

## Quarks to Quasars

### Research Paper Assignment:

### Exotic Claims, Falsifiability, and the Role of Experiment in Science

Outline and Annotated Bibliography due Mar. 18 [hard copy, in class]

Draft due Tuesday Mar. 25 by 6 pm

Final Version due Friday Apr. 4 by 6 pm

[Submit to Sakai drop box]

**Type:** research paper

**Format:** Word document (double spaced), APA or MLA style (see Hacker)

**Length:** 8-10 pages

In our semester long examination of modern particle physics and cosmology we have, and will continue to, come across many exotic, and in some cases downright outrageous, claims regarding the workings of nature. For such claims to be promoted to the level of "scientific theory", they must make predictions that can be tested by experiment (or observation). While no experiment can "prove" a scientific theory, a theory can (to some degree) be "falsified" by experiment. For this paper, each of you will carry out research into one exotic proposal of modern physics. A list of topics is provided below and we will select from this list via a lottery system. (If you would like to work on a topic different from anything on the list you will need to get my approval no later than Tues. Mar. 4). **A major focus of your research should be on the experiments or proposed experiments related to your topic.** You must offer a critique of the experimental evidence or proposals, working out for yourself the assumptions made in designing and analyzing the experiments. You are not just collecting information about a topic ... you need to understand it (and explain it) to the best of your ability. During the last week of class everyone will give a short (15 minute) oral presentations on their topic.

Many of the following topics are touched on in our textbooks, however, for this assignment you will need to go well beyond these resources. This research paper requires use of at least two technical articles (from Nature, Science, Physical Review Letters, Astrophysical Journal, etc) and at least two articles from the popular press (i.e., New York Times, Time magazine, Science News, Scientific American, etc).

**A Note on Web Resources and Plagiarism:** Since the following topics are all rather broad, I'm sure you will be searching the web for resources. This is a good strategy but can also be dangerous for the inexperienced. You should view the web as a tool to be used for tracking down primary references. Although you might glean some background information from the web (at sites such as wikipedia) your research must be based on your primary resources. Please note that I only allow "archival" sources to be used as references. Thus, unless you can verify that a website will be maintained and preserved (as is the case for on-line journals), it cannot be used as a reference for your paper. Finally, the web offers many temptations for the use of the "Copy/Paste" functions. DO NOT give in to such temptations! Copying text from the web (or anywhere else) and pasting it into your paper is **plagiarism** and such a transgression will earn an automatic F on this assignment (or worse!). I know you have heard all of this before, but please don't tune out this issue. Rather, you need to stay aware of it whenever you are doing literature research.

**The List:**

- 1) The Higgs mechanism and the Higgs boson [**Audrey**]
- 2) Super-symmetry and super-symmetric particles
- 3) CP violation and the arrow of time
- 4) Magnetic monopoles and charge quantization
- 5) Vacuum energy and virtual particles (Lamb shift, Casimir effect) [**Ben**]
- 6) Black holes and Hawking radiation [**Theresa**]
- 7) Modified Newtonian Dynamics (MOND) [**Dante**]
- 8) Dark stars (stars "powered" by dark matter) [**Matt R.**]
- 9) Extra-solar earth-like planets and astrobiology [**Jesse**]
- 10) Gravitational waves and their origins [**Bryan**]
- 11) Gravitational frame dragging
- 12) Do the laws of physics change with time?
- 13) Extra hidden dimensions [**Shishir**]
- 14) The truth about time travel [**Jeremy**]
- 15) Quantum teleportation [**George**]
- 16) Quantum computing
- 17) Quantum erasers and messing with the past
- 18) Colliding branes and a cyclic universe [**Zan**]
- 19) Accelerating expansion due to the "freezing out" of a new force
- 20) Quantum nonlocality of space: "Loopholes" in the experiments? [**Heather**]