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UNIVERSITY OF LEEDS

To whom it may concern
Department of Applied Mathematics and Theoretical Physics
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Wilberforce Road
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May 12, 2014

Dear Sir or Madam,

I wish to submit my application for the advertised post-doctoral position in bio-fluid dynamics (reference "LE03297"). Currently, I am a post-doctoral researcher at the University of Leeds where I am working on numerical modelling of ocean tides with Dr. Stephen Griffiths. I expect to finish the project by October 2014. Let me describe here why my profile agrees well with the requirements for the position and why it appeals to me.

As an undergraduate applied mathematics student at Moscow State University I gained excellent knowledge of core analytical and numerical techniques for solving ODEs & PDEs arising in problems of fluids and solids mechanics[1] (with practice in C (incl. MPI) and finite element (FE) packages). A two-year long course of laboratory practice (incl. fluid & gas dynamics lab) gave me some experience in experimental work. The studies were very challenging and enjoyable. I got a 1^{st} honours diploma and proved my strong background in mathematics by successfully passing GRE test in mathematics (92% below).

In my master thesis linear stability of laminar flows of non-Newtonian fluids was investigated with help of integral estimates and series expansions over a complete set of eigenfunctions. The main results have been published in a short paper. Since then I have often dealt with hydrodynamic stability and wave problems (see below). Also, as a student I was affiliated with the Composite Mechanics Department where I received extensive training in elasticity theory and other branches of solid mechanics[1].

After graduating, I received a scholarship to do a Ph.D. under supervision of Prof. Eugene Benilov at the University of Limerick, Ireland. There I worked in the fields of *geophysical fluid dynamics* and *liquid films*.

- The topic of my dissertation falls within the broad area of mathematical modelling of wave-mean flow interaction in the stratified rotating ocean. A peculiar phenomenon known as resonant over-reflection that can emerge in the problem of linear scattering of internal ocean waves by jets was examined. A fundamental conclusion that resonant over-reflection always coexists with instabilities was established.
- Additionally, I took part in research investigating the limits of the lubrication approximation in thin film flows. In particular, we examined instabilities and shock overturning in Stokes flows down an inclined plate and on the inside/outside of a rotating horizontal cylinder.

The described problems were investigated using the combination of asymptotic analysis and numerical simulations (using Comsol, a FE package, and Matlab). Four papers were published leading journals (plus one submitted)[1].

At the moment, I am working on global numerical modelling of ocean tides (in collaboration with Dr. Stephen Griffiths). I have developed a Fortran code that solves the underlying shallow water-like equations using an improved implementation of a popular finite difference scheme. A paper describing the improved numerical

[1] See the enclosed CV for additional details

scheme will be submitted shortly[1]. The major challenge for numerical modelling is the multi-scale nature of tides associated with generation of short *internal tides* by tidal flow over rough bottom topography. Special emphasis is placed on tackling this problem in a self-consistent and computationally efficient way. The need for better understanding of internal tide generation is motivated by their profound influence on the ocean circulation and climate. The relevant oceanographic results have been presented in a number of international conferences and papers are in preparation.

During my time in Leeds and Limerick I had decent teaching experience doing tutorials for several courses in Engineering and Science Maths[1]. Even though I wish to pursue a research career in applied mathematics, I also enjoy teaching and interacting with students.

The mathematical beauty of pure hydrodynamic problems and efficiency of asymptotic analysis in dealing with them has always fascinated me and this is where I am most experienced. However, I would be very interested to undertake a project in the vibrant area of bio-fluid dynamics that investigates processes incorporating effects from both fluid and solid mechanics. The complexity of bio-fluids problems (*e.g.* fluid-structure interactions, interfacial dynamics) is a very challenging but, I believe, with help of clever asymptotics and high-end numerical simulation further progress can be made.

As you can see, I have experience in a number of areas of fluid dynamics (viscous and geophysical) and good knowledge of solid mechanics. Little experience in biophysics would be the main weakness in my profile, however, I am very adaptable and would enjoy learning about models used in the field, and work on improving them.

I will be glad to attend an interview, either in person or by telephone, should you wish to arrange it. Thank you very kindly for your consideration and looking forward to hearing back from you.

Your sincerely,

Dr Vladimir Lapin

Research Fellow