Dear members of the Admissions Committee,

I know Filipp Uskov from the spring of 2016, when he began to study at the magistracy, and turned to me with a desire to conduct scientific research in the field of quantum computing. I provided him with introductory literature, and he quickly immersed himself in this new topic for him. Given Filipp's propensity for computing and programming experience, I recommended him to O. Lychkovskiy, who needed an assistant to perform cumbersome symbolic calculations, as capable of doing this work. Filipp successfully coped with the serious computational task set before him, the decision of which laid the foundation for his master's thesis.

The problem consisted in obtaining by methods of symbolic computer calculations the most accurate (more rigorous) lower estimate for the energy of clusters in a lattice of spin particles ½ with isotropic Heisenberg interaction (Ising model) in mixed quantum states. This hard-to-solve (NP-complete) computational problem is relevant for many applications, including adiabatic quantum computing. Filipp developed computational algorithms, implemented them in the language of the system of symbolic algebraic computations Wolfram Mathematica, and obtained the required evaluation by two different methods used in the literature: (1) the determination of energy from the stationary Schrödinger equation with partitioning of the spin system into clusters and estimating from below the ground state energy of an individual cluster; (2) by the variational method, having managed to break through in the two-dimensional case up to a lattice of size 9 spins (matrix size 512 x 512). This required taking into account the symmetries in the spin system under consideration and careful selection of the appropriate parametrization of the density matrix of the cluster of spin particles under consideration. Both methods showed fairly high accuracy in the evaluation obtained. In the process of carrying out the dissertation work, Filipp has established himself as a qualified researcher who is able to independently understand the algorithmic and computer methods required for computations, as well as in the current literature on the computational aspects of spin systems. Obtained by Filipp, the computational results formed the basis for the scientific work "Squaring parametrization of constrained and unconstrained sets of quantum states" by the author's collective consisting of N. Ilyin, E. Shpagina, F. Uskov and O. Lychkovskiy, published in January 2018 in the high-ranking international Journal (quartile Q1) Journal of Physics A: Mathematical and Theoretical, Vol. 51, No.8, 085301. This fact already shows a sufficiently high scientific level and significance of Uskov's scientific results.

Yours Sincerely,

Vladimir Gerdt

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