

## The beginning of Time --- the "Big Bang" (Gamow 1948)

The most accepted hypothesis is that time begins with the Big Bang.

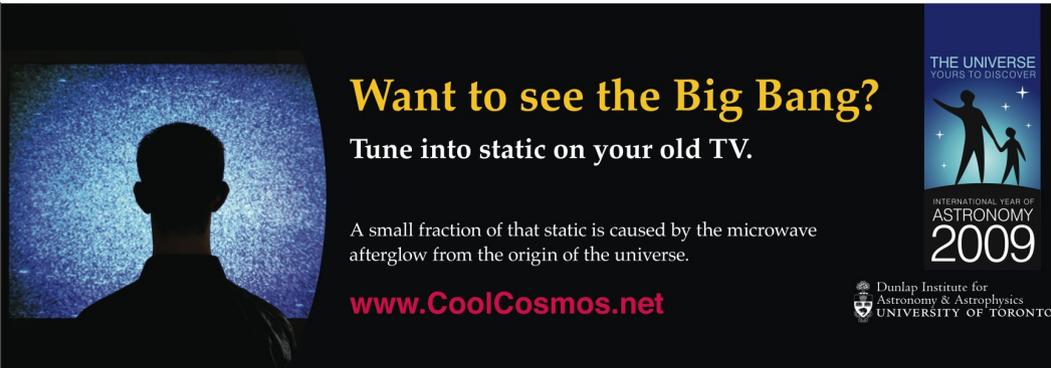
All universe was in a hot state and squeezed into the same point.

All known physics breaks down at such a state, matter is not normal.

A great "kick" started it all.

Since then the space has been expanding and the universe evolves...

*'The evolution of the world can be compared to a display of fireworks that has just ended; some few red wisps, ashes and smoke. Standing on a cooled cinder, we see the slow fading of the suns, and we try to recall the vanishing brilliance of the origin of the worlds.'* Lemaitre.



**Want to see the Big Bang?**  
Tune into static on your old TV.

A small fraction of that static is caused by the microwave afterglow from the origin of the universe.

[www.CoolCosmos.net](http://www.CoolCosmos.net)

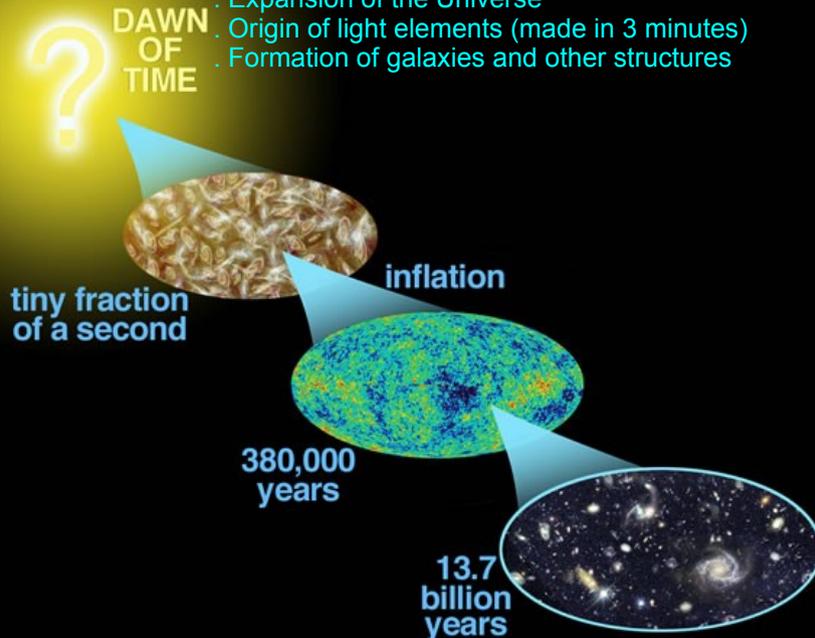
THE UNIVERSE  
YOURS TO DISCOVER

INTERNATIONAL YEAR OF  
ASTRONOMY  
2009

Dunlap Institute for  
Astronomy & Astrophysics  
UNIVERSITY OF TORONTO

The Big Bang theory successfully explains four key cosmological observations:

- . Origin of the cosmic radiation background
- . Expansion of the Universe
- . Origin of light elements (made in 3 minutes)
- . Formation of galaxies and other structures



## Backdrop of the Cosmos --- cosmic microwave background

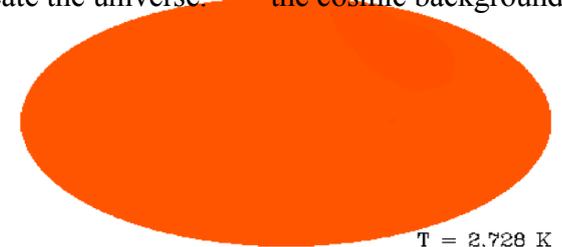
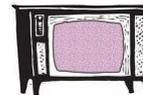
Before 380,000 yrs, temperature is so hot that electrons roam free.

Light scatter off these electrons and cannot reach us directly.

At 380,000 years, temperature  $\sim 3000$  K, electrons are absorbed into atoms.

Light can freely pass through.

These relic photons permeate the universe, --- the cosmic background



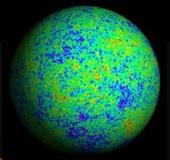
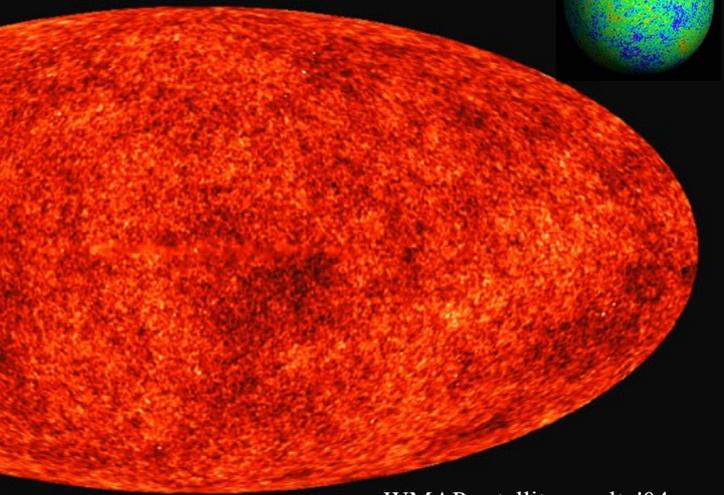
$T = 2.728$  K

The Early universe was **very very very** uniform!

# Backdrop of the Cosmos --- cosmic microwave background

- . thermal radiation of a 3000 Kelvin blackbody, redshifted
- . currently simmering at a temperature of 3 Kelvin (270 degs below zero)
- everything around us is heated to at least 3 Kelvin*

We can measure this 3K background to excruciating details.



**BLAST!**  
from Paul Devlin, creator of *Power Trip* and *SlamNation*

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As an official Special Project of the International Year of Astronomy 2009, BLAST! will be screening in communities around the world!

Cosmologist, Mark Devlin, Principal Investigator of BLAST!, to document the 1st launch of the telescope.

Paul Devlin takes you on a trip of a lifetime and explores creative ways of independent filmmaking.

Space Disco New review of BLAST! from Discovery.com

Barth Netterfield, BLAST Canadian Principal Investigator, journeyed to Antarctica for the 2nd launch.

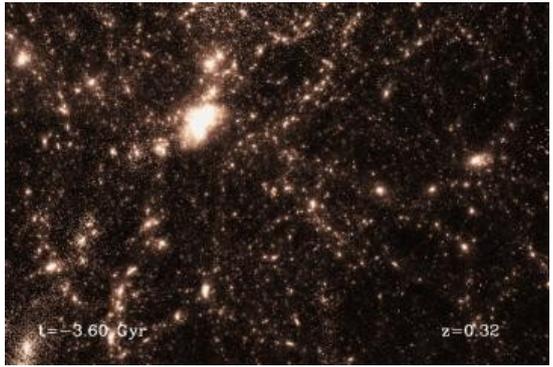
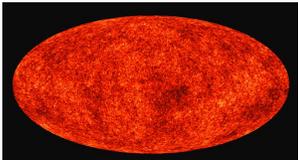
Go behind the making of BLAST! with the BLAST! project on ArtistShare.

BBC FOUR In the UK and missed the BLAST! broadcast? Watch it now on the BBC's iPlayer.

Gaelen Marsden BLAST team member, researcher at the U. of British Columbia in Vancouver, Canada. Read his interview with Universe Today.

# Formation of galaxies and clusters of galaxies

- . originates from tiny fluctuations in the early universe
- . over-dense regions grow denser (gravitational attraction)
- . under-dense regions become more under-occupied
- . gravity pulls material together to form structure
- . explains many observed properties of galaxies



cosmic flight movie --- galaxies from tiny fluctuations (J. Dubinski, Toronto)

# Is the Milky Way Galaxy at the center of THE universe?

- 1) Yes. We are at a special place because every other galaxy is receding away from us.
- 2) Yes. We are more evolved than other galaxies, some of which are just forming.
- 3) Yes. We are surrounded by the cosmic microwave background.
- 4) No. We are not a big galaxy so we can not be at the center.
- 5) none of the above argument is correct.

**No. Nobody is special. There is no 'center of THE universe'.**

**Residents in every galaxy has the same view...**

*The other galaxies 'look' younger to us because their earlier images have just reached us now.*

**Looking out to space = Looking back in time**

# The Milky Way Galaxy is at the center of our observable universe

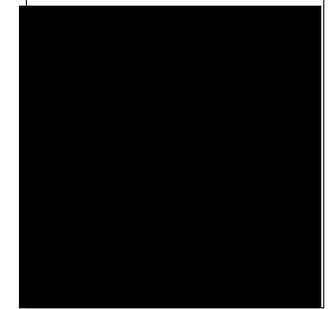
There is no edge to the physical universe. There is only an edge to our observable universe.

So, if the universe is infinite, why should there be a beginning?

Alternatives to the big bang theory?

**What if the universe is infinitely large and infinitely old?  
(steady-state universe)**

Olber's Paradox: the dark sky should not be dark if we can see infinite number of stars – every line of sight should be bright.



Also, galaxies are running away from us, yet we still have neighbours...