Oberseminar Nichtlineare Differentialgleichungen

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Formal Modulation Theory for Dynamic Bifurcations in PDEs

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Abstract: Classical modulation theory provides an alternative to center manifold theory for problems with continuous spectrum. This talk focuses on the development of formal modulation theory for dynamic bifurcations in slow-fast PDEs. We show that the formal part of classical modulation theory can be extended to the slow-fast setting using a novel adaption of the so-called geometric blow-up method and the method of multiple scales. We demonstrate the utility and versatility of this approach by using it to derive modulation equations, i.e. simpler closed form equations which govern the dynamics of the formal approximations near the underlying bifurcation point, in the context of model equations with dynamic bifurcations of (i) Turing, (ii) Hopf, (iii) Turing-Hopf, and (iv) stationary long-wave type. The modulation equations have a familiar form: They are of real Ginzburg-Landau (GL), complex GL, coupled complex GL and Cahn-Hilliard type respectively. In contrast to the modulation equations derived in classical modulation theory, however, they have time-dependent coefficients induced by the slow parameter drift, they depend on spatial and temporal scales which scale in a dependent and non-trivial way, and the geometry of the space in which they are posed is non-trivial due to the blow-up transformation. The formal derivation of the modulation equations provides the first steps toward the rigorous treatment of these challenging problems, which remains for future work.

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