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Advances in Thermodynamics of the van der Waals Fluid

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Preface

This book evolved out of a course on thermodynamics and statistical mechanics that I taught at Iowa State University. One of the topics covered was phase transitions, and one of the types of phase transitions covered was the first-order liquid to gas transition described by the van der Waals mean-field theory of fluids. This theory was formulated by van der Waals in 1873 and, augmented by Maxwell in 1875, is the first theory that predicts a phase transition from interactions between particles. However, the thermodynamic properties of fluids (gases or liquids) derived from the van der Waals equation of state and free energy have not been thoroughly studied previously.

This book is a comprehensive exposition of the thermodynamic properties of the van der Waals fluid, which includes a review of past work together with presentation of my own recent extensive studies. The main goal of the book is to provide a graphical overview of the many interesting and diverse thermodynamic properties of the van der Waals fluid through plots of these properties versus various independent parameters. The data for these plots are obtained from formulas derived herein, some of which have previously appeared in the literature. Many results not amenable to graphical illustration are also included.

I hope that this book will be useful to instructors as a teaching resource and to students as a text supplement for thermodynamics and statistical mechanics courses as well as to others who are interested in the thermodynamics of the seminal van der Waals fluid.

David C Johnston
Ames, IA
May 27, 2014

Author biography

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Dr David C Johnston is a Distinguished Professor in the Department of Physics and Astronomy of Iowa State University in Ames, Iowa. He received his BA and PhD degrees in Physics from the University of California at Santa Barbara and the University of California at San Diego, respectively. Prior to joining Iowa State University, he carried out research at the Corporate Research Laboratories of Exxon Research and Engineering Company in Annandale, NJ. His research area is experimental solid state physics, with an emphasis on the measurement and theoretical modeling of the electronic, magnetic, thermal and superconducting properties of solids. He is a Fellow of the American Physical Society and a former Divisional Associate Editor of the journal *Physical Review Letters*.