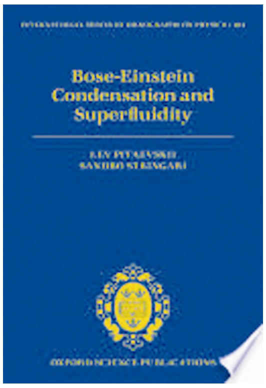

Bose–Einstein Condensation and Superfluidity. Lev Pitaevskii and Sandro Stringari. Oxford University Press, Great Clarendon Street, Oxford, OX2 6 DP, UK. 2016. xi + 553 pages. Price: £65.00.

This book on Bose–Einstein condensation (BEC) and superfluidity, is an extended version of the notable work by the pioneering researchers Sandro Stringari and Lev Pitaevskii, which first appeared in 2003. The first edition appeared to be a detailed version of a review paper 'Theory of BEC in trapped gases' that appeared in the *Review of Modern Physics* in 1999 by the same authors and their two other colleagues. Back in 2005, my research career started with this book and gave me a fresh feeling each time I went through it. It is one of the first books that appeared in the broad area of ultra-cold atoms and deals with the physics of both bosonic and fermionic atoms that are laser cooled to temperatures of the order of nano- or microkelvin. The first landmark in this area was the realization of a BEC of alkali atoms (Nobel Prize, 2001), a new phase of matter predicted by Albert Einstein using Bose statistics. Since then, it has been in the frontline of research with rapid theoretical and experimental developments, emerging as an interdisciplinary field. Especially, bridging between the different aspects of physics, ranging from the study of various phenomena/properties in fluids, nonlinear physics, strongly correlated systems, atomic physics, condensed matter, high-energy physics to quantum information processing.

The book is divided into three parts. The first part provides us the basic mathematical formalism required in understanding the properties of superfluid and BEC phases. In the mean field regime, the properties of a BEC are well captured by the celebrated Gross–Pitaevskii equation (GPE; see chapter 5), which is nothing but a nonlinear Schrodinger equation. The properties emerging from the nonlinearity on solitons and vortices remain as one of the main attractions, analysed from various perspectives. They may provide insights into the physics of quantum transport, Kibble–Zurek mechanism, localization phenomenon and much more. Apart from this, in chapter 5, the spectrum of low-lying collective excitations or quasiparticles is obtained using Bogoliubov theory, which is vital in many studies while probing quantum effects. They are relevant when studying the role of quantum fluctuations, estimating the critical velocity in a superfluid flow or the dynamical stability of condensates. As shown, the long-wavelength excitations or the Goldstone modes in condensates are phonon-like. Beliaev decay of phonons is captured by the quantum hydrodynamic description of the condensate and is discussed in chapter 6. The initial investigations to establish the link between condensation and superfluid started with superfluid helium, and are the subject of chapter 8, including its thermodynamic properties.

The first part of this book would not have been complete without discussion of the collisional or scattering properties of the atoms provided in chapter 9. At extremely low kinetic energies or temperatures, the interatomic interactions are solely determined by a single parameter, the *s*-wave scattering length. The latter can be easily tuned externally using either magnetic or optical field. It makes the cold atomic set-up a highly controllable quantum system in hand. The atom-traps are also briefly discussed in part 1.

Though the general predictions are made on uniform systems, the real ones are either optically or magnetically confined, resulting in an inhomogeneous atom density. Typically, the trapping potentials are approximated to harmonic-type, and the most common ones are the cigar, pancake or spherical geometries. The trapping geometry crucially determines the ground-state properties of the atomic cloud and becomes more significant if the atom–atom interactions are anisotropic, for example, dipole–dipole interactions, which are partially attractive and partially repulsive, are briefly touched upon in the last chapter of the book. The trapping potential can prevent the collapse of an attractive gas if the number of atoms is below a critical number. The results obtained for homogenous systems can be probed in trapped BECs in the Thomas–Fermi limit, where the condensate has a flat density profile at the trap centre. It is the case when the interaction energy dominates the kinetic energy and the local density approximation in general holds.

The finite temperature effects are addressed in chapters 10 and 13. In particular, the effect of two-body interactions on the critical temperature for the BEC transition is obtained in the Hartree–Fock approximation. Another important topic, the rotational effects in a trapped condensate is discussed in chapter 14. The stability of a single vortex line and a vortex lattice is considered in particular. The last chapter in part 2 covers the coherence properties of a BEC with an emphasis on the interference of two separate condensates and Josephson oscillations in a double-well potential.

Part 3 focuses on the superfluid properties of interacting Fermi gases. For small repulsive interactions, a BEC of Feshbach molecules may occur and for attractive interactions the usual BCS superfluid in a two component Fermi gas. The corresponding BCS–BEC crossover is studied in detail in chapter 16. The interesting case of unitarity limit, where the scattering length will drop out of the physical results, giving rise to universal functions for thermodynamic quantities, is also covered. The properties of trapped interacting Fermi gas such as density profiles and momentum distribution are discussed in chapter 17. The different thermodynamic relations, i.e. the Tan relations, are the subject of chapter 18. The hydrodynamic description of the Fermionic superfluids is provided in chapter 19, with a detailed analysis of the first and second sounds in a two-fluid model.

The discovery of BEC in alkali atoms has opened up several new directions. Subsequently, the degenerate quantum gases with atoms occupying different hyperfine states or with multi species become a reality, and various quantum phenomena have been probed in these systems. Among them, spinor condensates are used to study magnetism, including the frustrated spin lattices, and spin–orbit coupled condensates to simulate synthetic gauge fields. Quantum phase transitions are studied in atoms loaded in period optical potentials using Bose–Hubbard Hamiltonian, and the demonstration of Mott insulator to superfluid transition is among the landmark achievements. Lower-dimensional quantum gases are the subject of Chapters 23 (pancake or two-dimensional regime) and 24 (cigar or one-dimensional regime). Another interesting paradigm is the ultra cold dipolar gases such as atoms with magnetic moments or induced electric dipole moments. All of these topics are briefly covered in the last part of the book.

The great quality of this book is its high readability, and it can make an undergraduate student easily comfortable in advanced topics. Adequate introductions and explanations on the physical concepts rule out the need for referring to other books on related topics. This is a highly recommended book for graduate students working in the area of ultra cold atoms or degenerate quantum gases. Though the field has advanced rapidly into various horizons, the basic elements covered in the book are inevitable for any researcher in related topics. In the current edition, the authors have added very recent developments in cold atom research, making it timely for young researchers entering the field. The vast amount of topics covered in the book make it a lifelong companion. The material presented in the book can be covered as advanced courses in two semesters for doctoral or Master's students in universities/institutions. More and more books will appear in the field of cold atom research, but can never replace this one.

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Annual Review of Plant Biology, 2016. Sabeeha S. Merchant, Wilhelm Gruissem and Donald Ort (eds). Annual Reviews, 4139 E1 Camino Way, P. O. Box 10139, Palo Alto, California 94303-0139, USA. Vol. 67, vii + 729 pp. Price: US$ 109.

The advancements in cutting-edge technology and rigorous efforts from researchers have broadened almost every aspect of cell functions in plants. This trend is well captured by the *Annual Review of Plant Biology* (*ARPB*) this year, as always, with articles from renowned scientists on various aspects of plant biology associated with cellular energy dynamics, nutrient sensing, hormonal regulation and stress responses.

The book begins with historical perspectives on thioredoxin and redox regulation in bacteria and plants by Buchanan, whose career journey was almost synonymous with the field, along with many other colleagues of his time. He has described his early work on bacterial ferredoxin (Fdx) and CO_2 fixation, as well as work performed later on the identification of thioredoxins and redox regulation in plants. He has nicely illustrated the various aspects of CO_2 fixation and explained how the discovery of reverse citric acid cycle provides the basis for CO_2 fixation via multiple pathways.

Chloroplasts play a significant role in redox regulation, photorespiration and photosynthesis. The article by Peltier *et al.* describes the origin and evolution of NDH-complexes and their role in oxygenic photosynthesis. In cyanobacteria, the same cellular compartment is used for oxygenic photosynthesis and respiration, whereas these processes are compartmentalized in higher plants.

The article highlights various genetic and biochemical approaches, which helped to decipher the high degree of complexity of NDH-1s in cyanobacteria and chloroplasts. Chloroplasts, like mitochondria, are semi-autonomous organelles; they act as environmental sensors to regulate developmental cues and stress responses through retrograde signalling. In retrograde signalling, the expressions of nuclear genes is regulated by signals sent from chloroplasts to nucleus. The article by Xun *et al.* provides a mechanistic view of retrograde signalling not only in the context of organelles communication between chloroplast and nucleus, but also the interaction with hormone signalling and adaptive responses.

An important aspect presented well in this edition is nutrient sensing mechanism involving target of rapamycin (TOR) signalling. Despite the embryo lethal phenotype of *tor* null mutants, a wealth of information is available for TOR signalling in plants. This article describes not only the evolutionary conservation of TOR-signalling complexes but also reflects specific evolution that occurred in plants. TOR complexes in plants lack many components known in other eukaryotes and the known substrates such as S6K kinase and PP2A phosphatase-associated proteins are available in plants, but many others hitherto undiscovered. A comprehensive molecular view of TOR-regulated metabolic pathways such as nitrogen, starch and lipid metabolism among others is coherently presented. This is of particular interest to the present reviewers, as we are exploring signalling mechanisms in nutrient response and nutrient use efficiency, especially nitrogen and phosphorus[1,2].

Endocytosis dynamically regulates the membrane composition and cellular trafficking, besides mediating efficient communication between cell surface and interior in plants. Valencia *et al.* have provided updated information on clathrin-dependent and -independent endocytosis as well as regulating components in plants. The components of endosomal trafficking, including recycling of plasma membrane receptor proteins are regulated by stress factors and major phytohormones, and thus constitute an indispensable part of cell signalling. The function of FLS2 protein, a MAMP (microbe-associated molecular pattern) receptor, is endocytotically regulated upon binding of Flg22 ligand. Endocytosis regulates the receptor protein turnover and desensitizes the reactions. In contrast, the endocytosis of regulator of G-protein signalling (AtRGS1) allows sustained activation of G-protein signalling in *Arabidopsis*[3] and therefore provides a unique opportunity for the study of endosomal origin of signalling in plants.

Transcription factors (TFs) regulate development and environment-driven cellular homeostasis in plants. The advancement in computational biology tools led to the generation of huge datasets that govern complex transcriptional circuitry involved in spatio-temporal regulations of various genes and associated pathways. The article by Gaudinier and Brady deeply explores the mapping of transcriptional networks and also their biological implications. To delineate the complexity of TF networks, the authors have discussed both the transcription factor/gene centred approaches with specific examples of ethylene insensitive 3 (EIN3), speechless (SPCH) and vascular NAC domain 6 (VND6) as well as *ab initio* approaches involving DNase I hypersensitivity assays. They have explained how the miscellaneous information helps generate strong hypotheses of TF networks in the context of regulation of diverse biological processes in plants.