Quantum of Light Unify Forces of Nature

Seminar

Presented by

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Sponsored by

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Program Schedule

1. Social and Refreshments…….....09:00A-9:45A
2. Introduction……..……..10:00A-10:15A
3. Seminar Session 1……..……....10:15A-11:15A
4. Coffee Break……..……...11:15A-11:30A
5. Seminar Session 2……...11:30A-12:30P
6. Questions/Comments…….……..12:30P-01:00P
7. Conclusion, Credit/Remarks…….....01:00P-01:30P

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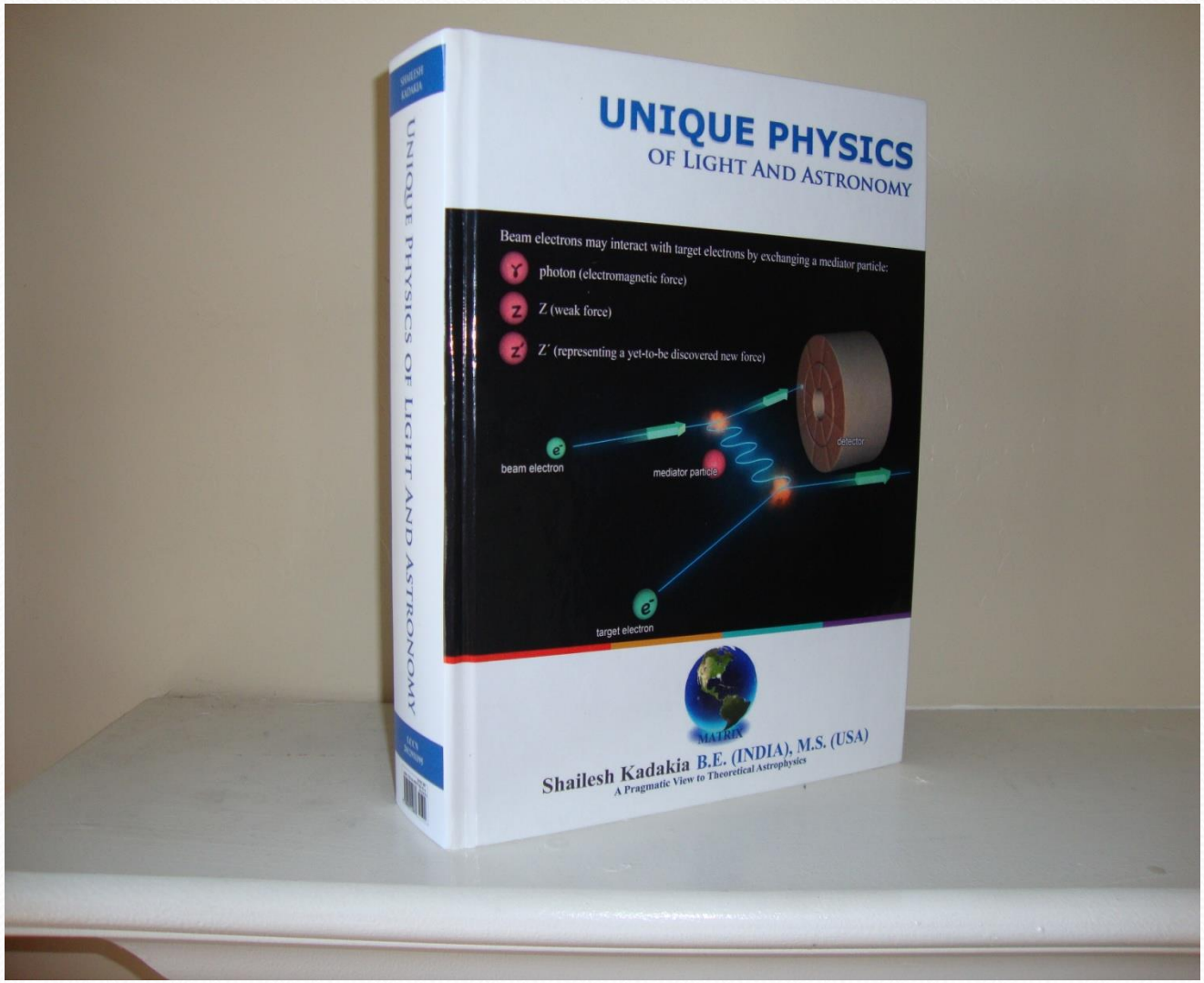

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Contents

1. Introduction to Relativity

- Clarify: Light is a wave, no rest mass and lacks gravity
- No interaction with Higgs field, Common sense
- Gravitational deflection vs. Snell's refraction effect

- Trajectory of a Golf ball vs. Bending of a straw, light
  a projectile interaction with water

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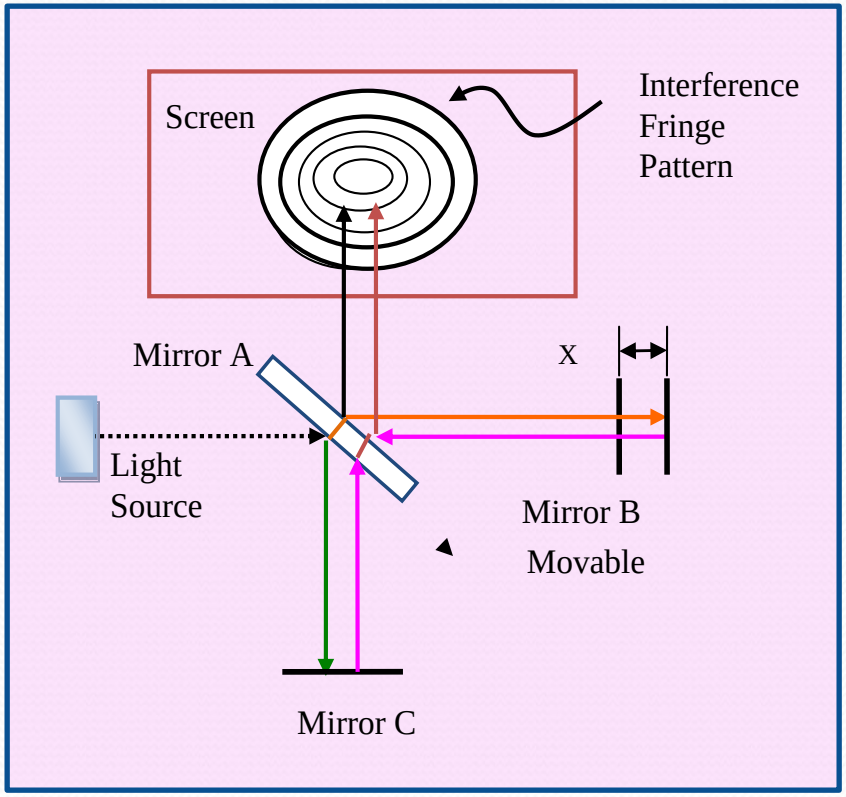
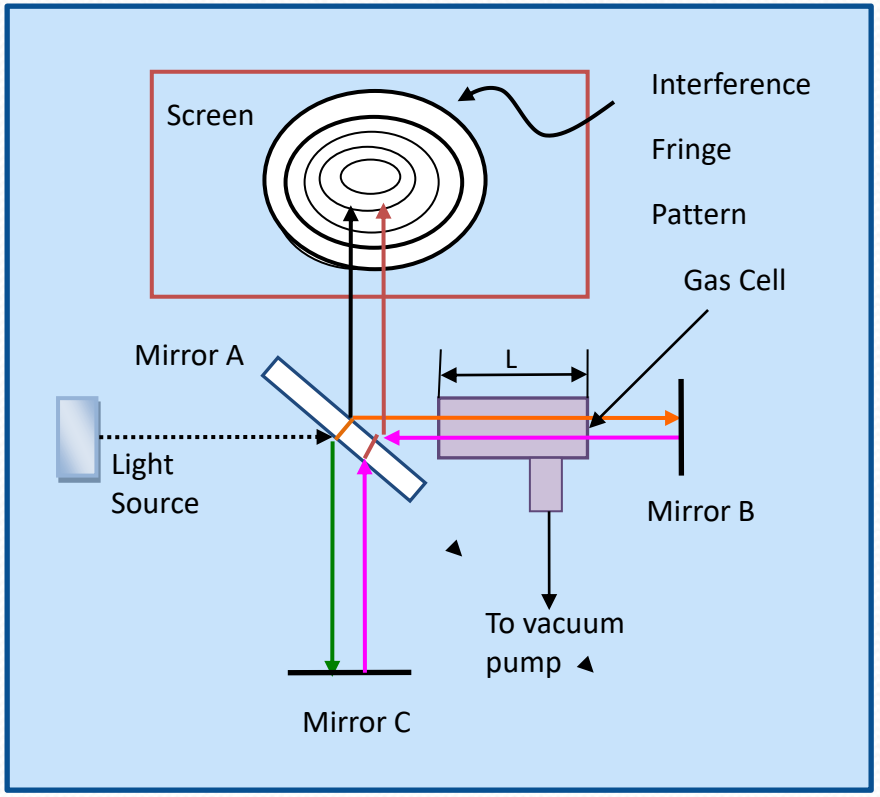
The Michelson's interferometer: Applications

- **A. Wave length λ of light B. Refractive index μ of air**



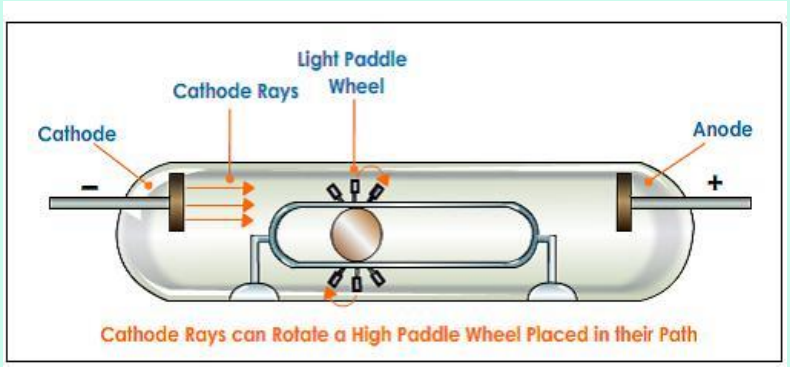


- **Newton's bright ring shifts Rings disappear**

Illustrate wave nature of Light

- Rotation of fan with charges on blades created by light

(A)



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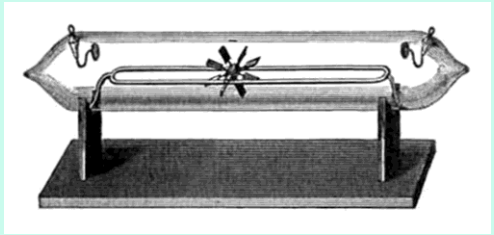

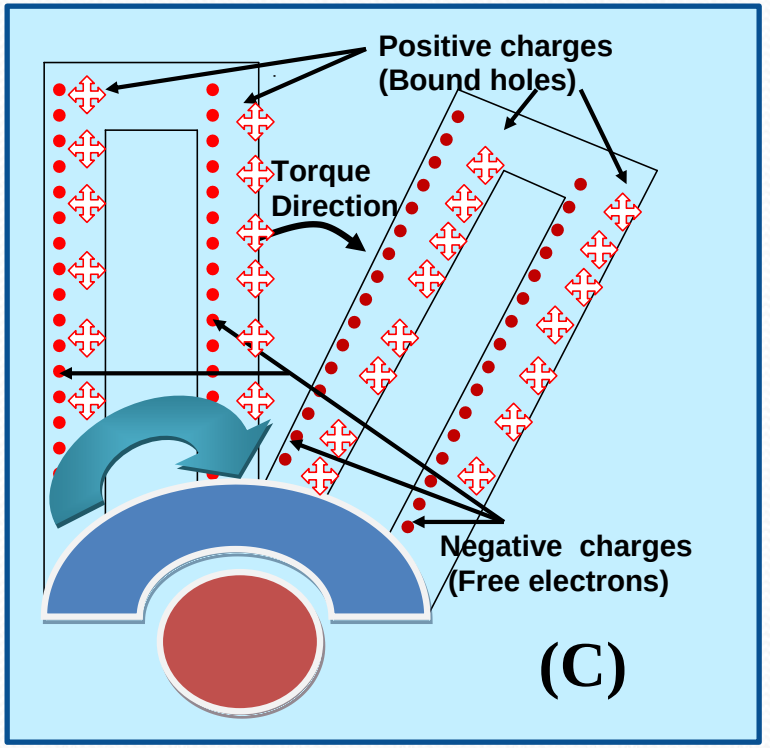

(A) Crooke's Tube: Cathode rays can rotate a paddle wheel

(B) Actual model

(C) Detailed picture of charges on blades

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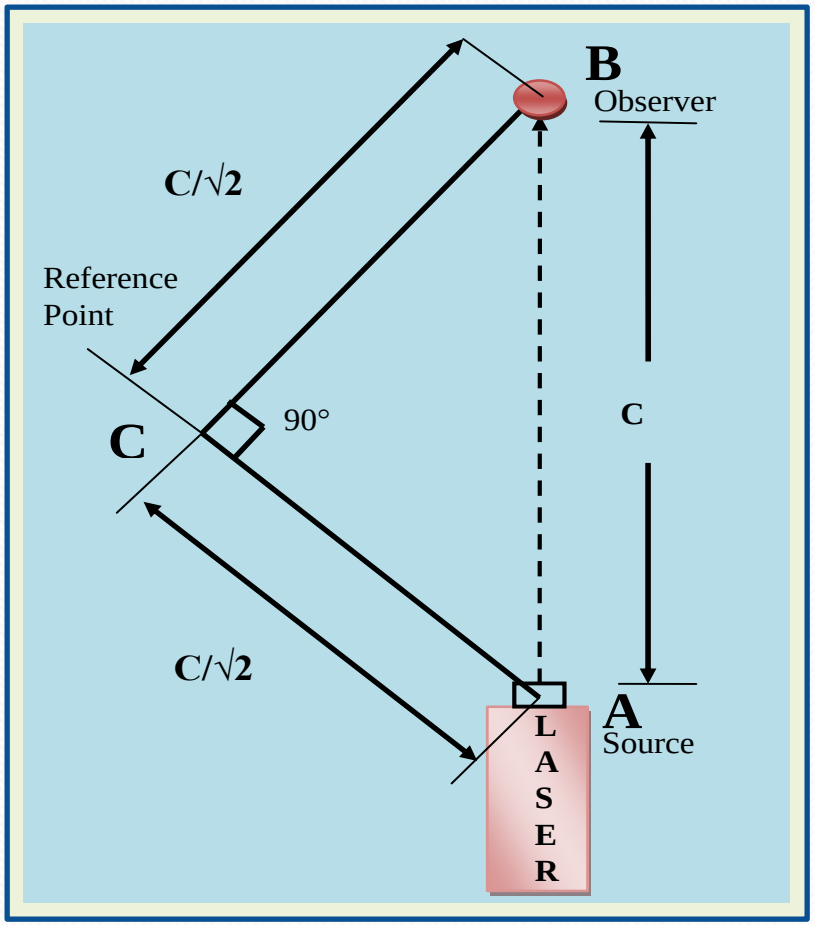
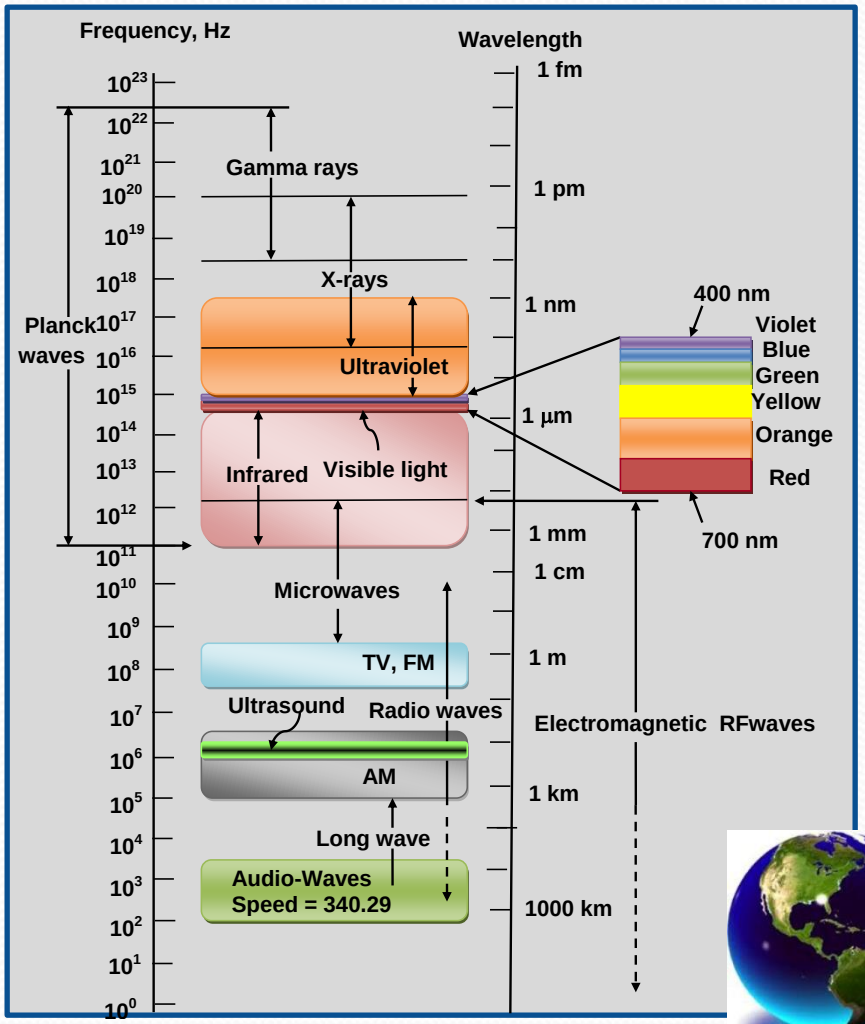
2. Quantum Theory of Radiation

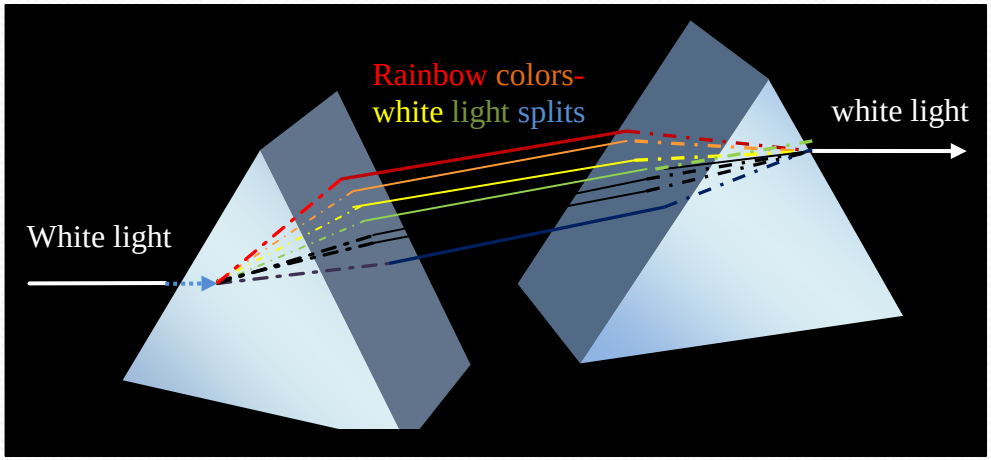
- True Speed of Light c & Absolute time
- Splitting frequency spectrum; RF EM and Planck waves





Distinguishing particles from waves

- Center of gravity unique to mass distribution
- Rest mass transforms into radiation energy waves
- Particles project force of gravity on other particles
- Light quanta: Do not interact with Higgs field (HF)
- Particles: Rest mass, interact with HF, & acquire mass
- Particle model violates 2nd law of thermodynamics in passage of light through a pair of prisms experiment



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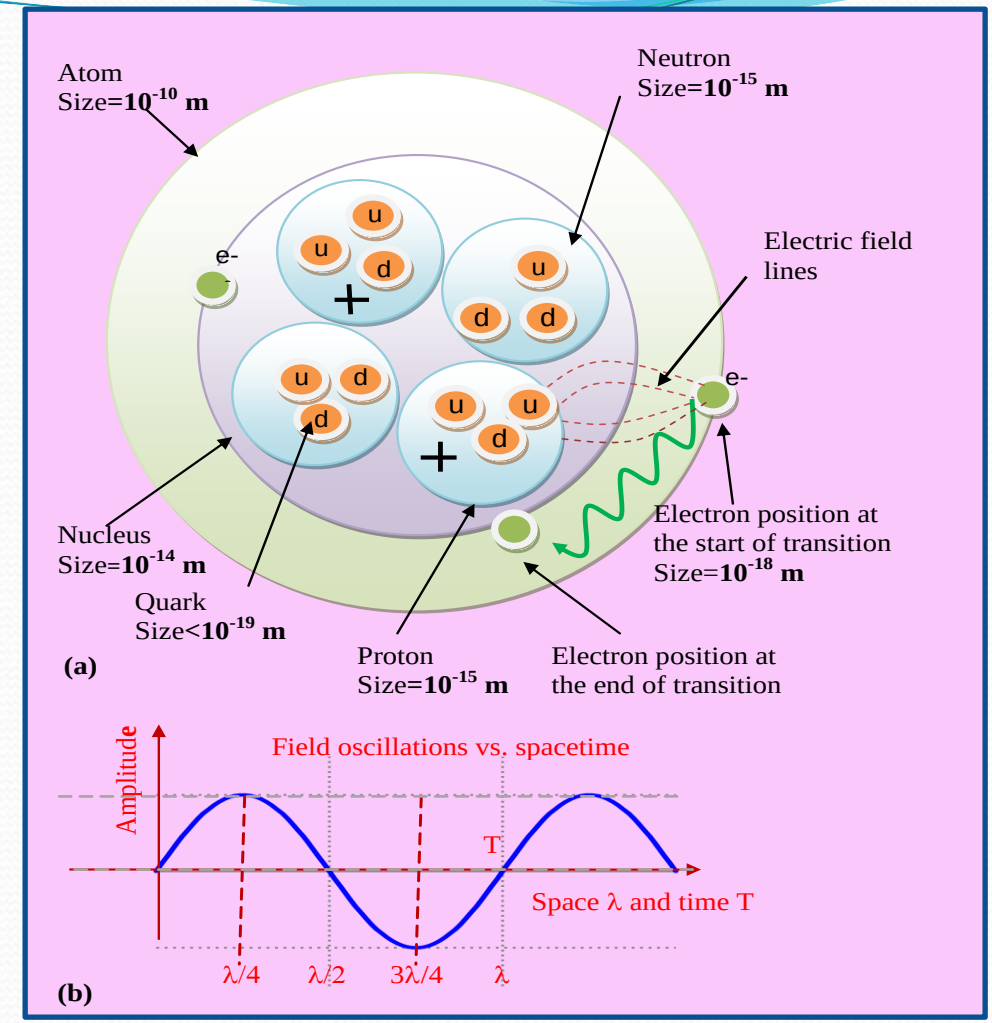
Creation of Radiations & Light

- Energy E = h × f eV
- Speed c = f × λ m/s
- ΔE Energy difference in quantum state.
- Speed of radiation α electron energy dissipation rate in electrostatic charge field (reverberation)
- f oscillation frequency
- λ wavelength of oscillation
- Speed c same in space & inner space of atoms



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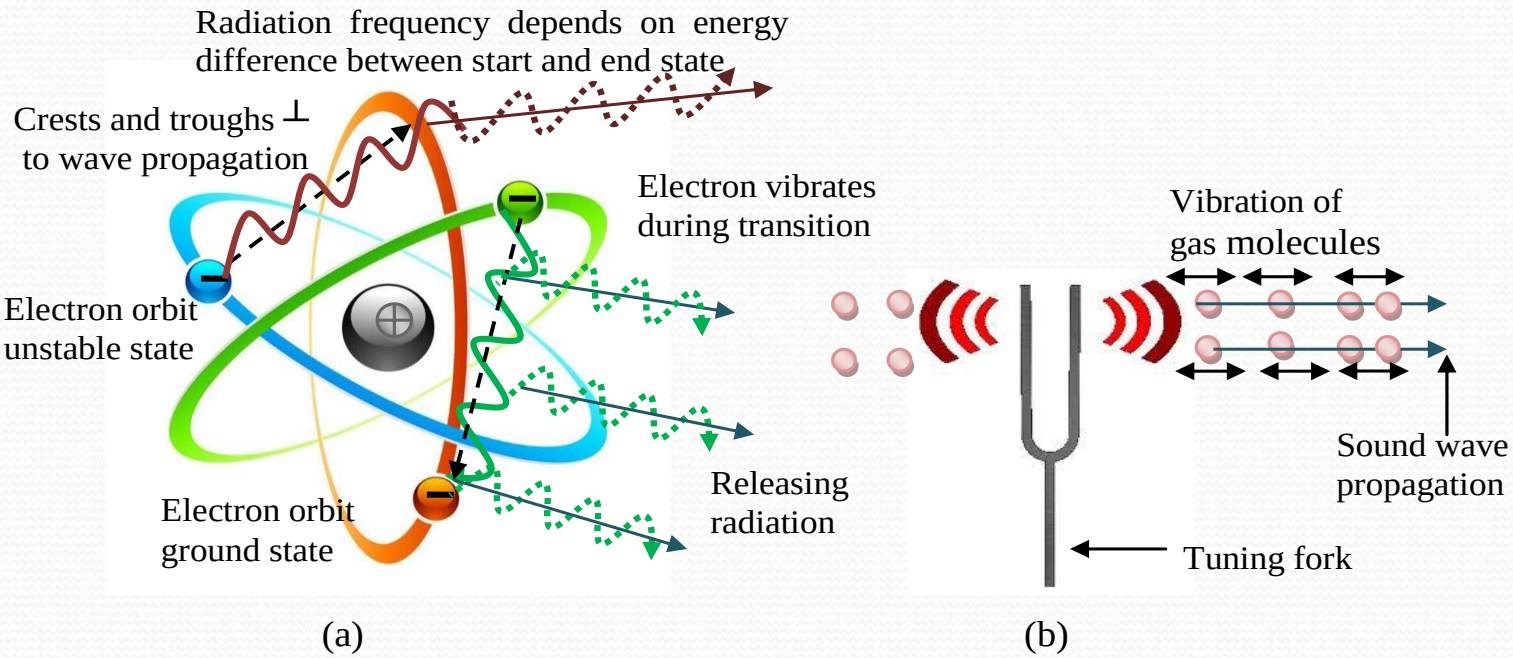
Transverse propagation of radiation

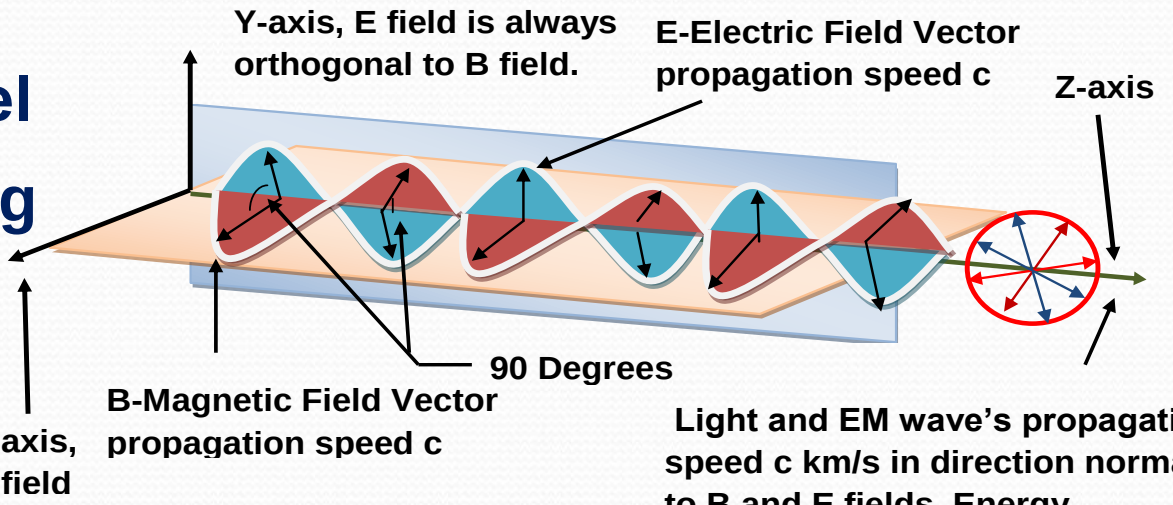
- Radiation & Light waves propagate perpendicular to
- direction of field oscillations.
- Sound waves travel in same direction as gas atoms.



- Light & Radiation path. Path of sound waves

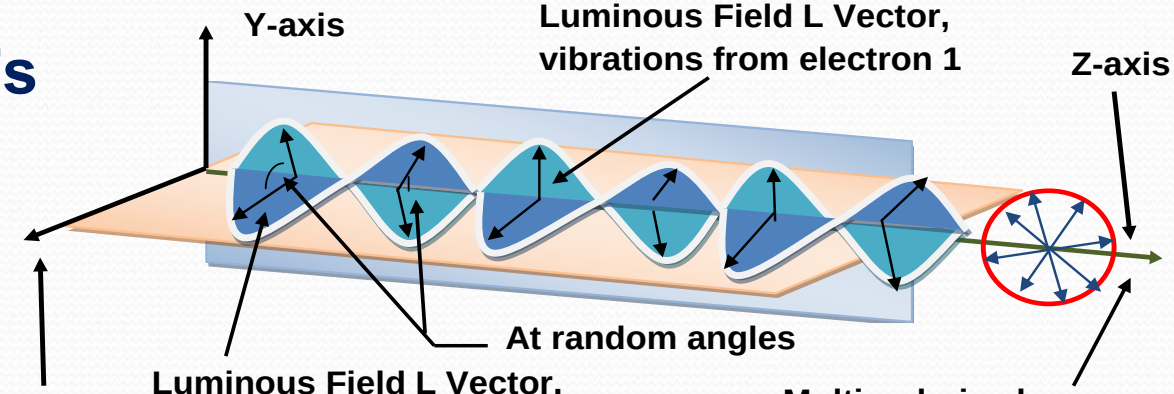
Maxwell's theory vs. Planck's Theory

- Maxwell's model
- Energy Poynting
- Vector theorem



Light and EM wave's propagation speed c km/s in direction normal to B and E fields. Energy $U_{avg} = \frac{1}{2}\,\varepsilon_0 E^2_{max} = \frac{1}{2}\,B^2_{max}/\mu_0$

- (b) Planck's
- Model
- E = h × f



Multi-polarized, non-coherent Light (Planck) waves propagation speed c km/s. Energy $U_{avg} = h \times \nu$

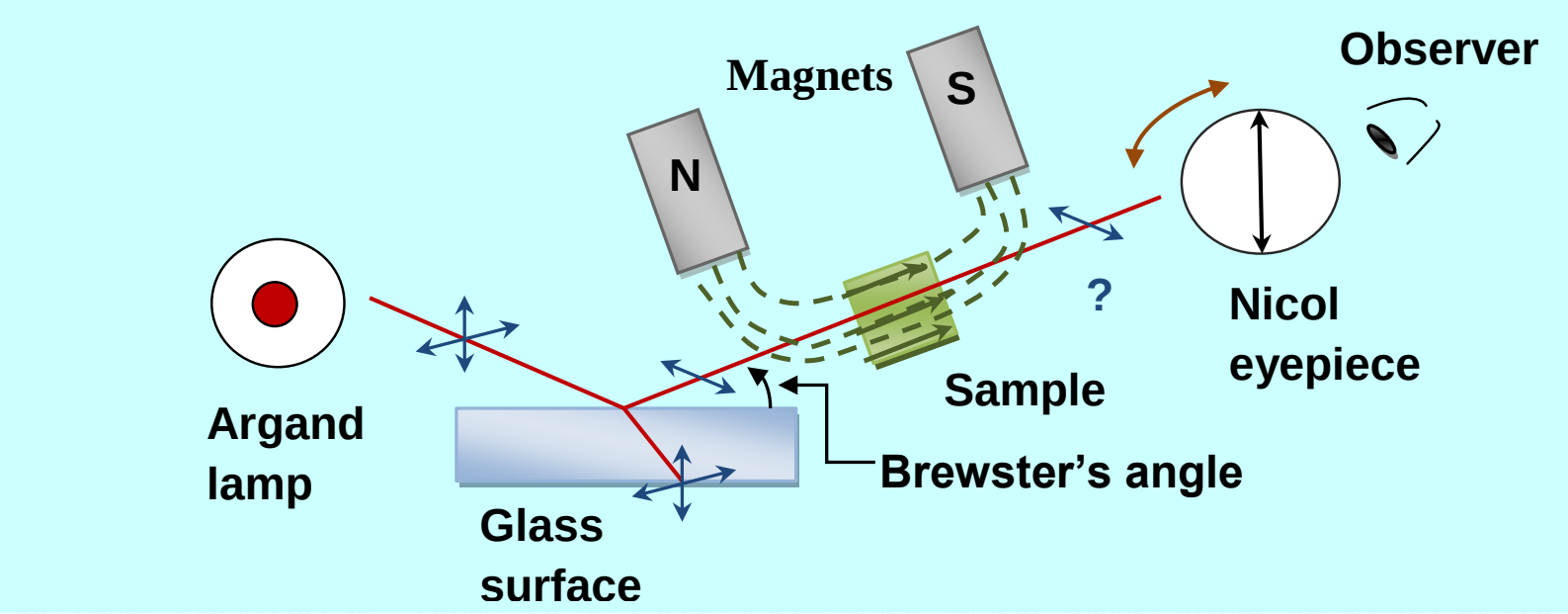
RF/EM waves vs. Light/Radiation waves

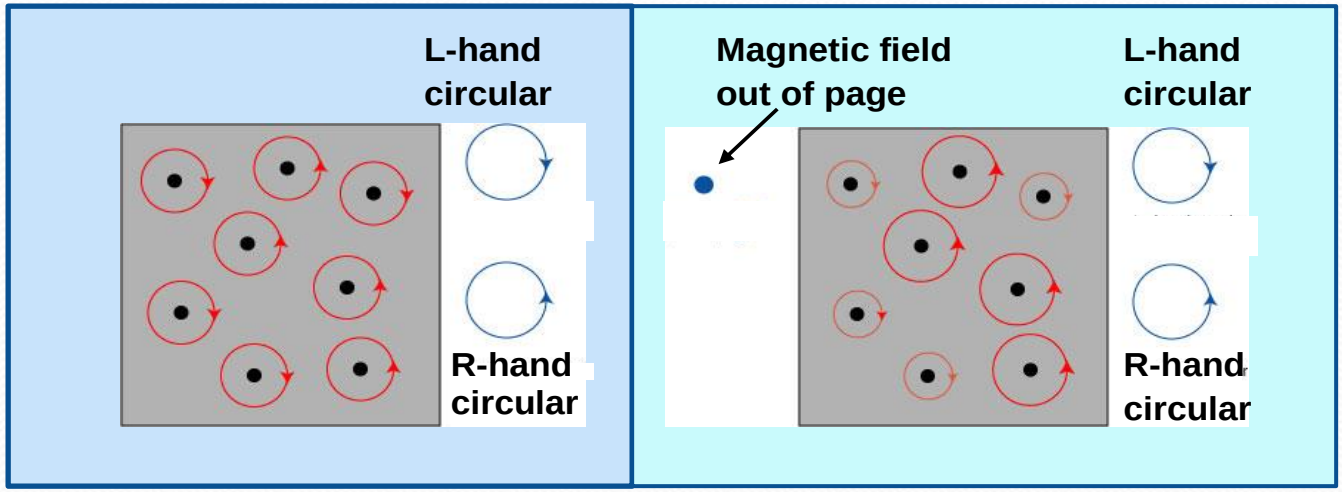
- Light, vibrations of electrons; bound charges in atoms
- RF/EM waves, oscillations of mobile charges in circuits.

- Light energy $U_{avg} = h \times \nu$, Intensity $L_{max} = (n / A) \times U_{avg}$
  where n is no. light quanta incident/unit time, A is area
- Einstein's Photoelectric equation $1/2 m_e v^2 = h \times \nu - \phi_m$
  where v electron ejection speed, ν frequency of incident quanta, and ϕ_m is work function of target.

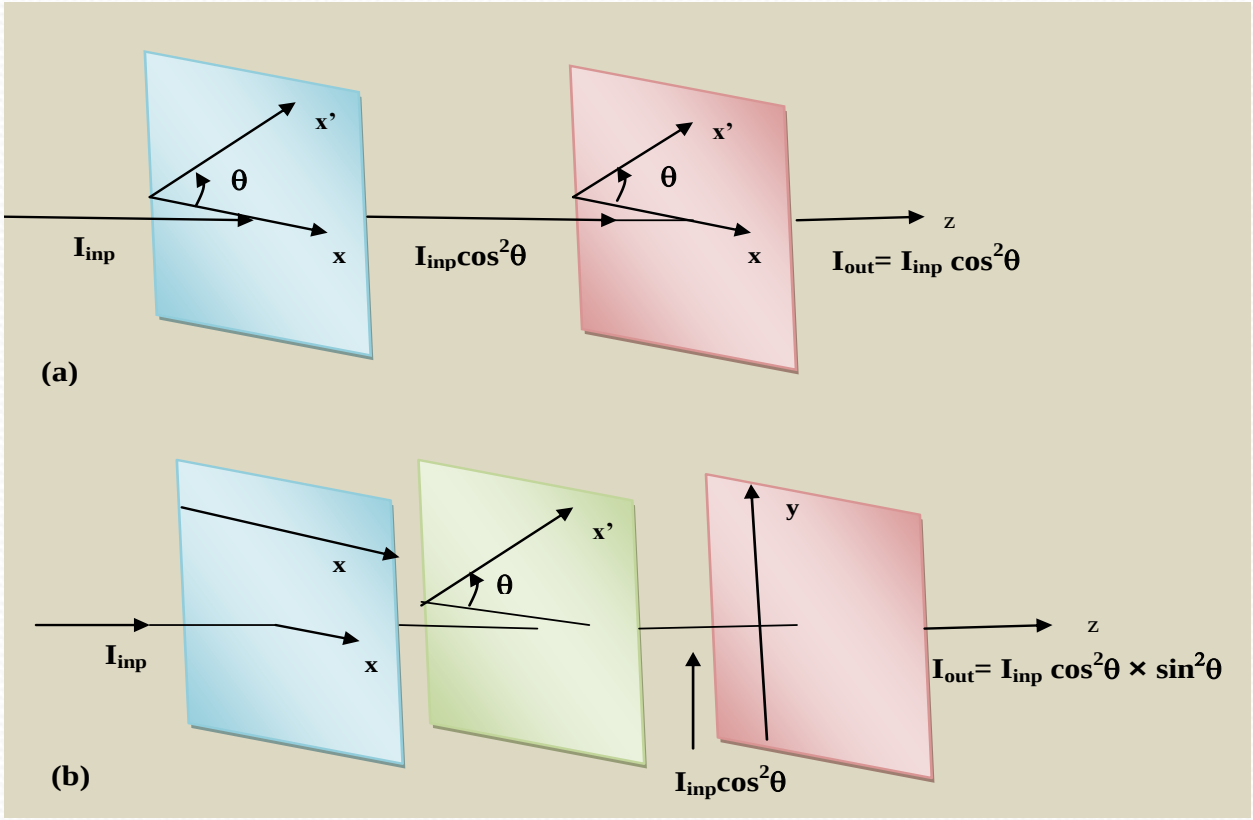
- RF/EM energy Poynting Vector theorem, E and B field vectors
- $U_{avg} = \frac{1}{2} \varepsilon_0 \times E^2_{max} = \frac{1}{2} \mu_0^{-1} \times B^2_{max}$ where
- $E_{max} = k_e \times Q/r^2$ and $B_{max} = (\mu_0/(4\pi \times r^2)) \times I \int ds \times r$

Experiment: Faraday's Rotation





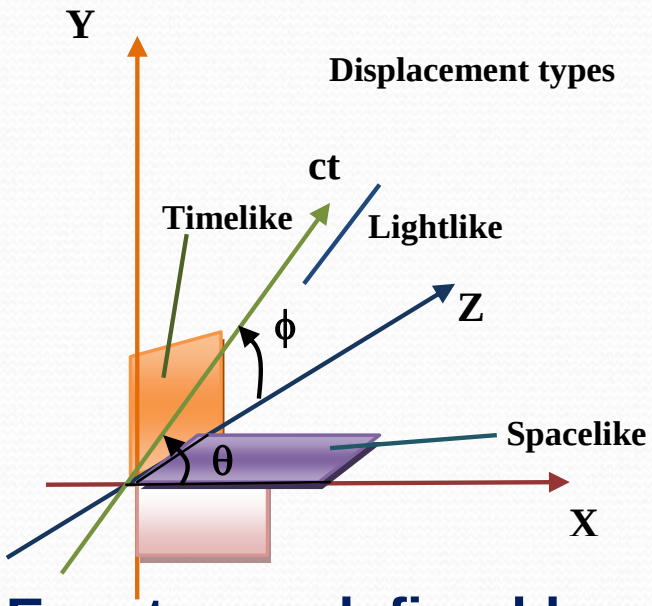
Passing of Light, pair Polarizer/Analyzer

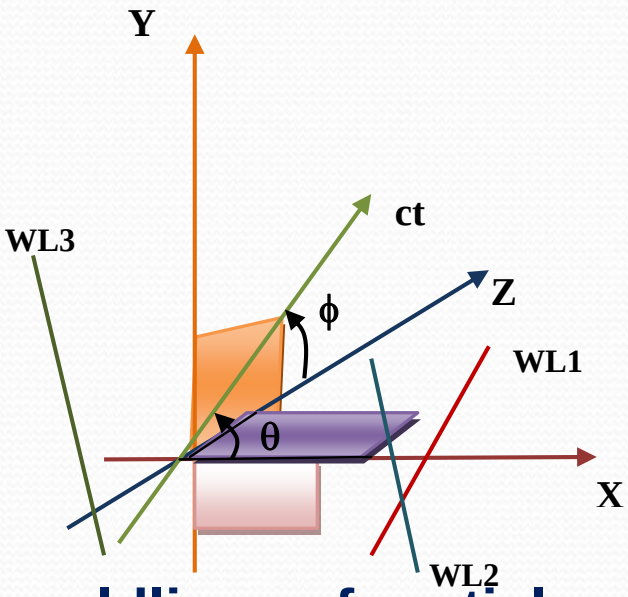


- (a) Polarized light at angle θ with polarizer/analyzer axes passes, $I_{out} = I_{inp} \cos^2\theta$, Mono-field characteristics of light
- (b) A blocked path, Polarizer axis at 90° to Analyzer axis is opened by adding a polarizer at θ° , $I_{out} = I_{inp} \cos^2\theta \sin^2\theta$

3. Fundamentals of Skylativity®

Worldlines and Timelike, Lightlike, and Spacelike Events





(a) Events are defined by spacetime interval metric.

(b) worldlines of particles are plots of positions vs. time.

- 1. Timelike, metric displacement; positive, occur in real time.
- 2. Lightlike, metric displacement; zero, time freezes.
- 3. Spacelike, metric displacement; negative, Communication freezes, Quantum entanglement for information exchange

VSL Skylativity® vs. Einstein's STR

Varying Speed of light Skylativity® Theory

- Speed of light variable $c = (\mu_m \times \varepsilon_m)^{-1/2}$, Light is a wave
- New mass equivalence $E = (m_\nu - m_n)\, c^2 + \Sigma\, h \times f_\iota$, m_n neutrino mass
- Length, mass, & time constant, speed c Doppler related
- Created by oscillations of electrons bound to nucleus
- Established RF/EM waves created by mobile charges
- Events are Timelike and Spacelike. No events are Lightlike.

Einstein's Special Theory of Relativity [STR]

- Speed of light constant $c_0 = (\mu_0 \times \varepsilon_0)^{-1/2}$, light is EM wave.
- Light, photon particles and waves, time travel possible
- Mass & energy equivalence $E = mxc^2$, light has zero rest mass
- Measures of Length, Mass and Time, Lorentz related
- Photoelectric Effect $1/2m_e v^2 = h \times \nu - \phi_m$, $E = h \times f$
- Events are Timelike, Lightlike, and Spacelike, events of past.

Skylativity® GTS vs. Einstein's GTR

General Theory of Skylativity® [GTS]

- Light/Radiation are refracted, follows Feynman's QED
- Light/radiation zero rest mass, insensitive to gravity
- Gravity deflects objects/particles with rest mass
- Explained the effect of gravity on atomic clocks
- As gravity decreases, λ of light shrinks, clocks speedup

Einstein's General Theory of Relativity [GTR]

- Cause of gravity and speed of propagation unknown
- Acceleration of objects is independent of mass
- Gravity warps spacetime & deflects light and matter
- As gravity decreases, λ expands, clock slowdown
- Solution of Einstein's field equation, real Universe

Einstein in India with Famous Poet Tagore

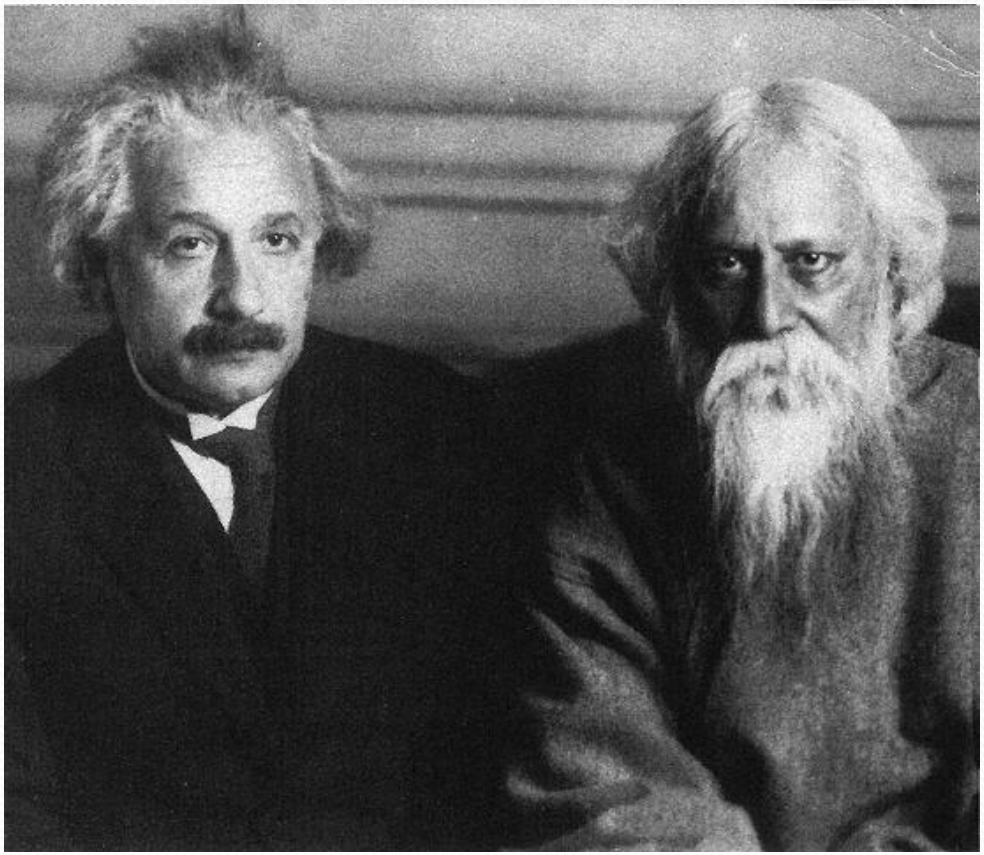
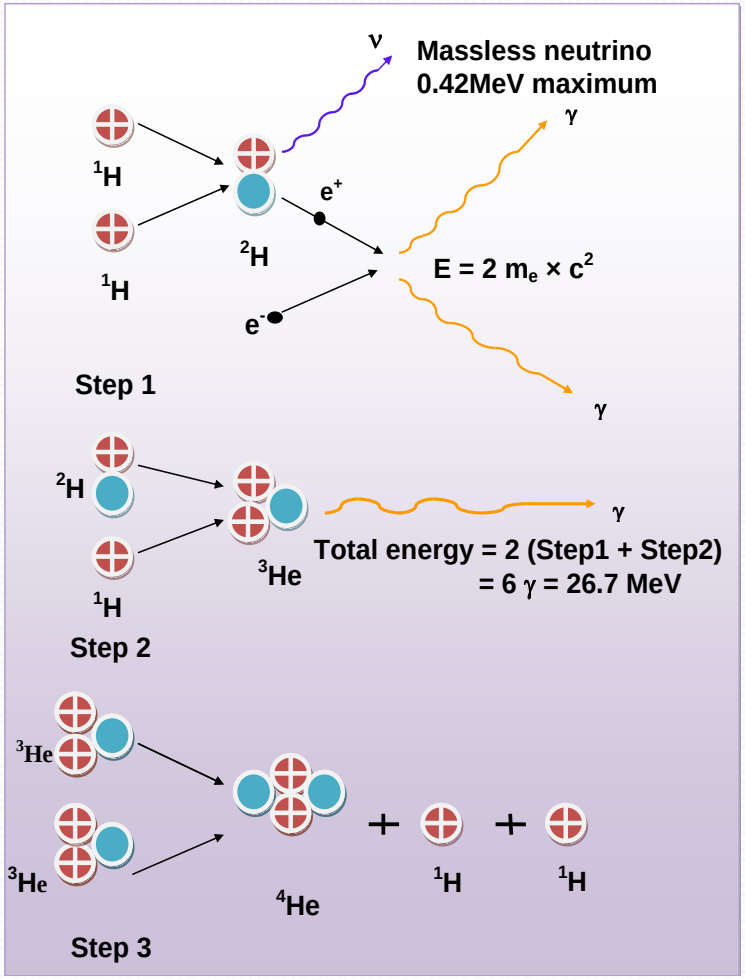


Figure: Albert Einstein with Rabindranath Tagore from India.
(Courtesy of the New York Times, August 10, 1930)

Limitations of Energy Equivalence

- Einstein's relation $E = m \times c^2$ holds well for thermonuclear fusion H_2 into He reaction that occurs in proto stars and in PP chain reaction of CNO cycle during stellar evolution
- Burning of H_2 into He 3 step process
- Step 1 2 protons $^1H + {}^1H \rightarrow {}^2H$,
- Step 2 $^1H + {}^2H \rightarrow {}^3He$,
- Step 3 $^3He + {}^3He \rightarrow {}^4He$
- Nuclear fission reactions on Earth in nuclear power plants and weapons release binding energy E_b $^{238}U \rightarrow {}^{235}U$
- $E_b = (Z x m_p + N x m_n - M_i x A_i) x 931.494$ MeV/u
  Z charge no., N neutrons & A mass no.
  $A_i = Z_i + N_i$, M_i is mass of isotope
- Empirical relation for E_b A > 15 in MeV
- $15.7xA - 17.8xA^{2/3} - 0.71xZ(Z-1)xA^{-1/3} - 23.6x(N-Z)^2xA^{-1}$



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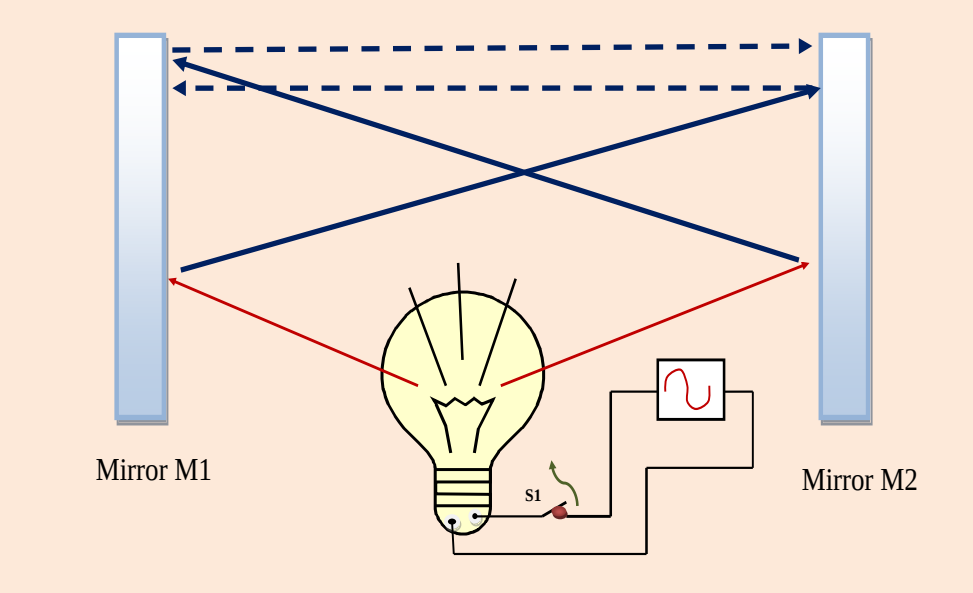
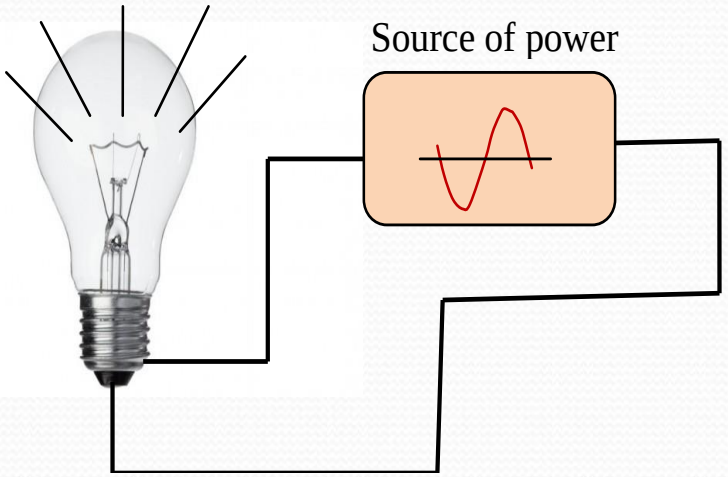
Applications of Skylativity®

- Light travels at null-geodesics in space, allows better accuracy on age and size estimates of Universe
- Provided a method to integrate gravity from celestial objects on quantum scale particles in nano space
- Improved accuracy of standard Cs atomic clocks
- Harnessing Solar Energy, low cost electric power
- Communication at Super Luminous Speeds reality
- Quantum Entanglement for Control at Galactic Distances
- Medical: Diagnostic and Treatment, MRI, CT Scan,
- Skin Care, Hair Removal by using Lasers therapy and Chemotherapy for cancer treatment.
- Predicts travel at Super Luminous speed, interstellar space missions & space voyage to stars are feasible.

4. Beyond Einstein's Relativity

- Experiments, Edison's Bulb - finite energy of light in (a)
- Filament mass unchanged after thousands of hours (b)





- (a) Light photons accelerated to speed c with finite energy and photons disappear after power is switched-off

(b) Mass of Tungsten filament remains unchanged after its useful life

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Complex Mass and complex dimensions

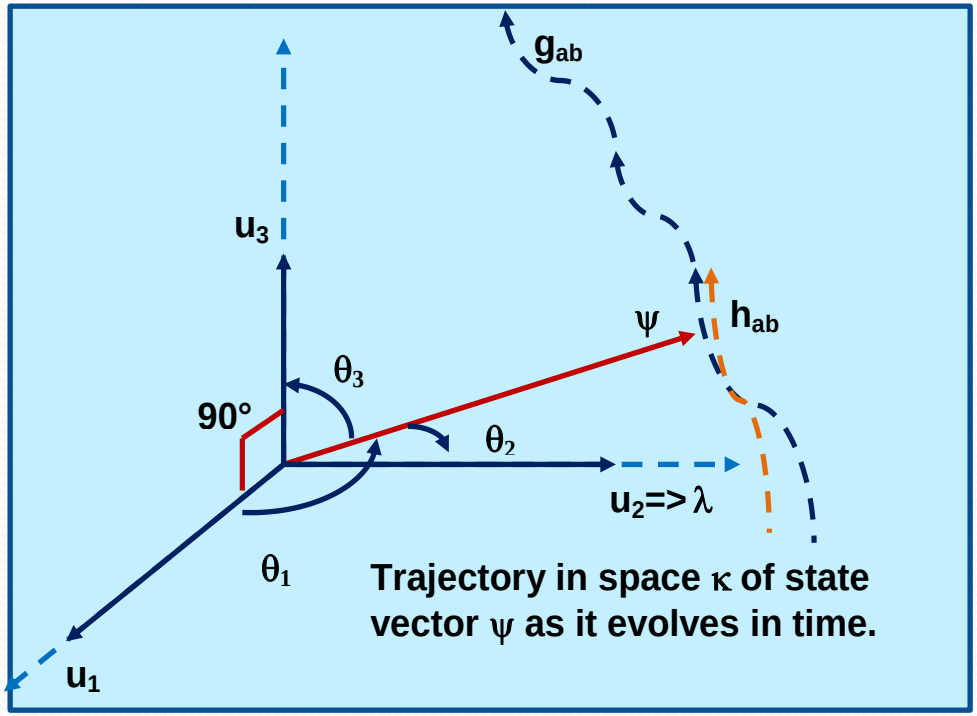
- Total M = real rest mass M_0 – i M_e virtual energy mass
- Rest mass, current CG*. Virtual mass CG* in future
- Hyperspace & Complex dimensions, Universe: Real and
- imaginary domains
- $X = X_r - i\, X_i$ where

$$X_i = \sum_{m=1}^{\infty} X_m \times P_m \text{ and}$$

P_m is probability,

and $T = T_r - i\, T_i$ where

$$T_i = \sum_{n=1}^{\infty} T_n \times P_n$$



CG* --- Center of gravity

Here P_n is probability of finding an object in hyperspace

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Stellar parallax technique

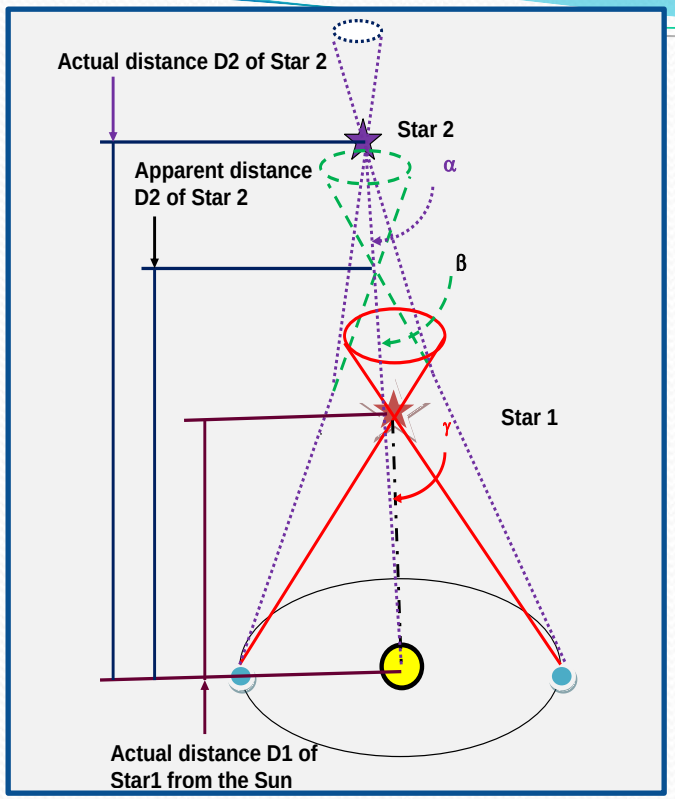

Figure: Position of star is affected by gravity of a nearby star.

- **Light zero rest mass, no gravity effect.**

  Observed bending ← Skylativity® refraction

- **$F = G (m_1 \times m_2)/r^2 = m \times a$, m nonzero rest mass**

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5. Overview: Lorentz's Transformations

- Lorentz Transformation & Time Dilation
- Time, Space diagrams for world point P
- Length contraction & time dilation
- $l = l_0 \times (1 - v^2/c^2)^{1/2}$ and $t = t_0 / (1 - v^2/c^2)^{1/2}$, c constant

  define factor $\beta = v/c$ for inertial systems S and S'
- $l = l_0 \times (1 - \beta^2)^{1/2}$ and $t = t_0 / (1 - \beta^2)^{1/2}$
- Apply Galileo translation to c, update β
- γ_a approaching and γ_r receding systems
- $\gamma_a = \beta / 1 - \beta$ and $\gamma_r = \beta / 1 + \beta$
- $\beta = 1/2$, $v = c/2$ gives $\gamma_a = 1$ time dilation infinite and length shrinks to 0, not real
- Life time and decay of neutrino emission

Lorentz Transformation of World Point P

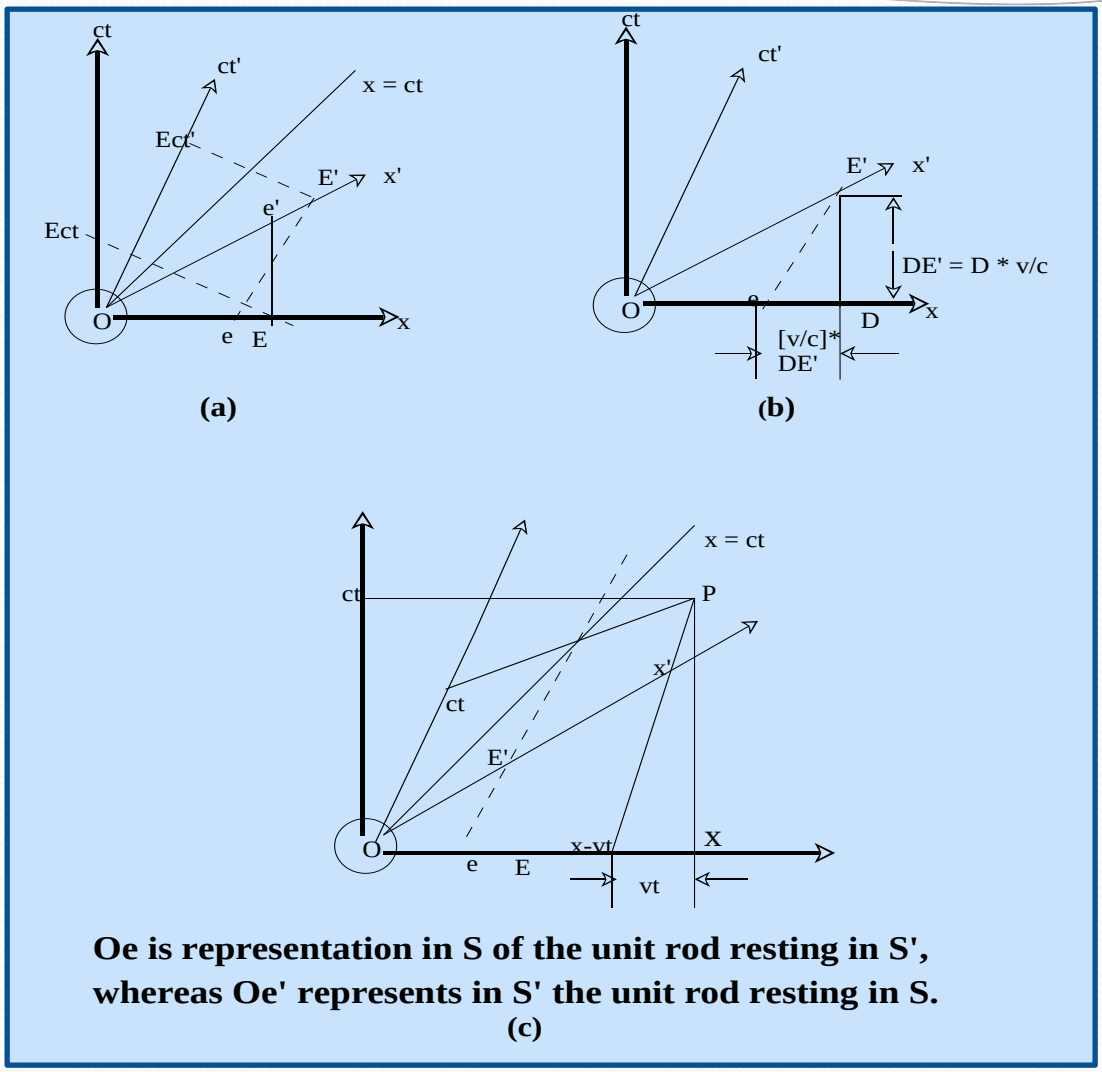

Figure: Lorentz transformation of world point P

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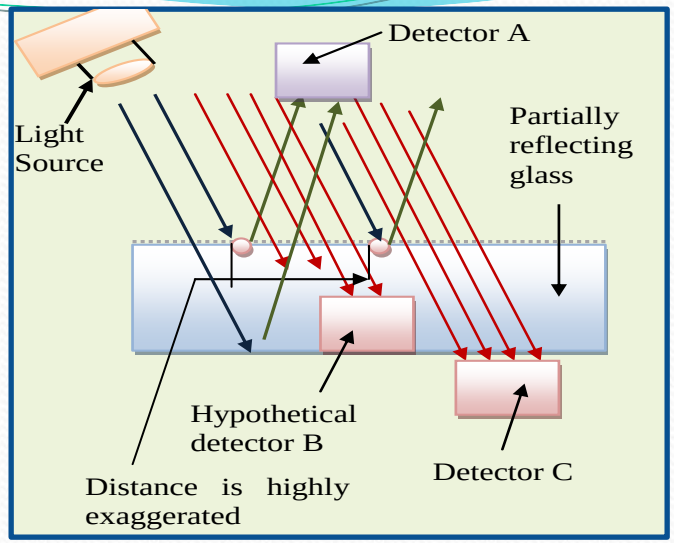
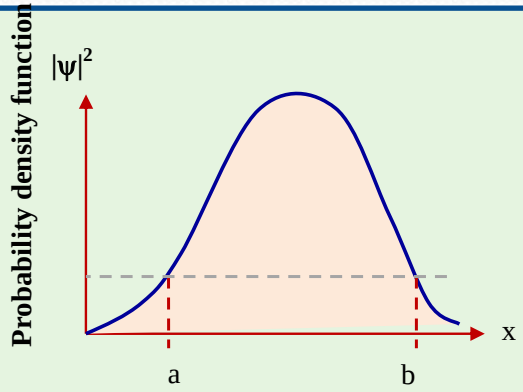
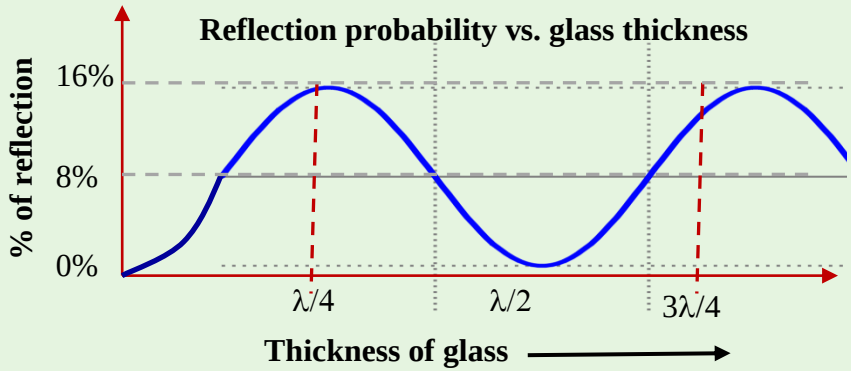
6. Feynman's Fascinating Theory (QED)

- Experiment enabled Feynman to invent Path Integral formalism & QED rules of Grand Principles. Reflected light was monitored on photo-multipliers from a partially reflecting glass plate of varying thickness.



(a) Reflection from glass



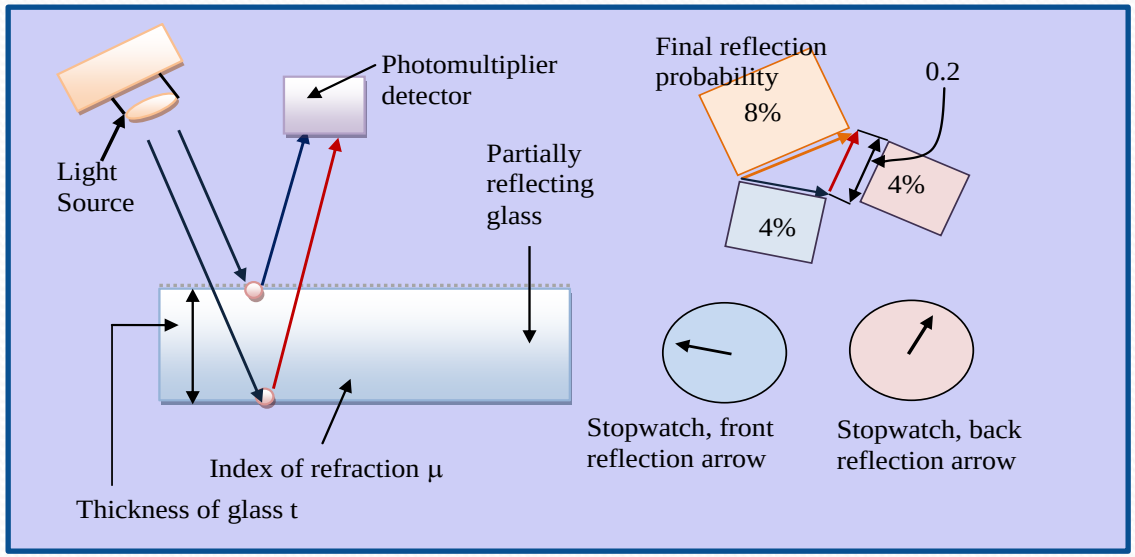


(b) Probability amplitude α electron location prob. $P_e(x) = \int|\psi^2|\, dx$

Kadakia's postulate: Probability amplitude PA α $P_e(x)$ where $P_e(x)$ is probability an electron is found at x, expected value.

QED Grand Principle

- Grand Principle: Event probability P(x), light will interact with surface of any matter is equal to the square of resultant PA length.
- PA General Rule: Event could happen in alternate ways. To derive composite probability of entire event perform four following steps
- 1 Draw PA vector of known length the way each event may occur
- 2 Adjust orientation of vector. Use a stop watch timer to time phase
- 3. Perform vector addition. Determine resultant probability length.
- 4. $P(x) = (|\text{resultant PA}|)^2$



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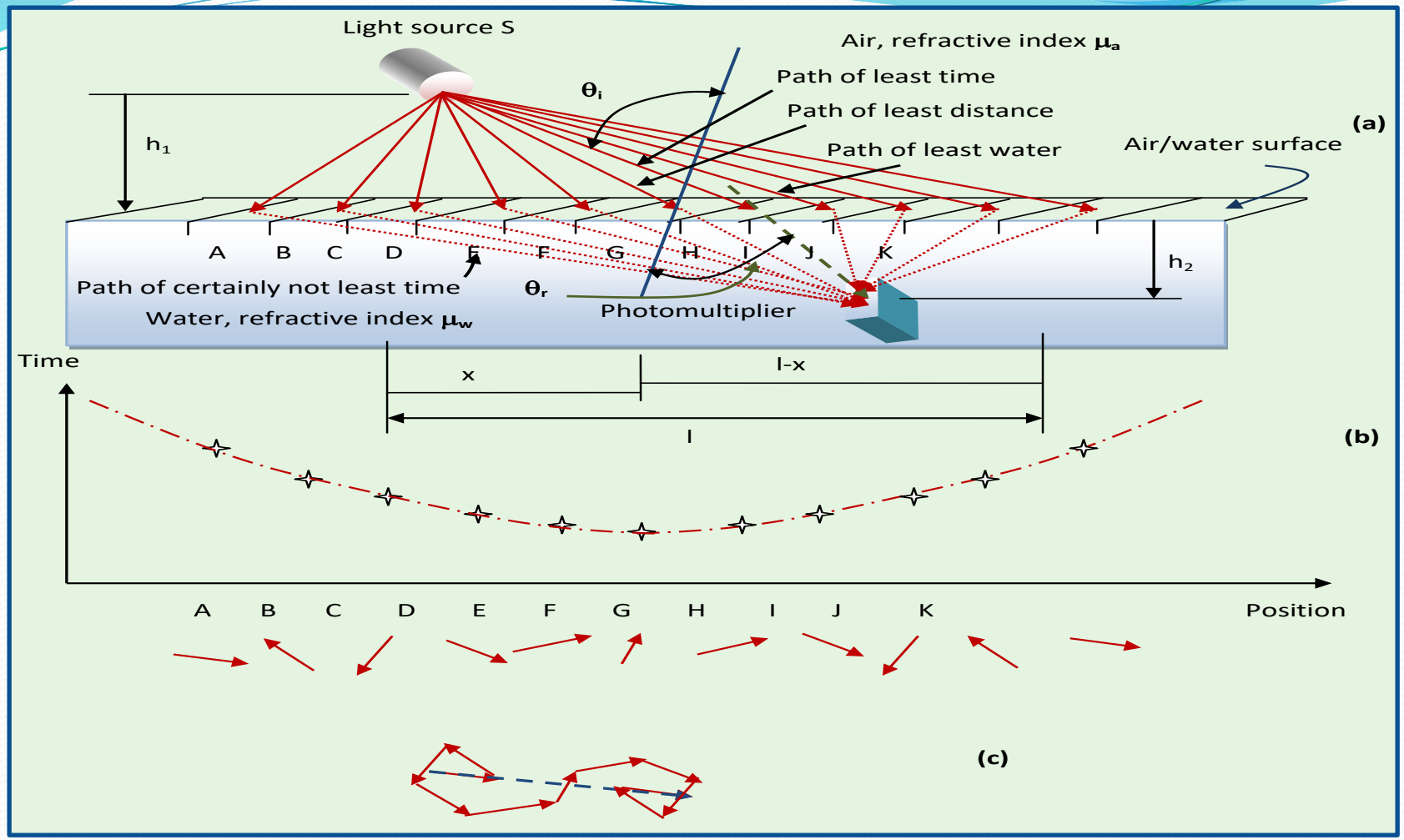
Path of Light: Through Air and Water

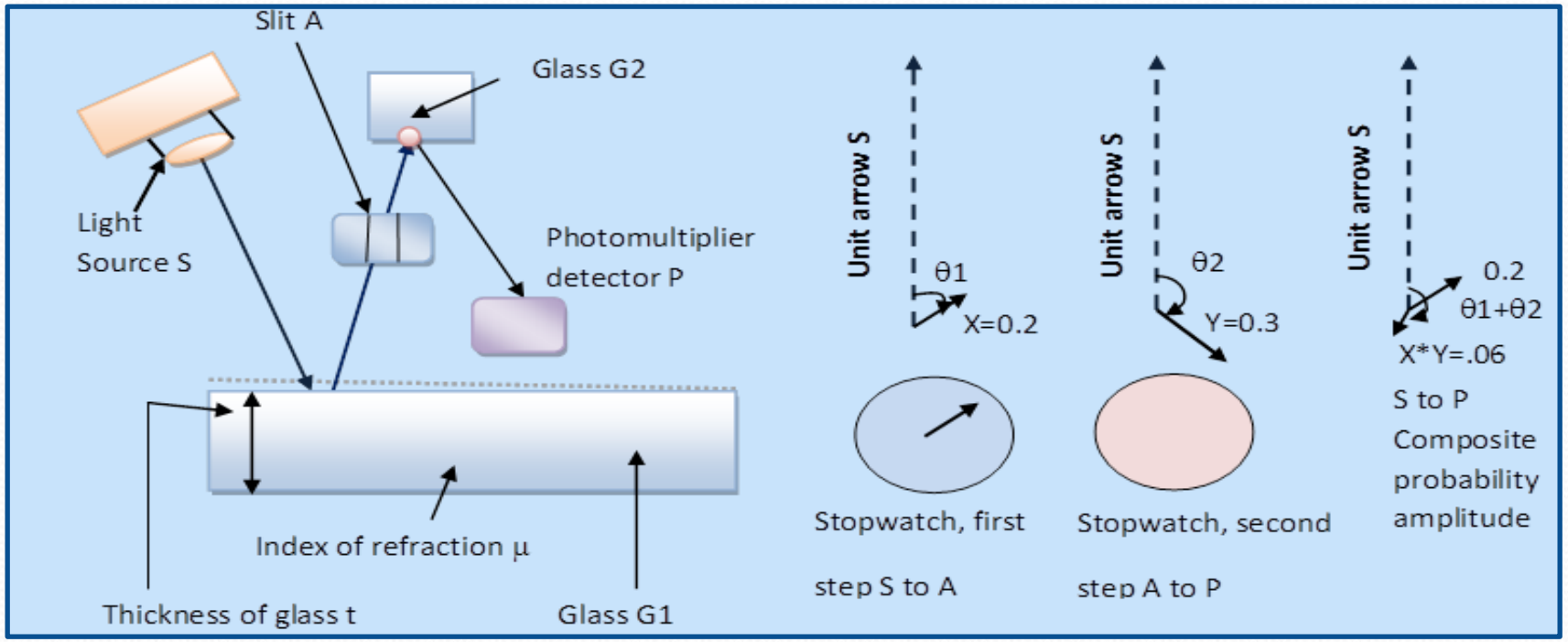


- **Fermat's Principle: Light travels between two points along a path that requires the lowest amount of time as compared to all other paths. Applications: $\theta_i = \theta_r$ and $\mu_a \times \sin\theta_i = \mu_w \times \sin\theta_r$**

Ex. Swimmer & Guard

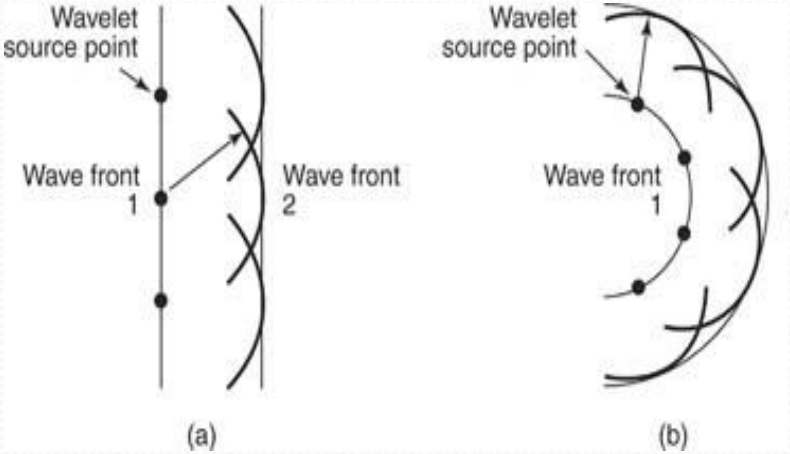
Probability of Composite Events

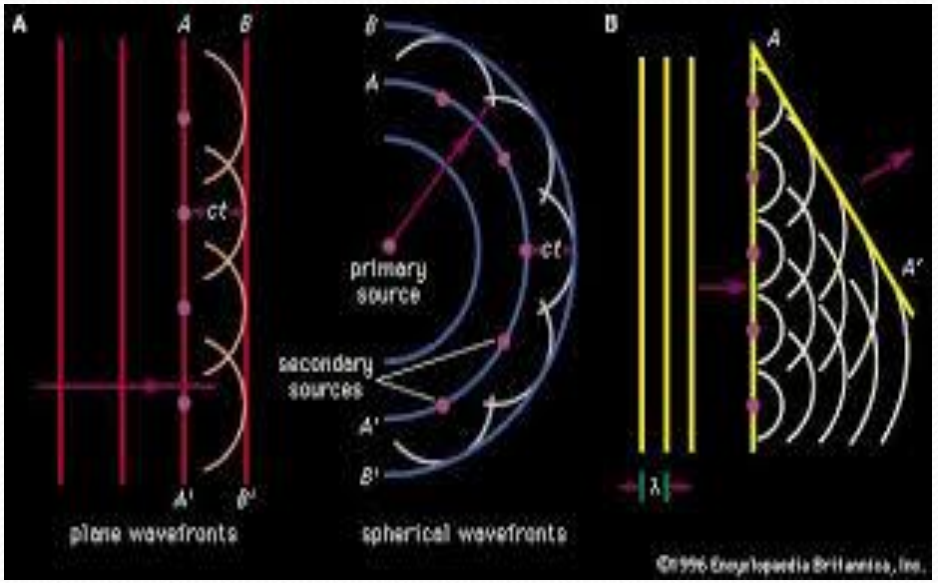
- **Probability P_{alt}: Something happens alternate ways, we add probabilities each way event occur.**
- **Probability P_{con}: Event happens in succession of steps, depending on no. of things happening concomitantly, we multiply the probabilities of each steps.**



Wave Propagation Principles

- **Huygens Principle: Every point on a wave front acts as a source for a secondary wavelet which spreads out in outward direction, speed c. The new wave front is tangential surface to all secondary wavelets.**





- **QED actions: Electron and light quanta interactions.**

1. **Quantum of light without gravitational mass travels in space freely.**
2. **Real particle electron moves in space-time if unobstructed and projects force of gravity on other particles due to its mass.**
3. **An electron can emit or absorb a quantum when interact.**

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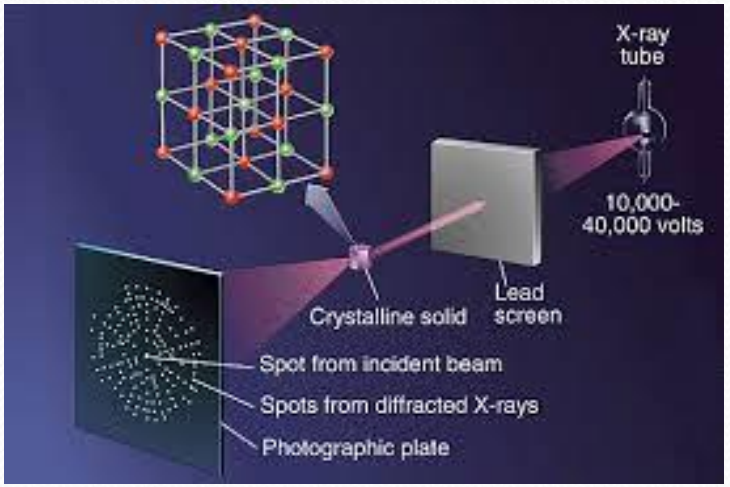
Applications of Feynman's QED

- Reflection of light from Soap Bubbles showing pretty colors in (a)
- Splotches of dark colors from drops of oil leak by cars on roads
- Beautiful colors of rainbow when sprinkles of rain fall and Sun is out
- Diffraction grating using x-rays to reveal atomic structure details of crystalline compounds. An arrangement is displayed in Figure (b)
- White light shines on a video disc, bright colors of rainbow appears.
- Wonderful colors from silvery signs of advertisement displaying text message on the top of a vehicle in motion.

(a) Soap film bubble



(b) x-ray diffraction for crystals

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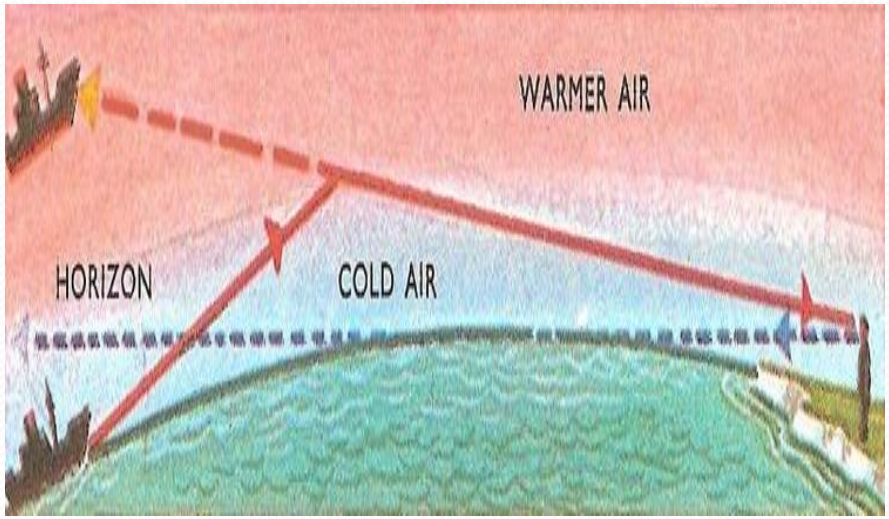
Applications of Feynman's QED

- Changing colors of shirts due to variation in viewing angle. Fabric of shirt is woven using fibers of different thicknesses, reflects different colors of light in preferential direction
- Phenomenon of mirage, image of sky appears like a pond of water to a driver driving a car on road in desert during hot summer as shown in Figure (b) and a ship appears floating in air above sea water in (a)
- Theoretical computation of electron magnetic moment
- Design of lenses to focus sharper image of a distant object

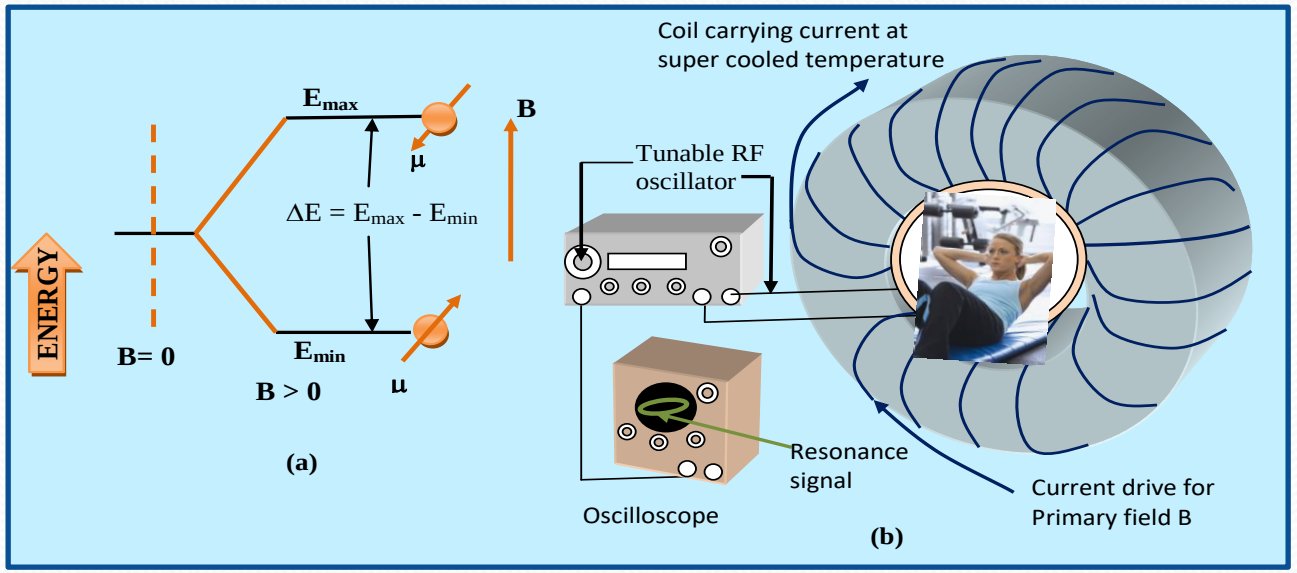


(a) Mirage: Ship appears lifted-up (b) Reflection of Sky, water.

MATRIX

7. Applications of Skylativity®

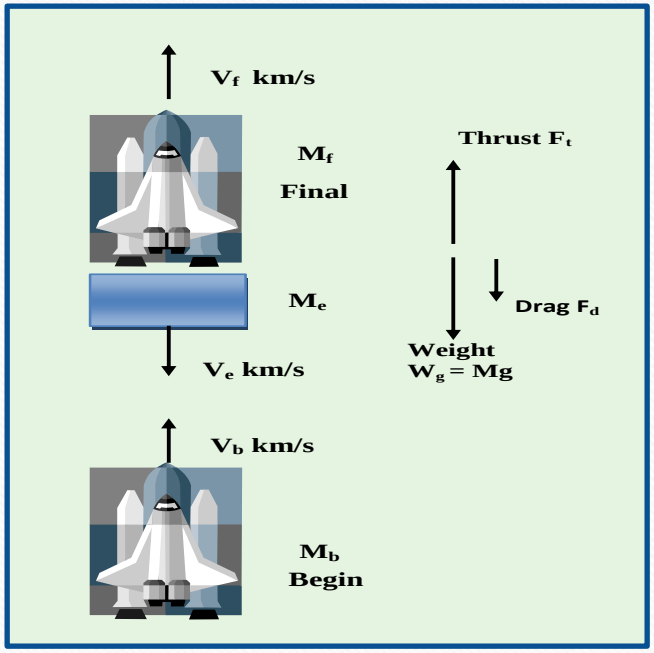
- Renewed purpose for Particle Collider of 21st Century. Search for more exotic particles Higgs boson and particles within dark matter
- Linear accelerators (SLAC) vs. Annular design (CERN) cost/benefit
- Unifications of forces & metrics for GUT, Extension of SMFPI chart to include characteristics of dark matter and dark energy
- Improved design of standard clock, integration of gravity effects on subatomic particles subject to forces at quantum scale (mechanics)
- MRI and CT scan for medical diagnosis and treatment in early detection of fracture and tumors.



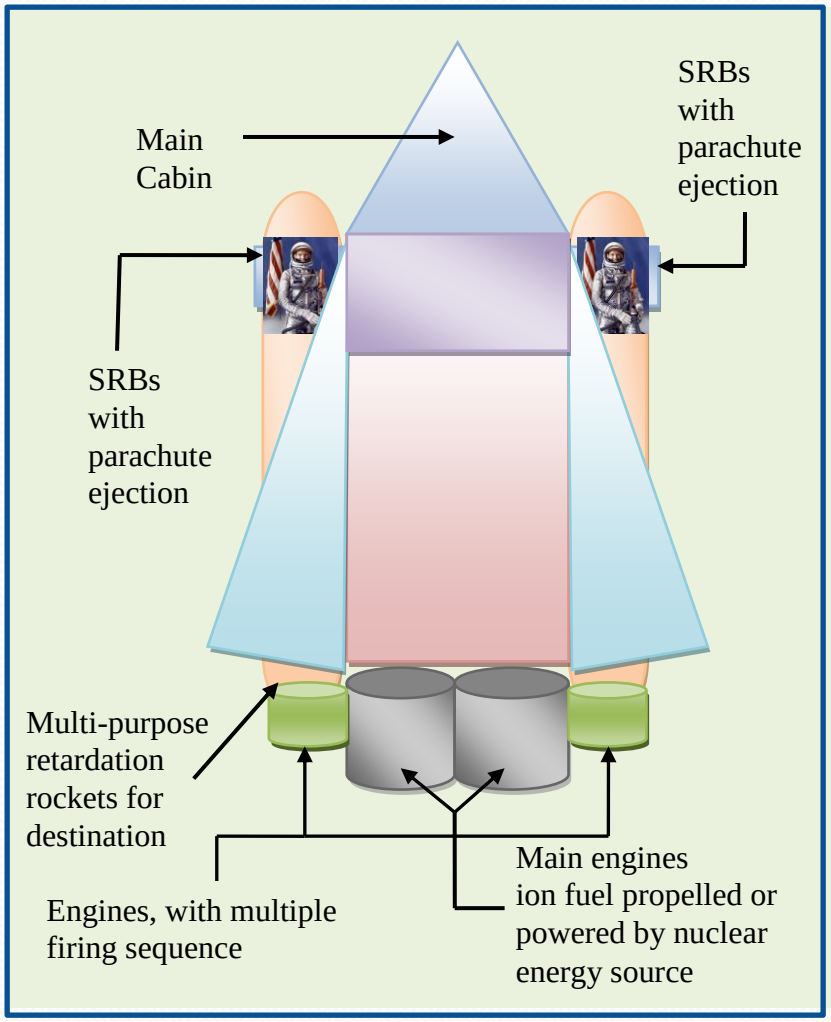
MATRIX

Space Missions for Edge of Universe

- Spacecraft speed improvement 10X in 10 Years goal possible
- Parachute ejection for safety
- Engines: Multiple firing sequence
- Cargo & Astronaut missions
- β decay: Carbon dating of species
- Resolution of solar neutrino puzzle



(a) Jet propulsion dynamics



(b) Novel features of spacecrafts

MATRIX

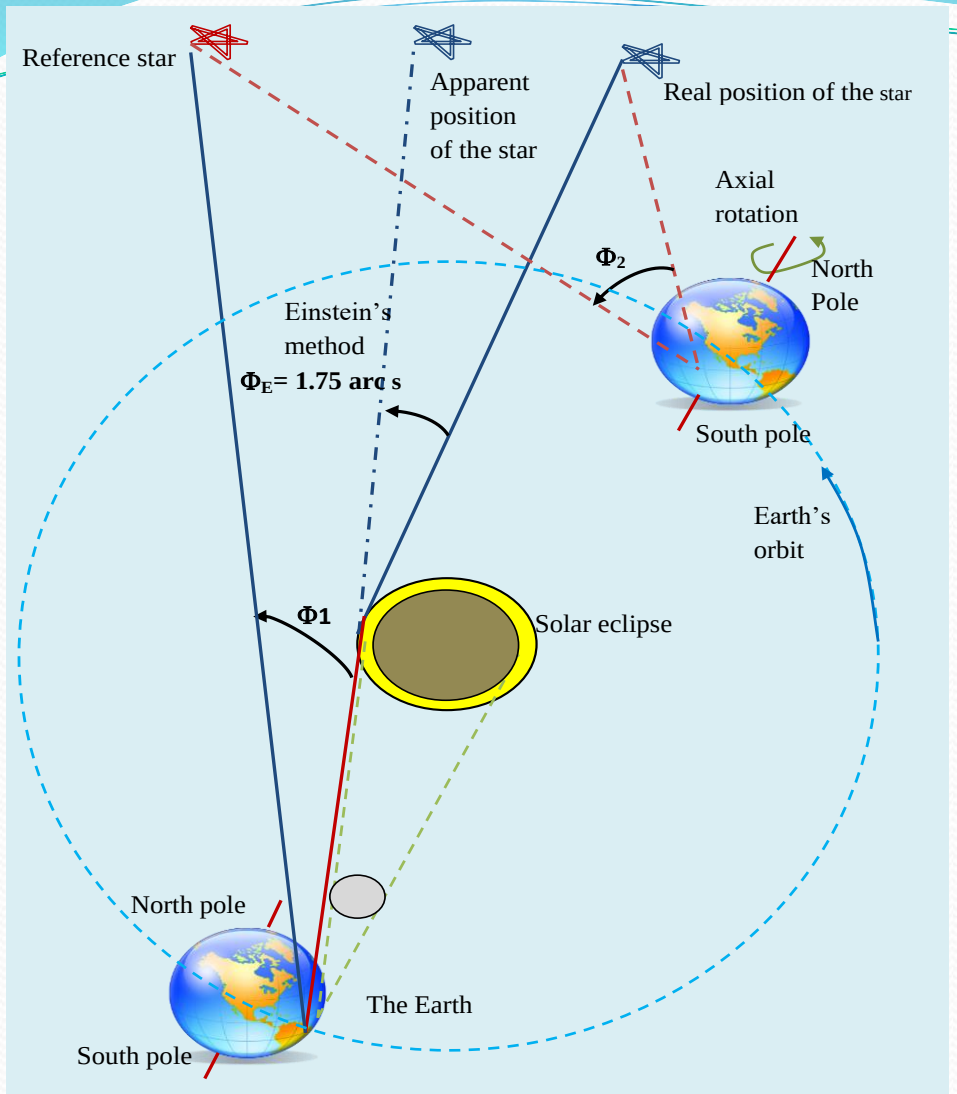
8. Quantum Theory of Gravitation

- Reasons for gravity: a. Fundamental property b Rotational inertia
- a. Objects with non-zero finite rest mass exhibit gravity analogous to electric charge force carried by electrons, protons, and quarks
- b. According to Keppler's law gravity effect imparts rotational motion and inertia to objects. Conversely, rotational inertia creates gravity & supplies gravitational potential energy, the work to overcome force
- Role of gravity in SMFPI chart not defined, graviton undetected
- Gravity propagation speed, speculative c km/s or infinite (∞), speed of quantum entanglement. Gravity pattern continuously overwritten
- Einstein's Theory of gravitation: Hypothetical and real tests
- Hypothetical: Buckets with atoms on a wheel experiment
- Real: a. Deflection of light from a star behind the sun by its gravity

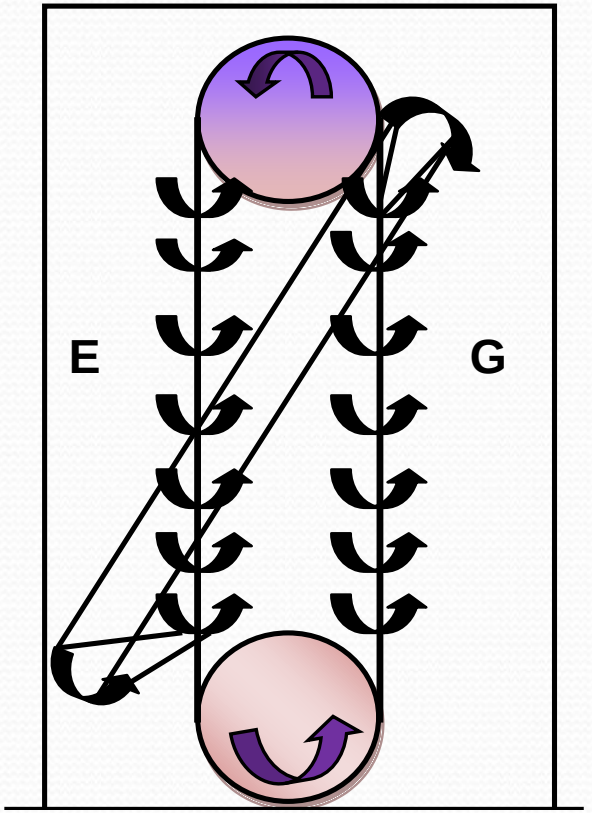
  b. Gravitational red-shift of solar spectrum (refraction 14° mA)

  c. Advance of perihelion of planet Mercury and shifts in orbits of all planets. (loss in solar mass, neutrino)

Hypothetical Experiment & Real Test



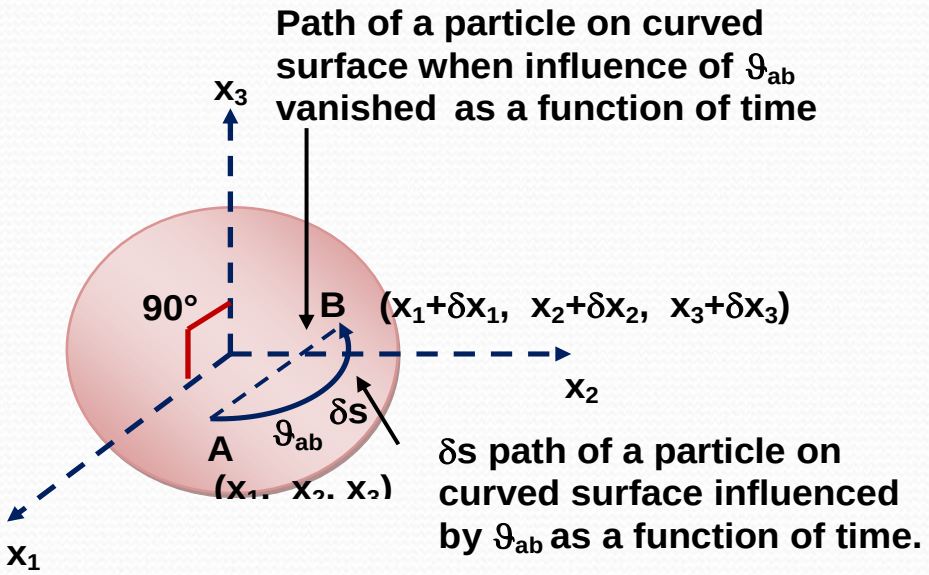
Buckets with atoms on a string, gravity causes shift in

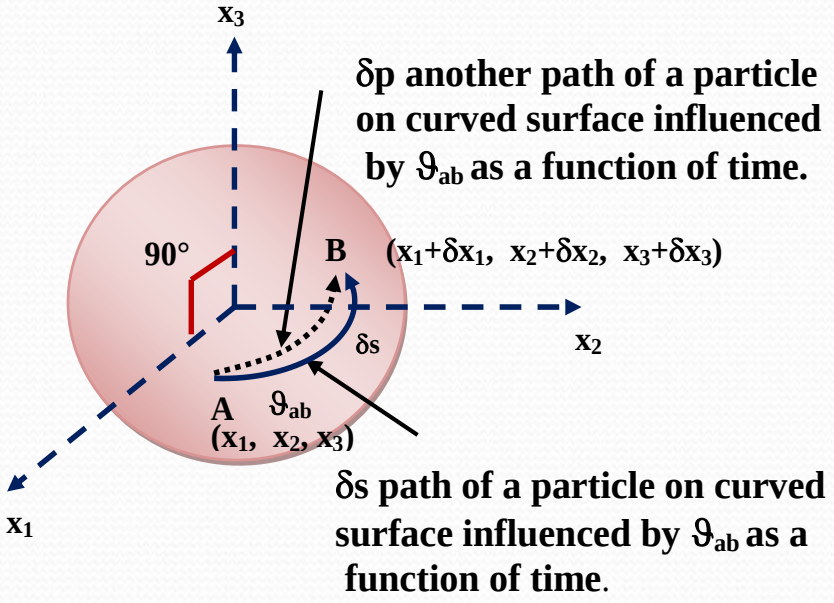


- **(a) Deflection of light from a star behind the Sun during an eclipse.**
- **(b) Effect of gravity on atoms at different heights**

Einstein's Legacy

- **Theorem : Uniqueness of gravitation. Universe is a complex domain**
- **With complex dimensions, Length, Mass, and Time whose state is defined by Einstein's complex spacetime field equation. Only one solution to his equation leads to real Universe for a given initial condition, all other solutions correspond to an imaginary Universe.**





- **(a) Trajectory of particles.**

  $(\delta s)^2 = \sum \vartheta_{ab}(\delta x_a)(\delta x_b)$, n dimension

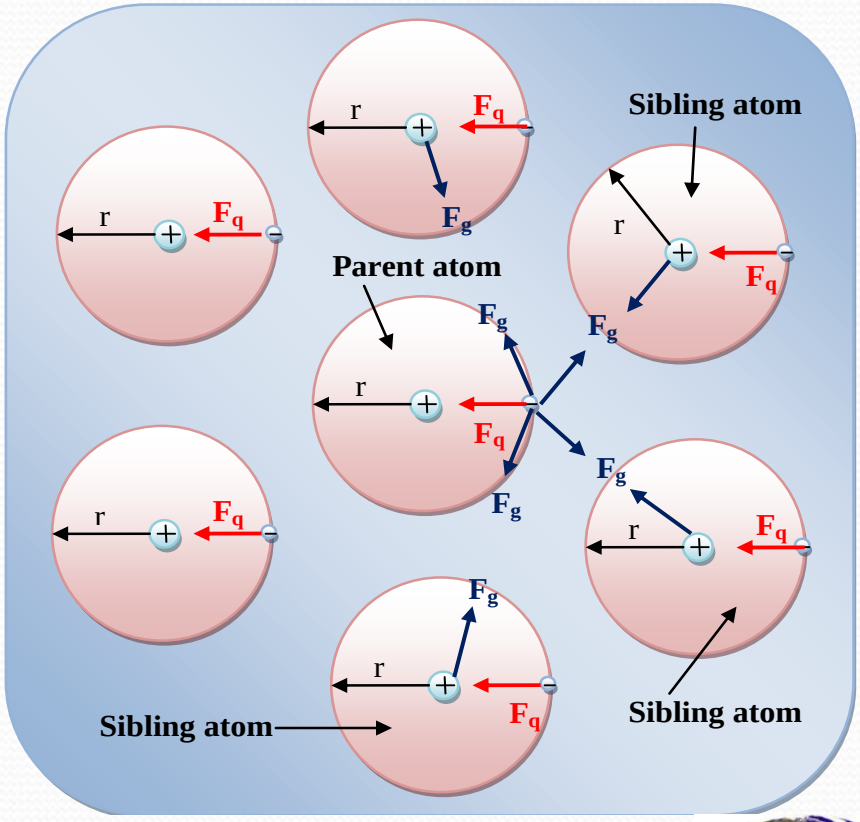
- **$(\delta s)^2 = (\delta t)^2 - (\delta x_1)^2 - (\delta x_2)^2 - (\delta x_3)^2$**

(b) Two different paths δp and δs on a curved surface influenced by ϑ_{ab}

MATRIX

Quantum Gravity

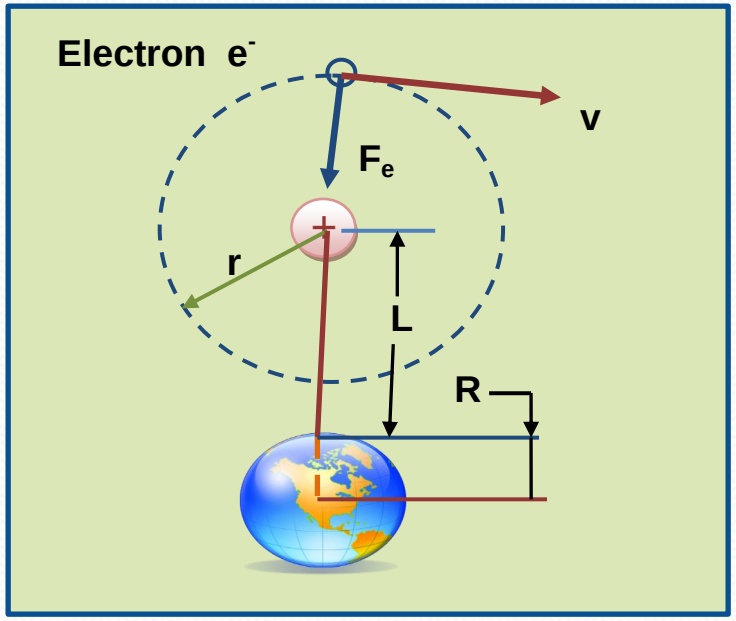
- Electric charge forces from protons binds electrons & nucleus
- Stable atom: Bohr's hydrogen model & Pauli's Exclusion Principle
- Charge forces (F_g) among electrons in parent atom & protons of sibling atoms form a molecule
- Net effective force ΣF_g accrue from large no. of molecules
- Effective F_g manifests itself and forms gravity effect & CG
- Direction: attracts molecules
- Distance range: Infinite
- Speed: Instantaneous Quantum Entanglement
- Center of gravity (CG) depending
- on mass distribution (molecules) of composite object

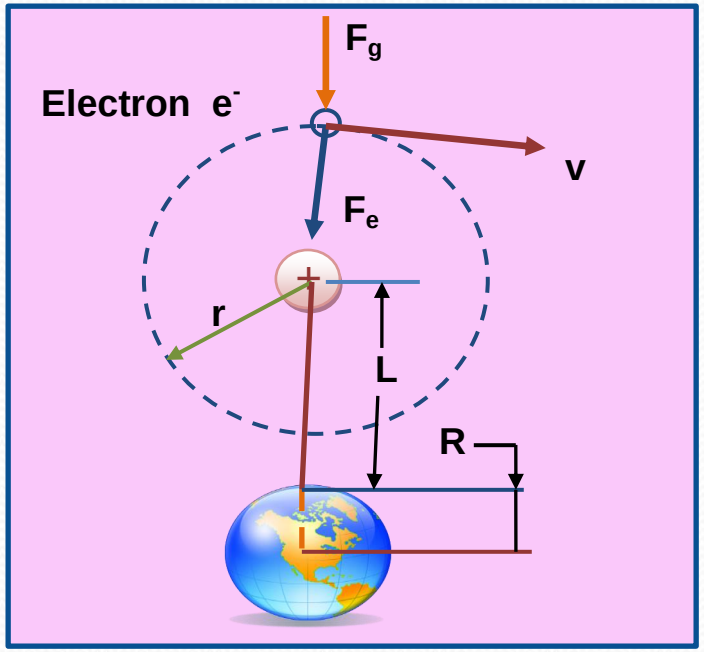


MATRIX

Gravity Correction

- Integration of gravity effects on atomic clocks. Emitted frequency $hf = E_i - E_f$, Bohr's H_2 atom model $f = k_e\, e^2/2r_0h[1/n_f^2 - 1/n_i^2]$
- Our model $f = k_e\, e^2/2r_0h[1/n_f^2 - 1/n_i^2]\,(1 + k_g)$ where k_g is k_{gL} or k_{gs}
- $k_{gL} = [g_L\, m_e(R + L + r_0)]/(k_e\, e^2/2r_0h)$ & $k_{gs} = [g_0\, m_e(R + r_0)]\,/\,(k_e\, e^2/2r_0h)$
- Computed value Δf differs at 19th decimal place due to gravity. For clocks not significant for one year, could effect 1 hr in billion years.

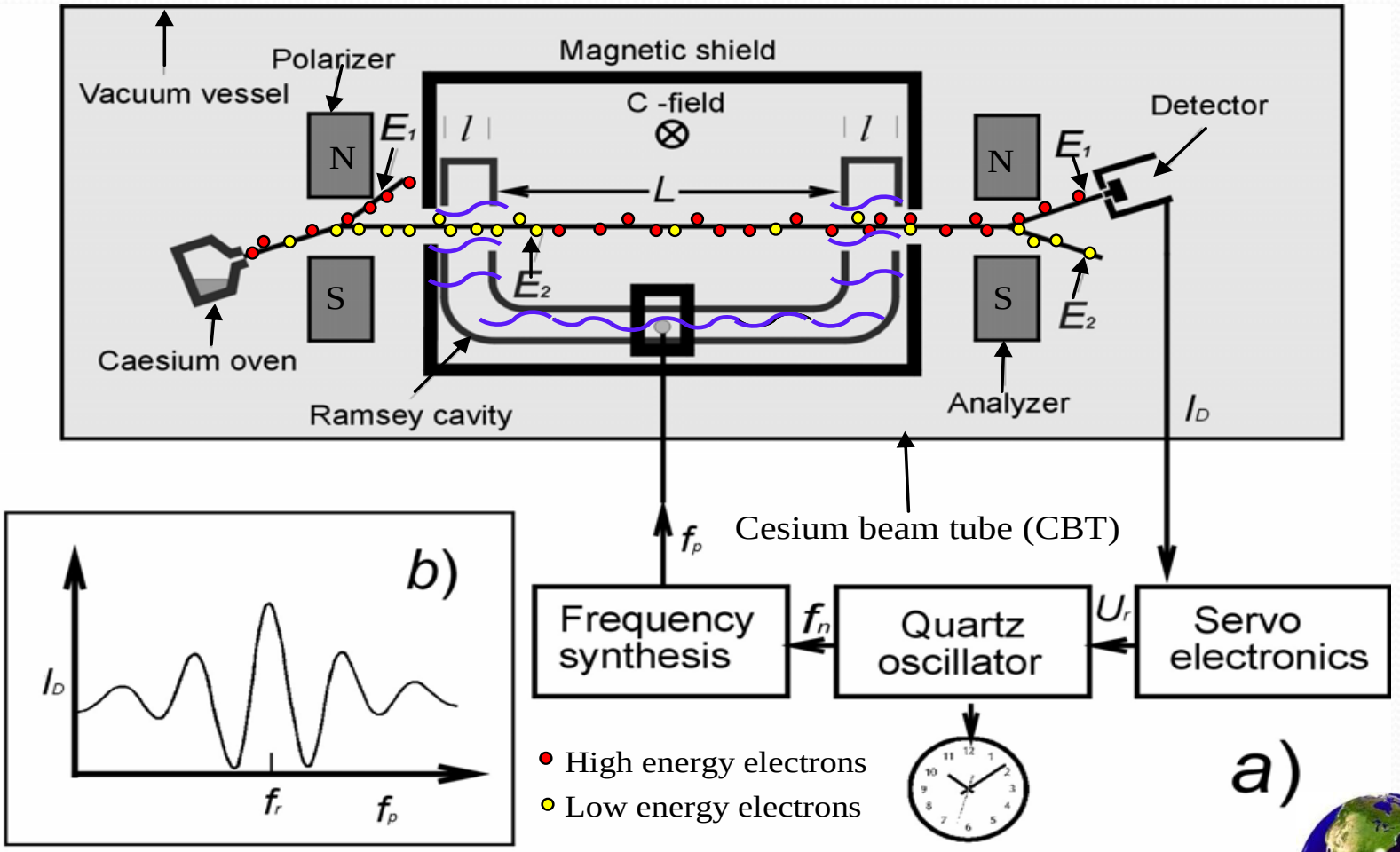




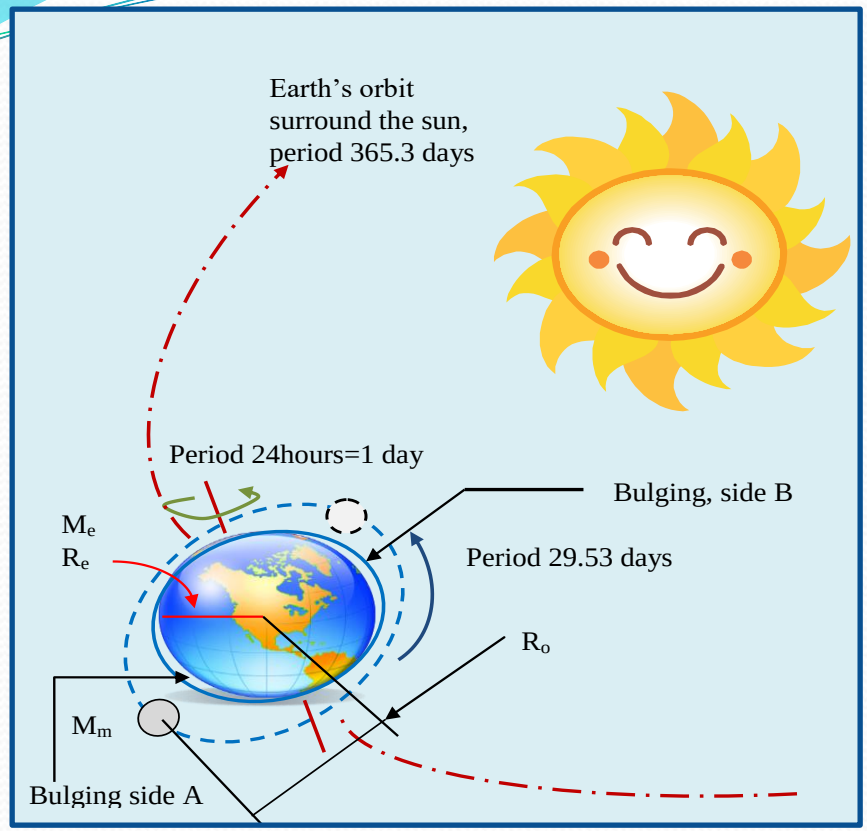
(a) Bohr model, forces on electron (b) gravity added at quantum scale in nucleus

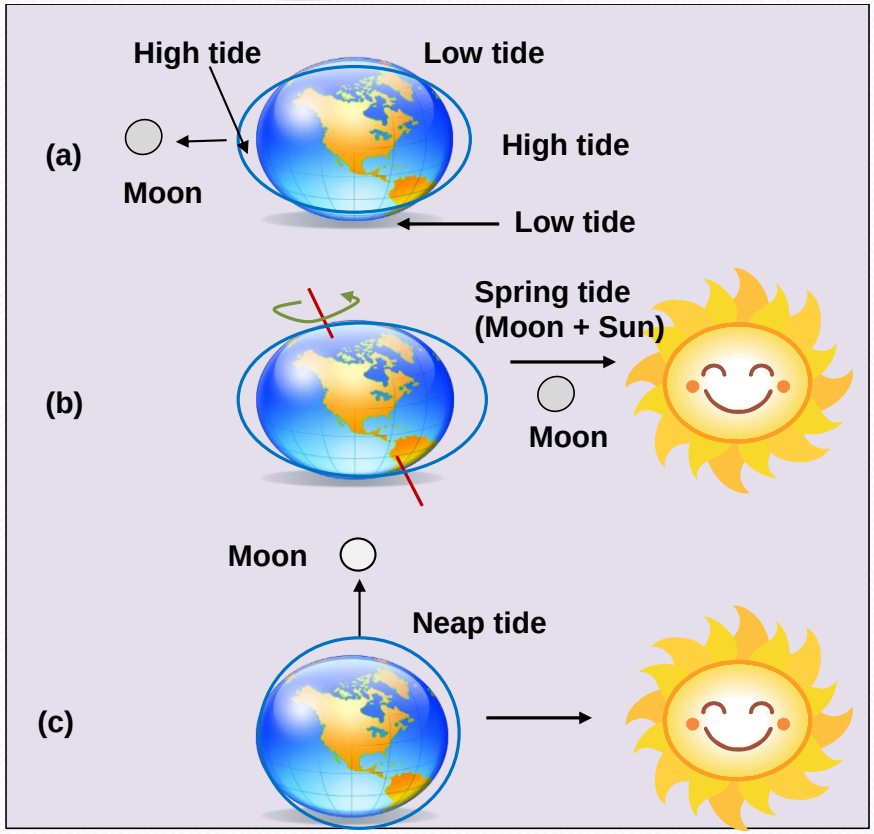
Cs Atomic Clock: Operation

- **Principle: Atomic frequency standard using magnetic field for selection of electron energies.**



Effect of Tidal forces on the Weather





(a) Bulging in shape of Earth by TF

- $F_t = 2\ G\ M_o \times M_e \times R_e / R^3_o$,

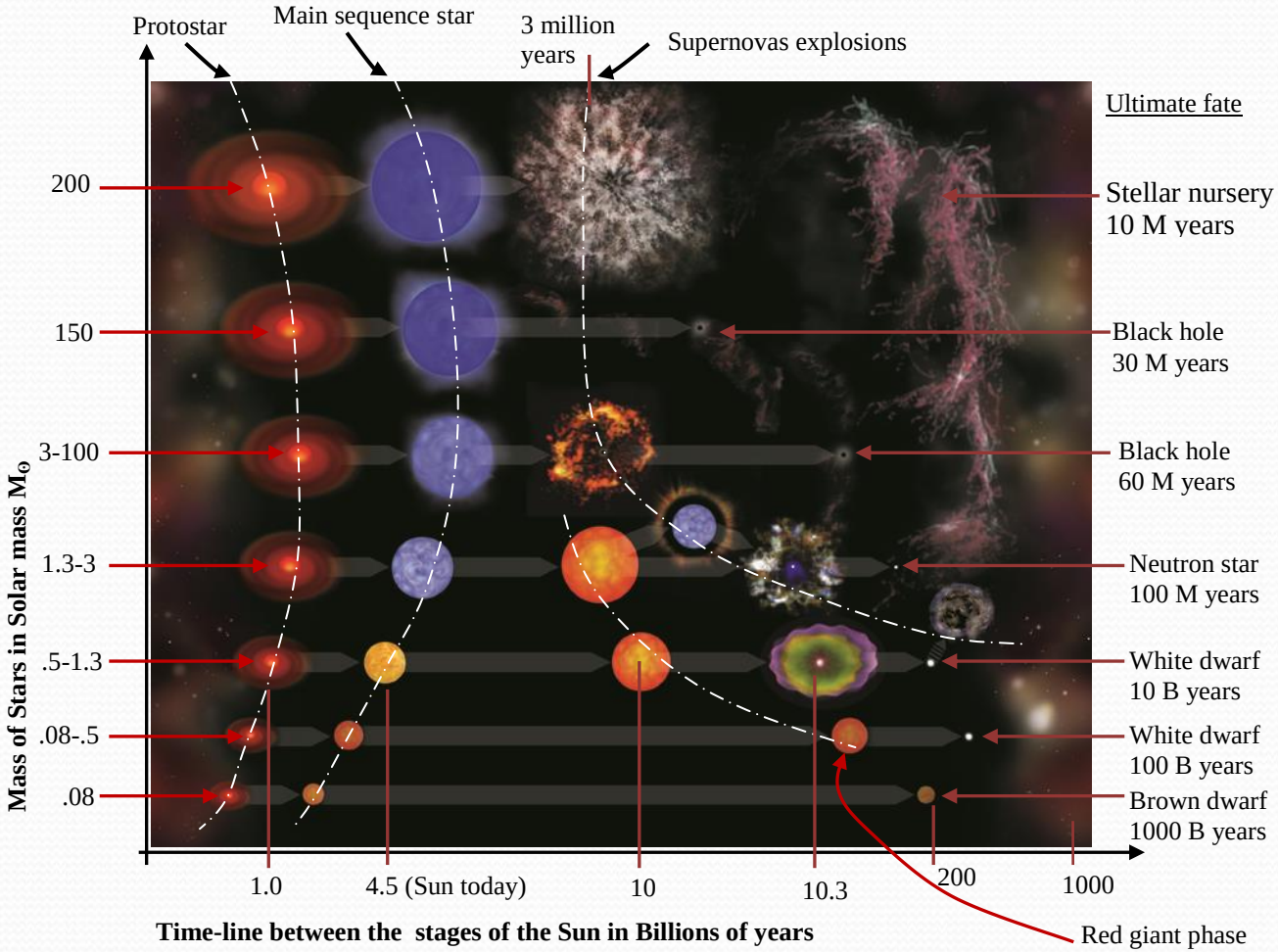
(b) Tides, low & high; determined by relative positions Sun & Moon

- Ratio $F_m / F_s = 2.178$. Improved weather forecast model, added Tidal Forces (TF) induced pressure change correction factor.

MATRIX

9. Evolution of Solar Systems

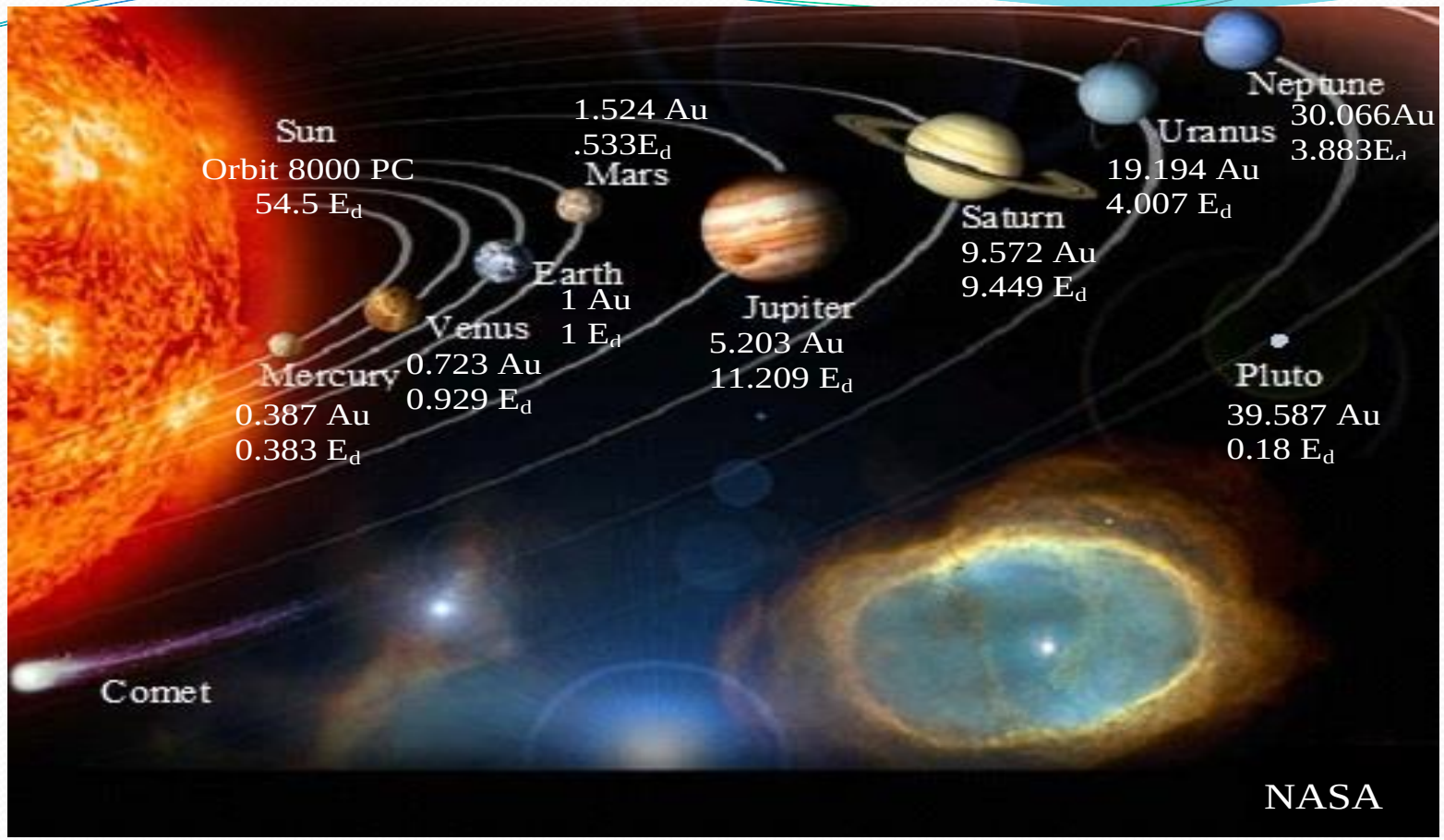
- Birth of stars, dwarfs, neutron stars, black holes, & solar systems



- Stages in the life cycle of stellar evolution (Courtesy of NASA)

MATRIX

Origin of Solar Systems

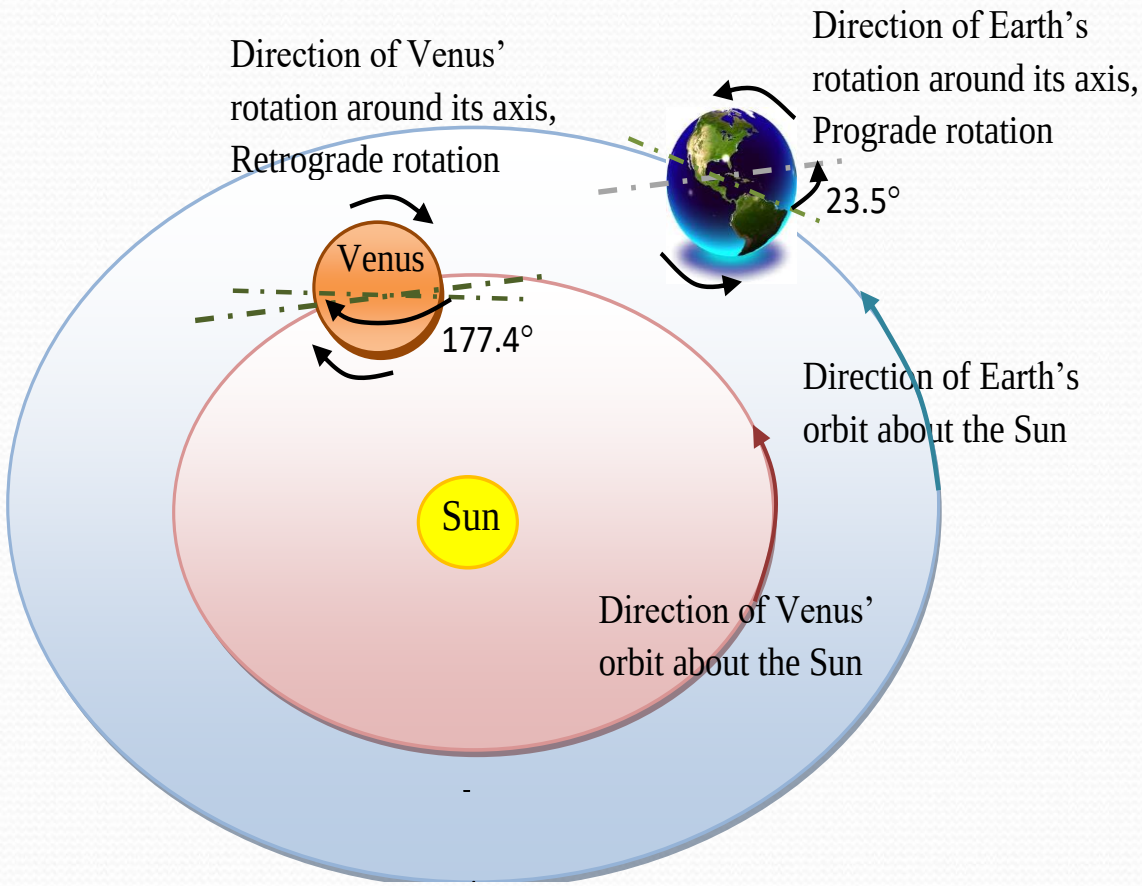


- **Competing theories about formation of Solar systems**

(a) Primary: Condensation of gas and solid matter in stellar nursery by the force of gravity leads to formation of planets

(b) Secondary: Ejection of matter from a protostar in active state

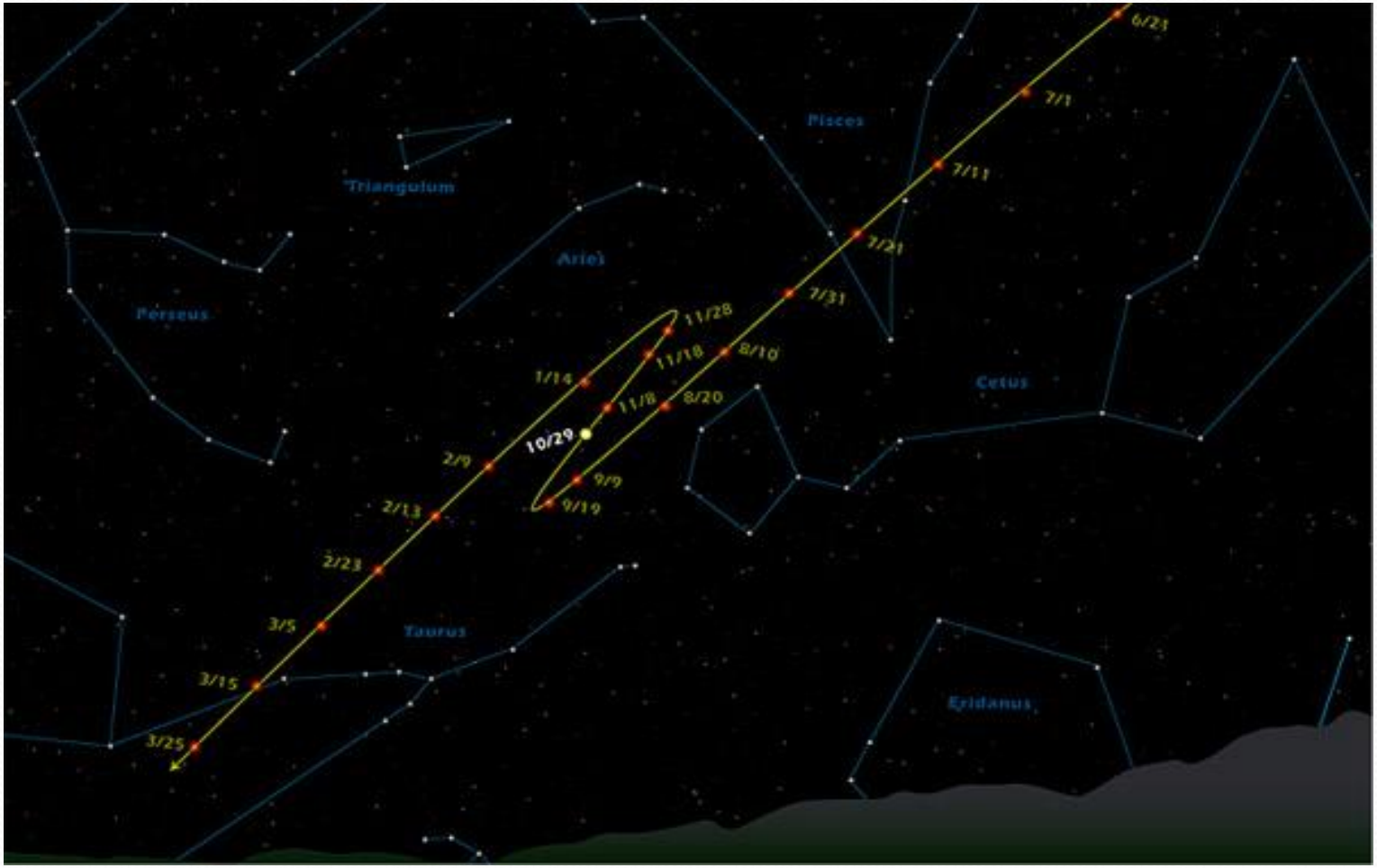
Prograde & Retrograde motion



- **Prograde motion: Planet's axial rotation in same sense as sense of its orbit around the Sun. All planets except retrograde ones.**
- **Retrograde motion: Planet's axial rotation in opposite sense to direction of its orbit around the Sun. Venus, Uranus & Pluto**

Prograde & Retrograde motion

- Mar's retrograde motion

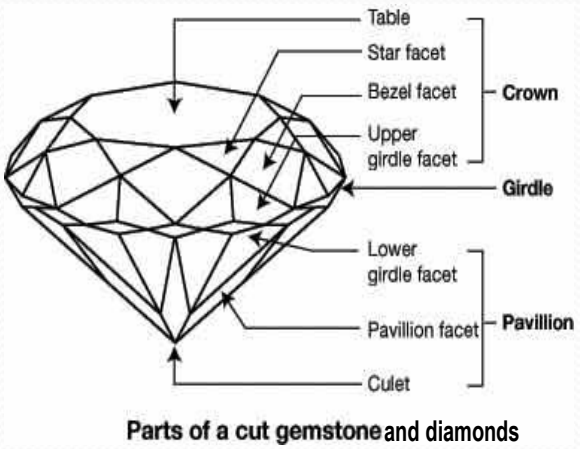


MATRIX

5 C's of Diamonds & Gems

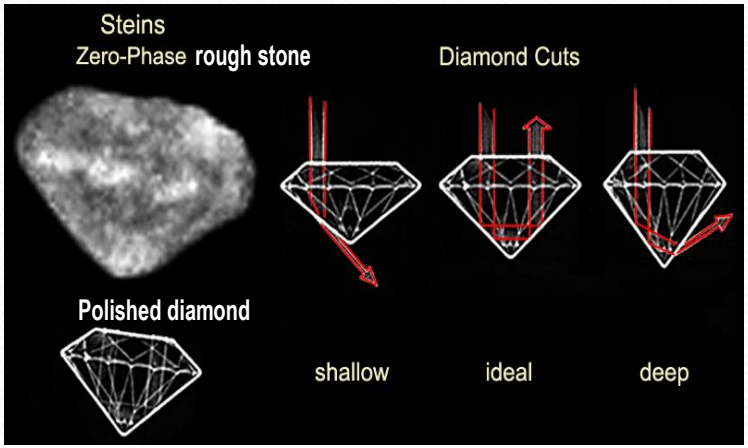
(a)

(b)



Parts of a cut gemstone and diamonds

(a)

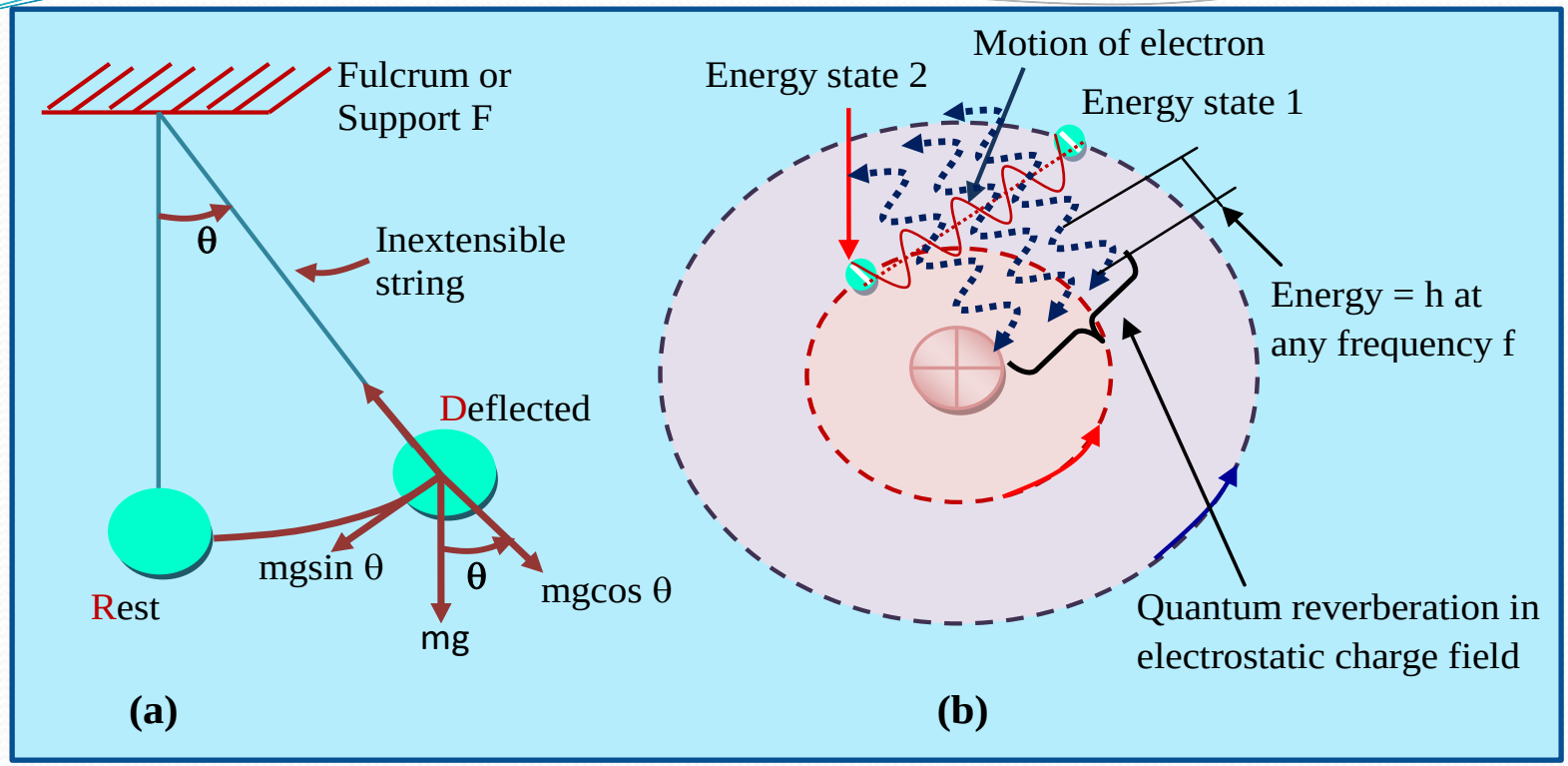


(b)

- Carat, Cut, Color, Clarity and Cost. High carat and more cuts gives sparkle to finished diamond, and is more expensive. Laser engraving to prevent theft and identification.

MATRIX

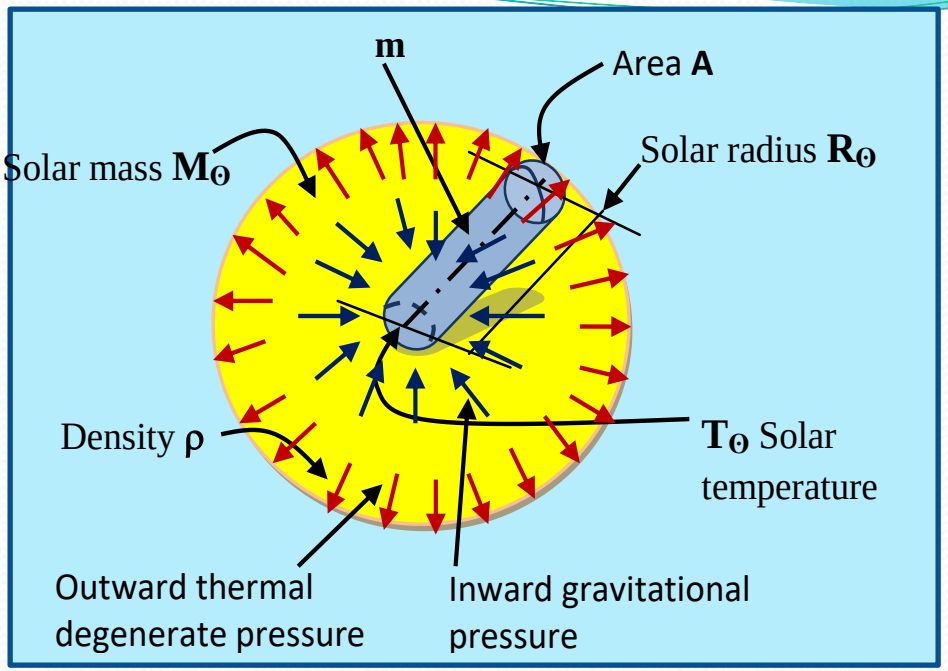
Analogy: Pendulum & electron motions



- **SHM of pendulum transforms Potential energy into KE**
  Oscillations of electron transform kinetic energy into radiations
- **Mass of energy radiating substance does not vanish in any event**
- **Increase in temperature amplifies magnitude of electron & atomic vibrations. Electrons emit radiations of different frequencies in range visible light and infrared. Object expands in size.**

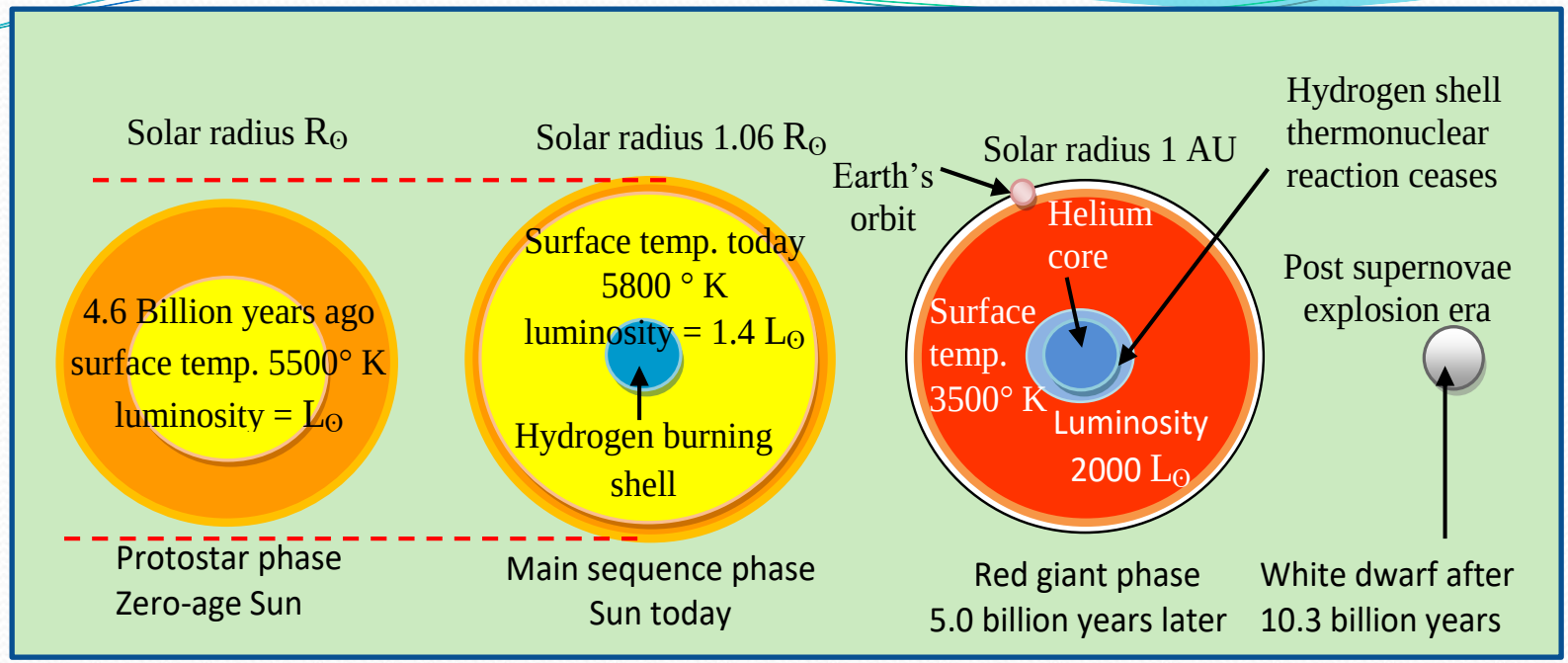
MATRIX

Corrected Temperature profile within Sun



- Temperature profile: Hydrostatic equilibrium principle
- Gravitational pressure = Thermal expansion, degenerate pressure
  $T_\odot = G \times m_A \times M_\odot / (k \times R_\odot)$ where m_A mass of hydrogen atom
- Equation predicts higher temperature at center than in reality
- At center helium concentration is very high as He atom is 4
- times heavier than Hydrogen and thermonuclear fusion ceas

Fate of Sun and our Solar Systems



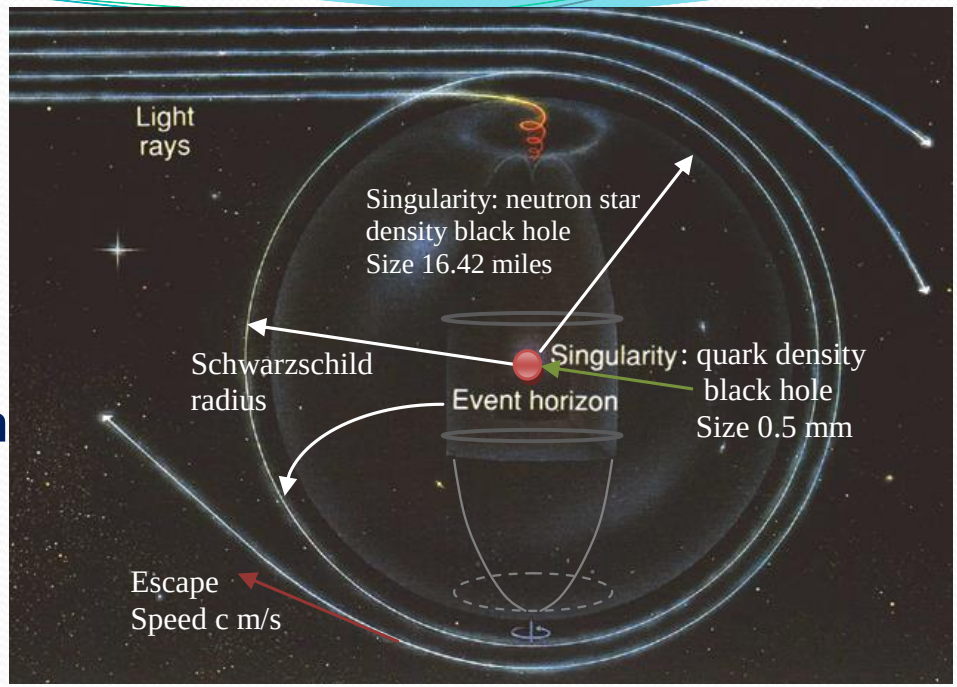
- **Stages in life cycle of Sun, White dwarf in a supernovae explosion**
- **Lifespan of Sun α T_{min} @thermonuclear fusion of H_2 into He occur**
- **T_{min} effects the mass fraction, mass of hydrogen suitable and the mass consumed to produce required brightness**
- **T_{min} α Mean Free path found by MFP PE = Internal energy**

  $k_e \times q_1 \times q_2/r = (3/2) \times k_b \times T_{min}$

MATRIX

10. New Physics of Black Holes (BH)

- $V_{esc} = (2G \times M/r)^{1/2}$ m/s
- $R_{sch} = 2G \times M/c^2$ m
- Density form of above equation
- Event horizon = R_{sch}
- $R_{sch} = 0.866 \times c \times (2\pi\rho_n \times G)^{-1/2}$ m
- Neutron star BH $R_{sch} < 26.44$ km
- Quark star BH $R_{sch} < 0.5$ mm
- Black holes key characteristics
- Mass, Charge & Momentum

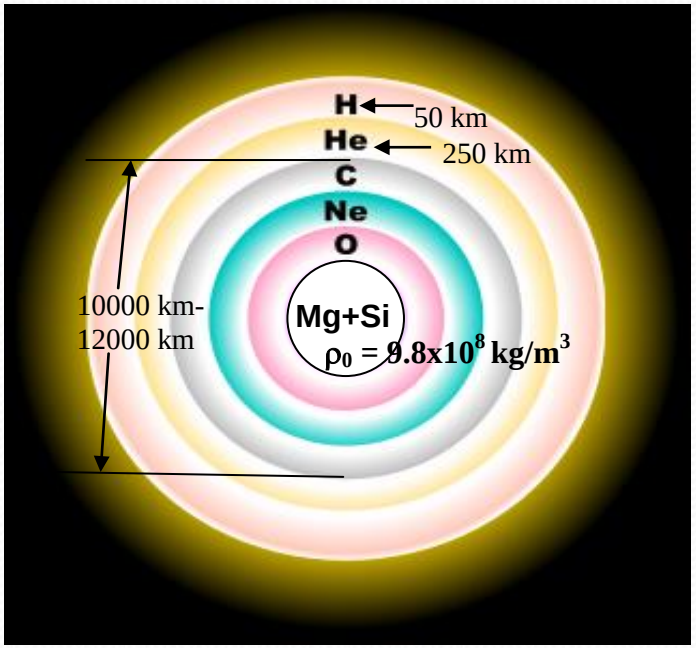


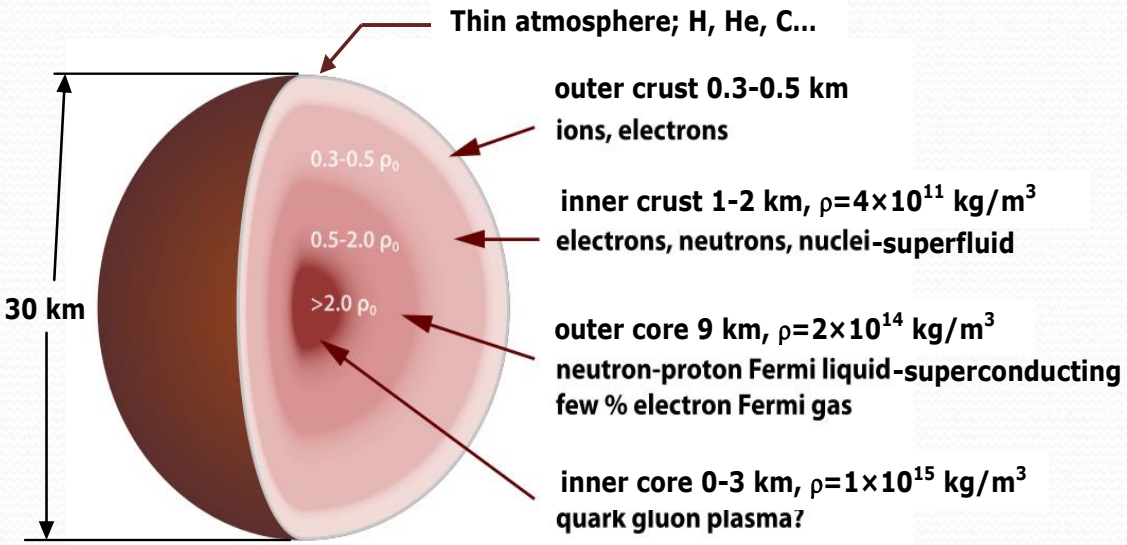
- Parameters: Escape speed, Schwarzschild radius, & event horizon.
- <u>Escape speed</u>: Launch speed at which an object is set free from gravitational field of massive body without further propulsion
- <u>Schwarzschild radius</u>: Radius of a sphere in which mass of a star is compressed so that escape speed at surface equals speed c m/s
- <u>Event horizon</u>: Edge of surface around a BH from where even light or any type of matter/object can not escape

MATRIX

Internal Structure: White dwarf & Pulsar

- Next phases in contraction of red giant star by force of self gravity





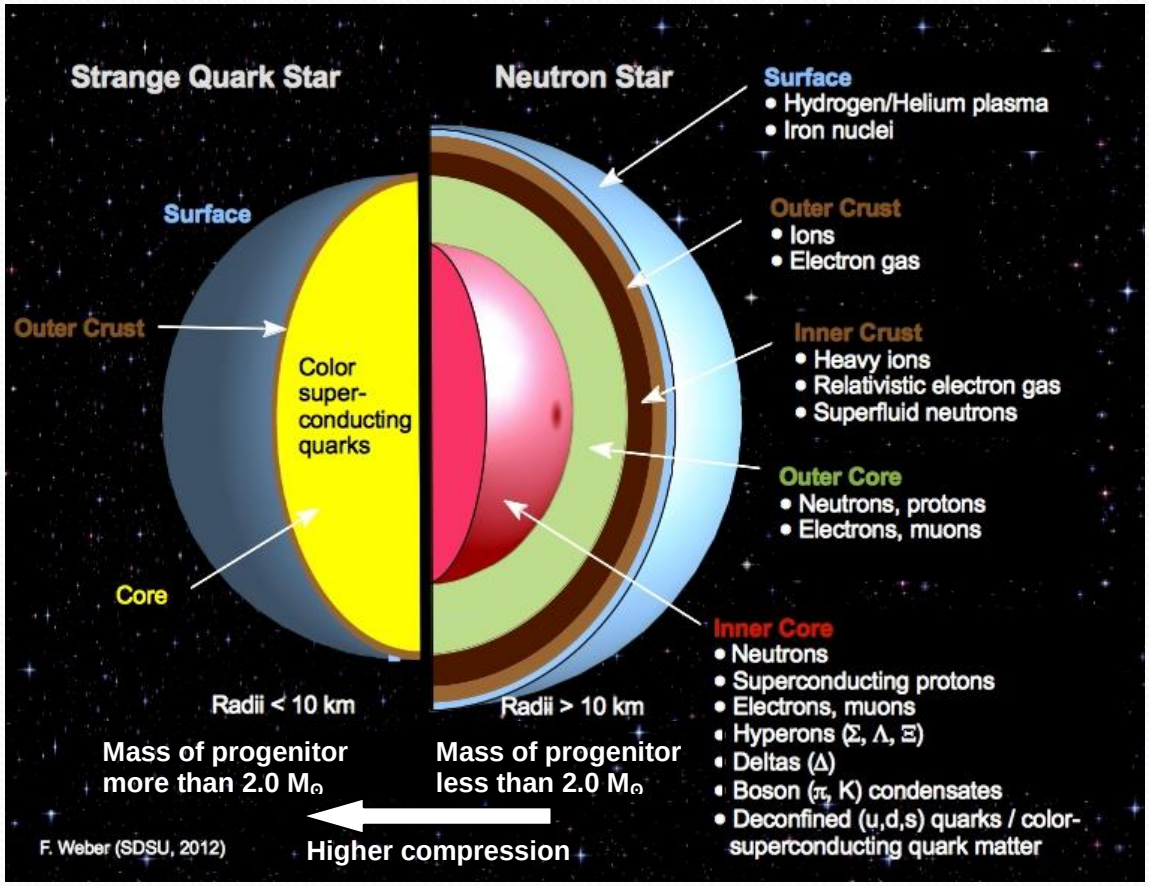
Internal composition of a neutron star

(a) White dwarf: Balancing force exclusion repulsion

(b) Neutron star matter density and layers. Balancing force neutron degeneracy

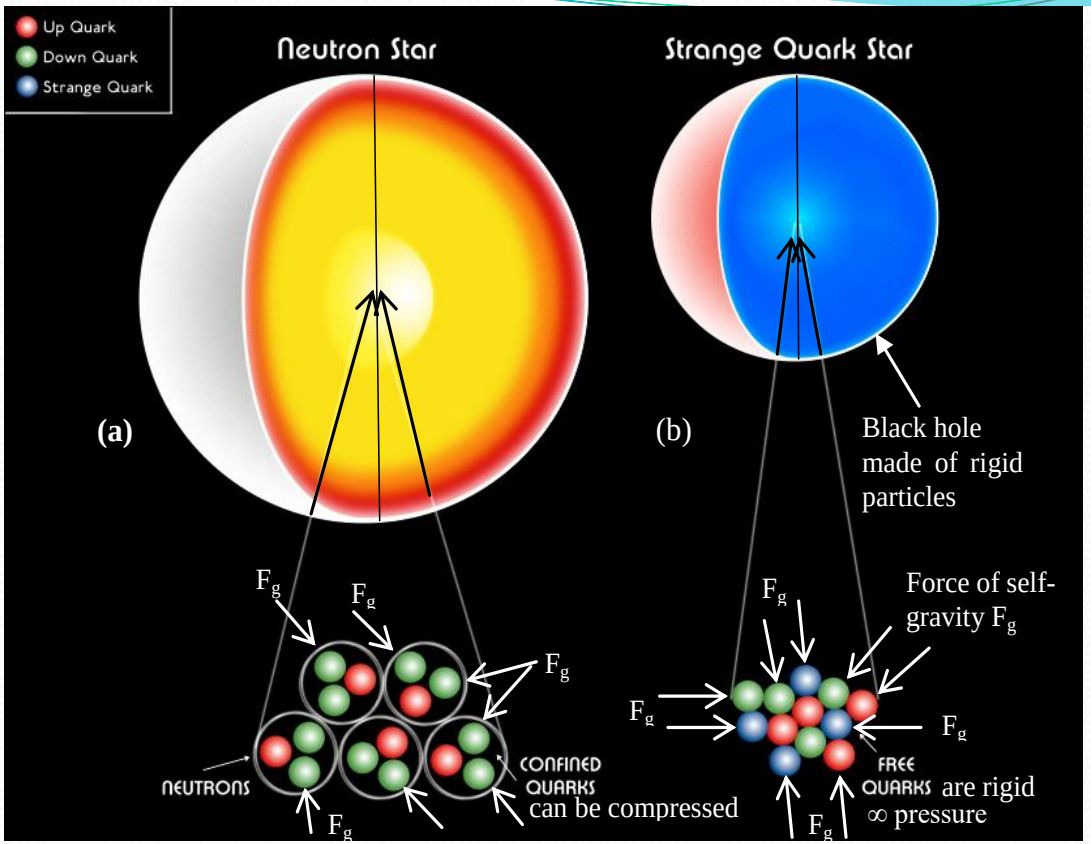
- Neutron stars emit rotating beams of light & x-rays, named as pulsar
- Pulsar emits gas ions that collide with electrons to form light
- Pulsar accretion disk steals matter from companion red giant
- and produces x-rays from hot spots.

Transformation of Neutron Star



- Progenitor star mass greater than 3.0 solar masses implodes to a black hole after it contracts to a neutron star
- Neutron stars are composed of complex confined matter
- Black holes are a sea of de-confined quarks

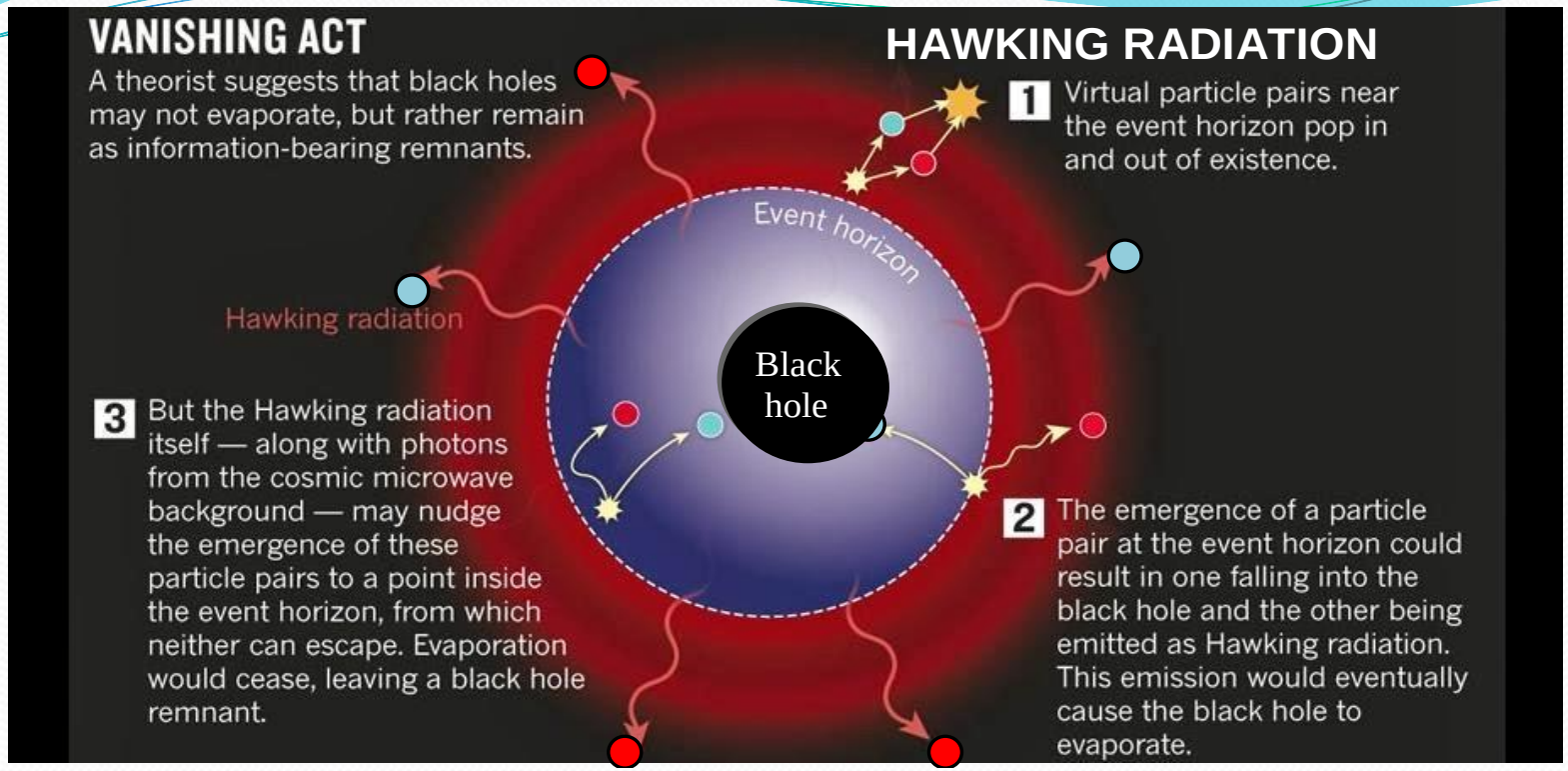
Black Hole: Strange Quark Star



- Quark degenerate pressure due to color charge prevents singularity
- Rigid particle quarks do not crash, differential ΔF_g not enough
- Black holes insensitive to light and radiations as there are no electrons to provide response. Light appears to be trapped.
- Interaction of light with electrons, Feynman's QED

MATRIX

Black Hole: Vanishing Act



- **Slim possibility: Black holes loose mass through Hawking radiation**
- **Very low probability: Speed of particles from Hawking radiation less than speed of light c. The particles fall right back.**
- **Size of black holes increases rapidly as it captures matter from red giant stars in proximity**

Nature of Matter/Energy in Universe

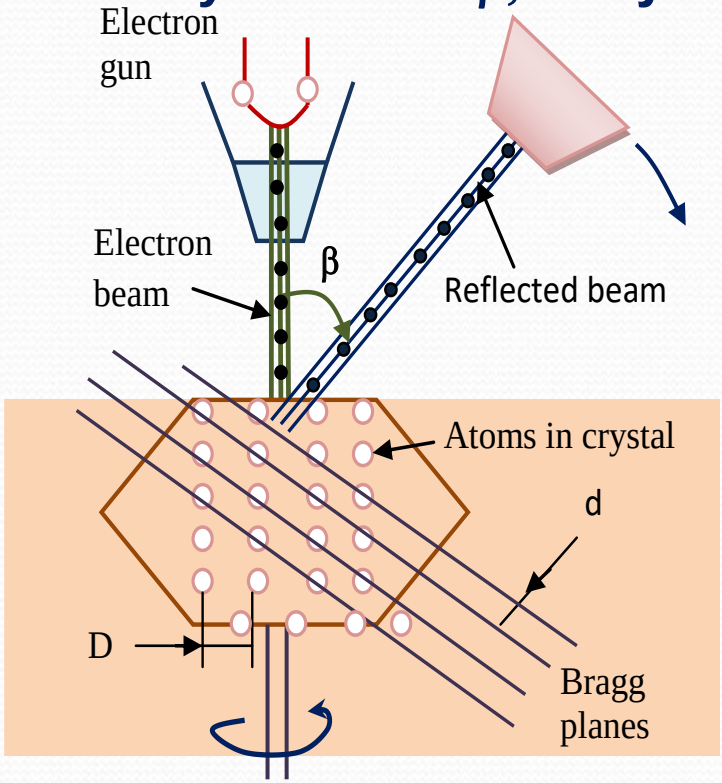
- Dark matter: An elusive matter, does not absorb, emit, reflect and refract light/radiations. Presence apparent by gravitational effects
- Dark energy: Cause for theoretical repulsive force that counteract gravity force and lead expansion of Universe at accelerating rate
- Color matter: Matter that provide response to various radiations such as visible light, x-rays & radio waves, and are easily sensed
- Color energy: Energy forms visible light, infrared, microwave, x-rays, cosmic rays, and RF EM waves which are detected and observed with ease.

- Dark matter: spontaneous
- Color matter: gradually created

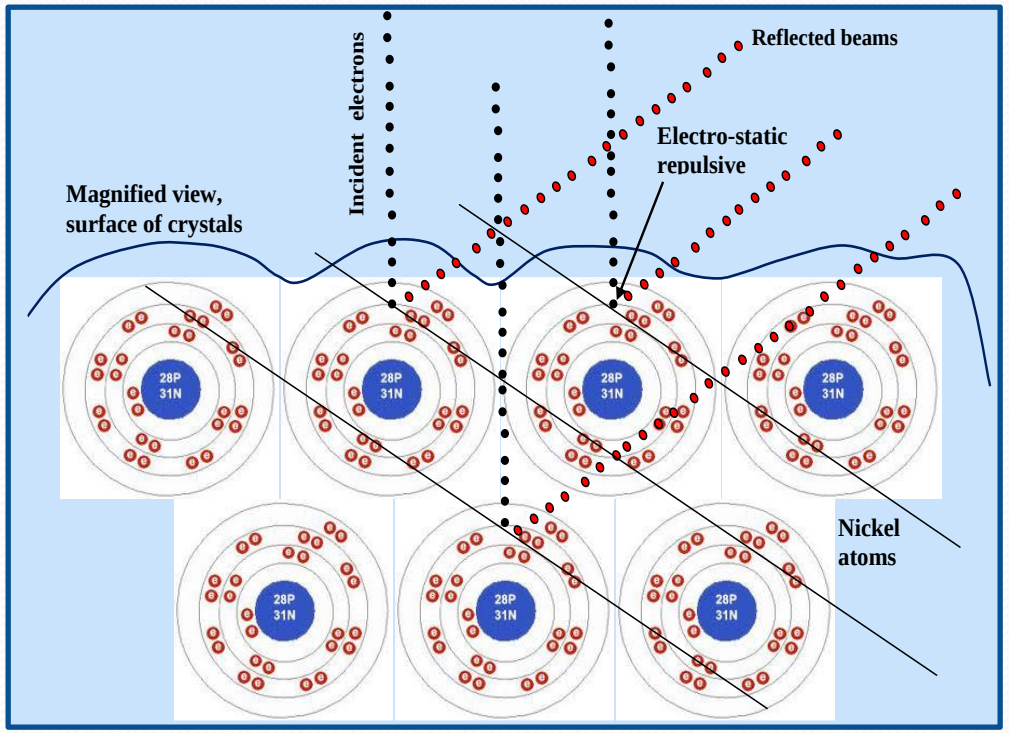
Progenitor size Solar masses M_Θ	Entity, implosion of Progenitor	Force type balancing gravity	Final Fate	Dark/Color matter
.08 High mass	Brown Dwarf $< 60\text{-}90 \times M_{jup}$	Electron degenerate	Black Dwarf:	Dark
.02 Low mass	Brown Dwarf $< 15 \times M_{jup}$	Coulomb's charge	Black Dwarf	Dark
1-1.5	White Dwarf	Exclusion repulsion	Black Dwarf	Dark
2-10	Neutron Star	Neutron degenerate	Supernova Black hole	Dark
20-200B	Black hole	Quark degenerate Color & Charge	Black hole:	Dark
Supernova blows	Stars	Thermal degenerate	Star life cycle:	Color
Stellar nursery coalesce	Planets $< 13 \times M_{jup}$ Stars $> 13 \times M_{jup}$	Coulomb's charge Thermal degenerate	Stars &Planets:	Color

11. Quantum Mechanics: Modern View

- Revisit Quantum behavior: Davison-Germer experiment
- Reflected electrons exhibit diffraction pattern, wave like behavior
- Electron wavelength α $1/V^{1/2}$, V accelerating voltage Peak at V = 54V
- Theory $\lambda = D \sin \beta$, X-ray scattering, Bragg's plane spacing $d = \lambda$



(a)

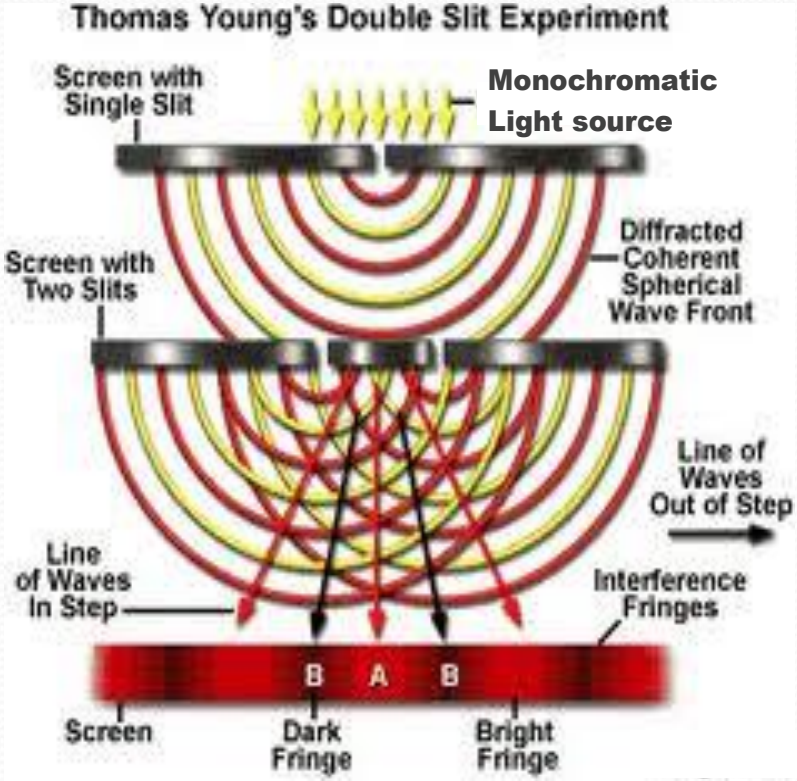


(b)

MATRIX

Revisit Quantum Behavior

- Revisit Quantum behavior: Young's Double Slit experiment
- Young's Double Slit, light interacts with both slits
- Depicting wave nature of light & interference patterns observed
- Bright fringes d sin θ_{bright} = mλ, dark fringes d sin θ_{dark} = (m+1/2)λ
- Linear position for small θ, X_{bright} = D × mλ/d



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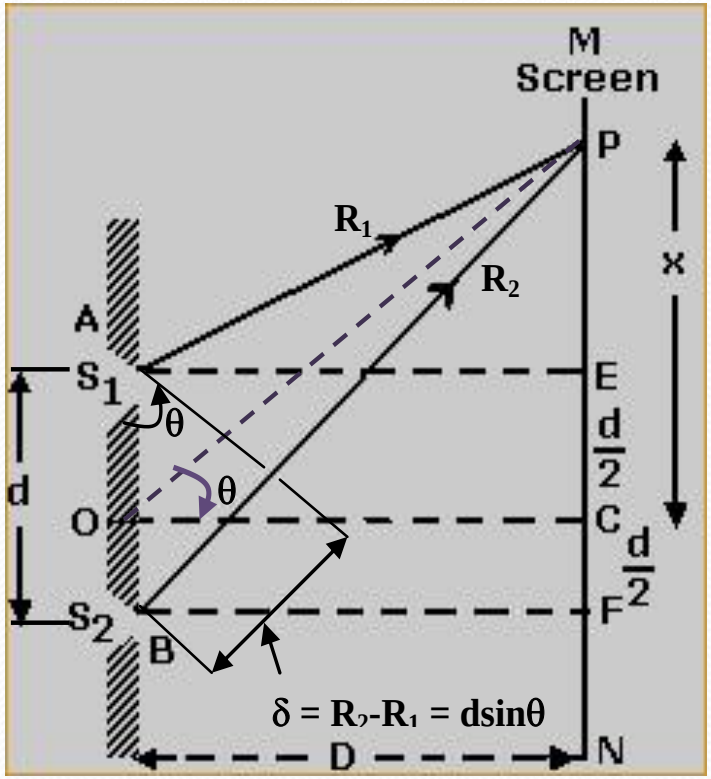
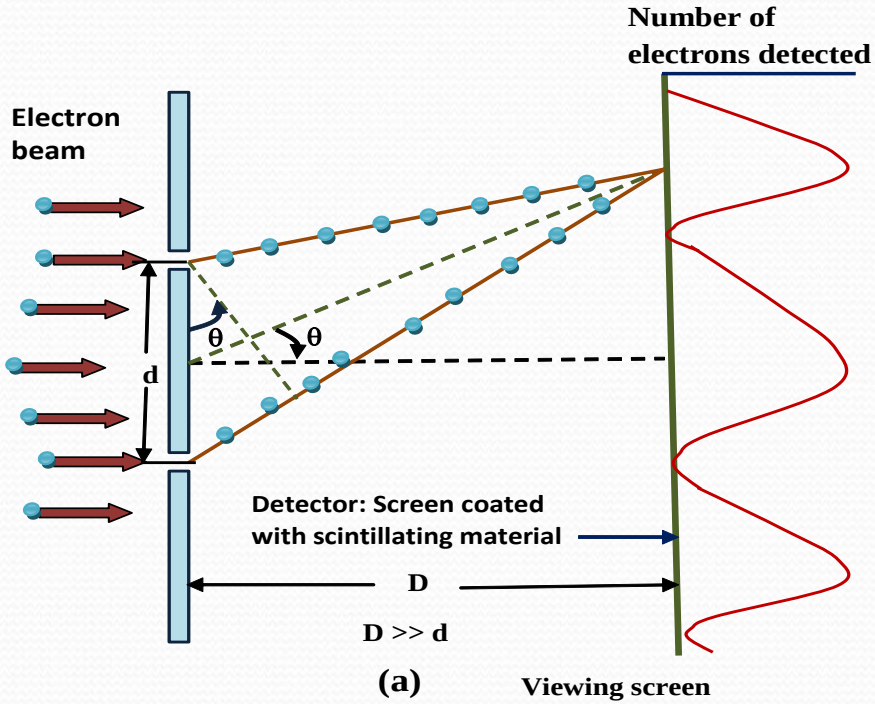


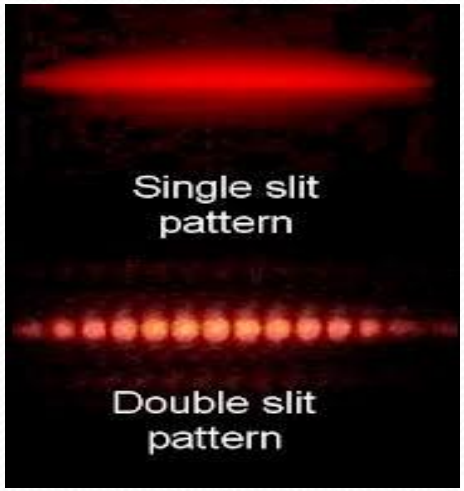
(b)

MATRIX

Young's Double Slit Experiment

- Revisit Quantum behavior: Young's Double Slit experiment
- Young's Double Slit, electron beam interacts with both slits
- Depicting wave nature of particles & interference patterns appear
- Bright fringes d sin $\theta_{bright} = m\lambda$, dark fringes d sin $\theta_{dark} = (m+1/2)\lambda$
- Image of E-beam sensitive to gravity, light waves not effected
- Gravity effects too weak , cannot be isolated from fringe position





(b)

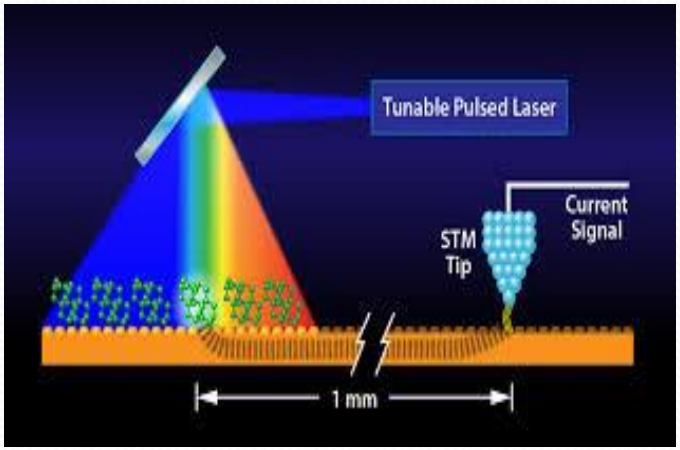
MATRIX

Quantum Mechanics: Applications

- Theorem: Distinction real vs. virtual particle, rest mass & CG
- Newton's laws at work, galaxies to nucleus size particles, quarks
- Schrödinger's equations model behavior of leptons and quarks
- $-\hbar^2 / (2\ m)\ \partial^2\Psi/\partial x^2 + V\Psi = E\ \Psi$ time dependent .(A) Steady state
- $-\hbar^2 / (2\ m)\ \partial^2\Psi/\partial x^2 + V\Psi = i\hbar\ \partial\Psi/\partial t$ time dependent .(B) Instantaneous
- Proof of Schrödinger's equation without gravity in wavefunction
- Suggest improvement in particle's wavefunction, gravity correction

Applications of Quantum mechanics

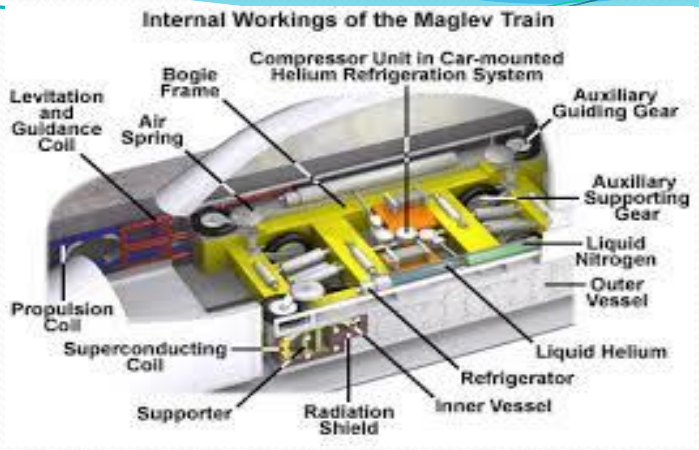
- Mystery of quantum entanglement
- Mystery behind darkness of black holes
- Scanning Tunneling Microscope
- Analyze superconductivity at NTP
- Quantum locking and levitation for high speed train propulsion
- Standard clocks for time & frequency



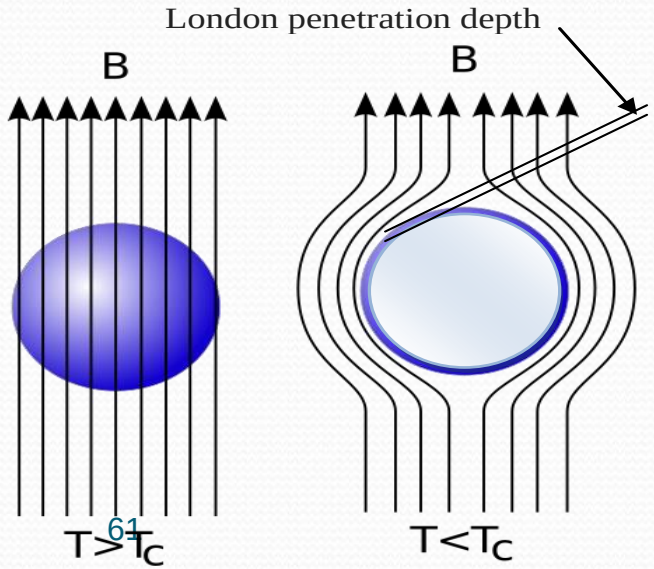
MATRIX

Quantum Mechanics: Applications

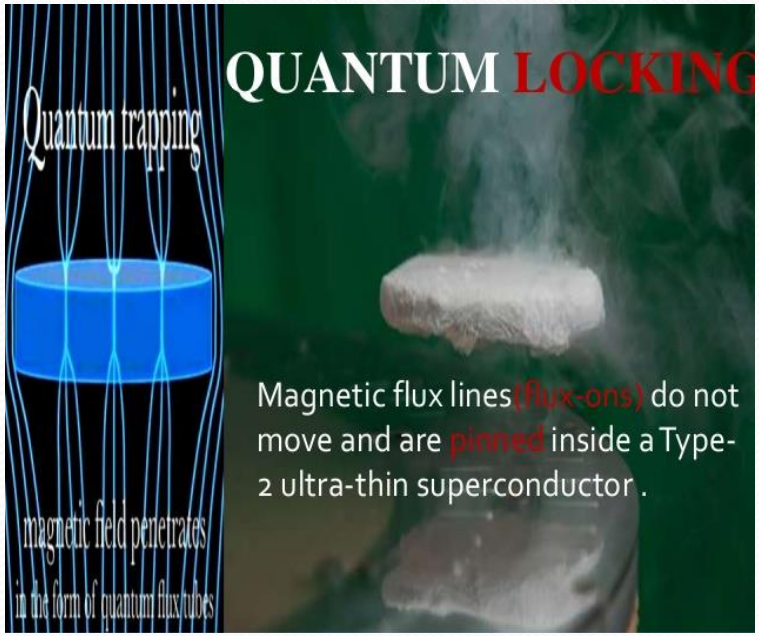
(a) Levitating train



(b) Propulsion system



(c) The Meissner Effect



(d) Quantum trapping

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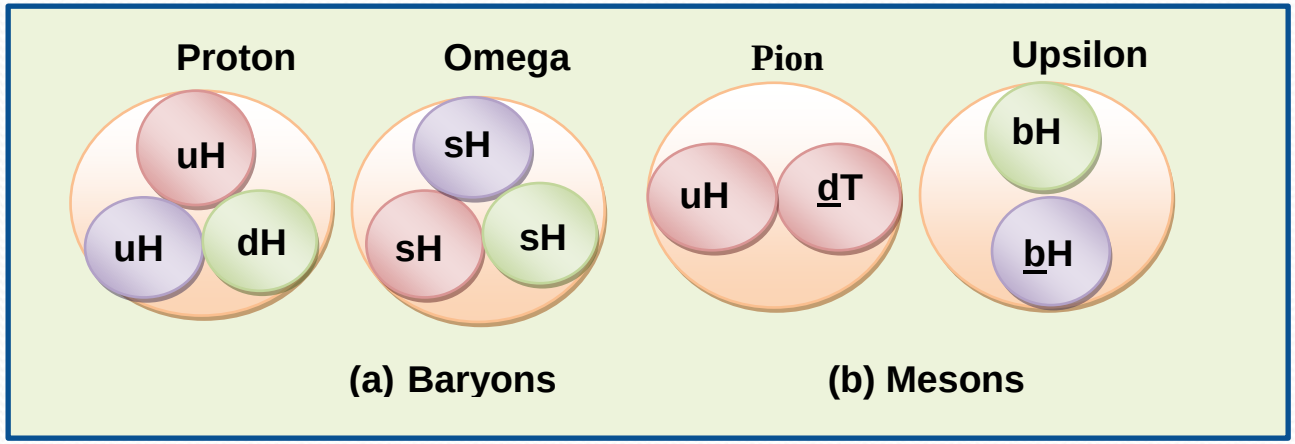
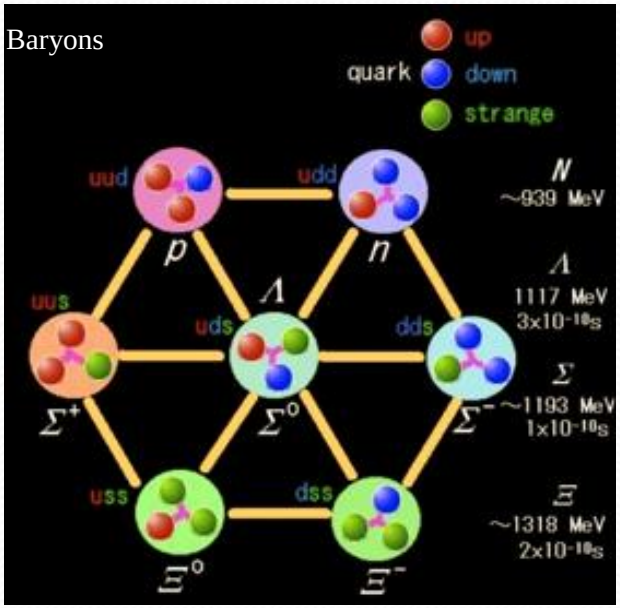
12. Quark Structure of Nucleus

- Standard model of fundamental particles (families) & interactions
- Fermions; quarks (6 flavors) and leptons (3 flavors) with neutrinos
- Baryons; 3 quarks combine under symmetry rules, eightfold way
- Mesons; 2 quarks combine under symmetry rules, tenfold way
- Quarks with three color & anti-color charge with strong color force
- Quarks have fractional electric charge ±1/3e and ±2/3e
- Symmetry; parity (angular momentum L) & Charge conjugation (L+S)
- All particles with corresponding antiparticle pair, examples.

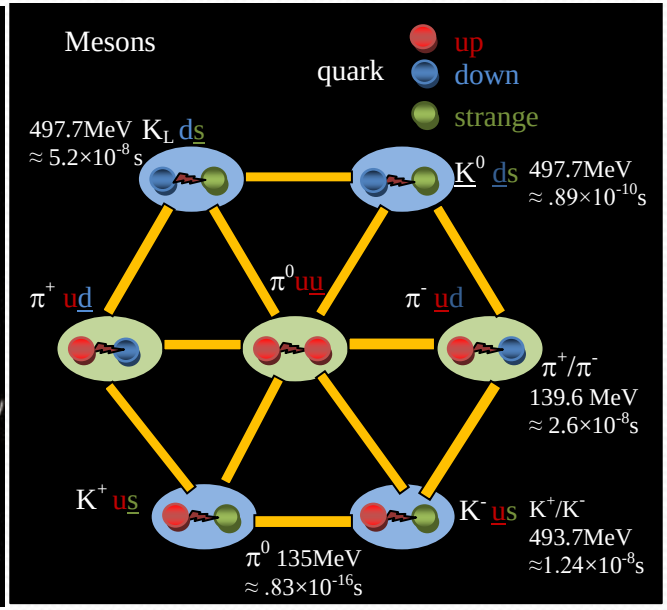


Interaction Types & Properties

- Interactions, 4 types, gravitation, electroweak, EM and Strong (F+R)
- Mediating particles: Graviton, W± and Z bosons, photons γ & gluons
- Electric charge force holds baryons & leptons in atoms via photons
- Strong color charge force binds quarks in baryons via gluons
- Mass of isolated quarks smaller (factor 100) than quarks in baryons, binding energy 300 MeV, mass due to strong color charge force



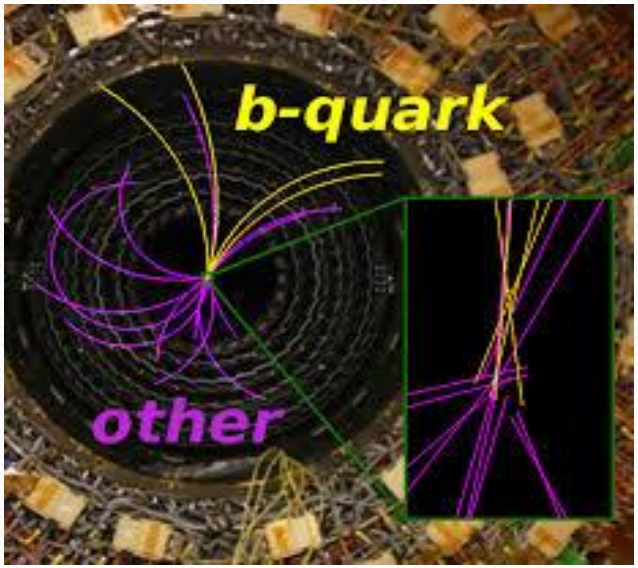
(a)



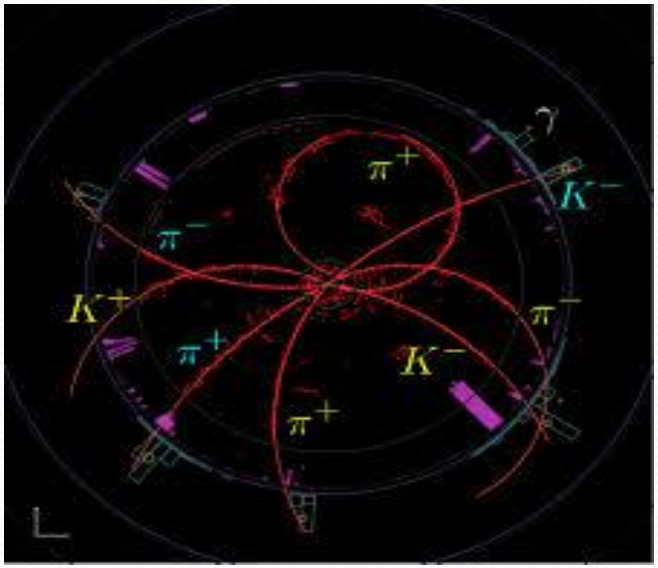
(b)

Detection of Hadron & Quark Jets

- Principle: Cross section area α $1/E^2$, E particle acceleration energy
- Isolate two jet quark events from three jets baryon and meson events
- 90% of composite particle mass correspond to binding energy mass
- Baryon system, Total energy = rest mass energy + binding energy
- $m_{tb} \times c^2 = 3(m_{rq} \times c^2 + \int F(x)\,dx)$, here F(x) color charge force, $60 \times F_q$ and $m_{be} \times c^2 = \int F(x)\,dx)$, where m_{be} binding energy mass.



(a)



(b)

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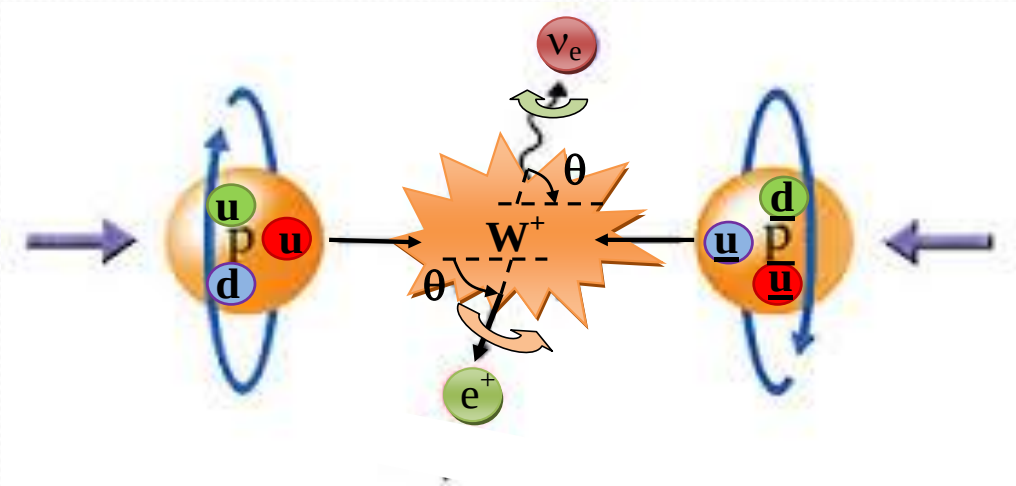
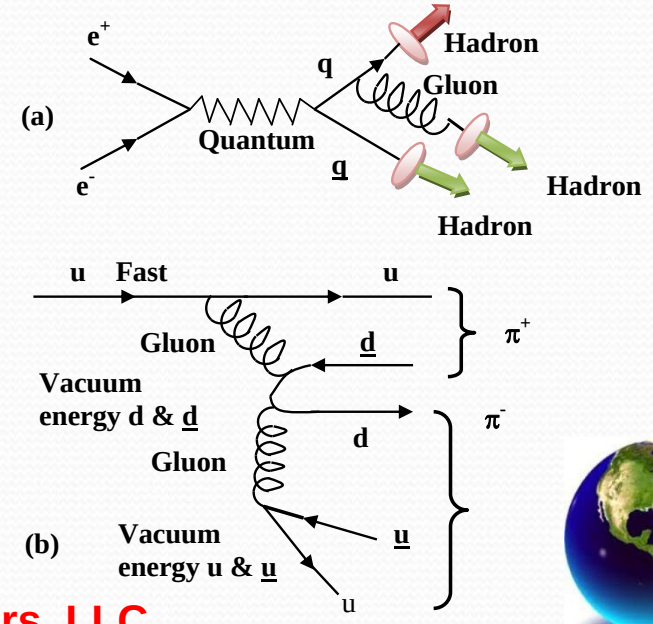
DYA Probes Quarks, Bosons & Hadrons

- Drell Yan Annihilation discovered nature of quarks & hadrons
- Composition of baryons (protons) 3 quarks, and mesons 2 quarks
- Quarks carry fractional charge, charge ratio for up & down quark 2:1
- Mass of confined quark >> mass of isolated quark (binding energy)
- Found new particles W and Z bosons, and gluons
- Energy materialize into massive hadrons via quark fragmentation
- $P^{+}(u_{lh}) + P^{-}(d_{rh})$ (annihilation) => W^{+} (decays) => $e_{rh}^{+} + \nu_e$

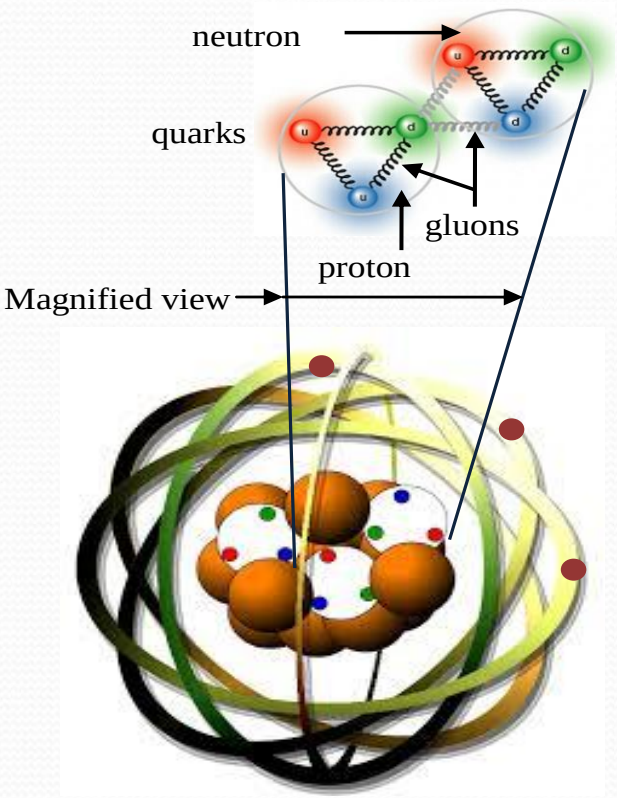




Drell Yan Annihilation mechanism

Significance of Color Charge

- **Quarks within cores of Iron and Aluminum metal target move slower than in protons and antiproton beams**



(a) Quarks within protons and neutrons of iron and aluminum targets.

(b) Quarks within proton and antiproton beams in a particle collider

String Theory Foundation

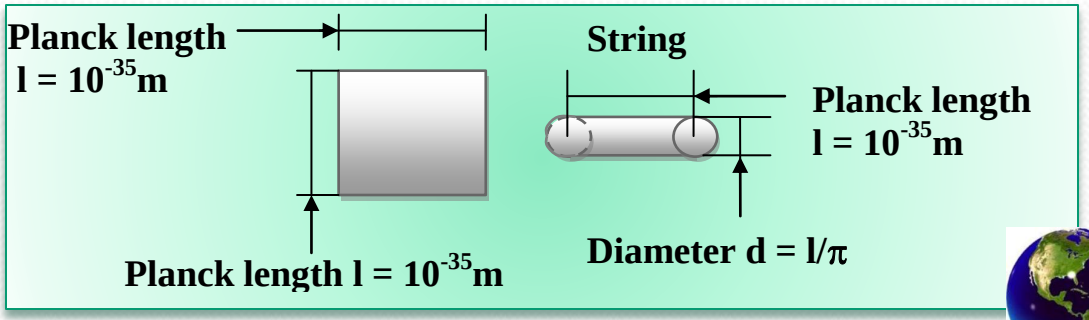
- Advances in technology led discovery of finer particles
- Many unanswered questions from standard model about quarks and neutrinos. Mass, isolation, interaction, gravity, charge, & generations
- Resolve 3 conflicts, Relativity theory & Quantum mechanics (QM)

a) Nature of space & time depend on observer (Special relativity)

b) Failure of Relativity and QM in unifying four forces of nature

c) Nothing any object or information can travel above speed of light c.

- Fundamental particle, string object of size Planck length
- Composite particles made from billions of strings each bundle of string oscillate at its unique frequency to impart different properties to different types of composite particles. Resolution of conflicts
- String parameters
- Length = 1.6161×10^{-35} m
- Mass = 2.1767×10^{-8} Kg
- Time = 5.3906×10^{-44} s



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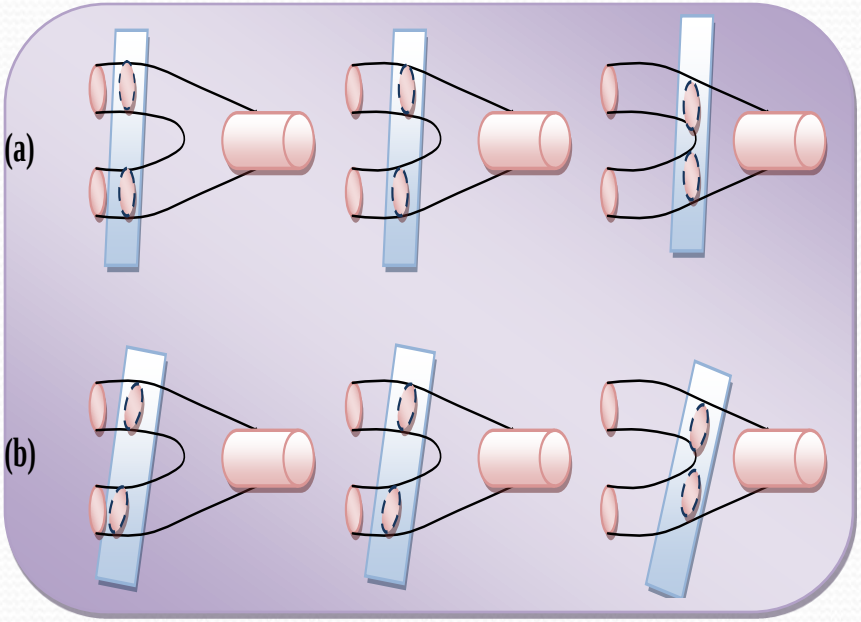
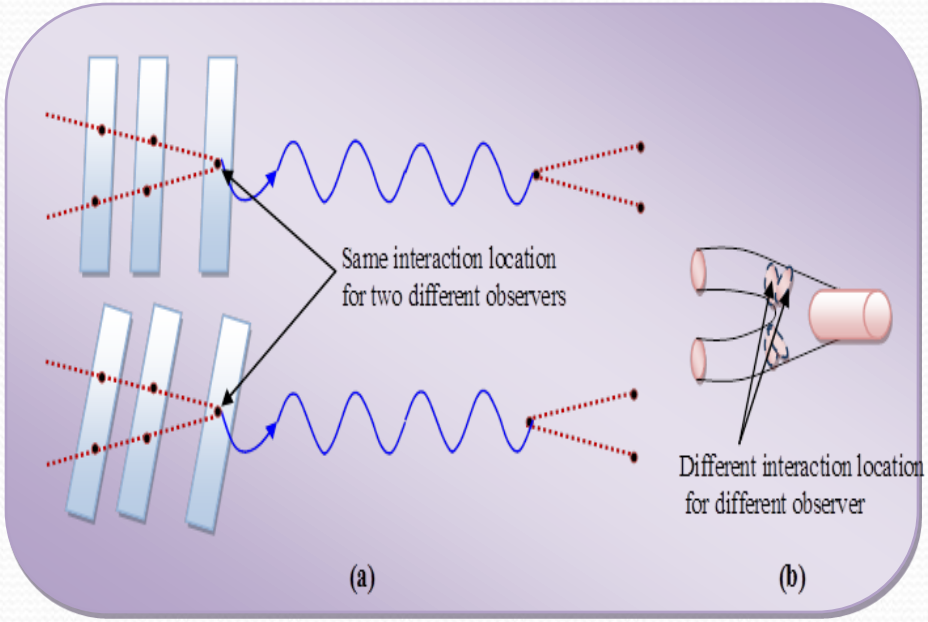
Resolution of Three Conflicts

- Smearing effect, finite versus zero length removes infinities
- Resonant vibration pattern of strings unifies forces of nature
- String theory assumes the speed premise holds well for gravity, radiations and all types of particles/objects
- For strings, resonant frequency limit set by nature of space fabric



A. Incoming strings combine at different locations as seen by two different observers



B. Point particle model, observers agree where and when particle interact at snapshots in time

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13. Evolving Universe

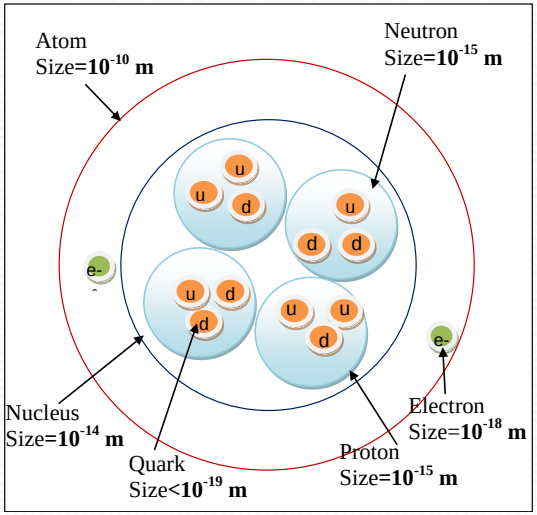
Scope of Universe: Size, age, and domain. Distance scale & dimensions

Solar system: Astronomical unit (AU) = 149.6 M kms = 92.96 M miles

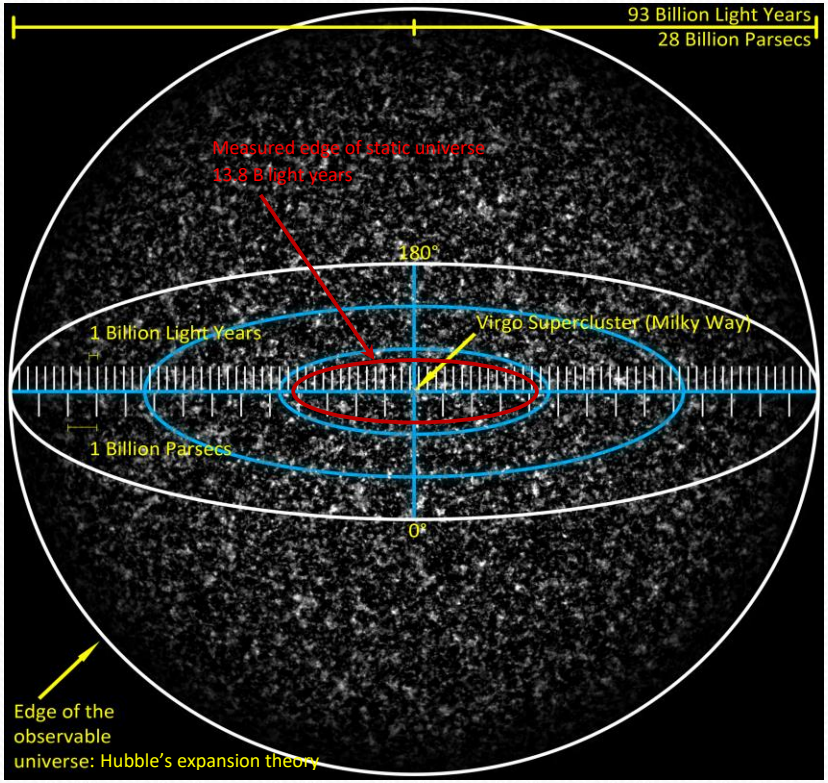
Within Milky Way: Light years 1 ly=9.4605T kms=1.8785T miles=63421 AU

Deep outer space: Parsec = 3.26 light years, most common usage MPC

- **Observed: Size 13.8B ly Age: 13.8B years Dimensions: x, y, z, t, θ & ε**



(a) Atomic scale



(b) Universe scale

- **Domain: Real & Imaginary**
- **Infinite, Past, present & Future**

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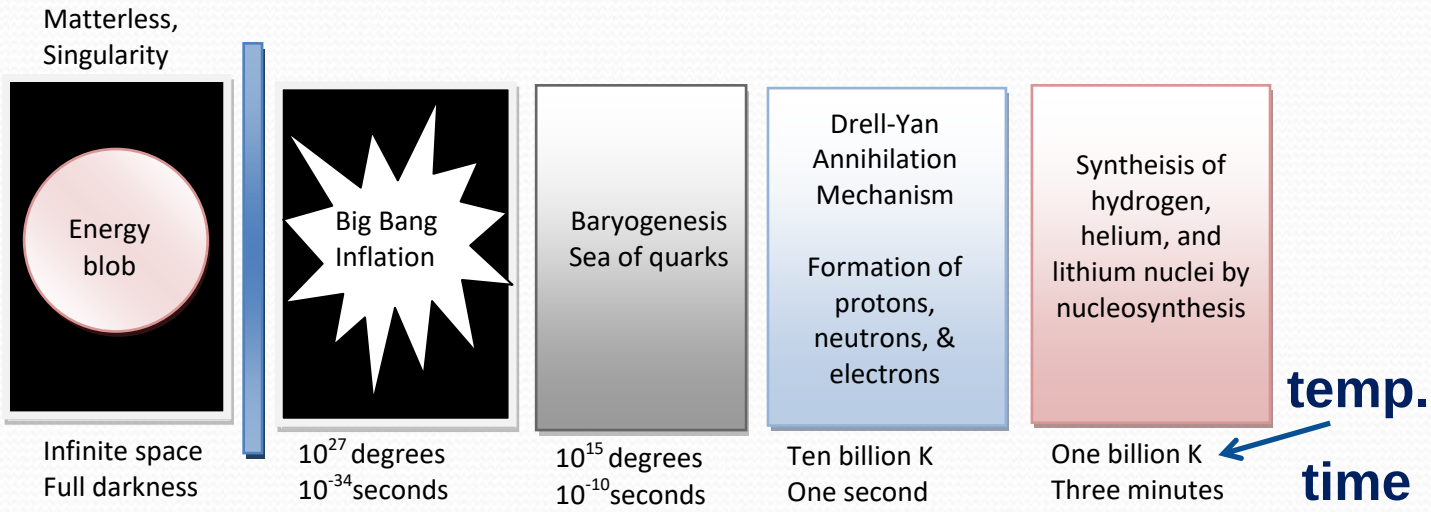
Theories about Creation of Universe

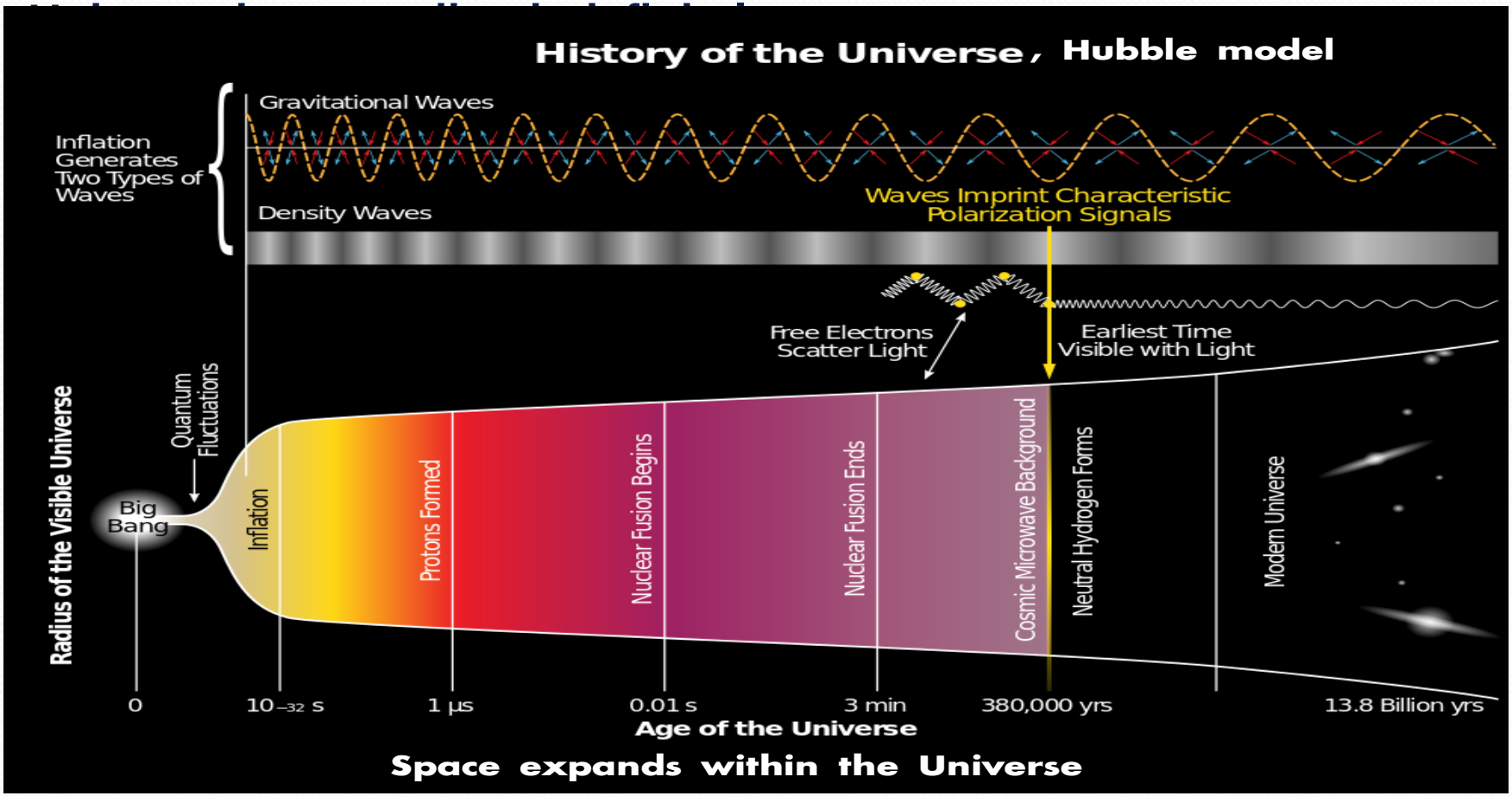
- Big Bang (BBT), Hubble Inflationary, and Sky's Infinite Universe
- BBT model: Developed by George Lemaître, a Belgium priest, 1930



- Problems: Horizon and flatness, CMB uniform in all direction <10ppm
- Lack of magnetic monopoles & missing mass, dark matter in excess
- Hierarchy problem and Quantum loop correction.
- Most of BBT problems solved by Hubble expansion law and Alan Guth's inflationary universe model in 1980's.

Theories about Creation of Universe

- Hubble's Law: $v = H_0 \times d$, & distance of remote galaxies, z-shift gives $d = z \times c/H_0$, d Mpc, c km/s & H_0 km/s per Mpc. Indefinite expansion



- Unlike light waves & CMB foot prints of gravity waves can't be detected. Gravity in fabric of space, continuously overwritten
- Hubble's inflationary model incomplete, lost monopoles

Theories about Creation of Universe

- Alan Guth's improved inflationary Universe model
- Higgs Mechanism:
  Imparts mass to particles and matter
- Broken symmetry
- Phase transition

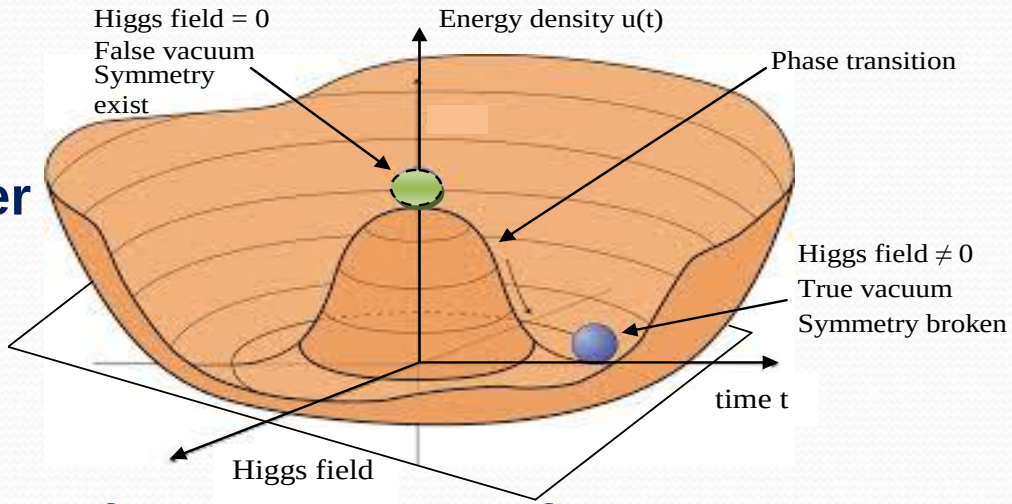
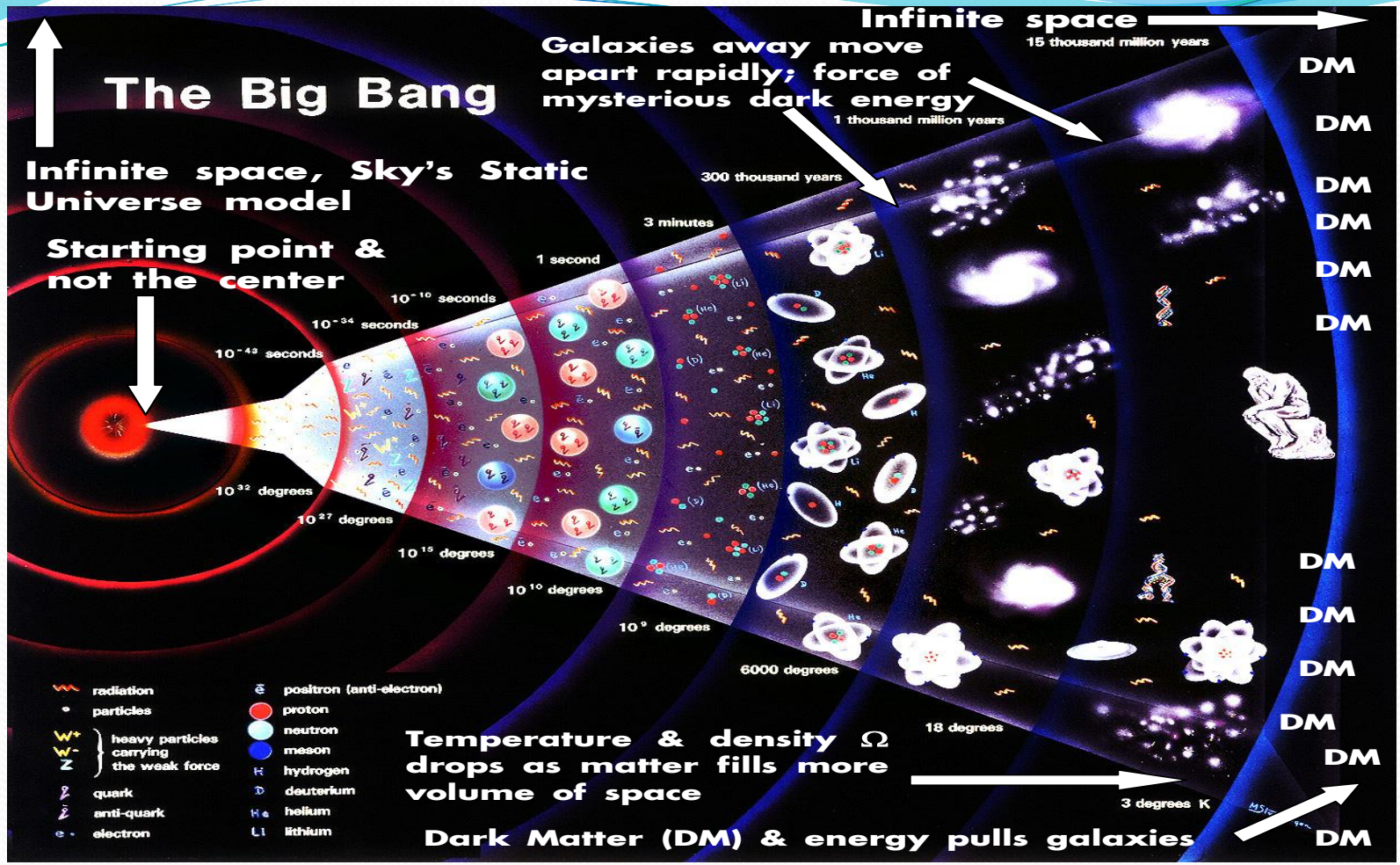


Table: Time vs. energy of particles soon after BB

Time after Big-Bang	Temperature of Universe	Energy of Particle
10^{-43} S	10^{32}K	>10^{4} GeV Gravity separates
10^{-35} S	10^{27}K	10^{4} GeV Strong separates
10^{-12} S	10^{15}K	10^{2} GeV
10^{-6} S	10^{13}K	1 GeV
2 S	10^{6}K	Tansparent to neutrinos
3 Minute	30000K	Production of Helium
3×10^{5} Years	3000K	Tansparent to light
1×10^{9} Years	5K	Galaxies form
5×10^{17} S	3K	At present

Sky's Infinite Universe



- Universe partitioned: Present, Past and Future segments
- Present 1 light sec., Past 1 light day, and Future > 1 light day
- Theorem: Energy conservation & roadmap to Multiverse

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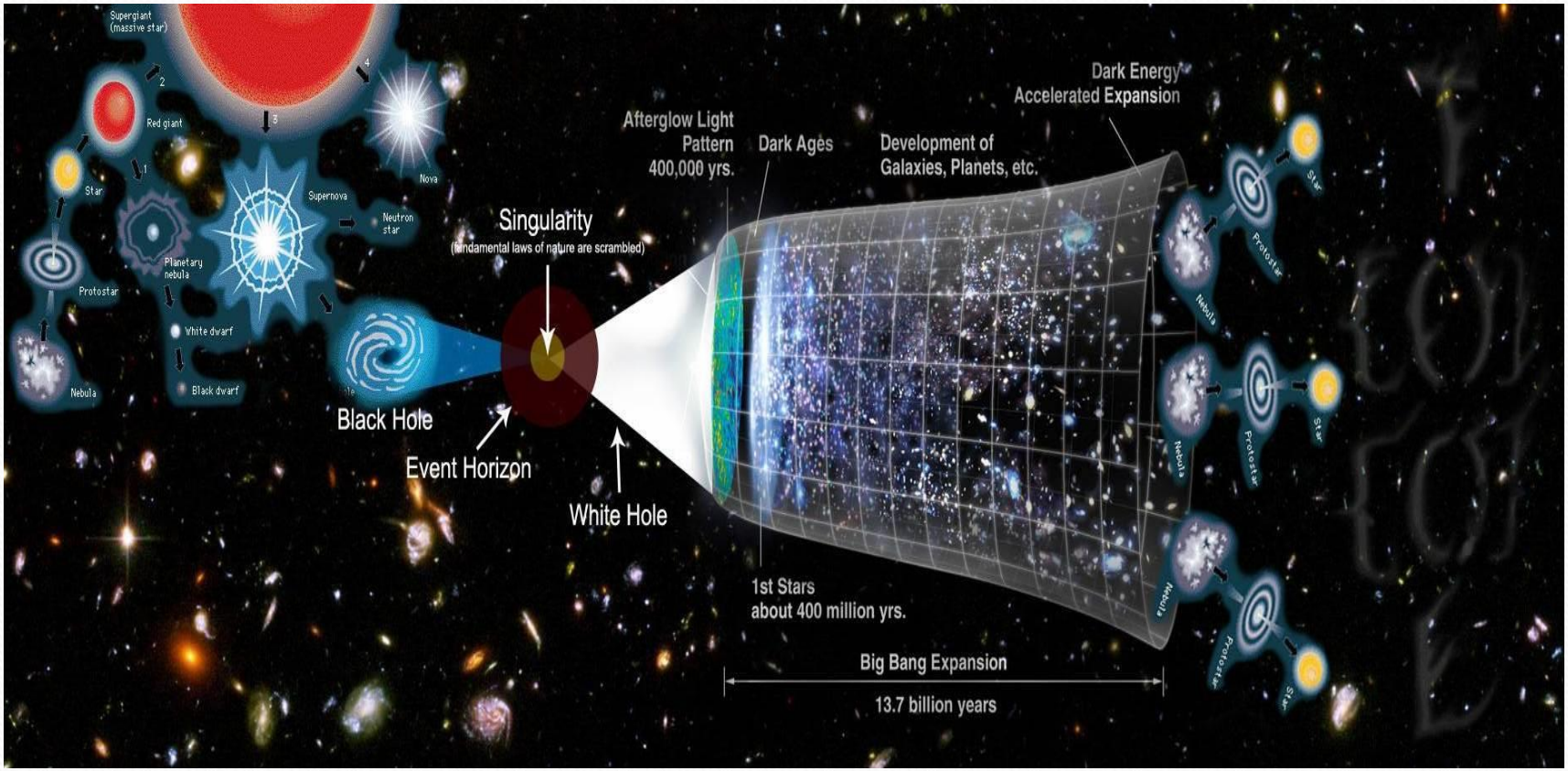
Multiverse: Composite Universe

- Composite Universe: Real; Einstein's legacy, Imaginary; Quantum probabilistic, and Supernatural; Faith based Cosmic origin



- Spiritual Universe and physical Universe concurrently co-exists in real time. Together identified as Multiverse

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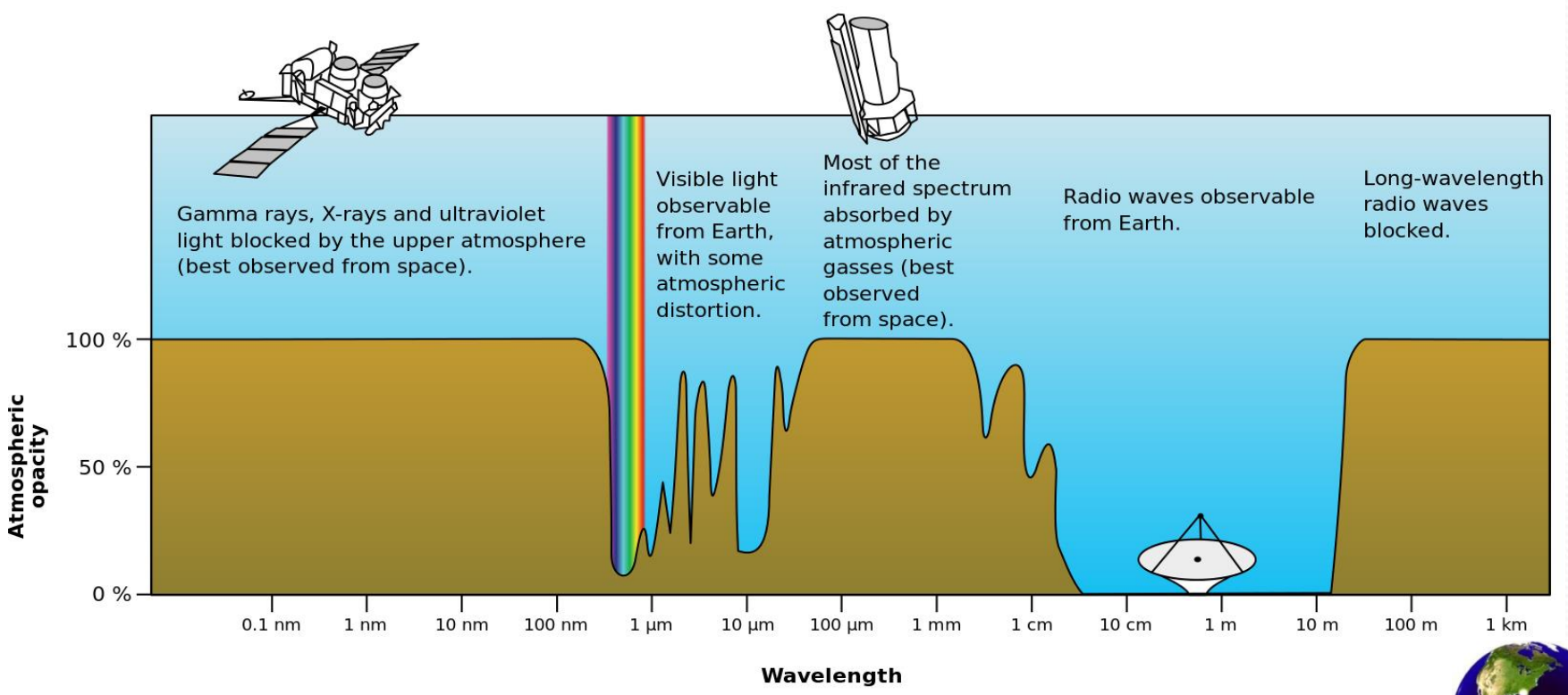
14. Space Exploration

- Astronomy in 21st Century: Imaging method customized for signals
- Sources: x-rays, visible, UV, gamma waves, IR, & gravity sensors
- Problem: Earth's atmosphere obstructs view in some wavebands
- Solution: Observatories located on land and in orbit, outer space
- Astronomy categories: Radio, IR, optical, UV, x-ray and gamma wave

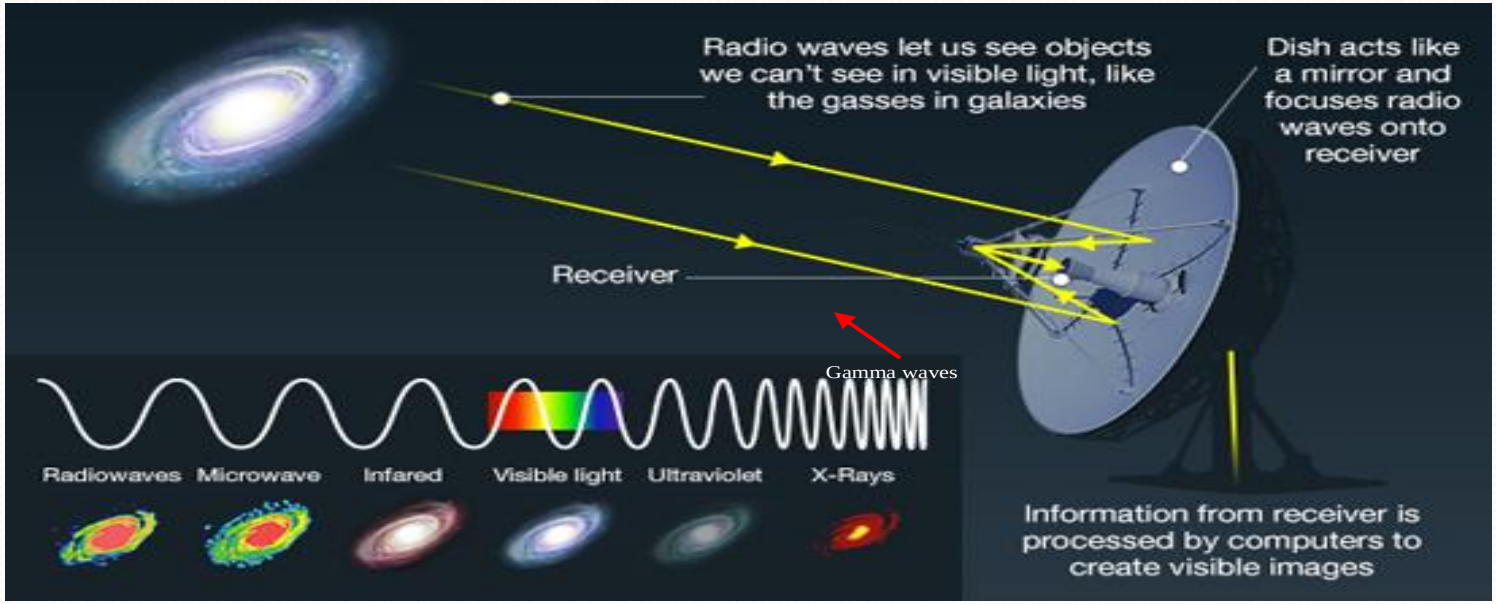


- Response of Earth's atmosphere vs. wavelength of signal

Radio Astronomy

- Very Long Base Line Interferometry employed in Atacama telescope
- Data from Four 12 m dishes and twelve 16 m dish, effective dia. 66m

(a)



(b)

- Operating principle of a radio telescope, Chile, S. America

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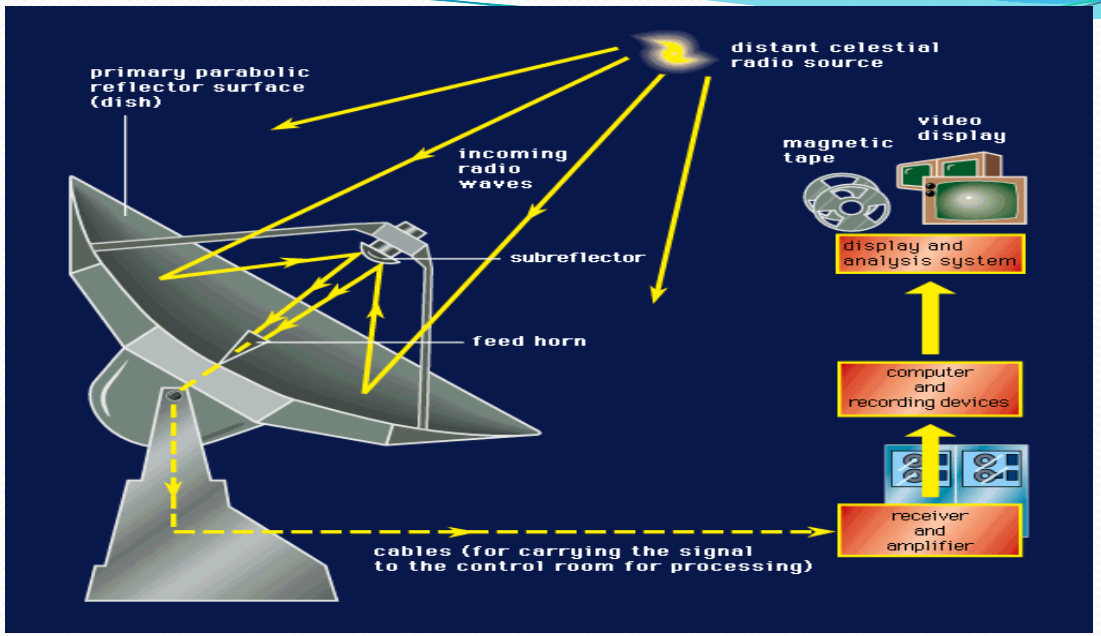
Radio Astronomy



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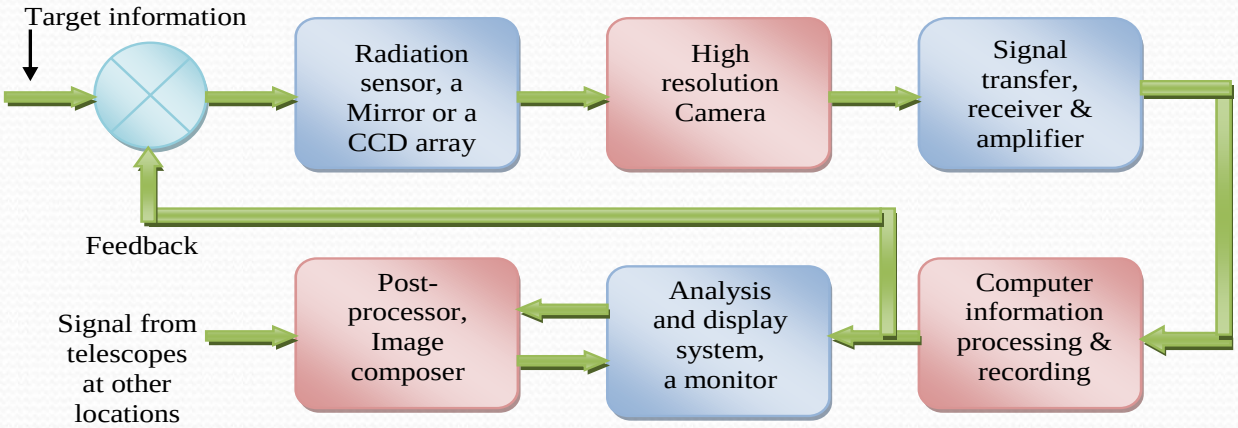


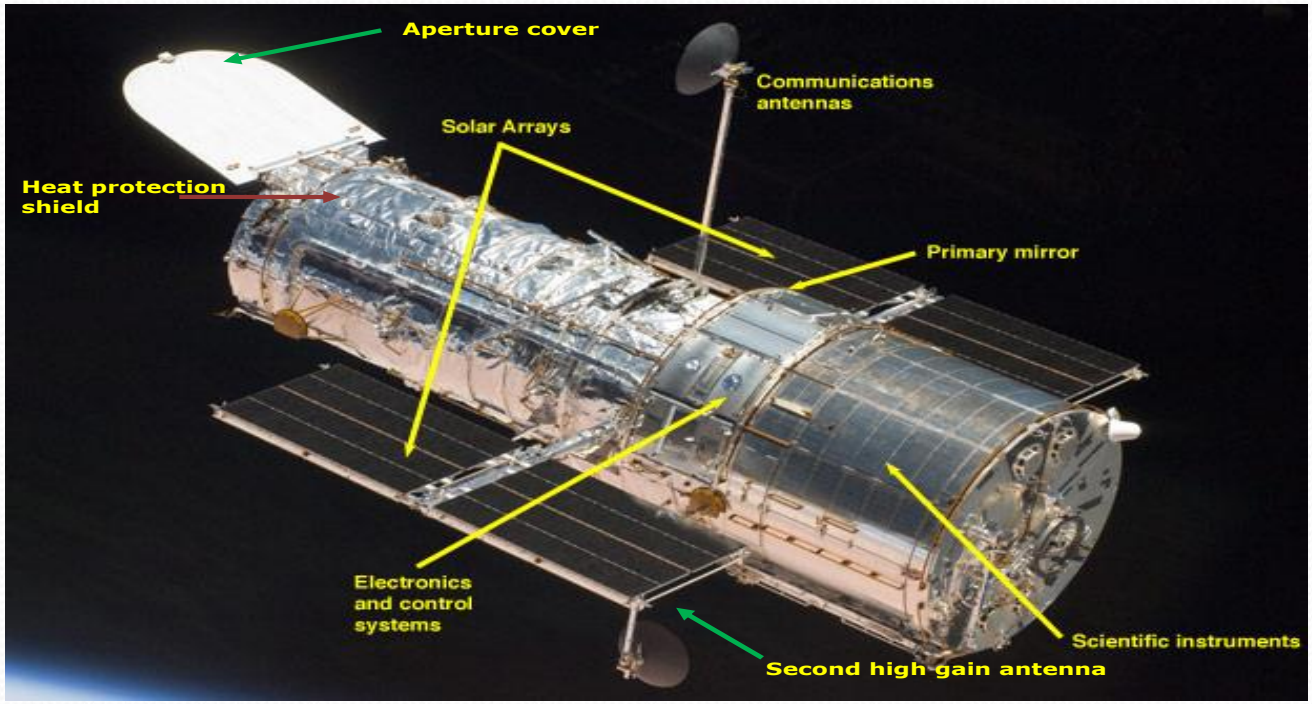
(b)

Signal flow in a typical telescope system design

Optical Astronomy

- Hubble Space Telescope (a) outside and (b) major discoveries

(a)



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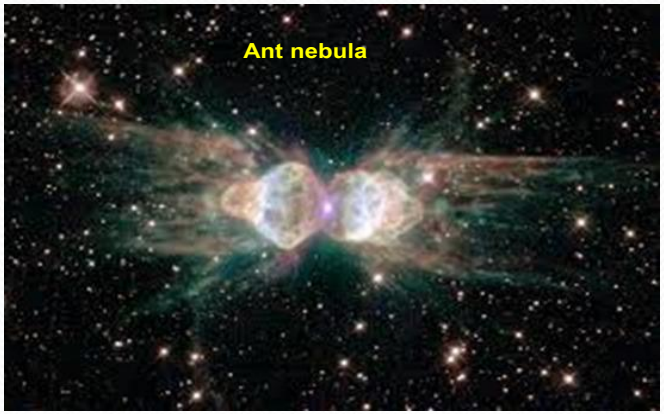

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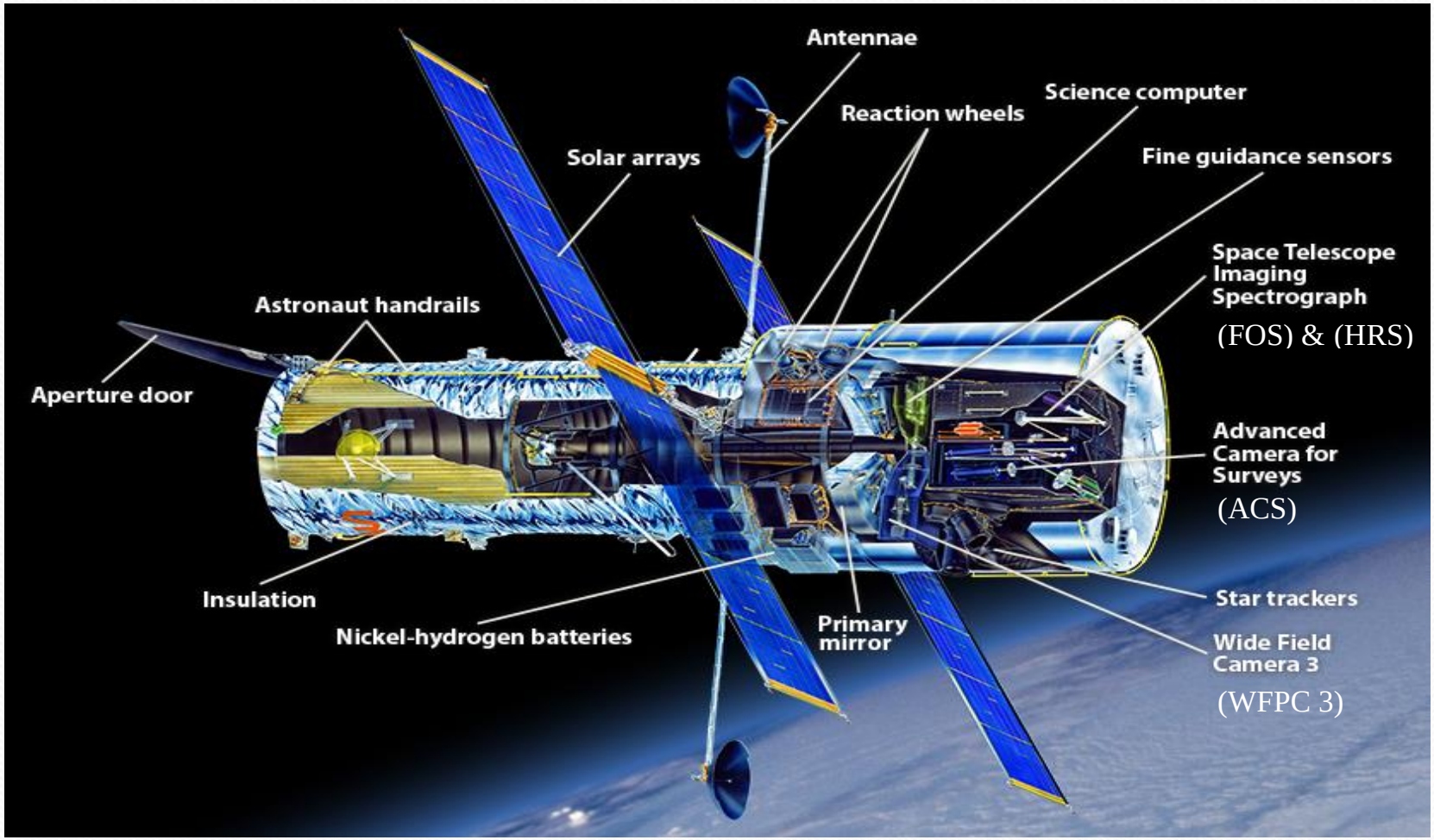
Optical Astronomy

- **Hubble Space Telescope: Scientific instrument payload**

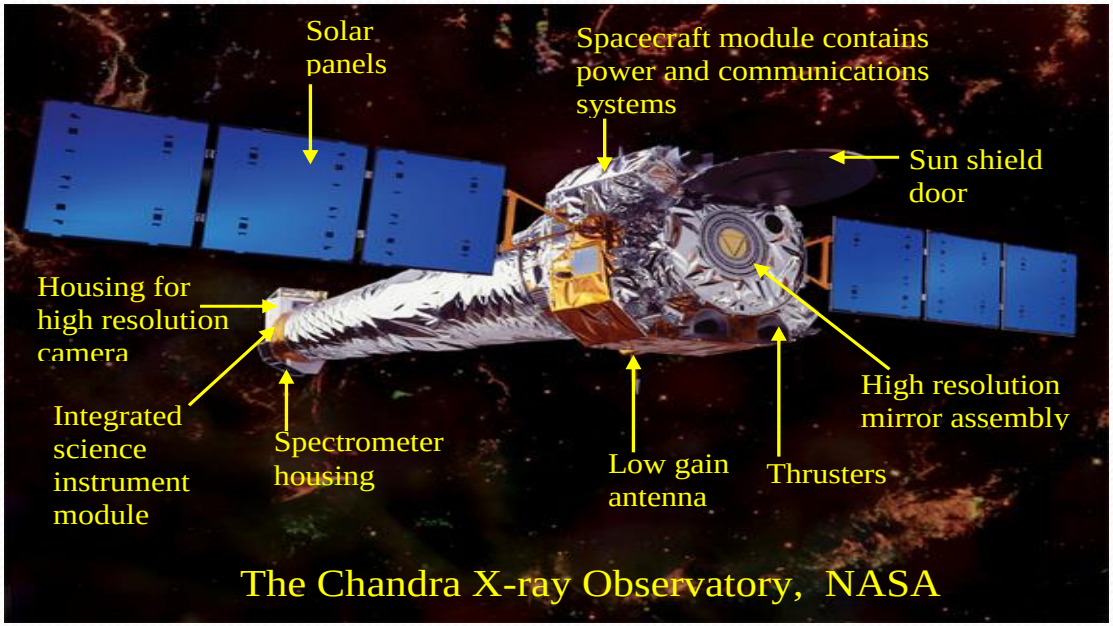


- **Five generations of instruments: Faint object camera, Wide field and planetary camera, Faint object spectrograph, High resolution spectrograph and high resolution photometer**

Chandra-CXO, NASA's Flagship mission

- **Chandra x-ray observatory (a) Payload and (b) major discoveries**

(a)



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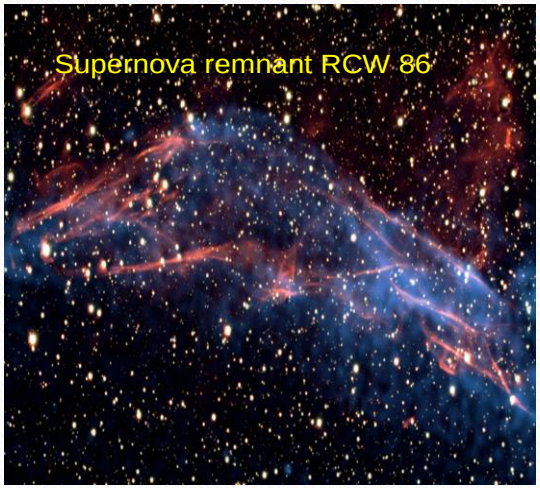

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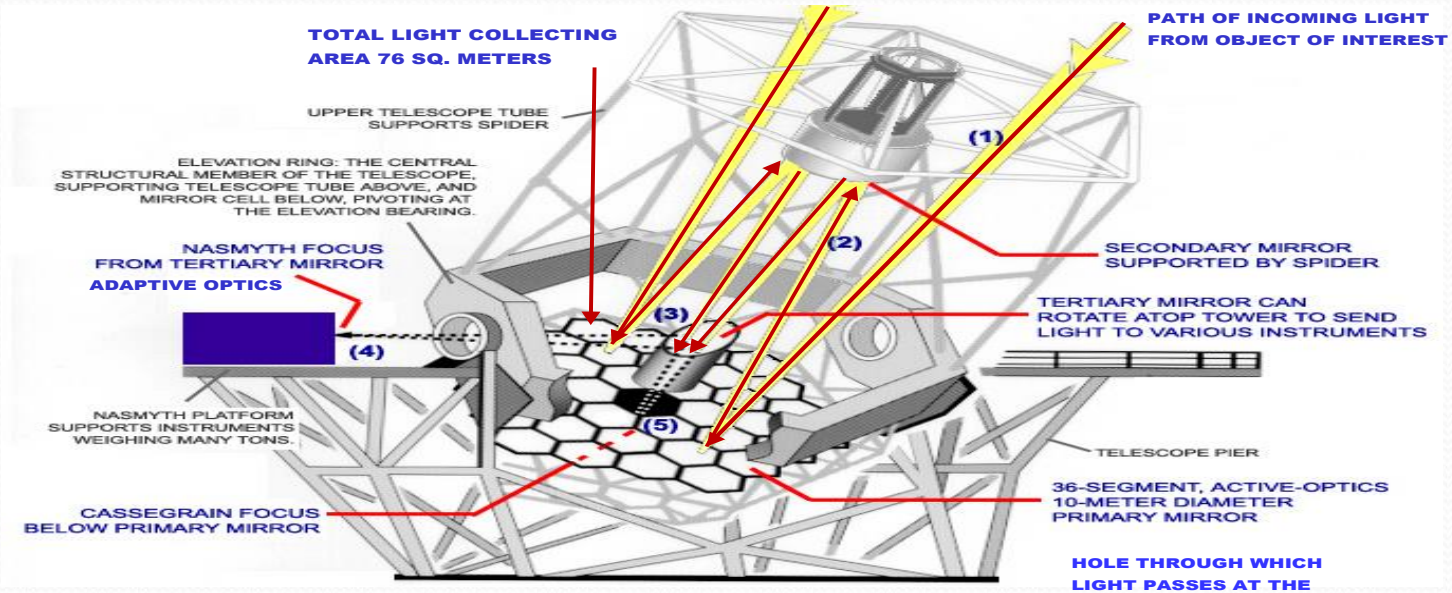
Optical Astronomy

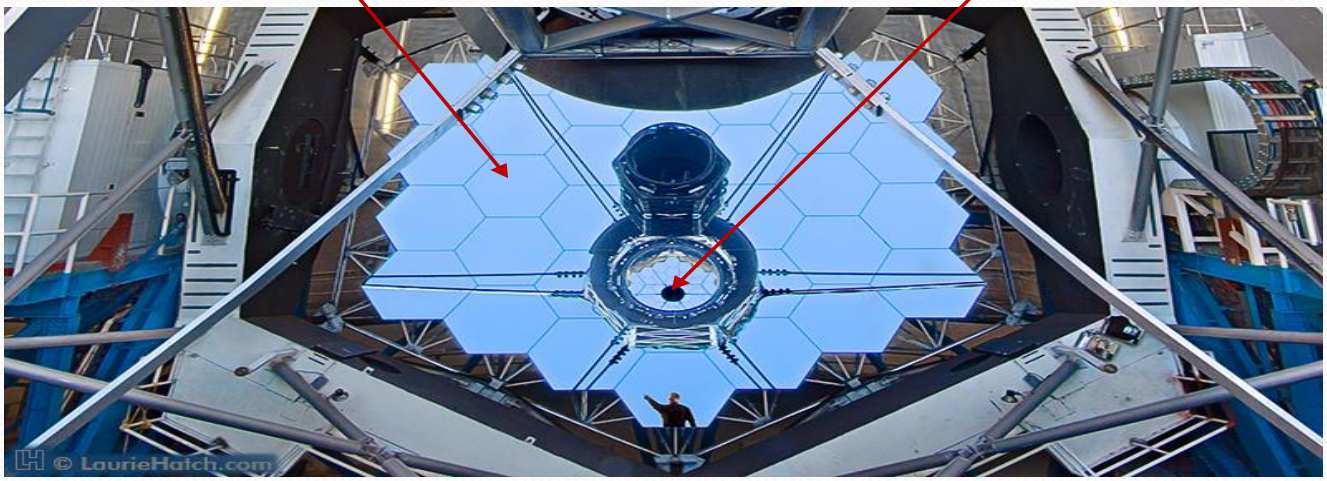
- Keck I & II Telescope Mauna Kea, Hawaii (a) Light path (b) Mirror assembly

(a)



(b)

FINISHED PRIMARY MIRROR 10.5 M DIAMETER
COMPOSED FROM 36-SEGMENTS 1.8 M DIAMETER EACH



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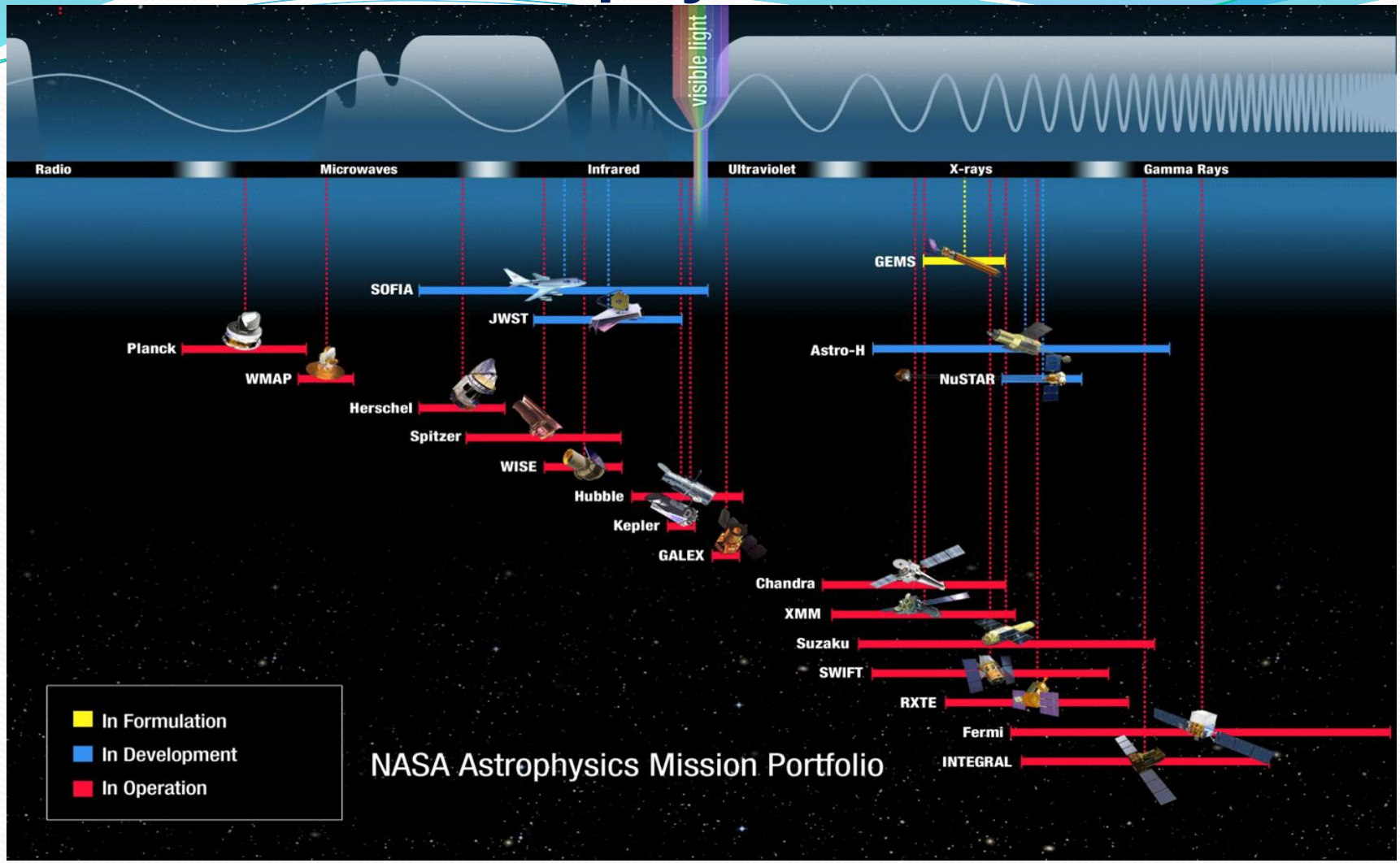
Features & Performance Summary

Telescope Name → Attribute/Features ↓	ALMA Radio	Keck I & II Optical	MAGIC Gamma ray	Hubble HST Optical & IR	James JWST Optical & IR	Chandra X-ray CXO
Launch Vehicle/ Date/Life years/status	Ground 03/2013	Mountain 01/23/93-96	Ground based 99 Ph1-05 Ph2	STS-31 Disc. 04/24/90-20 C	Ariane 5 ESA 10/2018-5.5-10 F	STS-93 Columbia 07/23/99-10 C
Altitude/Orbit km	5 km	4.215 km	2.2 km	559 km	1.5 million km	A139000-P15999
Mirror/Lense Dia & FL	Ant.12,7m	M 10m,17.5m	M 17 m-1.03m	M 2.4 m–57.6 m	M 6.5 m-131.4 m	M 1.2 m–10 m
Construction: Coating	66D:Rh,Ni	36 hex: Al	HC-974S:SiO_2	Parabola:Al,MgF	HC-18S:Be	Barrel: Indium
Resolution ang./spec.	10 marc-s	5-25marc-s	VLBI:.05°	0.4-10.8 arc sec.	0.1 arc sec.	0.5 arc sec 40-2000
Instruments: Camera	VLBI:	NIRC 1-2	PMT: 576	FO & WFP	NIRCam	High Resolution
Spectrometer	16km disk	HIREC		NICMOS	MIRI	ACIS CCDs
Transmission grating		DEIMOS			ISIM	LETG & HETG
Spectrograph		MOSFIRE		FO & HR	FGS & NIRSISS	
Signal Energy keV/ Wavelength λ nm	3m-30cm	1 meV – 2 eV 0.3-27 μm	20-200 GeV 300-650nm	1 eV – 3 eV 115 nm – 1000 nm	1 meV – 2 eV 0.6 μm-28 μm	0.1 keV-80 keV/ 0.0015 – 0.017 nm

Special features in construction of telescopes

- Alma: Four 12m and twelve 16 m dish antennas, effective dia. 66m
- Keck I & II: 36 hexagonal mirrors each 1.2m dia., effective dia. 10.0m
- MAGIC I & II: 974 segments each 0.25 m^2, effective area 236 m^2
- HST: Primary lens diameter 2.4 m parabola, focal length 57.6 m
- JWT: 18 hexagonal segments gives primary mirror dia. 6.5 m
- Chandra CXO: Primary mirror 1.2 m, barrel shape x-ray sense

NASA'S Astrophysics Missions



- Portfolio of NASA's mission in space (Courtesy of NASA 2010)

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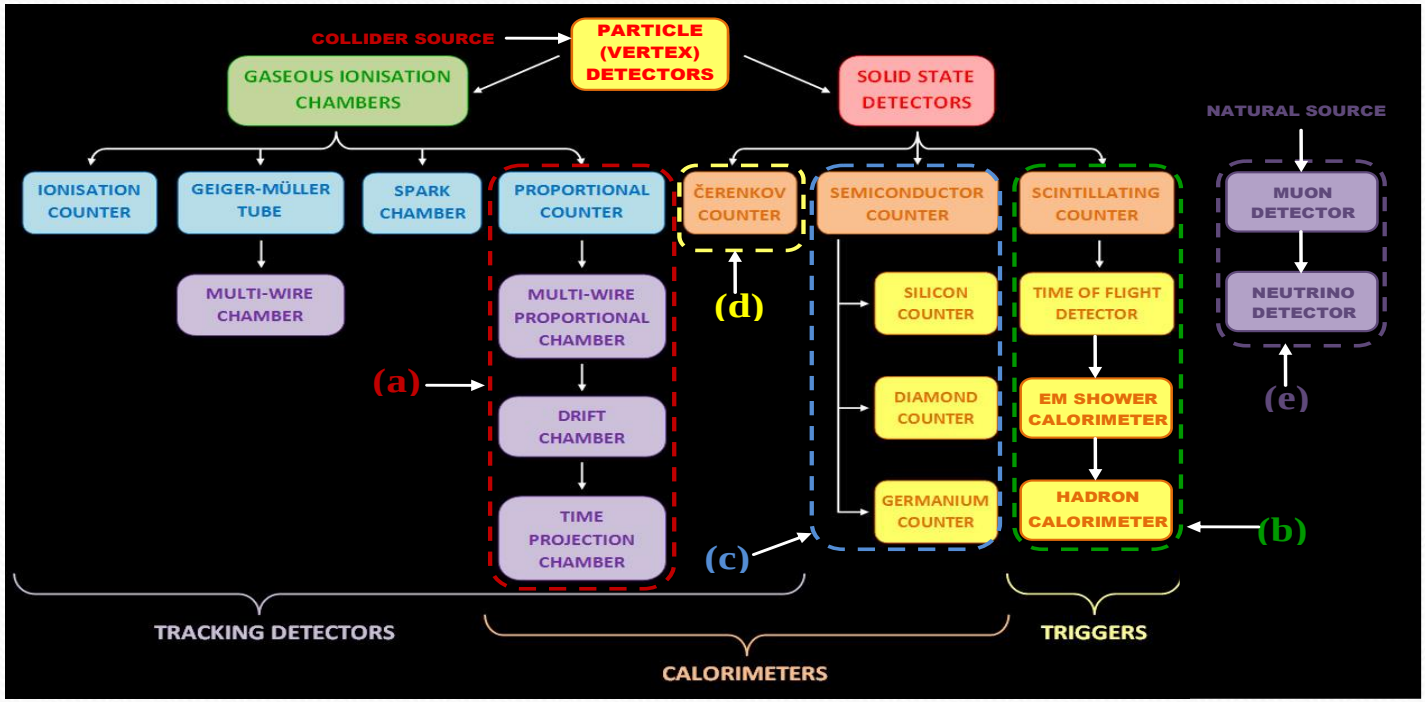
Particle Detectors & Cosmology

- Particles in outerspace resemble particles produced in colliders.
- Detectors in collider serve dual purposes: (a) Analyze particles after proton/anti-proton collision event, the remains in ionization/bubble chambers and (b) particles from Astronomical sources in space.
- Classification of particle trackers based on operating principle.

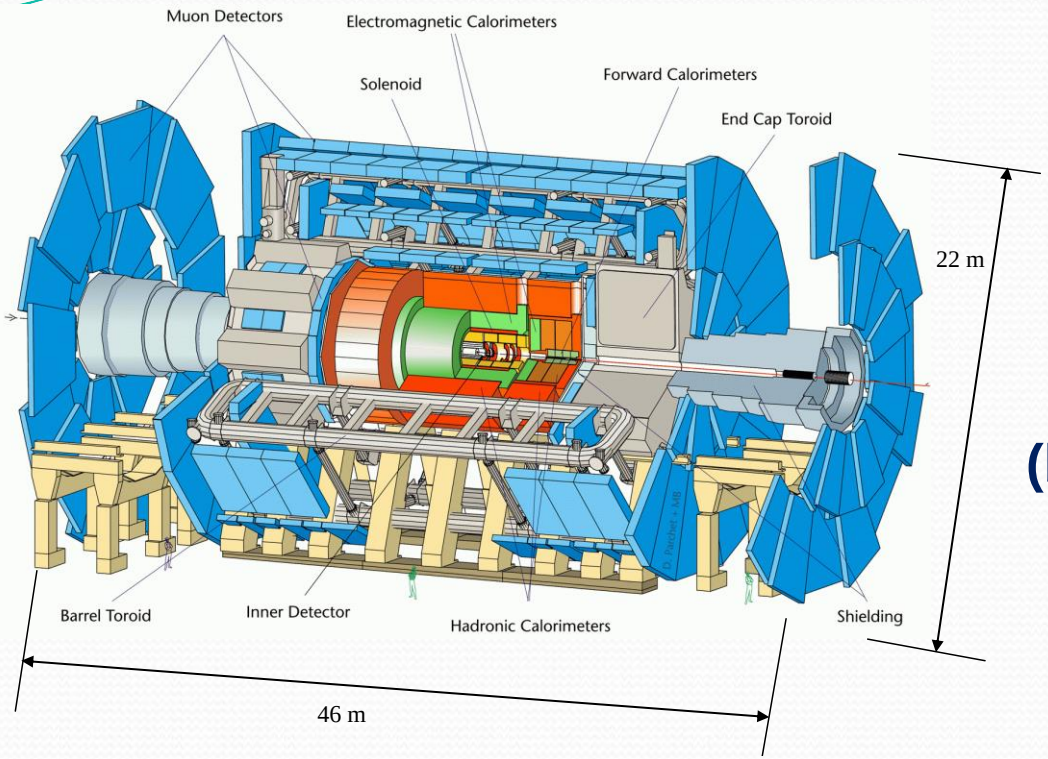


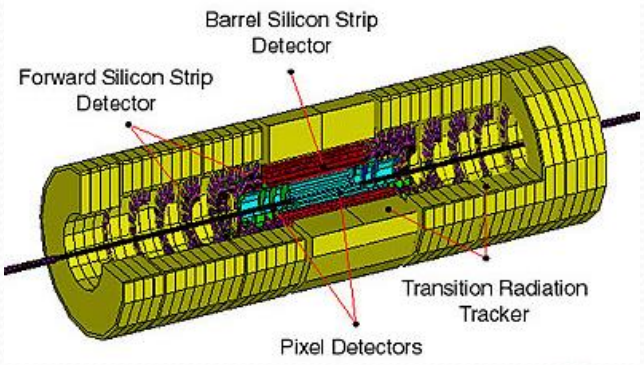
(a) Ionization & drift chamber (b) EM calorimeter & scintillation counter

(c) Silicon micro-strip detector (d) Cerenkov radiation detector

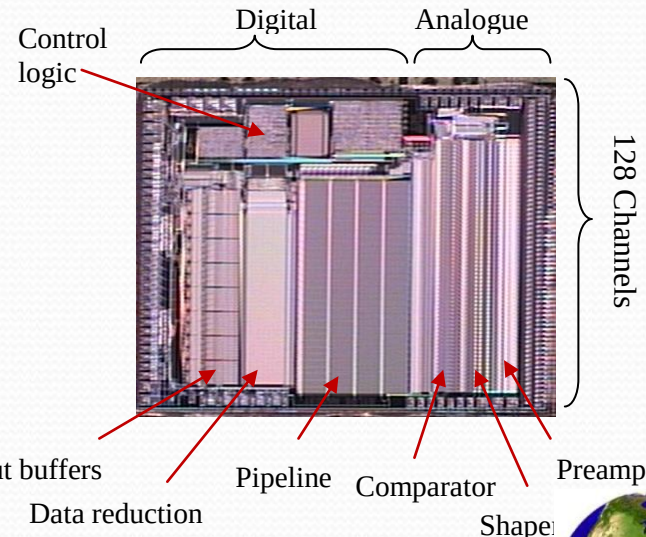
(e) Neutrino and muon detector

Detectors at LHC in CERN





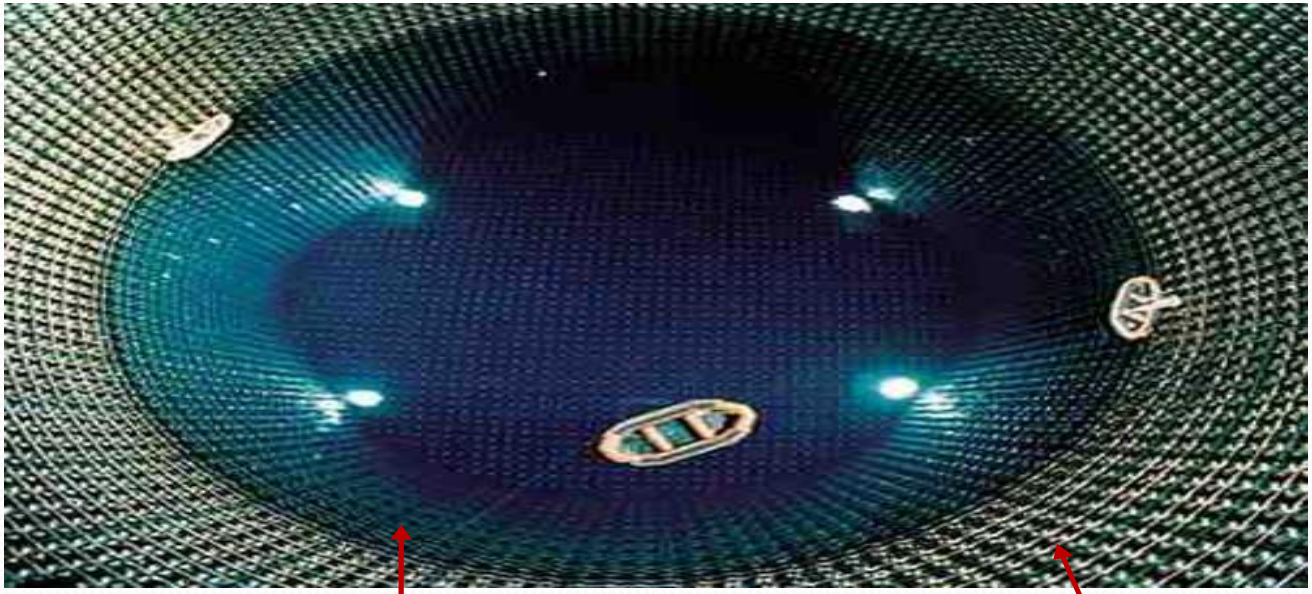
(b) Silicon microstrip module



- **(a) Cut-out section of ATLAS detector at LHC, CERN showing onion skin placement of different detectors**
- **(c) Frontend ASIC (Courtesy Lutz Feld, Freiburg university)**

Neutrino Detector Solves SNP

- **Solar Neutrino Puzzle solved by Super Kamiokande detector located at mount Ikenoyama in Japan detected Cerenkov at 390 nm**



50,000 tons of ultrapure water for detecting transmuted tau neutrinos.

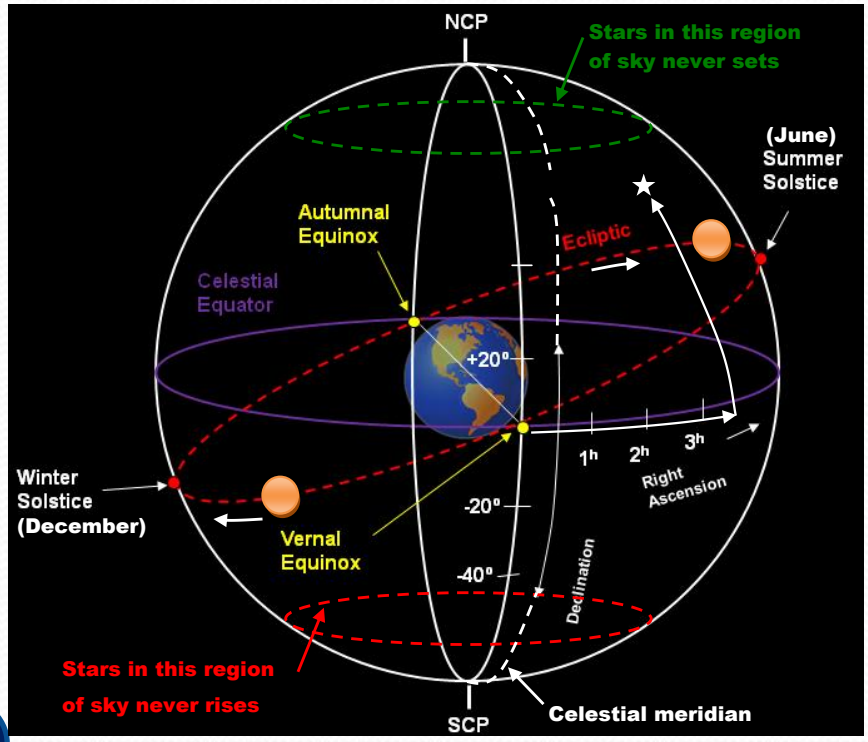
11000 photomultiplier hand- blown tubes coated with a thin layer of bialkali (Sb-K-Cs).

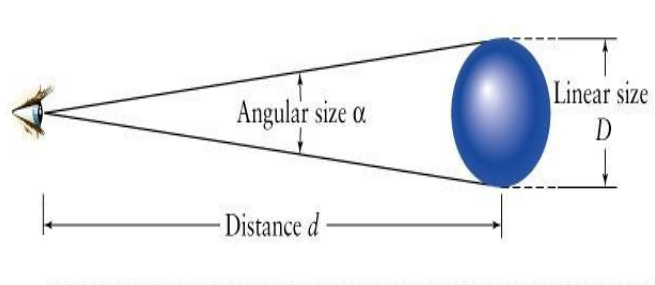
- **Solar Neutrino problem was confirmed at three different locations**

Observatory Name/Site	Year built/ Mine-depth	Fluid type/Quantity	# of Photo-multiplier tubes	Purpose/ achievement
Homestake Gold Mine/ Lead, South Dakota	1999-2007C/ Zinc- 1.6 km	Perchloroethlene 378,000 liters	Chloride→Argon 15 atoms/month	Verify neutrino deficiency- yes
Sudbury Neutrino Detector/ Sudbury, Ontario Canada	1999-2001O/ Nickel-2 km	Heavy water, D_2O/1000 ton*	9500, 18 m diameter array	3 phase project Detect Cerenkov
Super Kamiokande Detector/ Mount Kamioka, Hida Japan	1983-2008O/ Mozumi-1 km	Ultrapure H_2O/ 50,000 tons	11,000 Cathode alkali (Sb-K-Cs)	Detect Cerenkov 5K muon→tauon

Measures of Astronomy

- Small angle distance formula: D = αd/206,265 km here D is diameter of star, d is its distance from observer on Earth & α is angular size.
- Terms: Ecliptic, celestial sphere, diurnal motion, summer and winter solstices, vernal and autumnal equinox, Arctic and Antarctic circles, zenith, circumpolar, Synodic and Sidereal periods, Terrestrial and Jovian planets, tangential and radial components of space velocity, right ascension and declination, UBV photometry and H-R diagram

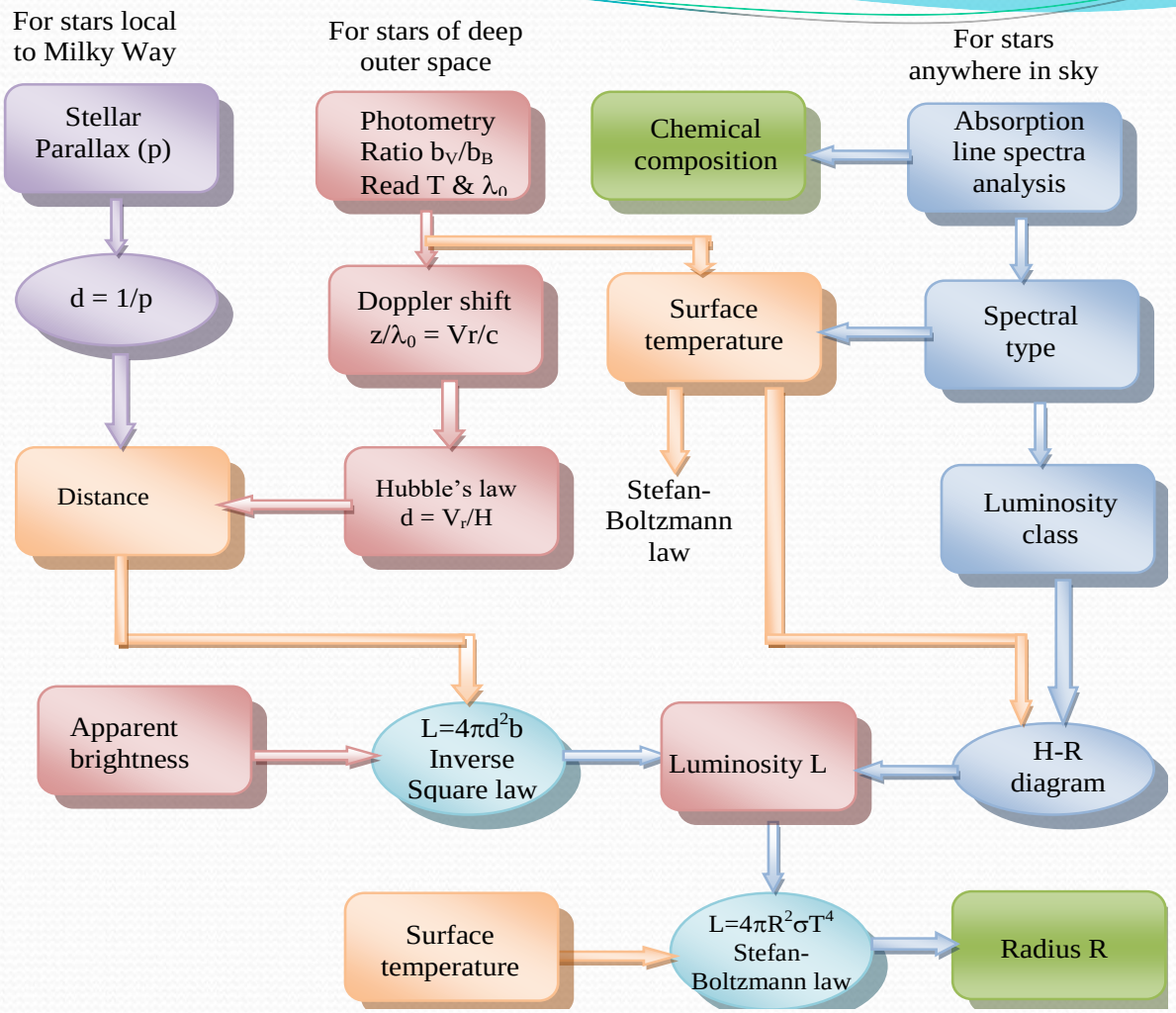




(b) Small angle distance formula

<= (a) Selected terms

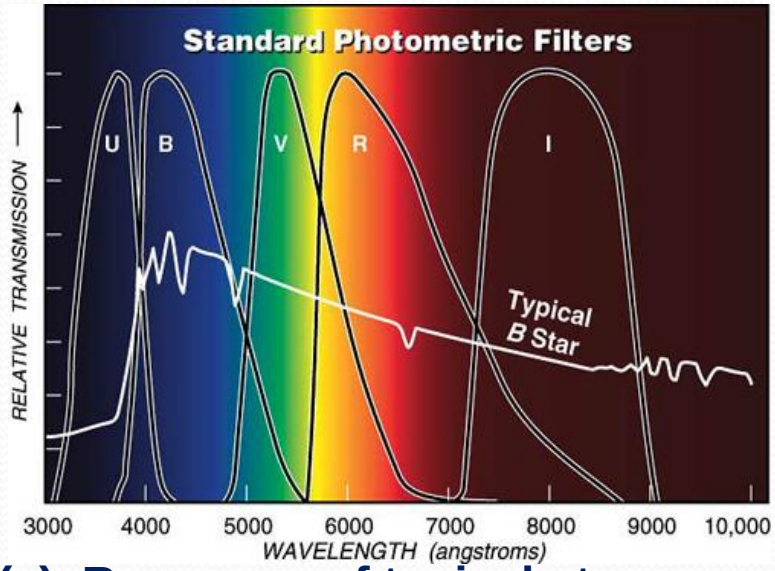
Measures of Astronomy



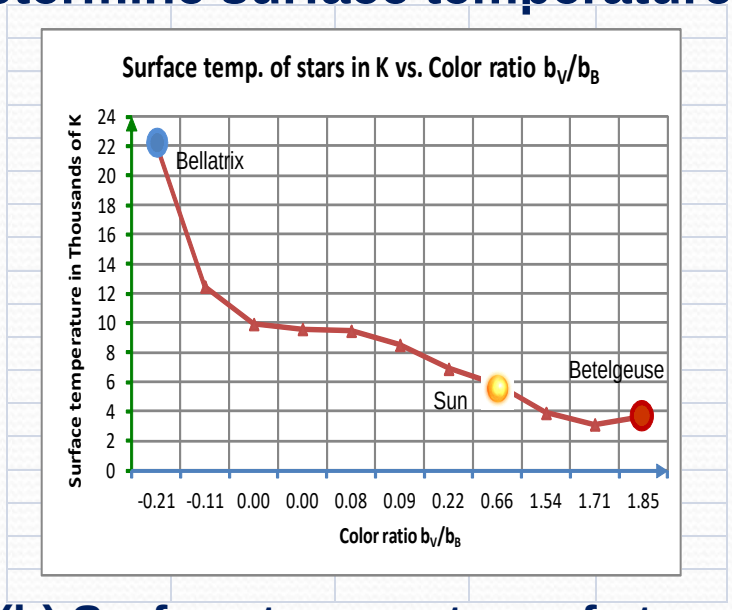
- **A flow chart to measure distances and radii of stars anywhere in sky by applying Inverse Square & Stefan Boltzmann Laws**

Measures of Astronomy

- UBV Photometry Principle: Peak intensity of light from stars observed by using different filters determine surface temperature.



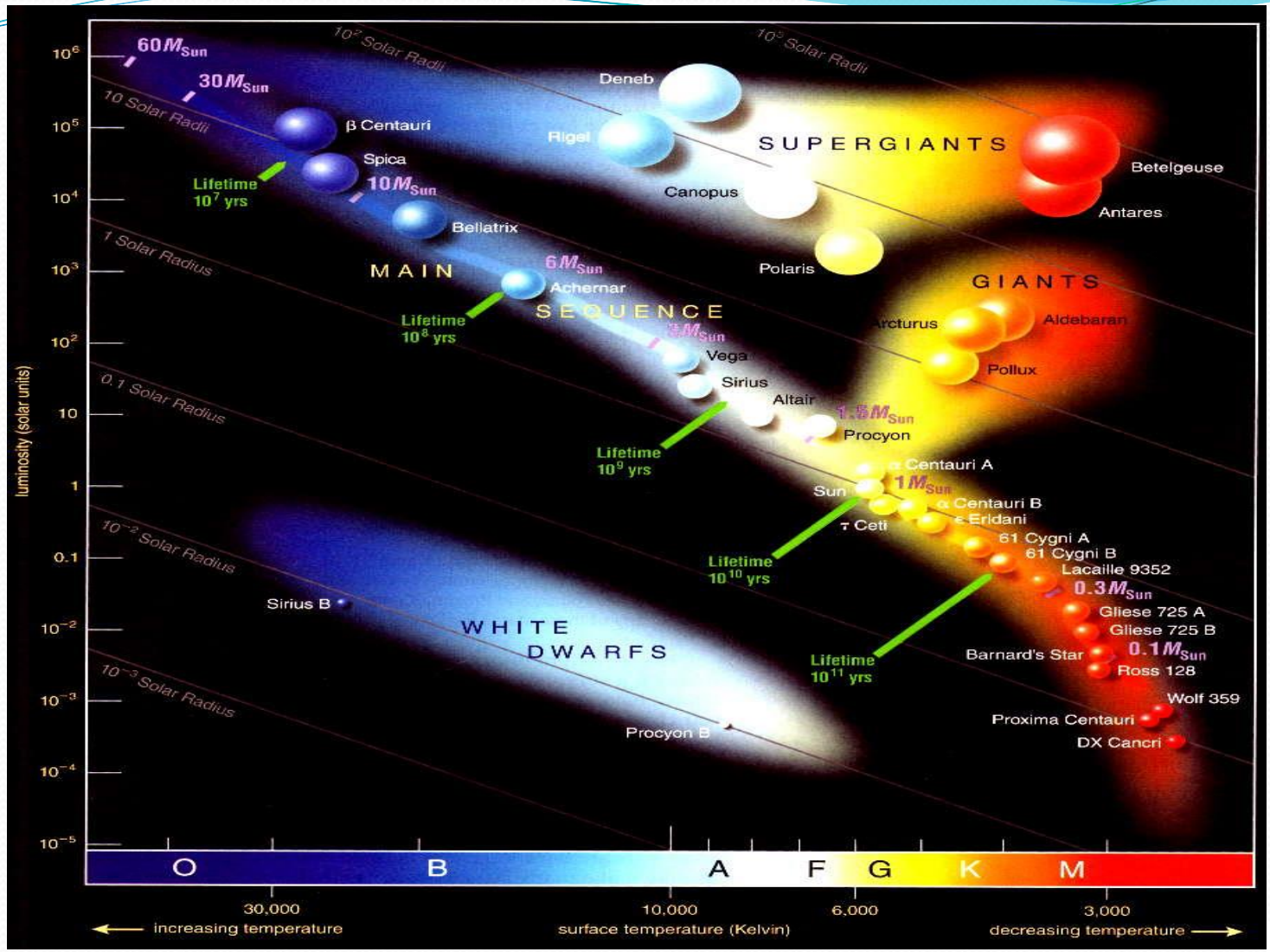
(a) Response of typical star through U, B, & V filters



(b) Surface temperature of stars versus color ratio b_V/b_B

- Surface temperature found by absorption line spectra analysis
- Wien's law is employed to determine unshifted wavelength λ_0 corresponding to intensity peak. $\lambda_0 = 2.898\times10^{-3}T^{-1}$
- Apply Hubble's law to find distance and radial velocity of stars
- Using Inverse Square law find luminosity L from apparent brightness b.

Measures of Astronomy



- Hertzsprung and Russell (H-R) diagram: Luminosity versus surface temperature.

Measure Distance of Stars

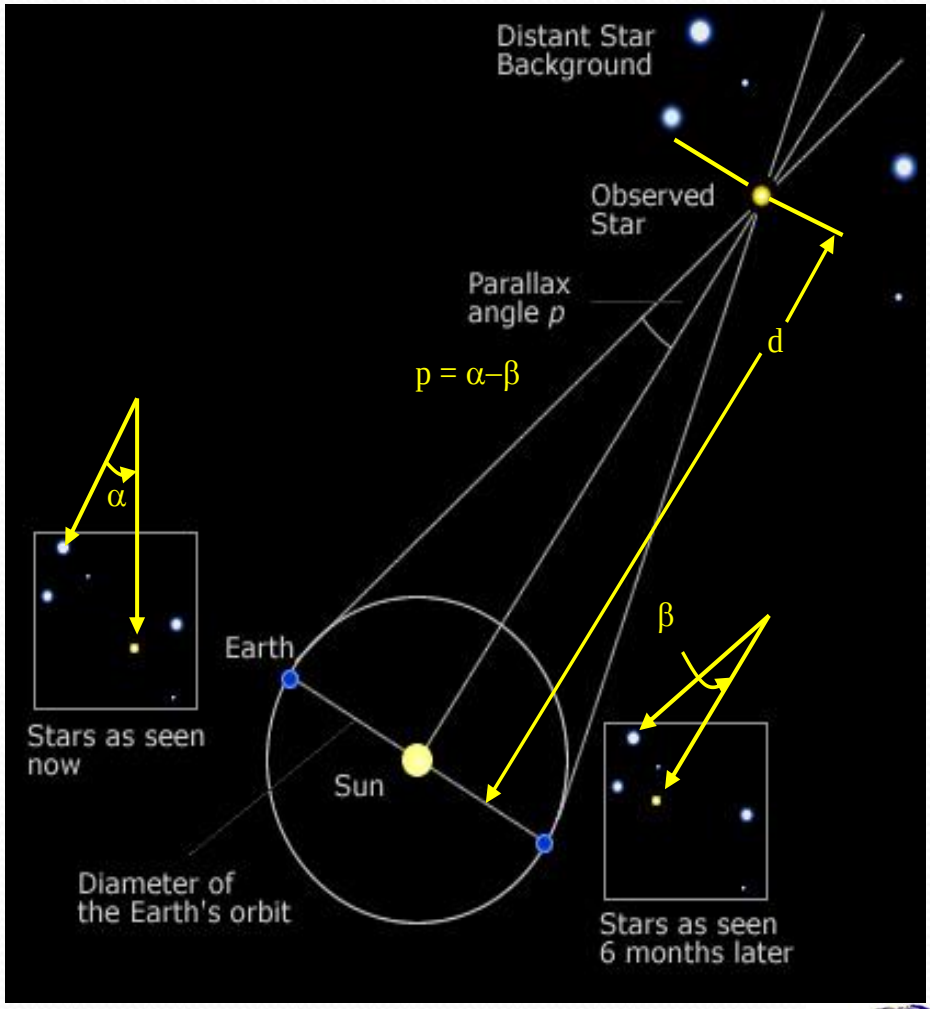
- Stellar parallax provides distance of a star in units of Parsec
- d = 1/p Parsec
- Distance from Doppler shift and Hubble's Law

  Radial velocity V_r

  $V_r = cz$ here z-red shift,

  $z = (\lambda - \lambda_0)/\lambda_0$

  and $d = zc/H$ Parsec



MATRIX

Distances, Radii, & Velocity of Stars

- Inverse Square Law relates luminosity of stars L with distance of star and apparent brightness. We measure b by comparing star light with light from a standard Candle and find d from Hubble's law

  $b = L/(4\pi d^2)$. L is found from H-R diagram or Inverse Square Law.

- Stefan Boltzmann Law relates luminosity L with surface area of star and the fourth power of its surface temperature.

  $L = 4\pi R^2 \sigma T^4$ where σ is Boltzmann constant value 5.67×10^{-8} $Wm^{-2}K^{-4}$

  From known values of L and T for a star we can find radius R

- Small angle distance formula: $D = \alpha d/206{,}265$ km here D is diameter of star, d distance from observer on Earth & α –arc sec angular size

- Tangential Velocity V_t is found by analyzing proper motion of stars

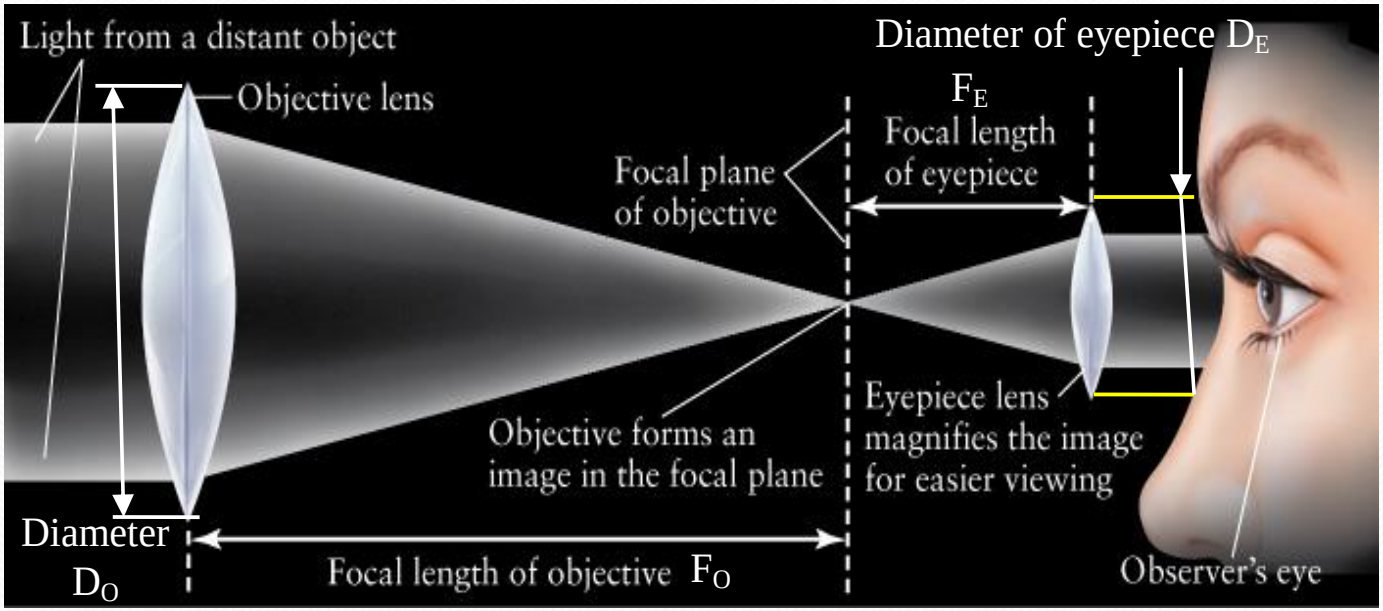
  $V_t = 4.74\ \beta \times d$ where d is distance in km and β is number of a the star appears to move tangentially.

  Space velocity $V = (V_r^2 + V_t^2)^{1/2}$ km

Measures of Telescope Systems

- Magnification or Magnifying Power M
- M = Focal length Objective (F_O)/Focal length of eyepiece (F_E)

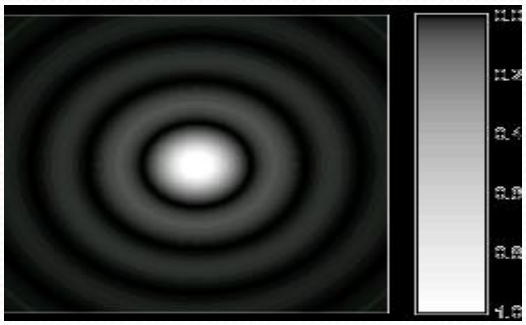
- Light Capture Ratio or Light gathering power (LCR)
- LCR = $(D_O/D_E)^2$ where D_O objective diameter & D_E Eyepiece dia.



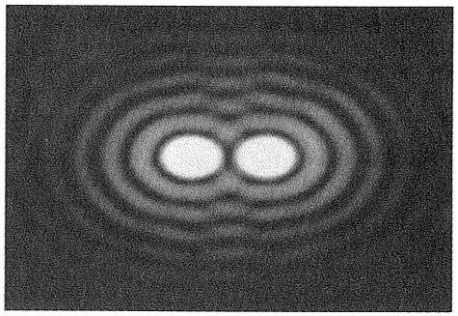
MATRIX

Measures of Telescope Systems

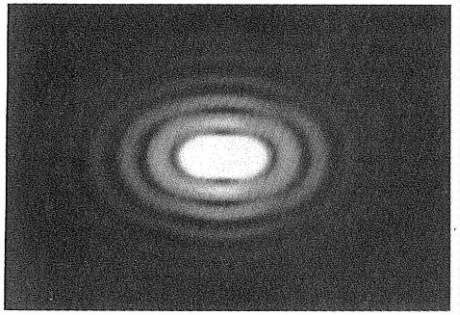
- Angular Resolution (AR): Ability of image forming device to discern objects separated by small angles as individual entities.
- Limited by merging of images caused by diffraction phenomenon due to wave nature of light. Rayleigh criterion establish AR value.



(a)



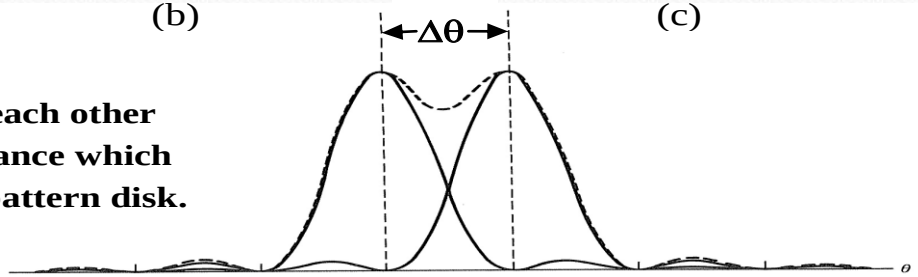
(b)



(c)

Rayleigh's Criterion

Two point sources are resolved from each other when they are apart by at least a distance which corresponds to radius of diffraction pattern disk.



(a) Image, single source (b) distance > AR (c) distance < AR

- AR $\theta = 1.22\lambda/D_O$ radians = 251,643 λ/D_O arcseconds, rad. => arcsec
- Spatial resolution $S = 1.22 (F_O \times \lambda) / D_O$ m

What is next?

- Resolve unanswered questions

1. What imparts gravity effect to real particles & objects with mass?
2. What is dark matter? Where in the Universe it exist?
3. Why force from dark energy moves all galaxies apart?
4. What gives quarks color charge and color force?
5. Are forces from dark energy and color charge in quarks related?
6. Why Quantum entanglement works? Can we read entangled property without destroying its status in entangled particles?
7. Why different flavors of quarks have difference in mass? In what way their interaction with Higgs field effects their masses?
8. Does life exist on other planets in dimensions known to us?
9. Can species other than humans possess intelligence like us yet exist in dimensions not known to us?
10. What lies outside the scope of observed Universe? How does it effect the state and fate of Universe known to us?

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What is Next?

Gravity, Dark Matter & Energy

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A Cosmic Symphony

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