Report on the Meeting of the CODATA Task Group on Fundamental Constants

3-4 November 2014
BIPM, Sèvres, France
Prepared by B. Wood, National Research Council

1. Opening of the meeting and introductions

The meeting opened at 9:00 am Monday morning and introductions were made. Members of the Task Group on Fundamental Constants in attendance were: David Newell (chair), Barry Wood (vice chair), Franco Cabiati, Estefania de Mirandés, Joachim Fischer, Kenichi Fujii, Savely Karshenboim, Peter Mohr, François Nez, Krzysztof Pachucki, Terry Quinn, Barry Taylor and Claudine Thomas.

Present as observers during the two days were: Martin Milton (BIPM Director), Richard Davis, Michael Stock, Hao Fang, Franck, Bielsa, Pierre Gournay, Stephan Solve (all of BIPM), Joachim Ullrich (President of the CCU), Ian Mills (past President of the CCU), Jonathan Sapirstein (U of ND), Michael Distler (Mainz U), Michael Eides (U of Ky), Randolf Pohl (MPQ), Ingo Sick (U of Basel), Paul Indelicato (LKB), Carl Williams (NIST), Jifeng Qu (NIM), François Biraden and Lucile Julien (LKB), Horst Bettin (PTB), Ian Robinson (NPL), François Piquemal (LNE), Nadine de Courtenay and Fabien Gregis (U of Paris).

The following sent their regrets: Zhang Zhonghua (NIM) and Nick Fletcher (BIPM).

A moment of silence was held in rememberance of Jeff Flowers, a Task Group member. Jeff joined the group in 2007 and had made numerous contributions to the theory and the experiments of hydrogen and helium, the gyro-magnetic ratio of the proton and the Rydberg constant.

A hard copy of the 2014 updates to the 8th edition of the SI brochure was distributed to the attendees.

The agenda of the meeting (TGFC/14-BIPM_01) is included in the last pages of this report, and the following summary is numbered according to the corresponding agenda items.

2. Review of the agenda.

The agenda was approved

3. Review of the report of the Task Group meeting held on Saturday, 30 August 2014, at the Windsor Barra Hotel, Rio de Janeiro, Brazil

Fischer pointed out that the 2 ppm mentioned in the DCGT section refers to just the pressure contribution and not the entire experiment. Taylor asked to have an instance of '2013' changed to '2014'. Wood replied that he would see that these changes were made. The minutes were then approved.

4. Update of new or expected results concerning

Because there were so many issues to be considered in this meeting, Newell referred to Barry Taylor's summary document (TGFC/14-BIPM_02) 'Developments relevant to the 2014 CODATA LSA since 31 December 2010' and stessed that as many of the 'Some Issues to be Considered' items should be resolved as possible. However, that document follows the RMP table of contents and not the agenda. It was decided to procede with the agenda items and the presentations first and then to return to TGFC/14-BIPM_02 and review any remaining items.

a. Planck constant h and Avogadro constant N_A

de Mirandés reviewed the status of watt balance experiments (TGFC/14-BIPM_03) and highlighted the changes since the 2010 LSA. The slides focused on several issues. The NPL mass exchange errors resulted in an enlarged uncertainty for the NPL-12 result. However this enlarged uncertainty was not incorporated into the NPL-90 result since it used a very different balance mechanism.

The second issue concerned if the NPL-12 result should replace the NPL-07 result as was done in the 2010 LSA and everyone agreed that it should.

It was then agreed that the NRC 2014 result should replace the NRC-12 result since it is a significant improvement of the same experiment.

The next issue concerned if the NRC-12 result should replace the NPL-12 result. Wood felt that it should but Robinson stated that NPL felt that it was an independent result and should stand. It was commented that this is a minor issue since the uncertainties are about a factor of ten different and the NPL result will be subject to the self-sensitivity criterion.

Then the issue of the disagreement between the NIST-07 and NIST-14 results was addressed. Williams commented that NIST is preparing a paper on how the authors feel that the two data should handled in the next LSA. This guidance was not available at the time of the meeting but was promised before the closing date.

The statistical analysis of the NRC-14 data was questioned. Wood replied that the authors had reviewed the analysis and still supported its approach and did not support revising their

uncertainty claim. Wood mentioned that an alternative covariant analysis has also been conducted. The uncertainty components of the Planck determinations for each of four masses have been reviewed and seperated into uncorrelated and correlated components and a covariance matrix had been created. This resulted in almost exactly the same value as reported in NRC-14 but with an uncertainty of 13 ppb as opposed to 19 ppb. However, the Birge ratio of these four determinatiuons was 1.4 and the the product of the Birge ratio and this uncertainty was again very close (within 1 ppb) to the originally stated uncertainty. Wood stated that he would make this information available to anyone interested.

There was discussion about how the Planck data set should be analyzed (using a multiplicative expansion to all input data as in the 2010 LSA or some other technique). A discussion ensued which touched on topics discussed at previous meetings. While the discussion was involved, most eventually felt that this was not the time to introduce a new technique into the LSA.

The impact of the so called 'speed of light' correction to free fall gravimeters was briefly mentioned. There seems to be some controversy about the validity of this correction amongst gravity experts. Fortunately, it represents only about 4 ppb and for the Planck data set this correction has an almost negligable effect.

de Mirandés then reviewed the preliminary results of the Extradordinary Mass Comparison using the IPK. It indicates that the unit of mass disseminated by the BIPM has not been consistent with the international prototype of the kilogram. In conclusion the BIPM mass unit in 2014 is about 35 micrograms (35ppb) above the IPK. A model based on time and balance dependent wear on the use of the various PtIr working standards at BIPM was presented.

Quinn stressed that the results show that the IPK and its six witnesses are quite stable despite the problems with the as-maintained BIPM mass unit.

Wood asked when the final corrections and uncertainties would be available for those laboratories involved with Planck determinations. Milton stated that he hoped that this information would be available before the end of the year.

Tayor asked if there would be an additional uncertainty included for the size of the correction. Several people commented that they did not expect this to be included.

Fischer asked if this mass correction could explain the difference between the NIST-07 watt balance and IAC results. However it was noted that the difference is too large to be caused by the BIPM mass unit correction.

Fujii presented the 'Present State of the International Avogadro Coordination (IAC) Project' (TGFC/14-BIPM_04). The information is similar to that presented in the Rio meeting. He reviewed the molar mass measurements at PTB, NRC, NIST and NMIJ. The inconsistency of the NRC result is being analysed by Volke at NIST. Fujii then discussed the lattice measurements at NIRIM and the slight shift in their results. Volume and mass

measurements of the ^{28}Si spheres were then presented, as well as surface characterization studies.

He concluded by showing that the newest Planck constant values (NIST, NRC and IAC) are consistent and within the CCM's recommendations and finished by noting that the IAC is still working towards a December 2014 publication of $\boldsymbol{N_A}$.

Bettin then showed (TGFC/14-BIPM_05) several slides reviewing the molar mass measurements of the IAC enriched silicon made by PTB, NRC, NMIJ and NIST. He also commented on the the homogeneity of the molar mass within the IAC enriched silicon boule, which seems very small.

Taylor asked about the mass differences at NMIJ and PTB and what affect the BIPM mass unit might have on these results. Bettin responded that the Extradordinary Mass Calibration data seems to put a kink in the drift of the PTB mass unit.

Newell asked what molar mass value (the best, an aggerate, exclude the NRC result…) would be used in the soon to be published IAC result. It seems that the IAC has not yet decided this issue.

b. Molar gas constant *R* and Boltzmann constant *k*

Fischer introduced (TGFC/14-BIPM_06) 'Current status of the redefinition of the kelvin'. He reviewed all of the contributing experiments but focused on the AGT experiments and in particular, those from LNE and NPL which have the lowest uncertainties but are inconsistent. Despite the NPL LNE inconsistency most members feel that the overall data set is quite reasonable. The NPL work has stopped but LNE work continues and the gas used by NPL is being used by the LNE experiment to re-verify its molar mass using a common laboratory.

Fischer also outlined the other experiments using different methods as required by the CCT. These include DCGT and JNT. Both the PTB DCGT and NIM JNT experiments hope to achieve < 3 ppm in 2014. Fischer breifly discussed the correlations common to the AGT experiments. Moldover at NIST has been asked to help create a covariance matrix to properly account for these effects.

c. Gravitational constant *G*

Newell presented TGFC/14-BIPM_07. It included up-to-date plots of the Planck and Boltzmann constants which had been previously discussed. He then went on to outline the development in the gravitation constant. There are three new values BIPM-14, LEN-14 (Florence) and UCI-14. The UCI-14 result was actually three determinations with different

fibers and Randy Newman left it up to the Task Group to aggregate them. The result shown is a simple weighted mean of the three values.

Quinn pointed out that there were meetings at the Royal Society and later at NIST to discuss the overall gravitational constant effort and to concentrate on an approach to resolve the discrepancy in the results. Mohr stated that IUPAP is considering a proposal for the creation of an advisory group to help coordinate a more comprehensive investigation.

Despite the three new data points the statistical situation of this data set has not improved much since 2010.

d. Fine-structure constant α

Newell went on in slide 6 of TGFC/14-BIPM_07 to review the fine structure constant. Kinoshita has a new mass independent 10^{th} order QED value which in combination with the Harvard-08 anamolous magnetic moment of the electron yeilds a new fine structure result. It is 1.49 sigma larger than the CODATA-10 result.

There is a new h/m result in ^{133}Cs from Berkley. Its uncertainty is larger that the other inputs.

e. Rydberg constant R_∞, muonic hydrogen, proton radius r_p

Although the second day of this meeting was devoted to muonic hydrogen and the proton radius other topics concerning the Rydberg were discussed in the first day. Mohr presented Doc TGFC/14-BIPM_08 'Atomic spectroscopy and the muonic hydrogen proton radius'. He then reviewed the initial experiment of Pohl of the Lamb shift of muonic hydrogen and a second experiment of a different transition by Antognini.

He illustrated the inpact of this data not only on the proton radius but also on the Rydberg. He also showed an interesting slide of the inferred value of the fine structure constant from electron data and the muonic hydrogen data which is also in disagreement with the CODATA-10 value.

There were several comments but most were repeated in the next day's session. However, it was noted that there are Lamb shift experiments, and high end-state hydrogen spectroscopy experiments planned at the LBK and at Garshing but it is not yet clear if they will resolve this matter.

f. Proton magnetic moment μ_p

On slide 8 of TGFC/14-BIPM_07 there is a graph with the new Mainz-14 result of the proton magnetic moment with an uncertainty reduction of 2.5 times CODATA-10 and in agreement with the CODATA-10 value.

g. Electron relative mass m_e

On slides 9-11 of TGFC/14-BIPM_07 there are plots with the new MPIK-14 result of the electron relative atomic mass with a very small uncertainty. The new data point is outside the CODATA -10 value but only by about 1.5 of CODATA-10's uncertainty.

Karshenboim felt that the proton magnetic moment and the electron relative mass results should be considered together.

h. Others?

No other items were discussed at this time.

5. Timeline for 2014 adjustment

Newell repeated that the closing date for the next scheduled adjustment is Dec. 31, 2014. He expects the new values to be posted online by May/June 2015 and the official report published in 2016. Mohr recounted various problems with the manuscript submission process.

6. Other topics

Eides asked Newell to explain why the anomalous magnetic moment of the muon result was not numerically included in the 2010 adjustment. Newell explained that at that time it was felt that there were still problems with theory. Eides stated that the only disagreement was about g-2 for the muon. Karshenboim commented that the particle data group does not actually compare theory and experiment. Eides stated that 2 to 3 sigma is often considered agreement in the particle data group.

Sapirsten added that muonic hydrogen and the charge radius are still problematic even among standard model theorists. This comment was apparently made at a conference marking 50 years of the quark (standard) model.

Newell stressed that the role of the Task Group on Fundamental Constants is to provide a consistent set of recommended values of all fundamental constants applicable to all of physics, not just one subgroup.

Taylor's summary document, TGFC/14-BIPM_02, was then considered and each of the 'Some Issues to be considered' items were discussed briefly. The summary responses for each of these items are included in TGFC/14-BIPM_09.

There was a comment that the CODATA recommended values were not considered terribly important by some sectors of theoreticians and particle physicists. Pohl disagreed and stated that his colleagues read each CODATA report 'very carefully' and consider them to be quite important.

There was a discussion about including an uncertainty for a theory of a theory, particularly as it applies to electron scattering results. A vote was held with 4 for inclusion of such an uncertainty and 5 against including such an uncertainty. Perhaps the resolution was defeated because there was not a clear consensus of how the uncertainty was to be assessed.

Cabaiti distributed a draft manuscript of the additive uncertainty expansion approach that he has been studying. A short discussion ensured but most agreed that it was important to be able to apply any new analysis techique to all the sub-fields and that this was not the time to introduce a new technique into the LSA.

Fischer asked if different analysis approaches (Bayesian, additive uncertainty expansion etc.) could be included in an appendix of the main publication. This will be taken under consideration.

There was considerable discussion about the timing of redefinition of the SI and it's impact on various meetings (TGFC, CCU, CIPM, CGPM) and on closing dates for new data in the next couple of years. This discussion continued after the meeting and now can be summarized as follows:

> On 1st July 2017, data to be considered for the special TGFC adjustment that will determine the values of the new defining constants must be accepted for publication in a peer-reviewed journal. The special adjustment will be a full adjustment, taking into account all data that meets the above criteria.

Williams asked about the number of digits to be used in the final definitions. Thomas pointed out that although this has been discussed at the CCU no decision has been taken. Ullrich stated that this will be resolved at the next CCU meeting.

Milton responded to a question about what would happen if, after the special LSA to set the final values, the CIPM or the CGPM voted not to move forward with the redefinition of the SI. He responded that he felt that by that time the decision to move forward should be seen as a foregone conclusion.

Karshenboim reminded the attendees of the Fundamental Constants 2015 Workshop on the determination of the fundamental constants to be held in Eltville Germany on February, 1 – 6, 2015.

7. Task Group administration

CODATA has suggested changing the status of the TGFC to a permanent committee. This would entail some adminsitrative changes and a change in the group's name, probably to CFC (Committee on Fundamental Constants). This issue will be discussed at the next general meeting of CODATA.

Newell stated that the Task Group is interested in adding a couple of new members. Considering the impact of the redefinition of the SI, scientists working in relative atomic mass and experimentists in Rydberg determinations are particularly needed. A suitable young scientist is also sought.

8. Date and location of the next Task Group meeting

The next Task Group meeting is tentatively planned for June or Sept, 2015 at BIPM and should be of one day duration.

9. Adjournment

The Monday meeting was adjourned at 16:15

Proton Radius Workshop

Tuesday, 4 November 2014
BIPM, Sèvres, France
Prepared by B. Wood, National Research Council

1. Opening of the meeting and introductions; review of the agenda

The meeting was opened at 9:00. The introductions were repeated (see Monday's minutes). The preliminary agenda is appended to the end of these minutes and these minutes follow the item numbering. Note that there are a number of changes in the presentation titles. Ulrich Jentschura was unable to attend the meeting but Paul Indelicato gave a related presentation instead.

2. "Charge Radius Experiment with Muonic Atoms (CREMA)", Randolf Pohl

Randolph Pohl of MPQ gave the first presentation (see TGFC/14-BIPM_10) 'Lamb shift in muonic hydrogen'. He began by stating what might be considered the theme of the workshop - that the proton radius results derived using electrons (and the basis of past CODATA recommended values) is in large (8 sigma) disagreement with the recent and more accurate results using muons. He reviewed how Lamb shift spectroscopy of hydrogen is used to determine the proton radius and went on to show how the muon is much more sensitive to the charge radius.

He reviewed both theory and experiment of the muonic hydrogen work and outlined the most likely systematic effects that could cause an error of this magnitude. A review of the theoretical calculations by other groups has revealed no significant inconsistency. As well, two measurements of different transitions of muonic hydrogen are self consistent.

He also discussed preliminary work on the Lamb shift in muonic deuterium which is consistent with the muonic hydrogen results and the proton-deuteron isotope shift.

Pohl then reviewed very preliminary work on muonic helium for which two experiments are essentially in agreement with conventional data.

Finally, Pohl stressed that we should recall that there are really two muon puzzles, the anomalous magnetic moment of the muon which has been in disagreement with the standard model for the last decade (by 3.6 sigma) and the proton radius from muonic hydrogen.

3 "The proton charge radius from electron scattering", Michael Distler

The second presentation (TGFC/14-BIPM_11) was by Michael Distler of the Universität

Mainz entitled 'The proton charge radius from electron scattering'. It outlined the fundamentals of scattering cross section measurements and the experimental results going back to the 60's. He discussed the fitting and assumptions necessary to extract the form factor from the scattering amplitudes. He went on to describe how improved fitting of electron scattering data extends the 'good fit' from low momentum transfer, Q^2, towards higher Q^2. Karshenboim stated that both the real and imaginary parts must be satisfied in these fits. Distler replied that this was true but that other constraints are also necessary. For example, that r_e must be less that r_m to get an acceptable fit.

Distler concluded with two main points: the MAMI data gives a consistent electron radius and that he does not see any way to reconcile a smaller charge radius (say from muonic hydrogen) with the electron scattering data.

5 "Alternative analysis methods for electron-proton scattering data", Ingo Sick

The third presentation (TGFC/14-BIPM_12) was made by Ingo Sick of the University of Basel and entitled 'On the importance of the tail of proton charge density'. He explained how the determination of the radius comes from the slope of $G_e(q)$ at q=0. However we cannot measure at q=0 and so it is important to consider what ranges of q and Q^2 are sensitive for the determination of the radius. In particular, he stressed that data with Q^2 >0.06 was not relevant for the radius determination.

He then went on to illustrate these points with three common types of fit (inverse polynomial, continued fraction and Own Pade) and extended it to the analysis of the 'world (e,e)'data set. At this point Taylor asked Ingo if he would recommend using R^{ch} = 0.886 ± 0.008 fm and R^{m} = 0.858 ± 0.024 fm. Ingo replied yes and that he feels that this simply confirms the existence of the disagreement.

He considered the implications of treating the muonic hydrogen radius as a constraint to these fits but concluded that more absolute data was required.

6 "Muonic Hydrogen and QED Theory", Ulrich Jentschura

Paul Indelicato of LKB presented TGFC/14-BIPM_13 entitled 'All-orders QED calculations of H, D, ^{3}He, ^{4}He and Carbon: Nuclear shape dependance' in place of Jentschura who could not attend. The talk discussed the general QED calculations applicable to the spectroscopic theory of hydrogen, muonic hydrogen and other systems. He ranked the various corrections in order of their magnitudes to illustrate what effects were most likely to be considered. He then considered various fitting algorithms, the Lamb shift, fine structure and hyperfine experiments of different systems (Deuterium, ^{3}He, ^{4}He). He also considered Zemach's radius, the magnetic radius and constraints that different experiments put on the charge and magnetic moment distributions.

Finally, he pointed out that there is 'no apparent problem' with muonic carbon and summarized that the puzzle is focused on hydrogen, either muonic or normal, and is observed in both charge radius and magnetic moment data.

7 "New Physics?", Michael Eides

The third presentation (TGFC/14-BIPM_14) was made by Michael Eides of the University of Kentucky and entitled 'Proton Radius Puzzle: *New Physics?*' He reviewed the proton radius problem and possible resolutions of the problem. He admitted that it was becoming increasingly harder to simply blame the problem on unknown systematics in the experimental data and spent most of his time on various theoretical resolutions.

He pointed out that the 'Standard Model is a self-consistent theory with a relatively small number of parameters that describes all laboratory experiments and almost all that we see in the cosmos. It has a rigid logical structure: it is very hard to amend (even harder to change) the Standard Model at the atomic scale and

1 Preserve agreement with the huge, massive low-energy experimental data
2 Preserve theoretical self-consistency.'

He then mentioned some of the great unknowns of observational physics (dark matter and dark energy) and of theoretical physics (the cosmological constant and quantum gravity). He concluded that the Standard Model is not yet complete and it should be amended but that it is rather difficult to do so.

The next 21 slides showed different speculative interactions, models, new particles etc. with comments about their limitations, development or agreement with other work. He concluded with four points.

- There are viable models on the market that do not contradict known experimental constraints and predict new effects that admit experimental verification.
- There are no theoretically attractive models. All models are ad hoc.
- All the models have problems with self-consistence (UV completion) and are theoretically unsatisfactory.
- In the absence of Occam's razor many more models can be invented.

Karshenboim quickly presented some slides from TGFC/14-BIPM_15 'Electromagnetic radii of the proton from atomic spectroscopy'. This talk again reviewed the charge radius puzzle but attempted to resolve the situation by 'producing an independent value of the magnetic radius'. It also evaluated its own approach by noting that 'the contradiction means that the overall picture is not self-consistent and certain calculations may involve inconsistencies'. Because of lack of time only a few of the presentation slides were actually presented.

Nez presented TGFC/14-BIPM_16 'Study of the 1S-3S transition'. He described studies at LKB that were attempting measure the 1S-3S hydrogen transition at different optical power and with relatively large numbers of atoms. He showed how the conventional correction of the Doppler effect was done by determining the velocity distribution at one pressure and that very recent results indicate that this distribution is pressure dependent. This may cause a shift

in the spectroscopic hydrogen charge radius result towards the muonic hydrogen results. The LKB results are very preliminary but they hope to soon have new results to clarify this issue.

Pohl presented TGFC/14-BIPM_17 entitled 'Hydrogen spectroscopy'. It outlines a 2S-4P experiment at Garching which is hoping to have an uncertainty that can resolve the charge radius puzzle.

9 Round Table discussion

A round table discussion was chaired by Krzysztof Pachucki. He began the discussion by summarizing that there is a disagreement between electronic and muonic systems but muonic helium seems OK, or at least not in obvious disagreement.

Karshenboim felt that the conventional physics charge radius of e-p and muon-p interactions must be the same.

Both Pachucki and Eides stressed that the universality of the standard model MUST be preserved or else it jeopardizes the entire standard model.

Pohl stated that there are no obvious flaws in the muonic hydrogen results and thus the discrepancy is real. He recommended not to average the situation because it only serves to cover up the problem. He said keep the puzzle as a puzzle until we have an actual solution.

Sapirstein said that there is a small but near zero chance of new physics. He agrees with Pohl not to obscure the problem in any sort of average.

Eides stated that the theory of muonic hydrogen is just as good as that of hydrogen. In fact, he felt that the muonic approach is a shorter route to the charge radius.

Sick said that muonic results are valid and so are the scattering results. Electronic hydrogen also seems to be OK.

Pohl stated (as has been discussed in previous TGFC meetings) that the only 'customer' for the CODATA recommended values (of the Rydberg and charge radius) at the highest accuracy are those interested in hydrogen. He advised that the TGFC should do the same in 2014 as it did in 2010.

Distler said the electron scattering results are very consistent but in disagreement with muonic hydrogen results. He felt that the TGFC should exclude the muonic results from the LSA calculation.

Eides also agreed with Pohl in not wanting the average the results. He believes that one or the other is wrong – so don't average them.

Ingo felt that we should keep the Rydberg constant based on hydrogen because that is its main use.

Distler felt that the Mainz scattering results and its analysis were superior to the analysis of the 'world (e,e) data set.

Others who had not previously voiced an opinion were asked if they thought that the muonic hydrogen results should be included in the 2014 LSA calculation of such constants as the Rydberg.

Robinson felt that there were two separate sets of data but that the Task Group must consider its users and follow the 2010 approach.

Julien felt that the muonic results should be included (averaged).

Nez asked if Sick could provide a set of analysis with the correlations with Michael's data taken into account.

Taylor felt that the TGFC should follow its 2010 approach and in essence agreed with Pohl.

de Mirandés agreed to follow the 2010 approach at least for the 2014 LSA.

Nez asked why we would treat this problem differently from any other.

Then a vote was held amongst the TGFC members '**To Not to Include the muonic results in the 2014 LSA'.** The tally was 8 for (not including the muonic results), 2 against and 1 abstention. It was stressed that although the muonic results would not be included in the LSA calculation they would be described in some detail and include the theory of muonic hydrogen.

It was also agreed that it was acceptable to average the Ingo and Distler electron scattering results. The magnetic results were not considered an issue.

12 Concluding remarks

Newell thanked the speakers and the BIPM hosts for contributing to a stimulating and productive meeting.

The meeting was adjourned.

DRAFT AGENDA

CODATA Task Group on Fundamental Constants

9:00 am Monday, 3 November 2014

BIPM

1. Opening of the meeting and introductions
2. Review of the agenda
3. Review of the report of the Task Group meeting held on Saturday, 30 August 2014, at the Windsor Barra Hotel, Rio de Janeiro, Brazil
4. Update of new or expected results concerning
    a. Planck constant h and Avogadro constant N_A
    b. Molar gas constant R and Boltzmann constant k
    c. Gravitational constant G
    d. Fine-structure constant α
    e. Rydberg constant R_∞, muonic hydrogen, proton radius r_p
        i. See Special Session
    f. Proton magnetic moment μ_p
    g. Electron mass m_e
    h. Others?
5. Timeline for 2014 adjustment
6. Other topics
    a. Timeline for possible adoption of new SI in 2018
7. Task Group administration
8. Date and location of the next Task Group meeting
9. Adjournment

DRAFT AGENDA

CODATA Task Group on Fundamental Constants

Special Session on Proton Charge Radius

9:00 a.m. Tuesday, 4 November 2014

BIPM

1. Opening of the meeting and introductions; review of the agenda
2. 9:15 a.m. "Charge Radius Experiment with Muonic Atoms (CREMA)"
   Randolf Pohl
3. 10:00 a.m. "The proton charge radius from electron scattering"
   Michael Distler
4. 10:45 a.m. Coffee break
5. 11:00 a.m. "Alternative analysis methods for electron-proton scattering data"
   Ingo Sick
6. 11:30 a.m. "Muonic Hydrogen and QED Theory"
   Ulrich Jentschura
7. 12:00 p.m. "New Physics?"
   Michael Eides
8. 12:30 p.m. Lunch
9. 1:30 p.m. Round table discussion
10. 3:30 p.m. Coffee break
11. 3:45 Concluding remarks