

**Special and General Relativity, Black Holes, Warp
Drives, Wormholes, Time Travel and a Pinch of
Cosmology.**

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Syllabus

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Special Relativity - Two Viewpoints

View #1-Definitions
View #1-Galilean Relativity
View #2-Events in Space-Time: Basic Building Blocks
 Events
 Everyday Experience = Aristotelian View
View #2-Aristotelian View: A Personalized Framework
 Geometrical Objects in Space-time
 What about Light?
 Discussion
 Final Thoughts
View #2-Galilean View: A Democratic Framework
View #2-Difficulties with the Galilean View
View #1-Special Relativity
 Review of Wave Properties
 Interference between Waves
 Interference Types
Spacetime Diagrams
Radar Method
Special Relativity
 Features of the Theory
 Minkowski Spacetime Diagrams
 Using Experiment to Calibrate the Axes
 General Spacetime Diagram Construction Procedure
The Strange World of Special Relativity
 Relationships between Events
 LightCones
Measurements in Special Relativity
 Using Lorentz Transformations
 Length Contraction
 Time Dilation
The Doppler Effect

- Sound and the Acoustic Doppler Effect
- Light and the Relativistic Doppler Effect
- How Do We Talk to Each Other in Relativistic World?
- The Famous Paradoxes
 - The Twin Paradox
 - The Pole in the Barn Paradox
 - Signals Faster than Light Paradox
- Questions

Dynamics in Special Relativity

First Thoughts on General Relativity

- Basic Ideas of Kinematics/Dynamics(motion in time)
- A QuickTour
 - Newton's Laws
 - Energy
 - Some questions arise
 - New predictions?
- Some 1st Thoughts about General Relativity
 - BlackHoles
- Digression to 4-Vectors
 - The Standard Language of Vectors
 - Time Dilation(the easy way)
 - Other 4-Vectors
 - A Further Generalization
- Now back to special relativity

General Relativity using Intervals and Space-time

Diagrams

- The Interval: The Fundamental Geometrical Object
- The Physics and Geometry of the Interval
- Einstein's Equation: TheFinalTheory
- An Example: BlackHoles

Black Holes, Gravitational Waves and Warp Drive

- The fuel of a star
- The life of a star
 - Start with stars like our Sun
 - The life of a heavy star
- BlackHoles
- Gravitational Waves
- Alcubierre(warp) drive
- History

- Alcubierre metric
- Physics
- Difficulties
- Mass-energy requirement
- Placement of matter
- Survivability inside the bubble
- Damaging effect on destination
- Wall thickness
- Causality violation/semiclassical instability
- Experiments
- Relationship to Star Trek warp drive

A Bit of Cosmology

- A Brief History
- Expanding Universe
- Inflation

Latest Developments

- Cosmic Background Radiation
- Dark Matter and Dark Energy
- Modified Gravity Theories

Worm Holes and Time Machines