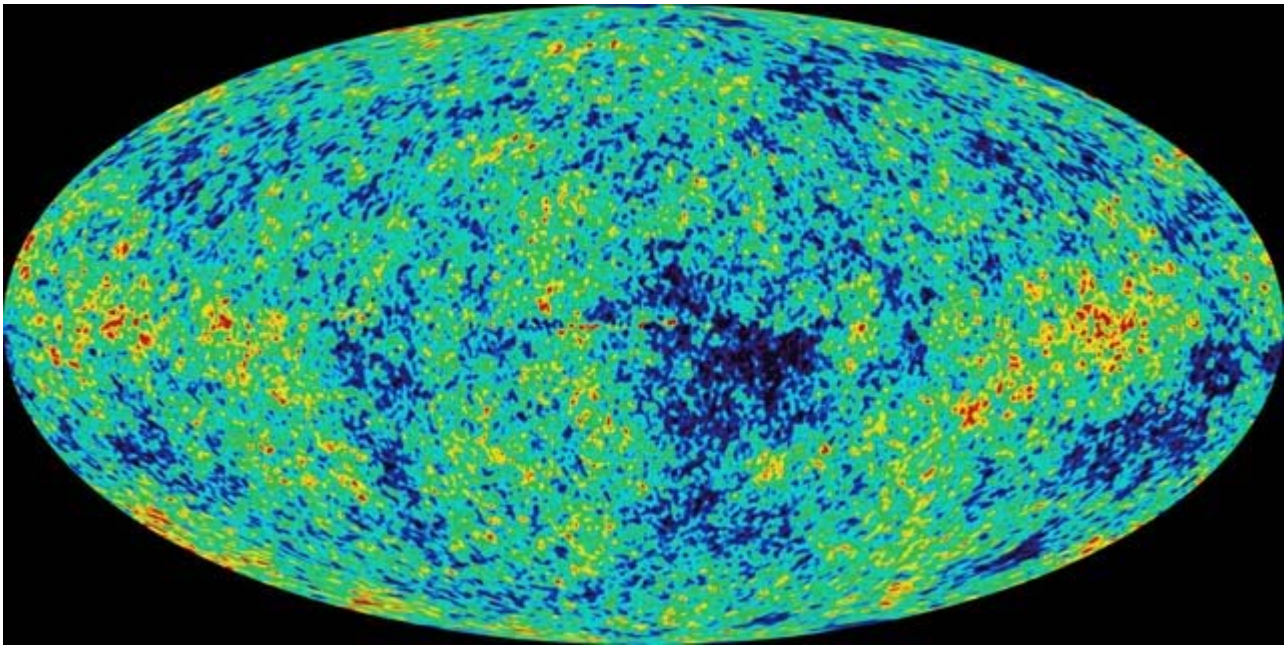
The New Cosmology

In the past five printings of this manual, this section has been rewritten in each one! Such is the speed at which our technology has advanced and our data about the Universe has increased. The most recent spacecraft to add to this information overload, the ***Wilkinson Microwave Anisotropy Probe (WMAP)***, has recently mapped the visible universe at such high a resolution and sensitivity that several fundamental questions have been answered.

Current theory states that after detonation, the Big Bang expanded, slowed, and then expanded again, to its present size. If this is true, tiny differences in the temperature of the background microwave radiation (on the order of 0.0003 degrees Kelvin) should be seen and at very small angles in the sky (less than ¼ degree). This ***anisotrophy*** indicates the turbulence and oscillations as the Universe cooled. WMAP has seen this, and moreover, almost exactly as predicted. Think of the color coded map below as reflecting echoes, where the peaks of the 'sound' is blue, fading to a low in red. The image shows the distribution of energy after 380,000 years from the Big Bang.



The All-sky Cosmic Microwave Background Radiation
Image courtesy of NASA/WMAP

From the data gathered so far (as of 3/01/05), we can make the following statements:

1) Our Universe is **13.7 billion years old**, give or take 200 million years,

2) **Ours is a flat universe**; that is, it extends in all directions evenly. Parallel beams of light will remain parallel no matter how far they travel into space. The data says that the cosmic inflation theory is correct (expansion, slowing, then expansion again), and the familiar scenery of galaxies continues beyond our current horizons.

3) **The matter we see is only about 4.4 per cent of all there is**; 23 percent is ***'dark matter'*** (comprised of particles still unknown to our physics), and the remainder of 73 percent being a repulsive force called ***'dark energy'***, which apparently is keeping the Universe expanding and accelerating.

4) **The Hubble constant is 71 km/sec per megaparsec**; that is, this is the speed of the expansion of our Universe. For over 6 decades, determining the true value of this number was the 'Holy Grail' of astrophysics.

5) The data also allows us to select the type of **inflation theory** to fit our observations. As you'd probably guessed, the simple theories can now be discarded, and a more complex early history of the Universe is shaping up.

   Further information will be obtained in 2007 when the ***Planck*** probe is launched. It will further refine our view of the background 'fossil light', and perhaps give us hints of the pre-creation conditions before the Big Bang!

Some Misunderstandings About the Big Bang

Most astronomers are confused about just what the Big Bang was, and sometimes spread that confusion to the public. In an attempt to set the record straight, below are six basic question, with both the misconceptions and the correct information about this universe-creating event.

1) What kind of explosion was the Big Bang?

WRONG : The big bang was like a kind of bomb detonating at a certain location in a previously empty space.

CORRECT: ***It was an explosion of space itself***. It didn't explode 'into' something, and it happened everywhere at once.

2) **Can galaxies recede from us at a speed faster than light?**

WRONG: Einstein's special theory of relativity forbids traveling faster than light!

CORRECT: They most certainly can, as special relativity does not apply to recession velocity, ***i.e., the expansion of the space that is carrying the galaxies with it.***

3) **Can we see galaxies receding from us traveling faster than light?**

WRONG: Of course not. Light from those galaxies never reaches us.

CORRECT: Since the ***expansion rate changes with time, we most certainly can.***

4**) Why is there a cosmic redshift in the light from distant galaxies?**

WRONG: Because receding galaxies are moving through space, and this creates a Doppler shift in the light.

CORRECT: Because ***expanding space stretches all light waves*** as they propagate through space, creating the observed Doppler shift.

5) **How large is the observable Universe?**

WRONG: The universe is 14 billion years old, so the radius is 14 billion light years.

CORRECT: Because space is expanding, the observable universe is ***actually larger than 14 billion light years in radius, about 3 times greater.***

6) **Do objects in the expanding Universe grow larger, too?**

WRONG: Yes, expansion enlarges everything.

CORRECT: No, the Universe expands, ***but objects in it do not***.