- Opening
    - Introduction
    - Topic: Quantum Mechanics
- Base Significance
    - Going from large scale to small
    - Previous topics, galaxies, black holes, universes
    - Quantum Mechanics is the smallest of scales
    - Not the domain of classical physics.
- Introduction
    - Entirely new way of analyzing the natural world.
    - Required a new generation of brave new intellectuals to tackle old problems.
    - It is not a subject of exact values, constants, simple kinematic mechanics, it is one of probability, waves, and uncertainty.
    - Early quantum theory led to computer breakthroughs, LED's, lasers, medical imaging, and superconducting magnets necessary for MagLev trains.
- Early formation
    - The modern concept was invented in the early 20th century by Erwin Schrodinger, Max Planck, Werner Heisenberg, Max Born, and other imaginative scientists studying the mysteries of black body radiation.
        - They were also driven by the discovery that subatomic particles do not act like they ought, almost like they were waves.
    - Einstein's 1905 paper on the photoelectric effect employed the precursors to quantum theory to explain the phenomenon
        - Relevant later in Einstein's career
        - Photoelectric effect: Emission of electrons or other loosely bonded subatomic particles when light strikes a material.
    - Early physicists did not realize what they were creating
        - Max Planck considered his famous equation relating energy elements and frequency of a wave to simply be a mathematical trick, and not related to reality.
        - Einstein took this and managed to show that EM waves can be described as a waves or particles with discrete quantums or energy which is dependant on frequency.
        - This was highly debated among the scientific community, at the end it was accepted along with much of the basic quantum mechanics which were still considered to be fringe physics.
        - Later refined to show that subatomic particles and EM waves are very similar in their neither are ever wholly particle or wholly wave
- Applications in Science
    - Bohr's Atom
        - Electron orbitals are not sure things, they are guesses
        - Orbitals are man made things based on discrete energy levels.

        - They are not clear cut orbits like those of planets, they are small bands of probability that an electron will or will not be on them.
    - Heisenberg's Uncertainty Principle
        - Derivation of the wave-particle duality of EM waves and subatomic particles
        - States that in an experiment, only one of the two states can be tested, therefore when observed, a particle or EM field is forced into a wave or a particle, therefore it is impossible to know all of the values of all of the properties of a system at the same moment.
        - This leads to making the field a study a probabilities, if they can not be known, they must be guessed.
        - Heisenberg surmises that certain physical properties are shared, such as momentum and position, and both cannot be known at the same moment, that is, they cannot be simultaneously measured.
    - Electron Spin
        - The result of Wolfgang Pauli and his exclusion principle
        - Pauli's solution to resolve the inconsistencies between molecular behavior and quantum mechanics
        - Essentially added another value to electrons, another discrete level of information
    - Quantum Entanglement
        - The coolest thing since the invention of podcasts
        - The Holy Grail of space nerds in quantum mechanics
        - Two particles, such as photons, interact physically.
        - They form a connection that is not well understood, but essentially means that one will mimic the other's state, spin, etc. and the other way around.
        - Scientists have measured the propagation of this phenomenon at speeds greater than 10,000 times the speed of light.
            - The transfer is theoretically instantaneous over any distance, but that is only a theory for now.
        - Essentially flaunts the universal speed limit.
        - There is now a caveat to that law, nothing can move faster than light, except information.
        - Infamously name "spooky action at a distance"
            - Marks Einstein's derision for quantum mechanics later in life.
- Summary
    - If force and energy are the bases for Newtonian Physics, information is the foundation of quantum mechanics
    - Information cannot be created or destroyed, only transferred.
        - Led to the discovery of Hawking Radiation