    - Continuous the rainbow
- Each element has a unique spectrum, how we find the compositions of the things.
- How we organize the periodic table is how they behaved.
    - Putting them in columns as they have similar behaviors and properties.

1-22-19

- Rutherford gold foil disproves that atoms are empty space and they have a nucleus.
- Light wave
    - No medium
    - Radiates in all directions at a constant speed
    - There is a spectrum
        - There's frequency, where you are and determines color
        - There's wavelength
    - Color
        - Cyan, magenta & yellow
        - We know it as red, green and blue.
        - Between 400 and 700 nm
- Light particle
    - Called a photon
    - Moves at c
    - Has a specific energy that's dependent on frequency?
- Spectra (spectroscopy)
    - Emission - black with colors
    - Absorption - rainbow with missing colors
    - Continuous - rainbow of colors
    - Each spectrum is unique, to each element
- Periodic table
    - Organization
- Thomson's plum pudding model didn't explain the spectra or the periodic table. He also could not find patterns.
- Rutherford came and did an experiment that proved an atom more and created a new model.
- Atoms are mostly empty space and the nucleus is very small.
- When a photon is emitted, a certain amount of energy is loss, the orbit gets smaller.
    - Electrons are just going to sit on the nucleus and the atoms will collapse.
- Rutherford's model predicted that all atoms would collapse & that was wrong.
    - His model is incorrect because all the atoms would have collapsed, and he couldn't really explain the periodic table. It did prove that atoms are mostly empty space and humans have never really touched anything

1-24-19

- Bohr's assumption
    - Angular momentum is quantized, can only have energy (full electrons, not halves)
    - An electron does not radiate
    - A single electron is emitted when it jumps from higher orbit to lower
- Angular moment gives us some allowed values of energy.
- Second assumption - if an electron is one of those orbits, it will not emit or absorb energy. The energy in one orbit is constant.
    - When and why do they do that?
- Third assumption - if you're in a higher orbit, it must emit a photon to jump down. If a photon comes in, it must have the exact amount of energy, it then can jump up. If the

            - The photons get absorbed and remitted and that's why it takes so long to get through.
        - This layer is very dense, much like the core.
    - Convective zone
        - Take high energy things, bubble to the surface of the sun, cool down and then drop back down because it's cold.
        - Transferring energy from the bottle layers to the top.
    - Photosphere
        - The layer of the sun that we can see.
        - We don't see the other layers.
        - The surface is not smooth. The sun has granules.
            - They move around a lot, so they don't last very long. The darker, the less energy.
    - Chromosphere
        - Mostly transparent to humans.
        - 25-kilometer thick.
        - Has a lot of emission lines.
        - 10k kelvin is the temperature.
        - The layer below is cooler than the layer above.
    - Transition region
        - Transitions from ten k degrees to a flaming million degrees.
        - We're getting hotter as we move away from the sun.
    - Corona
        - We knew this existed because there have always been solar eclipses.
        - Temperatures is a million degrees kelvin.
        - Emits the amount of light as full moon.
        - Particles coming out of it are going very fast.
            - We know this because of the temp.
        - Low density.
        - This layer extends so far out, we are technically living in the sun's atmosphere.
- Solar wind
    - Particles from the sun.
    - We found this from looking at the tails of comets.
- Sunspots
    - The sunspots are darker because the spots are colder.
    - Lifetime : hours to months
    - Umbra - dark region penumbra - lighter region.
    - Can travel around, move like storms, they do rotate with the sun
    - We can see the sun rotate by using the sun's spots.
- Some parts of the sun move faster than other parts
    - Differential rotation
- There is a lot of fluctuating fields because of the particles moving around - that is why the sun has a magnetic field.
- Magnetic fields are probably coming from the convection era

2-5-19

- We cannot predict come storms
- The most we could predict was a couple of hours to a day.
- If we knew storms were coming, we could change stuff on our end
- We must watch come storms and flares to prepare for it.
- We don't know when something will hit us.

1. Suppose you have discovered a new cepheid variable star. What steps would you take to determine its distance? First you'd determine its period and use it to find its luminosity and compare it to the luminosities we see and find its distance.
2. Which method would you use to obtain the distance to each of the following?
    a. An asteroid crossing earth's orbit radio wave - more accurate
    b. A star astronomer believed to be no more than 50 light years from the sun parallax or triangulation.
    c. A tight group of stars in the Milky Way Galaxy that includes a significant number of variable stars. RR Lyre
    d. A star that is not variable but for which you can obtain a clearly defined spectrum-R Diagram
3. What are the luminosity class and spectral type of a star with an effective temperature of 5,000 K and a luminosity of 100 times that of the Sun? Spectral class would be KO or G9 and the luminosity class would be Giant III
4. For centuries astronomers wondered whether comets were true celestial objects like the planets and stars, or a phenomenon that occurred in the atmosphere of Earth. Describe how you could determine which hypothesis is correct? You would shoot a radio wave at it and find out how far away it is. If it goes beyond earth's atmosphere, then it doesn't happen inside of earth's atmosphere.

15 Interstellar Medium Part 1

1. A molecular cloud is about 1,000 times denser than the average of the interstellar medium. Let's compare this difference in densities to something more familiar. Air has a density of about 1 kg/m3, so something 1,000 times denser would have a density of 1,000 kg/m3. How does this compare to the typical density of water? Of granite? (You may use Google to find the answer to this part of the question.) Is the density difference between a molecular cloud and the interstellar medium larger or smaller than the density difference between air and water or granite? The density of water is close to 1,000 times denser than air, like the cloud to the average interstellar mediums. It's basically the same as air and water but not as different to air and graphite.
2. New stars form in regions where the density of gas and dust is relatively high. Suppose you wanted to search for some recently formed stars. Would you more likely be successful if you observed at visible wavelengths or infrared wavelengths? Why? You'd be more successful if you observed at infrared wavelengths. This is because it's a high density of dust and gas, it can block visible light.
3. Why do molecules, including H2 and more complex organic molecules, only form inside dark clouds? Why don't they fill all interstellar space? Molecules such as h2 and other complex organic molecules only form inside dark clouds because it's hot. They need somewhere sheltered for them to bond together and the dark clouds protect them from the radiation.
4. Describe how the 21-cm line of hydrogen is formed. Why is this line such an important tool for understanding the interstellar medium? The 21-cm line of hydrogen is formed by the flip of the electrons. From up to down. This line is so important because it tells us the difference of the radio wavelength. It tells us that hydrogen is there.

- Neutron star - between 1.4 solar masses and three solar masses.
- Black hole - the black hole must be more than three solar masses.
- When a star dies, fusion will stop

T-Tauri Stars

- Between protostar and star
- Massive stars do not go thru this phase.

Space and time are the same thing

- Convert between them with speed of light
- Light always takes the shortest path between two points and sometimes bends.

Star evolution

- When it starts to die, the core contracts the outer layers expand.
    - Red giants
    - Red supergiants
- Low mass stars only fuse hydrogen and helium and they get carbon cores.
- High mass stars can fuse up to iron.
    - Why don't they go pst iron?
        - Takes more energy to fuse more than they get out of it.
- Cores contract once they're reached the last phase.
- Neutron stars are massive enough to overcome electron degrency.
    - Neutron gas.

Difference between white dwarfs and neutron stars is the ***mass***.

General relativity

Special relativity

Reference frame

- Inertial- velocity is constant

Equivalence principle - can't tell if you're in free fall or not.

Time dilation

Faster you're moving, the slower time is.

Length contraction

Harder to formulate

The person in the same reference as the object, will always have the true length.

Being close to a large object slows time down.

Unit Four Notes - Stars, Galaxy & Universe

4-9-19

- Hershel concluded that the sun was in the center.
- We have to see through lower frequencies
    - Give us an idea of what the galaxy looks like.
- Stars are not confined in the center, so there's a bulge in the center of the disk.
- Dark matter = what's beyond our galaxy.
- Thick disk have old stars 12-13 billion years old.
- In the halo, older stars than what's found in the thick disk.
- Galaxy doesn't move like a cd, but it looks like a cd.
- Object further from the orbit, take longer to orbit.

- One of the early Hypothesis to explain the high redshifts of quasars was that these objects had been ejected at very high speeds from other galaxies. This idea was rejected because no quasars with large blueshifts have been found. Explain why we would expect to see quasars with both blue shifted and red shifted lines if they were ejected from nearby galaxies. Because they could be going in any direction. You'd expect to see at least one coming at us.
- Could the milky way ever become an active galaxy? is it likely to ever be as luminous as a quasar? No, there's not enough stuff. No, because the galaxy is old. There is not enough material, we'd need a lot more gas and dust to wonder to the center.

26 The Evolution and Distribution

- What are the forms of evidence we have for the existence of dark matter? Some forms of evidence we have for the existence of dark matter would be that we discovered Neptune because of the orbit of Uranus, and It affects the motion of things that we can see.
- In a large cluster of galaxies, where would you find spirals? Where would you find ellipticals? In a large cluster of galaxies, you would find spiral near the outskirts and ellipticals near the center because ellipticals are more likely to collide together.
- Suppose you are standing in the center of a large, densely populated city that I exactly circular, surrounded by a ring of suburbs with lower- density population, surrounded in turn by a ring of farmland. from this specific location, would you say the population distribution is isotropic? Homogenous? This location would be isotropic because it's the same in every direction.
- How are galaxies today different from the earliest galaxies? We know more about galaxies today than back then with the help of technology. Since we have spent so many years on studying the evolution of galaxies, we can conclude more than what we could conclude back then.

23 The Milky Way

- We use radio and infrared cameras to see in galaxies
- The brightest part of the galaxy is a thing rotating disk
- Our galaxy has a bar with spiral arms
    - The bar's made of old yellow-red stars
- The galaxy is a barred spiral
- In the center, there's a bulge
    - Two times longer than it is white
    - Seen through infrared
- There's a dark matter halo around the galaxy
- Our galaxy has two major arms from the bar
    - The fainter arms are spurs
    - The suns on a spire, Orion's spur.
- The galaxy moves by differential rotation.
    - That's how we got the arms.
- We need more galaxy information to get how the galaxy formed.
- Gravity also helped with the formation of arms
- There's a black hole at the center of our galaxy - a supermassive black hole.
- Bright's radio source is in the nucleus of Sagittarius A - seen by radio waves.
- We need radio waves to estimate the galactic center.
- Formation of the galaxy
    - Gravity caused the thing disk to become clumps
    - Clumps formed into stars
- Thick disk may be from collision with other galaxies.