

## Proposals for experiment oriented topics

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### 1. Title: Resonant Coherent Excitation of Highly Charged Ions

*Task:* Ions passing through a periodic lattice (ordered rows or planes) of a crystal feel a time dependent perturbation of the potential. When one of the frequencies of the perturbation corresponds to the difference of internal energy levels of the ions, resonant coherent excitation (RCE) occurs. In this contribution, one needs to present recent experiments which investigate the RCE and to explain how this process can be applied for precision spectroscopy of highly-charged ions.

*Literature:* [1] <http://prl.aps.org/abstract/PRL/v102/i8/e085502>

[2] <http://prl.aps.org/abstract/PRL/v97/i14/e145502>

### 2. Title: The Size of the Proton: Precision Spectroscopy on Muonic Hydrogen

*Task:* The proton is the primary building block of the visible Universe, but many of its properties—such as its charge radius and its anomalous magnetic moment—are not well understood. An attractive means to improve the accuracy in the measurement of the root-mean-square charge radius,  $r_p$  is provided by muonic hydrogen (a proton orbited by a negative muon); its much smaller Bohr radius compared to ordinary atomic hydrogen causes enhancement of effects related to the finite size of the proton. In this contribution, one needs to explain a very recent experiment of muonic hydrogen which allowed to obtain a very accurate value of the proton radius.

*Literature:* [1] *Nature* **466**, 213-216 (8 July 2010) | doi:10.1038/nature09250; Received 22 March 2010

### 3. Title: Antihydrogen Production

*Task:* Antihydrogen atoms that are cold enough to be trapped for laser spectroscopy promise to provide the most stringent *CPT* tests with baryons and leptons, along with more sensitive tests for possible extensions to the standard model, building on the high accuracy of hydrogen spectroscopy. Here, one has to present experiments done at CERN which have successfully demonstrated Antihydrogen production.

*Literature:* [1] <http://cdsweb.cern.ch/record/581488/files/sis-2002-405.pdf>

[2] <http://cdsweb.cern.ch/record/294105/files/open-96-001.pdf?version=1>

[3] <http://hussle.harvard.edu/~gabrielse/gabrielse/papers/2002/AtrapColdAntihydrogenPRL.pdf>

#### 4. Title: Hard X-Ray Polarimetry

*Task:* Main photon matter interaction processes exhibit distinct photon polarization features (Synchrotron Radiation, Bremsstrahlung, Recombination, Inverse Compton Scattering) . Therefore, hard x-ray polarimetry plays a very important role in many different areas of physics. In this presentation, graduate students have to explain the technique and present few applications.

*Literature:* [1] R Novick - Space Science Reviews, 1975 – Springer,

<http://adsabs.harvard.edu/full/1975SSRv...18..389N>

[2] [http://wwwxray.ess.sci.osaka-u.ac.jp/~hayasida/Study/papers/Tokanai\\_2004.pdf](http://wwwxray.ess.sci.osaka-u.ac.jp/~hayasida/Study/papers/Tokanai_2004.pdf)

[3] [http://rsi.aip.org/resource/1/rsinak/v79/i8/p083101\\_s1?isAuthorized=no](http://rsi.aip.org/resource/1/rsinak/v79/i8/p083101_s1?isAuthorized=no)

[4] <http://www.springerlink.com/content/wuw41mk032553201/>

#### 5. Title: Strong Field QED: Nonlinear Compton Scattering

*Task:* A collision process of a photon and an electron is known as the Compton scattering and is well described by the Klein–Nishina formula based on quantum electrodynamics. For an extremely intense incident light, however, the process deviates from the Compton scattering due to nonlinear effects, such as intensity dependent frequency shift of scattered photons and generation of higher order harmonics. These phenomena, the nonlinear Compton scattering, become appreciable for the incident light power above  $10^{17}$ – $10^{18}$  W/cm<sup>2</sup> for 1 um wavelength. In this talk, one has to present an experiment at SLAC where nonlinear Compton scattering was observed in the collision with 46.6 GeV electrons.

Literature: [1] [http://prl.aps.org/abstract/PRL/v76/i17/p3116\\_1](http://prl.aps.org/abstract/PRL/v76/i17/p3116_1)

[2] <http://prd.aps.org/abstract/PRD/v60/i9/e092004>

[3] [http://prl.aps.org/abstract/PRL/v79/i9/p1626\\_1](http://prl.aps.org/abstract/PRL/v79/i9/p1626_1)

[4] [http://rsi.aip.org/resource/1/rsinak/v71/i2/p369\\_s1](http://rsi.aip.org/resource/1/rsinak/v71/i2/p369_s1)