



Background radiation predicted in 1940s - 1960s by Gamow, Dicke, Peebles.

**Discovered in 1965 by Penzias and Wilson** 



**Arno Penzias and Robert Wilson** 



#### **Robert Dicke**



#### **Cosmic Background Explorer (CoBE), launched 1989**



#### **CoBE** map of temperature across the sky







## Early Universe too hot for neutral atoms Free electrons scattered light (as in a fog) <u>After 380,000 years, cool enough for atoms; fog clears!</u>









Present Day



Present Day





Present Day



Present Day







#### **CoBE** map of temperature across the sky

### **CoBE map of temperature across the sky**



CMBR 'ripples' are the seeds of today's galaxies

Galaxy formation is highly sensitive to the pattern, or <u>power spectrum</u>, of CMBR temperature ripples

Present Day







First year WMAP results published 2003

#### Hubble diagram of distant Type Ia supernovae





## The future of the Universe:-

# No

# Big Crunch!!!