

differentiate a discontinuous function, it does not allow us to multiply the derivatives to make sense of the nonlinear differential equations of physics because of the problem of products of distributions.

I had earlier solved this problem by applying non-standard analysis to give the best solution of the problem of products of distributions.⁸⁸ However, there is no need for nonstandard analysis or distributions. The problem is solved quite simply in the same way by using the infinities and infinitesimals of Indian *ganita*. Specifically, we are able to obtain the most general junction conditions in relativity,⁸⁹ which subsume the Taub conditions for shocks and the Israel conditions for surface layers. In the non-relativistic limit, this reduces to conditions for Navier Stokes shocks with viscosity and thermal conductivity, a special case of which are the Rankine-Hugoniot conditions.

I will not go into the deeper issue of Penrose-Hawking singularity theory, which I have considered separately,⁹⁰ along with the coarse propagandist purposes⁹¹ to which it is put.

Likewise, it is easy to resolve the divergences of quantum electrodynamics.⁹² The same procedure can be used to resolve the divergences of classical electrodynamics,⁹³ by modifying the propagators of Maxwell's equations, hence the equations themselves.

Conclusions

Calculus as *ganita*, as it originated in India, provides a superior understanding of calculus, which is easy and better for practical applications and science. Newton's misunderstanding of calculus using fluxions, like its misunderstanding with axiomatic real numbers and limits, which provides no added practical value, but turns mathematics into metaphysics, which can derail science. Considering that Europeans struggled for nine centuries to understand even elementary Indian arithmetic of algorithms and negative numbers, it is natural that they failed to understand the non-Archimedean (polynomial) arithmetic on which the Indian calculus was based and which does not allow limits. Similar considerations apply to axiomatic probability, but were not covered in the above article for reasons of space.

The axiomatic method originated with the church, not any Euclid. It is more fallible than the scientific method used in Indian *ganita*.

Notes

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- 1 Article written as part of the book project "Ganita vs Mathematics" for a Tagore Fellowship. Currently, Visiting Professor, IIT Mandi, and Honorary Professor, Indian Institute of Education. Orcid: <https://orcid.org/0000-0002-5960-7785>.
 - 2 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).
 - 3 C. K. Raju, "Probability in Ancient India," in *Handbook of Philosophy of Statistics*, ed. Paul Thagard, Dov M. Gabbay and John Woods, *Handbook of Philosophy of Science*, vol. 7, (Elsevier, 2011), <http://ckraju.net/papers/Probability-in-Ancient-India.pdf>.
 - 4 C. K. Raju, "The Meaning of Christian 'Discovery,'" *Frontier Weekly* 47, no. 29 (2015): 25–31, <https://doi.org/http://www.frontierweekly.com/archive/vol-number/vol/vol-47-2014-15/47-29/47-29-The%20Meaning%20of%20Christian%20Discovery.html>. For the original texts, see <https://doctrineofdiscovery.org/>.

- 5 Charles M. Whish, , “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 (1834): 509–23.
- 6 Isaac Newton, “An Account of the Book Entituled *Commercium Epistolicum Collinii Et Aliorum, de Analysisi Promota*,” *Philosophical Transaction of the Royal Society of London*, no. 342 (February 1714): 173–224.
- 7 C. K. Raju, *The Funny History of Arithmetic: How “Superior” Europeans Blundered for 900 Years to Learn Elementary Indian Arithmetic (“Arabic Numerals”)* (Kant Academic Publishers, 2026).
- 8 C. K. Raju, “Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the Yuktibhasa,” *8th East-West Conference, plenary* (University of Hawai’i), January 2000; Raju, C. K. “Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the YuktiBhâsâ.” *Philosophy East and West* 51, no. 3 (2001): 325–62. <https://muse.jhu.edu/article/26555/pdf>. Also in Raju, *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of Calculus from India to Europe in the 16th c, CE*.
- 9 Raju, *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of Calculus from India to Europe in the 16th c, CE*.
- 10 H. T. Colebrooke, *The Algebra of Brahmegeupta and Bhascara* (John Murray, 1817).
- 11 Matteo Ricci, “Letter to Petri Maffei,” in *Documenta Indica*, XII (1581). A handwritten copy of this letter may be seen in the video of my MIT talk, “Calculus the real story”, <https://www.youtube.com/watch?v=IaodCGDjqzs>.
- 12 C. K. Raju, “Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the Yuktibhasa,” *8th East-West Conference* (University of Hawai’i), January 2000; Raju, *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of Calculus from India to Europe in the 16th c, CE*.
- 13 C. K. Raju, “In defence of decolonisation of mathematics”, invited talk 9th Pacific Rim Conference in Mathematics, Darwin, Australia, 17-21 July 2024, short abstract <https://ckraju.net/papers/Australia-prcm-abstract-short.pdf>, full abstract: <https://ckraju.net/papers/Australia%20prcm%20abstract.pdf>. C. K. Raju, “Busting Macaulay: The epistemic test, the theft of calculus by “Christian discovery”, and the myths and superstitions in the present-day teaching and practice of axiomatic math”, abstract for keynote at conference on "Mathematical traditions of South Asia", India International Centre, 5 Sep 2025. <https://ckraju.net/papers/abstract-for-IIC.pdf>.
- 14 See part II of the table of lectures posted at <https://x.com/CKRaju14/status/1999375906784313673>.
- 15 Richard Dedekind, *Essays on the Theory of Numbers* (Dover Publications, 1963), 2, <https://archive.org/details/essaysontheoryof0000dede>.
- 16 Isaac Newton et al., *The Method of Fluxions and Infinite Series : With Its Application to the Geometry of Curve-Lines*, 1 online resource (iv, ix–xxiv, 339 [i.e. 343] pages: illustrations, charts (Printed by Henry Woodfall, 1736), WorldCat, <https://archive.org/details/methodoffluxions00newt>.
- 17 For a summary, see Raju, *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of Calculus from India to Europe in the 16th c, CE*, 378; for an easier account see C. K. Raju, “Marx and Mathematics. 4: The Epistemic Test,” *Frontier Weekly*, September 8, 2020, <https://www.frontierweekly.com/views/sep-20/8-9-20-Marx%20and%20mathematics-4.html>.
- 18 <https://ganita.net/sitabhra-sinhas-buffoon-public-statements-on-real-numbers-and-euclid/>
- 19 Josiah Priest, *Bible Defence of Slavery: To Which Is Added a Faithful Exposition of That System of Pseudo Philanthropy, Or Fanaticism, Modern Abolitionism ... and Proposing a Plan of National Colonization*. W.S. Brown, 1851.
- 20 C. K. Raju, “‘Euclid’ Must Fall: The ‘Pythagorean’ ‘Theorem’ and the Rant of Racist and Civilizational Superiority — Part 1,” *Arumaruka: Journal of Conversational Thinking* 1, no. 1 (2022): 127–55, <https://doi.org/https://dx.doi.org/10.4314/ajct.v1i1.6>.
- 21 Augustus de Morgan, *Elements of Algebra: Preliminary to the Differential Calculus*, 2nd ed. (Taylor and Walton, 1837), p.xi
- 22 C. K. Raju, *The Funny History of Arithmetic: How “Superior” Europeans Blundered for 900 Years to Learn Elementary Indian Arithmetic (“Arabic Numerals”)* (Kant Academic Publishers, 2026).
- 23 H. S. Hall and S. R. Knight, *Algebra for Colleges and Schools* (Macmillan, 1956).
- 24 https://indianexpress.com/article/india/india-not-just-an-emerging-market-but-also-an-emerging-model-pm-modi-at-ramnath-goenka-lecture-10371417/?utm_source=substack&utm_medium=email
- 25 C. K. Raju, “Modi, Macaulay, and Padreism,” *Countercurrents*, December 13, 2025, <https://countercurrents.org/2025/12/modi-macaulay-and-padreism/>.
- 26 T. Preston, *Elementary Education Act 1870* (William Amer, 1870), <https://archive.org/details/elementaryeduca01britgoog>.
- 27 trans Dana C. Munro, *Translations and Reprints from the Original Sources of European History, No. 3, The Medieval Student*, II: No. 3 (University of Pennsylvania Press, 1897).
- 28 C. K. Raju, *Indian Calendar: Scientific Aspects* (Kant Academic Publishers, 2024), <https://play.google.com/store/books/details?id=ul0jEQAAQBAJ>; C. K. Raju, “A Tale of Two Calendars,” in

-
- Multicultural Knowledge and the University*, ed. Claude Alvares (Multiversity, 2014), <http://ckraju.net/papers/ckr-calendar.html>.
- 29 notes S. N. Banerjee, trans. J. S. Hoyland, *The Commentary of Father Monserrate, SJ, on His Journey to the Court of Akbar* (Oxford University Press, 1922).
 - 30 C. K. Raju, Statistics for Social Science and Humanities: Should We Teach It Using Normal Math or Formal Math?, video of lecture at JNU on 16 Sep 2020, starting at <https://youtu.be/A9Og1k-Z5O4?t=662>, The corresponding presentations slides start at <https://ckraju.net/papers/presentations/statistics-jnu.html#slide-org948751a>.
 - 31 L. Mendelson, *Introduction to Mathematical Logic* (van Nostrand Reinhold, 1964), 34.
 - 32 Satish Chandra Vidyabhushana, *The Nyaya Sutras of Gotama* (Pāṇinī Office, 1913).
 - 33 C. K. Raju, “Did Indians Have Scientific Temper?,” *ThePrint, India*, March 31, 2019, <https://theprint.in/opinion/do-indians-have-a-scientific-temper-ancient-texts-reveal-we-did-way-before-the-west/214767/>.
 - 34 C. K. Raju, *The Eleven Pictures of Time* (Sage, 2003).
 - 35 C. K. Raju, “Mathematics and Culture”, in *History, Culture and Truth: Essays Presented to D. P. Chattopadhyaya*, ed. Daya Krishna and K. Satchidananda Murthy (New Delhi, 1999), “Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the YuktiBhâsâ”, *Philosophy East and West* 51, no. 3 (2001): 325–62,
 - 36 C. K. Raju, “Decolonising Mathematics,” *AlterNation* 25, no. 2 (2018): 12–43b.
 - 37 C. K. Raju, “Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the YuktiBhâsâ”, *Philosophy East and West* 51, no. 3 (2001): 325–62, <https://doi.org/https://muse.jhu.edu/article/26555/pdf>. For a video of the computer program in action, see “Associative law fails for floats”, <https://www.youtube.com/watch?v=3sRqdxBemTM>.
 - 38 Republic VII.527
 - 39 Michael Masi, *Boethian Number Theory: A Translation of the de Institutione Arithmetica* (Studies in Classical Antiquity, vol. 6, 1983), 73.
 - 40 Dorothy V. Schrader, “DE ARITHMETICA, book I, of Boethius,” *The Mathematics Teacher* 61, no. 6 (1968): 615–28, <https://doi.org/http://www.jstor.org/stable/27957920>.
 - 41 C. K. Raju, *The Eleven Pictures of Time: The Physics, Philosophy and Politics of Time Beliefs* (Sage, 2003), chp., 2, “The curse on ‘cyclic’ time”.
 - 42 G. H. Hardy, *A Mathematician’s Apology* (University of Alberta Mathematical Sciences Society, 1940), <http://www.math.ualberta.ca/mss/>.
 - 43 C. K. Raju, Refutation of the Aryan Race Conjecture: The Arithmetic Evidence and Conquest-of-Greeks Theory. Kant Academic Publishers, 2022.
 - 44 L. E. Sigler, *Fibonacci’s Liber Abaci a Translation into Modern English of Leonardo Pisano’s Book of Calculation* (Springer, 2002).
 - 45 Brahmagupta, *Brahma-Sphuta Siddhanta*, ed. Ram Swarup Sharma (Indian Institute of Astronomical and Sanskrit Research, 1966).
 - 46 C. K. Raju, *Euclid and Jesus: How and Why the Church Changed Mathematics and Christianity across Two Religious Wars*. Multiversity and Citizens International, 2012.
 - 47 C. K. Raju, “‘Euclid’ Must Fall: The ‘Pythagorean’ ‘Theorem’ and the Rant of Racist and Civilizational Superiority - Part 2.” *Arumaruka: Journal of Conversational Thinking* 1, no. 2 (2022): 57–105. <https://doi.org/10.4314/ajct.v1i2.5>.
 - 48 C. K. Raju, “Racism in the Math Classroom: ‘Pythagorean Theorem’ and the Two Myths of ‘Euclid.’” Medium, February 3, 2022. https://medium.com/@c_k_raj/racism-in-the-math-classroom-pythagorean-theorem-and-the-two-myths-of-euclid-c83da308bda4. “The Church Origins of (Axiomatic) Math.” Medium, June 21, 2022. https://medium.com/@c_k_raj/the-church-origins-of-axiomatic-math-e08036dbe29d.
 - 49 Raju, “Computers, Mathematics Education, and the Alternative Epistemology of the Calculus in the YuktiBhâsâ”.
 - 50 H. M. Taylor, *Euclid’s Elements of Geometry*. Cambridge University Press, 1893.
 - 51 David Hilbert, *The Foundations of Geometry* (The Open Court Publishing Co., La Salle, 1950), <http://ckraju.net/geometry/Hilbert-Foundations-of-Geometry.pdf>.
 - 52 E. A. Moise, *Elementary Geometry from an Advanced Standpoint* (Addison-Wesley, 1963).
 - 53 George D. Birkhoff, “A Set of Postulates for Plane Geometry, Based on Scale and Protractor,” *Annals of Mathematics* 33 (1932): 329–45.
 - 54 <http://ckraju.net/geometry/Rajju-Ganit-poster.pdf>
 - 55 <http://ckraju.net/geometry/Geometry-workshop-home-assignment.pdf/>
 - 56 B. Russell, “The Teaching of Euclid,” *The Mathematical Gazette* 2, no. 33 (1902): 165–67.
 - 57 Plato, Meno, trans. Benjamin Jowett (n.d.), <http://classics.mit.edu/Plato/meno.html>.
 - 58 Āryabhaṭa, *Āryabhaṭīya of Āryabhaṭa*, ed. K. S. Shukla and K. V. Sarma (Indian National Science Academy, 1976).
 - 59 Lalla, शिष्यदीवृद्धि, ed. Bina Chatterjee (Indian National Science Academy, 1981).
 - 60 Kripa Shankar Shukla, *Vaṭeśvara-Siddhānta And Gola of Vaṭeśvara* (Indian National Science Academy, 1986).

- 61 Raju, *Cultural Foundations of Mathematics: The Nature of Mathematical Proof and the Transmission of Calculus from India to Europe in the 16th c, CE*.
- 62 Christoph Clavius [Christophori Clavii Bambergensis], *Tabulae Sinuum, Tangentium et Secantium Ad Partes Radij 10,000,000...* (Ioannis Albini, 1607).
- 63 Haribhadra Suri, ed., षट्दर्शन समुच्चय, 5th ed. (Bharatiya Jnanapeeth, 2000), verse 81, commentary 559, page 452.
- 64 Recall the Banach-Tarski theorem. Using the axioms of set theory, it is possible to prove that a ball of gold can be subdivided into a finite number of pieces which can be reassembled without stretching into two balls of gold of the same size as the first. Obviously, this laughable get-rich-quick scheme, based on the axioms of set theory, does not apply to the real world.
- 65 C. K. Raju, "Kosambi the Mathematician," *Economic and Political Weekly* 44, no. 20 (2009): 33–45, <https://doi.org/https://www.epw.in/journal/2009/20/special-articles/kosambi-mathematician.html>.
- 66 Thomas Aquinas, *Summa Theologica* (n.d.), *First Part*, Q. 52, article 3. <http://www.newadvent.org/summa/1052.htm#article3>.
- 67 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, no. 2 (2015): 27–33.
- 68 Raju, "Probability in Ancient India"; C. K. Raju, "Probability," in *Encyclopedia of Non-Western Science, Technology and Medicine*, ed. Helaine Selin (Springer, 2016), <http://ckraju.net/papers/Springer/Probability-springer.pdf>.
- 69 C. K. Raju, "Quantum-Mechanical Time," in *Time: Towards a Consistent Theory* (Kluwer Academic, 1994).
- 70 Raju, under "Logic."
- 71 Brahmagupta, *Brahma-Sphuta Siddhanta* chp. 18; Acharya Madhava, *Sarva-Darshan-Samgraha or Review of the Different Systems of Hindu Philosophy*, trans. E. B. Cowell and A. E. Gough (Trubner, 1882).
- 72 S. K. Abhyankar, *Bhaskaracharya's bijaganita and its translation* (Bhaskaracharya Pratishthan, 1980), 559.
- 73 E. A. Moise, *Elementary Geometry from an Advanced Standpoint* (Addison Wesley, 1990).
- 74 Raju, "Decolonising Mathematics"; C. K. Raju, "Zeroism," in *Encyclopedia of Non-Western Science, Technology and Medicine*, ed. Helaine Selin (Springer, 2016), <http://ckraju.net/papers/Springer/zeroism-springer-f.pdf>.
- 75 A. Robinson, *Nonstandard analysis* (North Holland, 1970).
- 76 H. J. Keisler, *Elementary Calculus: An Approach Using Infinitesimals* (Prindle, Weber & Schmidt, 1971).
- 77 C. K. Raju, "Products and Compositions with the Dirac Delta Function," *J. Phys. A: Math. Gen.* 15 (1982): 381–96.
- 78 Raju, "Zeroism."
- 79 <https://x.com/CKRaju14/status/1999375906784313673>,
- 80 <http://ckraju.net/papers/Mysore-course-brochure.pdf>.
- 81 <http://ckraju.net/Joseph/INSA-project-sanction-letter.gif>.
- 82 C. K. Raju, "Who Invented Calculus? Aryabhata or Madhava?," *Medium*, July 3, 2023, https://medium.com/@c_k_raju/who-invented-calculus-aryabhata-or-madhava-1574cd2b3162.
- 83 <https://www.youtube.com/watch?v=lmwZfMaNwfo>
- 84 C. K. Raju, "California, Indian Calculus and the Technology Race. 1: The Indian Origin of Calculus and Its Transmission to Europe," *Boloji.Com*, December 11, 2021, <https://www.boloji.com/articles/52924/california-indian-calculus>; C. K. Raju, "California, Indian Calculus and the Technology Race. 2: Don't Cancel the Calculus, Make It Easy!," *Boloji.Com*, December 24, 2021, <https://www.boloji.com/articles/52950/california-indian-calculus-and>.
- 85 C. K. Raju, "Decolonising Mathematics: How and Why It Makes Science Better (and Enables Students to Solve Harder Problems)," *Palestine Technical University Research Journal* 6, no. 2 (2018): 1–4.
- 86 C. K. Raju, "'Time: What Is It That It Can Be Measured?,'" *Science & Education* 15, no. 6 (2006): 537–51, <https://doi.org/10.1007/s11191-005-5287-z>.
- 87 C. K. Raju, "Teaching Mathematics with a Different Philosophy. 2: Calculus without Limits," *Science and Culture* 7, nos. 7–8 (2011): 280–85.
- 88 C. K. Raju, "Distributional Matter Tensors in Relativity," *Fifth Marcel Grossman Meeting on General Relativity* (Perth), August 1988.
- 89 C. K. Raju, "Distributional Matter Tensors in Relativity," in *Proceedings of the 5th Marcel Grossman Meeting*, ed. D. Blair and M. J. Buckingham (World Scientific, 1989), arXiv:0804.1998.
- 90 C. K. Raju, "A Singular Nobel?," *Mainstream* 59, no. 7 (2021), <http://www.mainstreamweekly.net/article10406.html>.
- 91 C. K. Raju, "The Christian Propaganda in Stephen Hawking's Work," *Lifestyle, DNA India*, January 16, 2011, <https://www.dnaindia.com/lifestyle/review-the-christian-propaganda-in-stephen-hawking-s-work-1495047>.
- 92 C. K. Raju, "On the Square of $x^{\{-n\}}$," *Journal of Physics A: Mathematical and General* 16 (1983): 3739–53, <https://doi.org/https://doi.org/10.1088/0305-4470/16/16/013>; C. K. Raju, "Renormalisation, Extended Particles and Non-Locality," *Hadronic J. Suppl* 1 (1985): 325–70.
- 93 Suvrat Raju and C. K. Raju, "Radiation Damping and Functional Differential Equations," *Mod. Phys. Lett. A* 26, no. 35 (2011): 2627–38.