1998 MBL Course
Methods in Computational Neuroscience
August 2 - 29; Woods Hole, MA

Animals interact with a complex world, encountering a wide variety of challenges: they must gather data about the environment, discover useful structures in these data, store and recall information about past events, plan and guide actions, learn the consequences of these actions, etc. Careful study of the natural context for these tasks leads to new mathematical formulations of the problems that brains are solving, and these theoretical approaches in turn suggest new experiments to characterize neurons and networks. This interplay between theory and experiment is the central theme of this course, which brings together scientists from different disciplines. Half the faculty members are physicists or mathematicians and a substantial fraction of the students come from the physics community. A detailed description of the course can be found in the 1998 MBL Guide at <http://www.mbl.edu>. Enrollment is limited to 22 students. **Course Directors:** William Bialek and Rob de Ruyter van Steveninck, NEC Research Institute.

Application Deadline: April 14, 1998. Admissions is competitive; student selection is determined by review committee. Women & Minorities are encouraged to apply.

Expected Course Fee: $1,750 (room and board offered at no additional charge). Limited financial aid is available. Financial aid requests are not a factor in admissions decisions.

For further information and application forms contact: **Carol Hamel, Admissions Coordinator, Marine Biological Laboratory, 7 MBL Street, Woods Hole, MA 02543; Voice: (508) 289-7401; E-mail: <admissions@mbl.edu>**

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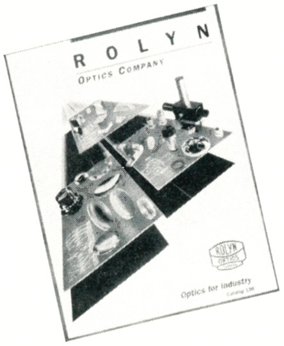

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Data Analysis for Physical Science Students (Cambridge U. P., 1991) and *Data Analysis for Nuclear and Particle Physics* (Cambridge U. P., 1986). *Error Analysis* is narrower in scope and less mathematical than *Data Reduction and Error Analysis for the Physical Sciences* by Philip R. Bevington and D. Keith Robinson (McGraw-Hill, 1992). The latter includes such additional topics as Monte Carlo techniques and nonlinear least squares, but Taylor's book has more explanatory material, including worked examples and figures.

Major changes from the first edition of *Error Analysis* include about twice the number of problems (with their level of difficulty indicated), the quick-check exercises within the text, end-of-chapter summaries of key equations and their interpretation, and many new figures, especially in the earlier chapters. Sections have been added in some chapters to expand on a topic, such as how to estimate the uncertainty in a background-subtracted measurement when the events of interest and the background both satisfy Poisson distributions. Such additions enhance a text already notable for its clarity.

The organization of *Error Analysis*, with its gradually increasing level of rigor and utility, makes it very suitable as a companion text in experimental courses for physics majors at all levels. First-year physics majors who buy and read this book will have a high-quality resource they can continue to learn from, even after they graduate.

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Unsolved Problems in Astrophysics

Edited by John N. Bahcall and Jeremiah P. Ostriker
Princeton U. P., Princeton, N.J., 1997. 377 pp. $69.50 hc ($24.95 pb)
ISBN 0-691-01607-0 hc (0-691-01606-2 pb)

The conference "Some Unsolved Problems in Astrophysics" was held at the Institute for Advanced Study in Princeton, New Jersey, in the spring of 1995. It was inspired in part by John Bahcall's 60th birthday and the 25th anniversary of his arrival at the institute. The celebrants—speakers and participants alike—included many veterans of the institute's postdoctoral program, which led Bahcall and his colleague, Jeremiah Ostriker, to a delightful idea: Produce a volume that might help to inspire the next generation of young astrophysicists.

The resulting book, *Unsolved Problems in Astrophysics*, is a collection of essays by the conference speakers. Its target reader, as Bahcall and Ostriker explain in their preface, is a typical second-year graduate student wanting to learn about thesis research opportunities in this field. The contributors were each asked to describe an open problem in astrophysics, summarize the state of our knowledge in both theory and experiment and, to the best of their abilities, point the student in a useful direction. Almost without exception, the contributors succeed wonderfully.

The book's 18 chapters are divided into two large sections, "Cosmology and Large Scale Structure" and "Astrophysical Laboratories," and one smaller one, "Galaxies and Quasars."

The cosmology section begins with two nicely coordinated chapters by P. J. E. Peebles ("The Cosmological Parameters") and by Paul Steinhardt ("In the Beginning . . .") that explore the stringent new tests of theory being provided by recent technological advances in observational cosmology. The Peebles essay, which serves as a general introduction to the field, describes the relationship between observables (the Hubble expansion, the cosmic microwave background, Big Bang nucleosynthesis and large-scale structure) and the cosmological parameters governing our universe (its age and extent, the densities Ω and Ω_{baryon}, the curvature of space and the cosmological constant). Steinhardt extends this theme by showing how the COBE (Cosmic Background Explorer) discovery of anisotropy in the cosmic microwave background has opened a window on the primordial fluctuations predicted by inflationary models. He stresses how future precision measurements of temperature correlations over a broad range of angular separations will distinguish decisively between competing models. The section continues with essays by William Press on statistical pitfalls in extracting the Hubble parameter; by Neta Bahcall on observational constraints on large-scale structure and peculiar velocities; by Ostriker on numerical simulations of the growth of structure; and by Roger Blandford on unsolved problems in gravitational lensing. (This last chapter offers the ambitious student not one research problem, but eight.)

The chapters in the "Astrophysical Laboratories" section span a broad range of topics: solar neutrinos (John Bahcall), particle dark-matter candidates (David Spergel), stellar mass and luminosity functions in the Milky Way and other galaxies (Andrew Gould), MACHOs (massive compact halo objects) and gravitational microlensing

(Charles Alcock), asymmetric type II supernova explosions (Peter Goldreich, Dong Lai and Mikael Sahrling), the structure of neutron stars (Malvin Ruderman), accretion flows around black holes (Ramesh Narayan), the highest-energy cosmic rays (James Cronin), and gamma-ray bursts (Tsvi Piran). Almost all of these take their charge—summarizing the field at an introductory level and pointing out future directions—quite seriously. One of these, read just before bedtime, kept me awake for several hours while I puzzled over the research challenges.

The third section, though quite brief, serves an important function in reminding the reader about problems more on the astronomical side of astrophysics. Scott Tremaine argues for the presence of massive black holes at the cores of many galaxies, discussing the influence the central black hole might have on the structure and dynamics of the galaxy. This theme is extended by Martin Rees, who explores in more detail the connection between quasars and the formation and growth of a black hole in a host galaxy. He describes the compelling evidence provided by observations of gas motion in spiral galaxy NGC 4258 for a central black hole, and he discusses exotic secular events that then might arise (for example, the "flares" produced when a star, deflected toward a central black hole, is ripped apart tidally, or the gravitational radiation from the merging of two such massive black holes). Finally, Richard Ellis describes progress made in surveying faint galaxies with the new high-technology telescopes and the picture emerging of regular- and dwarf-galaxy evolution. This chapter is particularly well done, carefully pointing out pitfalls in the interpretation of surveys while stressing the relevance of the work to theoretical efforts on galaxy formation.

Unsolved Problems succeeds because of the efforts made by the editors and authors to keep the material accessible to nonspecialists. Graduate students and colleagues were recruited to referee each chapter for both accuracy and clarity. A nice touch is the inclusion, in addition to references, of bibliographic notes for each chapter in which supporting, introductory material can be found.

I would have argued for only one change in the volume: the inclusion of two additional chapters. The vexing problem of a robust type II supernova mechanism would have nicely complemented the existing chapters on neutron stars (Ruderman) and asymmetric supernova explosions (Goldreich *et al.*). Similarly, a chapter on "Why Inflation?" could have helped a new graduate student to better understand the context of several of the chapters in the cosmology section.

Many of us are concerned that overly technical journal publications are an obstacle to communication between physicists from even slightly different subfields. It occurred to me, on reading this volume, that the second-year graduate student might have been a ruse: Perhaps this book is intended for all of us. In any case, on finishing the last chapter, I thought about what fun I could have teaching a special-topics astrophysics course using this book. Who would learn more, the graduate students or the teacher?

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Introduction to Mesoscopic Physics

Yoseph Imry
Oxford U. P., New York, 1997.
234 pp. $49.95 hc
ISBN 0-19-510167-7

Yoseph Imry's *Introduction to Mesoscopic Physics* is a propitious beginning for Oxford University Press's series Mesoscopic Physics and Nanotechnology. This is an area of physics in which there has been recent explosive development, made possible by nanofabrication methods and equipment, the development of which has been driven in turn by the technological goal of achieving ever denser digital electronic circuitry. As the physical limits of conventional electronic devices are approached, the understanding of the remarkable new physics of very small devices will be crucial for continued technological progress.

Imry, who is one of the central figures in the development of this field, provides in this text a valuable overview of these new physical phenomena. Despite its informal style and use of heuristic arguments to minimize heavy theoretical formalism, this compactly written book is demanding reading. But it should be accessible to graduate students and research scientists in condensed matter physics, particularly those with an interest in theory. Unfortunately, the book is marred by an unusually large number of typographical errors; they are irritating, but they do not seriously detract from its readability.

To give an idea of the scope of the text, there are chapters devoted to such subjects as Anderson localization, dephasing of electron waves by coupling to the environment, the Landauer formulation of conductance in terms of a scattering matrix, the quantum Hall effect, mesoscopic structures which include superconducting elements, and noise in mesoscopic systems. There are also ten appendices, ranging from a review of the Kubo formalism to the conductance of ballistic point contacts. Also noteworthy is the 20-page list of references, which provides a guide to a large selection of the relevant literature.

It may be appropriate to try to summarize the themes of the book by paraphrasing the author's concluding remarks on some of the interesting physics in this mesoscopic regime: 1) Elastic and inelastic scattering are very different: The first gives the electron a well-defined, albeit possibly complicated, phase; the latter induces a phase uncertainty that washes away quantum interference effects after a time τ_ϕ. 2) These interference effects thus exist up to a length scale $L_\phi = \sqrt{D\,\tau_\phi}$, and they induce such quantum phenomena as Anderson localization, nonohmic addition of quantum resistances and various Aharonov–Bohm oscillations. 3) The sample-specific nature of mesoscopic systems leads to sample-to-sample fluctuations in conductance and orbital magnetic response, some of which are universal in magnitude. 4) The phase coherence of the normal electrons on the scale of L_ϕ enables them to carry superconducting phase information over distances longer than the conventional normal metal coherence length $L_T \sim \sqrt{D\hbar/k_B T}$.

Among the things that appeal to me about this book is that Imry takes pains to identify issues that have engendered controversy, such as the "correct" relation of the Landauer formalism to measured resistances. He then explains the resolution of this controversy by more careful specification of the problem. Another formerly controversial issue is the existence and observability of persistent currents in normal metal rings. Imry also goes out of his way to identify areas that are incompletely understood and thus offer particular promise for future research. These include mesoscopics involving superconductors in addition to normal metals and semiconductors.

In conclusion, this interesting and relatively brief new book brings the reader into contact with some exciting developments in a very active area of condensed matter physics. It provides a ready reference to the main themes and results and belongs on the desks of all workers in this field.

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