

# PHYS 6610: Graduate Nuclear and Particle Physics I

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Institute for Nuclear Studies  
The George Washington University  
Spring 2018



THE GEORGE  
WASHINGTON  
UNIVERSITY  
WASHINGTON DC



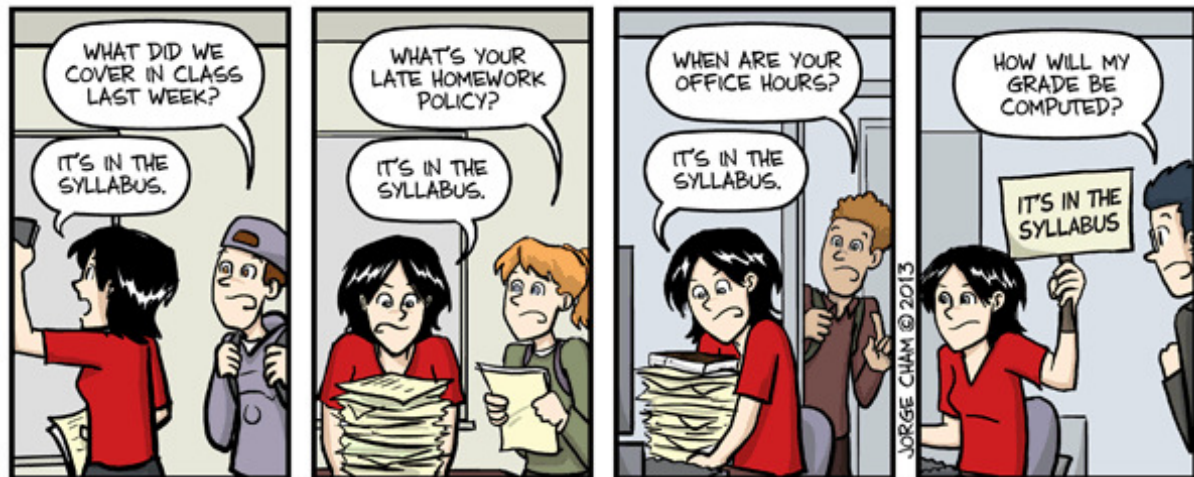
. Before We Start

## 0. Administrative Details

*Or: 5 minutes*

References: [Syllabus]

## (a) It's In The Syllabus



# IT'S IN THE SYLLABUS

This message brought to you by every instructor that ever lived.

[WWW.PHDCOMICS.COM](http://WWW.PHDCOMICS.COM)

... and a link is right here (weblinks are in violet).

## (b) Dates and Times

### Results of Doodle Poll:

- Regular lectures: Tu/Th 14:00-15:30 in Cor 309
  - **Surgery Hours: Fridays 12:30 in Cor 309** (unless “Snow Date”)
  - **“Snow Dates”: Fridays 12:30-14:00 in Cor 309**, Surgery 16:00
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### Shifted Lectures:

*not Tu 30 Jan* – relocated to *Fri 02 Feb at 12:30 – Surgery at 16:00*

*not Tu 27 Mar* – relocated to *Fri 23 Mar at 12:30 – Surgery at 16:00*

*not Th 29 Mar* – relocated to *Fri 13 Apr at 12:30 – Surgery at 16:00*

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- **Homework** (40% of grade): weekly; due Thursdays 12:00;
- **Mid-Term Exam** (30% of total): **Wed 21 Mar XX:XX??**, 2.0 hrs;
- **Final Exam** (30% of total) as Presentation:

30-minute talk about a topic that interests you; plus questions.

**Presentation Day is 01 or 02 or 03 May.**

Topic needs my approval and a “dress-rehearsal”.

## (c) Books/Weblinks

**“It is always useful to get a second viewpoint because it’s commonly the second one that makes sense – in whichever order you read them.” [J. Nearing]**

### Compulsory

[PDG] Particle Data Group: *Review of Particle Properties*: [pdgLive.lbl.gov](http://pdgLive.lbl.gov)

### Basis: Phenomenology

[PRSZR] B. Povh, K. Rith, C. Scholz, F. Zetsche, W. Rodejohann: *Particles and Nuclei*

[HG] E. M. Henley, A. Garcia: *Subatomic Physics*

[DFHMS] T. W. Donnelly, J. A. Formaggio, B. R. Holstein, R. G. Milner, B. Surrow:  
*Foundations of Nuclear and Particle Physics*

### Basis: Theory

[HM] F. Halzen, A. D. Martin: *Quarks and Leptons* (hard to find)

[CL] T.-P. Cheng, L.-F. Li: *Gauge Theories of Elementary Particle Physics*

### Weblinks – Click on Link to Access

[arXiv] [arxiv.org](http://arxiv.org): preprint archive

[inspire] [inspirehep.net](http://inspirehep.net): preprint & publication server

**Website:** <http://home.gwu.edu/~hgrie/lectures/nupa-18l/nupa-18l.html>

**Watch for clickable URLs in .pdf files and presentations: violet text, and some**



## (d) Litmus test: I Assume You “Heard Of” These

$$\begin{aligned}\partial_\mu F^{\mu\nu} &= j^\nu \\ \partial_\mu \frac{\partial \mathcal{L}}{\partial (\partial_\mu \Phi)} - \frac{\partial \mathcal{L}}{\partial \Phi} &= 0 \\ [\not{p} - m]u(p) &= 0 \\ \Phi(x) &= \int \frac{d^3k}{(2\pi)^3} \frac{1}{\sqrt{2E_k}} \left[ a(\vec{k}) e^{-ik \cdot x} + b^\dagger(\vec{k}) e^{+ik \cdot x} \right]\end{aligned}$$

Graduate courses Mechanics, Electrodynamics, Quantum Mechanics I+II:

Noether's theorem, relativistic field theory, radiation from moving charges, scattering (electromagnetic and QM), Klein-Gordon and Dirac equations with their second quantisations,  $\pi N$  scattering, spin and isospin.

***If any of these are unfamiliar to you, see me immediately!***

## (e) Contents

**This is a Gateway Course:  
Details by self-study & more advanced courses.**

### ***I. Tools***

Broad overview with “basic essentials” usually not in advanced books.

### ***II. Phenomena***

Use Tools, gain basic understanding for seminars on any (?) topic.

### ***III. Descriptions***

From basic understanding to GW-relevant specifics – contents flexible.

## (f) We Will Cover Almost Nothing

**Broad survey, emphasise basics relevant for GW research.**

**Each topic is easily a course all by itself.**

### **Topic which pained me to leave out:**

Models of heavy nuclei, nuclear decays, reactors, medicine, radiation safety,...

Details on experimental methods: accelerators, detectors, DAQ, analysis,...

Neutrinos, Beyond-Standard-Model speculations: supersymmetry, strings, ...

but maybe include some Nuclear & Particle Astrophysics, nucleosynthesis, phases of nuclear matter,...

## **In PHYS 6710: Nuclear and Particle Physics II:**

More specialised coverage of GW research

(EFT/Regularisation/Renormalisation, partial wave analysis, data, lattice,...)

## (g) Philosophy

***You*** work (read, think, ask, comment).

***I*** interpret. – Website: slides & some notes.

**Add some material not/different in textbooks.**

**HW expands concepts, adds not-covered. (Read!)**

***Be Prepared, Ask Questions, Make Comments!:***

**I added 15 minutes per lecture to satisfy your curiosity.**