Progress Report

Dimitrios Vardakis

Michigan State University

Department of Mathematics

—

May 17, 2022

I was admitted to the PhD programme of the Department of Mathematics at Michigan State University at Fall 2017 and the past 5 years I have been a profound PhD student of MSU. Since the very beginning I have felt very welcome, especially thanks to the faculty, the administrative staff and, of course, the community of international students in the department. During this time, I've worked to meet the programme requirements and also actively engaged in research and got familiar with the mathematics community worldwide.

First year. I attended and passed all my qualification exams and classes without any problems. This entailed Real and Complex Analysis, Algebra, as well as Geometry and Topology.

I also got my first experience teaching and helping students. This was amazing and very eye-opening experience; I got to know struggling yet eager and brilliant people trying to understand mathematics from an entirely new perspective. In particular, I was the instructor for the Differential Equations class (MTH235).

Second year. I spend quite some time looking for an academic advisor. Coming to MSU, I realised how many more interesting fields and disciples of mathematics exists and I didn't know of before. Eventually, professor Alexander Volberg agreed to be my advisor and since then we've been working on several projects. I got very excited over his brilliant ideas and the subjects he was interested in.

This was the time when I started attending mathematical conferences and I got to know in person the big names together with the younger researchers in the fields I was also working on myself. At the same time, I took several advanced classes and got familiar with many topics in modern mathematics. Indicatively, Functional Analysis, Multivariable Complex Analysis, Bellman Functions and others.

Additionally, I continued working as a teaching assistant, again for MTH235 and also for higher classes (MTH309), and did my best to help the students understand the various concepts they were introduced to.

Third year. My third year was the year I took my comprehensive exam. The syllabus consisted mainly of two books dealing with Geometric Measure Theory and fractals [1] and also analytic capacity, and Calderón-Zygmunt operators [2]. Those topics were very relevant to the research I had been doing at the time with prof. Volberg.

I continued to take classes and reading courses close to my interests, such as Fourier Analysis, Fourier Analysis on the Hamming cube and Geometric Measure Theory. Additionally, I kept attending conferences, inside the US but also in Europe, and even gave a contributing talk in the HAPDE2019 conference in Helsinki (Summer 2019).

That year I was deemed suitable to take the responsibility of a graduate level course. I was assigned as the grader for the Complex Analysis qualifying class (MTH829) and I was now helping graduate students grasp the even more advanced mathematical notions.

Fourth year. This was a long "online" year owning to the COVID-19 pandemic. Nevertheless, this did not prevent me from doing my research and following my responsibilities at MSU. I took dissertation credits (MTH999) along with reading courses and advanced special topics in analysis (MTH992) and started attending online conferences organised around the world.

During the this academic year two of our joint works with professor Volberg were accepted in important mathematical journals. One has already been published [4], and the other one [3] is awaiting publication in Saint Petersburg Mathematical Journal.

I was also the TA for MTH235 as well as the Linear Algebra course (MTH309).

Fifth year. This is the current year. I have already taken all of the offered classes that interested me and I am simply taking dissertation credits for now. I have so far completed all of the department's and the university's requirements for graduation (RCR training, presenting in seminars, course credits, qualification and comprehensive exams, etc.) in the past years. During the Fall semester I was the TA for MTH309, and during the Spring semester the grader again for the graduate course of Complex Analysis.

I am continuing my research with the supervision of prof. Volberg; another work of us [5] is being published at the end of this month on May 31st in Saint Petersburg Mathematical Journal. We are currently working on Cantor repellers and random planar Cantor sets. Simultaneously, I am writing my dissertation.

I am also attending more in-person conferences as they slowly "come back to life". In particular, this summer I am attending and presenting part of my research during the famed *El Escorial Meetings* in Madrid, and also attending the Workshop in Harmonic Analysis at CRM Barcelona organised in honour of Mickle Lacey's birthday.

Sixth year's plans. The next academic year will be my last as a graduate student in MSU. I will use that time to finish and defend my dissertation whilst applying for jobs in the US and Europe, mainly research-focused post-doctoral and tenure track positions.

I will also take advantage of the next year to actively attend even more conferences along with continuing my research.

I am extremely thankful to have been a student of MSU. I have developed a great deal as a mathematician and as an individual simply by being part of this big community and amazing which has supported me all these years of my study.

I would be most grateful if I would get the support of the Graduate School and of the Department of Mathematics for once more for the coming fall, so that I can focus on my research, finish my dissertation and also be able to complete my job applications for the year after.

Thank you for your consideration.

References

[1] K. Falconer. *Fractal Geometry.* John Wiley & Sons, Ltd, Sept. 2003. DOI: 10.1002/0470013850.

[2] X. Tolsa. *Analytic Capacity, the Cauchy Transform, and Non-homogeneous Calderón-Zygmund Theory.* Springer International Publishing, 2014. DOI: 10.1007/978-3-319-00596-6.

[3] D. Vardakis and A. Volberg. "Geometry of graphs of continuous functions intersecting many lines in a few points". In: (Sept. 7, 2019). arXiv: `1909.03203 [math.AP]`.

[4] D. Vardakis and A. Volberg. "Free boundary problems in the spirit of Sakai's theorem". In: *Comptes Rendus. Mathématique* 359.10 (2021), pp. 1233–1238. DOI: `10.5802/crmath.259`.

[5] D. Vardakis and A. Volberg. "Free boundary problems via Sakai's theorem". In: *Algebra i Analiz* 34 (3 May 31, 2022), pp. 252–275. URL: `http://mi.mathnet.ru/eng/aa/v34/i3/p252`.

DEPARTMENT OF MATHEMATICS, MICHIGAN STATE UNIVERSITY, EAST LANSING, MI. 48823

Email address: `vardakis@msu.edu`