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"SPACE" - the final frontier of science, technology and philosophy.

⊙ For the Space Scientist/technologist -

SPACE - Extends from above the Surface of the Earth to the limits of the Visible Universe.

(through any type of radiation.)

The Challenge is to go as far as technology permits - (and instruments, man, ...)

Make observations on the most distant Celestial objects from above the atmosphere.

Range: 0 to 20 billion light years.

MACRO DOMAIN

⊙ For the physicist - especially High Energy Physicist

In addition to the above domain, the interest and challenge is in studying phenomena that take place in

Smaller and Smaller dimensions of

Space $\rightarrow \ll 10^{-15}$ cms.

MICRO DOMAIN

⊙ For the Cosmologist

Both MICRO AND MACRO DOMAINS.

⊙ For the Philosopher

SPACE is Everything

What is SPACE?

① Is it mere emptiness? Vacuum? Nothingness?

What is there in the barometer tube above the mercury level - the so-called 'Void' created by Torricelli

Does Void exist or not - debate ranged from Aristotle to Einstein. ~ 2000 yrs.

(Infinite Velocity) (limiting velocity c)

② Space is filled with some medium - fine material? Ether?

③ What is Ether? (Aether - Greek mythology)
(Not Water, Not Fire, Not Air, Not Earth)

Aristotle and his followers:

Ether is not just the fifth element - it is the progenitor, the essence of all things, the basis underlying all other elements of nature.

Aristotle called ether immortal and divine.
(ether = blazing light in Greek)

GIARDANO
BRUNO
(16th century)

Ether - a fine, universal material that permeates everything and encloses everything.

Some Wrong ideas on ether: ??

Gilbert : Ether flows out of electrical bodies and ether propagates heat.

Galileo : Bodies exist and do not disintegrate into fine component parts, because the particles are held by the pressure of ether.

Descartes : Absolute emptiness is impossible. All physical bodies are the result of vortex motion in an incompressible and unexpandable ether.

17th, 18th and 19th. Century Scientists accepted ether to be the universal medium

Newton's ideas on ether were complex. - Sometimes affirmed and sometimes denied the existence of ether as a universal medium.

In Principia, Newton writes :
(1713)

" And now we might add something concerning a most subtle spirit which pervades and lies hid in all gross bodies, by the force and action of which spirit, the

particles of bodies attract one another at near distances and cohere, if contiguous; the electric bodies operate to greater distances, as well repelling as attracting the neighbouring corpuscles; and light is emitted, reflected, refracted, inflected and heats bodies; and all sensation is excited, and the members of animal bodies move at the command of will, namely by vibrations of this spirit, mutually propagated along solid filaments of nerves, from the outward organs of sense to brain, from the brain to muscles. But these are things that cannot be explained in a few words, nor are we furnished with that sufficiency of experiments which is required to an accurate determination and demonstration of the laws by which this electric and elastic spirit operates"

No mention of the connection between gravitation and ether. BUT

NEWTON'S DILEMMA.

ACTION AT A DISTANCE

Locke : • It is not inconsistent to imagine that the Creator might have chosen to Superadd to matter a faculty of thinking, just as he had given the bodies the capacity to attract without contact as Newton had shown, though as far as we can conceive that cannot be. We cannot exclude by reason alone the possibility that 'God may give to matter thought, reason, volition as well as sense and spontaneous motion.'

- Newton himself disagreed, ever dismissing the possibility that attraction is property of matter. It is "inconceivable" he wrote in a famous letter of 1693 "that inanimate brute matter should without MEDIATION of something else which is not material operate upon and affect other matter without mutual contact. 'Action at a distance through a vacuum' he wrote 'is so great an absurdity, that I believe no man who has in philosophical matters a competent faculty of thinking can ever, fall into it.'

"Trichism" of NEWTON

Passive Matter
+
Active Forces
+
Subtle Ether.

Active Forces
Divine.

Passive Matter
Not Spiritual.

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Huygens - the Champion of Wave theory of

light :

" There is no such thing, in the ordinary meaning of this word, no such body that travels from the Sun to the earth, or from a visible object to the eye. There is a state, motion or perturbation that was first at one place, then at another. ... Ether also fills the spaces between ordinary matter this could explain the transparency of certain substances

What vibrates is ether particles.

" Newton's idea about mutual attraction I consider to be absurd and am amazed that a man like Newton made so many difficult investigations and calculations, having as a basis nothing better than this idea.

What is wireless telegraph ?

Imagine a cat with its tail in Moscow and muzzle in Paris. When its tail is pulled it meows. Now that is ordinary telegraph. A wireless telegraph is the same, but without the cat.

• Fall of the ether ?

The ether was brought in for

1. to provide for the action of the law of universal gravitation - as a transmitting link
2. as the medium through which light travelled - responsible for all manifestations of EM forces - to solve all riddles of nature - physical, chemical, biological ...

All this required however **CONTRADICTORY PROPERTIES OF ETHER.**

CRUCIAL QUESTION

Is ether absolutely stationary ?

or
Do travelling bodies drag ether along with them ?

Maxwell :

Measure the velocity of light by measuring the time it requires to travel between two points on the surface of the earth. Compare this with the velocity in the reverse direction. This gives the velocity of motion of the earth w.r.t. these two points.

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A. A. Michelson } Starlight Interferometer
W. Morley } experiment (1881, 1887)

↓
The hypothesis of a Stationary Ether
was shown to be incorrect.

Velocity of the earth along its orbit is 30 kms/sec.
This should have been the velocity of
the ether wind. Expt. showed a velocity
less than 1.5 kms/sec. The latest limits
are less 50 cms/sec.

A beautiful theory had been slain
by an ugly fact?

Lorentz and Fitzgerald tried to save
the theory by their contraction hypothesis.
Ether did not survive, but the contraction
stayed!

Einstein's Special and General theories of
Relativity (1905, 1915)

- Einstein rejected the ether theory and
with it the whole idea of SPACE as
a fixed system or framework.
- Michelson-Morley experiment had established
that the velocity of light is unaffected
by the motion of the earth. →
So also w.r.t. motion of Sun, Moon, Stars, —

9.
"Laws of Nature are the same for all uniformly moving systems"

(Mechanical laws as well as Electromagnetic)

Many things followed

- Lorentz transformation - Space contraction and time elongation.
- Relativistic increase of mass
- $E = mc^2$

In General Theory of Relativity, taking into consideration the features of accelerated motion, formulated the Principle of Equivalence of Gravitation and Inertia →

There is no way to distinguish between the motion produced by inertial forces (acceleration, recoil, centrifugal force, etc.) and the motion produced by gravitational force.



Absolute motion does not exist.

What is gravitation then?

Gravitation of Einstein is entirely different from that of Newton. For Einstein, gravitation is not a force.

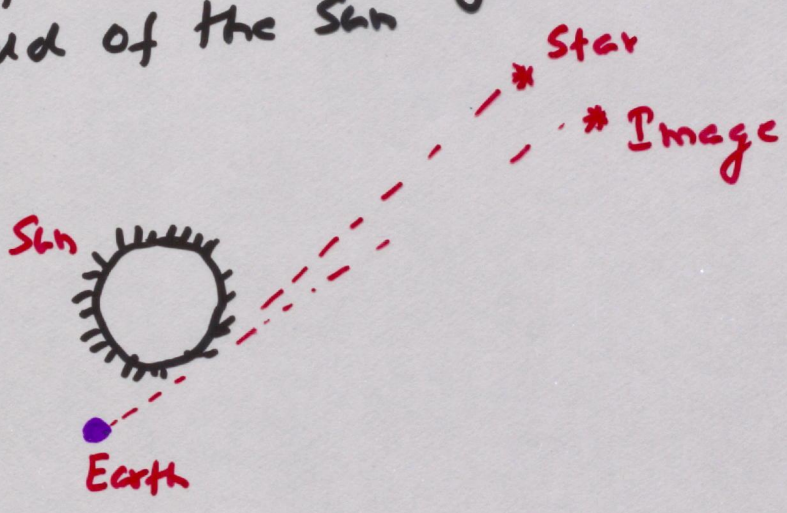
Einstein's Law of Gravitation contains nothing about force. It describes the

behaviour of objects in a Gravitational Field.

- motion of planets round the Sun, not in terms of 'attractive force' but simply in terms of the paths they follow. The paths are determined by the metric properties of space - more correctly Space-time Continuum.

∴ Stars, moons, and other celestial objects determine the properties of space around them.

Deflection of Starlight in the Gravitational Field of the Sun



- Gravitational Lensing
- Gravitational Red Shift.

1000 miles

(Sputnik)
 1957

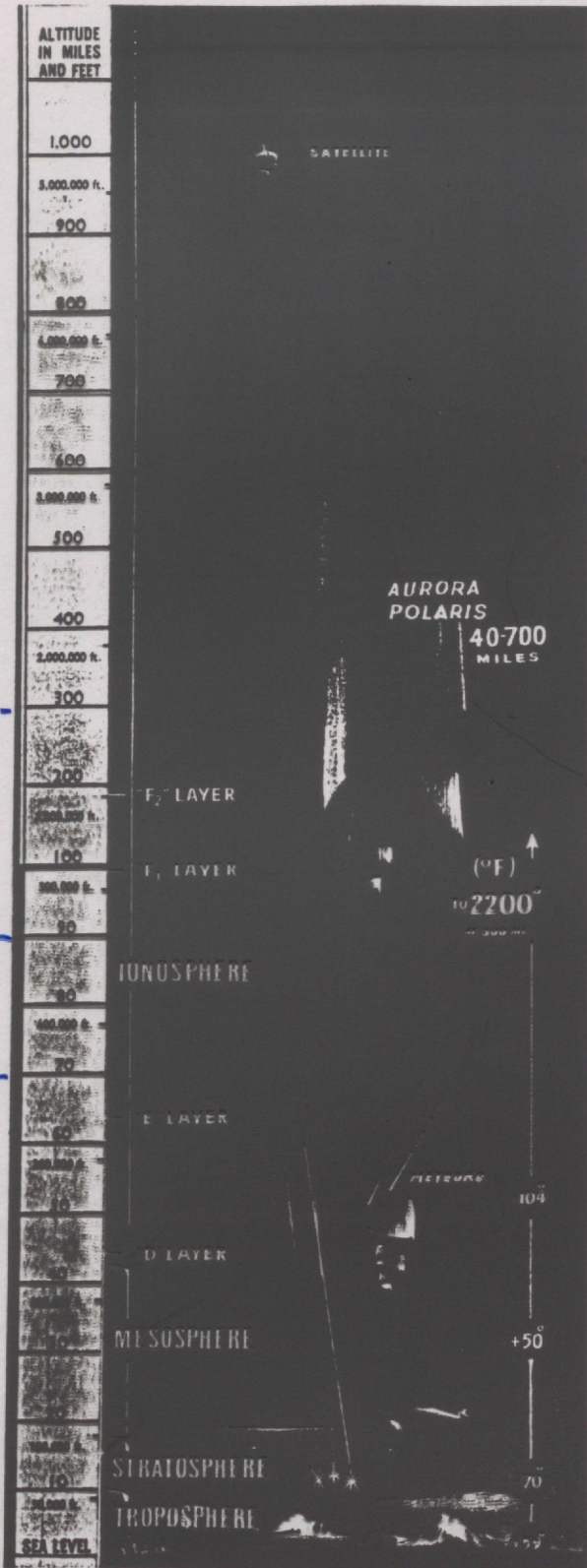
300 M

90M

70M

40M

10M



The normal idea of temperature no longer holds. It is a measure of the Speed of molecules.

Fig. 191 — THE EARTH'S ATMOSPHERE. Altitudes are shown on the left, temperatures on the right. The D, E and F layers are the various ionised layers of air which make up the ionosphere. It will be noticed that the aurorae stretch over a wide range. The satellite shown is the first Sputnik, which was launched in 1957, but the orbits of some other Earth-orbiting satellites are even further out than this.