Draft

Ending Academic Imperialism: a Beginning

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Abstract: Academic imperialism begins with Western education, which has not been seriously challenged in hard sciences. Colonialism changed the system of education as a key means of containing revolt, and stabilising Western rule. The change was possible (e.g. by Macaulay in India) just because a large section of the colonised elite had *already* swallowed the racist beliefs of the 18th c., that only the West had innovated in science. Those racist beliefs, in turn, were based on a bad history and philosophy of science violently distorted by the religious fanaticism which overwhelmed Europe from the Crusades in the 11th c. until the 17th c. Therefore, to end academic imperialism it is necessary to take the following steps. (a) Dismantle and expose the falsehoods of this Western history of science. (b) Change also the accompanying philosophy of science. (c) Use this to construct a new pedagogy, particularly in the hard sciences, and demonstrate its practical value, to dismantle the colonial education system. (d) Dismantle the Western power structure at the level of higher-education and research.

The immediate action items relate to (c) and (d). (1) Help repeat an experiment to test a new pedagogy of the calculus ("5-day course on calculus without limits") based on a new history and philosophy of mathematics, which enables the calculus to be taught very easily, with the help of computers, even to non-math students. (The calculus is at the base of hard science.) (2) Join and contribute to a new society and web-journal for History and Philosophy of Non-Western Science (HAPONOWS), which will not permit reliance on *secondary* Western sources, so that authors will have to assume that all such material is doubtful and untrustworthy.

1. Introduction and summary

The point about academic imperialism is not just to talk about it, but to end it.

Talking about it is useful only in so far as it helps to understand the key causes and remedies. Here is a summary of both, and a proposal for the critical first step.

Western education has been promoted on the grounds that it would help to "catch up with the West" in science and technology and thus obtain parity with the West in hard power. This belief makes the non-West imitate the West.

On the other hand, today, a scientific innovation is not treated as credible until it has been endorsed by the West (e.g. published in a "prestigious" [meaning Western] journal); this practice ensures that the non-West can *never* out-innovate or catch up with the West in science, for the West is always the first to know about any major innovations, well before they become public.

The two beliefs combined (that Western education is needed for science, and that Western endorsement is the best test of scientific truth and expertise), thus, actually are a recipe to ensure perpetual inferiority of the non-West, and to make the technology gap permanent, with the non-West always following in the footsteps of the West, but trailing behind, and never able to catch up.

For example, Western education has been encouraged in India for nearly two centuries, but India could not achieve technological parity with the West, in all these years—even its much vaunted space program, for instance, is still more than 40 years behind the West. (India just sent an unmanned mission to the moon. But the fact is that the US landed a man on the moon over 40 years ago, around which time, China, too, had acquired ICBM technology.) The cryogenic rocket technology used in India poses no military threat to the West. The West is happy to have a billion people following it at such a safe technological distance.

Unlike ordinary imperialism, in Iraq or Afghanistan, say, which is resisted, and drains the imperialist, academic imperialism is self-perpetuating. Common people, too, seek Western education for the economic benefits it might entail at the individual level, through proximity to the rulers. Thus, they acquire the attitudes and values the West wants them to have. *This soft power of the West is a stronger basis for imperialism than its hard power which is otherwise vulnerable.*

Thus, the technology gap between West and non-West is often very slender. Atomic bombs, for example, are easy to build. A country like Iran could easily do that, within a short time, *if it were allowed to do so*, without external interference. And if political pressure is the real means by which the technology gap is maintained, then how can that gap ever be overcome by imitating the West? On the other hand, Russia still has a whole lot of nuclear bombs and delivery missiles. But they are no longer seen as a major threat, after the Soviet Union succumbed to Western soft power and disintegrated without a blow.

Thus, the real strength of imperialism is soft power, not hard power. The West needs soft power to cement the vulnerabilities in its hard power. Imitating the West only enhances its soft power, without diminishing its hard power (which is based on the technology gap).

The present-day soft power of the West originated during colonialism. Unlike ordinary military conquests, colonialism involved a cultural conquest; it involved cultural imperialism. In India, the Britishers themselves wondered how a handful of people from a small nation coming from so far overseas could control such a vast population. Indoctrination through the colonial education system played a key role in this cultural imperialism. The aim of colonial education was to create a Western educated elite class of Indians who would be loyal to the British and help them to rule the masses. This loyalty was ensured by the education system which implanted the desired attitudes and values, and also instilled an unshakeable belief in Western superiority (and Indian inferiority). This is not exactly the way dogs and other animals are trained to obey their masters without a stick, but there is an analogy.

This colonial system of education could be initiated just because the gullible Indian elite (and the colonised, generally) had *already* swallowed the claim of Western superiority. In the early 19th c., there was no visible technology gap between West and non-West: the Battle of Plassey was not won by any technological superiority. Nevertheless it was argued that the West must be imitated since it was superior. That claim of superiority rested on the bad history that science is of Western origin, and is,

thus, practically owned by the West, which is *hence* intrinsically superior. This bad history was further reinforced by bad philosophy which claimed that Western ways of doing mathematics and science are universal, and other ways of doing them are worthless. As the owner-originator of universal knowledge the West claimed the right to rule the world. The sole virtue of others lay in how well they could imitate the West.

This understanding of the origin of Western soft power suggests a step by step process to dismantle it. The process must start by correcting history, modifying philosophy, and revitalizing education. Eventually, this process must be extended to change the present-day methods of validating science.

The first step is to undo the falsehoods of Western history of science. Far too many people incorrectly think this can be done just by highlighting some scientific contributions of the non-West. Certainly, it is important to highlight the contribution of the non-West, but that, by itself, is not enough, and past attempts to do so have repeatedly failed to change "mainstream" history of science. For example, it has been known for at least the last sixty years that Copernicus, a mere priest, only translated the works of Ibn Shatir and Nasiruddin Tusi (of Maragha) from their (Byzantine) Greek versions to Latin. Yet the mass of people still believe Copernicus was a revolutionary scientist. Most Western historians of science go on talking about the "Copernican revolution", pretending as if nothing happened. People have been indoctrinated to believe that any attempt to correct Western history is necessarily chauvinistic. This latter belief has been greatly helped along by the more extreme elements in the non-West who have often made wild claims. In any case, such information is often just ignored by the West.

Thus, the right thing to do is, first, *to expose the falsehoods of Western history.* Present-day academic imperialism is based on the formula "trust the West". This formula is the key to the Western indoctrination and propaganda, so critical to ordinary imperialism. Western propaganda would fail without such trust. To negate that propaganda, it is important to demonstrate that this trust in the West is misplaced.

Hence, also, it is important to demonstrate that the deliberate falsehoods of Western history of science are not limited to isolated instances in the past; those falsehoods are widespread, and systemic, and extend into the present. This can be demonstrated by exposing also contemporary Western icons at the highest level, such as Einstein. Hence, I have started the series of books, "False Gods of Science?", a summary account of which is in my book *Is Science Western in Origin?*.[1]

While exposure of Western falsehoods is necessary, it is not sufficient. The West has lived off the most absurd lies for so long that it has developed a defence mechanism against such exposures, and tries to maintain those lies by inventing further lies, for example about the persona of those who expose its lies. A number of Western historians see it as their job to promote and maintain falsehoods in history. So, the exposure of Western falsehoods needs to be *propagated* as vigorously as possible. While individuals may uncover the falsehoods of history, the propagation of such exposure has to be a collective effort. While such a collective effort is easy, there must be a widespread realization that it is needed, otherwise it is easy to isolate and paint the individual as a deviant or a chauvinist.

The second step is to understand and undo the the way bad philosophy has been used to support false history. For example, it has been claimed that the Western way of doing mathematics is the only right way, and must be imitated. On the one hand, this "philosophical" demand to imitate the West has a retrospective effect on the history of ideas, for it allows an easy way to dismiss non-Western

contributions as insignificant, since non-imitative. (For example, the pre-Newtonian Indian calculus is today dismissed as "pre-calculus", just because it does not imitate the present Western way of "limits".) On the other hand, this demand for imitativeness allows "science" itself to be used as a key weapon to run down beliefs in other cultures. A pet argument of Christian missionaries was that Hindus and Muslims and all non-Christians, in general, were superstitious, unlike Christians who were rational.[2]

More to the point is the way Western educated people, even those with the best intentions, have swallowed this belief. The Pakistani physicist, Pervez Hoodbhoy, for example, is today arguing that scientific development was arrested in Islam due to al Ghazali. As I have commented,[3] a curious aspect of Hoodbhoy's claim is that what Hoodbhoy calls "the key premises underlying *science*" are actually the key premises underlying post-Crusade Christian *theology,* which the church found it politically convenient to adopt during the Crusades. Those theological beliefs got mixed-up with mathematics, science, and its philosophy in the West. In fact, all those premises can be safely denied, and this de-theologisation leads to a *better* mathematics and science, and a better philosophy of science, as I have shown. In any case, the subterranean message underlying the missionary position is to adopt Western (indeed post-Crusade) values suited to the imperialist. The whole issue is a bit complex, and as I have discussed it extensively elsewhere,[4] so I will not enter into this issue (of science as a source of imperial values) here, and will only indicate why it is better to teach de-theologised mathematics.

The third step, and a key step, against academic imperialism is *to dismantle the colonial education system which indoctrinates people.* The need to decolonise education has so far been understood only in the context of political history and social sciences. In "hard" sciences, imitation of the West remains the norm. So it is here that it is most important to decolonise education, and demonstrate alternatives.

Since mathematics is at the root of science, it is a good idea to begin by decolonizing math education. Because imitation of the West has been painted as "progressive" since colonial times, it is important to demonstrate that decolonising mathematics education is not a "regressive" step, but leads instead to *gain* of practical value, and the only loss is that of Western indoctrination.

A key aspect of that indoctrination is to implant the belief in the conflicting claims that (a) "mathematics is universal", but that (b) "mathematics began with the Greeks" and other cultures had no real clue as to the right way to do math. Now, it is elementary commonsense that if (a) is true, and mathematics is indeed universal, then (b) must be false, for mathematics should have sprung up the same in all places! So, it is remarkable how many people who know neither mathematics, nor its history, or philosophy, adhere to *both* these claims, contrary to commonsense. Such contradictory convictions based on ignorance are the hallmark of superstition and indoctrination. In fact, both the beliefs (a) and (b) began during the Crusades, as beliefs politically convenient to the church.

The solution, thus, is to break such Western superstitions by means of practical pedagogical demonstrations. I believe all these elements (a new history, a new philosophy, and a new pedagogy, with a resulting gain of practical value) are captured in my 5-day course on calculus without limits. The basic point is that math teaching is difficult today because theology got mixed up with this math in the West. Therefore, de-theologising math also makes it very easy to teach.

Such demonstrations need to be replicated widely, advertised, and absorbed into the "mainstream" educational system, to destroy the superstition implanted and encouraged by the colonial education system, that there is no alternative to imitating the West. In fact, such demonstrations will create a

major dilemma for the West. Either it must lag behind in the area of math education which it today recognizes (as in the latest Obama budget) as a key area of concern in pedagogy, or it must abandon its cherished theological beliefs—beliefs on which much post-Crusade Western philosophy is based. This latter course will not be easy, so the non-West also has a comparative advantage here.

This course on calculus without limits is only a first step to decolonise education in hard science. (That first step is often the most difficult.) Once the first step is taken it will be readily seen that other similar changes are possible, for example, in the case of geometry and algebra. Other sciences such as physics and biology are also colored by Western doctrinal content which is of negative practical value, and it is important to demonstrate the entry of theology into these hard sciences, at least in the obvious cases, such as the work of Newton or Stephen Hawking, and to separate the practical value of these sciences from their doctrinal content.

The **fourth and the last step** is to dismantle the Western academic power structure at the level of higher education and research, for this exerts continuous pressure on school and undergraduate pedagogy. The politics of information here is more complex, and, unlike the first three steps, it might be better to do this more gradually.

Certain steps can be taken in this direction right away. Many people, even in the West, find stifling the existing power structure used to control journal publications. Although blind peer review is portrayed as a system of quality control, it is open to much misuse, like Roman Catholic confessionals, and has been rightly described as pre-censorship. Systems like the arXiv which provide an alternative way to disseminate knowledge have long been in place. Even these alternative systems have been challenged as too restrictive, leading to the formation of more recent alternatives such as viXra.

Quality control, especially in a digital age (where there is little cost associated with publication), should ideally take the form of *post*-publication *public* debate. Such debates can be encouraged, for example, by inviting comments by referees (and rejoinders by authors), within a system like viXra. The referees would not be spending any more time (if they were serious, in the old system) but the quality of debate would improve. Moreover, the fact is that with novel ideas, referees tend to err quite often, and, in this system, there would be room to correct such errors. Setting up such a system is a simple matter which sovereign states (and even universities and smaller institutions) can easily implement. Governments must actively encourage this change.

Side by side, the hold of commercial journal publishers in science, such as MacMillan, Springer, Elsevier etc., needs to be broken. Why should scientific information produced by public-funded research be turned into the private property of these publishers through copyright? If those publishers are charging only to meet operational costs, why should they hide the extent of profits they make in the process? Why should government agencies encourage the superstition that the prestige of a scientist is best decided by publications in such commercial journals? Why should public funded scientists be allowed to work for free for these commercial journals, as referees? All these sops and subsidies need to be withdrawn. Commercial publishers of science journals are free to exist. But let them do so on their own, or perish. These journal publishers are no longer needed to disseminate information, which can be quickly and efficiently distributed digitally. In particular, copyright laws should be amended to enforce free public access for all public funded research articles which are published even in commercial journals. At worst such journals may be allowed a time lag of not more than one to three months before allowing full public access.

As with history of science, such alternative measures must be accompanied by exposure of the falsehoods underlying the present system of Western endorsement. One such system of endorsement is fellowship of a Western society. This often depends upon proximity to some prominent member of that society, but is indiscriminately interpreted as an index of scientific achievement, as in the NCHER bill, to be made a law in India. Since such endorsements give people power in their own country, they can also be cynically exploited to manipulate scientific decision-making in these countries. Let someone first examine cases of some scientists who have been endorsed by the West, and see of what practical value their scientific work was to their societies across their lifetime. We also need to examine *who* benefited from their recommendations, when these scientists acted on government committees. Mashelkar and Narlikar, for example, would be good cases for such investigation in India.

The ultimate Western endorsement is the Nobel prize, and the politics of that endorsement is widely recognized in the case of the peace, literature and economics prizes. Those endorsements are believed to be weightier in the "hard sciences", although very similar processes operate also in those cases. However, as far as I know, there has never been any non-Western attempt to *study* those processes. Such a study might at least lead to the realization that Western endorsement ought not to be the key to scientific achievement, and alternative prizes instituted elsewhere may then look for more transparent means of decision-making.

Another common system of endorsement is the so called "impact parameter", related to the "ranking" of the journal. This is just another seemingly-objective way to say that mere peer review is inadequate, unless the peers are Westerners who count (or their affiliates). A detailed discussion of this would be out of place here, but two points are in order. For a commercial journal such an index (journal ranking) makes sense, for the publishers are concerned only with its consumers, who are scientists. This also makes journals themselves the focus of scientific research—which obviously suits those commercial publishers. However, the citation index is at best a *biased* measure of social popularity in the West—measuring this simple number is what all the big talk about the "scientific method" has been ultimately reduced to, in practice! Publication in these "high-impact" journals depends upon endorsements by referees and editorial boards predominantly from the West, so social networking is critically important in that as well. These journals will avoid non-Western knowledge, for example. In this way, Western endorsement is passed off as the sole index of scientific virtue. In fact, if the concern is with practical value, the validity of a scientific theory must be decided differently, irrespective of its social popularity. Also the the theory has to be judged by its impact on the *society* at large (and not just consumers of journals) over a longish time period. New ideas often involve complexities which the scientific community takes a long time to grasp.

Many further steps are possible. For example, it is desirable that international journals and conferences and societies should have internationally *representative* selection committees. This rarely happens today. However, I do not think sovereign states should try to enforce this, at least not right away. Rather, discussions about this, in the context of the ethics of science, need to be encouraged.

The timing and sequence of the steps is important. If Western history *and* philosophy of science are not first (and continuously) challenged, there will be resistance to changes in the educational system. And until the education system is changed, and Western indoctrination in elementary science education is eliminated, those who grow up with it, will resist any changes at the level of higher education and research.

Some further details are given below.

2. Why hard science?

There has not been any attempt to decolonise the pedagogy of "hard science" so far because it is generally harder to understand how academic imperialism functions in mathematics and science. This is so for two reasons.

First, the vast majority of people have too little knowledge of science or mathematics to judge the validity of a scientific claim on their own—they rely on authority. Whose authority? Clearly, Western authority. If a scientific claim is published in *Nature*, say, or has been endorsed by people in Harvard or MIT or Cambridge, then people will judge it to be true. Journalists will report it. Otherwise they may well judge it to be false or suspect. In general, scientific experts are believed to be only those who are socially recognized in the West, and even governments decide on the advice of such experts. [In a recent bill to regulate higher education and research in India (National Commission of Higher Education and Research Act, 2010), the government of India plans to make this principle of relying on Western social approval into a law!]

Second, scientists too use this method of "proof by Western authority". In fact, in complete contrast to the image of science and scientific method as based on reason and experiment, scientists rely heavily on authority. This happens for various reasons. Today, scientists are usually specialised (since specialisation leads to higher efficiency, hence profits). As specialists they are unsure about any matter even marginally outside their narrow field of specialisation, and prefer to rely on authority.

Further, scientific research and experimentation today requires large funds. Funding agencies judge the performance of scientists using *publications*. Hence, the most important part of a scientist's activity today is not thinking or doing (experimentation), but *writing* (publication)! Funding agencies do *not* judge the value of publications by reading them or applying their mind to those publications (for they may not understand that aspect of science). Instead, they proceed mechanically ("objectively") by using such yardsticks as the "number of publications" (which does not even measure *quantity* of work correctly); or they claim to assess the "quality" of a publication by its social popularity among other scientists ("citation index") or the proximity of those journals to Western scientific authority ("impact factor") etc. In the case of cinema, anyone would concede that box-office success does not guarantee *artistic* quality; however, popularity in the West ("citation index", "impact factor") is the sole basis used to judge *scientific* quality.

The net result is that, today, science has come to mean dependence on Western authority, since scientific truth needs certification, and the West is the ultimate authority to certify it. What is involved is not quality control but mind control!

On the other hand, there is a great demand for science in the non-West. Many people in the non-West have long believed the story that the West dominates the world just because of Western science. They therefore argue that the way to escape from Western dominance is to do more of science, and thus beat the West at its own game.

The irony is that this strategy coexists with the belief that any innovation must first be certified by Western authority. In medieval England, a serf was obliged to offered the virginity of his new bride to the local lord to complete the marriage ceremony; likewise every scientist today must first offer his idea to the West for approval, before it becomes credible. The process is euphemistically called "peer review". But there are numerous such "peer reviewed" journals. So "peer review" is regarded as untrustworthy unless the "peers" are Westerners. Moreover, this is a secretive process, which can be easily misused. It is a remarkable feat of gullibility that those who have been continuously exploited by the West for centuries trust it so implicitly. This system ensures that no scientific innovation can take place anywhere in the world without the West immediately coming to know of it. It is impossible to beat the West at its game with these rules!

The combined result of both beliefs is to ensure that the non-West is perpetually following the West, and perpetually behind, making the technology gap permanent. This is what actually happened in India. Western education in India was promoted using the argument that this would help India to "catch up" with the West. But even in 175 years, it has not been able to catch up. Some people, however, never learn. Despite the manifest and long-term failure of this strategy of imitating the West, it has *again* been advocated by the Indian National Knowledge Commission (NKC), whose chief said that Indians should learn trigonometry from the MIT open course materials, and not bother to develop their own course materials. In fact, even in the "elementary" mathematics of trigonometry and calculus, knowledge is *not* settled today, and significant innovations are possible. Significant innovations often take place where they are least expected. The chief of the NKC (and the advisor to the Prime Minister on Innovations) does not seem to understand this. However, such innovations could well be the key to overthrowing academic imperialism.

Thus, the increased demand for science in the non-West only *increases* its dependence on the West, and destroys *any* possibility of out-innovating the West in science. As already pointed out, unlike ordinary imperialism, such academic imperialism is self-perpetuating. Western educated Indian elite, loyal to the British and dependent upon them for a livelihood, were a miniscule proportion of the Indian population during the British Raj. Quite possibly it was the British who encouraged their allies, like Savarkar, to assassinate Mahatma Gandhi and thus subvert the independence struggle into a mere transfer of power to this very elite. Today the aim seems to be to entrain 10% of the Indian middle class into Westernised education and make their livelihood dependent upon the West. The NCHER bill leaves no room for doubt that real power in Indian higher education and research is being transferred to the West.

Thus, the search for parity with the West in hard power drives the non-West into the arms of Western soft power, which is self-perpetuating, and prevents the non-West from achieving parity.

Because "hard science" (and the associated hard power) is the carrot at the end of the stick, the fight against academic imperialism must begin by attacking the academic structures surrounding "hard science". The key such structure is that of education, and the first point of attack must be mathematics which is at the base of "hard science".

3. Colonial indoctrination and the history of science

In India, Western soft power and the colonial education project began with Macaulay in 1835. The BJP election manifesto for the previous election stated[5] that Macaulay admired Indian civilization, but wanted to "break [its] very backbone", by introducing English education. Such falsehoods do not help fight academic imperialism: a true understanding of the causes is needed to cure the malaise.

Macaulay, a racist to the core, and an admirer of other racists like Locke and Hume (both of whom he cites in his infamous Minute of 1832), had nothing nice to say about Indian civilization or the then-prevailing system of Sanskrit and Arabic education in India.

> higher studies ...[need a] language not vernacular.... What then shall that language be? One-half of the committee maintain that it should be the English. The other half strongly recommend the Arabic and Sanscrit....
>
> I have no knowledge of either Sanscrit or Arabic. But I have done what I could to form a correct estimate of their value. I have read translations of the most celebrated Arabic and Sanscrit works. ...I am quite ready to take the oriental learning at the valuation of the orientalists themselves. *I have never found one among them who could deny* that a single shelf of a good European library was worth the whole native literature of India and Arabia..[6].[Emphasis added]

The emphasis is intended to indicate that Macaulay wasn't just stating *his* personal opinion, but claiming that *everyone agreed with him on this point.* He goes on to pinpoint *what* he regards as especially superior:

> the department of literature in which the Eastern writers stand highest is poetry....But when we pass from works of imagination to works in which facts are recorded and general principles investigated, the superiority of the Europeans becomes absolutely immeasurable.[7]

That is the West has excelled in science, *therefore* worthwhile education must necessarily be Western. Macaulay begins his Minute by referring to the "the physics of Newton", although he also talks of the superiority of Western history.

Macaulay was only restating the very sentiments that Indians like Raja Ram Mohun Roy had articulated a decade earlier. In a letter of 11 Dec 1823 submitted to the same Viceroy (Bentinck) Roy had argued in favour of teaching "European science", and *against* Sanskrit schools.

> We were filled with sanguine hopes that this sum would be laid out in employing European Gentlemen of talents and education to instruct the natives of India in Mathematics, Natural Philosophy, Chemistry, Anatomy and other useful Sciences, which the Nations of Europe have carried to a degree of perfection that has raised them above the inhabitants of other parts of the world.
>
> ...our hearts were filled with mingled feelings of delight and gratitude; we

> already offered up thanks to Providence for inspiring the most generous and enlightened of the Nations of the West [Britain] with the glorious ambitions of planting in Asia the Arts and Sciences of modern Europe.
>
> We now find that the Government are establishing a Sangscrit school under Hindoo Pundits to impart such knowledge as is already current in India....This...can only be expected to load the minds of youth with grammatical niceties and metaphysical distinctions of little or no practicable use.... The pupils will there acquire what was known two thousand years ago, with the addition of vain and empty subtilties since....[8]

In fact, going beyond Macaulay, Ram Mohun Roy specifically pokes fun at the things that were then taught in Sanskrit schools.[9]

That is the gist of the matter. Those arguments have changed little in 175 years. Today we can discount the references to Milton's poetry or Locke's metaphysics, as mere British chauvinism. We could even reject Milton as "too Christian" and Locke as a racist. But what about Newton's physics? The belief remains that science is the creation of the West, so that Western education is needed to acquire this useful knowledge. Any other kind of education system continues to be regarded as inferior.

But is this belief true? In 1832, a few years before Macaulay's Minute, a little known Britisher, Charles Whish, was reporting in Britain about Sanskrit texts from south India which contained many kinds of infinite series, equivalent to the calculus.[10] (This was noticed even earlier by another Britisher.) These texts represented Indian innovations in mathematics and astronomy from the 5th to the 15th c. CE. Macaulay and Roy were simply wrong about their facts. Their decisions were based on ignorance and prejudice.

Roy was perhaps carried away by a Western myth: that science originated in the West. He would have been shocked to learn what has emerged more recently: that Newton's physics leans heavily on calculus copied from India in the 16th c., by Jesuits based in Cochin, just as much as Copernicus' astronomy was copied from the earlier Arabic works of Nasir ud din Tusi of Maragha, and Ibn Shatir of Damascus. I will not argue out the details of that history here, for they are already published *in extenso* in my books[11] and articles elsewhere.

The point here is only this: the moment it is admitted that science could have had a non-Western origin, and that Western science started off by *appropriating* non-Western science, the arguments of Macaulay and Roy for Westernised education fail with a resounding crash. *Why then should we continue to follow today the course of action they advocated? Let us reconsider it.* This is a particularly good time to do it, for we are again being urged to adopt those very educational policies.

The other point I want to emphasize: this is an abject lesson in the massive soft power that flows from distorted history. The Indian elite was taken in by this false history, and led by the nose. Their extreme gullibility was exploited to change the education policy of a vast country, and to maintain that change for 175 years (62 after independence). India could

hardly have been ruled for so long by the British without the active cooperation of the Indian elite, and indoctrination through colonial education played a key role in ensuring that cooperation. And distorted history was the tool used to initiate that indoctrination. India was colonised by a lie—by the false history skillfully used by Macaulay, not the battle of Plassey.

Western education consolidated the grip of the West over Indian minds. It deeply reinforced this terrible superstition about Western superiority, especially in science. (I use the word "superstition", for what else can one call a false belief which is not based on direct knowledge, and leads to a ruinous course of action?) Indians educated on this education policy were *so* overawed by the West, and learnt to trust it *so* implicitly, that they never considered it necessary to check *any* of the purported facts of history of science on which this policy was based. They haven't done so till now. We have seen that to this day the head of the NKC, who is also the advisor to the Indian Prime Minister on innovation, says that we ought to imitate the West in trigonometry (and calculus), and that we must not try and carry out any innovations about that here. He trusted only those advisors certified by the West, and they said so.

Even more remarkably, the Indian elite, with their canine loyalty to the West, won't tolerate anyone else challenging their absurd superstitions. They preserve their superstitious faith in the West by insulating it with thick layers of prejudice. If anyone questions the basis of that faith in the Western history of science, this protective layer of prejudice is instantly activated. The typical response may go like this "(1) We don't know the relevant science, (2) we don't know the evidence for that Western history which you challenge, (3) we haven't read what you have written, but (4) and we won't read it, and (5) if we do we won't believe it". Why not? Because it is so easy to brand the challenger as a Hindu or Muslim fanatic (no evidence needed, of course). Some people on a discussion list even insisted that they had a right to reject any such ideas without reading them. Such superstitions are a key intended outcome of Western education. It is hard to imagine a more terrible superstition which has ever afflicted India, because journalists and the government alike share this superstition, which is now being made into a law! After all isn't science all about *trusting* the West implicitly? *And* implanting this trust in the West in the minds of young children? If truth in *science* can only be decided by Western authority, how can truth be decided otherwise in the *history of science?*

It is on this very premise "We don't know, we don't want to know, but we trust the West" that similar false history continues to be taught in Indian schools to this day. This ensures that children grow up in awe of the West, so that the trust in the West is perpetuated.

An explicit example of such indoctrination may be in order. School texts[12] produced by the Indian government, today, emphasize that mathematics (and science) originated in the West. This is brought out by showing pictures of several Greeks. These include Pythagoras (p. 5), Thales (p. 79), Archimedes (p. 13), Heron (p. 199), and, of course, Euclid (p. 80). Although the last three are *supposedly* from Alexandria, in Africa, where the people might have been dark-skinned, the pictures aim also to establish the *race* of innovators by

showing them as white-skinned Caucasian stereotypes. Naturally, Indian school children grow up with the belief that they are *racially* inferior to Westerners.

When challenged to produce evidence for this bogus genetic history of Euclid, or even to produce evidence that "Euclid" at all existed, the authors of these texts could not produce any evidence[13] ("we don't have any evidence"). The lead author of this text, J. V. Narlikar, has publicly admitted his ignorance of history[14] ("we don't know"), which ignorance has also been publicly demonstrated by this author.[15] The key government official responsible for coordinating these texts asked what was wrong in relying on secondary sources![16] ("We trust the West.") And so they merrily retain those bogus white-skinned pictures in Indian school texts to the detriment of millions of Indian school children. ("We will not read what you say or act upon it.")

Why was Narlikar considered the right expert to write these texts on school mathematics? He is not a mathematician; in his scientific papers when he gets stuck on a difficult mathematical problem, he simply makes a facile hypothesis and skips ahead to the conclusion he wants, so his scientific papers are more like science fiction stories with some symbol content! The fact is that few people have read those papers, for no one really cares about science *per se* in India; the concern is not about producing practical value, it is about *social recognition of the scientist in the West.* For the Indian elite, science is all about fetching Western social approval, and for this it does not matter whether the science in question is right, wrong, or "not even wrong", like Narlikar's.

One cannot help noticing the uncomfortable fact that the comfortable life of these authors depends solely upon the recognition and political support they have from the West, and not because their science was of any practical value to anyone in India (or ever will be). Whatever be their intentions, their *actions* amount to *quid pro quo:* for they insist on instilling awe of the West, in the minds of trusting children, in the name of promoting science. (And one cannot *assume* their intentions are good, for they did not change those texts, or their recommendations, when their mistakes were pointed out.) It is sad that the government of a billion people has no other way to judge truth except to rely on experts, and no other way to select experts except by the criterion of Western recognition. And Indian industry follows suit. And so, India remains prey to the soft power of those imperial forces even today, with the help of the indoctrinated elite, exactly as the British had planned.

This extreme anxiety for Western recognition is itself clearly a consequence of the strong feelings of collective inferiority that prevail to this day. That feeling is generated not merely by imperialism but by indoctrinating people with racist history; and that history, propagated by Western historians, was used to derail the entire agenda of education in India, and to consolidate imperialism. Academic imperialism is being used to maintain real imperialism.

The aim of the colonial education policy was to create a class which would help the British to rule India—a class which would look like Indians, but would think and act like Britishers, and be loyal to the British imperialist, and promote British interests over those of the masses. It is through such "education" offered today that this class perpetuates itself. As

then so now, the clamor for Western education is based on this sort of false history (accompanied by bad philosophy of science) both of which the Indian elite class parrots without knowledge and without understanding.

3.2 So What?

The other sort of question that can be asked is this. So what if the calculus originated in India or the Copernican model originated in Maragha and Damascus? So what if Euclid never existed?

It is amusing, of course, to speculate what Macaulay would have done if he were aware that the calculus, central to Newton's physics, started in India. What would he have done had he known that Euclid was a fabrication from the time of the Crusades? Could he have spoken of the "false astronomy" in Arabic and Sanskrit texts if he realized that glorified Western astronomers like Copernicus, Tycho Brahe and Kepler[17] all had got their astronomy from those very Arabic and Sanskrit texts he condemned? Would Ram Mohun Roy have asked for European mathematics to be taught if he knew that both arithmetic and calculus was taken from India? Though interesting, we will not pursue these counterfactual speculations here, for the present agenda relates to action.

What difference does it make *today* that the calculus or arithmetic algorithms came from India or that Euclid and Claudius Ptolemy never existed? One sort of difference is clear enough. If science is the quest for social recognition from the West (Nobel prize etc.) then it is clear that such social recognition depends upon history, and the West continues to falsify history to this day. I was taught in school that Marconi invented the radio, and learnt much later that this was the work of J. C. Bose, as is *now* acknowledged in the West by the IEEE society, after a century-long struggle. The work of another physicist, S. N. Bose would have similarly gone into oblivion, and would have been attributed to Einstein, but for a lucky intervention by Dirac. And such processes of appropriation continue to this day. So better history would lead to better recognition and reduced anxiety about racial inadequacy!

More importantly, would the revised history change the way advanced physics or mathematics is done, today? Indeed, it would, but I will not elaborate on advanced physics or mathematics here (although I have done so elsewhere[18]).

Here I will look only at the effect on the education system, and I will focus on math education, at the early undergraduate level. (The importance of math education is obvious enough, even to the imitators of the West: just look at Obama's latest budget which provides 4.75 billion dollar of support for mathematics, science and engineering education.)

3.3 The real history

Let us try and see *why* math education should change. For this, it greatly helps to have an honest account of the past.

The real history is that most of elementary mathematics taught in school today (arithmetic, algebra, trigonometry and calculus) is *not* native to Europe, but was imported. For the case

of arithmetic and algebra, this is clear from their very names. Arithmetic algorithms are so called because al Khwarizmi's Latinized name was Algorismus, or Algorithmus, and those arithmetic techniques hence came to be known in Europe as algorithms (as opposed to the native European abacus technique). Al Khwarizmi's book *Hisab al Hind* (of which only Latin translations exist today) was written in the House of Wisdom in Baghdad. Though Arabs learnt this technique from Indians, Europeans learnt of this way of doing arithmetic, from Arabs; hence they also refer to "Arabic numerals". The terminology is misleading. The real issue is that elementary arithmetic algorithms (for addition, subtraction, multiplication and division) require the *place-value* system, while the Roman numerals are adapted to the abacus, and are *additive*. The particular signs used for these numerals are of no consequence whatsoever. Likewise the word "algebra" is derived from the Arabic *al jabr* (used in the title of another book by al Khwarizmi), which solves algebraic equations by force (*jabr*), by putting them on two contesting (*muqabala*) sides of an equation .

The key point is that when these arithmetic techniques reached Europe, they were not properly *understood* by Europeans. Why not? Because of cultural differences in ways of doing mathematics. Europeans relied on the abacus, which allowed only integers, and mainly permitted only addition. Because the abacus tied numbers to concrete entities (the counters used for counting, called jetons), it was not possible to represent negative numbers, so that subtraction presented difficulties. Multiplication had to be done by repeated addition, and division by repeated subtraction. The abacus provided no way to represent general fractions; and Romans and Europeans knew of only a few common fractions typically with denominator 12) and could not add or subtract fractions with different denominators.

European difficulties in understanding elementary arithmetic were manifested in various ways. For example, when Gerbert imported the algorithmus techniques from Cordoba around 967 CE, he inscribed the Arabic numerals on the back of jetons. (We get this picture from an 11th c. Latin manuscript.) Gerbert had not invented a novel way to do algorithmic arithmetic on the (Roman) abacus: he simply did not *understand* the fundamental difference between abacus and algorithmic arithmetic, and blundered as a consequence. I emphasize that Gerbert who later became Pope Sylvester was an extremely knowledgeable man in relation to his other European contemporaries. In fact, he was so knowledgeable that his contemporaries were fearful of him, and in Christian art he is depicted as a dangerous wizard. And this man had difficulty in understanding what is today taught to school children barely out of kindergarten and was traditionally taught at the earliest school level in India!

These difficulties were by no means confined to a single individual. They are manifested in a variety of other ways. For example, the Florentine merchants who traded with Arabs in spices quickly learnt that arithmetic algorithms provided a practical and commercial competitive advantage. Accordingly, they started learning algorismus, and, in fact, treated it as a sort of trade secret. However, many in Florence were uncomfortable with zero. The reason was that the Roman system of numeration is additive: XII means 10+1+1. On the place value system, however, it is not possible to interpret 10 in the same way as 1+0 = 1. Europeans hence found zero mysterious. They complained about this entity, zero, which had no value in itself, but could add any amount of value to another entity. This suspicion

of zero (called cypher, or hard to understand, from *sifr*) is incorporated in the 13th c. Florentine law that any financial contract in Arabic numerals must also mention the figure in words, something we still follow today in written cheques (though not in Internet banking transactions!).

There were other difficulties. For example, the Pythagorean mysticism associated with numbers persisted in Gnosticism. Therefore, a typical challenge problem might be to ask "Is unity a number?" And the expected answer was that "Unity is not a number, but the basis of being". This sort of number-mysticism persisted in Europe into the 17th c.; Kepler's books were called *Harmonice Mundi* ("Harmony of the Worlds") and *Mysterium cosmographicum* ("The Sacred Mystery of the Cosmos"), for he was an astrologer seeking evidence of divine harmony.

Even more difficult than zero and negative numbers was the issue of rounding of fractions, or zeroism, which had just no counterpart in the Western tradition of mathematics.

These historical difficulties are reflected in the present way of teaching arithmetic, which copies the Western method. Although the Jesuit mathematical syllabus was changed to include practical mathematics (mainly arithmetic) around 1570, the abacus method was regarded as easier, and retained at the elementary level. Thus, students first learnt the abacus, and then arithmetic algorithms; they retraced the European history of assimilation of arithmetic. The historical difficulties that arose in the minds of Europeans, such as Pope Sylvester, in the transition from abacus to algorismus are now replayed in the minds of the students who learn this way. Typical difficulties relate to subtraction, division and fractions.

Another difficulty relates to the problem of *division by zero,* where different conventions are obviously possible (contrary to the purported "universality" of mathematics). The typical response of a present-day mathematician is to say that division by zero is meaningless. On the other hand, the symbol ∞ *is* given a meaning in the so-called extended real number system, where division by zero *could* be partially defined. The two contradictory beliefs are captured in the following amusing rules incorporated into the structure of the recently invented Java computing language: division of an integer by zero is an error, but division of a floating point number by zero is infinity. That is, 2/0 is an error, but 2.0/0 is infinite! This shows that European difficulties with zero persist to this day!

Similar comments apply to trigonometry. Today Western historians say, in their typical ultra chauvinistic histories, that trigonometry originated in Greece, with Ptolemy. As in the case of "Euclid", nothing is known about the Claudius Ptolemy beyond the 12th c. accretive text of which he is asserted to be the sole author. The date for this Claudius Ptolemy is fixed in the 2nd c. CE by referring to four "observations". In fact it is is known that these so-called observations were not carried out, but the values were put in by back-calculation at a later date. Those fake "observations" should not therefore be used to date the manuscript. The text was clearly begun in Persia after the 6th c., for it begins by addressing a Cyrus. The non-textual evidence of the Roman calendar confirms that this *Almagest* text (with its better but still incorrect value for the length of the year) did not exist until the 6th c. in the Roman empire, which, despite repeated calendar reforms, never used that value for the length of the year. As a practical text on astronomy, the *Almagest* had to be an accretive text. That it

is manifestly accretive is seen from its star list which is headed by the present-day pole star (which was not the pole star in the 2nd c., and became so only after the 9th c.).

The very names tell a different story. Sine comes from the Indian *jya* (which changed to the vernacular *jiva*, and the Arabic *jiba*, but was written as the consonantal skeleton, *jb*, and misread as *jaib*, meaning pocket or fold, by the Toledo translators, who hence called it sinus.). Likewise cosine comes from *kojya*, an abbreviation of *koti-jya*. Among the first Europeans to learn from these Arabic texts was Regiomontanus (whom Western historians pass off as one of the originators of trigonometry). The very word "trigonometry" shows how notions which relate naturally to the circle were instead related to triangles (with which Europeans were more familiar). This creates difficulties today in learning it. Indians and Arabs traditionally defined an angle in a better way, using a flexible string to measure the arc of a circle.

Europeans, accustomed to the straight line, had difficulties with measuring the arc of the circle. Descartes, a leading European geometer, dismissed the possibility of such measurement as beyond the human mind. European navigators, similarly, had a major problem with curved lines (loxodromes), since they were accustomed to the straight line and a rigid straight edge to measure it. There was a great demand for trigonometric values (tables of secants) in the 16th and 17th c., in Europe, just because these helped to map loxodromes to straight lines.

These European difficulties with trigonometry are again reflected in present-day school education. As a relic of the European navigator's paraphernalia, a geometry-box or compass-box is essential part of the equipment of most students. The ritualistic character of these instruments is clear from the setsquares which students rarely use, and most don't understand. The protractor cannot be directly used to measure real-life angles, such as the angle subtended at the eye by a tree. The scale cannot be used to measure curved lines. A string or a measuring tape could be used for that, but is not included in the Western compass box. In fact, a string could replace the entire compass box.[19] All this shows that present-day math teaching is not based on any well thought out strategy, but merely on blind imitation of the West.

Similar remarks apply, *a fortiori* to the calculus. Not only was the calculus taken from India, it was not properly *understood* by Europeans such as Newton. Why not? Because of cultural differences between Indian and European mathematics. The calculus is taught today the way it was absorbed in the West, and *not* the way it was discovered (or invented) in India. Consequently, those historical European difficulties with the Indian calculus, are again replayed in the classroom today. This is a little more difficult to explain.[20]

4. Philosophy of mathematics

The claim in the preceding paragraph raises an interesting question: *can* there be cultural differences in mathematics? Those educated in the Western tradition, even if they do not know any mathematics, have been taught to believe that mathematics is universal. This has long been maintained in the West: that mathematics is universal, not merely global, but *universal*. Here is what Huygens[21] explicitly said in the

matter, long ago.

> no matter how inhabitants of other planets might differ from man in other ways, they must agree in music and geometry, since [music and geometry] are everywhere immutably the same, and always will be so.

Now, if mathematics is indeed universal, then shouldn't it have sprung up the same in all places? However, the West has also long claimed that *only* the ancient Greeks correctly understood how to do mathematics! Here is what a classic book on the history of mathematics says.[22]

> The history of mathematics cannot with certainty be traced back to any school or period before that of the Greeks.…though all early races knew something of numeration…and though the majority were also acquainted with the elements of land-surveying, yet the rules which they possessed…were neither deduced from nor did they form part of any science.

In other words, the *fact* is that different cultures did math differently, but in the *opinion* of Western historians what other cultures did was "land-surveying", not geometry. They maintain that only the Greek *race* understood geometry (because their genes were different). The slightest commonsense suggests the absurdity of believing both the two statements, "mathematics is universal", and that "mathematics originated only in Greece": if mathematics is a genetic or cultural achievement why should it be universal?

However, people brought up on Western education tend to be devoid of commonsense on this issue, for they have believed both statements for centuries. Not just ordinary people, but also the leading thinkers in the West. So the persistence of this belief is a tribute to the extraordinary gullibility of humans (or the extraordinary crookedness of the West). Such falsehoods may well be the key to Western imperialism (through the claim that Western knowledge is universal). In fact, *both* statements are false. We briefly indicated in the previous section that the claim of the Greek origin of mathematics and geometry is false. Let us now examine whether mathematics is, in fact, universal.

In fact, mathematics is not universal, and can be of different kinds, as it historically was. For example, mathematics in the non-West accepted the empirical as a means of proof, while Western mathematics has been emphatically metaphysical from the 20th c. (the empirical is accepted as a means of proof in the *Elements*, 1.1 and 1.4 for example; it was the analysis carried out by Hilbert and Russell which characterized these proofs as mistaken). Further, unlike, the traditional mathematics of calculation (*hisab*, *ganita*) which has plenty of practical value, Western mathematics focussed on deductive proof. This is also the case with present-day *formal* mathematics (which involves proving theorems), and its practical value is very uncertain, as we will further see below.

An oft-cited example of the universality of mathematics is the claim that 2+2 = 4. Let us examine this, or an even simpler claim that 1+1=2. As a piece of practical calculation this is fine. But is it a *universal* truth? Hundreds of thousands of logical circuits on a typical computer chip implement a different kind of arithmetic where 1+1 = 1 (or gate) or 1+1 = 0 (exclusive-or gate). Symbols such as 1, and + do not have any intrinsic meaning. They obey the rules we assign. If I take two stones and add another two stones, I have four stones. But if I break one of them I get 5 stones. Does that mean 2 +2 may possibly be 5? On the other hand, if I have 1 big fish, and 1 small fish, how many fishes does that

make? 2 big fishes or 2 small fishes? Might it not be better represented by 1.5 big fishes or 2.5 small fishes? The point once again is that *we* have to specify the rules. We have to specify that we are dealing not with computer circuits or with stones, or fishes, but with *integers*.

But, *can* we specify that we are dealing with integers? Let us try adding two numbers using a computer program. If we use a computer language such as C, we will certainly get 2 + 2 = 4. But we could well get 20,000 + 20,000 = -35, 528. (For a detailed account of why that number, and not any other, see my *Class Notes on C*.) The C language is not platform independent. So, we may need to try 2000000000 + 2000000000 = -29496796. This is the answer we would get on all platforms with the Java programming language.

Of course, it is possible to add much bigger numbers on a computer, using what is called floating point arithmetic. In this case, however, one gets into a different sort of problem. We could get 1 + 0.0000001 = 1. This means that the so-called associative "law" for addition does not hold, for we would have -1+ (1 + 0.0000001) = 0 but (-1 + 1) + 0.0000001 = 0.0000001. So if we add three numbers, the answer depends upon the order in which the numbers are added. It is also possible to do what is euphemistically called "infinite-precision arithmetic" on a computer. In this case, all that changes is this: the number of zeroes in the above sums can be made very large (say, a trillion zeroes). But there is just no way to do integer arithmetic on a computer, because there is no way to tell a computer what a mathematical integer is.

I would emphasize that all of this makes very little *practical* difference. For any known practical problem (such as sending a man to the moon), computer arithmetic is perfectly adequate. However, this practical (computer) arithmetic does not agree with the formal arithmetic taught to mathematics students. Formal arithmetic is based on what are called Peano's axioms, for which the associative "law" is sacrosanct and inviolable, and cannot be broken as in computer arithmetic. This is usually expressed by saying that computer arithmetic is (forever and inescapably) erroneous. Computers are mathematical criminals since they break the "universal" laws of arithmetic laid down in the 19th c. by Peano! Another way to put matters (and the way I have put them using the philosophy of zeroism) is that formal arithmetic, such as Peano's arithmetic, though a possibly useful simplification, is an unrealistic idealisation which can never be achieved. As the name "Peano's axioms" suggests, historically, all other cultures did arithmetic differently. The bottom line is this: mathematics is *not* universal. The claim that "Western mathematics is universal" (but that it originated in Greece) only furthers imperialism.

4.2 Infinity, mathematics and religion

I hope the nature of the difficulty, in the above examples, is clear by now. It concerns infinity. The integers are infinitely many, while a computer has only a finite memory, so it cannot store all the integers. Even specifying what an integer is really requires an infinity of instructions. Therefore, it is not possible to *specify* to a computer what an integer is, because such a specification would take an infinite amount of time. Therefore, a computer can never do arithmetic in the way the West has wrongly declared to be universal.

Cultural differences regarding mathematics become especially acute in mathematical questions about

infinity. I have tried to bring out the pivotal role of those cultural differences in mathematics by pointing out the historical difficulties regarding infinity which plagued the calculus when it first arrived in Europe. Fundamental to the calculus is a way to sum infinite series. What is the sum of 1 + ¼ + 1/8 + 1/16 + ...? Indians had a simple formula for this geometric series. But the European mathematicians of the 17th c. thought that the only way to obtain this sum was to physically perform an infinity of sums. That is: add ¼ to 1, then add 1/8 to the sum, and so on. Doing such an infinity of sums is a supertask—an infinite series of tasks. It needs infinite time. So, the European mathematicians of the 17th c. thought the answer to this sum was known only to God. Descartes explicitly said so.[23] Galileo broadly concurred.[24] *Infinity related naturally to theology.*

Now, Western mathematics was already deeply associated with religious beliefs. The very word "mathematics" shows this. Mathematics derives from the word "mathesis" which means "learning". For Plato learning or mathesis meant the recollection of knowledge of previous lives. He believed that people have had past lives, and that mathematics helps them to recall the knowledge of those past lives. This belief in past lives was directly related to beliefs about the immortal soul which survives death, and linked past lives to the present. In Plato's *Meno*, Socrates demonstrates a slave boy's knowledge of elementary geometry, and triumphantly concludes that he has proved the existence of the soul.[25] Plato, in his *Republic*, prescribed the teaching of mathematics for the good of the soul.[26]

This belief linking ("mystery") geometry to the soul began long before Plato, in Egypt, and it persisted for at least 8 centuries after Plato. We find Proclus, in the 5th c., writing a commentary on the *Elements* to explain why Socrates used geometry (and not geography, for example) to demonstrate the slave boy's innate knowledge. Proclus explains the term "mathesis" in explicit detail. His explicit aim in his *Commentary* is to bring out that mathematics, irrespective of its practical applications, is a *religious* activity for the good of the soul which "leads to the blessed life".[27]

Note also that Proclus' beliefs about eternity/infinity were at the dead focus of a religious war which the reigning Christian church waged against "pagans" whose leader he was. Proclus thought that the truths of mathematics are *eternal*. This related to his beliefs about time. In his book *Elements of Theology*, known to Arabs as part of the "The Theology of Aristotle", Proclus clarified how this belief about eternity (and past lives) related to quasi-cyclic time.[28] Now the belief in quasi-cyclic time was a common belief among various "mystery religions" which flourished in the early Roman empire. Christianity began as one such mystery religion in the Roman empire in the 2nd c.[29] *Hence,* the belief in quasi-cyclic time was also prevalent in early Christianity. This is made quite explicit[30] by Origen, the major expounder of pre-Nicene Christianity, and from whose notes and *Hexapla*, the present-day Bible (Vulgate, King James Version) derives. In 529 CE when Justinian shut down all schools of philosophy in the Roman empire, he declared Proclus a heretic, he also pronounced anathemas (curses) against 'cyclic time'.[31] At the same time, John Philoponus wrote an "apology" (tirade) against Proclus. (A few years later, in 553, Origen's beliefs were cursed by the church as the "doctrine of pre-existence".)

Apart from countering the key alterations to Christian doctrine, made by post-Nicene theology, Proclus' belief in the eternal truths of mathematics, hence an eternal cosmos, angered the church in various other ways. For example, it went against the doctrine of creation, as interpreted and emphasized by the post-Nicene church. One could say the first creationist controversy started in the 5th c., and it concerned the teaching of mathematics, not biology. Philoponus' argument against Proclus was that the world could not be eternal since adding a day to eternity would leave eternity unchanged. This was a bad argument. Two things made this argument worse: first, Philoponus' did not even grasp the essence of Proclus'

notion of eternity, and (deliberately?) confounded Proclus' notion of time quasi-cyclic time with his own notion of time (which I have called superlinear time). Second he had double standards about eternity, for he continued to believe in an eternity (in "linear" time) of torture in hell for non-Christians of any sort.

The point of bringing in Philoponus' arguments is twofold. First, to show how ideas about infinity have long been mixed with theology (and notions of eternity), in the West, and, second, to point out that infinity easily leads to paradoxes, and double standards.

There is a third issue here. How did Proclus' idea of a mathematics which is *eternally* true (i.e. true for all time) get transformed into Huygens idea of a mathematics which is *universally* true (i.e. true in all space)? But this is a long and complex story, and I won't go into it here, especially since I have explained this elsewhere. It suffices to point out that the post-Crusade church benefited politically from this transformation. Unlike *eternal* truths, which went against the doctrine of creation for example, *universal* truths did not interfere with church doctrine. On the contrary, they aided it as follows.

After the military failure of the Crusades the church switched from hard power to soft power. Muslims did not accept the Christian scriptures, but they accepted reason, as in the *aql-i-kalam* or Islamic rational theology. Hence, the church now sought to use reason to convert Muslims. Church theology was adjusted for this purpose, and this post-Crusade theology has come to be known as Christian rational theology. It claimed that the "Euclid's" *Elements* was primarily concerned with reason, and argumentation, and not with self-realization as Proclus had stated. This post-Crusade reinterpretation of the *Elements* was supported by the false history that it was authored by an unknown "Euclid" who, strangely enough, had the same beliefs as those of post-Crusade theology! This false history of "Euclid" also allowed the church to claim ownership of reason, as Pope Benedict does to this day.

It was these church beliefs which led to Huygen's superstition that Western mathematics must be universal. This superstition is strongly inculcated by the colonial system of education. All educated Indians have believed this though very few of them can claim to know mathematics, its philosophy, and history, and fewer would even attempt to justify it.

In fact, Indians never knew what hit them. The British victory of 1757 was not obtained by means of any technological superiority. It was obtained the good old way of using bribery to exploit dissension, after the Mughal empire had gone into terminal decline. Europeans had been waiting for this opportunity for over 250 years. But, within the next 60 years the British had convinced the Indian elite that the British ruled India because Indians were intrinsically inferior! And Ram Mohun Roy was himself pleading with the British to change the Indian education system! It was "universal" Western mathematics he wanted Indians to learn. Naturally, the British exploited this superstition to the hilt, and the West continues to do that today.

Now, we must recall, at this stage, that the set of symbols we have written down, namely 1 + ¼ + 1/8 + 1/16 + ... , does not have *any* intrinsic meaning (let alone a "universal" meaning). As Bertrand Russell, the prophet of formalism, put it, "in mathematics we never know what we are talking about". As with 1+1, the infinite sum will have only that meaning which we give it. Unlike the case of finite sums, such as 1+1, there is a wider range of disagreement regarding infinite sums, even in present-day mathematics. This is especially true for ("divergent") infinite series such as 1 + ½ + 1/3 + ¼ + ... or the

series 1-1+1-1+.... (= ½?), which arise in quantum field theory. But we will not discuss that here.

Europeans misunderstood the Indian method of summing an infinite series as numerical approximation. Explaining that method in terms of present-day formal mathematics requires some technical knowledge of formal mathematics. Basically, from the *Beejaganita* of Bhaskara II onwards, the Indian approach to algebra treated polynomials roughly as if they were numbers. From this perspective Indians thought of rational functions as what a formal mathematician would describe today as a non-Archimedean ordered field.[32] [Rational numbers, as distinct from rational functions, constitute a field where ordinary algebraic operations such as addition, multiplication, subtraction, and division can be carried out. This field has the the so-called "Archimedean" property, namely that for any positive x we can find an integer n such that $x < n$. This property, which holds for rational *numbers*, fails for rational *functions*. If the property fails, we can find an x such that $x > n$ for every integer n. We will also then have $0 < 1/x < 1/n$ for every n.] Consequently, it is formally possible to speak of infinities and infinitesimals in that context. As I have explained,[33] this corresponds to the principle of order counting, which is a simple and practical approach. As I have also explained, there is no need of any of this formalism on the philosophy of zeroism.[34]

When the calculus first arrived from India, Europeans did not understand the Indian way to sum infinite series. This was similar to the way Europeans, accustomed to the abacus, failed to understand arithmetic algorithms. (Their way to do mathematics was universal, remember?). They mistook the Indian way to do infinite sums as a process of numerical approximation (which it was not; formally speaking it was closer to a process of discarding infinitesimals in a non-Archimedean field; but it was based on a different philosophy). Because of the religious background of Western mathematics, Europeans thought mathematics ought to be exact, and should not neglect any finite quantity, however small. Therefore, while they were ready to accept the practical value of the numerical approximation, they were not willing to grant that (what they regarded as) numerical approximation could be called mathematics. They looked for an *exact* way to do infinite sums. This is evidently not possible physically. So they sought metaphysical ways to do it. These metaphysical ways naturally got entangled with their other metaphysical beliefs, for example about time. For example, Newton made a serious error in his physics. Believing this would make his use of calculus rigorous, he made time metaphysical, declaring that it was not important to be able to measure it exactly. (This error was corrected only in the theory of relativity, some two centuries later.[35])

Newton's metaphysical way to do calculus was called the method of fluxions (from the idea that time flows, and is, hence, infinitely divisible). After Newton's death, his documentation of church history seemed about to be revealed. Panicking at the thought, at this time, Bishop Berkeley mercilessly criticised Newton's mathematics (also calling him an "Infidel mathematician"). Irrespective of its motivation, the substance of his criticism was that Newton and Leibniz had followed illogical procedures. If a fluxion could be put to zero at the end of a calculation, then why not at the beginning, he asked? He emphasized that he was not questioning the numerical or practical answers that Newton had obtained. He was questioning the *process*, and saying that since the process was bad, it did not amount to mathematics.

Limits were eventually the answer Western mathematicians provided to Berkeley's objections, but limits required formal real numbers, and formal real numbers required set theory. The critical importance of set theory is that it makes it possible to perform supertasks metaphysically. Naturally, the metaphysical ability to perform supertasks made the mathematician feel powerful, and opposition to

such things (by a group called Intuitionists) was squelched (since truth in such metaphysical mathematics can only be decided by social authority).

The use of limits and set theory is beset by a variety of problems. Limits require set theory, and many mathematicians were apprehensive about the paradoxes of set theory. Those were believed to have been resolved by the axiomatic set theory which developed in the 1930's.

However, as in the case of Philoponus' arguments against Proclus, the set-theoretic way to handle infinities is beset by peculiar double-standards: one standard of proof within set theory, and another for talking about it. (This double standard of proof is how set theory really avoids being shown to be inconsistent.) Of course, limits, don't make any practical difference to the answer. Amusingly, even before the "acceptable" answer could be given, it had to be changed, for many cases where limits do not exist are important for physics. This led to the theories of Sobolev, Schwartz, and Mikusinski. Each of these theories is beset by further problems, which I have discussed in some detail elsewhere, and I won't go into those details here.

Even if we neglect all these issues, the metaphysics of set theory can lead to unacceptable physical conclusions.

As a concrete example, consider the Banach-Tarski theorem (also called the Banach-Tarski paradox). This says that in 3 dimensions, a solid ball may be cut and the pieces reassembled, without stretching (and using only translations and rotations) into two balls of the same volume as the original. This has been mathematically proved, according to formal mathematics. But if this could be done *physically*, then one ball of gold could be multiplied into two, and the two balls could be multiplied into four and so on, creating unlimited physical wealth. This physically impossible. Thus, the Banach-Tarski paradox also shows that what is mathematically proven may be forever physically impossible! If the objective of teaching mathematics is to teach science for the sake of its practical applications technology, it is clearly not a good idea to teach this sort of formal mathematics.

Nevertheless, the set theory underlying the Banach-Tarski theorem is used as the basis of *all* formal mathematics today. And this ("modern math") is what is taught in schools around the world, so that from an early age students learn to trust this, and value it, and to distrust any critiques, especially those coming from non-Westerners who lack authority.

(In fact, most people, even most professional mathematicians, do not study or understand axiomatic set theory which is the basis of modern mathematics. As I have publicly demonstrated, many professional mathematicians cannot even define a set precisely. They merely believe set theory to be valid on the strength of authority. And this is what they will inevitably propagate, if their expert advice is sought.)

The net effect of all these complexities is that mathematics, in general, and calculus, in particular, has become very hard to learn and teach. One must not make the mistake of thinking that Western theology is inflexible; but it it is relatively harder for the West to eliminate these difficulties, for those beliefs are central to the Western tradition for the last several centuries. This, therefore, seems a good point to begin the attack against Western academic imperialism.

5. The solution

From the above it is clear that academic imperialism is maintained by means of (a) a huge war-chest of lies about the history of science, (b) using those lies to impose and maintain Westernised education which indoctrinates impressionable young minds into awe of the West, and (c) by making Western certification as the key test of all scientific truth.

It seems to me the Western lies about history have sprung a major leak with the exposure of the fictions about the Copernicus, and now the calculus and the purported Greek origins of science. Undoubtedly, the West employs an army of priests who will try to plug those leaks, and maintain each lie, by telling a thousand more, as they have done in the past. However, it seems to me only a matter of time before Western history of science is accepted as a major fraud and the ship sinks. The Internet has played a key role in this. Barely 12 years ago, I had to travel long distances to obtain the original writings of Origen. Today, they are available at the click of a mouse. Whiteside's attempts to continue to suppress Newton's secret writings on the Bible were swiftly exposed, in a day, and he was left abusive and ranting. Another major Western figure was caught in a way that could never have happened before the Internet and video recordings. Presumably the Internet will be eventually controlled, but the damage to Western history is already done, and is irretrievable in my opinion.
ViXra or ArXivFreedom are other symptoms that the Western arrogation of the monopolistic right to certify science is being vigorously challenged.

However, as regards (b), it seems to me that things are moving in the other direction, towards greater Westernisation of education. That, at least, is what is happening in India, today. The carrot that is being dangled is that Indian knowledge of English (and the fact that most Indians are young) helps in call-centre jobs, and the present Indian government, which has become indistinguishable from a puppet of the US, is pushing this inspiring(!) vision of Call Centre India for all it is worth.

Setting aside such nightmarish visions, we are left with the same old argument that acquisition of science and technology requires Western education—apparently the examples of China, and, to an extent, Japan, can be argued back and forth.

Therefore, I feel it is very important to have an example which demonstrates clearly that de-Westernisation of knowledge can *aid* the acquisition of science and technology.

This is precisely what a revised pedagogy of mathematics makes possible. And I would like to begin exactly where the Chairman of the Indian National Knowledge Commission, and Advisor to the Prime Minister on Innovation has said there is no need for any innovation—namely in teaching trigonometry and calculus. This would also provide a lasting demonstration of just how bad government decision-making can get, even at the highest level, in matters related to science and technology.

The details have been explained in other places, and here I will only summarise the highlights.

First, as regards trigonometry, the ritualistic compass box associated with Western geometry needs to be changed. Curved lines are allowed to be measured using a flexible measuring tape. This allows the definition and measurement of an angle as the length of a curved arc. Note that this is an empirical process (possibly subject to errors, for mathematics need not be, and cannot be, any more exact than

physics).

Second, the notion of limits, and formal real numbers, and the requirement of set theory is dropped from the calculus. All those notions are a needless burden. They add nothing to either the practical or the theoretical value of the calculus. Historically these notions arose because Europeans did not understand the imported Indian calculus (which involved what would be called a non-Archimedean field of rational functions in formal mathematics). Europeans mistook this for a process of numerical approximation, and sought instead an *exact* process (for they believed that mathematics cannot discard the smallest quantity). Set theory allows infinite processes to be carried on metaphysically.

Third, formalism is replaced by the philosophy of zeroism. This is a practical philosophy which recognizes that it is impossible to *represent* anything (integer, person,...) *exactly*, in a constantly changing world. Therefore, in any representation, whatsoever, it is *always* necessary to discard something as "inessential". For any practical application of mathematics, it is already recognized that numerical approximation is unavoidable. Zeroism accepts such numerical "approximation" as inevitable, it accepts that entities (such as the difference quotient, or a person) cannot ever be represented uniquely. It regards it as an epistemological error to believe that metaphysical processes, such as set theory, incorporate greater certainty than physical processes.

These three steps would be a fundamental blow to the idea of mathematics as deductive, exact, and universal metaphysics, an idea which has been central to Western culture for several centuries.

Fourth, instead of symbolic manipulation, students are taught calculus as it historically developed, as a way to numerically solve ordinary differential equations. (Politically, this would permanently put to rest Macaulay's argument from Newton.) Practically, this allows the easy definition of a wide variety of functions as the solutions of ordinary differential equations. This approach naturally leads to the solution of a wide variety of nonlinear ordinary differential equations which arise in practice, and greatly extends the scope of the practical problems that the students can solve, especially with the aid of a computer package such as CALCODE for the solution of ordinary differential equations.

Fifth, should symbolic manipulation become necessary at some stage, all that students needs to know is an appropriate package for symbolic manipulation, such as MACSYMA (nowadays called MAXIMA). All these elements can be quickly taught in five days instead of the usual three year routine.

6. Conclusions

- Soft power rather than hard power has been the key basis of Western imperialism.
- Dismantling the soft power of the West requires a step by step procedure.
- First, the false history of science used to initiate Westernised education needs to be exposed. (This process has already begun, but it is necessary to propagate and amplify this exposure.)
- Second, the bad philosophy of science used to maintain this false history needs to rejected. It needs to be stressed that the present-day philosophy of mathematics is *not* universal, and not even secular. (This process of changing the philosophy has already begun, but, again, it is

necessary to propagate such practical and secular alternatives as zeroism.)

- **Third, and most important, the colonial education system, the basis of indoctrination, needs to be dismantled by actively adopting alternative models of pedagogy, *especially in hard sciences*, and preferably starting with mathematics. It should be clearly demonstrated that this leads to a gain (rather than loss) of practical value.**
- The 5-day course on calculus without limits provides such an alternative pedagogy which is a marked improvement over existing calculus pedagogy, is a beginning in this direction. The non-West has a comparative advantage in adopting this pedagogy, since the West will have difficulty in abandoning the theological head load which accompanies present-day calculus pedagogy.
- This process must be extended to other branches of mathematics, and also to physics and biology.
- In addition to changing the *pedagogy* of "hard science", it is necessary to dismantle the "trust the West" formula used to certify the validity of scientific innovations. This should be a slower process which begins by encouraging open access repositories like viXra. Laws should be amended to disallow commercial publishers from privatising the results of publicly funded scientific research. The falsehoods underlying the system of Western endorsements should be exposed, and scientific output should be judged by the longer-term practical value to people at large (and not just citations by readers of scientific journals).

1 C. K. Raju, *Is Science Western in Origin?*, Multiversity, Penang, 2009. Kindle edition a

2 I will not here go into the interesting history of this missionary position, which dates back to the Crusades; see, however, my response to a recent use of this argument by the pope against Muslims, in C. K. Raju, "Benedict's Maledicts", Zmag.: http://zmag.org/znet/viewArticle/3109. Reprinted in *Indian Journal of Secularism*, **10**(3) (2006) 79-90.

3 The comment is reproduced at "Islam and Science: a response to Pervez Hoodbhoy". http://ckraju.net/blog/?p=40.

4 C. K. Raju, *The Eleven Pictures of Time*, Sage, 2003.

5 The BJP manifesto stated "India's prosperity, its talents and the state of its high moral society can be best understood by what Thomas Babington Macaulay stated in his speech of February 02, 1835, in the British Parliament. "I have travelled across the length and breadth of India and I have not seen one person who is a beggar, who is a thief, such wealth I have seen in this country, such high moral values, people of such high caliber, that I do not think we would ever conquer this country, unless we break the very back bone of this nation, which is her spiritual and cultural heritage, and therefore, I propose that we replace her old and ancient education system, her culture, for if the Indians think that all that is foreign and English is good and greater than their own, they will lose their self esteem, their native culture and they will become what we want them, a truly dominated nation." This policy was implemented very meticulously by Britishers and the education system was created to make Indian's [sic] ignorant about themselves." Macaulay was in India in Feb 1835, and he had nothing to say in praise of India.

6 T. B. Macaulay, Minute on Education, 1835. The Minute may be found online on many sites, such as http://www.languageinindia.com/april2003/macaulay.html.

7 Ibid.

8 Raja Ramamohun Roy, letter to Bentinck, 11 Dec 1823. For an online version, see the reference at 2 above.

9 Macaulay gives some other arguments which are specious or dishonest, and we won't consider them further here.

10 Charles M. Whish, paper presented in 1832, "On the Hindu quadrature of the circle and the infinite series of the proportion of the circumference to the diameter exhibited in the four Shastras, the *Tantrasamgraham*, *Yukti-Bhasa*, *Carana Padhati* and *Sadratnamala*", *Trans. R. Asiatic Soc. Gr. Britain and Ireland*, **3** (1835) 509–523. The account of an earlier discussion and the statement of Heyne is in J. Warren, *Kala Sankalita*, Madras, 1825.

11 C. K. Raju, *Cultural Foundations of Mathematics: the Nature of Mathematical Proof, and the Transmission of the Calculus from India to Europe in the 16th c. CE*, Pearson Longman, 2007. For a summary account, see C. K. Raju, I*s Science Western in Origin?*, cited earlier.

12 *Mathematics: Textbook for Class IX*, (J. V. Narlikar, P. Sinclair, et al.), NCERT, New Delhi, 2005.

13 C. K. Raju, "Towards Equity in Mathematics Education 1:Good Bye Euclid!", *Bharatiya Samajik Chintan* **7 (**4) (New Series) (2009) pp. 255–264; an author of the above text was present when the paper was presented at the session on mathematics education, Indian Social Science Congress, Mumbai, Dec 2007. Available from http://ckraju.net/papers/MathEducation1Euclid.pdf. "Teaching Racist History", *Indian Journal of Secularism*, 11(4), 2008, pp. 25–28. *Jansatta*, 24 Jan 2008, edit page (in Hindi). No fresh evidence for the existence of "Euclid" has emerged since then!

14 J. V. Narlikar, "Four question that history might answer". In *Science, Philosophy and Culture; Multi-disciplinary Explorations,* Part 1, (ed.) D.P.Chattopadhayaya and Ravinder Kumar. PHISPC, Delhi, pp. 178-184. Narlikar stated that he was writing this paper to expose his ignorance of history.

15 C. K. Raju, "On Narlikar's four questions that history might answer", *Sandhan* 1(1) 2001, 164–167. This note was actually written as a confidential adjudicator's report on Narlikar's paper; and it was published without my prior knowledge. I had recommended that Narlikar's paper should published, so it could be debated, but that the title might be changed to "Four Questions that the *Library* Might Answer".

16 *Symposium on Mathematics in Relation to History, Culture and Technology*, India International Centre, New Delhi, Nov 2007.

17 I realize that this remark about Kepler will raise howls of protest from the scientifically and historically illiterate people, who never studied even the popular literature about Kepler, but simply want to hang on to the superstitious awe of the West which they imbibed from childhood. Some of the points I have made are as follows. As the Royal Astronomer to the Holy Roman Empire, Tycho Brahe was a natural recipient of the Indian astronomy texts obtained by Jesuits from Cochin. Is it any surprise that his planetary model (called the "Tychonic" model) is identical with that of Nilkantha in his *Tantrasangraha* of 1501? Now, Tycho kept some secret papers on astronomy which he didn't even give to Kepler who was his assistant. Why not? The only solid reason would be that they related to non-Christian sources, and any hint of that would have led to Tycho's ruin at that time of the Inquisition. Kepler decamped with those papers after Tycho's death or murder of which he has been accused (by people other than me). The question which I have raised is this: how did Kepler obtain the orbit of Mars with such enormous precision? Kepler was nearly blind: so he could not have made the observations, as Parameswaran in India did over a fifty year period. The other point that I have made is that we do not have to believe Kepler's stories on this point, since he was an astrologer by profession, hence either a bad scientist (if he believed in astrology) or a charlatan (if he did not believe in astrology, and knowingly cheated others). Then there is the issue of the way Kepler doctored his data. "Planet Fakery Exposed. Falsified Data: Johannes Kepler". *The Times* (London)

25 January 1990, 31a. See further references in *The Eleven Pictures of Time*, note 46 to chap. 5, p. 529.

18 C. K. Raju, *Cultural Foundations of Mathematics*, cited above, appendix. A quick summary regarding physics in my presentation at the Univ. Aix-de-Provence, an extended abstract and video of which can be found at http://tinyurl.com/yeygejb.

19 C. K. Raju, "Towards Equity in Mathematics Education 2: The Indian Rope Trick", Bharatiya Samajik Chintan. *Bhartiya Samajik Chintan* **7 (**4) (New Series) (2009) pp. 265–269. http://ckraju.net/papers/MathEducation2RopeTrick.pdf.

20 *Cultural Foundations of Mathematics*, cited at 10 above.

21 Christiaan Huygens, *The Celestial Worlds Discover'd: or Conjectures Concerning the Inhabitants, Plants, and Productions of the Worlds in the Planets*, London, 1698, p. 86.

22 W. W. Rouse Ball, *A Short Account of the History of Mathematics*, Dover, New York, 1960, pp. 1–2.

23 R. Descartes, R. *The Geometry*. Trans. David Eugene and Marcia L. Latham, Encyclopaedia, Britannica, Chicago, 1996, book 2, p. 544.

24 For a quick review of Galileo's arguments in his letters to Cavalieri, see Paolo Mancosu, Philosophy of Mathematics and Mathematical Practice in the Seventeenth *Century*, Oxford University Press, Oxford, 1996, pp. 118–122.

25 Plato, *Meno*, 81–86. *The Dialogues of Plato*, trans. B. Jowett, *Great Books of the Western World*, vol. 7, Encyclopaedia Britannica, Chicago, pp. 179-182..

26 Plato, *Republic*, 527, *The Dialogues of Plato*, cited above, p. 394.

27 Proclus, *Commentary*, Prologue, Part 1, 47. Trans. G. R. Morrow, Princeton University Press, 1970, p. 38.

28 For a better explanation of quasi-cyclic time, see my book, *The Eleven Pictures of Time*, cited above.

29 This date for the beginning of Christianity is based on the following considerations. First, the start point of the Christian calendar has nothing to do with any historical event. This start point was fixed by Dionysus Exiguus, in 536 CE, during a calendar reform (needed to fix the slip in the date of Easter). The date was obtained by a process of back-calculation from an arithmetic scheme to determine the date of Easter. He called it the Year of the Lord (AD). Later on earlier dates, before 1 AD, came to be given the appellation BC, leading to the belief that the Christian calendar related to the birth of Jesus Christ. Second, early Christians used the "fish" as a secret sign, suggesting that they were initially a cult strongly associated with the astrological beliefs related to the coming of the Age of Pisces. The exact start point of the Age of Pisces depends upon how the boundaries of star constellations are defined, and much difference of opinion is possible on something so vague. So what is important here is only the *expectation* about the Age of Pisces which then prevailed. As Bernal points out, this date was *then* fixed at 139 CE. This date of 139 CE fits in with other pieces of evidence: for example that the Jewish historian Josephus, writing in 96 CE makes no mention of Christianity (discounting the clumsy forgery called "Testimonium Flavium" introduced into it) or the evidence we have from Pliny, suggesting that Christianity had begun in his time, but few knew about it. More interestingly, from the viewpoint of the present article, the first theorem of "Euclid's" *Elements* involves the fish figure, suggesting that the book was specifically addressed to Christians. Martin Bernal, *Black Athena, The Afro-Asiatic Roots of Classical Civilization,* vol 1: *The Fabrication of Ancient Greece*. Free Association Books, London, 1987, p. 127.

30 For detailed quotes from Origen, see "Appendix on Origen", http://ckraju.net/papers/Appendix-on-Origen.pdf.

31 C. K. Raju, *The Eleven Pictures of Time*, Sage, 2003.

32 Edwin E. Moise, *Elementary Geometry from an Advanced Standpoint*, Addison Wesley, Reading, Mass., 1962, chp. 28: "An example of an ordered field which is not Archimedean", p. 388-93.

33 *Cultural Foundations of Mathematics*, cited above, chp. 3.

34 *Cultural Foundations of Mathematics*, cited above, chp. 8. See, also, "Zeroism and Calculus without Limits", http://ckraju.net/papers/Zeroism-and-calculus-without-limits.pdf.

35 See, for example, C. K. Raju, *Time: Towards a Consistent Theory*, Kluwer, 1994, chp 3b, or "On Time-3b. Einstein's Time" *Physics Education* (India), **8**(4) (1992) pp. 293-305. A summary is at http://tinyurl.com/yeygejb.