Self-assembled aggregates of dye molecules exhibit intriguing optical properties caused by their collective optical excitations, Frenkel excitons. The energetic, dynamic, and spatial properties of these excitons are responsible for special optical absorption, emission, and energy transport characteristics, which play an important role in optical materials as well as light-harvesting systems. The latter are abundant in natural photosynthetic systems, whose functioning is the topic of many scientific studies and may find applications in synthetic analogues. In this talk, I will introduce the topic of excitons in self-assembled molecular aggregates in general and light-harvesting antennae in particular. Next, I will discuss the modeling and experimental probing of the optical properties and dynamics of the excitons. The complexity of the systems considered and the resulting interplay between many degrees of freedom that govern the nature of the excitons, makes this an exciting and complex arena of research. Systems of particular interest during the talk will include nano-tubular aggregates, which occur in the photosynthetic apparatus of certain bacteria, but also can be created using synthetic dye molecules. Throughout the talk, connections between theory and experiment are made.

Fig. 1: Self-assembled double-walled nano-tubular aggregate of cyanine dye molecules, with fluorescence spectrum [from D. Eisele et al., Nature Chemistry 4, 655 (2012)].