Gravitational waves from merging neutron stars

https://nyti.ms/2zdFXUI

Assignments

• Read Ch. 12 ("Surveying the Stars")
• Do practice online quiz 06
This is the story of our sun
This is gonna be fun for everyone
Gonna learn what you need to know, learn this star inside and out
Chorus - "This is the sun, made up of mainly Hydrogen
And to add a little more fun we're gonna thow in helium"
The core is where our tour will start
This is where the sun's energy is generated
Next comes the interior zones
There are two and I know you know
Radiation, followed by convection
"Chorus"
Then we say hello to the photosphere
that is what we see when look at the sky,
and see the sun
Chromosphere comes up right next at a depth of 2500 km
Most of the sun's UV light is emitted next, and then we end it with the corona
This is where we get mostly x-rays, mostly x-rays, x-rays.

http://www.bartol.udel.edu/~owocki/phys133/ECP/Chismar-Kyle-1RightNow.mp4
What is the Sun's structure?
Gravitational equilibrium: Gravity pulling in balances pressure pushing out.

Pressure is greatest deep in the Sun where the overlying weight is greatest.

The outward push of pressure . . .

. . . precisely balances the inward pull of gravity.
Energy balance:
Thermal energy released by fusion in core balances radiative energy lost from surface.
Gravitational contraction... provided energy that heated the core as the Sun was forming.

Contraction stopped when fusion started replacing the energy radiated into space.
How long could the Sun shine if its energy came from chemical energy?

A. 10,000 years
B. 250,000 years
C. 25 million years
D. 1 billion years
E. 10 billion years
How long could the Sun shine if its energy came from gravitational contraction?

A. 10,000 years
B. 250,000 years
C. 25 million years
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E. 10 billion years
How long could the Sun shine if its energy came from gravitational contraction?

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How long could the Sun shine if its energy came from nuclear fusion in its core?

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B. 250,000 years
C. 25 million years
D. 1 billion years
E. 10 billion years
How long could the Sun shine if its energy came from nuclear fusion in its core?

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The Sun releases energy by fusing four hydrogen nuclei into one helium nucleus.
Decline in core temperature causes fusion rate to drop, so core contracts and heats up.

Rise in core temperature causes fusion rate to rise, so core expands and cools down.
What is the Sun's structure?
Methods of Energy Transport

• Radiation Zone
  • energy travels as photons of light, which continually collide with particles
  • always changing direction (*random walk*)
  • this is called **radiative diffusion**

• This is a **slow** process.

• Takes about **1 million years** for energy to travel from the core to the surface!
Methods of Energy Transport

• Convection zone
  • photons arriving at bottom of convection zone are absorbed instead of scattered by matter
  • the bottom of the zone is heated … hot gas rises to the top
  • cooler gas sinks to the bottom…just like when you boil a pot of water!
  • energy is brought to the surface via bulk motions of matter (**convection**)
Patterns of vibration on the surface tell us about what the Sun is like inside.

like earthquakes on earth: seismology

for sun: helio-seismology
• Neutrinos created during fusion fly directly through the Sun.

• Observations of these solar neutrinos can tell us what's happening in the core.
Solar neutrino problem: Early searches for solar neutrinos failed to find the predicted number. More recent observations find the right number of neutrinos, but some have changed form.
Solar Corona during an Eclipse
Sun-Earth Connection
What is the final fate of our sun?

In about 5 Billion years, it will become a Red Giant,

then a Planetary Nebula,

and finally a White Dwarf
Planetary Nebula NGC 3132

PRC98-39 · Space Telescope Science Institute · Hubble Heritage Team
Chapter 12
Surveying the Stars
**Luminosity:**
Amount of power a star radiates
(energy per second = watts)

**Apparent brightness:**
Amount of starlight that reaches Earth
(energy per second per square meter)
The amount of luminosity passing through each sphere is the same.

Area of sphere:

\[ 4\pi (\text{radius})^2 \]

Divide luminosity by area to get brightness.
The relationship between apparent brightness and luminosity depends on distance:

\[
\text{Apparent brightness (Flux)} = \frac{\text{Luminosity}}{4\pi \text{ (distance)}^2}
\]

\[
F = \frac{L}{4\pi D^2}
\]

We can determine a star’s luminosity if we can measure its distance and apparent brightness:

\[
\text{Luminosity} = 4\pi (\text{distance})^2 \times \text{(flux)}
\]

\[
L = 4\pi D^2 F
\]
Thought Question

How would the apparent brightness of Alpha Centauri change if it were three times farther away?

A. It would be only 1/3 as bright.
B. It would be only 1/6 as bright.
C. It would be only 1/9 as bright.
D. It would be three times brighter.
Thought Question

How would the apparent brightness of Alpha Centauri change if it were three times farther away?

A. It would be only 1/3 as bright.
B. It would be only 1/6 as bright.
C. It would be only 1/9 as bright.
D. It would be three times brighter.
So how far away are these stars?
Every January, we see this: distant stars

Every July, we see this:

nearby star

1 AU

Not to scale
Parallax and Distance

\[ d \text{ (in parsecs)} = \frac{1}{p \text{ (in arcseconds)}} \]

1 parsec (pc) = 3.26 light-years (ly)
What is the distance to a star with a parallax angle of 0.1 arcseconds?

A. 0.01 parsecs
B. 0.1 parsecs
C. 10 parsecs
D. 100 parsecs
E. none of the above
What is the distance to a star with a parallax angle of 0.1 arcseconds?

A. 0.01 parsecs
B. 0.1 parsecs
C. 10 parsecs
D. 100 parsecs
E. none of the above