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To: NESSF Selection Committee

Dear Colleagues,

I am writing to recommend my PhD student, Roy Smart, for the 2017 NASA Earth and Space Science Fellowship program. Roy is a highly creative young scientist with a diverse set of talents and a strong work ethic.

Roy began working in my lab as an undergraduate student in Spring of 2013. At that time he made many contributions to our sounding rocket effort, including testing of optical mounts to thermal vac, flight computer hardware, telemetry interface testing, and software for flight and ground support.

Roy developed entirely new control and data handling software for our MOSES sounding rocket payload, which flew successfully in 2015. The requirements for this code included many interfaces, including real time camera commanding, camera data through a custom FPGA interface, shutter control, subsystem power control, science data handling to both SSD and telemetry, discrete uplinks, a two-way serial communications protocol, and implementation of a virtual shell. He did not have the advantage of a real time operating system, but used multithreading and messaging concepts adeptly. By this approach, he improved upon the performance and usability of our original flight software. Most importantly, he eliminated more than 1 second of unnecessary dead time between exposures, which increased the science output of the mission. Roy's code performed flawlessly during integration and testing, and in flight. He was also a key member of my small operations team at White Sands Missile Range that year. Roy and three others carried the ball and solved a multitude of problems to keep the integration and testing on schedule while I returned to Montana for several weeks to deal with a family emergency. Roy impressed everyone at the range with his keen technical ability, presence of mind, and dedication to the mission.

As a graduate student, beginning in Fall of 2015, Roy has become a key player in the development of our new instrument, the EUV Snapshot Imaging Spectrograph (ESIS). He is picking up optics quickly, working on the alignment of the MOSES instrument for reflight and becoming an expert with the interferometer. He is also a great team member, and works very effectively with undergrads, grad students, professional engineers, and our colleagues at MSFC who are providing the detector system for ESIS.

Roy came to me about a year ago with a crazy idea. He wanted to develop a neural network to

invert the MOSES and ESIS rocket data.[1] I explained that this looked like a very challenging project, that I didn't know a thing about neural networks, and I would not be able to advise him on the implementation. That didn't seem to worry Roy. He attacked a scaled-down version of the problem as a project for my computational physics course, sought out expertise from the applied mathematicians across campus, took an artificial intelligence class, read a lot of literature, and kept attacking the problem with a combination of creativity and dogged persistence. Although I have been skeptical from the start, Roy has finally convinced me that his neural network approach is truly promising, and likely to result in a more realistic reconstruction of spectra. His success will make it possible to generate high fidelity 2D maps of doppler shift and line width from single exposures with our instruments, and that will have many implications for the kinds of solar science we can do in the future.

Roy completed the PhD written comprehensive exam last summer, passing on the first try. Now that he is finished with the comp and his coursework is nearly complete, he will be able to devote his attention to research. Meanwhile, Roy's interest in solar physics has been growing apace. Like all of my students, he participates actively in our solar journal club. He's also been coming to me, asking a lot of questions about the corona, transition region, chromosphere and photosphere. So, his ideas of how to apply MOSES data to solving scientific problems are developing rapidly at this point. I think that within another year he will be deeper in the scientific literature than many of his peers.

In 20 years, I have not seen a graduate student as creative and persistent as Roy Smart. And though he shows respect and deference to professors and other experienced people, he possesses sufficient initiative and self-confidence to explore his own unique ideas. He is an imaginative problem solver, an effective team member, and a good-spirited person who is bound to make his mark on the field of solar physics. I recommend him highly for the NESSF Fellowship.

Sincerely,

Charles C. Kankelborg
Professor of Physics

[1] Both of our rocket instruments, MOSES and ESIS, rely on solving a tomographic inverse problem to turn a series of EUV images into spatial and spectral data cube. We have several working algorithms to perform this inversion, but all are susceptible to similar artifacts.