Mathematics Behind Jujutsu Kaisen: Gojo Satoru's Infinity

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1 Introduction

In Jujutsu Kaisen, there is a scene that Gojo Satoru, the most powerful sorcerer alive, explains his technique with unsettling calm: Infinity. The concept is simple. Between any attacker and Gojo, there is always a distance. That distance can be halved, then halved again, then again, forever. No matter how fast the attack travels, it must first cross half the remaining distance, then half of that, then half of that, an infinite sequence of steps that, Gojo claims, can never be completed. Every attack slows asymptotically, and he is never reached.

Figure 1: Gojo Satoru's Infinity stopping an incoming attack. Image source: Jujutsu Kaisen Wiki (Fandom), *Limitless*, retrieved March 2026. Original work by Gege Akutami, Shueisha.

It sounds like the perfect defence. It also sounds deeply familiar to anyone who knows Zeno of Elea. The ancient Greek philosopher made the same argument, and mathematicians eventually proved him both right and wrong in ways far subtler than either he or Gojo Satoru fully appreciated.

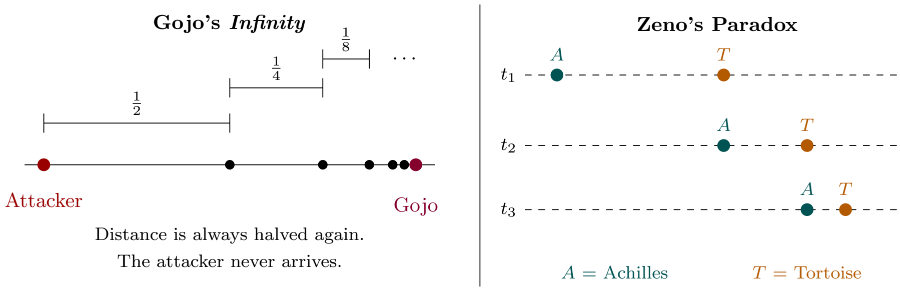


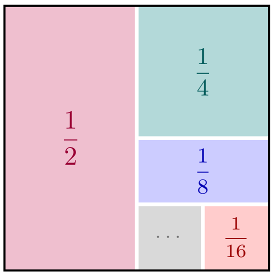
Figure 2: The same mathematical structure, separated by 2500 years. *Left*: Gojo's *Infinity* subdivides the distance to the attacker indefinitely, each step covering half the remaining gap. *Right*: Zeno's paradox places Achilles (A) and the tortoise (T) in the same logical trap: at each stage, Achilles reaches the tortoise's previous position, only to find it has moved on. In both cases, infinitely many steps stand between the pursuer and the target, and in both cases, the same mathematical question arises: can an infinite sequence of steps ever be completed?

What follows is an attempt to take Gojo's Infinity seriously as a mathematical object. The question is what mathematics actually says about infinite subdivision of space, and the answer, built from geometric series and a remarkable theory of measurement due to Henri Lebesgue, will reveal that Infinity is stranger and more fragile than it first appears. It will also explain, with some precision, why Ryomen Sukuna was able to defeat it.

2 Zeno's Paradoxes

Around 450 BCE, the Greek philosopher Zeno of Elea proposed a series of paradoxes designed to prove that motion is an illusion. The most famous involves Achilles, the greatest runner in the ancient world, and a tortoise given a head start in a race. Achilles, being faster, will obviously catch up. But consider what must happen first. Before Achilles can reach the tortoise, he must cover half the distance between them. Then, from that new position, he must cover half the remaining distance. Then half again. And again, forever. At every stage, the tortoise has moved a little further. Achilles must complete an infinite number of steps before he can draw level, and how can anyone ever complete an infinite number of anything?

The argument is logically watertight. It is also, as everyone knows from experience, completely wrong in its conclusion: Achilles does catch the tortoise, and we do cross rooms without difficulty. Gojo Satoru's technique places exactly this paradox between himself and anyone who tries to reach him. The distance is always halved. The steps are always infinite. The attacker, like Achilles, is always just short of arrival. In the world of jujutsu sorcery, the paradox is a weapon. And to understand whether it can be defeated, we need to understand what is wrong with Zeno's argument and what is right about it.



$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \cdots = ?$$

Figure 3: Each region represents one term of the series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \cdots$ The subdivisions fit together to tile the unit square without overlap, suggesting that their sum may be finite. But is it exactly 1? And if so, what does that mean for Zeno's infinitely many steps?

3 Geometric Series

The square in Figure 3 already contains the answer. The regions fit together perfectly. The sum of their areas must therefore equal the area of the whole square, which is exactly 1. An infinite number of pieces, fitting into a finite whole.

This is the key insight that Zeno lacked. The series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \cdots$ does not grow without bound. It converges to a finite value, and that value is 1. To see why, consider the partial sums. Let S_n denote the sum of the first n terms:

$$S_n = \frac{1}{2} + \frac{1}{4} + \cdots + \frac{1}{2^n} = 1 - \frac{1}{2^n}.$$

As $n \to \infty$, the term $\frac{1}{2^n}$ approaches zero, and so $S_n \to 1$. The infinite series converges, and its limit is exactly 1. More generally, for any real number r with $|r| < 1$, the geometric series satisfies

$$\sum_{n=1}^{\infty} ar^{n-1} = \frac{a}{1-r}.$$

The series $\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \cdots$ is the special case $a = \frac{1}{2}, r = \frac{1}{2}$, giving $\frac{1/2}{1-1/2} = 1$.

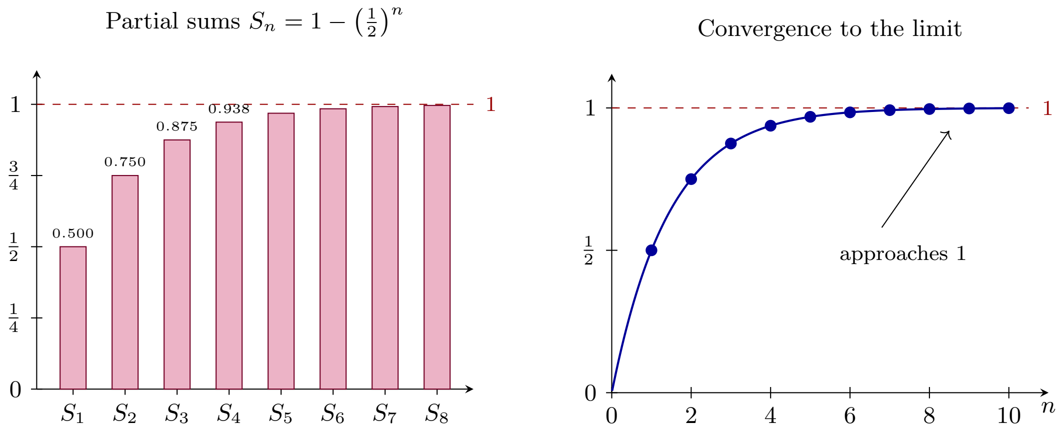


Figure 4: The partial sums $S_n = \frac{1}{2} + \frac{1}{4} + \cdots + \frac{1}{2^n} = 1 - \left(\frac{1}{2}\right)^n$ of the geometric series, shown as a bar chart (left) and as a continuous curve (right). In both panels, the red dashed line marks the limit $S = 1$. The partial sums increase steadily towards this limit but never exceed it, confirming that the infinite series converges to exactly 1.

This resolves Zeno's paradox precisely. Achilles must complete infinitely many steps to reach the tortoise, and he does complete infinitely many steps. But the total time required to do so is itself a geometric series, with each successive step taking half as long as the previous one. The sum of those times is finite. Infinity, here, is not an obstacle. It is a description of how the journey is divided, not a limit on whether it can be completed.

Gojo's Infinity is no different. An attacker approaching Gojo must cross infinitely many subdivisions of the remaining distance, but the total distance is finite, and the total time to cross it is finite. In the language of geometric series, Infinity offers no defence whatsoever. As a mathematical barrier against motion, Infinity simply collapses.

And yet something is missing from this picture. The points at which the attacker must pass, the subdivision points $\frac{1}{2}, \frac{3}{4}, \frac{7}{8}, \ldots$ between the attacker and Gojo, form an infinite set. How large, in a precise mathematical sense, is that set? The answer turns out to require a completely different kind of mathematics.

4 The Lebesgue Measure

The subdivision points $\frac{1}{2}, \frac{3}{4}, \frac{7}{8}, \ldots$ are countably infinite: they can be listed one by one, indexed by the natural numbers. To measure the size of such a set, we need a theory of measurement that goes beyond simply counting elements. The framework that makes this precise is the Lebesgue measure, developed by Henri Lebesgue in the early twentieth century, which assigns to every sufficiently well-behaved subset of $\mathbb{R}$ a non-negative number representing its total length.

The definition proceeds by covering. Given a set $A \subseteq \mathbb{R}$, we consider all possible ways to cover A by a countable collection of open intervals $\{I_n\}$, and we ask: what is the smallest total length such a covering can achieve? Formally, the Lebesgue outer measure of A is

$$m^*(A) = \inf \left\{ \sum_{n=1}^{\infty} |I_n| : A \subseteq \bigcup_{n=1}^{\infty} I_n \right\},$$

where the infimum is taken over all countable coverings by open intervals. For sets that are well-behaved enough to be measurable, this outer measure coincides with the Lebesgue measure $m(A)$. Intervals behave as expected:

$$m([a,b]) = b - a \quad \text{and} \quad m(\emptyset) = 0.$$

Furthermore, for any disjoint measurable sets (E_n), we have $m(\cup_{n=1}^{\infty} E_n) = \sum_{n=1}^{\infty} m(E_n)$.

The set $Z = \{\frac{1}{2}, \frac{3}{4}, \frac{7}{8}, \ldots\}$ of Zeno subdivision points is countably infinite: its elements can be listed one by one as $z_n = 1 - \frac{1}{2^n}$ for $n \in \mathbb{N}$. We claim that this set, despite containing infinitely many points, has Lebesgue measure zero. The proof is a direct application of the covering definition, and it is worth spelling out in full.

Proof. Let $\varepsilon > 0$ be arbitrary. For each $n \geq 1$, cover the point $z_n = 1 - \frac{1}{2^n}$ with the open interval

$$I_n = \left(z_n - \frac{\varepsilon}{2^{n+1}},\ z_n + \frac{\varepsilon}{2^{n+1}} \right),$$

which has length $|I_n| = \frac{\varepsilon}{2^n}$. The collection $\{I_n\}_{n=1}^{\infty}$ covers Z entirely, and the total length of the covering is

$$\sum_{n=1}^{\infty} |I_n| = \sum_{n=1}^{\infty} \frac{\varepsilon}{2^n} = \varepsilon \cdot \sum_{n=1}^{\infty} \frac{1}{2^n} = \varepsilon \cdot 1 = \varepsilon.$$

Since $\varepsilon > 0$ was arbitrary, the infimum of the total lengths of all such coverings is zero. Therefore $m(Z) = 0$. $\square$

This result holds for any countably infinite set, not just the Zeno subdivision points. A set can contain infinitely many elements and yet occupy no length whatsoever on the real line. The infinity of the elements and the size of the set, measured by length, are completely independent notions.

The implication for Gojo's Infinity is striking. The barrier does not consist of a solid interval of space. It consists of countably many points, and countably many points have Lebesgue measure zero. Measured with the full precision of modern mathematics, the obstacle that Infinity places between the attacker and Gojo occupies no space at all. It is, in the language of measure theory, a negligible set.

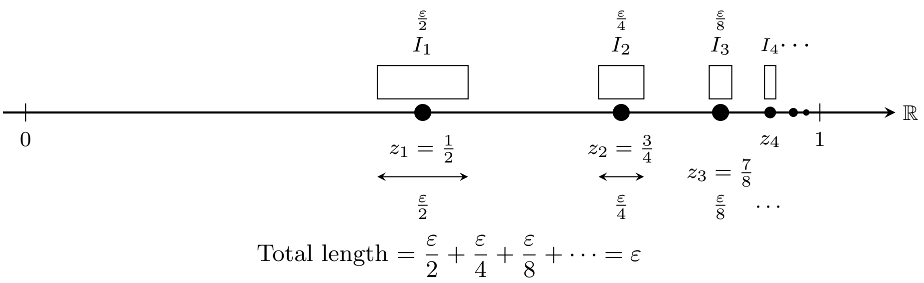


Figure 5: The covering construction in the proof that $m(Z) = 0$. Each point $z_n \in Z$ is enclosed in an open interval I_n of length $\frac{\varepsilon}{2^n}$. The intervals shrink rapidly as n increases, and their total length is $\sum_{n=1}^{\infty} \frac{\varepsilon}{2^n} = \varepsilon$. Since $\varepsilon > 0$ is arbitrary, the infimum of all such coverings is zero, and so $m(Z) = 0$.

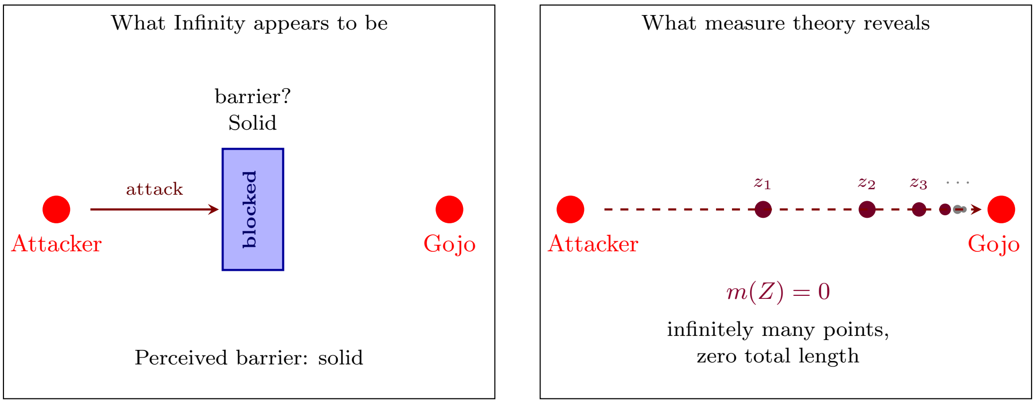


Figure 6: Gojo's Infinity appears solid (left), but measure theory reveals it consists of countably many points with $m(Z) = 0$ (right). If the barrier is negligible in length, what actually stops the attack? The answer lies in the geometry of space itself.

5 Riemannian Geometry: Infinity as a Metric Transformation

The Lebesgue measure tells us that the points of Infinity occupy no space. But this raises an immediate question. If the barrier has measure zero, why does every attack still slow to a halt before reaching Gojo? The answer came from the author of Jujutsu Kaisen himself.

In a 2021 collaboration with researchers from the RIKEN institute published in Jump GIGA, Gege Akutami worked with a team of mathematicians and engineers to formalise the mechanism behind Infinity. They concluded that Infinity is not merely a subdivision of distance. It is a transformation of the metric by which distance is measured.

To understand what this means, it helps to think about how distances are measured in curved spaces. In ordinary Euclidean space, the distance between two nearby points is given by $ds^2 = dx^2 + dy^2 + dz^2$. In a Riemannian manifold, this is replaced by

$$ds^2 = \sum_{ij} g_{ij}\, dx_i\, dx_j,$$

where g_{ij} is the metric tensor, a matrix that encodes how distances are measured at each point in space. Think of dx as the physical step the attacker takes, and ds as the actual distance the universe forces them to travel.

The RIKEN team proposed a specific form for this tensor, constructed via a Gaussian kernel function:

$$K(x, y) = \exp\left(-\frac{|x-y|^2}{\sigma^2}\right) \quad \text{and} \quad g_{ij} = \frac{K(x + dx_i, x + dx_j)}{dx_i \cdot dx_j}.$$

This is a masterstroke of mathematical modelling. The Gaussian kernel $K(x, y)$ measures similarity: it equals 1 when $x = y$ and decays exponentially as the Euclidean distance $|x - y|$ grows. By placing this exponential function inside the definition of the metric tensor g_{ij}, the geometry of space becomes highly non-linear.

Far from Gojo, g_{ij} approximates the standard identity matrix, meaning $ds \approx dx$; space behaves normally. But as an attacker's coordinates approach Gojo's ($x \to y$), the tensor g_{ij} forces the metric to blow up. In practical terms, as Sonoda explained, it is as if the density of the ruler has changed. A physical step of $dx = 0.1$ metres far from Gojo might translate to a felt distance of $ds = 0.1$. But near Gojo, that exact same physical step of $dx = 0.1$ is stretched by the exponential weight of the metric tensor into a staggering distance of $ds = 10$, then $ds = 100$, scaling infinitely. The attacker experiences the distances as expanding without limit, even as their Euclidean position barely changes.

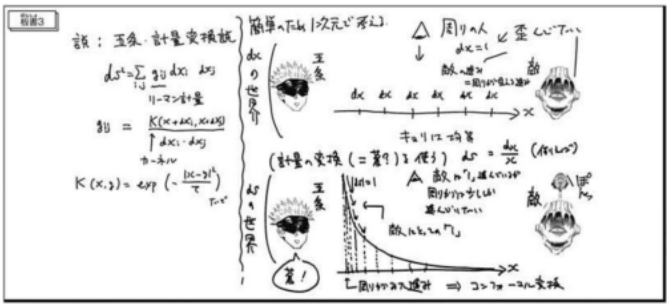


Figure 7: Image: Hino (RIKEN), reproduced from Gege Akutami, *Jujutsu Kaisen Abyss of Math Course*, Jump GIGA Summer 2021, Shueisha.

What makes this particular choice of kernel striking is that it comes from machine learning rather than physics: the same mathematical tool used to define similarity between images or music recommendations is what defines the geometry of space around Gojo.

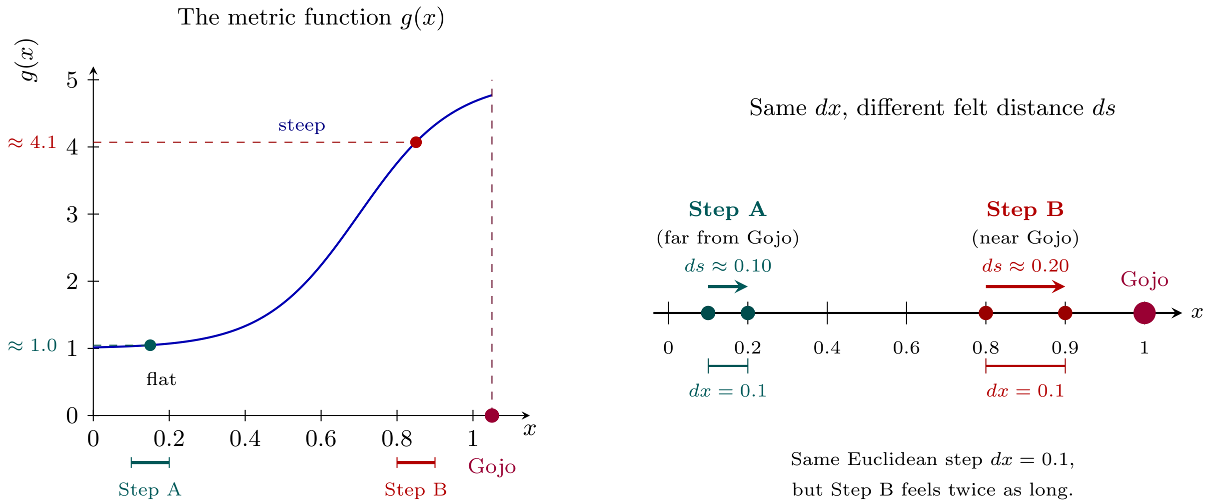


Figure 8: Left: the metric function $g(x)$ is nearly flat far from Gojo but rises steeply as x approaches his position. Right: two steps of identical Euclidean length $dx = 0.1$ at different locations. Step A, taken far from Gojo where $g \approx 1.0$, produces a felt distance $ds \approx 0.10$, indistinguishable from ordinary space. Step B, taken near Gojo, where $g \approx 4.1$, produces $ds \approx 0.20$ despite the same physical displacement. As the attacker draws closer, $g(x)$ grows without bound, and each successive step feels longer than the one before.

The set Z of subdivision points has Euclidean measure zero. But under the kernel-induced metric, distances near Gojo's position are amplified by the factor g_{ij}, and the measure of the same set in the distorted geometry can be infinite. The barrier that appears negligible in the flat geometry of Lebesgue theory becomes, in the curved geometry that Infinity creates, an impenetrable wall. The same set of points, measured by two different rulers, yields two completely different answers.

There is a simpler way to picture what the kernel-induced metric does. Think of a single function $\Omega(x)$ that measures how much the ruler is stretched at each point x between the attacker and Gojo. Figure 10 shows this directly. Far from Gojo, $\Omega(x)$ is flat, and distances are measured normally. Closer to Gojo, $\Omega(x)$ rises steeply, making every step feel longer. What matters most is that this curve is smooth and unbroken across the entire space, and it is precisely this smoothness that the next section will put under pressure.

6 Mahoraga's Adaptation and the World Cutting Slash

Two things are now clear about Gojo's Infinity. Its subdivision points form a set of Lebesgue measure zero, negligible in the flat geometry of the real line. And the kernel-induced metric amplifies distances near Gojo's position, making the barrier feel impenetrable from within the distorted geometry. But Ryomen Sukuna found a way through, and the path he took reaches deeper than either geometric series or Lebesgue measure.

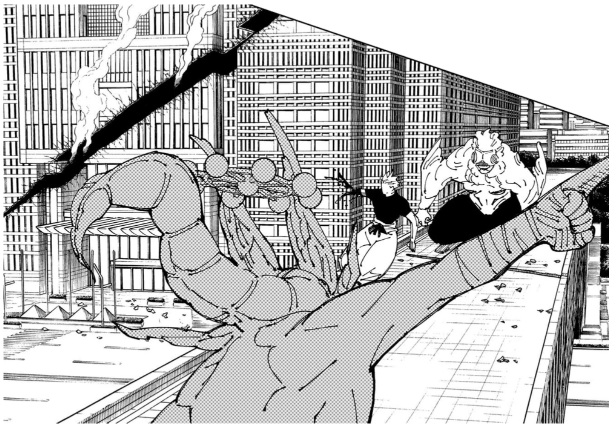


Figure 9: Mahoraga adapting to Gojo's Infinity during their battle. Image source: Jujutsu Kaisen Wiki (Fandom), *Eight-Handled Sword Divergent Sila Divine General Mahoraga*, retrieved March 2026. Original work by Gege Akutami, Shueisha.

Sukuna's strategy was to use Mahoraga. Mahoraga adapts to any technique it encounters. Against Gojo's Infinity, the wheel turned five times before Mahoraga found an answer. After a few adaptations, Mahoraga stopped targeting Gojo and started targeting the space around him. By aiming at the space that contained him rather than the person inside it, Mahoraga bypassed Infinity entirely. Sukuna modified his Dismantle technique to do the same. By expanding his target from Gojo to reality itself, the resulting slash severed Infinity, space, and Gojo simultaneously.

Figure 10: The conformal factor $\Omega(x)$ defining Infinity's metric (left): smooth and continuous, it grows rapidly as the attacker approaches Gojo, making every step feel longer. The World Cutting Slash (right) severs the continuity of $\Omega(x)$ at a single point, rendering the metric undefined across the cut. Infinity is not penetrated; the space carrying it is destroyed.

What Mahoraga discovered, and what Sukuna then replicated, is a single operation with a precise mathematical meaning. Infinity depends, at its foundation, on $\Omega(x)$ being continuous across space. Any ordinary attack must cross the points of Z one by one, and the distorted metric makes each crossing feel longer than the last. But Mahoraga's adaptation ignored Z entirely. It aimed at the spatial fabric itself, severing the continuity of $\Omega(x)$ at a single point. A cut that destroys continuity does not need to cross any particular distance. It renders the metric undefined across the severed region. The barrier ceases to exist not because it was penetrated but because the space that carried it was torn apart.

Sukuna only need to watch Mahoraga long enough. Mahoraga had found, through five rotations of a wheel rather than any calculation, that Infinity has a blind spot that it cannot defend against an attack aimed not at its points but at the topology of the space that holds them. Nothing in Infinity's construction protects against an operation that ignores its points and severs its space. Sukuna did not overpower Gojo's technique. He asked a question that was never built to answer.

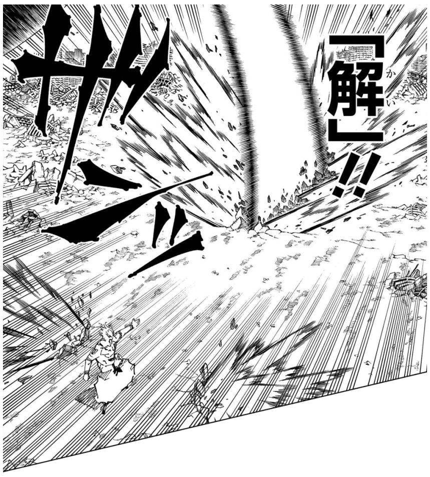


Figure 11: Ryomen Sukuna using the World Cutting Slash to defeat Gojo's Infinity. Image source: Jujutsu Kaisen Wiki (Fandom), *Ryomen Sukuna*, retrieved March 2026. Original work by Gege Akutami, Shueisha.

7 Conclusion

So, is Gojo's Infinity mathematically undefeatable? The answer depends entirely on which mathematical language you use to ask the question.

In the languages of geometric series and Lebesgue measure, the technique is fragile. It is merely a paradox of limits and a set of measure zero ($m(Z) = 0$) that can be surrounded and rendered negligible, just as Mahoraga accomplished through adaptation. However, under the lens of Riemannian geometry, Infinity becomes a formidable defence that exponentially distorts the metric space itself. Finally, topology reveals that even such a robust structure can fall if one severs the continuity of the space that supports it, exactly as Sukuna's World Cutting Slash did.

Of course, applying pure mathematics to a fictional universe has its inherent limitations. In Jujutsu Kaisen, variables like 'Cursed Energy' and authorial intent do not obey the strict axioms of real analysis. The RIKEN model is a brilliant translation of the manga's logic, but it still tries to cage magic inside an equation. No matter how beautiful the geometry, math simply cannot map the unpredictable nature of cursed energy.

Yet, this does not diminish the brilliance of the technique. Gojo Satoru built his ultimate defence on what sounded like a simple division of space. It took four of the deepest ideas in modern mathematics, such as convergence, measure, metric geometry, and topology, to fully understand why it stood, and ultimately, why it could fall. That, in the end, is what mathematics does best. It does not just calculate, but it illuminates.

References

[1] R. G. Bartle, *The Elements of Integration and Lebesgue Measure*, John Wiley & Sons, 1996, p. 19.

[2] R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 4th ed., John Wiley & Sons, 2011, pp. 94–101.

[3] J. M. Lee, *Introduction to Riemannian Manifolds*, 2nd ed., Springer, 2018.

[4] J. R. Munkres, *Topology*, 2nd ed., Prentice Hall, 2000.

[5] Jujutsu Kaisen Wiki, *Satoru Gojo*, `https://jujutsu-kaisen.fandom.com/wiki/Satoru_Gojo`, retrieved March 2026.

[6] Jujutsu Kaisen Wiki, *Limitless*, `https://jujutsu-kaisen.fandom.com/wiki/Limitless`, retrieved March 2026.

[7] Jujutsu Kaisen Wiki, *Eight-Handled Sword Divergent Sila Divine General Mahoraga*, `https://jujutsu-kaisen.fandom.com/wiki/Eight-Handled_Sword_Divergent_Sila_Divine_General_Mahoraga`, retrieved March 2026.

[8] Jujutsu Kaisen Wiki, *Ryomen Sukuna*, `https://jujutsu-kaisen.fandom.com/wiki/Sukuna`, retrieved March 2026.

[9] Tempenensis, *Jujutsu Kaisen: Abyss of Math Course, Part 2* (translation of Jump GIGA Summer 2021, Shueisha), `https://tempenensis.tumblr.com/post/658588987455422464`, retrieved March 2026.