Welcome to PSI





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Science Foundation

Combining μ H, H, He, HD⁺, Penning trap measurements



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Best test of H-energy levels

Best test of higher-order terms $\propto Z^{5...7}$

Best test of a three-body molecule

Best test of bound *g*-factors

Hyperfine splitting

Theory: QED, ChPT, data-driven dispersion relations, ab-initio few-nucleon theories

Experiment: HFS in μ H, μ He⁺, ...

Guiding the exp.

find narrow 1S HFS transitions with the help of full theory predictions: QED, weak, finite size, polarizability

Interpreting the exp. extract E^{TPE} , $E^{\text{pol.}}$ or R_{z}

Input for datadriven evaluations form factors, structure functions, polarizabilities

Testing the theory

- discriminate between theory predictions for polarizability effect
 - disentangle R_Z & polarizability effect by combining HFS in H & μ H
- ► test HFS theory
 - combining HFS in H & μ H with theory prediction for polarizability effect
- test nuclear theories

Spectroscopy of ordinary atoms (H, He⁺)

Electron and Compton Scattering

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Interplay with theory & other experiments

Theory: QED, ChPT, data-driven dispersion relations, ab-initio few-nucleon theories, LQCD







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HFS **Theory:** QED, ChPT, data-driven Theory dispersion relations, ab-initio few-nucleon theories, LQCD **Testing the theory** Interpreting the exp. ► bound-state QED for H, He⁺ extract E^{TPE} , $E^{\text{pol.}}$, ► HFS theory Guiding the exp. nuclear theories R_7 or R_F three-body molecules find HFS or LS Bound g-factors transitions TPE with the help of full

Input for data-

driven evaluations

form factors,

structure functions,

polarizabilities

Electron and

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Spectroscopy of ordinary atoms (H, He⁺)

> Hydrogen molecular ions

> > Penning traps

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theory predictions:

QED, weak, finite size,

polarizability

Polarizabilities

Scattering

experiments

Experiment: HFS in μ H, μ He⁺, ... LS in μ H, μ D, μ He⁺, ...

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HFS experiments

Heavier (Muonic) Atoms

Experiment: HFS in μ H, μ He⁺, ... LS in μ H, μ D, μ He⁺, ...

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polarizabilities

Scattering experiments

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Electron and Compton Scattering

Hydrogen molecular ions

Penning

traps

HFS experiments

Heavier (Muonic) Atoms

Experiment: HFS in μ H, μ He⁺, ... LS in μ H, μ D, μ He⁺, ...

HFS experiments

Heavier (Muonic) Atoms

Why are we here?

from puzzle to PRECISION

- Several experimental activities ongoing and proposed:
 - 1S hyperfine splitting in μ H and μ He⁺ (CREMA, FAMU, J-PARC)
 - Improved measurement of Lamb shift in μ H, μ D and μHe^+ possible ($\times 5$)
 - Medium- and High-Z muonic atoms
- Theory support is needed

MUONIC ATOM THEORY INITIATIVE

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No useless plenary discussions but

Coffee, Lunch, Dinner, Bowling, BBQ

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"Goofing off is harder than it looks. After the fourth cup of coffee, it's very difficult not to accomplish something!"

F. Hagelstein & A. Antognini

"I'm sick and tired of you taking credit for my work!"