C2 - COMMISSION REPORT 2017

Report to IUPAP Council

Symbols and Fundamental Constants are fundamental elements for modern science and technology

Main goal: The commission is working to guarantee the correct use and to supply motivation and investments in areas that needs to be consolidated and improved. Diffusion of the imporntace and the science behind fundamental constant and units.

Present Member's composition: Chair: **Vanderlei Salvador Bagnato** (Instituto de Fisica de São Carlos -Universidade de São Paulo),**ViceChair: William Phillips** (National Institute of Standards and Technology), **Secretary: Feng-Lei Hong (**Department of Physics -College of Engineering Science Yokohama National University), Members: **Ramesh Chandra Budhani** (, National Physical Laboratory-New Delhi), **Michael de Podesta** (National Physical Laboratory-Teddington), **Gerald Gwinner** (Department of Physics and Astronomy-University of Manitoba), **Marc Himbert** (LNE-INM), **Jinhee Kim** (Korea Research Institute of Standards and Science),**Michael Krystek** (Physikalisch-Technische Bundesanstalt), **Andre Luiten** (University of Adelaide), **Antti Manninen** (Centre for Metrology and Accreditation (MIKES), **Dr Martin Milton** (BIPM), **Alexander Potekhin** (Department of Theoretical Astrophysics-Ioffe Physico-Technical Institute),**Xing Zhu** (School of Physics-Peking University)

CCU meeting – RECOMMENDATION – C2 had active participation on the BIPM Consultative Committee for Units - CCU, held in Sévre –France during September 2017. The main results on the possible redefinition of the kilogram, ampere, kelvin and mole in 2018 : "*On the possible future revision of the International System of Units, the SI*", which took note of the intention of the International Committee for Weights and Measures (CIPM) to propose a revision of the SI that would link the definitions of the kilogram, ampere, kelvin and mole to exact numerical values of the Planck constant *h*, elementary charge *e*, Boltzmann constant *k* and Avogadro constant N_A". The recommendation was that the CIPM undertakes the necessary steps to proceed with the planned redefinition of the kilogram, ampere, kelvin and mole at the 26th CGPM in 2018

Meetings Supported: There was no meeting of the whole commission for the period of this report. Limited resources makes difficult to hold a regular annual meeting for this

Commission. There was , however many information exchanges between commissions members as well as between commissions. The proposal is to use regular meeting taking place within the Atomic, Molecular and Optics Community, often with the presence of many of the members of C2, to hold small meeting to debate relevant topics. Unfortunately the approach to have such meeting did not work so well. This chair recommend regular meetings for the commission.

Discussion : radian as a base unit in the SI – The commission conducted discussion about the proposition is that SI be modified so that the radian is a base unit. It is proposed that angles be considered to have "dimension" and therefore be reclassified as a base unit. IUPAP advice on the SI is primarily provided by Commission C2. C2 can submit proposals for resolutions to the IUPAP General Assembly, which meets every three years. IUPAP, in turn, can submit resolutions on policy issues to the CCU for their consideration. This is particularly appropriate, since IUPAP suggested the SI in the first place, and physical quantities and units are closely tied to physics. For example in 2008 IUPAP passed a resolution supporting the major redefinition of the SI in terms of fixed values of certain fundamental constants. This resolution was then submitted to the CCU and is expected to take place in May of 2018.

The current effort concerning the radian, now under discussion by C2, is to attempt to formulate a recommendation for a resolution to be considered by IUPAP at the next General Assembly in October of 2017. It is important for physicists to have input into the formulation and continuous evolution of the SI, and this can be done through IUPAP.

Diffusion activity : The importance of units, fundamental constants and symbols is well recognized in all levels of education. Pre-university students and undergraduates have little information about the wonderful science behind fundamental constants, symbols and units. We have produced a collection of movies, on popular level of understanding, that will be released during the GA-2017 . A collection of four movies discuss :

-The science behind fundamental constants

-The SI – International System of Units

- The redefinition of the SI: Fundamental constants as a basis

- The new definition and realization of kg

Gravitational G constant: Working group directed by Stephan Schlamminger, produced the following abbreviated reported:

The working group on the Newtonian Constant of Gravitation was created at the 28th General Assembly of IUPAP in November 2014. The purpose of the working group is to coordinate experimental efforts to measure the Newtonian constant or gravitation, G. This fundamental constant of nature describes the strength of gravity, the weakest of the four known fundamental interactions. The first laboratory measurement of the gravitational constant was carried out by Henry Cavendish at the end of the 18th century. In modern times, more than a dozen measurements have been described in the literature in the last 30 years. However, the agreement between the results is poor. The best results report relative standard uncertainties of about 20 parts in a million, but the relative difference between the largest and smallest value exceeds 500 parts. While it is important to invent new methods to measure G, it is also important to recheck existing measurements. A basic tenet of the scientific method is that results are reproducible, i.e., conducting the same experiment a second time will yield the same result. The reproducibility of a single G experiment has never been checked, instead new ideas are pursued. The working group believes a good step to understand the discrepancy of different experiments is to check the reproducibility of a single result. With the help of the working group the torsion balance that was used by T.J. Quinn and collaborators at the Bureau International des Poids et Mesures (BIPM) to measure the gravitational constant was transferred to the National Institute of Standards and Technology. There, an independent group of scientist is making a second measurement with nearly the original equipment. Data collection has started in the summer of 2017 and a preliminary result is expected at the end of 2017. A definitive result should be available by 2018. The measured result and its assigned uncertainty will yield interesting information on the reproducibility of one experiment which, in turn, could help understand the reproducibility of the whole data set. Members of the working group have secured another big G experiment. The apparatus used by Faller and Parks at the Joint Institute for Laboratory Astrophysics in Boulder Colorado. The experiment is no longer in use and endangered of being discarded. To avoid losing this experimental hardware, the apparatus was moved with support of the working group to NIST Gaithersburg.

Literature in revision: The "Red Book" and recommended sources of informationSYMBOLS, UNITS, NOMENCLATURE AND FUNDAMENTAL

CONSTANTS IN PHYSICS (Edition of 2010) is now under revision for a new edition. It is expected a whole revision completed by 2018.