

# Big Bang Theory & Other Recent Sciences 2014

Dr. Mahbub Khan



1. Recent Sciences Big Bang, Dark Matter, Dark Energy, Black Hole, Neutrino, God Particle, Higgs Field, Graviton, Expansion of Universe, and Search for Life elsewhere in the Cosmos. Recent Sciences Big Bang, Dark Matter, Dark Energy, Black Hole, Neutrino, God Particle, Higgs Field, Graviton, Expansion of Universe, and Search for Life elsewhere in the Cosmos. Dr. Mahbub Khan 408-859-3566-cell, mahbubkhan@ieee.org Yaseen Foundation 621 Masonic Way, Belmont, CA 94002 June 6, 2014

2. Knowledge belongs to Allah (swa) • Sūrah Al-Baqarah (2), Verse 255 • ...they encompass nothing of His knowledge except what He will.... • Sūrah Al-Baqarah (2), Verse 255 • ...they encompass nothing of His knowledge except what He will....

3. What is the Big Bang? • According to the big bang theory, the universe began by expanding from an infinitesimal volume with extremely high density and temperature • Why Do We Think the Big Bang Happened? • Universe is expanding (at an accelerated rate)

• Big Bang perfectly explains the abundance of Hydrogen, Deuterium and Helium in the universe. (Nucleosynthesis) • Observation of cosmic background radiation—the afterglow of the explosion—from every direction in the universe. • According to the big bang theory, the universe began by expanding from an infinitesimal volume with extremely high density and temperature • Why Do We Think the Big Bang Happened? • Universe is expanding (at an accelerated rate) • Big Bang perfectly explains the abundance of Hydrogen, Deuterium and Helium in the universe. (Nucleosynthesis) • Observation of cosmic background radiation—the afterglow of the explosion—from every direction in the universe.

4. History of Universe Universe expands and cools down as time passes

5. Olbers's Paradox Why the sky is dark? Universe had a beginning, and we can only see light from galaxies that has had time to travel to us since the beginning of the Universe. Visible Universe is finite !!

6. Expanding Space Analogy: Raisin bread where the dough is rising and expanding, taking the raisins with it.

7. Parsec  $1 \text{ pc} = 3.26 \text{ LY} = 2,206,264 \text{ AU}$  Speed of Light = 186,000 miles per sec,  $1 \text{ LY} =$  Distance travelled by light in one year  $1 \text{ AU} = 93 \text{ million miles}$ ,  $1 \text{ LY} = 5,880 \text{ billion miles}$

8. Galaxies at larger distances are moving away faster from us

9. Hubble's Law and Age of Universe Distant galaxies are receding from us with a speed proportional to distance. Velocity = Hubble Constant x Distance,  $V = H * D$   $T = D / V = 1 / H = 14 \text{ Billion years}$

10. Accelerating Universe Supernova Ia measurements show that the Universe is accelerating

11. Cosmic Background Radiation Blackbody radiation with a temperature of  $T = 2.73 \text{ K}$  R. Wilson & A. Penzias

12. Model Universes  $r < r_c \Rightarrow$  Universe will expand forever Maximum age of the Universe:  $\sim 1/H_0$   $r > r_c \Rightarrow$  Universe will collapse back Maximum age of the Universe:  $\sim 1/H_0$

13. 21st Century Cosmology solution: Inflation!

14. Dark Matter / Dark Energy The combined mass of all "visible" matter (i.e. emitting any kind of radiation) in the Universe adds up to much less than the critical density. Galaxies rotate much faster than needed by apparent matter The combined mass of all "visible" matter (i.e. emitting any kind of radiation) in the Universe adds up to much less than the critical density. Galaxies rotate much faster than needed by apparent matter Gravitational

lensing shows that some clusters contain 10 times as much mass as directly visible. Universe is expanding instead of collapsing with Gravitational force leading to Dark energy

15. Star Formation Gas in ISM needs to be compressed in order to collapse and form stars: shocks traveling through interstellar space can do this

16. Nuclear Binding Energy  $E = mc^2$

17. Deaths of Massive Stars: Supernovae Iron core ultimately collapses, triggering an explosion that destroys the star: Supernovae

18. Supernova Explosions

19. Famous Supernova of 1987: SN 1987A type II Supernova in the Large Magellanic Cloud in Feb. 1987

20. Sun • Average Star, Consists of Gas • Million times bigger than Earth • Central Temp: 15 Million Degrees K • Surface Temp: 5800 K • Studied by Helioseismology • Sun needs 1038 reactions, transforming 5 million tons of mass into energy every second, to resist its own gravity. • Average Star, Consists of Gas • Million times bigger than Earth • Central Temp: 15 Million Degrees K • Surface Temp: 5800 K • Studied by Helioseismology • Sun needs 1038 reactions, transforming 5 million tons of mass into energy every second, to resist its own gravity.

21. Solar Nebula Hypothesis Modern theory of planet formation • Planets form at the same time from the same cloud as the star. • Planet formation sites can be observed today as dust disks of T Tauri stars. • The sun and our solar system formed ~5 billion years ago. • Planets form at the same time from the same cloud as the star. • Planet formation sites can be observed today as dust disks of T Tauri stars. • The sun and our solar system formed ~5 billion years ago.

22. Solar System Modern Theory of Formation of Moon Large-Impact Hypothesis Impact heated material enough to melt it Collision not head-on Large angular momentum of Earth-Moon system Collision after differentiation of Earth's interior Different chemical compositions of Earth and Moon Relative sizes of the Planets Large-Impact Hypothesis Impact heated material enough to melt it Collision not head-on Large angular momentum of Earth-Moon system Collision after differentiation of Earth's interior Different chemical compositions of Earth and Moon

23. Our beloved Planet Earth

24. Sun Sun needs 1038 reactions, transforming 5 million tons of mass into energy every second, to resist its own gravity. Sun needs 1038 reactions, transforming 5 million tons of mass into energy every second, to resist its own gravity.

25. Fate of our Sun and End of Earth • The Sun will expand to a red giant in ~5 billion years. • Sun will expand up to ~ Earth's orbit • Earth will then be burnt to ashes by the Sun before the death of the Sun itself • The Sun may form a planetary nebula (but uncertain). • Sun's C, O core will become a white dwarf. • The Sun will expand to a red giant in ~5 billion years. • Sun will expand up to ~ Earth's orbit • Earth will then be burnt to ashes by the Sun before the death of the Sun itself • The Sun may form a planetary nebula (but uncertain). • Sun's C, O core will become a white dwarf.

26. Structure of Milky Way Sun orbits around galactic center with a speed of 220 km/s. 1 orbit takes the Sun approximately 240 million years Sun orbits around galactic center with a speed of 220 km/s. 1 orbit takes the Sun approximately 240 million years

27. Sun will expand beyond Earth's Orbit Sun will become Giant Star and then White Dwarf

28. Annual Motion of Earth and Sun Zodiac Constellations, Ecliptic, Celestial Sphere Precision period of Earth 26,000 years (North Star Polaris to change)

29. Tidally-Locked Orbit of the Moon Moon orbits Earth in a sidereal period of 27.32 days Moon's synodic period (to reach the same position relative to the Sun) is 29.53 days

30. Neutron Stars • A supernova explosion of a  $M > 8 M_{\text{Sun}}$  star blows away its outer layers. • The central core will collapse into a compact object of ~ a few  $M_{\text{Sun}}$  • Pressure becomes so high that electrons and protons combine to form stable neutrons throughout the object. • Density:  $\rho \sim 10^{14} \text{ g/cm}^3$  • A piece of neutron star matter of the size of a sugar cube has a mass of ~100 million tons!!! • A supernova explosion of a  $M > 8 M_{\text{Sun}}$  star blows away its outer layers. • The central core will collapse into a compact object of ~ a few  $M_{\text{Sun}}$  • Pressure becomes so high that electrons and protons combine to form stable neutrons throughout the object. • Density:  $\rho \sim 10^{14} \text{ g/cm}^3$  • A piece of neutron star matter of the size of a sugar cube has a mass of ~100 million tons!!!

31. Neutron Stars

32. Black Hole • Neutron stars can not exist with masses  $> 3 M_{\text{Sun}}$  • We know of no mechanism to halt the collapse of a compact object with  $> 3 M_{\text{Sun}}$ . • It will collapse into a single point – a singularity: • => A black hole !!! • Neutron stars can not exist with masses  $> 3 M_{\text{Sun}}$  • We know of no mechanism to halt the collapse of a compact object with  $> 3 M_{\text{Sun}}$ . • It will collapse into a single point – a singularity: • => A black hole !!!

33. Black Hole Schwarzschild Radius and Event Horizon • Velocity needed to escape Earth's gravity from the surface:  $v_{\text{esc}} \approx 11.6 \text{ km/s}$  • Event Horizon Escape Velocity =  $c$  (Nothing can escape) • We have no way of finding out what's happening inside the Schwarzschild radius. • Velocity needed to escape Earth's gravity from the surface:  $v_{\text{esc}} \approx 11.6 \text{ km/s}$  • Event Horizon Escape Velocity =  $c$  (Nothing can escape) • We have no way of finding out what's happening inside the Schwarzschild radius.

[34.](#) Measuring the Mass of Black Hole in the Center of Milky Way By following the orbits of individual stars near the center of the Milky Way, the mass of the central black hole can be determined to ~3.7 million solar masses.

[35.](#) General Relativity Effects Near Black Holes Black Holes can not be observed directly An astronaut descending down towards the event horizon of the black hole will be stretched vertically (tidal effects) and squeezed laterally.

[36.](#) Graviton • Graviton is a hypothetical elementary particle that mediates the force of gravitation, which is always attractive. • In General Relativity, Gravitation plays a special role, where matter modifies the 'shape' of Spacetime itself. • Quantization of gravity can be linked to the polarization of the Cosmic Microwave Background (CMB). That would provide a link between it and gravitational waves caused by inflation in the early universe. • Researchers working at the • South Pole Telescope (SPT) • have detected tiny fluctuations • known as B-mode polarization • in cosmic background radiation. • This reinforces the Big Bang • theory and the Inflation stages • Graviton is a hypothetical elementary particle that mediates the force of gravitation, which is always attractive. • In General Relativity, Gravitation plays a special role, where matter modifies the 'shape' of Spacetime itself. • Quantization of gravity can be linked to the polarization of the Cosmic Microwave Background (CMB). That would provide a link between it and gravitational waves caused by inflation in the early universe. • Researchers working at the • South Pole Telescope (SPT) • have detected tiny fluctuations • known as B-mode polarization • in cosmic background radiation. • This reinforces the Big Bang • theory and the Inflation stages

[37.](#) Higgs Particle or God Particle or Higgs Boson Higgs boson events from collision between protons in the LHC. The top event in the CMS experiment shows a decay into two photons (dashed yellow lines and green towers). The lower event in the ATLAS experiment shows a decay into four muons (red tracks) Nobel Prize Laureate Peter Higgs in Stockholm, December 2013 Higgs boson or Higgs particle is an elementary particle initially theorized in 1964 whose discovery was announced at CERN on 4 July 2012, and confirmed likely to be a Higgs boson in March 2013. The discovery has been called "monumental" because it appears to confirm the existence of the Higgs field, which is pivotal to the Standard Model and other theories within particle physics. It would explain why some fundamental particles have mass when the symmetries controlling their interactions should require them to be massless, and why the weak force has a much shorter range than the electromagnetic force. Higgs boson events from collision between protons in the LHC. The top event in the CMS experiment shows a decay into two photons (dashed yellow lines and green towers). The lower event in the ATLAS experiment shows a decay into four muons (red tracks)

[38.](#) Higgs field • The Higgs Field is an invisible energy field that exists everywhere in the universe. The field is accompanied by what may be a Fundamental Particle called the Higgs Boson which it uses to continuously interact with other particles. As particles pass through the field they are endowed with the property of mass, much as an object passing through Molasses will become slower. • Mass is transferred to particles from the field, which

contains the relative mass in the form of energy. Once the field has endowed a formerly massless particle the particles down because it has become heavier. • If the Higgs field did not exist, particles would not have the mass required to attract one another, and would simply float around freely at light-speed. • The Higgs Field is an invisible energy field that exists everywhere in the universe. The field is accompanied by what may be a Fundamental Particel called the Higgs Boson which it uses to continuously interact with other particles. As particles pass through the field they are endowed with the property of mass, much as an object passing through Molasses will become slower. • Mass is transferred to particles from the field, which contains the relative mass in the form of energy. Once the field has endowed a formerly massless particle the particles down because it has become heavier. • If the Higgs field did not exist, particles would not have the mass required to attract one another, and would simply float around freely at light-speed.

39. Higgs Effect • The process of giving a particle mass is known as the Higgs Effect. • Higgs Effect was first theorized in 1964 by Peter Higgs and its existence has been proven at the CERN particle accelerator in Geneva on July 4, 2012. This effect was seen as a missing piece of the Standard Model. • The Higgs effect occurs because nature wants to be at its lowest energy state. • Scientists assumed that vacuums (empty space) atually had energy, and that way, if a particle that we think of as massless were to enter it, the energy from the vacuum would be transferred into that particle, giving it mass. • The process of giving a particle mass is known as the Higgs Effect. • Higgs Effect was first theorized in 1964 by Peter Higgs and its existence has been proven at the CERN particle accelerator in Geneva on July 4, 2012. This effect was seen as a missing piece of the Standard Model. • The Higgs effect occurs because nature wants to be at its lowest energy state. • Scientists assumed that vacuums (empty space) atually had energy, and that way, if a particle that we think of as massless were to enter it, the energy from the vacuum would be transferred into that particle, giving it mass.

40. Neutrino Neutrino is an elementary particle which holds no electrical charge, travels at nearly the speed of light, has half-spin and passes through ordinary matter with virtually no interaction.  $n_0 \rightarrow p^+ + e^- + \nu_e$  Special Relativity Time dilation:  $T = T_0 / \text{SqRt} ( 1 - v^2 / c^2 )$  Space Contraction:  $L = L_0 \text{SqRt} ( 1 - v^2 / c^2 )$  Mass-Energy conversion:  $E = mc^2$  Neutrino is an elementary particle which holds no electrical charge, travels at nearly the speed of light, has half-spin and passes through ordinary matter with virtually no interaction.  $n_0 \rightarrow p^+ + e^- + \nu_e$  Special Relativity Time dilation:  $T = T_0 / \text{SqRt} ( 1 - v^2 / c^2 )$  Space Contraction:  $L = L_0 \text{SqRt} ( 1 - v^2 / c^2 )$  Mass-Energy conversion:  $E = mc^2$

41. Physical Basis of Life • All life forms on Earth, from viruses to complex mammals (including humans) are based on carbon chemistry. • Carbon-based DNA and RNA molecule strands are the basic carriers of genetic information in all life forms on Earth. • Basic building blocks are four amino acids: • ACGT // Adenine, Cytosine, Guanine, and Thymine • are integrated into DNA. • All life forms on Earth, from viruses to complex mammals (including humans) are based on carbon chemistry. • Carbon-based DNA and RNA molecule strands are the basic carriers of genetic information in all life forms on Earth. • Basic

building blocks are four amino acids: • ACGT // Adenine, Cytosine, Guanine, and Thymine • are integrated into DNA.

[42.](#) Origin of Life on Earth - Miller Experiment The experiment produced some of the fundamental building blocks of life: amino acids, fatty acids, and urea.

[43.](#) Extraterrestrial Origin of Life on Earth? • Some meteorites do show traces of amino acids. • Theory of the extraterrestrial origin of life is currently untestable

[44.](#) Earliest Fossils Built up layer by layer from single-celled creatures, similar to bacteria, ~3.5 billion years ago Stromatolites: Earliest fossils known Built up layer by layer from single-celled creatures, similar to bacteria, ~3.5 billion years ago

[45.](#) Origin of Life on Earth ~½ billion years ago, in the Cambrian Period, the diversity and complexity of life on Earth dramatically increased → “Cambrian explosion” Best-known fossils from the Cambrian period: trilobites Best-known fossils from the Cambrian period: trilobites All known fossils from the Cambrian period are from sea creatures No traces of life on land until ~400 million years ago

[46.](#) Geologic Time In geologic terms, higher life forms, in particular mammals and humans, have evolved only very recently. In geologic terms, higher life forms, in particular mammals and humans, have evolved only very recently. • Humans have existed for only ~3 million years. • Last hour of December 31

[47.](#) Life in our Solar System • Most promising candidate: Mars • Mars Rovers Opportunity and Spirit have found evidence for liquid water on Mars in the past, but possible evidence for life remain questionable at best • Other planets or their moons are unlikely to have ever provided suitable conditions for life. • Most promising candidate: Mars • Mars Rovers Opportunity and Spirit have found evidence for liquid water on Mars in the past, but possible evidence for life remain questionable at best • Other planets or their moons are unlikely to have ever provided suitable conditions for life. Simple building blocks necessary for formation of life may have been carried throughout the solar system by meteoroids.

[48.](#) Requirements for Life in Other Planetary Systems • Planetary systems are probably common. • Stable orbit around the star • → consider only single stars • Time for evolution • → consider only F5 or less massive stars • Moderate temperatures • → life zone around the star • Planetary systems are probably common. • Stable orbit around the star • → consider only single stars • Time for evolution • → consider only F5 or less massive stars • Moderate temperatures • → life zone around the star

[49.](#) Arecibo Message At dedication of Arecibo Radio Observatory, blocks of 23x73=1679 pulses were emitted, carrying the basic information about our human society.

50. Search for Extraterrestrial Intelligence (SETI) Programs to listen for intelligent messages from space: SETI

51. Life in Cosmos // Drake Equation Factors to consider when calculating the number of technologically advanced civilizations per galaxy:  $N_c = N^* \cdot f_p \cdot n_{LZ} \cdot f_L \cdot f_I \cdot f_S$  One communicative civilization per galaxy. There are billions of Galaxies.

52. References • Horizons, Exploring the Universe • By Michael Seeds and Dana Backman and additional references there in

53. At-Taqwa • Sūrat I-ḥujurāt (49), Verse 13 .....Verily, the most honourable of you with Allah is that (believer) who has At- Taqwa .....

<https://www.slideshare.net/iqratube/big-bang-theory-in-islam-dr-mahbub-khan>