Selected Research Works

Itzhack Dana

A. Introducing models of classical and quantum Hamiltonian dynamics:

The following paper introduces a new Hamiltonian model for *weak chaos* emerging by *perturbing pseudochaos*; this is the first model exhibiting accelerator-mode islands for *arbitrarily weak* chaos and a chaotic superdiffusion with very unique nature and features:
4. *[2004]* I. Dana, *Global Superdiffusion of Weak Chaos,* Phys. Rev. E **69**, 016212. [pdf file]

The following paper introduces general *modulated* kicked rotors exhibiting *quantum antiresonance*; results in papers D2.-D4. are thus generalized:
3. *[1996]* I. Dana, E. Eisenberg, and N. Shnerb, *Antiresonance and Localization in Quantum Dynamics*, Phys. Rev. E **54**, 5948-5963. [pdf file]

The following paper shows for the first time the *exact* equivalence, *both classically and quantally*, between generalized kicked Harper models (KHMs) and kicked charges in a magnetic field or kicked harmonic oscillators, thus showing that KHMs are realistic models:
2. *[1995]* I. Dana, *Kicked Harper Models and Kicked Charge in a Magnetic Field*, Phys. Lett. A **197**, 413-416. [pdf file]

The following paper introduces the realistic system of kicked charges in a magnetic field for *arbitrary* values of a *conserved* coordinate of the cyclotron-orbit center, on which the dynamics/transport properties depend *very strongly*:
1. *[1995]* I. Dana and M. Amit, *General Approach to Diffusion of Periodically Kicked Charges in a Magnetic Field,* Phys. Rev. E **51**, Rapid Communication, R2731-R2734. [pdf file]

B. Study of basic aspects of classical nonintegrable Hamiltonian systems:

The following paper shows for the first time the existence of accelerator-mode islands exhibiting *rotational quasiregularity* (see also paper B15.):
17. *[2007]* O. Barash and I. Dana, *Rotating Accelerator-Mode Islands*, Phys. Rev. E **75**, 056209 (nlin.CD/0612054). [pdf file]

The following paper is an extended version of paper B7.:
16. *[2006]* O. Barash and I. Dana, *Quasiregularity and Rigorous Diffusion of Strong Hamiltonian Chaos,* Phys. Rev. E **74**, 056202. [pdf file]

15. *[2005]* O. Barash and I. Dana, *Type Specification of Stability Islands and Chaotic Stickiness,* Phys. Rev. E **71**, 036222. [pdf file]

14. *[2004]* I. Dana and V.E. Chernov, *Periodic Orbits and Chaotic-Diffusion Probability Distributions,* Physica A **332**, 219-229. [pdf file]

13. *[2003]* I. Dana and V.E. Chernov, *Chaotic Diffusion on Periodic Orbits and Uniformity,* Physica A **330**, 253-258. [pdf file]

12. *[2003]* I. Dana and V.E. Chernov, *Chaotic Diffusion on Periodic Orbits: The Perturbed Arnold Cat Map,* Phys. Rev. E **67**, 046203. [pdf file]

The following paper extends the study of the new realistic model in paper A1. to *chaotic superdiffusion*:
11. *[1998]* I. Dana and T. Horesh, *Strong Variation of Global-Transport Properties in Chaotic Ensembles*, Lecture Notes in Physics **511**, 51-58. [pdf file]

Another extension of the study of the new realistic model in paper A1.:
10. *[1996]* I. Dana and T. Kalisky, *Symbolic Dynamics for Strong Chaos on Stochastic Webs: General Quasisymmetry*, Phys. Rev. E **53**, Rapid Communication, R2025-R2028. [pdf file]

The following paper introduces an *efficient algorithm* for determining the rotational-quasiregularity *type* of chaotic orbits:
9. *[1993]* I. Dana, *Type Specification of Chaos*, Phys. Rev. Lett. **70**, 2387-2390. [pdf file]

8. *[1990]* Q. Chen, I. Dana, J.D. Meiss, N.W. Murray, and I.C. Percival, *Resonances and Transport in the Sawtooth Map,* Physica D **46**, 217-240.

The first systematic *organization* of Hamiltonian chaos based on *rotational resonances*, giving a phase-space partition:
7. *[1990]* I. Dana, *Organization of Chaos in Area-Preserving Maps,* Phys. Rev. Lett. **64**, 2339-2342. [pdf file]

The first approach to Hamiltonian chaotic transport based on the unstable periodic orbits embedded in the chaotic region:
6. *[1989]* I. Dana, *Hamiltonian Transport on Unstable Periodic Orbits,* Physica D **39**, 205-230.

The first *Markov* model of Hamiltonian chaotic transport based on *rotational resonances*, giving a phase-space partition:
5. *[1989]* I. Dana, N.W. Murray, and I.C. Percival, *Resonances and Diffusion in Periodic Hamiltonian Maps,* Phys. Rev. Lett. **62**, 233-236. [pdf file]

4. *[1987]* W.P. Reinhardt and I. Dana, *Semi-Classical Quantization, Adiabatic Invariants and Classical Chaos,* Proceedings of the Royal Society of London A **413**, 157-170.

The following paper is an extension of (the next) paper B2.:
3. *[1987]* I. Dana and W.P. Reinhardt, *Intrinsic Nonadiabaticities on the Farey Tree,* Lecture Notes in Physics **278**, 146-150.

The following paper is the first study of adiabatic invariance in a nonintegrable system, providing a first solid ground to the so-called "adiabatic switching method":
2. *[1987]* I. Dana and W.P. Reinhardt, *Adiabatic Invariance in the Standard Map,* Physica D **28**, 115-142.

1. *[1985]* I. Dana and S. Fishman, *Diffusion in the Standard Map,* Physica D **17**, 63-74.

C. Phase-space quantum mechanics and applications:

The following paper introduces the *most general* known quantization of canonical maps on a phase-space two-torus (three representative cases of this quantization are studied in papers C12., C11.-C10. and C8., and D6.):
15. *[2002]* I. Dana, *General Quantization of Canonical Maps on a Two-Torus,* J. Phys. A **35**, 3447-3465. [pdf file]

The following paper presents a characterization of quasiperiodic functions by their *full* vortex structure in one unit cell, with exact results and first applications in several directions (the paper extends results in paper C9.):

14. *[2002]* I. Dana and V.E. Chernov, *Vortex Structure and Characterization of Quasiperiodic Functions,* J. Phys. A **35**, 10101-10116. [pdf file]

13. *[2001]* I. Dana, *Quantum Chaos on a Toral Phase Space for General Boundary Conditions: Recent New Results,* Physica E **9**, 542-547. [pdf file]

The following paper presents exact surprising results concerning the *allowed* boundary conditions (BCs) of quantum perturbed cat maps on a toral phase space (these BCs correspond to a *finite lattice* of points in the reciprocal toral phase space):

12. *[2000]* I. Dana, *Renormalization of Quantum Anosov Maps: Reduction to Fixed Boundary Conditions,* Phys. Rev. Lett. **84**, 5994-5997. [pdf file]

The following two papers, mainly C10., introduce the concept of *"band distribution"* (BD) for the classical-quantum correspondence on a toral phase space (paper C11. considers in detail the Husimi-BD case); it is assumed that the allowed BCs cover *all* the reciprocal toral phase space:

11. *[1998]* I. Dana, Y. Rutman, and M. Feingold, *Band Husimi Distributions and the Classical-Quantum Correspondence on the Torus,* Phys. Rev. E **58**, 5655-5667. [pdf file]

10. *[1998]* I. Dana, M. Feingold, and M. Wilkinson, *Band Distributions for Quantum Chaos on a Torus,* Phys. Rev. Lett. **81**, 3124-3127. [pdf file]

In the following paper, *"vortex-lattice wave fields"* with arbitrary vorticity per unit cell are comprehensively introduced into Fourier optics:

9. *[1997]* I. Dana and I. Freund, *Vortex-Lattice Wave Fields,* Optics Communications **136**, 93-113. [pdf file]

The following paper is a study of basic quantum properties of generalized kicked Harper models, for which the allowed quantum boundary conditions on a toral phase space cover *all* the reciprocal toral phase space:

8. *[1995]* I. Dana, *Extended and Localized States of Generalized Kicked Harper Models,* Phys. Rev. E **52**, 466-472. [pdf file]

Papers C1. and C3.-C7. present exact results concerning 2D crystal (Bloch) electrons in a perpendicular uniform magnetic field, derived using arguments based on phase-space translational invariance; a main result is a Diophantine equation for the *integer quantum Hall effect* in this system, generalizing the one derived by Thouless, Kohmoto, Nightingale, and den Nijs [TKNN, PRL 49, 405 (1982)] in several directions:

7. *[1990]* I. Dana, *Quantized Hall Conductance in a Glide-Plane Symmetry,* Phys. Lett. A **150**, 253-256.

6. *[1990]* I. Dana and J. Zak, *Splitting of a Bloch Band into Magnetic Subbands?*, Phys. Lett. A **146**, 147-149.

5. *[1985]* I. Dana and J. Zak, *Quantum Hall Conductances and Localization in a Magnetic Field*, Phys. Rev. B **32**, 3612-3621. [pdf file]

4. *[1985]* I. Dana, Y. Avron, and J. Zak, *Quantised Hall Conductance in a Perfect Crystal*, J. Phys. C: Solid State Phys. **18**, L679-L683. [pdf file]

3. *[1983]* I. Dana and J. Zak, *Adams Representation and Localization in a Magnetic Field*, Phys. Rev. B **28**, 811-820. [pdf file]

The following paper introduces the *most general* known subset of coherent states which is essentially *exactly* complete (up to one element, as in the case of the usual Von-Neumann lattice):
2. *[1983]* I. Dana, *Composite Von-Neumann Lattice,* Phys. Rev. A **28**, Rapid Communication, R2594-R2596. [pdf file]

1. *[1982]* I. Dana and J. Zak, *First-Principles Calculation of Diamagnetic Band Structure,* Phys. Rev. Lett. **48**, C1226-C1226. [pdf file]

D. Study of spectra and quantum-dynamics/transport phenomena in classically nonintegrable systems:

The following two papers introduce a novel, *statistical* approach to the quantum-chaotic ratchet effect, based on the natural complete set of initial states that are *uniform in phase space* with the *maximal* possible resolution of one Planck cell; this approach is *most* required in view of the *sensitivity* of the effect to the initial state (some more details and generalizations are given in paper D10.):
14. *[2011]* I. Dana, *Statistical Approach to Quantum Chaotic Ratchets: First Results and Open Problems*, to appear in JPCS. [pdf file]

13. *[2010]* I. Dana, *Statistical Approach to Quantum Chaotic Ratchets*, Phys. Rev. E **81**, 036210. [pdf file]

Papers D11. And D12. present the first experimental realization of *quantum-resonance ratchets* for *arbitrary* quasimomenta; a very simple case of the general theory in paper D8. is realized using atom-optics methods with Bose-Einstein condensates:
12. *[2010]* I. Dana, V.B. Roitberg, V. Ramareddy, I. Talukdar, and G.S. Summy, *Quantum-Resonance Ratchets: Theory and Experiment*, International Journal of Bifurcation and Chaos **20**, 255-261. [pdf file]

11. *[2008]* I. Dana, V. Ramareddy, I. Talukdar, and G.S. Summy, *Experimental Realization of Quantum-Resonance Ratchets at Arbitrary Quasimomenta*, Phys. Rev. Lett. **100**, 024103 (http://arxiv.org/abs/0706.0871). [pdf file]

10. *[2008]* I. Dana, *Quantum Ratchets on Maximally Uniform States in Phase Space: Semiclassical Full-Chaos Regime* (http://arxiv.org/abs/0810.1831). [pdf file]

9. *[2007]* O. Barash and I. Dana, *Quantum Accelerator Modes in the Absence of Gravity*, International Review of Physics **1**, 6-7. [pdf file]

The following paper introduces the concepts of *quantum resonance* and *quantum-resonance ratchets* in the free-falling frame of the general periodically kicked particle in the presence of "gravity" (a linear potential); results in papers D6. and D7. are thus generalized:

8. *[2007]* I. Dana and V. Roitberg, *Quantum Resonances and Ratchets in Free-Falling Frames*, Phys. Rev. E **76**, Rapid Communication, 015201(R) (http://arxiv.org/abs/0706.3993). [pdf file]

7. *[2006]* I. Dana and D.L. Dorofeev, *Fluctuations and Transients in Quantum-Resonant Evolution*, Phys. Rev. E **74**, Rapid Communication, 045201(R) (nlin.CD/0608022). [pdf file]

The following paper defines and studies the *most general* quantum resonances of the periodically kicked particle by deriving a general equation for the *"resonant"* quasimomenta; this equation is consistent with the allowed quantum boundary conditions (BCs) for the system on a toral phase space (these BCs correspond to a *countable set of segments* in the reciprocal toral phase space):

6. *[2006]* I. Dana and D.L. Dorofeev, *General Quantum Resonances of the Kicked Particle*, Phys. Rev. E **73**, 026206 (nlin.CD/0509035). [pdf file]

The following paper, extending paper D1., is a comprehensive study of the dependence of *spectra* ("Hofstadter butterflies") and *quantum diffusion* of the kicked particle in a magnetic field on the value of the conserved coordinate of the cyclotron-orbit center, especially near the value corresponding to *quantum antiresonance* of the system:

5. *[2005]* I. Dana and D.L. Dorofeev, *General Approach to the Quantum Kicked Particle in a Magnetic Field: Quantum-Antiresonance Transition*, Phys. Rev. E **72**, 046205 (nlin.CD/0504030). [pdf file]

4. *[1997]* E. Eisenberg, N. Shnerb, and I. Dana, *Solvable Model for Dynamical Localization near Quantum Antiresonance*, Quantum-Classical

Correspondence: Proceedings of the IV Drexel International Symposium on "Quantum Nonintegrability" (International Press, Boston), pp. 453-459.

3. *[1997]* E. Eisenberg and I. Dana, *Limited Sensitivity to Analyticity: a Manifestation of Quantum Chaos,* Foundations of Physics **27**, 153-170.

2. *[1995]* I. Dana, E. Eisenberg, and N. Shnerb, *Dynamical Localization near Quantum Antiresonance: Exact Results and a Solvable Case,* Phys. Rev. Lett. **74**, 686-689. [pdf file]

The following paper introduces the concept of *"quantum antiresonance"* for *perturbed degenerate* systems (kicked harmonic oscillators or kicked charges in a magnetic field for general potentials and/or general values of a conserved coordinate of the cyclotron-orbit center):
1. *[1994]* I. Dana, *Quantum Suppression of Diffusion on Stochastic Webs,* Phys. Rev. Lett. **73**, 1609-1612. [pdf file]

E. Other works:

2. *[1982]* I. Dana and J. Zak, *Perturbation Approach to the Impurity Problem in Lattice Dynamics,* J. Phys. C: Solid State Phys. **15**, 2115-2125. [pdf file]

1. *[1981]* I. Dana, *Retardation in Rigid Motion and Degree of Rigidity*, General Relativity and Gravitation **13**, 807-811.