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Dear Members of the Search Committee:

I am writing in the strongest possible support of **Tao Hu**'s application for a faculty position in your department. I have known Tao for more than three years while he was a postdoc in my group and am in a good position to evaluate his candidacy. Briefly, he is the most productive postdoc I ever had.

Tao obtained his PhD in biophysics from University of Minnesota and decided to switch fields to theoretical neuroscience. Before he joined my lab, I warned him that theoretical neuroscience is different from physics in that performing challenging calculations is less valuable than finding the right problem to work on. This is because a theoretical framework of neuroscience has not reached the same level of maturity as in physics. Little did I know that, in the short three years, my group has developed a theoretical framework, which is starting to approach the level of maturity characteristic of theoretical physics. Much of this advance happened thanks to Tao's work.

About the time when Tao joined my lab, I learned about compressive sensing – a novel mathematical development in the signal processing community. I suggested to apply compressive sensing to the problem of reconstructing neural circuits from optical stimulation experiments. Tao has simulated such experiments and showed that using sparse prior as is done in compressive sensing allows one to reconstruct connectivity from fewer trials than with conventional reverse correlation. The corresponding paper on the technique that we named REconstruction of Sparse Circuits Using Multi-neuron Excitation (RESCUME) was published in the proceedings of NIPS, a highly competitive neural networks conference. In addition to simulating RESCUME on synthetic data, Tao applied the method to mapping receptive fields of retinal ganglion cells.

Another idea related to compressive sensing is that of representing data, such as natural images or micrographs, as a linear combination of a few primitives from a large redundant dictionary was introduced in neuroscience by Olshausen and Field. Because such dictionary can be learned from data, it captures characteristic correlations and allows for an efficient representation of data.

Tao has developed this idea in two directions. First, he applied this idea to reconstruct three-dimensional structure of neuropile with a resolution higher than naively possible from the sampling frequency, a so-called computational super-resolution. This work allowed us to perform high-throughput reconstruction of

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neuropile with the resolution necessary to trace synaptic connections from the micrographs obtained by transmission electron microscopy.

Second, Tao worked with another postdoc in the group and myself to apply this idea to develop a theory of early sensory processing, such as that in the vertebrate retina, the olfactory bulb or the antennal lobe. By intepreting neuronal dynamics as constructing a series of stimulus representations in the inhibitory interneurons, we were able to build a systematic framework that explains many seemingly unrelated physiological observations. Despite the non-linear and recurrent nature of the network, we were able to describe network dynamics mathematically by mapping it onto a recently proposed algorithm from the compressive sensing community. Tao's contribution to this neural coding project was absolutely crucial.

In addition to the above work, Tao has written several papers on machine learning/signal processing where we apply ideas from neuroscience to propose novel cutting-edge algorithms. In particular, we proposed a new online learning algorithm for sparse representations and an energy-efficient design for sensor networks. These papers are submitted and will, no doubt, make a strong impact in the machine learning and signal processing communities. Moreover, Tao has worked on several other projects, some of which resulted in publications, others are still ongoing.

As you can see from the description of the projects that Tao completed during the three years in my lab, he demonstrated extraordinary breadth of expertise. He worked on the analysis of neuroscience data, novel machine learning/signal processing algorithms, and theoretical neuroscience. Such diverse combination of projects demonstrates his unique capability and is predictive of a distinguished future career. Tao possesses a unique theorist's toolset combining proficiency in both analytical calculations and numerical simulations. He is extremely hardworking, honest and modest scientist, who favors doing work to selling it. I hope that you will recognize Tao as a unique individual well positioned to make major contributions in science and to help his colleagues.

Sincerely,

Dmitri "Mitya" Chklovskii
Group Leader, Janelia Farm
Howard Hughes Medical Institute