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PHILIP BALL
Material Witness: Dirty physics

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My copy of *The New Physics*, published in 1989 by Cambridge University Press, is much thumbed. Now regarded as a classic, it provides a peerless overview of key areas of modern physics, written by leading experts who achieve the rare combination of depth and clarity.

It is reasonable, then, to regard the revised edition, just published as *The New Physics for the Twenty-First Century*, as an authoritative statement on what's in and what's out in physics. So it is striking to see materials, almost entirely absent from the 1989 book, prominent on the new agenda.

Most noticeably, Robert Cahn of Cambridge University has contributed a chapter called "Physics and Materials", which covers topics such as dopant distributions in semiconductors, liquid-crystal displays, photovoltaics and magnetic storage. In addition, the chapter by Yoseph Imry of the Weizmann Institute in Israel, "Small-scale Structure and Nanoscience", is a snapshot of one of the hottest areas of materials science.

All very well, but it begs the question of why materials science was, according to this measure, more or less absent from twentieth-century physics but central to that of the twenty-first. One may have thought that the traditional image of materials science as an empirical engineering discipline with a theoretical framework based in classical mechanics looks far from cutting-edge, and would hardly rival the appeal of quantum field theory or cosmology.

Topics such as inflationary theory and quantum gravity are still on the menu. But the new book drops topics that might be deemed the epitome of physicists' reputed delight in abstraction: gone are chapters on grand unified theories, gauge theories, and the conceptual foundations of quantum theory. Even Stephen Hawking's chapter on "The Edge of Spacetime" has been axed (a brave move by the publishers) in favour of down-to-earth biophysics and medical physics.

So what took physicists so long to acknowledge its materials aspects? "Straight physicists alternate between the deep conviction that they could do materials science much better than trained materials scientists (they are apt to regard the latter as fictional) and a somewhat stand-offish refusal to take an interest," claims Cahn.

One could say that physicists have sometimes tried to transcend materials particularities. "There has been the thought that condensed matter and material physics is second-rate dirty, applied stuff," Imry says. Even though condensed matter is fairly well served in the first edition, it tended to be rather dematerialized, couched in terms of critical points, dimensionality and theories of quantum phase transitions. But it is now clear that universality has its limits — high-temperature superconductors need their own theory, graphene is not like a copper monolayer nor poly(phenylene vinylene) like silicon.

"Nanoscience has both universal aspects, which has been much of the focus of modern physics, and variety due to the wealth of real materials," says Imry. "That's a part of the beauty of this field!"