Fluxions, Forces, and Fields

An overview of the mathematisation of physics in Europe through the modern period

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Zella Baig

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A Look Back

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1. Mathematics within science is a somewhat recent idea - experiment was key

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1. We will discuss vector notation later in fact

Tracing Back

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1. No real reason, but more just commonly known as a 'big' event

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1. So we can already begin to draw these links between these (famous) people

Beyond Maxwell

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1. Explain what wrangler means

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1. explain this was a professional/guiding relationship

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1. Mention how we will analyse why it was dynamics which dominated energy

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1. Mention how we can now see there's a clear line of succession, and we'll be looking at how each figure influenced the next

Not Just Mathematics

Of course, there are other overarching themes as well:

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1. Explain what baconianism is - empiricism, collaboration, etc. Science was investigated. This leads on well to the next point

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1. It still was studied, and it was rigourous, but it wasn't a science and was almost a 'plaything'

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1. Mention how in his work he would often discuss god, and the ancients
2. also bring up how his physical work is but a portion of his alchemy and other work

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1. One major reason for this was the concept of force at a distance

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1. As well as being haughty, he was also a very petty man - bring up removing 'esteemed' to 'mr'

Experimental Philosophy

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1. Mention how sometimes it appears as if Newton himself didn't know what he meant; conflicting uses

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1. Discuss in detail - getting measurements from Flamsteed, the royal astronomer, and applying etc

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1. Religious backing, make his work iron clad as to prevent arguments against it

Gottfried Leibniz (1646-1716)

- Who discovered calculus first?

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1. Newton discovered first, as he claims, but leibniz published first. Newton quarrels as usual

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1. Again newton preferring geometry, or perhaps to cover up that he had published later as he was perfecting it

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1. Discuss fluxions (which are adding eg a small dt term), and fluents which are both integrals and derivatives of functions of time. Mention sloppy notation usage

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  - *The Development of Newtonian Calculus*[8]
  - *Dot-Age*[9]
  - *The History of Calculus*[10]

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1. Discuss how this isn't likely the major factor, as the next head of the royal society was very anti newton

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1. Newton's calculus more influential simply for the scientific ramifications - his philosophy and the discovery of Halley's comet

The Dynamical Age: Continental Physics

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1. This showed that newton's work really was quite important - it had allowed for major work towards the problem which had stumped many other mathematicians. Lent credit to newton

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- Development of Lagrangian mechanics & applications to further contexts (such as the motion of sound)

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Laplacian Physics

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1. Discuss napoleons upbringing - had laplace as a teacher, was fond of mathematics

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1. these had traditionally been the bread and butter of newtonian calculus

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1. Allowed for great development of ideas internationally

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1. Energy ideas were floating around - it being created, being a fluid, etc

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- Natural philosophy shifted towards a focus on (conservation of) energy - in particular heat[14]

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1. Many reasons for this - perhaps discuss steam engines, practical applications. Baconiamism - applications of science to improving lives

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[15] Thomson, 1851.

1. Thomson knew there was something relating heat and energy, investigated it

Thomson & Tait

- Together, they publish *Treatise on Natural Philosophy*:[16] the first high-level mathematically-inclined physics textbook[iii], as well as a synthesis of their work on energy

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[18] Gooding and James, 1985.

1. Thomson busy with other pursuits, told to read on faraday as thomson (and the world) recognised his brilliance
2. faraday the opposite of a mathematician - almost all practical work, but amazing experimenter; give brief overview

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1. Quote from several years later but you can see how thomson influenced maxwell

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1. Instead claims to be a mathematical model which he uses to develop Faraday's work

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1. This was interesting given how much of a headache aether theory had caused EM models

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Vortex Model

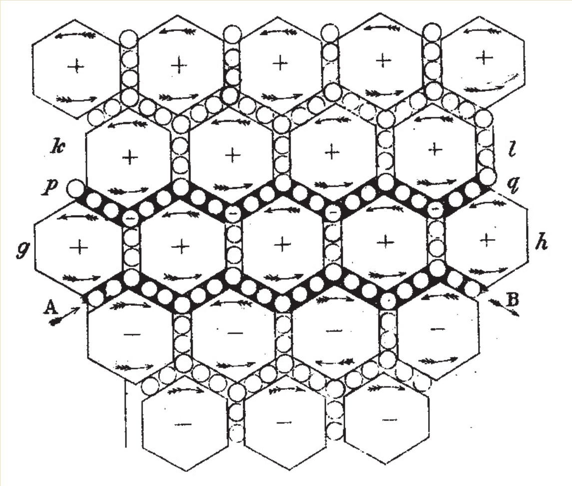
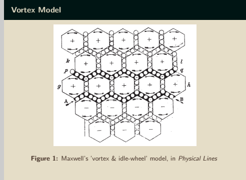


Figure 1: Maxwell's 'vortex & idle-wheel' model, in *Physical Lines*



1. Describe the motion of the wheels and current particles; explain how it led to the curl dependence

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1. Discuss how there were various other parameters each representing components of fields along certain axes
2. Also mention how this led to conceptual complexity - dealing with so many interconnected equations

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1. Discuss how this was brought about with textbook usage by Clifford and Gibbs mainly, when lecturing in the US. Heavyside was mainly consolidating Maxwell's work

Aether Theory & Special Relativity

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The First Cracks

- Following Maxwell's work, electromagnetism became dominant[26]

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1. Dominant in the sense it led to an explosion of work around electromagnetism, light, and energy.

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- The nature of the aether[iv] was hotly debated due to conflicting theories and results (often from the same experiment)

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1. Discuss michelson morley experiment and conflicting results - stokes' dragging hypotheses, fizeaus water experiment etc.

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1. Stress this point - Lorentz was seemingly not aware of the physical connotations; had merely shown that this was a hypothesis that could work. Also had funnily enough made a factor of 2 error in his work

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1. He may also have been unwilling to let go of the idea of aether theory, or alternatively he may not have actually grasped the ramifications of what this implied for aether theory

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Conclusion

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- Development of continental force-based physics
- Shift towards disciplinary rigour with Thomson and others
- Maxwellian development of electromagnetic theory
- The final steps away from the aether - after thousands of years

1. discuss how we have had a massive shift in just the period of a few hundred years - can link it with the explosive rate of human growth as well. Discuss how it has led to so much advance in science and mathematics, as the lines between the two are blurred.

Thank You

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