## SELECTED WORKS AND RESEARCH DIRECTIONS

### Superconductivity in strongly disordered systems

The weak coupling singlet-paring superconducting state is built and studied on the basis of exact single-particle wavefunctions in strong disorder. It is shown that near the Anderson localization transition the multifractal correlations of single-particle states may significantly alter the character of the superconducting state. In particular it is shown that a pseudo-gap may arise in the region of localized single particle states which persists above the critical temperature. It is also shown at a weak Coulomb interaction the superconducting transition temperature for weak coupling may increase with increasing disorder.

*M.V.Feigelman, L.B.Ioffe, V.E.Kravtsov, E.A.Yuzbashyan, Phys.Rev.Letters,* **98**, *027001 (2007).*

*M.V.Feigelman, L.B.Ioffe, V.E.Kravtsov and E.Cuevas, Annals of Physics* **365**, *1368 (2010).*

*V.E.Kravtsov, arXiv: 1109.2515*

### Random matrix ensembles with multifractal eigenstates

Unconventional Random Matrix ensembles with multifractal eigenstates are systematically studied and the various eigenvalue and eigenfunction statistics are compared with those at the Anderson localization transition in 3D systems. The method of virial expansion to compute various distribution functions of almost diagonal random matrices is developed and applied to critical random matrix ensembles with multifractal eigenstates. In particular, the Chalker's scaling relationship between the local DoS correlation function and the scaling of inverse participation ratio is proven for strong multifractality.

*V.E.Kravtsov, K.A.Muttalib. Phys.Rev.Lett.,* **79**, *1913 (1997).*

*V.E.Kravtsov and A.M.Tsvelik. Phys. Rev. B.,* **62**, *9888 (2000).*

*O.Yevtushenko and V.E.Kravtsov. J.Phys.A: Math.Gen.,* **36**, *8265(2003).*

*V.E.Kravtsov, O.Yevtushenko and E.Cuevas, J.Phys.A,* **39**, *2021(2006).*

*E. Cuevas, V. E. Kravtsov, Phys.Rev.B.,* **76**, *235119 (2007).*

*F.Franchini and V.E.Kravtsov, Phys. Rev.Lett.* **103**, *166401 (2009).*

*V.E.Kravtsov, A.Ossipov, O.M.Yevtushenko and E.Cuevas, Phys. Rev. B*

**82**, *161102 (R) (2010).*
*Random matrix representation of critical statistics - V.E.Kravtsov in: The Oxford Hanbook on Random Matrix Theory. ed. By G.Akemann, J.Baik, and P.Di Francesco, Oxford University Press, 2010, pp.250-269.*

**Anderson localization in the space and time domains**

Various issues of theory of Anderson localization in one- and multi- dimensional systems are studied using rigorous analytical methods. In particular, the center-of-band anomaly of eigenfunction statistics in the one-dimensional Anderson localization model is systematically studied. Localization in the time domain of driven quantum systems, in particular driven random matrices, is analytically investigated. In particular, the role of interaction and the meaning of the time-reversal symmetry breaking for periodically driven systems is clarified. In the earlier works the catastrophe of high-gradient operators in the nonlinear sigma model of localization is discovered which could mean existence of Levi flights at the Anderson transition point of the local random Hamiltonians.
*V.E.Kravtsov and V.I.Yudson, Annals of Physics* **326**, *1672 (2011).*
*V.E.Kravtsov and V.I.Yudson, Phys. Rev. B* **82**, *195120 (2010).*
*Nonlinear quantum coherence effects in driven mesoscopic systems.-*
*V.E.Kravtsov. In: Nanophysics: coherence and transport. Ed. by H.Bouchiat, Y.Gefen,S.Gueron,G.Montambaux and J.Dalibard. (Les Houches, Session LXXXI, 2004), Elsevier, Amsterdam, 2005.*
*D.M.Basko, M.A.Skvortsov and V.E.Kravtsov. Phys.Rev.Lett.,* **90**, *096801 (2003).*
*D.M.Basko and V.E.Kravtsov, Phys.Rev.Lett.,***93**, *056804 (2004).*
*V.E.Kravtsov, I.V.Lerner, V.I.Yudson. Phys.Lett.A.,* **134**, *pp.245 (1989).*

**Relaxation and transport in non-equilibrium quantum systems**

Energy, spin, and current relaxation and transport in quantum systems out of equilibrium is studied.
*Jumps in current-voltage characteristics in disordered films -B.L.Altshuler, V.E.Kravtsov, I.V.Lerner and I.L.Aleiner, Phys. Rev.Lett.* **102**, *176803 (2009)*
*Infrared catastrophe in two-quasiparticle collision integral- O.V.Dimitrova*

*and V.E.Kravtsov, JETP Lett.,* **86***, 670-676 (2007) [Pis'ma v ZhETF,* **86***, 762-768 (2007)].*
*Bohm-Aharonov magnetization of mesoscopic rings caused by inelastic relaxation - O.L.Chalaev and V.E.Kravtsov. Phys.Rev.Lett.,* **89***, 176601 (2002).*
*Electron kinetics in isolated mesoscopic rings driven out of equilibrium.- V.I.Yudson and V.E.Kravtsov. Phys.Rev.B.,* **67***, 155310 (2003).*
*The relationship between the noise-induced persistent current and dephasing rate.- V.E.Kravtsov and B.L.Altshuler. Phys. Rev. Lett.,* **84***, 3394-3397 (2000).*
*Direct current in mesoscopic rings induced by high- frequency electromagnetic field. - V.E.Kravtsov, V.I.Yudson. Phys.Rev.Lett.,* **70***, 210-213 (1993).*

**Selected earlier works**

<u>Critical level statistics:</u>
*Universal spectral correlations at the mobility edge.- V.E.Kravtsov, I.V.Lerner, B.L.Altshuler and A.G.Aronov. Phys.Rev.Lett.,* **72***, 888(1994).*
*Spectral correlations in disordered electronic systems: Crossover from metal to insulator regime. - A.G.Aronov, V.E.Kravtsov, and I.V.Lerner. Phys.Rev.Lett.,* **74***, 1174 (1995).*
*Spectral rigidity and eigenfunction correlations at the Anderson transition.- J.T.Chalker, V.E.Kravtsov and I.V.Lerner. Sov.Phys.-JETP Lett., 64, 486-391 (1996). [Pis'ma ZhETF,* **64***, 355 (1996)].*
*Topological spectral correlations in 2D disordered systems.- V.E.Kravtsov and V.I.Yudson. Phys.Rev.Lett.,* **82***, 157 (1999)*
*Critical spectral statistics as the Luttinger liquid of energy levels at a finite temperature.- V.E.Kravtsov. Ann.Phys. (Leipzig),* **8***, (1999).*

<u>Distribution of mesoscopic fluctuations and multifractality</u>
*Statistical properties of mesoscopic fluctuations and scaling. - B.L.Altshuler, V.E.Kravtsov, I.V.Lerner. Pis'ma Zh.Exp.Teor.Fiz.,* **43***, 342(1986). [JETP Letters,***43** *, 441 (1986)]*
*Statistics of mesoscopic fluctuations and instability of one-parameter scaling. - B.L.Altshuler, V.E.Kravtsov, I.V.Lerner. Zh.Exp.Teor.Fiz.,* **91***, 2276(1986). [Sov.Phys.JETP,* **91** *, 1352 (1986)]*
*The spectrum of relaxation times in disordered conductors. - B.L.Altshuler, V.E.Kravtsov, I.V.Lerner. Pis'ma Zh.Exp.Teor.Fiz.* **45***, 160 (1987).*

*Applicability of scaling description to the distribution of mesoscopic fluctuations. - B.L.Altshuler, V.E.Kravtsov, I.V.Lerner. Phys.Lett.A.,* **134***, 488 (1989).*
*Distribution of mesoscopic fluctuations and relaxation properties in disordered conductors.- B.L.Altshuler, V.E.Kravtsov, I.V.Lerner. in: "Mesoscopic phenomena in solids." ed. by B.L.Altshuler, P.A.Lee, and R.A.Webb, North Holland, 1991, pp.449-521.*

Random walks at quenched disorder

*Random walks in media with constrained disorder. - V.E.Kravtsov, I.V.Lerner, V.I.Yudson. J.Phys.A.,* **18***, L703 (1985).*
*The Einstein relation and the exact Gell-Mann-Low function for random walks in a medium with random drifts. - V.E.Kravtsov, I.V.Lerner, V.I.Yudson. Phys.Lett.A.,* **119***, 203(1986).*
*Classical diffusion in a weakly disordered media. - V.E.Kravtsov, I.V.Lerner, V.I.Yudson. Zh.Exp.Teor.Fiz.,* **91***, pp.569 (1986). [Sov.Phys.JETP,* **91***, 336 (1986)]*

Nonlinear optics of disordered media

*Theory of phase conjugation of light in disordered nonlinear media. - V.E.Kravtsov, V.I.Yudson, V.M.Agranovich. Phys.Rev.B.,* **41***, 2794 (1990).*
*Theory of second-harmonic generation in strongly scattering media. - V.E.Kravtsov, V.M.Agranovich, K.I.Grigorishin, Phys.Rev.B., 44, 4931-4942 (1991).*
*Nonlinear backscattering from opaque media. - V.M.Agranovich, V.E.Kravtsov. Phys.Rev.B.,* **43***, 13691(1991).*

Vortex dynamics in superconductors

The microscopic theory of vortex motion in type II superconductors is developed (Kopnin-Kravtsov force) and applied to the resistance and Hall effect in the vortex state.
*N.B.Kopnin, V.E.Kravtsov. Pis'ma Zh.Exp.Teor.Fiz.* **23***,631 (1976).*
*N.B.Kopnin, V.E.Kravtsov. Zh.Exp.Teor.Fiz.* **71***, 1644 (1976).*
*A vortex in type II superconductors is considered as a natural mesoscopic system. The averaged density of the core states which are relevant for the vortex dynamics, is calculated.*
*M.A.Skvortsov, V.E.Kravtsov, and M.V.Feigel'man. JETP Lett.* **68***, 84 (1998). [Pis'ma ZhETF,* **68***, 78 (1998)].*