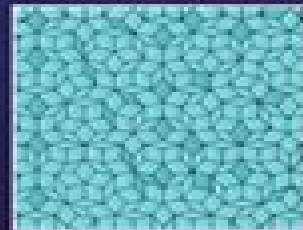
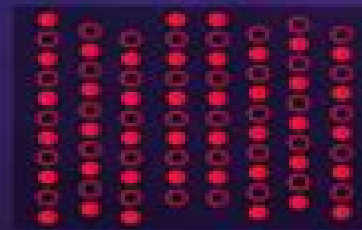


# Bridging the Gap Between Quasicrystals and Incommensurate Modulated Structures

Quasicrystals (QCs) and incommensurate (IC) modulated structures are two types of aperiodic crystals that have long-range order without lattice translational symmetry



QCs  
✓ Ordered  
✓ Non-periodic structure



IC modulated structures  
✓ IC modulation superimposed on the basic crystal lattice

However, the relationship between these two classes of materials remains largely unexplored so far

## Construction of hexagonal metallic-mean approximants of the honeycomb lattice



Large hexagon (L)



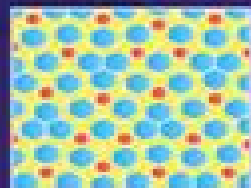
Tilings

Parallelogram (P)

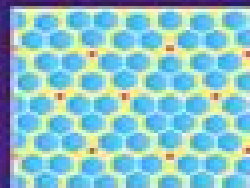


Small hexagon (S)

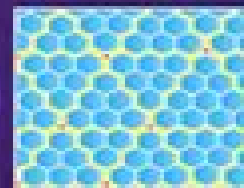
$$\text{Length ratio } (\ell/s) = \text{Metallic mean } (\tau_k) = k + \sqrt{(k^2 + 4)}/2$$



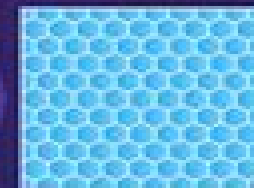
$k = 1$   
(golden-mean tiling)  
 $\tau_1 = 1.618...$



$k = 2$   
(silver-mean tiling)  
 $\tau_2 = 2.414...$



$k = 3$   
(bronze-mean tiling)  
 $\tau_3 = 3.302...$



$k \rightarrow \infty$   
Single honeycomb domain



Majority L tiles in the honeycomb domain



S and P tiles as domain walls



Applicable to polymers and colloidal systems

This study sheds new light on domain wall structures, enhancing our understanding of aperiodic crystals

# Quasicrystals And Incommensurate Structures In Condensed Matter Third International Quasicrystal Conference

**Ted Janssen, Gervais Chapuis, Marc de  
Boissieu**



## **Quasicrystals And Incommensurate Structures In Condensed Matter Third International Quasicrystal Conference:**

**Quasicrystals And Incommensurate Structures In Condensed Matter - Proceedings Of The Third International Meeting On Quasicrystals** Agostinho Gomes, M Jose Yacaman, D Romeu, V Castano, 1990-03-01 [Quasicrystals and](#)

[Incommensurate Structures in Condensed Matter](#) Agostinho Gomes, 1990 **Quasicrystals** J.-B. Suck, M. Schreiber, P. Häussler, 2013-04-17 Quasicrystals have been the object of intense research efforts for a good 16 years now. In recent years this area of solid state physics and crystallography has grown into a mature field in its own right. Hence several books on quasicrystals have appeared in the interim; see Appendix and chapters on quasicrystals have been introduced into new books on solid state physics and into new editions of existing monographs. However, most of the former have been written for scientists specialised in this field rather than for students and the latter additions are often rather brief. We therefore decided to fill the gap between these two extremes with a book which provides an introduction to the structure and physical properties of quasicrystals and covers in sufficient detail all important fields in quasicrystal research and even applications. The chapters have been written by specialists and each is based on the author's insight into this field. However, much effort has been put into achieving an introductory character and making the text accessible to newcomers to the field. [Aperiodic](#)

[Crystals](#) Ted Janssen, Gervais Chapuis, Marc de Boissieu, 2018 This book explains aperiodic crystals which cannot be described by the classical model of 3 dimensional periodicities. The study of these new types of material necessitates describing them in dimensions larger than three. It describes the physical and mathematical methods to solve and characterize them and to understand their physical properties. **Quasicrystals**, 2007-12-17 This book is aimed at researchers who are working in a field of quasicrystals to provide a reference to recent developments and ideas in the field and also at graduate students who intend to study quasicrystals to provide introduction of ideas. Topics in this book cover an entire field of quasicrystals both experimental and theoretical including new developments, the state of the art in quasicrystallography, new families of quasicrystals, phasons in aperiodic solids, ab initio studies on stability, mechanism, quantum transport phenomena, elastic/plastic properties and surface of quasicrystals. Comprehensive reviews by experts in the field. Complete reference of original papers and new topics. Intelligible introduction of quasicrystals by experts.

*Quasicrystals and Incommensurate Structures in Condensed Matter*, 1990 *Quasicrystals* Christian Janot, 2012-10-18 In 1984 physicists discovered a monster in the world of crystallography: a structure that appeared to contain five fold symmetry axes which cannot exist in strictly periodic structures. Such quasi periodic structures became known as quasicrystals. A previously formulated theory in terms of higher dimensional space groups was applied to them and new alloy phases were prepared which exhibited the properties expected from this model more closely. Thus many of the early controversies were dissolved. In 2011 the Nobel Prize for Chemistry was awarded to Dan Shechtman for the discovery of quasicrystals. This primer provides a descriptive approach to the subject for those coming to it for the first time. The various

practical experimental and theoretical topics are dealt with in an accessible style The book is completed by problem sets and there is a computer program that generates a Penrose lattice Quasicrystals and Incommensurate Structures in Condensed Matter Agostinho Gomes,1990 Geometry and Thermodynamics J.C. Tolédano,2012-12-06 Distinct scientific communities are usually involved in the three fields of quasi crystals of liquid crystals and of systems having modulated crystalline structures However in recent years there has been a growing feeling that a number of common problems were encountered in the three fields These comprise the need to recur to exotic spaces for describing the type of order of the atomic or molecular configurations of these systems Euclidian superspaces of dimensions greater than 3 or 4 dimensional curved spaces the recognition that one has to deal with geometrically frustrated systems and also the occurrence of specific excitations static or dynamic resulting from the continuous degeneracies of the stable structures considered In the view of discussing these problems a NATO Advanced Research Workshop has assembled in Preveza Greece in september 1989 50 experts of the three considered fields with an equal proportion of theorists and experimentalists 35 hours of conferences and discussions have led to a more detailed evaluation of the similarities and of the differences in the approaches implemented in the studies of the three types of systems The papers contained in this NATO series book provide the substance of this workshop The reader will find three types of papers Some very short papers giving the main ideas stated on a subject Papers comprising 8 10 pages which stick closely to the contents of the talks presented Longer papers providing more extensively the background and results relative to a given topic It is worth summarizing the principal outputs of the workshop

*Russian Mathematical Surveys* ,1993 **International Books in Print** ,1990 **Physics Briefs** ,1991 **Aperiodic Crystals** Ted Janssen,Gervais Chapuis,Marc de Boissieu,2018-05-24 Over the past several decades a This book deals with the characterisation of the structure the structure determination and the study of the physical properties especially dynamical and electronic properties of aperiodic crystals The treatment is based on a description in a space with more dimensions than three the so called superspace This allows us to generalise the standard crystallography and to look differently at the dynamics The three main classes of aperiodic crystals modulated phases incommensurate composites and quasicrystals are treated from a unified point of view which stresses similarities of the various systems The book assumes as a prerequisite a knowledge of the fundamental techniques of crystallography and the theory of condensed matter and covers the literature at the forefront of the field Since the first edition of this book in 2007 the field of aperiodic crystals has developed considerably with the discovery of new materials and new structures Progress has been made in structure determination in the interpretation and understanding of the structural characteristics and in the calculation of electrons and phonons This new edition reflects these new developments and it includes discussions of natural quasicrystals incommensurate magnetic and multiferroic structures photonic and mesoscopic quasicrystals The second edition also includes a number of new exercises that give the reader an opportunity to check their understanding of the material **Quasicrystals** Christian Janot,1997 In

1984 physicists discovered a totally unexpected form of matter a structure that appeared to contain five fold symmetry axes which cannot exist in strictly periodic structures that became known as quasicrystals In an effort to understand these structures a theory that employed higher dimensional space groups was conceived enabling the creation of new alloy phases that exhibited the properties expected from this model Now in its second edition Quasicrystals A Primer offers an up to date and accessible introduction to the subject for students approaching it for the first time Providing lively treatments of a range of practical experimental and theoretical topics the book has been completely updated to reflect the latest advances in quasicrystal research and application Helpful problem sets and a computer program that generates a Penrose lattice are included as well Students and researchers in materials science crystallography and condensed matter physics will welcome this new edition of a trustworthy user friendly survey of an important topic in crystallography

**Proceedings of the 5th International Conference on Quasicrystals, Avignon, 22-26 May, 1995** Christian Janot, 1995 Aperiodic Crystals Ted Janssen, Gervais Chapuis, Marc de Boissieu, 2007-05-24 Most materials and crystals have an atomic structure which is described by a regular stacking of a microscopic fundamental unit the unit cell However there are also many well ordered materials without such a unit cell This book deals with the structure determination and a discussion of the main special properties of these materials Incommensurate Crystals, Liquid Crystals, and Quasi-Crystals J.F. Scott, N.A.

Clark, 2012-12-06 In this NATO sponsored Advanced Research Workshop we succeeded in bringing together approximately forty scientists working in the three main areas of structurally incommensurate materials incommensurate crystals primarily ferroelectric insulators incommensurate liquid crystals and metallic quasi crystals Although these three classes of materials are quite distinct the commonality of the physics of the origin and description of these incommensurate structures is striking and evident in these proceedings A measure of the success of this conference was the degree to which interaction among the three subgroups occurred this was facilitated by approximately equal amounts of theory and experiment in the papers presented We thank the University of Colorado for providing pleasant housing and conference facilities at a modest cost and we are especially grateful to Ann Underwood who retyped all the manuscripts into camera ready form J F Scott Boulder Colorado N A Clark v CONTENTS PART I INCOMMENSURATE CRYSTALS A Theory A PHENOMENOLOGICAL THEORY OF THE TRANSITION SEQUENCE INCLUDING AN INCOMMENSURATE COMMENSURATE PHASE SANDWICHED BY REENTRANT COMMENSURATE INCOMMENSURATE PHASE Yoshihiro Ishibashi 1 DAUPHINE TWIN DOMAIN CONFIGURATIONS IN QUARTZ AND ALUMINUM PHOSPHATE M B Walker 9 ELASTIC AND INELASTIC SCATTERING FROM QUASI PERIODIC STRUCTURES T Janssen and R Currat 19 ARE EXOTIC CONSEQUENCES OF INCOMMENSURABILITY IN SOLIDS EXPERIMENTALLY OBSERVABLE J B Sokoloff 35 B Theory Numerical Methods THE APPLICATION OF AXIAL ISING MODELS TO THE DESCRIPTION OF MODULATED ORDER Julia Yeomans 45 TWO DIMENSIONAL MODELS OF COMMENSURATE INCOMMENSURATE PHASE TRANSITIONS Pall D Beale

**Quasicrystals** Enrique Maciá-Barber, 2020-12-17 This book provides an interdisciplinary guide to quasicrystals the 2011 Nobel Prize in Chemistry winning topic by presenting an up to date and detailed introduction to the many fundamental aspects and applications of quasicrystals science It reviews the most characteristic features of the peculiar geometric order underlying their structure and their reported intrinsic physical properties along with their potential for specific applications The role of quasiperiodic order in science and technology is also examined by focusing on the new design capabilities provided by this novel ordering of matter This book is specifically devoted to promoting the very notion of quasiperiodic order and to spur its physical implications and technological capabilities It therefore explores the fundamental aspects of intermetallic photonic and phononic quasicrystals as well as soft matter quasicrystals including their intrinsic physical and structural properties In addition it thoroughly discusses experimental data and related theoretical approaches to explain them extending the standard treatment given in most current solid state physics literature It also explores exciting applications in new technological devices of quasiperiodically ordered systems including multilayered quasiperiodic systems along with 2D and 3D designs whilst outlining new frontiers in quasicrystals research This book can be used as a reader friendly introductory text for graduate students in addition to senior scientists and researchers coming from the fields of physics chemistry materials science and engineering Key features Provides an updated and detailed introduction to the interdisciplinary field of quasicrystals in a tutorial style considering both fundamental aspects and additional freedom degrees provided by designs based on quasiperiodically ordered materials Includes 50 fully worked out exercises with detailed solutions motivating and illustrating the different concepts and notions to provide readers with further learning opportunities Presents a complete compendium of the current state of the art knowledge of quasicrystalline matter and outlines future next generation materials based on quasiperiodically ordered designs for their potential use in useful technological devices Dr Enrique Maci Barber is Professor of condensed matter physics at the Universidad Complutense de Madrid His research interests include the thermoelectric properties of quasicrystals and DNA biophysics In 2010 he received the RSEF BBVA Foundation Excellence Physics Teaching Award His book Aperiodic Structures in Condensed Matter Fundamentals and Applications CRC Press Boca Raton 2009 is one of the Top Selling Physics Books according to YBP Library Services

*Introduction to Quasicrystals* Marko Jaric, 2012-12-02 Aperiodicity and Order Volume 1 Introduction to Quasicrystals deals with various aperiodic types of order in quasicrystals as well as the basic physics of quasicrystalline order and materials Questions about the nature of order and the order of nature are addressed This volume is comprised of six chapters the first of which introduces the reader to icosahedral coordination in metallic crystals with emphasis on the structural principles of metallic materials that are crystalline and may be expected to carry over to aperiodic materials The discussion then turns to short and long range icosahedral orders in glass crystals and quasicrystals The origins of icosahedral order are explained and the physical properties of icosahedral materials are described The chapters that follow focus on the

metallurgy of quasicrystals the crystallography of ideal icosahedral crystals and stability and deformations in quasicrystalline solids The book concludes with a discussion on symmetry elasticity and hydrodynamics in quasiperiodic structures A pedagogical review of continuum elastic hydrodynamic theory for quasicrystals and related structures is presented This book is intended primarily as an introduction for new students in the field and as a reference for active researchers

**Incommensurate Crystals, Liquid Crystals, and Quasi-Crystals** J.F. Scott, N.A. Clark, 2012-05-29 In this NATO sponsored Advanced Research Workshop we succeeded in bringing together approximately forty scientists working in the three main areas of structurally incommensurate materials incommensurate crystals primarily ferroelectric insulators incommensurate liquid crystals and metallic quasi crystals Although these three classes of materials are quite distinct the commonality of the physics of the origin and description of these incommensurate structures is striking and evident in these proceedings A measure of the success of this conference was the degree to which interaction among the three subgroups occurred this was facilitated by approximately equal amounts of theory and experiment in the papers presented We thank the University of Colorado for providing pleasant housing and conference facilities at a modest cost and we are especially grateful to Ann Underwood who retyped all the manuscripts into camera ready form J F Scott Boulder Colorado N A Clark v

CONTENTS PART I INCOMMENSURATE CRYSTALS A Theory A PHENOMENOLOGICAL THEORY OF THE TRANSITION SEQUENCE INCLUDING AN INCOMMENSURATE COMMENSURATE PHASE SANDWICHED BY REENTRANT COMMENSURATE INCOMMENSURATE PHASE Yoshihiro Ishibashi 1 DAUPHINE TWIN DOMAIN CONFIGURATIONS IN QUARTZ AND ALUMINUM PHOSPHATE M B Walker 9 ELASTIC AND INELASTIC SCATTERING FROM QUASI PERIODIC STRUCTURES T Janssen and R Currat 19 ARE EXOTIC CONSEQUENCES OF INCOMMENSURABILITY IN SOLIDS EXPERIMENTALLY OBSERVABLE J B Sokoloff 35 B Theory Numerical Methods THE APPLICATION OF AXIAL ISING MODELS TO THE DESCRIPTION OF MODULATED ORDER Julia Yeomans 45 TWO DIMENSIONAL MODELS OF COMMENSURATE INCOMMENSURATE PHASE TRANSITIONS Paul D Beale

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