COHESION

A Scientific History of Intermolecular Forces

Why does matter stick together? Why do gases condense to liquids, and liquids freeze to solids? This book provides a detailed historical account of how some of the leading scientists of the past three centuries have tried to answer these questions.

The topic of cohesion and the study of intermolecular forces has been an important component of physical science research for hundreds of years. This book is organised into four broad periods of advance in our understanding. The first three are associated with Newton, Laplace and van der Waals. The final section gives an account of the successful use in the 20th century of quantum mechanics and statistical mechanics to resolve most of the remaining problems.

Throughout the last 300 years there have been periods of tremendous growth in our understanding of intermolecular forces but such interest proved to be unsustainable, and long periods of stagnation usually followed. The causes of these fluctuations are also discussed.

The book will be of primary interest to historians of science as well as physicists and physical chemists interested in the historical origins of our modern-day understanding of cohesion.

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John Rowlinson obtained his MA and D. Phil. from Oxford in 1950, after which he took up a position in the Chemistry Department at the University of Manchester. In 1961 he was appointed Professor of Chemical Technology at the Imperial College of Science and Technology. After 13 years in London Professor Rowlinson returned to Oxford to become the Dr Lee's Professor of Chemistry, a position he held for 19 years. In 1970 he was made a Fellow of the Royal Society. During his distinguished career Professor Rowlinson was awarded a number of prizes including the Leverhulme medal from the Royal Society and the Meldola and Marlow medals from the Royal Society of Chemistry. He was the Andrew D. White Professor-at-large at Cornell University for 6 years and in the year 2000 he was knighted.

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Preface

The aim and scope of this work are set out in the first chapter. Here I explain the conventions that I have used and thank those who have been kind enough to criticize my efforts.

The work is based on primary printed sources. A few letters and other informal documents have been used but only if they have already been printed. Secondary sources are given when they refer directly to the matter in hand or when they seem to be particularly useful. No attempt has been made, however, to cite everything that is relevant to the background of the subject since this would have led to the inflation of an already long bibliography. This policy has led to a fuller coverage of the 18th century than of the 19th where the secondary literature is potentially vast. In contrast, there are almost no directly useful secondary sources for the 20th century, but here the number of primary sources is impossibly large. It would have been easy to have given ten or more times the number listed. The choice is inevitably biased by the recent aspects of the subject upon which I have chosen to concentrate; others might have made other choices, but no one could give a comprehensive coverage of the last century.

The references are listed in four main groups, one at the end of each of the Chapters 2 to 5. There is so little overlap between those in each chapter that this method seemed less clumsy than a consolidated list for the whole book and leaves each chapter almost self-contained. The form in which the titles of journals is abbreviated follows the usual conventions. A few journals that are often known by their editor's name are shown by inserting this name in brackets before the title, e.g. (*Silliman's*) *Amer. Jour. Sci. Arts*. The journal that is now called the *Annalen der Physik* was often abbreviated, after its editors, *Pogg. Ann.* or *Wied. Ann.* etc. during the 19th century, and was formally the *Annalen der Physik und Chemie* until 1899, when Paul Drude became the editor; the simple form *Ann. Physik* is used here throughout. The dates at which some journals appeared differ from the nominal date on the volume. This problem is particularly acute for the publications

of the French Academy. Here the nominal date is used and the actual date of the appearance of the paper is noted if this relevant. The *Annual Reports of the British Association* are dated by the year in which the meeting was held; they were usually published a year later. The place of publication of books is given but not the name of the publisher. Cross-references to 'Collected Works' are given for some foreign authors but not for most British ones such as Maxwell or William Thomson.

Experimental work is described in the units of the time when it was made but a translation into the current units of the Système International is added. The ångström has, however, been retained to describe intermolecular separations. This unit is more convenient than the correct SI unit, the nanometre (10 Å = 1 nm), since almost all the distances quoted are in the range of 1 to 10 Å.

The index of names covers only those whose scientific work is being discussed; authors of secondary sources are not indexed, although I admit that the distinction between primary and secondary is not easily defined. Biographical references are given for the major workers in the field who had died by the end of the 20th century in December 2000, but not for those believed to be still alive. These references are given at the point in the text where the scientist's work first becomes important to this narrative, and so not necessarily at the first citation. If he or she is one of those in *The Dictionary of Scientific Biography*, ed. C.C. Gillispie, 18 vols., New York, 1970–1981, then a reference to that work is generally thought to be sufficient; it is abbreviated DSB. Additional sources are given only if they are particularly important for the subject of this book, or have been published later than the DSB article. If the scientist is not in this work then the next source is the volumes of J.C. Poggendorff, *Biographisch-Literarisches Handwörterbuch zur Geschichte der exacten Wissenschaften*, Leipzig, now Berlin, 1863 onwards. This is abbreviated Pogg. References to the British *Dictionary of National Biography* are abbreviated DNB but details are omitted since the work is ordered alphabetically and since a new edition is now being prepared.

I thank those who have been good enough to read parts of the book and give me advice on how they might be improved: Robert Fox, Ivor Grattan-Guinness, Rupert and Marie Hall, Peter Harman, John Heilbron, John Lekner, Anneke Levelt Sengers and Brian Smith. Others are thanked in the references for more specific information.

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