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12/19/17

Dear Graduate Committee:

It is my pleasure to very strongly recommend Ms. Sarah Kelly for admission into a top graduate program in the Mathematical Sciences. Sarah has serious talent for mathematics, and is very interested in continuing her training so that she can work on interesting and hard problems.

I know Sarah from advising her undergraduate research, and from being her academic advisor. Mathematically and computationally, Sarah just "gets it", and quickly. For her research, she is working on data assimilation for convection diffusion (contaminant transport in a fluid). Sarah quickly learned the finite element method and how to use a software package called Freefem++, and has done a very nice job implementing the various problems/tests. So far, she has written a code that creates and meshes a domain on a specific Army Research Lab test river, solves Stokes on it to get a velocity field, and then uses the velocity field to solve for how a contaminant will be transported downstream over time. This task has gone quite smoothly, and I have observed that she is a very good mathematician and an excellent programmer. She is currently working on adding in the data assimilation, which will address the problem of not knowing the initial condition very well (may not know where all small spots of contaminant are) by feeding in data measurements from later times back into the solver. I expect she will get results for this over the break or in early January, and combining this with some associated theory she is working on, there is no question this will make an excellent paper in *SIAM Undergraduate Research Online*. I note that this project involves two other junior-level undergraduate students, and even though Sarah is clearly the most talented one, these three have done a nice job working together.

Sarah has taken a different path than the usual math major, in that Sarah transferred to being a Mathematical Sciences major only in the spring of her junior year (May 2017). Prior to that, she was an Electrical and Computer Engineering major with a math minor, but had decided that she liked her math courses so much better, and wanted to make the switch. Hence this year, she is taking 8 senior level math courses and doing undergraduate research in mathematics, in order to graduate with a BS in Mathematical Sciences in May 2018. Her fall grades just came in, and not surprisingly, she got all A's (in Advanced Calculus, Advanced Engineering Math [a second course in diffeq], Intro to Proof,

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Undergraduate Research, and Technical Writing). In the spring, she will take Abstract Algebra, Linear Programming, Advanced Calculus II, Numerical Analysis, and a second semester of Undergraduate Research. Based on her 3.92 GPA and her performance this fall, I would be shocked if she does not get all A's in these courses as well.

Based on my experience with Sarah, and talking with her other math professors, I am absolutely certain Sarah not only belongs in a top-tier graduate program, but will excel there. Each year, Clemson sends two or three undergraduate students to top programs and in general they do quite well (e.g. U. Chicago, Waterloo, UC San Diego, UC Boulder, Georgia Tech, etc.). Sarah is definitely at this level, although she doesn't have the "stats" that those students had in terms of papers and grad courses, since she switched to math so late. Comparing her to my former undergraduate research advisees Nathan Heavner (doing very well in Applied Math PhD program at UC Boulder) and Ben Cousins (NSF grad fellow, Goldwater Scholar, finished PhD in Computational Science at Georgia Tech this year and is now postdoc at MSRI) at this stage, I rate Sarah above Nathan and at about the same level as Ben.

On a more personal level, I have enjoyed advising Sarah's research. She is energetic, pleasant, respectful, and easy to get along with. She shows up for meetings on time and with results. This is the student you wish the rest of the students would be like.

I have no hesitation in giving Sarah Kelly my strongest recommendation for admission to a top-tier graduate program in Mathematical Sciences.

Please do not hesitate to contact me if you have any questions.

Sincerely,

Leo G Rebholz

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