Fuzzy chaos: advection-reaction-diffusion patterns in complex flows. **(Mentor: Kevin Mitchell)** Many physical, chemical, and biological processes produce a growing front within a flowing fluid—important examples include autocatalytic chemical reactions in stirred media, phase transitions in liquid crystals, and plankton blooms in oceanic flows. Often the underlying fluid advection generates fractal distributions of passive tracers; in this case, Tel et. al. showed that the comparable distribution of a growing agent exhibits similar filamentary structure down to a small cut off scale, forming a kind of "fattened" fractal. This result assumed that the front growth speed v_0 was slow relative to the fluid. Recently, a new construct—burning invariant manifolds (BIMs)—has successfully explained patterns formed by advection-reaction-diffusion fronts in both theoretical studies and laboratory-scale experiments. Importantly, the BIM approach is nonperturabtive in the front speed v_0. In this project, REU students would first work to establish the connection between these competing approaches by computing BIMs in the limit of a small front speed v_0, where the BIM patterns should agree with the fattened-fractal approach of Tel et. al. Students would then investigate larger v_0 speeds, where the BIM approach is expected to succeed, but the fattened fractal approach is expected to break down. Understanding this breakdown would, for example, have implications for the mean reaction rate of the active agent. REU students completing this project would have demonstrated proficiency with numerical simulation (in Matlab) and would have developed a practical fluency with basic low-dimensional dynamical systems techniques.