PHD POSITION IN *GEOMETRIC ANALYSIS AND APPLICATIONS TO MICROBE ECOLOGY (GAAME)*
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1. Research description

We will apply the tools of geometric, microlocal, and harmonic analysis to the following categories of long-standing open problems: 1) geometric inverse problems, particularly inverse spectral geometry problems; 2) locality principles for solutions to the heat equation in non-smooth settings; 3) finite propagation speed of the wave equation in singular geometric settings; 4) understanding the Poisson relation in singular settings. From a purely theoretical mathematical perspective, we will simultaneously tackle long-standing problems in microbe ecology. We will implement a novel game theoretic approach to microbe ecology in development since 2012. The connection between geometric analysis and game theory may not be obvious, but it is profound. Viewing non-cooperative games from a geometric analytic perspective is the key ingredient in the proof of Nash's prized theorem on the existence of equilibrium strategies in non-cooperative games. Using geometric analysis, we classified the level sets of payoff functions for non-cooperative games. Combining geometric analysis with non-cooperative game theory we aim to rigorously mathematically explain two ecological phenomena of microbes: (A) tremendous phenotypic variability within species and (B) tremendous taxonomic diversity. We will simultaneously use these same mathematical tools to (C) revolutionise the mathematics which describes the motility patterns and spatial distribution of marine microbes.

2. Pre-requisites

(1) Strong general mathematics background, with a significant focus on *pure/theoretical* mathematics.
(2) Strong background in analysis and geometry.
(3) Experience with and/or an interest in game theory.
(4) Experience with computer programming.
(5) Experience with and/or an interest in marine biology and oceanography.
(6) Master's degree or 4-year bachelor's degree completed no later than August 15, 2019.

3. Goals

Although there will be collaboration with biologists and oceanographers, the primary focus of the thesis is *pure/theoretical* mathematics. We aim to prove theorems! At the same time, the thesis will also involve collaboration with the Menden-Deuer lab, see: `http://mendendeuerlab.com/` and `https://vimeo.com/13706822`. We will also work with the Department of Marine Sciences `https://marine.gu.se/english`. In this context, some experience with computer programming is required, as we will analyze data and perform simulations. This PhD position is suitable for students whose primary passion is for theoretical mathematics, especially analysis, PDE, and geometry, but who also are keen to connect with and apply that theoretical mathematics to biology. Since the mathematical subject matter is relatively broad, there will be a certain amount of freedom to pursue specific directions of interest in the general field of geometric analysis. At the same time, we will tackle specific mathematical problems in collaboration with our research partners at biology. The goal is a deep yet multi-faceted thesis, which we reasonably expect will be a compilation of research articles (publications) completed during the course of the doctoral studies.

It is strongly recommended to read some of the research publications found here, to get a sense of the mathematical topics which may be included in the thesis: `http://www.math.chalmers.se/~rowlett/rsummary.html` To see how we use pure, theoretical mathematics in the application to microbe ecology, interested applicants are strongly encouraged to work carefully through the mathematical proofs in this paper: `https://link.springer.com/article/10.1007/s12080-018-0384-1`

In case of questions, please contact julie.rowlett@chalmers.se