

## **Effect of Topological Dimension on Rigidity of Vehicle Formations: Fundamental Limitations of Local Feedback**

**Bassam Bamieh**  
**University of California, Santa Barbara**

**Friday, May 9, 2008 3:00-4:00pm Harold Frank Hall 1104**

---

### **Abstract:**

We consider the role of topological dimension in problems of network consensus and vehicular formations where only local feedback is available. In particular, we consider the simple network topologies of regular lattices in 1, 2 and higher dimensions. We address the question of rigidity of such formations, or in other words, how closely do such formations resemble solid objects. A common phenomenon appears where in dimensions 1 and 2, rigid formations are impossible in the presence of any amount of additive stochastic perturbations, and in the limit of large formations. In dimensions 3 and higher, tight formations are indeed possible! We show that microscopic error measures that involve only neighboring vehicles do not suffer from this effect, implying that it is unrelated to string instability issues. This phenomenon reflects the fact that in dimensions 1 and 2, local stabilizing feedbacks can not suppress the long spatial wavelength “meandering” motions of large formations. We point out connections between this analysis and the statistical mechanics of harmonic solids where such phenomena have long been observed, as well as connections with the theory of resistive lattices as has been observed by others.

---