usefully learn from the development of Anglo-American eugenics and human genetics, it makes a marvellous story. Kevles has done a prodigious amount of research and has uncovered a wealth of fascinating material. In the first part of the book, however, the author's lack of philosophical sympathy with the central characters, Galton, Pearson and Davenport, is rather too much in evidence. I found myself irritated by his periodic forays into psychoanalysis, as when he speculates that "Galton may well have diverted frustration over his own lack of children into an obsession with the eugenic propagation of Galton-like offspring". And his portrait of Pearson seems somewhat one-sided, if the accounts of other authors are anything to go by. Contrast Kevles's assertions that Pearson was "blinded by eugenic prejudice" and that he "often display[ed] a relentless closed-mindedness" with Helen Walker's assessment (in the *International Encyclopedia of the Social Sciences*): "his first thought was to get to the truth and if intellectually convinced of an error, Pearson was ready to admit it". Questions of personality aside, Kevles hardly conveys adequately the magnitude and scope of Pearson's achievements as a scientist, which were by no means restricted to the study of human heredity and statistical theory.

I have, though, nothing but praise for Kevles's treatment of the "golden age" of British genetics: the age of Ronald Fisher, Lionel Penrose, Julian Huxley, J.B.S. Haldane and Lancelot Hogben. It was a time when the Galton Laboratory in London, in spite of being chronically underfunded, boasted an astonishing concentration of talent and completely transformed the study of human genetics. Perhaps, indeed, it was partly *because* of the lack of funds that they achieved so much: Haldane remarked that, in the absence of equipment, they were forced to *think*. It is an exciting, even inspiring tale. And Kevles tells it beautifully.

The work done at the Galton laid the foundations for all modern research on the subject: research which was eventually to give rise to a new branch of medicine. With it came, first, genetic counselling, then programmes of genetic screening — for sickle-cell in blacks and Tay-Sachs in the Jewish population. Also amniocentesis and, latterly, chorionic biopsy, making it increasingly possible to detect genetic and chromosomal abnormalities in the womb and selectively to abort. The advent of *in vitro* fertilization raises possibilities previously undreamt of. We are still a long way from being able, as Huxley put it, to "take charge of our own evolution". But we are a lot closer than when he said it. And no closer, I fear, to knowing what we shall do with this power when we have it.

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# Insight into Earth's changing face

*Joe Cann*

**New Views on an Old Planet: Continental Drift and the History of the Earth.** By Tjeerd H. van Andel. *Cambridge University Press: 1985. Pp.324. £15, $19.95.*

A CENTURY ago, gentlemen of leisure considered it quite the proper thing to take an active interest in geology. After all, geology had brought about the Huttonian Revolution, which extended the age of the Earth at least a thousand-fold, and evidence from fossils was central to the ideas of Darwin. Geology was seen as a key part of scientific culture.

How different is the situation now! The Huttonian Revolution, which achieved as great a cultural change as the Copernican, is now taken for granted, even in the country of its birth. Where is the monument at Jedburgh, where the signpost to Siccar Point? Moreover geology has since brought about another revolution, so that continents are mobile, sliding over the Earth, splitting and colliding, and separated by dynamically evolving deep-ocean basins, rather than fixed and anchored as the old orthodoxy would have it. So why is geology not again a central science? Is it because of the lack of informed popularization by creative geologists? Certainly much popular geological writing is abysmally inept.

Against this background it is particularly interesting to read Tjeerd van Andel's new book. van Andel is not only a scientist who has contributed important elements to the new geological framework, but also a man of scholarship and wide erudition. Here he sets out to tell one part of the new story: how our ideas of geological history have been changed and how we have gained radical new insights into the changing face of the Earth.

This is only one half of the story, an important point to stress, since the book scarcely touches on geological process, the mechanisms by which geological changes occur. This is perhaps partly because the subject is treated entirely without mathematics, but also, I suspect, because van Andel's main interest lies in Earth history. The book arose from a series of lectures to non-geologists at Stanford, and van Andel does try very hard to use the smallest possible selection of the multifarious and notorious specialist vocabulary of geology.

There are five main sections, starting with the most recent topic, the last ice age, moving on to continental drift, and building on that to examine climates of the past, before proceeding to look at the earliest stages of Earth history and, finally, the history of life. *New Views on an Old Planet* is well enough written and presented, but its main strength is the depth of insight it shows. A scientist of van Andel's calibre does not bankrupt his knowledge in the writing of a single book, but selects creatively from his considerably greater store. Whatever the educational bargain-hunters of the present day say, a close involvement with research does enrich and enliven teaching (and popularization); that shows clearly here. Perhaps the book will encourage other prominent geologists to attempt similar works, and perhaps this in turn will restore to geology some of its former public understanding.

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### New edition

• *World Nuclear Directory: A Guide to Organizations and Research Activities in Atomic Energy,* 7th Edn, consultant editor C.W.J. Wilson. The *Directory* includes details of some 2,000 laboratories and establishments worldwide, and is published by Longman/Gale Research. Price is £95, $180.

# Catholic interests

*H.W. Paul*

**Uneasy Genius: The Life and Work of Pierre Duhem.** By Stanley L. Jaki. *Martinus Nijhoff:1985. Pp.472. Dfl.175, $65.50, £44.50.*

"SHH! Papa is looking for a theorem." His daughter's silence did not help Pierre Duhem (1861–1916) to discover any great theorems, but he did enough good physics to find a couple of equations that share his name with Margules and Gibbs. Less because of his physics than because of his work in the history and philosophy of science, Duhem is one of the best known of the generation of nineteenth-century giants whose immense productivity drives the jet-setters of today to despair. *Nature*'s obituary in 1916 hit the right note:

> If Duhem did not concentrate his main efforts on the discovery of new phenomena or the measurement and remeasurement of physical constants, he at least played an equally important part in the advancement of our knowledge by evolving order out of chaos, and uniting isolated portions of mathematical physics in the form of a connected and logical theory.

Be this as it may, Duhem's classic work in thermodynamics has been resurrected lately by mandarins of the calibre of Prigogine and Truesdell. A reprinting in 1961 of his *Recherches sur l'Hydrodynamique* (first published in 1903) shows the value of older work on the mechanics of fluids for the engineer when he has to worry about the shock waves produced at supersonic speeds. Contrary to the opinions of Perrin and Langevin, Duhem's anti-atomism and opposition to relativity did not doom him

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to interment in the graveyard of dead paradigms. Like Berthelot, his lifelong scientific opponent, Duhem also contributed to the development of the modern theory of explosives. Perhaps because he was kept in Bordeaux for most of his academic life, Duhem did not have a stable of students who worked on his ideas, and this contributed to his scientific oblivion in France.

In his brilliant study *The Origins of Modern Science*, written nearly 30 years ago, Herbert Butterfield paid proper homage to the work of Duhem in laying bare the structure of mediaeval physical thought. From the viewpoint of the anticlerical republican establishment, Duhem's discovery of the genius of mediaeval Catholicism was as unwelcome as his embarrassingly cogent attacks on Berthelot's rotten thermochemistry. At least this was of more ideological significance than Duhemian fulminations on the shaky status of Maxwell's worm-eaten equations. As a right-wing, publicly conspicuous Catholic in the state university, Duhem had no chance of getting a chair in Paris. This probably made little difference to the fortunes of science. At the end of the nineteenth century, a new galaxy of scientists appeared in Paris and the provinces — the Curies, Perrin, Sabatier, Brillouin, Langevin — who were also acceptable ideologically to the Third Republic, an intolerant mistress intent on re-establishing France as a great scientific power. By a perverse logic of events, Duhem was also one of the main contributors to another of the Republic's successful programmes, the creation of a set of decent provincial faculties of science.

Stanley Jaki's book is the first complete study of Duhem. This extensive treatment of the life and work of the author of the most famous book on theory in physics, *The Aim and Structure of Physical Theory* (1906), can only be welcomed with serious reservations. Its defects issue from Jaki's uncompromising hostility towards the Third Republic and most of Duhem's enemies. In addition to the distortions resulting from Jaki's gut Catholicism, there are basic misconceptions concerning the French educational system (including *grandes écoles* in the *Université*) and the history of science in France (that Darwinism was pushed in the faculties of science). Often the style seems to be modelled on the first sentence of *Areopagitica*. Still, this is a book on an "uneasy genius" that deserves to be chewed and digested. In the end, historical truth remains as elusive as scientific truth, which, as Houllevigue said, "resembles more a woman in a veil than the resplendent nude that painters make arise out of a well". □

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# Beauty of defects

*A.K. Jonscher*

**Defects and Defect Processes in Nonmetallic Solids.** By W. Hayes and A.M. Stoneham. *Wiley:1985. Pp.472. £54.30, $47.*

EARLY concepts of solid state physics were developed on the model of a perfect crystal — an ideal which proved extremely fruitful in generating a whole new branch of science. While it was recognized from the outset that defects were an inevitable and often a highly beneficial ingredient in any real solid, for a long time it was considered sufficient to regard them as small perturbations of the perfect host lattice and, in any case, to treat them as isolated and non-interacting entities. Only gradually did the impact of developing technology — of, for example, heavily doped and later amorphous semiconductors, or the progressive refinement of semiconductor devices or superionic conductors — demand a better understanding of the fundamental processes involving defects. The interaction of defects, exemplified by the phrase "ecology of solid state pollution", as a keyword-conscious researcher described simultaneous diffusion of two impurities in silicon, became increasingly a topic of detailed study.

Hayes and Stoneham's book is an important and probably a unique addition to the literature of this subject. It is remarkable in several respects. First, it combines outstanding readability with a depth of treatment which can be deceptive in that it can give the reader the impression that he has understood a certain point, until on closer examination he will find that on any single page there may be several other matters raised which require further study. The treatment is made both interesting and illuminating by the frequent inclusion of summary tables and other "integrating" features which bring together aspects of the subject not normally found under one heading, such as a full-page glossary of the main species of excitons.

The second unusual feature is the inclusion of many theoretical discussions which start with the simplest concepts and bring in, sometimes almost as asides, progressive refinements of approach which demand much wider reading. If one wishes to delve further, the up-to-date bibliography is very helpful; if not, one has at least been left under no illusion that the simple picture is the end of the matter.

The following chapter headings give an impression of the sheer breadth of the book's contents: "Electronic Properties" (mainly of perfect lattices but with electron-hole drops thrown in for good measure); "Interatomic Forces and Atomic Motions" (including defects and amorphous solids); "Lattice Defects" (with a discussion of fast ionic conductors); "Spectroscopy of Solids" (with descriptions of optical, EPR and DLTS techniques); "Electronic Properties of Point Defects" (with a comprehensive review of defects in many different materials); "Radiation-induced Defect Processes" (ranging from radiation damage and ion implantation to laser annealing and photolysis); "Properties of Surfaces" (with special emphasis on defect phenomena and including a discussion of sintering); and finally "Special Systems" (which manages to include amorphous solids, metal–insulator transitions, intercalates and polymers).

The book will be a challenge to able final-year students — it will broaden their horizons but they should beware of becoming too engrossed in the detail — while for post-graduates this will be an ideal text to provide the background to many research topics. Teachers, too, will here find inspiration, though it may be necessary to dig deep into the subsidiary literature to follow up the items which are mentioned almost casually in the text. To a large degree, this is much more than a didactic text and has many features of a reference source. The seemingly effortless way in which the authors treat a wealth of topics should not deceive anyone into thinking that things are all that easy. □

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