Signals & Noise

PHY 123 CRN54050 4u PHY 253 CRN54051 3u

FALL 2013 TR 2:10-3:30 Physics 185

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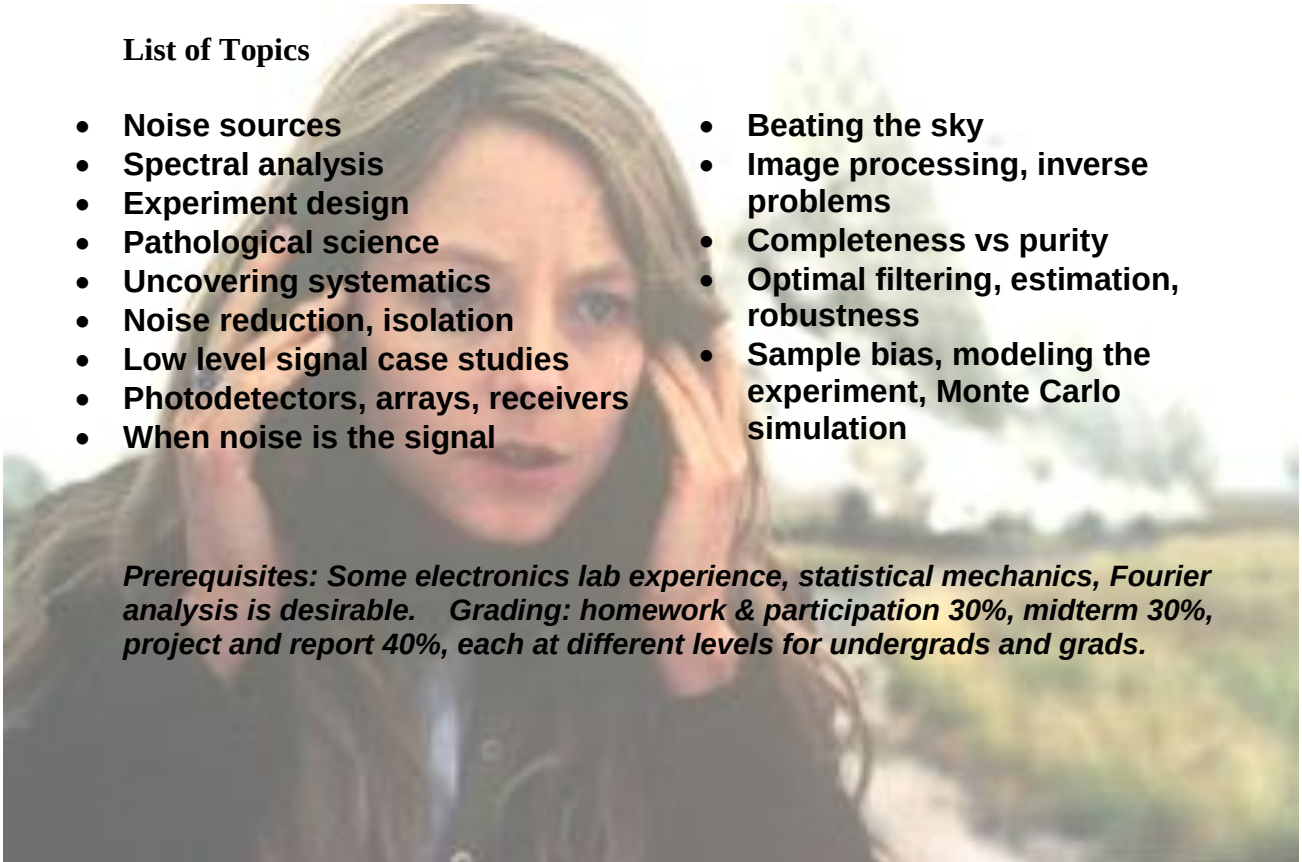
Research at the frontier in physics and other fields often deals with signals which are buried in random noise and systematic error. This course will cover techniques of experiment design, measurement, and analysis designed to avoid systematic error and optimize signal/noise ratio. Extraction of signals from noise, optimal filters, and examples of low-level detection spanning a range of subjects from laboratory physics, remote sensing, and astronomy will be discussed. Many examples will be from detection of radiation (UV to sub-millimeter) and imaging, including inverse problems and data analysis. Each student will gain experience with spectrum analyzers and oscilloscopes. Theorists as well as experimentalists in several fields should find this course fun and useful. Using these tools and techniques of experimental physics, students undertake a hands-on advanced lab project of their own choosing.



List of Topics

- **Noise sources**
- **Spectral analysis**
- **Experiment design**
- **Pathological science**
- **Uncovering systematics**
- **Noise reduction, isolation**
- **Low level signal case studies**
- **Photodetectors, arrays, receivers**
- **When noise is the signal**
- **Beating the sky**
- **Image processing, inverse problems**
- **Completeness vs purity**
- **Optimal filtering, estimation, robustness**
- **Sample bias, modeling the experiment, Monte Carlo simulation**

Prerequisites: Some electronics lab experience, statistical mechanics, Fourier analysis is desirable. Grading: homework & participation 30%, midterm 30%, project and report 40%, each at different levels for undergrads and grads.

Contact, the movie [Warner Brothers 1997]