

Preface

This book introduces the theoretical description and properties of quantum fluids. The focus is on gaseous atomic Bose–Einstein condensates and, to a minor extent, superfluid helium, but the underlying concepts are relevant to other forms of quantum fluids such as polariton and photonic condensates. The book is pitched at the level of advanced undergraduates and early postgraduate students, aiming to provide the reader with the knowledge and skills to develop their own research project on quantum fluids. Indeed, the content for this book grew from introductory notes provided to our own research students. It is assumed that the reader has prior knowledge of undergraduate mathematics and/or physics; otherwise, the concepts are introduced from scratch, often with references for directed further reading.

After an overview of the history of quantum fluids and the motivations for studying them (Chap. 1), we introduce the simplest model of a quantum fluid provided by the ideal Bose gas, following the seminal works of Bose and Einstein (Chap. 2). The Gross–Pitaevskii equation, an accurate description of weakly interacting Bose gases at low temperatures, is presented, and its typical time-independent solutions are examined (Chap. 3). We then progress to solitons and waves (Chap. 4) and vortices (Chap. 5) in quantum fluids. For important aspects which fall outside the scope of this book, e.g. modelling of Bose gases at finite temperatures, we list appropriate reading material. Each chapter ends with key exercises to deepen the understanding. Detailed solutions can be made available to instructors upon request to the authors.

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Carlo F. Barenghi
Nick G. Parker

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Barenghi, C.F.; Parker, N.G.

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