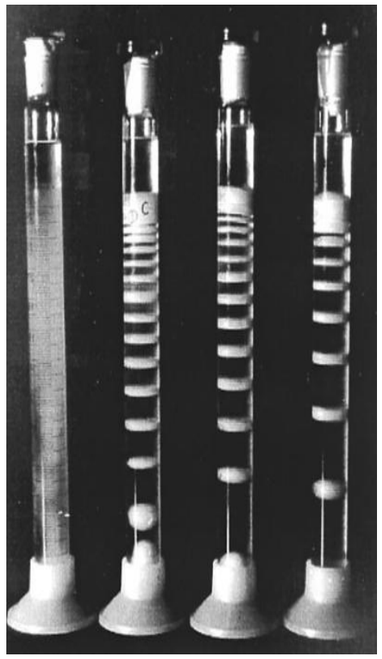
Liesegang Patterns



What Have I Done

This project was concerned with the study of *Liesegang Patterns* in a reaction tube. Liesegang patterns are formed by a simple reaction, typically in gels, when the reaction product precipitates in a recurrent fashion. They consist of bands where the reaction product precipitated, which are spaced at distances which increase at a geometric rate. While Liesegang patterns are ubiquitous and easy to generate in experiments, there is a vast number of different model equations proposed in the literature.

My goal of this project was to find a model that is different from the models proposed in the literature and that has desirable smoothness properties and models the phenomena relatively close to the real world experiment.

The reaction-diffusion model for the pattern formation

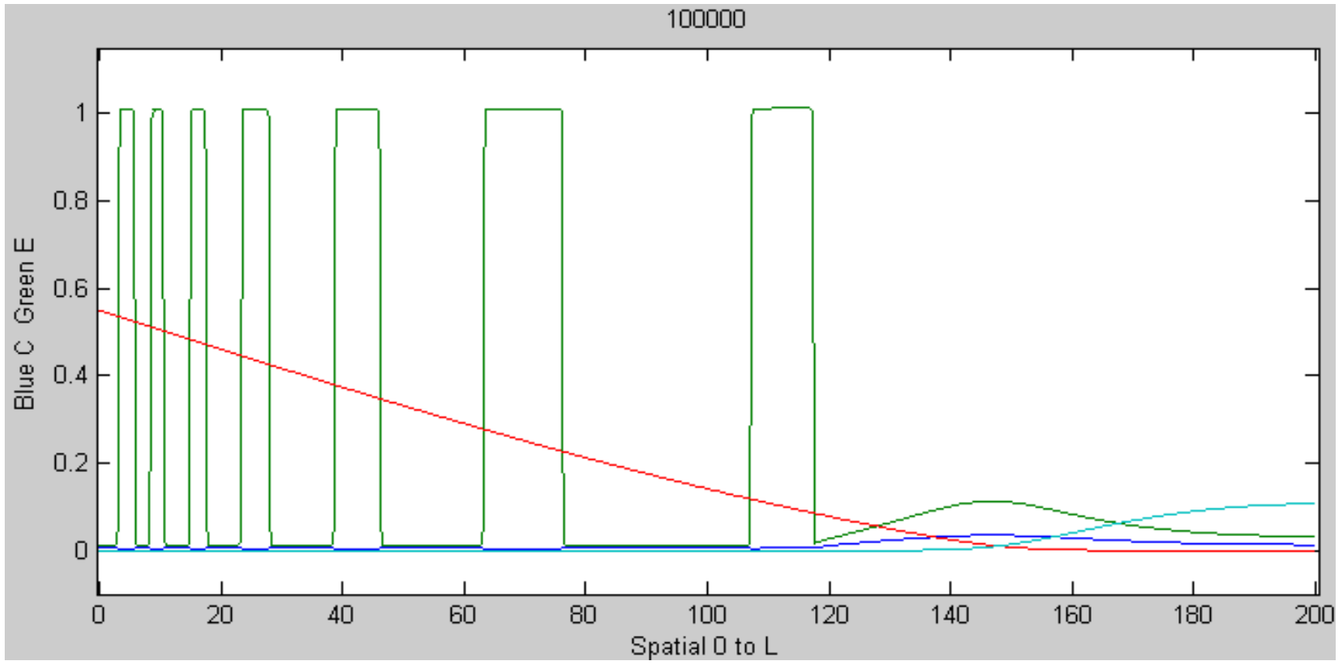
The model I and my fellow researchers Ryan from Michigan State University and Sam from Harvey Mudd College came up with is a smoothed version of Keller's model [1] for the Liesegang pattern formation. This model is based on a reaction-diffusion model with cubic term which contains a kinetic threshold for reaction term. –different from discontinuous model such as Lagzi [2] and also different from Cahn-Hilliard equation model as in Droz model [3].

$$a_t = a_{xx} - ab$$

$$b_t = d_b b_{xx} - ab$$

$$c_t = c_{xx} - \text{alpha} * e(1-e)(e-kt) - c + ab$$

$$e_t = d_e e_{xx} + \text{alpha} * e(1-e)(e-kt) + c \quad , d \ll 1$$



You can see the increasing space and width among each spikes

Conclusion

Now that we have a model that produces a phenomena of Liesegang pattern from simple ODE dynamics and also has a parameter space to work with we can try to produce more interesting patterns such as 'Revert Pattern' or It's 2-dimensional version of model with similar kinetics.

References:

[1] Keller J B and Rubinow S 1981 Recurrent precipitation and Liesegang rings J. Chem. Phys. 74 5000-7

[2] F. Molnr Jr, F. Izsk, and I. Lagzi. Design of equidistant and revert type precipitation patterns in reaction diffusion systems. Phys. Chem. Chem. Phys.,10, (2008) 2368~2373

[3] Antal T, Bena I, Droz M, Martens K and Rácz Z 2007 Guiding fields for phase separation: controlling Liesegang patterns Phys. Rev. E 76 046203

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