Preparing to Explore the Universe with the James Webb Space Telescope

Like a giant golden eye, NASA's James Webb Space Telescope will peer back to the beginning of time and watch galaxies collide. It will capture gorgeous images of stars and planets being born. It will search for new planets and pursue the age-old question: is life out there?

Astrophysicist Jane Rigby, who grew up in Sussex County, Delaware, is the deputy project scientist for this amazing new space tool. She will show us how it will revolutionize our view of the universe and fill us in on preparations for the telescope's launch in October 2018.

James Webb Space Telescope Mural Image
Illustration courtesy of Northrop Grumman
Gravitational waves

https://nyti.ms/2jRIEnF
Assignments

• For Mon., 02 OCT.
  – Study Ch. 5
  – Do Online Quiz #03

• Tues. 03 Oct, Vernon lecture, 7:30 p.m. Clayton Hall
  – with signed attendance, get chance to correct 1st midterm for half-back on up to 10 points lost (up to 5 point net).

• 1st Midterm is Friday, Oct. 13 (not on purpose!).
Light: The Cosmic Messenger
What is light?

Newton used a prism to show that white light is made up of all the colors of the rainbow.
The Solar Spectrum
Light is an “Electromagnetic Wave”
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Wavelength $\lambda$ determines properties of wave, e.g. color for visible light

visible light:

\[ \lambda = 0.4 \text{ – } 0.8 \text{ micron} \quad (\mu\text{m} = 10^{-6} \text{ m}) \]
\[ = 400 \text{ – } 800 \text{ nanometer} \quad (\text{nm} = 10^{-9} \text{ m}) \]
blue - red
Light is an electromagnetic wave.

Speed of light

\[ c = \frac{\lambda}{P} \]

wavelength/period

\[ c = \lambda \times f \]

wavelength × frequency

\[ c = 300,000 \text{ km/s} \]
Clicker Question

The longer the wavelength of light,
A. the longer its period.
B. the lower its frequency.
C. both A and B
D. None of the above.
Clicker Question

The longer the wavelength of light, 
A. the longer its period. 
B. the lower its frequency. 
C. both A and B 
D. None of the above

\[ \lambda = c \quad P = \frac{c}{f} \]
\[ \lambda \uparrow \Rightarrow P \uparrow \Rightarrow f \downarrow \]
Light waves come in particle bundles

- Particles of light are called **photons**.
- Each photon has a wavelength and a frequency.
- Energy of a photon is proportional to its frequency.
Wavelength, Frequency, and Energy

\[ \lambda \times f = c \]

\( \lambda \) = wavelength, \( f \) = frequency

\( c = 3 \times 10^5 \text{ km/s} = \text{speed of light} \)

\[ E = h \times f = \text{photon energy} \]

\( h \) is “Planck’s constant”

\( h = 6.6 \times 10^{-34} \text{ joule} \times \text{s} \)
Clicker Question

The higher the photon energy,
A. the longer its wavelength.
B. the shorter its wavelength.
C. Energy is independent of wavelength.
Clicker Question

The higher the photon energy,
A. the longer its wavelength.
B. the shorter its wavelength.
C. Energy is independent of wavelength.

\[ E = hf = \frac{hc}{\lambda} \]

\[ E \uparrow \Rightarrow f \uparrow \Rightarrow \lambda \downarrow \]
Power

- **power**: the rate at which energy is used/emitted
- It is measured in units called **watts**.
  
  1 watt = 1 joule per second
- A 100 watt light bulb radiates 100 joules of energy every second
- This is also about the average amount of power used by the human body
- Sun has power (a.k.a. “Luminosity”) of
  
  \[ L_{\text{sun}} = 4 \times 10^{26} \text{ W} \]