The Indian calculus and its relevance to physics today

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Abstract

It is well known by now that the calculus developed in India and was taken to Europe by Cochin-based Jesuits in the 16th c.[1] But is the Indian invention of calculus just a matter of past glory or is it relevant to physics today? YES, this revised history is relevant today. Those who copy make mistakes, so the copy is inferior to the original. However, colonial education taught us to regard anything Western as superior: the university calculus we teach today is based on the inferior Western copy, not the original Indian calculus which developed as *ganita*[2] using Indian "non-Archimedean" arithmetic.

Conceptual mistakes also accompanied the earlier transmission of Indian arithmetic, algebra, and trigonometry to Europe, as is clear from the very words in use today, "zero", "Arabic numerals", "surd", "trigonometry", "sine".[3] However, Newton's mistake in understanding the calculus is much harder to understand. That mistake originated in Western religious superstitions about mathematics as eternal truth, hence perfect, which arose from the spiritual Egyptian mathematics advocated by Plato, and its transformation by the Crusading theology of reason.[4]

Most physicists (and even mathematicians), however, lack an in-depth understanding of even the formalist philosophy of mathematics underlying present-day university calculus ("real numbers", formal limits), or its more advanced versions (Schwartz distributions, generalised functions, non-standard analysis). Hence, they find it difficult to understand the generic difficulties of the Western calculus,[5] and are unable to relate these to current problems concerning infinity in physics such as the renormalization problem of quantum field theory,[6] the problem of shocks in relativity or in real fluids,[7] or the problem of runaway solutions with radiation damping in classical electrodynamics.[8]

1 C. K. Raju, *Cultural Foundations of Mathematics: the nature of mathematical proof and the transmission of calculus from India to Europe in the 16th c. CE*, Pearson Longman, 2007.

2 C. K Raju, "Ganita vs mathematics: Ten myths of formal math and the need to reject them", Talk at International conference on Plurality in Math, Kolkata, Dec 2015. (To appear in Proc.) Extended abstract at http://ckraju.net/blog/?p=111. Also, "Calculus: ganita or math?" talk at Indian Institute of Science, 7 Dec 2015. Video at https://youtu.be/U-r1CWU-KKM.

3 C. K. Raju, "Eternity and Infinity: the Western misunderstanding of Indian mathematics and its consequences for science today." *American Philosophical Association Newsletter on Asian and Asian American Philosophers and Philosophies* **14**(2) (2015) pp. 27-33. Draft at http://ckraju.net/papers/Eternity-and-infinity.pdf. Or see the abstract, presentation and video of my talk at MIT, "Calculus: the real story".

4 C. K. Raju, *Euclid and Jesus: how and why the church transformed mathematics and Christianity across two religious wars*, Multiversity, 2012.

5 C. K. Raju, "Calculus the real story", talk at MIT, Cambridge, Mass., 26 April 2015. Abstract at http://ckraju.net/papers/Calculus-story-abstract.html. Video: https://youtu.be/IaodCGDjqzs. Blog and link to presentation: http://ckraju.net/blog/?p=106.

6 C. K. Raju, "On the square of x^{-n}" *J. Phys. A: Math. Gen.* **16** (1983) pp. 3739–53.

7 C. K. Raju, "Distributional matter tensors in relativity", *Proceedings of the Fifth Marcel Grossman meeting on General Relativity*, D. Blair and M. J. Buckingham (ed), R. Ruffini (series ed.), World Scientific, Singapore, 1989, pp. 421–23. arXiv: 0804.1998.

8 Suvrat Raju and C. K. Raju, "Radiative Damping and Functional Differential Equations", *Mod. Phys. Lett. A*, **26**(35) (2011) pp. 2627-2638. arXiv:0802:3390. C. K. Raju, "Functional differential equations. 3: Radiative damping" *Physics Education* (India), **30**(3), July-Sep 2014, Article 8. http://www.physedu.in/uploads/publication/15/263/7.-Functional-differential-equations.pdf.

Perhaps the easiest way to understand Newton's mistake is that in his attempt to make calculus perfect, through his misguided theory of fluxions, he made time metaphysical.[9] The absence of a physical measure of time was the precise reason for the failure of Newtonian physics and its replacement by relativity.[10] Since Newtonian physics and gravitation come as a package deal, Newtonian gravitation too should be corrected. This line of thought culminates in my retarded gravitation theory,[11] which is Lorentz covariant, and corrects for the failure of Newtonian gravitation beyond the solar system. Specifically, it easily account for the rotation curves of spiral galaxies, without dark matter. Within the solar system it accounts for small deviations such as the NASA flyby anomaly.

9 C. K Raju, "Time: what is it that it can be measured?" *Science&Education*, **15**(6) (2006) pp. 537–551. Draft available from http://ckraju.net/papers/ckr_pendu_1_paper.pdf.

10 C. K Raju, *Time: Towards a Consistent Theory*, Kluwer Academic, 1994. Fundamental theories of physics vol. 65.

11 C. K. Raju, "Retarded gravitation theory" in: Waldyr Rodrigues Jr, Richard Kerner, Gentil O. Pires, and Carlos Pinheiro (ed.), *Sixth International School on Field Theory and Gravitation*, American Institute of Physics, New York, 2012, pp. 260-276. http://ckraju.net/papers/retarded_gravitation_theory-rio.pdf. Also, CKR, "Functional Differential Equations. 4: Retarded gravitation" *Physics Education* (India) **31**(2) April-June, 2015, http://www.physedu.in/uploads/publication/19/309/1-Functional-differential-equations-4-Retarded-gravitation-(2).pdf.