

One Century of Relativity

Djamel Dou.

⁺*Institute of Exact Science and Technology, University Center of Eloued, Eloued, Algeria.*

Abstract

The goal of these lectures is not to axiomatize the theory of relativity, mathematicians have already enough axioms. We will rather attempt to explain the basic physical ideas of relativity at an introductory level using standard geometrical terms. With an eye on the problem of communication between physicists and mathematicians, we hope that at the end of these lectures the reader "who is supposed to be pure mathematician" will get acquaintance with the language that is generally used by physicists.

1 Outlook

In this lectures we cover the following topics:

- **Special Relativity: Inertial Systems, Galileo Relativity, the postulates of Special Relativity, Why Lorentz Transformations!, Implications of Lorentz transformations, Geometrical Interpretation of Lorentz Transformations, Minkowski space (space-time) and connection with Riemannian geometry, Lorentz Transformations as Isometries (Killing Vectors) , Poincaré Group , The mathematical Setting of Special Relativity: Rebuilding Special relativity (Axiomatic).**
- **General Relativity: Why General Relativity(The gravity)!, Equivalence Principle, The Relation between the physical and the Mathematical meaning of the Equivalence principle (Locally flat Manifold), Principle of Least Action, Variational Methods, Geodesic Equation from Principle of Least Action. Symmetries and Noether's Theorem, Energy-Momentum Tensor, Einstein Equation.**
- **Exact Solutions of Einstein Equation: Symmetric Spaces (Universes), Schwarzschild solution (discussion of real and apparent singularities using Geodesic equation), Taub' Solution, Freedman universe...etc , cosmology -Big bang-.**
- **More about Black Holes: Horizon, Penrose diagrams, ...**
- **Advanced Topics (brief discussion): Black Hole Laws and Thermodynamics, The question of Black Hole Entropy, Cosmic-censorship, What is Quantum Gravity!!! , Where are we after 100 years of relativity !.**