

Source of  
continuous  
spectrum



Cloud of gas



Continuous spectrum  
with dark lines



Continuous spectrum

Bright line spectrum

X-ray

ultraviolet

optical

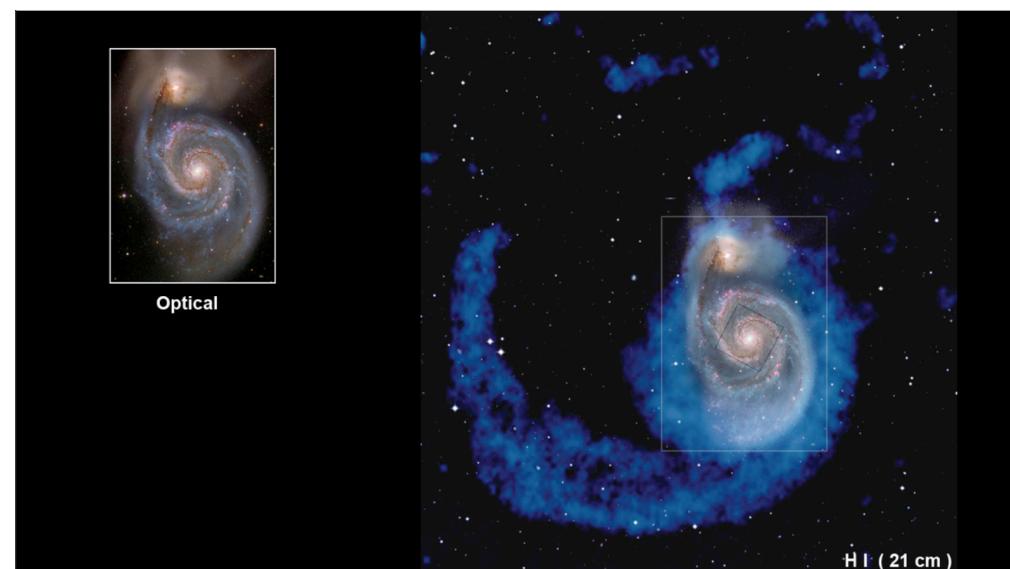
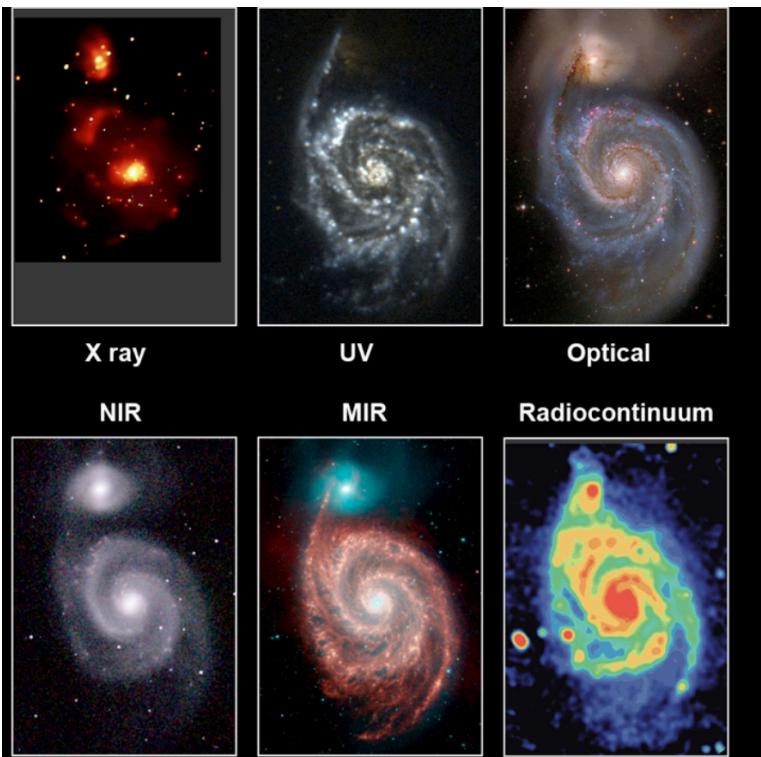
infrared

radio

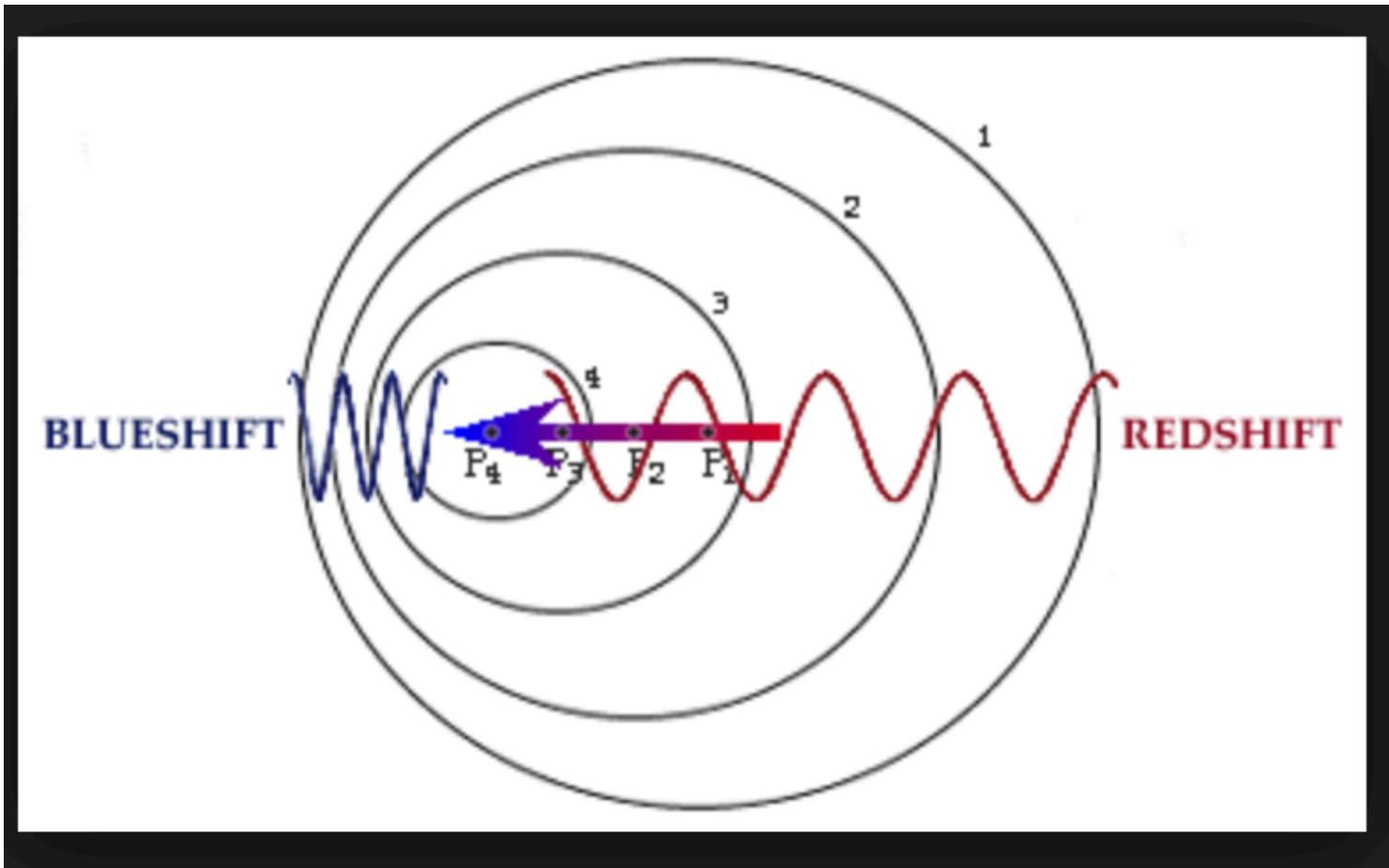


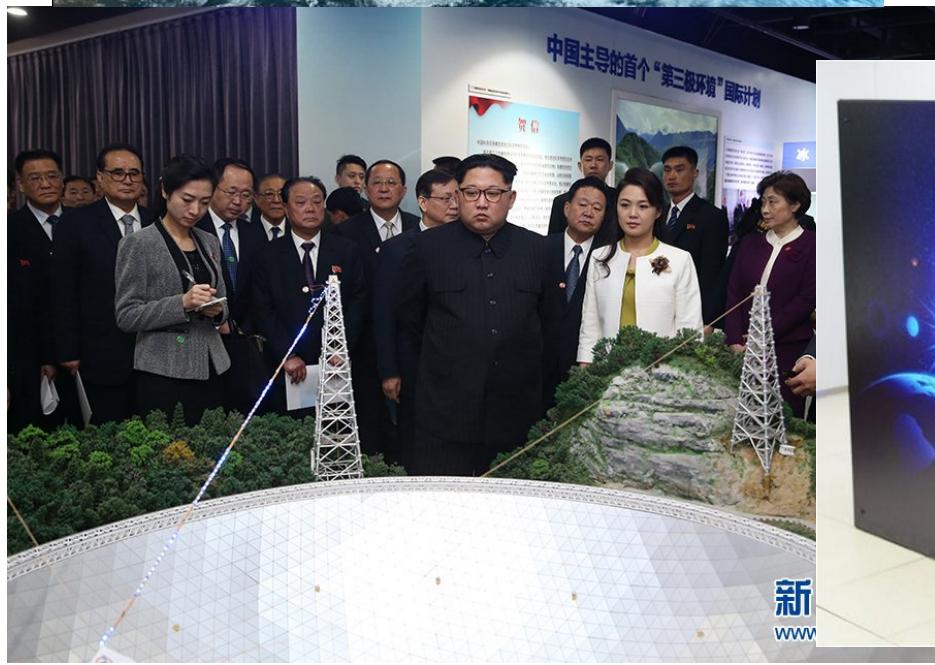
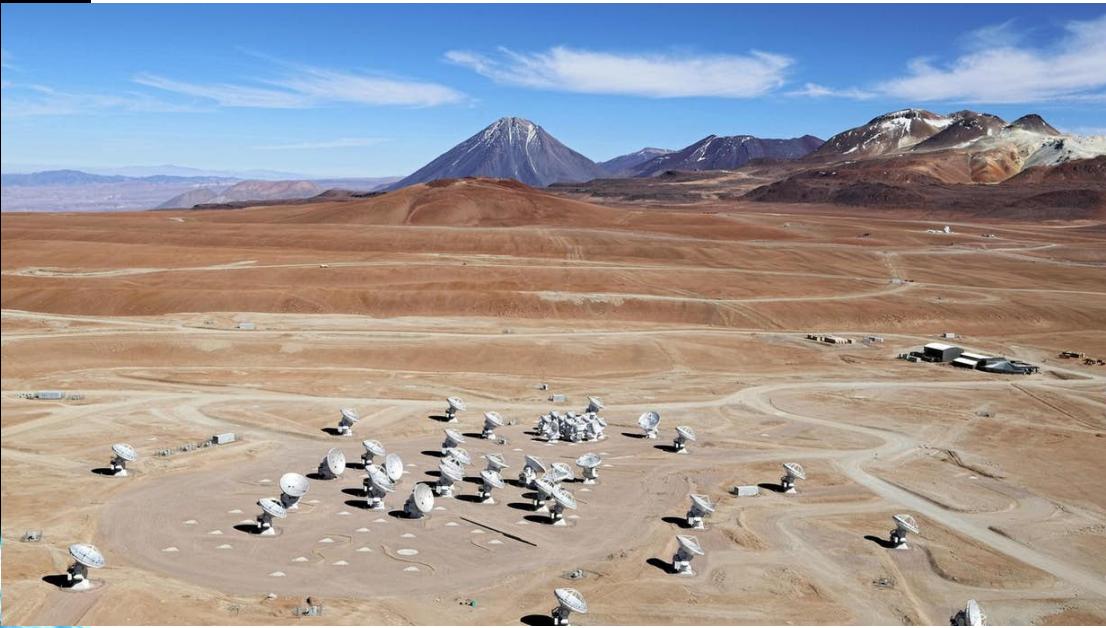
short  
wavelength

long  
wavelength



# Doppler Effect





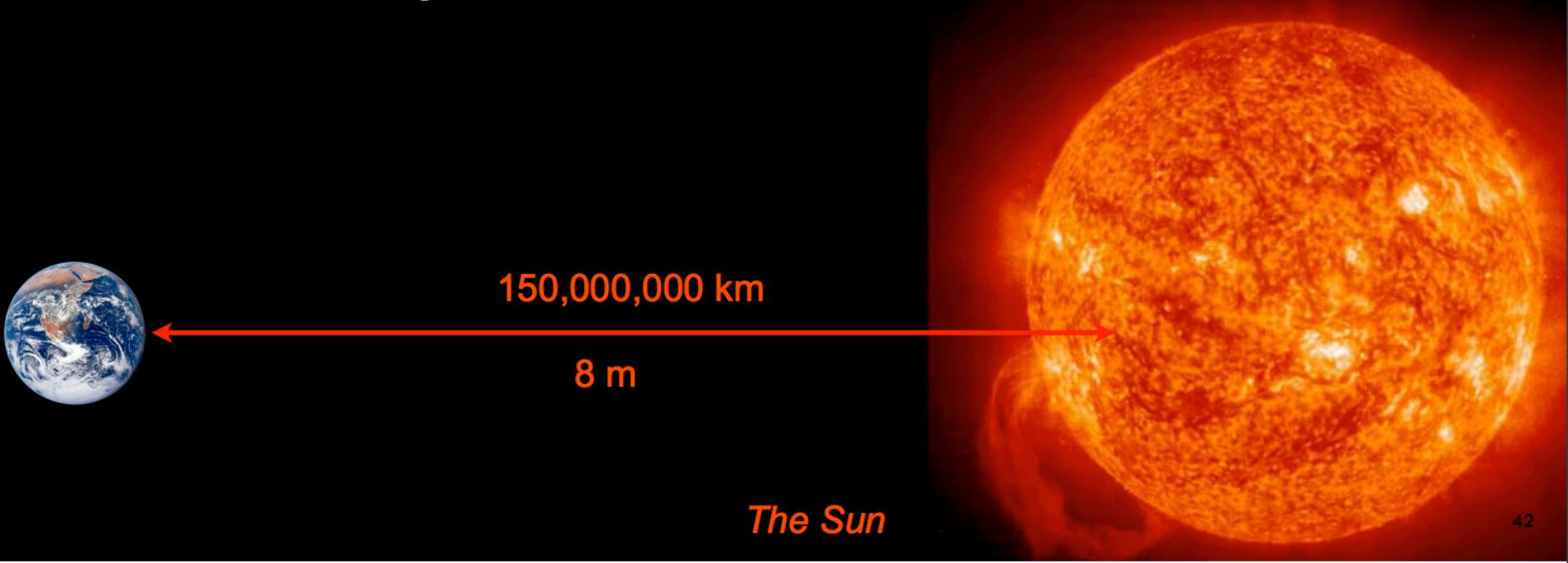
# Important numbers

- Astronomical Unit (AU):  $1.5 \times 10^{13}$  cm
  - Sun to Earth
- Speed of light:  $3 \times 10^5$  km/s
- Light year:  $10^{18}$  cm

The finite speed of light, combined with these enormous distances, means that when we look out into the universe, the light we see was emitted some time ago – a long time ago, if the object is very distant. When we look out into the Universe, we are looking back in time.



The finite speed of light, combined with these enormous distances, means that when we look out into the universe, the light we see was emitted some time ago – a long time ago, if the object is very distant. When we look out into the Universe, we are looking back in time.





The finite speed of light, combined with these enormous distances, means that when we look out into the universe, the light we see was emitted some time ago – a long time ago, if the object is very distant. When we look out into the Universe, we are looking back in time.



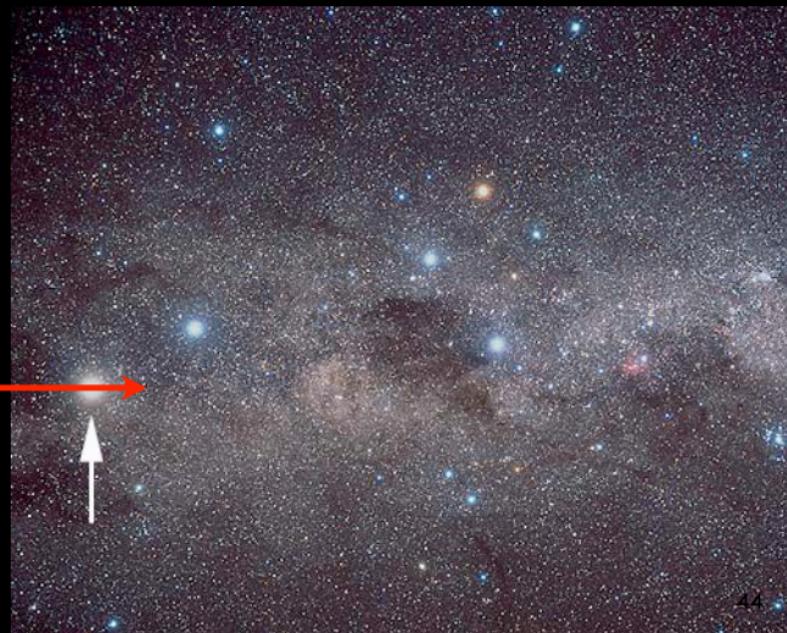
The finite speed of light, combined with these enormous distances, means that when we look out into the universe, the light we see was emitted some time ago – a long time ago, if the object is very distant. When we look out into the Universe, we are looking back in time.



40 trillion km

4.3 y

*The nearest star, alpha Centauri*

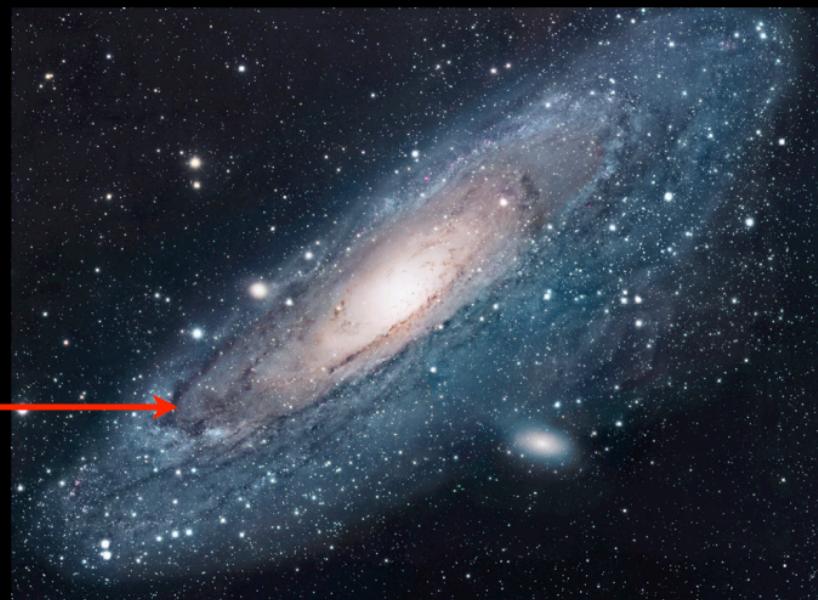


The finite speed of light, combined with these enormous distances, means that when we look out into the universe, the light we see was emitted some time ago – a long time ago, if the object is very distant. When we look out into the Universe, we are looking back in time.



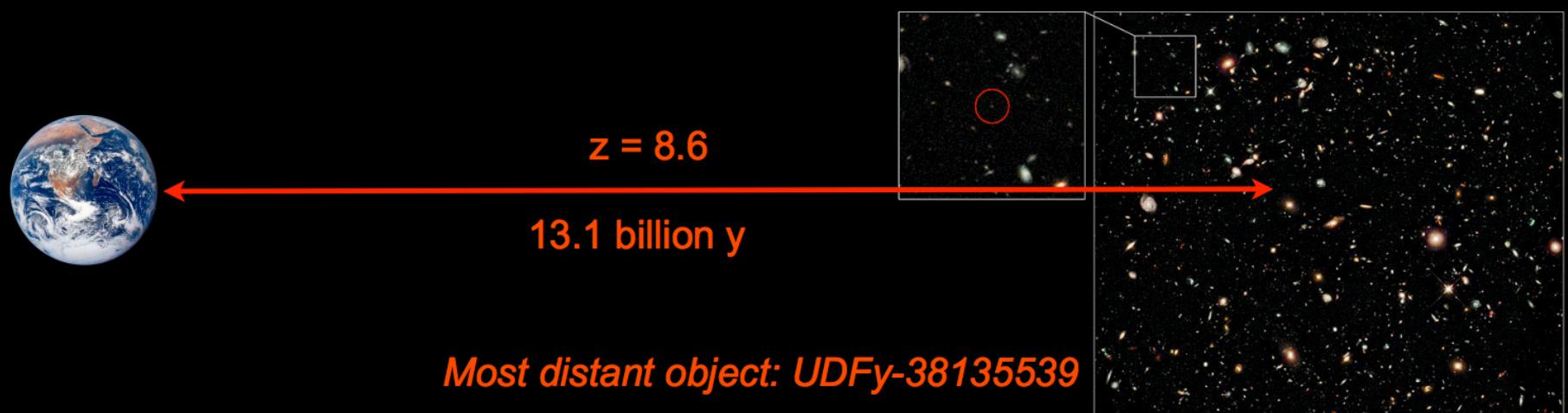
2,000,000 ly

2 million y



*The Andromeda galaxy*

The finite speed of light, combined with these enormous distances, means that when we look out into the universe, the light we see was emitted some time ago – a long time ago, if the object is very distant. When we look out into the Universe, we are looking back in time.



# Next class: Stars, the Building Blocks of the Universe

