



Kármán vortex street behind a circular cylinder. This is one of over 200 photographs collected in *An Album of Fluid Motion* by Milton Van Dyke (176 pp. Parabolic Press, Stanford, Cal., 1982. \$20.00 cloth, \$10.00 paper). Designed as a supplement for students and teachers of fluid mechanics, the book contains pictures from around the world, organized generally to go from low speeds to high, from creeping flows to shock waves and hypersonic flight. The photograph above, taken by Sadatoshi Taneda, shows water flowing at 1.4 cm/sec past a cylinder 1 cm in diameter, with $R = 140$. Integrated streaklines are shown by electrolytic precipitation of a white colloidal smoke illuminated by a sheet of light. The vortex sheet is seen to grow in width downstream for some diameters.

essential to all life forms as we know them, has often been neglected in chemical evolution studies. Benton Clark gives a picture of the cosmochemistry of sulfur and its function in planetary evolution. There's no question that sulfur plays a major role in both energy transduction and enzyme action. The recent discoveries of the Galapagos vents and the possible chemistry going on in the vents suggests that in many instances sulfur may have been one of the basic requirements for processes that may have led to life.

In his discussion of interfacial water and water in thin films, Duwayne Anderson points out how molecular precursors probably have a circumscribed aqueous environment. Indeed, this necessity may limit life to areas where this water can be liquid.

There's much controversy about the nature of the early atmosphere. The dogma of a reducing atmosphere stoutly defended by Stanley Miller and Harold Urey seems to be succeeded by the idea that life arose in an atmosphere that developed from methane, to carbon monoxide, to carbon dioxide. Experiments have shown that organic molecules can be synthesized with a carbon source of methane, carbon monoxide or carbon dioxide. Indeed, the basic question of the origin of organic matter seems in essence to have been solved, since we know that the universe is full of organic matter, whether in the interstellar medium, in meteorites or in planetary atmospheres. The data

given to us by radioastronomers, by Voyager and from the analysis of meteorites, are convincing evidence that simulation experiments in the laboratory have given us a reasonable picture of prebiotic processes. However, in discussing the evolution of atmospheres Lynn Margulis and James Lovelock show us that bacteria may have dominated the Earth's biosphere since early pre-Cambrian times, altering its surface and atmosphere, maintaining and developing the environment for further life. According to them, the Earth has to be looked at as an evolving system of interacting parts rather than as a static structure. Without such interactions, without the carbon compounds generated by some organisms and utilized by others, the Earth might have been as arid and sterile a planet as Mars.

Astronomers tell us that planets are plentiful in the universe. Noting the abundance of main sequence stars slowed in their periods of rotation, they infer the presence of bodies that orbit around them even though they lack observational evidence of them. On the other hand, the data suggesting that Barnard's star has a planet of the size of Jupiter rotating around it have been seriously called into question. The time appears to be ripe for a search, a comprehensive program using space-based instruments. According to David Black, the search for other planetary systems constitutes a most important aspect for astronomy in the coming

decade. With the availability of the space telescope, this question might be answered before the end of the century.

In his own inimitable way, Phillip Morrison sums up the series of lectures: "I expect to see an enlarging of the disciplines to form at last an interdisciplinary pool, aware of larger philosophical issues. We need not try to solve them or to prescribe their limits, but we must recognize their human importance, their intellectual existence as an increasing element within scientific thought. If that were the only positive result from the SETI investigation, I think it would still be judged by history to have proved extremely worthwhile."

This book provides a summary of the state of the art of the search for life in the universe. A useful synopsis, it can provide the serious student with a general overview of an exciting field of scientific endeavour.

* * *

Cyril Ponnamperna is the director of the Laboratory of Chemical Evolution at the University of Maryland. He has written several books and many papers on chemical evolution and the origins of life.

The Cosmic Code: Quantum Physics as the Language of Nature

H. R. Pagels

370 pp. Simon & Schuster, New York, 1982. \$17.50

According to its dust jacket, *The Cosmic Code* "explains—and celebrates—the world of infinitesimal particles and reveals to the layman how physics is moving toward a new understanding of the universe." This is actually a rather modest statement of the scope of this book, which also includes discussions of special and general relativity, the Copenhagen interpretation of quantum mechanics, the Einstein-Podolsky-Rosen paradox, Bell's inequality, the problem of measurement, the foundations of probability theory, the origin of thermodynamic irreversibility and the nature of physical laws.

A physicist who sets out to write about such topics for lay readers faces a difficult task. Balanced on the slippery high wire of nontechnical language, an author must maintain a precarious balance between oversimplification and incomprehensibility. Above all the author must present the physics correctly. Pagels often does not. He states that Einstein's general theory of relativity is needed to resolve the twin paradox (it isn't), that gravity is the curvature of space (instead of spacetime), that the round-trip time for a light beam grazing the Sun is increased because "the beam has to bend slightly" (instead, it is because the light slows

down), that the binary pulsar's "loss of energy is revealed by the...slowing down [of] its orbital period" (loss of energy causes the orbital period to diminish and the orbital motion to speed up), that "averaging over the microworld description...introduces the arrow of time" (it doesn't; averaging alone cannot introduce a distinction between the two directions of time) and that Wolfgang Pauli's exclusion principle states "that two electrons cannot sit on top of each other" (it states that no more than two electrons can "sit on top of each other").

Chance lies at the heart of what Pagels calls "quantum weirdness," and he devotes several chapters to it. "Mathematicians," he writes, "have never succeeded in giving a precise definition of randomness or...probability.... Mathematicians don't know what randomness is!" To illustrate the inadequacies of Andrei Kolmogorov's algorithmic definition of randomness, Pagels asks the reader to consider the sequence 3141592..., which passes all statistical tests for randomness. Yet this sequence is really the decimal expansion of π with the decimal point omitted. But what does Pagels mean by "this sequence"? If he means an infinite sequence, he must specify its mode of construction, and then Kolmogorov's definition tells us how random it is. Pagels seems to have confused the problem of defining a random sequence with the problem of recognizing one.

Niels Bohr and Werner Heisenberg argued that it is impossible in principle to give a classical description of what is happening in an atom between observations. Here is how Pagels explains this doctrine. "What is actually going on in the quantum world depends on how we decide to observe it. The world just isn't 'there' independent of our observing it; what is 'there' depends in part on what we choose to see—reality is partially created by the observer." But the main point of the Copenhagen interpretation is that *no* statement of "what is actually going on in the quantum world" can be complete. Bohr and Heisenberg did not argue that observations "partially create" reality but that reality, at the atomic or subatomic level, cannot be fully described in "operational" language.

Much of *The Cosmic Code* is in the form of historical narrative. But it is a curious kind of history, stressing modern contributions and ignoring their antecedents. As told by Pagels, the story of symmetry and invariance begins in the twentieth century with Emmy Noether; Galileo and Christiaan Huygens do not appear. The story of gauge invariance and gauge fields begins with Chen Ning Yang and Robert Mills, omitting Hermann Weyl and even the connection between gauge

invariance and conservation of electric charge.

DAVID LAYZER
Harvard University

Nuclear Magnetism: Order and Disorder

A. Abragam, M. Goldman

626 pp. Oxford U.P., New York, 1982. \$69.00

The application of thermodynamics to spin systems goes back a long way, but even before the heyday of nuclear

magnetism there was skepticism and controversy. For example, few of us were sophisticated enough to think deeply about the implications of an experiment by Alan Portis on selective radiofrequency excitation of an inhomogeneously broadened paramagnetic resonance line, which showed that a macroscopic system of electron spins could not be described by a simple temperature. Disbelief greeted the prediction by Albert Overhauser that saturation, that is, heating, of an elec-

High Resolution Infrared... New Products, New Frontiers

At Spectra-Physics, Laser Analytics Division, we've been working hard, improving the state-of-the-art in Pb-salt semiconductor Tunable Diode Lasers (TDL's), and developing new products to enhance their capabilities and expand their application.

Technology Advancements

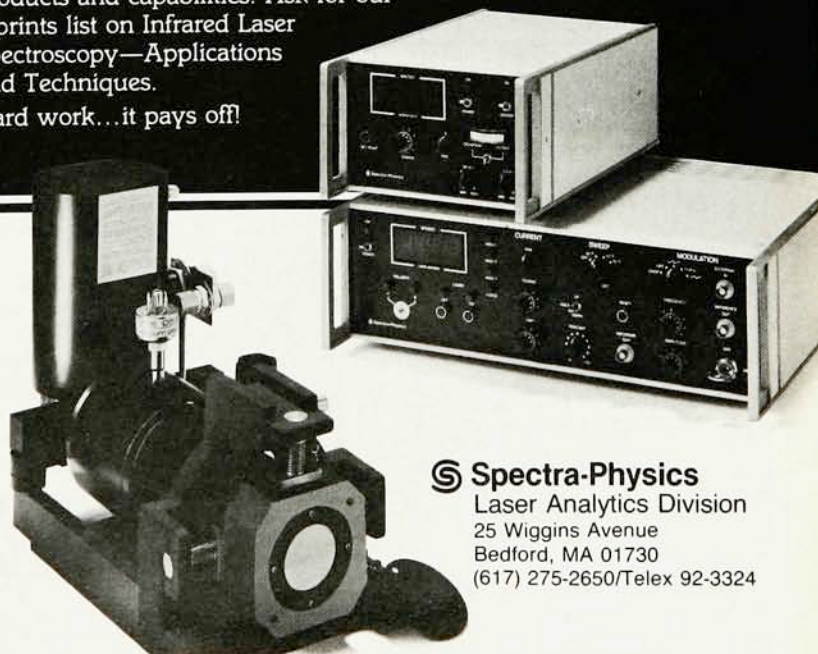
- Improved laser yield
- Increased stability
- Improved reliability
- Higher power
- Increased per mode tunability

New Products

- Cryogen-free, copper-doped Germanium detectors
- Closed Cycle refrigerator with new stabilized cold finger
 - for Ge:Cu detector
 - for diode laser sources
- Ultra-stable 100 m White Cell
- Cryogenic Temperature Sensors and Controllers

If your research is in the 3-30 micron region, put our technology to work. Call or write today for more information about Laser Analytics products and capabilities. Ask for our reprints list on Infrared Laser Spectroscopy—Applications and Techniques.

Hard work...it pays off!



Spectra-Physics
Laser Analytics Division
25 Wiggins Avenue
Bedford, MA 01730
(617) 275-2650/Telex 92-3324

Circle number 24 on Reader Service Card