
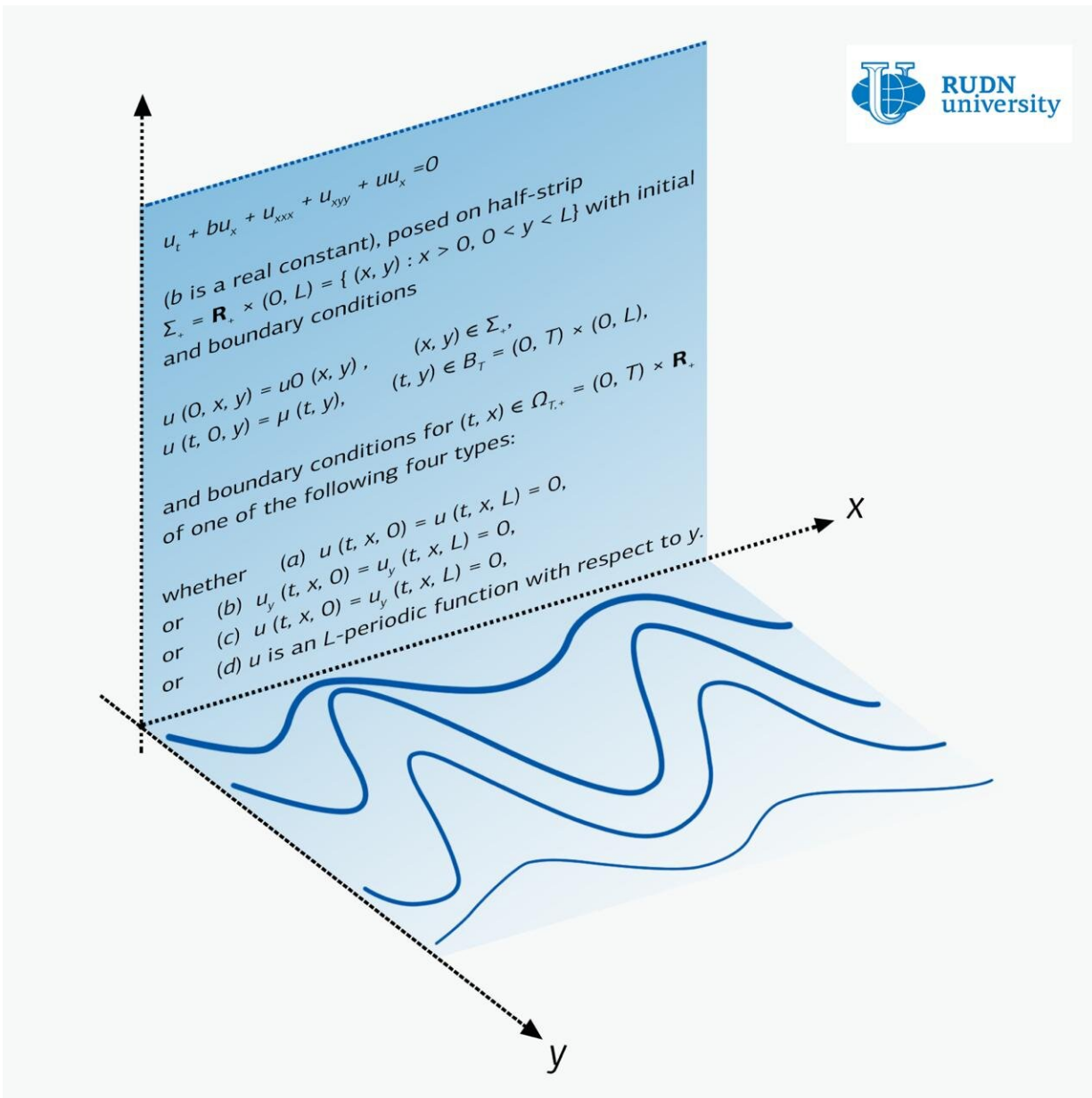


# Mathematician describes movement in a flat strip of plasma for first time

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$u_t + bu_x + u_{xxx} + u_{xyy} + uu_x = 0$   
 ( $b$  is a real constant), posed on half-strip  
 $\Sigma_+ = \mathbf{R}_+ \times (0, L) = \{ (x, y) : x > 0, 0 < y < L \}$  with initial  
 and boundary conditions  
 $u(0, x, y) = u_0(x, y), \quad (x, y) \in \Sigma_+,$   
 $u(t, 0, y) = \mu(t, y), \quad (t, y) \in B_T = (0, T) \times (0, L),$   
 and boundary conditions for  $(t, x) \in \Omega_{T,+} = (0, T) \times \mathbf{R}_+$   
 of one of the following four types:  
 whether (a)  $u(t, x, 0) = u(t, x, L) = 0,$   
 or (b)  $u_y(t, x, 0) = u_y(t, x, L) = 0,$   
 or (c)  $u(t, x, 0) = u_y(t, x, L) = 0,$   
 or (d)  $u$  is an  $L$ -periodic function with respect to  $y.$

Credit: RUDN University

A RUDN University mathematician has for the first time proved the theorem of existence and uniqueness of solutions of the Zakharov-Kuznetsov equation in a strip. Such theorems are very rare for partial differential equations. The new results can be applied in fields such as astrophysics, for instance, in describing the propagation of plane waves in plasma. The article is published in the journal *Nonlinear Analysis: Real World Applications*.

The Zakharov-Kuznetsov [equation](#) is a one-function equation of two variables  $x$  and  $y$ . For physics,  $x$  is the direction of wave propagation, and the deformation of the medium occurs along the perpendicular direction  $y$ . For example, in the oscillation of a guitar string, the wave appears to run down the string, while the oscillations occur perpendicularly relative to the run of the wave.

There are a large number of results that describe solutions of the Zakharov-Kuznetsov equations in the case when there are no constraints on  $y$ . But the question of wave propagation in the strip—when  $y$  is limited—was not extensively studied until recently.

RUDN University mathematicians dealt with the Zakharov-Kuznetsov equation in the strip. They examined three main cases—when there are no oscillations on the boundary of the strip, when there is no current on the same boundary, and when the [boundary conditions](#) are periodic in structure. The latter case corresponds to the propagation of waves in a medium whose structure is periodic in  $x$ .

In all these cases, mathematicians managed to prove theorems of existence and the uniqueness of their solutions. For systems of [partial](#)

[differential equations](#), which include the Zakharov-Kuznetsov equation, such equations are very rare.

These results are the first for solutions of the equation with [initial conditions](#) in the strip. Flat plasma flows with boundary conditions, which were among the phenomena considered by RUDN University scientists, can occur in physics and astrophysics.

The Zakharov-Kuznetsov equations belong to a wider category of equations known as the Korteweg-de Vries equations. In the study of this category of equations, it is now possible to describe solitons—waves whose shape does not change during movement. Physicists consider solitons as a tool for modern optical data transmission systems. The study of solitons, which can arise in the Zakharov-Kuznetsov equations, is one of the options for the development of the work done by RUDN University mathematicians.

**More information:** Andrei V. Faminskii. Regular solutions to initial-boundary value problems in a half-strip for two-dimensional Zakharov–Kuznetsov equation, *Nonlinear Analysis: Real World Applications* (2019). [DOI: 10.1016/j.nonrwa.2019.06.009](https://doi.org/10.1016/j.nonrwa.2019.06.009)

Provided by RUDN University

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