



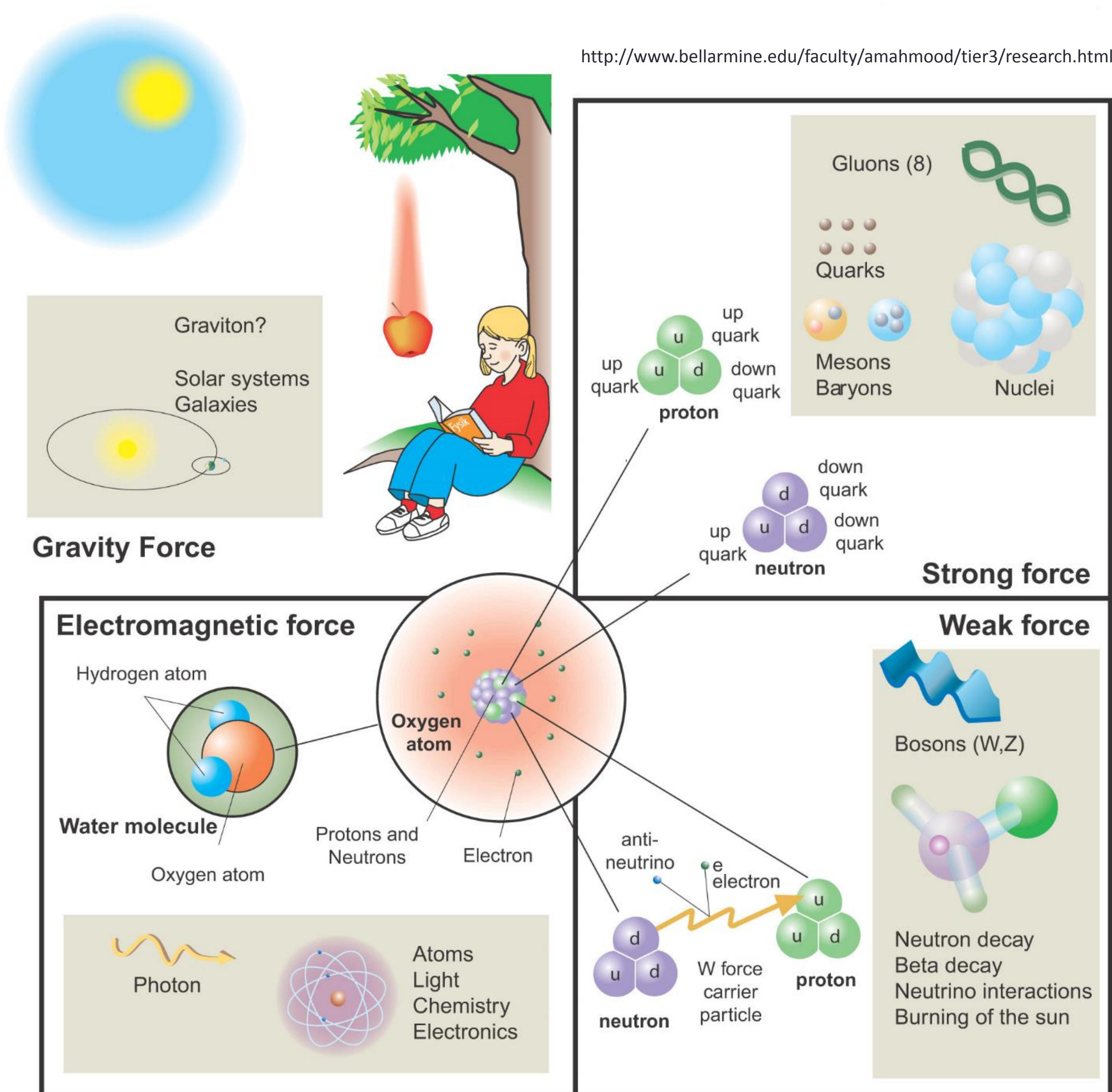
Duke University

Proton Charge Radius (PRad) Experiment in Hall B

On behalf of PRad Collaboration, Hall B
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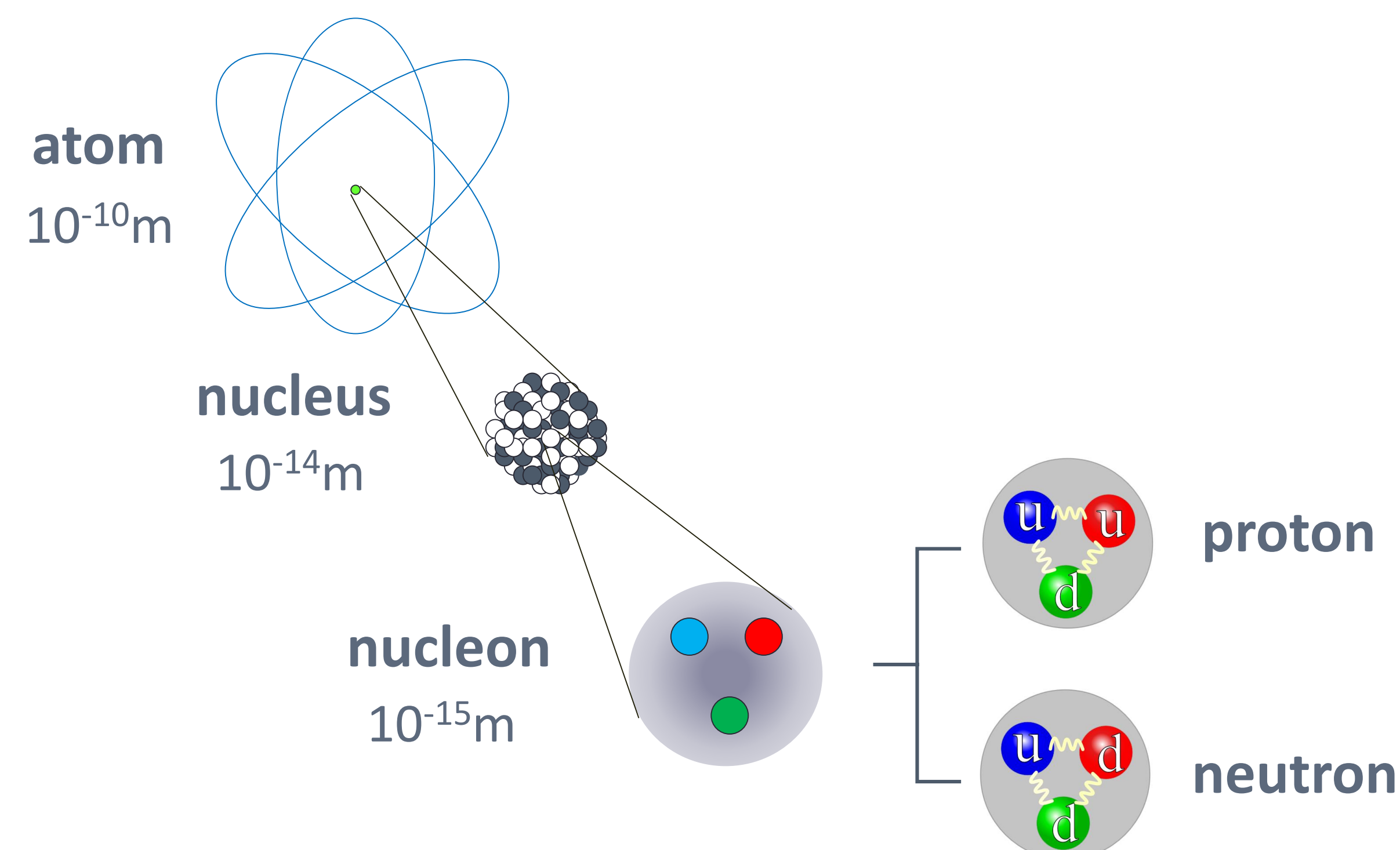


FUNDAMENTAL FORCES IN NATURE



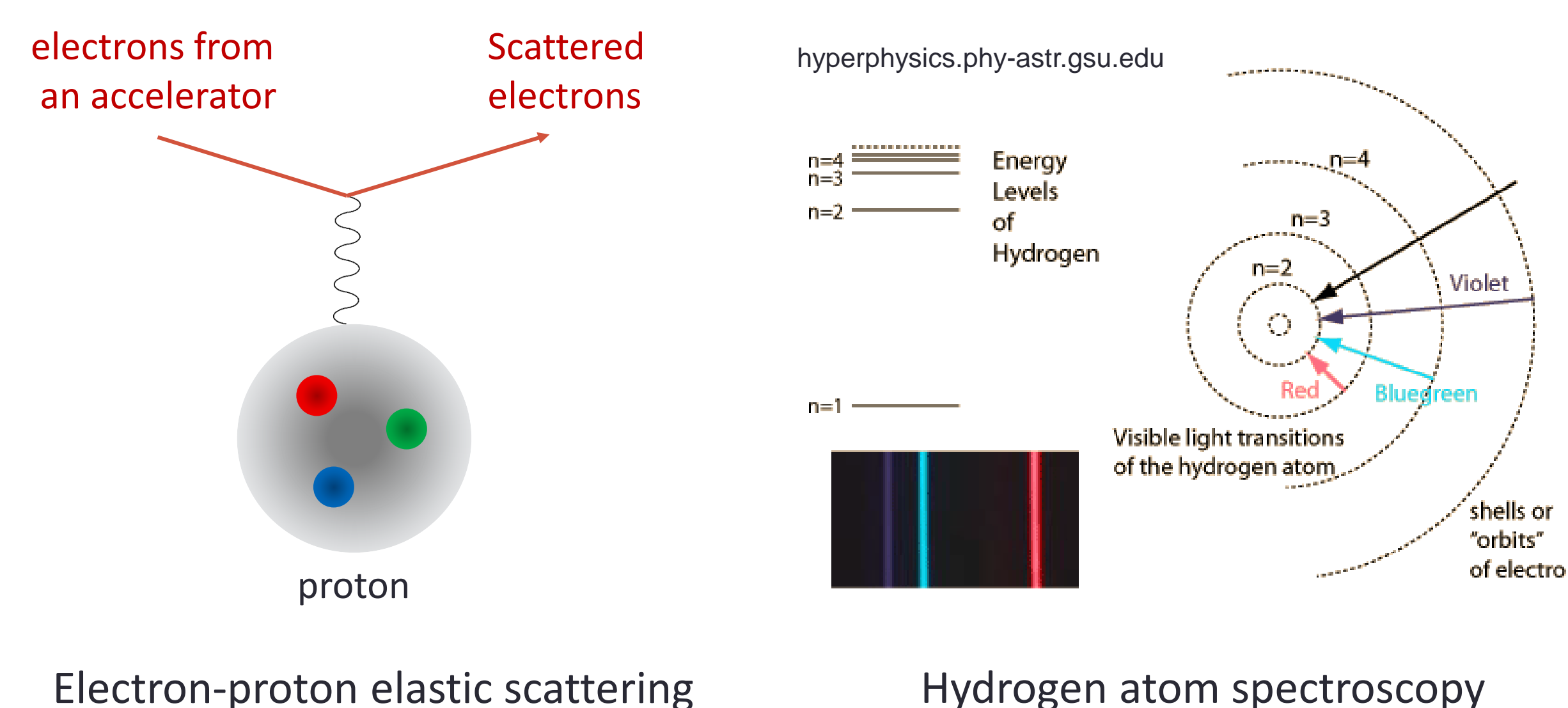
STRUCTURE OF MATTER

- Most of the visible mass and energy in the universe around us comes from nuclei and nuclear reactions
- The nucleus is a unique form of matter in that all the forces of nature are present (gravity, strong, electromagnetic, weak)



MEASURE THE SIZE OF PROTON

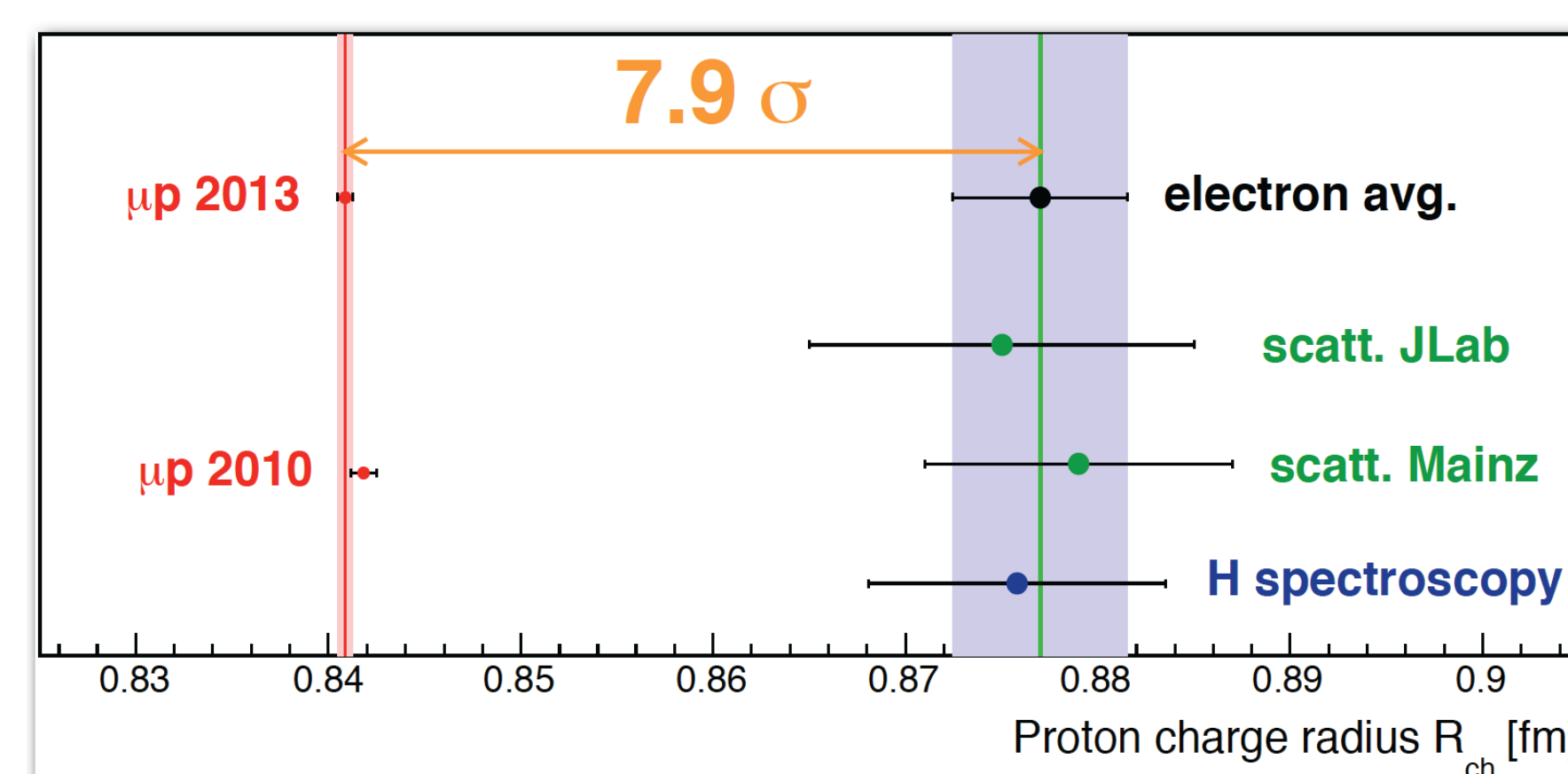
- The charge radius of proton can be experimentally determined in two ways:
 - Elastic scattering experiments
 - Hydrogen atom optical spectroscopy measurements



PROTON RADIUS PUZZLE



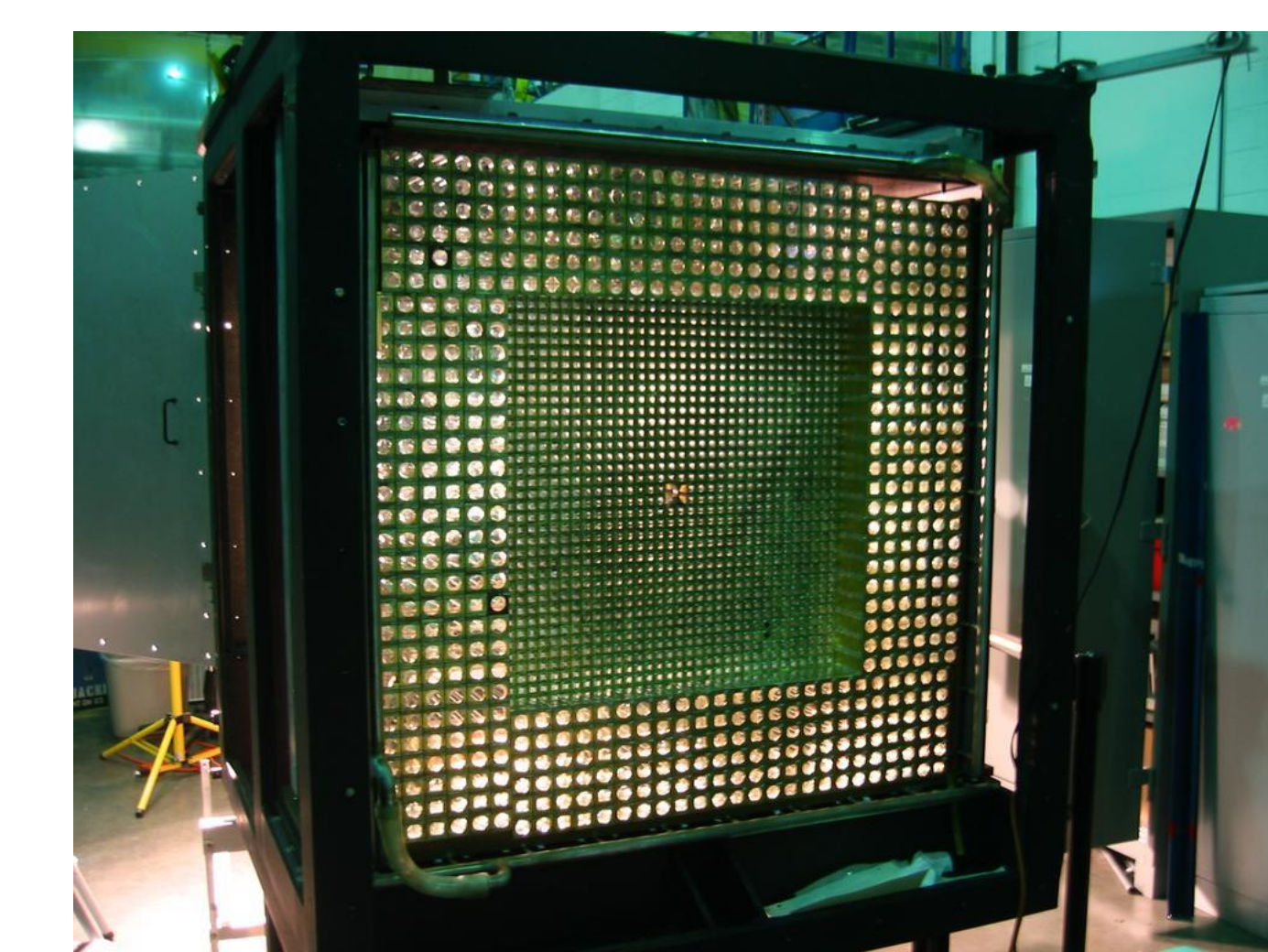
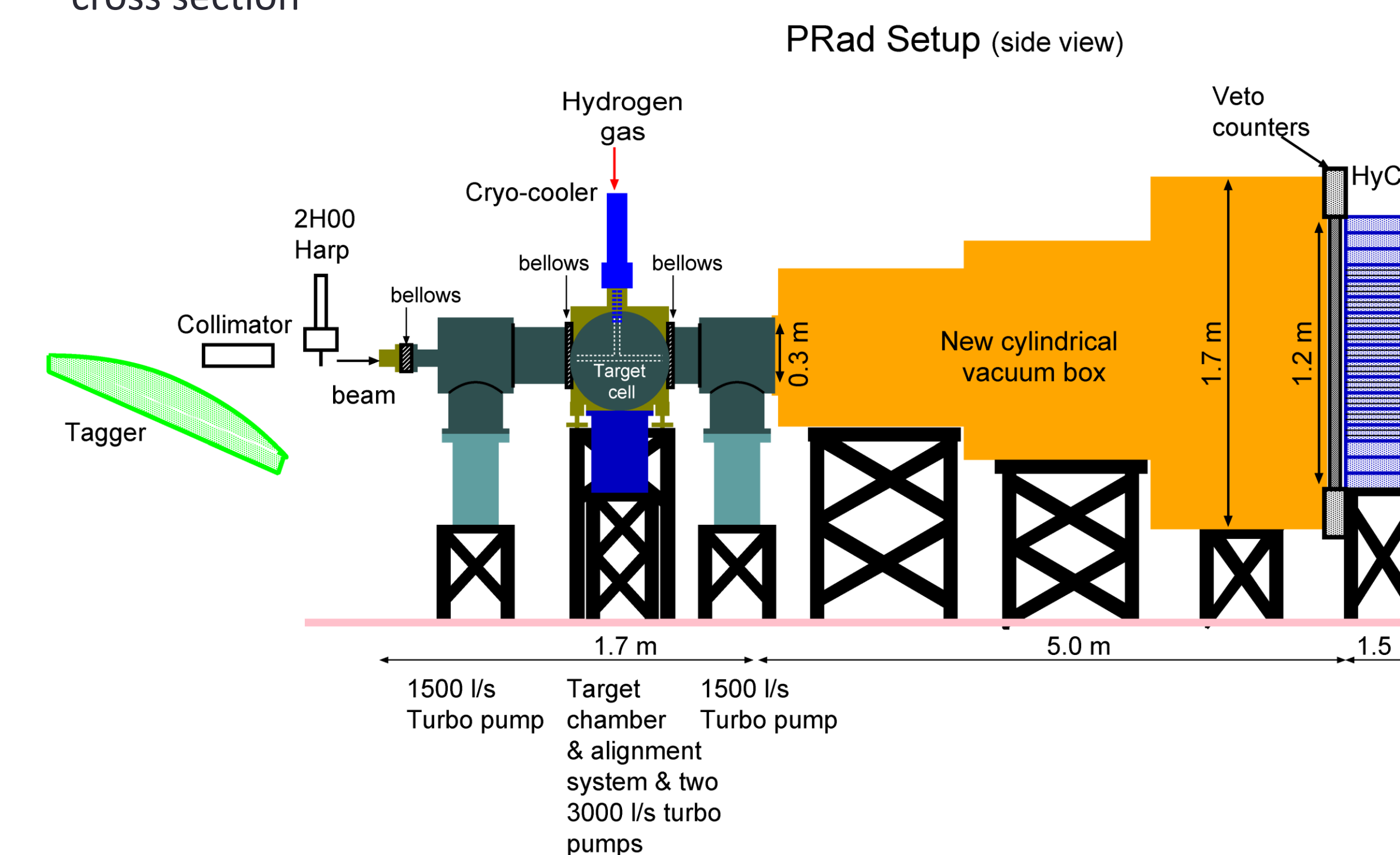
- The proton radius puzzle was recently developed by the spectroscopy measurement of muonic hydrogen at PSI (muonic hydrogen atom consists of a muon and a proton. Muon is a particle like the electron but about 200 times heavier.)
- PSI value of proton charge radius is the most precise one, but smaller than most of the electron based experimental results and analysis
- The discrepancy is not understood yet, thus called the "proton radius puzzle"



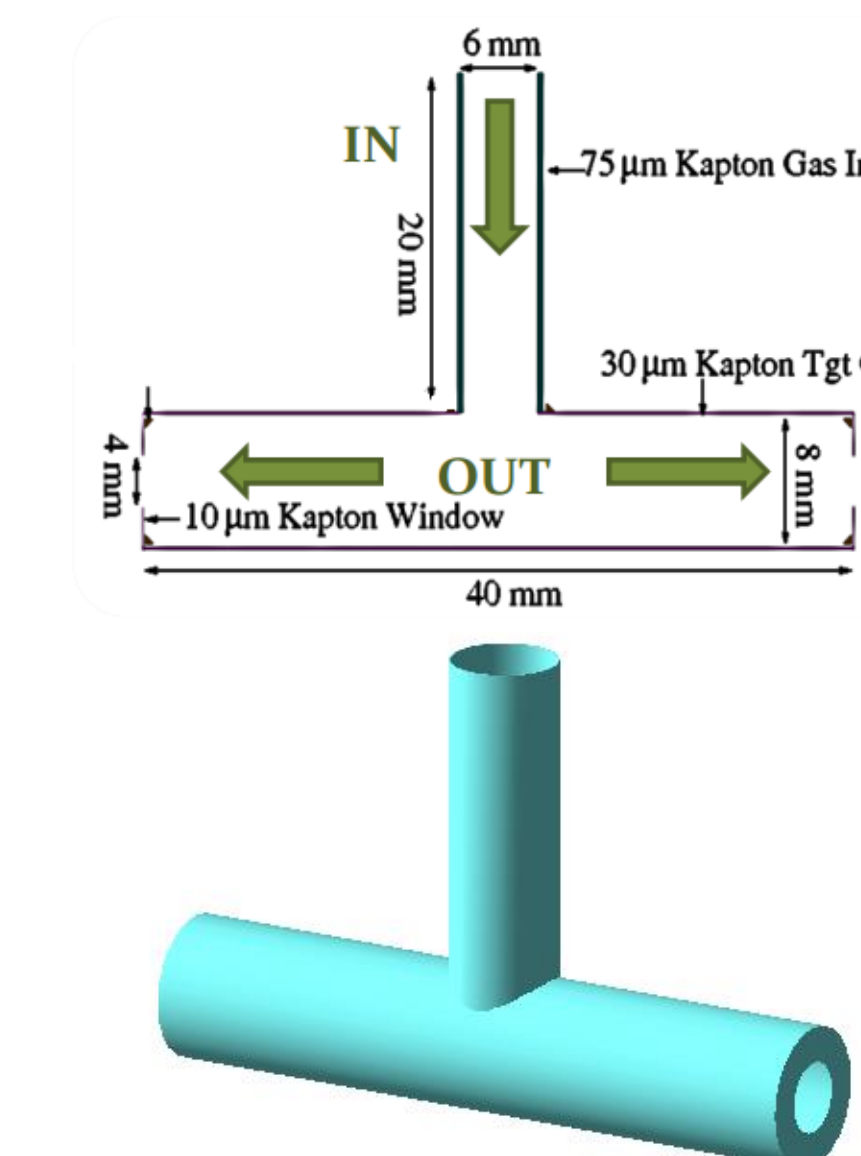
Large discrepancy between the proton charge radius determined from muon and electron based measurements

THE PRad EXPERIMENT

- Aims to solve the proton radius puzzle
- Electron-proton elastic scattering experiment at unprecedentedly small angles
- Different from previous scattering experiments: Non-magnetic and calorimetric
- Background is suppressed by using a windowless gas flow target
- electron-electron scattering is measured simultaneously to normalize the e-p cross section

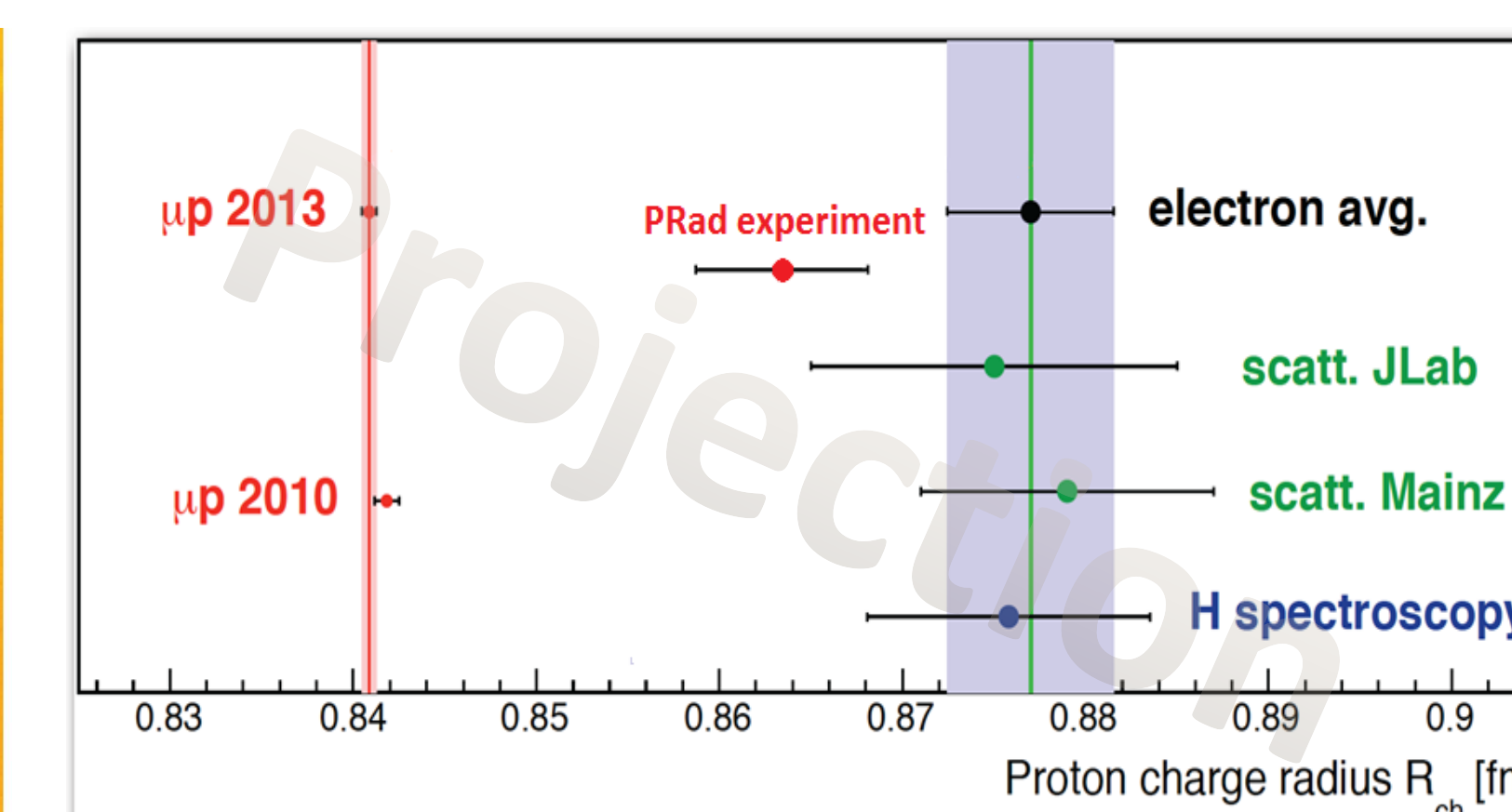
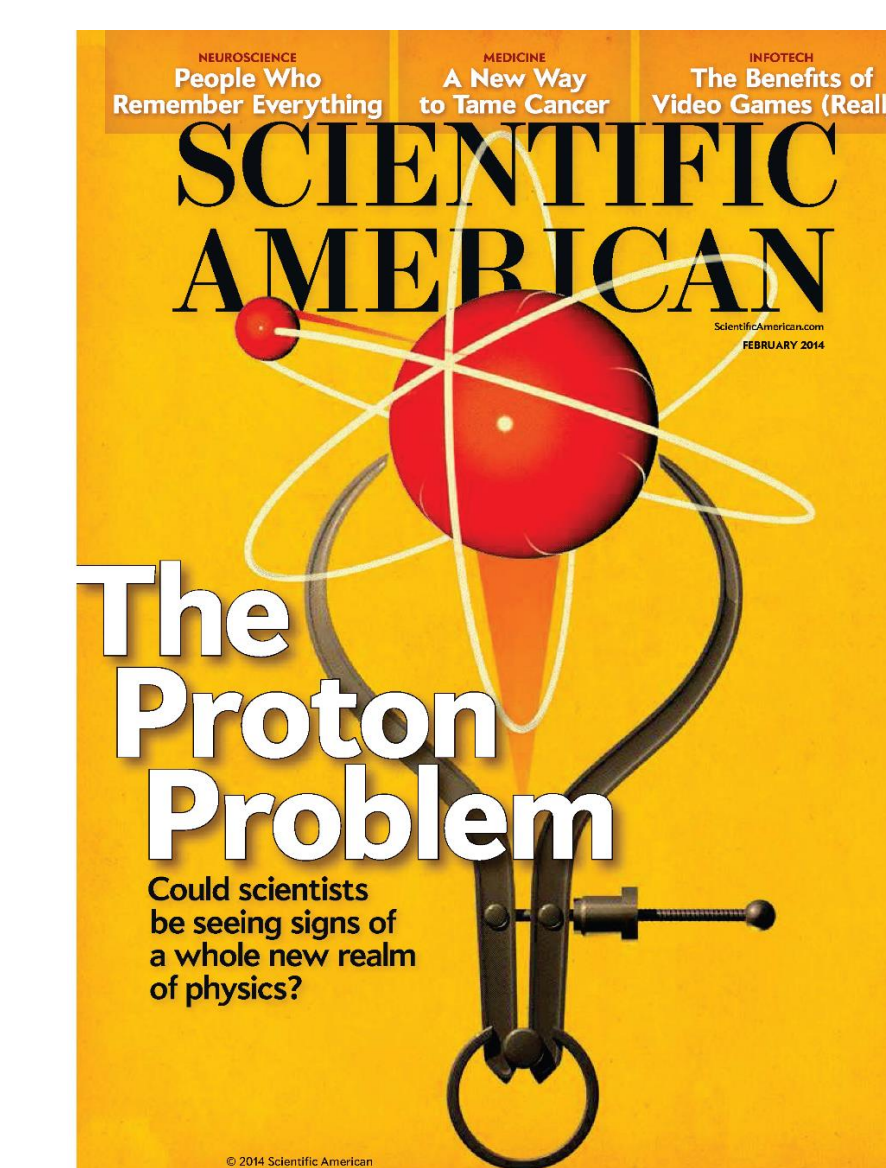


Detector: Hybrid Calorimeter (HyCal)



Windowless gas-flow target

Proton radius remains puzzling - PRad will elucidate



The expected precision of PRad experiment is less than 1%, better than the previous scattering experiments