

Hertford to Hartford Lecture, 2006

Understanding the World, from Aristotle to Quantum Mechanics



The Significance of David Hume

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The Birth of Philosophy



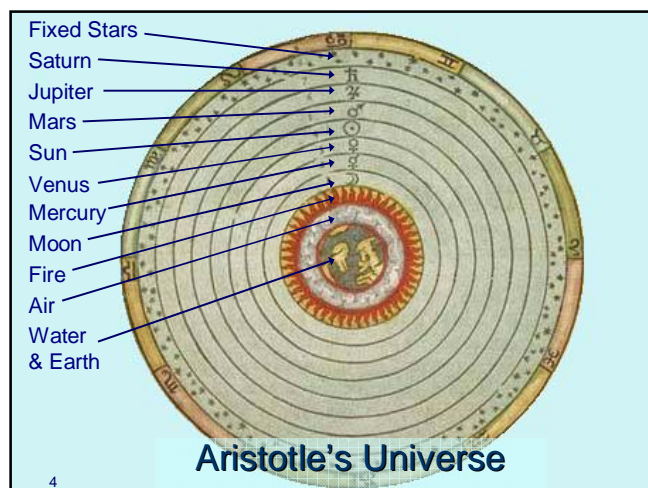
- The ancient Greeks, distinctively, aimed for rational understanding independent of religious tradition.
- Many different philosophers and “schools”:
 - Various “Pre-Socratics” (c. 600 - 400 BC)
 - Plato and his *Academy* (387 BC -)
 - Aristotle (pictured) and his *Lyceum* (335 BC -)
 - Pyrrhonian sceptics (c. 320 BC -)
 - Epicureans (c. 307 BC -)
 - Stoics (c. 300 BC -)

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The Institution of Scholasticism

- Roman Empire became Christianised:
 - Pagan temples and libraries destroyed 391 AD;
 - Non-Christian “schools” closed down 529 AD.
- Plato and Aristotle adopted:
 - Christian Platonism (e.g. Augustine 354-430)
 - Christian Aristotelianism (e.g. Aquinas 1225-74)
- The Christian Aristotelian worldview became dominant in the medieval monastic schools, hence “Scholasticism”.

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Rediscovery of the Classics

- Ancient texts survived in the Byzantine Empire, or in the Arabic world.
 - Manuscripts brought West when the Ottoman Turks attacked, fostered the development of Humanism in Renaissance Italy.
- Printing (invented 1450) gave them much wider circulation, e.g.:
 - Lucretius (rediscovered 1417, printed 1486)
 - Sextus Empiricus (translated into Latin 1562)

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Upheaval and Instability

- Many factors contributed to Western instability in the period 1500-1650, e.g.:
 - growth of population and trade;
 - discovery of the New World (America etc.);
 - consequent economic disruption;
 - realisation that ancient maps etc. were wrong;
 - suggestions of cultural relativity;
 - technology of gunpowder and consequent centralisation of power.

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The Hereford "Mappa Mundi" (c. 1290)

based on the writings of Orosius, a pupil of Saint Augustine, part of a compendium of knowledge to refute the pagans



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The Reformation

- The Reformation added to this crisis:
 - Luther rebelled against the Church of Rome, starting in 1517;
 - Many parts of Europe (especially in the North) became Protestant;
 - Savage wars throughout Europe arising from religious differences (e.g. Thirty Years' War 1618-48, English Civil War 1639-51);
 - Peace "of exhaustion" at Westphalia, 1648 led to greater religious toleration.

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The Problem of the Criterion

- A sceptical problem raised by Sextus Empiricus in his *Outlines of Pyrrhonism*:

How can any criterion of reliable knowledge be chosen, unless we already have some reliable criterion for making that choice?

- Roman Catholics appeal to tradition (Church, Bible, Aristotle); Protestants appeal to the believer's personal response to the Bible;
- How to know who is right? (Maybe neither?!)

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Aristotelian Science

- Elements and Natural Motions
 - Four elements: fire, air, water, and earth.
 - Fire/air naturally move upwards, water/earth downwards, each seeking its natural place.
- A Teleological Physics
 - Strivings, horror of a vacuum etc.
 - Everything strives towards the eternal, hence heavenly bodies move in circles, and must be made of a fifth element, *aether*.

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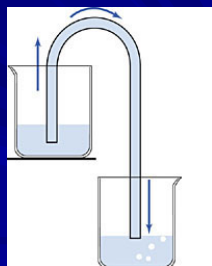
Intelligibility, or Empty "Explanation"?

- "Why does water rise up a siphon pipe?"
"Because Nature abhors a vacuum."

- "Why does opium make one sleep?"

"Because opium has a *dormitive virtue*, whose nature is to stupefy the senses."

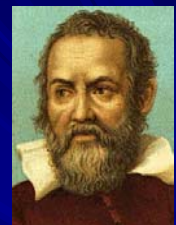
Molière (1673)



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Galileo's Experiments

- Aristotle couldn't explain:
 - the flight of a cannonball;
 - a sledge sliding on flat ice;
 - water dripping from a gutter.
- Galileo suggested (and claimed to have carried out) another critical experiment:
 - dropping a heavy and a light ball together from the Leaning Tower of Pisa.



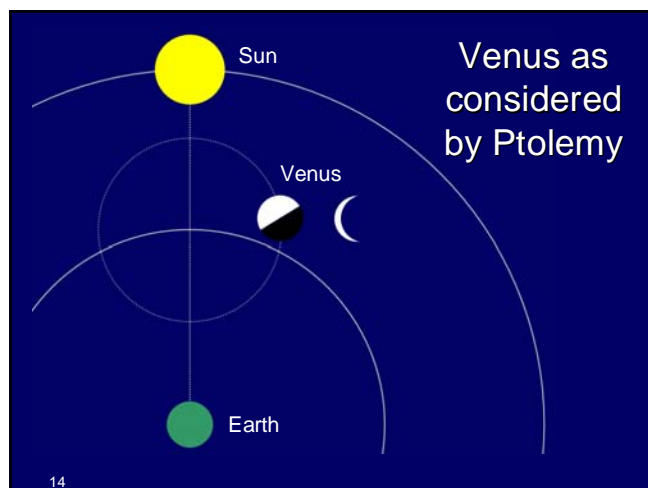
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Galileo's Telescope

- The telescope was invented in Holland in 1608, and Galileo made his own in 1609.
- What he saw with it refuted Aristotle's cosmology:
 - Mountains and valleys on the moon;
 - Four moons orbiting around Jupiter;
 - Innumerable stars too dim for the naked eye;
 - Phases of Venus, sometimes "full" (implying that it is then on the opposite side of the Sun).

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From Final to Efficient Causes

- Aristotelian science was based on purposes, or "final" causation:
 - Things *strive* to reach their natural place, or to avoid abhorrent situations (e.g. a vacuum);
- Galileo preferred "efficient" causation:
 - The outcome depends on where the causal sequence happens to lead.
 - Matter doesn't *strive*; it is *inert*, remaining in its state of motion or rest unless acted on.

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The "Mechanical Philosophy"

- The paradigm of efficient causation is via *mechanical* contact:
 - Interaction between contiguous particles of matter by pressure and impact.
- Compared with the pseudo-explanations involving "occult" qualities (horror of a vacuum, dormitive virtue etc.), this seems:
 - genuinely explanatory;
 - genuinely *intelligible*.

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The Father of Modern Philosophy



- Attacks Aristotle using the sceptical problem of the criterion;
- Builds on Galileo's mechanical philosophy grounding it on a theory of matter's "essence";
- Makes room for mind as a distinct "essence".

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Descartes and Essences

- The properties of matter follow from its essence, simple geometrical *extension* (i.e. extendedness in space).
 - Laws are mathematically expressible (e.g. in the framework of "Cartesian" co-ordinates).
 - Bodies are passive, remaining in the same state (*inertia*) until a force is applied.
- Mind is a distinct, active *immaterial* substance, whose essence is *thinking*.

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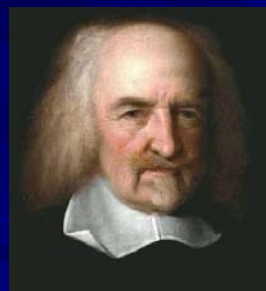
Descartes' Physics

- Since matter's essence is *extension*, non-material extension is impossible. Thus:
 - The physical world is a *plenum* (no vacuum);
 - All motion must take the form of *circuits* of matter within the plenum.
 - This can be expected to give rise to *vortices*, circular motions like whirlpools.
 - A vortex can explain why the planets orbit the Sun without shooting off under inertia.

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The Monster of Malmesbury

(and Magdalen Hall = Hertford College!)



- Hobbes denies
 - immaterial substance;
 - witchcraft;
 - reliance on revelation.
- Hobbes asserts
 - universal determinism;
 - obedience to sovereign in religion and morals.

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Hobbes' Leviathan (1651)



- In the state of nature, the life of man is 'solitary, poore, nasty, brutish and short'.
- The only solution is *absolute* sovereignty.

Materialism and Atheism

- Hobbes sees "immaterial substance" as a contradiction in terms.
 - So everything that exists is material, even God and the angels.
- Many took Hobbes to be an atheist.
 - In 1666 Parliament cited his "atheism" as probable cause of the plague and fire of London!
 - His books were publicly burned in Oxford in 1683, because of their "damnable doctrines".

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The Evils of "Hobbism"

- In 1668, Daniel Scargill of Corpus Christi Cambridge was expelled. In his public recantation, he confessed:

"I have lately vented and publicly asserted ... divers wicked, blasphemous, and Atheistical positions ... professing that I gloried to be an *Hobbist* and an *Atheist* ... Agreeably unto which principles I have lived in great licentiousness, swearing rashly, drinking intemperately ... corrupting others ..."

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Opposing Materialism

- The main *argument* against Hobbist materialism was to insist on the limited powers of "brute matter", which:
 - is necessarily *passive* or *inert* (as demonstrated by the phenomenon of inertia);
 - in particular, cannot possibly give rise to mental activity such as perception or thought.
- This point was pressed by Ward (1656), More (1659), Stillingfleet (1662), Tenison (1670), Cudworth (1678), Glanvill (1682), Locke (1690).

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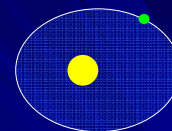
Boyle's Corpuscularianism



- Robert Boyle speculated that material substances are made of imperceptible “corpuscles”.
 - Corpuscles are both extended and impenetrable.
 - Empty space is extended but penetrable. Hence extension is not identical with matter, and a vacuum is a possibility.
- The word “corpuscularianism” avoids the atheistic associations of ancient “atomism”.

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Meanwhile, in the Heavens ...



- In 1627 Johannes Kepler published tables enabling the calculation of planetary positions to an accuracy which turned out to be over 1000 times better than any previous method.
- Kepler's method is based on the hypothesis that each planet moves in an *ellipse* around the Sun (which is at one “focus” of the ellipse).
- The method's sheer accuracy led over time to general acceptance of that hypothesis.

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Newtonian Physics



- Isaac Newton took Descartes' concept of inertia, and Boyle's theory of “atoms and the void”, but postulated a force of gravity acting through it.
 - If gravity acts in inverse proportion to the square of the distance between two objects, and bodies accelerate in proportion to the total force acting on them, then the elliptical motion of the planets around the Sun can be elegantly explained.

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Refuting Aristotle and Descartes

- Newton's theory could also predict – using the very same equations – the motion of cannonballs etc. on Earth.
 - Another nail in the coffin of the Aristotelian supposition that heavenly bodies act differently.
- In his *Philosophiae Naturalis Principia Mathematica* (1687), Newton also proved mathematical results indicating that a vortex could not possibly generate elliptical motion.
 - Descartes' theory was thereby discredited.

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Gravitation and Intelligibility

- Newtonian gravity acts at a distance with no intermediate mechanical connexion.
 - But this is deeply “unintelligible”.
 - Descartes had objected to the idea of gravity as “occult”: one body would have to “know” where the other was to move towards it.
 - Many Newtonians took the operation of gravity to be proof of divine action, a new resource against Hobbist materialism.
 - Newton took a more *instrumentalist* attitude.

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Newton's Methodological Instrumentalism

- Newton's public response to the objection: “Hypotheses non fingo”
 - “I feign no hypotheses”; there's no obligation to invent speculations about how gravity operates (at least until more evidence comes to light giving a basis for more than *mere* hypothesis).
 - If the gravitational equations (etc.) correctly describe the observed behaviour of objects, then that theory should be accepted whatever the unperceived underlying reality might be.

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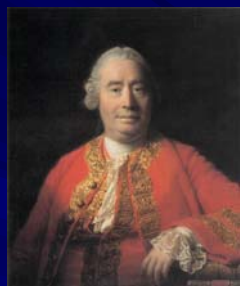
Overview: Intelligibility and Why It Matters

- Aristotle's world is intelligible because it is completely driven by *purposes* – even inanimate objects *strive* towards goals.
- However Galileo, Descartes, Hobbes etc. dismissed this as an illusion:
 - Aristotle's purposes just *describe* what objects actually do – they don't *explain* it at all.
 - Only mechanical interactions are genuinely *intelligible*, enabling us to understand *why* things act as they do.

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- Man is distinctively rational, made in the image of God to understand His universe.
 - Geometric physics gets closest to divine Reason.
- The intelligibility of matter reveals not only its *powers*, but equally importantly its *limits*:
 - Thinking matter is impossible, so there must be an immaterial substance, making the soul potentially independent of the body.
- But gravitation poses a problem:
 - It may show the need for a divine overseer ...
 - ... or that matter has more powers than we can "understand": if gravitation, then why not thought?

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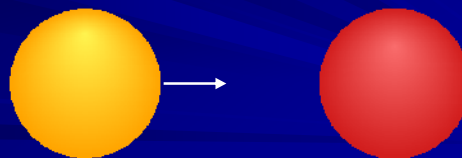
David Hume, 1711-76

- Newton is right to insist that science can be done without intelligibility.
- Gravity is "unintelligible", but *mechanical* causation is equally unintelligible.
- The aim of science is to describe things' observed behaviour as simply as possible, in terms of the fewest possible causes.

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Hume on Mechanical Causation

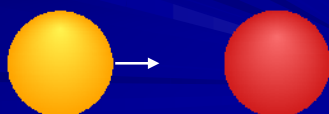
- Suppose we see a yellow billiard ball moving towards a red one and colliding with it. Why do we expect the red one to move?



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A Thought Experiment

- Imagine Adam, newly created by God, trying to envisage what would happen:
 - how could he possibly make any prediction at all in advance of experience?



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"Intelligibility" and Experience

- The "intelligibility" of mechanical causation seems to be an illusion, based on familiarity.
- When we have repeated experience, our expectation comes so naturally that we imagine we could have known – even the first time – what would happen.
- That's wrong: only experience can tell us what causes what. But are we justified in extrapolating this experience to the future?

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Why Expect Uniformity?

- What ground can we give for expecting future events to resemble past events?
 - Self-evidence? No.
 - Logical reasoning? No: neither of these, because it's clear that extrapolation *could* fail, so it can't be a matter of pure logic.
 - Sensory knowledge? No: what we perceive of objects gives us no insight into the basis of their powers, hence no reason to extrapolate.
 - Experience? No: that would be circular.

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Hume on Induction – Negative

- In advance of experience, we cannot know *anything* about what causes what.
 - So experience is *our only basis* for making predictions about the unobserved.
- All inference from experience is based on the assumption that we can extrapolate from observed to unobserved (“induction”).
 - But this assumption has *no rational foundation* whatever! The basis of our reason is animal instinct rather than angelic insight.

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Hume on Induction – Positive

- The Foundation of Inductive Reasoning
 - Scientific (like all empirical) reasoning is founded not on insight, but on a brute assumption *that the future will resemble the past*, for which no solid basis can be given.
- Good and Bad Reasoning
 - But this doesn't mean that all inductive reasoning is equally good (or bad). The wise thing to do is to *reason consistently* with this irresistible brute assumption.

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Example: Miracles

- Why Do I Believe a Miracle Report?
 - Because I have *experience* that reports of witnesses tend to be true. My belief is based on inductive extrapolation.
- Why Shouldn't I Believe a Miracle Report?
 - Typically, the inductive evidence *against* any miracle will be far stronger than the inductive evidence in favour. I have lots of experience of people being mistaken, misled, tricked ...

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Immanuel Kant (1783)

- Hume *has to be* wrong, because we have clear examples of “synthetic *a priori*” knowledge: truths about the world knowable independently of experience, that we see *had to be* that way:
 - Metaphysical principles (e.g. universal causation)
 - Euclidean geometry (e.g. Pythagoras' theorem)
 - Newtonian mechanics (e.g. conservation of momentum).

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Hume's Triumph!

- Einstein's General Relativity (1915)
 - Space is gravitationally “curved”
 - So Euclid's axioms probably aren't true, and they're certainly not knowable *a priori*.
- Quantum Mechanics (1925)
 - Fundamental particles don't work at all as we (or Newton) would have expected: their behaviour is *describable*, but not “intelligible”.
 - Genuine randomness seems to be ubiquitous.

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