English summary

The thesis of Tobias M. Wintermantel with the title “Complex systems dynamics in laser excited ensembles of Rydberg atoms” presents experimental and theoretical findings showing that an ultracold gas under laser excitation to Rydberg states can provide a tunable platform for studying the interesting complex dynamics emerging in driven-dissipative systems. The three main finding supporting this connection are:

(i) The discovery of self-organized criticality (SOC) in our Rydberg system under facilitated excitation via three signatures: First we observe self-organization of the density to a stationary state. Second, we find scale invariant behavior in the bulk observable density. And third, we measure a critical response of the system in terms of power-law distributed Rydberg excitation avalanches. In further studies, we unravel an intrinsic mechanism in the system which stabilizes the SOC state via atom motion. Furthermore, a controlled stabilization mechanism via tuning of the laser driving is presented. These results can help answer the question of why scale invariant behavior is so prevalent in nature.

(ii) A connection between the power-law growth of the Rydberg excitation number and epidemic spreading is revealed.