convincingly demonstrates that the two notebooks, one concerned with questions on Aristotle's *On the Heavens*, the other with questions on Aristotle's *On Generation and Corruption*, represent Galileo's own lectures, which were, however, derived directly from lectures by Jesuit professors who taught at the Collegio Romano between approximately 1577 and 1592 and from the famous *Commentary on the Sphere of Sacrobosco* by the Jesuit astronomer Christopher Clavius. Moreover, Galileo probably wrote these lectures around 1590 rather than in 1584, as previously believed. Instead of being trite exercises of a 20-year-old student, the lectures are probably the product of a 26- or 27-year-old professor at the University of Pisa. In his essay on Duhem, Wallace argues further that in *De motu*, the third unpublished notebook written around 1590, Galileo may also have derived his key ideas from unpublished lectures of the Jesuit professors of the Collegio Romano (pp. 310–315).

But what can be made of our new knowledge of Galileo's earliest extant lectures? Will it, as Wallace believes, furnish insight into Galileo's "intellectual formation" and enable us to identify "the philosophy with which he operated during the first stages of his teaching career" (p. 228)? It will—provided the lectures really reflect Galileo's genuine opinions arrived at by serious reflection. If, however, they are mere rearrangements of the lectures of others made—or perhaps compiled—for the sole purpose of meeting the teaching requirements of the University of Pisa, or any other university, then our confidence in them would seriously diminish. It is not farfetched to suppose that Galileo would have prepared university lectures that contained basic ideas to which he did not personally subscribe. He seems to have done this very thing in 1599 and 1603, when he taught a course at Padua that was "little more than a popular summary of the main points in Clavius's commentary on Sacrobosco" (p. 137). Since Galileo was already a convinced Copernican in 1597, any lectures based on Clavius, who was a resolute geocentrist, could not have reflected Galileo's true beliefs in 1599 and 1603. In Wallace's favor, however, is the *De motu*, which truly reflected Galileo's beliefs. If its major ideas were primarily derived from Jesuits at the Collegio Romano, as Wallace suggests, then perhaps the other two notebooks, filled with concepts also derived from the same group of Jesuits, represent Galileo's genuine opinions at the time he wrote them.

In these articles, Wallace has presented much that is new and of great importance and has done so with profound scholarship. He has raised issues that will be pursued for some time to come on the always fascinating problem of Galileo's relationship to his predecessors.

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Galactic Astronomy

The Structure and Evolution of Normal Galaxies. Papers from a NATO Advanced Study Institute, Cambridge, England, Aug. 1980. S. M. FALL and D. LYNDEN-BELL, Eds. Cambridge University Press, New York, 1981. xiv, 272 pp., illus. $29.95.

Normal galaxies are the subject of much activity, both theoretical and observational, as witness at least a dozen other conference proceedings published on related aspects of the same subject over the last decade. Our picture of the structure and composition of galaxies is changing rapidly, and the 16 brief review papers in these latest conference proceedings are useful summaries of the current status of the field.

The emphasis of work on galaxies has changed dramatically as new and unexpected observational and theoretical results have become available. Thus, the discovery that elliptical galaxies rotate more slowly than their ellipticities suggest has led to the view that these systems are not oblate spheroids but rather triaxial bodies slowly turning end over end. Aspects of this view, as well as of structurally similar components of disk systems, namely bulges and bars, are discussed in a series of papers by F. Bertola, J. J. Binney, G. Illingworth, J. Kormendy, and M. Schwarzschild. These five papers, together with S. Tremaine's description of galaxy mergers, cannibalism on a galactic scale, give an excellent summary of the observational and theoretical aspects of the subject. Although I have grouped elliptical galaxies together with parts of disk (spiral) systems, kinematically they are quite different. The relatively low rotational velocity of many elliptical galaxies is a property not shared by the bulges of disk systems. Rather, the kinematic data for bulges are consistent with their being oblate spheroids flattened by their own rotation. Illingworth, who makes this point in his review, is careful to note that the bulges he has studied are all intrinsically fainter than his sample of elliptical galaxies. Objects with similar luminosities are, at present, too few to test for similarities in dynamics.

Another kinematic finding, that of a constant rotational velocity at the outer regions of spiral galaxies, is also an underlying theme in several of the papers. This result, first described nearly a decade ago in 21-centimeter studies of spirals, has been repeatedly confirmed by optical and more extensive 21-centimeter measurements. Previously it was thought that the rotational velocities decreased well within the optical image, reflecting the decrease of luminosity and its implied mass. An appropriate question today would invert the situation: Are there any isolated galaxies that do show a systematic decrease of rotational velocities at large radii? R. Sancisi, in a concise review of the distribution and kinematics of the neutral hydrogen component of galaxies, cautiously suggests at least two such examples. He notes, however, that the presence of noncircular motions in the plane or large-scale motions perpendicular to the plane of these systems could also account for the inferred decrease in rotational velocity.

The resultant greater gravitational attraction in the outermost parts of a spiral, much greater than implied by the luminosity distribution, requires a drastic change in the mix of the mass responsible for this gravitational attraction compared to the mass (stars) responsible for the luminosity; that is, material with a high mass-to-luminosity ratio is required. This has led many astronomers to believe that most spirals are surrounded by halos of optically invisible matter. Has our view of spirals, their composition and evolution, been based on only a few percent of their total mass, that part that shines so brightly at optical wavelengths? The "ghost" component, if it really exists, is perhaps the major unsolved problem in the study of spiral galaxies.

The spiral pattern found in disk systems has long been a complex riddle. The observed spiral shapes should be quickly smeared over because of differential rotation. Why then are spirals so common? A number of elegant phenomena have been invoked to solve this riddle, for example, stochastic spirals and shock patterns from density waves, each continually generating new spiral features. A. Toomre focuses on yet another view, "a neat old phenomenon" that he calls swing amplification, "a strong cooperative effect that inhibits interarm travel and encourages gravitational bunching."

Star formation rates and the related topic of chemical evolution are discussed by B. F. Madore and B. E. J. Pagel, respectively. Both reviews end on a cautious note because of the uncertainty about many aspects of these topics.

Radio and x-radiation are common properties of peculiar galaxies, objects outside the scope of this conference. But many normal galaxies display such phenomena on a reduced scale. R. D. Ekers discusses the radio continuum emission from normal galaxies and A. C. Fabian the x-rays from these systems and from clusters of galaxies.

The usefulness of these proceedings is enhanced by two indexes, one general and one of individual objects. A brief glossary of some of the jargon and abbreviations common to this topic is also included.

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Cognitive Science

Perspectives on Cognitive Science. Papers from a meeting, La Jolla, Calif., Aug. 1979. DONALD A. NORMAN, Ed. Ablex, Norwood, N.J., and Erlbaum, Hillsdale, N.J., 1981. x, 304 pp. $19.95.

Scientific progress usually leads to fragmentation and to a proliferation of subsciences. It is a rare but important occasion, therefore, when events reverse that trend, when specialists discover unexpected bonds between their specialties and join together in a common enterprise.

Such are the claims for the young field of cognitive science, which promises to integrate those parts of psychology, computer science, linguistics, neuroscience, anthropology, and philosophy that are dedicated to understanding the phenomena of cognition. Obviously, a clear statement of the shared problems, goals, methods, and theories underlying this integration would be enormously valuable to all concerned, so in August 1979 in La Jolla, California, an attempt was made to provide it.

"It was to be the 'defining meeting,' the meeting where many of those concerned with the birth of Cognitive Science could record its origins, speak of its hopes, and chart its course" (p. v). So writes Donald Norman in his prefatory description of the plans that brought together 11 eminent cognitive scientists. This book is the result.

However, the book turns out to be not so much defining as illustrative. And although the editor claims that it provides ten perspectives on cognitive science, "each viewing a different set of topics, each presented in a different style" (p. vi), there are really only two: one view favoring information-processing theories of cognition, the other objecting to them. Not surprisingly, those who agree offer a more coherent perspective than do those who object.

This contrast of views might have been predicted from the list of participants. Five of the contributors work in the branch of computer science that has come to be called artificial intelligence (A.I.); the other five represent neurobiology, psychology, linguistics, philosophy—disciplines not noted for seeing eye-to-eye about anything.

The conference was opened by Herbert A. Simon, who commented, "I think that most of us today would prefer to define cognitive science as the domain of inquiry that seeks to understand intelligent systems and the nature of intelligence" (p. 14). Obviously, Simon sees no need to distinguish cognitive science from A.I. Simon's colleague, Allen Newell, explains how the core of intelligence is provided by symbol structures and their manipulation. "The great news," Newell says, is that we now know "how it is possible for mind to exist in this physical universe" (p. 84). Together, Simon and Newell summarize what might be called the standard theory of cognition at the present time—the theory that serves as the point of origin for a space of theoretical alternatives, the theory that provides a landmark relative to which other views can be located. Compared with the theories available 25 years ago, the standard theory is clearly an impressive advance.

Marvin Minsky, another founding father of A.I., is less concerned to define cognitive science than to present his latest ideas about the nature and function of memory. Roger Schank illustrates how he has used computer programming to help him understand the role of memory in understanding language. Terry Winograd describes the gradual evolution of his own understanding of what it means to say that a person or a computer understands language: "The importance of a paradigm may not lie so much in the answers it provides as in the questions it leads one to consider" (p. 261). All three struggle toward basic redefinitions of the standard view, but redefinitions that preserve the insights gained from the standard theory that cognition is information processing.

These are distinguished scientists, whose chapters offer fascinating insights into current thinking in A.I. The other contributors are equally distinguished, but far more diverse. Their contributions will be read with interest by colleagues in their own disciplines, but they do not add up to a coherent alternative to the standard theory. Either the authors describe their own on-going work or they accept the standard theory as the criterion of relevance and try to relate their remarks to that. The former strategy leads to heterogeneity, the latter invites misunderstanding or trivialization.

The reader is left wondering what cognitive science really is. Is it a new science, synthesizing from half a dozen different disciplines those parts concerned with mental phenomena? Or is it merely a new name for artificial intelligence? A branch of A.I., perhaps, on a par with robotics or automata theory? The rhetoric of this book suggests the former view; its contents suggests the latter.

Those who believe the rhetoric (and some do feel that A.I. is trying to kidnap cognitive science) will not be satisfied with the general picture that emerges from this book. Their attempts to revise that picture can be expected to stir up much of the intellectual excitement in this field in the next few years.

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Plastids

Chloroplasts. J. REINERT, Ed. Springer-Verlag, New York, 1980. xxi, 240 pp., illus. $46. Results and Problems in Cell Differentiation, vol. 10.

Plastids may be considered the fundamental organelles of the living world, since they contain apparatus essential for the trapping of light energy and its conversion to chemical energy. In higher plants chloroplasts may account for over 50 percent of the soluble protein of leaves and store starch as a major carbohydrate. Plastids are not confined to terrestrial plants but also occur in aquatic plants, where they have developed specialized pigments to trap light from spectra attenuated by passage through water. In other circumstances they have also adapted to their immediate environment to become starch storage organelles (amyloplasts), to develop pigments other than the chlorophylls that confer