General Relativity Marathon Master Page

Howdy! This page will be dedicated for the "General Relativity Marathon", a magical secret seminar that will happen every **Saturday** in **RIII Seminar Room** at a time that is usually announced here.

You can find the lecture notes prepared for this seminar here (click).
They will be updated regularly.

The topic of this seminar is **The theory of general relativity**. I'll be updating this page with relevant material: mainly the lectures notes I'll be writing for this seminar, as well as presentation slides when needed, some resources/links/books and whatever I found to be of aid in my understanding of the theory. Let's see how this goes!

Resources I found useful in order of usefulness:

Books (all available at our Library):

- General Relativity by Wald: Excellent book. Gets to the physics right away and introduces the maths when necessary.
- Spacetime and Geometry by Carol: Starts introducing all the maths first. It can be a bit slow at the beginning.
- General Theory of Relativity by P.A.M. Dirac: Extremely concise (less than 70 pages) which makes it very handy if you're already familiar with the subject. Doesn't motivate anything. Excellent for reference/revision.
- Gravitation by Misner Thorne and Wheeler: Very nice writing which makes it entertaining to read, but it's a giant book. Uses weird notation and analogies sometimes. This book is considered "too old" by many.

Online lectures (in general: watch at 2x):

- What is a Tensor? , What is a Manifold? , What is General Relativity? series by XylyXylyX: Excellent, very highly recommended. The first two series introduces the mathematics with GR in mind. They're pretty long (130+ hours in total, or 60+ hours if you watch at 2x), but very comprehensive. They tend more towards the mathematical side. The last of them "What is General Relativity" is still ongoing to this date.
- General Relativity by Alexander Maloney: A graduate course on general relativity. I enjoyed these a lot.
- General Relativity by Leonard Suskind: Only 10 lectures. Very popular. I find them OK.

"Matter tells spacetime how to curve"

$$G_{\mu\nu}=8\pi T_{\mu\nu}$$

"Spacetime tells matter how to move"

$$\frac{\partial^2 x^\lambda}{\partial\tau^2} = -\Gamma^\lambda_{\mu\nu}\frac{\partial x^\mu}{\partial\tau}\frac{\partial x^\nu}{\partial\tau}$$

-John Wheeler

Session Date	Topic
15th September	Introduction, degrees of freedom, notions of invariance, locality, field theories, motivation
22nd September	Session canceled due to Jacobs Games and Alumni Homecoming
29th September	Special relativity: Part 1 - Inertial frames, Galilean transformations, Lorentz transformations
6th October	Special relativity: Part 2 - Lorentz transformations, Lorentz invariance, four vectors
13th October	Special relativity: Part 3 - Metrics and the correct notion of distance, the invariant interval, tensors, the Minkowski metric, the geometry of SR
20th October	Session canceled due to organizer being away for the weekend.
27th October	The Algebra of SR, worked examples and paradoxes
3rd November	**Double Session:** Motivation to GR, the Einstein equivalence principle, the principle of general covariance, tensors
10th November	Session canceled due to the University Physics Competition happening during the weekend
17th November	Tensors, the Einstein summation convention, coordinate transformations
24th November	**Double Session:** Pseudo-riemanian manifolds, topology
1st December	The geodesic equation, the christoffel symbols, parallel transport, the covariant derivative
Winter Break	
16th February	Review, the covariant derivative, the metric connection, curvature
23rd February	Curvature, fluid mechanics, the energy-stress tensor
2nd February	The energy-stress tensor, the Einstein tensor, the Einstein Field Equation
9th March	Determining the constant, the newtonian limit, symmetries, Lie derivatives and the killing equation
16th March	The Schwarzchild solution, the Schwarzchild blackhole, Kruzkal coordinates
23rd March	Kruzkal coordinates, conformal transformations, causal structures and Penrose diagrams
2nd April	Optional topics: The FLRW Model, the linearised EFE, the Kerr solution, the teleparallel equivalent of GR, the warp drive metric