Simulating quantum spin systems using ultracold Rydberg atoms

Nithiwadee Thaicharoen, Adrien Signoles, Miguel Ferreira-Cao, Renato Ferracini Alves, Titus Franz, André Salzinger, Asier Piñeiro Orioli, Jürgen Berges, Shannon Whitlock, Gerhard Zürn, Matthias Weidemüller

Physikalisches Institut, Universität Heidelberg, Im Neuenheimer Feld 226, 69120 Heidelberg, Germany

Institut für Theoretische Physik, Universität Heidelberg, Philosophenweg 16, 69120 Heidelberg, Germany

ExtreMe Matter Institute EMMI, Planckstraße 1, 64291 Darmstadt, Germany

IPCMS (UMR 7504) and ISIS (UMR 7006), University of Strasbourg and CNRS, 67000 Strasbourg, France

University of Science and Technology of China, Hefei, Anhui 230026, China

There is a currently growing interest in utilizing dipolar interacting Rydberg spin systems to study of non-equilibrium phenomena, like thermalization or relaxation of isolated quantum systems. The tunable strong, long-range interactions as well as the long lifetimes of highly excited Rydberg atoms also provide new opportunities for investigating the dynamics of strongly correlated many-body quantum systems with beyond nearest-neighbor coupling.

We present an experimental realization of a dipolar spin model by coupling two strongly interacting Rydberg states utilizing a microwave field. We study spin dynamics by letting spin systems evolve under designated interactions. The resulting magnetizations after the dynamics are extracted from the systems utilizing a state-tomography technique and a selective ionization. The result of the dynamics will be discussed in the talk.