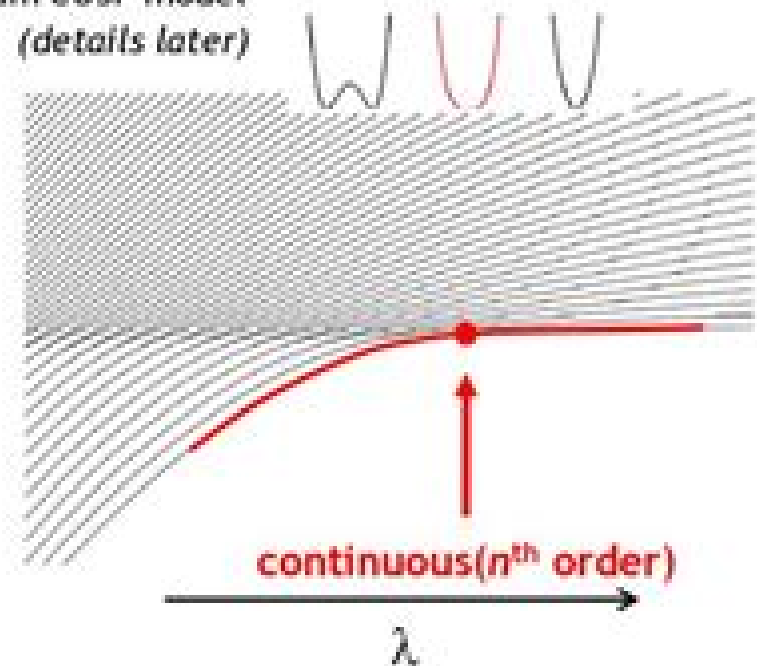
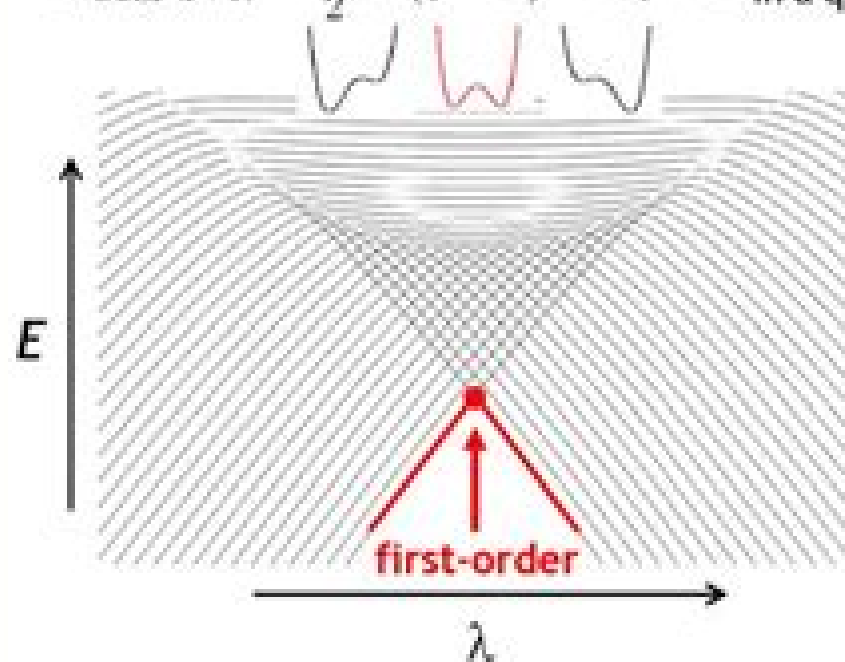


# Quantum phase transition (QPT)

A *nonanalytic* change (in the *infinite-size limit*) of **ground-state properties** of a system by varying an **external control parameter**  $\lambda$  at absolute zero temperature (only quantum fluctuations present)

$$H_{\text{Cusp}}^{\lambda}(p, q) = \frac{p^2}{2} + (q^2 - 1)^2 - \lambda q - 1$$

potential-wells evolutions  
in a quantum CUSP model  
(details later)



- Examples:**
- ferromagnet-paramagnet transitions
  - insulator-superfluid transitions
  - superradiant phase transitions
  - ...

# Quantum Phase Transitions

**Sei Suzuki, Jun-ichi Inoue, Bikas K.  
Chakrabarti**



## Quantum Phase Transitions:

**Quantum Phase Transitions** Subir Sachdev, 2001-04-23 Quantum Phase Transitions is the first book to describe in detail the fundamental changes that can occur in the macroscopic nature of matter at zero temperature due to small variations in a given external parameter. The subject plays a central role in the study of the electrical and magnetic properties of numerous important solid state materials. The author begins by developing the theory of quantum phase transitions in the simplest possible class of non-disordered interacting systems: the quantum Ising and rotor models. Particular attention is paid to their non-zero temperature dynamic and transport properties in the vicinity of the quantum critical point. Several other quantum phase transitions of increasing complexity are then discussed and clarified. Throughout the author interweaves experimental results with presentation of theoretical models and well over 500 references are included. The book will be of great interest to graduate students and researchers in condensed matter physics.

**Quantum Phase Transitions** Subir Sachdev, 2011-04-07 Describing the physical properties of quantum materials near critical points with long range many body quantum entanglement, this book introduces readers to the basic theory of quantum phases, their phase transitions, and their observable properties. This second edition begins with a new section suitable for an introductory course on quantum phase transitions assuming no prior knowledge of quantum field theory. It also contains several new chapters to cover important recent advances such as the Fermi gas near unitarity, Dirac fermions, Fermi liquids, and their phase transitions, quantum magnetism, and solvable models obtained from string theory. After introducing the basic theory, it moves on to a detailed description of the canonical quantum critical phase diagram at non-zero temperatures. Finally, a variety of more complex models are explored. This book is ideal for graduate students and researchers in condensed matter physics and particle and string theory.

**Understanding Quantum Phase Transitions** Lincoln Carr, 2010-11-02 Quantum phase transitions (QPTs) offer wonderful examples of the radical macroscopic effects inherent in quantum physics: phase changes between different forms of matter driven by quantum rather than thermal fluctuations, typically at very low temperatures. QPTs provide new insight into outstanding problems such as high temperature superconductivity.

Conductor Insulator Quantum Phase Transitions Vladimir Dobrosavljevic, Nandini Trivedi, James M. Valles Jr., 2012-06-28 Quantum phase transitions describe the violent rearrangement of electrons or atoms as they evolve from well-defined excitations in one phase to a completely different set of excitations in another. The chapters in this book give insights into how a coherent metallic or superconducting state can be driven into an incoherent insulating state by increasing disorder, magnetic field, carrier concentration, and inter-electron interactions. The problem necessarily involves many interacting particles, and therein lies the challenge to develop a multi-faceted theory. Experiments probing microscopic structure, transport, charge, and spin dynamics provide important clues. What sets this book apart is a strong dialog between experiment and theory that has the potential to solve some major issues in many-body physics. The ideas and methods developed here are bound to have repercussions in all spheres of physics.

Equilibrium and Nonequilibrium Aspects of Phase Transitions in Quantum Physics Ricardo Puebla, 2018-09-17 In this book the equilibrium and nonequilibrium properties of continuous phase transitions are studied in various systems with a special emphasis on understanding how well established universal traits at equilibrium may be extended into the dynamic realm going beyond the paradigmatic Kibble Zurek mechanism of defect formation This book reports on the existence of a quantum phase transition in a system comprising just a single spin and a bosonic mode the quantum Rabi model Though critical phenomena are inherent to many body physics the author demonstrates that this small and ostensibly simple system allows us to explore the rich phenomenology of phase transitions both in and out of equilibrium Moreover the universal traits of this quantum phase transition may be realized in a single trapped ion experiment thus avoiding the need to scale up the number of constituents In this system the phase transition takes place in a suitable limit of system parameters rather than in the conventional thermodynamic limit a novel notion that the author and his collaborators have dubbed the finite component system phase transition As such the results gathered in this book will open promising new avenues in our understanding and exploration of quantum critical phenomena

**Quantum Ising Phases and Transitions in Transverse Ising Models**  
Bikas K. Chakrabarti, Amit Dutta, Parongama Sen, 2008-12-22 Investigations into the zero temperature phases in various frustrated and random Ising models in a transverse or tunnelling field have caught attention very recently in the context of quantum magnetisation of glasses and other frustrated systems This book gives a detailed discussion of the various theoretical techniques developed for the study of transverse Ising models and of the results of these studies with regular and random frustration dilution randomness etc Recent developments in the studies on their quantum relaxational dynamics such as in quantum hysteresis are also treated The detailed presentation of original results and the reviews given here are expected to inspire further research in the exciting field of quantum many body systems with randomness and frustration

*Some Examples of Quantum Phase Transitions* Jinwu Ye, 1993      *Quantum Phase Transitions in Transverse Field Spin Models* Amit Dutta, Gabriel Aeppli, Bikas K. Chakrabarti, Uma Divakaran, Thomas F. Rosenbaum, Diptiman Sen, 2015-01-28 The transverse field Ising and XY models the simplest quantum spin models provide the organising principle for the rich variety of interconnected subjects which are covered in this book From a generic introduction to in depth discussions of the subtleties of the transverse field Ising and related models it includes the essentials of quantum dynamics and quantum information A wide range of relevant topics has also been provided quantum phase transitions various measures of quantum information the effects of disorder and frustration quenching dynamics and the Kibble Zurek scaling relation the Kitaev model topological phases of quantum systems and bosonisation In addition it also discusses the experimental studies of transverse field models including the first experimental realisation of quantum annealing and the recent realisation of the transverse field Ising model using tunable Josephson junctions Further it points to the obstacles still remaining to develop a successful quantum computer

**Quantum Phase Transitions in Cold Atoms and Low Temperature Solids** Kaden Richard Alan

Hazzard,2011-06-28 The primary focus of this thesis is to theoretically describe nanokelvin experiments in cold atomic gases which offer the potential to revolutionize our understanding of strongly correlated many body systems The thesis attacks major challenges of the field it proposes and analyzes experimental protocols to create new and interesting states of matter and introduces theoretical techniques to describe probes of these states The phenomena considered include the fractional quantum Hall effect spectroscopy of strongly correlated states and quantum criticality among others The thesis also clarifies experiments on disordered quantum solids which display a variety of exotic phenomena and are candidates to exhibit so called supersolidity It collects experimental results and constrains their interpretation through theoretical considerations This Doctoral Thesis has been accepted by Cornell University Ithaca USA *Quantum Phase Transitions* ,2010

**Quantum Phase Transitions in the Presence of Disorder and Dissipation** Chetan Vyankatesh Kotabage,2011 A quantum phase transition is a phase transition at absolute zero occurring under variations in an external non thermal parameter such as magnetic field or pressure Quantum phase transitions are one among the important topics currently investigated in condensed matter physics They are observed in various systems e g in the ferromagnetic paramagnetic phase transition in LiHoF<sub>4</sub> or in the superconductor metal phase transition in nanowires A particular class of quantum phase transitions which is phase transitions in the presence of disorder and dissipation is investigated here An example of this class is the ferromagnetic paramagnetic phase transition in Ni<sub>1-x</sub>V<sub>x</sub> or CePd<sub>1-x</sub>Rh<sub>x</sub> caused by variations in chemical composition In these system sic disorder is due to random positions of doping element and the dynamics of order parameter fluctuations is dissipative due to conduction electrons These quantum phase transitions are explained using the following approach The Landau\_Ginzberg\_Wilson functional which is derived from a microscopic Hamiltonian is treated by the strong disorder renormalization group method For ohmic damping phase transitions are strongly influenced by disorder and the critical point is an infinite randomness fixed point which is in the universality class same as that of the random transverse field Ising model The scaling form of observable quantities is activated type rather than conventional power law type For superohmic damping the strong disorder renormalization group method yields one of the recursion relationships different from ohmic damping This difference indicates a more conventional transition for superohmic damping Abstract leaf iii Quantum Scaling in Many-Body Systems Mucio Continentino,2017-04-17 Focusing on experimental results this updated edition approaches the problem of quantum phase transitions from a new and unifying perspective **Quantum Ising Phases and Transitions in Transverse Ising Models** Sei Suzuki,Jun-ichi Inoue,Bikas K.

Chakrabarti,2012-12-14 Quantum phase transitions driven by quantum fluctuations exhibit intriguing features offering the possibility of potentially new applications e g in quantum information sciences Major advances have been made in both theoretical and experimental investigations of the nature and behavior of quantum phases and transitions in cooperatively interacting many body quantum systems For modeling purposes most of the current innovative and successful research in

this field has been obtained by either directly or indirectly using the insights provided by quantum or transverse field Ising models because of the separability of the cooperative interaction from the tunable transverse field or tunneling term in the relevant Hamiltonian. Also a number of condensed matter systems can be modeled accurately in this approach hence granting the possibility to compare advanced models with actual experimental results. This work introduces these quantum Ising models and analyses them both theoretically and numerically in great detail. With its tutorial approach the book addresses above all young researchers who wish to enter the field and are in search of a suitable and self contained text yet it will also serve as a valuable reference work for all active researchers in this area.

**Some Basic Aspects of Quantum Phase**

**Transitions** Diana V. Shopova, 2003

**Some Basic Aspects of Quantum Phase Transitions** Diana V. Shopova, Dimo I.

Uzunov, 2003

**Novel Quantum Phase Transitions in Low-Dimensional Systems**

Junhyun Lee, 2016

We study a number of quantum phase transitions which are exotic in their nature and separates non trivial phases of matter. Since quantum fluctuations which drive these phase transitions are stronger in low dimensions we concentrate on low dimensional systems. We consider two different two dimensional systems in this thesis and study their phase transition. Quantum Phase Transitions in Impurity Models and Percolating Lattices Manal M. Al-Ali, 2013. This thesis investigates the influence of random disorder and dissipation on zero temperature quantum phase transitions. Both phenomena can fundamentally change the character of the phases of a quantum many particle system and of the transitions between them. If dissipation and disorder occur simultaneously in a system undergoing a quantum phase transition particularly strong effects can be expected. In the first paper reproduced in this thesis we study a single quantum rotor coupled to a sub Ohmic dissipative bath. We find that this system undergoes a quantum phase transition from a delocalized phase to a localized phase as the dissipation strength is increased. We determine the exact critical behavior of this transition it agrees with that of the corresponding long range interacting classical model. Therefore the quantum to classical mapping is valid for the sub Ohmic rotor model. In the second paper we investigate the influence of sub Ohmic dissipation on randomly diluted quantum Ising and rotor models. We find that the zero temperature quantum phase transition across the lattice percolation threshold separates an unusual super paramagnetic cluster phase from an inhomogeneous ferromagnetic phase. We determine the low temperature thermodynamic behavior in both phases and we relate our results to the smeared transition scenario for disordered quantum phase transitions. In the last paper the influence of Ohmic dissipation on the random transverse field Ising chain is studied by means of large scale Monte Carlo simulations. Our simulations show that Ohmic dissipation destroys the infinite randomness quantum critical point of the dissipationless system. Instead the quantum phase transition between the paramagnetic and ferromagnetic phases is smeared as predicted by a recent strong disorder renormalization group approach. Abstract page iv

Dissipative Quantum Phase Transitions Philipp Werner, 2005

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