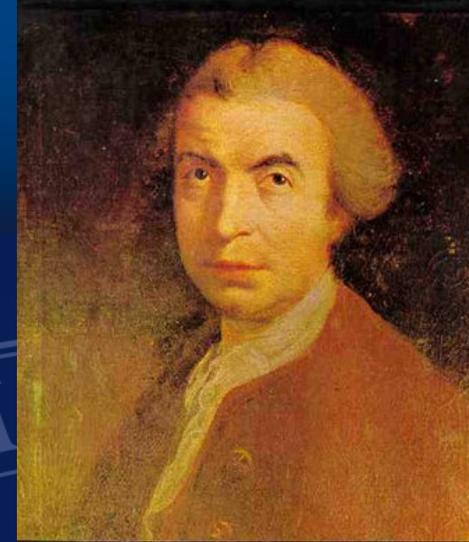




UNIVERSITÀ DEGLI STUDI
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Boscovich and Leibniz: A reappraisal



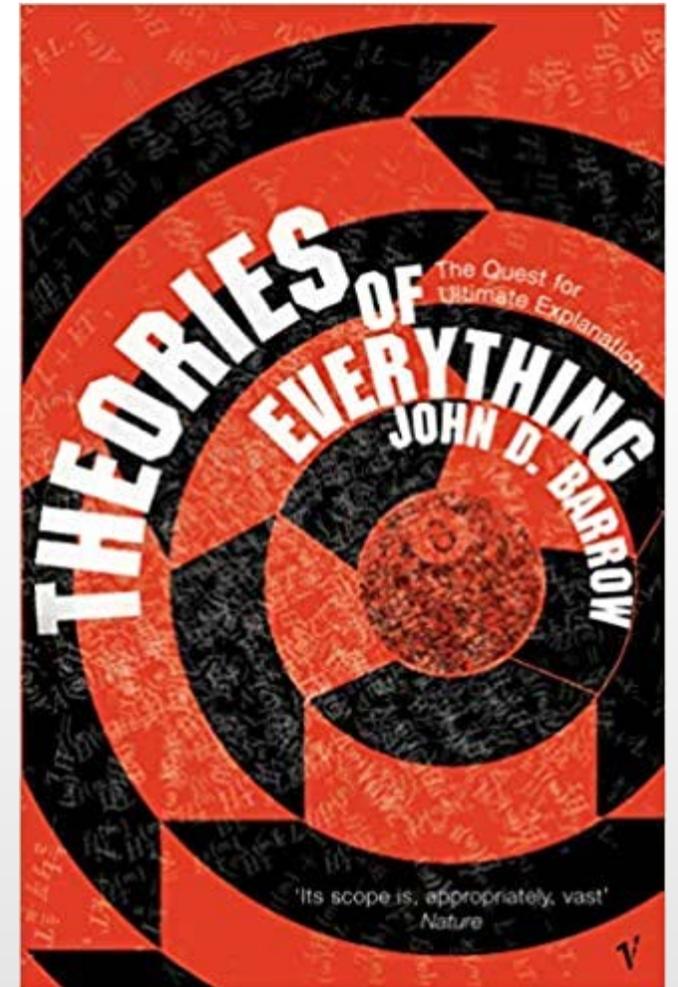
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Who's who - R.J. Boscovich (1711-1787)

One of the most remarkable and neglected figures in the history of modern European science was Roger Boscovich. A Dalmatian Jesuit, at once a poet and architectural advisor to Popes, cosmopolitan diplomat and man of affairs, socialite and theologian, confidant of governments and Fellow of the Royal Society, but most of all a mathematician and scientist, Boscovich was a passionate Newtonian who was the first to have a scientific vision of a Theory of Everything. His most famous work, the *Theoria Philosophiae Naturalis*, was first published in Vienna in 1758 [and a so-called "Venetian edition" followed in 1763].

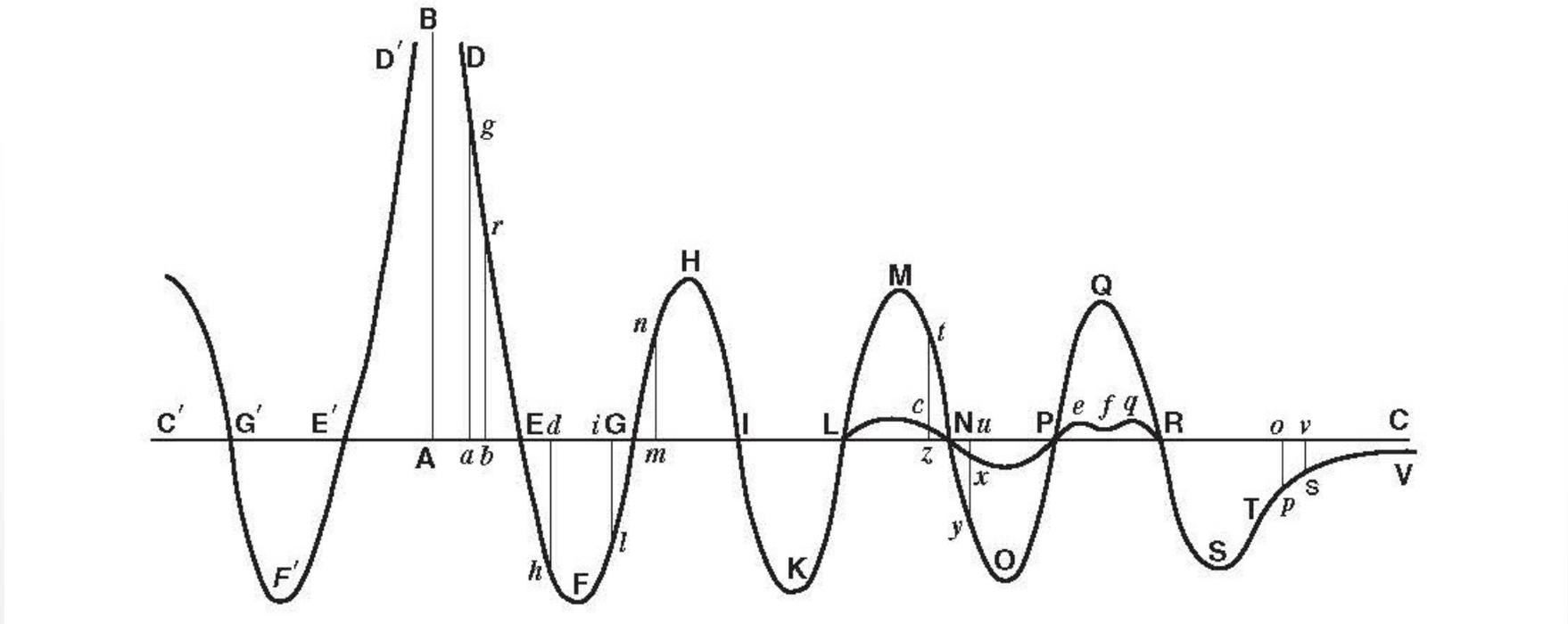
Boscovich proposed a grand unified force law which included all known physical effects. This was his 'Theory', as he called it. It approached the inverse-square law of Newtonian gravitation at large distances ... but on smaller length scales, it is alternately attractive and repulsive and so gives rise to equilibrium structures whose sizes are dictated by the characteristic length scales built into the force law.

(J.D. Barrow, *New Theories of Everything*, p.20)



Boscovich's theory (1758/1763)

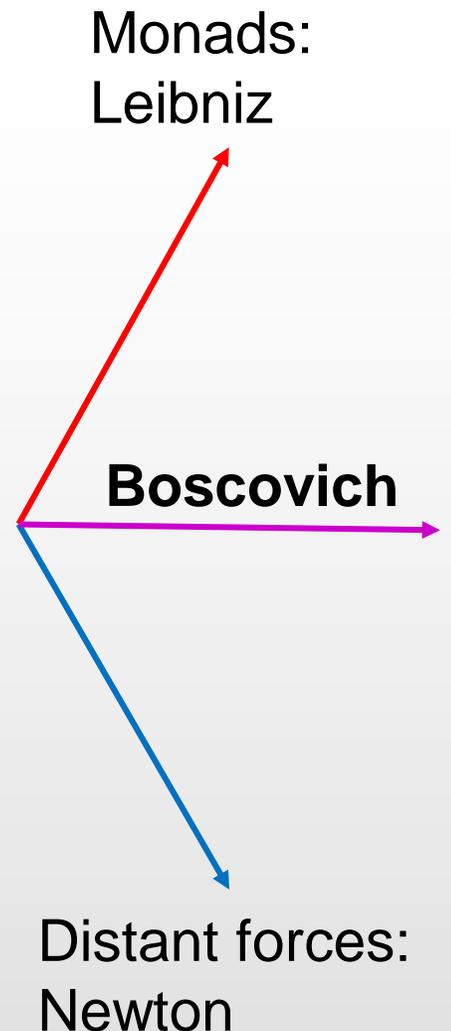
- The law:



- The curve expresses a force F acting between any couple of "points of matter" (distance is on x -axis).
- F is conceived as a continuous function of the distance, so that at each distance there is only one force value possible; if distance is only slightly varied, then force is also varied.
- Repulsion and attraction are not different forces but different phenomenal manifestations of a unique F .
- F is repulsive when the curve is above the x -axis and attractive when this is under it. Moreover, it is infinitely repulsive when the distance is infinitely small (ED grows asymptotically), and infinitely small when the distance grows infinitely. In between, force is alternatively repulsive and attractive.

An intermediate system

- Boscovich's opening of the *Theoria* (§ 1):
 - "The following theory of mutual forces ... presents a system that is midway between that of Leibniz and that of Newton [*systema exhibet medium inter Leibnitianum et Newtonianum*]; it has very much in common with both, and differs very much from either."
- Some details of this sense of being halfway:
 - "It indeed holds to those simple and perfectly **non-extended primary elements** upon which is founded the **theory of Leibniz [*Leibnitii theoria*]**; and also to the **mutual forces varying as the mutual distances of the points vary**, the characteristic of the **Newtonian system [*Newtoniano systemate*]**... It considers forces of a kind that engender recession, and are called repulsions. Further, the idea is introduced in such a manner that, **where attraction ends, there, with a change of distance, repulsion begins**; this idea, as a matter of fact, was suggested by Newton in the last [26/31] of his Queries to the *Optics*."
(§ 2)
- Boscovich also gives examples of the differences of his theory with Newton's and Leibniz's.



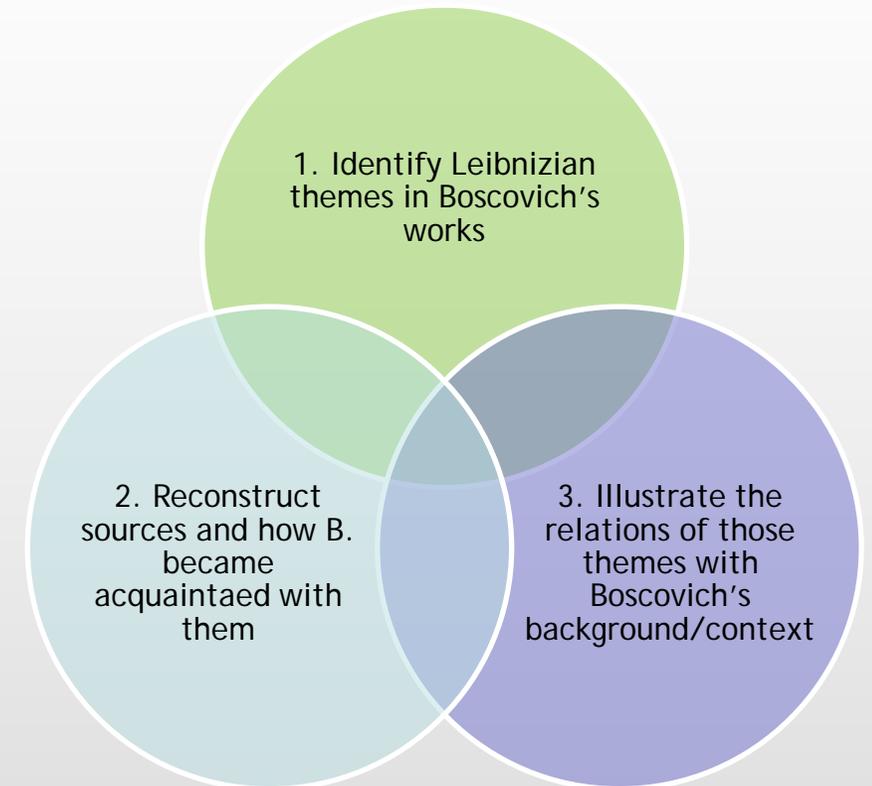
Scholarship on the Boscovich-«Newton & Leibniz» connection

- The asserted similarities are somewhat generic, and many scholars have emphasized this claim in various ways.
- Some examples:
 - “The reconciliation of the two adversaries [Newton and Leibniz] now becomes the scientific parole of the [18th century] ... The balance between the demands of the thought and those of experience ... seems now feasible only by virtue of a general natural philosophy ... The most important work in the field of natural philosophy of this time, Boscovich’s *Theoria philosophiae naturalis* [1763], expresses the distinctive manifestation of such twofold tendency.” (E. Cassirer, *Theory of Knowledge*, II, 426-427.)
 - “Boscovich derives his metaphysical principles from Leibniz, but integrates them with Newtonian physics.” He claims that “matter consists of identical points of no extent, having no essential properties except inertia and the capacity of exerting forces on one another ... depending on their mutual distances” and, on the other hand, that such “**point centers of force are spatial versions of Leibniz’s monads**” (M. Hesse, *Forces and Fields*, p. 164.)
 - “**Newtonian physics, together with Leibnizian monadology**, formed the basis also of a different school of thought, perhaps best characterized by R.J. Boscovich, for whom force was the ultimate element of reality.” (M. Jammer, *Concepts of force*, p. 148)
 - To these classics we should add scholars like L.L. Whyte, R. Schofield, A. Thackray, G. Gale, M. Grmek, M. Friedman, and certainly many others who did valuable, influential work

Paper's aims

- Looking at the texts more precisely and within the complex of Boscovich's works in natural philosophy may bring to reconsider Boscovich's «midway» and his relation to both Newton and Leibniz.
 - I do not claim that the previous parallels are mistaken, but we need something more founded in Boscovich's texts
 - We do have fine-grained reconstructions of Boscovich's ties with the Newtonian tradition...
 - But we do not have anything similar regarding Boscovich and Leibniz - we only have conceptual convergences, which can be inspiring but also misleading if this is not accompanied with source-based work

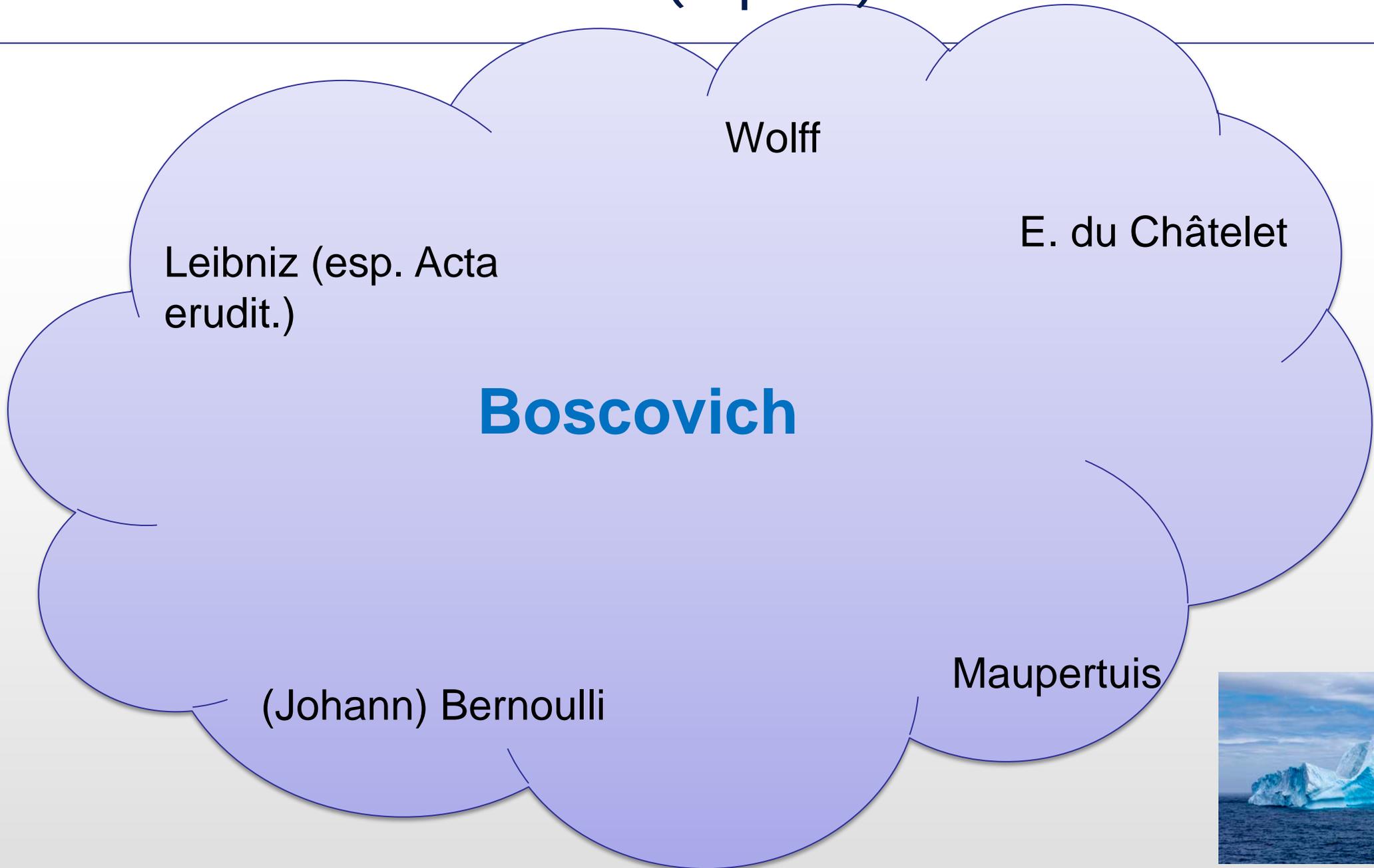
An ideal paper of this kind should, more or less:



1. Identifying Leibnizian themes: some provisional result

- Fundamental issues (contexts in which Leibniz and «Leibnizians» are often cited):
 - *Vis viva* and the notion of force (*De viribus vivis*, 1745)
 - Monads as «unextended» entities grounding extension (*De materiae divisibilitate*, 1748/1757)
 - The concept of continuity (*De continuitatis lege*, 1754)
 - All of them are reconsidered in the *Theoria philosophiae naturalis* (1758/1763)
- Other issues:
 - pre-established harmony (Boscovich 1754, § 23; Boscovich 1755b, 13 note *a*, and 279)
 - principle of sufficient reason (Boscovich 1754, §§ 125-130; Boscovich 1755b, 14-15 note *b*, and 279-283; see also Boscovich 1755b)
 - Ascribes to Descartes and Leibniz a relational notion of space (Supplement “De spatio ac tempore”: Boscovich 1763, Suppl. I,2). However, as argued by Baldini (1992a, 35-40), Boscovich’s notion of space has its origins in the Jesuit tradition and is largely independent from that of Leibniz
 - Leibniz’s contributions to mathematics, in particular to the Calculus
 - Leibnizian tradition and the distinction between complete and incomplete induction (discussed, with reference to Wolff, in Boscovich 1754, § 134-135; Boscovich 1755b, 46 footnote *a*, and 301-302)

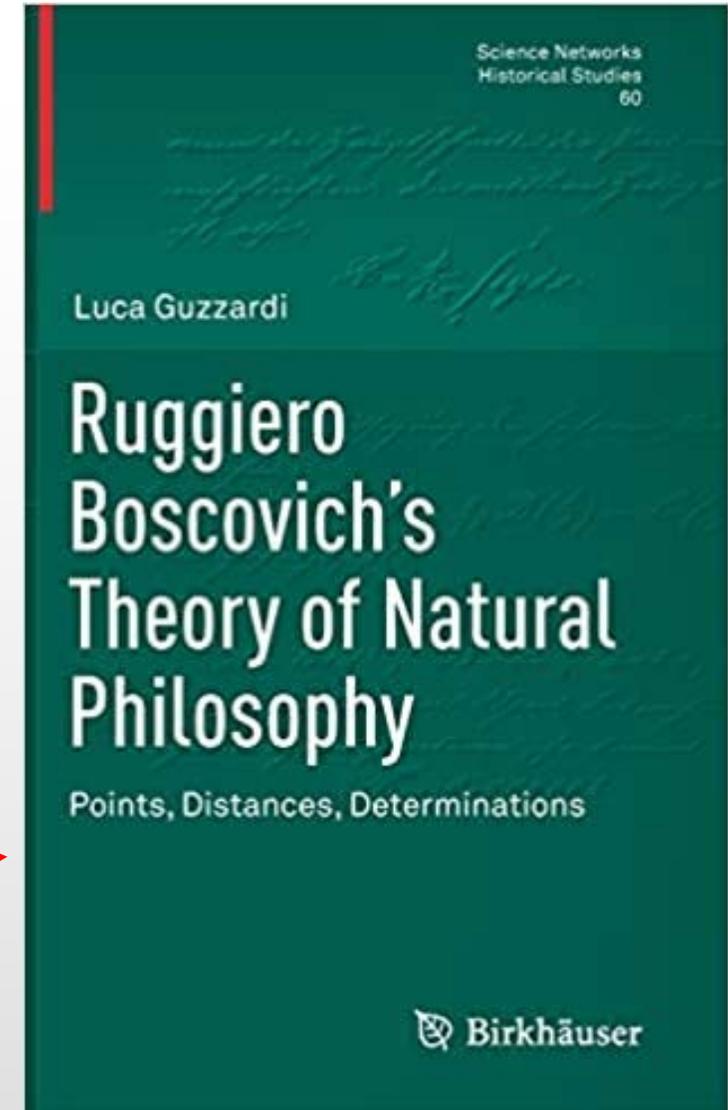
2. Boscovich's sources: the (explicit) Leibnizian cloud



Boscovich's reception of Leibnitian themes

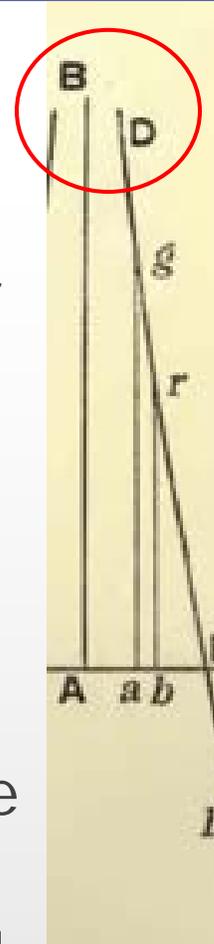
- Fundamental issues:
 - *Vis viva* and the notion of force (*De viribus vivis*, 1745)
 - ☺ Essentially against the notion of living force, that he finds somewhat «metaphysical» (not grounded in the physical phenomena). Of course he «instrumentally» uses mv^2 , but he does not consider it a special notion (there are only «dead forces»)
 - (*De viribus vivis* is the «dissertation» where Boscovich first introduces his law of forces!)
 - Leibnizian monads as «unextended» entities for grounding extension (*De materiae divisibilitate*, 1748/1757)
 - ☹ Rejects, as it is interpreted as a form of «Zenonism»
 - The concept of continuity (*De continuitatis lege*, 1754)
 - ☺ Approves and tries to reformulate

Chap. 5



3. Boscovich's context

- Boscovich first presented the «law of forces» in 1745
- It raised some concerns within the Society of Jesus: did it endorse some form of (unacceptable) atomism or the idea that extension arise from unextended entities?
- Somebody wrote a letter to Boscovich asking him to reflect on the structure of matter
- Boscovich's answer was a manuscript «On the divisibility of matter» (1748)
 - The manuscript is lost, we only have the published abridged version *De materiae divisibilitate* (1757)
 - As reconstructed through the correspondence, the original ms probably was the very first version of his *Theoria philosophiae naturalis*.



First repulsive branch of Boscovich's law of forces:

- Repulsion grows asymptotically as distances between bodies diminish infinitely
- This applies at every size, even with particles forming bodies, and within them
- We can subdivide bodies through and through; we shall reach a void distance between couples of points
- So there is no contact between «points» forming bodies; they are structures of points standing at a distance caused by repulsion
- **Extension arises from unextended entities**

3. Boscovich's context

- Similar questions were debated at the Collegium Romanum by the mid of 1600:
- **Is it possible to compose a continuum out of unextended entities (such as points)?**
 - The idea was unorthodox but inspired some Jesuits (Juan de Lugo, Sforza Pallavicino...). They were called «the Zenonists».
 - Mainstream Jesuit philosophy rejected this through Aristotle's doctrine of continuity: a continuum cannot be composed of points, since points are common boundaries which are obtained when something is divided into parts.
 - Zenonist doctrines were listed as "propositions not to be taught in the Jesuit schools" (1650-51)
 - There seems to be an influence of Zenonism on Leibniz (P. Beeley, *Kontinuität und Mechanismus. Zur Philosophie des jungen Leibniz in ihrem ideengeschichtlichen Kontext*, 1996)
- Boscovich on points and Zenonism:
 - "[Points of matter] are completely unsuitable for composing a continuous quantity. To this conclusion, I am brought from the very notion of point as well as of the continuous extension ... It is evident from here how much this kind of points differs from the Zenonistic. They are indeed regarded as unextended and contiguous one another so that they build extension. [Zenonists' points] are proved to be completely impossible through mathematical demonstrations." (Boscovich 1748/1757, § 12)
- Boscovich's "material points" reflect this debate much more than Leibniz

3. Boscovich's context

- Boscovich looks at Leibniz through his (anti)Zenonist glasses:
 - In *De materiae divisibilitate* (§ 12) the Leibnizians are charged to maintain that “monads are unextended, but in such a manner that they ... compose an extended continuous quantity”; therefore, they fall “into the same absurdities in which Zeno's points also fell.”
 - In the *Theoria* (1763, § 139) Boscovich reports a passage of *De materiae divisibilitate*: “If [monads] are both by nature impenetrable and at the same time have to make up a continuum (i.e., they have to be contiguous), this leads to an absurdity and proves the impossibility of entities of this sort. For, from the idea of non-extension of any sort, and of contiguity, it is proved by an argument instituted against the Zenonists many centuries ago and this argument has never been satisfactorily answered.”

Towards an understanding of Boscovich's Leibnizian legacy

- Many things are not clear in these passages, but one *is*: for Boscovich, Leibnitians were an updated form of Zenonists.
 - It was Zenonism that influenced Boscovich's reading of Leibniz
- Moreover, according to Boscovich, both Leibnitians and Zenonists were mistaken about the role of unextended entities in composing matter.
 - Boscovich might be mistaken about Leibniz's monads, but to be sure they did not inspire his conception of "material points" as the primary constituents of matter.
- If this is right, assertions like those by Hesse, Jammer, etc. should be revisioned:
 - It is difficult to maintain, with Hesse, that "point centers of force are spatial versions of Leibniz's monads"; or, with Jammer, that "Newtonian physics, together with Leibnizian monadology, formed the basis" of Boscovich's theory.
- **Of course, even my story is just half of the story. I did not touch the question of how Boscovich knew about Leibniz's monads, and this is still open.**

Towards an understanding of Boscovich's Leibnizian legacy

- Boscovich's "being at midway" between Newton and Leibniz of course signals convergences with both...
- But we must always take into account Boscovich's Jesuit legacy, and this is particularly evident with Leibniz.
- It was a mix of elements from originally Jesuit doctrines plus mathematics that shaped his reception of Leibniz and Leibnitianism.
- So, we should adopt the following pattern:

Leibnitian theme → Jesuit background/context → adjustment

- This can be repeated (in positive) with the principle of continuity, that Boscovich strongly associates with Aristotle on the one hand and mathematics on the other.

Acknowledgements

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