

- Chemical Revolution 18-19 century
 - Atomism, can be used to create things
 - Periodic table which left room on the table to discover
 - Atoms were used to explain chemistry
 - "Matter" is not one thing, lots of things
- 19th Century
 - 1850: Geissler tubes → posed many questions (i.e. neon signs)
 - Geissler Tubes led to X-rays
 - produced amazing photos
 - X-rays showed there were things still to be explained
- Radioactivity
 - Curie's refined "uranium film exposure"
 - Can measure radioactivity → radium from uranium ore
 - 1 ton uranium = .2 g of radium
 - Radiochemistry
- Atomic Models
 - What are atoms / what they look like?
 - JJ Thomson: corpuscle: subatomic particles that were negatively charged (electron) from cathode tube, could deflect with neg. magnet
 - atoms composed of particles only
 - Plum-pudding model
 - Ernest Rutherford
 - disproved JS about only electrons
 - dense mass in center of atom (gold foil experiment)
- Transmutation and Popularization
 - Radioactivity form of transformation (atoms can change)
 - Protons composing up nucleus of atom
 - Frederick Soddy - "Interpretation of Radium"
 - When radioactivity happens, atoms change, lots of energy released (how to harness?)
- Atomic Visions
 - H.G. Wells: in response to Soddy, talks about bombs
 - Speaks of infinite fire radioactivity bomb
 - Linking scientific to political
 - "Tinkering w/ Atoms may blow up the earth" → Atomic culture
 - Science talk bridging to journalistic talk
 - Pre-Atomic Age in 1910-1930's
- Atomic Fads (1910's)
 - AE for "health"
 - "Energies might be good for you"
 - Radium chocolate bars etc.

- Watches (glow in dark)
- "Radium Girls"
- Edna Byers dies from Radium Water and NY Mayor
 - Gave way to assoc. of radioactivity w/ death + disease
- Flourishing of Physics
 - 1900-1910's: Quantum Theory
 - 1920's: Quantum Mechanics
 - 1929: cyclotron (particle accel.)
 - 1932: Cockcroft-Walton Generator (particle accel. / split atom)
 - Copenhagen, Göttingen, Paris, Cambridge, Berkeley, Japan, USSR
- Atomic Models
 - 1932: Neutron discovered (James Chadwick)



\bullet = electron, negative
 \circ = proton, positive
 \circ = neutron, neutral

- Artificial Radioactivity
 - 1934: Frederic & Irene Joliot-Curie
 - Make non-radioactive things radioactive by bombarding it w/ radioactivity
- Chain Reaction
 - Shoot neutrons at element which undergoes nuclear reaction which releases neutrons into other elements
 - 1934: Leo Szilard
- Slow Neutrons
 - LE are much more likely to hit nucleus
 - 1934: Enrico Fermi
- Physics and Politics 1930's
 - Nazi got rid of all physicist that were Jewish
- Hahn Meitner 1938
 - $n \rightarrow {}_{92}^{235}\text{U} \rightarrow {}_{35}^{89}\text{Kr} + {}_{56}^{136}\text{Ba}$
 - splitting the atom (nuclear fission)
 - get nucleus just outside strong force that the electric force pushes them away
- Secondary neutrons, fission chain reaction
 - Szilard's neutron chain reaction w/ fission can mean bomb (1939)
 - exponential reaction
 - first one to think in terms of bomb
 - initially denied this theory to Germans - Self-censorship

- Fermi said "crazy" "too many unknowns to assume fission is dangerous"
"germans will eventually get it"
- Szilard said "all we need is one day"
- scientific insurance w/ publications
- Szilard's Experiment 1939
 - Proved nuclear fission
- Bohr and Wheeler Sep. 1939
 - Why making an atom bomb will be hard
 - U-238 (99% in nature)
U-235 (1% in nature) ← only ones that can fission from all neutron energies (fast + slow), including ones from fission reactions
Can sustain exponential fission chain reactions (fissile)
 - Are neutrons from chain reactions fast? Is this why U-238 sucks?
 - U-238 will absorb slow neutrons, stops chain reactions
 - get rid of U-238, need 80-90% U-235 or other fissile fuel
 - HARD to separate distinction between U-238 & U-235 (chemically identical)
- Neutron Cross-Section
 - Cross-section: likelihood of subatomic particles hitting
- The Situation in late 1939
 - Every scientist in the world knows about nuclear fission and chain reactions
 - Everyone has already heard of idea of atomic bombs
 - Can they be made? Maybe - maybe not - hard to say:
 - Don't know cross-section of U-235
 - Don't know if you can separate U-235 / U-238
 - Don't know how much U-235 you might need
 - Don't know if fissile fuels other than U-235
 - But can prob make nuclear reactor