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

3 July 2004, National Physical Laboratory
Teddington, Middlesex, UK
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The subject meeting was held at the National Physical Laboratory at Teddington, Middlesex, UK. In attendance were the following Task Group members: F. Cabiati, K. Fujii, S. G. Karshenboim, I. Lindgren, W. Martienssen, P. Mohr (Chair), F. Nez, B. W. Petley, T. J. Quinn, B. N. Taylor, B. M. Wood, and Z. Zhonghua. Also present as observers were J. Flowers of NPL, A. Waseda and N. Kuramoto from NMIJ/AIST.

The agenda of the meeting is included as the last page of this report, and the following summary is numbered according to the corresponding agenda item.

1. The meeting opened soon after 10:30, and introductions were made. Task group members were requested to provide any corrections to the information on the Task Group Member list.

2. The agenda of the meeting was reviewed and accepted.

3. The report of the previous Task Group meeting, held on 4 July 2003 at the BIPM, was reviewed and accepted as distributed to the task group members (with a correction $s^{-1} \rightarrow s^{-2}$ on the unit for $G$ on p. 1).

4. The article on the 2002 least-squares adjustment has been accepted by the *Reviews of Modern Physics* and is scheduled for publication in the October issue. At this meeting, the manuscript was reviewed with an emphasis on new material, constants that changed significantly, and issues on which the Task Group focused attention at the previous meeting in 2003. Several changes in the text of the article, to be made at the proof stage of production, were decided. Changes that involve more extensive discussion will be made in the paper on the next adjustment (2006).

A statement will be added early in the paper (p. 5, end of Sec. C) giving the criteria for use of data that is either unpublished, published in a conference proceeding, or in an abstract. In general, a Ph.D. thesis with no other publication is not a sufficient basis for including the result of an experiment or calculation that is otherwise unpublished. However, in the case of an established group with an ongoing project, a
private communication or conference proceedings publication can be sufficient do-
umentation, at the discretion of the Task Group. This applies to the Chu et al. result
for the cesium recoil experiment. In this case, there is conference proceedings report
and not an “official” reviewed publication, but Chu has endorsed use of his data in
the adjustment in a private communication.

Near the end of Sec.I.D, “accurately known constants” will be replaced by “accurately
measured constants”

At the end of Sec. I.D, the relevant time scale for the variation of the constants will
be changed from “a human lifetime” to “10 years.”

The section on measurement of the lattice spacing of silicon will be updated to take
into account the recent findings that the 2003 lattice spacing measurements made at
IMGC were affected by a systematic error associated with the use of the two-mode
stabilization technique. In Sec. III.I.2, the references and conclusions of Cavagnero,
et al., 2004 and Bergamin et al., 2003 discussed in Sec. III.I.2 will not be included in
the manuscript. However, the input data for and recommended value of the lattice
spacing will remain as given in the manuscript.

It was pointed out that there is a Metrologia paper giving a PTB analysis of the
Michaelis, et al., 1996 measurement of $G$, discussed in Sec. III.Q, which should be
referenced instead of the Wöger, 2004 private communication.

Some information should be added to the paper as a guide to the location of discussion
concerning particular constants. For example, comments could be added to the outline
in Sec. I.E. indicating which sections are relevant to the determination of $\alpha$ and $h$.
Also, in Sec. IV on the analysis of data, additional guidance on which parts are relevant
to particular important constants could be provided.

The section of the constants table (on p. 71 of the manuscript) concerning the Wien
displacement law constant and related radiation constants should be reconsidered.
Possibly an alternative set of constants should be presented. This will be left for the
next adjustment.

5. Some new results that are likely to influence the future values of the constants were
presented CPEM2004 or associated meetings.

There are a number of watt balance experiments in various stages of development
from “proposal” stage to “consistent results at the level of $10^{-7}$ and yielding a number
soon” stage. The groups are from Mexico, BIPM, BNM, NMIJ, METAS, NPL, and
NIST. While there were no results reported, a member of the NIST group remarked
in a session that although their experiment had an intentional unknown uncertainty
to maintain objectivity, the uncertainty was sufficiently small that they could say that
at the moment they did not agree with the results of the silicon crystal Avogadro determination of $h$.

The International Avogadro Coordination (IAC) is underway and has the long-range time span of 2004-2010. It is expected that the isotopic purification of silicon will take about 2.5 years. It is also expected that new silicon crystal lattice spacing results will come from IMGC-NMIJ work.

For the anomalous magnetic moment of the electron, there is work in progress on the theoretical calculation by Kinoshita, and an improved experimental value should be forthcoming from work of Gabrielse and coworkers at Harvard University. Together, these results could improve the best value of the fine-structure constant $\alpha$ by about an order of magnitude.

A new experiment to measure atomic recoil in the absorption or emission of photons by an atom is underway at the LKB in Paris. They are using a method that is different from the Chu et al. experiment, which will provide an independent result for the fine-structure constant $\alpha$.

Spectroscopy of hydrogen and deuterium that yields a value of the Rydberg constant and the proton and deuteron charge radii is expected to continue with improved accuracy. The 1S–2S transition in hydrogen will continue to be the subject of extremely high precision experiments at the Max Planck Institute at Garshing. The group at the LKB is carrying out measurements of the 1S–3S transitions in hydrogen and deuterium. A new project to accurately measure the 2S–nS,nD transitions in hydrogen and deuterium is underway at the NPL by Flowers and Marguiles and coworkers.

In a session devoted to gravitation, a number of progress reports were presented. No new results for $G$ were given in the session, but it can be expected that new values will eventually result from this work.

6. Although not presented at CPEM2004, a project is underway at MIT by Kleppner and coworkers to measure transitions in hydrogen from the 2S to higher states using ultra-cold hydrogen; private communication 2004.

Other work in progress of likely relevance is a measurement of the gas constant $R$ in Italy and a measurement of the Stefan-Boltzmann constant $\sigma$ at NPL.

7. The next CODATA recommended values of the constants is expected to be the 2006 set. Following the convention of the previous two adjustments, this would mean that the cutoff date for information that would necessarily be included would be 31 December 2006. It is likely that there will be significant new information available at that time which will influence the adjustment of the values. There is work in progress in several areas (watt balances, hydrogen and deuterium spectroscopy, $a_e$, atom recoil,
gravitational constant, for example) that should yield new results by the projected deadline.

We also expect that the paper on the 2006 adjustment can be published early in 2007 in order to provide a more rapid turnaround from the cutoff date for data to the recommendation of values of the constants. The interval between adjustments has already been reduced from \(\sim 13\) years to \(\sim 4+\) years, and the final target of 4 years with minimal delay after the cutoff should be achievable.

8. In this adjustment, two new constants \(R_p\) and \(R_d\) were added. We may wish to consider adding others, possibly data on tritium or the lifetime of the neutron, for example.

It is planned to produce additional listings of the constants, in particular, wallet cards and charts with values of the constants as in the past. The Task Group will be notified when such items are available.

The results of the 2002 adjustment of the constants will be used to make semi-empirical/theoretical predictions for transition frequencies in hydrogen and deuterium. It is necessary to carry out such an analysis in close coordination with the detailed results of the least-squares adjustment in order to obtain the most accurate predictions for the spectra. Preliminary results of such an effort are available on the Web at physics.nist.gov/hdel.

Detailed numerical information associated with the least-squares adjustment, necessary for this and related analyses, will be made available on the Web site of the fundamental constants at physics.nist.gov/constants.

An analysis of the effect of possible new definitions of the kilogram on the values of the constants will be made in order to provide information for discussions of such possible redefinitions.

The semi-annual meeting of CODATA will take place in Berlin in November. The Task Group has been asked if a representative would attend and report on the group’s activities. Werner Martiessen has kindly agreed to attend the meeting and represent the Task Group. We extend thanks to him for undertaking this task.

9. It is planned that the next meeting of the Task Group will be held at the BIPM in mid 2005. The date will be set to be in proximity to the dates of other relevant meetings at the BIPM, as in the past several years.

10. The Task Group meeting was adjourned at about 16:00.
AGENDA

CODATA Task Group on Fundamental Constants

10:30 am Saturday, 3 July 2004
National Physical Laboratory
Teddington, Middlesex, UK

1. Opening of meeting and introductions.

2. Review of agenda.

3. Review of minutes of the Task Group meeting on 4 July 2003 at the BIPM.


5. Discussion of relevant new information from reports at CPEM2004.

6. Review of other new data relevant to the next adjustment.

7. Schedule for the 2006 CODATA recommended values.

8. Other topics for discussion.

9. Date and location of the next Task Group meeting.

10. Adjournment.