

*Leibniz's Space – Time Theory*  
*An Introduction*

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## *Lee Smolin, Time Reborn*

Leibniz had a vision of a world in which everything lies not in space but immersed in a network of relationships. These relationships define space, not the reverse. Today the idea of a universe of connected, networked entities pervades modern physics, as well as biology and computer science.

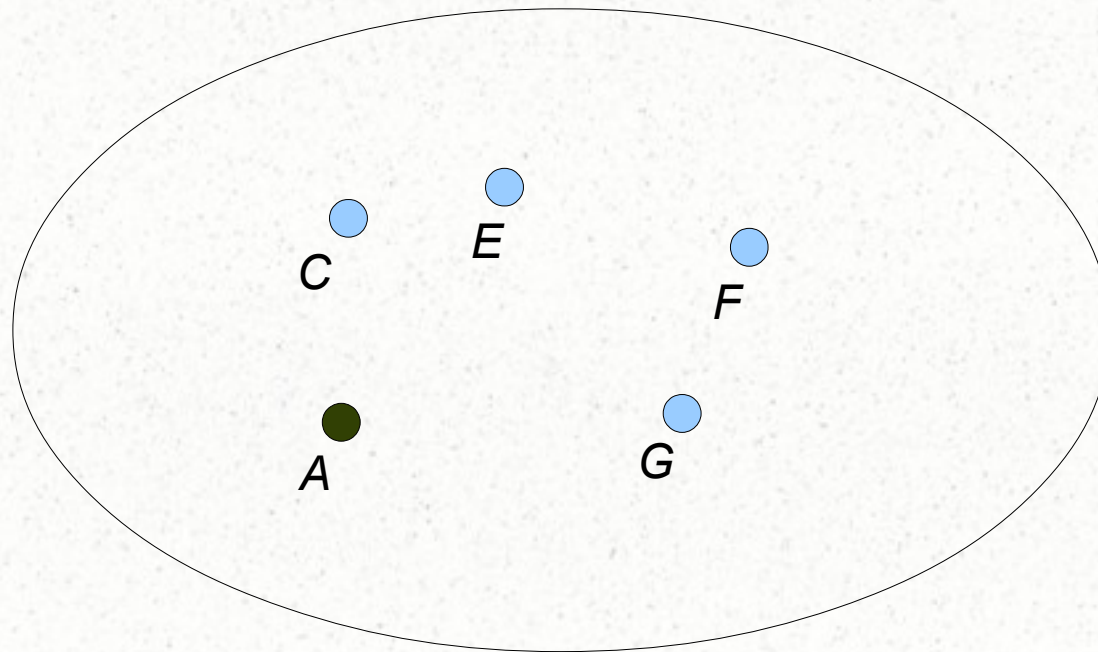
## *Four Topics*

- Quantity and order as the main characteristics of space and time.
- The philosophical roots of Leibniz's space and time concept.
- Space and time in physics and metaphysics – two examples.
- Closing remarks

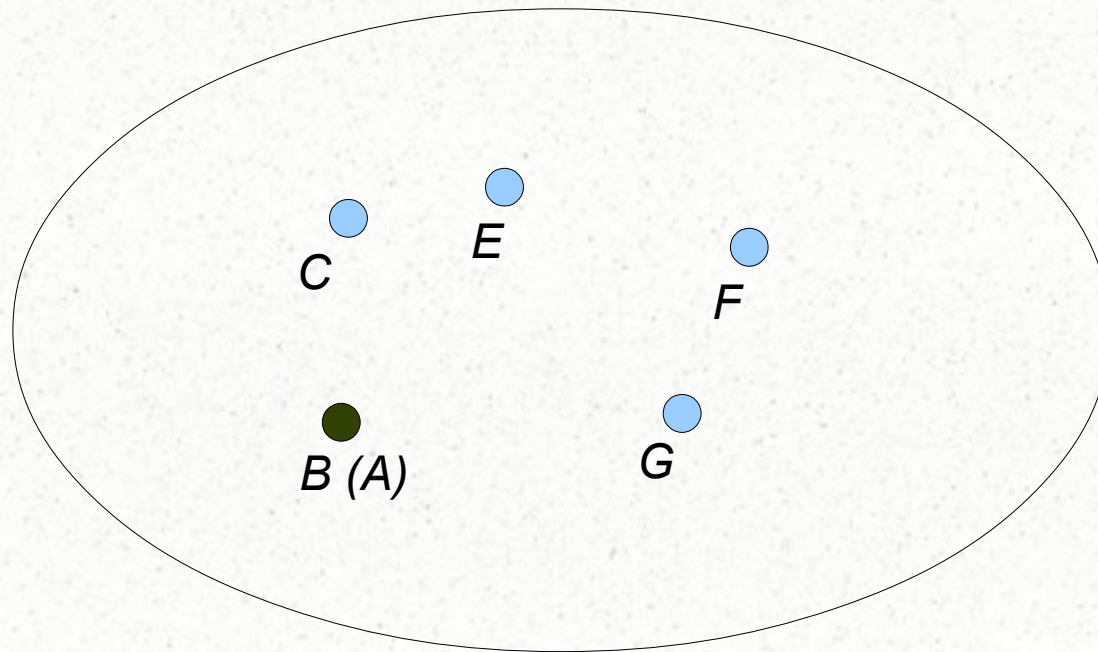
## *How to introduce Space and Time*

- Experiences in everyday life.
- Measurements with clocks and rulers.
- The difference between distance and space.
- Reality and ideality of space and time.
- Leibniz on place, situation, and space.
- The difference between quantity and order of space and time.

# *Leibniz's Fifth Letter to Clarke*



# *Leibniz's Fifth Letter to Clarke*



Motion:  $B \rightarrow A$

Place:  $B = A$

Situation:  $B \neq A$

## *Some Definitions*

- *Place* is that which we say the same to *A* and *B* when the relation to coexisting things remains unchanged.
- *Space* is that which results from places taken together.
- *Situation* is a relation which is in the body that fills up the place.
- Space as a *quantity* results from the totality of places.
- Space as an *order* results from the totality of situations.

## *A first Summary*

- Quantity results from the reduction of situations to places.
- Each place in space is equivalent to each other, and each situation differs from each other situation.
- Quantity and order are two different aspects of space and time that reflect the difference between physics and metaphysics in Leibniz.



## *Leibniz's Fifth Letter to Clarke*

I answer that order also has its quantity; there is in it that which goes before and that which follows; there is distance or interval. Relative things have their quantity as well as absolute ones. For instance, ratios or proportions in mathematics have their quantity and are measured by logarithms, and yet they are relations. And therefore, though time and space consist in relations, yet they have their quantity. (N. 54)

## *G.W. Leibniz, The Monadology*

§ 1: The *monad* which we are to discuss here is nothing but a simple substance which enters into compounds. *Simple* means without parts.

§ 2: There must be simple substances, since there are compounds, for the compounded is but a collection or an *aggregate* of simples.

§ 3: But where there are no parts, it is impossible to have either extension, or figure, or divisibility. The monads are the true atoms of nature; in a word, they are the elements of things.

## *G.W. Leibniz, The Monadology*

§ 9: It is even necessary for each monad to be different from every other. For there are never two things in nature which are perfectly alike and in which it is impossible to find a difference that is internal or founded on an intrinsic denomination.

§ 14: The passing state which enfolds and represents a multitude in unity or in the simple substance is merely what is called *perception*.

§ 15: The action of the internal principle which brings about change or the passage from one perception to another can be told *appetition*.

## *G.W. Leibniz, The Monadology*

§ 22: Since every present state of a simple substance is a natural consequence of its preceding state, in such a way that the present is great with the future [...].

§ 61: In this respect compound beings are in symbolic agreement with the simple.

§ 72: Neither are there entirely *separated* souls or higher spirits [*genies*] without bodies. God alone is entirely detached from body.

## *A second Summary*

- The order of space and time in Leibniz results from the activity of monads.
- Each point in space is an individual point and each moment in time is an individual moment.
- Quantity and order are related to one another. There is no order without quantity because there is no monad without a body.
- Space, time and matter depend on one another.
- Space and time are imaginary entities.

## *Epistemological Consequences*

- Monadology, § 79: Souls act according to the laws of final causes through their appetitions, ends, and means. Bodies act according to the laws of efficient causes or the laws of motion. And the two kingdoms, that of efficient and that of final causes, are in harmony with each other.
- The view from inside.
- The view from outside.

## *Leibniz's Fifth Letter to Clarke*

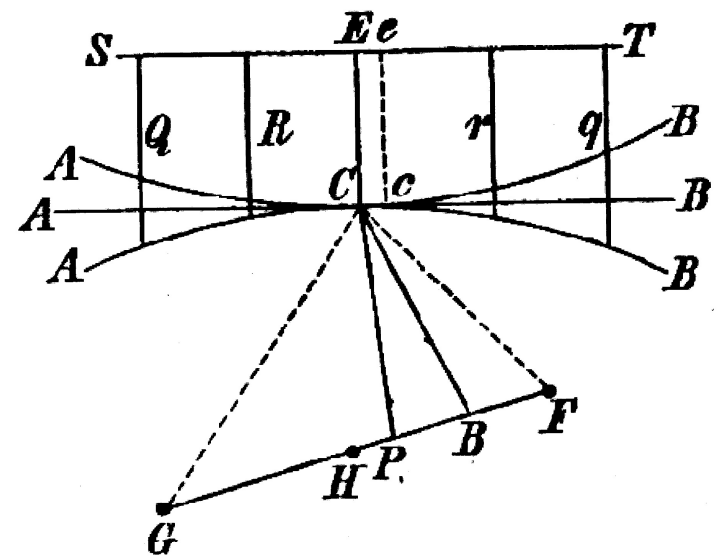
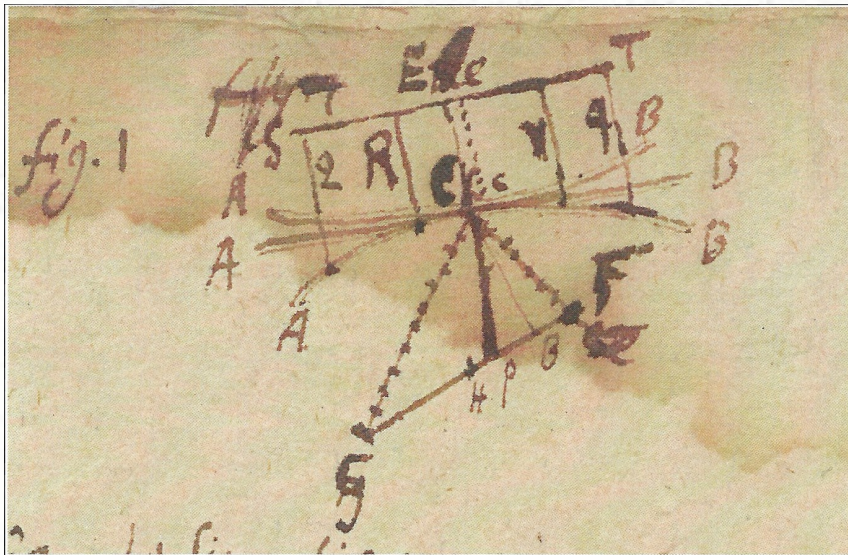
- There would happen no change which could be observed by any person whatsoever [in a finite empty space]. There are imaginations of philosophers who have incomplete notions, who make space an absolute reality. (N. 29)
- I answer, motion does not indeed depend upon being observed, but it does depend upon being possible to be observed. (N. 9)

## *Tentamen anagogicum*

For the way in which Descartes has tried to explain the law of refraction by efficient causes or by the composition of directions in imitation of the reflection of bullets is extremely forced and not intelligible enough. To say no more about it here, it shows clearly that it is an afterthought adjust somehow to the conclusion and was not discovered by the method he gives.



# *Tentamen anagoricum*



## *Tentamen anagogicum*

For given a curve  $AB$  concave or convex and an axis  $ST$  to which the ordinates of the curve are referred; then it is seen that each ordinate, like  $Q$  or  $R$ , there corresponds another one equal to it, its twin,  $q$  or  $r$ . But there is one particular ordinate  $EC$  which is unique, or the only determinate one of its magnitude, and has no twin, since the two twins  $EC$  and  $ec$  coincide in it and make but one.

## *A third Summary*

- Quantity and order are necessary for a physical explanation.
- The order of space and time follows the principle of the most determination (maxime determinatum), which guaranties the existence of a unique path.
- Space and time determine a light ray in such a way that it follows the most determined path.

## *Immanuel Kant, Critique of Pure Reason*

- Empirical reality and transcendental ideality as quantity and order in Leibniz.
- The constitution of the object of knowledge in space and time. (Leibniz's 5<sup>th</sup> letter to Clarke, N. 29 and N. 9.)
- The subject of knowledge as an historical one, i.e. as a subject that constitutes itself in time. (See the constitution of the monad by its internal principle.)