Think • Vol 25 • No 73 • Summer 2026, 73–78

DOI: https://doi.org/10.1017/S1477175626101092

The Non-existence of Physical Infinities and Its Implications

*Peter J. Riggs**

Research School of Physics, Australian National University, Canberra, Australia
*Corresponding author. Email: peter.riggs@anu.edu.au

Keywords: physical infinities; manifestation of infinity; physical consequences of infinity

Abstract

Could our universe be infinitely big? Could it be infinitely old? Could there be infinitely many separate universes? Although arguments against the existence of such physical infinities have been made throughout history, it is only in recent years that substantial arguments against their existence have been made. This article adds to the case against physical infinities and lists some of the astounding implications if no types of physical infinities exist.

Whence Physical Infinities?

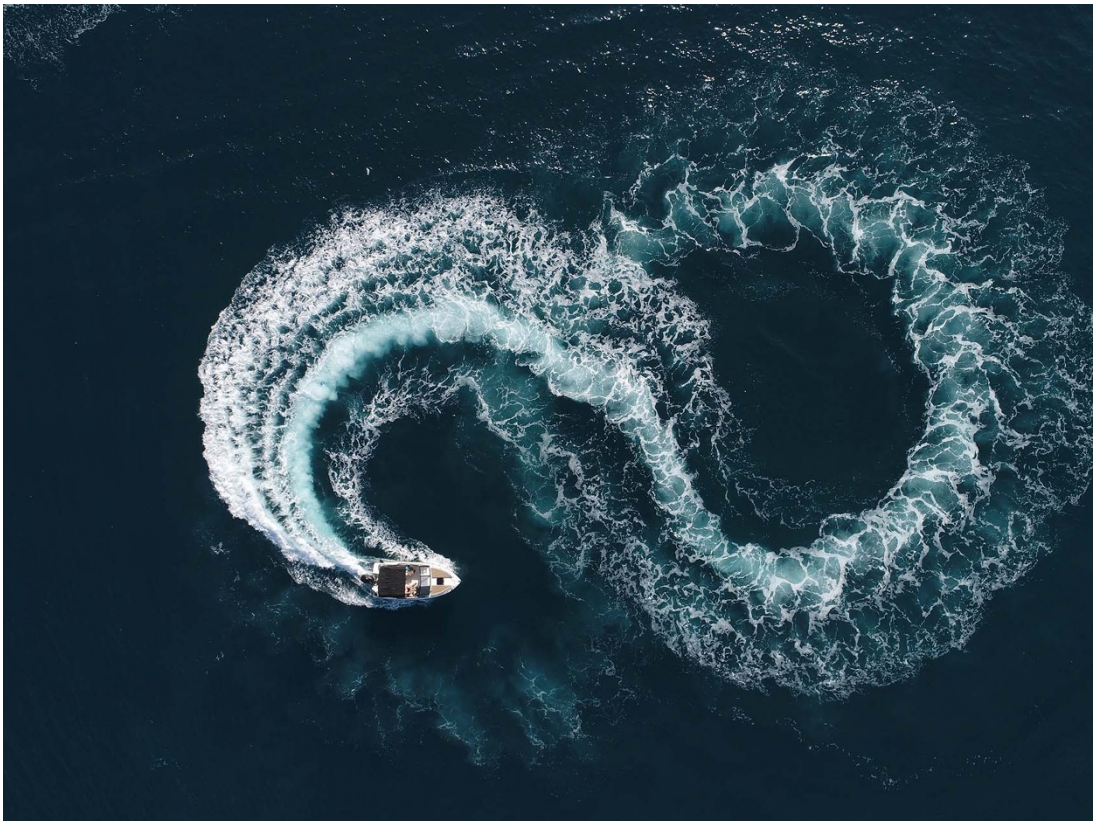
Defining and characterizing 'infinity' is an age-old problem in classical mathematics and philosophy. Infinity is larger than any quantity that can be specified and has no limits. Moreover, we also know that the mathematics of infinity requires there to be levels of infinities. The characterization of mathematical infinity is one matter but the actualization of infinity (i.e. physical infinity) is quite another. We shall be exclusively concerned with physical infinity. The aims of this article are twofold: to present new arguments for accepting that physical infinities do not exist; and to list some of the staggering implications which follow from such non-existence.

What is the ontological status of physical infinity? Over the last two and a half millennia, there have been both mathematicians and philosophers who thought that infinity is *only a concept* with no physical manifestations. There is also a sizeable number of academics and scientists who embrace the possibility of physical infinities. Does nature exclude physical infinities? If so, what are the implications for physical science and, more generally, for the cosmos? There are different types of physical infinities. A little thought on the issue of the possibilities for physical infinities reveals that there are (at least) the following types:

- infinitely many;
- infinite in extent;
- infinitely variable;
- infinite in magnitude;
- infinitely divisible;
- infinitely dense;
- infinitely curved;
- infinitely large; and
- infinitely small.

Some of these infinities will be denumerable (i.e. countable if one had an infinite amount of time) and some continuous (i.e. non-denumerable). Infinitely many, for example, would be denumerable as it refers to a set of individual physical entities. Importantly, the various types of

https://doi.org/10.1017/S1477175626101092 Published online by Cambridge University Press



Credit: https://www.shutterstock.com/g/dotshock

physical infinities are to be distinguished from physical quantities which increase or decrease without limit. These are sometimes labelled as quantities which 'go to infinity' or have an 'infinite limit'. Such quantities are *never* infinite. They always have finite values at any particular moment of time, irrespective of how large or small they might get. The future of the physical universe should be included in this context, that is, whether the universe will expand 'forever'. Even if expansion continues indefinitely, the universe and its contents can be finite at any given time.

We also need to recognize that physics alone cannot establish that physical infinities exist, regardless of whether physical theories postulate any physical infinities. The size of space is a premier illustration. Information about distant parts of the universe is obtained from electromagnetic waves (e.g. visible light) and very recently from gravitational waves, which are both limited since they travel at the speed of light in vacuum. Observation and measurement cannot ever show that the universe is infinite in size as, no matter what distance we can collect data from, there would always be more space beyond what we can observe in an infinite universe. Arguments in a similar vein can be made against other types of physical infinities. Although not itself constituting a case against physical infinities, it is necessary to acknowledge the limitations of physics in this respect.

Irrespective of whether physical infinities exist or not, infinity as a mathematical 'device' is an enormously helpful aid in describing physical systems. Uses for infinity include: a substitute for an extremely large number; a limit for a series of terms; a boundary condition for an equation; for the integration of physical variables; and for simplifying otherwise complicated

https://doi.org/10.1017/S1477175626101092 Published online by Cambridge University Press

calculations. The extent to which mathematical infinity is employed, almost without question, as a (formal) aid throughout physical science is widespread.

'Does nature exclude physical infinities? If so, what are the implications for physical science and, more generally, for the cosmos?'

It is not possible in a short article to do justice to two and a half millennia of debate over infinity. Instead, we shall have to be content with presenting contemporary arguments for accepting that physical infinities do not exist and then add to them by offering new arguments. Lastly, we shall list the chief implications of such non-existence (with which most of the academic philosophical community will not be familiar) and call attention to the significance of these implications.

The Existing Rationale for Accepting that Physical Infinities Do Not Exist

In order to set the scene for the recent arguments summarized below, we begin by considering the historical views of some noteworthy thinkers. The period from the ancient Greeks to the nineteenth century was so influenced by theology that views on infinity were heavily tainted and consequently we shall bypass them. In 1831, the famous mathematician Carl Friedrich Gauss announced that he was totally against the use of an infinite quantity as an actual entity and that infinity was only a 'figure of speech'. The philosopher Hans Vaihinger declared in 1924 that the application of the concept of infinity to the real world is a misuse of the concept. The renowned mathematician David Hilbert claimed in 1926 that since physical infinities are never observed, we should accept that they do not exist. Further, he claimed that philosophers and scientists had been seduced into thinking the infinite was real because both very large and very small aspects of physical reality are often encountered.

Just a few years prior to his death, the physics Nobel laureate Paul Dirac expressed the opinion (in 1981) that the most important challenge in physics was to get rid of infinity. Yet, infinities in physical theories not only persist, but their use continues unabated. It seems that the seductive influence of the infinite, which Hilbert mentioned, remains with us to the present day.

Most physicists do accept the possibility of physical infinities in specific instances such as the universe being infinite in space and/or time. Contemporary acceptance of the universe being infinitely large and/or infinitely old stems from models of the universe which have these traits. However, these models, which are mathematical, may not truly represent the physical universe. Therefore, these models cannot be used to decide the issue of the existence of physical infinities. Although there are many physicists who accept that physical infinities arise with respect to the universe itself, infinities are not tolerated in quantum field theories where mathematical procedures (called renormalization) have been developed to remove them. Why should infinities in quantum theories be treated differently from infinities in other physical theories? It comes down to probabilities: the mathematical formalism is required to give finite results for the probability of the values of physical quantities since no physical outcome can have infinite probability. A manifestation of infinity is strictly forbidden in the guise of the probability of physical values.

Let's now turn to the views of prominent contemporary physicists George Ellis and Max Tegmark. They have been openly claiming for several years that physical infinities are non-existent and that twenty-first-century physics ought to reflect this situation. Ellis and his associates point out that it is common for infinities to intrude into modern physics and cosmology, so that many physicists take physical infinities

https://doi.org/10.1017/S1477175626101092 Published online by Cambridge University Press

to be part of the natural order of reality. Ellis continues to 'champion' his case against the existence of physical infinities in public debating forums. Although Ellis is convinced that physical infinities do not exist, he does acknowledge that the question has not yet been conclusively decided in academia and that there are far-reaching implications.

The primary case against physical infinities offered by Ellis and his associates concerns detailing relations involving infinite numbers. These relations state that the result of either adding or multiplying infinity (denoted ∞) by any other number is still infinity, or in symbols:

$$\infty + a = \infty \, and \, \infty \times b = \infty$$

for any numbers a, b. They argue that the above relations fail to hold for all conserved quantities and since significant physical quantities (e.g. mass-energy) are conserved, they conclude that physically infinite quantities do not exist. Furthermore, Ellis and his associates argue that the hypothesis that physical infinities exist is not testable and therefore, as a hypothesis, it cannot be part of science.

Tegmark agrees that there is no evidence for the existence of physical infinities. He also claims that the assumption of infinities underlies modern physics and yet, physics can be done *without* invoking infinities. Tegmark also argues that this should apply to natural laws too. It should also be noted that *if* all physical theories could *not* be made to work without the use of infinities, then this would be an indication that physical infinities do exist. However, as Tegmark notes, physics can be done without the infinite.

New Reasons for Accepting that Physical Infinities Do Not Exist

In addition to the historical and recent arguments, we can further strengthen the case against physical infinities by offering four novel arguments which indicate that the claim that there are no physical infinities is correct. These arguments are as follows.

The utility of infinity does not justify accepting its physical existence

This can be seen with reference to another quantity widely used in physical science which clearly has no physical existence. Consider the imaginary number $i = \sqrt[2]{-1}$, namely the square-root of minus one. The number i has huge utility in areas such as quantum theory, telecommunications theory, hydrodynamics, optics and electrical circuit theory. Despite this utility, we have no difficulty in realizing that i amounts of any physical objects do not exist nor does any physical quantity, such as length, have the magnitude of i. We accept these realizations without question as it is self-evidently absurd to suppose otherwise. The number i is merely an abstract mathematical entity without any physical manifestations. Analogous to the use of the imaginary number i, the utility of infinity as it appears in physics *does not furnish grounds* for there being infinitely many physical objects nor for physical quantities having infinite magnitudes.

Assuming physical infinities can lead directly to unphysical outcomes

It is not hard to envisage circumstances where the presence of physical infinities would lead to unphysical consequences. If, for example, a spaceship was powered by an infinite energy source then the spaceship would be capable of moving at the speed of light in vacuum. Travelling at the speed of light would enable the spaceship (in its frame of reference) to be anywhere in the universe, regardless of distance. Worse still, since this sort of travel would not need any time interval to travel between different locations, the spaceship could be at *all* locations (i.e. be everywhere) at the same time. Obviously, these outcomes are physically untenable.

Assuming physical infinities can lead directly to incorrect results

It is also possible to point to cases where the assumption of one or more physical infinities has led directly to incorrect results. In 1974, for example, theoretical physicist Frank Tipler

https://doi.org/10.1017/S1477175626101092 Published online by Cambridge University Press

published a mathematical model in which an *infinitely long*, very dense cylinder was rotated at a (tangential) speed close to the speed of light. This rotational motion generates paths around the cylinder which are closed on themselves not only in space but also in time. This model predicted that if a spaceship was flown on one of these closed paths, then it could travel back into its own past, that is, the cylinder plus spaceship would become a time travel machine capable of taking people backwards in time. Tipler suggested that this result would also hold for a suitably long cylinder of finite length. Tipler used the assumption of an infinite length in order to simplify greatly the calculation of what would happen when a very dense cylinder was rotated near the speed of light. It was not until several decades later that Tipler did the (much more difficult) calculation using a finite cylinder length only to discover that the time travel effect did not arise. In other words, assuming an infinite quantity produced a (non-trivial) incorrect result.

'Irrespective of whether physical infinities exist or not, infinity as a mathematical "device" is an enormously helpful aid in describing physical systems.'

There are not infinitely many levels of physical structures

If physical infinities did exist then we would find that there are unending levels of physical structures. The most prominent example would have to be in the field of elementary particle physics where the basic level of matter seems to have been experimentally reached, namely quark–gluon plasma. There are no empirical indications that deeper levels of structure exist: for example, despite years of searching by the world's largest particle accelerators, such as the Large Hadron Collider, (so-called) supersymmetric particles have not been found – the detection of which would have implied that quarks and gluons consist of minute vibrating objects (known as 'strings' or 'superstrings').

The historical and contemporary arguments together with the above new ones provide a sound rationale for accepting that physical infinities do not exist. It is also to be expected that other compelling reasons against physical infinities will be forthcoming in future. Accepting the proposition of the non-existence of physical infinities allows some *astonishing implications* about the nature of the cosmos to be drawn.

Chief Implications

Despite making a comeback in the latter part of the twentieth century, ontological realism in respect to scientific entities has been the subject of repeated criticisms. However, there are good reasons for adhering to ontological realism, especially to well-founded ontic claims of current physical theories in respect to entities such as atoms, molecules, stars, planets, galaxies, cells, viruses, etc. Indeed, it is the case that most scientists (and much of the general population) do hold ontological realist perspectives and that science and technology does provide knowledge about aspects of reality. In what follows, we shall list some of the important implications of the non-existence of physical infinities from a realist stance.

We will use the term 'universe' to refer to a single, self-contained reality and the term 'cosmos' to include the larger notion of a multiverse, namely a reality consisting of many separate, individual universes. There are a host of quite spectacular implications for cosmogony (the study of the origin of the cosmos), cosmology (the study of the structure and evolution of the universe on astronomical scales) and physics in general if physical infinities *of any type* do

https://doi.org/10.1017/S1477175626101092 Published online by Cambridge University Press

not exist. We hereby list the most prominent of these stunning implications:

- The universe is finite in size;
- The cosmos is not infinitely old;
- The cosmos cannot be constituted by infinitely many separate universes;
- There is no eternally recurring (or cyclic) cosmos;
- The total energy of the universe has either a finite value or is zero;
- Both space and time are only finitely divisible;
- The laws of nature have restrictions on their form other than that imposed by logical consistency;
- There are strict limits on the possible variations in the values of the basic constants of nature;
- Physical fields (e.g. electromagnetic) are discrete (in a relevant sense);
- There are no physical, as distinct from mathematical, singularities (e.g. in the centres of black holes); and
- The vast majority of physical theories are strictly false.

These implications are of immense significance as they either are solutions to some *long-standing, fundamental questions* or would allow for the immediate solution of such questions. Unfortunately (and perhaps frustratingly), we shall have to leave the reader to contemplate the above implications as discussion of them would be extensively long and therefore will have to wait for another day.

Concluding Remarks

A sound rationale has been presented for accepting the non-existence of physical infinities. It needs to be better recognized that there are convincing arguments for this acceptance and that it leads immediately to answers to many fundamental questions about the nature of the physical world. Clearly there is much at stake in determining whether nature excludes physical infinities! Of particular significance for contemporary cosmology are the implications for the age and structure of the universe. In light of the case presented and the importance of the issues involved, further arguments supporting the conclusion that physical infinities do not exist should be pursued.

Acknowledgement. The author thanks the editor for helpful suggestions.

Peter J. Riggs

Peter J. Riggs is a physicist and philosopher of science in the Research School of Physics at the Australian National University. He is author of the books *Quantum Causality: Conceptual Issues in the Causal Theory of Quantum Mechanics* (Springer Academic, 2009) and *Whys and Ways of Science* (Melbourne University Press, 1992). His current research interests include: the foundations of physics; the philosophy of space and time; and methodology of science.

Cite this article: Riggs PJ (2026) The Non-existence of Physical Infinities and Its Implications. *Think* **25**, 73–78. https://doi.org/10.1017/S1477175626101092

© The Author(s), 2026. Published by Cambridge University Press on behalf of The Royal Institute of Philosophy. This is an Open Access article, distributed under the terms of the Creative Commons Attribution licence (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted re-use, distribution, and reproduction in any medium, provided the original work is properly cited.

https://doi.org/10.1017/S1477175626101092 Published online by Cambridge University Press