

Foreword

The International Workshop on ELECTRONIC CRYSTALS, ECRYS-2005, was the fourth in the series of such meetings held in France: following ECRYS-93 in Carry-le-Rouet, ECRYS-99, in La Colle-sur-Loup, and ECRYS-02 in Saint-Flour.

The Workshop brought together nearly 100 researchers, chemists and physicists, from 11 countries; it was hosted by the Institut d'Études Scientifiques of the CNRS, at Cargèse, Corsica, France. The Workshop was supported by the European Physical Society, the Office of Naval Research Global of US, the Department of Mathematics and Physics of the CNRS, France.

ECRYS Workshops are intended to provide a cross-link between various communities engaged in parallel studies of static and dynamic properties of superstructures formed by electrons and vortices. Representatives of such electronic crystals are charge and spin density waves in low dimensional materials, Wigner crystals of electrons in bulks, at 2D interfaces and in wires, stripe phases in conducting oxides including the family of high T_c superconductors, various forms of charge order in organic quasi 1D one- and two-dimensional materials, charged colloidal crystals. ECRYS Workshops consider also related systems like vortex lattices in superconductors, domain walls in magnetic and ferroelectric materials.

While microscopic physical mechanisms are diverse and specific to each system, the general phenomena are quite universal: a depinning above a threshold, collective transport properties due to the sliding phenomena, non-stationary and memory effects, glassy properties due to numerous metastable states, aging dynamics and rejuvenation phenomena, etc.

In recent years, much of experimental progress has been achieved in fields covered by ECRYS Workshops with the use of advanced techniques: focused ion beam and reactive ion etching for fabrication of CDW submicronic devices, atomic resolution in UHV STM, point contact spectroscopy, electron photoemission, microbeam diffraction, coherent X-ray diffraction, pulse laser light excitation, etc.

The present proceedings highlight the state-of-art in this field. The topics discussed at the Workshop were related to microscopic mechanisms and quantum effects, charge ordering and charge disproportionation, ferroelectricity, collective effects in pinning and sliding, glassy behavior, tunneling, high magnetic fields and field induced density wave, two dimensional electron solids at heterojunctions, meso- and nanostructures of charge density wave materials. A short session was also devoted to charges in soft matter. Theoretical aspects ranged from the phenomenology of the collective sliding to microscopies of strongly correlated electrons.

The discussion forum opened by the Workshop ECRYS-05, as well as the preceding ones, fills the need of an international meeting with a cross-disciplinary nature for a review of new developments and results in the field of spontaneous superstructures. The present ECRYS-05 Workshop Proceedings demonstrates, we believe, the lively research activity in this field and will serve as a useful reference document. We are grateful to all participants of the Workshop for their active contribution.

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To the memory of Anatoly I. Larkin



Anatoly Larkin passed away on 4 August 2005, at the age 72.

Only two months before our conference we discussed with Anatoly a possibility of attending the ECRYS, but unfortunately he was bound to the Aspen program where his seemingly very strong health has betrayed him.

Anatoly Larkin graduated from Moscow Engineering Physics Institute in 1956 where he got his M.S. under supervision of A. Sakharov. For the first 10 years afterwards he worked at Kurchatov Institute of Atomic Energy in Moscow and it was there that he got Ph.D. in 1960 under supervision of A. Migdal. Later Larkin gave the tribute to these notorious tutors: he proved himself to be the best teacher, in the community of solid state theory at least.

His golden decades 1966–1995 were devoted to the Landau Institute of Theoretical Physics. Beyond cases of efficient collaboration within his generation, Larkin has brought up a whole constellation of well known theorists; each Ph.D. of his disciples was a new word in science.

Since 1990, Larkin paid long term visits or took part in running programs over the world: ISI at Torino, Weizmann Institute, Bell Labs, Agronne N. L., Humboldt Award.

His last decade was given to the Theoretical Physics Institute at the University of Minnesota. But each summer he was back to Russia, always bringing new results, which report used to open the Landau Days meeting. His presence enlightened the scientific life of the Institute and around. People of younger generations were waiting for an occasion to discuss with him.

Years 1990's–2000's brought to A.Larkin most of highest awards of our science:

London Prize in Low Temperature Physics 1990, Russian Academy of Sciences membership 1991, Hewlett-Packard Europhysics Prize 1993, Award of Excellence of the World Congress on Superconductivity 1994, Onsager Prize 2002, Bardeen Prize 2004.

The conference devoted to his 70 years anniversary (MPI Dresden) brought together many best people in the condensed matter theory.

Citation index of publications by A. Larkin exceeds 13 000. He is a co-author of the comprehensive review on vortices (G. Blatter et al.) from 1990's and of the new encyclopaedic book "Theory of Fluctuations in Superconductors" (written with A. Varlamov). A. Larkin made seminal contribution to diverse problems of theoretical, condensed matter and low temperature physics, adding his earlier excursions to plasma, nuclear and particle physics. The topics range over magnetism, ferroelectricity, superconductivity in numerous aspects, quasi 1D conductors, mesoscopic and nano systems as the latest excitement.

The principle achievements of Anatoly Larkin include:

- phase transitions (with V. Vaks et al., and particularly with D. Khmel'nitskii),
- superconductivity: fluctuations (with L. Aslamasov), inhomogeneous FFLO states and the semiclassical method (both with Yu. Ovchinnikov), junctions,
- solutions for 1D and quasi 1D electronic systems (with I. Dzyaloshinskii, then with K. Efetov, P. Wiegmann, later with A. Finkelstein),
- gauge theory of strongly correlated electrons and high- T_c problems (with L. Ioffe),
- weak localization (with L. Gorkov and D. Khmel'nitskii, then also with B. Altshuler, A. Aronov, K. Efetov, S. Hikami),
- pinning: vortices in conventional (with Yu. Ovchinnikov) and high- T_c (with V. Geshkenbein, L. Glazman, M. Feigelman, A. Koshelev, V. Vinokur) superconductors,
- Charge Density Waves (with K. Efetov, later with S. Brazovskii),
- mesoscopics, nanoscales, quantum chaos (with I. Aleiner, M. Feigelman, V. Galitski, L. Glasman, A. Kamenev, K. Matveev, M. Skvortsov, et al.).

Larkin inventions at ECRYS conferences

Of these many subjects, it is the notion of pinning that has the broadest impact on topics of ECRYS conferences. Larkin has devoted much effort to it through 70's and again in 90's. His pioneering work of 1970 (developed through the decade in collaboration with Yu. Ovchinnikov in 1973 and 1979) has led to today's concepts of collective (weak) and local (strong pinning). Together with K. Efetov, in 1976 he applied the idea of pinning to CDWs and emphasized the importance of the charged character of the electronic crystal. In 90', Larkin conducted numerous studies (with V. Geshkenbein, et al.) on pinning of the vortex state in real of High- T_c superconductors. At the same time A. Larkin (together with S. Brazovskii) developed the theory of local metastable states in CDWs that are due to solitons or dislocations. It allowed to explain in single, unified picture several long standing puzzles of CDWs: a low temperature peak of the dielectric susceptibility, a very nonlinear I-V characteristic, and a second threshold field.

Another ECRYS topic can be traced back to his 1968 work with D.Khmel'nitskii, awarded as a discovery, which is in fact nothing but the theoretical prediction for today's stripe phases.

Next ECRYS topic, charge ordering and ferroelectricity in organic conductors, originates from the 1972 work by A. Larkin and I. Dzyaloshinskii on the Mott insulator state in 1D. This collaboration of two talents resulted also, in 1974, in the direct solution for the gapless regime of 1D interacting electrons which already contained all ingredients of the Luttinger liquid picture, which may be necessary in applications like ARPES, discussed at the earlier ECRYS meetings. In a while, A. Larkin and K. Efetov extended this science to spin-gap cases of electron attraction, recovered the dualism of CDW-Superconductivity and its resolution by 3D interactions, and suggested a phenomenological concept of the later bosonisation: today's most common tool.

Much of recent theory attention and big experimental searches are devoted to one of the FFLO (Fulde-Ferrel-Larkin-Ovchinnikov) stripe phases in superconductors.

A. Larkin and L. Aslamasov work on the paraconductivity influenced the first theories (J. Bardeen, L. Gorkov) of sliding CDWs in a time of that experimental discovery. Among other inventions of A. Larkin discussed at ECRYS is his 1978 work with P. Lee on solitons tunnelling through impurity.

We wish these Proceedings will serve to memory of the outstanding scientist, great teacher, man of devotion - **Anatoly I. Larkin**