

An Introduction to the History of Scientific Ideas in Western Culture

(Talk 2)

From the Greeks to the Enlightenment

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Greek Natural Philosophy and the Judaeo-Christian tradition

- * **Hellenism:** spread of Greek culture from about 333 BC (Alexander) to 63 BC (Roman domination).
Rome continued the tradition.
- * **Birth of Christ:** ... Roman-occupied Israel ... cultural climate ... Greek was the language of educated/wealthy ...

In adulthood, Jesus rejected the Greek culture and established ... in local Aramaic ... a religion for ordinary people living in harsh times ... based on the scriptures of Jewish people of the area.
- * Brief introduction to how these came together over the centuries, and how 'modern' science emerged.
Mention Philo of Alexandria (c 20-40 AD) (Personal view)

Neoplatonism: a spiritual re-awakening of Platonic thought (Plotinus (204-270 AD))

Intro: ... very low period of Roman history, from cities to ends of empire. Material world ... low ebb ... little cause for hope.

Neoplatonism (an impression):

- * There is a great order ... many levels of existence ... with 'The One' (indefinable) at its heart.
- * The **Cosmos** – everything else - is a **divine emanation** (a sort of radiation) from **The One**

Neoplatonism (contd):

- * 1st emanation – called 'nous' by Plotinus – a sort of cosmic intellectual spirit (a universal wisdom, perhaps, containing the world of ideas and more ...)
- * 2nd emanation – from the 'nous' comes the (World) Soul ...

The soul is the author of nature ... beautiful in Plotinus:

'Who that truly perceived the harmony of the Intellectual Realm could fail, if he has any bent towards music, to answer to the harmony in sensible sounds? What geometrician or arithmetician could fail to take pleasure in the symmetries, correspondences and principles of order observed in visible things?'

(Soul is between the 'nous' and the material world.)

Neoplatonism – big influence on development of Christianity

In particular ... understanding of the Judaeo-Christian vision taking hold in the Roman world's Greek cultural environment.

Neoplatonism

Judaeo-Christian

The ONE

God

Structurally
similar

Nous

Son or Logos

Soul

Holy Spirit

All three
transcendental

In Christianity, through Christ, God has made direct contact with the world of the senses ... gives human history a spiritual, not just material significance.

What was transcendent in Greek philosophy has, in Christianity, become immanent: 'And the word became flesh and dwelt among us'. (John, Ch I, v. 14)

* **312 AD** – Emperor Constantine becomes Christian; 380 AD, Roman Empire adopts Christianity as official religion.

* **St Augustine (354-430 AD)** – Plato incorporated in Christianity

Reflecting the spirit of Neoplatonism, St Augustine incorporated/ replaced Plato's demiurge by a Judaeo-Christian God who created the world *ex nihilo*. (Comment on current cosmological models.)

Comments

- * Suddenly ... throughout Roman Empire ... there was a higher power than human leaders – God.
- * This God valued all people equally – rich + poor; powerful + weak; **new!**
- * Every human soul is valued and immortal; how we behave in this world matters in the next **world beyond our senses**.

Comments (contd)

* By fall of Roman Empire – corruption, being over-extended militarily, moral decadence – Christianity was established.

And the **reality** of the **transcendental world** seemed much more important than that of the decadent **material world** that had failed.

So ... Church became super-powerful in the void left behind. Even the pagans who sacked Rome became Christians.

Then for centuries, the **metaphysical idealists (now the Church)** had a period of dominance.

* Should try to comment on the legacy (-ve and +ve) of all this on the development of Western civilisation. (Whew!)

(Tarnas pp. 167-70)

What about the teachings of Aristotle?

- * While the **Christian Church** was establishing its authority, **matters concerning the nature of the physical world** were 'on hold', largely in the hands of Islamic scholars who maintained and extended the **works of Aristotle**.
- * By about 1000 AD ... Church more relaxed about discussing the world of the senses:
 - machines ...ploughs, windmills ...
 - trade with Islamic world established ...
 - barbarian Christian world adopted the growing materialism ...

Gross oversimplification of nearly a millenium ... St Thomas Aquinas!

St Thomas Aquinas (1225-1274 AD) – Aristotle enters Christianity

* Renewed interest in compatibility of **Christian thought** and **Greek natural philosophy (Aristotle)**

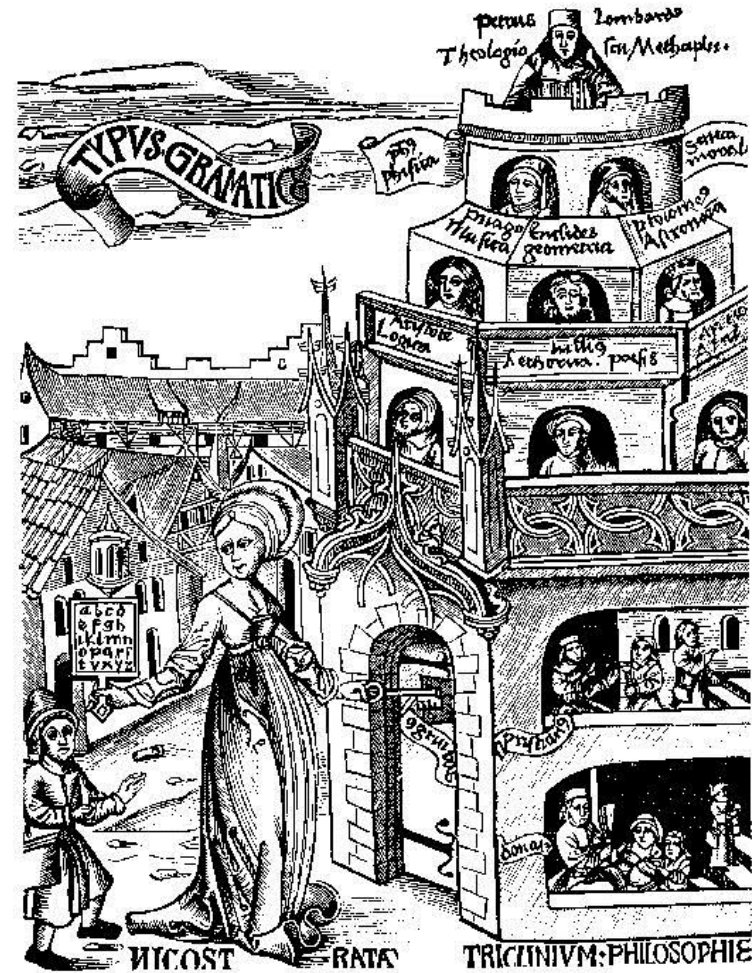
* TA argued that knowledge (in particular of God, main aim of learning at this time) comes from two sources:

- Reason (using sense information)
- Faith and Christian Revelation

Both come from God who cannot contradict himself; so they must be in agreement.

TA came up with a grand, inclusive, hierarchical, philosophical scheme:

* Describe it



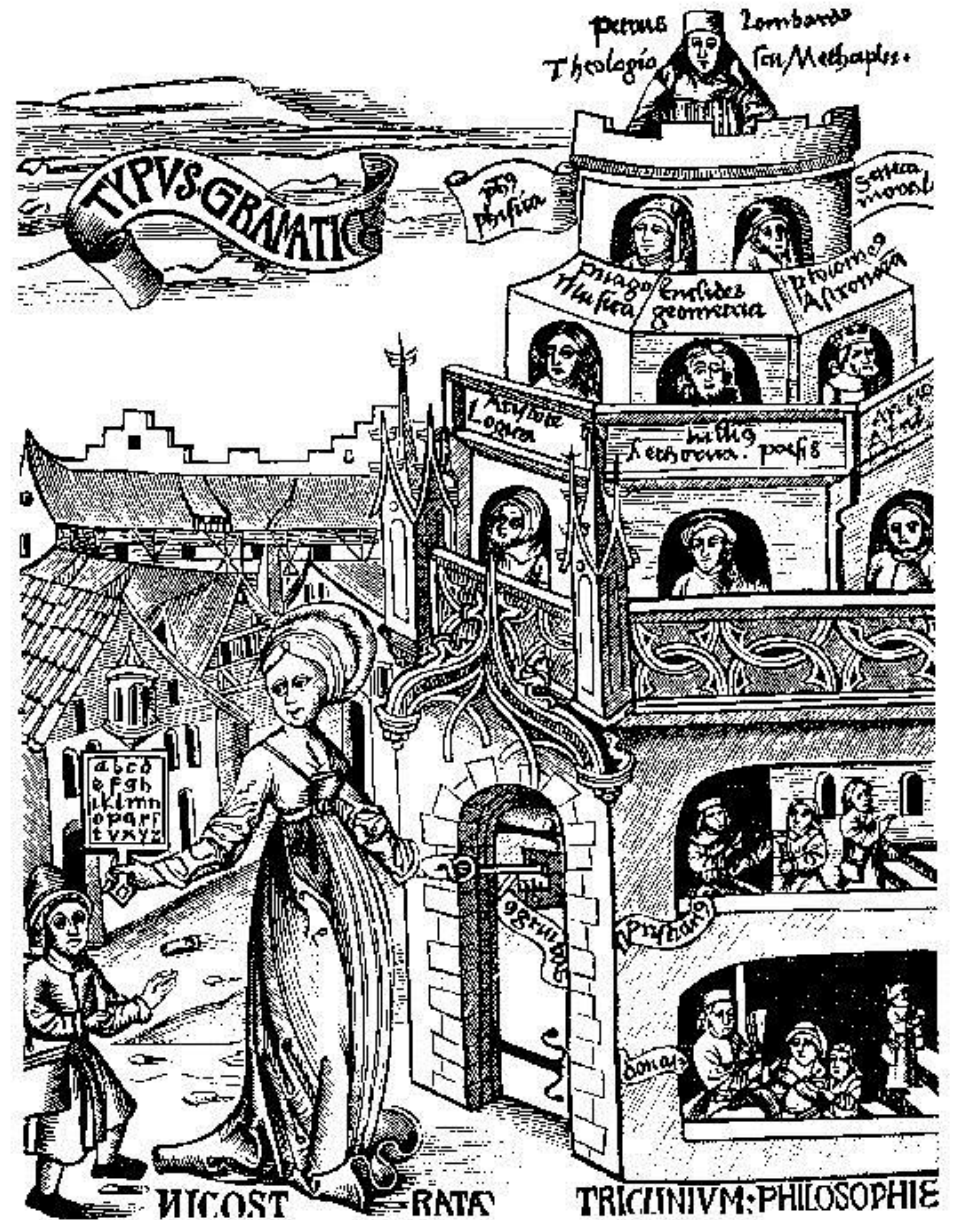
Representation of Medieval Learning

- * Ptolemy's astronomy
- * Medicine of Galen
- * Logic of Aristotle ('science')
- * Theology – Queen of the Sciences

Everything in TA's scheme had its place in the divine hierarchy:

- * Animals: lion lowly worm
- * Materials: gold ... dust
- * Regions: heaven ... earth

See Christian Aristotelian cosmos from *Cosmographia* by Peter Apian (1524)



* Earth – heaviest, most imperfect at centre;
surrounded by water, air and fire.

* Celestial realm – starting with moon
eventually reaching the
Empyrean heavens.

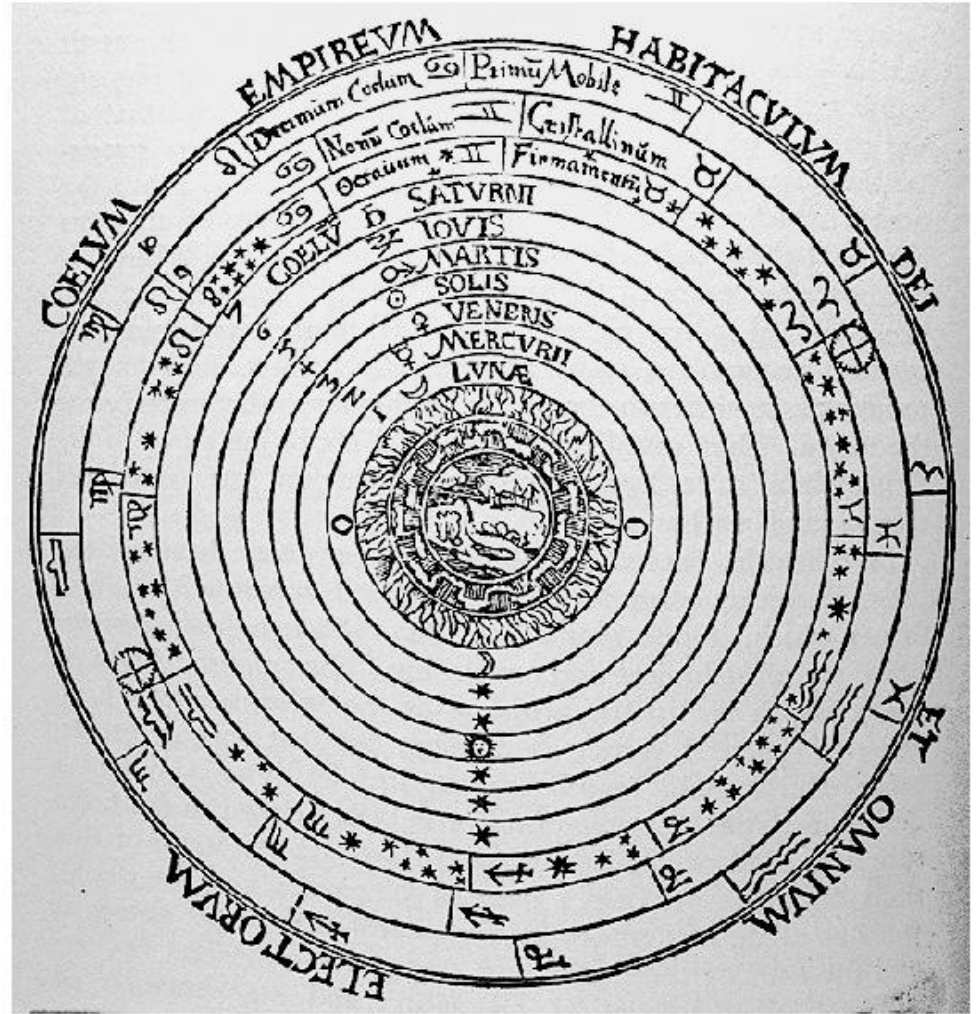
Judaeo-Christian God (not Prime Mover).

Departures from this order were linked
with disasters:

‘... these late eclipses of sun and moon
portend no good to us.’

King Lear by Shakespeare (c 1605)

Shakespeare is full of rich references
world view of Aristotle/Aquinas.



Comment on Aristotle's Natural Philosophy

- * Was he really the empiricist he claimed to be or was he a metaphysical idealist?

Discuss (a) Plato's problem on the motion of the planets; (b) earthquakes.

- * So the physics (as we now know it) that Aquinas built into his philosophy was wrong.
- * However, the view had been growing, within the C13th Church, that there was another way to gain knowledge of God – by examining his creation in detail: Nature cannot lie!

The scientific baby was kicking in the womb 3 centuries before it was 'born' (traditionally associated with Galileo).

How did science progress from Aristotle?

Shortly after Aquinas, Aristotle was being questioned:

- * Roger Bacon in *Opus Maius On Experimental Science* (1266):
 - ‘... I wish now to review the principles of wisdom from the point of view of experimental science, because without experiment it is impossible to know anything thoroughly.’

(Compatible with the neoplatonistic view of nature as being good.)
- * Bishop of Paris (1277) condemned Averroists (radical followers of Aristotle) for proposing that heavenly bodies could not travel in straight lines – implying that the Creator had limited powers.
- * Soon, view emerged that a logical, mechanical universe could be seen as a manifestation of the power and intelligence of the Creator:

Oresme (1323-1382), building on impetus theory of Buridan (1300-1358):

‘God, when He created the world, moved each of the celestial orbs as He pleased, and in moving them He impressed upon them impetuses which moved them without His having to move them any more except by the method of general influence whereby He concurs as co-agent in all things which take place.’

Translate into everyday English!

Freeman Dyson (Princeton Institute for Advanced Studies)

‘It is probably not an accident that modern science grew explosively in Christian Europe and left the rest of the world behind. A thousand years of theological disputes nurtured the habit of analytical thinking that could be applied to the analysis of natural phenomena.’

Science grows during the Reformation

- the Rise of Causality

- * **Reformation¹** – protestant reform movement (Calvin, Knox – Geneva!)
 - Biblical revival – translation of Bible into ordinary language
 - Improvement in intellectual and moral standards of clergy
 - Emphasis on sovereignty of God
- * **Why did science take off during the Reformation? Why not 2000 years earlier in Athens; or Babylon, China, Egypt, India ...?**
 - Some felt spirit of Reformation was significant – new intellectual freedom gave impetus for sceptical secular tradition to try to re-assert itself.
 - Einstein – not right question – why did science ever take off?

¹ *Cambridge Encyclopaedia*

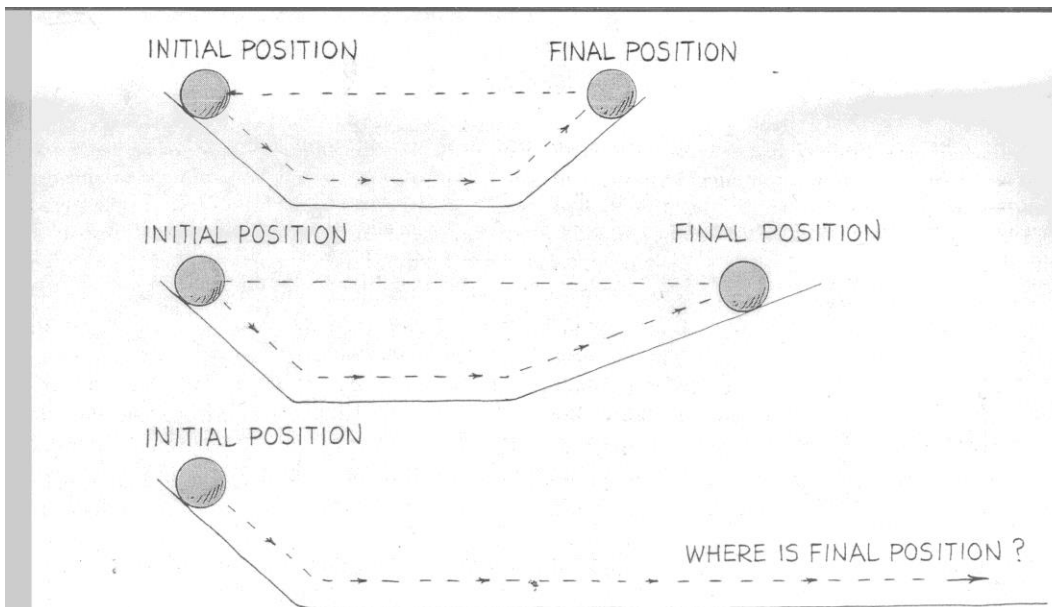
The Rise of Causality

- * **Causality**¹ – word that entered philosophy via science after Newton:
 - describes relationship between events in terms of the application of a ‘law’
 - implication: nature is predictable because these ‘laws’ exist
- * Idea that a similar causality applied outside physics was a cornerstone of the Enlightenment.

¹ For our purpose today!

Galileo (1564-1642) – key experiment

- * Fast-forward past Copernicus, Brahe, Kepler and Galileo's own amazing astronomical discoveries.
- * Discuss this experiment:



Conclusion: object will continue to move
In a straight line with a steady speed.

**Forces produce changes
in motion/acceleration.**

(cf. Greeks: forces
produce motion/velocity)

* Developed by Newton in his *Principia*: $F = ma$

* ‘Strict’ causality: if at some instant we know

- an object’s position;
- its speed and direction of motion

then, using $a = F/m$, which tells us how an object’s motion is changed by a force, we can predict its subsequent motion, moment by moment.

* Laws of Nature: spectacular success of Newtonian mechanics ... elegant maths ... led to his laws being regarded as ‘*universal laws of nature*’. Discuss

* Laplace’s famous boast: given at some instant the position and velocities of all particles, he could predict the future of the universe.

Comments on What is science? and the Laws of Nature

Galileo: ... long way towards defining science on introducing

- * **primary or measurable qualities**: things all 'reasonable' people could agree on – number, length, weight ...
- * **secondary or immeasurable qualities**: things more dependent on the mind of the observer – taste, colour, ...

An example of Galileo's science: measured how distance d travelled down a slope depended on the time t :

Found relationship could be described by a 'law': $d \propto t^2$

(Very much in the spirit of secular scepticism – see how one quantity depends on another by means of experiment – no big picture.)

However, as we've seen:

Comment on $d \propto t^2$

This 'law' is different in an essential way from previous efforts to describe the world, which were 'holistic' – in the sense of being attempts to provide a narrative in terms of which everything could be described – e.g. the universe as a living organism (Aristotle/Aquinas) with meaning and purpose. Both material and spiritual worlds are included – the immanent and the transcendent.

People were asking limited questions about the natural world, questions that nature (experiment) could answer, such as, 'How does d depend on t ?'. Questions such as this yielded lots of partial truths which may or may not have been connected in a holistic way. This is very much in the spirit of secular scepticism

Then something amazing happened!

(1) Newton's 'laws' were so spectacularly successful – describing both the terrestrial and celestial spheres of the Greek world – that they became 'elevated' in status, more in the spirit of metaphysical idealism:

The universe 'possesses' an intelligence that is accessible to human awareness, if that has been developed to a high enough degree.

Do $F = ma$ and $F = GMm/r^2$ not exemplify such awareness?

(2) The same secular sceptic (non-holistic) approach led to further universal schemes such as electromagnetism and thermodynamics.

A non-holistic approach yielding holistic results!

But:

This new holistic picture was completely different in nature from the old ones – it was **physics** as we now know it – holistic with caveats!

Based on many limited questions relating **measurable** quantities, this picture can only describe the (immanent) material world. No place for the ‘soul’ or God or any (transcendental) non-material in the day-to-day activities of science – so Christians, Muslims, Jews, Hindus ... as well as atheists, can work harmoniously at CERN, not knowing what the others **believe** about the things science cannot touch.

So, to suggest that science cannot be compatible with religion is to **misrepresent science** – we shouldn’t do it!

Very different from Aristotle’s universe where science and religion were intertwined.

Philosophers set out to apply Newton's methods beyond the material ('outer') world, in the ('inner') worlds of the human mind:

Plan: - to formulate general laws on the basis of observation ('inner ' and 'outer'), and
- to deduce specific conclusions from such laws.

Isaiah Berlin

Condorcet: human and physical events were 'equally susceptible to being calculated and all that is necessary to reduce the whole of nature to laws similar to those which Newton discovered with the aid of calculus, is to have a sufficient number of observations and mathematics that is complex enough'.

IB commenting on the Enlightenment

A wider thesis underlay the Enlightenment:

- To all true questions there must be one true answer, and only one, all other being false.
Otherwise, questions cannot be genuine questions.
- There must be a path which leads clear thinkers to correct answers ... as much in the moral, social and political worlds as in the natural sciences ...
- If the answers to these questions – the truth – are discovered ... men will follow them, for there would be no temptation to do otherwise.

And so a perfect life can be conceived ...

(The 'heaven' of the new secular religion based on reason and observation.)

Isaiah Berlin (contd):

This creed was not confined to Enlightenment thinkers. In various forms it has been in Western thought from the pre-Socratics ... if no true answers to questions exist, how can knowledge be attainable in any province? This was heart of rational, and indeed spiritual, thought for many ages.

I do not know why I have always felt sceptical about this almost universal belief, but I did.

Now set up for discussion of C20 science (QM)

Comment on **Enlightenment** – updated version(s) of pre-Socratic/Sophist thought – experience and reason central to knowledge and morality – humanism.