



# Magnetic Phase Transitions and Magnetoelastic Coupling in a Two-Dimensional Stripy Antiferromagnet

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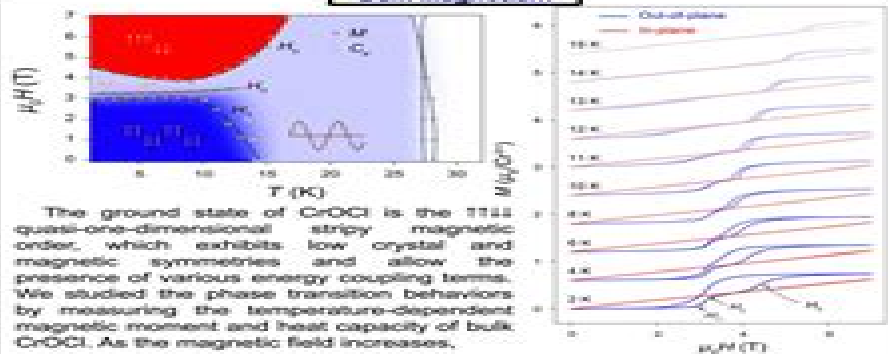
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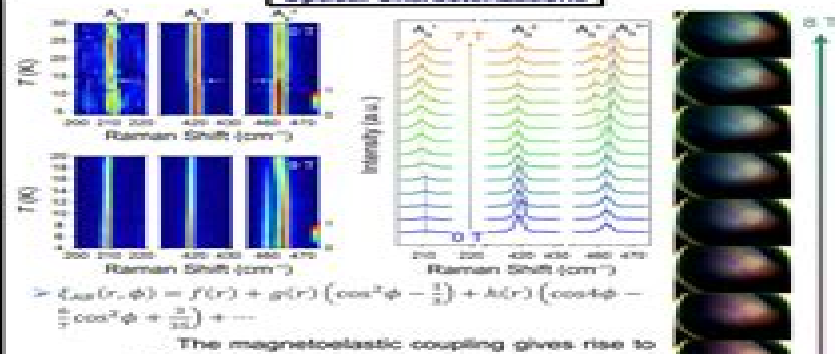
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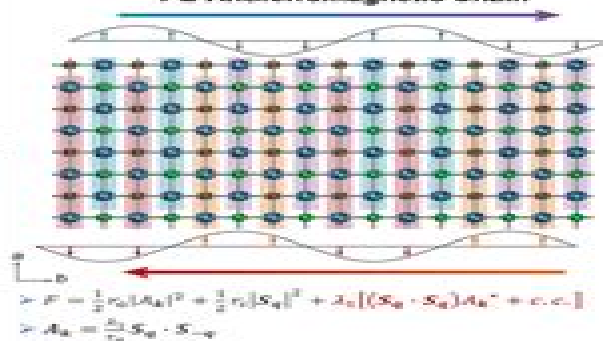
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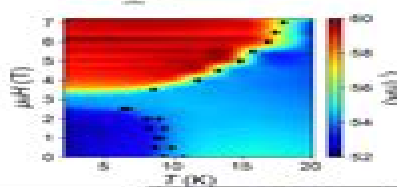
## Optical Characterizations



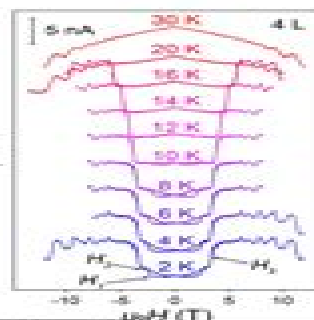
## 1-D Antiferromagnetic Chain



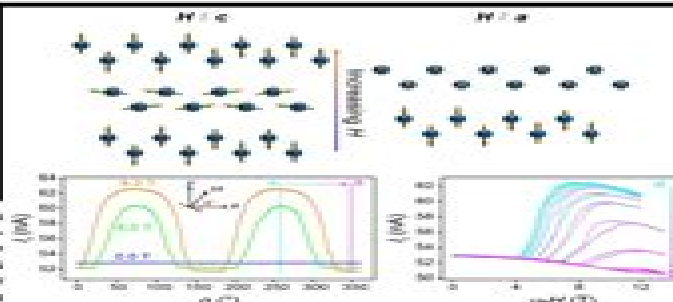
Tunneling magnetoresistance is another sensitive probe to detect the magnetic phase transitions and structural transitions in ultra-thin magnets. We constructed the phase diagram of a 4-L CrOCl sample using the tunneling current data, confirming the persistence of magnetic order and magnetoelastic coupling in 2D limit.



## Tunneling Magnetoresistance



DFT shows that the single-ion anisotropy makes the  $a$ -axis the secondary easy axis. When



the external field is rotated in the  $ab$ -plane of the sample, the tunneling current shows exactly 180° periodic symmetry, implying the  $C_2$  in-plane symmetry of CrOCl. The external field along the  $a$  axis drives the system into the collinear 1111 phase where the spins point towards along  $a$ . The remarkable in-plane anisotropic magnetic field response is a compelling evidence for the stripy antiferromagnetic order of CrOCl, which has been proved to be the physical origin of numerous fantastic quantum phenomena.

$$H = \sum_{i,j} J_{ij} (S_i \cdot S_j + 2 S_i^z S_j^z) - D \sum_i (S_i^z)^2 - g \mu_B \sum_i \mathbf{H} \cdot \mathbf{S}_i$$

CrOCl	Lattice constant (Å)			Exchange Parameters (meV/Cr)					
AA-BB-Tell	a	b	c	$J_{ab}$	$J_{bc}$	$J_{ac}$	$D_a$	$D_b$	$D_c$
bulk	3.89	3.20	7.68	0.059	0.061	0.060	0.043	0	0.045

## Anisotropy

## Summary and Reference

We verified the magnetoelastic coupling effect in exfoliated CrOCl by Raman spectroscopy and investigated the magnetism of few-layer CrOCl by tunneling magnetoresistance. Combining the characterization results with first-principle calculations, we uncovered the multi-step magnetic phase transitions under the external field along the easy axis down to 2D limit. Our findings not only advance the understanding of this unexplored promising material, but also reveal the rich physics and potential for spintronic devices of magnetoelastic materials.

[1] Nano Letters 22, 3 (2022).

# Magnetic Phase Transitions

**Ausloos M.**



## **Magnetic Phase Transitions:**

Magnetic Phase Transitions, 1983      **Magnetic Phase Transitions In Single Crystals** David P Belanger, 2022-07-27

Magnetic crystals are ideal systems to study the universal properties of phase transitions particularly systems with quenched randomness and frustration Pure systems with different symmetries provide the foundation for studies in corresponding systems with quenched randomness Because phenomena near phase transitions have universal properties results from bulk magnetic crystals provide a basis for understanding phase transitions in films and nanoparticles as well as many non magnetic materials This motivates the subject of this book which discusses phase transitions studies in magnetic crystals from the perspective of an experimentalist who has done extensive work in the field The advantage is that many experimental techniques are described in sufficient detail for a good understanding of the results and their comparison to theory

**High-field Magnetic Phase Transitions** Maurits Willem van Tol, 1972      **Magnetic Phase Transitions** M.

Ausloos, R.J. Elliott, 2012-12-06 The present volume contains the courses given at a Summer School on Magnetic Phase Transitions held at the Ettore Majorana Centre for Scientific Culture at Erice Trapani Italy in July 1983 under the auspices of the Condensed Matter Division of the European Physical Society in their series on Materials Science and Technology The student participants came from West Germany Great Britain Brazil Greece Switzerland Sweden Italy USA and The Netherlands The lecturers came from various European countries Israel USA and Canada The atmosphere at the meeting was excellent and a good spirit of companionship developed during two weeks of working together The spread of interests among the lecturers and students was diversified but balanced The main lecturing contributions are reported in this volume They represent up to date reviews in a pedagogical style In addition informal presentations on current research interests were made which have not been included The school attempted to summarize the current position on the properties of magnetic phase transitions from several points of view The range and scope of the theoretical techniques and of particular aspects of materials or phenomena as observed experimentally were very well put forward by the lecturers The grouping of manuscripts in chapters does not represent however the schedule followed during the school Contributions on mean field approximations and renormalization group methods either for static or dynamic phenomena can be found at various places in the following sections      Structural and Magnetic Phase Transitions in Minerals S. Ghose, J.M.D. Coey, E. Salje, 2012-12-06

This volume in Advances in Physical Geochemistry presents the latest synthesis of theory and experimental data pertaining to structural and magnetic phase transitions in a variety of geochemically important minerals The book is the first to cover the impact of this rapidly progressing area of solid state physics in earth sciences and reflects its growing significance for mineralogy and petrology      **Tabulation of First Order Magnetic Phase Transitions** Charles S. Naiman, Robert Gilmore, MITHRAS INC CAMBRIDGE MASS., 1963 A literature search has been carried out and a tabulation has been made of all known first order magnetic phase transitions The table includes all substances which have been found to undergo such

phase transitions and their relevant characteristics have been studied The search has been conducted up to July 1963 One kind of transition the so called spin flopping type exists for a very large class of materials Since it can be characterized analytically in terms of other parameters of these materials it was felt preferable to give a discussion of this transition rather than an exhaustive literature search In order to properly guide the nature of the search a definition of first order magnetic phase transitions is formulated in terms of familiar thermodynamic quantities Some of the implications of this definition are discussed An example of a first order magnetic phase transition is discussed AF spin flop and characterized by three parameters anisotropy energy and parallel and perpendicular susceptibilities Author Magnetic Phase Transitions (Volume 48) Ausloos M.,1983 Structural and Magnetic Phase Transitions in Minerals S. Ghose,J.M.D. Coey,E. Salje,2011-12-06

High-field magnetic phase transitions Tol Maurits Willem van Nieuwenhuise,1972 An Unusual Series of Magnetic Phase Transitions in  $\text{EuNi}_5\text{P}_3$  John Victor Badding,1989 **Effects of Pressure on Magnetic Phase Transitions** Vishnu Chandra Srivastava,1969 Magnetic Resonance of Phase Transitions Frank J. Owens,Charles P. Poole,Horacio A. Farach,2013-10-22 Magnetic Resonance of Phase Transitions shows how the effects of phase transitions are manifested in the magnetic resonance data The book discusses the basic concepts of structural phase and magnetic resonance various types of magnetic resonances and their underlying principles and the radiofrequency methods of nuclear magnetic resonance The text also describes quadrupole methods the microwave technique of electron spin resonance and the Mossbauer effect Phase transitions in various systems such as fluids liquid crystals and crystals including paramagnets and ferroelectrics are also considered Physicists and scientists working in energetic materials laboratories will find the book invaluable

Magnetic Phase Transitions at Low Temperatures John Edgar Rives,1972 Integral Systems, Solid State Physics and Theory of Phase Transitions V. V. Dodonov,Vladimir Ivanovich Man'ko,1991 **The Physics of Phase Transitions** Pierre Papon,Jacques Leblond,Paul H.E. Meijer,2007-07-27 This book occupies an important place at the crossroads of several fields central to materials sciences The expanded second edition incorporates new developments in the states of matter physics and includes end of chapter problems and complete answers **Magnetic Phase Transitions** Yamada Kagaku Shinkō Zaidan,1990 Magnetic Phase Transitions in Epitaxial  $\text{Fe}$ ,1995 Experimental Investigations of Magnetic Phase Transitions James Alexander Brug,1984 **Magnetic Phase Transitions in Chromium and Gadolinium** John Thomas Stocke,1968 **Magnetic Phase Transitions** Marcel Ausloos,Roger J. Elliott,1983 The present volume contains the courses given at a Summer School on Magnetic Phase Transitions held at the Ettore Majorana Centre for Scientific Culture at Erice Trapani Italy in July 1983 under the auspices of the Condensed Matter Division of the European Physical Society in their series on Materials Science and Technology The student participants came from West Germany Great Britain Brazil Greece Switzerland Sweden Italy USA and The Netherlands The lecturers came from various European countries Israel USA and Canada The atmosphere at the meeting was excellent and a good spirit of companionship developed during two weeks of

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