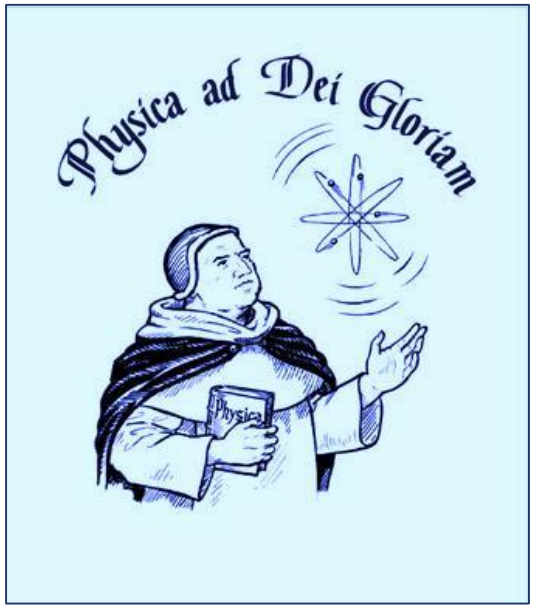
Science before Science Study Group

Week Thirteen



St. Thomas Aquinas,
Pray for us.

St. Albert the Great,
Pray for us.

Prayer before Study

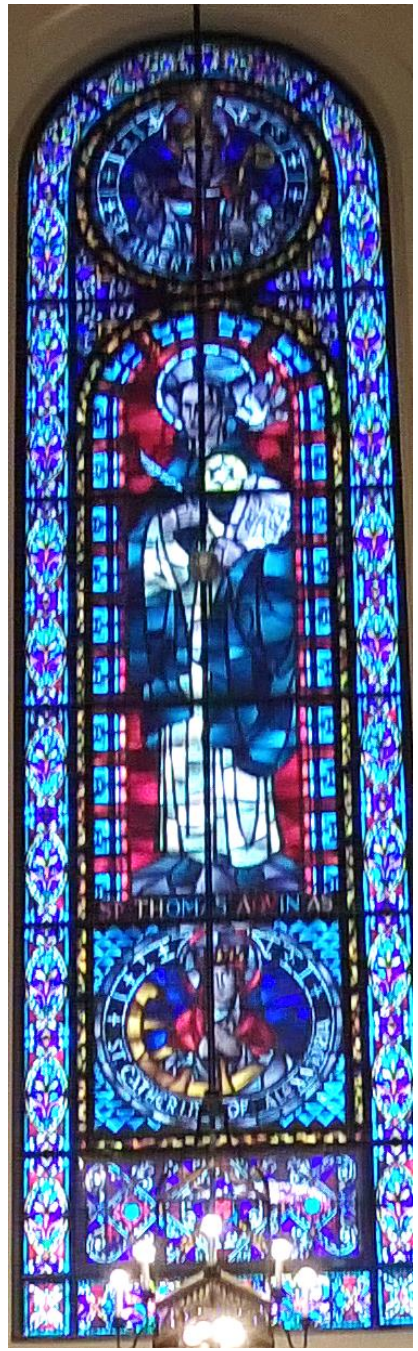
Almighty God, You who are the creator of all things and our loving Father, send us Your Holy Spirit to illuminate our minds so that we can understand how You have revealed Yourself to us through the world around us.

Grant to us
keenness of mind
capacity to remember,
skill in learning,
subtlety to interpret,
and eloquence in speech.

May You guide the beginning of our work, direct its progress, and bring it to completion.

We ask this through Thy Son, Jesus Christ, Our Lord.

Amen



Chapter 6: Summary

- Galileo versus St. Thomas – problem of our cultural milieu
- Three levels of abstraction – *physica, mathematica, metaphysica*
  - How Descartes, Einstein and Aristotle views the world
- The division of the sciences
  - Pure, Applied and Methodological Sciences
- Modern physics in part of *physica* – a tool !
  - A mixed science – formally mathematical and materially physical
  - Understand changeable being as quantitative – empiriological
- Empiriological versus Ontological
  - Ontological ascend to the intelligible (the essence)
  - Empiriological descend to the observable

Chapter 6: Summary (continued)

- Nature of physics
  - Water waves and light waves
  - Light is both extended and a particle!
  - Water waves – metaphor for light – we have same mathematics representing two totally different phenomena
  - Approximate character of measurements
  - Ontological explanations of empiriometric results can change quickly and drastically
  - Work of trying to establish the ontological ground of the empiriometric is little done
- Kant’s Attempt to Ground Modern Physics: Kant’s Gödel's Theorem
  - Take the empiriometric as the whole of *physica*
  - Basically proved Gödel's theorem 150 years before Gödel
  - Empiriometric physics cannot prove its own foundations
  - Easy to take the empiriometric construct to have everything – forget what was left behind
  - Metaphor of people who are experts at chess – explaining all things in term of chess
  - Mathematics is abstracted from the real that empiriometric science is so powerful

Chapter 6: Summary (continued)

- Mathematics
  - St. Thomas – is connatural to man – easy mode for man's nature – resolved in the imagination – more comfortable at lower levels of thinking
  - The less a thing the closer to the first property – quantity – the more it can be described by mathematics
  - The four causes in mathematics – formal, material, efficient and final
    - Lack of final causality in mathematics means there is no good in mathematics
  - Motion in mathematics? Time is treated as if all moments existed at one time.
    - Modern physics – return of Parmenides error
  - Three pitfalls: serial thinking, algorithmic thinking and beings of reasons
- Chemistry and Biology
  - As these subjects become more complex systems – empiriometric becomes less and less effective
  - More properly ruled by the empirioschematic

Chapter 6: Summary (continued)

- Modern science is radically different from what came before
  - Yes and No
- Galileo was largely responsible for its birth
  - Galileo had many who came before him in the middle ages (e.g. Buridan)
- Catholicism is intrinsically opposed to modern science
  - Modern science was possible because of the beliefs of Christianity
- Galileo was first to argue that man could hope to understand how the world works
  - Medieval were known to have the following motto - that God has ordered all things by weight, measure and number
- Galileo was first to argue that we could understand it by observing it
  - This is blatantly false for Aristotle's dictum was that all knowledge comes through the senses

Chapter 6: Summary (continued)

- Is modern science radically different from what came before it?
  - Yes and no
    - Yes – Newton's theory was first full empiriometric theory – and whole areas of investigation were brought under it (motion, planetary motion)
    - Not a sudden thing but a culmination of much work done in the Middle Ages
    - No – because St. Thomas and Aristotle know and used all areas including the empiriological (mixed sciences)

Chapter 7:
From the Big Bang and Time Travel to Evolution - Summary

Inertia

- Error in taking the empiriometric directly as ontological (explanation of the real)
  - Motion and rest are the same thing
  - Existence of inertia means that motion does not need cause
  - Rest and motion – two states of being not really fundamentally different
    - They are purely relative
    - One man's rest is another man's motion
- Triply wrong
  - Ontological identification of motion with rest (errors of Parmenides/Heraclitus)
  - Cannot overturn fundamental principles of basic physica because the empiriometric depends on them
  - Error of using the empiriometric directly as ontological
- Unwind the truth to see fundamental philosophical truths at work!
  - Uncover rudimentary history of concept of inertia
  - Need culture with certain beliefs

Inertia (2)

- First discovery of physics beyond the fundamental physics of Aristotle
  - Inertia – first an ontological solution – problem of local motion
  - Then expanded through empiriometric study
  - Ontological notion of inertia is what became Newtonian physics
  - Ontological and empiriometric are intertwined
  - Let's start with empiriometric view and it will lead us back to the ontological notion
  - We will give a viable ontological notion of inertia
- Start with empiriometric notion – let it lead us back to the ontological
- Inertia – tendency of a body to remain in its state of rest or uniform motion unless acted on by outside force
  - Distinguish two pieces of inertia – momentum and energy
    - Momentum is a vector law – six types
      - Back and forth – quantitatively they add and substract
    - Energy is scalar
    - Conservation – never lost or gained!
      - Back and forth versus up and down – are separately conserved
    - Need both to 'constrain' colliding objects
      - E.g. pool ball - (1,0) – (-3,4) still conserves momentum!
      - Need the energy to constrain the problem

Inertia (4)

- Notice equivocal use of word “constrain”
  - Have we explained how it happens?
  - Mathematics can’t cause anything
  - We have not found the cause
  - Using language – many get confused
- What causes the above behavior?
  - An ontological question
  - What makes it keep going?
    - What does it mean to keep going?
- Motion is process of reducing something from potentiality to actuality by means of some agent
  - Ball is not everywhere at once!
  - Agent – efficient cause
  - What causes motion after you let go of throwing a ball?

Inertia (5)

- Aristotle
  - Air somehow moves it
  - For planets – moved by special separated intelligent beings
  - Two solutions – both violate his dictum
    - That things must start from the senses
  - Influence of pagan culture in which Aristotle lived – eternalism
  - Aristotle – fell prey to idea that world has an absolute necessity
    - This is an *a priori* approach
    - Counter again to Aristotle – all knowledge comes through the senses
- Criticism
  - Came from Catholic culture
  - John Philoponus (490 – 570 AD)
    - Could not have God given planets a kinetic force – just as heavy and light things?
    - Also thought that stars were made of ordinary matter
    - By emphasizing the freedom of God with respect to creation – guards against thinking that the world has an intrinsic necessity
- Guard against intrinsic necessity and *a priori* explanations
  - Listen to Aristotle's dictum – all comes through the senses
  - One cannot just abstract top-level principles and then deduce the universe as it is
  - Particulars are not contained in the abstract
    - Observation/experimentation are indispensable part of physics

Quote – John Philoponus

Catholic culture,[324] John Philoponus of Alexandria (c. 490 – 570 A.D).[325] Stanley Jaki says:

> *Aristotle's theory of motion did not lack critics in classical antiquity, but none of them was as incisive as Philoponus....*
>
> *Against ... [the] claim that all celestial bodies were moved by angels, Philoponus ...[says,] in view of the omnipotence of the Creator, 'could the sun, moon and the stars be not given by God, their Creator, a certain kinetic force (kinetike dunamis) in the same way as heavy and light things were given their trend to move...?'*
>
> *...such a question struck as much at the roots of Aristotelian cosmology as did Philoponus' insistence that the stars were not made of the ether but of ordinary mater (fire); that they differed in colour....*[326]

Inertia (6)

- John Buridan of Paris - High Middle Ages

The High Middle Ages, or High Medieval Period, was the period of European history that commenced around 1000 and lasted until around 1250.

In the high Middle Ages,[328] John Buridan of Paris (before 1300-1358) attacked Aristotle's contention that air keeps an object in motion.[329] He said take the case of a

> *... hoop and mill wheel,[330] if you should say that the surrounding air moves so great a weight circularly after a man ceases to move it, I would object. Because if you should take a rag and wipe the contiguous air away from the wheel, you will not stop the wheel in this way... If the air which I set in motion when I throw a stone can move the stone, why will it be that if I blow the air at you as swiftly as I can without the stone you can hardly feel it?*
>
> *Therefore... the mover impresses on the moved thing not only motion, but along with it a certain impetus or some force or other quality—not the kind of force we usually mean by that name--which impetus has the nature of moving that thing on which it is impressed, just as a magnet impresses on iron a certain force moving the iron to the magnet. And the more swift the motion the more intense the impetus will be. And this impetus in a rock or arrow is continually diminished by the resistance contrary to itself until it is no longer able to move the projectile.*[331]

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[326] *Science and Creation*, pp. 186-187.

[327] Of course, the universe is, as we've seen, self-consistent and hangs together in a very tight way with universal laws; this follows from its being (i.e., intelligibility or rationality). We will discuss the universe more in a later section of this chapter.

[328] The high Middle Ages reinvented this idea, under the influence of the rebuilt and re-emerging Catholic culture, before having access to Philoponus's work.

[329] Like nearly all the scholars in the Middle Ages, Buridan took Aristotle as the place to start in science. St. Thomas's canonization (just 50 years after his death) helped insure respect for Aristotle would continue.

[330] In his text, one page before this quoted section, Buridan argues that the mill wheel would continue forever if there were no forces of resistance to slow it down and eventually stop it. He goes on to say that, "...it would not be necessary to posit intelligences to move the heavenly bodies." He argues God gave them an impetus that they would always retain, because of lack of resistance (now called friction).

He further demonstrates impetus theory and explains the air's role in local motion. He says:

> *One who wishes to jump a long distance drops back a way in order to run faster, so that by running he might acquire an impetus which would carry him a longer distance in the jump. Whence the person so running and jumping does not feel the air moving him, but rather feels the air in front strongly resisting him.*[332]

John Buridan – just after St. Thomas

- Buridan even says that impetus is proportional to the mass and the speed of the object!

Pierre Duhem on Thomas Aquinas

If we left the impression that St. Thomas did not contribute to mechanics,[333] we will correct that impression here. Pierre Duhem notes that in St. Thomas,[334]

> *For the first time we have seen human reason distinguish two elements in a heavy body: the motive force, that is in modern terms, the weight; and the moved thing, the corpus quantum or as we [Newtonians] say today the mass. For the first time, we have seen the notion of mass being introduced in mechanics and being introduced as equivalent to what remains in a body when one has suppressed all forms in order to leave only prime matter quantified by its determined dimensions...St. Thomas...came to distinguish three notions in a falling body: the weight, the mass, and the resistance of the medium...*[335]

HISTORY OF SCIENCE

Pre-Socratics: *Pythagoras (c. 469-c.569 BC), Heraclitus (c. 540-c.480 BC), Parmenides (c. 510-c.480 BC), Democritus (460-370 BC)

Socrates->Plato (pupil of Socrates 470-399 BC) (427-327 BC) → Academy at Athens

Pupil — Eudoxus of Cnidus (408-355 BC)---Pupil of Plato

Aristotle (384-322 BC):
Conception of Science
Seed planted
Founded Lyceum Research Center:
Theophrastus (d. 287 BC)
Strato of Lampsacus(d. 270 BC)

Pupil

Demetrius of Phaleron (student of Aristotle) Founds Museum Research Center, Alexandria for all **HELLENISTIC SCIENCE** (297 BC to 500 AD):

*Euclid (325-265 BC)
*Aristarchus of Samos (310-230 BC)
*Archimedes (287-212 BC)
Strato of Alexandria (268 BC)
raindrop effect and objects move more swift as they approach the ground
*Eratosthenes (276-194 BC)
*Hero of Alexandria (c 62 AD)
*Claudius Ptolemy (85-165AD)
Hipparchus (190-120 BC)

Epicurus (341-270 BC)

Seed Dies

Roman Period (100 BC-300 AD)
Interested in practical, not knowledge for its own sake.

Constantine's Rome....slow fall of West
As the Barbarian take over of Roman institutions proceeds, Christian science only gets rudimentary start:
Philoponus (before fall and Muslim take over leave it splintered)
Seed planted again

Muslim Period (700-1250 AD)
Take over Christian learning and assimilate Greeks
Seed dies
(when Islamic Theology finally gains ascendancy in the heart of the culture with its disbelief in secondary causality).

1100-1250 AD *First robust conception of science*
Culture is able to receive it
Christianity finally is able to form its own distinctive culture. First Universities in the world founded.
University of Bologna, (before 1080), Paris (1150), Oxford (1167), Cambridge (1209), Padua (1222), Naples, Sienna, Rome, Prague, Vienna, Florence ...
Fibonacci, *Grosseteste, Albert the Great, Jordanus, Roger Bacon

c. 1250 AD *Thomas Aquinas clarifies and fills out unstated conclusions of Aristotle's understanding of science based in the material world.*
All medieval universities required a basic knowledge of Greek science and the schools of medicine had advanced study of science.

1250-1600 AD *Growth of Science*
including Copernicus's powerful summary of arguments for heliocentrism
*Thomas of Bradwardine, de Marchia , *Heytesbury, Dumbeleton, Swineshead, Theodoric of Freiberg (optics), *Jean Buridan, *Nicole d'Oresme, *Albert Saxony, George Peurbach, Regiomontanus), *Copernicus, Toscanelli, *Domingo de Soto, *Tycho Brahe, *Johanus Kepler, Gilbert

Black Plague
1350-ended 1690? (killed 1/3 to 1/2 of Europe

1600-1800 AD **Era of Newton**
The Scientific Revolution
*Galileo, *Descartes, *Newton, *Hooke, Boyle
Power of Empiriometric for first time seen in Newton's simple equations that describe gravity and motion here and in space.
Power of isolated empiriometric method opens up possibility and temptation to ignore physical in its full sense.
Problem appears: Humanists, and through them the culture, take this to mean triumph of mechanism and idealism. Kant demonstrates the logical consequences of taking the empiriometric method (in particular as given in Newton) as a starting point.
17?? The Enlightenment takes empiriometric science as its standard bearer.

1800-2000 AD *The Scientific Revolution Advances*

Maxwell, Darwin, Einstein, Bohr, and others give Electricity and Magnetism, Relativity, Quantum Mechanics, Electroweak Theory and much more, including String Theory.

Each success of the empiriometric method apparently confirms the mechanical and philosophical idealism and thus the Enlightenment program. Increasing number of elite adopt Enlightenment views.

2003 – ? AD
Reestablishment of Science on Critically Physical Foundation

Ontology of Inertia (1)

- Remember
  - The empiriometric hides as much as or more than it reveals!
  - Lower certainty of these principles relative to the first principles and sense data
  - To begin we used only reasoning from our common experience – immediately accessible to the intellect and senses
- Ontology import of inertia
  - Any body has the potentiality to receive and when is has it, to give a quality called impetus
    - This quality is a mere accident (i.e. not one arising from the substance)
  - The measure of the body's resistance to impetus is called its (inertial) mass
  - The momentum is a measure of the intensity of the impetus

Ontology of Inertia (2)

- During a collision – need measure of a body's ability to act as an agent – to give its impetus away
- We need to introduce another quantity – ***dynamis*** and call its (measured) intensity energy
- Obviously dynamis and impetus are intimately related
  - Dynamis appears to be a higher more general quality (can cause heat or impetus)
  - Kinetic dynamis (related to motion) and caloric dynamis (related to heat)
  - Caloric dynamis is practically always present to some degree in collision
  - Kinetic dynamis can be converted to caloric dynamis
  - In elastic collisions – both the intensities of kinetic dynamis and impetus are conserved
- Ontological explanation – only a likely one - not certain
  - Measurements mediated by mathematics
  - Need to take into account special relativistic laws which modify the Newtonian ones
  - Empiriometric then moves one further from the ontological
    - Have mass-energy conservation – the two are interchangeable
    - Concept of energy is generalized to included some sense the motion (momentum)
    - Absurd to say a body moving is the same as a property of the body! They get intertwined empiriometrically

Relativity: Time and Space

- Jacques Maritain
  - Einstein and Heisenbery liberated modern physics from philosophy
    - Not that philosophy isn't important
    - But empiriometric not longer accountable to answer to philosophy!
- Relativity – completely left behind ontological notions – the distinction between space and time
- Three notions – space, time and relative motion

Relative Motion

- Start with what is called Galilean relativity
  - Both Galileo and St. Thomas recognized relativity and perception of motion
- Newton
  - Use dynamics and astronomy developed in previous 400-500 years
  - He discusses relativity of motion
    - But in fact time and space were absolute
    - An empiriometric hypothesis
    - ***Space and time have no meaning apart form matter***
- Imagine only two balls in the universe and an observer (of arbitrarily small size and mass) sitting on a ball
  - How does observer decide which ball is in motion?
    - Empiriometric person would say it makes no difference!
      - Only interested in finding measurements that the observer can do
      - But ontologist (physicist in the broad sense) – something can't move unless something reduces it from potentiality to act.

Angel Eye View

- Place is one the categories of accidental being
  - Common place is its relation to the immediately surrounding material things
  - With just two balls – only can reference to the other ball
  - How does the observer decide when an object is in motion
  - Given the mass and relative speed of each he can deduce where they would originate if they had stared as one joined body with a certain amount of dynamis available for conversion to impetus
  - This is the point of rest from which motion should be measured
  - We have look from an “angel eye” point of view
    - Which our observer doesn’t have
    - To measure it we must in some way be able to sense the balls
    - We need the equivalent of light

Special Relativity

- How Einstein look at the problem
  - More empiriometric than Newton
  - He considered how actual measurements could be done
    - And how to correlate the measurements mathematically
- Consider a clock on a train platform – audibly says the time every second
  - There is a departing supersonic train
    - At first person on train will hear time in same way as some one of the platform
    - As train speeds up the clock sound will take more time to get to the train
    - As the train go to supersonic speeds it will appear that time is going backward
      - The train catches up with 'times' emitted before he left
    - Example of difference between empiriometric correlation of measurements and ontological realities
    - In one way Einstein is less empiriometric than Newton
      - His requirement that one consider how measurements are actually done caused him to maintain the reality of the connection between time, space and matter
    - All empiriometric science ties up ontological entities in beings of reason (so as to coordinate the measurement using the mathematics)
    - It is very hard if not impossible to unravel it

Forward Time Travel (Special Relativity)

- Time slows down when one moves – famous twin paradox
- Upsilon – 50 light years away
  - Travels at 0.9806 times the speed of light
  - Time as determined by stay-at-home twin is 102 years
  - Take 10 years to go and 10 years to come back as measured by the traveling twin
  - When traveling twin returns – he is only 20 years older and most of the people he knew are dead (or very old)
  - Has he traveled forward in time? How do we understand this?
  - Empiriometric is very good at prediction; not designed for telling you what really (ontologically) happened!
  - If forced, the empiriometric physicist – he will use concepts used in the empiriometric – explanation will be highly mechanistic – will neglect other categories in favor of the first accident – quantity.
  - We must try to resolve the conflict between empiriometric and ontological

Resolving (1)

- SR assigns equal value to all reference frames
  - We can without changing anything assign one reference frame to be a preferred frame (analogy in general relativity in the big bang cosmology)
  - Chose it as at rest with the universe
    - We don’t want to improve the theory as empiriometric
  - We interpret relativity as
    - Time slows down when one is moving relative to this preferred frame
    - How does time slow down (time dilation)?
  - What is time? (not how to measure it but what it really is)
    - Time is the measure of motion
    - Motion is only possible because material things are composites of form and matter – they can change
    - Absolute time of itself (i.e. without material things) makes no sense ontologically

Resolving (2)

- Events (in his frame) are occurring at a slower rate for the traveling-twin
- Travelling twin
  - Has fewer conversations; fewer breaths; less activity of all kinds
  - But you may say – the body like all material thing has its own motion independent of the rest of the universe
  - Partially true
    - Body takes input from the surroundings
    - E.g. cold – human embryos can be slowed to a virtual standstill
    - Your age is regulated by the bodies immediately surrounding you
- Thought experiment
  - Each twin has a light pulsing watch – sends out pulse once per year
  - Travelling twin sends out a total of 7,300 pulses over 20 years of his trip
  - Stay-at-home twin sends out a total of 37,320 pulses over 103 years
  - Traveling twin sees 365 pulses during the outgoing phase of his trip and 36,865 pulses during the return.
  - Stay at home sees 3,650 pulses in 101 years of the trip and 3,650 pulses in the last year
  - Do the pulses set the pace for the twins? Obviously not.
  - This is an odd asymmetry between the two twins that remains unaccounted for.

Resolving (3)

- In empiriometric physics we postulate a new real being (e.g. neutrino)
- We are looking for real causes
- We postulate
  - *The existence of a material being that permeates the entire universe and is at rest in the universe frame*
  - Being of a totally new type – not the mechanical ether of the 19th century physics
  - It has the properties of material things – just not mass
    - It has potential to be divided; can have many parts
    - Can interact with all things in the universe
    - Things that are moving will interact differently that those at rest
    - Hence we can say that things moving have reduced rate of motion
    - It somehow poses a timing scale for things in contact with it
    - We call this ‘ether’ – plana in the kid’s book and the PFRs
- Our postulate doesn’t affect the empiriometric results
  - In general it may – may leads to further empiriometric work to conclude that different ontological explanations apply

Resolving (4)

- It is convenient in SR to treat all frames as relative
  - It does not imply that all frame are identical
  - Could quickly lead to radically irrational statements like time and space can be converted into each other – in reality and not just in their mathematical description
- Just because our empiriometric methods do not immediately reveal the real – we cannot abandon the real
  - Time is a measure of motion
  - Space is what we get when we leave behind the matter between bodies
    - Space leaves behind motion
  - Time and space are completely different ontologically
- Don’t forget - *Physica* is about conforming our minds to real being