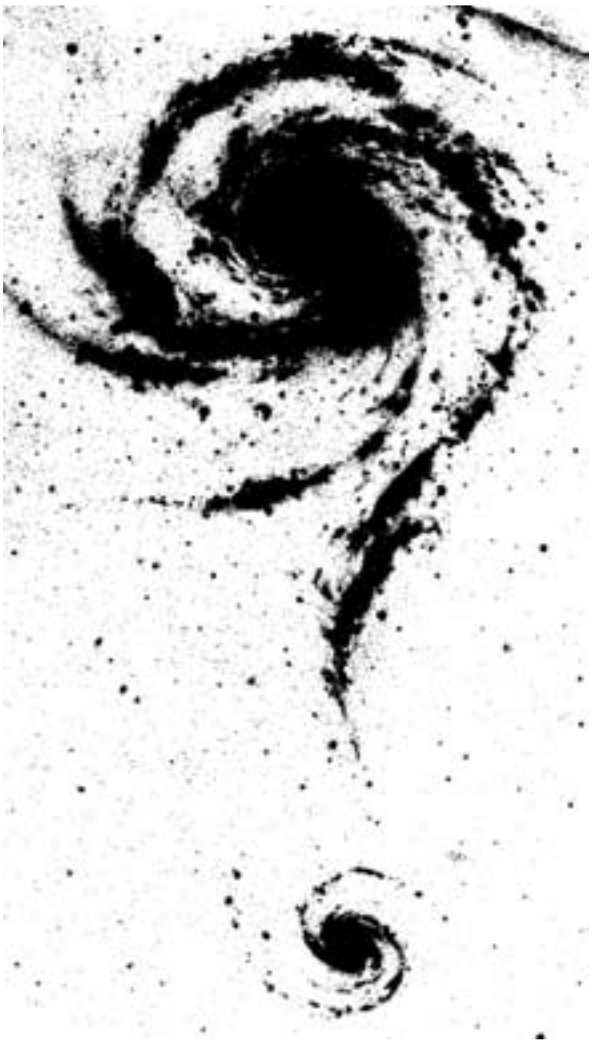
Is God Expanding, Too



(*bara'*, "to create") בדא

"The heavens are telling the glory of God; and the firmament proclaims his handiwork."
Psalm 19:1

A journey on the evolution of our understanding of the universe and of our notion of God.
First United Methodist Church of Arroyo Grande
Leader: Jamie Foster

Is God Expanding, Too?

First United Methodist Church of Arroyo Grande, 275 N. Halcyon. The class will be lead by Jamie Foster.
It will consist of five 2.5-hour sessions (including a meal), Wednesdays 6:00-8:30pm, July 3, 7, 10, 17, 24, and 30, 2002.
Tentative schedule and outline:

This course will explore the interface between science and religion using the issues of creation and the universe as the medium. It will be an exploratory journey for all involved (don't expect "answers"). We'll grapple with what we know, or with what we think we know, regarding the creation of the universe and its fundamental laws (of physics), and with what God has to do with that. And we'll look broadly at how science and religion relate. Participants will go away with some marvelous thoughts, ideas, and questions to ponder.

1. Introduction: how the course will be conducted, review/expand this outline, distribute materials.
   Has our understanding or concept of God been keeping pace with science's understanding of our world?
   How do you describe God today?

2. Getting a grip on the universe via color slides, including an exposure to cosmological issues.
   Some of the WOW! facts of the bigger world in which we live, and the tiny world of which it's made.
   Drawing the universe on 2 sheets of paper.

3. Detailed tracing of the evolution of man's understanding of the origins and structure of the universe
   from Egyptians, Sumerians, Phoenicians, Greeks, Euclid, Copernicus, Galileo, Newton, Einstein...

4. The Big Bang: An overview of theoretical and astro- physics as its relates to our universe from Time=0, or
   What we seem to know about how the world ticks and the laws of nature.

5. Discussion of the evolution of our understanding of God, and how theologians view creation.

6-8. Blending science and religion, particularly regarding cosmological and laws-of-nature issues:
   Does religion take into account what science knows? Should it?
   Does science tell us anything about freedom, evil and suffering, religious intolerance, or predestination?
   What are the "theories" and "data" of religion, and what are the "traditions" and "judgments" of science?
   What role does revelation play, either on the road to Damascus (Paul) or Bowes Moor (Fred Hoyle)?
   Does the universe need a Creator? Does design imply a Designer?
   How do the methodologies of science and of religion compare and contrast?

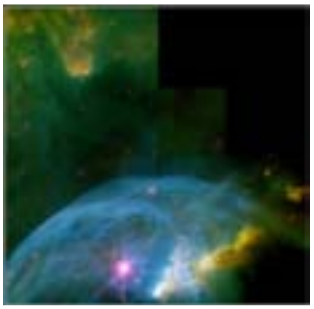
   How can we know something without knowing everything?
   What does it mean to be both observer and participant?
   What does it mean for something to "exist?"
   How do we have faith, but not blind faith?
   Just how rational is the universe?
   How do super colliders research religion?
   Is the universe intelligent or intelligible?
   Can beauty be a guide to truth?
   Does God play dice? Are they loaded?

8. Wrap up.
   How do you describe God now?

Table of Contents

This document was prepared using MS Word 2000 on an IBM PC. Machine-readable copies are available on a CD-ROM in any of the formats that Word will output. The fractals were generated using WinFract v18.21, and are also available. Pi was calculated using PiW v1.31 and is available up to 250,000 digits. No charge; just ask...

The Big Bang



T=0	Creation. Infinite Singularity?
$T=10^{-43}$ second	Planck barrier, before which all calculations break down, can't describe space, time, matter, etc. The universe is at about 10^{32} degrees and the size of an atom. Gravity separates from "parent" force. For all practical purposes, this is the beginning of the Universe. The density of the universe is 10^{96} times that of water. One unit of quantum time.
$T=10^{-35}$ second	Strong nuclear force begins separating out, universe is 10^{-24} centimeters big and 10^{28} degrees Kelvin (K). Baryon synthesis. X bosons are transmuting between quarks and leptons. After this point, X bosons cannot exists as the universe further cools, so they decay into quarks and anti-quarks at different rates. This difference ultimately results in the proton:anti-proton imbalance (1 billion and 1 : 1 billion). The inflationary period begins due to phase changes of particles and consequent release of energy.
$T=10^{-30}$ second	The asymmetric decay of X particles is complete, and the ultimate matter:anti-matter ratio of the universe is fixed.
$T=10^{-32}$ second	Universe is softball size, at 10^{27} degrees Kelvin.
$T=10^{-20}$ second	Hawking's mini blackholes are done; today, 100 million per cubic light year (theoretically).
$T=10^{-18}$ second	The universe is a million billion degrees - staggering, but reproducible (for fractions of a second) in modern accelerators.
$T=10^{-12}$ second	Universe is about 10^{15} degrees (1 trillion degrees).
$T=10^{-10}$ second	Weak force and Electromagnetic force separate as W and Z particles decay. Universe is about the same size as today's solar system.
$T=10^{-7}$ second	Proton creation at 100,000,000,001 protons to 100,000,000,000 anti-protons resulting in today's ratio of 100,000,000,000 photons (created by one proton annihilating one anti-proton) to the one remaining proton.
$T=10^{-5}$ second	Meson creation.
$T=10^{-4}$ second	Quarks form protons and neutrons in a sea of neutrinos, electrons, and photons. Universe is 10^{12} degrees.
$T=10^{-2}$ second	Universe is 200 billion degrees, hundreds of types of particles being created and annihilated.
	Little disagreement among physicists from this point on...

$T=10^{-1}$ second — Neutrino decoupling. Because neutrons are minutely heavier than protons, protons become slightly more abundant as they are easier to make. At 10^{10o}K, the formation of both ceases, locking in their ratios forever. The remaining neutrinos travel the universe to this day, virtually free as they interact with very little (billions are passing through your head right now). The average density of the universe at this point is less than that of water.

T=1-8 minutes — Nuclei form; the universe is a hydrogen to helium fusion reactor that produces a predictable 75:25 hydrogen:helium ratio that exists everywhere in the universe today. The universe's hydrogen (and deuterium at 10^{-3}% and lithium at 10^{-6}%) and helium are fossils of the Big Bang.

$T=3x10^5$ years — Radiation and matter separate. Background microwave radiation is born.

$T=5x10^5$ years — Atoms begin forming. The universe is about 2,000° K.

$T=10^6$ years — Quasars begin to form, universe starts to take on its familiar form of bright spots in a black sky. The microwave background radiation reflects this period of time when photons began flowing freely between the atoms.

$T=10^9$ years — Galaxies form as local areas of reduced expansion rates. Gravity draws the material in, and distant gravitational influences induce modest rotation. Eventually, the rotation speeds up as the galaxy draws in, until it matches the gravitational attraction and stabilizes. Even smaller localities condense to form stars, nucleosynthesis begins, 1st generation stars go supernova, and provide matter for 2nd generation stars with slighter greater amounts of heavier elements. Quasars form.

$T=10^{10}$ years — Planets form in 2nd and 3rd generation star systems that include the heavier elements..

$T=1.2x10^{10}$ years — Microscopic life.

$T=1.5x10^{10}$ years — Today (+/- 5,000,000,000 years)

FUTURE

Years from now. Assuming life does nothing about it...

7×10^9 — Our sun engulfs the earth.
10^{11} — Galaxies evaporate from clusters of galaxies.
10^{12} — Stars cease to form; all massive stars have become either neutron stars or black holes.
10^{14} — Longest-lived stars use their fuel and become white dwarfs.
10^{15} — Dead planets are detached from dead stars via stellar collisions.
10^{17} — White dwarfs cool to black dwarfs at 5° Kelvin. Still expanding, though slowing to zero.
10^{19} — Neutron stars cool to 100° Kelvin. Expansion has stopped, collapse has started.

Timeline from Earth's (our) point of view...

bya = billion years ago
mya = million years ago
ya = years ago

4.6 bya	Earth forms
4.0 bya	Life begins (on Earth)
3.0bya	First multicelled life forms
2.0 bya	Sex is invented
1.0bya	Plants have taken over to the extent that oxygen is being generated in abundance.
600 mya	Cambrian, algae's grip is broken, new forms of life "every day"
500 mya	Trilobites, creatures of all kinds
230 mya	Dinosaurs appear (and last until about 65mya)
150 mya	First mammals appear (awareness, curiosity, seekers)
10mya	Human-like creatures
4mya	Hominids (Australopithecus afarensis, on 2 legs, great ape-size brain, "Lucy")
2mya	Homo habilis ("handy man," larger brain, primitive tools)
1.6mya	Homo erectus (much larger brain, long-term group sites, complicated tools, fire)
500,000ya	Homo sapiens
300,000ya	Only minor modifications remain to make modern man
100,000ya	Man was Man, Neanderthals come and go
35,000ya	Invention and art develop in Europe, awareness, collective conscious, speech Evolution speeds up 100x, Cro Magnons, cave paintings. Outburst of consciously created designs and patterns, innovative. Pendants: evoking powers of Nature Invention: forming, manipulating, sharing images. Language developing
10,000ya	Agriculture
6,000ya	Earliest writings - Sumerian.
3,000ya	Iron Age
few centuries ago	Technology begins developing.

What could happen with another million (10^6) or billion (10^9) years!!!

Creation is divine wisdom realizing itself.
(Isaiah 43:1-13)

The Creation Story (Genesis 1-2:3)

In the beginning God created the heavens and the earth. The earth was without form and void, and darkness was upon the face of the deep; and the Spirit of God was moving over the face of the waters. And God said, "Let there be light;" and there was light. And God saw that the light was good; and God separated the light from the darkness. God called the light Day, and the darkness he called Night. And there was evening and there was morning, one day.

And God said, "Let there be a firmament in the midst of the waters, and let it separate the waters from the waters." And God made the firmament and separated the waters which were under the firmament from the waters which were above the firmament. And it was so. And God called the firmament Heaven. And there was evening and there was morning, a second day.

And God said, "Let the waters under the heavens be gathered together into one place, and let the dry land appear." And it was so. God called the dry land Earth, and the waters that were gathered together he called Seas. And God saw that it was good. And God said, "Let the earth put forth vegetation, plants yielding seed, and fruit trees bearing fruit in which is their seed, each according to its kind, upon the earth." And it was so. The earth brought forth vegetation, plants yielding seed according to their own kinds, and trees bearing fruit in which is their seed, each according to its kind. And God saw that it was good. And there was evening and there was morning, a third day.

And God said, "Let there be lights in the firmament of the heavens to separate the day from the night; and let them be for signs and for seasons and for days and years, and let them be lights in the firmament of the heavens to give light upon the earth." And it was so. And God made the two great lights, the greater light to rule the day, and the lesser light to rule the night; he made the stars also. And God set them in the firmament of the heavens to give light upon the earth, to rule over the day and over the night, and to separate the light from the darkness. And God saw that it was good. And there was evening and there was morning, a fourth day.

And God said, "Let the waters bring forth swarms of living creatures, and let birds fly above the earth across the firmament of the heavens." So God created the great sea monsters and every living creature that moves, with which the waters swarm, according to their kinds, and every winged bird according to its kind. And God saw that it was good. And God blessed them, saying, “Be fruitful and multiply and fill the waters in the seas, and let birds multiply on the earth." And there was evening and there was morning, a fifth day.

And God said, “Let the earth bring forth living creatures according to their kinds: cattle and creeping things and beasts of the earth according to their kinds." And it was so. And God made the beasts of the earth according to their kinds and the cattle according to their kinds, and everything that creeps upon the ground according to its kind. And God saw that it was good. Then God said, "Let us make man in our image, after our likeness; and let them have dominion over the fish of the sea, and over the birds of the air, and over the cattle, and over all the earth, and over every creeping thing that creeps upon the earth." So God created man in his own image, in the image of God he created him, male and female he created them. And God blessed them, and God said to them, "Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth." And God said, "Behold, I have given you every plant yielding seed which is upon the face of all the earth, and every tree with seed in its fruit; you shall have them for food.

And to every beast of the earth, and to every bird of the air, and to everything that creeps on the earth, everything that has the breath of life, I have given every green plant for food." And it was so. And God saw everything that he had made, and behold, it was very good. And there was evening and there was morning, a sixth day.

Thus the heavens and the earth were finished, and all the host of them. And on the seventh day God finished his work which he had done, and he rested on the seventh day from all his work which he had done. So God blessed the seventh day and hallowed it, because on it God rested from all his work which he had done in creation. (Genesis 1-2:3)

In the beginning was the Word, and the Word was with God, and the Word was God. He was in the beginning with God; all things were made through him, and without him was not anything made that was made. In him was life, and the life was the light of men. The light shines in the darkness, and the darkness has not overcome it. (John 1:1-5)

CREATE -D

C. in me a clean heart, O God, and	Ps 51.10
Then the Lord will c. over the	Is 4.05
he did not c. it a chaos, he formed	45.18
of those who c. dissension and	Rom 16.17
that he might c. in himself one new	Eph 2.15
eyes on high and see: who c. these?	Is 40.26
the Lord has c. a new thing on the	Jer 31.22
Has not one God c. us? Why then	Mal 2.10
creation which God c. until now	Mk 13.19
c. in Christ Jesus for good works	Eph 2.10
c. after the likeness of God in	4.24
For everything c. by God is good	1Ti 4.04
the world was c. by the word of	Heb 11.03
who c. heaven and what is in it, the	Rev 10.06

CREATION

But from the beginning of c.,	Mk 10.06
Ever since the c. of the world his	Rom 1.20
For the c. waits with eager longing	8.19
depth, nor anything else in all c.,	8.39
one is in Christ, he is a new c.;	2Co 5.17
nor uncircumcision, but a new c.	Gal 6.15
God the first-born of all c.;	Col 1.15

CREATOR

Remember also your C. in the days	Ecc 12.01
entrust their souls to a faithful C.	1Pe 4.19

בָּרָא, bara'. This Hebrew verb is used in the Old Testament nearly exclusively to denote <u>divine</u> creation. It is used throughout the Creation Story in Genesis 1: 1-2, 4a, 21, 27 (three times), 2:3-4. It denotes an act that cannot be described but simply happens, without further intervention, through God's command. The word is used later in the OT to denote powers or events specifically of God. Israel, for instance, is created with bara', but not the other nations. Bara' is not limited to remote primitive time, but also the imminent future.

Isaiah uses bara' when Yahweh creates a condition where salvation and righteousness thrive.

In Psalms, a worshipper prays that God might create (bara') in him a clean heart, indicating that Man is alone the work of God, the Creator.

Basically, bara' expresses the notion that everything has its origin in the will of the Creator and has been predetermined by Him.

Wow!

"The universe is not only queerer than we imagine, it is queerer than we can imagine." J. B. S. Haldane, British geneticist. Einstein, "The only thing that is incomprehensible about the world is that it is comprehensible."

The known universe weighs about 10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000 tons. That is ten trillion trillion trillion tons (10^{49} tons).

The density of outer space is about one hydrogen atom per cubic inch. This is about $6x10^{23}$ less dense than water.

The number of atomic particles in the universe is about 10^{80} (100 million trillion trillion trillion trillion trillion trillion). Though a large number, it's short of a googol (10^{100}). The lesser number, though, still represents one of the largest numbers that corresponds with something "real" to most people.

The average temperature of the universe is 2.7° Kelvin (-454.54° Fahrenheit).

The radius of the universe is estimated to be about 104 billion trillion (10^{23}) miles. The radius of the Local Group of galaxies, which includes our own Milky Way galaxy and about 200 billion stars, is about 15 million trillion (1.5×10^{17}) miles.

How many stars are there in the entire universe? This is not known, but an estimate can be made as follows. There are about 100 billion stars in the average galaxy. There are estimated to be about 1 trillion galaxies. This suggests that there are about 100 billion trillion (10^{23}) stars in the universe.

Part of the problem of counting stars is that stars are coming and going all the time. The estimates run as high as 600,000 new stars being born every second, or about 20 trillion per year. Of course, about that many "go out" (either quietly or as novae) each year, too.

The Virgo cluster of galaxies is moving away from us at 2.7 million miles per hour; the Hercules cluster at 24.1 million miles per hour; the Hydra cluster at 136 million miles per hour; and the most distant galaxies and quasars at 540 million miles per hour (which approaches the speed of light at 670 million miles per hour).

There are voids between galaxies of as much as 330 million light years. If you were to find yourself in the middle of such a void, your "sky" would appear totally black as there would be no stars close enough to see with the unaided eye.

The universe has no center and no edge.

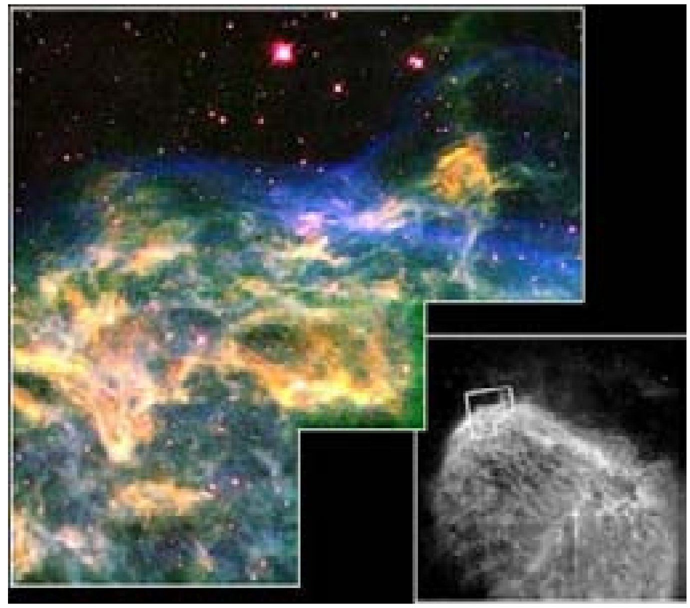
There is no way to know what is happening now in the universe; data arriving at our location is limited by the speed of light and other electromagnetic forces. In a very real sense, astronomers are cosmic archaeologists.

The nearest star, Alpha Centauri, is about 4.3 light years distance.

One percent of the hiss and crackle you see on an untuned TV (the static) is from the background microwave radiation, remnant of the Big Bang. On April 23, 1992 the American Physical Society announced that ripples had been found in this radiation.

A lump of sugar contains as many atoms as there are stars in the observable universe.

Definitions



Anthropic Principle: Things are as they are because we are. Our universe with its particular parameters and laws is highly unlikely. If any one force was slightly stronger or weaker relatively, things would not have worked. And out of it came intelligence that can (nearly) understand it. If it were any other way, who would be around to ask?

Axial Age: 800-200B.C., a time of transition during which the major religions emerged in the civilized world.

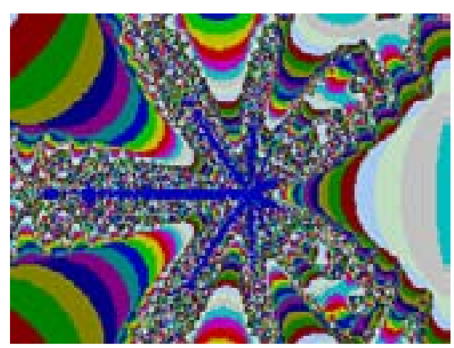
Bekenstein Bound: a calculation of the number of bits of quantum information in a given space with a given amount of energy (=mass), and the rate of change. A human being (assuming 100 kilograms and under 2 meters) has 2.57686 x 10^{45} bits of quantum information which changes at the rate of 3.86262 x 10^{53} states per second. This calculates to $10^{1,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000}$ (the exponent of that number is 10^{45}) possible combinations of the individual quantum states. These are enormous numbers, quite incomprehensible, but still finite. This calculation places an upper and finite limit on just how complex a human being can be.

Big Bang: The beginning of time, space, matter, and energy from a singularity. Generally, this model only implies an expanding universe in which the past was hotter and denser than the present. Beyond that, the details are being discussed. It is also referred to as the Hot Big Bang.

Big Crunch: If the universe is closed (see dark matter), it will eventually collapse upon itself, reversing the process back into a singularity. Whether it reaches a singularity in this process is debatable.

Black Holes: "rips" in the fabric of space and time so dense and distorted by gravitational forces that not even light can escape. They are (theoretically) the final phase of matter before reaching the stage called a singularity. Black holes are created by collapsing stars (and, if Hawking is right, by very early moments in the birth of the universe). See Hawking radiation.

Bubble Theory: Version of the Big Bang that has bubbles forming at 10^{-35} seconds into time, each of which ultimately becomes its own universe. At 10^{-32} seconds, the inflationary period ends and typical Big Bang scenarios take over. This solves the observational problem of uniform radiation as it gives matter time to mix evenly in those early moments. This inflationary period also provides for enough time for matter to disperse sufficiently such that the universe doesn't collapse back in on itself too soon, and creates a flat universe.



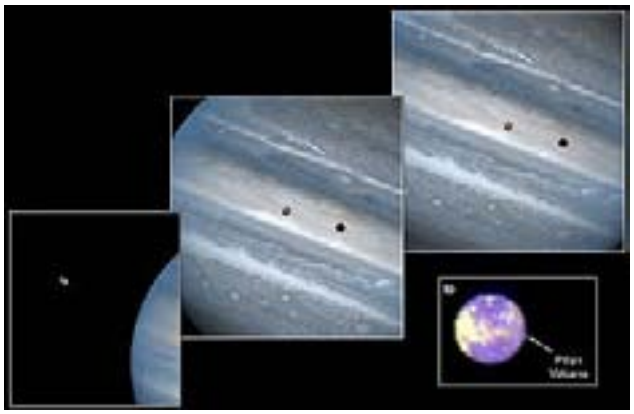
Chaos Theory: The synthesis of creative mathematics and modern computer power that delves into the disorder, complexity, and unpredictability of the universe. Key elements are initial

conditions and feedback. One characteristic is that chaotic systems reveal self-similar, aesthetically pleasing patterns at any level. This was expressed by Benoit in coining the term fractal.

Compressibility (algorithmically): The degree to which a set of data can be expressed in a more precise, or shorter, formula. Random numbers are not compressible at all in that their is no more efficient way to express them than to list them. On the other hand, the list of all positive even integers is highly compressible into the formula $X_0=0$, $X_n=X_{n-1}+2$. Without compressibility, science would be mere fact collecting. The brain is the most efficient compressor known, processing images, sounds, etc.

Cosmic Ray: "incoming" proton or nucleus.

Cosmos: literally translates to "order" and "beauty" (as in "cosmetic").



Dark matter: (sometimes called exotic matter, though it amounts to 99% of the mass of the universe). Unknown form of matter that drew in known elements to form the first stars and galaxies and clusters. The exact amount of this matter will determine if the universe is closed (enough to slow the expansion, stop it, and cause it all to fall back in on itself), or open (not enough, in which case the expansion will not stop).

Deduction: Process of logical reasoning that begins with "known" axioms and derives more meaningful or helpful statements. The deductions are only as good as the axioms. See Euclidean geometry.

Deism: Belief in a divine being who sets off the universe and then sits back and watches. Also called the religion of reason; no time for mysticism or mythology.

Determinism: The notion that all events are determined by prior events.

Dogma: a body of opinion, categorically and authoritatively stated.

Electro-weak theory: Unification of the electromagnetic force and the weak nuclear force, as put forth by Weinberg and Salam in 1967. Predicted existence of W and Z bosons.

Electromagnetic force (EMF): responsible for light and behavior of charged particles, keeps electrons about nucleus; second strongest. Since first of the four forces to be studied, it was arbitrarily set at 1.

Elementary particles: The neutron, proton, and electron are not fundamental particles. They, in turn, are made up of more fundamental (elementary) particles. More than thirty are known, and there relationships are by and large not well understood. These include, for example, the baryons (lamda, sigma...), mesons (pions, K-mesons...), and leptons (muons). Many of these come in various charges (positive, negative, neutral). Most, if not all, have their anti- counterpart.

Emanation: a process whereby reality emerges in gradations, flowing from a single, primal source.

Entropy: the measure of disorder in a system which is constantly increasing as a result of the 2nd law of thermodynamics.

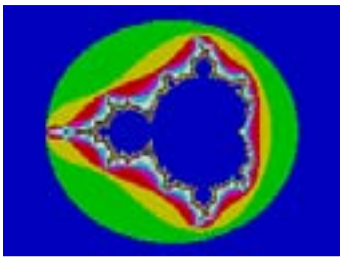
Epiphany: the appearance of a god or goddess on earth in human form.

Euclidean geometry: System of geometry entirely deduced from five axioms proposed by Euclid (Greek, 3rd Century B.C.). One axiom is "through every two points is a unique straight line." One deduction from Euclid's axioms is Pythagoras' theorem: the sum of the squares of the legs of a triangle equals the square of the hypotenuse ($a^2 + b^2 = c^2$).

Event Horizon: the spherical boundary about a black hole where the escape velocity exceeds the speed of light, i.e. the point of no return. The more massive the black hole, the greater surface of this horizon. An event horizon cannot decrease, but it can increase.

Exclusion Principle: No two electrons can occupy the same energy space at the same time. This limits how tightly matter can be packed. It can be overpowered by gravity, however, if enough mass is present (1.4 or more solar masses).

FLOPS: floating point operations per second (a unit of computer processing speed).



Fractal: beautifully rich and diverse pattern created by repeated application of relatively simple functions using complex numbers that are fed back into the repetitions (iterations). The most famous is probably the Mandelbrot set named after an IBM computer scientist, Benoit Mandelbrot. The formula is $Z_n = Z_{n-1}^2 + c$. Is the picture at the bottom of the page something big (star birth) or small (atom)?

General Relativity: Gravity is not a force, but rather a consequence of curved space and time. Finally, mercury's orbit was explained, and the bending of light from a distant star as it swung by the sun (in total eclipse) was observed as empirical proof on May 29, 1919.

Gluon: see Vector Bosons.

Gödel's Theorem: It is impossible from within a system of axioms ever to prove that the axioms are consistent. Specifically, mathematical statements exist for which no systematic procedures could determine whether they are true or false. The proof of this centers around the concepts of self-reference and paradox, such as when you consider the veracity of statements such as "this statement is a lie."

Godhead: the inaccessible hidden source of the reality we know as "God."

Grand unified theory (GUT): the ultimate simplicity, the one entity from which came gravity, strong nuclear, weak nuclear, electromagnetic forces, and matter. This is a goal of theoretical physics. Some say neither grand nor unified; at best a model. Gravity is the most difficult to account for.

Graviton: see Vector Bosons.

Gravitation, Theory of: Attraction between masses, holds universe together. Varies indirectly with the square of the distance. Difficult to overestimate this contribution to physics and astronomy. Explains many astronomical observations (particularly orbits), predicted an unknown planet, binary stars, and explains tides. $F = Gm_1m_2/r^2$. We know the rule, but we don't know what makes it go. There is not yet a satisfying quantum theory of gravitation; at nuclear scales, gravitation is so relatively weak as to be inconsequential. The gravitational constant is $G = 6.672 \times 10^{-8}$ cm^3 gm^{-1} sec^{-2}. Gravity = 10^{-38} the EMF.

Hawking radiation: emissions from black holes, leading to loss of energy and eventual explosion. It comes about as a result of the quantumization of gravity at the Event Horizon - one particle goes in leaving a companion particle free to leave. The leaving particles are this radiation, estimated at 6,000 megawatts surrounding a black hole but 10^{-13} centimeters in size. Not all will explode as they are so big it would take "forever."

Higg's Boson: Theoretical particle that embodies or provides mass.

Holy Spirit: term used by rabbis to denote God's presence on earth, as distinguished from the utterly transcendent divinity which we cannot know. In Christianity, it would become the third "person" of the Trinity.

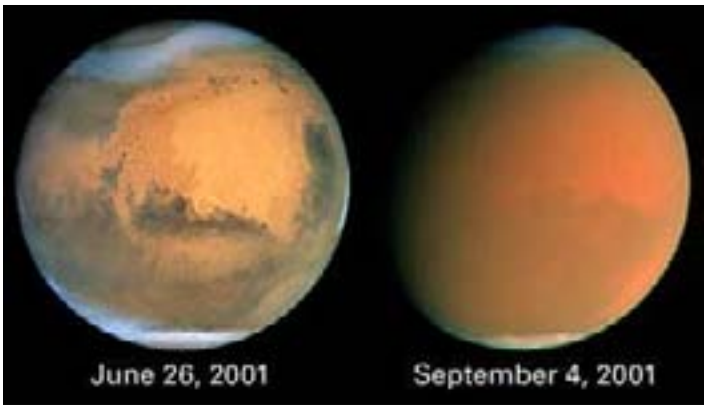
Hubble's Law: the velocity of recession of a galaxy is proportional to its distance from us. In other words, the universe is expanding. The term "velocity" is somewhat misleading in that these bodies are not moving through space, but rather are being carried along by the expansion of space itself.

Idolatry: worship or veneration of a human or man-made reality instead of the transcendent God.

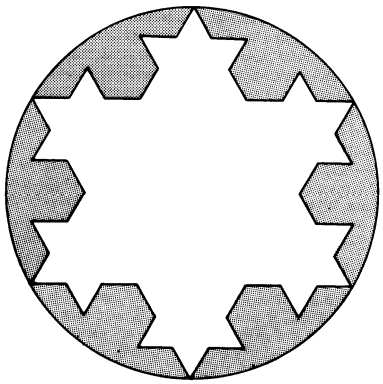
Immanent: Existing or remaining within; inherent.

Incarnation: the embodiment of God in human form.

Induction: Statement of belief arrived at from observed facts by generalization rather than sequential argument. For example, the dawn has followed dusk with every observation, therefore the sun will rise tomorrow. Such statements are considered inferior to deduced statements. Reflects the notion that we can "depend" on Nature.



Infinity: A tricky notion. There are infinities and there are infinities. For example, there are an infinite number of whole numbers (1, 2, 3...), but there is also an infinite number of fractional numbers between just one pair of whole numbers! There is also the idea of finite but unbounded. The surface of a sphere is finite, yet has no edge or center. By adding a triangle to each leg of the previous generation of triangles in the illustration at right, the perimeter of the white center grows to infinity without ever breaking through the boundary of the outside circle - infinite but bounded.



Inflation: A component of the Big Bang theory that says that during the first fraction of a second, a tiny seed containing all the mass and energy in the observable universe was blown up from a size smaller than a proton to about that of a basketball. This smoothed out most irregularities leading to a very isotropic (as observed) universe, and also explains why the universe today seems so close to the line between infinite expansion or ultimate deceleration and collapse. The energy for this inflation is theorized to be the release of latent energy in particles as they changed from one state to another (as when ice melts) beginning after the first 10^{-35} second.

Light year: Distance light travels in one year, or about 6 trillion miles.

Metaphysics: The branch of philosophy that examines the nature of reality, including the relationship between mind and matter, substance and attribute, fact and value. 2. (used with a pl. verb). The theoretical or first principles of a particular discipline. 3. (used with a sing. verb). A priori speculation upon questions that are unanswerable to scientific observation, analysis, or experiment. 4. (used with a sing. verb). Excessively subtle or recondite reasoning.

Neutron star: A collapsing star that has overcome the exclusion principle. This is the final stage for a star under 3.6 solar masses. Over that mass, it collapses further to become a black hole.

Newton's 1st Law: Inertia. Everything at rest tends to stay at rest, and every thing in motion tends to stay in motion.

Newton's 2nd Law: Force times mass equals acceleration.

Newton's 3rd Law: Every action has an equal and opposite reaction. This and the 2nd law lead to the application of the rocket equation, dV = Isp * g * ln(Mo/Mf).

Newtonian Gravity: F(orce) = g (constant) x m_1 (mass 1) x m_2 (mass 2) / d^2 (distance)

Non-Euclidean geometry: A system of geometry using a different set of axioms. Euclid's fifth axiom is dropped (through every point it is possible to draw a line parallel to another line). Actually, given curved space, this 5th axiom doesn't hold.

Nothing. Physicists use this word in at least 4 different ways; be careful with context. 1. Lack of matter; 2. Lack of matter and energy; 3. Lack of matter, energy, and the four-dimensional space-time manifold; and 4. Lack of any entity, being, existence, or dimensionality whatsoever.

Numinous: the sense of the sacred, of transcendence which inspires awe, wonder, and terror.

Observer Principle: An extension of relativity that suggests that without an observer, there can be no particles. Without life, the universe would have failed (as perhaps many other bubbles have).

Olbers' Paradox: If the universe were infinite, then there should be no black spots in the night sky. The universe is not infinite in this sense, plus the fact that light sources are rushing away from us down-shifts their energies, adding less light for the night sky.

Omega Point Theory: a testable physical theory for an omnipresent, omniscient, omnipotent God who will one day in the far future resurrect every single one of us to live forever in what is essentially heaven.

Order: The opposite of random, related to entropy. The concept of order depends, however, on whether gravity plays a role or not. Where gravity is negligible (molecules of air in a box), disorder is featureless. Where gravity is significant (a system of stars), disorder takes on structures.

Panentheism: Creation is part of God, but not all of God.

Pantheism: Belief in the divine being and nature as all wrapped up in one entity; everything is God and God is everything.

Paradox: A seemingly contradictory statement that may nonetheless be true. 2. One exhibiting inexplicable or contradictory aspects. 3. An assertion that is essentially self-contradictory, though based on a valid deduction from acceptable premises. An example: What happens when a cat is dropped that has buttered toast (butter side up) attached to its back?

Parsec: one parsec equals 3.26 light-years. There are also kiloparsecs (thousand) and megaparsecs (million).

Particle physics: The study of the fundamental parts of matter and the forces that hold them together or break them apart. See the "Table of the Particles." This includes the particles that make up the familiar parts of the atom (proton, electron, neutron): quarks, muons, photons, bosons, etc.

Photons: The particle of which light is made. A flashlight bulb emits about 10^{20} photons per second (and that's only about 10% of the energy given off, the remainder being heat).

Planck barrier: A point in the age of the universe at about 10^{-43} seconds where all current calculations and theories break down. We don't know much of anything from T=0 to the Planck barrier. Planck's time is calculated by merging three constants: gravitational, uncertainty, and the speed of light:
G = 6.672 x 10^{-8} cm^3 gm^{-1} sec^{-2} (gravitational constant)

$h = 6.625 \times 10^{-27}$ gm cm^2 sec^{-1} (uncertainty constant, meaningful at atomic level, insignificant to a BB)
$c = 3.0 \times 10^{10}$ cm sec^{-1} (speed of light)
$t_p = SqRt(Gh/c^5) = 1.33 \times 10^{-43}$ sec (Planck's time)
Light crosses an atomic nuclei in 10^{-24} seconds; Planck's time is incomprehensibly less. A human life span would be communicated to other beings by telling them to relate their three constants, come up with a Planck time unit, and then stating that our average lifetime is 70 years, or 1.66×10^{52} Planck units.

Prophet: one who speaks on God's behalf.

Proton: see Vector Bosons.

Pulsars: Rapidly rotating neutron stars that emit rapidly pulsing cosmic radio signals.

Quantum Mechanics: system that describes sub-atomic particle interaction based on Heisenberg's uncertainty principle. Focuses on probability and statistics, not absolutes. Newtonian rules do not apply. It is not possible to know both momentum and position of a particle, nor is it possible to predict exactly what will happen in a certain circumstance. There is no clear distinction between a wave and a particle for any of the elementary particles. Quantum behavior at the atomic scale is unlike any phenomenon with which you have experience or can conjure up an image (wave action, clouds, billiard balls, pendulums, springs, particles, etc.). In the classical bullets, water waves, electrons, 2-hole experiment - electrons arrive in lumps (like bullets, click - click), but the probability of arrival is an interference pattern (like water waves). Electrons behave both as particles and as waves.

Quarks: constituent of matter (along with leptons), three of which make up each proton and neutron. An up quark "u" is +2/3, and a down "d" is -1/3 (where -1 is an electron's charge). A neutron is one up and two downs (+2/3 -1/3 -1/3 = 0), and a proton is two ups and one down (+2/3 +2/3 -1/3 = +1).

Quasar: A word coined in 1964 by shortening quasi-stellar, refers to very distant (very old), very powerful energy sources that are some of the largest entities in the universe. Quasar 3C 345 is almost 78 million light years across. What we see of these today is what they were doing when the universe was only 2 billion years old. Probably a black hole attracting all kinds of fiery galactic debris (stars).

Sentient: Having sense perception; conscious; experiencing sensation or feeling.

Scientific Method: The process of experimentation, observation, hypothesis, and falsification.

Second law of thermodynamics: states that any change in the universe will lead to an increase in entropy (disorder). With the change in form of energy, some energy is lost. This is the law that prohibits the development of a perpetual motion machine.

Singularity: Infinitely dense point of time, space, and matter. In the beginning was a singularity.

Special Relativity: Light travels at a constant speed regardless of the motion of its source, making light different from any other traveling object whose speeds are relative. An observer can only measure relative speeds. This lead (rather simply) to the notion that mass and energy are equivalent and interchangeable according to the equation E (energy) = m (mass) times c^2 (the speed of light squared).

Steady State Theory: A 1948 model of the universe that called for the continuous creation of new matter to exactly balance the dilution caused by expansion of the universe such that it remained the same forever. The rate of creation is actually quite small to make this work, about one atom per cubic meter every ten billion years; which doubles the mass every 10 billion years. Its fate was sealed when the background radiation was discovered in 1965.

Strong nuclear force: binds protons and neutrons into nuclei, trillions times more powerful than gravity. Strong force: strongest of all four forces, holding quarks together and atoms together. Strong = 1000x EMF.

Teleology: the idea of a physical system seeking out, being directed toward, or being drawn to an ultimate goal.

Theism: Belief in a divine creator who stays involved in the ongoing processes, especially those related to human beings.

Theology: critical reflection on the life and thought of a religious community. 1. The study of the nature of God and religious truth; rational inquiry into religious questions. 2. A system or school of opinions concerning God and religious questions. 3. A course of specialized religious study usually at a college or seminary.) The context of theology is the worshipping community.

Uncertainty Principle (Heisenberg's): states that pairs of quantities such as position and momentum of a particle cannot be measured simultaneously. This leads to the "smeared out" electron, and not the electron that can be pinpointed in space and time. There is uncertainty and randomness making prediction impossible. Certainties are eliminated, but probabilities can still be calculated. The "margin of error" is expressed as $\Delta x \times \Delta p >= h/4\pi$, where Δx is the change in the particle's position, Δp is the change in the particle's momentum, and $h = 6.625 \times 10^{-27}$ gm cm^2 sec^{-1}. This is so small a number that uncertainty is significant only below the atomic level, not to everyday things. It is interesting that pi (π) plays a role here. See Bekenstein Bound.

Unification: Bringing two or more previously unrelated phenomena or data together by means of a more fundamental underlying principle. Rainbows, blue skies, and sunsets are unified by the principle of light scattering by objects in the atmosphere. Newton unified the motions of the planets with motions on Earth by his laws. Maxwell unified electricity and magnetism in the 1860s, and got a bonus in that his theory also turned out to explain light and optics. Evolution unifies today's living world with ancient living worlds.

Universe: everything that exists.

Vector bosons: Particles that transmit forces among particles. They may be pictured as medicine balls being passed from boat to boat, carrying some energy each time, and self-annihilating after one pass. The gluon is a vector boson that passes the strong nuclear force; and the proton is a massless particle, a vector boson, that passes electromagnetism. Two known as W's and one a Z transmit the force responsible for radioactive decay. The graviton is the boson theorized for the transmission of the gravitational force. Named after their discoverer, Bose. See the "Table of the Particles."

W: see Vector Bosons.

Weak nuclear force: radioactive decay, second weakest of the four. The weak force = 10^{-10} of the EMF.

White dwarf: A collapsing star that has yet to overcome a critical mass. Stars under 1.4 solar masses stay at this state "forever." Those of greater mass go on to be a neutron star.

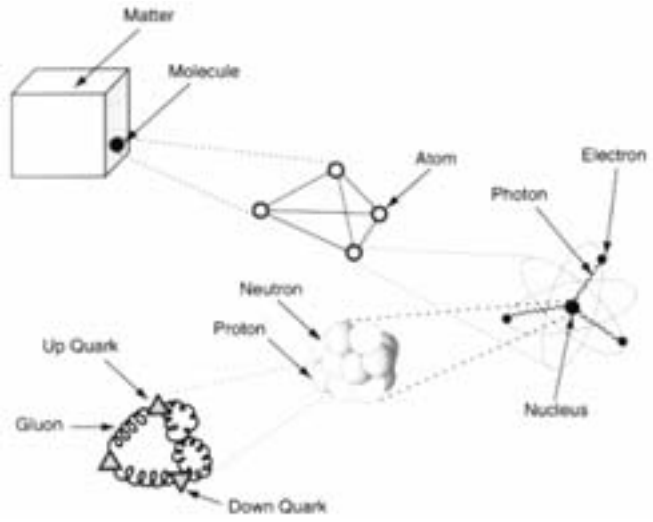
Yahweh: the name of God in Israel. Yahweh may have originally been the god of another people, adopted by Moses for the Israelites. By the 2nd century BC, Jews no longer pronounced the holy name, which is written YHWH.

Z: see Vector Bosons.

Table of the Particles

	Name	Mass(es)*	------- Forces** ------- Feels	Mediates		----- Charge ---- Electric	Color	Spin	Group	Group	
e□ ❍□ ♦	charged leptons (electron, muon tau)	1/1836; 1/9; 1.9	EMW	-			-1	no	1/2	leptons	fermions
◆$_e$□ ◆$_❍$□ ◆$_♦$	neutrinos	<1/30	$<10^{-8}$; <1/3500;	W		-		0	no	1/2	leptons fermions
u, c, t	up, charm, top quarks	1/235; 1.6; 165	EM W,S	-		+2/3	yes	1/2	quarks	fermions	
d, s, b	down, strange, bottom quarks	1/135; 1/6; 5.2	EM, W,S	-		-1/3	yes	1/2	quarks	fermions	
♈	photon	0	none	EM (binds electrons and nuclei into atoms)		0	no	1	gauge boson		
$W^{+/-}$	weak boson	85	W, EM	W		+/-1	no	1	gauge boson		
Z	weak boson	97	W	W		0	no	1	gauge boson		
g	gluon	0	S	S (binds quarks into hadrons***)		0	yes	1	gauge boson		
h	Higg's boson	not known (65-160?)	W	generates mass		0	no	0	boson		

*Expressed in units of one proton mass.
**EM=electromagnetic, W=weak, S=strong, gravity is ignored due to relative weakness.
***hadrons: baryons: proton, neutron, and others made of the three quarks
mesons: pions, kaons, others made of a quark and an anti-quark



Below are the first 11,422 digits of Pi which we calculated to just over 250,000 decimal digits. Pi is the mathematical ratio of the diameter of a circle to its circumference (pi x diameter = circumference). It took our 33MHz 486DX2 PC almost 13 hours to compute all 250,000 digits using an iterative algorithm developed by Borwein and Borwein (*Scientific American*, February, 1988), and programmed by Harry Smith in 1994 (PiW v1.31). x_n converges on 1/Pi using the following formula: Let: $y_0 = SqRt(2) - 1$, $x_0 = 6 - 4 * SqRt(2)$;
$y_n = (1 - SqRt(SqRt(1 - y_{n-1}^4))) / (1 + SqRt(SqRt(1 - y_{n-1}^4)))$; $x_n = ((1 + y_n)^4 * x_n) - 2^{(2n+1)} * y_n * (1 + y_n + y_n^2)$

"And he made a molten sea, ten cubits from the one brim to the other; it was round all about, and his height was five cubits; and a line of thirty cubits did compass it about." (I Kings 7:23, also II Chronicles 4:2) This relates to the great Temple of Solomon, and would suggest a value of pi = 3.

It is interesting to note that for all intents and purposes, 250,000 digits of accuracy is quite unnecessary. With fewer than the digits of accuracy shown in larger type, the perimeter of the known universe can be calculated to within the diameter of an atom.

Pi=3.141592653589793238462643383279502884197169399375105820974944592307816406286208998628
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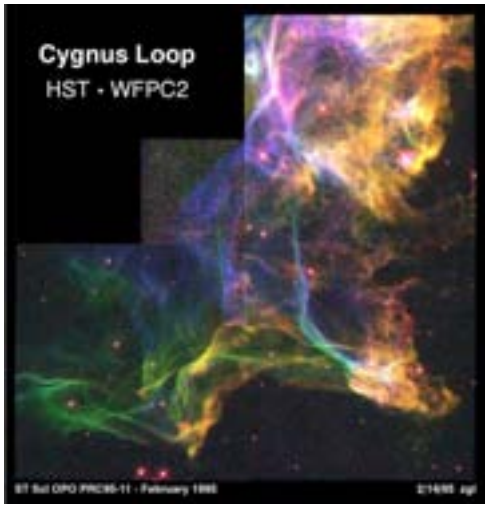
A Chronology of the Evolution of Science

3500BC Sumerians develop the wheel.
Sumerians develop cuneiform.
Egyptian hieroglyphics.

1800BC Sumeria/Babylon/Egypt: math system based on 60. Identified sun, moon, and the five planets (mercury, venus, mars, jupiter, saturn) - these became the seven days of the week. Zodiac, 12 constellations, months. Math / Astronomy / Calendar. But no zero.

sun = day
moon = month
sun = year

1500BC Canaanites (Phoenicians) needed shorthand language - developed aleph and bet, the first two letters of the Greek and Hebrew alpha-bets. The Hebrew bara' (to create) is spelled aleph, dalet, bet: בראּ.



This nebula in the constellation Cygnus (the Swan) shows the expanding blastwave from a supernova which occurred about 15,000 years ago and lies about 2,500 light years away. The blast is moving from left to right, and more recently impacted a denser cloud of

1375BC Amenhotep, sun god Aton.

1100BC Phoenicians navigate the sea with Big Dipper and North Star.

700BC First evidence of sun dials in Egypt, gnomon pointing North. Greek (Ionian) astronomer Thales noted that the Big Dipper never dropped below the horizon in Greece, but did in Egypt. Anaximander (Thales' student?) concluded that the earth must be a sphere.

586BC Babylon / Egypt / Greeks
Determining eclipses of the sun.
Predictability sensed. Thales predicts a solar eclipse.
Stonehenge an observatory?

520BC Greece: Pythagoras believes whole numbers are the basis of the universe. Discovered rational (a/b) and irrational (e.g. pi) numbers, the latter of which the Pythagoreans abhorred and kept deadly secret along with zero. Zero could imply a void or infinity, neither of which could possibly be. It was philosophy, not ignorance, that caused the rejection of zero. Later in life, he was revered as a religious leader. He spoke of the harmonies of the universe, having just discovered the harmonics derived if one plucked a string of full length, then half length, then quarter length, etc. Unfortunately from today's point of view, he got a bit carried away with the power of numbers.

500BC Phoenicians go around Africa - reported that sun was always in northern half of sky. Herodotus didn't believe it. Abacus. Babylonians "invent" zero as a digit/placeholder - the written version of an empty column on an abacus - but without value. Remnants of this "digit mentality" for zero persist today on the keyboard and telephone (1, 2, 3… 0). Mayans are the only civilization to start calendar dates with zero, thus avoiding the debate about whether the century starts with 2000 or 2001.

440BC Greece: Leucippus said every event has a cause. Democritus said all matter is made of tiny parts that were indivisible - atoms.

400BC Plato thought the mind alone was were the answers were, and talked of eternal Forms and Ideas manifesting themselves as our world. These Forms are the blueprints for a perfect world; all we see is a flawed copy. He and Aristotle agree that the universe is rational, the latter carrying the idea much farther. Aristotle was a bit more down to earth, the great cataloger and collector of observations, though he never tried to relate them together nor do experiments on them. He spoke of Four Causes. He scoffed at Pythagoras' idea that ten was a "perfect" number. He did, however, reject the void and infinity as did the Pythagoreans. Either would undermine his notion of a Prime Mover, the ultimate cause (acting on the outside sphere).

350BC Ponticus (Greek) says earth is immovable and the center of everything except mercury and venus which go around the sun. Earth is a sphere (noticed stars sank at horizon, also shadow shape of earth on moon). Aristotle and Thales suggest earth made of the five elements (earth, water, air, fire, and ether). Eudoxus made map of heavens with lines radiating from North Star. These became longitudes and then latitudes. Aristotle has notion of cause and effect. Around 340BC, Aristotle writes On the Heavens in which he provides three pieces of evidence for a spherical earth: the lunar eclipses are round, the pole star's apparent change of position from Greece to Egypt (by which he calculated the circumference of the earth to be 400,000 stadia, as best we can tell he only missed by a factor of 2), and the sails of a ship arriving on the horizon are seen before the hull.

300BC Euclid does his geometry thing in Alexandra, Egypt.

280BC Aristarchus uses trigonometry to develop sizes of sun, moon, and earth. He also concluded that the atars must be at least millions of miles apart. Heliocentrists.

240BC Eratosthenes found way to measure spherical earth using sun's shadow down a pipe. No shadow at Syene, 7^{o} shadow at Alexandra which is a known distance apart. Multiplying to 360^{o} gave them a figure of 400,00 stadia (which, assuming a stadium is 200 yards, was only off by a factor of two).

150BC Hipparchus. Using trigonometry, calculated distance to moon of 240,000 miles (close!). This was the first indication of the size of the universe.

134BC Hipparchus makes excellent maps of heavens. Noted from previous maps that positions were shifting. Estimated 26,700 years for rotation.

Discovered vernal equinox and star magnitude.

100sBC Abacus and astrolabe (calculating devices) are used. Lucretius postulates an infinite number of cycling universes.

140AD Ptolemy says earth is center of universe. Eight spheres surround the earth, each carrying the sun, moon, stars, and the five known planets. The moon's path was a known problem. This model was liked by the church as it allowed plenty of room outside this system for heaven and hell.

~400AD St. Augustine says, "The world and time both had a beginning. The world was made, not in time, but simultaneously with time." This is amazingly prophetic of modern cosmology, particularly given the time's completely erroneous ideas of space and time. He put the date of creation at about 5,000BC, which interestingly marks the emergence of civilization from the last ice age.

Hindus of India have no problem with zero, or with voids and infinities. The word zero may trace back to the Indian *sunya* (empty) which the Arabs turned to *sifr* which later scholars Romanized to *zephirus* which is our root for zero. *Sifr* also lead to cipher.

1100AD Maimonides (Jewish) sought proofs of a "primary mover". He introduces creation ex nihilo. Muslims go with the "atomist" approach (as opposed to Aristotilian) which requires a vacuum (void) in which atoms could move. They had no problem with zero. And now, neither did some Jews.

1200AD Aquinas extends Maimonide's "primary cause" theory.

1202AD Fibonnaci sequence: 1, 1, 2, 3, 5, 8… Nature's generations. Explains the development of the Golden Ratio (1.61803…) in nature (nautilas shell). He seized upon the Muslim/Arabic use of zero as it helped in his rather complicated calculations.

..1500AD Augustin-Aquinas-Roman Catholic dogma stifles scientific progress in Europe. Muslims become most advanced in astronomy with focus on getting to Mecca, time for prayer, and predictable calendars. Muslim scholars exported the "new mathematics" (trigonometry, algebra, zero) from India to Europe.

1425AD Brunelleschi puts zero to work in art – the vanishing point. Just as multiplying by zero collapses the number line to a point, the vanishing point causes the universe to collapse to a tiny dot, a *singularity*. Nicholas of Cusa (see last page of Session 7) thinks this through and declares that the earth can't be the center of the universe.

1454AD The printing press publishes a recently discovered (1417) copy of "On the Nature of Things" which was written about 57BC discussing the notion that everything was made of atoms.

1543AD Copernicus determines mathematically that orbits are better explained if the sun were the center. He hesitates to publish due to the Church. His book was printed as he died, in enough copies to preclude suppression by the church or anyone. This creates quite a storm with the Church.

1570AD Thomas Diggs asks, why is the night sky dark if there are an infinite number of stars? Kepler answered by saying there must be an edge. Olber's name would be given to this paradox in the 19th century.

1572AD Brahe watches a new star (super nova). Heavens not unchanging.

1608AD Lippershey discovers telescope, tries to develop as war weapon.

1609AD Kepler discovers planets circling the sun in an ellipse. Galileo discovers the Milky Way is made of stars. Galileo observes the moons of jupiter, suggesting that not everything need orbit the earth. Big stir in Church circles - heavens not supposed to have moving parts. Venus shows crescent phases - another clue suggesting helio orbit. Found moon to be pot-marked and the sun to have spots. Church says, "No!" However, the monotheists' notion of a rational deity spurred the scientific pursuit of that rationality by the likes of Kepler, Galileo, and Newton.

Kepler links ellipses and parabolas with the concept of an infinitely distant focus (flashlight on the wall demo). This creates the seeds for projective geometry which Poncelet would perfect in the early 1800s.

Galileo plays with "falling objects" using inclined planes, and discovers that Aristotle was not right in suggesting that heavier objects fall faster than lighter ones. He learned that they fall at the same rate, and that the time it takes an object to fall is proportional to the square root of the distance. This was one of the first applications of mathematics to physics.

Galileo/Kepler/Descartes exhibit first notion of "laws" of nature (calculating, predicting, measuring).

1612AD Marcus sees a fuzzy spot in the constellation Andromeda. Looks like a cloud so he calls it a nebula. Goes on hold for 3 centuries.

1633AD Urban III is Pope, allows Galileo's book to be published (mathematical). But Galileo renounces Copernican theory and is arrested.

16xxAD Rene Decartes develops the Cartesian coordinates, unifying geometry and algebra. Reluctantly (he feared the void), he has to put zero in the center. He also didn't "believe in" negative numbers. He also coined the term "imaginary numbers" to denigrate proposed solutions to quadratics such as $x^2 + 1 = 0$. The imaginary number i is the square root of -1.

1642AD Blaise Pascal designs a digital calculating machine. He also demonstrates that nature does NOT abhor a vacuum (zero/void) while experimenting with what would become barometers. When he

combined probability theory with zero and with infinity, he found God. God, you see, was a good bet.

John Lightfoot and James Ussher establish creation dates of about 4000BC.

1666AD Newton discovers that light is made of colors of light (which would later help to determine makeup of the stars based on absorption spectra). Three laws developed. Develops theory of Gravity based partly on Galileo's earlier work, which the Church didn't like either. Newton shifted the scientific world from thinking about static systems to dynamic systems. He notes that the universe cannot remain static - otherwise gravity would pull it in on itself. Newton senses the need to include "the flux of time" in his calculations (dynamic), so he creates "fluxions" (called derivatives today) for use in mathematics, which later become known as differential equations, or differential calculus. He was not afraid of zero or infinity. Others, who were still fearful, adopted "the calculus" because it worked. To their credit, there were 0/0 flaws in Newton's (and Leibniz's) calculus. Newton's works are not published until 1687AD.

1671AD Leibniz, who developed a calculus parallel to Newton, also designs a computer. Leibniz weighed in on the imaginary number *i* as a bizarre mix of existence and nonexistence, of 1 (God) and 0 (void). Likened *i* to the Holy Spirit – ethereal, barely substantial.

1755AD Wright and Kant saw the Milky Way as a disc-shaped conglomerate of stars of which our sun was one. GALAXY coined from the Greek for "milky." Kant's mechanistic universe would hold for a couple centuries, and keep the scientists out of religion and vice versa.

17xxAD D'Alembert introduces the idea of *limits*, thus removing the 0/0 flaw in calculus.

1771AD Messier discovers and catalogs 103 fuzzy spots which he discovered while hunting comets. Turns out these are distant galaxies.

1783AD John Mitchell writes that a sufficiently massive and dense star could "hold its own light." He suggested that there could be many of these, and that while we couldn't "see" one, we could observe its gravitational influences on other visible bodies. This began as an investigation of the question, "is light a wave or a particle?" If a particle, he concluded, then gravity would effect its ability to escape from one of these immensely dense objects.

1787AD Charles' Law: describes the relationship between the volume of a gas and its temperature.

1796AD Laplace further develops Mitchell's idea that stars may be so drawn in by gravitational forces so that not even light can escape.

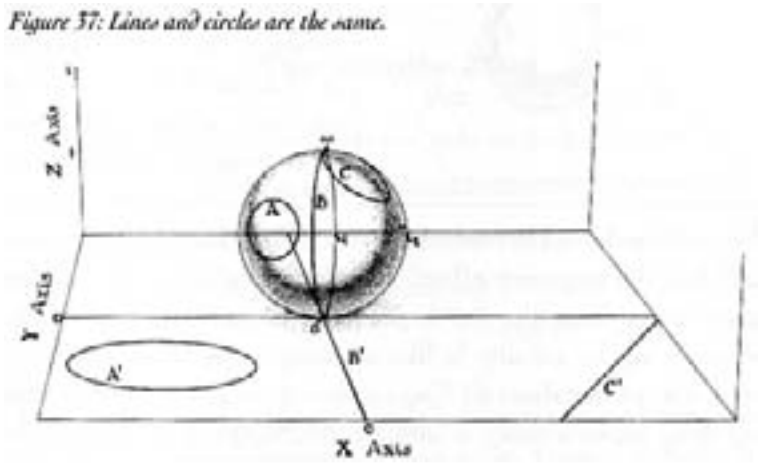
1820AD Thomas Colman develops commercially operable calculating machines based on the work of Pascal and Leibniz.

1822AD Babbage develops a working model of his "Difference Engine," a calculating machine.

1823AD Olber's Paradox is recognized (though he was not the first to think of the problem). He suggested that maybe intervening matter was absorbing the light (but that would eventually heat up the matter to glowing hot).

1830sAD Gauss plots complex number (real and imaginary numbers) on a Cartesian grid with the x-axis for real numbers and the y-axis for the imaginary numbers.

Riemann combines Gauss' grid with projective geometry. Line become circles and vice versa. And (tada!), zero and infinity become simply poles on a globe. Squaring any number on the globe spirals out to infinity (if >1) or descends to zero (if <1). Amazingly, 1, -1, and *i* hang out at the equator as if drawn equally by zero and infinity. Try squaring ad infinitum any number on a calculator. Then try continually squaring 1 or –1. Zero and infinity were no longer "out of control", but rather simple poles on a globe.



1833AD Babbage moves on to the "Analytical Engine," more akin to our digital computer. He works on a design that would have 50 decimal digits, 1000 numbers of storage, use punched cards, have conditional control; but it was never completed.

1838AD Henderson and Bessel discover distance to nearest stars: Cygne 61 at 6 light years (ly), and Alpha Centare at 4.3ly. We become a speck in space.

1848AD Edgar Allan Poe suggests that to look out into space is to look back in time!

1850AD Thomson discovers absolute zero as a limit to temperature based on the limit of zero space for a shrinking volume of gas (extension of Charles' Law, 1787). Thomson is better known as Lord Kelvin. $0^oK = -273.16^oC = -459.69^oF$. This begins thermodynamics, the first "barrier" for science: can't ever get there, can't make a perpetual motion machine.

1850sAD Till the turn of the century, not much would happen in the design of computing machines, except that the pressure (or need) for such a device would grow with the development of mathematics (differential equations).

1873AD William Jevons (British) first suggests the possibility of a beginning of the universe by arguing that it must have had a point in time of maximum heat and order as a logical conclusion to Clausius' "heat death" hypothesis. It took 50 years for the idea to come back and take hold. (While entropy cannot decrease with the future, it need not ever have been zero - but could

approach zero exponentially forever ago. Also, it now is understood that the maximum entropy will never be reached in a "heat death," either, because the potential entropy increases faster.)

Late1800s Cantor proves that if you throw a dart at a number line, you'll never hit a rational number. Set Theory. Countable and uncountable infinities. The infinity of the rational numbers takes up zero space.

1890AD Computational devices include partial results, storage, printing of results, and reintroduction of past results. Hollerith and Powers introduce punch cards for the census bureau. IBM, Remington-Rand, Burroughs take shape.

1900AD The Milky Way is the whole of the known universe.

Maxwell Planck solves the "ultraviolet catastrophe" (infinitely small wavelengths emit infinite energy) by introducing quanta. Atomic particles can only vibrate at district units of energy. Nothing in between is allowed. The equivalent notion is a car that can only go in speeds that are multiples of ten, but never 33 or 58 miles per hour. This seems to contradict Nature; people don't come in only 5-foot or 6-foot versions. Light comes in packets.

1905AD Einstein develops special relativity, and $E=mc^2$. Photons, too. To give you an idea of the relative transformation, one gram of mass turns into $1 million dollars of energy (in 1983 dollars). Light is both a wave and a particle (quantized) – a wave function.

1910AD Ernest Rutherford does experiments implying that atoms had a structure of a tiny nucleus surrounded by electrons.

1912AD Slipher sees the Andromeda Nebula and concludes it's coming towards us at 125mps.

1913AD Slipher sees a dozen fuzzy objects moving away from us at 2 million mph. First hint at expanding universe. Cheered by an assemblage of scientists that didn't know quite what it meant but had a gut feeling it was big. Bohr proposes that atomic particles can exists only in certain states (energies).

1916AD Einstein develops general relativity. When Einstein was doing his thing, galaxies were not conceived. Those objects were nebulae in our own Milky Way. He was so taken aback by his own equations that indicated no universe could be static that he invoked a "cosmological constant" to counteract the gravitational forces that would otherwise necessitate expansion or collapse. He later called this the greatest blunder of his life.
Schwarzschultd explains black holes as objects from which nothing escapes.

1917AD Sitter discovers an expanding universe via the equations of general relativity. Einstein instigates "cosmology" - the study of the origin, history, and shape of the universe.

1918AD Sun is dethroned as center of anything.
Size of universe beginning to be imagined.

1920AD Curts says Andromeda independent Galaxy. Hubble uses cepheids (class of star) to estimate distance to Andromeda - 750,000ly. He also notes Andromeda galaxy is about the same size as ours. Size of universe becoming immense as they measure galaxies as far away as 100 million light years.

1920s-30s Quantum mechanics developed; explains Bohrs' states and Einstein's photons. The two main points are that everything occurs (energies exist) in discreet sizes, or chunks (much like movies are really "flicks"), and that it is fundamentally impossible to know everything simultaneously about a particle. As Neils Bohr once said, "If you're not shocked by quantum theory, you don't understand it."

1922AD Alexander Friedman (Russian) develops models of the universe based on general relativity, including proposing a cyclical universe expanding from Big Bang and then contracting to Big Crunch. He predicted what Hubble would later observe, that the universe is expanding.

Hubble Space Telescope.

1927AD Heisenberg uncertainty principle. At the zero-point energy, you get uncertainty. Commonly stated, you can't know precisely both a particle's position and its velocity.

1929AD Hubble's Law.

1930AD Dirac, while studying Einstein's equations and trying to explain why an electron must spin twice before you see the original face, postulated anti-electrons (also called positrons) and therefore electrons that <u>appear from nothing,</u> later confirmed in the lab.

An IBM team lead by Aikens builds the Harvard Mark I, a computer with 23 decimal digits, all 4 math operations, that does a multiplication in 3-5 seconds.

1939AD Oppenheimer solves the equations of stellar collapse for stars greater than 1.5 solar masses - black holes.

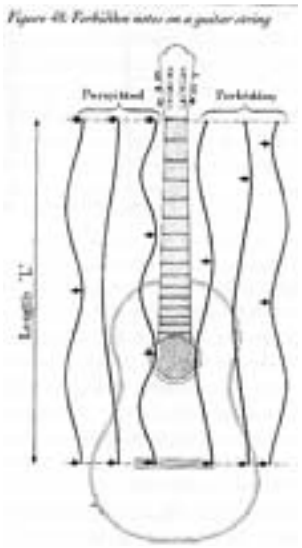
1940sAD Relativity and quantum mechanics come together.
<u>Steady-state</u> theory proposed (Gold/Bondi/Hoyle, after seeing the movie *The Dead of Night* that ends by returning to the circumstances in which it began).

1942AD Eckert and Mauchly build the ENIAC at the University of Pennsylvania. It has 10 decimal digits of accuracy and can do 300 products per second. It contains 18,000 vacuum tubes, takes up 1,800 square feet of floor area, and runs on 180,000 watts of electricity.

1945AD Von Neumann develops a simpler computing concept with unlimited theoretical computing ability, which includes programs, memory, subroutines, assemblers, etc.

1947AD The 1st RAM memory is developed. Now operations occur in 2-4 microseconds. Computers are now the size of grand pianos and contain 2,500 smaller tubes. These include the EDVAC and the UNIVAC (1951).

1948AD Big Bang Theory. The name was actually coined by Hoyle in an attempt to denigrate the idea. Presented in a paper by Alpher, Bethe (who was talked into loaning his name), and Gamow.

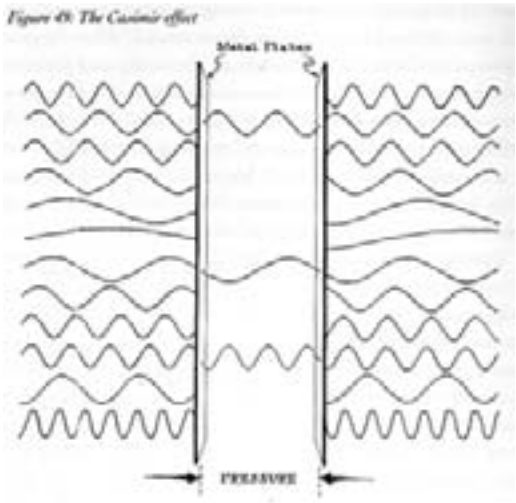


Casimir and Polder discover the force of nothing. Energy waves behave as do guitar strings, only certain packets (quanta) can exist in a given "box" of space. This effect was eventually measured in 1995 by Lamoreaux. Vacuums are invested with infinite energy.

1950sAD Computer technology develops magnetic core memory, transistors, batch processing and time sharing.

1960sAD Quarks are discovered as being constituents of protons and neutrons.

Printed circuit technology further advances computers.



1963AD Schmidt identifies 3C273, the first quasar, and possible black hole.

1965AD Penzias and Wilson (Bell Labs) discover what turns out to be the cosmic background radiation left over from the Big Bang, and are awarded a Nobel Prize in 1978. Actually, Dicke and Peebles had predicted this radiation and were looking for it when they read about the guys at Bell Labs stumbling on it. Penzias and Wilson thought it might be bird droppings on their dish. This energy is at about 2.7^{o} Kelvin, and confirms Friedman's earlier predictions.

Penrose develops a theory regarding the formation of singularities (which would later be called black holes).

1967AD Jocelyn Bell discovers pulsars and labels them LGM1 through LGM4, Little Green Men, because the regularity of their pulsing signals initially suggested extraterrestrial intelligence. They ultimately were determined to be rotating neutron stars that emit (through a complicated process) regular pulses.

1968AD Hawking and Penrose detail the proof that time and space have a beginning in a singularity at the Big Bang by using just general relativity and the observed matter of the universe.

1969AD John Wheeler coins the term black hole, and Chandreshkar and Oppenheimer expand the work. Black holes were among the first objects predicted purely by mathematical reasoning, and are now the object of intense "hole hunts."

1968AD Gabriele Veneziano begins modern string theory with his paper on the dual resonance model of the strong interactions.

1970AD Hawking announces black holes can evaporate and explode. He and Penrose prove that singularities must exist in black holes (if black holes exist).

1970AD Yoichiro Nambu, Leonard Susskind, and Holger Nielsen independently discover that the dual resonance model devised by Veneziano is based on the quantum mechanics of relativistic vibrating strings, and string theory begins. Particles are seen as strings, not dots, thus eliminating that nasty zero. Different particles are made of the same strings that vibrate differently. This also blocks a black hole from going to zero (and tearing holes in the fabric of space-time).

1970sAD Apple and Radio Shack bring on personal computers.

1973AD Tryon theorizes that particles can come and go in a vacuum given quantum mechanics and uncertainty. They appear and disappear, sometimes expand. They come from nothing. Cygnus X-1 is discovered - a binary system in that constellation where one of the binary stars is likely a black hole.

1980sAD Very large scale integration reduces size and increases power of what become known as microcomputers.

1981AD Bubble Theory.
Catholic Church officially forgives Galileo. Many scientists have yet to forgive the Church.

1984AD String theory acceptance begins by the mainstream physics community as an actual candidate theory uniting quantum mechanics, particle physics and gravity. String theory requires 10 dimensions (M-Theory requires 11), about 7 more dimensions than we are comfortable contemplating. These other dimensions are wrapped up into extremely small spaces that are irrelevant to our every day world, much as the probability of the existence of things "hits" (approaches) 1 from our macro point of view. Unfortunately, string theory isn't testable, and may never be testable, so technically it is not science, but philosophy.

1986AD Computers on desktops are processing a few megaflops (floating point operations per second). The fastest is a Cray-2 at 1 gigaflop.

1986AD de Lapparent, Geller & Huchra - large-scale structure, superclusters and voids.

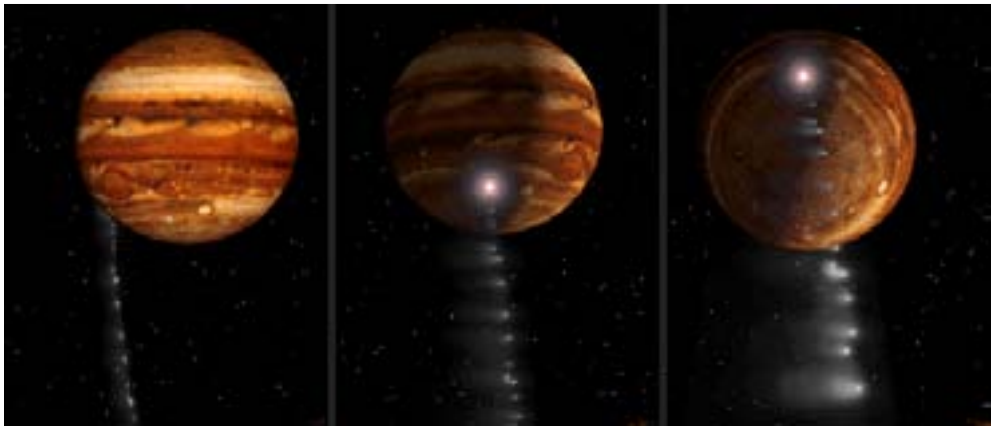
1992AD Ripples in the background radiation are discovered. Measured at 2.735^{o}K. Some of these ripples are 500 million light years across - how could something be 500 million light years across when the universe was only 300,000 years old? Because space itself was expanding faster than the speed of light. This was confirmation of a major prediction of the Big Bang theory. It was done by the Cosmic Background Explorer (COBE), and unmanned earth-orbiting NASA satellite.

Thinking Machines, Inc. ships a 100 gigaflop machine, the CM-5 to Los Alamos research labs at a cost of $10 million. The company says they can produce a 2 teraflop (trillion) machine (called an ultracomputer) for anyone willing to pay $200 million for it.

April, '94 Top quark is discovered at Fermi National Accelerator Laboratory. This was a collaborative effort on the part of hundreds of scientists and technicians, in the same manner as many great structures were built at the hands of many.

1995AD Hubble telescope data indicates a younger universe than some of its components (stars). New Hubble data also indicates that we are moving in a current, or in a direction, not entirely consistent with a universe expanding from a Big Bang.

1995AD June 12, 1995. Scientists reports that helium is discovered 9 billion light years from Earth, and in the proper amounts as predicted by the Big Bang theory.



Comet Shoemaker-Levy fragments crash into Jupiter.

1995AD First extra-solar planet orbiting an ordinary star.

1996AD D-branes and black-holes.

1997AD Photon-photon scattering produces electron-positron pairs.

1998AD Supernovae observations suggest that the expansion of the universe is accelerating. What is producing this acceleration? Perhaps Einstein's gravitational constant wasn't such a bad idea. Perhaps it's the force of the vacuum (Casimir effect), thanks to the zero-point energy. In any case, it appears ours is an icy fate, not a firery one.

NASA studies the possibility of propulsion from nothing using the Casimir effect. It's a long shot! Theoretically, the power of zero is infinite, and a vacuum holds an infinite amount of

energy; but for now, it appears that all we can get from nothing is nothing. God, on the other hand, seems to have gotten quite a bang out of the void.

1998AD Neutrino oscillation demonstrated.

1998AD Time reversal assymetry observed for K meson decay.

2000AD Tau neutrino observed.

01Oct01 MAP (Microwave Anisotropy Probe) officially reached its observing station at L2, a point 1.5 million km further from the Sun than the Earth, but on the Earth-Sun line. Over the next 6 months MAP makes a map of the whole sky in 5 microwave bands, studying minute temperature variations in the 2.725 K radiation left over from the Big Bang, giving new insights into the nature of the Universe.

24Apr02 The Hubble Space Telescope has measured the ages of white dwarfs in the globular cluster M4. The oldest white dwarfs are 12.7 +/- 0.7 billion years old in this cluster, so the Universe is 13-14 billion years old.

23May02 The Very Small Array (VSA) and the Cosmic Background Imager (CBI) both released new high angular resolution data on the minute temperature differences around the sky in the 2.725 K blackbody radiation left over from the Big Bang. The 24 May 2002 New York Times reported the CBI results under the headline: "Scientists Develop the Universe's Baby Pictures" which is a pretty good description of these results.

From Seife's book, Zero: The Biography of a Dangerous Idea
Pages 214-215.

To Infinity and Beyond

> However, if we do discover a complete theory, it should in time be understandable in broad principle by everyone, not just a few scientists. Then we shall all, philosophers, scientists, and just ordinary people, be able to take part in the discussion of the question of why it is that we and the universe exist. If we find the answer to that, it would be the ultimate triumph of human reason — for we would know the mind of God. —STEPHEN HAWKING

Zero is behind all of the big puzzles in physics. The infinite density of the black hole is a division by zero. The big bang creation from the void is a division by zero. The infinite energy of the vacuum is a division by zero. Yet dividing by zero destroys the fabric of

mathematics and the framework of logic—and threatens to undermine the very basis of science.

In Pythagoras's day, before the age of zero, pure logic reigned supreme. The universe was predictable and orderly. It was built upon rational numbers and implied the existence of God. Zeno's troubling paradox was explained away by banishing infinity and zero from the realm of numbers.

With the scientific revolution, the purely logical world gave way to an empirical one, based upon observation rather than philosophy. For Newton to explain the laws of the universe, he had to ignore the illogic within his calculus—an illogic caused by a division by zero.

Just as mathematicians and physicists managed to overcome the division-by-zero problem in the calculus and set it once more upon a logical framework, zero returned in the equations of quantum mechanics and general relativity and, once again, tainted science with the infinite. At the zeros of the universe, logic fails. Quantum theory and relativity fall apart. To solve the problem, scientists set out to banish zero yet once more and unify the rules that govern the cosmos.

If scientists succeed, they will understand the laws of the universe. We would know the physical laws that dictate everything to the edges of space and time, from the beginning of the cosmos to its end. Humans would understand the cosmic whim that created the big bang. We would know the mind of God. But this time, zero might not be so easy to defeat.

The theories that unify quantum mechanics and general relativity that describe the centers of black holes and explain the singularity of the big bang, are so far removed from experiment that it might be impossible to determine which are correct and which are not. The arguments of string theorists and cosmologists might be mathematically precise and at the same time be as useless as the philosophy of Pythagoras. Their mathematical theories might be beautiful and consistent and might seem to explain the nature of the universe —and be utterly wrong.

All that scientists know is the cosmos was spawned from nothing, and will return to the nothing from whence it came.

The universe begins and ends with zero.

A Chronology of the Evolution of the Concept of God

Karen Armstrong's last paragraph of A History of God: "Human beings cannot endure emptiness and desolation; they will fill the vacuum by creating a new focus of meaning. The idols of fundamentalism are not good substitutes for God; if we are to create a vibrant new faith for the 21st century, we should, perhaps, ponder the history of God for some lessons and warnings." Yeah, let's do that... These notes are mostly extracted from Armstrong's book.

12,000BC(?) In the beginning, man created gods. Some suggest the most primitive notions were monotheistic, much like some modern African tribes. Mother Gods, gods of agriculture, were prominent:

- Ishtar in Babylon
- Anat in Canaan
- Isis in Egypt
- Aphrodite in Greece

2000BC Abraham settles in Canaan, having come mostly likely as a chieftain from Mesopotamia. Then Isaac, and then Isaac's son, Jacob, who gives birth to the 12 tribes of Israel. Jacob recognizes (is told) that his God will go with even to other lands - GOD OVER ALL LANDS.

1700BC New Year Festival in Babylon. Annual celebration to stay linked with the divine world; scapegoat sacrificed to cancel the old dying year, sacramental. Enuma Elish is an epic poem telling of the victory over chaos, not a factual creation story, but a spiritual one. In it, the gods themselves were created, first three, then two by two, from a formless, watery waste. First three had names that related to abyss, void, and bottomless gulf. The rest emanated from these in an evolution of divinity, getting better and better gods with each step:

- Lahmu/Lahamn - "silt," water and earth still muddied up
- Ansher/Kisher - horizons of sky and sea
- Anu/Ea - heavens and earth

The story is a continual struggle to keep chaos at bay. Babylon was considered sacred, of divine importance (a theme carried in most religions). Man was created by mixing divine blood with dust (again, a familiar concept of man coming substantively from part of, or in the image of, God).

1400BC Canaanites tell similar stories:
Baal - god of storm and fertility
Yam - seas and rivers
El - the Canaanites High (Sky) God. As in Isra-El, beth-El, Ishma-El
Lotan - seven-headed dragon (Hebrew Leviathon), latent, unformed.
These early stories also involved gods dying and be resurrecting in some way.

1200BC Third wave of Hebrew settlement - escapees from Egypt who were freed by Moses' God, Yahweh. God the LIBERATOR (partial, warrior, savage) and REVEALER.

800BC Pentateuch (first five books of the Old Testament) were written by, at least, four different authors:
- J, talks of Yahweh (more fiery / Mt. Sinai), southern kingdom
- E, talks of Elohim (milder deity, "the only god that matters"), northern kingdom
- D, Deuteronomist
- P, Priestly (Genesis 1)

GOD the CREATOR.

869BC Eli-jah ("Yahweh is my God") wandered the land preaching loyalty to the one God. Elijah's Yahweh was not in the fire, the wind, the earthquake, but in a realm apart.

800-200BC Axial Age. New ideologies grew worldwide, new religious systems. New prosperity, new classes, intellectual and cultural pursuits arose. India was abandoning external gods in favor of self-realization (Yoga, karma). Hinduism and Buddhism transcends gods. Reasoning and intelligence are also insufficient. The prophets of Israel develop the idea that Yahweh is THE ONE GOD.

742BC Isaiah sees Yahweh on his throne above the Temple. He has a numinous (sacred, awe, wonder, transcendence, terror) experience. Despite God's "otherness," he speaks with Isaiah. One God. History was a dialogue with God. This God wanted compassion, not (animal) sacrifices.

7th-5th BC Idea of the Covenant with Israelites arises, revealing continued polytheistic thinking. A monotheistic god was unheard of, till this time. Joshua (Moses' successor) sets out this covenant, contract.

J's creation story is somewhat unique in that man is brought from adamah, not of divine stuff. P suggests that the Israelites had not heard of Yahweh until he was revealed from the burning bush. According to this tradition, Abraham called God "El Shaddai" (High God of the Mountain) because he didn't know his true divine name, Yahweh.

Hosea teaches that God wants to be loved (*hesed*), to be known (*yada*, the same verb as when Adam knew Eve, an internalizing). Hosea's loss of a wife made him think of God's loss of His people. Hosea's desire to win his wife back spoke to him of God's giving Israel another chance. In a sense, he was creating a God in his (Hosea's) own image.

538BC Siddhartha Gautama leaves home. Buddha would not answer questions about nirvana, existence, etc. as these were experiences beyond words and reasoning. Judaism and Christianity also contain this notion to some degree. The Greeks, on the other hand, were logic and reason junkies.

400BC Aristotle speaks of the UNMOVED MOVER, the god at the top of the heap that is at once thinker and thought, pure, eternal, immobile, spiritual. Man is privileged to share the divineness of reason. Aristotle's god was not the creator, however; he is indifferent to creation.

50BC The Wisdom of Solomon is written, suggesting that WISDOM is an important aspect of God in us, another aspect of an unknowable God.

0-33AD Jesus Christ. The "Son of God" meant intimacy, "with God." It was to mean that Yahweh actually had a son like the pagan gods did all the time. He was probably a Pharisee (as was Paul before his conversion), and much more sympathetic towards them than Matthew suggests. The Gospels say he had "powers" (*dunamis*), see Philo in next paragraph, which Jesus never claimed were exclusively his. By faith (an inner attitude, not a correct theology), he told his disciples that they could have these powers, too. Paul never refers to Jesus as God, but as the Son of God in the Jewish sense; he did not believe him to be God incarnate. This distinction, however, was lost on the Gentiles who did come to believe that he was divine. Jesus' death needed an explanation, and it soon developed that it was for our (Man's) own good, as in he died for us.

Philo, Jewish philosopher, distinguishes God's incomprehensible essence (*ousia*) from his activities in the world which he called powers (*dynameis*) and energies (*energeiai*). Philo also spoke of the divine Logos.

30AD Yahweh is God and FATHER of us all. Love and mercy was emphasis. God of CREATION and NATIONS. God of REDEMPTION.

70AD Mark's Gospel is written first, and as such is considered most reliable.

100AD John is written. John's "Word" (*Memra*) was not the same as Philo's. Rather, it speaks to "glory," "Holy Spirit," and "Shekinah" which emphasize the separateness, the difference between God's presence in the world and His incomprehensible reality.

Acts is written, with a clear Jewish conception of God, talking as did Moses of WINDS, FIRE, etc.

Educated pagans looked to philosophy, not religion, for enlightenment. They put these faiths in the likes of Plato and Pythagoras, who were seen as sons of gods. To these, the Christian God seemed FEROCIOUS and PRIMITIVE.

1st C AD Rabbis began the notion that each person's experience with God is different. "God comes to each man commensurate with a man's power to receive." To this day, theological ideas about God are very private, unenforced matters in Judaism. So incomprehensible was God that His name was not spoken, and His name in the scriptures is YHWH, and is not pronounced. GOD is IMMANENT (within, inherent). God is WITHIN EVERYONE, and therefore dealings with others are sacred encounters.

The divinization of Buddhas takes hold (who died 600 years earlier).

Christian were not into theology. Their creeds (*credere* from *cor dare*, to give one's heart) were emotional, not intellectual. The early Christians shared the Jewish notion that "theologies" were personal.

200AD Clement of Alexandria characterizes God as *apatheia*, utterly impassable and unable to change or suffer. Christians could participate in this divine life by imitating calmness and imperturbability. He thought you could imitate Jesus and do as well, for he did believe Jesus was divine. This imitation could be likened to an actor fully taking on a role. Superhuman calm.

Origen, a student of Clement, developed a theology that stressed the CONTINUITY of God, of LIGHT, OPTIMISM, and JOY. He developed a symbolic method of reading the Bible (non-literal). Belief in Jesus as divine was only a phase that would help us on our way to transcendency, to seeing God face to face. Neither believed God had created ex nihilo (out of nothing).

250AD Plotinus speaks of purification (*katharsis*) and contemplation (*theoria*) to find the essence of things. It is a descent into self as opposed to an ascent into something else. The greatest truths about the One are given in silence. The One IS ALL AND NOTHING. But since we did have some idea of the divine, the One must have opened up somehow. He spoke of two emanations, Mind (*nous*) then Soul (*psyche*), which added to the One, formed a Triad. This One does not come to us, we must search it out.

300sAD Belief in Jesus as divine was finalized, a gradual process since His life. Jesus himself focused on his human frailty side, most succinctly put in his self reference as "the Son of Man."

This decade was the first of theological passion in the churches of Egypt, Syria, and Asia Minor. How, exactly, did Jesus and God relate? If there was only one God, how could Jesus be divine?

A distinction between esoteric (secret) tradition and exoteric (public) emerges. Secret wasn't meant as exclusive, but rather that some notions of divinity could simply not be expressed (publicly) but had to be experienced personally, "secretly."

Cappodocians (eastern Turkey) suggest God has an unknowable, single essence (*ousia*), and three expressions (*hypostases*) which make Him known: Father, Son, and Spirit. GOD IS TRANSCENDENT, CREATIVE, and IMMANENT. They went out of their way to explain that there were not three gods. The notion of Trinity was an attempt to remind Christians that God was NOT GRASPABLE, that we shouldn't start thinking about God in too human a way.

381AD Nicene creed (the output of a gathering of bishops at Nicaea on May 20, 325), "maker of heaven and earth" *ex nihilo*. For the first time, an official doctrine insisted that Christ was no mere creature. GOD was CREATOR and REDEEMER.

400AD Augustine (of Hippo) suggests that God is TIMELESS, which Christians didn't take well, specifically related to Christ. "God did not wish to teach men things that are not relevant to their salvation." He also spoke of a different sort of trinity, a trinity of faith: *retineo* (holding the truths of Incarnation in our mind), *contemplatio* (thinking about them), and *dilectio* (delighting in them).

The idea of Christ's dying as atonement for original sin develops.

The Shiur Qomah (of the mystics) introduces two essentials common in all three monotheistic faiths: it is essentially IMAGINATIVE, it is INEFFABLE (indescribable).

6th C AD God is NOT SOMETHING THAT EXISTS. God is both God and not-God, good and not-good. (Denys.) God, Father, Son, etc. are not meant to be informative about Him, but to draw people to Him. Denys developed a theurgy that focuses on dogma rather than kerygma. It is a method to stop us thinking, and work towards feeling ecstasy (through the paradoxes of prayer and theoria). It's not what we do, it's what happens. Unlike Plotinus who experienced ecstasy two or three times, Denys believed ecstasy should be a constant state of a Christian.

Dionysus Exiguus (monk) established a calendar for the Pope that extended the Easter tables (which revealed the date for Easter each year). Some side work in this process brought Dionysus to calculate the birth date of Christ, and to set the year 1AD. Unfortunately, he missed. Most scholars agree today that based on our current "Dionysian" calendar, Christ was born in 4BC. But as long as we all agree to live with the same error… Worse, though, there is no 0AD, which throws any calculation that crosses that point off by one year.

The notion of Incarnation suggests that "God" and man must be inseparable.

610AD Muhammad lived in the Arab world which up till then had an ideology called muruwah: obey the chief, no after life, avenging wrongs to the tribe, protecting vulnerable members. It was a religion for the tribes that lived literally day to day, hand to mouth. Individual lives were meaningless, one could avenge a murder by killing anyone in the guilty tribe. Muruwah, at this time, was being challenged by istaqa, a capitalist, self-sufficiency ideology that reflected a very recent success in material things. In this year, Muhammad went to Mount Hira to worship Al-Lah, the High God of the ancient Arabian pantheon, referred to as "the God," whom he thought was identical to the God of the Jews and the Christians (Muslims are quite tolerant of visions of God, but equally intolerant of injustice). Till now, the Arabs had not had "a messenger." On the 7th night of Ramadan, Muhammad was awoken on the mountain by angels. He was told to "Recite!" Like Moses, Muhammad was reluctant. But he was enveloped by a great presence, three times, nearly crushing him, until he "recited!" The Koran would be revealed to Muhammad bit by bit over time (unlike the one session when Moses received the Torah). Muhammad's Koran would become to Islam ("the act of existential surrender that each convert makes to al-Lah," and a *muslim* was one who had done so) what Jesus is to Christianity. Islam is socialist in many ways. GOD was a MORAL IMPERATIVE. Theologizing was not appreciated. They are, however, to look for signs, to be open to God's epiphanies. They are not to abdicate reason, but to look at the world attentively and with curiosity (which lead them to build a great tradition in the natural sciences, which the Christians found threatening). "O my Sustainer, cause to me to grow in knowledge." It took 700 years or so for Judaism to become monotheistic; Islam got there in 23 years through the Koran. To give allegiance to material things or lesser beings is the greatest of Islamic sins. al-Lah is as-Samad, "the Uncaused Cause of all being." GOD is GREATER, visible only in what he does. GOD is ABSOLUTE, RICH and INFINITE, GIVER OF LIFE, KNOWER OF ALL THINGS, PRODUCER OF SPEECH.

8-9th C AD Muslims develop their theologies (various sects, etc.). They emphasize God's IMMANENCE and PRESENCE IN THE BELIEVER. The Koran was eternal, having been in the mind of God, and represented God in their midst (as does Jesus for Christians and the Torah for Jews). The Koran speaks of an OMNIPOTENT and OMNISCIENT GOD, but avoids total predestination in stressing personal responsibility. This was a point of contention between the sects. Some Muslims solved this as do some Jews and Christians - by separating two facets of God, His essence and His activities.

The Falsafahs (philosophy) wanted to use reason (and science) to get at the Truth; it mattered not from whom it came. They provided Aristotelian proofs of God's existence. GOD was SIMPLICITY itself; HE WAS ONE, PURE REASON.

971AD A leading Ismalia thinker suggests that God should be thought of in negatives: nonbeing, not ignorant, etc. It speaks to the inadequacy of language.

late 900sAD A Talmudist suggests that GOD is a RELIGIOUS DUTY (*mitzvah*).

1013AD Al-Baqillani (Muslim) develops "atomism" or "occasionalism." Everything in the world is dependent on God's DIRECT ATTENTION. Everything is made of discontinuous individual atoms with no specific identity of its own. Only God had reality continuously, and only He could redeem us from our nothingness. There were no natural laws in Al-Baqillani's world, God alone held it together from moment to moment.

1096-99 The first Crusade. Their GOD wasn't much more than a PRIMITIVE TRIBAL DEITY.

1100AD al-Ghazzali suggest that GOD is THAT WHICH IS FINDABLE (working off the Arabic word for existence which derives from the root "that which is findable.") He also suggests that not everyone is capable of experiencing the highest levels of awareness. He likens the no-God claims by those who can't experience God to the no-music claims of the tone-deaf. GOD is an ALL ENVELOPING REALITY and the ULTIMATE EXISTENCE which is perceived in a special way. From here on Muslims and Jews alike would (generally) stop trying to prove God.

1200sAD Thomas Aquinis suggests a transcendent God: perfection, simplicity, timelessness, omnipotence, omniscience. "I am what I am." God is "He who is." Aquinis offered five proofs of God: 1. Aristotle's Prime Mover, 2. there must be a beginning, 3. there must be a Necessary Being, 4. the hierarchy of the world implies a Perfection, and 5. that the order and

This plate is from Martin Luther's *Biblia*, 1534AD.

purpose of the universe cannot simply be chance.

The sefiroth (mystics) expresses names God gave to himself and the means by which he created the universe: Supreme Crown - nothingness, no color or form,
Wisdom - ideal form of all created things,
Intelligence - building to house all this (first three limit of human understanding),
(These first three are somewhat Trinitarian.)
Love/Mercy, Power (stern judgment), Compassion, Lasting Endurance, Majesty, Foundation, and Kingdom. Physical origins of the universe is not the point, rather a self-revelation. These are the 7 days of Creation.

1492AD Jews were expelled from Spain, exiled once again from city after city across Europe. Turned to a more direct experience of God where absolute HOMELESSNESS was Godliness.

16th/17th Centuries

Reformers. Europe was split into Roman Catholic and Protestant. In both reformations, attention was directed away from angels, saints, etc. to God alone. In all three monotheistic religions, reform meant getting back to the basics, shedding all accretions. Some even suggested that God transcends all religions!

Martin Luther (1483-1546) offers the doctrine of JUSTIFICATION, the restoration of a relationship between the sinner and God. This was Paul's justification by faith. God's foolishness is wiser than man's wisdom. Luther doubted that God could be proved.

The issue of evil and God's creation was dealt with, largely as a result of the continued/renewed Jewish exile. Luria (1542-1620) suggested there was an area of Creation that God had drawn himself away from, thus "making room" for evil. Luria's redemption required "works," at the same time that Calvin and Luther were suggesting man could contribute nothing to salvation. The Christian community, too had suffered (e.g. disease, scandals, Fall of Constantinople). They began to focus on Jesus, and his pain (stations of the cross); consider the sometimes gruesome artwork depicting the crucifixion. People seemed to be concentrating on anything but God.

Puritans and Jesuits see God as a dynamic force which could fill one with confidence and energy, despite the Puritans' large downside (evil, etc.). Puritans and Jesuits were also enthusiastic scientists. Some say the first scientific society was not the Royal Society of London or the Academia del Cimento, but rather the Society of Jesus (Jesuits). Hell and the devil were as much on the minds of people as God.

The Reformers had no problem with science, in fact, encouraged it. It was another way God was revealed. In fact, they spoke of God addressing us in the ways we can understand (like a speaker adjusts his comments to his audience), including mathematics and science. Calvin thought the Creation story was "baby talk" (*balbutive*), put to us so we could grasp a meaning.

The Roman Catholics weren't quite as accommodating to science. Copernicus (-1543) and Galileo (1613) were not well received. The Catholic Church condemned the heliocentric ideas not because it endangered belief in God the Creator, but because it contradicted the word of God in Scripture. Protestants, too, were embracing a new literalism that disfavored the heliocentric idea. Also, where were heaven and hell in this system? Islams didn't have to locate a place for these, they were in you. The Kaballists also had no problem with heliocentrism as they took the Creation story metaphorically.

Leonard Lessius (Jesuit, 1554-1623) suggests that the existence of God can be deduced like any other fact, based on the design of the world (how could this have happened by chance?). Until these "rationalists," God was a symbol of reality which had no existence in the usual sense, and could only be experienced through prayer and contemplation.

Pascal (1623-1662) is first to acknowledge that there is no way to prove the existence of God. That belief in God was a personal choice was a radical, new concept. Pascal had a revelation, leading him to concentrate on the idea that God REVEALS. Pascal, mathematician that he was, liked the odds. To believe involved finite risk for infinite gain.

Rene Descartes (1596-1650, "I think therefore I am") deduced much about God. Instead of trying to prove the existence of God, God was to be used to prove the reality of the world. He was the first to attempt to "explain" stories in the Bible with scientific truth by suggesting that manna was really a type of dew. The feeding of the five thousand was done by people pulling out hidden picnics that they had brought with them; the symbolism was lost.

Newton thought of God as THE GREAT MECHANIK. God set it all up and kept it running. Dominion was the point, not perfection. Newton thought we knew God only by knowing the natural world. He had no time for miracles, or anything else "unexplainable."

1700sAD The end of the 18th Century saw the first "true" atheists, denying the existence of any god. Until now, "atheists" were more those who didn't see god the way you did, but still did see a god. There was also a distinction between those who simply lived as if God didn't exist (more), and those who actually believed there was no God (less). "Atheist" was an insult; no one would have called themselves an atheist.

The technological developments from here on provided people, particularly in the West, with a heretofore unknown sense of autonomy. Change would become the norm, institutionalized in fact. A new myth developed: Progress. People began to think that future generations would be better off than themselves. Specialization began; keeping up in all areas became impossible. Persons sensed being a pioneer rather than a conserver of tradition. People didn't have to rely on anything, including revelation from God, to discover the truth.

Kant's (Critique of Pure Reason, 1781) God was tacked on to his ethical framework, encouraging a moral life. Man was more the center of religion than God. Kant argued that the proofs of God proved nothing. To some Christians, this was liberating.

Wesley (1703-1791) did his thing while "religion of the heart" was taking some hold. It urged men and women to abandon proofs and discover God within. John and Charles founded the Holy Club, long on methods and disciplines. Later, John traveled to America and was impressed (converted) by a Moravian sect which eschewed all doctrine in favor of affairs of the heart. Being "born again" was crucial, to experience God continually. Doctrines were dangerous, the psychological effect of Christ's words on the believer was the best "proof." The mystics would see this as dangerous, too, however; their goal was peace and tranquillity, not the frenzied behavior of the born-again Christian. God was INTERIOR and an EMOTIONAL STATE.

Pantheism (God is all that is, God is in every stone) returned to some extent. Everything that existed yearned to return to its Divine SOURCE. Even the three persons of the Trinity would finally submerge into the primal Unity (a Grand Unifying Theory!?).

Sometimes interesting to see how sin was viewed: only in man's mind, somehow necessary, to holy (Ranters).

The Calvinists didn't like Newton's God who didn't have much to do once the cosmos was set in motion. They preferred a God that was literally ACTIVE and ACTING in the world.

Jewish Hasidism develops. The whole world was full of God's PRESENCE. A devout Jew could experience God in the tiniest actions: eating, drinking, making love. The DIVINE SPARKS were everywhere, in every gust of wind and blade of grass. Every man is a redeemer of his own world. This was a new message of hope for Jews in a rather cruel world.

Mysticism and rationalism may not be that far apart. Many rationalists tell the value of unconscious thinking, "sleeping on it," and inspiration (such as Archimedes and Einstein). It was suggested that metaphysical speculation was a necessary precursor to prayer as it revealed man's limitations. Paradox played a role in religious thinking (e.g. if God is creator of all, why evil?).

During these centuries, theologians went from proving God on the basis of reason and science, to suggesting that in fact God was unnecessary (dead), and that all could be explained "naturally."

1800sAD God is DEAD. Transcendency fought subjective experience. Theologies were fighting skepticism. Philosophers pointed out that God had been so separated from man as to become an idol. It was as if man had become the opposite of God.

Karl Marx (1818-1883) saw God as IRRELEVANT, and religion the opium of a suffering people. The literal understandings of God made believers vulnerable to scientific attack.

Darwin and Lyell rock the boat, but only for those who took the stories too literally. Islam simply accepted that God created without offering any details as to how. Freud didn't help any either, suggesting that belief in God was an ILLUSION. God worked in mankind's infancy, but it was time to move on to science. Other psychoanalysts thought God had been HELPFUL, or was an effective SYMBOL OF EXCELLENCE.

Muhammad Abduh (1849-1905) thought science and philosophy were the two most secure paths to knowledge of God. Muslim mystics had often used math and science as aids to contemplation.

Muhammad Iqbal (1877-1938) was to the Muslims of India what Gandhi was to the Hindus. He stressed the importance of individualism. The universe was an Absolute on the highest order of individuation and which men called "God." To be more like God, each must become more INDIVIDUAL, more CREATIVE, and must express that creativity in action. This was at the same time that individualism in the West was becoming a new form of idolatry as it was becoming an end in itself.

Some Jews spoke of God as the WORLD SOUL, immanent in all things yet still above all things. This reflects the essence-versus-activity dualism. The Jews, too, had developed a sense of individualism having learned to be Spirit-filled from within. Their experience with external forces was not great. This lead some, like Hermann Cohen (1842-1918) to deny an external existence for God, but rather an ETHICAL IDEAL. He spoke of Moses' hearing "I am what I am" as an expression that God is SIMPLY BEING ITSELF.

1900sAD For the Jews, and many others, the traditional idea of God was destroyed by the Holocaust. Dostoevsky said that the death of a single child could make God unacceptable. It raised in spades all the omnipotent/impotent God paradoxes; some say to the point of destroying conventional theology.

In fact, atheism (as we moderns normally think of it) has taken hold as it never has before. Many find it liberating to be rid of the God who terrorized their childhood. Jean-Paul Sartre (1905-1980) spoke of the God-shaped hole in the human conscious.

During the 1950s, Logical Positivists (like A. J. Ayer, 1910-1991) asked whether it made sense to believe in God, whether the idea of God had any meaning. He (they) argued about the difference between meaningful and meaningless statements, focusing mostly on testability. The Logical Positivists were criticized with their own ammo, in that their own postulates were not verifiable in any meaningful way.

Science became a threat only to the Western Christians who had developed a tradition of taking scripture literally and interpreting doctrines as thought they were objective fact. God as FIRST CAUSE had been abandoned in the Middle Ages by the Jews, Muslims, and Greek Orthodox Christians.

1920AD The Year of Disaster, as the Muslims see it (Britain and France marched into the Middle East). The Koran taught that a society living according to God's will/could not fail; something was going wrong. Out of this came a focus on the future. Islam became a call for future action. GOD IS BECOMING as opposed to "done."

Paul Tillich (1868-1965) preferred the definition of God as the GROUND OF BEING. His was a more transpersonal rather than personal God; not a being, but being.

Jesuit Pierre Teilhard de Chardin (1881-1955) combined God and science. Christ is the "omega point," the climax of evolutionary process when God BECOMES ALL IN ALL. Other Jesuits, however, spoke of a more transcendental theology, God as the SUPREME MYSTERY (and Jesus as the decisive manifestation of what man can become). In the 1960s, process theology develops which also focuses on God's unity with the world, inextricably bound up in world processes. God the GREAT COMPANION, the FELLOW-SUFERRER, who UNDERSTANDS.

Some suggest we should look to art. God is to be found in the senses, and not in the more cerebral and abstract parts of the mind.

The trick seems to be keeping God not so transcendental as to be a nullity, and not so personal as to become an idol.

Martin Buber (1878-1965) suggested that religion consisted entirely of an encounter with a PERSONAL God which took place nearly always IN MEETINGS WITH OTHER HUMAN BEINGS. God is a PRESENCE and an IMPERATIVE, the meaning we must work out for ourselves, individually.

Ernest Bloch (1885-1977) sees God as the HUMAN IDEAL THAT HAS NOT YET COME TO BE. We look ahead.

Horkheimer (1895-1973) said God's existence was not the point. But the IDEA of God was important ethically and morally, a longing for JUSTICE. It speaks to our cry as children, "It's not fair."

Albert Einstein (in 1921) was asked what his theories did to theology. His reply, "Nothing. Relativity is a purely scientific matter and has nothing to do with religion."

1970sAD Fundamentalism develops, highly political spirituality that is literal and intolerant. All three of the world's monotheistic religions has developed a fundamentalism. It is fiercely reductive. It may be argued that this is actually a retreat from God, that putting up "family values" and "Holy Lands" as the focus is but a new idolatry - a continual temptation, it seems, for monotheistic peoples whose truer focus is COMPASSION.

1994AD Tipler suggests that the tenses used in "I am what I am" say that God is WHAT HE IS BECOMING or WILL BE; the future is where it's at. He offers scientific (physics) proof of God, and immortality for every individual (see his book in the bibliography).

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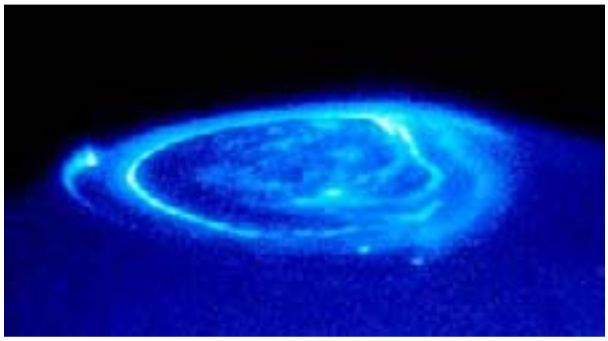

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Horsehead Nebula.

Einstein, Christmas, and Infinity

[This story was told by Franklin Scott, Parish Minister at First United Methodist Church, Arroyo Grande, CA during his sermon on 12/31/95 in which he recounted three Christmas stories. He said this one was told to him by one of the students in the story. I've taken some literary liberties in telling it here, but I think I've been true to the meaning…JF]

The note read, "We've been here every evening this Christmas season, and you've missed them all. Guess you'll have to wait until next year to be caroled." It was Christmas Eve when we disappointed Princeton University carolers left that note on our physics professor's door. We had been there every cold winter's night that Christmas season to bring Professor Einstein some Christmas cheer, but to no avail. He was never home.

The holiday break ended in mid January, and we all poured into Prof. Einstein's lecture hall for the first day of class after Christmas. It was fairly routine - Einstein was emitting physics faster than anyone could take notes, let alone absorb the full meaning and importance of each iota. We were exhausted, as usual. As we left class, the professor handed an envelope to each of us who had signed that Christmas Eve note. In it his message read, "Be at my house Monday night, 6pm sharp."

"How could we be in trouble over trying to keep Christmas?" we wondered silently to ourselves. But show up we did. Who wouldn't, after all, respect the bidding of a man who, by now, was the epitome of science, and responsible for, among other things, our grade in Physics 501.

We gathered in the front room of the professor's apartment at the appointed time that Monday night, and before we had time to take off our winter jackets, he reappeared from the back with his violin in hand and a bright Christmas scarf about his neck. "We're going caroling," he announced, and lead us out the door and down the street to a low-income housing project not too many blocks away. As we walked, he explained that Christmas is not a single event that ends or has to wait for some cycle to repeat, but an attitude that can exist in every second of every minute of every hour of every day of every week of every month of every year for ever - infinitely.

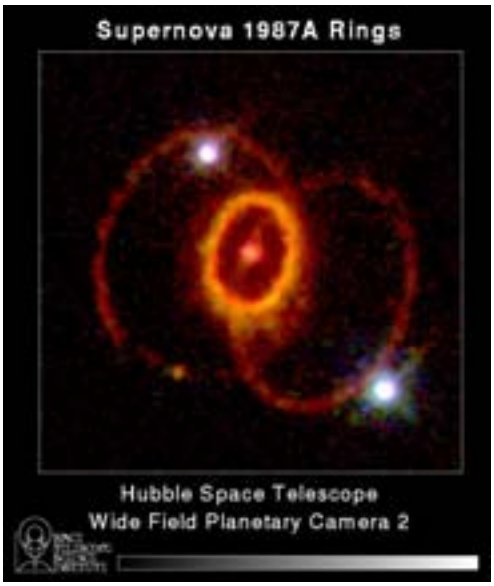
Our first stop was at the front steps of an elderly man, who upon hearing our carols, hobbled on crutches to come out and greet us. It was difficult for him, but he wanted us to know that our caroling had just made Christmas for him. The smiles of gratitude and joy that greeted us all that night made all of our Christmases, too. Here it was the middle of January, and Christmas was even more Christmas than on December 25th.

I suppose you could say it was a miracle. We learned the true meaning of Christmas not from a man of the cloth, but from a man of science. Christmas really can be in us all, all the time - every time - that we do it for the least of His children.

In The Beginning...There Was A Computer...And God Said...

(Humor from the Internet - author unknown)

In the beginning there was the computer. And God typed...



A supernova which burst into view in February, 1987. The star exploded about 169,000 years ago in the Magellanic Cloud (a satellite galaxy companion of the Milky Way).

C:\>Let there be light!
Enter user id.
C:\>God
Enter password.
C:\>Omniscient
Password incorrect. Try again.
C:\>Omnipotent
Password incorrect. Try again.
C:\>Technocrat
And God logged on at 12:01:00 AM, Sunday, March 1.

C:\>Let there be light!
Unrecognizable command. Try again.
C:\>Create light
Done
C:\>Run heaven and earth
And God created Day and Night. And God saw there were 0 errors.
And God logged off at 12:02:00 AM, Sunday, March 1.
Approx. funds remaining: $92.50.

And God logged on at 12:01:00 AM, Monday, March 2.
C:\>Let there be firmament in the midst of water and light
Unrecognizable command. Try again.
C:\>Create firmament
Done.
C:\>Run firmament
And God made the earth. And God saw there were 0 errors.
And God logged off at 12:02:00 AM, Monday, March 2.
Approx. funds remaining: $84.60.

And God logged on at 12:01:00 AM, Tuesday, March 3.
C:\>Let the waters under heaven be gathered together unto one place and let the dry land appear and
Too many characters in specification string. Try again.
C:\>Create dry_land
Done.

C:\>Run firmament
And God divided the waters. And God saw there were 0 errors.
And God logged off at 12:02:00 AM, Tuesday, March 3.
Approx. funds remaining: $65.00.

And God logged on at 12:01:00 AM, Wednesday, March 4.
C:\>Create lights in the firmament to divide the day from the night
Unspecified type. Try again.
C:\>Create sun_moon_stars
Done
C:\>Run sun_moon_stars
And God saw the day and the night. And God saw there were 0 errors.
And God logged off at 12:02:00 AM, Wednesday, March 4.
Approx. funds remaining: $54.00.

And God logged on at 12:01:00 AM, Thursday, March 5.
C:\>Create fish
Done
C:\>Create fowl
Done
C:\>Run fish, fowl
And God created the great sea monsters and every living creature that creepeth wherewith the waters swarmed after its kind and every winged fowl after its kind. And God saw there were 0 errors.
And God logged off at 12:02:00 AM, Thursday, March 5.
Approx. funds remaining: $45.00.

And God logged on at 12:01:00 AM, Friday, March 6.
C:\>Create cattle
Done
C:\>Create creepy_things
Done
C:\>Now let us make man in our image
Unspecified type. Try again.
C:\>Create man
Done
C:\>Be fruitful and multiply and replenish the earth and subdue it and have dominion over the fish of the sea and over the fowl of the air and over every living thing that creepeth upon the earth
Too many command operands. Try again.
C:\>Run multiplication
Execution terminated. 6 errors.
C:\>Insert breath
Done
C:\>Run multiplication
Execution terminated. 5 errors.
C:\>Move man to Garden of Eden

File Garden of Eden does not exist.
C:\>Create Garden.edn
Done
C:\>Move man to Garden.edn
Done
C:\>Run multiplication
Execution terminated. 4 errors.
C:\>Copy woman from man
Done
C:\>Run multiplication
Execution terminated. 3 errors.
C:\>Insert woman into man
Illegal parameters. Try again.
C:\>Insert man into woman
Done
C:\>Run multiplication
Execution terminated. 2 errors.
C:\>Create desire
Done
C:\>Run multiplication
And God saw man and woman being fruitful and multiplying in Garden.edn
Warning: No time limit on this run. 1 errors.
C:\>Create freewill
Done
C:\>Run freewill
And God saw man and woman being fruitful and multiplying in Garden.edn
Warning: No time limit on this run. 1 errors.
C:\>Undo desire
Desire cannot be undone once freewill is created.
C:\>Destroy freewill
Freewill is an inaccessible file and cannot be destroyed. Enter replacement, cancel, or ask for help.
C:\>Help
Desire cannot be undone once freewill is created. Freewill is an inaccessible file and cannot be destroyed.
Enter replacement, cancel, or ask for help.
C:\>Create tree_of_knowledge
And God saw man and woman being fruitful and multiplying in Garden.edn
Warning: No time limit on this run. 1 errors.
C:\>Create good, evil
Done
C:\>Activate evil
And God saw he had created shame.
Warning system error in sector E95. Man and woman not in file: Garden.edn. 1 errors.
C:\>Scan Garden.edn for man, woman
Search failed.
C:\>Delete shame

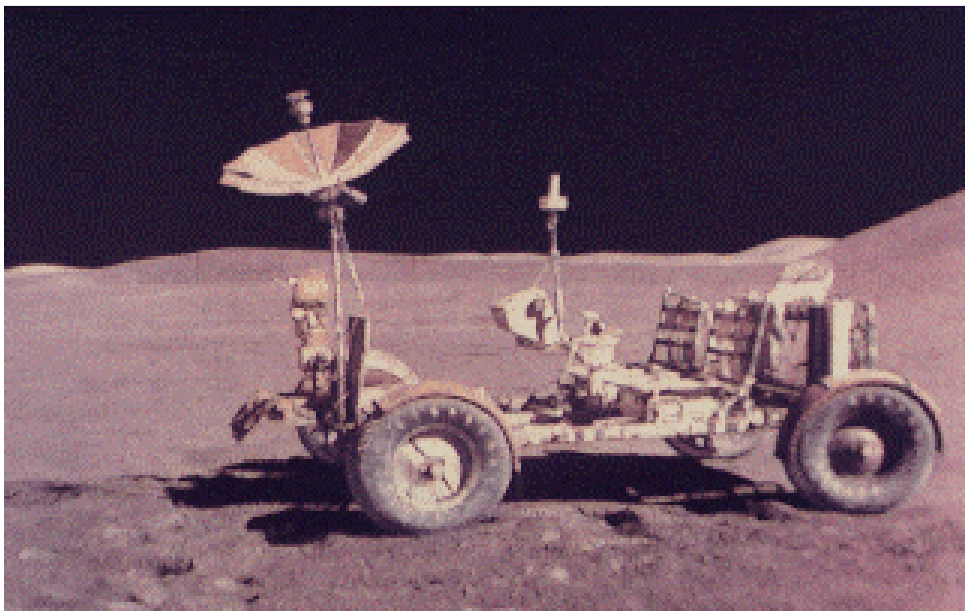
Shame cannot be deleted once evil has been activated.
C:\>Destroy freewill
Freewill is an inaccessible file and cannot be destroyed. Enter replacement, cancel, or ask for help.
C:\>Stop
Unrecognizable command. Try again
C:\>Break
C:\>Break
C:\>Break

ATTENTION ALL USERS *** ATTENTION ALL USERS
COMPUTER GOING DOWN FOR
REGULAR DAY OF MAINTENANCE AND REST IN FIVE MINUTES. PLEASE LOG OFF.

C:\>Create new world
You have exceeded your allocated file space. You must destroy old files before new ones can be created.
C:\>Destroy earth
Destroy earth: Please confirm.
C:\>Destroy earth confirmed. Flooding...

COMPUTER DOWN *** COMPUTER DOWN. SERVICES WILL RESUME SUNDAY, MARCH 6 AT 6:00 AM. YOU MUST SIGN OFF NOW.

And God logged off at 11:59:59 PM, Friday, March 6.
Approx. funds remaining: $0.00.



Lunar Rover, Apollo missions.

Session 1: Introduction

"Irrationality is the square root of all evil." Douglas Hofstadter

1. Welcome.
   Introductions: leader, classmates (any physicists, theologians, creationists, non-Christians...).
   Distribute materials.

2. Why this course?
   a. Nature and scripture both reveal truths. We are responsible for studying both.
   b. Bothered by general irrational approach to science and "simple" approaches to religion.
      i. scientology, astrology, pseudo-sciences
      ii. cults, fringe religious groups
   c. This stuff fascinates.
   d. Religion is in trouble to the extent that it doesn't keep up with science, risk loosing thinkers.
   e. Both science (disease fighting to nuclear weapons) and religion (love/peace to doctrinal wars) have social effects.

3. You can! Remembering kindergarten...

4. Caveats from and about the leader:
   a. A layperson in both science and religion.
   b. Christian background but little formal training.
   c. Don't let the material overwhelm you, our discussions will be "high level," not fraught with detail. The information is provided for those interested. While I tried to be as accurate as possible, please understand that these are simply my notes organized as my quantum-based (chaotic?) brain thought best...
   d. Neither this course nor any conclusions which may come of it should be considered final; new ideas and information present themselves nearly every day...

On the back, please:

5. Describe God (however you want...).
6. Describe your cosmology (how the universe began, if it had a beginning, when, by whom or what, etc.).
7. Describe/define time.
8. Describe/define life.
9. Describe how life began on earth.
10. Given the nature of this course, what two questions are you the most interested in hearing answered or discussed?

Session 2: Getting a Grip on the Universe; A Cruise

"If you get simple beauty and nought else, you get about the best thing God invents," Elizabeth Browning.

miles		
8,000	earth's diameter	
24,000	earth's circumference	
240,000	earth to moon	
800,000	sun's diameter	M&M
93,000,000	earth to sun	
778,000,000	sun to jupiter	
950,000,000	earth travels in 1 orbit of sun	
4,500,000,000	sun to neptune	
5,900,000,000	sun to pluto (average, 4.4-7.4b)	
3,720,000,000,000	sun to Oort cloud	
25,000,000,000,000	to nearest star	90 miles away
594,000,000,000,000,000	across the Milky Way	M&M
14,850,000,000,000,000,000	to M31 galaxy	5 inches
71,280,000,000,000,000,000	nearest other group	24 inches
356,400,000,000,000,000,000	nearest cluster (Virgo)	10 feet
2,316,600,000,000,000,000,000	to next big cluster	65 feet
2,138,400,000,000,000,000,000	distant clusters diameter	60 feet across
90,000,000,000,000,000,000,000	observable universe (15bly)	.6 miles

These slides are from Ward's catalog (educational supply house)
- /GC = "Galaxies in Color" (173 E 0734)
- /GU = "Galaxies and the Universe" (173 E 0760)
- /SU = "Structure of the Universe/Cosmology" (173 E 0761)

Slides also came from The Astronomical Society of the Pacific
- /AS = "The Hubble Space Telescope: A Clear View" (AS234)
- /A5 = "Splendors of the Universe," Anglo-Australian Telescope, Set #5

Slides from *Science & Art Products*, Malibu, CA
- /CU = "Colors of the Universe"
- These images are available at ftp:ftp.stsci.edu/pubinfo/jpeg/(name).jpg

Letters-numbers preceding slash indicate Jamie's slide presentation order for this session:
- MW = Milky Way
- GG = general galactic
- COS = cosmology
- HST = Hubble Space Telescope slides

Slot 69 on the tray.

HST01/AS02. Fragment G of comet Shoemaker-Levy crashed into Jupiter 1 hour and 45 minutes before this shot on July 18, 1994. The small dark feature to the left of the circle pattern is fragment D at about 1 day old. The dark sharp ring at G is about 80% of the size of the earth.

HST02/AS04. This shot of Saturn, taken in December of 1994, shows a rare storm that appears as a white arrow-head-shaped feature near the equator. The side to side extent of this "thundercloud" is about the size of the earth. (SatStorm)

HST03/AS07. The moons (at least 5) and rings of Uranus as seen on August 14, 1994 when the planet was 1.7 billion miles from earth. (UranusA)

HST04/AS09. Protostar Cocoon in Orion. Of the five young stars visible in this 0.14 light-year view, four are surrounded by gas and dust trapped in their orbit. This is evidence supporting the theory that planets emerge from rings of dust and gas swirling about young stars. This group is about 1500ly from us. (Orionproplyds)

HST05/AS11. White dwarfs in globular cluster M4 (Messier) at 7000ly in Scorpius. The cluster contains over 100,000 stars. The picture is 47ly across. At right is a blow up of an area .63ly across with 75 white dwarfs. The universe is not yet old enough for any white dwarfs to have completely cooled. These may become "cosmic clocks." (M4WD)

HST06/AS12. The Cat's Eye Nebula (NGC 6543). One of the most complex planetary nebulae showing concentric gas shells, jets of high-speed gas, and shock-induced knots of gas. It is 3000ly away in Draco. (NGC6543a)

HST07/AS13. The Cygnus Loop. This supernova lies 2500ly away in the constellation Cygnus (the Swan). The explosion occurred about 15,000 years ago. The blastwave is moving from left to right, and has recently impacted a cloud of denser than average interstellar gas. These shock waves heat the gases to glowing colors. (CygnusLoop)

HST08/AS15. Supernova 1987a Rings. This celestial feature exploded into view in February of 1987. It is located in the Large Magellanic Cloud and erupted about 169,000 years ago. (SN1987A_Rings)

HST09/AS16. NGC 4881 and Distant Cluster. This is an elliptical galaxy in the outskirts of the Coma Cluster at about 300 million light-years distance. Globular star clusters like these are used to measure the Hubble Constant, and thereby the age of the universe. Studies of these images put that constant at 70 km/sec/megaparsec, well within the accepted 50-100k/s/m range in use today. The smaller the constant, the older the universe. (NGC4881)

HST10/AS17. A Head-On Collision in the Cartwheel Galaxy at 500 million light-years distance in the constellation Sculptor. The striking ring feature is the result of the collision, possibly with one of the galaxies at right in the photo. Like a rock tossed into a lake, the collision sent a ripple of energy out through the galaxy at 200,000mph. The ring of several billion new stars is about 150,000 light-years in diameter (our Milky Way galaxy would fit inside). Top left shows the knotty structure of the new star ring. Bottom left shows detail of the core. (Cartwheel)

HST11/AS18. A Deep View of the Early Universe. One of the deepest images reveals a population of faint blue galaxies at 3 to 8 billion light-years away. These objects are about 4 billion times fainter than the unaided eye can see. These galaxies show a wide variety of shapes suggesting collisions and interactions were common. The blue color indicates intense star formation with many young, hot, blue stars. This exposure took about one full day and 48 orbits of the telescope around the earth.

MW01/GC01. Wide angle view of the Milky Way in Sagittarius toward the galactic center taken from Cerro Tololo Observatory in Chile. Picture shows many bright diffuse nebula and star clouds and a dark rift through the center. NOAO photo.

MW02/GC02. A near infrared view of the Galactic nucleus located about 30,000 light years from the Sun. The dark red patch to the right of the bright nucleus is part of a ring of dust and gas surrounding the nucleus at a radius of about 6 light years. Picture is 50 light years on a side. NOAO photo.

MW03/GU01. The distribution and increasing number of stars at 10pcs, 100pcs, 1,000pcs, and 5000pcs from the sun. This slide demonstrates how star counts from the sun's position indicates the shape and size of the Milky Way Galaxy.

MW04/GU02. This slide shows the Galaxy seen edge-on from a point outside the system. The left side shows the general structure and the sun's position and the right side shows galactic latitude positions with respect to the galactic plane and the sun. Important constellation regions are noted in terms of galactic latitude.

GG01/GU17. Chart illustrating the four basic types of galaxies and their subtypes. The types are based upon the size of the nucleus, the openness of the spiral arms, the existence of a bar, the existence or absence of dust and gas, and the ellipticity of the body. Representative Examples of Types of Galaxies

GG02/GU29. Diagram showing the Hubble classification of galaxies. In this scheme the type SO is a transitional type between the elliptical and spiral forms. This classification is based upon morphology and did not originally include the irregular types. It does not indicate an evolution of one type into another.

GG03/CU01. Scattered throughout the Universe are great clouds of gas and dust known as nebulae. Shown in this photo is The Orion Nebula, one of the largest and brightest in the sky. Its distance from earth is about 1600 light years, yet it can be seen with binoculars. In photographs we see this pinkish color of ionized hydrogen gas. The blue "reflection nebula" to the left gets its color from dust and non-luminous gas that is reflecting the light of bright stars embedded in it. Nebulae like Orion are now known to be stellar nurseries--meaning that new stars are forming out of the gases that make it up.

GG03/CU02. The Horsehead Nebula is part of an unusual and interesting combination of many types of nebula. The horsehead shape is a "dark" nebula that we see as a silhouette in front of a bright strip of red "emission" nebula. We can also see in this photo, blue "reflection" nebulae. The Horsehead Nebula is in the constellation of Orion and also is about 1600 light years away. The dark horsehead is one light year in diameter which is about 70,000 times the distance between the Earth and the Sun.

GG03/CU03. This is a wide field photograph of The Scorpio Complex, a large area of sky looking toward the center of our Milky Way galaxy. The great variety of color is unusual and again shows many different types of nebula that exist. The yellow/orange cloud surrounds a very bright orange star called Antares--which is the brightest star in the constellation Scorpio. There is a bright red "emission" nebula, a blue "reflection" nebula, and dividing the star clouds are the twisting knots of "dark" nebula.

GG03/CU04. This huge nebula is named "The Pelican" for its long pelican-like face and body. Perhaps it also looks like the prehistoric bird, the Pterodactyl. Looking closely you see that the face of the pelican is made up of cascading streamers and tendrils of mixed bright and dark nebulosity.

GG03/CU05. One of the most remarkably detailed clouds of nebulosity in the sky is The Trifid Nebula. The bright pink of the flower looking cloud is created as hydrogen gas is charged by the hot stars within it. The blue portion is not charged particles, but is surrounding dust reflecting the light of nearby bright blue stars. The entire complex is surrounded by a subtle wreath of blue nebulosity.

GG03/CU06. All of the nebulae we have been looking at are in our own Milky Way Galaxy. Galaxies are like "islands in space" made up of stars and nebulae. They are separated by vast distances of space from other "islands" of stars. Let's now look at some examples of beautiful galaxies that are visible from Earth. This galaxy is numbered M33. It is a nearby spiral galaxy seen nearly face-on.

It also contains many large nebulae like our Orion nebula. They can be seen in this photo as small pink regions.

GG03/CU07. Spiral galaxies have the appearance of spinning in space. This spiral, The Whirlpool Galaxy, shows us many long arms with twisted knots of pink nebula, bright and dim star regions, and dark dust lanes. It is about 35 million light years away, so the light that was recorded on film for this photo left the galaxy 35 million years ago--traveling two hundred million trillion miles! The yellow-orange glow next to the main spiral is actually a separate galaxy connected by a bridge of stars.

GG03/CU08. This is the well known Andromeda Galaxy. It is the largest close spiral galaxy to us at 2.5 million light years away. Large galaxies contain more than a hundred billion stars. The core of galaxies is often a yellow-orange color because it is made up of older, cooler stars. The cooler stars burn yellow to red. The outer arms are made up of younger hotter stars that burn more blue and white. Two small companion galaxies can also be seen in this photo.

GG03/CU09 - Galaxies are so far away, we normally cannot see their stars individually. We only see the collective cloud-like glow of their billions of stars. This galaxy, M101, has a very small core and very long arms. No two galaxies are alike, yet there are billions of galaxies in the Universe.

GG03/CU10 - Sometimes a single star in a distant galaxy will die with a tremendous explosion. This is called a supernova. There is so much energy in each single star that even though it may be in a galaxy 40 million light years away, the supernova can be seen as bright as a star in our own galaxy. This photo of M81 contains the supemova 1 993J which is marked by an arrow. Before the star exploded it could not be seen at all. A few months later it had faded again and no longer could be seen.

GG03/CU11 -This is what remains of a star that exploded in our own galaxy in the year 1054. It is known as The Crab Nebula because of its compact and intricate network of filaments and tendrils. This supernova explosion was recorded by Chinese astronomers who described it as a "guest star" that appeared, then slowly faded. A small portion of the original star that exploded is still in the center of the nebula and is called a pulsar. Pulsars are tiny, but extremely dense neutron stars that spin very fast and emit high energy radio wave pulses.

GG03/CU12 - As time passes the remnant debris ejected from a supernova travels further out into space. This photo of The Veil Nebula supernova remnant shows one side of a 30,000 year old supernova explosion. It still retains a fine filamentary structure in an arc that has traveled far from the original star.

GG03/CU13 - A star is an enormous nuclear furnace that continually fuses hydrogen atoms into helium. At some point it uses up all its hydrogen and quits functioning as a star. When this happens, depending on its mass, it can collapse and go supernova, or it can begin ejecting its matter more gently out into space. This latter type of dying star creates what is called a planetary nebula. The one in this photo is called The Dumbbell Nebula. It shows the red, yellow, and greenish-blue colors seen in this type of nebula.

GG03/CU14 - This is The Helix Nebula. It is the largest and closest planetary nebula. Because visual observations through telescopes appear black and white to the human eye, and because these nebula tend to be small and round, early astronomers thought they looked like planets and so named them "planetary" nebulae. The original star can be seen in the center of the nebula. All that is left is a small hot core of the original star.

GG03/CU18 - The next two slides are of unusual color phenomena of the Moon. This is a Total Lunar Eclipse. A lunar eclipse occurs when the Earth's orbit takes it between the Sun and the Moon so the Moon

is in the shadow of the Earth. As sunlight passes by the Earth it bends or refracts in our atmosphere and blue is removed. This dim red-orange light is all that is left to illuminate the Moon.

GG03/CU19 - At new moon, the Moon is between the Earth and the Sun. For a day or two before and after new moon, only a small crescent of the Moon is lit by the Sun. But the rest of the moon's surface is illuminated by sunlight that is reflected off of the Earth and back to the Moon. The result is called a Moon With Earthshine and is the ghostly blue-gray light seen in this photo.

The "Sombrero" galaxy.

GG07/GC03. NGC 224 (M31). A short exposure of the Andromeda Galaxy, class: Sb. This shows a concentration of stars in the central bulge and dust lanes close to the bulge. A dwarf elliptical galaxy is to the right and a satellite trail is beneath M31. NOAO photo.

GG08/GC04. NGC 224. A wide angle view of the entire galaxy made with CCD electronics and a Schmidt telescope. Blue stars in the spiral arms are apparent and a yellowish tint in the central bulge shows older stars. Satellite elliptical galaxies NGC 205 and NGC 221 are seen above and below the galaxy respectively. Distance: 2.2mly. NOAO photo.

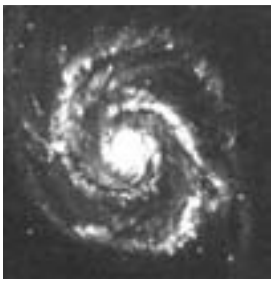
GG09/GC07. Large Magellanic Cloud. This is a visual photo of the LMC, a dwarf irregular galaxy in Dorado. The large red hydrogen cloud is the Tarantula Nebula. It is about 10 times more massive than the SMC and contains about 2 billion stars. Distance: 52kpc. NOAO photo.

GG10/GC08. Large Magellanic Clouds. This is a CCD image of LMC in Dorado. It is an exaggerated color image emphasizing red hydrogen regions. The Tarantula Nebula is prominent in the upper center of the image and is a site of active star formation containing many young supergiants. NOAO photo.

GG11/GC09. NGC 4594 (M104). This is a true color image of the Sombrero Galaxy in Virgo. This galaxy is nearly edge-on with a dark obscuring lane of dust evident. It is a class Sa but its central bulge is exaggerated here to show the fainter sections. Distance: 13mpc. NOAO photo.

GG12/GC11. NGC 5236 (M83). Direct visual image of the southern "Pinwheel" galaxy in Hydra, a type Sc spiral in a near face-on view point. Distance: 4.5mpc. NOAO photo.

GG13/GC12. NGC 5194/5 (M51 and M52). Historically, this is the first galaxy whose spiral structure was clearly recognized. The main galaxy, the "Whirlpool" is a type Sa face-on spiral and its companion is a small amorphous peculiar galaxy. Both are found in the constellation of Canes Venatici. These two galaxies passed close by each other several hundred million years ago interacting and distorting the near spiral arm of M51. Distance: 14mly. NOAO photo.



The "Whirlpool" galaxy.

GG14/GC13. NGC 9646. This is a face-on Sab galaxy in the constellation Cygnus. It has a poorly developed bar and well-defined spiral arms. Note the blue color of the spiral arms denoting young blue giant population I stars and the yellow center denoting older red giant population II stars. It is over 70,000 light years in diameter. Distance: 20mly. NOAO photo.

GG15/GC14. NGC 3627 (M66). This is a direct visual image of an Sb galaxy in the constellation Leo. Its spiral arms show the effects of tidal distortions of a past encounter. USNO photo.

GG16/GC16. NGC 4603. This is a computer enhanced image of an Sc spiral galaxy in Centaurus. Note its small nuclear bulge and open spiral arms typical of Sc galaxies. NOAO photo.

GG17/GC20. NGC 772. This is an unusual Sb spiral galaxy in Aries. One bright set of spiral arms projected above the galactic disk contain numerous blue supergiants. This galaxy is large measuring over 100 thousand light years across. Distance: 80mly. NOAO photo.

GG18/GC21. NGC 1199, NGC 1190 and NGC 1189. NGC 1199 is the large type E3 elliptical galaxy in the upper left. The face-on barred spiral galaxy is NGC 1189 and the lenticular type SO galaxy at the bottom is NGC 1190. The remaining smaller galaxies are much further away. Note the difference in colors of the elliptical and spiral galaxies. The elliptical galaxy is redder and the spiral galaxy bluer being composed of older red and younger blue stars respectively. True color CCD image. NOAO photo.

GG19/GC23. Southern Ring Galaxy. This is a direct photograph of a ring galaxy in Volans. Ring galaxies result from the collision of galaxies. Distance: 83mpc. NOAO photo.

GG20/GC24. NGC 5128. This is a class E0 peculiar galaxy in Centaurus known as "Centaurus A". It is a typical elliptical galaxy but with an unusual dark obscuring dust lane across it center. It is a strong radio and X-ray source and is the closest of the known active galaxies. Distance 4.3mpc. NOAO photo.

GG21/GC25. NGC 1275. This is a CCD three color image of a Seyfert galaxy in the Perseus cluster of galaxies. Violent activity in the nucleus results in the filamentary material seen being explosively ejected into space. It is a strong source of radio emission and may be the result of the collision of a giant elliptical galaxy and a smaller spiral galaxy. Distance: 71mpc. NOAO photo.

GG22/GC26. NGC 7625. This is an unusual Sa galaxy in the constellation Pegasus. It is slightly over 30,000 light years in diameter. The chaotic absorption feature just south of the nucleus, possibly due to dust, is rare. This may be more than one object, possibly galaxies in collision. Distance: 75mly. NOAO photo.

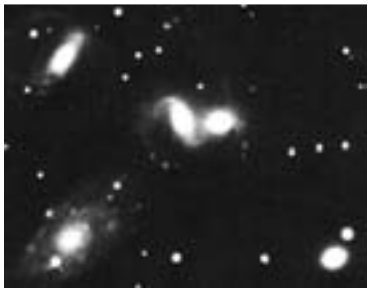
GG23/GC27. NGC 3310. This is an unusual Sbc galaxy in the constellation Ursa Major. It is called the "Bow and Arrow" galaxy because of its linear jet-like feature running from near the center toward the upper right, and crossing the pronounced arc. The central region is comprised of a confused inner ring and a very bright, off-center nucleus. NGC 3310 has been interpreted both as a violent ejection (the arrow) and as a merger remnant where a much smaller galaxy plunged almost directly into the heart of NGC 3310 leaving the arrow as a debris tail and disturbing the nuclear structure. Distance: >45mly. NOAO photo.

GG24/GC28. NGC 4567/8. This is a computer enhanced CCD image of two interacting Sb galaxies called the "Siamese Twins". They are found in Virgo. Bright HII regions appear along the contact point between each galaxy. Distance: 28mpc. NOAO photo.

GG25/GC29. NGC 7253. Although given only one identifying number, this is a pair of interacting galaxies. There appears to be much diffuse material between the galaxies and many internal dust lanes. The smaller member may be, in itself, three systems in contact. Three color CCD image. NOAO photo.

GG26/GC30. NGC 5394/5. These are interacting galaxies of the "M51- type". It is composed of a large inclined spiral (5395) and a smaller open spiral with a bright nearly stellar nucleus. The apparent attachment of the two was caused by their interaction. They are approximately 50 and 100 thousand light years across. Three color CCD image. Distance: 110mly. NOAO photo.

GG27/GC31. NGC 7752/3. These are interacting galaxies in Pegasus. Note how the arm of the larger galaxy extends to the smaller galaxy much as in M51. Although they are 30,000 light years apart,



"Stephan's Quintet."

they are still interacting. Three color CCD image. Distance: 150mly. NOAO photo.

GG28/GC32. Stephan's Quintet: NGC 7317, 7318a, 7318b, 7319, 7320. This is a collection of five galaxies in Pegasus. The CCD chip was not large enough to image all five though the glow of the fifth is seen on the far lower right. Four of the five show large red shifts while the fifth (below center) shows a low red shift. It may be interacting with the others. CCD three color image. NOAO photo.

GG29/GC35. NGC 4676a/b. This is a computer generated image of the two interacting galaxies, NGC 4676A, an SOp peculiar spiral and N/GC4676B, A SBap peculiar barred spiral, both in Coma Berenices. Streams of gas flow between the galaxies as detailed by the computer image. Distance: 88mps. NOAO photo.

GG30/GC37. This is the cluster of galaxies Abell 2199 including NGC 6166 in Hercules. Distance: >300mly. NOAO photo.

GG32/GC38. Unique color image of the giant arc concentric with the distant cluster of galaxies Abell 370. The arc is probably a highly distorted image of a distant galaxy produced by a gravity lens with Abell 370. NOAO photo. (See "Distant galaxies seen through cosmic lens," *Science News*, May 6, 1995, p. 287.)

GG33/A561. Faint planetary nebula (Ack 277-03.1), in Vela. Has no NGC designation as it wasn't discovered until 1966 (the New General Catalog was published in 1880s). This is a very faint and hard to photograph object (explains the graininess of the photo).

GG33/A562. NGC 1360 - a diffuse planetary nebula. Unusually featureless. The faint red smudge is probably traces of material ejected from the central star during the "red giant" phase. About 1000ly.

GG33/A563. NGC5189 - the Spiral planetary nebula. Astonishingly complex structure. The filaments are reminiscent of supernova (like the Crab nebula). About 3000ly. The term "planetary nebula" was first used in 1791 to describe spherical, green colored nebula - very visible, looking very planet-like.

GG33/A564. NGC 2736 - the Pencil nebula. This is a supernova remnant of an event that happened about 12,000 years ago. It's an expanding shock wave.

GG33/A565. NGC 6618 - the Omega nebula, named because of its shape which is rather like the Greek letter omega. It is also known as the Swan. In Sagitarius about 6000ly away. This nebula is "backlit," the star which provides the light being in and behind the material of the nebula yielding the crisscross structure on the right.

GG33/A566. R Aquarii and its nebula. This has a variable, symbiotic star pair (red giant and white dwarf) at the center. The dwarf draws material from the giant and occasionally ejects the surplus as the strange loops. The white dwarf also provides the energy (ultraviolet) which powers the curious red looped nebula seen estending east-west here.

GG33/A569. The Red Rectangle. Unusual class of nebulae surrounding mature, sun-like stars that are about to turn into planetary nebula. Not all pre-planetaries have these outbursts, and even when they do they only last a few thousand years - which is why they are rare. This particular one is an even rarer version with a binary star system at its center. Much of the dust is suspected to be diamond or diamond-like material.

GG33/A570. Shapley 1, a planetary nebula. This nebula is expanding at about 30km/s, and has a binary star at its center. The system is about 3500ly away. The shape is a torus (doughnut).

GG33/A572. NGC2442-3, a barred spiral galaxy in Volans. Unusually bright center. About 50mly away. It is clearly disturbed (numerous and bright clumps in the lower arm), most likely by a nearby galaxy neighbor with which it will likely merge eventually.

GG33/A573. NGC 5078 and distorted companion IC 879. This is a lens-shaped galaxy crossed by a distinct dusty band. Light through the band looks dimmer and yellower as does sunlight through the smoke of a fire (blue is dispersed). The two are interacting. One possible source of the dust is a spiral galaxy that fell into this galaxy millions of years ago.

GG33/A575. NGC 4945, a spiral galaxy. About 12mly away, and seen edge-on. One of the dustiest known.

GG33/CU15 - Some stars live erratically and die quickly such as the Wolf-Rayet star that created this nebula - The Crescent Nebula. Wolf-Rayet stars are very hot, fast living stars that eject their matter throughout their lives. There are about 200 Wolf-Rayets that have been studied.

GG33/CU16 - This is The Pleiades star cluster, also known as The Seven Sisters of ancient lore. To the unaided eye, only six or seven stars can be seen, but in telescopes over 300 have been counted. The blue clouds of nebulosity are left over from the creation of this young star cluster. Notice the unusual wind swept appearance of the surrounding nebulae.

GG33/CU17 - Surrounding the core of our galaxy are large clusters of tens of thousands of stars called Globular Star Clusters. One of the best known is M13 shown in this photo. It is in the constellation Hercules and is one of the most beautiful objects to view through a telescope.

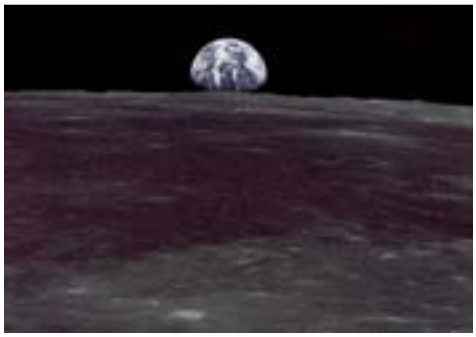
GG33/AS01. Spring thaw on Mars.

Web sites:

Solar system information:
http://seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html

Hubble Space Telescope images:
http://

NASA:
http://www.nasa.gov



Earth rise as seen from the moon.

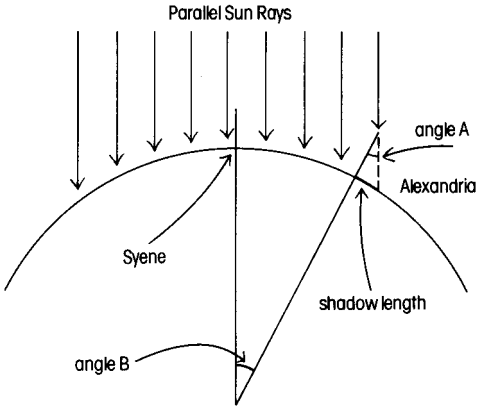
See also the Wow! facts of the universe (consult the Table of Contents).

Drawing the universe on 2 pieces of paper:

Tape two 8½x11 sheets of paper end to end. (1/16th inch = about 50mly; 22" = 17.6bly.)
Lay horizontal.
Sharpen a pencil as sharp as possible.
Place a dot about ½ inch from the right edge. This is our Local Group (10mly in diameter).
Our Milky Way is about 1/100th of that diameter, and of course the solar system a tiny fraction.
A 1/16th-inch dot covers about $3x10^{20}$ miles of space; earth is but $8x10^{3}$ miles in diameter.
Place another tiny dot just to the left of the first: nearest cluster of galaxies, M81, about 7mly away.
Place a third dot about 1/32nd of an inch from the first two in the direction of the center. This is the next closest group of galaxies, M101, at about 15mly away.
Place a dot about 1/32nd of an inch directly "up" from the first dot. This is the Virgo Cloud at about 20-30mly away.
Place the largest string of galaxies by making a 1½-inch wavy line about 1/3 the way to the left.
Randomly place additional strings of galaxies so that a very open spider's web pattern emerges.
Locate the most distant galaxy about 18½ inches to the left of the first dot.
Label the left hand edge: "background radiation."
There should be essentially nothing in the area from 18½ inches to the left hand edge.

Measuring cosmic distances:

a. angles on the earth, shadows cast by ancient monoliths and wells. (See the figure at right.)
b. triangulation from earth observations at either extreme position of the earth's solar orbit.
c. cepheids, stars whose brilliance is determinable by the period of the brilliance's variation; and then comparing the known brilliance to the observed brilliance, the difference being the diminishing of the brilliance by the square of the distance ($1/d^2$).



Eratosthenes concluded that angle A must equal angle B, which was 7°, and thereby calculated the circumference of the earth to be 25,000 miles (Syene to Alexandria was 500 miles).

The following two (unnumbered) pages are star charts for our area for 9:00pm this evening (the night of Session 2). One is marked "NE" and the other "SW" (at the bottom of the pages) indicating the direction of viewing. I've marked on these charts a few of the objects you've seen in the slides. The arc about a quarter of the way up from the bottom represents the horizon, below which objects are not viewable (at that time, anyway). Some of the objects (like the Large Magellanic Cloud) are only visible from the southern hemisphere. The charts were produced using SkyGlobe for Windows v2.0; if you'd like charts for any upcoming place and time, just ask Jamie.

If the Milky Way galaxy was a tea tray:

The sun would be a point about ½ way to the center of the tray.
The visible stars would be within 3mm of that point.
Planets would be so close to the sun that not even a microscope could resolve them.

Our Local Cluster would contain other trays, pie plates, marshmallows, cobwebs from a few feet to dozens of yards apart.

The closest other cluster, the Virgo Cluster, would be 100 yards from our tray.

The Coma Cluster would be 1 mile away.

The Gemini Cluster would be 4 miles away.

Other objects would be over 50 miles away.

Session 3: Discussing the Evolution of Cosmology (and Science)

"How often have I said to you that when you have eliminated the impossible, whatever remains, however improbable, must be the truth" -The Sign of Four

1. Review the Evolution of Science timeline (begins on page 18).

2. Like the evolution of life, the evolution of science picks up speed exponentially, building rapidly on prior work. Progress in communications technologies fuels this fire, as does computing technology.

3. The future of space travel technology: nuclear fuels (some today), solar sail, interstellar ram jets, wormholes, baby-verses...

4. The scientific method has been successful (that is, has lead to confirmable predictions and/or to technologies that work). Some say that's because nature gets the final say through experimentation.

5. The evolution of science has lead us beyond man's natural ability to sense information. Our bodies naturally accept only a narrow range of information (energies) impinging on it. We see only to 1/100th of an inch. From touch and sound (the lowest energy levels we sense) to vision (the greatest), we sense little compared to what scientific instrumentation has opened up.

6. The evolution of life was not initially intended to be a significant portion of this course, but it became so when the issue of whether the universe is itself alive and evolving surfaced. Likewise, computer development surfaced midstream as relevant. Also, life being the ultimate in complexity begs us to ask if a "Designer" is implied or evidenced.

7. Computer technology is within reach of being able to process and store as much information as the human brain does (10^{15} bits at 1,000 teraflops low end, 10^{17} bits at 100,000 teraflops high end). At current pace, the technology should be there by 2010. By 2030, a machine of that capacity will be available at desktop prices (couple thousand 1995 dollars).

8. Draw a line on the chronology where your birthday is.

9. What strikes you as significant?

Session 4: The Big Bang

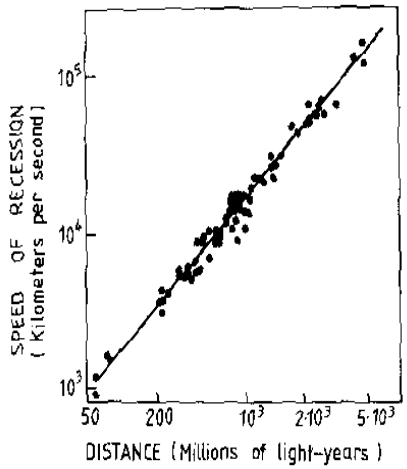
"It has long been an axiom of mine that the little things are infinitely the most important" -A Case of Identity.

"In the beginning God created the heavens and the earth" (Genesis 1:1), "but no one was there to see it" (Steven Weinberg in *The First Three Minutes*).

"Do you have a destiny, or do you float around accidental-like on a breeze? I think both." Forrest Gump.

Preparation: 1. Ask people, "How did the universe begin?" Be prepared to report on the responses you get.
2. Jot down three questions you have concerning the origin of the universe or anything in it.

Trace the first second and beyond. See the Big Bang, page 4.



Hubble's Law.

Confirmations(!) and Questions(?) of the Big Bang:
- Hubble's Law! (Space itself is expanding...)
- Microwave Background Radiation (MBR)!
- Ripples in the MBR!
- Hydrogen:Helium ratio!
- Black holes? (Look for Hawking Radiation?!)
- Closed universe?
  - Rates of expansion fairly well known:
    - About 5-10% every 1 billion years.
  - Distances to far objects not accurately known.
  - Relax; at least 10, maybe 100, billion years to go regardless.
  - Density of the universe is a big question (only 1% in stars, 10% if we include inferred matter).
  - Initial acceleration had to be within 10^{-35} of the critical speed for us to be here!
    - Otherwise, nothing would come together, or there'd be no time to develop.
- Why this universe (see coincidences below)?
- Why so isotropic (the same in all directions)? But with local irregularities (e.g. galaxies and stars)?
- Do we get something for nothing with the Big Bang, violating the laws of conservation?
  - With the mass energy of the universe being proportional and opposite in sign to the gravitational potential energy, no conservation law need be broken for spontaneous appearance assuming a finite universe.
- Does it explain features of today's universe, like the clustering of galaxies?
- Who or what caused the Big Bang?

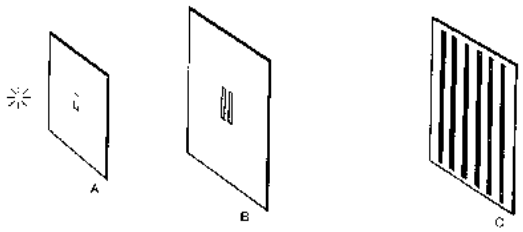
Meanings of the Big Bang (BB):
- Doesn't preclude a Creator; merely narrows the time frame for action.
- Time before the BB is meaningless, nothing can cross the BB barrier.
- Gravity is king at very large scales, quantum mechanics at very small.
  - From 10^{25} meters to the boundary of the universe, to 10^{-16} meters in the land of quarks.
- Was it good? Or, can science comment on its goodness?

Space itself is expanding.

Quantum Mechanics:

Forget the "billiard ball" image.

Particles are both particles and waves. Electrons aren't just particles, they're waves, too. Light (photon) isn't just a wave, but a particle also. In the two-slit experiment, photons evidence wave interference with a bright light. With dimmer light, individual photons can be seen hitting (particle) the screen, but still in an interfering pattern. And with just one photon, there will be a pattern - it interferes with itself!



Young's two-slit experiment.

Some suggest the particles are waves on Monday through Wednesday, particles Thursday through Saturday, and on Sunday we all rest. An electron's waveness may best be described as a probability cloud (Neils Bohr's work). It is "smeared out" until by observation it is forced to "make up its mind," or collapse into a particle at a particular place and time. There is no reality until it is observed, and that observation causes fundamental and unknowable disturbance to the system. In this sense, we create by observing! This leads us to the Schroedinger's Cat dilemma. And how qualified must the observer be, how high up the complexity ladder?

Stars

Gravity held at bay by nuclear fusion.

When fuel is exhausted, Pauli Exclusion Principle (electrons) takes over counteracting gravity, making white dwarfs if below 1.5 solar masses.

Except Chandrasekhas shows that solar masses over 1.5 will overcome electrons Exclusion, and go to neutron Exclusion, making neutron stars, if less than about 3.5 solar masses.

Above 3.5 solar masses, stars may collapse into black holes.

Cosmic Coincidences:

1. Fine line or balance between expanding or collapsible universe.
2. 3D is perfect (2D makes the brain unworkable, 4D makes the earth's orbit unstable).

3a. The relative strengths of the four forces lead to the nature and stability of matter.

3b. The relative abundances of the elements are within a narrow "workable" range.

4. The manufacture of Carbon requires fine tuning, resonances right, between helium, beryllium (which is unstable yet a stepping stone to C), and carbon. Additionally, the next step, C->Oxygen is just out of resonance enough that ample quantities of C will persist.
5. Star light emission (highly dependent on exact charge of an electron, a constant) on which life depends.
6. Water. It can dissolve an extremely wide range of substances. It expands when frozen.

Nature's Laws are like the rules of Chess:

All we can do is watch.

We don't know all the rules.

Even knowing all the rules does not make one a good player.

The game is infinitely more complex than the rules would imply.

We can focus on an uncomplicated corner of the board.

We can test rules (like predicting where a red bishop may go; until a black bishops shows up...).

We can make approximations (we don't know why, but it seems a good idea to surround the king).

We assume that the rules apply throughout the game (time) and across the board (space).

Mathematics is the language of cosmology and physics. (What's the God language?)

Does our understanding of the Big Bang in any way diminish the mystery or awe of creation? Does understanding photons and light refraction lessen our appreciation of rainbows?

Exploring how the questions of the evolution of life and of cosmology relate (outline of Gribbin's book):

Many universes evolving (from black holes?); some "bearing fruit?"

Is the universe alive? Was it born? Will it die?

Where is the line between life and non-life? Somewhere between atom and cell, probably between phage and bacteria. Life is not possible without a system (in which to eat and breath).

Electron surrounds the nucleus, behaves as a wave. So do we, but our mass is so great that the wave-portion (determined as a Planck's constant relationship to mass) is ignorable at every day masses, but not at the particle level.

C (carbon) is particularly well suited to bonding, and bonding in more different ways than others. This is due to its 4 outer-shell electrons being exactly ½ that the outer shell "wants." Will form long chains, and rings, with side connections to other atoms, or more chains. DNA is just a long, double C chain. Amino acids -> protein -> DNA

C, H, N, and O are the abundant products of star nucleosynthesis. The diversity in organic compounds is due to number of different combinations, not a large number of fundamentally different constituent elements.

Earth is 4.5byo. Life is 4.0byo. Only .5by to produce life?

Maybe from interstellar dust, or better, soot. The CHNO + energy (radiation) could do it.

1968 NH_3 discovered in space (by spectral analysis in the microwave energy band (1.26cm). Then H_2O was discovered, then formaldehyde (H_2CO). Maybe the "seed" of life came in on a comet. 10,000 tons/year of organic compounds rained down from space - which would accumulate to the total tonnage of life mass on the planet in 300,000 years.

Then they discovered C-based molecules in the background radiation; it's everywhere! In fact, the warm puddle start or the earthly bio-soup is mostly outdated, replaced by the notion that life's precursors developed in interstellar space.

Space has formic acid (HCOOH) and methanimine (H_2CHN) which combine to form glycine (NH_2CH_2COOH), and amino acid - one step from life! Life everywhere/anywhere in the universe may well have evolved from interstellar pools of stuff. This extends the time to develop replicators from .5by to 14by.

1990 pyrene ($C_{12}H_{10}$) is discovered in space.

One wavelength absorption pattern has been explained by cellulose, a polysaccharide!

DNA is an alphabet of four letters: A, C, G, T. A chromosome has 5 billion pairs, times 46 in a human equals 20 billion bits of information to describe the making, care, and maintenance of a human. This could store about 3 billion letters (500 million words; 5,000 books at 400 pages each with 300 words to a page.) A lot to replicate error-free among 10^{15} cells in your body, let alone from generation to generation.

Cells to protect the replicating machinery.

Photosynthesis. Chlorophyll. We see green because the red and blue energies are absorbed. This is curious in that our sun radiates more energy in the yellow/green, and there are much more efficient processes possible. Some plants do use these energies, but pass the "output" first to chlorophyll, an unnecessary step, and then on down the chain... A speculative notion is that photosynthesis by chlorophyll developed in space where red and blue energies dominate. Parts of the chlorophyll molecule (porphyrin family rings) explain an absorption line observed by astronomers (at 443nm). Banded iron formations at the 2bya line indicate a burst of oxygen on the scene; one of the world's first environmental disasters (to the critters that could not tolerate free oxygen).

The energy available to oxygen users, and the development of sexual reproduction quickened the pace.

Moon:Earth ratio is 10x normal moon:planet ratio, and our moon is much closer. This is very significant in that this creates tides, which may have had a big influence on the development and/or evolution of life.

Life complex, universe simple.

1000x as many cells in your body as stars in the Milky Way.

If the entire universe were a black hole, light might travel for billions of years but eventually loop back to our feet. Space-time is enclosed by gravity (dark matter included).

Why are things as they are?

Atoms are the size they are due to particle masses and relative force strengths.

Planets are set by electric forces (pushing apart) and gravity (pulling together).

Gravity and electric forces balance well at the earth's surface. 220lbs is the threshold for becoming likely that gravity will cause a broken bone (atoms separate) in a fall.

Why is CHNO important to the universe (as opposed to life)? Nucleosynthesis? Main sequence stars? The Milky Way?

Like this planet, by forces of life, the Milky Way is far from equilibrium, and staying that way.

Why the order, the spirals, in a galaxy? These patterns persist for scores of rotations.

The weak force is "just right" to allow neutrinos to maximize the dispersal of supernova stuffs.

Supernova are somewhat rare (1 per 10 years); still, several 100 million since our sun was born.

Anyone point is the galaxy is exposed to supernova forces every few million years.

Spiral arms are by density waves (cars on the beltway behind a big truck when seen from above).
This balance requires narrowly confined particle and force parameters.
Keeps itself in equilibrium. A halo surrounding the galaxy helps, but eventually a bar develops.
Self regulating system! Life, or just a "thermostat"?
Supernova every 100K to 1 million years keeps the galaxy going..., like cells in a body?!
Elliptical galaxies once thought to be old due to old red stars in them. Now seems that these are the result of galaxy collisions which had old reds in them. Ellipticals are very big, further evidence of merger; computer collision models bear this out. Is this combining analogous to "devouring?"

Star nucleosynthesis: H
He
C
O
Si
Fe (lowest energy)

lead/uranium side
_____
____
___

Our universe is a black hole - eventually we collapse, nothing gets out. Could our universe be one of many, each a black hole of another universe? Could universes be evolving, each with slightly "mutated" laws of physics, some that make for stable galaxies (and life), and others that do not?

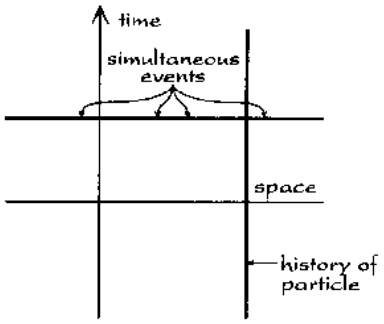
But then how did all that get started? That's where quantum theory comes in. The universe appears to have zero energy: negative gravity balances positive energies at the singularity. This could have been the quantum appearance of something from nothing, which probably happens a great many times but is so unstable that it recollapses to nothing quicker than the universe can "notice." But in our case, the laws were such that the inflation period took over before the gravitational collapse. Any size could come of this as x + -x is zero regardless of how big (or small) x is. These "wavicles," or fluctuations have been experimentally shown with pressures outside of two parallel plates. The ULTIMATE FREE LUNCH: a universe from nothing. It is technologically feasible to start a universe, a black hole, with what amounts to a super hydrogen bomb. In any case, a universe would eventually happen that would develop black holes - replicate! Those that are the most effective are those that have lots of baby universes. Life as we are familiar with it, simply takes advantage of that which is conducive to galaxy development.

The universe is one among many, is alive, needs no supernatural start, and has about 10^{20} other planets that could take advantage of the same laws and chemicals that are everywhere that earth did to produce life.

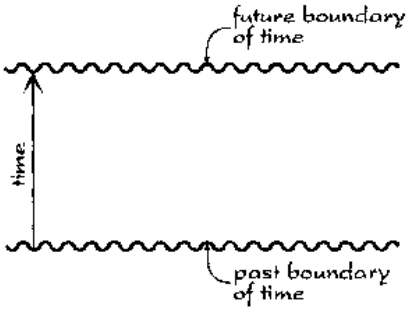
Jubilant astronomers unveiled humankind's most spectacular views of the universe, courtesy of the newly installed Advanced Camera for Surveys (ACS) aboard NASA's Hubble Space Telescope. Among the suite of four ACS photographs to demonstrate the camera's capabilities is a stunning view of a colliding galaxy dubbed the "Tadpole" (UGC10214). Set against a rich tapestry of 6,000 galaxies, the Tadpole, with its long tail of stars, looks like a runaway pinwheel firework. Another picture depicts a spectacular collision between two spiral galaxies -- dubbed "The Mice" -- that presages what may happen to our own Milky Way several billion years from now when it collides with the neighboring galaxy in the constellation Andromeda. Looking closer to home, ACS imaged the "Cone Nebula," a craggy-looking mountaintop of cold gas and dust that is a cousin to Hubble's iconic "pillars of creation" in the Eagle Nebula, photographed in 1995. Peering into a celestial maternity ward called the Omega Nebula or M17, ACS revealed a watercolor fantasy-world of glowing gases, where stars and perhaps embryonic planetary systems are forming. April 30, 2002.

The Time-Space Cone of the Big Bang

(from Davies' The Mind of God)

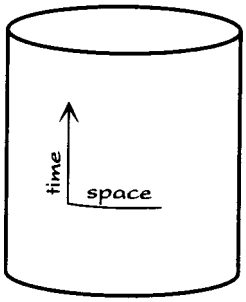


Start by representing space-time on a diagram with time drawn vertically and space horizontally. Space is reduced to one dimension for these purposes. A vertical line then represents a point in space throughout time, and a horizontal line represents all space at one point in time. Drawing this on a piece of paper may prove instructional...

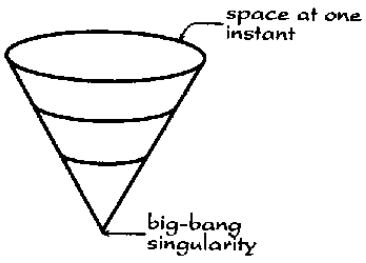


If time is bounded in the space (as the Big Bang suggests), then we can imagine a limit or an edge on the paper at the bottom. There may also be a future boundary of time; in any case, there certainly is a limit as to how much time as "happened" so far.

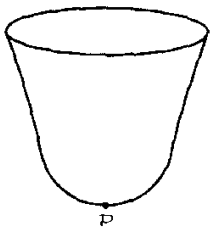
Then, if we roll the sheet into a cone horizontally, we may begin to understand Einstein's notion that space may be infinite yet bounded. A horizontal circle would represent all of space at a given time. (The two dimension analogue would be a sphere, and the three dimensional analogue a hypersphere which is very difficult to imagine but perfectly well-defined and understood mathematically.)



To represent the expansion of space, turn the cylinder into a cone. The point at the bottom becomes the singularity when all of space occupied one point at the beginning of time. An abrupt point would indicate that space and time popped into being abruptly together.



Quantum cosmology, however, holds that the very bottom of the cone is not pointed, but rather rounded. The point at the bottom is replaced by a hemisphere, the diameter of which is the Planck length (10^{-33} cm), small by human standards but infinitely bigger than a point singularity. Above this hemisphere, the cone opens "normally." In that hemisphere, time begins to bend around into space. Or put another way, time gradually emerges from space. Time is still bounded in the past, but there is no obvious first moment ("P" in the diagram looks like a first moment, but that is only an artifact of the drawing; there is no more of a first moment here than there is a first spot on a globe).



The upshot of all this is that according to the Hartle/Hawking theory, there is no origin of the universe, and that does not mean it is infinitely old. Time is limited but has no starting point. Creation *ex nihilo* becomes a matter of actualization of quantum possibilities.

Session 5: Historical Notions of God

"Whence arises all that order and beauty we see in the world?" - Isaac Newton

Preparation: Read the Chronology of the Evolution of the Concept of God (see the Table of Contents), and mark, circle, or otherwise note those concepts which appeal or make sense to you.

Share favorite concepts of God.

Review the Chronology of the Evolution of the Concept of God (see the Table of Contents).

Not all views of nature and religion suggest an origin, therefore none need be explained. The best example are the cyclically oriented views, including rhythms of the seasons, starting calendars over with each dynasty, and the Hindu cycles ranging up to the life cycle of Brahma at 311 trillion years. Even today, some cosmologists theorize cyclical big bangs and big crunches.

Judeo-Christian doctrine was among the first to depend on linear or progressing time (as opposed to cyclical). A fundamental concept is that God did create the universe at some point, and that events are unfolding and progressing toward a future (the Fall, the Covenant, the Incarnation, Resurrection, Second Coming...). Another critical feature is that God is separate from His creation.

Ways of relating God and Creation:

1. "Eternal" can mean one of two things: forever in time, or totally outside time.
2. Deism = God starts the universe off and sits back and watches.
3. Theism = God creates and stays involved.
4. Pantheism = God and the physical universe are one and the same.
5. Panentheism = the universe is a part of God, but not all of God.
6. God created from pre-existing stuffs (e.g. pagan creation myths), or
7. God created *ex nihilo* (from nothing), as in the current Christian doctrine.
8. God of the Gaps = using God to explain what science can't. This is very unstable as science tends to squeeze God out as it explains more and more.
9. God as: designer, creator, mathematician, mind, the orderer, necessary, simplest being...

Could the universe create itself? Or did God cause the Big Bang?

Other miscellaneous thoughts:

God has always been a call to action.

Historical monotheism calls for mercy not sacrifice, and compassion rather than liturgy.

Christians who have focused on an anthropomorphic vision of a FIRST CAUSE who created the world in some way similar to how we might do it, are confused by the separation of science and religion. This separation says

the religious descriptions of creation are symbolic expressions of spiritual and psychological truths, not scientific truths. Creation ex nihilo was not an official doctrine in Christianity until the Council of Nicaea in 341AD. The challenges of science may shock the church into a fresh appreciation of the symbolic nature of scripture.

The God of the Mystics is making a come back. Note the current growing interest in Yoga, meditation, and Buddhism. This God is not easy to approach or apprehend. This mysterious and subjective experience takes science out of the issue. This imaginative process is not unlike an art form. It gets us beyond simplistic notions of God, to higher states, if you will.

Human beings have always created faiths for themselves. They create new ones when needs be. They naturally cultivate the sense of wonder and the ineffable significance of life.

There is probably more similarity to notions of God over the eons by monotheistic peoples than difference.

The most primitive, and monotheistic, gods were more spirits; the peoples were surrounded by the unseen. Otto (German theologian) suggests that this spirit, numina, is basic to religion, even more basic than explaining creation and providing a basis for ethical behavior.

Abraham/Isaac/Jacob's God was familiar, day-to-day, present and involved, much like the gods of the Golden Age in Greece. They came and went, acted, participated. Epiphanies (God taking human form) were commonplace.

Myths abound regarding the rhythms of nature. Gods simply kept the system going; ensuring fertility and stability.

Chinese dynasties were cyclical Hindu cycles go up to one hundred years of Brahma, or 311 trillion years!

Judaic notions rejected cyclical nature, opting for a god that created everything at a moment, and things progress unidirectionally from there. God is separate from the Creation.

Prophet discovered Yahweh was the only god. Righteous people were to make him known (Abraham covenant). There are no other gods.

Prophets discover that Yahweh is not only their god, but the god of all nations. And he used all nations to bless or curse other nations.

Plato's Forms an Ideas play into development of monotheism. Thinking is not so much what we do, but what happens to the mind.

Yahweh transcends nations, is the god of all people, is alone as creator of heaven, earth, and human beings.

God alone is necessary; He created ex nihilo (out of nothing). Omnipotent.

creatio continua - lessens distinction between creation and conservation of the world.

Monotheism brought intolerance (my one god is better than yours...) during the Axial period. Paganism was very tolerant, almost expectful, of others' gods. Unlike the Inn, the pantheon was never full. Hinduism and Buddhism continue the idea of transcendency above the gods. This development of monotheism also marked the beginning of GOD AS MASCULINE, and his religion would be managed by men, unlike earlier days when women were powerful, too, such as Esther and Judith. This period of monotheism development must have been rocky. "Yahweh alone" (Deuteronomy 6:4-6, the shema) meaning the only one permitted to be worshipped, became interpreted by the Jews today as one and unique.

Is God dependent upon man to act in this world?

Judaism was born with Yahweh, the one and only god, about the time of Isaiah II. No rational claim was made, Yahweh was simply accepted as the answer to despair, the provider of hope. Yahweh was not cozy, however; he was beyond the human mind.

P introduced the idea that God cannot be seen. We experience an afterglow of divine presence, which is not to be confused with God himself. This is the glory (kavod) of Yahweh. P also provided the Genesis 1 creation story, drawing on Enuma Elish. Things did come from an abyss, but there was no struggle with other gods. No gradual emanation, rather an effortless act of will. Man was created not as an after thought, as in the Babylon story, but as the climax and in the image of God to carry on His creative tasks. CREATOR AND RULER. When P says God rested on the Sabbath, and calls his people to do the same, it was a call to live the divine life.

J.B. Phillips' offerings as to how we perceive God (from his book, <u>Your God is Too Small</u>).

Resident Policeman
Parental Hangover
Grand Old Man
Meek and Mild
Absolute Perfection
Heavenly Bosom
God-in-a-Box
Managing Director
Second-Hand God
Perennial Grievance
Pale Galilean
Projected Image
God in a Hurry
God for the Elite
God of Bethel
God without Godhead

Clues to Reality
Focus
Life's Basic Principles
Christ and Sin
Reconciliation
Demonstration
Abolition of Death

Session 6: How Science and Religion Operate / The Creation Story

"O Lord, how manifest are Thy works! In wisdom Thou hast made them all. When Thou sendest forth Thy Spirit, they are created." (Psalms 104:30)

Preparation: Read the following list of characteristics, and indicate by check marks whether science, religion, or both apply. Think of the meaning as opposed to just the terminology.

Science	Religion	
_____	_____	works with data.
_____	_____	has theories.
_____	_____	is a path to true knowledge.
_____	_____	can show fundamental realities.
_____	_____	develops models.
_____	_____	has revolutions (paradigm shifts).
_____	_____	is subject to revision, tentative, incomplete.
_____	_____	counts on faith.
_____	_____	is subjective.
_____	_____	is objective.
_____	_____	is rational.
_____	_____	is based on personal judgment.
_____	_____	utilizes criticism.
_____	_____	has traditions.
_____	_____	is more of a way of life.
_____	_____	involves pluralism.
_____	_____	is participatory.
_____	_____	is evolving or developing.
_____	_____	develops laws.
_____	_____	involves revelation.

Sensing the Creation story. While the story is read, jot down what you sense or feel that God or the writer is trying to get across. What are the key points? The space below is for your notes and thoughts:

Discussion points regarding the Creation Story:

God created purposefully and freely. God is sovereign, transcendent, willful. The world is dependent.
God orders and arranges. The world is good, orderly, intelligible.
"The heavens and the earth" means everything (whether expanding or not).
Creation was by the one God, not a fight between good and evil, not any of the pagan gods.
Creation was by the God of the Covenant and the Liberator of the slaves.
"The earth is the Lord's and the fullness thereof..." Psalm 24:1-2.
God confronts Job about the Creation, Job 38-41 (quite the lecture, actually):
    The wonders of God's creation are beyond our grasp.
    Human understanding and divine understanding are vastly different.
    Our power and God's cannot be compared.
    Human values and God's are worlds apart.
    The Creator cares about, loves, Creation.
Our response is wonder and worship. The Bible does not attempt to explain Creation, but exhilarates in it. They answer the questions of the heart and ask for response.
The word *genesis* is Greek for "beginning," in Hebrew "in the beginning."
Genesis 1:1-2:4 is a carefully worded poem of praise to God containing the accumulated faith of a covenant people.
The second creation story (Gen 2:4-25) is very ancient, recited for centuries over fires; also a story of faith. (Adam and Eve story.) Deals more with mankind's need for God as opposed to sin.
The creation psalms are songs of worship, chanting beauty, order, and wonder.
Jews are surprised by Christian tendency to literalize the creation poetry.
Statements of faith, not science.
God acted, and is continually acting.
What can we say about creation? It was good; it was very, very, very good!
In a brief phrase "he made the stars also," the galaxies, clusters, and superclusters are made!
Made in the image of God?:
    We are to enjoy and be satisfied with what we are.
    We are to be good stewards.
Describe a time when you felt such wonder and majesty that you could only praise God. Over what?
    Mountains, trees, sunsets, sex, love, music...
    Try to *see* something by next session that you haven't noticed or appreciated before.
If God created the world for our benefit, what does that say about the character of God?
An important notion is that we can and should rest on the 7th day. God will care for us (as the lilies of the field which neither toil...). Even God rested on the Sabbath.

Should we worry more about nuclear proliferation or religious fervor proliferation? (This was a note I made during this session's discussion in 1995.)

Genesis' initial conditions:

1. It was dark upon the surface of the ocean.
2. The earth was formless, disorganized.
3. The earth was void or empty.

The order of events in Genesis worded more scientifically:

1. Creation of the physical universe (space, time, energy, matter, planets, galaxies, etc.).
2. Transformation of the earth's atmosphere from opaque to translucent.
3. Formation of a stable water cycle.
4. Establishment of continent(s) and ocean(s).
5. Production of plants on the continent(s).
6. Transformation of the atmosphere from translucent to transparent (Sun, Moon, stars are visible).
7. Production of small sea animals.
8. Creation of sea mammals.
9. Creation of birds (possibly same time as #8).
10. Making of land mammals.
11. Creation of mankind.

Uses the simplest of terms.
Focuses on only the highlights; selective (details, such as dinosaurs, excluded).
Purpose is to demonstrate God's miraculous power.

The Bible and Science/Nature – "dual revelation"

Notes from Hugh Ross' The Fingerprint of God

Bible verses that teach God reveals through His creation:

Job 10:8-14	Psalm 50:6	Ecclesiastes 3:11
Job 12:7	Psalm 97:6	Habakkuk 3:3
Job 34: 14-15	Psalm 98:2-3	Acts 17:24-31
Job 38-41	Psalm 104	Romans 1:18-25
Psalm 8	Psalm 139	Romans 2:14-15
Psalm 19:1-6	Proverbs 8:22-31	Colossians 1:23

Fundamentalism, in requiring "young earth" interpretations of scripture, have alienated many who relate even on the simplest of levels to scientific discoveries and understandings. Ross argues that scripture and science go hand in hand, and that both reveal truths about God.

Evidence for "long creation days" (pp. 146-155):

1. Genesis 1 fits the form and the function of a Biblical chronology.
2. A long period of time is clearly acceptable with the definition of yowm, 'ereb, and boqer.
3. The unusual syntax of the sentence enumerating specific creation days suggest indefinite time periods.
4. The 7th day in Genesis 1 and 2 is not closed out.
5. The events of the sixth day clearly cover more than 24 hours.
6. The wording of Genesis 2:4 suggests a long time span for the creation week.
7. In describing the eternity of God's existence, Bible writers compare it to the longevity of the mountains or of the "foundations of the earth".
8. Truthfulness and a purpose to reveal truth, both in the creation and the written Word, are fundamental attributes of God. He does not lie.
9. The Bible affirms that the creation reveals God's existence, His handiwork, His power, and His divine nature.
10. The Bible writers' statements about the vastness of the universe also serve as indicators of its age.
11. The Sabbath day for man and Sabbath year for the land are based on analogy with God's work week.
12. The onset of "death through sin" does not restrict the length of creation days.
13. The subjection of the creation to "its bondage of decay" does not restrict the length of creation days.

Bogus evidence for a "young universe" based on faulty assumptions, faulty data, misapplication of principles, laws, and equations, and ignorance of mitigating evidence (pp. 155-159):

1. The continents erode too quickly.
2. The earth's magnetic field decays to rapidly.
3. The sun burns by gravitational contraction and is, therefore, relatively young.
4. The galaxy clusters are not dispersed.

"Divine craftsmanship" – nature reveals not instantaneous mass production, but rather of time and attention to detail, of infinite care and delight. "And God saw that it was good."

Compare and contrast science and religion (notes from Barbour's Religion in an Age of Science):

a. The success of the methods of science.

The scientific method is the only path to knowledge?

Matter (and energy) is the fundamental reality?

Biblical literalism (where differ from science, it's metaphorical)

Galileo, "the book of nature and the book of scripture are both of God."

Rejuvenated by 1970s and 80s fundamentalists, needed as a mainstay in this world of moral confusion and rapid cultural change.

Alternatives: treat science (human observation) and religion (revelation) as totally separate.
indirect interactions and boundary issues (dialogue).
integration.

Religious experience, story, and ritual are the data of religion, and belief the theories.

imagination ----> concepts, beliefs -----> beliefs influence
analogies | experience and
models <---- religious experience <------- interpretation
story and ritual

Religious experience: numinous experience of the Holy (awe, reverence, being grasped)
mystical experience of Unity (meditation, joy, harmony)
transformative experience of reorientation (guilt to forgiveness)
courage in facing suffering and death
moral experience of obligation (morality)
experience of order and creativity in the world

Strength of a (scientific or religious) theory: agreement with data, coherence, scope, and fertility.

Truth: correspondence, coherence, pragmatic.

Science does not lead to certainty; always subject to revision, tentative, incomplete. But it does offer solid testing and evaluating procedures.

Christianity's data: The Creation of the World, creator, psalms, hymns
The Covenant with Israel, liberator and redeemer
The Life of Christ, savior

Models are analogical, extenders, intelligible; probably looser, broader, more multiplicit and less subject to change in religion.

God as: Ruler, Father/Mother (agape, Creator), Lover (Eros, Savior), Friend (philia, Sustainer)

Paradigms - set of conceptual and methodological assumptions, framework, community

A major shift is a "revolution."

In science and religion: data are paradigm-dependent, paradigms are more resistant to falsification (than theories, more likely to call on auxiliary assumptions, ad hoc ideas, or anomalies), and their are no rules to choose one over another (Barbour, pp. 53-54).

Christianity: Greek/Alexandrian, Latin Augustinian, Medieval Thomistic, Reformation, and Modern-Critical. Core belief that all suffering was deserved (God's justice) used auxiliary assumptions to explain apparent injustice - until Nazi holocaust.

Tentativeness Vs commitment.

Faith, but not blind faith. Stages of Faith (Barbour, pp. 63+). Religious faith is more dependent on personal, all encompassing involvement than science. Even divine revelation is not complete until received by fallible humans.

Science and religion both: objective and subjective
rational and personal judgment
criticism and tradition
tentative and committal

Vary more by degree than by fundamentals: but religion seems alone with story and ritual, non-cognitive attitudes, personal transformation, and revelation in history. Both are accused of being Western-laden, sexist (access, research topics)

Religious pluralism (global) is more profound than that of science. With the former, agreement is more elusive and the consequences of disagreement greater.
Attitudes: absolutism, approximations of truth (where one's own is the closest), identity of essence, cultural relativism, and pluralistic dialogue.

Religion is more a way of life than is science (more pervasive).

Rational argument is not a single sequence of ideas (like a chain as weak as its weakest link), but rather many ideas woven where it's stronger than its strongest strand.

b. A new view of Nature.

Paradigm shift from Newtonian to Quantum. Nothing is absolute, determinable, or reductionist.
The atom of quantum theory can't be "pictured" (wave/particle duality).
Quantum: Complementary (observer/participant)
Indeterminacy: human ignorance, experimental/conceptual limitations, or fundamental "property" of Nature)
System-level laws (holistic, a bound electron is a state of the system - not an independent entity).
Indeterminacy: Life? Human Freedom? God's action in the World? (pp. 116-118).
New physics and Eastern mysticism/religions, metaphysical.
Wholeness (Brahman in India, Tao in China).
Yin/Yang.
Dynamic, ever-changing = life is transitory
Barbour says overstressed similarities and ignored these differences:
undifferentiated unity Vs highly differentiated science.
wholeness to the exclusion of the particles.
time of science Vs timelessness of mysticism (and western religion).
different goals (science Vs mysticism), different realms.
There are some metaphysical implications of the new science:
Temporality and Historicity (things take time, and leave a history)
Chance and Law, indeterminacy.
Wholeness and Emergence, higher-level laws are important, non-reduction
Spirit, God's presence and activity in the world, explains creation and redemption as two aspects of a single divine purpose and activity.
Genesis: looking for scientific information is bad science and bad theology
Human experience behind Creation: 1. dependence, finitude, contingency, 2. wonder, awe, gratitude, 3. interdependence, order, beauty in the world.
Theological affirmations: 1. world is good, orderly, coherent, intelligible, 2. dependent on God, 3. God is sovereign, free, transcendent, purposeful, willful.
Intent was not to exclude science, but to exclude the nature gods of the time.
New Cosmology: design, chance, necessity? Why this "reality?"
Intelligible?/Contingent?
Torrance: God is infinitely free to create, or not. We can discover the order only by observing (can't be deduced out of some necessity or set of rules).
Einstein: Deep rational order, necessity of events, no personal arbitrary God.
Polkinghorne: God is the common ground of rationality. Orderliness can be understood as God's faithfulness. Invokes early Christian concept of *logos*, combining Greek idea of rational order with Hebrew idea of the active Word of God.
Contingencies: Existence - why is there anything? Relates to *ex nihilo*.
That the universe is here is the datum of theology, the details are irrelevant.
Boundaries - why a beginning of time, an edge to the universe? Relates to continuing creation.
Laws - why these laws of nature? Nothing is predetermined (quantum), God is not just a clockmaker. There are higher level laws that arose without disobeying fundamental laws, but that were not "given" based on those fundamental laws.
Events - fundamental indeterminacy given quantum theory. God's immanence and participation.
God is both eternal (character and purpose) and temporal (affected by interaction).
Significance of Humanity:
Immensity of time and space. Universe must be old and big to develop heavy elements and have planets with life emerge. Complexity and consciousness may be better "significance" standards. Mid-size entities (not atoms or galaxies) seem to be better suited for "higher levels."
Interdependence. We are both interconnected with the universe and cut off from distant parts.
Life elsewhere. Most scientists are open to that. Logos not confined to expression in Christ alone. Redemption may be revealed in other ways, to other worlds, in ways appropriate to "them."
Chance and Purpose. This is not incompatible with theism, even if we don't say that God is really controlling all the quantum chance happenings. Natural laws, including chance, may be instruments of God's intentions. There can be purpose without an exact predetermined plan. The Gospel does not promise us immunity from life's chances (hardship, suffering, catastrophes, etc.), but rather the courage to affirm life in spite of them knowing that God's love is with us in the midst of them.
Visions of the future:
Myths of a cyclical nature.
End-of-time myths.
Early prophets (Amos, Micah, Isaiah 9-11) hope was dramatic intervention by God.
Christ - Kingdom of God, mostly future, but some "in our midst" references. With the passage of time, there has arisen diversity in Christian expectation. Some take Revelation literally (a time-specific final conflict).

Some speak of it metaphorically as a reason for urgency to accept God's rules, to "build his Kingdom" here and now.

Science says: open, Big Crunch, Comeback (Hindu cycles), current expansion appears to have 100 billion years to go (though our sun only 5-10 billion).

Does the end of humanity greatly effect our value? Each entity has 3-4 values:

1. intrinsic value of the moment.
2. contribution to the future (near and distant).
3. ongoing contribution to the life of God.

(4. conscious survivors of death.)

Only #2 is partly effected by an end to the universe, or our planet.

Evolution:

Darwin's: variants, natural selection.

Challenged Christianity 3 ways:

1. Biblical literalism (though not a big problem to many)
2. Human dignity, no sharp lines between us and them animals.
3. Design (did God design the eye, or did an impersonal, natural process)

Punctuated equilibrium (bursts of species versus stasis, degrees of time).

Nonadaptive change: detrimental changes (antlers get too big), genetic piggy-backing of superfluous traits, genetic drift (chance survival due to environmental change)

Multilevel: kinship, altruism, look at species as well as individuals.

Active role of genes. Genes not only lead to proteins, but proteins can effect genes.

DNA: four letters (ACGT), three-letter words (amino acids) combine to form thousands of varying-length sentences, each sentence a protein. All living things from microbes to humans use the same DNA system.

Origin: sparks in a soup, meteorites, crystals in clay replicating.

Redundancy (repeated information) and Rules (allowed combinations).

Chance: mutations, recombinations, drift, climate...

Directionality: dice are loaded, built in constraints, modular structures are relatively stable which conserves advances. Think of a gear which can go randomly in either direction, but has a ratchet that tends to inhibit movement in one direction.

Hierarchies:

Genealogical: gene, organism, species.

Organizational: atom, molecule, cell, organ, organism, population, ecosystem.

Entities at one level share properties with other entities at that level, but little in other levels. Information, however, moves from level to level. Lower level subsystems are necessary conditions, higher level systems constrain subsystems.

Theological responses to chance:

1. It's not really chance, we just don't know enough.
2. God designed a system of laws and chance.
3. God influences events without controlling them.

Models of Creation:

God as purposeful designer imposing order in chaos.

Potter (Jer. 18:6, Is a. 64:8), architect (Job 38:4), gardener (Gen. 2:8)

Lord and King, ruling to bring about intended purpose(s).

World is a manifestation of God's Word, an expression of divine Wisdom.

New Testament, God creates through the Word (John 1).

Father of not just persons, but things of nature, too (Matt. 6:26).

Mother (Is a. 49:15, 66:13). Both parental notions seem an appropriate relationship.

Spirit (Gen. 1:2, Ps. 104:30). Brings together Creator and Redeemer, inspired Christ.

artist or poet interacting with canvas or paper (modern theologians).

Peacocke: experimenter, improviser; rejects omnipotence for self-limited God who suffers with the world, is continual involved in ongoing creation.

c. A new context for theology.

Human Nature

Humanity is a unique part of nature, differing from small to large degree from all other living things. Despite unconscious impulse, we are capable of rational reflection. Despite pressures of socialization, we take responsibility for moral choices. Despite genes and culture, we are not completely determined but are agents with at least a modicum of freedom.

Cultural evolution is gaining on biological evolution: selection of ideas rather than of individuals, transmission of information via language and institutions rather than genes. More rapid, greater degree; old ideas can resurface (extinct critters can't).

Human brain is the most complex system known. 100 billion neurons, each connected

with 100s or 1000s of other neurons by synaptic junctions (as many as 100 trillion of them). We know relatively little about how this works.

Dualism: Mind and Body are two distinct entities that interact causally. How did mind evolve?

Materialism: behaviorism, objective events are what matter, stimulus/behavior.

Two-Aspect Theories: mind and body are on separate, parallel tracks, perfectly synchronized by God.

Multilevel Theories: reality is organized on many levels, fits with evolution and human versus non-human life, mental states are "higher level emergent properties."

Evolution of Religion: ritual, story, religious experience.

800-200BC: the Axial Period, parallel developments:

China, Confucius, Tao Te Ching
India, Gautama the Buddha, Bhagavad Gita
Persia, Zoroaster,
Greece, Plato and Aristotle
Israel, prophets, Hebrew Bible
All tell initial revelatory experiences, have sacred scripture, teach morals and ethics,

Religion preserves the social order, but also provides for change.

Judaism: two main stories: creation, and covenant (Christianity adds Christ)

Man is a creature, but a unique creature.
Man is an individual, but in a community.
In God's image, but fallen.
A unitary person (not a body-soul dualism).

Christ: relevant to understanding of human nature. Christ was viewed as the realization of true humanity, and reveals the power of reconciliation. In Christ, God had taken the initiative. Whatever happened at Easter and Pentecost convinced the of Christ's person and mission. "God was in Christ, reconciling the world himself," (2 Cor. 5:18). Human/divine thing a struggle. Perhaps we should focus on relationship and history rather than substance. Christ was free to do his (human) thing; but God acted through him. "Not my will, but thine be done," Luke 22:42). Lampe: God as Spirit was in Christ. In the OT, God's Spirit was in creation and human life (notably the prophets); then in and through beginning at his baptism. This notion of Spirit may bring together and redemption as a single continuous activity of God. There is an of God's relationship and involvement with man; we saw Christ as product of a divine activity that has been developing throughout history. God's immanent activity increasingly focused with individual persons increasingly responsive. Some even suggest Christ was a new species. At maybe a culminating point in the evolution of God's participation: rather than an absolute line drawn between Christ and other humans, view it as a matter degree or a spectrum starting with religious participants, to prophets, saints, founders, and finally Christ. For the Christian, Christ is the distinctive but not exclusive revelation of the power of God.

Process Thought

Views of Nature:

Medieval	Newtonian	20th Century
fixed order	change as rearrangement	evolutionary, historical, emergent
teleological	deterministic	law and chance, structure, openness
substantive	atomistic	relational, ecological interdependent
hierarchical anthropocentric	reductionistic	systems and wholes, organismic
dualistic (spirit/matter)	dualistic (mind/body)	multileveled
kingdom	machine	community

Every new occurrence can be looked on as a present response (self cause) to past entities (efficient cause) in terms of potentialities grasped (final cause).

Process thought - a balance between anthropomorphic and mechanomorphic outlooks.

The role of God (Whitehead):

The primordial ground of order. (Answers the question "why these laws?")
The ground of novelty. (Why new things?)
God is influenced by events in the world. ("Consequent nature" of God)

God is eternal in character and purpose, temporal in content of experience. God will exist in perfect love, goodness, and wisdom. He knows all reality, but the future which is inherently unknowable. He is infinitely sensitive and ideally responsive.

God is more like persuasion than compulsion. More ethical, and more in keeping with , indeterminacy, etc. God's action is the evocation of a response. God's role is not readily detectable. God works patiently, gently, and

unobtrusively. may seem to limits God's power, but it is consistent with our understanding evolution over long periods of time.

The idea of the Spirit closest parallels understanding God's presence in the world and in . Spirit was involved with creation ("When Thou sendest forth Thy Spirit, are created"). Spirit inspires prophets (Is. 42:1), and is present in worship prayer (Ps. 51:11). Christ received the Spirit (Mark 1:10), as did the early community (Acts 2). Interesting to note that the Spirit has no gender association (no dualism in that or nearly any regard).

Prayer is openness and responsiveness to God's influence or persuasion.

Our lives are a continual dialogue with God in which we respond with our actions.

Leads to responsible selfhood, including the body; a holistic existence.

Why evil and suffering:

Buddhism and Hinduism - all is deserved. Avoids question of why a God allow evil. Further, in Hinduism, suffering is part of an illusory world, maya, which is not ultimately real.

Augustine - suffering is the consequence of human sin which is misused . Relates to Perfect Creation and a Fall, which Barbour argues against.

Some argue that it's not so much evil as a discipline or a test, a temporary means to good.

Manifestation of God's self-limitation to effect three goals:

1. human freedom (virtue comes of free choices, not compulsory acts).
2. laws of nature (rationality, dependability).
3. moral growth (as in Rom 5:3).

This does allow God to (nearly) literally participate with us in suffering.

Immortality? We are immortal in that we become of permanent part of God's experience and history. God's goal is not a static final realm, but rather a continuing advance toward richer and more harmonious relationships.

God's relationship to nature

Biblically, God is creator and designer, architect, potter, craftsman, life-giving Spirit, liberator, judge, shepherd, father, mother (nurturer), redeemer.

Theology	Dominant Model	Conceptual elaboration
Classical	Ruler-Kingdom	Omnipotent, omniscient, unchanging, sovereign
Deist	Clockmaker-Clock	Designer of a law-abiding world
Neo-Thomist	Workman-Tool	Primary cause working through 2ndary causes
Kenotic	Parent-Child	Voluntary self-limitation and vulnerability
Existentialist	(none)	God acts only in personal life
Linguistic	Agent-Action	Events in the world as God's action
Embodiment	Person-Body	The world as God's body
Process	Leader-Community	Creative participant in the cosmic community

Classical and Deist seem inappropriate given: human freedom, evil and suffering, patriarchy, religious intolerance, an evolutionary world, and law/chance in nature.

Neo-Thomist, while allowing some dualism, ultimately gets back to God's control - which doesn't help with evil/suffering, true freedom, etc.

Existentialism doesn't see God participating actively, outside self. Ignores community.

Agent or purposefulness is a key theme in the Bible. Intent is important, not just the action(s). But notion of particular actions (miracles, Christ) are lost.

The body model doesn't seem to allow enough independence of God from the world.

Process. Social. Ecological. God is the leader of a cosmic community that's neither monarchical nor democratic. Like a wise teacher and her class, a loving parent with children. Process theology deals well with human freedom, evil and suffering, masculine/feminine, inter-religious dialogue, evolutionary and ecological world, and chance and law (pp. 260-262). But what about God's transcendence and power (p.264)? A continued journey; no end. It is human life that holds the greatest opportunities for God's influence. In fact, Barbour suggests that the central Christian model for God is Christ; love more than power or justice. Process theology 1. provides for agreement with the data, 2. coherence, 3. scope, and 4. fertility (pp. 265-266).

God is the Lord of all life, not just some religious realm. The Biblical God is Creator as well as Redeemer.

Session 7: The Big Questions

"If you understand God, it is not God you understand." St. Augustine.

"What we believe in must be in harmony with what we know; otherwise faith is debased into superstition and idolatry." Gerhard Staguhn.

"No Theory of Everything can ever provide total insight. For, to see through everything would leave us seeing nothing at all." John Barrow.

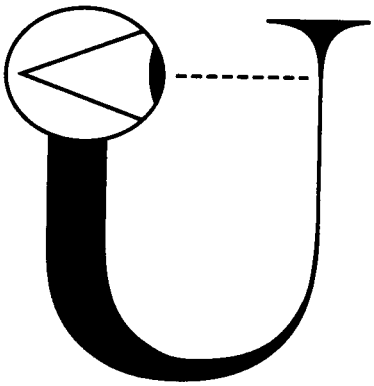
"Science without religion is lame; religion without science is blind." Albert Einstein.

Share what you saw or appreciated for the first time since our last session.

Break into groups of 3-5. Generate a list of "big questions" from your point of view.

On December 25, 2000 – what birthday would Jesus celebrate? 2000? Or 3720_8? Or $7D0_{16}$? Or 11111010000_2? Or 2001? Or 2004? Or 3721_8? Or $7D3_{16}$?…

If the universe was born in a quantum-ruled environment, how did a "classical" world emerge?



John Wheeler's "participatory universe." The observer/participant emerges at some point and looks back at its origins.

Does this represent what's going on?

1. Does there have to be a First Cause?

G -> E_n... -> E_4 -> E_3 -> E_2 -> E_1

G=God, L=Law, E=Event

L L L L L
G -> E_n... -> E_4 -> E_3 -> E_2 -> E_1

G G G G G
L L L L L
-> E_n... -> E_4 -> E_3 -> E_2 -> E_1

G G G G G G
L -> E_n... -> E_4 -> E_3 -> E_2 -> E_1

2. Why this universe?
3. Is the cosmos dependent on anything outside it (contingency)?
   -> E_4 -> E_3 -> E_2 -> E_1 -> (back to) E_4
4. Is it easier to imagine God as necessary as opposed to the universe as necessary?
5. Does the complexity imply a God versus natural causes? Was the universe always so complex?
   Did the complexity arise spontaneously, or by God? Why the order?
   At what level(s) is the universe complex?
6. Why the Laws? (Actually, at high energies, it looks like there are not as many nor are they as complicated as they seem down here in our low energy environs.)
7. Singularity: does it emit chaos or order? Hawking says totally random and chaotic.
8. What is life from a physicist's point of view? Does it require a divine spark or life force?
   Reductionist versus holistic.
   What greater holism, then, is life part of? Flow of energy to keep negative entropy, to keep order.
9. What is a miracle? An event contrary to natural laws?
10. What does it mean to exist? Rocks exist, so do Wednesdays and pi. Does the mind exist?
    In space? In time? Existing conceptually, at higher levels of complexity and organization...
11. Did God cause the Big Bang?
12. Is the universe a computer?
13. Is mathematics already "out there?"
14. How can we know something without knowing everything?
15. Does design imply a Designer?
16. Can there be a Theory of Everything?
17. Does quantum theory's uncertainty principle explain, or allow for, free will?
18. How close is the Bible to scientific knowledge? How important is that?
19. What one piece of evidence can bring one closer to God?
20. Is God a stabilizer?
21. How does creation relate to day-to-day life?
22. Should seminaries teach science, and laboratories religion?
23. Where is the mind/matter boundary?
24. How do we have faith, but not blind faith?
25. Just how rational is the universe?
26. How do super colliders research religion?
27. Is the universe intelligent or intelligible? Is God intelligible (comprehensible)?
28. Can beauty be a guide to truth?
29. Does God play dice? Are they loaded?
30. Does religion take into account what science knows? Should it? Vice versa?

Nicholas of Cusa (1401-1464AD)

Nicholas was a Catholic cardinal. He studied everything there was to study. Among other things, he struggled with whether or not God was conceivable. Being passionately interested in the mathematical and physics concepts of infinity, he likened the theological question of God to infinity.

As a circle is enlarged, the arc and the chord become closer to being equivalent. At an infinitely large circle, they are equivalent. This infinite shape became Nicholas' symbol of the infinity of God. He further developed St. Augustine's thoughts that in God's infinity, all insoluble, finite opposites are dissolved into oneness (like the arc and the chord).

For Nicholas, one encounters the divineness of God through constantly failing in the struggle to understand or comprehend. God as a target is not strikeable, but in the ricocheting we discern truths.

Nicholas was in many ways the first to break the Ptolemaic version of the universe. He argued that the universe must be infinite and inconceivable to be of God. His thoughts about everything being at once the center and not the center of the universe were prophetic of relativity. He suggested that the cosmos was dynamic, not static. Nothing could be motionless, including the earth. All measures, to Nicholas, were relative (relativity) and lack precision (uncertainty).

Nicholas, through this nothing is precise, even argued that the earth is not spherical though it tends to be spherically shaped. We know today that he was right, the earth is oblated at the poles because of its rotation, and is not a globe, but rather, technically, a rotary ellipsoid.

He spoke of reciprocal forces in the universe. Everything acts on everything else. He even concluded that other planets in the universe could harbor life!

If that weren't amazing enough, Nicholas also spoke prophetically of quantum theory. He said, "We will never reach the simplest elementary units existing entirely in reality, for in the realm of the subtly differentiated there is no absolute largest or smallest even though our reason believes in their existence."

As Staguhn says, "Nicholas integrates the idea of progress into faith; to be inspired by infinity means to move forward constantly, to cross frontiers, not to settle back and make oneself comfortable in a rigid religious system or even revert to the heathen creeds of occultism and magic."

To Nicholas, science was one of the means by which the human intellect can arrive at a perception of God.

Session 8: The Big Questions (continued); Wrap Up

Continued discussion...

How do you describe God now? Has He expanded in your mind?

Course Evaluation

Date_____

I'd very much appreciate feedback on this course, particularly suggestions aimed at making the course better. Hopefully I'll be doing the course again, and those future class members would really like you to be honest now. Thanks for your help, and thanks for sharing this journey with me! Jamie.

The things I liked most:

The things I liked least:

Please mark an "X" along the line that indicates your position:

There was: |_____|
too much science — too much religion

There was: |_____|
too much detail — not enough detail

Overall, the course was: |_____|
excellent — poor

The materials were: |_____|
fascinating — of little interest

I wanted more: |_____|
discussion — lecture

I wanted more: |_____|
questions — answers

<u>On the back side, please express any suggestions you have to improve the course.</u>