Starting out by first giving different examples of how one might introduce statistical physics and describing that one of his aims is to explain the equivalence of all these approaches, he systematically introduces the subject. What should be especially appealing to students is the close link to computer simulations, although the book is not a book on computational physics. Basic concepts are introduced in a clear and compact way, where the 'fruit fly' of statistical physics, the Ising model, is a kind of standard example. The whole is supported by a collection of classic papers, which in many cases, marked important steps in our understanding and/or lead to new ways of thinking about, for example, phase transitions.

This is an interesting book, which can serve both as the basis of a modern statistical physics course as well as a guide to modern developments, which are often not covered in statistical physics courses.

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Strings, Branes and Gravity: TASI 99
By J. HARVEY, S. KACHRU and E. SILVERSTEIN

2001, £91.00 (hbk), pp. ix + 941. World Scientific, ISBN 981 02 4774 5. Scope: multi-author review. Level: postgraduate and specialist.

A popular step in the career of an advanced graduate student in theoretical particle physics is a four-week stay in Boulder, Colorado, for the Theoretical Advanced Studies Institute (TASI) summer programme. The school provides a series of lectures on current research topics, usually introducing or reviewing material not available in textbooks at a more accessible level than the original papers. Traditionally some attempt has been made to keep a balance between the more formal topics in string or field theory and more phenomenological aspects of particle physics or cosmology.

Each year the lecture notes are collected into a single volume and nearly always provide a very useful, if advanced, survey of some of the most recent and popular research ideas. The latest edition from TASI 99 is no exception. The lectures lie mostly at the formal end of the spectrum, with a strong emphasis on topics that have grown out of recent ideas about duality in string theory. Broadly, this is the conjecture that apparently distinct versions of string theory are actually different limits of a single underlying theory, often dubbed 'M theory'. Most importantly, and as the major obstacle to providing a direct proof of these dualities, typically states and interactions, which have a perturbative description in one limit, are described by non-perturbative effects in the other limits. However, this difficulty is also the source of the power of the duality conjecture, since it provides new ways of describing previously incalculable non-pertubative physics.

Central to this new framework of M theory is the recognition that one must include a new class of states in string theory, called 'branes', if the duality is to hold. These are extended p-dimensional membranes, higher-dimensional analogues of the one-dimensional strings, which can oscillate and, in general, carry other excitations, most notably gauge fields.

One of the most important application of these ideas, and one which features prominently in the lectures, is the conjectured 'AdS – cft' correspondence due to Maldacena. Here the duality is between, in one limit, a quantum conformal field theory, in the classic example a four-dimensional $SU(N)$ gauge theory living on a brane and, in the other, string theory in an anti-de Sitter space – time. This idea has rapidly produced a vast research literature, motivated by the spectacular promise of understanding the general non-perturbative structure of gauge theories and, in particular, the holy grail of explaining confinement. With four sets of lectures covering different aspects of the correspondence, including one placing it within the broader notion of 'holography', the volume provides a good introduction to this remarkable conjecture.

Other notable topics span a review of 'matrix theory', which is a putative fundamental formulation of M theory, an introduction to modern cosmology, together with one on the string-theory description of black holes, and lectures on duality and compactification and particle physics phenomenology in the M theory context. It is worth noting that all these articles are technical in nature and aimed at budding experts, requiring a good background in quantum field theory and general relativity. For those in the field, the volume is an excellent addition to the line of perennially useful and timely collections of TASI lectures. For the community at large, it provides a detailed and technical introduction to many of the fascinating and promising ideas currently in vogue in string theory and formal particle physics.

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Synchronization. A Universal Concept in Nonlinear Science.* In the series *Cambridge Nonlinear Sciences
By A. PIKOVSKY, M. ROSENBLUM and J. KURTHS

2001, £70.00, US$100.00 (hbk), pp. xix + 411. Cambridge University Press, ISBN 0 521 59285 2. Scope: monograph. Level: specialist and general scientific reader.

While lying sick in bed for a couple of days during 1665, the distinguished Dutch scientist Christiaan Huygens was astonished to observe '. . . a wonderful effect that nobody could have thought of before'. The pendula of two clocks in the room seemed to be swinging in exact antiphase: when one pendulum swung to the right, the other swung to the left, and vice versa. Furthermore, their synchronization continued for as long as his patience lasted, making it extremely unlikely that the effect could have arisen by chance. He quickly realized that the 'eternal agreement' of the clocks was attributable to a weak coupling, through their being mounted on the same beam; the movement of one pendulum infinitesimally moved the beam, and thus the other clock. The interaction of the two oscillations, although extremely weak, was sufficient to bring about their synchronization.

Over the ensuing centuries, it has become clear that synchronization by no means restricted to swinging pendula, nor even to mechanical systems. Rather, it is a quite general phenomenon that can arise in innumerable different situations including, for example, electronic circuits, adjacent organ pipes (which can almost silence each other by resonating in antiphase), lasers, the light pulses emitted by clouds of fireflies, and flocks of flying birds flapping their wings in synchrony.

How does one define synchronization? The authors take synchronization to be an *adjustment of rhythms of oscillating objects due to their weak interaction*. Of course, where the interaction is not weak, the notion of synchronization no longer makes any sense because there is then only a single unified system. The oscillations of the separate subsystems must also be self-sustained. Thus the population oscillations in the famous hare–lynx system do not represent synchronization because neither population would separately oscillate. In true synchronization, the adjustment of rhythms occurs for a restricted range of frequency mismatches within which, if the frequency of one oscillator is slowly varied, the second oscillator will be constrained to follow.

Synchronization phenomena are important in a myriad of different ways. One topical example is the Millennium Bridge in London, where the steps taken by pedestrians were effectively synchronized by the 'global coupling' provided by the weak oscillatory response of the bridge to their feet, leading to large and potentially dangerous excursions. (The bridge had to remain closed for several months while damping systems were incorporated.) Another example is the mammalian cardio-respiratory system, where episodes of synchronization occur between breathing and heart beat. The lengths of these episodes seem to be associated with the state of the system, being longer in athletes than sedentary individuals and completely absent in a patient in coma. Recent evidence has emerged linking the synchronization number (i.e. the number of heartbeats per breath) during anaesthesia to the depth of anaesthesia, which could obviously have useful applications.

The authors have attempted to provide a definitive account of synchronization that is accessible on many levels. They address the wide audience of scientists that are likely to be interested, taking explicit account of their different levels of mathematical preparation. The book is in three parts. Following the introduction, there are five chapters treating the subject with a minimum of mathematics. They concentrate on the basic physical concepts, supported by diagrams, graphs and only the most basic of equations. This part should be comprehensible to anybody willing to read the text carefully, to study the diagrams and to think. The six chapters forming the second part treat classical synchronization in all its aspects, including large populations of globally coupled oscillators such as the light-emitting fireflies mentioned above. The third part consists of three chapters that treat the forms of synchronization that are now known to arise in systems exhibiting deterministic chaos. The appendices include translations from French and Latin of some of Huygens' historic writings, which are apposite and extremely interesting, as well as some more formal mathematical material.

Have the authors succeeded in their aims? They certainly have, in my opinion. Their book has all the hallmarks of a classic. It is currently unique, the first attempt to cover synchronization phenomena in a comprehensive and unified way in English. By drawing together many different threads from diverse areas of science and weaving them into a coherent whole, they come close to identifying a new scientific subject or, at least, to confer respectability on a subject that was already starting to emerge. They have presented it in a comprehensible and interesting way, but with full mathematical detail for those who need it, and have provided an extensive bibliography. Every scientist working in the area will want a copy of this book, and every science librarian should buy one. No doubt it will run through many editions, and deservedly so.

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Theory of Solidification*. In the series *Cambridge Monographs on Mechanics
By S. H. Davis

2001, £50.00, US$74.85 (hbk), pp. xiv + 385. Cambridge University Press, ISBN 0 521 65080 1. Scope: monograph. Level: postgraduate and specialist.

The physical theory of fields and interfaces in three dimensions generally begins with a reduction to one dimen-