Review for final

May 9, 2009

You must be familiar with the following concepts from Special Relativity:

- Euclidean space, Minkowski space, orthogonal transformation, Lorentz transformation
- Notation: $\mathbb{R}^n$, $\mathbb{R}^{k,n}$.
- Orthogonal group, Euclidean group, Lorentz group, Poincare group.
- Notation: $O(n)$, $E(n)$, $O(k,n)$, $P(k,n)$.
- Relation between classical and relativistic velocity: $v = (\gamma, \gamma \vec{v})$.
- Momentum of a particle, and its relation with classical energy and momentum:
  $$p = -mc^2v = (-E, \gamma \vec{p}).$$
- Conservation of energy-momentum for interacting particles.
- The Cauchy stress tensor.
- The Stress-energy-momentum tensor, and the conservation law.

You must be familiar with the following concepts from linear algebra:

- Vector space, covector space, tensor spaces.
- Linear algebras, linear operators.
- Linear maps as tensors, and vice-versa.
- Wedge products.
- Notation: $V, V^*, \otimes^{r,s} V, \Lambda^r V^*$.

You must be familiar with the following concepts from differential calculus:

- Coordinates, vectors, covectors, tensors, alternating tensors.
- The $d$-operator.
- The $\ast$-operator.
- Covariant derivatives of vector and tensor fields, and Christoffel symbols.
- The geodesic equation, and its derivation.
- The Riemann curvature operator.
- The Jacobi equation, and its derivation.
- Sectional curvature, Ricci curvature and scalar curvature.
- The two Bianchi identities.

You must be familiar with the following concepts from electromagnetism:

- The Classical Maxwell equations.
- The magnetic vector potential and the electrical pseudopotential.
- Wave equations for $\vec{E}$, $\vec{B}$, $\vec{A}$ and $\varphi$.
- The relativistic Maxwell equations.
- The electromagnetic 4-potential.
- The 4-potential wave equation.

You must be familiar with the following concepts from General relativity:

- The interpretation of gravity.
- Newton’s law of gravitation, and the gravitational potential.
- The ‘plausibility argument’ for the field equations.
- The field equations.