163rd MSS-Seminar
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Room 00.156,
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Emerging collective phenomena: from nonlinear flow networks to active matter

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Nature is full of examples where individual components, exhibiting simpler behavior, self-organize and generate emerging complex behavior as a group. Such collective behavior emerges at every level and scale, from the self-sustained oscillations in the brain vasculature to the mesmerizing behavior of a flock of birds. In this talk, we will approach the physics of nonlinear flow networks and active matter from opposite points of view. We will learn how passive nonlinear ducts that transport fluid can display emerging phenomena when arranged in a complex network, and will discuss how we have built such a nonlinear flow network in the lab. In the case of active matter we will go in the other direction, from the collective behavior to the local rules that support it. We propose a graph-neural-network-based scheme that takes the collective movement of the particles and learns the forces present in the system. After training the network, one can extract both active and passive interactions between particles. We validate this approach with numerical data, and extract physical conclusions from experiments of synthetic active particles.