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GUEST EDITORIAL

The 'historic' storm at the Mumbai Science Congress*

The 102nd Indian Science Congress, meeting at Mumbai during 3–7 January 2015, was dominated by loud national debate about the history of science in India, a subject that does not normally figure on the Congress programme. The dust raised by the storm has just begun to settle down; so it is time to look back on it and attempt to analyse the roots of the debate.

The centre of the controversy was a symposium on 'Ancient science through Sanskrit', organized for the Congress essentially by a group of Sanskrit scholars and academics. Surely it is appropriate for the Congress to debate the subject, especially as there are such polarized views on it. To over-simplify matters somewhat, the opinions that are commonly heard in public discourse come from two distinct camps. One claims that our ancients knew all about many branches of modern science and technology, ranging from relativity and quantum mechanics to stem cell biology and aerospace technology. The other camp sarcastically dismisses any claim about past achievements as dubious, if not absurd. These debates are often tied to a related philosophical issue as well: do Indians have (or have they ever had) what Jawaharlal Nehru liked to call a scientific temper? I believe both camps have gone too far. This is surprising because there has recently been an increasing number of more authentic accounts of classical Indic science published in India and abroad.

Now the debates surrounding the Congress generated three specific controversies. The first concerned ancient Indian aviation technology. A presentation made on the subject, based on *Bruhat Vimana Sastra* attributed to Maharshi Bharadwaj and *Vaimanika Sastra* (*VS*) by G. R. Josyer, described four types of 'vimanas' from these 'ancient' books. One of these vimanas was supposed to fly at around Mach 10, another had a base exceeding 300 m in diameter; but curiously there is not a word on the crucial question of weights. These designs have been shown to be scientifically unsound in a critical analysis of *VS* (*Scientific Opinion*, 1974) by a group of reputed scientists in the Departments of Aerospace and Mechanical Engineering at the Indian Institute of Science, Bengaluru (H. S. Mukunda, S. M. Deshpande, A. Prabhu, H. Nagendra and S. P. Govindaraju, all of them by the way genuine lovers of Sanskrit). For example, the designs violated Newton's laws, and even got the sign wrong for the thrust of their engines. The work seems traceable to an original dictated by a self-taught, impoverished but serious Sanskrit scholar in Karnataka sometime during 1900–1922, and could not have been Vedic by any criterion. This effort at creating a false history of Indic science is a spectacularly bad example of the absurd lengths to which attempts at glorification of our past can go.

But the other two controversies were of the opposite kind. One concerned the 'theorem of Pythagoras' (5th century BCE), although there is no record of even a statement of the theorem by Pythagoras. The Egyptians and the Babylonians used several 'Pythagorean' integer triplets as early as the 2nd millennium BCE, but they stated no general proposition. An explicit statement of the theorem does however appear in Baudhayana's *Sulva Sutra* (a manual of the ritual geometry needed in the construction of Vedic fire altars), asserting the equivalent theorem that the square of the diagonal of a rectangle is equal to the sum of the squares of the two sides. The date of the work lies roughly between the 5th and 8th century BCE. Thus Baudhayana's assertion of one of the hoary results in geometry is the earliest available record in the world, and predates Pythagoras.

The third controversy concerns plastic surgery, which seems to have been driven in several parts of the world by the need to repair broken noses (apparently an ancient and common punishment worldwide), cleft lips, etc. The first records go back to Egypt in 3000–2500 BCE. In the 6th century BCE, Suśruta consolidated Indic ayurvedic knowledge in an encyclopaedic and foundational text called the *Suśruta Samhita*. This included the practice of plastic surgery, in which India clearly remained well ahead of the rest of the world. Thus the first major rhinoplasty in modern West was performed as late as 1815 by a British surgeon who had served in India for 20 years, and was triggered by British press reports about how Maratha soldiers who had lost their noses in the Anglo-Mysore wars were surgically set right in Pune. There was no European competition to so-called 'Indian Nose', so Indic claims on plastic surgery seem to be on solid ground.

Regarding the scientific temper issue, even a cursory examination of classical Indic philosophy and scientific

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thinking shows that a strong rationalistic streak has been present, side by side with mythology of some kind, for almost as many millennia as our civilization has flourished. A striking example here is the ancient Samkhya school of philosophy, mentioned already in the Upanishads and boasting a distinguished 20th century admirer in J. B. S. Haldane. The Nirisvara (non-theist) branch of this school went so far as to say that there was no evidence (no pramana) for the concept of Isvara or god. Samkhyas believed in conservation of matter, saying 'nothing material can be realized from the non-material', *na-avastuna vastu-siddhih*; and so would have summarily dismissed any claims to produce matter out of nothing. According to Samkhya, nature experiences evolution due solely to its own internal dynamics; so there was no room for creationism. Inanimate nature could nevertheless be beneficial to human-kind – as with rain for example; so they attributed the apparent design that often characterizes nature to pure accident. These views have survived for thousands of years in India, despite the scathing criticism of great acharyas like Samkara. Is it not astonishing that the rationalist movement in India never takes the Samkhya views of the world as starting points?

Samkhya philosophy has had a strong influence on classical Indic scientific thinking. Charaka (~1st century CE?) describes how Agnivesa, the founding father of Ayurveda, engages in a discussion 'surrounded by Samkhya philosophers'. Bhaskara (12th century) begins his famous treatise on algebra, the *Bija-ganita*, with an invocation that is a clever punning stanza that can be interpreted as praising either number or the Samkhyas.

In public Sanskritic discourse science and mythology – siddhanta and purana in Sanskrit – are often mixed even today, but the debate between them has a long history in India. In such debates the arguments have varied from the rather sensible view that the puranas are for salvation and the siddhantas are for worldly affairs (vyavahara), so their domains were different, to the pauranic criticism that siddhantic calculations cannot be accepted as proofs of reality. An interesting case of famous adversaries involves Āryabhaṭa (5th century CE) for whom eclipses were a matter of shadows, but Brahmagupta (7th century CE), brilliant mathematician as he was, upheld the pauranic Rahu–Ketu story even as he predicted eclipses by the shadow theory. Nilakantha, a versatile Kerala astronomer–mathematician–philosopher (1444–1545), said that his work was rooted in yukti (skill, reasoning), not in the sacred scriptures. Contrast this with how Francis Bacon (1561–1626), just a little later, invoked God and *Bible* quite often, and another century later Newton secretly wrote much more about theology than he did about science. So we cannot accuse Indic classical science of being unduly irrational.

Finally, a few words about Indic mathematics, which I consider has not yet gained the global or domestic recognition it deserves. Apart from the well-known numeral system, and the algorithmic/computational revolution it sparked, the number of advances made in India long before they were (re-)discovered in Europe keeps increasing as we learn more of our own history. Look at these examples: a large part of algebra, first solutions to linear and quadratic indeterminate equations (Aryabhata, Brahmagupta); the binomial theorem, the combinatorial formula and Pascal's triangle (Pingala 3rd century); second-order interpolation formulas and the Newton–Raphson method (Brahmagupta), the Fibonacci numbers (Virahanka 700 CE, Hemachandra ~1150 CE); the basics of differentials, maxima of functions, mean value theorem, etc. (Bhaskara ~12th century, Munjala ~ 800 CE); infinite series, and a precursor of what later came to be known as calculus and analysis (Madhava 14th century): so the list goes on. These contributions are not just 'little' mathematics, and the 'big picture' of their collective influence on the world was succinctly and accurately summarized by Hermann Weyl when he wrote (Preface to *The Theory of Groups and Quantum Mechanics*, 1928):

> 'Occidental mathematics has in past centuries broken away from the Greek view and followed a course which seems to have originated in India and which has been transmitted, with additions, to us by the Arabs; in it the concept of number appears as logically prior to the concepts of geometry.'

This extraordinary tribute is a striking recognition of the slow, silent but inexorable diffusion of Indic mathematical ideas to Europe through creative Islamic volunteers, culminating four centuries ago in a redefinition of what mathematics was, and the profound revolution that we call modern science. With a legacy like this we do not need to invent unlikely stories about the past; we just need to work hard in the present.

It is high time we learnt once again to distinguish science from mythology (either can be fun, but they are best when not mixed), evidence-based reasoning from unthinking acceptance of authority or speculation, and the rational from the superstitious (realizing that a full life may not be purely rational: consider Ramanujan, for example). To make that happen is a responsibility that scientists here must accept, working in close collaboration with friendly outsiders. Our youth are hungry for a sensible knowledge of our past, but are denied an opportunity to acquire it by a marvellous educational system that shuns history in science curricula, and by the paucity of attractive but reliable accounts of the fascinating history of Indic ideas. Our academies, universities, museums and other institutions need to make such a project a national mission. Anything less would be irrational blindness to a unique legacy.

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