# INTERNATIONAL SCHOOL AND WORKSHOP ON ELECTRONIC CRYSTALS ECRYS-2020 TERMINUS

http://lptms.u-psud.fr/ecrys2020/

August 17-29, 2020

Institut d'Etudes Scientifiques de Cargèse, Corse, France.


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# Charge density wave,  mon amour

Pierre Monceau

*1950 Peierls instability*

*Fröhlich theory of superconductivity*

*1960 SDW in chromium*

*1972 CDW in transition dichalcogenides*

*Peierls transition in 1D materials*

*1976 Sliding CDW*

*1980 Organic superconductivity*

High Tc tsunami

# Some events in the 1970-1980 decade

1972 Watergate

1973 UK becomes member of the EU

1974 first barecode in an American supermarket

1975 end of the Vietnam war

1976 severe drought in France

1977 first starwar movie

1979 Iran revolution

1981 AID pandemy

PHYSICAL REVIEW VOLUME 128, NUMBER 3 NOVEMBER 1, 1962

# Spin Density Waves in an Electron Gas

A. W. OVERHAUSER
*Scientific Laboratory, Ford Motor Company, Dearborn, Michigan*
(Received June 11, 1962)

Chromium was found antiferromagnetic by Shull and Wilkinson in 1953 as a result of a neutron-diffraction experiment

The theory of the SDW state is founded on the work of Overhauser,[11] who showed that the paramagnetic state of an electron gas with a uniform background of positive charge, when treated in the Hartree-Fock approximation, was unstable with respect to the formation of a static spin-density wave. Overhauser pointed to the magnetism of chromium as an example of the SDW state,

The origin of the SDW in chromium, as first understood by Overhauser,[28,29] lies in the pairing of electrons with holes of opposite spin. The pairing is between momentum states separated by **Q**. When **Q** is a vector that "nests" the electron and hole Fermi surfaces, the total electronic energy is lowered and a spiral-density wave results. The ground state is formed from two spiral waves of opposite helicity, resulting in the linearly polarized SDW. For pure chromium, the nesting vector is incommensurate with the lattice and $Q=(1\pm\delta)2\pi/a$ where $a=2.88$ Å. The period of the SDW modulation is $\approx 27$ lattice constants at $T_N$.[30]

# On the theory of superconductivity: the one-dimensional case

By H. Fröhlich, F.R.S.

*Department of Theoretical Physics, University of Liverpool*

(*Received* 1 *December* 1953)

The one-dimensional case of free electrons interacting with lattice displacements is solved by a self-consistent method. It is found that for a certain range of the interaction parameter a single sinusoidal lattice displacement is strongly excited in the lowest level of the system. Its wave-length is such as to create an energy gap in the single-electron energy spectrum with all states below it filled, and all above it empty. This periodic lattice displacement plays the role of an 'inner field' and leads to periodic fluctuation in the electronic density in such a way that the two stabilize each other. In an infinite medium described by a periodic boundary condition they are not fixed absolutely in space, but only relative to each other. Excitation of electrons across the gap leads to a decrease in both the electronic density fluctuations and the width of the gap.

The whole system, electrons plus lattice displacements, can move through the lattice without being disturbed provided the velocity $v$ is sufficiently small. The inertia of this system is equal to that of all electrons augmented by a term due to the lattice displacements. Elastic scattering of individual electrons which normally leads to the residual resistance is impossible if $v$ is sufficiently small. The linear specific heat of normal electrons is eliminated and replaced by an exponential term.

VOLUME 14, NUMBER 7 PHYSICAL REVIEW LETTERS 15 FEBRUARY 1965

# SUPERCONDUCTIVITY IN GRAPHITIC COMPOUNDS

N. B. Hannay, T. H. Geballe, B. T. Matthias,* K. Andres, P. Schmidt, and D. MacNair
Bell Telephone Laboratories, Murray Hill, New Jersey
(Received 20 January 1965)

Superconductivity in intercalation compounds of graphite with alkali metals:

$C_8K$ $T_c \approx 0.15K$ but no superconductivity in $C_8Li$

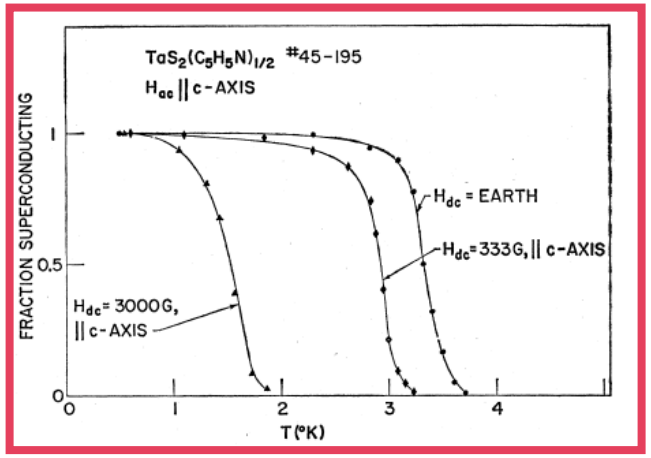
now $C_6Yb$ ↑ $T_c = 6.5K$, $C_6Ca$ ↑ $T_c = 11.5K$

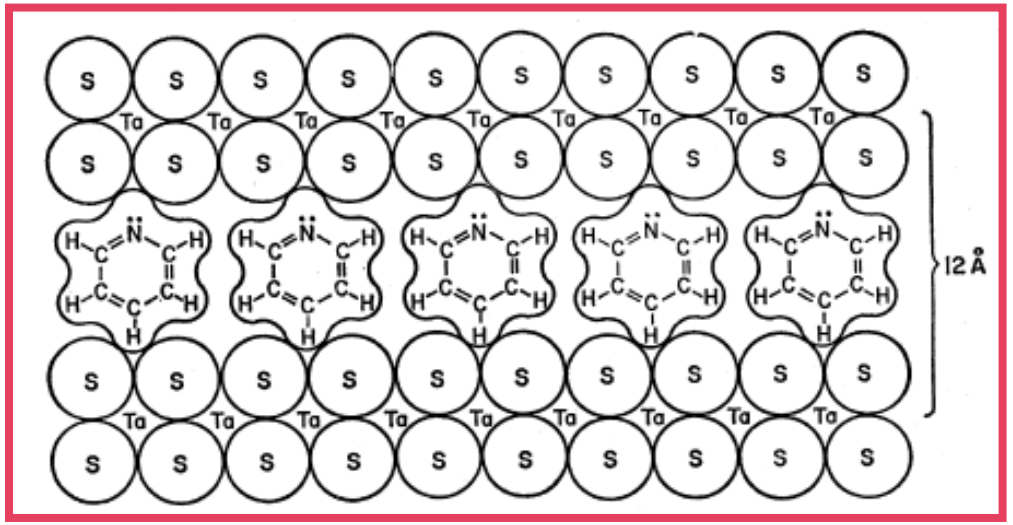
# Superconductivity in Layered Structure Organometallic Crystals

F. R. Gamble; F. J. DiSalvo; R. A. Klemm; T. H. Geballe

*Science*, New Series, Vol. 168, No. 3931. (May 1, 1970), pp. 568-570.

**Abstract.** *Superconductivity persists in several, layered, transition metal dichalcogenide superconductors when the layers are spread apart to accommodate organic molecules between them. These materials are of interest not only because of their two-dimensional character but also because they may provide a means for examining hypotheses regarding organic molecules and superconductivity.*



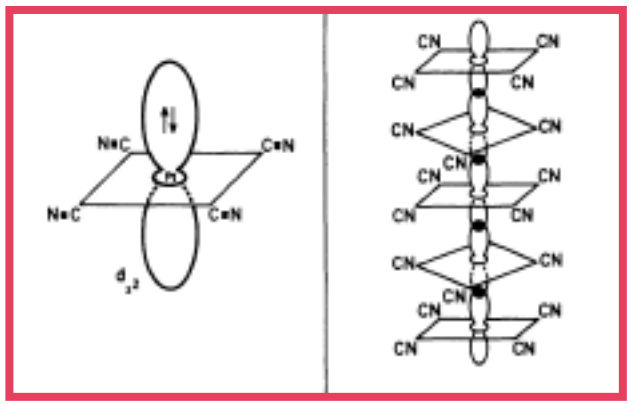



PHYSICAL REVIEW B VOLUME 8, NUMBER 2 15 JULY 1973

# Evidence for a Peierls Distortion or a Kohn Anomaly in One-Dimensional Conductors of the Type $K_2Pt(CN)_4Br_{0.30} \cdot xH_2O$

R. Comès, M. Lambert, and H. Launois
*Laboratoire de Physique des Solides,* Bâtiment 510, Université Paris-Sud, Centre d'Orsay*
*91405-Orsay, France*

H. R. Zeller
*Brown Boveri Research Center, CH-5401 Baden, Switzerland*
(Received 4 December 1972)



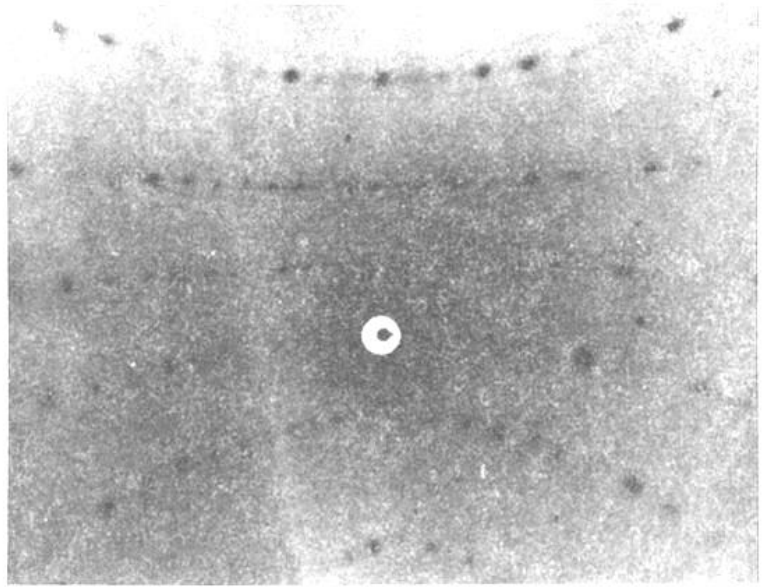



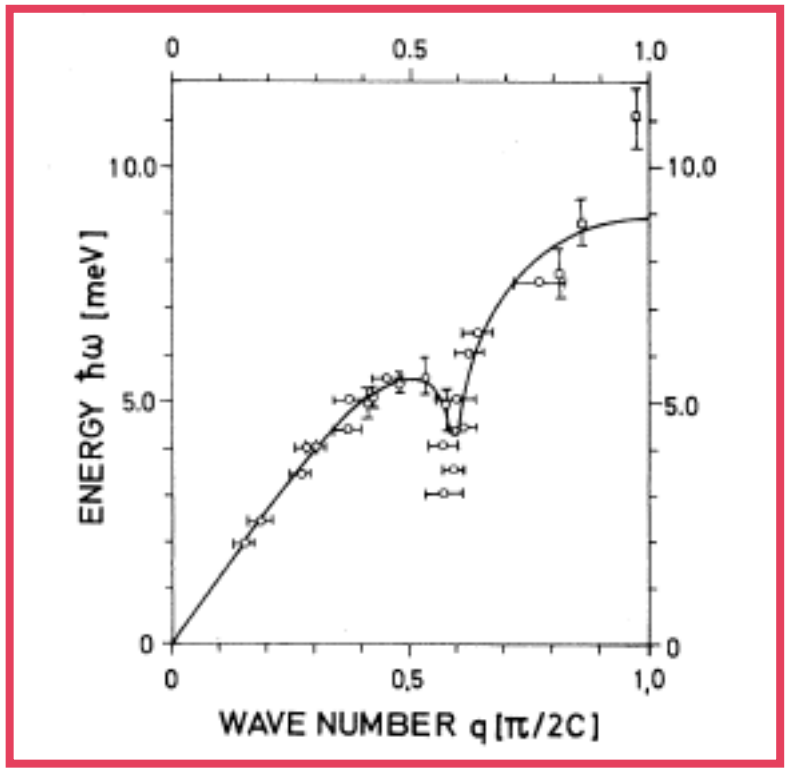
FIG. 6. X-ray diffuse scattering from $K_2Pt(CN)_4Br_{0.30} \cdot x\,H_2O$ with $MoK\alpha$ monochromatic radiation. The film holder is a flat camera, and the crystal was oriented with its $c$ axis tilted 15° from the vertical, around a horizontal axis.

# Observation of Giant Kohn Anomaly in the One-Dimensional Conductor $K_2Pt(CN)_4Br_{0.3} \cdot 3H_2O$

B. Renker, H. Rietschel, L. Pintschovius, and W. Gläser
*Institut für Angewandte Kernphysik, Kernforschungszentrum Karlsruhe, 75 Karlsruhe, Germany*

and

P. Brüesch, D. Kuse, and M. J. Rice
*Brown Boveri Research Center, CH-5401 Baden, Switzerland*
(Received 19 March 1973)




*Renker et al., Phys. Rev. Lett. 30 (1973) 1144*

# Precursor Effects of Superconductivity up to 35°K in Layered Compounds*

T. H. Geballe
*Stanford University, Stanford, California 94305, and Bell Laboratories, Murray Hill, New Jersey 07974*

and

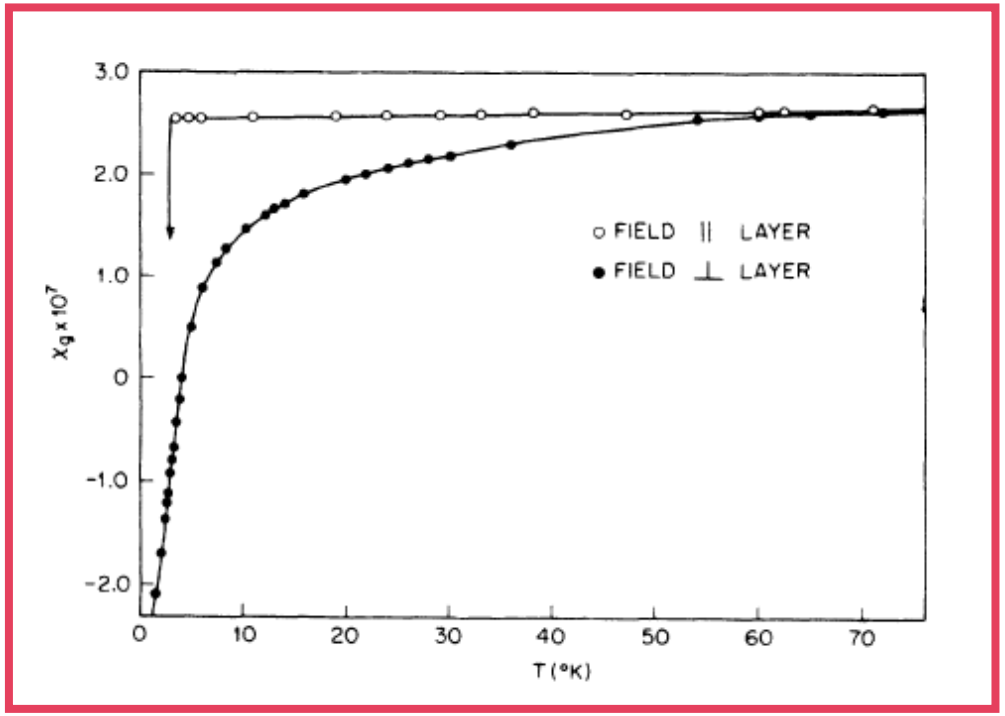
A. Menth
*Bell Laboratories, Murray Hill, New Jersey 07974*

and

F. J. Di Salvo†
*Stanford University, Stanford, California 94305*

and

F. R. Gamble
*Syva Research Institute, Palo Alto, California 94304*
(Received 2 June 1971)



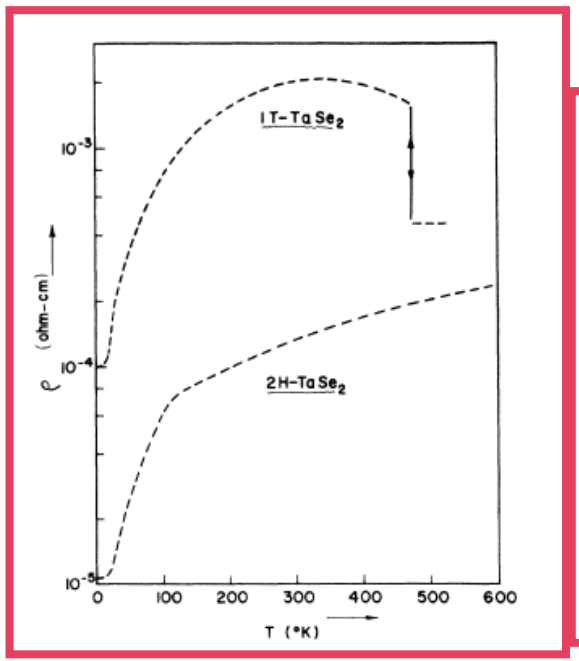

*Geballe et al., Phys. Rev. Lett. 27 (1971) 314*

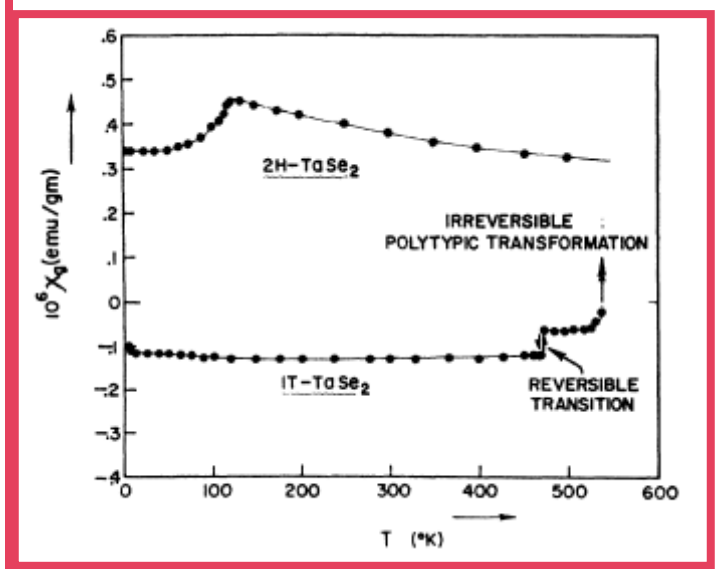
VOLUME 32, NUMBER 16 PHYSICAL REVIEW LETTERS 22 APRIL 1974

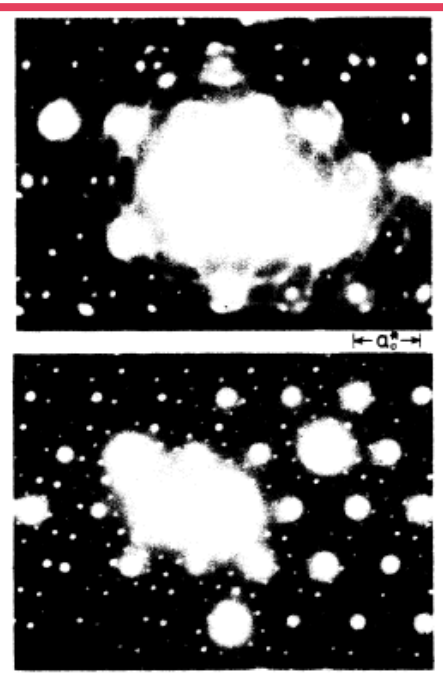
# Charge-Density Waves in Metallic, Layered, Transition-Metal Dichalcogenides

J. A. Wilson, F. J. Di Salvo, and S. Mahajan
*Bell Laboratories, Murray Hill, New Jersey 07974*
(Received 4 December 1973)

The previously termed "anomalous" properties of the various polytypes of $d^1$ $TaS_2$, $TaSe_2$, etc. are attributed to charge-density waves, their periodic structure distortions, and the superlattices they induce.



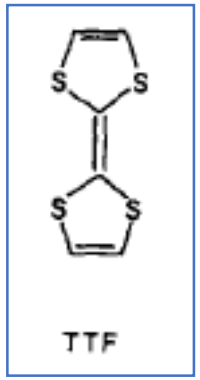
# SUPERCONDUCTING FLUCTUATIONS AND THE PEIERLS INSTABILITY IN AN ORGANIC SOLID*

L.B. Coleman, M.J. Cohen, D.J. Sandman, F.G. Yamagishi, A.F. Garito and A.J. Heeger

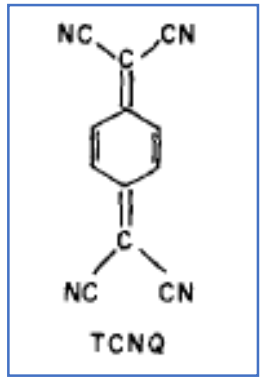
Department of Physics and Laboratory for Research on the Structure of Matter, University of Pennsylvania, Philadelphia, Pennsylvania 19174, U.S.A.

(*Received* 20 *February* 1973 *by E. Burstein*)

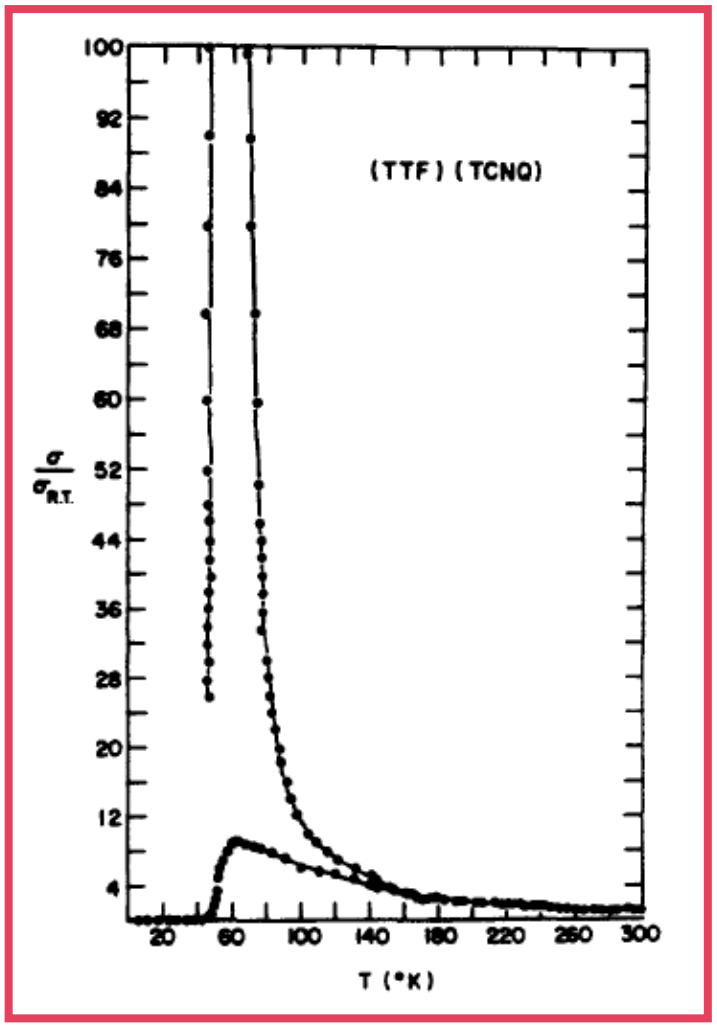
The discovery of extraordinary conductivity maxima in a class of organic charge transfer salts is reported. The data are interpreted as resulting from superconducting fluctuations at high temperatures. A possible mechanism for achieving high temperature superconductivity is suggested based on the electron–phonon interaction, in the strong-coupling limit, and the Peierls soft-mode instability in pseudo-one-dimensional systems. Procedures are suggested for the possible eventual stabilization of the superconducting state.




TTF




TCNQ




*Coleman et al., Solid St. Com. 12 (1973) 1125*

# Incommensurate phases in dielectrics

$A_2BX_4$ *family*

*Biphenyl*

$NaNO_2$

$\beta$-$ThBr_4$

*Quartz*

$K2SeO_4$

*Soft mode*

*Solitons*

*Phasons-amplitudons*

*Devil's staircase*

*Ferroelectric transition*

*Discommensurations*

*Lock-in transition*

# Predominant role of chemists in the synthesis of low dimensional materials

Garito, MacDiarmind

Fabre, Bechgaard

Rouxel, Meerschaut

Cassous, Valade

and many others

Many bulk properties of CDW's can be qualitatively understood within the Fukuyama-Lee-Rice model. This model treats the CDW as an elastic medium that interacts with impurities by adjusting its phase. In most CDW conductors, the CDW phase is weakly pinned, which means that the phase is only partly adjusted at the impurities. In this case, the phase-coherence length can be of the order of micrometers along the chains.

Conferences on **Physics in One Dimension** :Saarbrücken (1974), Siofok (1976), Dubrovnik (1978), Helsingor(1980)

Topics: *disorder and localisation, lattice dynamics, magnetic chain systems, conducting polymers and quasi- 1D*

**Nato Conferences**
-Electron-phonon interactions and phase trnsitions (1977)
Topics: *Central peak, Jahn-Teller distortions, solitons, A15*

- The Physics and Chemistry of low-dimensional solids, Tomar Portugal 1979

-Low dimensional conductors and superconductors (1987)

-Physics and Chemistry of low-dimensional inorganic conductors, Les Houches (1995)
*Luttinger liquids, molybdenum and tungsten bronzes,…*

**Yamada Conference** Lake Kawaguchi (Japan) (1986) Physics and chemistry of quasi-one-dimensional conductors
*CDW dynamics, superconductivity, SDW, crystal structure, synthesis and technonolical applications*

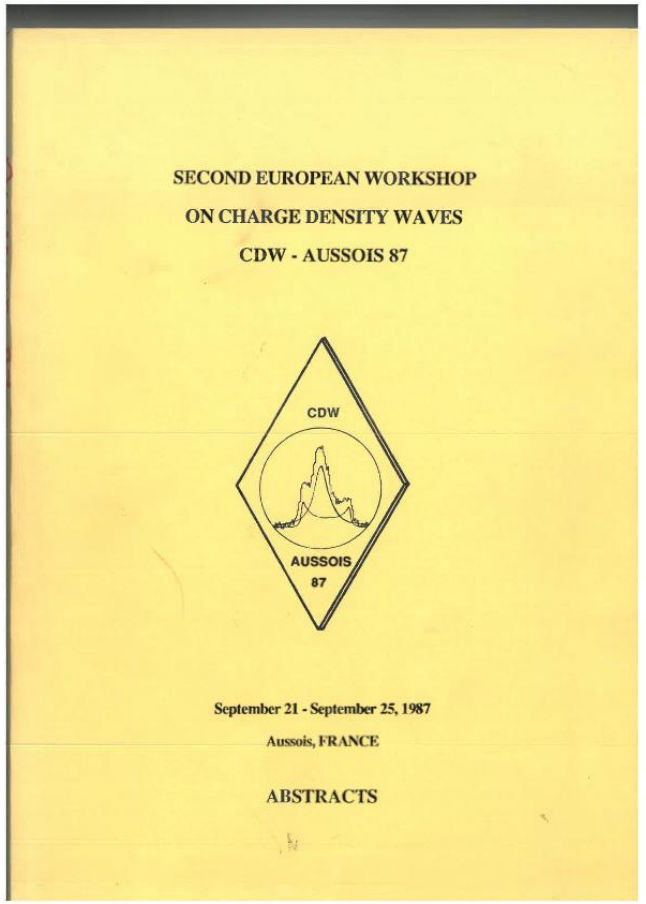
Problems related to conducting polymers and technological applications will be treated in International Conference on science and technology of synthetic metals **(ICSM**)

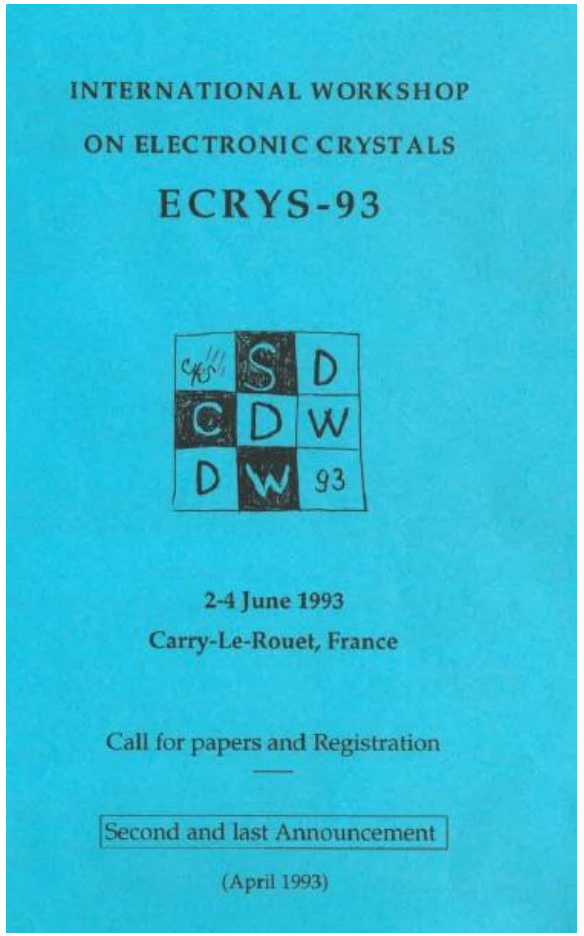
**ISCOM** International Symposium on crystalline organic metals, superconductors and ferromagnets.
The ISCOM is a conference series in the field of conducting, magnetic, and dielectric molecular crystals

European workshop on charge density waves

The first one: Zagreb in 1975

The second one at Aussois in 1987




The third one at Dubrovnik in 1978 ( TTF-TCNQ, doped polyacetylene, polymers $(SN)_x$

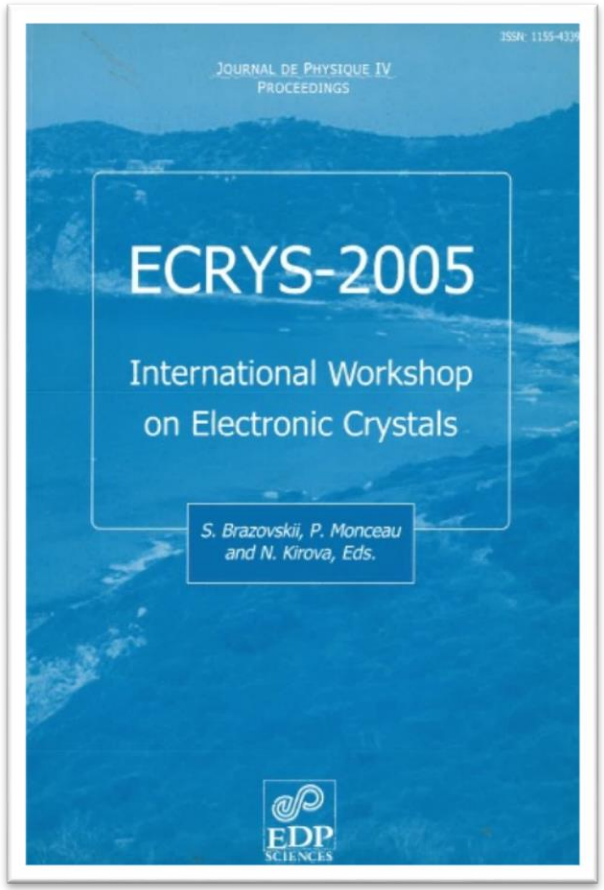
# ECRYS

Ecrys workshops intend to provide a crosslink between various communities engaged in parallel studies of spontaneous superstructures formed by electrons, vortex,…

1987  Aussois
1993 Carry le Rouet
1999 La Colle sur Loup
2002 Saint Flour

Cargèse 2005, 2008
2011 first summer school + tutorials , 2014,
2017 and finally 2022

Representatives of such electronic crystals are charge and spin density waves in low-dimensional materials, Wigner crystals, stripe phases including high Tc superconductors, various forms of charge order in organic one- and -two dimensional materials and ferroelectricity , charge colloidal crystals, vortex lattices in superconductors, domain walls in magnetic and ferroelectric materials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ECRYS-2005
International Workshop
on Electronic Crystals
S. Brazovskii, P. Monceau
and N. Kirova, Eds.
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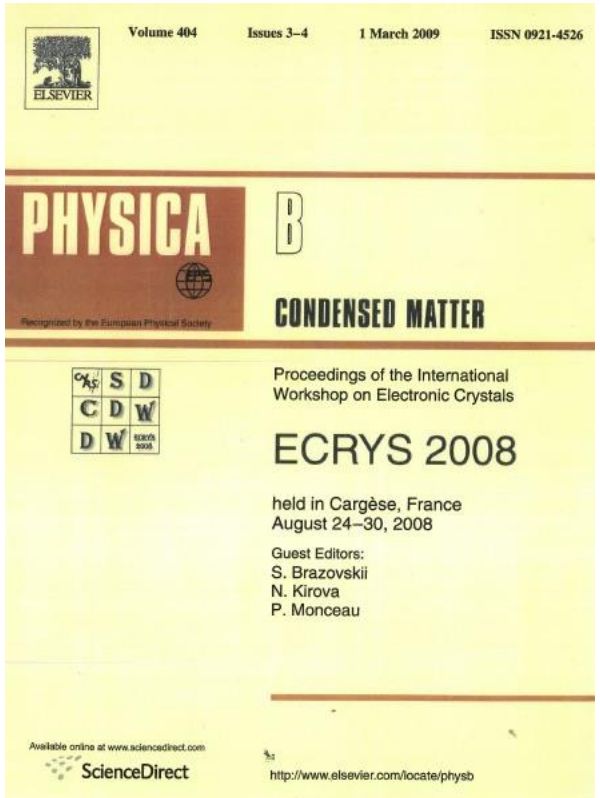
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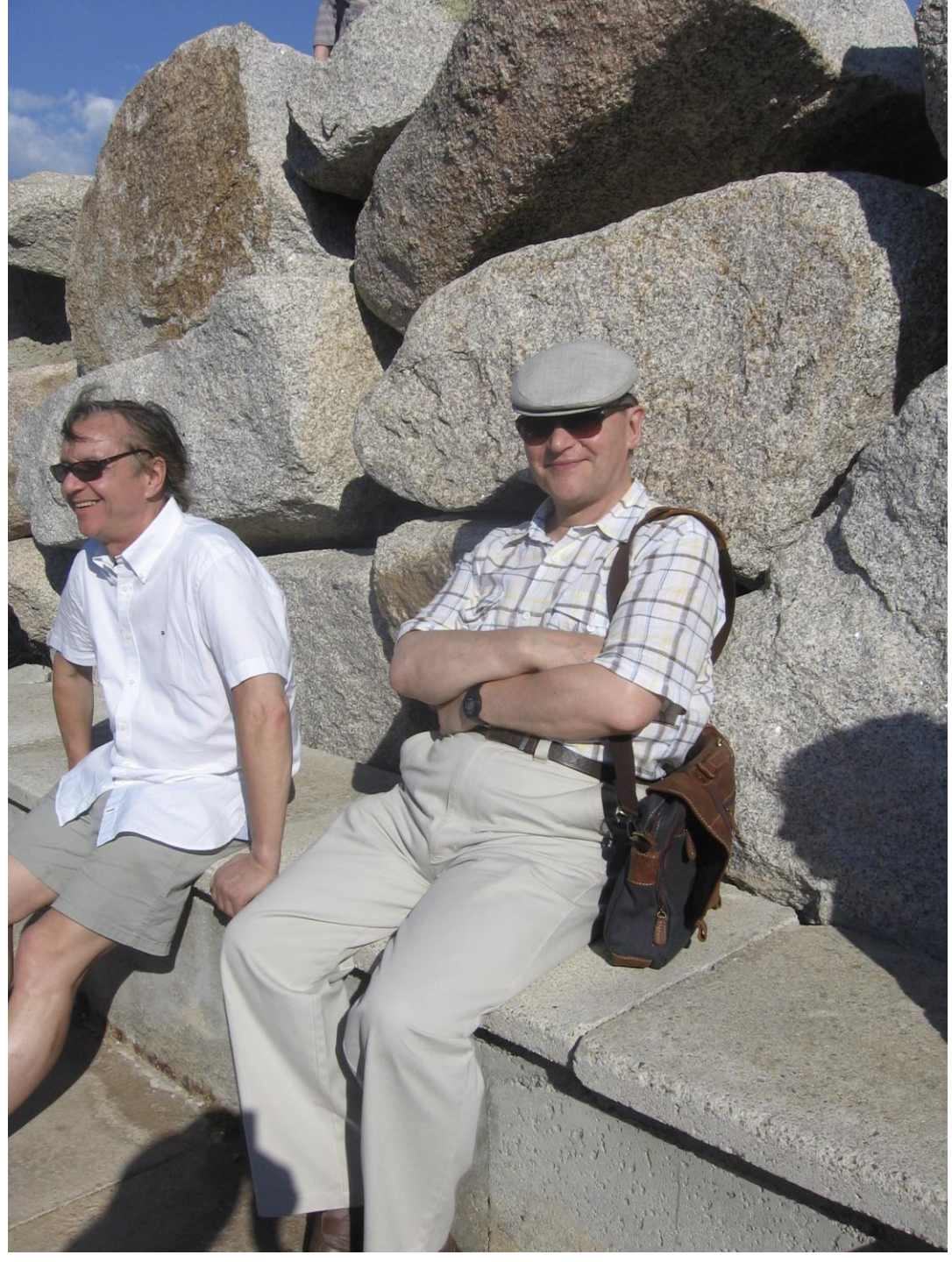
S. Brazovskii
N. Kirova
P. Monceau
Available online at www.sciencedirect.com
ScienceDirect
http://www.elsevier.com/locate/physb

2008

2011

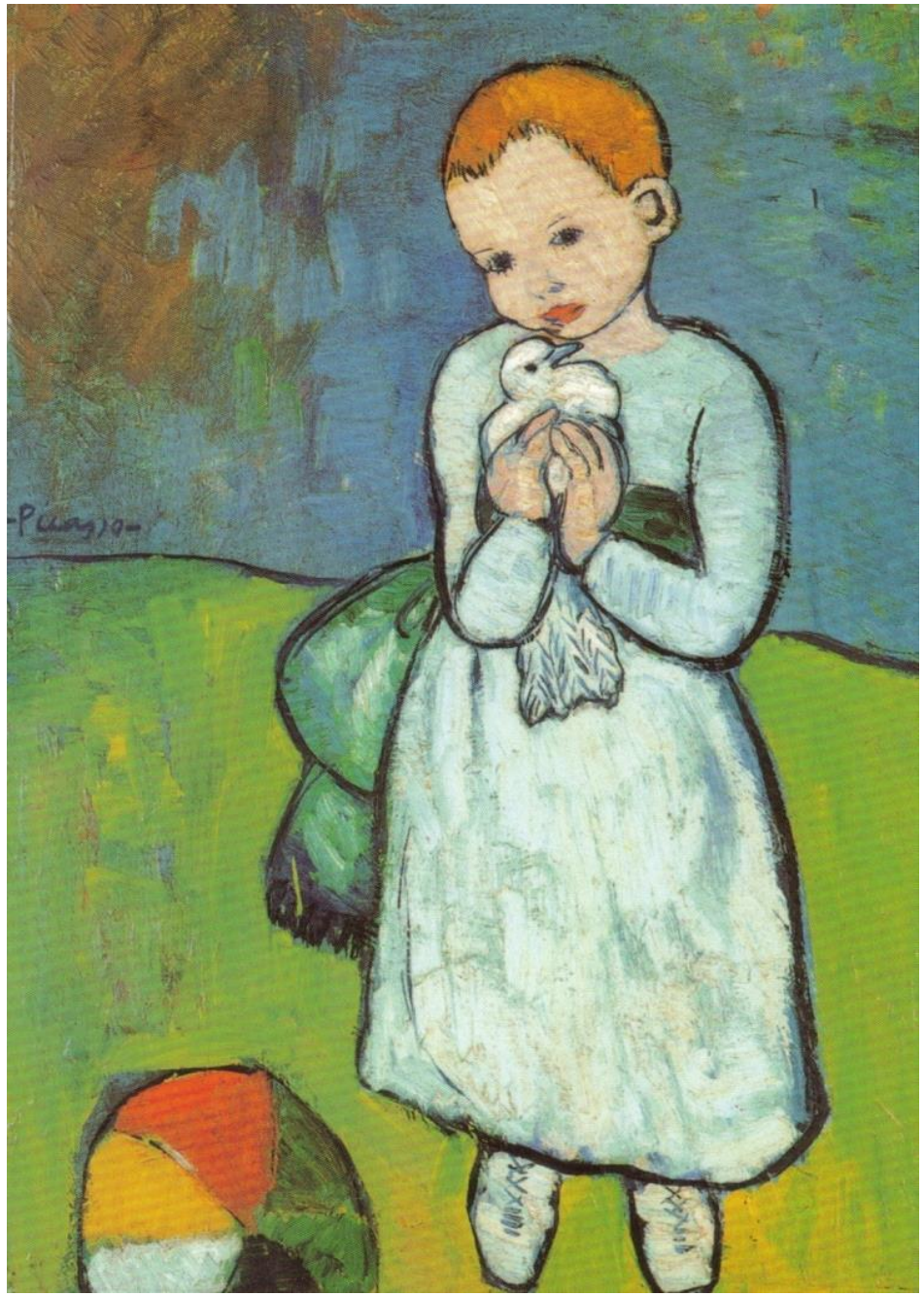
2011


14/01/08



# Orientations

Properties of CDW single layer and twisted layers
Moiré CDW
Fast time-resolved probes such as femtosecond optics, ARPES and X-ray diffraction
Electrostatic doping
chirality
……



# L’onde soltaire

Publishing House: « Le Verbe et l’Empreinte »  (Saint Laurent du Pont, Isère)


Marc Pessin

Peintre et graveur, Marc Pessin s'est d'abord fait connaître par son travail autour de l'écrit. " Sculpteur sur papier" selon Alain Bosquet, il a, depuis plus de cinquante ans, édité ou illustré de très nombreux écrivains et artistes, de Léopold Sédar Senghor à Jean-Pierre Chambon. Michel Butor, Andrée Chedid, François Cheng, Georges-Emmanuel Clancier, Paul Eluard, Guillevic, Pierre Péju, etc. De ces rencontres sont nés des livres, dialogues entre l'artiste et les auteurs, objets qui rendent tangibles et amplifient la parole des poètes. L'abstraction, le graphisme des lignes et des courbes, la pureté du métal, la minéralité des encres ou encore la sobriété d'un gaufrage caractérisent cette œuvre et fondent sa singularité. Tour à tour peintre, calligraphe, archiviste, archéologue, naturaliste, cet artiste insaisissable multiplie les approches et les formes d'expression. Le graveur nous entraîne dans son imaginaire fascinant, un univers infini et riche de sens.