Curriculum vitae of Mikhail Bondarko

Personal: born on 21 August, 1977; married, 1 child.

Nationality: Russian.

Work address: St. Petersburg State University, Department of Mathematics and Mechanics, Universitetsky Prospekt, 28, 198504, St. Petersburg, Russia.

Education and degrees

1994–1999: student of St. Petersburg State University, Dept. of Mathematics and Mechanics.

1999: M.Sc. in Mathematics; thesis title: "Associated Galois modules for Dedekind rings".

25 October, 2000: Ph.D. in Mathematics; thesis title: "Galois module structure of ideals".

13 July, 2007: the "Doctor of sciences" degree in Mathematics; thesis title: "Explicit formal groups and finite group schemes; applications to arithmetic geometry".

7 December, 2015: the academic rank of Professor of the Russian Academy of Sciences.

Employment

St. Petersburg State University, Dept. of Mathematics, Faculty of Higher Algebra and Number Theory.

Full professor: October 2008 – present.

Associated professor: November 2004 – October 2008.

Assistant professor: October 1999 – October 2004.

I have made 23 foreign academic visits and 23 invited talks at international mathematical conferences (in Russia, Germany, France, Italy and Poland).

Awards and grants

2 young scientist awards:

Russian Young Mathematician prize (Pierre Deligne competition), 2006;

2014 Young Mathematician Competition prize (Dynasty foundation).

I was the principal investigator of 3 RFBR research grants. I am currently a co-investigator of 2 Russian Scientific Foundation grants.

Research activity

Research interests: algebraic geometry, homological algebra and K-theory, algebraic number theory, category theory, algebraic topology.

I have 41 papers published; for 22 of them I am the only author.

12 of my papers were dedicated to the study of additive Galois modules. In [Bon00], [Bon02], [Bon03a], and [Bon06c] an interesting new relation be-

tween associated Galois orders (and modules) and the Galois cohomology of formal modules was studied. The main tool was a new method relating associated Galois orders with the tensor square of the extension; it gave some new "operations" on associated modules.

In [BoV03], [Bon03b], [Bon05a], [Bon05b], and [Bon07b] several classification results for formal groups over (the rings of integers) of mixed characteristic complete discrete valuation fields were obtained; they generalize the well-known results of J.-M. Fontaine.

In [Bon06a] and [Bon06b] these results were applied to the study of finite flat commutative group schemes. It was proved that the generic fibre functor is 'almost full' for these group schemes; this extends seminal results of J. Tate (for p-divisible groups) and M. Raynaud (for the case of the absolute ramification index e being smaller than the residue field charateristic p). A complete classification of finite local flat commutative group schemes over these valuation rings in terms of their Cartier modules (as defined by F. Oort) was given. It was also proved that the minimal dimension of a finite height formal group F such that a given local group scheme S can be embedded into F equals the number of generators for the coordinate ring of S.

These results were used for deducing a collection of "finite wild" criteria for good, semistable and ordinary reduction of Abelian varieties (i.e., one can recover the reduction by looking at the Galois module coming from a finite level of the p-torsion for the variety A). Note that previously a finite wild criterion of this sort was known for $e < p$ and good reduction only (and my criterion generalizes this result of B. Conrad), whereas the general "infinite" wild criteria (i.e., one should look at the whole p-torsion for A) were proved by Grothendieck.

My recent research (starting from [Bon09]) is mostly dedicated to motives and triangulated categories (and various types of "filtrations" for them); I have 13 published papers on these subjects (and two more are accepted for publication).

In [Bon09] I gave a new description of the category of geometric Voevodsky motives DM_{gm} over a (characteristic 0) field in terms of Suslin complexes of smooth projective varieties. This allowed me to prove that Voevodsky motives are anti-isomorphic to Hanamura one (this was a well-known conjecture). I also proved the existence of an exact conservative *weight complex* functor $t : DM_{gm} \to K^b(Chow)$. This is quite remarkable since $K^b(Chow)$ is a "much simpler and much more classical" category than DM_{gm}, whereas conservativity means that t does not kill non-zero objects. t vastly extends the weight complex of H. Gillet and C. Soule. I also proved that $K_0(DM_{gm}) \cong K_0(Chow)$ answering a question of Gillet and Soule.

In the process of extending these results, in [Bon10a] a new formalism of *weight structures* for triangulated categories was introduced and applied to Voevodsky's motives. This notion is an important "cousin" of t-structures (as introduced by Beilinson, Bernstein, and Deligne in their seminal 1982 paper).

This theory has found several applications in representation theory (in particular, [Bon10a] currently has 59 citations in the Mathscinet database). A rich collection of results related to weight structures and t-structures was recently obtained in [Bon16b].

As demonstrated in ibid., [Bon10a] and [Bon15], the theory may be successfully applied to the stable homotopy category of spectra along with other "topological" triangulated categories. Note in particular that the *weight complex* functor for the *spherical* weight structure on SH is exactly the functor sending a spectrum into the complex of free abelian groups calculating its singular homology; so the *weight-degenerate* object of SH are exactly the acyclic spectra, whereas the corresponding *weight spectral sequences* are Atiyah-Hirzebruch ones.

Another "non-motivic" application of weight structures was described in [BoS18a]. In this paper a new nice description of so-called non-commutative localizations of rings and additive categories was given; this allowed to describe the latter using explicit formulae generalizing the ones of Gerasimov and Malcolmson.

Besides, in [Bon12] interesting "Hodge-theoretic" examples of weight structures were constructed; these weight structures also give an example of an interesting notion of *transversality* of weight structures to t-structures.

There are two important "types" of weight structures for motivic categories. For various motivic categories (including the motivic homotopy categories of Voevodsky and Morel) one can consider the so-called Gersten weight structures (see [Bon10b], [BoD17], and [Bon18b]). The corresponding weight spectral sequences are the coniveau ones; this yields a vast extension of their functoriality properties. In [Bon10b] and [Bon18b] the existence of Gersten weight structures was shown to imply several direct summand results on the cohomology of regular semi-local schemes. The t-structures *orthogonal* to Gersten weight structures are the corresponding *homotopy* ones. For motivic categories over a field these t-structures were introduced by Voevodsky and Morel, whereas for a wide range of motivic categories over much more general base schemes these t-structures were introduced and studied in detail in [BoD17]. This gave interesting applications to smooth commutative group schemes (including abelian and semi-abelian ones).

Yet the so-called Chow weight structures seem to be even more important for motives and their applications. In [Bon10a] and [Bon11] the Chow weight structures were constructed for motives over a field. This gave a satisfactory theory of "weights" for motives. These weights essentially lift to motives Deligne's weights for mixed Hodge complexes and for mixed complexes of Galois representations. The general theory of weight structures yields weight filtrations and weight spectral sequences for any (co)homology theory defined on motives; these spectral sequences vastly generalize Deligne's ones. Moreover, in [BoK18] a new approach to Chow weight structures over fields was introduced; it gives "reasonable" weight structures without using any resolution of singularities of results (and so, one does not have to invert the base field characteristic in the coefficient ring).

In [Bon14], [BoI15], and [BoL16] Chow weight structures for various motivic categories over quite general (Noetherian excellent separated finite dimensional) base schemes were introduced. This gives the corresponding motivic versions of weights of mixed complexes of étale sheaves (including perverse sheaves) and of mixed Hodge modules. The functoriality properties of these motivic weights are quite similar to their étale analogues; yet the proofs are much simpler. Once again, the general theory yields weight filtrations, weight spectral sequences, and the calculation of the Grothendieck groups of the subcategories of compact objects for these motivic categories. Note that the classical construction of weight spectral sequences heavily depends on seminal resolution of singularities theorems (of Hironaka and de Jong); so my motivic results yield some extensions of these theorems to the setting of much more general schemes (so, one may speak of "motivic resolution of singularities").

Now I list some of the applications of Chow weight structures.

In [Bon18a] they (along with the localization properties of weight structures and the conservativity of the weight complex functor) were used to calculate the intersections of the levels of the Voevodsky's slice filtration with the ones of the dimension filtration (for a wide range of motivic categories; these results are completely new).

In [BoL16] the Chow weights of K-motives were shown to be closely related to the existence of (homotopy invariant) K-groups of negative degrees for singular schemes. This yielded the vanishing of certain $K_i(X)$ for $i < -\dim(X)$ under quite mild restrictions on X; note that the corresponding statement for Quillen's K-groups is a famous conjecture of Ch. Weibel.

In [Bon15] it was proved that standard motivic conjectures over perfect fields imply the existence of mixed motivic sheaves over any (Noetherian excellent finite dimensional separated) scheme S (as conjectured by Beilinson). Under some additional restrictions on S it was shown that the Chow weight structures yields "nice weights" for motivic sheaves (that satisfy all the properties proposed by Beilinson); a certain motivic version of the seminal Topological Decomposition Theorem (of Beilinson, Bernstein, and Deligne) was also deduced.

Weight structures can be used for constructing interesting (co)homology theories on triangulated categories. In [BoT17] this method was used for proving some general results on Picard groups of tensor triangulated categories endowed with weight structures. Several motivic applications of these results (corresponding to certain Chow and Gersten weight structures) were also described.

Furthermore, in [BoS14] very interesting new *Chow-weight* homology theories on motives were introduced; one may say that these functors are extensions of the Chow group ones from Chow motives onto Voevodsky ones (using the Chow weight structure for the latter). These homology theories gave several "mixed motivic" generalizations of the seminal "decomposition of the diagonal" results of S. Bloch and V. Srinivas. In particular, the non-vanishing of certain easily defined subquotients in the singular cohomology of a complex variety yields the non-vanishing of the corresponding Chow-weight homology and motivic homology groups; conjecturally, the converse results are also valid.

I also have three (interesting) recent papers that are not related to motives and weight structures.

In [BoS15] a complete description of all possible vanishing sets of cohomological functors from a (small) triangulated category was given. This general result was applied to the study of "localizations of coefficients" for triangulated categories.

In [Bon12b] some Weak Lefschetz-type statements for étale cohomology and homotopy groups of local set-theoretic complete intersection varieties that are not necessarily proper were proved. The proof used the properties of perverse sheaves; this allowed to extend to arbitrary base fields several cohomological results that were previously known over complex numbers only (since their proof relied on the Stratified Morse theory of Goresky and MacPherson). I am planning to extend these results to étale homotopy groups soon.

In [Bon16a] it was studied to which extent the comparison functor from the motivic homotopy category $SH(k)$ into Voevodsky motives $DM(k)$ is conservative. I gave a fairly complete answer to this question; the result is really useful since it allows to carry over certain properties of $DM(k)$ onto the "much more complicated" $SH(k)$.

Teaching experience

I have been teaching algebra to students for 18 years. During this time I lead seminars and read lectures on basic Algebra and Number theory; I have also organized seminars and read courses on various advanced branches of modern algebra (and related subjects). I am currently the scientific advisor of one Master student and one PhD student. I was the scientific advisor of the Master thesises of the following students: Alexey Dievsky, Vladimir Sosnilo, Sergey Yakovenko, and David Kumallagov.

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