**Research areas:** mathematical physics, in connection to algebra, geometry, integrability, and combinatorics. Specific areas of interest include:

- homotopical algebra; algebraic operads;
- enumerative geometry; moduli of curves;
- integrable hierarchies; topological recursion.

**Featured results.** This selection includes problems that were widely recognized as central to the field of geometry and integrability, and which, over the span of 10 to 15 years after they were posed, were successfully addressed:

- **2006:** The *r*-spin conjecture of Witten (1991) states that the partition function associated to the intersection theory of the spaces of *r*-spin structures on algebraic curves is the string tau function of the *r*-th Gelfand–Dickey hierarchy. This conjecture is proven in arXiv:math/o612510.
- **2010:** A natural generalization of a conjecture of Dubrovin–Zhang (1997) embeds Gromov-Witten theory into the realm of integrable systems: it states that the partition function of any semi-simple cohomological field theory is governed by a hydrodynamical integrable hierarchy. In this way it is proven in arXiv:1009.5351.
- **2015:** The Liu–Zhang conjecture (2004), further refined by Dubrovin–Liu–Zhang, states that any deformation of a semisimple hydrodynamic bi-Poisson structure can be extended to a full dispersive Poisson pencil, which gives a full classification of such integrable systems. This conjecture is proven in arXiv:1501.04295.
- **2019:** The *r*-ELSV formula conjectured by Zvonkine (2006) connects the expansions in completed cycles in the center of the group algebra of the symmetric group with the special cohomological field theory coming from the *r*-th roots of the canonical line bundles. It is proven in arXiv:1905.04524.
- **2024-1:** The DR/DZ conjecture of Buryak (2014), further refined by Buryak–Dubrovin–Guéré–Rossi to the so-called strong DR/DZ equivalence, states that the Buryak's construction of integrable systems using double ramification cycles is Miura equivalent to the Dubrovin-Zhang hierarhies. It is proven (in its strong form) in arXiv:2405.12334.
- **2024-2:** The Borot–Eynard conjecture (2011) on KP integrability of non-perturbative differentials in topological recursion is a far-reaching generalization of the celebrated Krichever construction of KP solutions from  $\theta$ -functions on Riemann surfaces. It is proven in arXiv:2412.18592.

**Further past results.** In addition to the six problems highlighted above, a number of other open questions have been addressed. The following list–likely not exhaustive–summarizes some of these cases:

- Liu-Zhang conjecture on vanishing of higher bi-Hamiltonian homology of the dispersionless KdV hierarchy.
- Liu-Zhang-Zhou conjecture that relates Hurwitz Frobenius manifolds and rationally constrained KP hierarchies.
- Blot conjecture on the dilaton equation for the quantum tau function of the quantized KdV hierarchy.
- Borot et al. conjecture on a universal differential-algebraic formula for the x y swap in topological recursion.
- Alexandrov-Dhara / Chidambaram-Garcia-Failde-Giacchetto conjectures on r-Brezin-Gross-Witten tau function.
- Hock conjecture on quantum dilogarithmic corrections for essential singularities in the x y swap relation.
- Norbury–Scott conjecture on spectral curve for the Gromov–Witten theory of  $\mathbf{P}^1$ .
- Lin–Zhou conjecture on expressions of monomial in  $\psi$ -classes on the moduli space of curves as boundary strata.
- Faber–Pandharipande conjecture on reconstruction of descendant Gromov–Witten invariants from the restricted ones.
- Blot et al. conjecture on relation between the trees of Ω-classes and double ramification cycles.
- A series of conjectures of Buryak et al. on various tautological relations involving trees decorated by  $\psi$ -classes.
- Giacchetto-Kramer-Lewański conjecture on topological recursion for spin Hurwitz numbers with completed cycles.
- Borot–Garcia-Failde conjecture on topological recursion for fully simple maps.
- A series of conjectures due to Do, Karev, and Manescu on combinatorial structure of Hurwitz generating functions.
- Sannomiya-Katsura-Nakayama conjecture on ground states degeneracy function of the  $\mathbb{Z}_2$  Nicolai model.

Also, some previously known and widely recognized results have received fundamentally new proofs, based on ideas that differ substantially from the original approaches. Examples include:

- Faber intersection number conjecture on top intersections in the tautological ring of  $\mathcal{M}_{g}$ .
- Witten conjecture on intersections of  $\psi$ -classes and the KdV hierarchy.
- The ELSV formula connecting Hurwitz numbers and intersection theory.

Among other results let us mention development of the theory of wheeled PROPs and pre-Lie deformation theory; homotopy theory of cohomological field theories; homotopical revision of the BCOV theory; interrelations of non-symmetric and higher order analogs of all operads involved in the algebraic 2d gravity package; development of the Maurer-Cartan methods in deformation theory, development of the Givental group action technique; interrelations between the theory of Frobenius manifolds and topological recursion and KP integrability; interrelations of enumerative geometry and topological recursion; universal formulas for the moment-cumulant correspondence in the free probability theory; contributions to the theory of Poisson brackets of integrable systems; and various results around computations with double ramification cycles, Hurwitz theory, and geometry of moduli spaces of curves and their relations to integrability.