



## General Relativity and the Einstein Equations [

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Electronic books

Monografía

Aimed at researchers in mathematics and physics, this monograph, in which the author overviews the basic ideas in General Relativity, introduces the necessary mathematics and discusses some of the key open questions in the field. - ;General Relativity has passed all experimental and observational tests to model the motion of isolated bodies with strong gravitational fields, though the mathematical and numerical study of these motions is still in its infancy. It is believed that General Relativity models our cosmos, with a manifold of dimensions possibly greater than four and debatable topology

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**Contenido:** CONTENTS; I: Lorentz geometry; 1 Introduction; 2 Manifolds; 3 Differentiable mappings; 4 Vectors and tensors; 4.1 Tangent and cotangent space; 4.2 Vector fields; 4.3 Tensors and tensor fields; 5 Pseudo-Riemannian metrics; 5.1 General properties; 5.2 Riemannian and Lorentzian metrics; 6 Riemannian connection; 7 Geodesics; 8 Curvature; 9 Geodesic deviation; 10 Maximum of length and conjugate points; 11 Linearized Ricci and Einstein tensors; 12 Second derivative of the Ricci tensor; II: Special Relativity; 1 Newton's mechanics; 1.1 The Galileo-Newton spacetime 1.2 Newton's dynamics - the Galileo group 2 Maxwell's equations; 3 Minkowski spacetime; 3.1 Definition; 3.2 Maxwell's equations on  $M^4$ ; 4 Poincaré group; 5 Lorentz group; 5.1 General formulae; 5.2 Transformation of electric and magnetic vector fields (case  $n = 3$ ); 5.3 Lorentz contraction and dilatation; 6 Special Relativity; 6.1 Proper time; 6.2 Proper frame and relative velocities; 7 Dynamics of a pointlike mass; 7.1 Newtonian law; 7.2 Relativistic law; 7.3 Equivalence of mass and energy; 8 Continuous matter; 8.1 Case of dust (incoherent matter); 8.2 Perfect fluids III: General relativity and Einstein's equations 1 Introduction; 2 Newton's gravity law; 3 General relativity; 3.1 Physical motivations; 4 Observations and experiments; 4.1

Deviation of light rays; 4.2 Proper time, gravitational time delay; 5 Einstein's equations; 5.1 Vacuum case; 5.2 Equations with sources; 6 Field sources; 6.1 Electromagnetic sources; 6.2 Electromagnetic potential; 6.3 Yang-Mills fields; 6.4 Scalar fields; 6.5 Wave maps; 6.6 Energy conditions; 7 Lagrangians; 7.1 Einstein-Hilbert Lagrangian; 7.2 Lagrangians and stress energy tensors of sources; 7.3 Coupled Lagrangian 8 Fluid sources 9 Einsteinian spacetimes; 9.1 Definition; 9.2 Regularity hypotheses; 10 Newtonian approximation; 10.1 Equations for potentials; 10.2 Equations of motion; 11 Gravitational waves; 11.1 Minkowskian approximation; 11.2 General linear waves; 12 High-frequency gravitational waves; 12.1 Phase and polarizations; 12.2 Radiative coordinates; 12.3 Energy conservation; 13 Coupled electromagnetic and gravitational waves; 13.1 Phase and polarizations; 13.2 Propagation equations; IV: Schwarzschild spacetime and black holes; 1 Introduction; 2 Spherically symmetric spacetimes 3 Schwarzschild metric 4 Other coordinates; 4.1 Isotropic coordinates; 4.2 Wave coordinates; 4.3 Painlevé-Gullstrand-like coordinates; 4.4 Regge-Wheeler coordinates; 5 Schwarzschild spacetime; 6 The motion of the planets and perihelion precession; 6.1 Equations; 6.2 Results of observations; 6.3 Escape velocity; 7 Stability of circular orbits; 8 Deflection of light rays; 8.1 Theoretical prediction; 8.2 Results of observation; 8.3 Fermat's principle and light travel parameter time; 9 Red shift and time delay; 10 Spherically symmetric interior solutions; 10.1 Static solutions. Upper limit on mass 10.2 Matching with an exterior solution

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