Semjon Adlaj

An open report on

«Modular equations and fundamental problems of Classical Mechanics»

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in the conference-hall of the Computing Center of the Russian Academy of Sciences

at a meeting of the A.A. Dorodnitsyn seminar

«Methods for solving problems of Mathematical Physics»

First video

V.I. Vlasov: Semjon Adlaj is a researcher of the department of Mechanics of our institute. You have 50 minutes.

Thank you. So, I must respond immediately to the main question, which is often asked by my colleagues; and of course, it is of interest to all. What is the relationship between the modular equations and the fundamental problems of classical Mechanics? Why such a title? And of course, I must settle this question before anything else. We all know of the upcoming mathematical congress in 2022. And the time has come to prepare for it. In such a fashion as our athletes wonderfully prepared for the Sochi-2014 Olympics. Here is one of the most active organizers of the upcoming congress. Get acquainted: Nikolai Alexandrovich Vavilov. A man of extraordinary talents. He reads primary sources in their original and quite distinct languages. That is, he is an entirely phenomenal person. My whole family is very happy to meet with him every year in St. Petersburg. Very interesting. And so, in particular, he read Cauchy original writings. He also read Galois. And here is his quote, which I cannot but present to you, as it struck me for being so unconventional. Well, as I already said, an extraordinary man. So, I now read it: «There are tens of thousands of mathematicians like Cauchy, but Galois is the only one of his kind»! At a conference in Tula, where I delivered a talk, I met a remarkable specialist, on quasicrystals, from Krasnoyarsk, Alexey Viktorovich Timofeenko. After his plenary presentation (on Parquet-Hedron) I learned from him about quite a striking man: our compatriot Yuri Ivanovich Merzlyakov, who worked in that very subject, which I intend to present to you. It is quite a dramatic story, but I have no time, so right now I'm moving on. You might later on learn all this from the Internet. It is, as well, very-very complicated, but let me, currently skip it, although there is so much that deserves a separate report here. So, my report in Tula was entitled: «On the little-known, dinkum revolutionary contribution of Evariste Galois». Well, I think that my promise was fulfilled, and now you, probably, won't be bored, I promise you, and, if needed, I am ready to continue, after the report, responding to questions, which, moreover need not necessarily be strictly formal, as they are at workshops. They might possibly be indirect. So here is a well-known review of the theory of Galois, called «the Galois Theory from Lagrange to Artin»; and I just want to draw your attention here to a quote. Who knows English: «The sections of the second memoir dealing with elliptic integrals were never written, nor, apparently, was any part of the third memoir». The last letter of Galois consisted of three memoirs, and he (Kiernan) says, that's the second and third memoir ... Now Kiernan says: «The outline-of this material in the letter was very sketchy, and did not influence later Mathematics». «It did not influence later Mathematics»! That's the second and third memoirs. So, here's the original manuscript for you, which, in particular, is known to Nikolai Vavilov. And indeed, these are the first two pages of this letter. Absolutely fantastic writing; it was written the day before the assassination of Evariste Galois. In total, it contains seven pages. And indeed, in the classical sense of the theory of Galois, which is taught in all the universities, it was set out on these first two pages. Here then, as is poorly visible, there are these simple groups, and it ends with the fact, that the smallest simple group has order 60. Right here! All the information in abundance! So, the material set out in many textbooks is all here! On these two pages! The next two pages: it already is that which «did not influence later Mathematics». That's what I was talking about then. Well, we might in anticipation proceed a bit further ahead and declare the fact that it is, of course, quite there, you might say, the most contemporary Mathematics! Just, at times, it is being attributed to others. That done by Galois alone and entirely, is sometimes attributed to many, and many others. So what is going on here, and how is it, moreover, related to the modular equations and to the problems of Mechanics? So, quite simply I might show you, for example, the third memoir, the longest. It consumes three pages: so here it is and still no one knows how to decipher it! So, there is such a famous mathematician − Alexander Grothendieck, and there is his famous period conjecture. Here, I draw your attention: a conjecture! And it was undoubtedly inspired by this last part of Galois's letter. Grothendieck, being a noble man, admitted that Galois abilities have exceeded his, being of higher order. That is, upon comparing himself with Galois, Grothendieck had always perceived himself very modestly. So, in fact and still, the next generations will have to deal with the third memoir. I can only tell you about the second. So, here is a poorly visible, which in fact is a very clear and detailed image. It later turned out that the projector was intentionally installed with a damaged lens. So that, in the near future, I promise you: you will learn about it. So, there are the famous elliptic functions of Weierstrass and Jacobi. In Watson and Whittaker course of analysis there are two distinct sections: that according to Weierstrass and that according to Jacobi. And they are not unified, that is, people learn that here is a theoretical approach of Weierstrass, and another more hands-on approach of Jacobi. However, the matter of fact is that, of course, there is a unifying approach, and it is what needs to be learned from the constructive Galois Theory view point. So here it is. This is the Galois essential elliptic function. It possesses amazing symmetry properties. Canonical and really quite natural. Which you will now see here and in practice − in problems in Mechanics. Moreover, in the fundamental problems of Mechanics. So, here it is not seen clearly, although it is quite detailed, so you can then consider the references, perhaps. That is possible, since everything here is posted on the Internet in its public domain − long live Alexandra Elbakyan! So, here are the points calculated. There is a guide to special functions, the NIST digital library of mathematical functions, which is available on the Internet. There the quarter-period points of the Weierstrass function are calculated. Note, we have eighth-period points here! And then we have quite efficient algorithms, for dividing points in half, which are of most immediate importance for accurate practical applications! As you know, the subject of elliptic functions was started with elliptic integrals, and then continued into elliptic curves. So here is today different names for one and of the same subject! Just in order to divert attention from the fact that the same tasks stand, although named differently. But these subjects come together in applications, so that Mechanics and elliptic functions are inseparable parts! Quite sadly, such is the state of affairs today that the «elliptic functions» are avoided, upon hearing them, or attempts are made to reduce them to degenerate cases in sines and cosines. Here, and often, exact solutions are replaced by the so-called approximate solutions, which, strictly speaking, from the point of view of mathematical logic, as rightfully pointed out by my colleague who is the chief-scientific researcher of the Rostec Corporation, that these solutions are generally incorrect. And so here, I draw your attention to the so-called approximate solutions, and I will give you an example, which are simply and plainly incorrect. By the way, I have twice − then there is a witness who was a graduate student of Ernest Borisovich Vinberg whose report was followed by an interesting dispute, to which I listened. So here, I met with Vinberg twice, and he confirmed to me that, most strikingly, the Moscow State University, where the Department of Higher Algebra is located, does not study the theme of this second memoir of the letter of Galois. He was very surprised, as a man sincere and well-deserved, but he genuinely did not know about this very great endeavors. Since, as a matter of fact, this is the theory of elliptic curves, in the current terminology, but it is nothing else than another naming of the subject of modular equations. Galois was the one who established the connection between the roots of the modular equation and the torsion points of elliptic curves! It's his sole merit, and I spoke about this for the first time in St. Petersburg. And my dear friend, whose conference

I attend every year in St. Petersburg, asked me to write an article on this subject. So now you can find it on the Internet. So here, then, is a fundamental object in general in all Mathematics, and I must say, in Mechanics, as well! This is the so-called the fundamental domain of action of the modular group! That is, for us, from the point of view of Mechanics and its interests, each point is an elliptic equivalence class, I'm sorry, that is a lattice equivalence class. So, as you know, the elliptic functions are doubly periodic − they are defined on a torus, and each point corresponds to the equivalence class of such a torus. So here's this fundamental domain of action of the modular group on the upper half-plane, and more precisely said, and this is very important as from now on we shall proceed with such refinements, that rational straight line must necessarily be added to the upper half plane. And not only a rational line but the rational projective line, that is, the rational straight line, replenished with a point of complex infinity. The complex infinity point is, in fact, the boundary point of this fundamental area, here, and all rational points correspond to the same boundaries of modular domains, which are formed under the action of the modular group. I, unfortunately, cannot continue to infinity, so that will emerge into a wonderfully beautiful picture, which does not have anything in common with this finite one here. So, this is some partial image. And so, the fundamental domain is a domain of the so-called Klein modular invariant. This means that it is a bijective mapping of the modular domain onto the Riemann sphere. Moreover, the infinity point is mapped to the infinity point. That is, here, we have in mind the replenished fundamental domain. So here, it is an injective and surjective mapping; which, in other words, is called − a modular form of weight zero. A central object in number theory. You probably have heard these very wonderful thing about all these monstrous groups. I do not even recall how would it be translated to Russian, but what we are really interested in is not only the modular invariant, but its inversion. As a matter of fact, if you look at these standard textbooks on number theory such, for example, Manin − Panchishkin, then you find proofs, that the said function is bijective. But such a proof would not suffice for us. We need a constructive proof − we need to present the inverse! So here it is presented for you − not merely the inverse but a fast inverse. And look here to what is being used. Here, at the bottom, I ask for your attention, it is the arithmetic-geometric mean. These are fantastically elementary things which are not taught, for whatever reasons, at the Moscow State University or other leading universities. This is quite strange since it is exactly what is needed for calculating elliptic integrals. Not, in any case, the Taylor series, with their convergence troubles, but these functions which are also suitable for the calculation of elliptic functions, which are present everywhere! They are ubiquitous! By the way, there is the 1976 article by Richard Brent. But let's move ahead, since our time is too limited for a stop, and I want to get to the most important thing. I have to tell you what the modular equation is. Otherwise, it would be rather funny if I finish without you knowing what a modular equation is. A single equation, at least. So here is the modular equation. Attention: definition. We have arrived to the main definition. So, this equation, well, as it turns out, it possesses rational coefficient, connects the values of modular invariant, which is quite unjustly named after Klein, though of course, all this is due to Galois, not Klein, at a point tau, that is, a point in the modular region, with the point n tau, that is, a multiple of tau. So, this modular equation, which connects these two values, possesses properties of symmetry, and if we now consider the rational field, obtained by adjoining the rational function of j in its variable tau, that is, the Klein modular invariant, then over this so obtained field, we have a univariate-function field; and for this univariate function we get the modular equation of level n. Amazing! But that's exactly what Galois wrote about. He just wrote right away, as he had little time, about all this very capaciously and succinctly. He immediately, of course, as he went to his death the next day, proceeded to his target. And, I'll just give you a concrete example. Here are two modular equations of level 3 and 5. So that's just for you to see. Here is three. It was calculated by Smith in 1895. And here are five. Berwick − and it is already 1916. Why do I quote this twice? This is not fundamental in any way. We just have such a normalization of the modular invariant at the point i: 12 cubed, that is, 1728. At times you might read that there is a deep meaning to this. I'll tell you. There is no deep meaning in this. You must take the correct normalization − 1. And here's this other normalization, whereas the upper − is that normalization to 1. Of course, nowadays we have computers. There is a site, a wonderful site, I forgot the name, oh yes, Sutherland. He, with the help of a computer, calculated three hundred equations (https://math.mit.edu/~drew/ClassicalModPolys.html). But I would not recommend to anyone taking the three hundredth, since no USB flash drive would suffice. The size of the corresponding file may exceed a terabyte. I do not know exactly how much. I'm afraid, that I have not completed my work. I would like to carry out the calculation here, in order to tell you, but I have not done it. So, excuse me. And, so, this letter of Galois, which was characterized by Hermann Weil, here today a conference of Oleg Georgievich Smolyanov is going on, where I gave a talk in English and where he (Weil) was very often mentioned. Absolutely wonderful physicist. And here is how he quite succinctly characterized this letter of Galois. He says: This is «the most substantial piece of writing in the whole literature of mankind». But why did he say that? Because, he too read the manuscript. And not whatever is written about it. You might read too about whatever is written about it, with all sorts of warnings not to exaggerate its importance. But those, of course, did not read the original manuscript. So there in the original manuscript, Galois, in a fantastic way, presented the necessary and sufficient condition for depressing the degree of the modular equation of level p. So, all know, of course, no doubt, the concept of irreducibility of a polynomial. Or, at least, heard about it. This is a concept that Galois introduced. But, probably, very few know, that he introduced this other concept. The concept of depressability of the degree of an equation. That is, an equation can be irreducible, but, simultaneously, its degree might be depressable! This is perfect, as here he has all such absolutely capacious things that require a very long time ... So, in particular, he immediately determined all the Galois groups for all modular equations of level p! So, they turned out, attention here: the Galois group for the modular equation of prime level p is the projective special linear group over a prime field of p elements. That is, the finite field of p elements, which was also introduced by Galois. But the field of finite elements was introduced by Galois not for the sake that people just study them in algebra on their first or second course, then to be forgotten. He introduced them for this construction to be made! That is, he has identified all the Galois groups for these modular equations of prime level p, and he further said, that all these groups are simple! This required very long and painful efforts to grasp, because this concept was combined with the group, possessing a subgroup of index p, in three instances, only! So, of course, these subgroups of index p are not normal, since the ambient groups are simple, and these groups possess groups of index p, that is, subgroups of index p in 3 cases, only, for p equal to 5 , 7 or 11! And never more! In no way and no one can understand how did he arrive at these things and how did he know that! Because, by the way, the case of 5, yields the decisive contribution for solving the quintic equation! That is, you can read in encyclopedias (including the Soviet encyclopedia), that the quintic equation was solved by Hermite and Klein. This is quite unfortunate since Cauchy seems to had managed to mislead us. As he struggled against Galois for a very long time, even after his murder, and Klein intentionally emphasized Cauchy, in order not to mention Galois! As matter of fact, Cauchy did steal the papers of Galois and handed them to Hermite. Hermite then had no choice but to refer to Galois! But the history maintains its silence here. As Hermite had a single construction which Galois had determined for the case of 5. Here, I show it to you now on the next slide. That what Galois did is called in modern language: a permutation representation of the projective special linear group over the field of five elements. The group turned out to be isomorphic to the alternating group A5. That is, the group, and I clarified here: this is a group of rotations of the icosahedron, that is, a group of order of sixty! This is precisely the group of the quintic equation in the most general case, if we adjoin the square root of the discriminant to the field, generated by the coefficients. So here it is, this unique construction, which resolves the equation of the fifth degree. I have no time and will not begin to tell you how this equation is constructively solved. I'll just tell you that all sorts of computer applications such as the Mathematica, and others, cannot do it, until now, because Hermite made a typo! And in order to make the correction, you need to understand the branching of the solution, and so being a programmer would not suffice. You have to, as might be said, deal with elliptic functions! Nevertheless, what Galois did on these two pages, is absolutely sufficient! And nothing else is required! Although the modular equations are very bulky, they turn out to be very efficiently solvable via the elliptic functions! That is, quite exactly for the account of that connection, about which I told you, between the torsion points of elliptic curves and the roots of modular equations. We have here the most modern applications. As you know, the torsion points of elliptic curves is quite a domain of current and most advanced research. And it is, by the way, very well sponsored. And very sorrowly, what a miracle, that the elliptic functions are now still being avoided in Mechanics. Never mind, it is merely a matter of time since they are certainly to come back, especially due to current and relevant applications. So, now we go on to skip all this since that time is so little. So, let's get to Mechanics. Here then, somebody who recently wrote a doctoral thesis. It is a pity, that this is very badly seen. Here then this 2016 paper in English. There are four citations: there is Huygens, Appell and, well, your humble servant − the fourth. So, they...

I.F. Kozhevnikov: maybe it 's better to make a full screen? I don’t see anything!

Yes, then it’s better to be done. Then it was not yet known that the lens of a working projector was intentionally replaced with a damaged lens in order to sabotage the report. .

A.F. Telegin: below, below, here.

So, this is the Russian original. Now this is very surprising.

A. F. Telegin: previous page? This is just that. And here in Russian!

So, this is the article of 2016, this is the Russian version. So, I’ll read it to you, if not everyone can see it. I'm curious to hear such things about myself. Well, right away, I’ll say in advance that this is such a misinterpretation...

A.F. Telegin: wrong, yes!

... a raise in the citation index:

«According to Semjon Adlaj many (if not all) authoritative sources of the Mechanics currently refer to the elliptic solutions of the problem (the problem of the period of the pendulum is meant). Thus, the method for solving the problem of determining the period of oscillations of a pendulum with large deviations by integrating the differential equation of motion leads to elliptic integrals. As is known, elliptic integrals do not allow a solution to be obtained in elementary functions, but only an approximate solution by the method of iterations.»

Well, in general, this is certainly a nightmare.

A.F. Telegin: they do not understand!

Nevertheless, this reflects the state of affairs. Today. What degradation has it at times comes to. A good statement about this was made, I think, by Valery Vasilyevich Kozlov. There were Abelian integrals with which humanity had reached heights, whereas now that knowledge has somehow been lost. Well, then, that surely ought to be brought back. So, the famous book of Appell. Sorry, this is Landau. This is Lev Landau. So, he calculates the period of the pendulum right below. Here he writes that «the first term of this expansion corresponds to the well-known elementary formula». So which elementary formula? This is a period of small oscillations of the pendulum formula. So, why is there such a misconception that people confidently write such things which would seem quite strange? Because authoritative sources, and Landau is undoubtedly an authority, says so! And then of course, some, well, let’s say here, not so long ago − it’s already the year 2010, say:

“Unfortunately, a single analytic expression, describing the trajectories of the pendulum in the libration and rotation zones, is impossible”! That is, it is somehow written in black on white. But the fact is that, of course, Jacobi described the problem of the pendulum to us. Notice! Not Gauss. Gauss was a man who adhered to what he said, concerning a work, which if not entirely done then it is not, at all, done. And so he did not do it. And now I will show you what remained to be done. With this example, only in 2013, for the first time in the world, get acquainted: David Simpson. This is a NASA scientist who wrote a textbook on physics, here it is available to you, for your review. Here, then, this is our elementary task, concerning the pendulum. Here you have the period, please. Here is a formula, such a formula. And then look what he now writes − formula «O.17». The formula for the period is expressed through our well-known formula for small oscillations of the pendulum. However, multiplied by this: one divided by the arithmetic-geometric mean of the unit and cosine of theta in half, where theta is the angle of maximum deviation. For the first time, only in 2013 did such a formula appear in a physics textbook. And many said that since this formula is not in the textbook on physics, then it does not exist. It does not exist! But it turns out that Gauss discovered this formula! In 1799, May 30! Just over two hundred years have passed until ... And now I will tell you what we want to come to. We want to come to interesting applications, it is imperative that people there are not disappointed, we will definitely come to the Dzhanibekov effect. But for this, it turns out, I have to tell you such absolutely fundamental things about the simple pendulum. So, this pendulum is, notice, in the lower stable equilibrium position. Here the Hamiltonian is written out, here we have the kinetic energy − this is theta with a dot squared in half minus the cosine of theta − this is the potential energy, that is, this is total energy, here it is minus one, in the lower equilibrium position. So, there is, of course, such a trivial solution that I decided to express in this form. By the way, I showed you that function, that essential function, which actually is the Galois elliptic function. Absolutely this display. Just a little time. So, then, why am I writing it in this form? So this is not that familiar look. This is e in degree and, multiplied by theta − angle of deviation. So here. So, in the case of a stable position, we, as you know, have this, let's, now I will depict a pendulum here. Here is his lower stable position. Here. Hence, the period of small oscillations of the pendulum. When is he faithful? The formula for the period of small fluctuations? Well I'll tell you. The thing is absolutely correct from the point of view of logic, here we have a specialist who can confirm. From the point of view of logic, this formula is true only when the pendulum is standing. That is, it is in a lower position of equilibrium. That is, as soon as we deviate, this formula is already incorrect. That is, what is called approximate, another strict mathematical language, it means incorrect. It is wrong. Period. Nevertheless, in a lower equilibrium position, in a stable equilibrium position, it means, you see, we have a differential equation - it is non-linear! No one promised uniqueness of solutions! Here! Therefore, the reasoning, or two reasoning, is that kinetic energy should be positive; and there is physical reasoning that the lower position is stable. So here. These two arguments are wrong! So, if you just give your students, because I know that students came here to check by virtue of the equation, this is the solution. Here. It turns out that we have infinitely many solutions. And of course, they are in a complex field of how people will mind. And you can even agree with them for now, so these are truly comprehensive solutions. In a complex area. But their period is real! The period is two pi time the square root of l divided by g! Strictly and precisely! This is just the case! This period is not just a tautology; it would seem that the pendulum is here in a lower equilibrium position. Here. There are, besides this solution, there are infinitely many solutions that have exactly a period of two pi times the square root of l divided by g. And why is this so important? Although it seems that this is some kind of, well, why?

A.I. Diveev: But what g is here under your root of that?

g is the acceleration of free fall.

A.I. Diveev: A!

I beg your pardon for being so hasty, many things deserve more attention, and I do not mention them, so I will be glad to continue to explain as much as needed. So, here let me present to you the Gauss formula that I mentioned, so this is 1799, when he calculated the length of the lemniscate of Bernoulli. And he wrote that it would be a new era in analysis. But he wrote this to his desk. Appell was born the year Gauss died. He did not know about it. Although he had a whole chapter on elliptic integrals and on the Landen transforms. He did not undertake the last step, this is just the last step. The calculation of the period of the pendulum via the arithmetic-geometric mean remained to be done. And that is why Whittaker did not know either. And, subsequently, Landau did not know it. And then Arnold did not know. Well and so on. Until this calculation which appeared in 2013. Well, I won't do it, I'll just give such a primitive analogy, nevertheless, it may be useful to someone. So, to say that the small oscillation formula is correct, is the same as saying that we have such a function, it is analytic everywhere except for single pole: divide one by (one minus x) and consider its Taylor series. Now, if we take this constant term − one, and then propose to approximate this function with this constant term. That is why I absolutely do not understand that insistence, when there is an exact formula, when people stubbornly do not want to introduce it to courses in Mechanics, because I suggested it before it appeared in the United States. I suggested it to many of my colleagues. By the way, there one wonderful person who didn't reach us today, but nevertheless, he had already introduced it, at the PhysTech. He must be here. Unfortunately, he seems not to arrive, as I do not see him. Well, that is, in the end we will have it, of course. In courses in Mechanics, the exact formula for the period of the mathematical pendulum should be given. So, that means, well, here are also very important things, but I'm not sure that I will talk about them, because there are things that are even more important. So, it turns out, there is the duality that Appell discovered for the pendulum, it continues on to the duality between the lower equilibrium and the upper equilibrium. So, those who wanted to brush aside the solutions of the lower equilibrium position for being complex and void of mechanical meaning, here they are real-valued now.

Second video

Here the uniqueness of solution is violated! So, in vain, Arnold did not listen to his teacher: there is such a wonderful person (Jean Leray) an expert on algebraic topology. He was then discussing the Euler equations with him. And for Arnold the equations of motion for a fluid and for the rigid body are much alike. Arnold was then told of the violation of uniqueness. But, instead, Arnold chose another approach − that of a dynamical system, and it has, generally led, as must be said, to nowadays non-constructive approach. So, we must go back to these ideas! So here, I want to say, that this upper equilibrium position, which ought not, in any case, be perturbed, then when told about the violation of stability, it would be explained in such a manner, where we are told that if we slightly disturb this position, then the pendulum would overturn. This is absolutely such a vapid thing, well, it's just that some kind of, to some extent temporary, contagion from which we shall soon get cured. The case in fact is that the pendulum in its upper equilibrium position be must not, in any case, be perturbed, because and again this equation has no unique solution. And the upper equilibrium position is its non-unique solution. It has other solutions, as we might say, a clockwise rotation or, I don't know, it might be a counterclockwise from your point of view? There are two rotations − clockwise and counterclockwise. Two! So, in general, we have three solutions! In the sense that none of these solutions can be obtained from another via a finite «real» phase shift. That is, as soon as we deviate, there is no longer such solution. By no means do we then have any other option! And only in this upper equilibrium position do we have such two equitable critical solutions. So that's it. So. Glory to God, I've managed to arrive here with you. Now I am calm and I can take a little break.

Jacobi − 1850! Here he wrote, the problem of the rotation of any solid body, which is not solicited by any accelerating force, is amenable to resolution by novel formulas so elegant and so perfect, that I cannot help but communicate them to your glorious Academy. And, by the way, unfortunately, this has been lost to some extent! Because Jacobi, this is what he did, there was a lot of work, but it was his last big work, because he soon died there due to illness. By the way, Gauss lived another five years later, but after that he did not continue with anything on this topic. And Appell, and this is his merit, that he carefully reproduced this work like no one else! Because others, and you don't have to write about this anymore, but they somehow wrote, one might say, here I shall give you such an example, masterful: this is Arnold's famous book: «Classical Methods», I beg your pardon: «Mathematical Methods in classical Mechanics». Here, although I must say that, of course, this book is absolutely wonderful and very interesting, but we still have to implement algebraic methods, which, if it's so very fluently to be said, Mechanics began with Newton's work. Now, he wrote this Principia, which is a perfectly geometric book, which Gauss later praised, very interesting. Then there was probably a stage − Euler, who did a lot of absolutely wonderful work. Until now, we cannot reproduce them all.

Glad to see you! The speaker is greeting Maria Vladimirovna Sevastyanova. Right on, we have participants of the Smolyanov conference.

And the third contribution, and I hope that will be able soon recognized, is due to Galois! Because, of course, Mathematics and Mechanics are completely inseparable. And, as I said, elliptic functions and curves are completely central to Mechanics when it comes to exact solutions. So, look, it's too small here, and I want to draw your attention. This is where Arnold deduces Poinsot's construction, and he says: here we have this body returning to its original position up to a rotation through an angle of two pi, that is, pi is the famous constant, p over q − he does not say what p over q is but he clearly means whole numbers. And he begins to speculate upon whether this ratio is rational or irrational. This is exactly what I told you, concerning a masterful diversion of our attention to a discussion of rationality. And, in fact, what is the deepest thing which he remained silent about? It is, of course, that we need that angle explicitly calculated! Not arguing whether it is rational or not. And here is Landau, whom Arnold liked to criticize. Landau here speaks openly and honestly about this: here this expression contains elliptic functions in a complicated manner! Then he writes again «in a complicated manner», and then he sources Whittaker. So here − Landau is my hero. By the way, Galois said that the worst thing an author can do is to conceal the difficulties from the reader. Well, Landau doesn't do that. And here is Whittaker for you, but Whittaker still cheats and ends the task there with dots, and so on. In general, he refers to Appell. Well, let's now go back somehow to our days. Here is the famous production of Feynman, with which the entire Internet is teeming. As he told and described there, how he received the Nobel Prize. How did he get such a great inspiration when someone tossed a plate and it would precess, this is, the motion which he called wobbling. And it was quite obvious to him that the proper rotation went on faster than precession. And he began to calculate this ratio for the plate. Well, by the way, I will draw your attention to the fact that since we shall assume that the plate is a flat body, and since it is symmetrical, then it is really quite easy to understand that the moments of inertia are: one, one, two. Yes. Because for a flat body, the third moment of inertia is the sum of the other two. So, he calculated what that ratio was, well, then he talked about how it led him to diagrams, and how it all started from there. However, after his death, there was Benjamin Chao, who dealt with the Chandler effect, it concerns the precession about the Earth's axis − the Chandler wobble. He knew the correct ratio, of course, and he says, wait, this cannot be true! What was obvious to Feynman turned out simply not being true. So somehow, I would also remind, many do not quite know, that an obviosity need not turn out to be true. So, that ratio, what seemed to him so, turned out to be exactly the opposite. And what did Feynman say? It was some kind of complicated equation. Let's talk about this complicated equation. Now we are generally quite close to our main theme, which we want to come to. This book, here probably the experts would know: Schaub, Junkins: Analytical Mechanics of Space Systems − tethered systems. This is the fourth edition, concerning space tethered systems. They calculated that ratio.

The first call in connection with the maliciously created obstacles for attending the discussion of the report, despite the open invitation “welcome everyone”, which was announced on the website of the FRCIC RAS. (II, 7:02)

So this is the case when theta is equal to zero, this is B over C, that is, here the moments of inertia: one to two. This is just that complicated Feynman equation, but nevertheless there is an excuse here: of course, Chao also avoided discussing this formula, because it turns out some kind of uncomfortable thing that one wouldn't want to talk about, what if we have such a spherical tensor of inertia, where the ratio would turn out to be one to one. So, for a sphere, we get that ratio of precession to proper rotation is one to one. Well, of course, we would not want to talk about it, so such a place ought to be somehow avoided! But! Now we have learned about Feynman that he did not read Maxwell carefully. This is the same Maxwell, who is an absolutely amazing scientist who researched electromagnetism. He had eleven equations, and in the modern interpretation − four. By the way, this was not exactly his wording, but it is clearly − his merit. He confirmed that this problem is so delicate that even Newton himself somehow tried to bypass it. And, by the way, in this work he solved this Feynman's problem completely and clearly. Therefore, Feynman only had to read Maxwell before anything, and before somehow re-doing the calculations. So, this is just revealing different levels of carefulness.

The second call in connection with the maliciously created obstacles to the passage for an open discussion of the report. (II, 8:24)

So, this is just that famous book. This is the third edition. I forwarded this picture from there. This is almost the most important place. Look at it, please. Someone, perhaps, might want to object, since as I said, there is an error here. This is the axis that corresponds to the largest moment of inertia! Here! And this is for the smallest! Here, on this sphere, the kinetic polhodes are depicted, that is, these are the trajectories of the motion of the angular momentum vector in body's frame! That is, as you know, when external forces do not act on the body, the angular momentum vector is motionless in the motionless space. And here is the trajectory of its movement in the body, that is, the coordinate system associated with the body. This is the trajectory. Here are the polhodes, pay attention: they have such a direction here − from the center outwards! And here − to the center inwards! That is, these are oppositely directed curves. The curves, separating them are separatrixsemicircles, and this is exactly the circle that corresponds to the critical solution, and here it goes here, and here it is met by another, but this an all-over inflow and there are no outflow. Well, in general, people, of course, can fix that here! Anyone wants to fix it? What should be there? Would anyone like to specify the directions? Well, in general, here we have such directions here. Well, probably, these here and these there. That is, there will be two incoming and two outgoing. In general, let's supposedly be ...

V.V. Sazonov: There must be an instability here − different directions. This is incorrect.

Yes! Yes, absolutely right! That's what I'm talking about! Great, Viktor Vasilievich! This is what we are talking about. This is a wrong picture. Right! So, there is such a proposal: we are entering here. And here the directions will be in the opposing direction. I hope everyone agrees with me? Are there any objections or not? Here we have it, as it were, the orientation goes here in this direction, so here it is just the orientation toward the center. And here it will be like this: it's like an orientation in the other direction, an opposite orientation. So what I want to draw your attention to is very important for today's report! In general, the most important thing is that the curves on these two sides of the separatrix, the kinetic polhodes possess two opposite orientations! This is very important for practice! When we have a transition from one trajectory to another under an influence of some engine.

V.V. Sazonov: Why are you showing the wrong picture there?

Well. So, I'll tell you now, I'll tell you now. This is also a very good question: why am I showing you this incorrect picture?

The first SMS-message, concerning further illegal obstacles to the passage of listeners. (II, 11:34)

Because we are now supposedly now I shall correct it. This is just the whole point. Here is a famous work, one might say, by Petrov-Volodin, concerning the Dzhanibekov effect, well, relatively speaking, because this is a recent 2013 paper. These are the formulas. This is a parametrization of these very separatrices. Here. And here is another − the book of Suslov, the of 1946. There is the same parameterization. Plus, minus, plus, minus, plus, minus. Here, too, plus, minus. There are eight parameterizations. So then we are confused again? After all, we have just decided that we have four, and here we have eight! How come? So, here are three other sources. Here is Appell, Markeev, Tong & Dullin, who wrote an interesting article there about such a maneuver for divers into water, which, I hope, will be implemented at some point. It's very small here. This is that same problem with that damaged lens. So that's it. And here, in general, a very cautious approach, where there is just a single solution given: Chernousko, Zhuravlev and Rosenblat, and then figure it out yourself! Well, this is probably the right approach. Well, that means we have now reached the culmination! So, attention: this is an interesting article by Viktor Filippovich Zhuravlev, 1996, which, by the way, is often quoted by Western sources, it has been translated into English. Hence, the solid angle theorem in rigid body dynamics. Unfortunately, Viktor Filippovich is not here. I would like to clarify with him − an assumption, I have. The fact is that, of course, when the Dzhanibekov effect was discovered. This, of course, was incorrectly said by the previous speaker (S.Ya. Stepanov) that “it immediately became to be called the Dzhanibekov effect”. It was classified for many years. And only later, somewhere in the nineties, Dzhanibekov was able to discuss this topic with academicians. And apparently then, so I think, Zhuravlev got acquainted with this and he then wrote such a thing about Poinsot's interpretation. I'm just quoting. «The incompleteness of Poinsot's geometrical interpretation is related to the condition for there to be no slipping». And there he gives an example. Here, in another of his books, published recently with Rosenblatt, he talks about the Dzhanibekov effect for an axially symmetric body, where he indicates it being «ill-posed, according to Hadamard». It is his expression, and it is very, very remarkable for he notes that many authors bypass this issue in silence. And so, I must confirm that he did not silently bypass it. These very sensitive places are the purpose of my report. So, come on, as I then clarify that issue that has not yet been clarified, because, of course, I am probably already late as always, so let me tell you now without further delay.

A.F. Telegin: About five minutes more, right?

Oh, okay. Fine! In five minutes I can finish everything! This means that we have here, just as it was the case of the pendulum, why do I want tell you about it here, because the case here with critical solution, we have, turns out to violate the uniqueness again! So, we have Dzhanibekov's wingnut. Among those who are sitting here, there are some with whom we will further discuss this someday, I have such a video to show you about the Dzhanibekov effect and its a wonderful modeling, performed by the wonderful team of Mathematical Modeling of the Department of Theoretical Mechanics of UrFU. And this is precisely the critical case! Not at all a neighborhood of it! God forbid! Else, it is completely and fundamentally distinct! Because Dzhanibekov himself had a very succinct and cool description of this phenomenon. He said that the wingnut rotates here in the opposite direction. That is, in its moving body coordinate system, the orientation is flipped to the opposite! This is really quite remarkable! This is the deepest point! And what does correspond to this critical movement as the wingnut rotates in a critical case. Just like the case of the pendulum in its upper equilibrium position, we have here a stationary rotation, and why do I want get your attention, because I wanted to tell Oleg Georgievich Smolyanov about this at the seminar! I showed the animation there, but he saw this analogy! I tried so hard to approach it and I did not know how to approach her, but so he says: «It's just like a pendulum in the upper equilibrium position»! This means that, as it turns out, we have one somersault, and there is an opposite somersault, and moreover, they correspond to one and the same rotation! Clockwise! I'm not talking about the other rotation − counterclockwise. There are also two somersaults! Two opposite somersaults! But with these two somersaults and with this permanent rotation, there is one amazingly remarkable axis, which was, quite rightfully, called the Galois axis, because it is the axis of symmetry of a triaxial body! This is amazing, how is possible, as the axis of symmetry is possessed by an axially symmetric body when two moments of inertia − A = B − coincide. It turns out that there is a generalized axis of symmetry! That is, a triaxial rigid body has its MacCullagh ellipsoid.

The third call in connection with the maliciously created obstacles to the passage for an open discussion of the report. (II, 16:46)

It is not a Poinsot ellipsoid and its principal axes are proportional to the principal moments of inertia. And so the axis orthogonal to the circular section of the MacCullagh ellipsoid is the generalized axis of symmetry − the Galois axis. It turns out to possess an absolutely wonderful property! That it rotates perfectly evenly during a strictly critical motion! So, now, as Evgeny Alexandrovich Mityushov said, I now show you the correct picture, here it is, this correct picture, here is the orientation here and here. But what about the question that I have asked many, but still have not received an answer? Here we have a rigid body, but what about its mirror reflection? What equations of motion does the mirror image satisfy? The question, it would seem, can be avoided, or you can sit and read about what happened. Here it is somehow very difficult to see (that problem with the damaged lens is, again, reminding us of itself), so now I'll, so there is an error in the rocket booster algorithm. So, there is something quite interesting here, but...

A.F. Telegin: Somewhere there is a 180-degree turn.

Yes, there is. In general, I want to say that this is not a mistake of engineers, it is a mistake, as it were, ours − It is an algorithm error! So, this is an entirely fundamental question here, concerning a mirror, which many people prefer just to ignore. It is related to the picture I showed you. It turns out that to some extent those who had 8 solutions are also right. But no, that would certainly be too dishonest to praise them as if they were correct. They certainly are incorrect, because they somehow altered the sign in the Euler equations! But if employ a non-tensorial approach, and choose to apply precisely the right-hand rule; so we write down the Euler equations according to the right-hand rule. There is also Euler equations that correspond to the left-hand rule! They are not any worse, and so, you might contrapose the right pseudo-vector of the angular momentum which moves in the body to the left pseudo-vector, since you must not forget that the angular velocity «vector» is not a really a vector, but a pseudo-vector! A pseudo-vector is not simply a one that changes its direction, as Wikipedia would often and incorrectly say! This is analogous to discussing a directed graph which has an edge with negative weight, and this would not mean that that is equivalent to flipping the direction of the edge! Negative weight and direction are two different things! So, my colleague D.L. Abrarov pointed these things out. Very few responded to his letter, but he just made an absolutely wonderful observation, which many feared like fire when it came to the Klein bottle. About what we really have, if you look at the orientation change, we have a parametrization of the Klein bottle! And Klein came up with this, who as, you know, had a very direct relationship to Mechanics. Now, I don't have the time to talk about this, so let me just show you what I mean by the end of my report. Here is the problem which was posed by Loyd for a thousand-dollar-bonus.

The second SMS-message, concerning illegal obstacles to the passage of listeners. (II, 20:12)

Attempts for solving did not succeed, because the parity here is not the same! So? But here is another task − here the parity match! You see, here is the task. Here we need to get this piece out of here.

V.I. Vlasov: You have one minute!

Fine! Wonderful! Ideally! So, this is a most difficult puzzle, but it is solvable. And such exercises might be useful in order to feel this chirality: there are chiral objects, for example, the Mobius strip. So, there are two Mobius strips, there is a right and a left one. But the question can be asked for the Klein bottle: is there a right and left Klein bottle? So you understand, right? There are achiral objects, in the sense that their mirror images correspond to a rotation, and there are chiral ones, that is, like the right and left hand.

A.I. Diveev: Chiral?

Well, yes, chiral, in Russian the word chiral is avoided, because, yes, Pasteur introduced this term when he studied isomers.

Well, basically, I'm done, this is just a three-page bibliography. I'm glad you're all here to the end. And I now pause.

V.I. Vlasov: Thank you very much. Please tell me who has? Have a seat, Semjon Frankovich. Here you are, on a chair. Who has? Well, not far, well, right here, so that you can answer questions. Please tell me who has questions?

Yu.A. Fleorov: One small one, here I did not understand the purpose of the report. What was the purpose of the report? Just briefly, please.

Yes. Good. In short, yes. Thanks for the question. This is really the most important question. And, of course, I probably won't explain it at length, so the purpose of the report is pointing out the fact that Mathematics and Mechanics, contrary to such a typical point of view, which is spread, for some reason, but only in Russia, in my opinion. Yet, Mechanics is a part of physics, or Mathematical Physics, in general; and now a conference of Smolyanov is going on, dedicated to Mathematical Physics, and Smolyanov does not consider Mechanics to be some kind of separate part, which would be separate; and he being an expert on quantum field theory, and there are very interesting such analogies with Classical Mechanics: this one, for example, well, here some have seen an analogy, as it were, with Classical...

Yu.A. Fleorov (shouts, interrupting): The purpose of the report!

The purpose of the report is that Mathematics and Mechanics are one. And elliptic functions, which are now a separate branch of Mathematics, are actually a branch of Mechanics! And we must work together! We cannot leave the Mechanics to those handicraft methods that existed before Euler! Where everything was in sines and cosines. This is, of course, very good, by the way, even Newton is sometimes not referred to there, because few people have studied Principia: quite an interesting book, so at times very limited methods are applied to Classical Mechanics and taught to students. And this, of course, is absolutely not something that is very beautiful, very important, very relevant! Clearly, Classical Mechanics would have faded without it. Here is a wonderful V.A. Egorov seminar on the Mechanics of space flight, and this is where the Classical Mechanics is needed for a most practical applications! And of course you can't just limit yourself to an arsenal of mathematical methods. Just like physics allows itself everything! Uses Mathematics to its fullest, because group theory and algebra are there! And classical Mechanics should not be left out!

V.I. Vlasov: Have you received an answer to your question?

Yu.A. Fleorov: Got it. Thank you.

V.I. Vlasov: Thank you. Please, of course.

A.I. Diveev: I have this question. You know, I've watched this movie about the Dzhanibekov effect, the rotation around the middle axis, which has the axis of inertia, right?

Yes

It is intermediate in terms of moment of inertia. In general, now, as it were, all the cosmonauts are there, they even show examples on websites: they are astronauts now, any, when they arrive, they take books there, boxes. They twist them, throw everything up and they somehow rotate around different axes. Indeed, it does not rotate around the main axis of symmetry, it does not rotate around the third, but rotates around the middle one, but is unstable. I have a question here, wait. Semjon, and what else?

What is the question?

A.I. Diveev: The question is that the Dzhanibekov effect was discovered in 1985. In 1991, a paper was already written that ...

Yes, an American paper. It is not about that at all. What is the question?

A.I. Diveev: The question is, did you discover something new after that?

Yes, good. Thanks, yes. Here, by the way, is the animation that was made on another space station. That one no longer existed, and much later, when another one appeared − the Mir station.

This clarification was required, since S.Ya. Stepanov ignorantly wrote, in the theses of the aforementioned previous report, that “one of the reasons for the intensification of such activity was the video filmed by cosmonaut V.A. Dzhanibekov during repairs at the Mir space station and placed on the Internet”. However, in reality, the discovery of Dzhanibekov was accomplished by him on July 25, 1985 after docking of the restored Salyut-7 station with the Progress-24 cargo ship. He then did not conduct any video filming of his discovery in his last space mission. No less ignorant is S.Ya. Stepanov addition that “this curious movement was immediately named “the Dzhanibekov effect”. In fact, this name arose only in the 90s after the popularization of video filming carried out on board the Mir station, which V.A. Dzhanibekov never visited.

The fourth call in connection with the maliciously created obstacles to attend the open discussion of the report. (II, 24:41)

Now I will answer your question. It is, in fact, an absolutely profound observation, which is precisely that, starting with the pendulum, which, in a critical case, does not have a unique solution. Take these kinetic polehods − they have the same orientation. At the critical point, you don't have a unique solution. You have directions inbound and outbound, and in two different orientations. Thanks to the Dzhanibekov effect, one might say, the Galois axis is revealed. This is a very elementary thing, but without...

A.I. Diveev: A certain singularity of that...

V.I. Vlasov: Turn off the sound!

Yes, I'll turn it off now. By the way, yes! In order to clarify your question, let's look at this animation of a strictly critical decision. You see what a miracle! A stunt! It all starts out the same. And now, before your very eyes: this one axis is rotating! All three have one shared axis! Now look here what a miracle will occur! So...

V.I. Vlasov: But I think you answered the question?

Yes, but we only need − 25 seconds more. Now look − all three have one axis! This is what Oleg Georgievich Smolyanov referred to “as a pendulum in the upper equilibrium position,” that is, two somersaults in opposite directions! And here, in this sense, this is what is called «unstable rotation» in the literature, right? So this axis alone is very stable in this respect! This Galois axis rotates evenly! In this case, a rotation about the middle axis of inertia and regardless of whether there or not a somersault takes place. It does alone and rotate evenly! Given that you have a permanent rotation and a somersault − in one direction and in the other. The Galois axis is the same and rotates uniformly.

A.I. Diveev: Question. There are a lot of these cases, for example, in aviation, right? When an airplane takes off on a high, great aerobatics, can this theory be applied to calculate flight?

Of course there are applications for this. It will be great if people have the enthusiasm to listen to continue this work in different directions. Of course, that's the point! I just want to designate this kind of topic: the connection between Mathematics and Mechanics! And this is in order to continue this in different areas.

A.I. Diveev: So that no one doubts!

V.I. Vlasov: In my opinion, Semjon Frankovich has already answered your question.

The answer is yes. Very good thanks!

V.I. Vlasov: Please, the next question.

Yes. Required.

V.V. Shevchenko: Well, Mathematics and Mechanics are sisters, as Anatoly Alekseevich Dorodnitsyn said, but in another report he has this idea − why it took two thousand years from Archimedes to Newton to establish a simple linear relationship from which all mechanics grew, and you never answered. Because there was Mathematics of functions and there was no Mathematics of operators, so everyone just played with a coin and looked for a functional connection between what they observed − forces and speeds. With the birth of operator Mathematics ...

V.I. Vlasov: The question is what?

V.V. Shevchenko: Here, a generalization, right? Did it really lead to a new physical representation? Do you also offer some kind of generalization of existing Mathematical concepts? If so, what are the ideas?

Yes. Well, all this is quite interesting, of course, and even leads to further reflections, for example, for me. This point, perhaps to be made, is that new questions arise.

V.V. Shevchenko: A new Mathematics of some kind? You mentioned groups here, right? So you want to consider ... There are some classical equations. Groups or what? You generalize, right?

V.I. Vlasov: You have already asked your question, let it be answered!

Yes, actually, let's take this approach to elliptic functions. It turns out that there is such an approach that Sophus Lee introduced later, he referred entirely to Galois. In order to study differential equations, you need to investigate their group of symmetry.

V.V. Shevchenko: Oh, here.

And this is the required approach! That is, it's not like...

Third video

A.S. Sumbatov: So, I want to first show what the very axis of this gentleman is, which he called the axis of the noble Galois. There is ...

V.I. Vlasov: Please, I ask you to maintain silence!

A.S. Sumbatov: Kinetic moment and ... you need to turn on the light!

V.I. Vlasov: Turn on the light!

A.S. Sumbatov: Where a unit vector is considered, it means that it is directed along the middle axis. The cross product is considered...

V.V. Sazonov: in a system related to the body, right?

A.S. Sumbatov: Yes, it is in the body-related system. This is in the axle-related system.

V.V. Sazonov: A is less than B or greater?

A.S. Sumbatov (rushing): Yes, yes, yes, B is the middle axis. Here. (A.S. Sumbatov dismisses V.V. Sazonov's question, since he did not understand that there are two fundamentally different ways of ordering the axes of inertia. He is one of those who are fundamentally unable to distinguish an even permutation from an odd one). The cross product is considered, K times this vector. The answer is obvious. Hence, minus C r, zero, A p. Farther. This means that all arguments about this vector refer to motion on the separatrix. Step to the side − there is no vector. For separatrix motion only. Hence, on the separatrix, according to Euler, the motion occurs according to the following law: hence, p and r are some constants divided by the hyperbolic cosine. These constants depend on the moments of inertia and initial conditions. Thanks (to V.I. Vlasov for the chalk). This is the constant multiplied by the hyperbolic tangent. We turn to this vector product, and we see with you what, then, this movement along the separatrix. Strictly. Step aside − these formulas are wrong. But they didn't come from nowhere. They came from a general solution. There, elliptic integrals simply degenerate into hyperbolic functions. Let's take this hyperbolic cosine out of the bracket. With some constant, here we also have a constant vector. This constant vector ... Thanks (to the same V.I. Vlasov for moving the board closer to the audience). This vector is constant − this is constant C s. This constant vector, as we can see, is fixed in the body. Perpendicular to the middle axis. This is zero. And this vector, so it means, that, the speaker named, as you heard. This means that if we calculate the absolute velocity of the end of this vector in a fixed coordinate system, then we see with you that the local velocity is zero, and only the portable one remains. The portable speed is omega, multiplied by this vector tau. And this cross product turns out to be constant. The constant is as follows: the square of the angular momentum vector divided by the square of the middle moment of inertia.

V.V. Sazonov: Yes, but this is a vector, so how is it directed?

A.S. Sumbatov: So this is a vector, which means it is perpendicular, and due to this constant, you can choose different directions. This means that this vector is perpendicular to the middle axis, and its speed in absolute space is constant. The fact that the direction of the vector cannot be chosen «at the expense of some constant» is apparently not known to A.S. Sumbatov. The direction of a vector and a scalar are objects of different categories, and even more so since a scalar for A.S. Sumbatov, as it is for A.A. Burov and S.Ya. Stepanov (with whom he had been preparing, for quite a time, such a short and shameful presentation) is never complex-valued. And never for him, nor for them, any kind of compactification, let alone a complex one, is considered. Already here, any listener who has mastered the Mathematics program in general education school, even without necessarily being familiar with the topic of the report, becomes suspicious of A.S. Sumbatov's competence. And already, in the next few seconds, any residual doubts, concerning his incompetence will forever be dispelled as that confusion turns out not being accidental but fundamentally insurmountable for A.S. Sumbatov.

V.I. Vlasov: On the separatrix.

A.S. Sumbatov: Everything is on the separatrix.

V.V. Sazonov: No, but you wrote a vector formula. Here is a vector on the left and a number on the right.

A.S. Sumbatov: No, no, no, this one stands here, like his, here is a vector product.

V.V. Sazonov: Yes, but on the right is a scalar.

A.S. Sumbatov: And on the right is a scalar, well, of course, the modulus, it is speed.

V.I. Vlasov: Modulus.

A.S. Sumbatov: Modulus, modulus. Speed. This means that this is the vector that the speaker calls there. Let's say vector Adlaj, tau. A.S. Sumbatov stubbornly continues to confuse the velocity vector of the end of the original vector, which he could not calculate and therefore replaced it with a scalar, with the original vector. The inevitability of such a shameful, albeit prepared for a long time together with the more cautious S.Ya. Stepanov, failure was substantiated here http://semjonadlaj.com/Otrbivok.pdf. Looking ahead, in fairness, we note that S.Ya. Stepanov did not manage to avoid his shameful fate on the same day. So, if you look closely at this result here, then this is something and a ribbon from the side. This has nothing to do, so to speak, with the problem of integration and, in general, the motion of a rigid body. We have exact formulas. Analytic formulas, and these are hyperbolic functions are combinations of exponents. What could be better than an exponent? There are no problems!

V.I. Vlasov: I have a question for you. Can I?

A.S. Sumbatov: Yes.

V. I. Vlasov: Tell, please, Alexander Sumbatovich. Here is Sergey Yakovlevich's explanation, he spoke at the last seminar about the so-called Dzhanibekov effect, is it correct? Appropriate?

A.S. Sumbatov: Correct. I'll explain it on my fingers.

V.I. Vlasov: I See.

A.I. Diveev: So nothing comes out of this?

A.S. Sumbatov: Where from this? This is generally why I say: this is something and a ribbon on the side. Nothing comes out of this.

V.I. Vlasov: No, nothing comes out of this.

A.S. Sumbatov: It's like a play on the wall. Of unknown artist.

I took his 2012 publication. It's in «Notices» of the American Mathematical Society. I will not say the content of this work, the work seems to be devoted to the calculation of the Mathematical period, because there are no references to important works known that get exactly the same results, very close, with the help of this mean, the arithmetic-geometric mean in this particular problem. Sumbatov often, but usually secretly, accuses others of plagiarism, since not only does not have the slightest ability to independent scientific work, but also has no idea about independent scientific work, preferring to stay in a dense circle of false scientists. I'll just give you one small detail. At the very beginning, the information about the author says: Semjon Adlaj, Professor of Mathematics at the Computing Center, so, the Russian Academy of Sciences. We do not have such a position in our staff list. A little lie. And indeed, attempts to dismiss S. Adlaj is no longer limited not only by moral and ethical standards, but also by the norms of the civil and criminal code. Disinformation about the dismissal spread long before it was implemented. Then I started looking at other things. Here is just one example of fraud. So, the two of them, so to speak, with his wife, they organized means... Further, he also refutes himself, stating in the police report that he does not know the «lady», which he not only locked with a key, but also tried to resist her release. A video of his confession, in which he reveals the customer, is available here https://www.youtube.com/watch?v=eIguiWRa4h0. Further, after additional discussions with S.Ya. Stepanov and V.N. Zakharov, he assumed «all responsibility» before an investigator who questioned him exactly six months later, on July 31, 2019.

Fifth video

So, in science, please! This remark was intended to prevent the rapid degradation of the seminar to the level of the Bazaar, which was sought by A.S. Sumbatov and his overt and hidden patrons.

V.I. Vlasov: please, on science. Sergey Vladimirovich, please! In science!

S.V. Pikulin: Well, I would like to comment on some points concerning the algebra of the beginning of the report.

V.I. Vlasov: well, listen! Please!

S.V. Pikulin: So, it is about the history of Galois. Well, really Evariste Galois calculated the group of the modular equation. It is unclear what S.V. Pikulin agrees with. The report did not talk about calculating any equations, but emphasized Galois ' contribution in identifying a class of simple groups corresponding to all modular equations of level p, where p is a prime. He found out that it coincides with the General polynomial of the 5th degree (surprisingly, we are not talking about modular equations, but about one modular equation! But the speaker shrugs it off and never returns to the discussion. And even a modular equation of level 5 cannot coincide with a General equation of the 5th degree, if only because its degree is the sixth. This is the significance of identifying Galois groups of modular levels, which was described in the report, but not understood By S.V. Pikulin, who continued to Express those common and erroneous judgments that S.F. Adlaj repeatedly warned about) , which then allowed Hermit and Kronecker to provide an opportunity to present the equation of the 5th degree in Brings form as a resolvent of the modular equation (the speaker seems to pronounce tantra with a standard set of terms, without being able to comprehend his own expressions, based on forced, in the course of his preparation, the most superficial acquaintance with a new topic for him), and the modular equation, although it is in the sixth degree, but it is specially constructed (S.V. Pikulin did not understand where the modular equation comes from and therefore does not know that it is not designed by anyone, either «specially» or otherwise), all its roots are known, and this allows, in fact, to solve the general equation of the fifth degree in elliptic functions. This story is well known and described in the literature. In the literature on Mathematics, in textbooks on Algebraic Geometry. And also in the literature on the history of Mathematics. For example, in this book: Klein « the development of Mathematics in the nineteenth century.» Everything is detailed. The role of Galois is adequately and fully reflected. It is quite typical when the next ignoramus shamelessly gives himself the right to make his own, completely unremarkable, verdict on how the role of Galois was reflected: adequately and completely. So, I think that Galois does not need the intercession of anyone, including the speaker. So, but the speaker for some reason did not want to refer to literature.

V.I. Vlasov: Please tell me, did you hear anything new about algebra in the report?

S.V. Pikulin: No. More than that, then. So, as far as I understand, the speaker claims that the methods of Galois Theory are applicable to Mechanics. Galois Theory deals with well-defined objects. It is the Galois extension of fields, that is, it is separable, normal algebraic extensions of fields. Not a word was said about the fields here. Banal lies and inattention! S.V. Pikulin again gives a template interpretation of Galois Theory, and failed to understand that the report was about the second memoir of the last letter of Galois, and not just the first, which became, as it was told, the basis for the interpretation of Galois Theory in the sense that S.V. Pikulin learned, but was not even able to assume the existence of another unconventional interpretation of the deeply constructive Galois Theory. Moreover, in the report, for the purpose of subsequent exposure, a slide was presented on which it was stated that the 2nd and 3rd memoirs did not have an impact on Mathematics. It is not clear what S.V. Pikulin was doing during the report, but he continues to be unaware of the very fact of the existence of the 2nd and 3rd memoirs of the last letter of Galois and apparently does not have any ability to identify contradictions in his own poorly connected and primitive presentation of standard interpretations. Also, a Galois group is a group of automorphisms of these extensions that rearrange something. Some equation or sheets of surface, Riemann surfaces. Nothing else is visible here. Here and further S.V. Pikulin, uses the opportunity given to him by his supervisor V.I. Vlasov, and begins to voice his primitive views. Accordingly, the Galois Theory does not seem to have any relation to the material presented. Next, Lee's Theory of continuous differential equations was mentioned. This is a very useful approach that has produced a lot of results. At least, Noether Theory, which provides conservation laws, and so on and so forth. But here again, we are not talking about any symmetries, let alone continuous ones. Therefore, the Lie Theory and the theory of symmetries of differential equations also have no relation to the material presented. Further. It was said that… About non-uniqueness. This is the key point. So, I want to draw attention to the fact that the linearity of the equation and the uniqueness of the solutions have no direct relation. For example, in the complex domain, there is Cauchy theorem, which, therefore, gives uniqueness. Well, there we are talking about analyticity and not about linearity, and the given examples of non-uniqueness of solutions are simply incorrect. S.V. Pikulin has serious problems with logic, which do not allow us to understand what exactly he criticizes, and even more so, where he avoids making clear. Differential equations in the report were not considered in the usual way (for S.V. Pikulin and his instructors) in normal form, and the Cauchy theorem was never mentioned, since the conditions for its application were not met. This simply ruins the entire logical structure of the report. From which I conclude that the material presented is extremely improbable and probably erroneous.

A.F. Telegina: I don't understand! What is wrong? What are the wrong constructions? Can you explain?

V.I. Vlasov (shouts interruptingly): Who has else? All is said.

A.A. Burov: And I can still say a few words about Mechanics!

V.I. Vlasov: Why a few words? You are a specialist!

A.A. Burov: So, in the announcement for this report, we were offered to replace the Mechanics with something new. Because it is said that we are still, so to speak, the entire mass of Mechanics, as I understand it, since no exceptions have been made, so to speak, they were looking for some approximate equations, solutions of some equations. To be honest, I did not find out what new Mechanics could be replaced with. And what reasons for this should be, this is also not clear to me. What is there? We have, for example, let's digress, Lyapunov's theory of stability. There is a Lyapunov definition of stability. We are told that we need to correct it with the help of equations, and our inverted pendulum is stable. Well, there is a pointer, please. I suggest everyone to put it on a finger or on a table. Anywhere. To make it stand. Now, if you have it, then I will believe it. The Lyapunov people say it will not stand. With a small deviation, so to speak, and that's it. Formal formulas do not give us the truth, so to speak, with respect to the qualitative behavior of the system, and therefore everyone who deals with Mechanics understands well that they work with models, and when it comes to interpreting the result, they look at how the parameters or definitions introduced affect on what is in comparison with what is observed. To say that with the help of formulas you can correct the world, you can correct the pendulum that falls for everyone, you know, but from the point of view of the formula it does not fall, I would not say that. For this I would not correct the theory of stability. Now, as regards, here some words sounded, by the way, all the equations in mechanics were not presented on the board, that is, the equations that were studied were not presented. A.A. Burov's seemingly benign ideology is founded upon his inability to carry on any error-free calculations. He is never willing to make any corrections, strongly prefering to produce "research", unworthy of all that paper which he relentlessly wastes on it. They were written messily, so to speak. Okay, what can you do? Here Vasily Ivanovich (Nikonov) asked about the kinetic moment theorem, now it turns out to be preserved for us. But in my opinion, in the old manuscripts, it was not very fulfilled. But I don't remember a lot of things already. Now, as for, it means. Well, the work of Tong-Dullin was mentioned, it is generally not quite there, we are talking about how to make the body, due to the moving masses, do pirouettes in the famous top, which was discussed there. There are no moving masses and this is a completely different system, so to speak. Now, as regards, here I remembered something significant. This means that we are talking about what we are invited to consider, so to speak, building Mechanics in complex time. Well, there is an analytical theory of differential equations that uses complex time as an independent form. I and my colleagues, I don’t know, maybe someone has, I don’t have a clock that can measure complex time. I don't know what happens during the complexification of time, I have nothing to do with it. And there is no point in discussing this. In the same way, there is no point in replenishing time in a complex sense, at infinity, with some additional point, as we see in the theory of functions of complex variables. This is an area inaccessible to experiment. And you can talk about it whatever you like! Okay, this is a Mechanics of some world, I don't mind. But not ours. And we will not build this theory! Well, if there are those who wish, then I do not mind! That's all.

V.I. Vlasov: Thank you, Alexander Anatolyevich. Who else has a desire to come out?

Thank you, finally on business.

V.I. Vlasov: Please, Sergei Yakovlevich. You, as the head of the relevant department, now is the time for you to speak.

By the way, I support all this. This is all good discussion relevant to the case: any critical views. It was quite funny to find out that A.A. Burov, who proclaimed himself, in coordination with V.I. Vlasov, a specialist in rigid body dynamics, protests so frivolously and violently against the introduction of complex time, as if he was not even superficially acquainted with the works of Sofia Kovalevskaya. The main thing is ridding of this riffraff here. Referring to A.S. Sumbatov.

V.I. Vlasov: Please, Sergei Yakovlevich.

S.Ya. Stepanov: Okay. Well, in general, here the central part of the speaker's attention was occupied by this task, which Dzhanibekov set. Indeed, this is an interesting task that has caused a certain wave of discussions. True, I must say that from the very beginning, here are the teams that were engaged in Mechanics, Theoretical Mechanics, who studied the motion of a rigid body with a fixed point, the Euler case, they did not have any questions, because the solution, the exact solution in this Euler case was known, there were no omissions, because as stated this is the solution. But people who are not completely familiar, first of all, with Mechanics, they, on the first wave, began to talk about the fact that the laws of physics are not being fulfilled for this very movement. Well, in the end, this first wave somehow came down, and in general it was supported, of course, not by specialists in Mechanics, but by pseudo-scientific people who do not have this exact knowledge. Well, there was a lull for a while. And now the second wave has risen.

V.I. Vlasov: Please close the door, who is sitting next to it!

S.Ya. Stepanov: And here in our department there were just two people who are walking on the crest of this wave (alluding to D.L. Abrarov and S.F. Adlaj), that is, explaining this very effect of Dzhanibekov not with the aid of new physical some laws and negation of classical physical laws, but with the aid of new mathematical approaches. I repeat once again that Euler's solution has been known for a long time, and it is accurate, and it is stated by many sources in many textbooks on Theoretical Mechanics. Well, where do these very doubts come, concerning what is written in the textbooks has not been fully done and in some cases has been done incorrectly.

A.F. Telegin: Where do doubts come from?

S.Ya. Stepanov: This of course happens in light of the fact that, well, some elementary foundations of Mathematics are somehow misunderstood. Well, in particular, here it was demonstrated a lack of understanding of what the uniqueness of the solution means. We have uniqueness theorems for solutions.

A.F. Telegin: also a lack of understanding.

S.Ya. Stepanov: And it turns out that in these problems, which are described by the Euler equations, for which the theorems on the uniqueness of solutions are quite obviously satisfied. The Lipschitz condition on the right-hand side is satisfied. And for these equations ... the non-uniqueness of solutions is attributed to these equations. Well, there are also other features, of course. That is, to consider this very time t is equal to infinity. Time t is infinity, when it is added to some definition of anything, it is generally introduced in a special way and is not completely equivalent to arbitrary critical points. Well, usually this means the limiting behavior at an unlimited increase in t. Consider the initial conditions for differential equations, that is, consider the Cauchy problem (S.Ya. Stepanov, together with S.V. Pikulin, stubbornly considers the Cauchy problem, which has never been discussed in the lecture), in which the initial velocity coordinates are set at t infinity, is absolutely wrong, because if we consider the derivative at the point t − infinity from some function, then there will be, which means that it will be necessary to consider the limit of the ratio (f at infinity plus dt) minus (f at infinity). Divided by dt. And this is always zero. S.Ya. Stepanov has just "substantiated" that the derivative of any function is equal to zero at infinity and thus became a widely-known person: https://vk.com/public132056427?w=wall-132056427_101. Furthermore. If we consider the initial condition at the point t infinity, then any finite point is spaced from this point for an infinite time, and therefore, from this point we cannot get to any finite point. This means that the consideration is the same as it was proposed here, the initial condition at t infinity, in which the points that, as it turns out or turns out, are the only ones, is absolutely meaningless. Well, other things. For example, the analytic continuation to the point t − infinity is considered. Moreover, this is considered here for the separatrix motion, which is described by hyperbolic functions, and this is the very tool. And it is known that for any hyperbolic function, and for an exponent, the point t − infinity is an essentially singular point. I will note that it is impossible to continue an analytic function to an essentially singularity point, since there simply no limit exits. S.Ya. Stepanov, who for many years listened to explanations about analytic continuation, continued to confuse this fundamental concept with the concept of a limit. It turned out that S.Ya. Stepanov never did understand the basics of analysis, and as he already stated, without understanding his own sentence, the derivative of any function at infinity is equal to zero! Of course, he completely lacks any ideas, concerning the basic constructions of complex analysis, such as the Riemann sphere. So it turns out, what does it mean, when explaining these very ... this Dzhanibekov effect, in the process of explanation a number of incorrect interpretations of elementary provisions of Mathematics are allowed. Of course, it is enough to accept at least one incorrect interpretation, as anything can be deduced from this. And here we see a whole series of misunderstandings, here, a distorted understanding of the most common concepts of Mathematical Analysis, the theory of functions of complex variables, the theory of differential equations, and so on. Therefore, the fact that as a result of such completely inadequate distortions of Mathematical Analysis and other areas of Mathematics we get some ... the need to involve Galois groups or the need, therefore, some absolutely incredible considerations, it is completely unfounded. V.I. Vlasov is apprached by Yu.A. Fleorov to organize an urgent termination of the seminar, fearing that S.F. Adlaj will be given the opportunity to respond to S.Ya. Stepanov and others. By prior agreement, and contrary to the rules of the seminar, V.I. Vlasov was asked to end the seminar on the pretext that it had been too long. Here. Wherein. At the same time, I also wanted to note the following. That Semjon Frankovich is working on this work, he has been working on this task for many years. After defending a thesis, which was devoted to the forms of a thread in outer space. Well, for satellite systems. Forms, balanced forms of the thread. I offered him a continuation of the work for… using… considering the dynamics of a filament in outer space. This is an important task that… in which we are engaged in the department, and a group of employees is engaged in this task. But, after many years, he did not take up this problem, but began to consider this Dzhanibekov effect. I have repeatedly told Semjon Frankovich that this problem has been completely solved. S.Ya. Stepanov learned about the Dzhanibekov effect from the most common sources which provided the most primitive interpretations, so, in fact, he never dared to approach S. Adlaj with his stupid conclusions, which he is now shamelessly declaring. To break into an open door and say that something else needs to be added here, well, there is no point. Well, nevertheless, nevertheless, it means that Semjon Frankovich continued. Today we heard a report, in which, of course, some interesting such words were heard about Galois groups and so on. But this has nothing to do with this task. Moreover, our Mechanics department is not generally Galois group specialists. So, these works that are being carried out, they are not carried out within the framework of state assignments, which are assigned to our department.

By the way, rigid body dynamics has been removed from our research topics! It must come back! This fundamental and difficult topic, being pointed out, was, taking advantage of the scientific incompetence of the managing administration of the FRCIC RAS, trickily replaced with other second-rate, contrived S.Ya. Stepanov tasks, in order to redirect the state funding to himself and his «confidants»: A.S. Sumbatov and A.A. Burov. The imitation of scientific activity is incompatible with genuine scientific work, which S.Ya. Stepanov is trying to liquidate for a quiet further parasitism on the state budget.

S.Ya. Stepanov: Here, rigid body dynamics in outer space. Here Burov is there, I'm working on rigid body dynamics. S.Ya. Stepanov cannot openly admit that the rigid body dynamics was eliminated by a behind-the-scenes collusion and is trying to connect it with «outer space». We have already seen how A.A. Burov works on rigid body dynamics (with a stubborn denial of complex time).

We have to go back to rigid body dynamics.

S.Ya. Stepanov: Everyone is engaged in rigid body dynamics. The results that were reported today show that no new results have been obtained in this area. Therefore, as the head of the department in which Semjon Frankovich Adlaj is listed, I can say that for many years, at least more than five years, he has not received results that would correspond to our state assignments. I hoped all the time that his enthusiasm for Galois groups and other Mathematical branches of all sorts would eventually jump out, and somehow we would get something like that for Mechanics. But today I am fully convinced that these hopes are in vain. As a result of those distorted ideas in mathematics that Semjon Frankovich has in his head, it is hardly possible to unravel them. You can unravel them only if you sit down at the desk again. Because when more complex Mathematical concepts are accumulating, which are built on the basis of simple concepts, and in these simple concepts, which cannot be unraveled, the only way, I now think that this way, which Semjon Frankovich traveled after defending his dissertation, was the way degradation of Mathematical qualifications, and today it is practically absent. Instead of a Mathematical qualification, there is some kind of confusion in his head. And personally, I do not expect new results. S.Ya. Stepanov is mistakenly presuming that his opinion has a non-zero value!

V.I. Vlasov: Thank you. I think that our discussion has been somewhat protracted. In general, we have been in session for two and a half hours.

Good Discussion! The main thing is not to disband this boor. This is about A.S. Sumbatove − the perpetrator of a criminal offense. It was not yet known then that the crime had been prepared in advance with S.Ya. Stepanov, and as it turned out later − with V.N. Zakharov.

V.I. Vlasov: Although, in general, this already exceeds all norms.

But interesting.

V.I. Vlasov: I must ... stop! I must summarize and say that today we have heard one of the employees of the department, it means, which is headed by Sergei Yakovlevich, that Semjon Frankovich is his student, he defended his dissertation under his leadership, that is, what he has positive, he is all this, he owes all this to Sergei Yakovlevich.

Unfortunately, I have to object! S.Ya. Stepanov never delved into the essence of S.F. Adlaj dussertation, but only successfully parasitized on its successful defense, which was supported by V.A. Sarychev, despite A.A. Burov and A.S. Sumbatov.

V.I. Vlasov: Which, in fact, contributed to the defense of the dissertation itself. Therefore…

And he supported this comrade. S.Ya. Stepanov continued in every possible way to prevent the retirement of A.S. Sumbatov, who for decades visited his workplace only once a week. His attempts to dismiss the most active researcher S.F. Adlaj were aimed at transferring his workplace to a pseudoscientist under his control.

V.I. Vlasov: Therefore, the opinion of Sergei Yakovlevich is decisive here. And I think, knowing him as an extremely gentle person, even excessively soft, from my point of view, I have to agree, there is no other option but to agree with Sergei Yakovlevich. The softness, being described, by V.I. Vlasov is, in fact, a repugnant manifestation of the cautious hypocrisy of S.Ya. Stepanov, who prides himself for fooling people as naive as to trust him. Unfortunately, the report certainly made a strange impression, and a number of people have already spoken out.

Here's another weirdness. Pointing to the board where he wrote down the sum of the natural numbers: - 1/12.

V.I. Vlasov: Wait. I will not repeat the words that were said so unflattering, but in general the picture is quite sad, and I can only join the words of Sergei Yakovlevich with the wishes to somehow change the scientific line of Semjon Frankovich. On this…

I thank everyone who came to the report.

And thanks to the successful video recording (despite all attempts to disrupt it, including those punishable up to two years imprisonement, in accordance with article 127 of the criminal code of the Russian Federation https://www.youtube.com/watch?v=eIguiWRa4h0), the genuine scientific level of

S.L. Skorokhodov, A.S. Sumbatov, S.V. Pikulin, A.A. Burov and S.Ya. Stepanov

was unusually clearly, succinctly and definitively revealed, as if they did not realize that their performances are now publicly and for centuries documented. And the coordinators of the seminar

V.I. Vlasov, and Yu.A. Fleorov

publicly appeared irrevocably and forever complicit in a vile anti-scientific conspiracy. Some others were more cautious and preferred to remain silent behind the scenes. Among them

G. M. Mikhailov, V. N. Zakharov, A. N. Poroshchay and M. A. Posypkin,

who invested a lot of efforts to create illegal obstacles in the way of those invited to the open report of S.F. Adlaj.

References:

0. The announcement of S.Ya. Stepanov report December 20, 2018: http://semjonadlaj.com/Legal/20181220_1600.jpg .

1. Video report on January 31, 2019: https://www.youtube.com/playlist?list=PL8StSu9qOYd6vYHtDiS7JNrCbF8CgjfdF.
The objection by S.L. Skorokhodov, executed by a command from V.I. Vlasov https://www.youtube.com/watch?v=lQwtHhjcG4I&feature=youtu.be.
A shameless concession by the thug A.S. Sumbatov https://www.youtube.com/watch?v=eIguiWRa4h0.
Two "discoveries" by S.Ya. Stepanov https://vk.com/public132056427?w=wall-132056427_101.

2. The slides of the January 31, 2019 report: https://easychair.org/smart-slide/slide/Jx5F#.

3. What has the January 31, 2019 report revealed? http://semjonadlaj.com/Talks/Exposure8.pdf,
An excerpt from the presentation of A.S. Sumbatov: http://semjonadlaj.com/Talks/Otrbivok.pdf.

4. A February 5, 2019 "protocol", concerning my January 31, 2019 talk: http://semjonadlaj.com/Talks/VlasovStepanov20190205.jpg.

5. An open letter to V.V. Sazonov from April 26, 2019 http://semjonadlaj.com/Talks/Clarification.pdf.

6. From the letter of M.A. Posypkin to A.A. Zatsarinnyi on June 26, 2019: http://semjonadlaj.com/Talks/PosZats20190626.jpg.

7. An amusing "evaluation" by V.N. Zakharov, dated November 6, 2020, that is, after I was illegaly fired on October 7, 2020 and before I was reinstated on February 20, 2021: http://semjonadlaj.com/Talks/Zaharov20201106.jpg.

8. Another "evaluation", dated (later yet) December 16, 2020, by V.A. Samsonov, concerning my January 31, 2019 talk (throughout which he kept silent): http://semjonadlaj.com/Talks/C567728F-EF79-49C9-B6EA-7F21B14FDC4A.jpeg.

9. Some links to "neutral" articles about mediocre persons on the corrupt and politicized Russian-language Wikipedia:

https://ru.wikipedia.org/wiki/Флёров,_Юрий_Арсениевич
https://ru.wikipedia.org/wiki/Степанов,_Сергей_Яковлевич
https://ru.wikipedia.org/wiki/Соколов,_Игорь_Анатольевич