The big bad book of the 1930s

People should re-read long-forgotten books from time to time, partly to understand how they may have been led astray but also for mere old time's sake.

THE 1930s were the decade of the big book. Everybody has a handful of titles tucked into the back of his mind — Born's *Atomic Physics*, Dirac's *Quantum Theory*, Sidgwick's *Organic chemistry of nitrogen* and books like that. One does not have to have been alive at the time to have known of them. But the big book of the 1930s that hardly anybody remembers, and which fewer have read, is in many ways the most interesting of them all, if only because it is a touching reminder of how it is possible to be at once dead right and dead wrong, but entirely oblivious of the second possibility. The book is *Relativity theory of protons and electrons* by A.S. ("Sir Arthur") Eddington, published by Cambridge University Press in 1936. Technically a summary and synthesis of Eddington's research on the connection between quantum theory and relativity in the preceding eight years, the book comes out as a kind of declaration of faith that the problem of the Universe is now solved, but that there may be a little tedious computation left to be carried out.

Much of that impression has to do with the style of Eddington's prose, so pure in its self-confidence that even admissions of previous error read assertively, as when Eddington lists ten previously published papers in the *Proc. R. Soc.* and continues "...it was suggested that ... correspond to electrons of opposite spin ... this misjudgement persisted ... I think there is no other point on which I went so completely astray ... the other lines of development..., though sometimes requiring substantial amendment,... contain advances which in principle have been retained."

But the essence of the appeal of Eddington's book is the sheer brazenness of its conviction that the problem (of the Universe, of particles and all that) had been solved. "I think it will be found that the theory is purely deductive, being based on epistemological principles, and not on physical hypotheses", says the *Introduction*. The last sentence of this moving text, 329 pages later, is "and so we may look forward with undiminished enthusiasm to learning what lies hidden in the atomic nucleus — even though we suspect it is hidden there by ourselves." If Jean-Paul Satre had been known in 1936, Eddington would have been called an existentialist.

In the event, he was called an aristotelian by the late Sir Herbert Dingle (who

separately, but successfully, sued *Nature* for libel in 1973) and found the label insupportable. Dingle, a polemicist among academics, who gave *Nature's* readers the first news of Eddington's big book (139, 784; 1973), seems to have been the one to coin the word "cosmolatry" (between cosmology and idolatry) to describe the faith of those who take the Universe to be their god. The know-all philosophy, said Dingle, has "grown so confident that we have no need to unmask it; it has itself discarded masks..." And (of Eddington), "if he had a philosophy big enough for his intuitions, we should know something".

Eddington naturally replied (*Nature* 139, 1000; 1937) in the manner of a British civil servant by describing Dingle's attack as "entertaining", but surprisingly continued by reaffirming his belief in the *a priori* Universe. "One consequence of the new outlook which, I believe, rouses the passions of the Galileans, is that a law of nature has a compulsory character, and is not merely an empirical regularity which we have hitherto found to be fulfilled in our limited experience."

Schrodinger, when he came to review the book almost a year later (*Nature* 140, 742; 1937), did not give his hand away on these grand philosophical issues, but stayed with the text. Thus "...this theory has succeeded in accounting for bewilderingly numerous and complicated facts from comparatively simple (though strange) first principles... we have before us a sketch of unusual grandeur, of which not the details alone need further development and, maybe, further modification".

A further byplay (also recorded in *Nature*) is relevant in the sequel. One of the other big books of the 1930s was E.A. Milne's *Relativity, gravitation and world-structure*. Milne's book was reviewed in *Nature* anonymously by Eddington, who savaged it in the politest possible way: "when he finds... particles the properties of which are like those of cosmic rays, we congratulate him on the happy resemblance of his selected model to the actual universe. But the particles... occur in his model because he put them there. That he did so undesignedly does not affect the question." Ironically, Milne (who was the nicest of men) was later that same year proposing the vote of thanks at a lecture by Eddington on the structure of the Sun.

So what did Eddington's own book accomplish? In his grand design, the scheme was to calculate everything from nothing. Much in sneaking awe of Dirac, Eddington was similarly preoccupied by the meaning of the numbers that seemed to dominate the structure of the Universe, not merely the fine structure constant ($1/137$) but the large numbers which are the ratios of the coupling constants for the forces between particles. His book (well worth reading even now) contains a calculation of the ratio of the mass of the proton (calculated numerically as 1847.6) and of the number of particles (protons and electrons) in the Universe, roughly 10^{79} .

Milne, who returned to Oxford as soon as the Second World War was over, used to hold a seminar twice a week on topics of his audience's choice. Because there were only a handful of people in the audience, most people were required to prepare something to talk about quite often. Foolishly knowing nothing of the affair of Eddington's review, I volunteered on one occasion to talk about Eddington's book. Milne was exceedingly kind, allowing that it was a difficult conception the grand old man had set himself, and that it was natural that he should have converted young people so easily to his way of thinking. He said that Eddington was devoid of physics.

That must be so. Certainly he had the bad luck to be publishing his big book when the whole of physics was changing in ways that he could not have guessed (but there are signs, in the later chapters, that he was trying to adapt to the discovery of the neutron four years earlier). But Eddington's book also has some entertaining ideas that are worth knowing about even at this late stage.

For example, it is a good way of learning about Cayley algebra; there is a discussion of the reasons why the simplest approximations to the real Universe must have five dimensions (one for time and one for curvature) and why, in general, there must be ten (shades of superstrings, but also a simple count of the number of independent variables in a symmetrical metric). Getting from 10 (or 16) to 136, to approximate to the fine-structure constant, requires a little more incredulity — and then adding one to make 137 is an assault on common sense. But who, among the aristotelians, will think that bad form?

John Maddox