systems they deal with; and the comparative material manages to shed new light upon the implicit problematic—the state of secondary education in the United States.

Secondary education shapes the flow of students to higher education largely through curricular tracks and exit examinations. In most national systems a clear differentiation occurs at the upper, or postcompulsory, stage of secondary education, with the advanced academic tracks then being highly responsive to university influence. In addition, the instruments that actually govern transitions from secondary to higher education—secondary exit exams, university entrance exams, or, in the United States, standardized tests—have a powerful bearing on the nature and goals of secondary schooling.

Universities shape secondary education largely through the training of teachers and administrators. These effects are more difficult to document than those running in the opposite direction, but Clark suggests in his conclusion that the critical variable is the degree of university control over teacher training: the greater the university's influence, the higher the academic prestige of teachers and the greater the academic content of the curriculum they teach.

The two papers on the United States analyze these two channels of interaction by focusing respectively on students and on teachers. Carol Stocking's point of departure is the comparatively wide separation of secondary from higher education in this country. To bridge this gap a large and rather costly set of linkages has arisen, consisting of high school counselors, college recruiters, and the standardized testing industry. In the United States, unlike other countries, these mediations do little to encourage student achievement: since entrance to higher education is largely open, the structure of arrangements and rewards does not serve to motivate the majority of students. This feature of American education emerges with particular force from this comparative context.

Gary Sykes accurately depicts the structural characteristics that have prevented American teachers from attaining effective professionalization and higher status. One might quibble that the slant of his argument is largely foreordained by too liberal comparisons between independent professionals (chiefly medical doctors) and teachers, even though the latter are dependent employees offering what is almost a commodity type of service. But comparatively Sykes's point holds up. And thus his concluding exhortation that the status of the teaching profession be raised through more rigorous standards seems reasonable despite the formidable obstacles he has described.

In his conclusion Clark makes good use of the comparative perspective to depict the "distinctive problem" of American high schools in more general terms. Above all, the American weaknesses seem to stem from the desire to achieve universal secondary education in comprehensive schools. The difficulties are compounded by the close linkages with primary (rather than with higher) education, by local control (which inhibits teacher professionalism), and by geographical zoning (which tends to preclude choice among schools within districts). The result is a system that is singularly lacking in specialization, hierarchy, and competition. These seem to be precisely the qualities that energize upper-secondary education in other countries.

The moral that Clark draws runs counter to current reformist thinking within secondary education: "Americans need to consider whether noncompetitive and nonranked comprehensive high schools should be pushed toward competition, ranking and specialization" (p. 320). In other words, we might try to think in terms of carrots rather than sticks, of devising schemes that would draw greater effort from our students instead of forcing perfunctory fulfillment of numerous specific requirements.

The School and the University strikes a refreshing note in the recent debate over American secondary education, raising issues that require and deserve further exploration. It also constitutes a valuable guide for understanding the complicated pathways to and within higher education in the countries covered. Finally, it deserves recognition as an effective application of the comparative approach.

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Star Formation

Naissance et Enfance des Etoiles. Birth and Infancy of Stars. ROBERT LUCAS, ALAIN OMONT, and RAYMOND STORA, Eds. North-Holland, Amsterdam, 1985 (U.S. distributor, Elsevier, New York). xlii, 823 pp., illus. $159.25. Les Houches, Session 41. NATO Advanced Study Institute. From a summer school, Les Houches, France, Aug. 1983.

The universe we see when we look out to its furthest horizons contains a hundred billion galaxies. Each of these galaxies contains another hundred billion stars. That's 10^{22} stars all told. The silent embarrassment of modern astrophysics is that we do not know how even a single one of these stars managed to form. There's no lack of ideas, of course; we just can't substantiate them.

The observational evidence at hand is this: The most luminous stars observed in our galaxy, the Milky Way, are tens of times as massive as the sun, and hundreds of thousands of times as luminous. Given that these stars shine by converting hydrogen into helium, we know that only 0.7 percent of the central mass of the stars can be converted into radiant energy. Knowing how fast this energy is being radiated away, we can also calculate how long these stars can have been shining. That turns out to be roughly ten million years: These stars are young. They must have formed recently. Our sun, in comparison, is almost a thousand times older, and the age of the Milky Way may be 15 billion years.

The luminous young stars generally are found in the vicinity of dark interstellar clouds consisting of cold gas interspersed with dust grains that absorb starlight. The very youth of these stars, as well as their positional correlation with the dust clouds, strongly suggest that they form when cold interstellar dust clouds contract and condense into dense, massive objects—stars.

When we examine this hypothesis, which lies at the foundation of all modern theories of star formation, we immediately encounter three difficulties: (i) The contracting gas clouds must radiate energy in order to continue their contraction; the potential energy that is liberated in this pre-stellar phase must be observable somehow, but we have yet to detect and identify it. (ii) The angular momentum that resides in typical interstellar clouds is many orders of magnitude higher than the angular momentum we compute for the relatively slowly spinning young stars; where and how has the protostar shed that angular momentum during contraction? (iii) Interstellar clouds are permeated by magnetic fields that we believe to be effectively frozen to the contracting gas; as the gas cloud collapses to form a star, the magnetic field lines should be compressed ever closer together, giving rise to enormous magnetic fields, long before the collapse is completed. These fields would resist further collapse, preventing the formation of the expected star; yet we observe no evidence of strong fields, and the stars do form, apparently unaware of our theoretical difficulties.

The 15 short courses that make up the proceedings of this summer school together form an excellent introduction to the subject, as well as an outstanding summary of current thinking about star formation. The expositions generally are clear, largely self-contained, and documented with extensive lists of references to the literature. Many of the observational data at hand are summarized in a series of seven courses, given by Dennis Downes, George Herbig, James Lequeux, Peter Mezger, Jean-Loup Puget, Stephen Ridgway, and Gareth Wynn-Williams. A course given by J. Mayo Greenberg interprets the observational data available on interstellar grains, discusses laboratory experiments that simulate some of the observed physical conditions of interstellar space, and ends with a discussion of the growth and evolution of dust grains in star-forming regions.

Since stars appear to be forming in giant molecular clouds—clouds sufficiently cool to permit the existence of molecules—one may ask how these clouds themselves originate. Bruce Elmegreen discusses that question and examines the currently popular view he first helped to propose, that star formation during the contemporary era may be a self-propagating process in which the formation of stars in one portion of a cloud produces a compression of gas in neighboring regions, thus triggering a further collapse resulting in additional star formation. In a further course Elmegreen examines cluster formation—for stars are seldom found in isolation. As a general rule they appear to form in associations or clusters of stars with varying masses. The mass distribution among these stars may be an important clue to the processes active during collapse.

In recent years, radio and infrared observations have provided us with spectral information about the physical conditions deep inside molecular clouds and about the chemical and isotopic composition of matter there. William Langer, in his course, discusses chemical reactions at play under these circumstances and the chemical evolution of cloud material to be expected. Again, we may have a tracer here of events taking place during protostellar collapse.

At this point in the volume, the stage is set for Joseph Silk, Werner Tscharnuter, and Harold Yorke each to take the bull by the horns and see whether a magnetohydrodynamic approach, which comprises (i) competing cooling and heating mechanisms, (ii) the transfer of radiative energy, (iii) various types of instabilities, (iv) fragmentation into cloudlets, (v) the initiation of star formation, and (vi) the onset of countervailing influences unleashed by stellar winds, which are the outflow of material observed in all young stars, can lead to a self-consistent model of star formation. The three courses provide somewhat different perspectives but overlap reasonably well. The arguments are well presented and permit the reader to perform similar calculations for himself or herself. A final course, by Gregor Morfill, turns the subject of star formation upside down by asking what we can conclude about the formation of stars by working backward in time from the present appearance of the solar system—the sun, the planets, the asteroids, and the comets believed to still contain pristine matter, hardly processed by the evolution that the sun and planets have undergone. In this type of analysis, mineralogical evidence—gathered from meteorites that occasionally arrive from interplanetary space and fall on earth to be picked up and analyzed—plays a central role. Morfill shows how evidence of this kind can be used to construct a coherent picture of the protoplanetary disk out of which the earth and other planets must have condensed.

Completing the volume are short summaries of 12 relevant seminars that were given during the summer school session.

This is a wonderful book. I am planning to teach an undergraduate course during the coming semester that concentrates on the astrophysics of star formation. I know that the material in the volume will greatly help me in clarifying the subject of star formation for my students.

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Aquatic Chemistry

Chemical Processes in Lakes. WERNER STUMM, Ed. Wiley-Interscience, New York, 1985. xx, 435 pp., illus. $59.95. Environmental Science and Technology.

Aquatic chemistry has its origins in a variety of applied disciplines: limnology, oceanography, geochemistry, and water-quality engineering. Until recently, chemistry played a subservient role in the development of these disciplines. For example, the chemistry of lake waters has been studied at least since Birge and co-workers began their pioneering work on Wisconsin lakes in the early 1900's, but for most of this century limnological chemistry focused on routine analyses performed primarily by or for biologists to answer questions of biological interest. Only in the past few decades has aquatic chemistry been recognized as a discipline worthy of academic pursuit in its own right. This change in status was stimulated by concern about the behavior of chemical pollutants that enter natural waters in society's wastes. Realization that the scientific issues about pollutant transformation and fate are complicated far beyond the scope of conventional chemical analysis led to the development of graduate-level academic programs in aquatic chemistry.

The 1970 book *Aquatic Chemistry* by Werner Stumm and James J. Morgan was the first modern treatment of the "new discipline" of natural water chemistry, and it has served as the standard reference ever since. Its paradigm is that of the equilibrium model, and it emphasizes thermodynamic and ionic equilibrium approaches to describing the chemistry of natural waters. These are satisfactory for some inorganic constituents and indeed often are an essential first step in developing a quantitative understanding of such systems. Nonetheless, aquatic chemists soon recognized that equilibrium descriptions are not adequate for many substances of great interest (such as organic pollutants) and that lakes must be treated as the open systems that they really are. This implies greater emphasis on the processes, mechanisms, and kinetics of solute behavior than on the static (equilibrium) states toward which the systems tend (but which they seldom reach).

Chemical Processes in Lakes is an outgrowth of the gradually increasing focus on dynamic aspects of aquatic chemistry, and it reflects a quantum jump in the sophistication of the discipline. Its paradigm is the process-oriented box model, but insofar as most chapters strive to describe lake processes mechanistically, the boxes are not "black." The book has a strong chemical-engineering flavor, but in spite of the emphasis in the book on models, the level of mathematics is not overwhelming. The book reflects the current research approaches and interests of many aquatic chemists, and it probably will influence the tone of the next generation of aquatic chemistry textbooks. Because of its many authors, the style of writing in it, and the "case-study" approach of some of its chapters, the book would not be practical as a textbook itself, except perhaps in advanced seminar and reading courses. It should be widely read, however, not only within the relatively small community of chemists interested in lakes but among aquatic scientists in general. As the editor points out in his preface, lakes are convenient experimental systems with which to study processes occurring in other aquatic systems. Most lakes are rather small and can be sampled with simple and inexpensive equipment (compared with that required for oceanographic work). Lakes also have much greater chemical and biological diversity than oceans. In some cases, lakes can be manipulated experimentally, but even passive studies, when appropriately designed, can lead to a mechanistic understanding of fundamental aquatic processes.

The first and last chapters probably are the broadest, most general, and most didactic treatments in the book. Imboden and Schwarzenbach introduce the concepts of