

Relativity, Spacetime, Gravity and Cosmology
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Syllabus

Spring 2017

Special Relativity - Two Viewpoints

Boccio-Definitions

Boccio-Galilean Relativity

Geroch - Events in Space-Time: Basic Building Blocks

Events

Everyday Experience = Aristotelian View

Geroch - Aristotelian View: A Personalized Framework

Geometrical Objects in Space-time

What about Light?

Discussion

Final Thoughts

Geroch - Galilean View: A Democratic Framework

Geroch-Difficulties with the Galilean View

Boccio-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 ala Boccio
 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 ala Geroch

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

Notes on Weinberg - The First Three Minutes

- supplemented by modern(after 1977) developments.

Introduction: The Giant and the Cow
The Expansion of the Universe
Details concerning later evolution of the universe
 After the first three minutes
The Cosmic Microwave Background
Recipe for a Hot Universe
The First Three Minutes

Notes on the Inflationary Universe

The Very early Universe

- The Standard Model of Particle Physics: 1970's
- Grand Unified Theories(GUTs)
- The Magnetic Monopole Problem
- The Inflationary Universe
- Implications/Remaining Problems-Inflationary Theory
- A New Inflationary Theory

Latest Developments

- CosmicBackgroundRadiation
- Dark Matter and Dark Energy

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

Worm Holes and Time Machines