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Final Oral Examination for the Ph. D. Degree

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Ultracold Rubidium and Potassium System for Atom Chip-based Microwave and RF Potentials

Wednesday, 15 April 2015, 9:00 a.m.

William Small Physical Laboratory, Rm 122

Open to the Public

Abstract: In this dissertation we study the development of microwave and RF near-field potentials for use with atom chip trapped atomic gases. These potentials are inherently spin-dependent, able to target individual spin states simultaneously. In contrast with traditional atom chip potentials, these RF traps can be operated at arbitrary bias magnetic field strengths and thus be combined with magnetic Feshbach resonances. Furthermore, these potentials can strongly suppress the potential roughness that plagues traditional atom chip potentials. We present a dual chamber atom chip apparatus for generating ultracold 87Rb and 39K atomic gases. The apparatus produces quasi-pure Bose-Einstein condensates of 104 87 Rb atoms in an atom chip trap that features a dimple and good optical access. We have also demonstrated production of ultracold 39K and subsequent loading into the chip trap. We describe the details of the dual chamber vacuum system, the cooling lasers, the magnetic trap, the multi coil magnetic transport system, and the atom chip. The apparatus is well suited for studies of atom-surface forces, quantum pumping and transport experiments, atom interferometry, novel chip-based traps, and studies of one-dimensional many-body systems.

Bio: Austin R. Ziltz was born on the 30th of April, 1986 in Harrisburg, Pennsylvania. He attended West Hanover Elementary School, Central Dauphin East Junior High and Central Dauphin High School. After being inadvertently electrocuted several times during his youth, he eventually found a passion for physics. In 2004, he entered Bucknell University. He graduated with honors in 2008 with a Bachelor of Science in Physics and a minor in Mathematics. Austin entered the College of William & Mary in the fall of 2008, and began work with Dr. Seth Aubin in the Ultracold Atoms Group to develop microwave and RF atom chip potentials and the apparatus with which to study them. He received a Master of Science in 2010. Austin began working for Laser & Plasma Technologies in Hampton, Virginia in October 2014, developing corrosion detection instruments for the Navy.