

Winter 2007

PHY 250 Signals & Noise

3 UNITS CRN 57655 T Th 10:30-11:50 Room PHY 525

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Research in physics and other fields often deals with signals which are buried in random and systematic noise. This course is a tour of techniques of measurement and analysis designed to avoid systematic error and optimize signal/noise ratio. Extraction of known and unknown signals from noise, and examples of low-level detection spanning a range of subjects from laboratory physics to cosmology will be covered. Many examples will be from detection of radiation (UV to sub-millimeter) and imaging, including inverse problems and data analysis. Theorists as well as experimentalists in several fields will find this course fun and useful. Extensive course web materials will be used. Some books will be placed on reference. Students choose their own project.

Reference: *Data Analysis: A Bayesian Tutorial* 2nd Edition, by D. Sivia & J. Skilling (Oxford, 2006) Recommend purchasing.

Reference: *Experimental Physics, Modern Methods* by R.A. Dunlap

Reference: *Detection of Light From the Ultraviolet to the Submillimeter* 2nd Edition, by George Rieke

List of Topics

- Noise sources, spectral analysis, fluctuation-dissipation
- Experiment design, null experiments
- Pathological science
- Uncovering systematics
- Noise reduction, isolation
- Low level signal case studies
- Photodetectors, arrays, receivers
- When noise is the signal
- Image processing, inverse problems
- Completeness vs efficiency
- Optimal filtering, estimation, robustness
- Sample bias, models, Monte Carlo simulation

Prerequisites: Undergraduate lab, statistical mechanics, Fourier analysis, and some electronics is desirable but not required.

Contact the movie [Warner Brothers 1997]