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Two-photon cooling of atomic hydrogen[1]

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Since 2010, determinations of the proton charge radius through spectroscopic comparisons of hydrogen and muonic hydrogen (a bound state of a muon and a proton) have been inconsistent. As a result, it is anticipated that the current set of hydrogen data may contain unknown or poorly controlled systematic effects. Therefore, there is a need for additional hydrogen data using new experimental techniques. Since most systematic effects in hydrogen spectroscopy can be traced back to the finite temperature of the atoms, I will discuss our plans to implement a two-photon laser cooling technique for hydrogen. This technique could reduce the temperature of a hydrogen sample to near the recoil limit of $\sim$1 mK. Spectroscopy of this cold, and possibly trapped atomic sample would likely allow us to better understand the proton radius puzzle. In addition, I will discuss our plans to measure the hydrogen 2S-8D transition in a new apparatus using optical preparation of the 2S state. This measurement will first be attempted with a cryogenic (4K) source of atomic hydrogen.

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