mahatma Gandhi Junior College, Wanadongri, in presence of nearly 120 students. Dr. Manabendra Nath Bera was the speaker.

Science experiment demonstration programs were organised in three coaching centres. Mr. Rajat Kakde and Mr. Ashish Lokhande, members of BSS-Nagpur conducted the programs. Altogether, nearly 200 students participated in the programs.

Madhya Pradesh

'Learning science through experiments' activities were conducted statewide in 5 districts in the month of December.

State level Seminar on Nobel Prize in Chemistry was organized on 14 Jan, 2022. Dr. Shailaja Jain (Post doctoral fellow, Herbrew University, Israel) was the speaker.

A two-day Winter Science camp was organised in Guna district on Dec 25 and 26.

State level workshop on science experiments demonstration was organized on Jan 29 and 30.

State level class on Astronomy versus Astrology was conducted by Dr. Manabendra Bera (All India Secretariat member, BSS).