

HIGH MAGNETIC FIELD RESEARCH

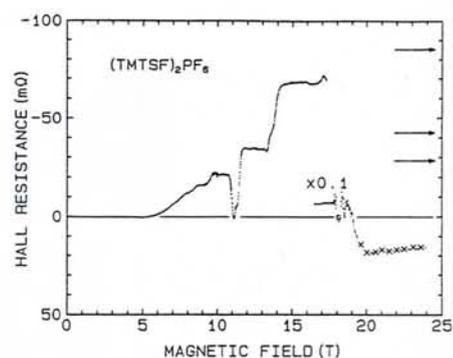
Field Induced Phase Transitions in Quasi One-Dimensional Metals

Bechgaard Salts are members of the tetramethyl-tetraselenafulvalenium family, denoted as $[(TMTSF)_2X]$, and crystals of this material for different compounds X are made of linear conducting chains with a weak coupling between the chains. Consequently, the conduction bandstructure is highly anisotropic, *i.e.*, the bands are almost completely flat in the *c*-direction, slightly dispersive in *b*-direction and almost free-electron like in the third *a*-direction. The

Fermi surface resembles therefore a set of slightly warped, almost parallel sheets.

When a magnetic field is applied parallel to the *c*-direction, carriers moving in the *a*-*b* plane cannot describe a closed orbit on this Fermi surface, and the only possible movement is along the sheet of the Fermi-surface in one or in the opposite direction.

It has been shown theoretically that the application of a magnetic field to such systems effectively makes the carrier motion



The Hall resistance at 0.5 K as a function of the magnetic field along the *c*-axis for a $(TMTSF)_2PF_6$ single crystal using different contact points. The quantized values of $h/2ne^2$ are marked on the right [Cooper J.R. *et al.*, *Phys. Rev. Lett.* **63** (1989) 1984].

NORDITA

Copenhagen

Two Assistant Professorships

NORDITA, the Nordic Institute for Theoretical Physics, has two openings for Assistant Professors starting in September 1992, or some other date to be agreed upon.

One of the positions will be in frontier areas of strong interaction physics. This is intended to contain nuclear structure, physics of hadrons, of quark degrees of freedom in nuclei, and of quark gluon plasmas, as well as the study of quantum chromodynamics in the confinement region.

The other position will be in frontier areas of condensed matter physics, statistical physics, nonlinear physics and related areas, including the theory and simulation of complex systems.

NORDITA is supported by the five Nordic countries — Denmark, Finland, Iceland, Norway and Sweden — and the Institute is located in Copenhagen, on the premises of the Niels Bohr Institute of Copenhagen University. Research at the Institute is at present carried out mainly in astrophysics and cosmology, complex systems (including neural nets), condensed matter physics, elementary particle physics and nuclear physics. There are thus good opportunities to carry out cross disciplinary studies. The scientific staff includes six positions as permanent professors, four positions as assistant professors, and Nordic assistant professors. In addition there is a fellowship programme for Nordic graduate students and postdoctoral fellows. The Institute's activities include an extensive visitor programme for scientists from all over the world, and symposia and summer schools arranged either by NORDITA itself or in cooperation with other Nordic institutes.

The successful applicants are expected to guide Fellows at roughly the postdoctoral level, to interact with colleagues at NORDITA and elsewhere in the Nordic countries and to take an active part in the organization of meetings and courses. The positions provide excellent opportunities to pursue original research and to have contact with a wide range of developments in theoretical physics, and the assistant professors will be encouraged to invite guest scientists to visit NORDITA.

The initial appointments will be for three years, with the possibility of renewal up to a total of six years. The annual salary will be in the range of 240000 - 310000 Danish kroner depending on experience.

Any person interested in one of the appointments should send a *curriculum vitae*, a list of publications and the names of three referees **at the latest by 31 October 1991** to:

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There is no restriction on the nationality of the applicant. Those wishing to recommend suitable candidates are urged to contact the Director.

completely one-dimensional. A well known theorem in solid state physics states that a fully one dimensional system with a certain carrier density is unstable under the formation of a spin density wave. Since, in this particular case, the instability is the result of the application of an external field it is referred to as a field induced spin density wave (FISDW) which opens a gap in the energy spectrum around the Fermi energy. Field induced symmetry breaking has the important effect of introducing two characteristic lengths, namely the period of the FISDW and the magnetic length.

Experimentally, the Hall resistance of $(TMTSF)_2PF_6$ samples at low temperatures and high fields show characteristic plateaux with values of the Hall resistance in the vicinity of $h/2ne^2$, with $n = 1, 2, 3, \dots$ (see the figure). These plateaux occur at magnetic fields B with a $1/B$ periodicity typical of magnetic quantum oscillations. The Hall plateaux bear a strong similarity to those observed in the quantum Hall effect which are explained by pinning of the Fermi energy on localized states in the gaps between Landau levels.

For the Hall plateaux observed in Bechgaard salts, the idea of the pinning of the Fermi energy is retained in much the same way, but its physical origin is believed to lie in a continuous adjustment of the wavevector of the FISDW to the magnetic length, thus minimizing the energy. At a certain field, the wavevector changes abruptly from n to $n-1$ times the magnetic length when this is energetically more favorable: this jump is accompanied by a spike in the Hall resistance which precedes the next plateau. The experimental results thus confirm and extend the theoretical concepts.

Although many questions concerning this peculiar behaviour of Bechgaard salts remain unanswered, it is fairly well established that a new magnetic field induced phase has been discovered. This example substantiates the belief that many fascinating discoveries in high magnetic fields are still ahead of us.

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