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Foreword

Celebrating the 60th anniversary of Andrij Shvaika

"Dumb looks are still free," but those of you who carry pocket change will be able to obtain real answers, according to the rate schedule taped to Andrij's office door. This notice may deter some from entering, but if it does they are missing something truly special. Andrij's office is indeed a place where everybody comes to get their questions answered and, in spite of the rate schedule, he generously offers his *always correct* answers for free. Andrij's intelligence, calmness, sense of humor and kindness are features you quickly learn after meeting him.

Andrij Shvaika was born on November 8, 1960 in Lviv. In 1982, he was granted a Master's Degree in Physics from Lviv State University, where he prepared his thesis entitled "Dynamics of orientational vibrations in lead germanate type crystals" under the supervision of Dr. Ihor Stasyuk. Andrij's early scientific career started in Karpenko Physico-Mechanical Institute of the Academy of Sciences of the UkrSSR, where he was working on the problems of adhesive properties of metals. In 1985 he returned to the University as a research fellow in the Department of Theoretical Physics, where he later gained a Doctor of Philosophy Degree in 1995. He then moved full-time to the Institute for Condensed Matter Physics of the National Academy of Sciences of Ukraine, where he started as a researcher in 1990. Andrij Shvaika was titled as a Senior Researcher in 2000 and was conferred a Doctor of Science Degree in 2011. At present, Andrij is a Leading Researcher (since 2011) in the Institute, and he heads a research line focused on the dynamical mean-field theory (DMFT) of strongly correlated electron systems, and his results are well known and recognized among other DMFT research groups worldwide. His educational activity includes lecturing in the Ivan Franko National University of Lviv and in the Lviv Polytechnic National University, along with an advanced course of Quantum Statistics for post-graduates in the Institute for Condensed Matter Physics. Andrij Shvaika is also an associate editor of the "Condensed Matter Physics" journal (and has been since 2011).

In his Ph. D. thesis, entitled "Investigation of the model with local anharmonicity in the theory of high–T_c superconductors", Andrij summarized his results on the study of the Müller model [1–6], which was used to describe YBaCuO–type high–temperature superconductors. Advanced skills in Green's functions and diagrammatic techniques, which Andrij developed during his work at that time, made him an expert in performing highly complex analytical derivations, a skill that he still uses today. His collaboration with Professor Ihor Stasyuk was extended to the study of the thermodynamics of the pseudospin–electron model [7–10] where they defined conditions for first– and second–order phase transitions.

Unusual properties of narrow-band systems (transition metals and their compounds, high-temperature superconductors, some organic systems, etc.), such as the metal–insulator transition or electronic ferromagnetism, can only be explained by taking into account local electron–electron interactions. Andrij's personal contribution to this problem includes both the development of general analytical approaches and the application of these methods to specific models. Andrij's best known result is his construction of perturbation theory in terms of the electron hopping for Hubbard–type models [11–13] and applied to the case of infinite dimensions. Within this approach, based on the Larkin equation for the irreducible part of the Green's function, Andrij obtained a number of analytical results for approximations to the alloy–type approximation and the Hartree–Fock approximation including a formula for the dynamical charge susceptibility [14, 15]. These publications gained an interest from scientists, that were working on similar problems, but within the Dyson equation approach. As a result, Andrij established a strong and fruitful collaboration with Professor Jim Freericks (that continues to grow). Studying the Falicov–Kimball model, they obtained [16] a new representation for the spectral function of f–electrons which, in contrast to the original representation by Brandt and Urbanek, allows one to consider arbitrary low temperatures, since all calculations are performed on the real time axis only. For this model, they also proved [17] the equivalence of forms for the free energy obtained by Plishke within the coherent potential approximation (on the real axis) and by Brandt and Mielsch within the dynamical mean-field theory approach (on the imaginary axis). A special place among Andrij's scientific achievements hold the analytical results in the Green's function method. In particular, he proposed [18, 19] a general approach for spectral relations of multi–time correlation functions in terms of multi–time temperature Green's functions, which is important for determining the real frequency behavior of dynamical correlation functions from their imaginary axis formulations.

In the same spirit of the expansion over the electron hopping, Andrij developed [20–22] the dynamical mean–field theory for the case of correlated hopping (in Hubbard-like models). He proposed a grand-canonical potential functional and a Φ–derivable theory that does not introduce the self-energy, which allowed one to calculate the thermodynamical functions. Interestingly, this is a class of problems for which the self-energy is nonlocal within the dynamical mean-field theory approach. Within this framework, Andrij calculated dynamical susceptibilities [19] and studied the effects of correlated hopping on the optical conductivity and transport coefficients [23–26] for the Falicov–Kimbal model and defined conditions for a pronounced improvement of thermoelectric properties of the system.

Shortly after being introduced to Jim, Andrij was introduced to Professor Thomas Devereaux, which started a new direction of joint research devoted to the study of equilibrium optical and x–ray spectroscopy of strongly correlated electronic systems within the dynamical mean–field theory. This collaboration resulted in an analytical derivation and calculation of the electronic Raman (and inelastic x–ray) scattering cross section [27–33], and x–ray photoemission spectroscopy [34] for the metallic and insulator phases of the Falicov-Kimball model. In addition to the homogeneous phase, Andrij generalized the formalism onto the case of the charge–density–wave (CDW) ordered phase, where along with Raman scattering, he also examined optical and dc–transport properties of the system [35–37]. This collaboration formed the basis for a successful sequence of cooperative grants from the U.S. Civilian Research and Development Foundation (two awards: 2002–2004 and 2006–2008).

With the development of ultrafast spectroscopy, which allows one to study the processes of relaxation in the excited systems on a femtosecond timescale, theoretical studies of nonequilibrium dynamics of highly correlated electronic systems have flourished. Andrij's interest in this field is focused on the development of analytical approaches and calculations of inelastic light scattering and photoelectron emission spectra in the ordered systems. In particular, he extended the nonequilibrium dynamical mean–field theory to solve the problems with charge–density–wave order [38–40]. The nonequilibrium state is caused by an external perturbation (*e.g.*, a strong and ultrafast electromagnetic pulse), which depends on time and thereby breaks the time-translation symmetry. In the case of a spatially uniform constant electric field, the Bloch oscillations of the dc–current, which smoothly decrease with time in the normal state, decay very quickly in the ordered state. However, when approaching zero temperature, the decay disappears and the current instead shows complex oscillations, which indicates the possible formation of a steady state. Furthermore, Andrij calculated time–resolved photoemission spectra [41] in pump–probe experiments for CDW systems. It was found that it is much easier to excite a Mott insulator than a quantum–critical CDW or a weakly coupled CDW. Within this approach, the nonresonant component of the nonequilibrium electronic Raman scattering cross section for the uniform phase of the Falicov–Kimball model was calculated [42]. From the ratio of the Stokes to anti–Stokes components, the effective temperature of the bosonic two-particle excitations was determined. On the other hand, the effective temperature of the fermionic one–particle excitations was obtained from the nonequilibrium photoemission spectra. By comparing the time evolution of these two effective temperatures, one can estimate how far is an excited system from thermal equilibrium (where the effective temperatures of bosonic and fermionic excitations should be the same).

In addition to his scientific interests, Andrij is one of the pioneer developers for supporting the Ukrainian language in the Babel system in LaTeX. He also created the design of the "Condensed Matter Physics" journal in LaTeX and developed a technical realization of its web-version.

It is a great honor to work with Andrij Shvaika. We always learn something new from him and also enjoy his friendship. The part of this special issue of "Condensed Matter Physics" journal dedicated to Andrij Shvaika on his 60th anniversary involves selected contributions from his close collaborators and friends, which cover a wide range of topics closely related to Andrij's scientific interests. The Editorial Board of "Condensed Matter Physics" journal, all contributors of this special issue and numerous colleagues and friends from Ukraine and abroad warmly congratulate Andrij Shvaika on the jubilee, wishing him a Happy Birthday and long life of health and happiness.

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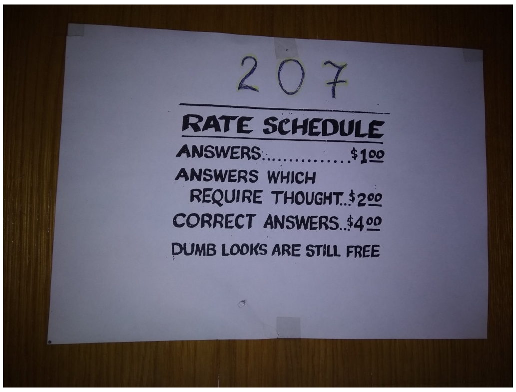

References

1. Stasyuk I.V., Shvaika A.M., Schachinger E., Physica C, 1993, **213**, No. 1, 57–70, doi:10.1016/0921-4534(93)90758-I.
2. Stasyuk I.V., Shvaika A., Schachinger E., Physica B, 1994, **194**, 1965–1966, doi:10.1016/0921-4526(94)91482-6.
3. Stasyuk I.V., Shvaika A., Physica C, 1994, **235**, 2173–2174, doi:10.1016/0921-4534(94)92308-6.
4. Stasyuk I.V., Shvaika A.M., Low Temp. Phys., 1996, **22**, No. 5, 411–414.
5. Stasyuk I.V., Shvaika A.M., Czech. J. Phys., 1996, **46**, Suppl. 2, 961–962, doi:10.1007/BF02583788.
6. Stasyuk I.V., Shvaika A.M., Ferroelectrics, 1997, **192**, No. 1, 1–10, doi:10.1080/00150199708216165.
7. Stasyuk I.V., Shvaika A.M., Tabunshchyk K.V., Condens. Matter Phys., 1999, **2**, No. 1(17), 109–132, doi:10.5488/CMP.2.1.109.
8. Stasyuk I.V., Shvaika A.M., J. Phys. Stud., 1999, **3**, No. 2, 177–183, doi:10.30970/jps.03.177.
9. Stasyuk I.V., Shvaika A.M., Tabunshchyk K.V., Acta Phys. Pol. A, 2000, **97**, No. 3, 411–414, doi:10.12693/APhysPolA.97.411.
10. Stasyuk I.V., Shvaika A.M., Tabunshchyk K.V., Ukr. J. Phys., 2000, **45**, No. 4–5, 520–528.
11. Shvaika A.M., Phys. Rev. B, 2000, **62**, No. 4, 2358–2371, doi:10.1103/PhysRevB.62.2358.
12. Shvaika A.M., Physica C, 2000, **341**, 177–178, doi:10.1016/S0921-4534(00)00435-4.
13. Shvaika A.M., Acta Phys. Pol. B, 2001, **32**, No. 10, 3415, Preprint arXiv:cond-mat/0106044.
14. Shvaika A.M., Condens. Matter Phys., 2001, **4**, No. 1(25), 85–92, doi:10.5488/CMP.4.1.85.
15. Shvaika A.M., J. Phys. Stud., 2001, **5**, No. 3, 349–354, doi:10.30970/jps.05.349.
16. Shvaika A.M., Freericks J.K., Condens. Matter Phys., 2008, **11**, No. 3(55), 425–442, doi:10.5488/CMP.11.3.425.
17. Shvaika A.M., Freericks J.K., Phys. Rev. B, 2003, **67**, No. 15, 153103, doi:10.1103/PhysRevB.67.153103.
18. Shvaika A.M., Condens. Matter Phys., 2006, **9**, No. 3(47), 447–458, doi:10.5488/CMP.9.3.447.
19. Shvaika A.M., Condens. Matter Phys., 2016, **19**, No. 3, 33004, doi:10.5488/CMP.19.33004.
20. Shvaika A.M., Phys. Rev. B, 2003, **67**, No. 7, 075101, doi:10.1103/PhysRevB.67.075101.
21. Shvaika A.M., Phys. Status Solidi B, 2003, **236**, No. 2, 368–371, doi:10.1002/pssb.200301681.
22. Shvaika A.M., Acta Phys. Pol. B., 2003, **34**, No. 2, 803–806.
23. Shvaika A.M., Condens. Matter Phys., 2014, **17**, No. 4, 43704, doi:10.5488/CMP.17.43704.

24. Dobushovskyi D.A., Shvaika A.M., Zlatić V., Phys. Rev. B, 2017, **95**, No. 12, 125133, doi:10.1103/PhysRevB.95.125133.
25. Dobushovskyi D.A., Shvaika A.M., Condens. Matter Phys., 2018, **21**, No. 2, 23702, doi:10.5488/CMP.21.23702.
26. Dobushovskyi D.A., Shvaika A.M., Condens. Matter Phys., 2020, **23**, No. 1, 13703, doi:10.5488/CMP.23.13703.
27. Shvaika A.M., Vorobyov O., Freericks J.K., Devereaux T.P., Phys. Rev. Lett., 2004, **93**, No. 13, 137402, doi:10.1103/PhysRevLett.93.137402.
28. Shvaika A.M., Vorobyov O., Freericks J.K., Devereaux T.P., Phys. Rev. B, 2005, **71**, No. 4, 045120, doi:10.1103/PhysRevB.71.045120.
29. Shvaika A.M., Vorobyov O., Freericks J.K., Devereaux T.P., Physica B, 2005, **359**, 705–707, doi:10.1016/j.physb.2005.01.200.
30. Shvaika A.M., Vorobyov O., Freericks J.K., Devereaux T.P., J. Phys. Chem. Solids, 2006, **67**, No. 1–3, 336–339, doi:10.1016/j.jpcs.2005.10.048.
31. Shvaika A.M., Freericks J.K., Condens. Matter Phys., 2012, **15**, No. 4, 43701, doi:10.5488/CMP.15.43701.
32. Pakhira N., Freericks J.K., Shvaika A.M., Phys. Rev. B, 2012, **86**, No. 12, 125103, doi:10.1103/PhysRevB.86.125103.
33. Devereaux T.P., Shvaika A.M., Wu K., Wohlfeld K., Jia C.J., Wang Y., Moritz B., Chaix L., Lee W.S., Shen Z.X., Ghiringhelli G., Braicovich L., Phys. Rev. X, 2016, **6**, No. 4, 041019, doi:10.1103/PhysRevX.6.041019.
34. Pakhira N., Shvaika A.M., Freericks J.K., Phys. Rev. B, 2019, **99**, No. 12, 125137, doi:10.1103/PhysRevB.99.125137.
35. Matveev O.P., Shvaika A.M., Freericks J.K., Phys. Rev. B, 2008, **77**, No. 3, 035102, doi:10.1103/PhysRevB.77.035102.
36. Matveev O.P., Shvaika A.M., Freericks J.K., Phys. Rev. B, 2009, **79**, No. 11, 115130, doi:10.1103/PhysRevB.79.115130.
37. Matveev O.P., Shvaika A.M., Freericks J.K., Phys. Rev. B, 2010, **82**, No. 15, 155115, doi:10.1103/PhysRevB.82.155115.
38. Freericks J.K., Matveev O.P., Shvaika A.M., Devereaux T.P., In: Ultrafast Bandgap Photonics, Society of Photo-Optical Instrumentation Engineers (SPIE) Conference Series, Vol. 9835, Rafailov M.K., Mazur E. (Eds.), 98351F, doi:10.1117/12.2223335.
39. Matveev O.P., Shvaika A.M., Devereaux T.P., Freericks J.K., Phys. Rev. B, 2016, **93**, No. 4, 045110, doi:10.1103/PhysRevB.93.045110.
40. Freericks J.K., Matveev O.P., Shen W., Shvaika A.M., Devereaux T.P., Phys. Scr., 2017, **92**, No. 3, 034007, doi:10.1088/1402-4896/aa5b6c.
41. Matveev O.P., Shvaika A.M., Devereaux T.P., Freericks J.K., Phys. Rev B, 2016, **94**, No. 11, 115167, doi:10.1103/PhysRevB.94.115167.
42. Matveev O.P., Shvaika A.M., Devereaux T.P., Freericks J.K., Phys. Rev. Lett., 2019, **122**, No. 24, 247402, doi:10.1103/PhysRevLett.122.247402.