Atoms of Silence

Hubert Reeves
244 pp. MIT Press, Cambridge, Mass. 1984. $14.95

A unified scenario of the cosmos, including ourselves as sentient beings, is now emerging; it is based upon the time-honored concept of change. From galaxies to snowflakes, from stars and planets to life itself, we are beginning to identify an underlying pattern penetrating the fabric of all the natural sciences—a sweepingly encompassing view of the formation, structure and maintenance of all objects in our richly endowed Universe.

As we currently experience the golden ages of astrophysics and biochemistry, these two interdisciplines are themselves being synthesized into the grander transdiscipline of cosmic evolution. For me, cosmic evolution includes all aspects of evolution—galactic, stellar, elemental, geological, chemical, biological and cultural—thus making classical neo-Darwinism just one small segment of a much broader evolutionary scheme stretching well beyond mere life on Earth. And if Darwin created a veritable revolution in understanding by helping to free us from the anthropocentric belief that humans basically differ from other life forms on our planet, then cosmic evolution is destined to extend that intellectual revolution by in turn releasing us from regarding matter on Earth and in our bodies any differently from that in the stars and galaxies beyond.

Atoms of Silence is an anecdotal précis of cosmic evolution as told by the well-known French nuclear physicist, Hubert Reeves. The book is ably translated by Ruth and John Lewis, and is based on the original (and now somewhat dated) 1981 French edition. It is pitched to the intelligent lay public, but is also the kind of book from which research scientists could benefit (including some technical end notes and appendices), and is especially the sort of book that all working physicists can heartily recommend to our nonscientific friends.

Despite his disavowal in the introduction, "I have . . . [resisted] the temptation to polish my phrases for 'literary' effect," Reeves knows well how to turn a phrase. His writing is clean, poetic, upbeat and metaphorical, and it appeals to the sense of wonder in us all. His account of childhood reminiscences of Montreal's cemetery of the Côte des Neiges is particularly poignant; here he shares with us comparisons of birth, life and death in the organic soil amid the tombstones with those of the diversely evolving objects now being observed in the gassy nebulosities of the constellation Orion. His analogies are deep and lasting, providing us with a sense of cyclical or spiral change, a kind of cosmic reincarnation. And it is refreshing to see a physicist admitting what we don't know as well as what we do.

Of course, like any work that attempts both to achieve the breadth of a survey and to be comprehensible to the general public, there are shortcuts in the accuracy. I suspect that experts in various specialties could quibble with many of Reeves's passages, yet I found no grievous errors that might render the work useless. My only significant gripe is the lack of adequate balance: Given his expertise, Reeves perhaps naturally stresses nuclear or elemental events, but he does so to the near exclusion of galactic, neurological and cultural evolution. He devotes hardly a line to the development of intelligence and the onset of *Homo*—subjects which doubtless stretch beyond reason the expertise of most physicists, but

which nonetheless are key facets in the full panorama of cosmic evolution. Furthermore, even within the many nuclear-evolution discussions, Reeves elects not to address clearly issues that have always bothered me. For example, he implies on page 55 that Li^7 was synthesized in tiny amounts in the early universe, states on page 56 that nothing heavier than He^4 was made via primordial nucleosynthesis, returns on page 60 to suggest again that lithium was created in trace amounts early on, and yet retreats once more on page 83 claiming that none was produced in the immediate aftermath of the Big Bang. Nor does he address the central issue of how massive stars might rebound as supernovae after the production of Fe^{56}—a crucial and dramatic change required to populate interstellar space with newly made heavy elements. Even so, the role of cosmic rays in nuclear, chemical and biological evolution is well described in this book, as are the roles played by chance, energy and forces in the organization of complex structures.

All in all, Reeves has captured well the essence of the "big picture." What this book lacks in details, it achieves superbly in breadth. He has thus done a service to both the scientific and nonscientific communities, despite the specialization we are forced to endure, by generalizing on a grand scale. Indeed, cosmic evolution may well be the greatest story ever told.

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Microwave and Optical Ray Geometry

S. Cornbleet
152 pp. Wiley, New York, 1984. $36.95

This book presents a lot of good, fundamental geometry that is useful in the design of microwave, optical and acoustical systems of radiation and reception. It is strictly a text on ray geometry, however, and regrettably, takes no account of polarization or the effect of surface reflections in lens systems. Of course diffraction and interference are not included. Considerable attention is given to ray tracing in reflector and lens systems of complex shapes, and to the generation of shaped beams from lens and reflector systems. Cornbleet mentions briefly Cassegrainian and Gregorian constructions, but the Schwarzschild and the newer Dragonian reflector systems are absent. Waves in stratified media are given considerable attention and would appear to bear on the ray picture of large (multimode) optical fibers and integrated optics.

The illustrations (line drawings) are frequent, clear and beautiful—as they should be in a book on geometry. The author has published several papers on ray geometry related to microwave antennas and knows his subject very well. I wish I had had this book when I was designing radar antennas.

The subjects discussed include the laws of refraction and reflection; the zero-distance phase front; a mechanical description of optical surfaces and of ray-tracing in nonuniform media; rays in linear, cylindrical, spherical and axisymmetric media; and geodesics and trajectories. There are four appendices, including one on Luneburg lenses.

The avowed purpose of the author is to present new geometrical methods and their application to real problems. He does so very well, and succeeds in revealing the beauty and elegance of ray geometry.

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Interstellar Chemistry

W. W. Duley, D. A. Williams
251 pp. Academic Press, New York, 1984. $49.50

Astrochemistry is an exciting and relatively new field, and yet it is sadly neglected by most astronomers and astrophysicists. This neglect is probably due to the fact that the field does not fit in neatly with departmental structure at universities, so that it is difficult for a graduate student (or advanced undergraduate) to get adequate training in it. This book on chemistry in interstellar space, written by two practitioners in the field (one from Toronto, the other from Manchester), should help to remedy this situation. The writing is at the right level for graduate students, and the book is rather successful in combining two features that are difficult to reconcile: a pedagogical approach for the student (including sets of problems) on the one hand, and the flavor of current research (and future directions) on the other.

Unlike "terrestrial" textbooks of chemistry, the authors give a semiqualitative treatment of reactions in the gas phase, of photochemistry and of the surface physics relevant to dust grains. They introduce the reader to the background of astronomical observations in an innovative way—in terms of a few individual objects, with "real" data rather than schematic diagrams. The inclusion of "real data" extends to laboratory chemistry as well—the book includes a fairly extensive library of chemical reactions, as well as figures that give real potential-energy surfaces for a few particularly important or illustrative reactions. The authors treat surface chemistry on dust grains