

10/1/08

Advances in the Frontiers of Physical Sciences

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NIAS

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Science is one of the main streams that contribute to the ocean of knowledge and has been regarded by many as the most systematized knowledge (Scientia = episteme = Certain Knowledge) – this aspect has changed over time.

What is Science? Some Typical Statements

- **Plato (~400BC):** Knowledge of heavens could not be gained by staring at the sky for the simple reason that knowledge of sensible objects were impossible. The true realities were not part of the visible world; they belong to the world of pure numbers and perfect geometrical figures. And inevitably these were not seen by eyes, but by reason and thought.
- **Socrates (400 BC):** How could one hope to understand nature without knowledge of himself? Science has little practical value.
- **Archimedes (87 BC):** The ability to observe what happens, to understand what is observed and use information to discover new ideas is the mark of the scientist.
- **Newton (~1670 AD):** Science consists of discovering the frame and operations of nature reducing them as far as may be to general rules or laws – establishing these rules by observations and experiments and then deducing the causes and effects of things.
- **Campell (1921):** Science is the study of those judgments concerning which universal agreement can be obtained.
- **Feynman (20th century):** Nothing is certain or proved beyond doubt. It is not that you are finding out the truth, but you are finding out that this or that is more likely.

What is Science? Some Typical Statements

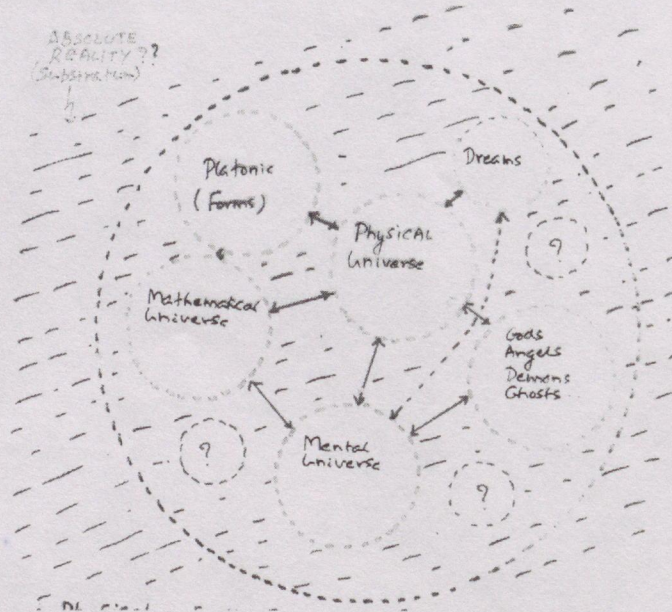
- **Arthur Peacocke (20th century):** Science too only infers the best explanation and its description of realities to which it refers are inevitably metaphysical, reversible and not naively realistic without qualifications.
- **Richard Dawkins (20th century):** Science is simply mute before the ultimate questions of meaning, purpose and value.
- **Van Daniel Liberman (20th century):** In science one never possesses the complete truth. One can only look for.
- **Steven Weinberg (20th century):** The task of the physicist is to see through appearances down to the underlying very simple symmetric reality.
- **Peter Medawar (20th century):** While many philosophers may treat science with immense respect, many scientists have an exasperated contempt for philosophy.
- **Searle (20th century):** The results of science are often relevant to philosophers, but seldom crucial for any particular philosophic position.
- **Feyerabend (20th century):** Astrology, voodoo, witchcraft, rain-dancing, and much more besides are no less reasonable than astronomy, medicine, and metallurgy.

What is Science? Some Typical Statements

- **Neurath (20th century):** Science is like a boat which we rebuild plank by plank while staying afloat in it.
- **Swamy Ranganathnandaji (20th century):** Science means knowledge and India's Vedanta says that this knowledge must include the "knower" beyond the "known". The "known" is studied scientifically to-day in the west. But what about the knower? It is here in the field of the knower that the Upanishads emphasized and did scientific research by brilliant men and women over four thousand years ago. Vedanta deals with the science of the knower, the science of consciousness along with the science of the known.
- **Charles Townes (21th century):** Science is the attempt to understand the structure of our universe and how it works including ourselves. We try to understand what particular objects are and how they work and so on. Religion is the attempt to understand the purpose and meaning of the universe including our own lives. If there is a purpose and meaning to the universe that must be something to do with the structure and behaviour. So clearly there is a relationship between science and religion that can be inferred if we study the matter carefully.

An important point that Townes emphasizes is that both Science and Religion are attempts at understanding - which means that they are tentative and contingent.

What does "the Universe" stand for?



Technology (crafts) proceeded Science till the 17th Century

- **3000 BC – 1600 AD:** Potter's Wheel, Wheeled carriages, Ship, Lever, Pulley, Wind Mill, Porcelain, Mechanical Clock, Compass, Gun Powder, Spectacles, Printing Machine, Metal Types Main Spring Watch, Microscope
- **1600 – 1800 AD:** Telescope, Mercury Barometer, Pendulum Clock, Steam Engine, Steam Driven Car, Spinning Jenny, Flush Toilet, Gas Lighting, Cotton Gin, Visual Telegraph.
- **1800 – 1900 AD:** Steam Locomotive, Steam Ship, Arc Lamp, Gyroscope Spectroscope, Bicycle, Cement, Electromagnet, Rail Road, Electric Generator, Electric Telegraph, Revolver, Safety Match, Ice Making Machine, Elevator, Kerosine, Steel Production Process, Internal Combustion Engine, Type Writer, Dynamite, Telephone, Phonograph, Incandescent Lamp, Transformer, Fountain Pen, Gasoline Powered Car, Aluminum, Pneumatic Rubber Tyre, Electric Fan, A.C. Motor, Motion Picture Projector Safety Razor, Submarine.

Revolution in transportation, communication, lighting, entertainment occurred in the 19th century.

Scientific Development 17th and 18th centuries

- Newtonian Dynamics (Newton)
- Optics (Newton, Huygens, Young)
- Electricity and Magnetism (Gilbert, Faraday, Volta, Ohm)
- Heat and Thermodynamics (Carnot, Joule)
- Kinetic Theory of Gases (Boyle, Gay-Lussac, Clausius)
- Structure of Matter (Cavendish, Priestly, Lavoisier)
- Discovery of Planet Uranus (Herschel)
- Introduction of Stellar Spectroscopy (Herschel)
- "Cell" as the unit of Life (Leeuwenhoek) – Single Lens Microscopic observations!

Major Scientific Discoveries of the 19th century

- Theory of Evolution (Darwin, Wallace)
- Theory of Heredity (Mendel)
- Theory of Conditioned Reflexes (Pavlov)
- Electro-Magnetic Theory (Maxwell)
- Creation of EM Waves (Hertz)
- Discovery of X-rays (Roentgen)
- Discovery of Radioactivity (Becquerel)
- Discovery of Electron (Thomson)

Technology Developments of the 20th Century

Electronics (Valve, solid state), Radio, Television, Computers,
Radar, X-ray Machines, Refrigeration, Vacuum,
Superconducting Magnets, Lasers, Particle Accelerators,
Detectors, Atom, Hydrogen, Neutron, Bombs, Radio
Telescopes, Space Telescopes, Tomography, Nanotechnology,
IT, Internet, E-mail,

The 20th C.

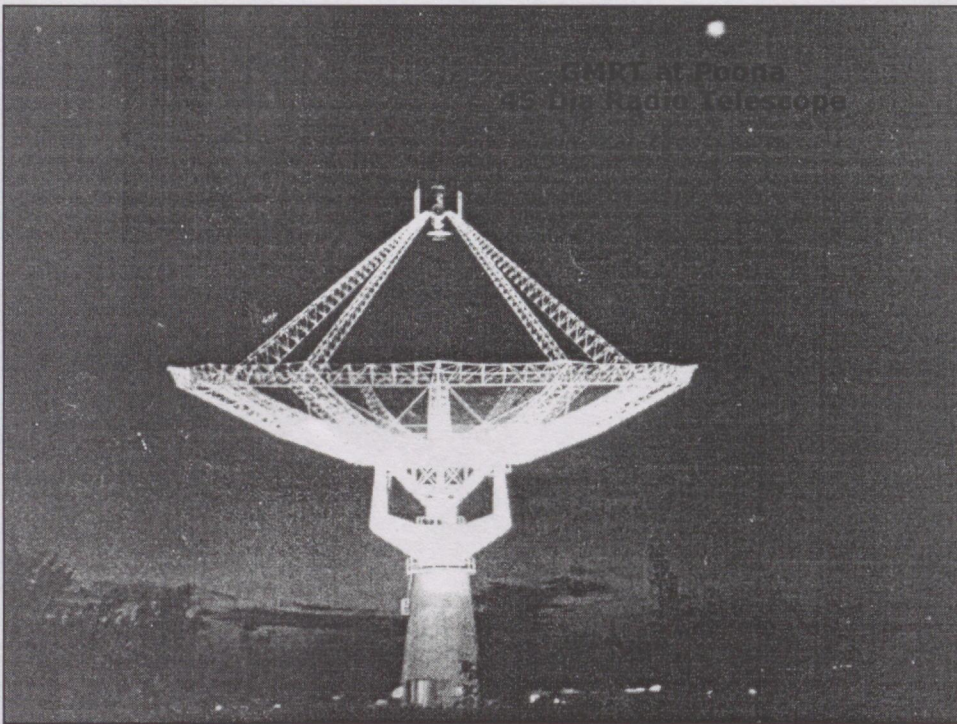
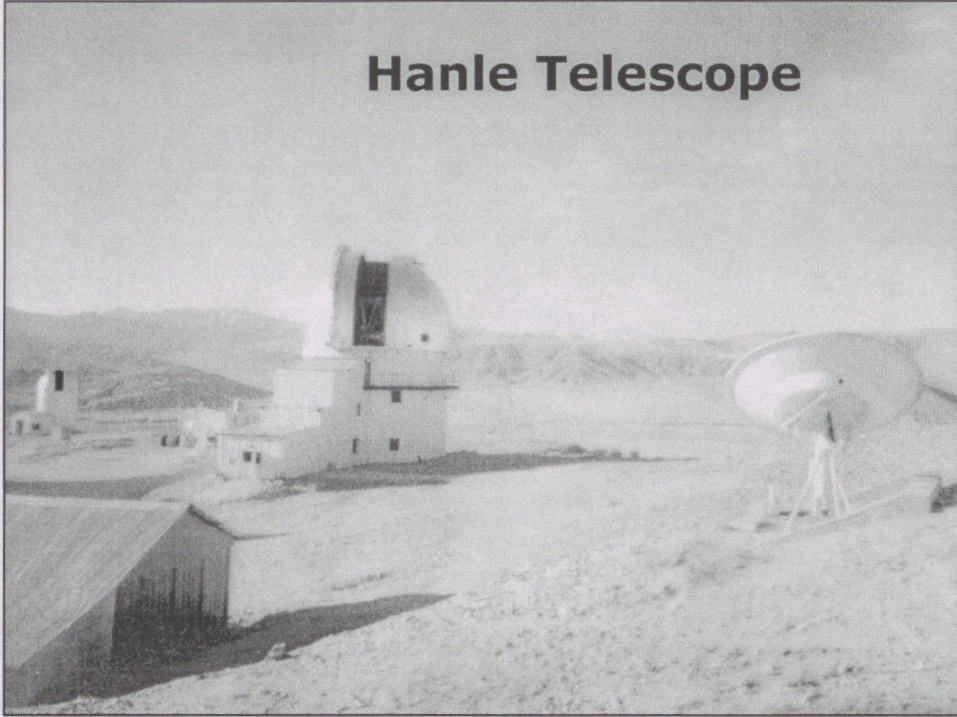
Developments in Astronomy

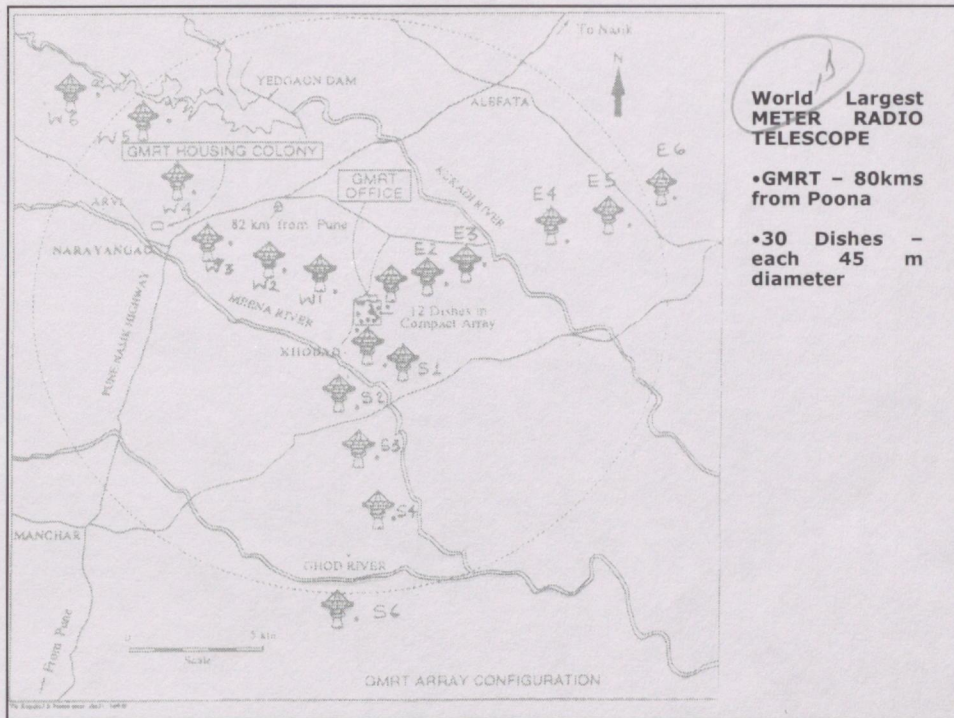
- Formulation of quantum Hypothesis (Max Planck)
- Formulation of theories of (a) Special Relativity, (b) General Relativity (Einstein) *cf Randon*
- Discovery of ~~Random~~ (madam Curie)
- Discovery of Proton (Thomson)
- Discovery of the Nucleus (Rutherford)
- Bohr's Atomic Hypothesis (Bohr)
- Discovery of Cosmic Rays (Hess)
- Discovery of Neutron (Chadwick)
- Quantum Mechanics (Schrödinger, Heisenberg, Pauli, Dirac)
- Dirac's theory of the electron (Dirac)
- Discovery of the positron (Anderson)
- Discovery of the Mesons and other Elementary Particles (Anderson, Powell,...)
- Standard Model – theory of Elementary particles

Major Developments and Discoveries of the 20th Century

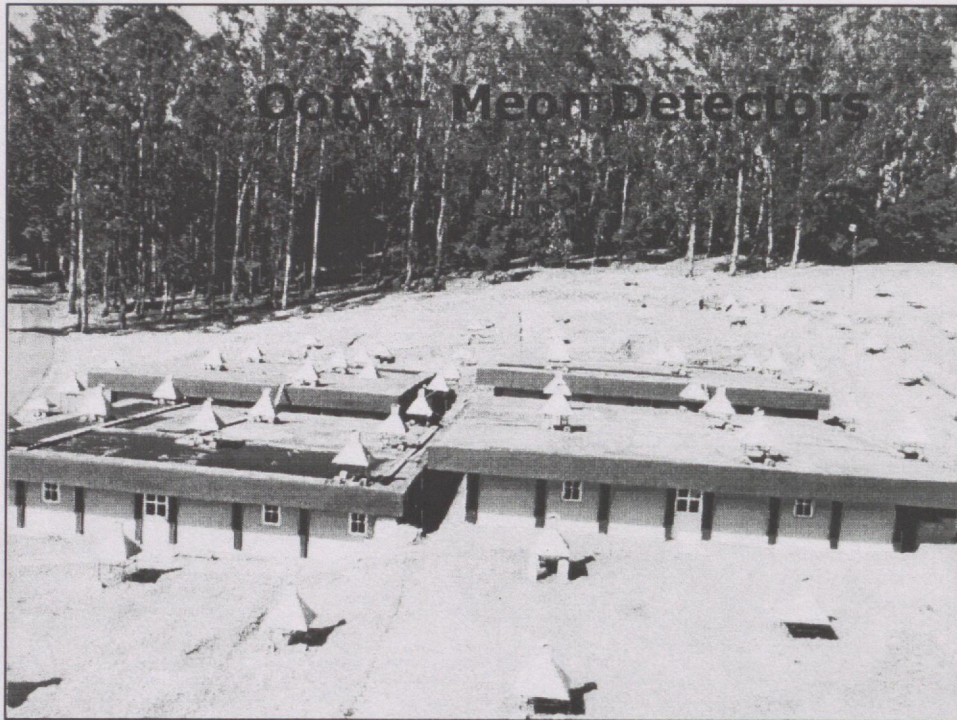
- Discovery of Radio Astronomy (Jansky)
- Discovery of external Galaxies (Hubble)
- Discovery of Expanding Universe (Hubble)
- Formulation of Big Bang Theory (Le Maitre)
- Discovery of Quasars, Pulsars, Neutron Star, Black Holes
- Discovers of Universal Microwave Radiation (Penzias and Wilson)
- Discovery of accelerating universe (Dark Energy?)

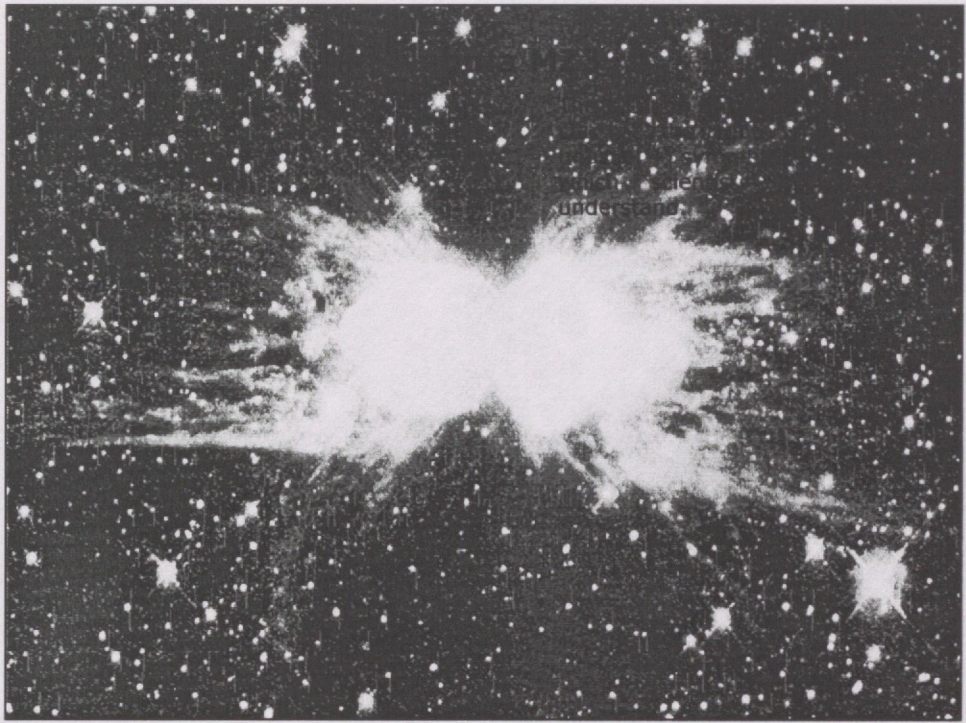
Hanle Telescope



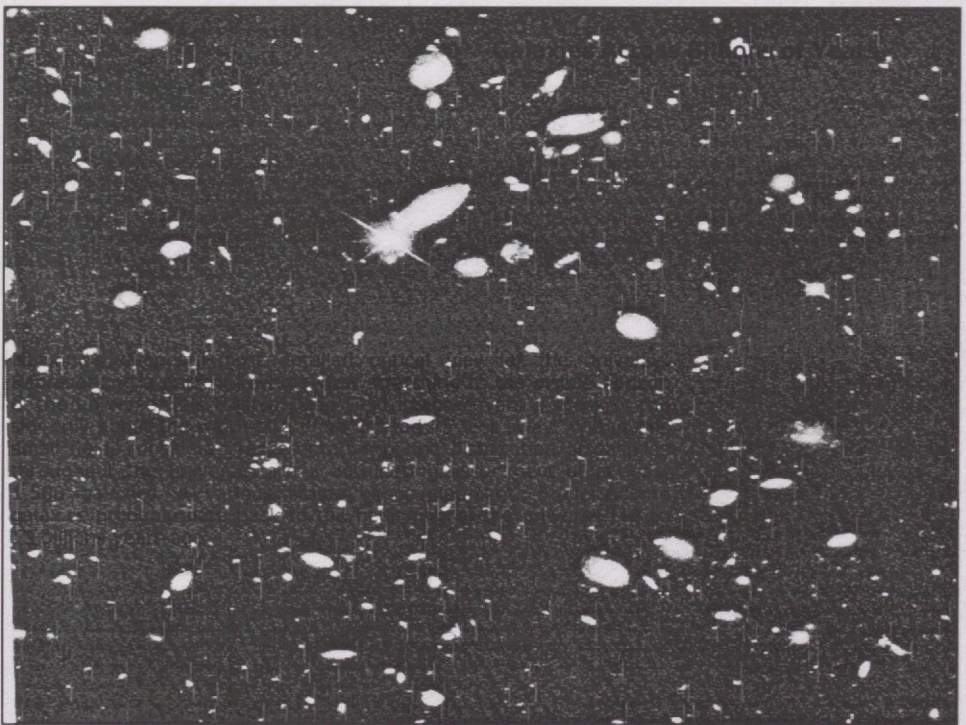


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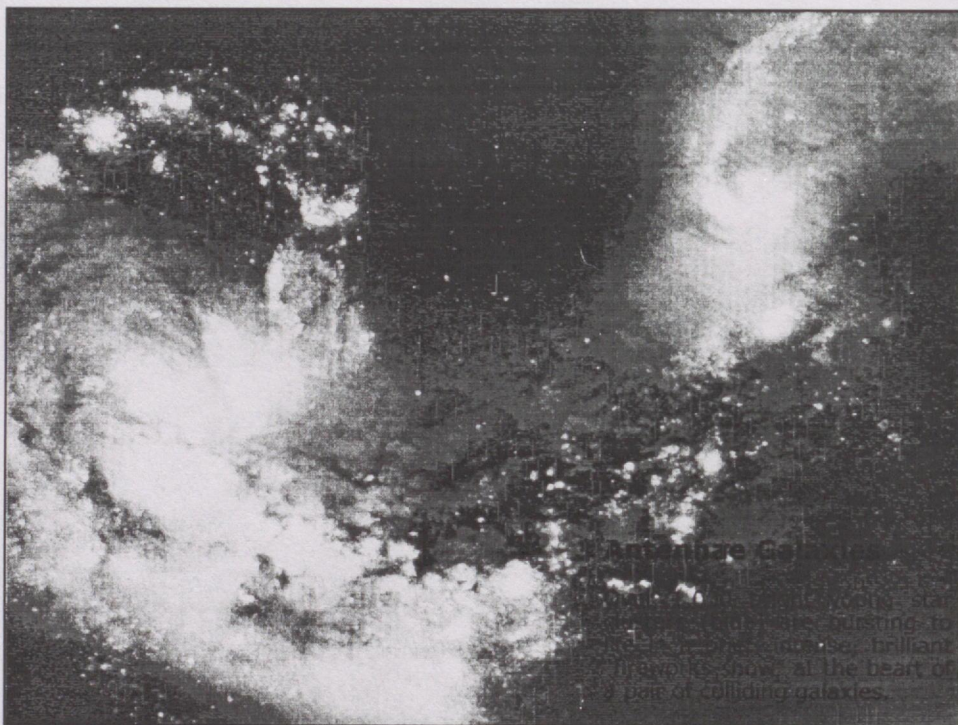


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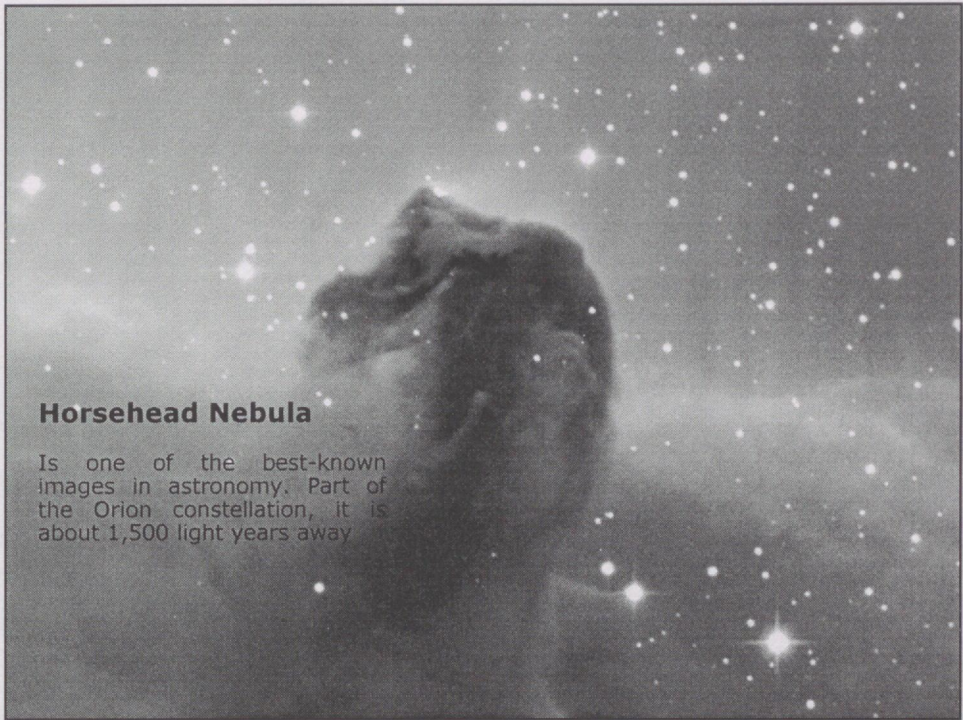
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800,000 light years
(remains 1)
in below



✓

Star-forming Cloud
This image shows a star-forming region, where bright stars are being born from the gas and dust clouds. The bright stars are the result of the collision of two galaxies.

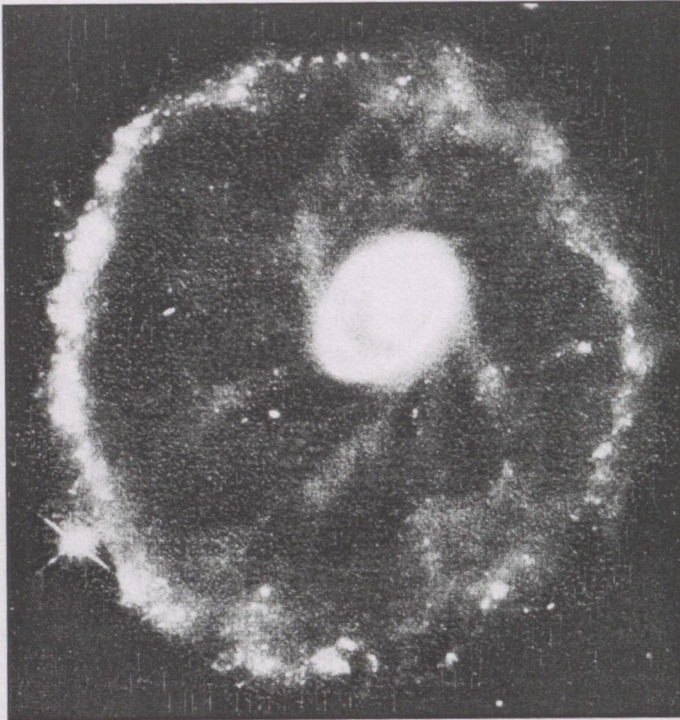


Horsehead Nebula

Is one of the best-known images in astronomy. Part of the Orion constellation, it is about 1,500 light years away



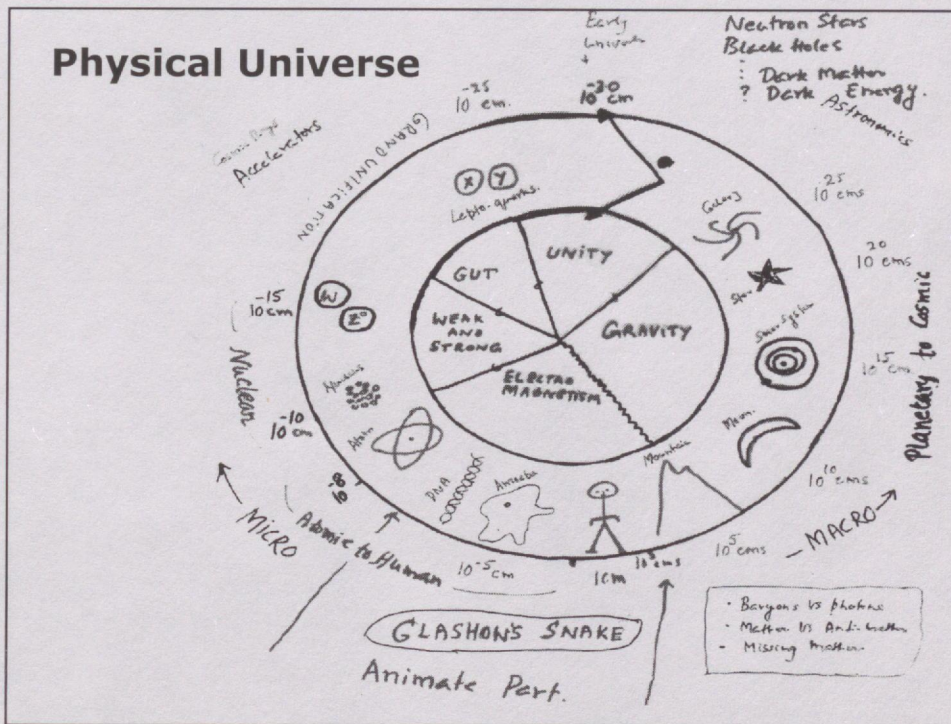
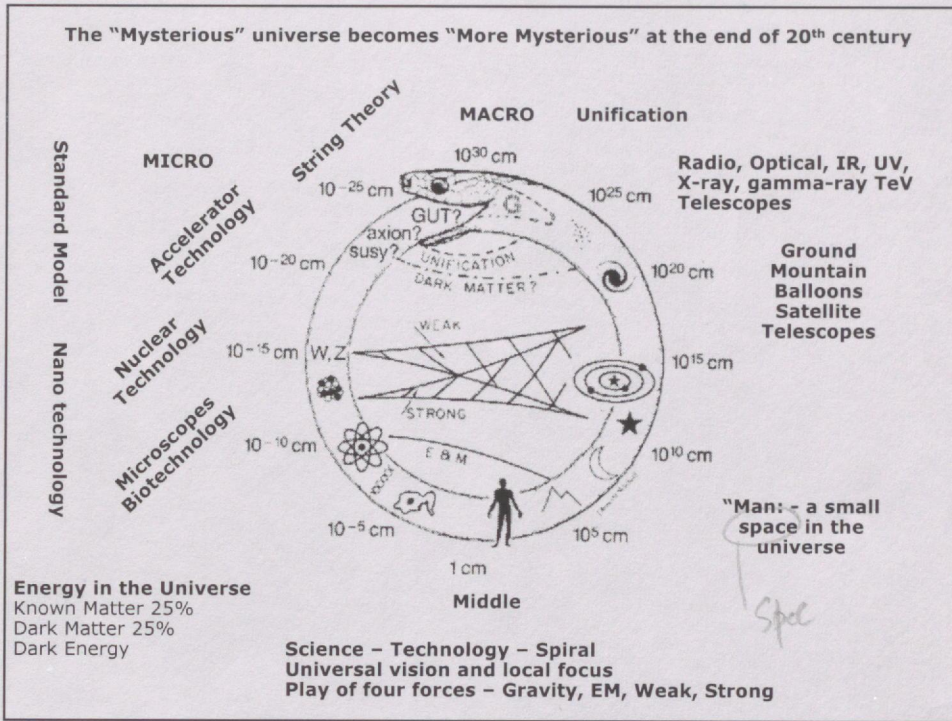
Butterfly Nebula M2-9




Cartwheel Galaxy

The galaxy ring is 150,000 light years across, large enough for our entire galaxy to fit inside, and is located 500 million light years away in the constellation Sculptor.





Falling Stone – Deeper Implications

- School Boy: Gravitational force acting on Gross Matter
 - Chemist: Gravitational Force acting on Molecules, Atoms of Silicon, Iron, etc.
 - Particle Physicist: Gravitational Force acting on Protons, Neutrons, Electrons of the Atom. In addition there are EM forces and Nuclear Forces binding these – actually quarks and anti-quarks and gluons
 - Quantum Physicist: All this is activity in the quantum-vacuum – empty space
- 

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Virtual Status

What is Vacuum?

Repository of all fundamental particles (discovered and yet to be discovered) in negative energy states.

CREATION OF VACUUM, Particles, Forces, Laws, Constants Antropic

- The origin of the universe...
- At 10^{-35} seconds...
- At 10^{-32} seconds...
- At 10^{-12} seconds...

1. At 10^{-35} seconds, temperature 10^{32} degrees Kelvin. The strong force separates from the weak and electromagnetic forces. The universe is a plasma of quarks, gluons, and other particles. Inflation ends and the expanding universe begins to cool. By this time it expands a factor of 10^{28} in size.

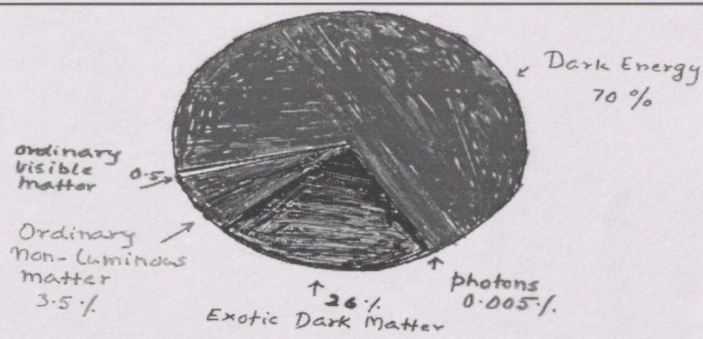
2. At 10^{-32} seconds, temperature 10^{27} degrees Kelvin. The electroweak force separates into weak and electromagnetic forces. The universe is a plasma of quarks, gluons, and other particles. Quarks combine to form protons and neutrons. Protons have a mass 1836 times that of electrons. This is the strong force that binds nucleons together by the Gluon (SU(3) color and SU(2) spin) interaction.

3. At 10^{-12} seconds, temperature 10^{12} degrees Kelvin. Protons and neutrons combine to form deuterium and helium. The universe is now mostly hydrogen and helium. The expansion of the universe continues to slow down.

4. At 10^{-6} seconds, temperature 10^6 degrees Kelvin. The universe is now mostly hydrogen and helium. The expansion of the universe continues to slow down.

↑ origin of life ???

↑ Consciousness ???



Composition of the universe
Visible and invisible. 2005

Dark Energy : - in $\frac{2}{3}$ of universe.
 • Gravitationally Repulsive.
 • No one knows what it is made of

First Evidence 1998 Supernovae observations
 2002 Survey of 250,000 galaxies

{ Hubble Telescope
 Wilkinson Microwave Background Anisotropy (WMAP) Probe
 Sloan Digital Survey (SDSS) Gravitational Lensing

Thank you