Let’s Review… A Theory

Diagram:
- Data
- Records
- Experiments
- Observations

Arrow leading to "THEORY!"
Astronomy Notes
The Universe

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Big Bang Animation
Forget the big bang, tune in to the big hum

The big bang sounded more like a deep hum than a bang, according to an analysis of the radiation left over from the cataclysm. Physicist John Cramer of the University of Washington in Seattle has created audio files of the event which can be played on a PC. "The sound is rather like a large jet plane flying 100 feet above your house in the middle of the night," he says. Giant sound waves propagated through the blazing hot matter that filled the universe shortly after the big bang.

These squeezed and stretched matter, heating the compressed regions and cooling the rarefied ones. Even though the universe has been expanding and cooling ever since, the sound waves have left their imprint as temperature variations on the afterglow of the big bang fireball, the so-called cosmic microwave background. Cramer was prompted to recreate the din last heard 13.7 billion years ago by an 11-year-old boy who wanted to know what the big bang sounded like for a school project.

To produce the sound, Cramer took data from NASA's Wilkinson Microwave Anisotropy Probe. Launched in 2001, the probe has been measuring tiny differences in the temperature between different parts of the sky. From these variations, he could calculate the frequencies of the sound waves propagating through the universe during its first 760,000 years, when it was just 18 million light years across. At that time the sound waves were too low in frequency to be audible. To hear them, Cramer had to scale the frequencies 100,000 billion billion times.

Nevertheless, the loudness and pitch of the sound waves reflect what happened in the early universe. During the 100-second recording (http://www.npl.washington.edu/AV/BigBangSound_2.wav), the frequencies fall because the sound waves get stretched as the universe expands. "It becomes more of a bass instrument," says Cramer.

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Author: Marcus Chown
The universe started as a single point.
That point was extremely dense.
It became unstable and exploded outward.
Today the universe continues to expand.
The Doppler Effect
Evidence for the Big Bang

light from distance galaxies all shift toward red

We see light from a star that has a fixed position to us, like this
Shifts in the Electromagnetic Spectrum

Blueshifted

Unshifted

Redshifted

Red Shift = away
Blue Shift = toward
Evidence for the Big Bang

Cosmic Background Radiation
What is the Big Bang Theory?

- George Lemaitre (a priest and physics professor) proposed the theory of the expanding universe.
- 13.82 billion years ago, violent expansion occurred from a single point, the size of an atom.
- All matter and space were created; first quarks, electrons, protons, neutrons, atoms and larger elements.
- For every million photons, 1 proton was made.

*The “Big Bang” was a name (mockingly) given to Lemaitre’s idea – and it stuck 😊*
Cosmic Microwave Background Radiation (CMB)

- CMB is the “after glow” or “leftovers” from the big bang that permeates (spreads) in all directions of the universe.
- Physicists agreed that CMB was leftover ‘heat’ in the form of microwave radiation, which was still cooling from the Big Bang.
- Original temperature of the universe: 3000 Kelvin
- Today, universe is approximately 3 Kelvin
- The amount of cooling says how far the light has travelled, which determined the age of the universe: 13.82 billion years.
Cosmic Microwave Background Radiation

- The first sound of microwave radiation was thought to be pigeon droppings! :) Their detection of this CMB was made from a Horn Antenna!
- COBE (Cosmic Background Explorer) was launched in 1989 - 500 miles from Earth. Detected the near perfect blackbody spectrum in 1992.
- WMAP launched in 2001. In 2003, the WMAP satellite gave a better resolution of the small fluctuations of temperature.
- (WMAP = Wilkinson Microwave Anisotropy Probe)