Harvey Mudd College
Mathematics

Senior Thesis
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Research Proposal:
Ridge Coarsening in Evaporatively-Driven Climbing Films

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1 Introduction

When the evolution of a thin film mixture of alcohol and water on an inclined plate is examined several interesting instabilities form. Where the base of the thin film rejoins the larger reservoir, small ridges form which slowly drift to the side and merge with others, coarsening into larger ridges. These instabilities are driven primarily by the alcohol evaporating more quickly than the water, forming surface tension gradients, thus causing what is known as Marangoni convection.

2 Prior Research

Professor Hosoi [1] published a paper last year describing these instabilities in which she developed a model using lubrication theory to explain many of the observations. It resulted in a fourth order PDE modeling the height of the film. The analysis is primarily qualitative, and only briefly looks at the coarsening of the ridges. Also recently published was a paper by Bertozzi, Grun and Witelski [2] which discusses and models the ridge coarsening that occurs in a similar fourth order PDE. I worked with Professor Hosoi this past summer looking at this problem. I primarily worked on numerically solving the PDE, but we also worked on applying the analysis used in [2] to our problem.

3 Proposed Research

I will continue the work from this summer of looking at the coarsening that occurs in these ridges. I hope for this project to encompass analytical, numerical, and even some experimental work in examining this system. I hope to use some digital photography equipment at CGU to photograph and obtain some quantitative data describing the coarsening and other instabilities in the system, which I could compare with analytical and numerical results.

References

[1] A.E. Hosoi and J.W.M. Bush, *Evaporative instabilities in climbing films*, Fluid Mech., 442 (2001) pp. 217-239.

[2] A.L. Bertozzi, G. Grun, and T.P. Witelski, *Dewetting films: bifurcations and concentrations*, Nonlinearity, 14 (2001) pp. 1569-1592.