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Cold Atom Electron/Ion Source with Rydberg Blockade and Electromagnetically Induced Transparency BEN SPARKES, DENE MURPHY, RICHARD TAYLOR, RORY SPEIRS, DAN THOMPSON, ROBERT SCHOLTEN, The University of Melbourne, CXS COLLABORATION — Rydberg atoms provide an interesting system for research on long-range dipole interactions and applications including quantum information and quantum simulations. At the low temperatures and atomic densities typical of laser-cooled atom clouds, the dipole interaction can lead to Rydberg blockade, where an atom in a Rydberg state will affect the internal energy levels of neighbouring atoms, preventing simultaneous excitation. Rydberg blockade can create spatial order and thereby reduce disorder-induced heating which currently limits the minimum temperature of ultracold plasmas and cold atom electron and ion sources (CAEIS). We will present our latest results investigating Rydberg blockade and disorder-induced heating from our rubidium CAEIS. Combining the competing effects of Rydberg blockade with our ability to shape the electron and ion bunches can in principle allow improvements to the brightness and emittance of the source for nanofabrication and imaging. We have also used the bunch shaping ability to probe the transition from blockade to electromagnetically induced transparency (EIT). EIT can be used to determine the coherence of the atomic system, and the combination of EIT with Rydberg blockade has potential for use in photonic phase gates.

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