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# INFINITY

Finite Attempts to Capture The Infinite

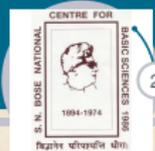
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***“It is incumbent on the person who specializes in physics to discuss the infinite. And to inquire whether there is such a thing or not, and, if there is, what it is. ”***

Aristotle, Physics III, 202b34

# Plan of Talk



2

## Introduction

### A Few Paradoxes

The Dichotomy ( Zeno of Elea (c. 450 BC ) )

Galileo's Paradox

Halley / Olber's Paradox

### Infinity in Modern Physics

Infinite Divisibility of Space

Infinite Extension of Space

Dante's Universe

## Conclusion

## References and Bibliography

# Introduction



- ▶ The first recorded use of word “Infinite” is credited to Anaximander ( pre-Socratic Greek philosopher ).
- ▶ His term “*apeiron*” can be translated as - limitless, boundless, indefinite, infinite.
- ▶ In 1655, the Oxford mathematician John Wallis <sup>1</sup> first wrote down the ‘lazy eight’ symbol for Infinite -  $\infty$

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<sup>1</sup>Famous for writing codes for both sides in the English Civil war.

# Zeno of Elea



Figure: Zeno of Elea (c. 490-430 BC)

# The Dichotomy

The Dichotomy paradox was put forward to show that motion is just an 'illusion'.

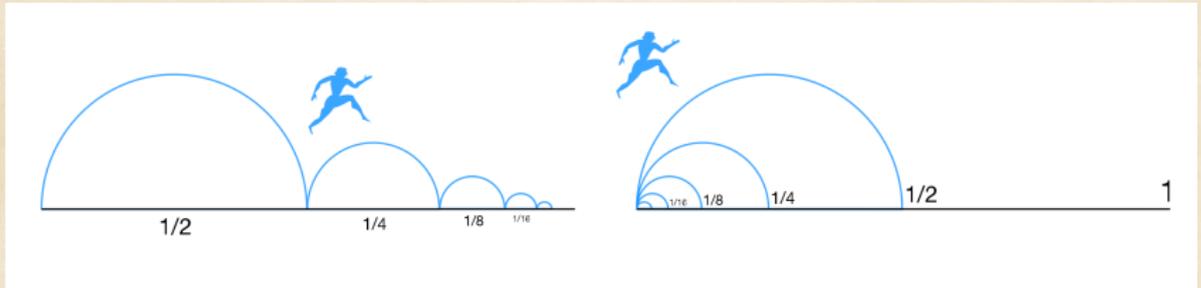


Figure: The Dichotomy

Because Zeno rejected the Infinite, he concluded that motion is not possible.

# Galileo Galilei

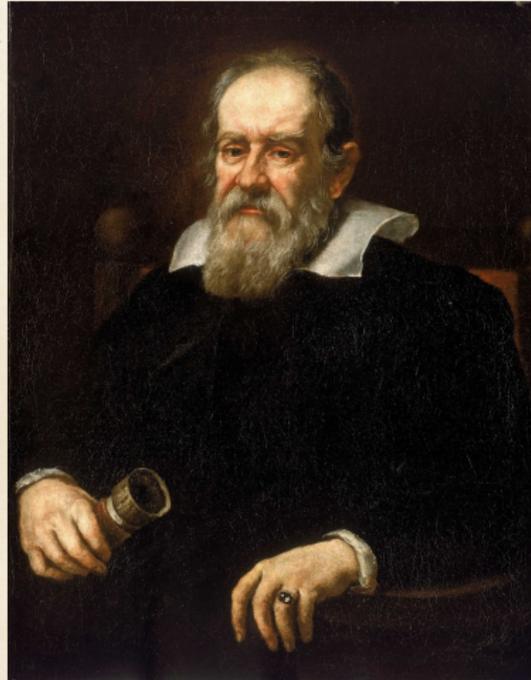


Figure: Galileo Galilei (1564-1642)

# Galileo's Paradox



- ▶ Put the set of integers in one-to-one correspondence with the set of square of integers.
- ▶ Galileo asked, which list is bigger?
- ▶ Because set of squares is already subset of set of integers, does infinity come in different sizes?
- ▶ Galileo never resolved this paradox. He only concluded -  
“We cannot speak of infinite quantities as being the one greater or less than or equal to another.”

# Sir Edmund Halley



Figure: Sir Edmund Halley (1656-1736)

# Halley / Olber's Paradox

- ▶ Another interesting paradox arises if one considers an infinite Universe.
- ▶ Sir Edmund Halley realized that a Universe containing infinite number of stars should shine like the surface of a star, day or night. But It Doesn't!



**Figure:** Looking into the woods. Everywhere your line of sight ends on a tree trunk.

# Infinite Divisibility of Space

Quanta of Space



10

- ▶ Two most powerful theories of 20<sup>th</sup> century are General Relativity and Quantum Theory.
- ▶ If we rely on these theories, taken together, we are forced to accept that space is not infinitely divisible. **Space itself can be thought of as an ensemble of *atoms of space*.**
- ▶ Notice that Zeno's Dichotomy paradox is resolved if space is not infinitely divisible.
- ▶ There is no necessarily infinite toward the small.<sup>2</sup>

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<sup>2</sup>Carlo Rovelli

# Infinite Extension of Space

Is Universe Infinite?



11

- ▶ Archytas of Tarentum was a 5<sup>th</sup> century Greek thinker.
- ▶ Archytas claimed that the Universe must be infinitely extended because of the following:  
“If I arrived at the outermost edge of the heaven, could I extend my hand or staff into what is outside or not? It would be paradoxical not to be able to extend it.”
- ▶ Aristotle considered this argument to be “most important” reason why people believe in the existence of the infinite.

# Dante Alighieri



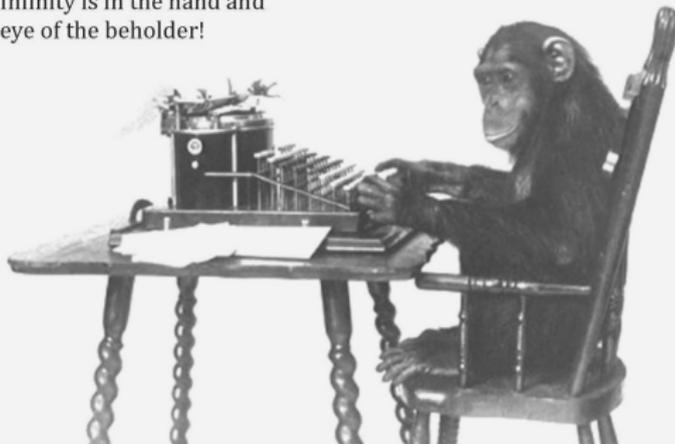
Figure: Dante Alighieri (1265-1321)



We don't really know what infinity is, but there are strong reasons to believe that physical infinities are less likely.

## The Infinite Monkey Theorem

Infinity is in the hand and  
eye of the beholder!



# References and Bibliography



15

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**Thank you!**