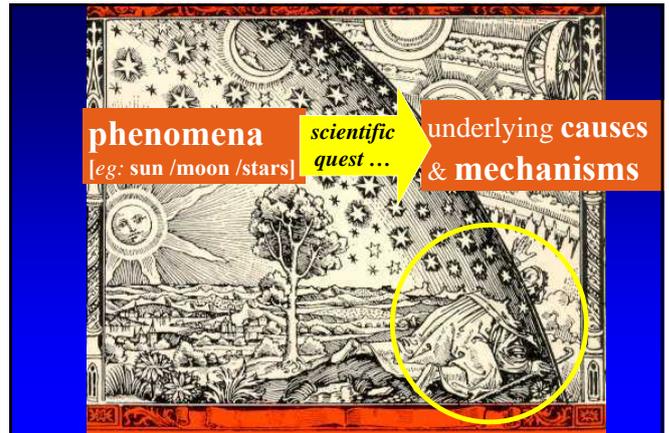


CiS Manchester, 2014

The Laws of Physics and the Reliability of God

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"Why does the universe go to the bother of existing?"



"Even if there is only one possible unified theory, it is just a set of rules and equations..."

What is it that breathes fire into the equations and makes a universe for them to describe?"

Stephen Hawking,
A Brief History of Time

Overview

The Laws of Physics & the Reliability of God

- Our human experience of **change and regularity**.
- Our familiarity with basic laws of physical science ...
But do scientific laws really exist?
or are they convenient fictions? "In praise of critical realism".
- An Invitation: to view *this world* through the 'spectacles' of the Bible.
 - *Why* do scientific laws exist? – *what* or *who* guarantees their reliability?
- Discovering how God's *reliability* underpins *both* the scientific enterprise *and* purposeful everyday living.

Our human experience of change and regularity.

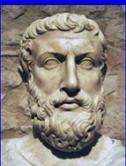
Conflicting views amongst the pre-Socratic Greek philosophers:



Heraclitus of Ephesus,
535-475 BC

Change is central to the universe:

"No man ever steps into the same river twice, for it is not the same river".



Parmenides of Elea,
5th C. BC

The appearance of change is an illusion:

"'what is' is one, change is impossible, and existence is timeless, uniform, necessary, and unchanging".

Can we discover stability & reliability in a world of change?

- both an existential and a scientific question!

The Wise & Foolish Builders

“Everyone who hears these words of mine and puts them into practice is like a wise man who built his house on the rock.

The rain came down, the streams rose, and the winds blew and beat against that house; yet it did not fall, because it had its foundation on the rock.”

[*The Gospel According To Matthew 7: 24-27]



Regularities of the natural world

☐ Sunrise/sunset (Day/Night)



Regularities of the natural world

Circumpolar constellations

5 constellations in the northern hemisphere circle around the pole star in each 24 h period, without dipping below the horizon.



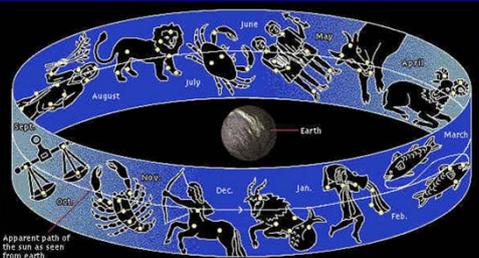
Regularities of the natural world

☐ Lunar Cycle (Month).



Regularities of the natural world

☐ Annual apparent rotation of the constellations (Year) & movement of the sun through the constellations of the zodiac



Regularities of the natural world

☐ The 4 Seasons

“As long as the earth endures, seedtime and harvest, cold and heat, summer and winter, day and night will never cease”

The Book of Genesis 8:22



The Uniformity of Nature

- Bertrand Russell [*Problems of Philosophy*, 1912] noted that:
 - The scientific method is obliged to assume the **uniformity of nature** in order to proceed,
 - yet cannot itself *substantiate* this implicit assumption.
- “The principle itself cannot, without circularity, be inferred from observed uniformities, since it is required to justify any such inference”.

- The concept of *Laws of Nature* is significant as an affirmation of ‘**uniformity through ordering**’.

observed situations → *laws of nature* → non-observed situations.

The goal of theoretical physics is to figure out the **laws** that underpin all natural phenomena.

From the very largest (galaxies) all the way to the very smallest (quarks and leptons).



Cf game of Chess

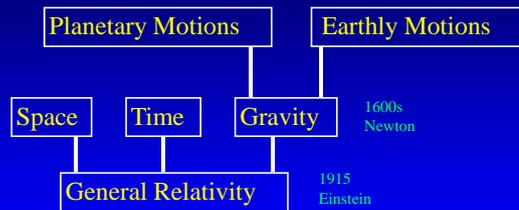
What we understand *best* about physical reality, we formulate as **Scientific Laws**

“There is a **rhythm** and a **pattern** between the **phenomena of nature** which is not apparent to the eye, but **only to the eye of analysis**: and it is these rhythms and patterns that we call **Physical Laws**.”



Richard Feynman
The Character of Physical Law.

Unification of Physics - I



The Quest for Order *

- There is **something** about the world & the human mind which **allows us to objectively discern patterns within nature**, for which explanations may be advanced & evaluated.
- This is apart from the human propensity to **impose patterns** upon our experience, even where they do not ‘really’ exist. [eg. ‘canals’ upon Mars].
- **The Kantian tendency**, to consider the ‘*thing in itself*’ as *invariably* without inherent order, is **unconvincing**, since:
 - the natural sciences posit a publicly observable & replicable regularity to the world.
 - the *laws of physics* evidently antedate physicists!

* “**The architecture of the universe is built according to invisible universal rules.**” H.R. Pagels, *The Cosmic Code*, (1984).

Partial scepticism about objective scientific laws*



* Giere argues for the role of ‘the scientist’s particular perspective, even when reading an instrument.’

Philosophy & the Laws of Nature

Anti-Realist [D. Hume; I. Kant; E. Mach]
Observation imposes order on the extra-mental world.

Quasi-Realist [J.S. Mill; D. Lewis]
Laws as the simplest /fewest assumptions that can explain the totality of the natural order.

Realist [Armstrong, 1983; *et al.*]
Laws of nature exist independently of human minds.
Human law-statements are fallible attempts to express laws of nature.

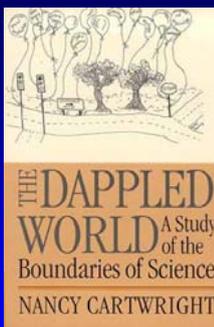
The legitimacy of Scientific Laws

What everything *is* and what everything *does*.

- They go by various names, “natural law,” “scientific law,” “theory.”
- Some regularities can be exactly, quantitatively described for each case. Others are statistical regularities (when many cases are examined together).
- All scientists must believe in such regularities & know that they are “out there.”
- Scientists are all “realists” with respect to scientific laws. Scientists discover them and do not merely invent them.
- **To be regular means to be regulated. It involves a *regula*, a rule or law.** Thus the word “law” is natural for well-established theories & principles.
- We speak of Newton’s laws, Boyle’s law, Dalton’s law, Thermodynamic laws, Mendel’s laws, Laws of Quantum Mechanics & of Relativity, Kirchhoff’s laws.
- But “The laws that describe the world are a patchwork, not a pyramid”.

Limitations of Scientific Laws??

“There is **no pyramid of laws** with the laws of physics basic and others subservient. Instead the world is dappled, containing lots of different localised domains in which there can be true laws capable of useful application”.



No God, No Laws!

“Laws come from limited models that cannot apply to the real world without *ceteris paribus* [other things being equal] clauses”.

Some Basic Laws [& patterns*] of General Chemistry

- Law of **Constant Composition**.
- Law of **Multiple Proportions** (Dalton, 1804)
- Law of **Mass Action** (Guldberg & Waage, 1864-79)
 - * Johann Dobereiner’s **Triads** – eg. Cl, Br, I - (1829)
 - * Dimitri Mendeleev’s **Periodic Table** (1869)

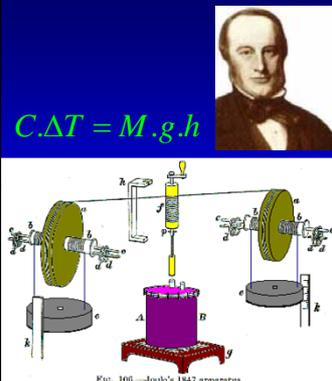


Elementary Scientific Laws

- Gas Laws: (P,V, T): Boyle’s, Charles’. $PV = nRT$
- Dalton’s Law of partial (gas) pressures: $P_{total} = \sum_{i=1}^n p_i$
- Laws of Electricity: Ohm’s: $V=I.R$ Voltage & Current
- Optics: Snell’s Law of refraction: $\sin \theta_1 / \sin \theta_2 = n_2 / n_1$
Abbe’s law of optical resolution: $\Delta x = \lambda / 2n \cdot \sin \alpha$
- Classical Mechanics: Newton’s Laws of Motion: $F = m.a$
- Inverse Square Laws: (Gravitation, Electrostatics, Optics)
 $Intensity \propto 1/distance^2$
- Mechanical Equivalent of Heat (James Joule)

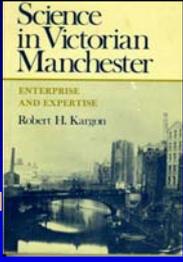
James Prescott Joule - the mechanical equivalent of heat & the first law of thermodynamics.

Mancunian (born Salford 1818, died Sale 1889), brewer and Physicist





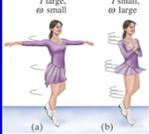
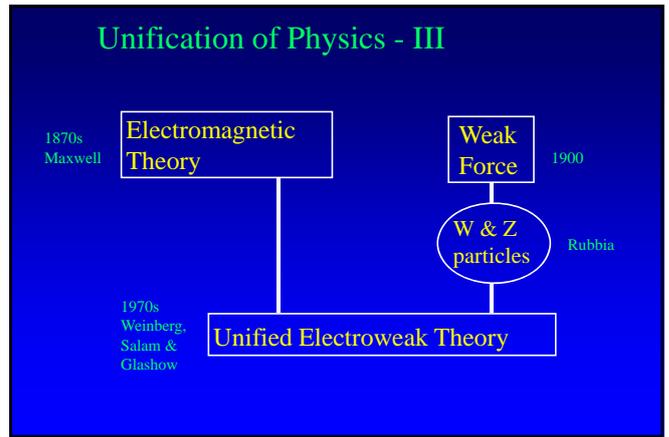
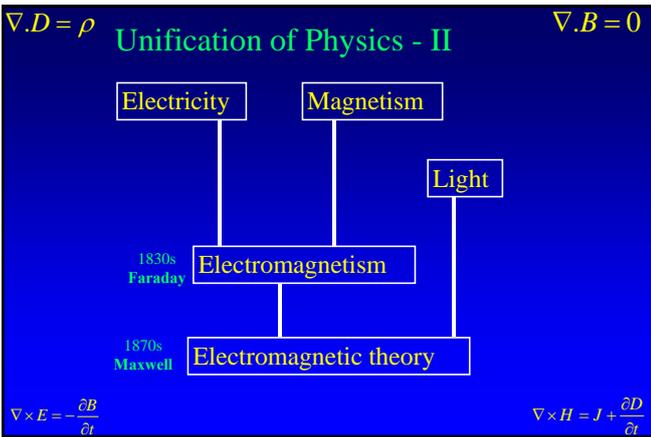
James Joule & the conservation of energy



“I shall lose no time in repeating and extending these experiments, being satisfied that the **grand agents of nature** are, **by the Creator's fiat**, indestructible and that **whatever mechanical force is applied, an exact equivalent of heat is always obtained**”.

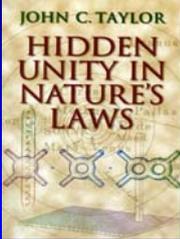
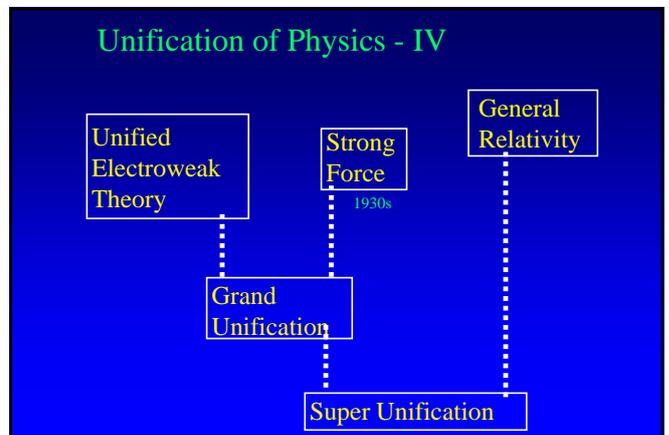
Some Conservation Laws:

- **Mass** (or Mass/Energy)
- **Angular Momentum** – skaters rotating on ice [Sochi Olympics]
- **First Law of Thermodynamics:**
 - Zeroth Law
 - **First Law** (Energy; Enthalpy)
 - **Second Law** (Entropy; Free Energy)
 - Third law
- **Conservation Laws & Symmetry** [Emmy Noether]

Scientific laws are beautiful

- Scientific laws, especially “deep” laws, are beautiful.
- Scientists have long sifted through possible hypotheses & models partly *via* criteria of beauty & simplicity.
- The Bible shows us a God who is profoundly beautiful.

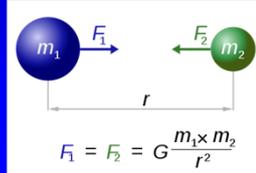
'Constants of Nature'

□ **R, G, μ, ε, h, c, ...**

□ **Constants (C)** appear in an equation when a *proportionality factor* is replaced by an *'equals'* sign:

$$\text{Intensity} \propto (1/\text{distance}^2)$$

$$\text{Intensity} = C. (1/\text{distance}^2)$$



□ **Constants are not always 'constant'**

- they sometimes vary with conditions.

○ e.g. The 'Dielectric Constant' or *complex relative permittivity* (ϵ^*) for most materials *varies* with the measurement frequency etc.

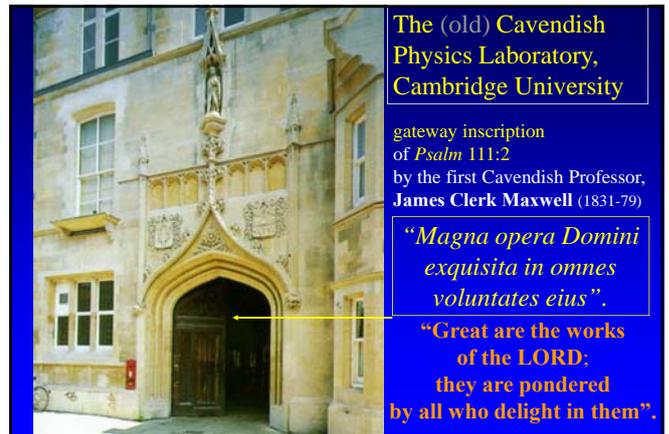
□ However, there are certain basic **'Constants of Nature'** that *do* appear to be *invariant* (unchanging).

□ At present, it is not possible to explain *why* they have the particular values they do have.

□ But these values appear **'fine-tuned'** to make carbon-based life possible. If they were even minutely different 'C-life' could not exist – for many reasons, including the fact that elemental carbon would not exist.



... to explore the worldview of the Bible and its perspective on 'life, the universe and everything ...'. Let it's spectacles re-focus your vision - it's a great experiment!



The (old) Cavendish Physics Laboratory, Cambridge University

gateway inscription of *Psalm* 111:2 by the first Cavendish Professor, James Clerk Maxwell (1831-79)

"Magna opera Domini exquisita in omnes voluntates eius".

"Great are the works of the LORD: they are pondered by all who delight in them".

For science to be possible, the world must be:

- **Good:** hence worthy of careful study.
- **Orderly & rational:** behaving in an exact way so that what we find out one day will be true the next.
- **Open to the human mind:** or we could not find it.
- **Not a necessary order: but a contingent order** that can only be found by making experiments, not just by pure human thought alone.
[God was **not** compelled by *higher laws* to make it in only one possible way; for God there are no *higher laws*].

"You are worthy, our Lord and God, to receive glory and honour and power, for you created all things, and **by your will** they were created and have their being."
Revelation 4:11

God made the world according to his own free decisions.

Biblical Language for Divine Reliability

- Promise and Fulfilment
- The Covenants of God

The regularity of the movements of the stars & the seasons witness to the power & reliability of the Creator

Job 38: ³¹ "Can you bind the beautiful Pleiades?
Can you loose the cords of Orion?
³² Can you bring forth the constellations in their seasons
or lead out the Bear with its cubs?
³³ Do you know the laws of the heavens?
Can you set up *God's* dominion over the earth?
³⁴ "Can you raise your voice to the clouds
and cover yourself with a flood of water?
³⁵ Do you send the lightning bolts on their way?
Do they report to you, 'Here we are!'"

The Bible explains why science is possible – its laws are grounded in the stability & reliability of God's covenants.

- This is discussed in several parts of the Bible, for example in the *Book of the prophet Jeremiah* chapter 33 and verses 20-26.

Jeremiah 33 – the covenantal reliability of God

²⁰ "This is what the LORD says:
"If you can break my covenant with the day and my covenant with the night,
so that day and night no longer come at their appointed time,
²¹ then my covenant with David my servant
- and my covenant with the Levites who are priests ministering before me -
can be broken
and David will no longer have a descendant to reign on his throne.
²⁵ This is what the LORD says:
"If I have not established my covenant with day and night
and the fixed laws of heaven and earth,
²⁶ then I will reject the descendants of Jacob and David my servant
and will not choose one of his sons to rule over
the descendants of Abraham, Isaac and Jacob.
For I will restore their fortunes and have compassion on them."

God's covenant with day & night

- Day & night come at their appointed time.
- This is in consequence of God's covenant faithfulness.
- A covenant is **not** an arrangement God is *externally obliged* to keep; but an obligation he *freely chooses* to lay upon himself and thereby will keep because of his own integrity.
- God's covenant with day/night is bound up with the **'fixed laws of heaven and earth'**.

"As long as the earth endures, seedtime and harvest, cold and heat, summer and winter, day and night will never cease." *Genesis 8:22*

Laws of Nature: their status & scope

- They are **universal**: -valid at every place & time.
- They are **absolute**: – do not depend upon the nature of the observer.
- They are **eternal**: – grounded in the mathematical structures used to represent the world.
- They are **omnipotent**: – nothing can be outside their scope.

NB: these attributes share remarkable affinities with those ascribed to the Christian God.

[Paul Davies (1992), *The Mind of God*. 72-92.]



God & the Laws of Nature

- **Question:** How can God be said to act reliably, unless by external compulsion? *NB* 13th C debate...
- **Answer:** by Duns Scotus & William of Ockham, 13th C.
 - The reliability of God is ultimately grounded in the divine nature itself:
 - Because of a deliberate & free divine decision to act like this.
- God's **absolute power** [*potentia absoluta*], referring to **t = 0**, permits **his free choice** from a set of possible actions.
- Our concern, now in science, is with the *potentia Dei ordinata*, the **ordained power** of God, referring to **t > 0** the way in which God orders the creation at present.
- **Paradox:** on account of the divine omnipotence, God has **committed himself** to a course of action...

God shows himself

- ❑ In reality, what people call “scientific law” is divine.
- ❑ God reveals himself through his governance of the world.
- ❑ Scientists must believe in scientific law in order to carry out their work.
- ❑ Thus scientists are constantly confronted with God himself.
- ❑ They are constantly depending on who he is and what he does in conformity with his divine nature.
- ❑ Unbelieving scientists will suppress this truth.
- ❑ But even theists can live like virtual atheists!
- ❑ We must recover a robust understanding of God’s involvement in detailed daily care for His world.

Don't let 'chronological snobbery' make us ignore the wisdom of Dante when he says:
“The **glory of Him who moves all things penetrates the universe** and shines in one part more and in another less...”
... and speaks of:
“... the **Love** that moves the sun and the other stars”



Dante Alighieri
(1266 – 1321)
The Divine Comedy:
Paradise, I, 1 &
XXXIII, 145

