

International scientific conference  
«Algebraic and geometric methods  
of analysis»

Book of abstracts



May 31 - June 5, 2017  
Odessa  
Ukraine

## LIST OF TOPICS

- Algebraic methods in geometry
- Differential geometry in the large
- Geometry and topology of differentiable manifolds
- General and algebraic topology
- Dynamical systems and their applications
- Geometric problems in mathematical analysis
- Geometric and topological methods in natural sciences
- History and methodology of teaching in mathematics

## ORGANIZERS

- The Ministry of Education and Science of Ukraine
- Odesa National Academy of Food Technologies
- The Institute of Mathematics of the National Academy of Sciences of Ukraine
- Taras Shevchenko National University of Kyiv
- The International Geometry Center

## PROGRAM COMMITTEE

<b>Chairman: Prishlyak A.</b> ( <i>Kyiv, Ukraine</i> )	<b>Maksymenko S.</b> ( <i>Kyiv, Ukraine</i> )	<b>Rahula M.</b> ( <i>Tartu, Estonia</i> )
<b>Balan V.</b> ( <i>Bucharest, Romania</i> )	<b>Matsumoto K.</b> ( <i>Yamagata, Japan</i> )	<b>Sabitov I.</b> ( <i>Moscow, Russia</i> )
<b>Banakh T.</b> ( <i>Lviv, Ukraine</i> )	<b>Mashkov O.</b> ( <i>Kyiv, Ukraine</i> )	<b>Savchenko A.</b> ( <i>Kherson, Ukraine</i> )
<b>Fedchenko Yu.</b> ( <i>Odesa, Ukraine</i> )	<b>Mykytyuk I.</b> ( <i>Lviv, Ukraine</i> )	<b>Sergeeva A.</b> ( <i>Odesa, Ukraine</i> )
<b>Fomenko A.</b> ( <i>Moscow, Russia</i> )	<b>Milka A.</b> ( <i>Kharkiv, Ukraine</i> )	<b>Strikha M.</b> ( <i>Kyiv, Ukraine</i> )
<b>Fomenko V.</b> ( <i>Taganrog, Russia</i> )	<b>Mikesh J.</b> ( <i>Olomouc, Czech Republic</i> )	<b>Shvets V.</b> ( <i>Odesa, Ukraine</i> )
<b>Glushkov A.</b> ( <i>Odesa, Ukraine</i> )	<b>Mormul P.</b> ( <i>Warsaw, Poland</i> )	<b>Shelekhov A.</b> ( <i>Tver, Russia</i> )
<b>Haddad M.</b> ( <i>Wadi al-Nasara, Syria</i> )	<b>Moskaliuk S.</b> ( <i>Wien, Austria</i> )	<b>Shurygin V.</b> ( <i>Kazan, Russia</i> )
<b>Herega A.</b> ( <i>Odesa, Ukraine</i> )	<b>Panzhenskiy V.</b> ( <i>Penza, Russia</i> )	<b>Vlasenko I.</b> ( <i>Kyiv, Ukraine</i> )
<b>Khruslov E.</b> ( <i>Kharkiv, Ukraine</i> )	<b>Pastur L.</b> ( <i>Kharkiv, Ukraine</i> )	<b>Zadorozhnyj V.</b> ( <i>Odesa, Ukraine</i> )
<b>Kirichenko V.</b> ( <i>Moscow, Russia</i> )	<b>Plachta L.</b> ( <i>Krakov, Poland</i> )	<b>Zarichnyi M.</b> ( <i>Lviv, Ukraine</i> )
<b>Kirillov V.</b> ( <i>Odesa, Ukraine</i> )	<b>Pokas S.</b> ( <i>Odesa, Ukraine</i> )	<b>Zelinskiy Y.</b> ( <i>Kyiv, Ukraine</i> )
<b>Konovenko N.</b> ( <i>Odesa, Ukraine</i> )	<b>Polulyakh E.</b> ( <i>Kyiv, Ukraine</i> )	

## ADMINISTRATIVE COMMITTEE

- Egorov B., chairman, rector of the ONAFT;
- Povarova N., deputy chairman, Pro-rector for scientific work of the ONAFT;
- Mardar M., Pro-rector for scientific-pedagogical work and international communications of the ONAFT;
- Fedosov S., Director of the International Cooperation Center of the ONAFT;
- Volkov V., Director of the Educational Research Institute of Mechanics, Automation and Computer Systems named after P. M. Platonov;
- Bukaros A., Dean of the Faculty of automation, mechatronics and robotics

## ORGANIZING COMMITTEE

Kirillov V.  
Konovenko N.  
Fedchenko Yu.

Hladysh B.  
Nuzhnaya N.  
Osadchuk E.

Maksymenko S.  
Khudenko N.  
Cherevko E.

НТБ ОНАФТ

## Integrable systems with dissipation on the tangent bundle of two-dimensional manifold

Maxim V. Shamolin

(Institute of Mechanics, Lomonosov Moscow State University, 1 Michurinskii Ave., 119192 Moscow, Russian Federation)

*E-mail:* shamolin@rambler.ru, shamolin@imec.msu.ru

We study nonconservative systems for which the usual methods of the study, e.g., Hamiltonian systems, are inapplicable. Thus, for such systems, we must “directly” integrate the main equation of dynamics. We generalize previously known cases and obtain new cases of the complete integrability in transcendental functions of the equation of dynamics of a four-dimensional rigid body in a nonconservative force field.

We obtain a series of complete integrable nonconservative dynamical systems with nontrivial symmetries. Moreover, in almost all cases, all first integrals are expressed through finite combinations of elementary functions; these first integrals are transcendental functions of their variables. In this case, the transcendence is understood in the sense of complex analysis, when the analytic continuation of a function into the complex plane has essentially singular points. This fact is caused by the existence of attracting and repelling limit sets in the system (for example, attracting and repelling foci).

We detect new integrable cases of the motion of a rigid body, including the classical problem of the motion of a multi-dimensional spherical pendulum in a flowing medium.

This activity is devoted to general aspects of the integrability of dynamical systems with variable dissipation. First, we propose a descriptive characteristic of such systems. The term “variable dissipation” refers to the possibility of alternation of its sign rather than to the value of the dissipation coefficient (therefore, it is more reasonable to use the term “sign-alternating”) [1, 2].

We introduce a class of autonomous dynamical systems with one periodic phase coordinate possessing certain symmetries that are typical for pendulum-type systems. We show that this class of systems can be naturally embedded in the class of systems with variable dissipation with zero mean, i.e., on the average for the period with respect to the periodic coordinate, the dissipation in the system is equal to zero, although in various domains of the phase space, either energy pumping or dissipation can occur, but they balance to each other in a certain sense. We present some examples of pendulum-type systems on lower-dimension manifolds from dynamics of a rigid body in a nonconservative field.

Then we study certain general conditions of the integrability in elementary functions for systems on the two-dimensional plane and the tangent bundles of a one-dimensional sphere (i.e., the two-dimensional cylinder) and a two-dimensional sphere (a four-dimensional manifold). Therefore, we propose an interesting example of a three-dimensional phase portrait of a pendulum-like system which describes the motion of a spherical pendulum in a flowing medium (see also [3, 4]).

To understand the difficulty of problem resolved, for instance, let us consider the spherical pendulum ( $\psi$  and  $\theta$  — the coordinates of point on the sphere where the pendulum is defined) in a jet flow. Then the equations of its motion are

$$\ddot{\theta} + (b_* - H_1^*)\dot{\theta} \cos \theta + \sin \theta \cos \theta - \dot{\psi}^2 \frac{\sin \theta}{\cos \theta} = 0, \quad (1)$$

$$\ddot{\psi} + (b_* - H_1^*)\dot{\psi} \cos \theta + \dot{\theta} \dot{\psi} \frac{1 + \cos^2 \theta}{\cos \theta \sin \theta} = 0, \quad b_* > 0, \quad H_1^* > 0, \quad (2)$$

and the phase pattern of the eqs. (1), (2) is on the Fig. 0.1.

The assertions obtained in the work for variable dissipation system are a continuation of the Poincaré–Bendixon theory for systems on closed two-dimensional manifolds and the topological classification of such systems.

The problems considered in the work stimulate the development of qualitative tools of studying, and, therefore, in a natural way, there arises a qualitative variable dissipation system theory.

Following Poincaré, we improve some qualitative methods for finding key trajectories, i.e., the trajectories such that the global qualitative location of all other trajectories depends on the location and the

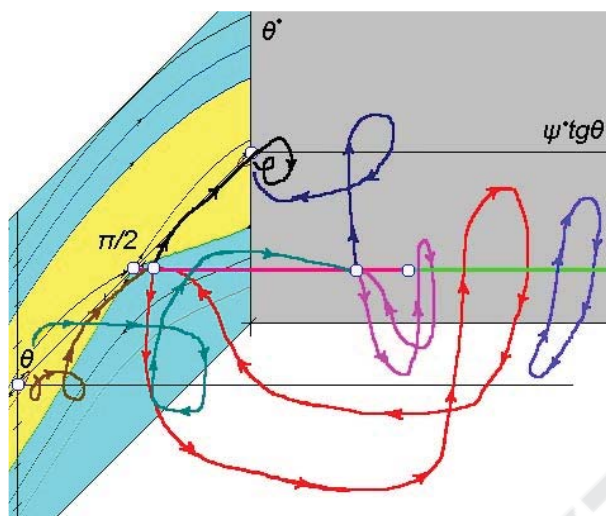


FIGURE 0.1. Phase pattern of spherical pendulum in a jet flow.

topological type of these trajectories. Therefore, we can naturally pass to a complete qualitative study of the dynamical system considered in the whole phase space. We also obtain condition for existence of the bifurcation birth stable and unstable limit cycles for the systems describing the body motion in a resisting medium under the streamline flow around. We find methods for finding any closed trajectories in the phase spaces of such systems and also present criteria for the absence of any such trajectories. We extend the Poincare topographical plane system theory and the comparison system theory to the spatial case. We study some elements of the theory of monotone vector fields on orientable surfaces.

#### REREFENCES

- [1] M. V. Shamolin. Classes of variable dissipation systems with nonzero mean in the dynamics of a rigid body. *Journal of Mathematical Sciences*, 122(1) : 2841–2915, 2004.
- [2] M. V. Shamolin. *Methods for Analysis of Variable Dissipation Dynamical Systems in Rigid Body Dynamics*. Moscow : Ekzamen, 2007.
- [3] M. V. Shamolin. Dynamical systems with variable dissipation: approaches, methods, and applications. *Journal of Mathematical Sciences*, 162(6) : 741–908, 2009.
- [4] M. V. Shamolin. New Cases of Integrability of Equations of Motion of a Rigid Body in the  $n$ -Dimensional Space. *Journal of Mathematical Sciences*, 221(2) : 205–259, 2017.

<b>Konovenko N., Lychagin V.</b> <i>On projective classes of rational functions</i>	<b>71</b>
<b>Kozerenko S.</b> <i>Orientations of trees and signed Markov graphs</i>	<b>73</b>
<b>Kuzmenko T.</b> <i>Constructive description of <math>G</math>-monogenic mappings in the algebra of complex quaternions</i>	<b>74</b>
<b>Lyubashenko V.</b> <i>Moyal and Rankin-Cohen deformations of algebras</i>	<b>76</b>
<b>Markitan V.</b> <i>Fractal properties of sets associated with Markov representation of real numbers defined by a double stochastic matrix</i>	<b>78</b>
<b>Matsumoto K.</b> <i>Warped product semi-slant submanifolds in locally conformal Kaehler manifolds</i>	<b>79</b>
<b>Mormul P.</b> <i>Weak and strong nilpotentizability in the monster towers hosting flag distributions</i>	<b>80</b>
<b>Mukhamadiev F. G.</b> <i>The local density and the local weak density of <math>N_7^{\mathcal{O}}</math>-kernel of a topological space <math>X</math> and superextensions</i>	<b>82</b>
<b>Muradoglu Z., Gunduz Aras C.</b> <i>A study for decision making problems by using interval soft sets</i>	<b>84</b>
<b>Muradov R. S.</b> <i>Archimedean copula functions and their some algebraic properties with applications</i>	<b>85</b>
<b>Obikhod T. V.</b> <i>BPS states of Fourfolds as candidates for Kaluza-Klein modes</i>	<b>87</b>
<b>Parasyuk I. O.</b> <i>Landau-type inequalities for curves on Riemannian manifolds</i>	<b>88</b>
<b>Prislyak A., Prus A.</b> <i>Morse-Smale flows on torus with hole</i>	<b>90</b>
<b>Reinov O.</b> <i>On nuclear operators with trace <math>V = 1</math> and <math>V^2 = 0</math></i>	<b>91</b>
<b>Sabitov I. Kh.</b> <i>Multiple roots of the volume polynomials for polyhedra</i>	<b>92</b>
<b>Samokhvalov S.</b> <i>Theory of gravity in the affine frame</i>	<b>93</b>
<b>Shamolin M. V.</b> <i>Integrable systems with dissipation on the tangent bundle of two-dimensional manifold</i>	<b>94</b>
<b>Turhan T., Ayyildiz N.</b> <i>On geometry of spatial kinematics in Lorentzian space</i>	<b>96</b>
<b>Turhan T., Ayyildiz N.</b> <i>A study on the integral invariants of a closed spacelike ruled surface</i>	<b>97</b>
<b>Vasilchenko A. N.</b> <i>Dual modules over Steenrod algebra 2</i>	<b>98</b>
<b>Vlasenko I.</b> <i>Topology of the basin of attraction of surface endomorphisms.</i>	<b>100</b>
<b>Voloshyna V.</b> <i>About some properties of functions determined as transformations from <math>W^n</math> to <math>W^m</math>-representation</i>	<b>101</b>
<b>Vyhivska L.</b> <i>On the problem of product of inner radii symmetric non-overlapping domains</i>	<b>103</b>
<b>Yildirim S., Ayyildiz N.</b> <i>A Study on Rectifying Curves in Semi-Euclidean Spaces</i>	<b>104</b>
<b>Арсеньева О. Е., Кириченко В. Ф., Суровцева Е. В.</b> <i>Эрмитова геометрия почти контактного метрического многообразия</i>	<b>105</b>