Published in *Contemp. Phys.* **44**, 275 (2003).

Review of *Fundamentals of Equations of State* by Eliezer, Ghatak and Hora

To many physicists, "equation of state" conjures up memories of Van der Waals' equation and not very much else. They will be startled to realise that the term is of course equally applicable to quite different equations describing Bose-Einstein and Fermi-Dirac assemblies, white dwarf and neutron stars, supernovæ, plasma and nuclear matter. In fact, the equation of state (EOS) describes any physical system by the relation between its thermodynamic properties e.g. pressure, volume and temperature. The EOS thus provides a universal way of considering Nature under all possible conditions, just provided that local thermodynamic equilibrium can be maintained. The concept is applicable even under very extreme conditions, leading to interdisciplinary studies and applications in e.g. high pressure physics, geophysics, astrophysics, and plasma physics.

Studies of the EOS should therefore be seen as of fundamental importance in physics, which is what provides the justification for reprinting Eliezer et al's interesting book. It is an ambitious work, seeking to cover the subject in 366 pages. After an introductory chapter to set the scene, the authors summarise classical thermodynamics and statistical mechanics in just 8 pages, providing the essential basis for much that follows. The next 14 chapters treat matter in all its variety, including ideal gases, vibration and rotation in molecular gases, Bose-Einstein condensation, the Fermi-Dirac EOS (both non-relativistic and relativistic), ionization and the Saha equation, the Debye Hückel equation, the Thomas-Fermi and related models, the Grüneissen EOS, fluid mechanics, shock waves, the EOS for thermonuclear fusion under inertial confinement, the EOS in astrophysics (extensively, in 44 pages), and the EOS in elementary particle physics. There is a thoughtful Forword by Edward Teller, and 8 appendices treating topics such as the density of states for a particle in a box, and the derivation of Stirling's formula. A list of references is provided at the end, grouped by chapter.

The book was originally published by Cambridge University Press in 1986 with a slightly different title. The present version published by World Scientific seems to be a straight reprint, with the text unchanged apart from a new Preface. In the latter, the authors refer to some of the many new results reported since 1986, and argue that

> "...the unchanged text of the original publication... may be of even greater relevance now for advanced lecturing and for important new research and applications."

It takes either courage, or laziness, to reprint a book after a gap of 16 years, without updating anything. In the present case, I feel that it is the former quality that applies, as this is one of those books that seems almost timeless in its relevance and applicability. Quite possibly, it can be reprinted again in 2018 without change, or with only very minor ones e.g. extensions of the applications and to the corresponding references.

The readers of the book should include all physicists who take a broad view of their subject and do not confine themselves just to narrow specialisms. The EOS is one of those unifying concepts that is applicable across almost all of physics, and beyond it to chemistry, materials science and engineering. The book is probably not recommended reading for many particular lecture courses but, because it provides a cross-cut through the traditional packaging of the subject, it has someting useful for almost all courses and levels of presentation beyond 2nd year undergraduate, not least because it provides such a nice demonstration of the essential unity of physics.

Peter V.E. McClintock,
Lancaster University.