Final Project: Research Paper **KSU PHYS953, NQO**

The final project will be an investigation of a topic or problem in the areas of nonlinear and quantum optics, that will involve a literature search and some original work. The purpose of the paper is to pose a question about your chosen topic and try to answer that question. Please keep in mind you do not to answer the question you have posed. Your paper will be evaluated on a complete literature search, a good discussion on the question, and a well-executed attempt in answering the question.

The final project will consist of three parts:

Part 1: Abstract and bibliography	Due November 19, 2007
Part 2: Six to eight page paper	Due December 3, 2007
Part 3: 10 minute presentation	Starting December 7, 2007

1. Part 1

For Part 1, you will need to provide a draft title, abstract, and bibliography. In your abstract, you will need to state a draft question that the paper will try to answer. I will look over your topic and approve it so you can do the rest of the project. On the back is a short list of research topics. Feel free to pick any topic in quantum and nonlinear optics you wish.

2. Part 2

Part 2 is a six to eight page paper on your topic. The paper should include:

The title and abstract
An introduction to the topic
A discussion of prior work
A section stating the question your paper wishes to answer
A section of your own work investigating the question
A summary comparing your conclusions with respect to prior work
A list of references

Paper Format: 10 or 12 pt font, Times New Roman Font, 1 inch margins

3. Part 3

For Part 3 you will need to give a 10 minute talk about your topic, with 3 minutes for questions. The talk will be given in class at the times listed below. For your talk, **you will only have the white/black board at your disposal**; do not prepare a computer-based talk. You are encouraged to provide handouts to the class for your talk. Also, you are encouraged to practice your talk using a white/black board before you give your talk. Your talk will be evaluated on the clarity of presentation as well as the use of time (in other words, do not go over time!).

List of Sample Topics and Questions

- Self focusing in a rare gas with estimations of focusing versus pulse intensity
- Explaining how to describe the Compton effect semi-classically
- Quantum mechanically description of stimulated Raman scattering
- Explaining how to describe the photoelectric effect semi-classically
- Discuss how quantum entanglement can be used for secure communications
- Discuss the theory and operation of an optical parametric chirped-pulse amplification, OPCPA
- Investigate the thermodynamics of laser mode-locking and how nonlinear effects are involved
- Self similar behavior in optical fiber and the third order nonlinearity
- Quantum optics in cold atoms: how does one generate entangled states?
- How to generate entangled light using second order nonlinear processes in crystals.
- What is the quantum eraser and how can one demonstrate this?
- How is two-photon absorption used for biological imaging?
- Discuss the role of electrons and holes in the nonlinear optics of III-V semiconductors
- The quantum mechanics of electromagnetic noise: Shot and thermal noise
- The quantum description of heterodyne and homodyne optical detection
- The quantum theory of a laser: the master equation.
- The role of higher order nonlinear effects in laser mode-locking
- Quantum optical description of electromagnetically induced transparency in atomic systems
- Quadrature squeezing in optical fibers
- Applications of squeezed noise in gravity wave detection
- Nonlinear spectroscopy of gases: theory of saturated absorption
- Entanglement and quantum teleportation of states

Ask me if you want more topics.

Schedule to the end of the Semester

Nov. 7 (W)	Field Quantization: single mode fields	G2	
Nov. 9 (F)	Field Quantization: multimode fields	G2	MP4 Summary
Nov. 12 (M)	Quadrature Operators and the Quantum Phase: Zero Point Energy	G2	
Nov. 14 (W)	Coherent States	G3	
Nov. 16 (F)	More on coherent states	G3 Exam 2	MP4 Review
Nov. 19 (M)	Phase-space pictures of coherent states	G3 Exam 2 due Final Project Part 1Due	
Nov. 21 (W)	No Class		
Nov. 23 (F)	No Class		
Nov. 26 (M)	Quantum mechanics of beam splitters: revisit the Aspect experiment	G6	
Nov. 28 (W)	Entanglement	G6	
Nov. 30 (F)	Optical Tests of Quantum Mechanics: EPR Paradox and Bell's Theorem	G9	
Dec. 3 (M)	Optical Tests of Quantum Mechanics: Bell's Theorem and the Aspect experiment	G9 Final Project Part 2 Due	
Dec. 5 (W)	Catch-up…TBA		
Dec 7 (F)	Final Project Presentation	Final Project Part 3 Due	
Dec 10 (M)	Final Project Presentation, Technically Exam Period 4:10 p.m. - 6:00 p.m. Actual time TBA: Possibly 4:00 p.m. - 7:00 p.m: Cardwell 119 or 220 (I will bring pizza)	Final Project Part 3 Due	