Astronomy Notes

White Dwarfs

- A dead star
- No nuclear reaction in the star
- Core is helium or carbon or oxygen
- In order for helium to go into carbon you need 100 million degrees
- The star is not big enough to
- You need a balance of gravity and pressure in equilibrium
- The source of the pressure is the electron gas- Fermi gas which is not an ideal gas- this is a gas out of fermions (electrons, protons, neutrons)
- Any half integer spin particle is a fermion
- Any integer spin particle is a boson- these are responsible for force interactions
- Fermions don't like to interact with each other
- Only one fermion can be in a single state
- Pauli exclusion principle- they need to be in opposite spins to occupy the same state
- Millions of bosons can be in the same state
- A neutron star is a Fermi gas
- Electrons in a metal is an example of a Fermi gas
- For every two electrons you have two protons
- The more massive the white dwarf the smaller the radius
- The Sandrachekar limit is 1.4 solar masses
- When this limit is exceeded, a supernova happens
- Radius cannot be negative
- The less massive the star is the more luminous for white dwarfs star
- The star sheds the mass and that mass becomes a planetary nebula
- The limit on the reduced white dwarf is 1.4 solar masses
- Stars greater than 8 solar masses can either become a black hole or a neutron star
- Let's say a star has 50 solar masses, you can fuse heavier atoms
- At 3 billion degrees you can make nickel and iron
- Formation of iron and nickel is the death blow for a star
- A supernova occurs
- A neutron star and white dwarf are very similar
- Neutron star or a black hole can produce a supernova
- Crab nebula is the leftover from a supernova
- Atoms are made out of nucleus and electrons
- When you squeeze the atom, electrons push each other
- Electrons repel one another
- You need a LOT of pressure to squeeze the atoms
- 10^15 density
- Beta decay- a proton becomes a neutron or a neutron becomes a proton
- If a proton captures an electron, it results in a neutron and a gamma ray – this is B- decay
- Charge is conserved

- Mass is also conserved
- If a neutron star doesn't collapse it is because of the Pauli exclusion principle
- You can't have a neutron star which is more massive than five suns
- If you pass the limit of too much mass, the neutron star collapses into a black hole
- First observation of a neutron star is a pulsar
- Pulsar
- A neutron star is an ideal sphere
- Magnetar is a neutron star with an extraordinary magnetic field
- The magnetic axis and rotational axis do not match up
- So it's like a light house
- If your antenna happens to be in the way of the waves, you hear ticks
- The more they are squeezed by gravity, the faster they spin

Black holes

- Space and time are one thing
- Space and time do not exist independently
- Nothing can move faster than the speed of light
- Light moves at 45 degrees on the space vs. time graph
- How do you know if you live in flat space or curved space? – If you form a triangle. If the internal angles are more than 180 degrees, space is curved
- Stars are characterized by escape velocity
- The more massive and dense a star, the higher the escape velocity
- If the escape velocity is the speed of light, light cannot escape