In the Quantum Gases & Quantum Information group at the University of Amsterdam a quantum information platform is being created in the form of a permanent magnetised atom chip with trapped rubidium-87 ($^{87}$Rb) atoms. This creates an unique scalable platform where quantum information is stored in qubit states encoded in the hyperfine levels of the ground state. Operations on qubit states are created by quantum logic gates involving single-qubit transitions and often a control mechanism evoked by Rydberg excitation.

Extension of single-qubit to two-qubit quantum gates require controlled interactions, which will be created via Rydberg excitation and the concomitant Rydberg blockade mechanism will serve as a control mechanism in quantum logic gates. Electromagnetically Induced Transparency (EIT) spectroscopy is used to calibrate the wavelength of the coupling laser used during Rydberg excitation. The experimental set-up allows for spectroscopy on Rydberg states $n = 19 – 28$ in a room temperature vapour cell. The Rydberg level hyperfine splittings in these states is studied and the influence of magnetic fields on excitation pathways is investigated experimentally and theoretically.

Additionally, these quantum gates call for single-site addressing which will be realised via the use of a Spatial Light Modulator (SLM). The pixelated structure behind the liquid-crystal allows for phase modulation by altering the optical axis through applying a varying voltage across the pixels, thereby creating arbitrary shaped light fields in the image plane. For optimal operation the phase response as a function of applied voltage is linearised. Secondly, the backplane curvature is compensated by applying a corrective phase pattern obtained through the use of Phase Shifting Interferometry (PSI). Combined these two topics are an important progression towards the realisation quantum information on an atom chip.