

Physics 123/253

Signals & Noise, Fall 2013

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Syllabus

Week	Subjects Covered
0 Sept 26	Organization of the course. Detectors. Measurement. Statistics. Error Lab
1 Oct 1, Oct 3	More Statistics. Electronics Noise Lab
2 Oct 8, Oct 10	Fourier analysis. Power spectrum. Spectral density. Fourier Techniques. Wiener-Khinchine theorem. Sample theorem, Nyquist. Aliasing. Noise sources, spectral analysis. Digital spectral analysis.
3 Oct 15, Oct 17	Noise sources. Fluctuation-dissipation theorem. Johnson noise, shot noise, 1/f noise. Noise Lab 2 Device noise, KTC & flicker noise, noise in amplifiers. Signal/Noise ratio. Systematics. Chopping. Assign Experiments
4 Oct 22, Oct 24	Lab Experiments Systematics. Experiment design. Chopping, lock-in detection. Null experiments. Examples. Uncovering systematics. Inclusive signatures. Sample bias. Monte Carlo simulation.
5 Oct 29, Oct 31	Optimal filters. Theory and applications. Signal Processing. Examples from optical, radar, sonar, CMB. Low level signals. Low level analog noise reduction. Noise in amplifiers. Quantum noise limits. Electrical isolation. Grounding schemes and ground loops. Dynamic range. Pulse propagation. Common mode problems.
6 Nov 5, Nov 7	Detector physics. Photodiodes. Photomultiplier tubes. Intrinsic photoconductors. Infrared applications. Black Body Radiation. Signal Sensitivity, Quantum efficiency, noise equivalent power. Superconducting tunnel junctions. Amplifiers. Readouts, AD converters. Sampling noise.
7 Nov 12, Nov 14	Arrays. Correlated double sampling. CCD devices and their limitations. Charge transfer efficiency. CMOS devices and their problems. Hybrid PIN diode arrays. Novel architectures, thick silicon. Background and systematics avoidance.
8 Nov 19, Nov 21	Image processing. Removal of instrumental signatures. Fixed pattern noise, fringing, crosstalk. Correction algorithms. De-bias, gain calibration, flat fielding. Shift and stare imaging. Super flats. Image reconstruction. Fringing removal. Optimal co-addition. Optimal filter examples. Automated object detection and generation of photometric catalogs. PSF weighted photometry. Second moments. Weak lens shear detection. Control of shear systematics.
9 Nov 26	Exploratory Data Analysis. Pathological Science.
10 Dec 3, Dec 5	Far IR techniques. Bolometer arrays. SQUID arrays. Laboratory dark matter searches. Particle detectors. Microwave detectors. Dicke switch. Cosmic microwave background history, WMAP. Systematic errors. Microwave spectral analysis. Planck and beyond.