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FOR ALL-SKY ASTROPHYSICS

# What is the Big Bang?



[www.spacetelescope.org](http://www.spacetelescope.org)



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# The Big Bang

**What is the evidence for the big bang?**



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# Hubble's Law

Velocity



distance

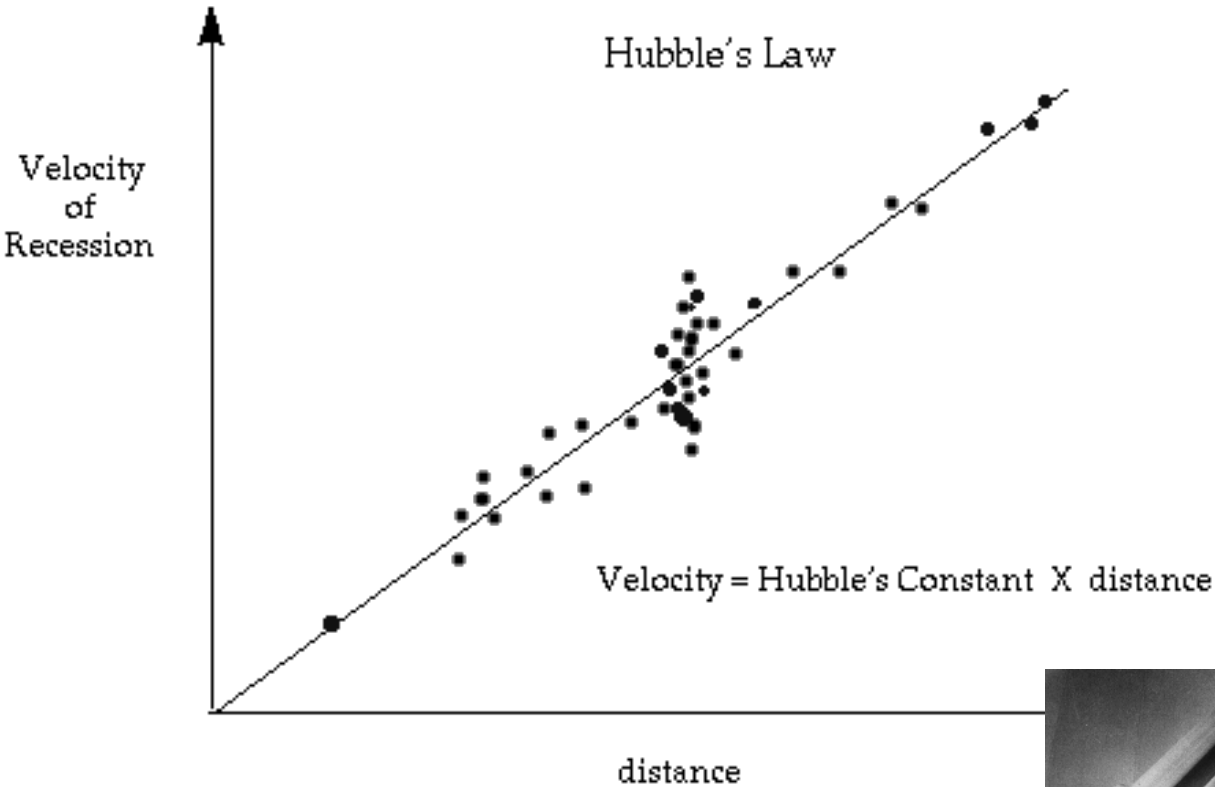


Edwin Hubble



# Hubble's Law

Velocity




distance

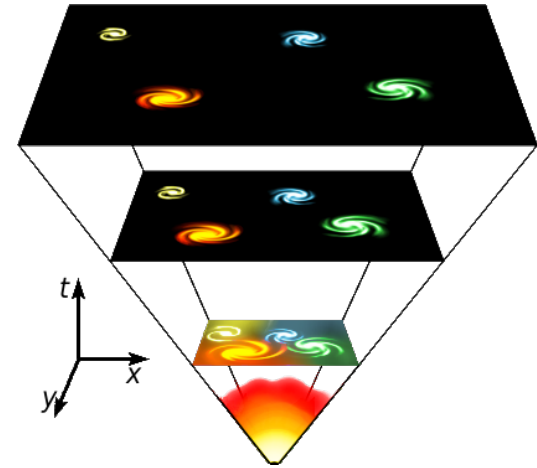


Edwin Hubble



# Some predictions

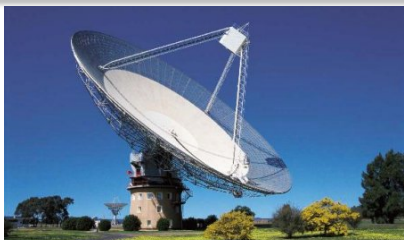
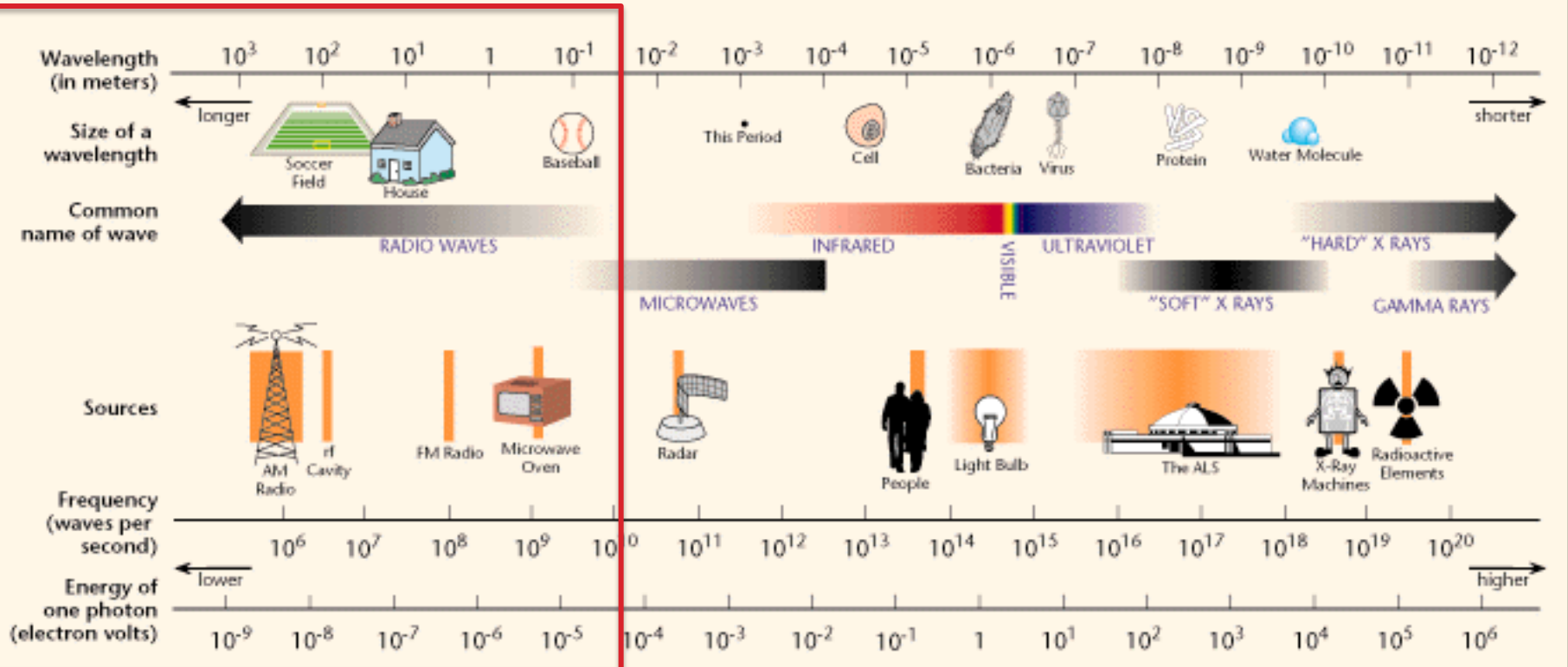
- › If the Galaxies in the Universe are expanding away from each other - at some point in the past they must have been close together. 
- › If the Universe started with an explosion it must have generated an enormous amount of photons or “light”.
- › PREDICTION:
- › **We should be able to detect the left over “light” that was created at the start of the Universe.**
- › But where do we look for it .....WE NEED RADIO TELESCOPES





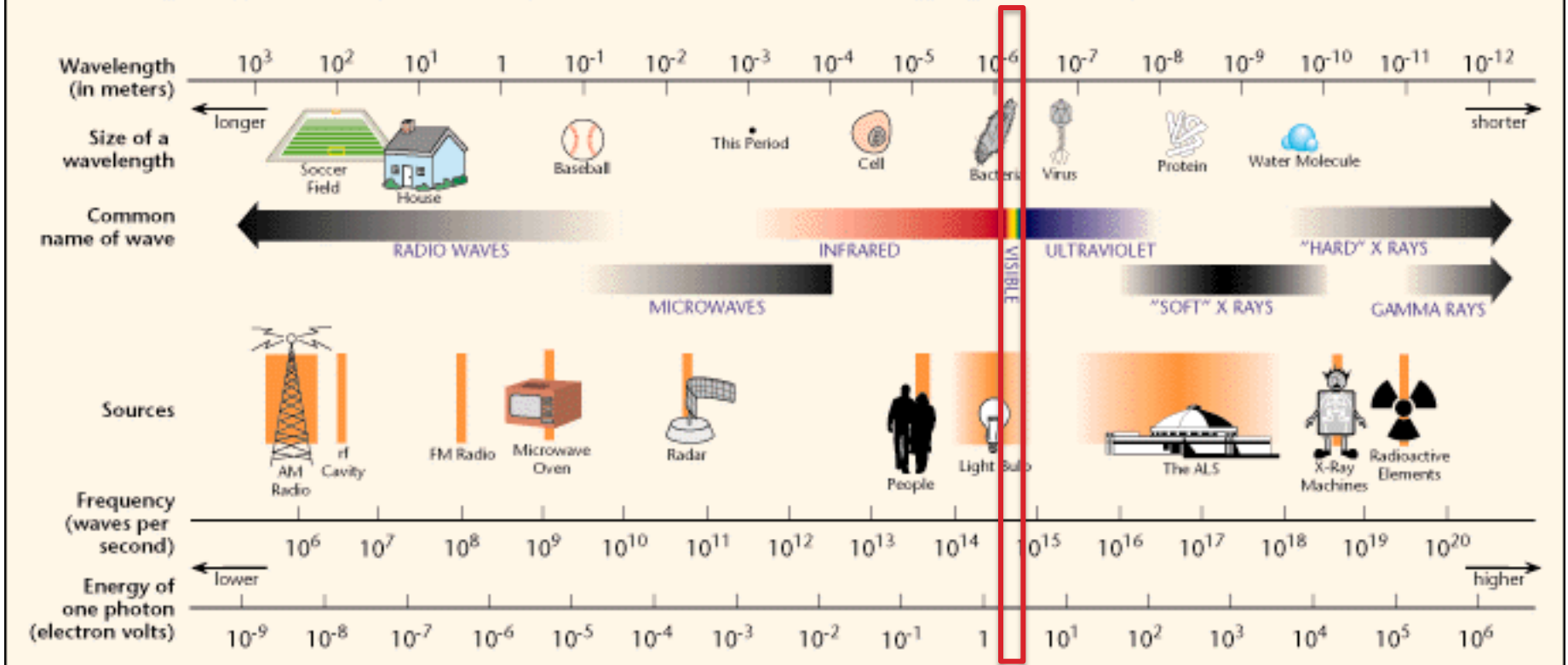
# What is radio astronomy?

## THE ELECTROMAGNETIC SPECTRUM





## THE ELECTROMAGNETIC SPECTRUM



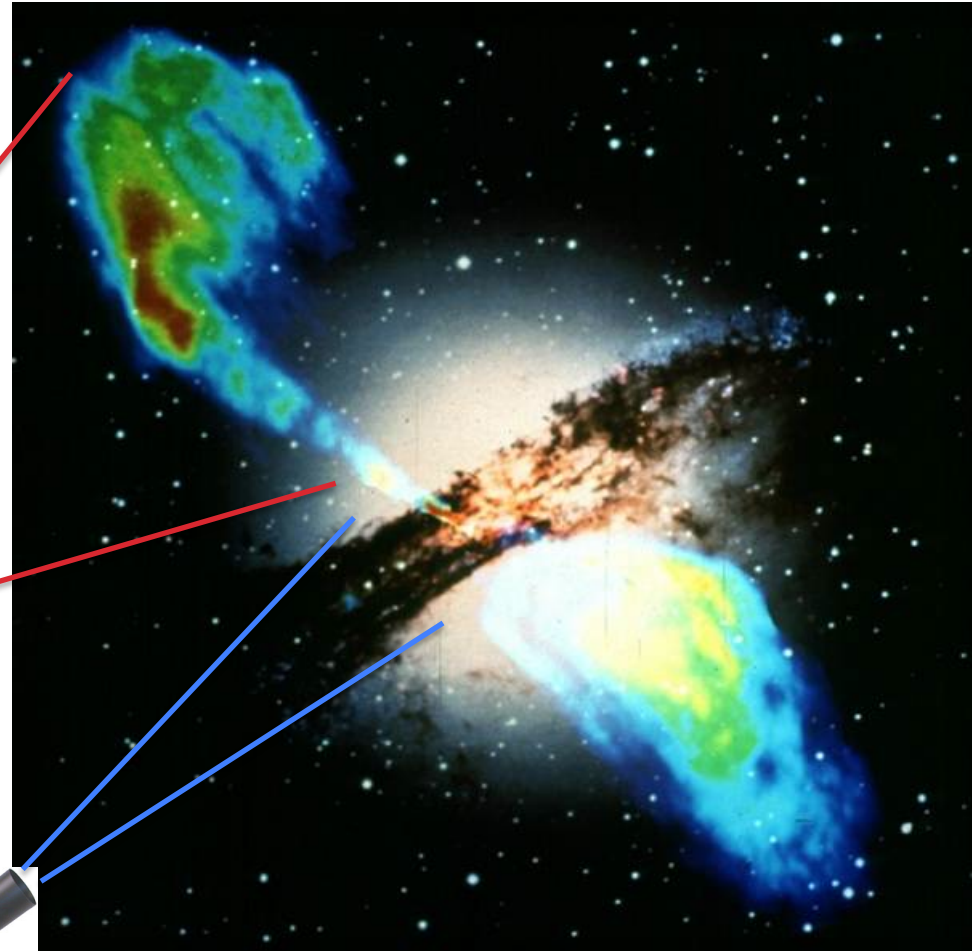
↔  
∴  
↔  
= One trillionth of the available information



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# What do we “see” in the radio waves?

- › **Radio waves** trace the colder quieter photons ( $E=hf$ ).
- › **Optical light** traces stars and dust.

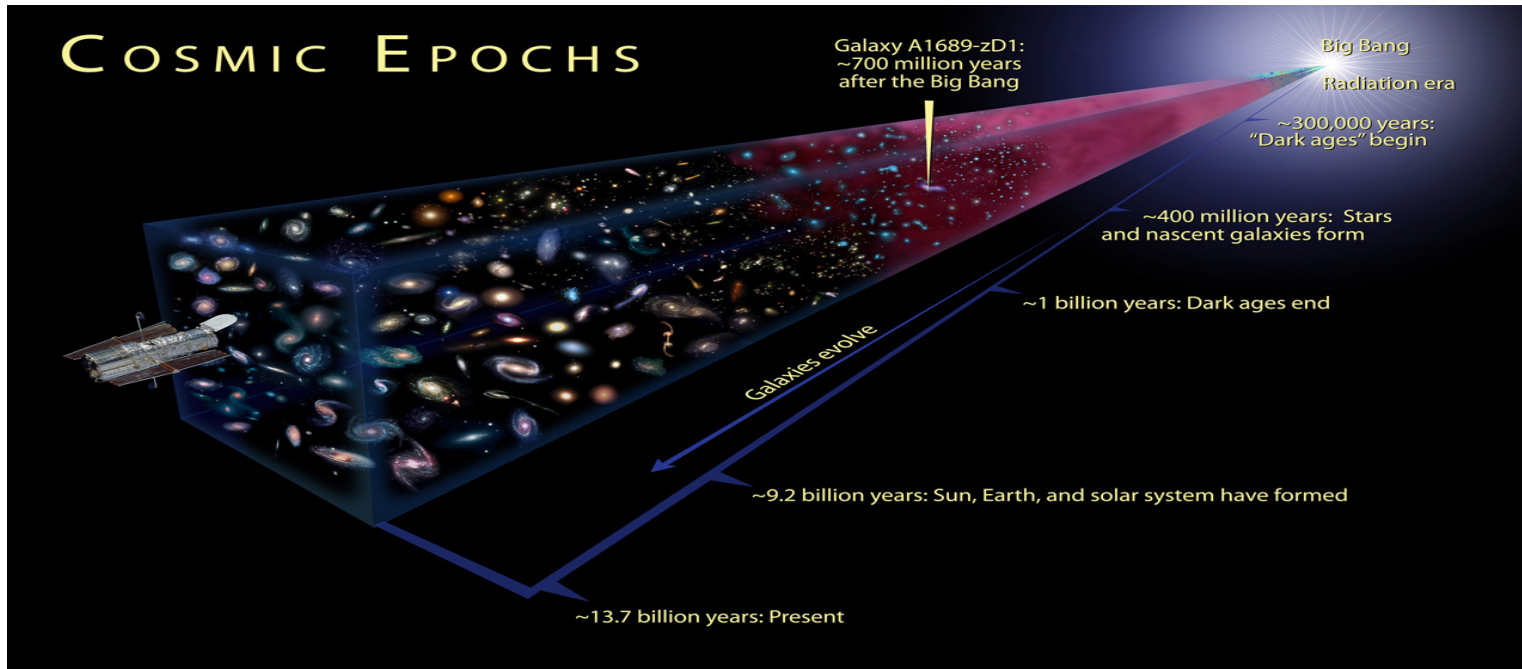






# What is the cosmic microwave background radiation?

- › The cosmic microwave background radiation is the relic afterglow of the initial big bang fireball (predicted in the late 1940s)
- › It is the radiation that was released in the Big Bang and has now “cooled”.
- › It emits at radio wavelengths (microwaves).

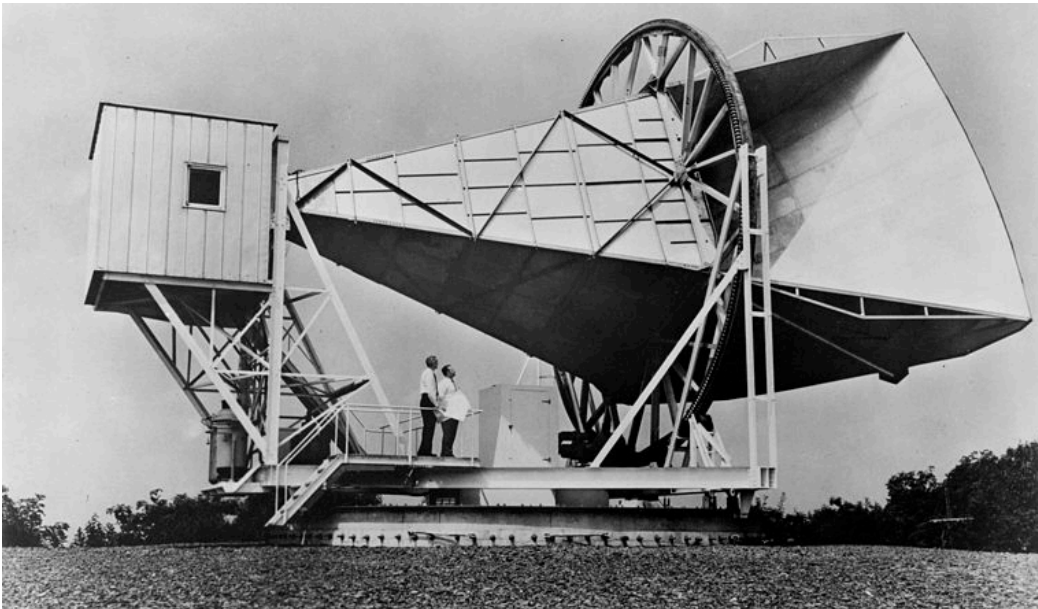
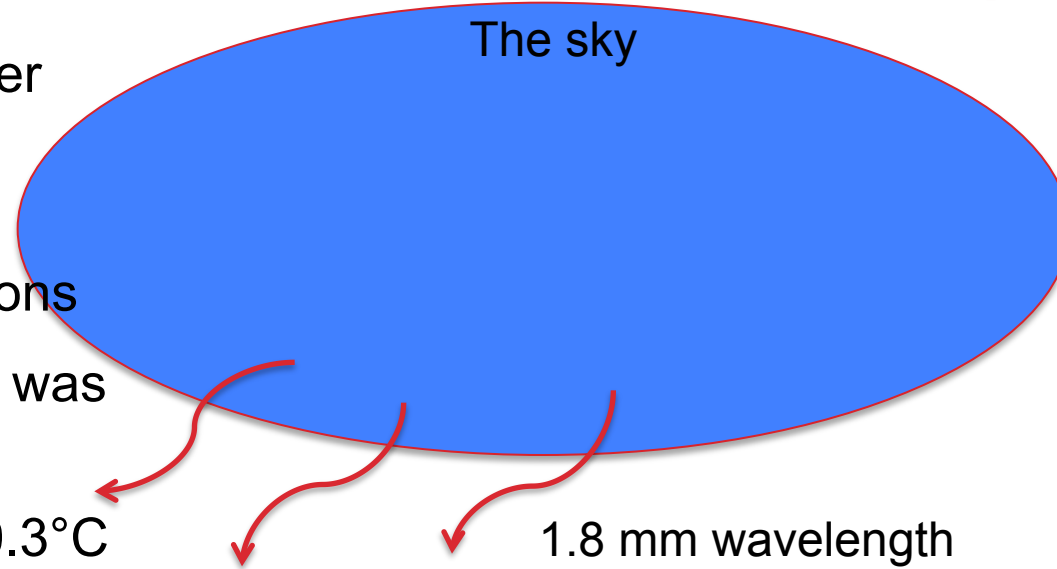




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# The discovery of the cosmic microwave background radiation

- › Penzias and Wilson 1978 discover the CMB and win Noble prize
- › They discovered that space was emitting radio waves in all directions
- › The temperature of this radiation was very cold but NOT zero.
- › Temperature = 2.7 Kelvin or  $-270.3^{\circ}\text{C}$

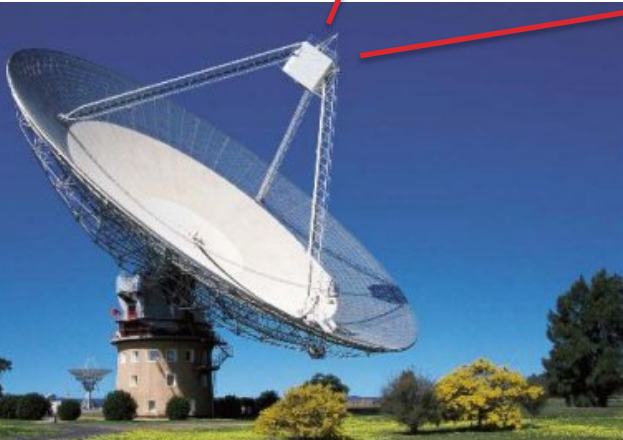
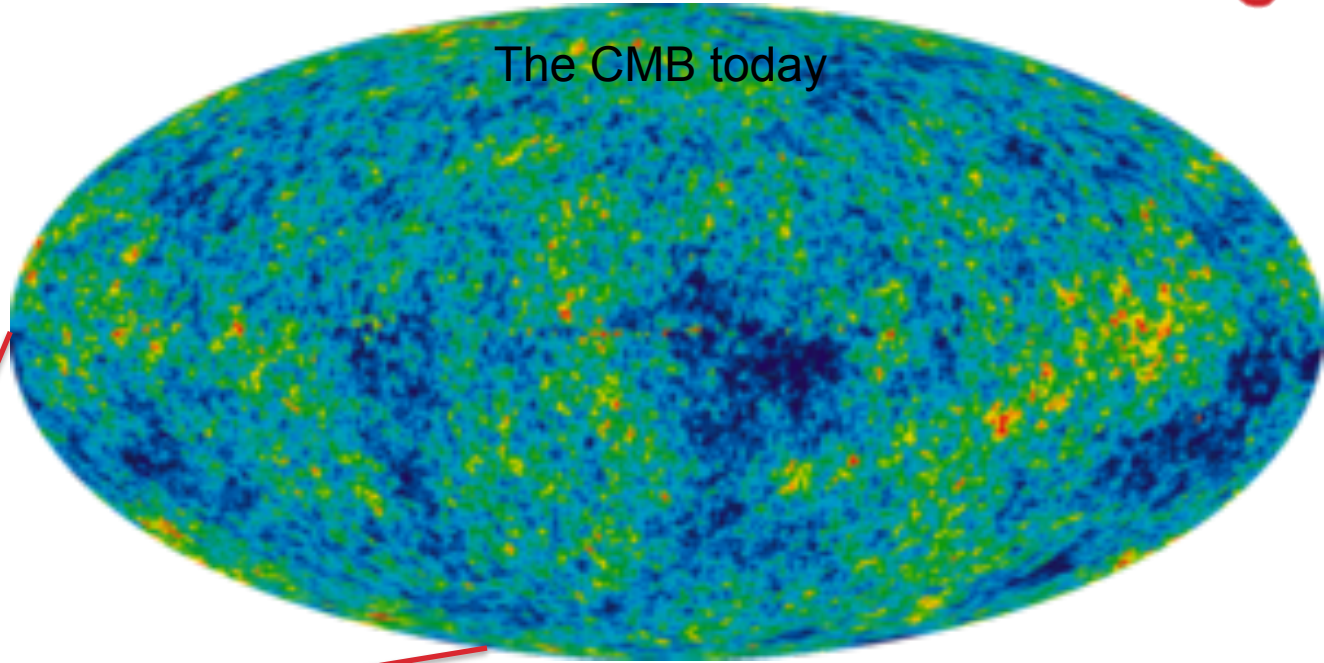




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# What we see with our new telescopes today

The CMB today



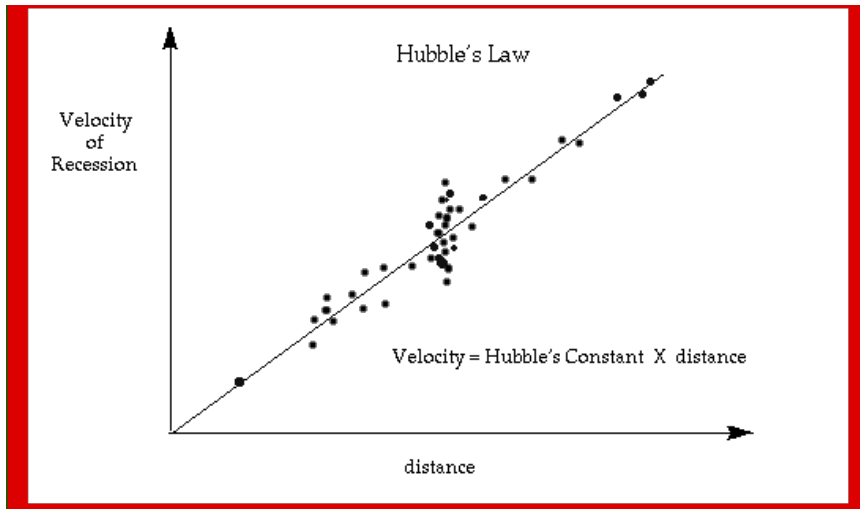
- › With our best telescopes today we see slight peaks and troughs in the CMB temperature which help us to study the early structure in the Universe



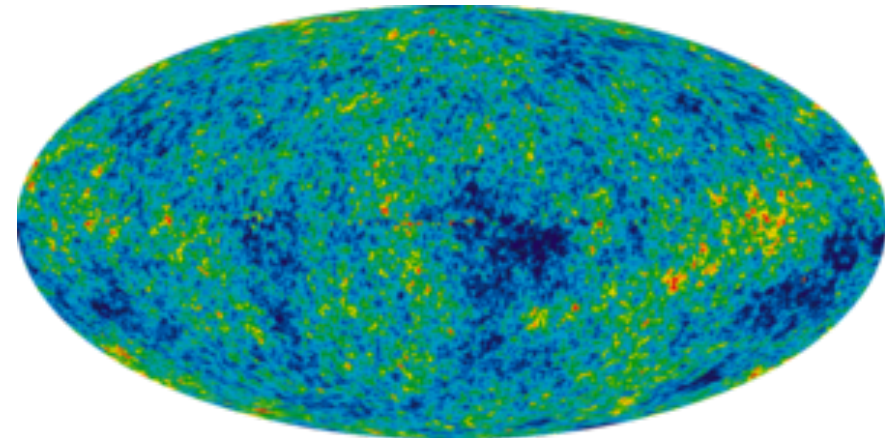
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# Two pieces of evidence for the Big Bang

## Hubble's Law



## The Cosmic Microwave Background Radiation



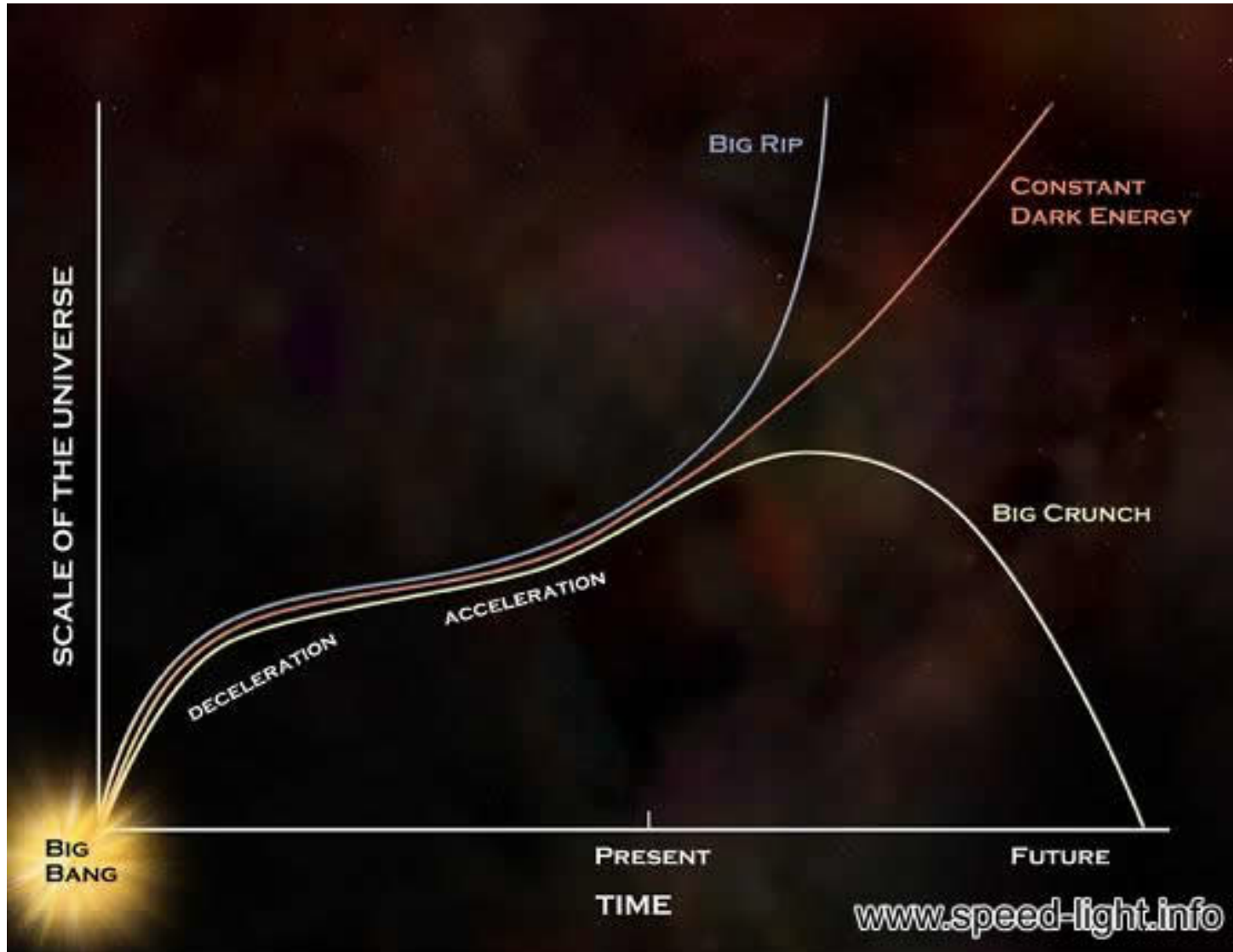


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**What happens next?**



# What is the big rip?

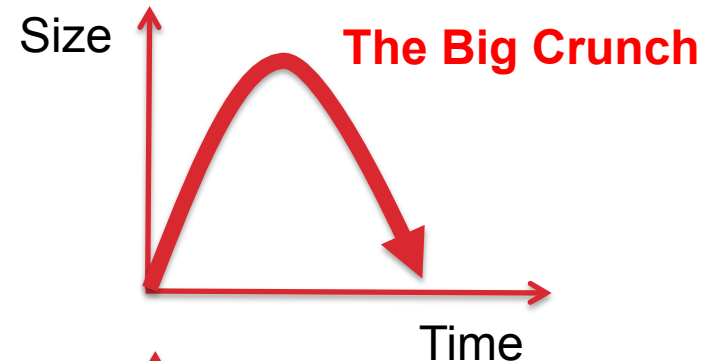




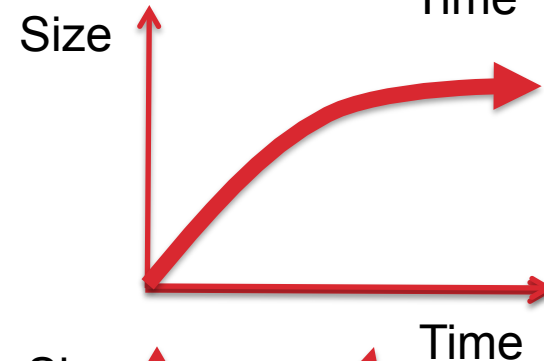
# The fate of the Universe

› Possible outcomes for the fate of the Universe.

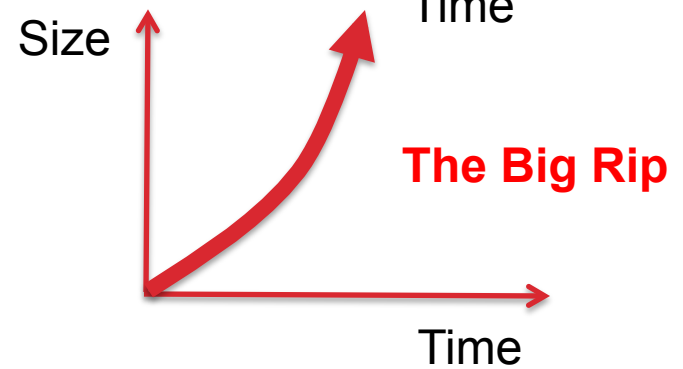
› The Universe collapses back in on itself



› The Universe expands to a constant size



› The Universe starts to expand more rapidly

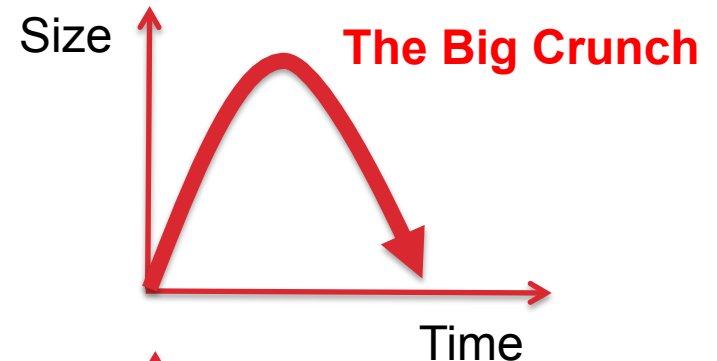




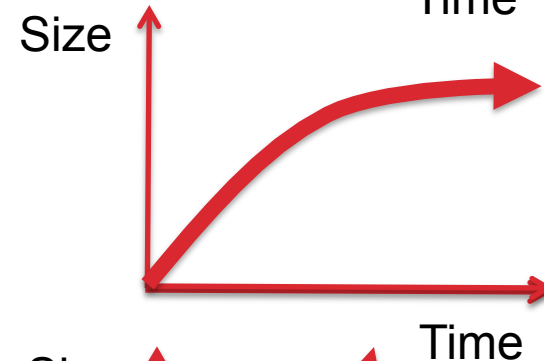
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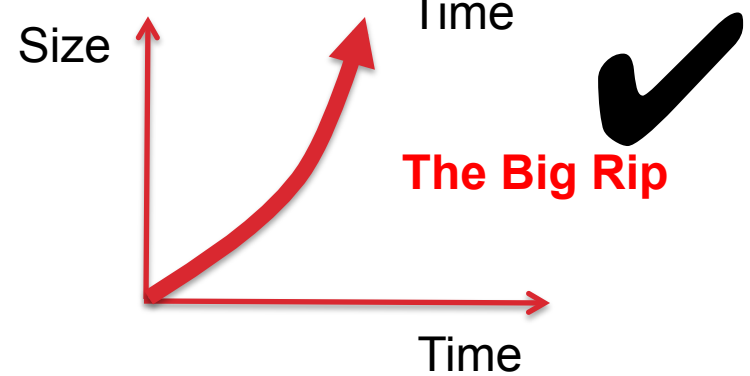
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# What is the evidence for the Big Rip



Distant Supernovae

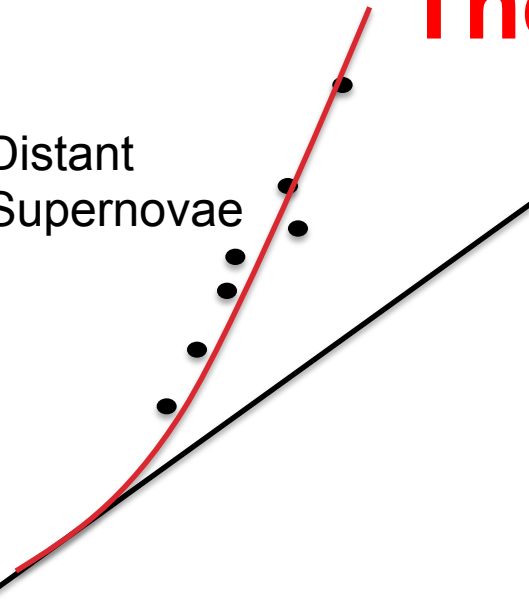
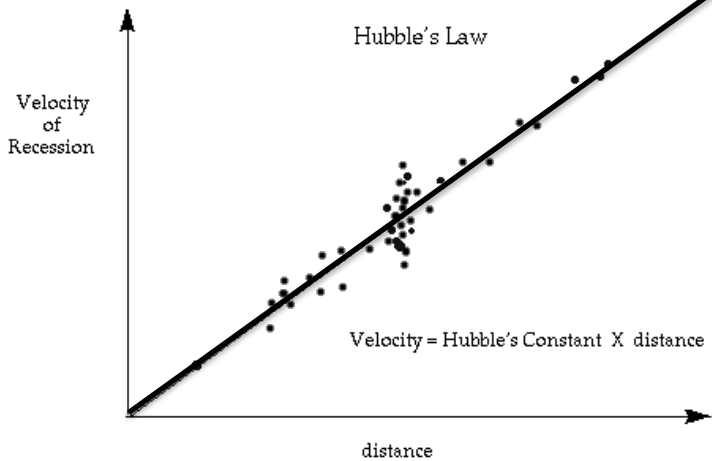




# What is the evidence for the Big Rip

## The Big Rip

Distant  
Supernovae

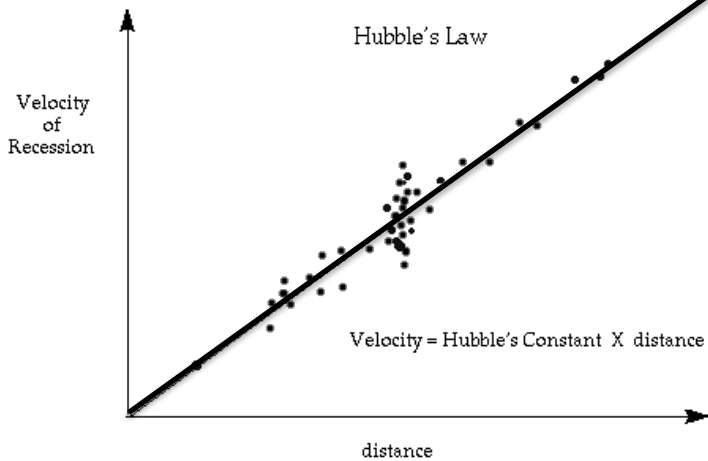




## The Big Rip

Distant  
Supernovae

CAASTRO team leader Brian Schmidt wins this years Noble prize.





- › The Universe is expanding and the two pieces of evidence are:
  - › Hubble's Law
  - › The Cosmic Microwave Background Radiation
- › Radio astronomy allows us to probe the Universe in ways we cannot using optical light alone.
- › The fate of the Universe is uncertain however it appears that the Big Rip scenario might be correct