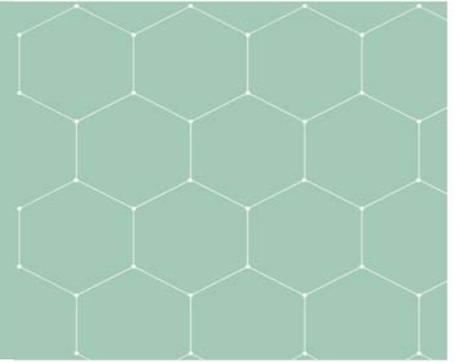




**PHYSICS**  
**COLORADO STATE UNIVERSITY**



## **CSU PHYSICS COLLOQUIUM**

### **Laser Spectroscopy of Atomic Hydrogen & the Proton Size Puzzle**

**Arthur Matveev**

**Max Planck Institute of Quantum Optics**

February 26, 2019 at 8 a.m.

Lory Student Center 322

#### **Abstract**

One of the ways to test modern fundamental theories, such as quantum electro-dynamics (QED) is to perform high precision measurements of systems, whose properties can be computed with the same level of precision. The atomic hydrogen is a good example of such a system. Thanks to its simplicity, very complicated QED calculations can be performed very precisely. Measurements of transition frequencies in hydrogen can be compared with theory, which can possibly reveal discrepancies, driving the development of the theory. An example of this approach is the Proton Size Puzzle [1], which is a  $4\sigma$  difference between the values of the proton charge radius, obtained from spectroscopy of atomic hydrogen and muonic hydrogen.

In the talk, I will discuss the experimental measurements of different transitions in atomic hydrogen, performed at the Max-Planck Institute of Quantum Optics in Garching, Germany. The most precisely measured transition is the 1S-2S [2, 3] transition, which was measured in 2010. It needs to be combined with one or more other transitions. In 2017, we have published the measurement of the 2S-4P transition [4], which gives an interesting result for the understanding of the Proton Size Puzzle. Finally, the preliminary results of 1S-3S transition measurement completed using a novel and promising method referred to as the Direct Frequency Comb Spectroscopy will be presented and discussed.

[1] A. Antognini et al, Science 339, (2013) 417

[2] C. G. Parthey et al., Phys. Rev. Lett. 107, 203001 (2011) [3] A. Matveev et al, Phys. Rev. Lett. 110, (2013) 230801

[4] A. Beyer et al, Science 358, (2017) 79

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# PHYSICS

## COLORADO STATE UNIVERSITY

### **Biography:**

Artur Matveev was born in 1982, in Tajikistan which was part of USSR that time. After the collapse of USSR his family moved to Russia. He studied in Moscow Institute of Physics and Technology; the MA degree was obtained in 2005. His master work was done in Lebedev Physics Institute in Moscow, the work was concerned with spectroscopy of Coherent Population Trapping Resonances in Rubidium with the help of femtosecond frequency comb.

After study he joined the group of Prof. Theodor Hänsch in Max Planck Institute of Quantum Optics in Garching (Germany), as a Ph.D. student. The Ph.D. work was focused on the measurement of hyperfine splitting of the 2S state in atomic hydrogen. The Ph.D. thesis was defended in December 2009. After the PhD defense he stayed as a Postdoc in the group of Prof. Hänsch, working in the field of high-precision spectroscopy of atomic hydrogen. During this work in 2010 he participated in the most precise measurement of atomic transition 1S-2S in atomic hydrogen. After this measurement he has started the work on transition 2S-4P, which results was published in 2017. He also joined the project on direct frequency comb spectroscopy of transition 1S-3S in hydrogen, which preliminary results will be discussed in his talk.