



## 2022 CER Lunchtime Lectures - Humboldt, Science, and The Geography of Nature

### Western Culture and the Study of Nature

January – Natural Philosophy and the Study of Nature

February – Natural History and the Taxonomy of Nature

March – Ecological Imperialism and the Geography of Nature

April – Physical Geography and the Science of Nature

### Humboldt and the Science of Nature

May – The Science of Nature: Humboldt and the Empirical Earth

June – The Romance of Nature: Science, Imagination, and the Poets of Nature

July – The Invention of Modern Nature: The Earth as a “Natural Whole”

August – The Evolution of Nature: Humboldt, Darwin, and Biogeography

September – The Economy of Nature: Ecology, Culture, and Cosmos

### Humboldt and the Geography of Nature

October – The Great Disruptors: Physical Geography as Modified by Human Action

November – The Earth Managers: New Science and Environmental Change

December – The Anthropocene: Gaia and the Geography of Nature





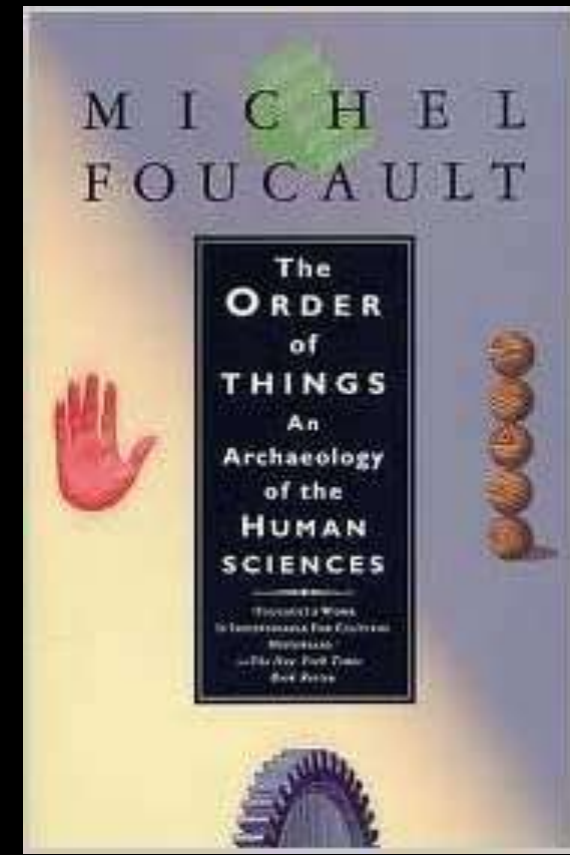
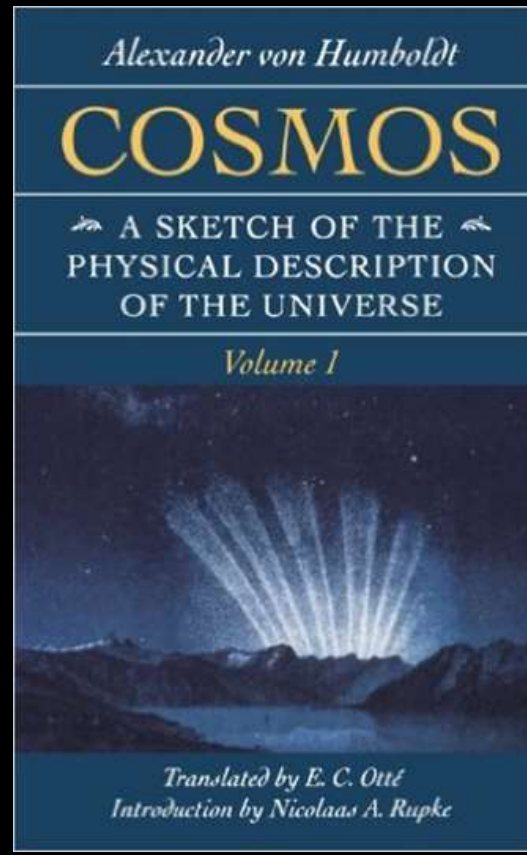
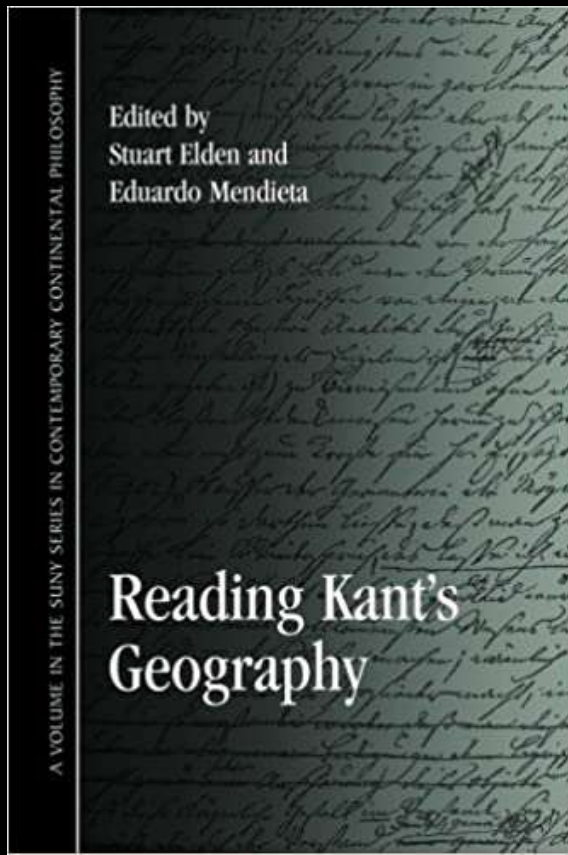
**Center for  
Environmental  
Research** at Hornsby Bend



# Physical Geography and the Science of Nature

Kevin M. Anderson, Ph.D.

Austin Water Center for Environmental Research

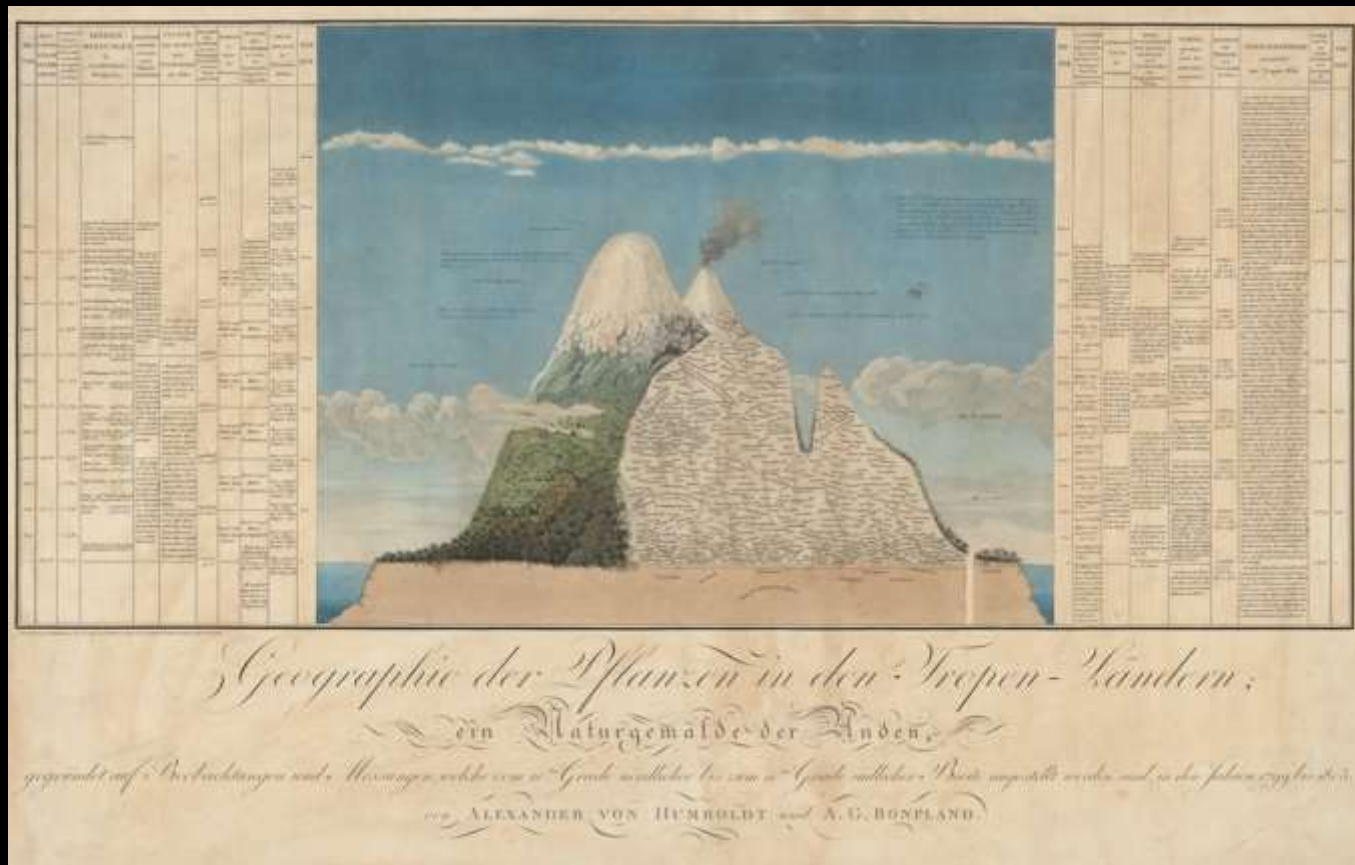
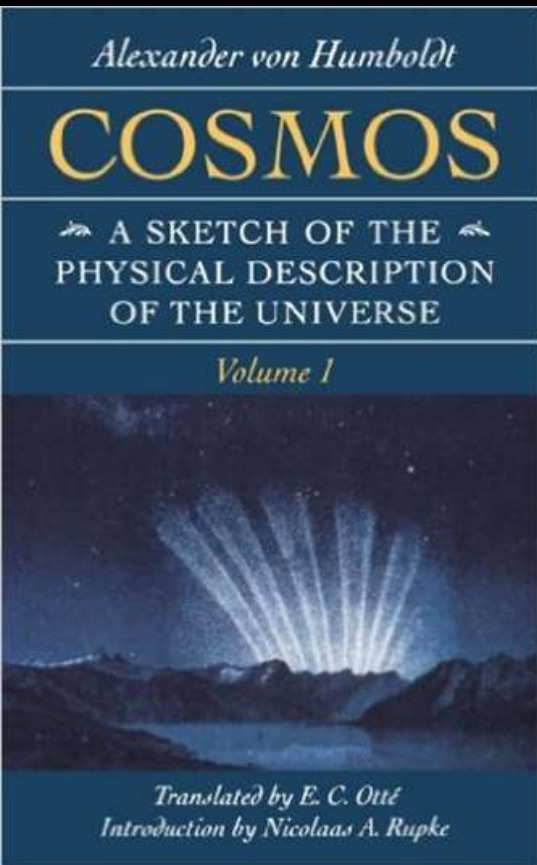


# Humboldtian Cosmos - A Vision of the Unity of Nature

The Cosmos is both ordered and beautiful.

*Unity in diversity, and of connection, resemblance, and order, among created things most dissimilar in their form, one fair harmonious whole...*

*Kosmos, 1845*





# Humboldtian Science – Geography? Earth Science?

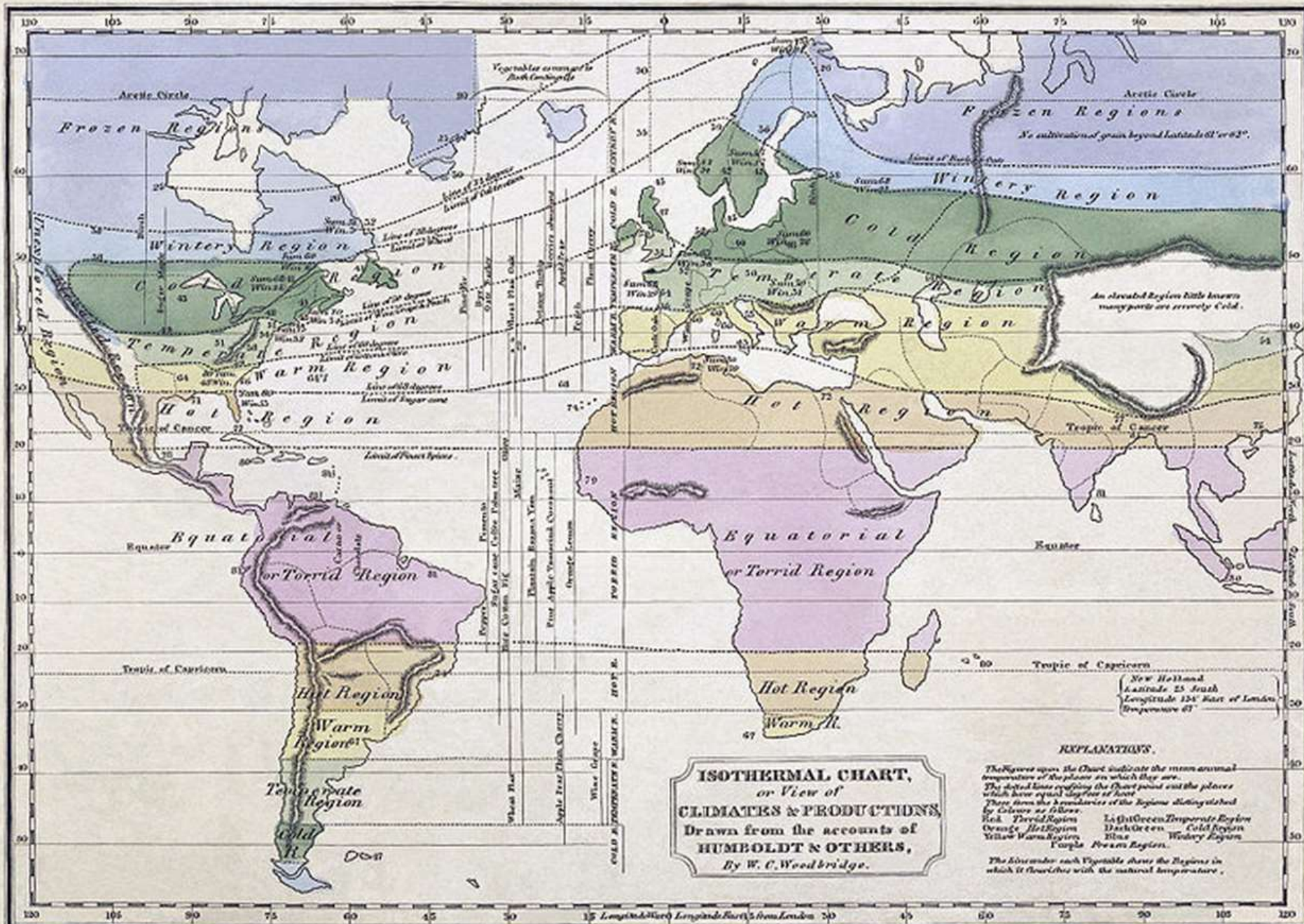
“the accurate measured study of widespread but interconnected real phenomena in order to find a definite law and a dynamic cause”

- 1. Explore – “Nature speaks and the scientist must go out and listen”
- 2. Collect – gather data for or against an idea/theory
- 3. Measure – widespread, accurate, collaborative
- 4. Connect – detect patterns that point to underlying laws
- 5. Cosmopolitan science – international collaboration





# Humboldtian Science – Order and Change



Revised according to Act of Congress the 15<sup>th</sup> day of January 1830 by William C. Woodbridge of the State of Connecticut.



# Natural History

## Aristotle → Observation and Description

- Bestiaries, Herbals
- Encyclopedias of New Nature
- Realism - Artists as Naturalists
- Scientific Revolution/Taxonomy



# The Science of Nature

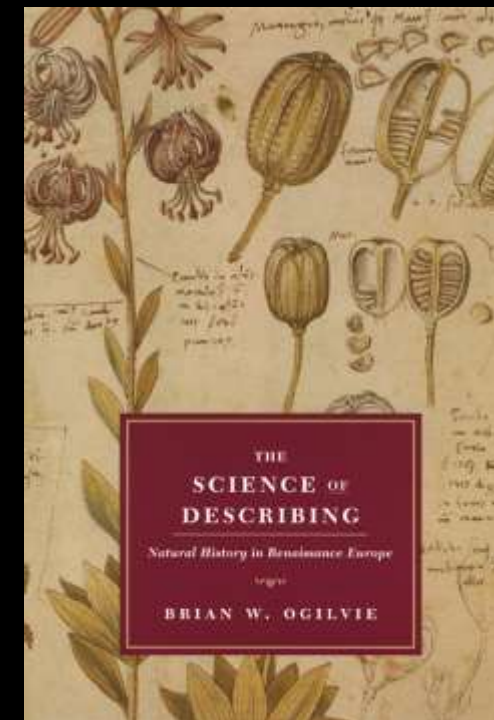
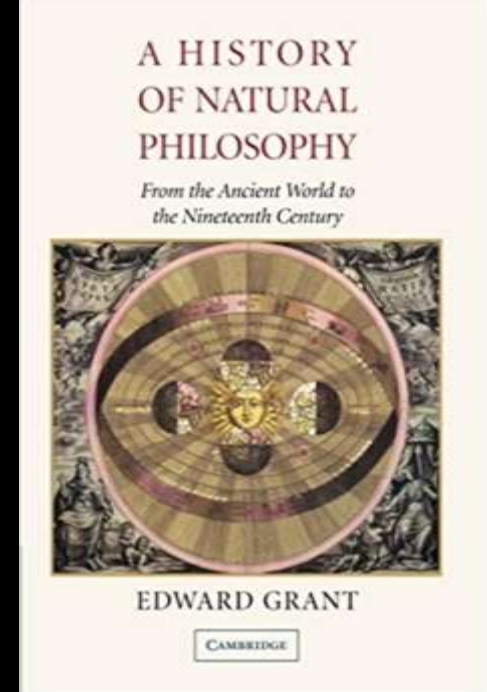
## How did empirical science emerge from Aristotle's natural philosophy?

- Aristotle → 19th century
  - Natural philosophy = the practice of studying nature  
*physis* (Greek) *natura* (Latin) - the physical universe
- The Science of Nature – The Scientific Revolution
  - From description to explanation
  - Natural Laws and the Order of Nature
  - Empirical Observation and Knowledge

What is the relationship between –

- Knowledge from experience (empirical)
- Knowledge from reason (mathematical/geometrical/logical)

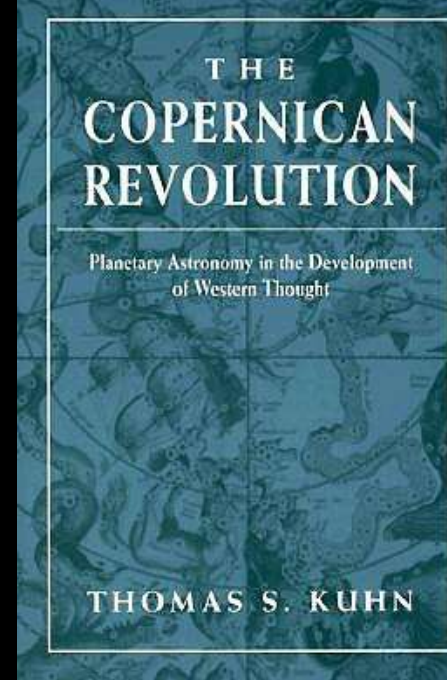
Epistemology – the study of knowledge





# The Science of Nature

## Explaining Order and Change



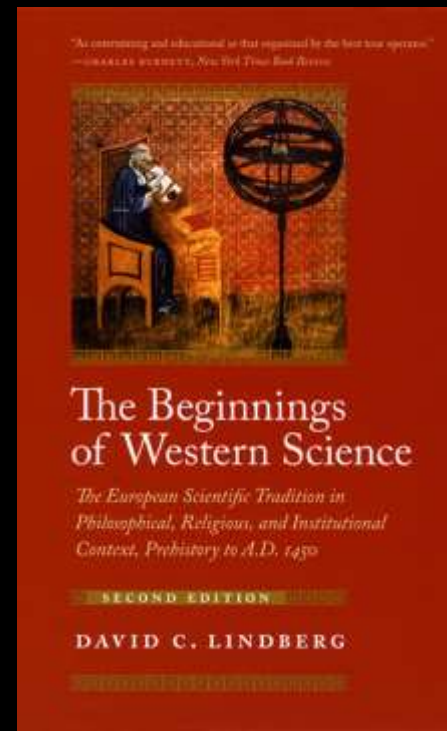
The Copernican Revolution – a new order for the universe

Nicolaus Copernicus, *On the Revolutions of the Heavenly Spheres*  
1543

The Scientific Revolution - a new way of generating knowledge  
prioritizing empirical knowledge and material causes

Francis Bacon, *New Organon, or true directions concerning the  
interpretation of nature* 1620

- “take the question to nature” and learn by direct observation and experiments
- Nature’s Laws are mathematical
- What is the relationship between experience and reason?





# The Scientific Revolution 1543-1687

(1966)

## Epistemological Revolution

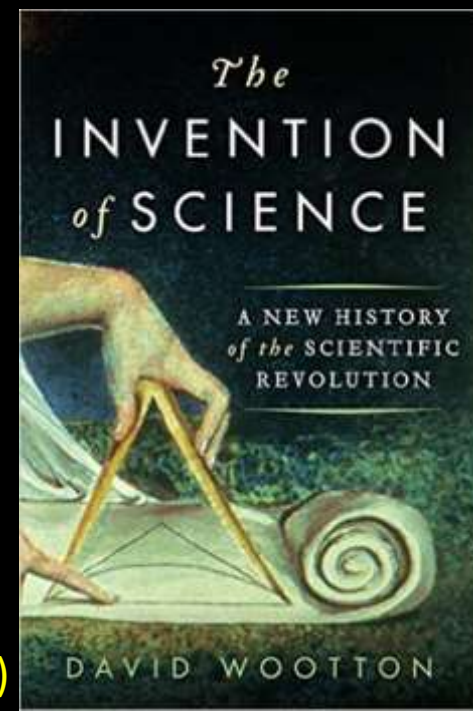
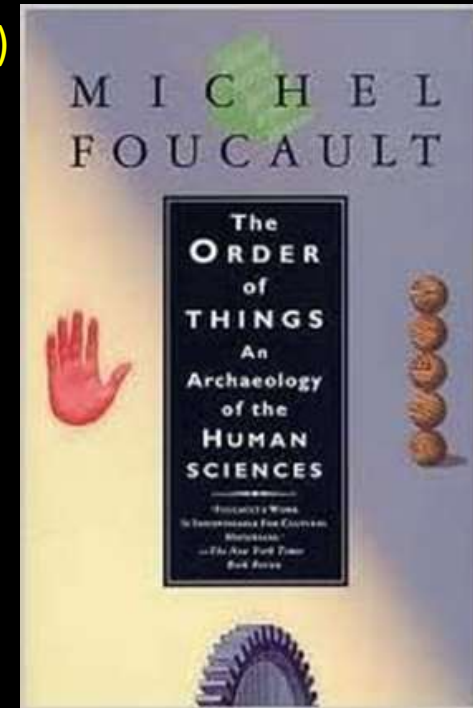
### Foucault

- All periods of history have possessed certain underlying epistemological assumptions that determined what was acceptable as truth and knowledge
- Discourse (language, how we talk about things) shapes our understanding of things and the order of things
- Epistemological assumptions have changed over time and the conditions of discourse have changed too.

### Wootton

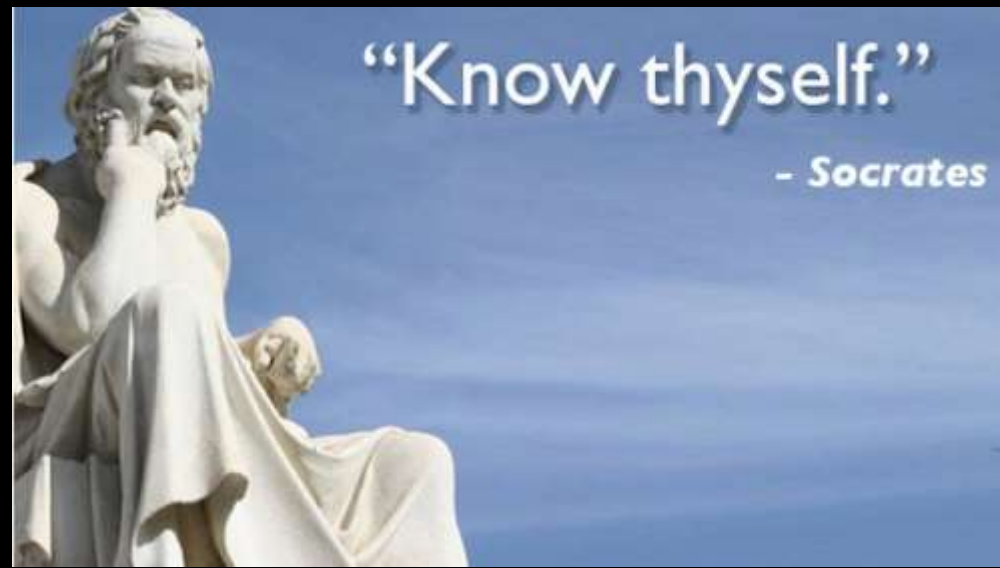
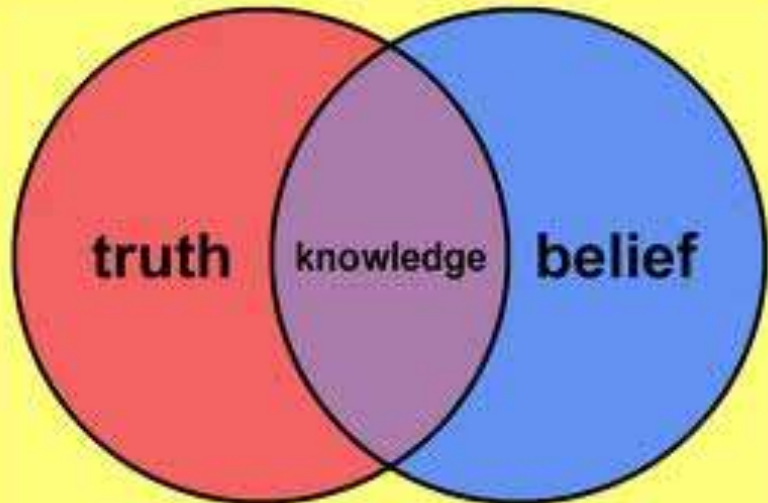
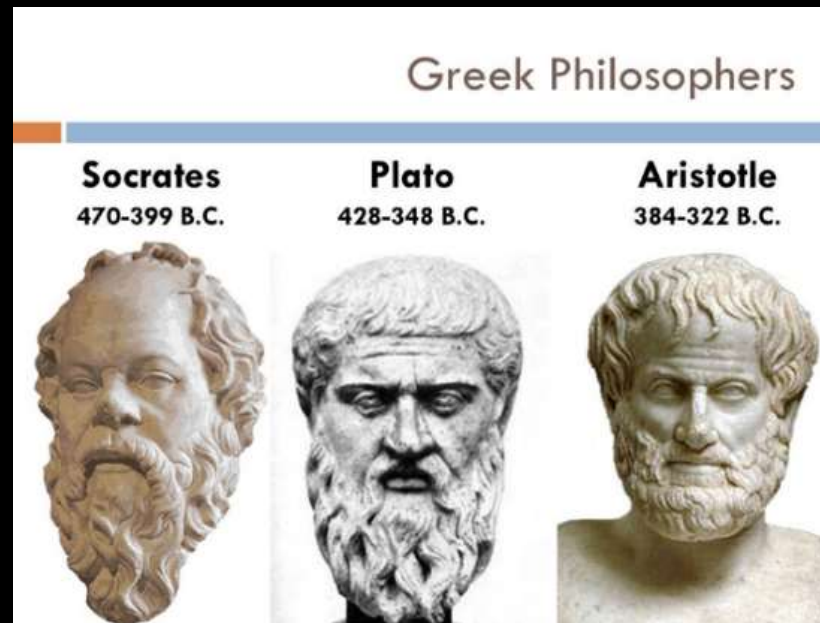
- Epistemological assumption of the Scientific Revolution - Discovery of new knowledge is possible
- “The dramatic success of the new science in explaining the natural world promotes this “natural philosophy” as an independent authority challenging the old theological philosophy and constructing a new world view.”

(2015)



# Epistemology - The Study of Knowledge

## Classical Western Philosophy - Knowledge and Truth

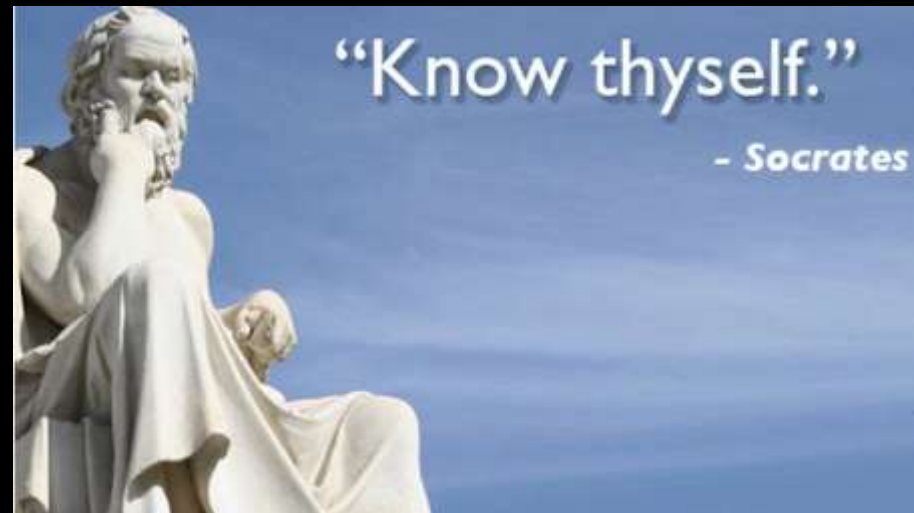
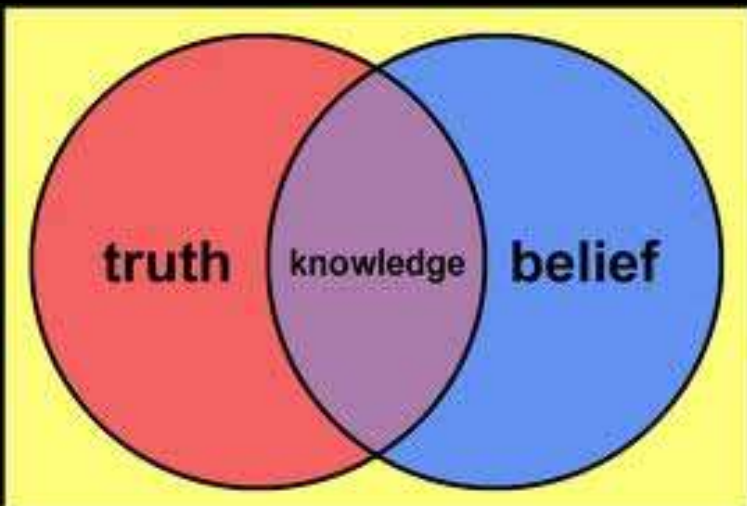




# Epistemology - The Study of Knowledge

## Classical Western Philosophy - Knowledge and Truth

- Epistemology - from the Greek words “episteme” and “logos”
- “Episteme” can be translated as “knowledge” or “understanding”
- “Logos” can be translated as “study” or “account”
- Epistemology focuses on questions such as -
  - “What is the difference between believing and knowing?”
  - “What does it mean to say that we know something?”
  - “What does it mean to say that something is true?”
- Strongest kind of knowledge = justified true belief



# Epistemology - Rationalists vs Empiricists

Rationalists - there is a priori, innate knowledge

Plato – we have innate knowledge of the Forms/Ideas

- A priori – before/not dependent on experience
- mathematical entities (triangles, largeness, Pi)
- moral ideals (goodness, virtue, piety)
- aesthetic concepts (beauty)

• These Forms/Ideas are abstract representations of the material world, independent of humans, and support all our rational activities (truth).

• Pi – the number pi exists outside of space and time and has the characteristics it does regardless of any mental or physical activities of human beings.

Empiricists - there is no such thing as innate knowledge

Aristotle – all knowledge is derived from experience (either sensed via the five senses or reasoned via the brain or mind) and are dependent on and derived from the material world.

Where is Pi?

## Greek Philosophers

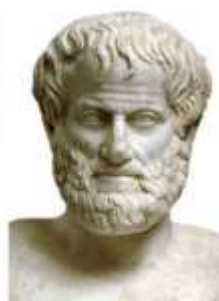
Socrates  
470-399 B.C.



Plato  
428-348 B.C.



Aristotle  
384-322 B.C.





# Epistemology – Rationalists vs Empiricists Heavens vs Earth

Plato (left) and Aristotle (right)  
a detail of *The School of Athens*  
(1510) by Raphael.

Aristotle gestures to the earth,  
representing his belief in  
knowledge through empirical  
observation and experience of the  
material world.

Plato gestures to the heavens,  
representing his belief in the Forms  
and abstract knowledge  
independent of the material world.





# The Role of Logic in Knowledge

## Rationalists vs Empiricists

### Deduction vs. Induction

- For Plato logic means the descent from a knowledge of universal Forms (or ideas) to a contemplation of particular imitations of these (deduction) producing a logic of relation to ideals, which are outside of empirical Nature.
- For Aristotle, therefore, logic implies the ascent from the study of particular phenomena to the knowledge of essences (induction) producing a logic that tells us what belongs to what (natural kinds) and reveals the order of empirical Nature from within.



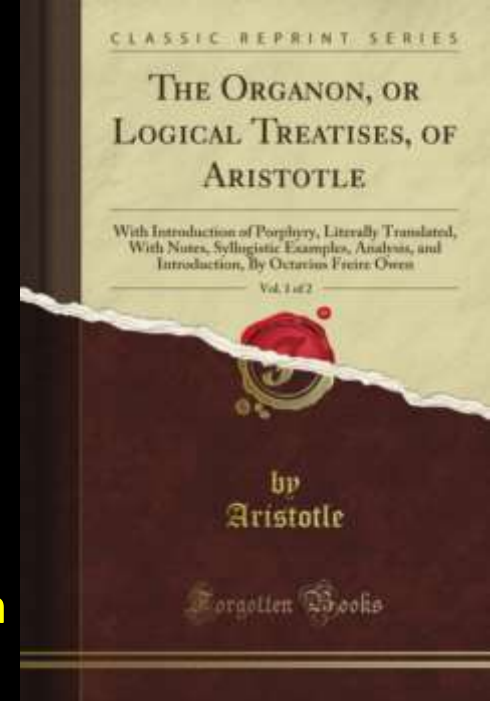


# Representation, Knowledge, and Nature

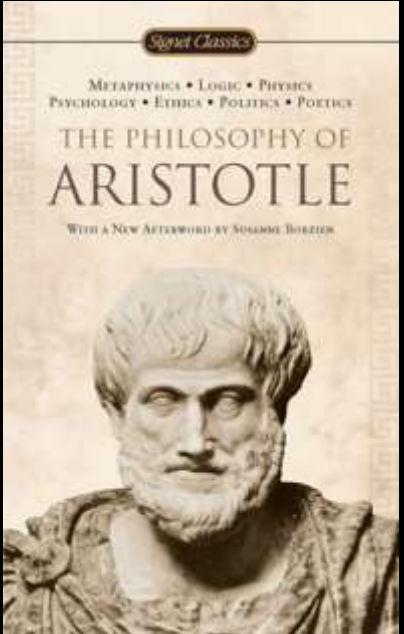
## Empiricism vs. Rationalism

- Aristotle's logical treatises are called the *Organon* - "tool"
- Like his teacher Plato, Aristotle's philosophy aims at the universal.
- Empiricist Representation - Aristotle, however, found the universal in particular beings. For Aristotle, these essential properties of things have no independent existence apart from particular beings.
- Rationalist Representation - Plato finds that the universal exists apart from particular beings and is related to them as their independent prototype (and eternal exemplar or representation) -> the Form.

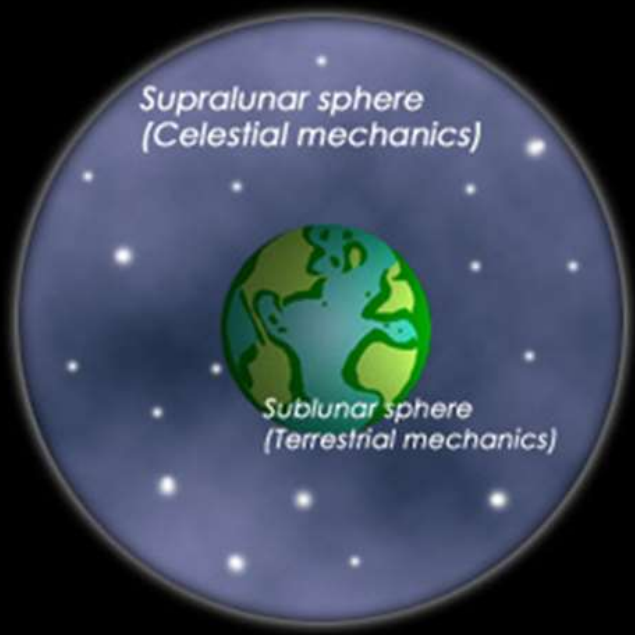
Knowledge from experience vs. Knowledge from reason



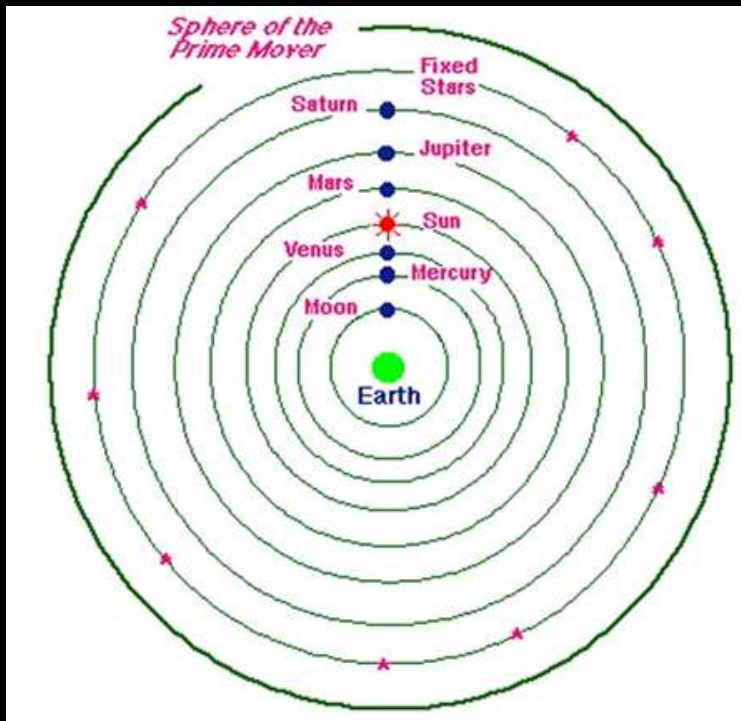
# Aristotle's Empirical Kosmos



# The Ordered Universe



Aristotelian Cosmology (simplified)

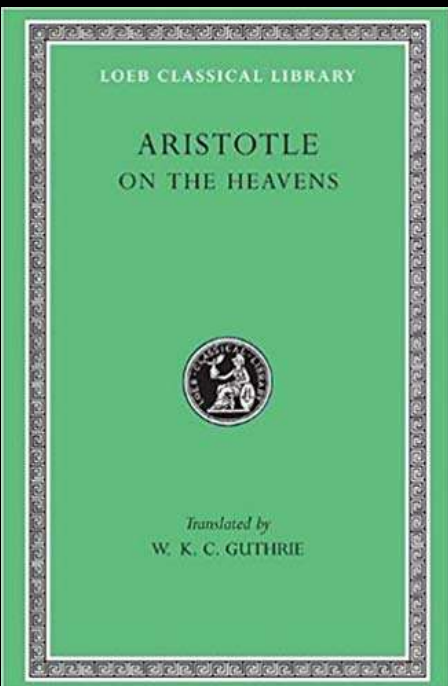


Aristotle's Universe

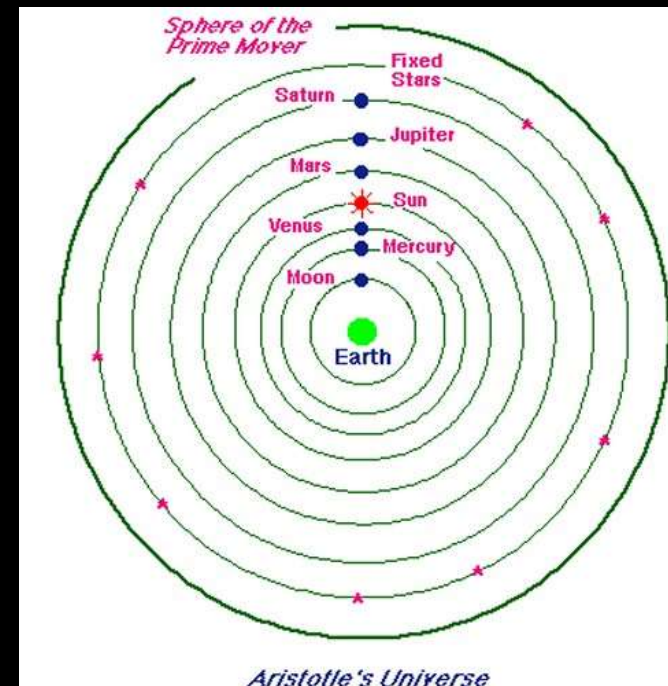


# The Science of Celestial Nature – Perfection vs. Imperfection

- In his books *On the Heavens*, and *Physics*, Aristotle put forward his notion of an ordered universe or Kosmos/Cosmos
- The Cosmos is divided into two distinct parts - sublunary region and celestial region
- Sublunar Sphere – from Earth to Moon - the abode of change and corruption
- Celestial/Supralunar Sphere – the region of perfection (Platonic)
- The Changeless Eternal Cosmos encompassed all existence and had no temporal beginning or end – and all motions came ultimately from a Prime Mover, who is eternal, unchanging and does not intervene in the world (no miracles).



Aristotelian Cosmology (simplified)



Aristotle's Universe

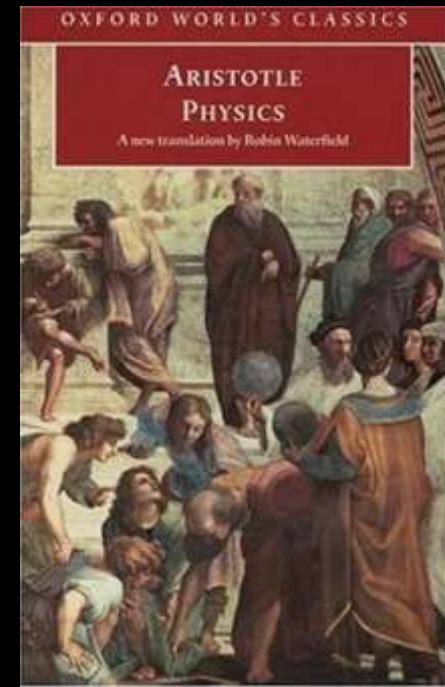
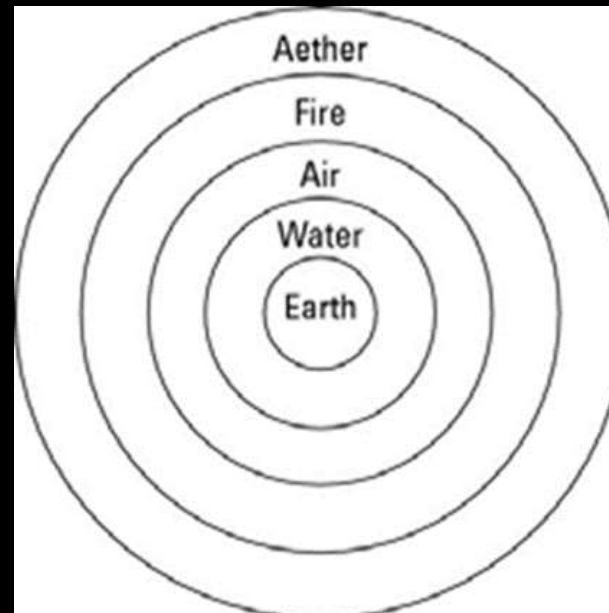
# Sublunary Nature – The Material World of Change and Imperfection

## The Mess of the Many

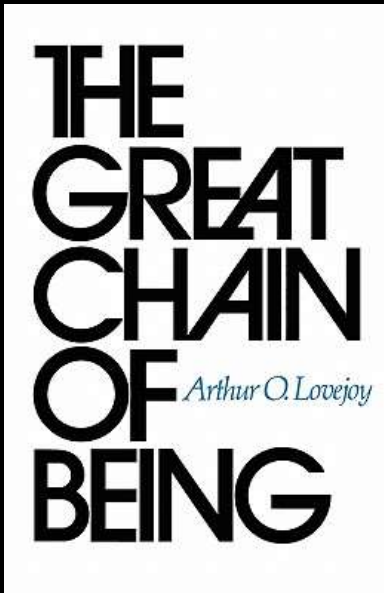
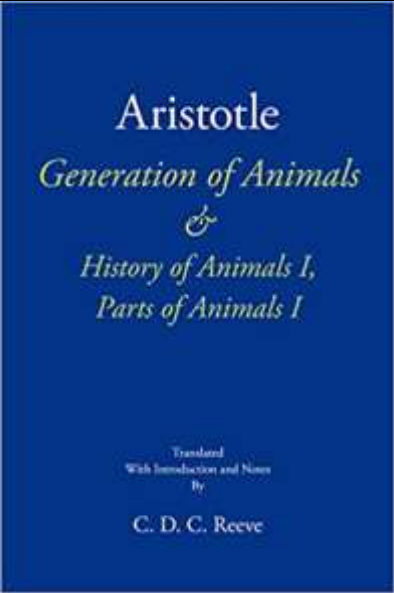
- Things with separate existence (individual particulars)
- Things that are changeable
- Things come into being, grow, mature, decay, and die
- How to explain Order? Change? Identity? Difference?

## Four Elements – Earth, Water, Air, Fire

- All physical things made of two or more elements
- Earth and Water = heavy, move downward
- Air and Fire = light, move upward
- Motion, Change, Transformation explained by elements







# The Order of Sublunary Life “Scala Naturae”

## The Classification of Living Things

- Minerals at the base the physical world.
- Plants lacked sensation, motion, and reason, and so are ranked lowest on the scale of life.
- He ranked animals over plants based on their ability to move and sense, and graded the animals by their reproductive mode, live birth being "higher" than laying cold eggs
- Warm-blooded mammals and birds again being "higher" than "bloodless" invertebrates
- The Great Chain of Being is a graded scale of perfection rising from plants on up to humans at the top since humans are the “rational animal”

	ability to grow and reproduce	ability to move	ability to think rationally
Humans	X	X	X
Animals	X	X	
Plants	X		
Minerals			

# Aristotle and Epistemology – Three Types of Knowledge

The Theoretical Sciences - Episteme

- “Scientific” Knowledge

The Productive Sciences - Techne

- Making of useful objects

The Practical Sciences - Phronesis

- Human Conduct

## Aristotle's Three Types of Knowledge

### Episteme (Scientific Knowledge)

Universal, context-free and objective knowledge  
(explicit knowledge)

### Techne (Skills and Crafts Knowledge)

Practical and context-specific technical know-how  
(tacit knowledge)

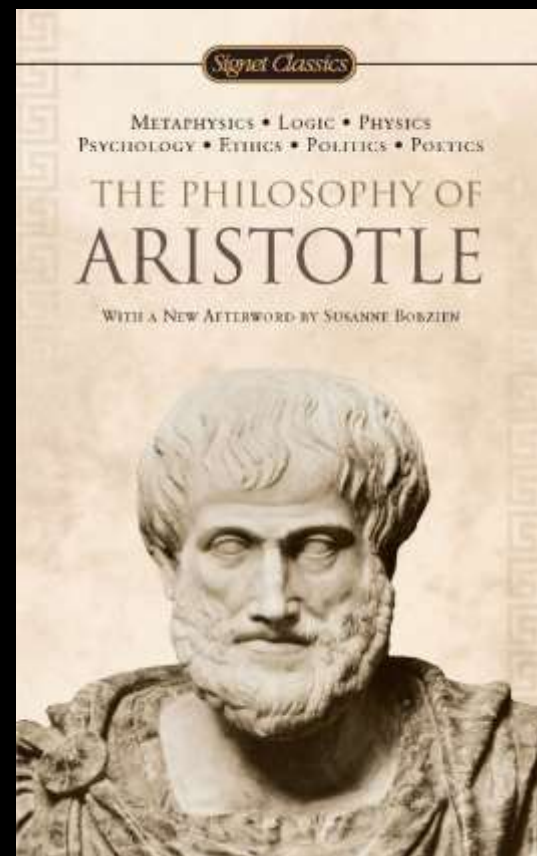
### Phronesis (Practical Wisdom)

Experiential knowledge to make context-specific  
decisions based on one's own value/ethics (high  
quality tacit knowledge)

© Duncker, Toronto, 2002

## Episteme – “Scientific” Knowledge

- Physics/Natural Philosophy
- Metaphysics – things that are unchangeable, distinct from body/matter, eternal substance (God)
- Mathematics – things that are unchangeable but are abstractions from physical entities with no separate existence





# The Empiricist Problem of the “Exact Sciences”

- Mathematics – things that are unchangeable but are abstractions from physical entities with no separate existence?
- The “Exact Sciences” - Astronomy, Optics, Mechanics (mathematical sciences)
- “In Astronomy, where does the balance lie between the mathematical and the physical?...Must the astronomer concern himself with the real structure of things, as Aristotle’s astronomical scheme suggests?” Lindberg 2007

“An entertaining and educational as that organized by the best text operators.”  
— CHARLES BURNETT, *New York Times Book Review*

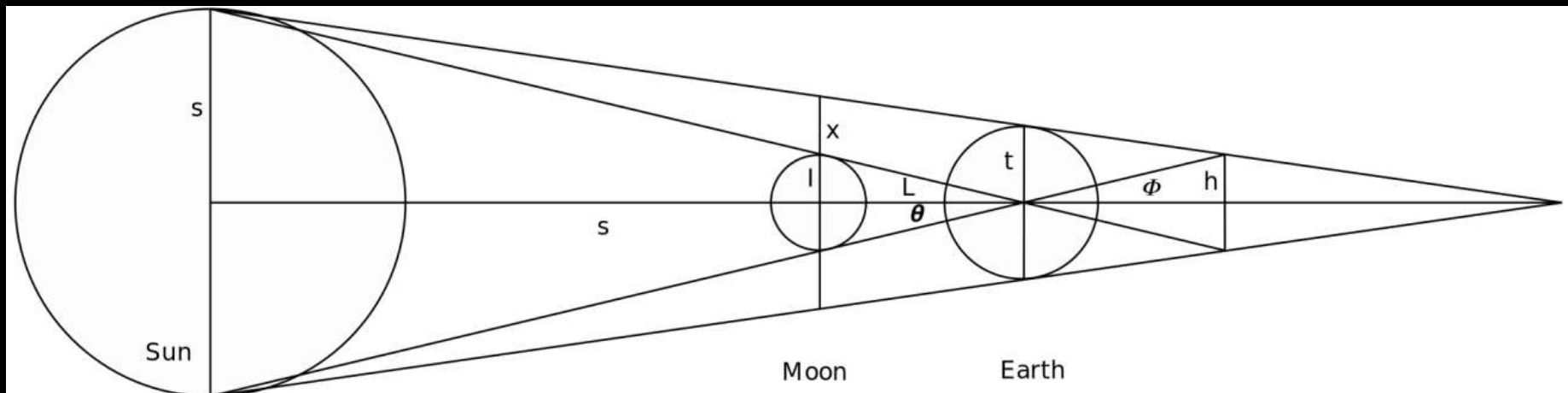


## The Beginnings of Western Science

*The European Scientific Tradition in Philosophical, Religious, and Institutional Context, Prehistory to A.D. 1450*

SECOND EDITION

DAVID C. LINDBERG

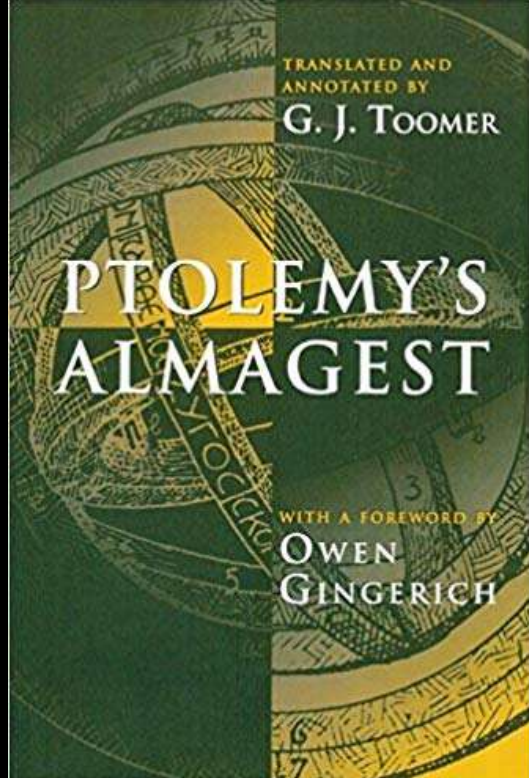


# Roman Natural Philosophy – Empirical Problem of Celestial Imperfection

Claudius Ptolemy AD 100 – c. 170

Heavenly bodies did, in fact, not move with perfect circular motions: they speeded up, slowed down, and the planets even stopped and reversed their motions.

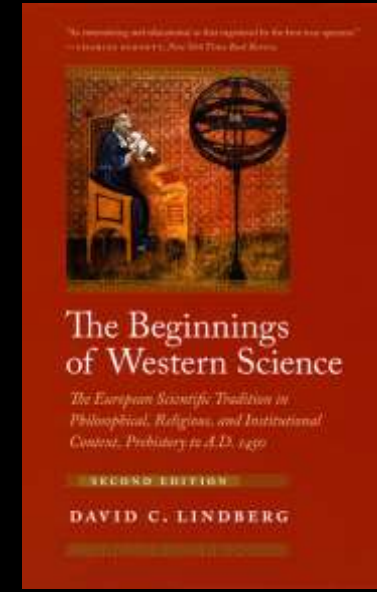
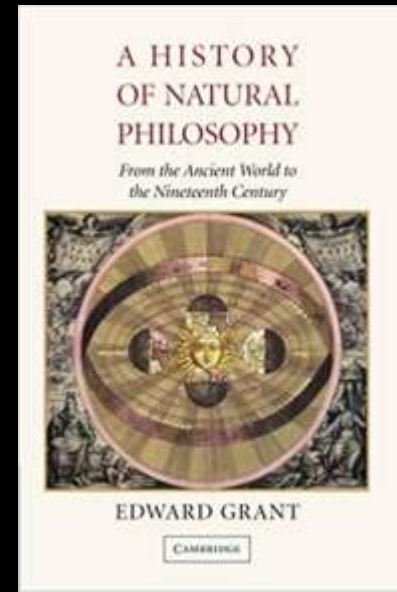
Ptolemy presented a complete system of mathematical constructions that accounted successfully for the observed motion of each heavenly body in a geocentric universe but complicated with many more types of cycles





# Scholasticism, Theology, and Medieval Natural Philosophy before 1543

- “Scholastic Philosophy” the most common approach to natural philosophy was to comment on or to dispute questions arising from Aristotle’s natural philosophy, especially his *Physics*, *On the Heavens*, etc. (Old Knowledge)
- Theological problems with Old Knowledge and Aristotle – Prime Mover vs. Christian God – no intervention (miracles), not omnipotent, eternal universe
- Problematic empirical tendency in Medieval Natural Philosophy – the tendency to restrict analysis to causal principles discoverable through the exercise of human observation and reason, without regard for the teachings of biblical revelation or church tradition.
- “Divine or supernatural causation was never denied, but it was placed...outside the province of natural philosophy.” Lindberg

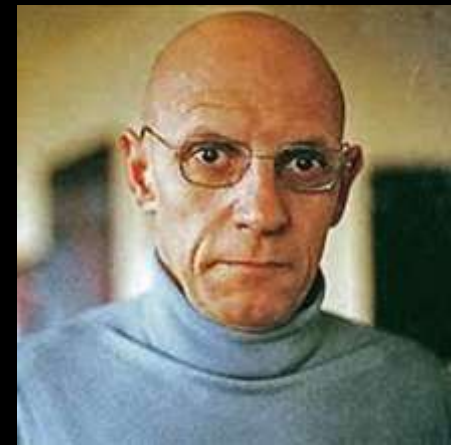
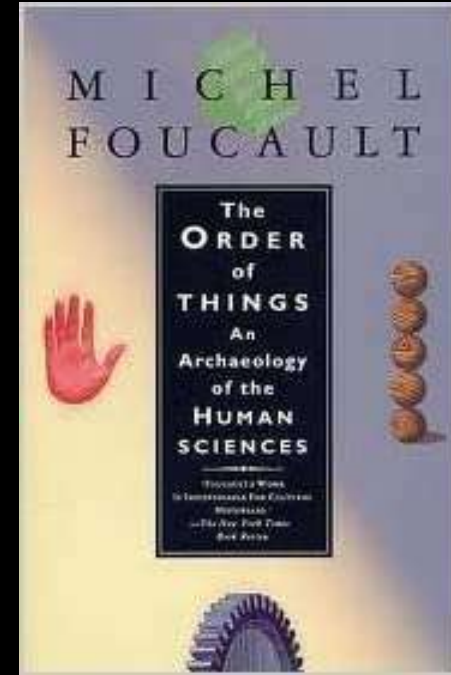


# Foucault

## Epistemology and Representation Order and Knowledge

Michel Foucault *The Order of Things* (1966)

- Foucault endeavors to excavate the origins of the human sciences, which have their root in "life, labor, and language", that is: biology, economics, and linguistics.
- These offer universal scientific truths about human nature that are, in fact, often mere expressions of ethical and political commitments of a particular society.
- Discourse (language, how we talk about things) shapes our understanding of things and the order of things
- Foucault's central claim - all periods of history have possessed certain underlying epistemological assumptions (episteme) that determined what was acceptable as, for example, scientific discourse.

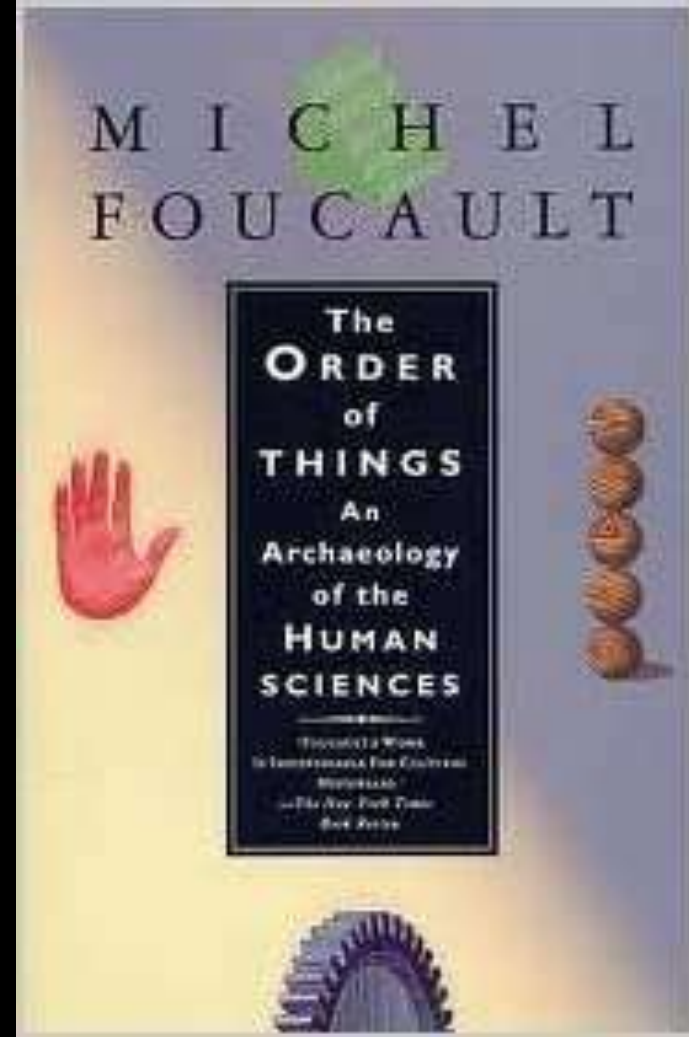


1930-2004

# Epistemology in historical context

- Episteme – Not Aristotle's use of the term but that the conditions of discourse have changed over time, from one period's episteme to another.
  - Classical -> Renaissance -> Modernism
- Classical episteme - representation, ordering, identity and difference (Greeks)
- Renaissance episteme - resemblance and similitude (Natural History)
- Modernism episteme - categorization and taxonomy (Scientific Explanation of Order and Causality)

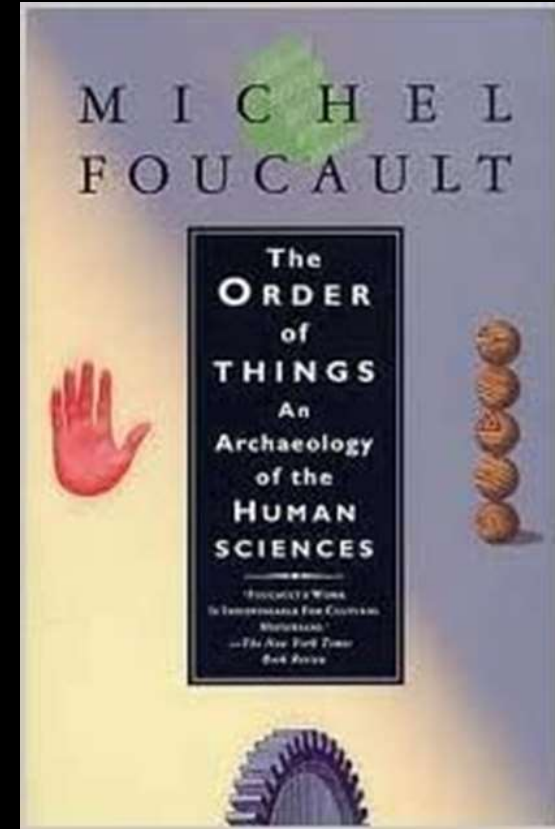
Foucault offers an analysis of what knowledge meant—and how this meaning changed—in Western thought from the Classical period through the Renaissance to the present. At the heart of his account is the notion of representation





# Epistemology and Representation

- For Foucault the key to Classical knowing is the idea, that is, a mental representation.
- Classical thinkers might disagree about the actual ontological status of ideas (their formal reality – rationalists vs. empiricists), but they all agreed that as representations (epistemically, if not ontologically) they were “non-physical” and “non-historical”, that is, precisely as representing their objects as “ideas” or “universals”, they could not be conceived as having any role in the causal networks of the natural or the human worlds.
- Foucault’s “critical philosophy” undermines such claims by exhibiting how they are the outcome of contingent historical forces, not scientifically universal truths.



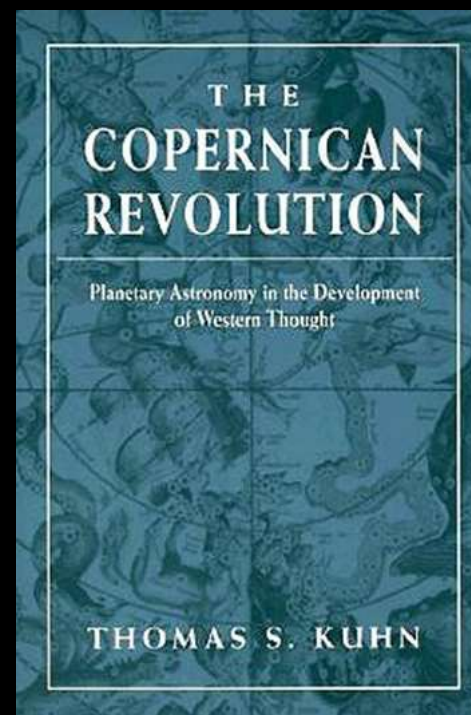
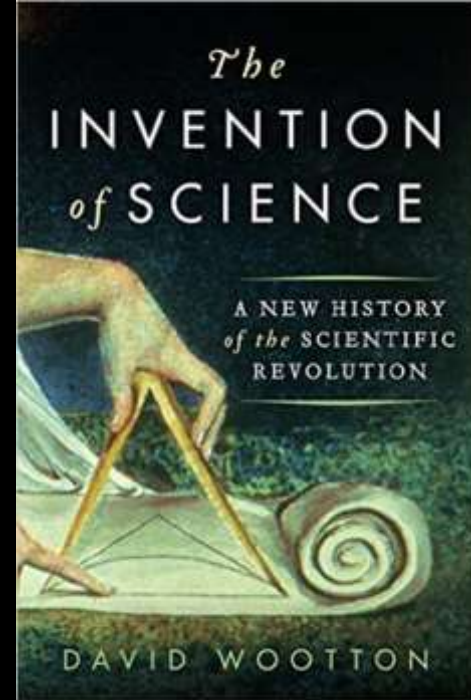
# Wootton

## The Scientific Revolution 1543-1687

### Reason vs. Experience

### Epistemological Assumptions

- Epistemological assumption of the Scientific Revolution - Discovery of new knowledge is possible
- Wootton (2015) “The dramatic success of the new science in explaining the natural world promotes this “natural philosophy” as an independent authority challenging the old theological philosophy and constructing a new world view.”
- Epistemological Change of the Scientific Revolution –
  - Scholastic “learn from the past” becomes “experience can actually teach you that what other people know is wrong.”
- Epistemological Assumption of the Scientific Revolution - Discovery of new knowledge is possible

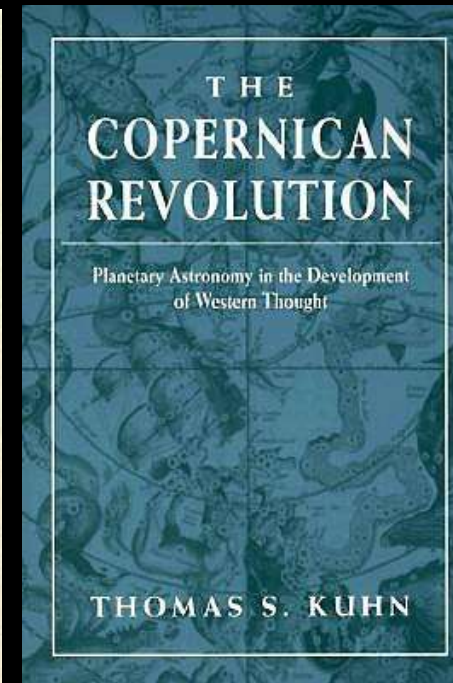
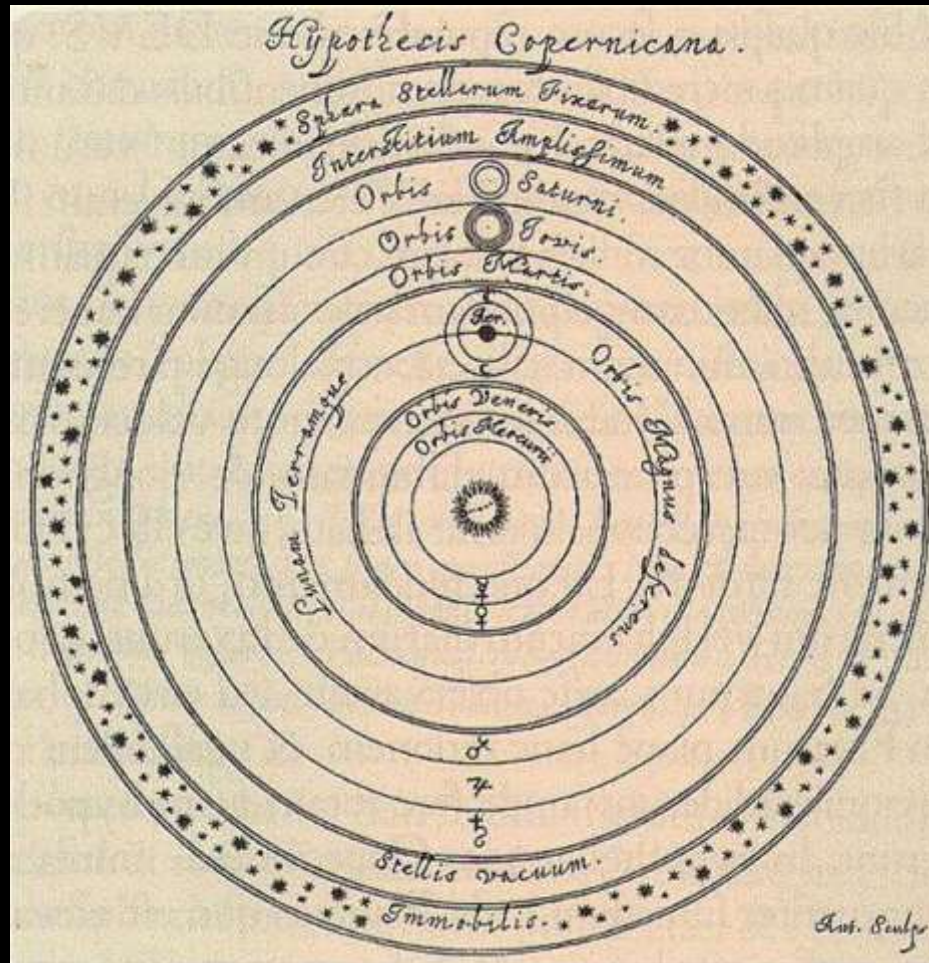




# The Order of Things - The Re-Ordered Universe

## Cosmological Model – Heliocentric vs. Geocentric

- Nicolaus Copernicus (1473–1543)
- The Heliocentric Cosmos – simplifies the Ptolemaic Geocentric Cosmos
- *On the Revolutions of the Heavenly Spheres* 1543

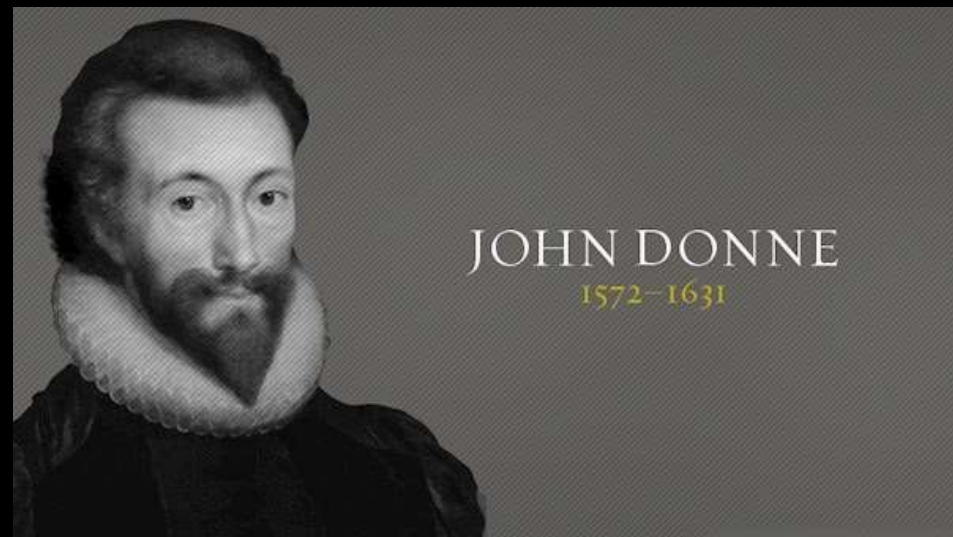




# Discourse, Renaissance Episteme, and the Order of Things

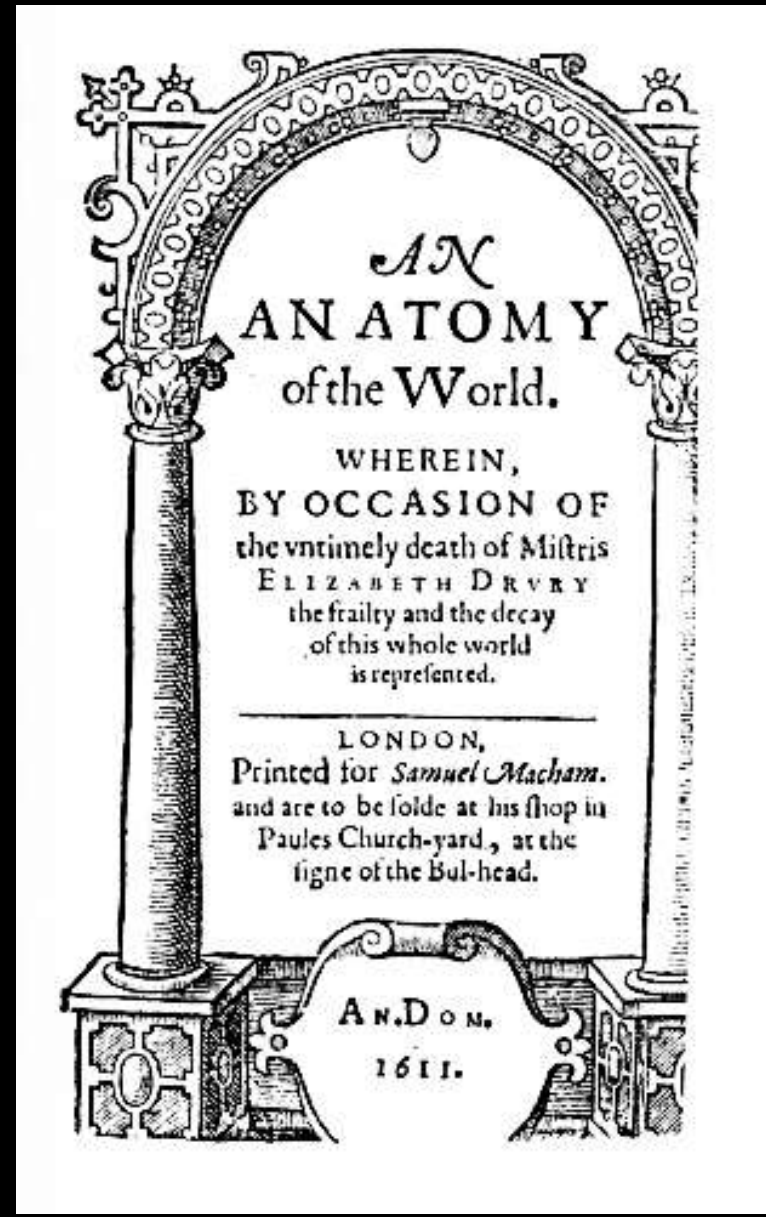
## *An Anatomy of the World* 1611 - John Donne

And new philosophy calls all in doubt,  
The element of fire is quite put out,  
The sun is lost, and th'earth, and no man's wit  
Can well direct him where to look for it.  
And freely men confess that this world's spent,  
When in the planets and the firmament  
They seek so many new; they see that this  
Is crumbled out again to his atomies.  
'Tis all in pieces, all coherence gone,  
All just supply, and all relation;



JOHN DONNE

1572-1631

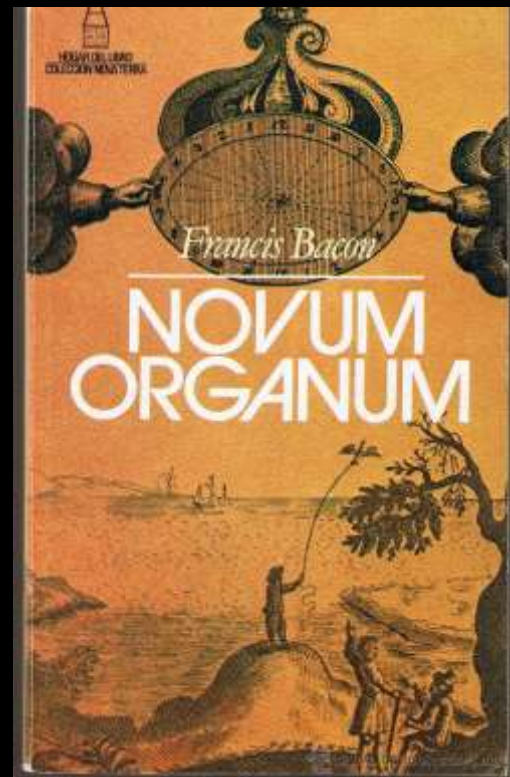


# The Scientific Revolution – Empiricist Epistemology

## Experimental Natural Philosophy

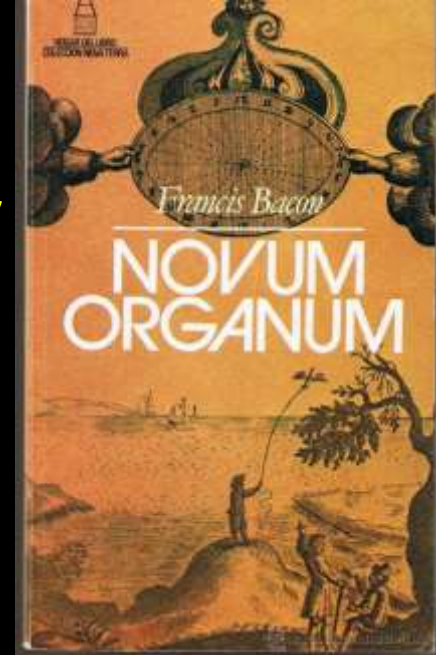
Francis Bacon 1561 – 1626

- The *Novum Organum* "New Tool" (1620). The title is a reference to Aristotle's logical work *Organon* (Tool) – Bacon's Method – more rigorous inductive reasoning
- Bacon argued that Scholastic natural philosophy was too focused on what Aristotle said in books rather than physical nature itself, and the natural philosopher should instead "take the question to nature" and learn by direct observation and experiments
- Not merely description – take the question to nature through artificial experiments to provide additional observances of a phenomenon
- Material Nature - Apart from the "laws of nature" themselves, the causes relevant to natural philosophy are only efficient causes and material causes i.e. matter and motion.

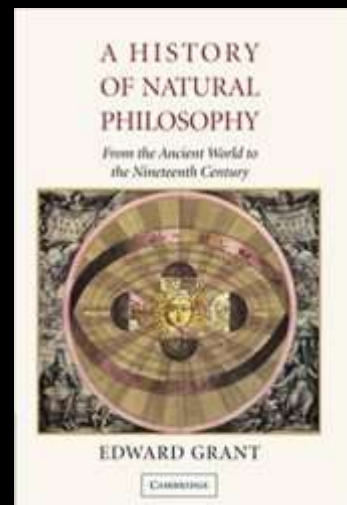


# Bacon – Mathematics and the Science of Nature

- Grant (2007) “Francis Bacon gave voice to the most significant problem that confronted natural philosophy in its lengthy history from Aristotle onwards: What is the proper relationship between natural philosophy and mathematics and the exact sciences?”
- Bacon was convinced that the “Great Mother of the Sciences” natural philosophy had to embody within itself all of the exact sciences because it “nourished within itself a multiplicity of specialized sciences, such as physics, chemistry, biology, and their numerous subdivisions”
- Natural Philosophy had to merge with mathematics and the Exact Sciences - Astronomy, Optics, Mechanics
- Nature’s Laws are mathematical



1620

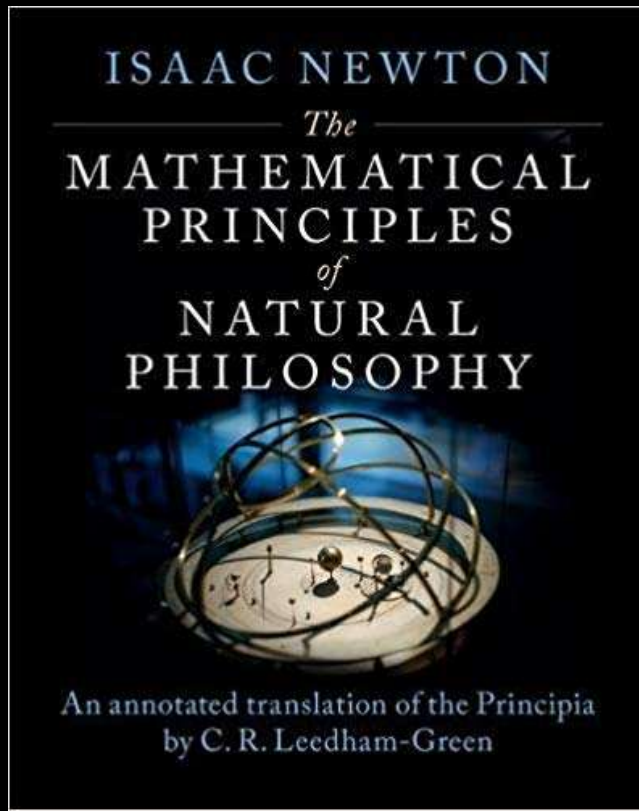




# The Science of Nature - Newton

## Reconciling Mathematics and Natural Philosophy

- *Philosophiæ Naturalis Principia Mathematica* (1687), whose title translates to "Mathematical Principles of Natural Philosophy"
- By the end of the 17<sup>th</sup> century, the transformation of natural philosophy was manifest in Newton's great work "the very title of which reveals that a union of mathematics and natural philosophy had already occurred." Grant (2007)

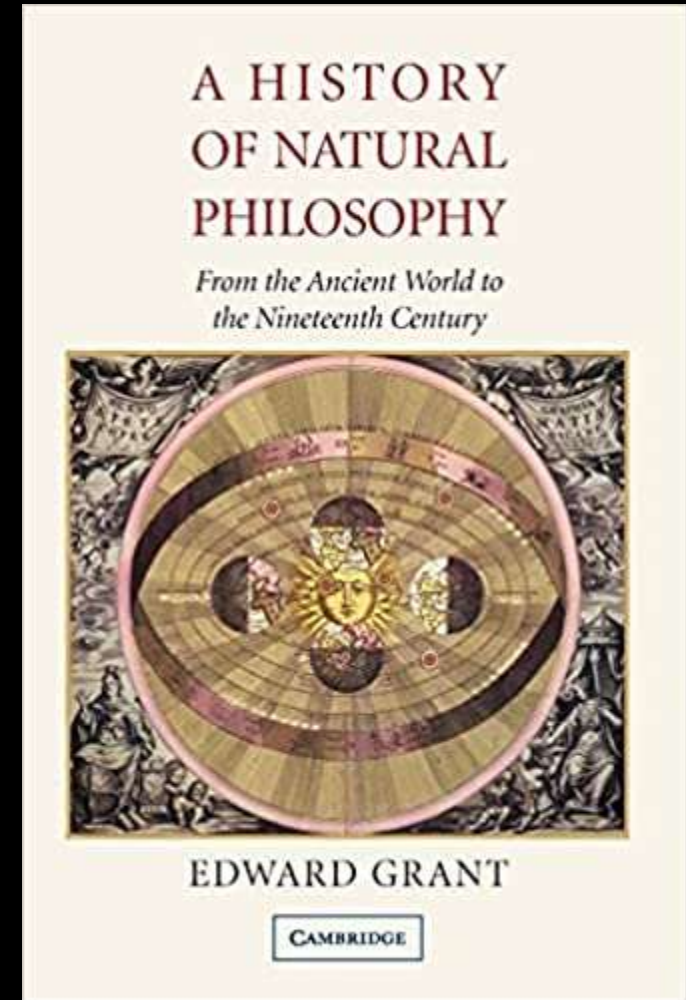


Isaac Newton (1642–1727)

# The Science of Nature - Newton

## Reconciling Mathematics and Natural Philosophy

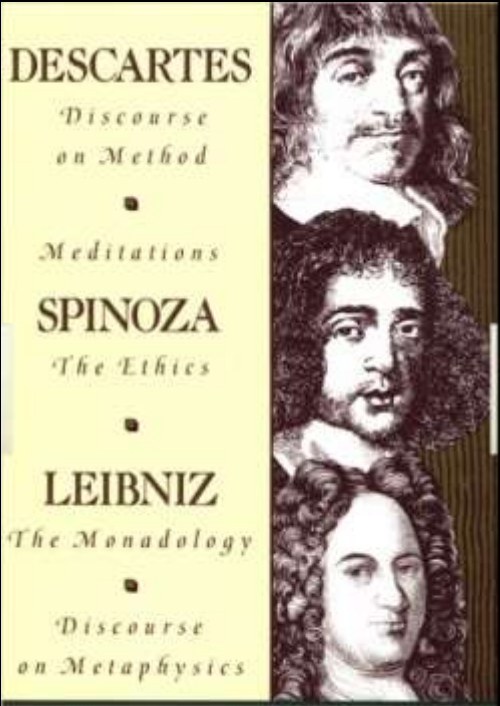
- “The Scientific Revolution occurred because after coexisting independently for many centuries the exact sciences of optics, mechanics, and especially astronomy merged with natural philosophy in the 17th century.” Grant (2007)
- “This momentous occurrence broadened the previous all-too-narrow scope of the ancient and medieval exact sciences which now, by virtue of natural philosophy, would seek physical causes for all sorts of natural phenomena, rather than being confined to mere calculation and quantification...” Grant (2007)
- Philosophers - But what is the epistemological and ontological status of mathematical ideas?
- Rational or Empirical?



# Rationalism

- Innate knowledge
- Knowledge is based on reason and logic
- Mathematics and logic is the paradigm of knowledge
- Genuine knowledge is certain
- Experience (sense perception) does not produce certainty

1596-1650



1632-1677

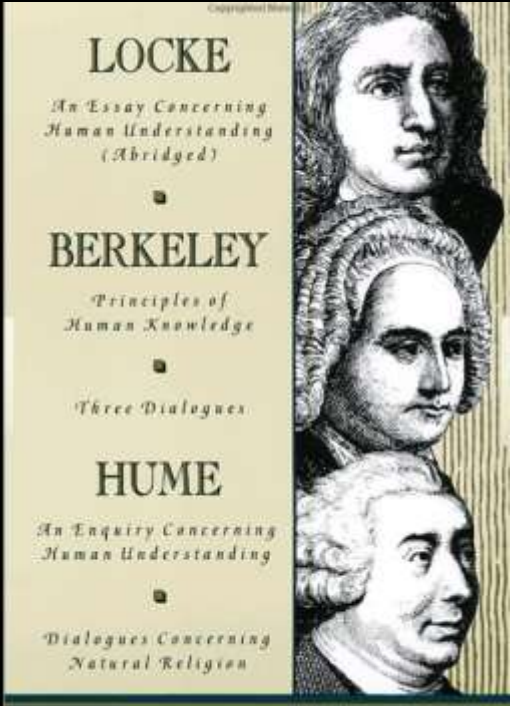
1646-1715

THE RATIONALISTS

# Empiricism

- No innate knowledge (tabula rasa)
- Knowledge is based on experience and experimentation
- Experimental science is the paradigm of knowledge
- Experience and experiment rarely, if ever, produce certainty
- Problem of mathematics and certainty

1632-1704



1685-1753

1711-1776

THE EMPIRICISTS

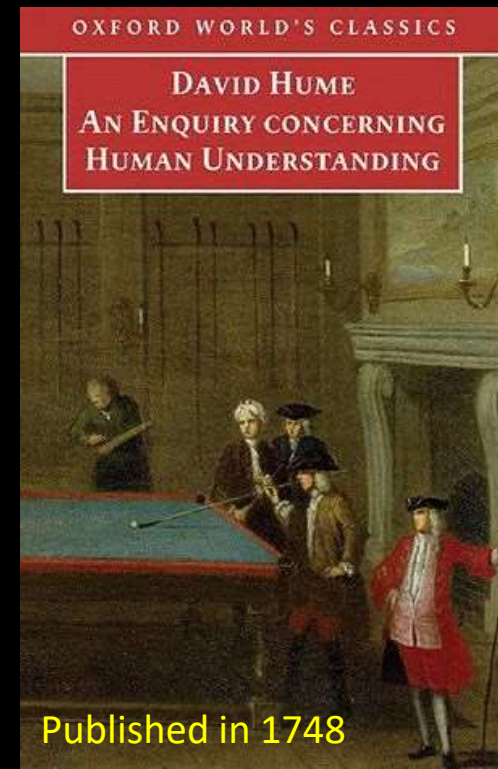
Versus



# The Uncertain Conditions of Empirical Knowledge

## The Skeptical Empirist - David Hume 1711-1776

- Empiricism - All knowledge from experience
- Undercut the certainty of scientific inductive knowledge by showing that since we know only what our senses tell us, we really can know nothing at all...with certainty.
- Problem of Induction - inductive reasoning and belief in causality cannot be justified rationally; instead, they result from custom and mental habit.
- This problem of induction means that to draw any causal inferences from past experience it is necessary to presuppose that the future will resemble the past, a presupposition which cannot itself be grounded in prior experience.



# The Uncertain Conditions of Empirical Knowledge

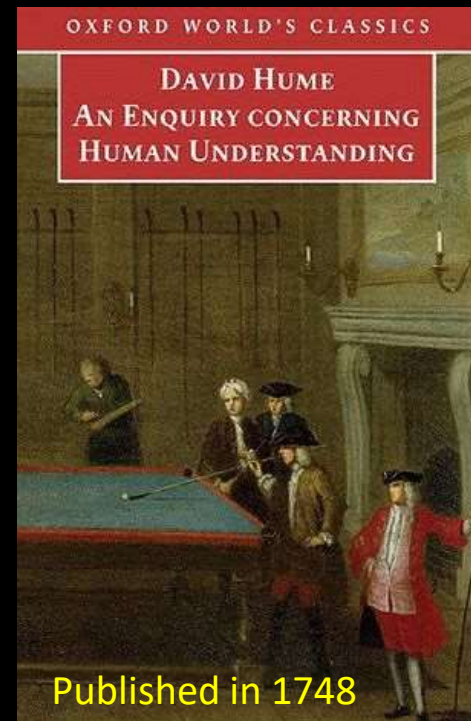
## The Skeptical Empirist - David Hume 1711-1776

### The Problem of Causality

- Causality - We never actually perceive that one event causes another, but only experience the "constant conjunction" of events.

### The Problem for Empiricist Morality – The Fact–Value Distinction

- Empirical knowledge and moral truth - This barrier between 'fact' and 'value' implies it is impossible to derive ethical claims from factual arguments, or to defend the former using the latter.
  - No empirical evidence of God or immortal souls
  - Cannot derive an “ought” from an “is”



# Beyond Rationalism and Empiricism - Immanuel Kant 1724-1804

## Redefining the Conditions of Knowledge

- Set out to create a synthesis of rationalism and empiricism
- Hume was right in one respect – we cannot know with absolute certainty anything outside our perceptions or experience, but we can know phenomenal reality – the world as it presents itself through our experience of it.
- Experience provides the content of our knowledge and reason provides the form - the independent world and the human mind are a unity.
- The Forms are in us, but not separate from us...



"All our knowledge begins with the senses, proceeds then to the understanding, and ends with reason. There is nothing higher than reason."

Immanuel Kant

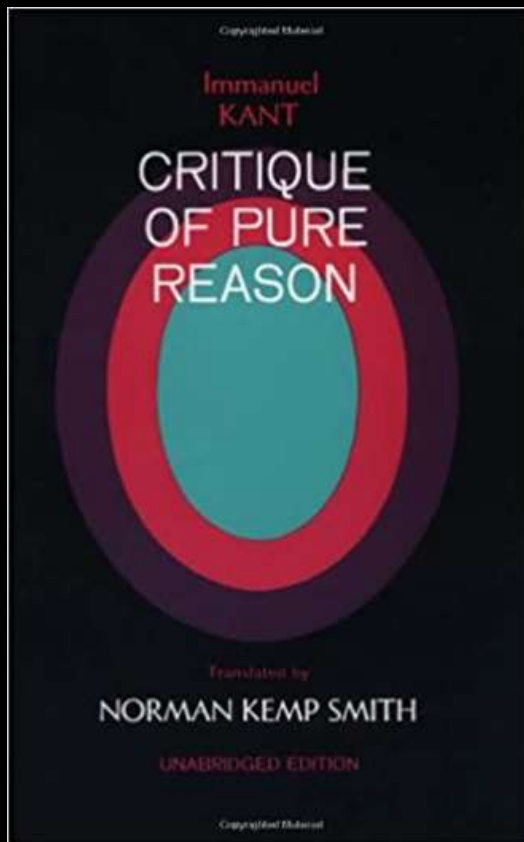




# Immanuel Kant - Transcendental Idealism

## Redefining the Conditions of Knowledge

- Kant named his brand of epistemology "Transcendental Idealism", and he first laid out these views in *The Critique of Pure Reason* (1781)
- The project of *The Critique of Pure Reason* is to examine whether, how, and to what extent human reason is capable of a priori knowledge (knowledge prior to experience, that is, transcends experience).

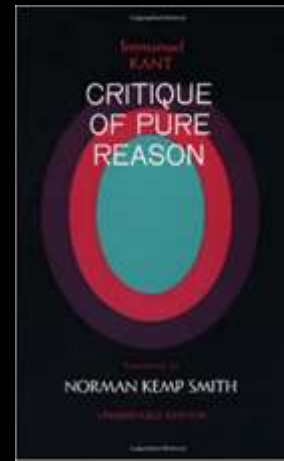
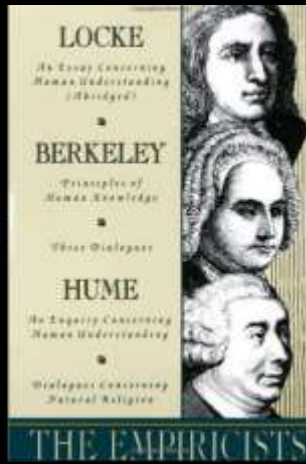


# Redefining the Conditions of Knowledge Through the Horns of the Dilemma

- Kant - there are fundamental problems with both rationalism and empiricism.
- To the rationalists he argued, broadly, that pure reason is flawed when it goes beyond its limits and claims to know those things that are necessarily beyond the realm of every possible experience: the existence of God, free will, and the immortality of the human soul.
- No empirical evidence of God or immortal souls possible
- To the empiricist he argued that while it is correct that experience is fundamentally necessary for human knowledge, however, reason is necessary for processing that experience into coherent thought.
- Kant concludes that both reason and experience are necessary for human knowledge.



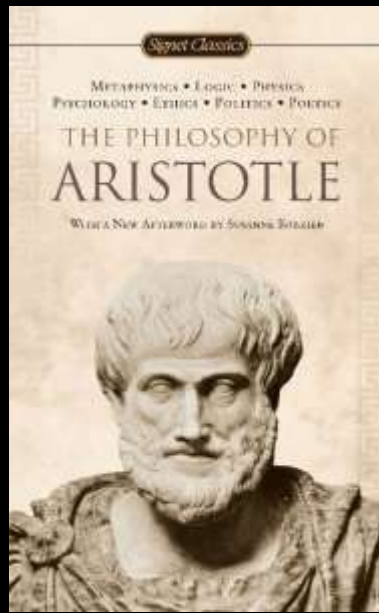
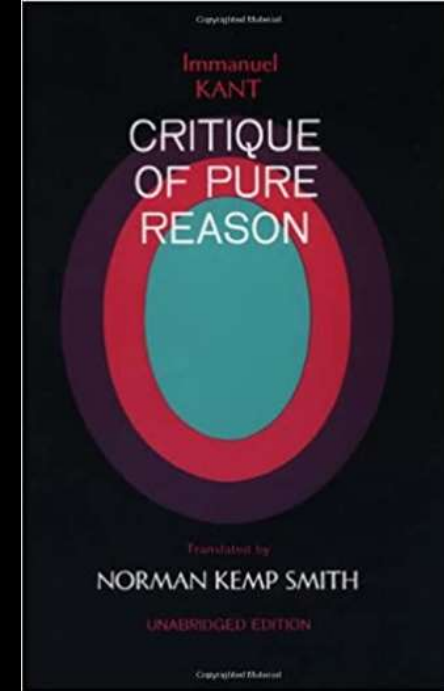
Versus



Kant maintains that our understanding of the external world has its foundations not merely in experience, but in both experience and a priori (transcendental) concepts.

- Metaphysics for Kant concerns a priori knowledge
- he associates a priori knowledge with reason and logic.

However - we are back to Aristotle's problem with the Exact Sciences



Aristotle's Theoretical Sciences – Episteme

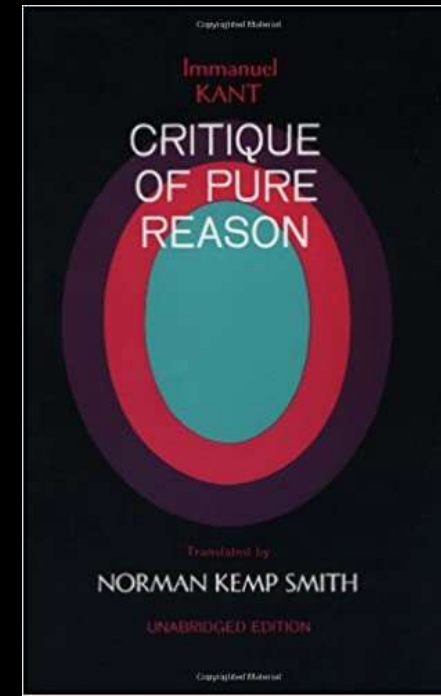
- Representation, Order, Identity, Difference
- Physics/Natural Philosophy
- Metaphysics – things that are unchangeable, distinct from body/matter, eternal substance (God)
- Mathematics



# Epistemology - Transcendental Idealism

## Noumena and Phenomena

- Idealism - space and time are merely formal features or “categories” of how we perceive objects, not things in themselves that exist independently of us or properties or relations among them.
- Empiricism - We cannot know the things-in-themselves (*noumena* “das Ding an sich”) – ideas, concepts which have no existence separate from reason and representation.
- Idealism - objects we intuit in space and time (experience) are appearances, (phenomena), not objects that exist independently of our intuition.

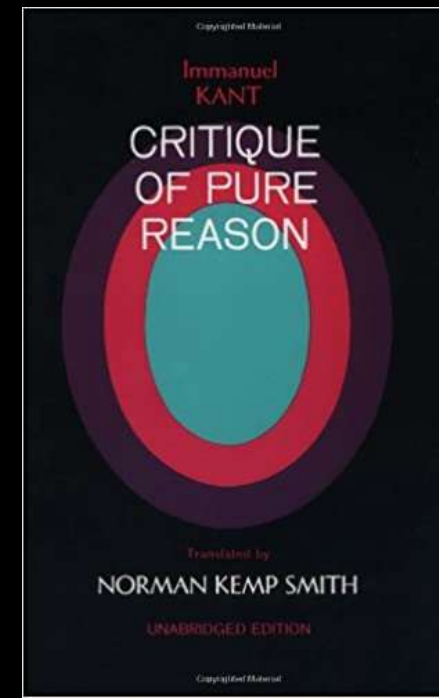


# Epistemology - Transcendental Idealism

Mind is part of Nature

Representation - Understanding and Imagination

- Mind gives order to Nature – through understanding and imagination - and is part of the order of Nature
  - Representation - The main types of representations are intuitions, concepts, and ideas.
  - We can only know *noumena* through understanding and imagination.
- Human engagement with the world – rationally and empirically – philosophy, science, art – we are part of nature
- To know nature better is thus to know ourselves better, for knowledge is a deeply human project combining understanding and imagination.



# The Science of Nature - Reconciling Mathematics and Natural Philosophy

Immanuel Kant



I assert that, in any particular natural science, one encounters genuine scientific substance only to the extent that mathematics is present.

Cambridge  
Texts in the  
History of  
Philosophy

Kant

Metaphysical  
Foundations of  
Natural Science

Edited by  
Michael Friedman



ISAAC NEWTON  
*The*  
MATHEMATICAL  
PRINCIPLES  
*of*  
NATURAL  
PHILOSOPHY



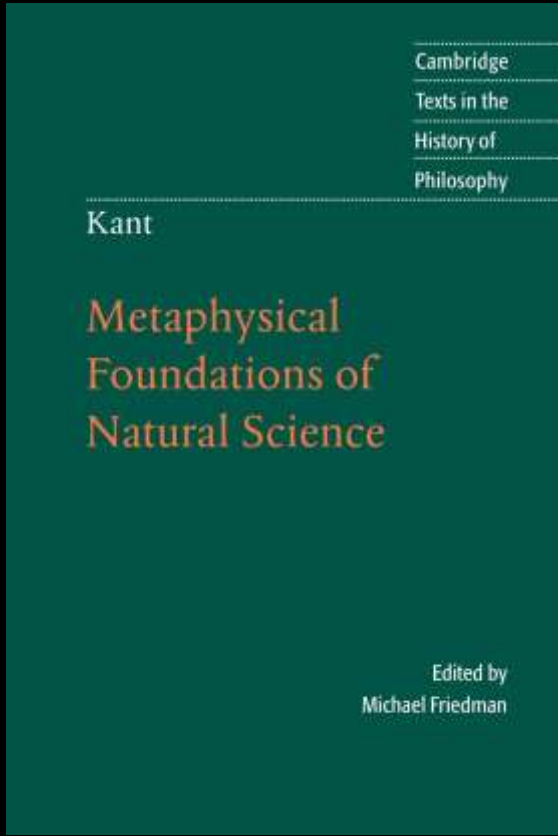
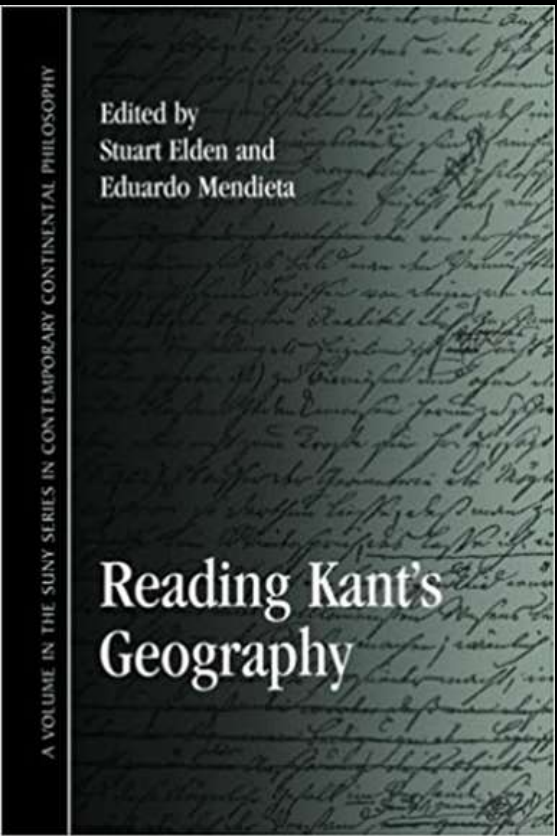
An annotated translation of the *Principia*  
by C. R. Leedham-Green



# Kant and Physical Geography – the Sublunary World

From 1755 he started teaching Philosophy at the University of Königsberg. The teaching system at the University of Königsberg at that time was based on teachers offering courses. They were not being payed by the University, but they received pay directly from their students.

Kant started lecturing on the subject of physical geography (natural science) in 1756 and continued for forty years.

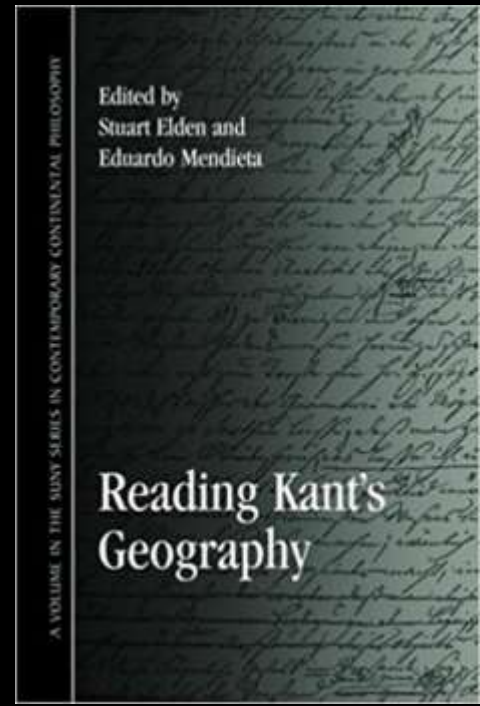


# Kant and Physical Geography

## The Mess of the Many

### Order, Richness, Complexity, Process

- In his lectures on Physical Geography (Natural Science), Kant expressed profound dissatisfaction with the system of classifying the natural world that had been devised by Linnaeus who named and classified plants according to a small number of features of their external structure.
- It did not convey the richness and complexity of natural phenomena, nor did it sufficiently emphasize the importance of integrative and unifying processes that were not directly visible.
- The essential prerequisite of a satisfactory form of natural science was a full description of phenomena as they actually occurred and coexisted in the world.



# Kant and Physical Geography – Descriptive Science

## Unity and Interconnection

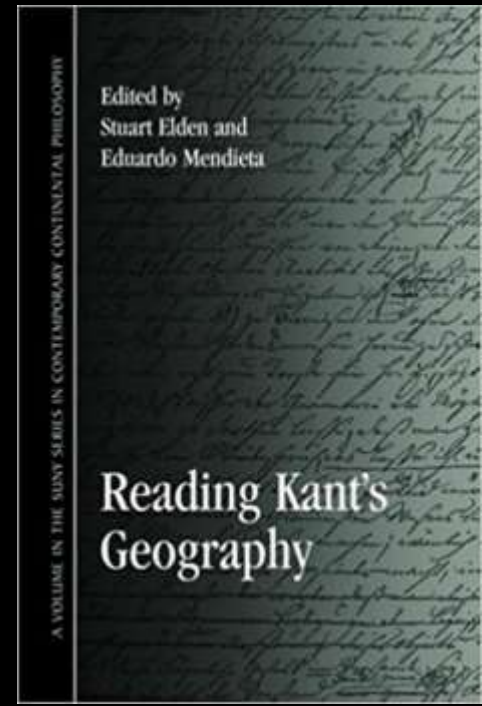
- The earth was one interconnected whole – but it was also conceived of as made up of different natural units, of regions.

## Regionalism and Environmental Determinism

- Regionalism in its strongest form became environmental determinism – the climate and environment of a particular region affected everything from the vegetation to the moral and intellectual properties of humans living there.

## Racism and Environmental Determinism

- Kant agreed that geographical regions determine human capabilities and potential. Humans from warmer, wetter regions are lazy and intellectually inferior – America and Africa
- Humboldt vehemently objects to environmental determinism and racism



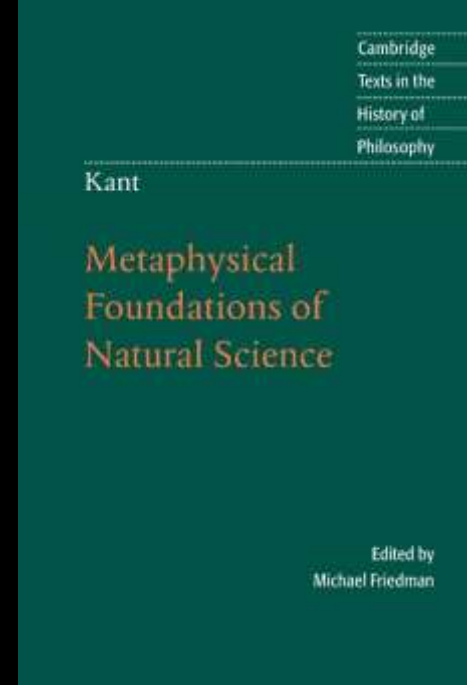


# Description and the Science of Nature

## Natural History – purely descriptive “Earth sciences”

- Biology
- Botany
- Mineralogy
  - The classification of Earth materials (rocks and fossils – paleontology)
  - Descriptive - collecting, naming, classifying
- Geognosy (Geology)
  - The description of the structure of rocks beneath the surface
  - Fieldwork, mining (Utilitarian)
- Physical Geography
  - Description of landscapes – spatial distribution and relations
  - Fieldwork, mapmaking (Utilitarian)

“History” with no history - no temporal explanation



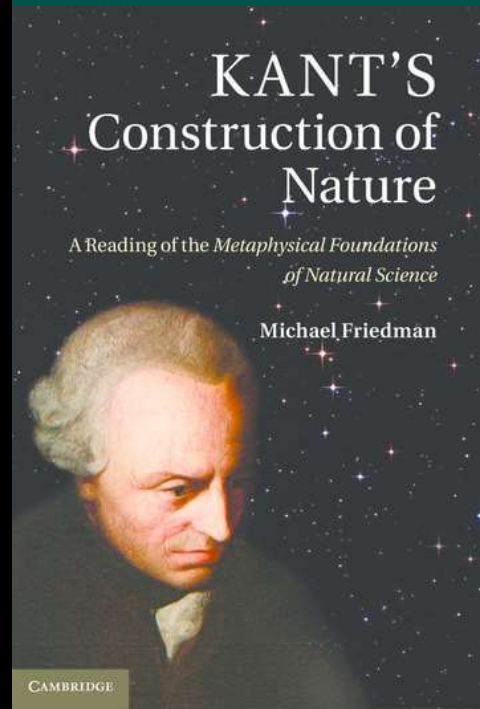
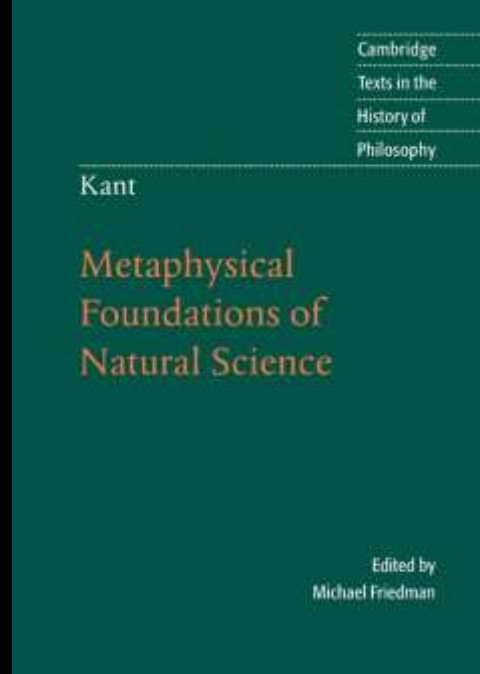
# Explanation and the Science of Nature

## Natural Philosophy – The Explanative Science

- The causal science
- Temporal explanation – Earth history

## Earth Physics (Earth science)

- “regularities amongst the phenomena of the descriptive Earth sciences with a view to determine their causes”
- Time/History – origins of valleys
- The Earth must have a history (either biblical or not) and so a theory of the Earth about origins and development is needed to explain the present
- Kant rejected biblical explanation and timeline



# Humboldtian Science

## Physique du monde, Universal Natural Science

- “the accurate measured study of widespread but interconnected real phenomena in order to find a definite law and a dynamic cause”
- “to discern the constancy of phenomena in the midst of apparent changes.” *Cosmos*
- Nature and the human mind are a unity
- To know nature better is thus to know ourselves better, for knowledge is a deeply human project combining understanding and imagination.

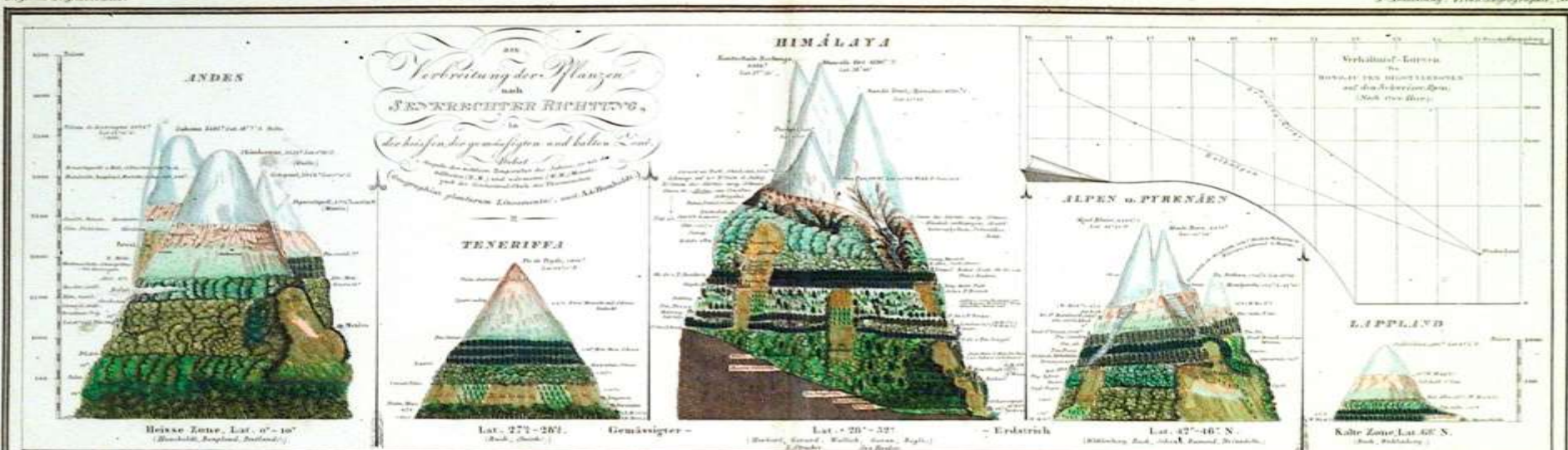


Kant  
1724-1804



Humboldt  
1769-1859

### UMRISSE DER PFLANZENGEOGRAPHIE.



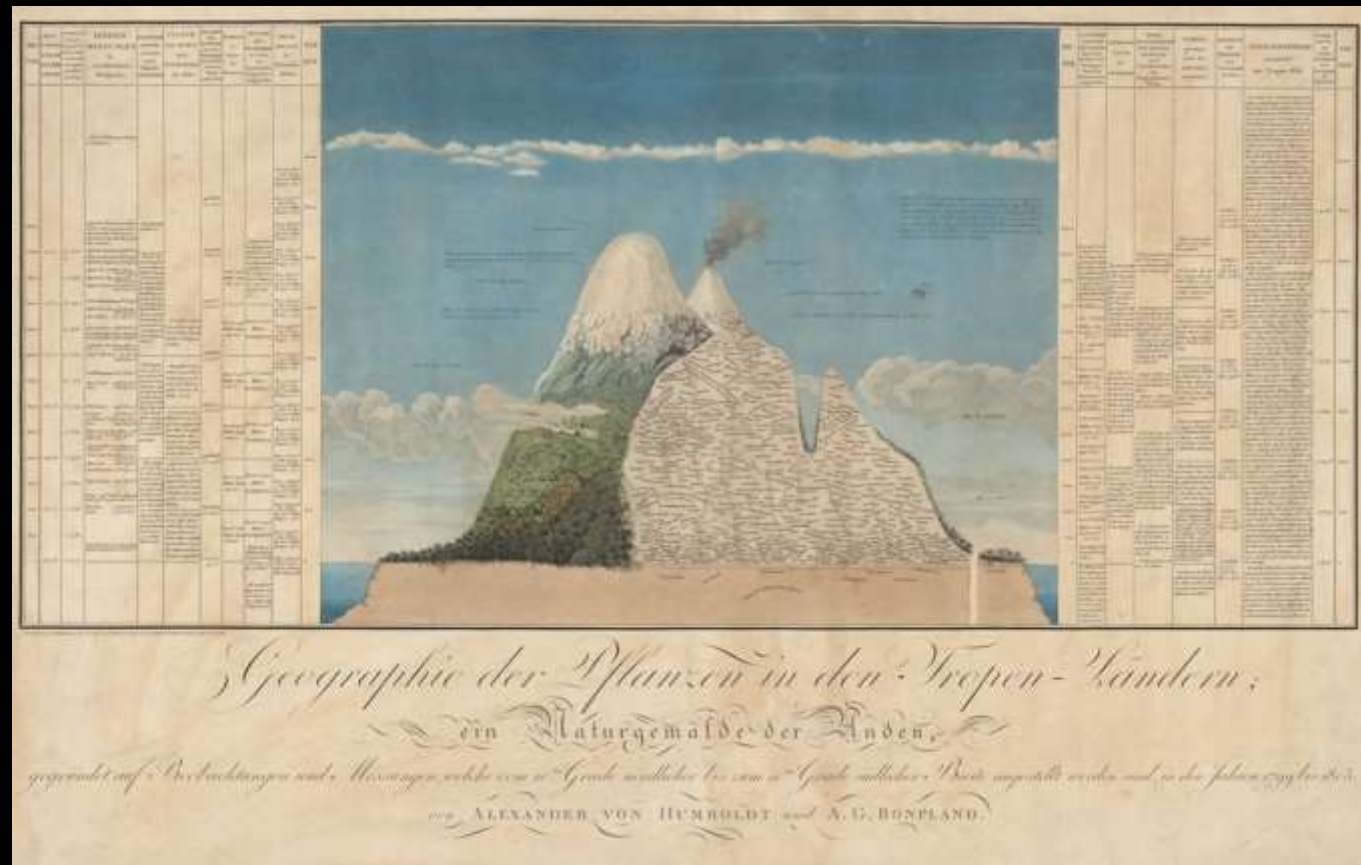
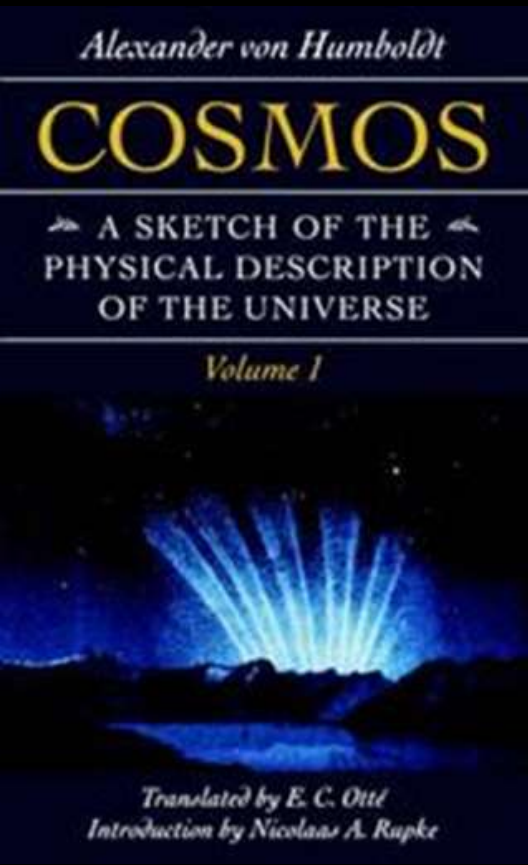


# Humboldtian Cosmos - A Vision of the Unity of Nature

Understanding and Imagination

The Cosmos is both ordered and beautiful.

*Unity in diversity, and of connection, resemblance, and order, among created things most dissimilar in their form, one fair harmonious whole...  
Kosmos, 1845*











Applause

