

Drude, is forced to reckon not with honorable retirement but with painful self-reflection. For Jakob the venue that crystallized his character and exalted his profession has been upended. Now even the once formidable Reich that Jakob helped "unify" during the campaign of 1870 is collapsing. Indeed, the character of the descent they share also shifts from classical to modern: The head-wound Jakob suffered as a young lieutenant now recurs as a maiming of his psyche.

Physics is the touchstone of this portrayal of psychic dissonance. One of those whose work "sought to order all phenomena under a single principle," Jakob finds himself out of sorts with the revolutionizing thrust of the new physics. More than out of sorts: cast off. Too intelligent to dismiss the brilliant work of the young turks, Niels Bohr and Albert Einstein, Jakob is still loath to abandon a career dedicated to the formulation of the relations of the world-ether. His very identity is tied to the fate of the "electromagnetic standpoint."

Indeed, because classical physics seeks to elucidate the "essence" of nature, as the hegemonic discipline it entails qualities of character as well as intellectual stamina. Now that the rising generation—*Knabenphysik*—has employed its mathematical wiles to undermine the classical imprint, a cultural void has opened up, giving rise to expressions of rancid nationalism, careerism, egoism, and the cult of the irrational. Caught in the squeeze between the technologizing and mathematicizing of physics—between the *Geheimrat* and the *Privatdozent*—Jakob beats a tired retreat. Having asked the "fundamental questions" throughout his career as a theorist, Jakob recoils at the possibility that the answers he sought were all along couched in an impenetrable mathematics that suggests the only remaining valid standpoint is—anything goes.

If culture-pessimism unhinges Jakob, his unyielding identification with the classical paradigm kills him. His interior transit, across a psychosocial mine field, has become a death-trip. McCormmach tracks Jakob through the interstices of career, character, profession, and historical moment, in the process laying bare, in graceful, spare prose, the "irrational" underside and "extrarational" orbit of scientific rationality and progress. Personal antipathies and jealousies, bureaucratic tyranny and individual stubbornness, racism, nationalism, ambition, thematically configure this unfolding of the dreams and delusions of the German scientific mandarin. The all-too-human context of scientific striving has never more scrupulously nor graphically been represented.

McCormmach has taken heady risks in exposing his scholarly specialty to the light of day. But the result—a model of economy, penetration, and boldness—more than justifies the effort. It is neither trendy, nor tendentious, nor a slick vehicle for making the history of science palatable and entertaining. Quite the opposite. Of all the compounded ironies that make this history-as-novella beguiling, none is more striking than the one fashioned by the contrast between the ease of access, due to the narrative form and the personal, "confessional" idiom, and the demanding nature of the material, the intellectual, social, and psychological terrain traversed. This deceptive work rewards slow reading and "shuttled" perusal of the scholarly notes. The jettisoning of the classical framework, in physics as in the culture as a whole, came as a series of shocks extending over a generation. The ramifications of that cumulative shock-wave, here so incisively and affectingly explored, have exact parallels to our own nested crises.

If the novella doesn't quite come off—if Jakob is subject to too weighty, self-conscious, and philosophical pronouncements—the history conveys the breakdown and collapse of a grand and grandiose conceit: our own.

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Robert Andersen, who writes about the politics of science, is working on a book on the atomic scientists.

Cosmic Plasma

H. Alfvén

164 pp. Reidel (US dist. Kluwer, Boston, 1981). \$39.50

Cosmic Plasma, characteristic of the work of Hannes Alfvén, is full of thought-provoking and original ideas. Although I very much enjoyed reading it, it is by no means an easy book. The ideas are important and provocative, but they are presented weakly. I was also put off by the truism that Alfvén repeats in many forms that in making theoretical speculations in new fields one must be very careful if one is to avoid incorrect theories: Either the theory must be rigorous, self-consistent and rational, or it must be thoroughly grounded in laboratory experiments. It is true that first theories of a subject such as the Earth's magnetosphere have been grossly in error and have had to be discarded. But, it is also true that the theory of plasma physics has advanced with predictive theories as well as theories after the fact. Everyone agrees that bad science has not usually paid off!

One difficulty in following Alfvén's arguments results from the analogies he makes between electric circuits and cosmic phenomena. It is not easy to

understand how pieces of plasma are to behave like wires while the rest of the plasma is to be ignored. When Alfvén applies these equivalent circuit models to cosmic situations, he invokes voltages and electric fields whose origins are not intuitively clear. For example, he attributes the voltages driving the auroral currents to a slippage between the magnetospheric plasma and corotation. But what is the slippage due to? Couldn't the situation be the other way around, with the slippage due to the resistance in the circuit? Too often the reader must supply the missing qualitative ideas in these circuit pictures.

Another difficulty in reading this book is a consequence of the prominent lack of uniqueness in the models Alfvén suggests. For example, in his construction of the magnetosphere-tail model he starts with sets of currents taken from observation whose choice he does not explain.

Although the physical explanations Alfvén presents are unclear, the ideas he sets forth are impressive. One such idea is the importance he finds in double layers, too long neglected, in cosmical phenomena. He gives many examples of phenomena in which the double layer may be crucial. It certainly plays some role in aurorae, where local acceleration takes place. It is probably important also in solar activity. Alfvén also maintains it is significant for larger-scale phenomena, such as the heliosphere, cosmic-ray acceleration in the heliosphere and, on the largest scale, galactic radio sources. It is difficult to judge whether double layers are active in these larger settings, which require large currents to pass through small regions, until one understands why plasmas prefer this configuration. Although it is dangerous to argue from laboratory experiments to such large-scale phenomena, double layers might be present and should be taken seriously. We need an argument that establishes that double layers are or are not present. What is not needed is ignoring them. Alfvén is quite right to emphasize this need.

Alfvén advances the idea that filamentation is prevalent on astrophysical scales. Unfortunately, the origin of filamentation that he presents—pinch effects and magnetic ropes—is not convincing. Starting with a pinch effect that is already a filament, he shows that given the proper geometry it will be enhanced. Here he ignores the induced electric fields associated with pinching the longitudinal fields, which stabilize the pinching. He also fails to clarify the origin of the driving longitudinal electric fields.

Alfvén emphasizes that it is inappropriate to treat phenomena locally. A case in point is the exploding double layer, where the energy source is forced

This book well merits reading. The great originality of Alfvén's physical insight is evident despite the weakness of his presentation. He has, ironically, lived up to Kadomtsev's dictum, which he quotes: "When rigor appears to conflict with simplicity, simplicity is given preference." For rigor read clarity, and for simplicity read originality.

Intermolecular Forces: Their Origin and Determination

616 pp. Oxford U.P., New York, 1981. \$74.00

The study of intermolecular forces, however, cannot properly be separated from the calculation of the properties of the system, because *ab initio* quantum methods are feasible only for molecules containing a small number of electrons. As a result, semi-empirical methods involving the adjustment of parameters to fit observed thermodynamic and transport properties are necessary.

Lennard-Jones potential is no longer regarded as an adequate intermolecular potential, at least for the inert gases. In addition, dramatic progress in the theory of liquids has occurred in this period. Geoffrey C. Maitland, Maurice Rigby, E. Brian Smith, and William A. Wakeham, who have made important contributions in the field of intermolecular forces, have succeeded admirably in covering this broad field in their recent book, *Intermolecular*

The book covers recently developed spectroscopic and scattering techniques in detail, with a treatment that is self-contained and clear. Developments in the theory of liquids during the past 25 years, such as computer simulations, perturbation theory, and integral equations based upon the Ornstein-Zernike equations, appear clearly and concisely. In fact, the treatment

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For use in mass spectrometers, electron and ion velocity analyzers, X-ray and vacuum U.V. spectrometers, and neutral particle experiments. Detects electrons, ions, protons, UV, X-ray photons, energetic neutral atoms and molecules. Guaranteed delivered gain. Typical electron gain: 10^6 at 2.5 kv, 10^7 at 3 kv, 10^8 at 3.5 kv. Gain is stable with count rates in excess of 10^6 per second. No ion feedback or spurious pulses. Non-magnetic. Low noise: less than 1 count/minute at 10^7 gain. Ultra vacuum operation. Bakeable to 350°C . Rugged. Flight proven in many rocket launches. Size: 1.25" high, 2" diameter.



All solid state. Output: 500v to 6.1 kv. Low noises: less than 300 microvolts RMS. Low drift: less than .01%/hour, 0.02%/day. Lightweight.

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