

METROLOGY, THE UNIVERSE AND EVERYTHING



Helmholtz Symposium Program

March 27, 2012

PTB Physikalisch
Technische
Bundesanstalt

125
Jahre genau

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Sponsor of the seminar:
Helmholtz-Fonds e.V.

Information

Conference date:

The symposium "Metrology, the Universe and Everything" on the occasion of PTB's first 3×42-1 years and the Helmholtz Prize award ceremony will be held on March 27, 2012.

Conference venue:

Stadthalle Braunschweig
(Braunschweig Civic Centre)
Leonhardplatz, 38102 Braunschweig, Germany
Conference Hall
Phone: (0531) 7077-0

Telephone numbers

Fire, emergency medical care

Phone: 112

Police

Phone: 110

Taxi

Phone: (0531) 66 666

Phone: (0531) 59 91

Phone: (0531) 6 21 21

Local organizers

Phone: (0531) 592 30 09

Public transport

Included with your conference documents is a ticket for the public transport in Braunschweig (Braunschweiger Verkehrs AG). The ticket is valid for travel within the town center (Zone 40) from Monday, March 26, to Wednesday, March 28.

Foreword



Prof. Dr. Joachim Ullrich
Chair of the Administrative Board,
Helmholtz-Fonds e.V.

On behalf of the Helmholtz-Fonds e.V. and its partners, I am honoured to welcome you to the 2012 Helmholtz Symposium and the Helmholtz Prize award ceremony.

This year's Helmholtz Symposium is embedded in the festivities for the 125th anniversary of the Physikalisch-Technische Bundesanstalt and its precursor – the Physikalisch-Technische Reichsanstalt.

The Helmholtz-Fonds and PTB share many interests that are reflected in this symposium. For a globalized society it is of essential importance to support the development of high-precision measurements and the promotion of young academics in all fields of technology. Here, the Helmholtz-Fonds is glad to provide contributions within its portfolio of activities.

After having served as Chair for more than 16 years, Prof. Dr. Ernst Göbel has handed over his duties to me, both in the Helmholtz-Fonds and as the President of the Physikalisch-Technische Bundesanstalt. I thank him for his tireless endeavours to promote and develop metrology.

I hope all participants enjoy a fruitful symposium and have a pleasant time in Braunschweig.

125 years of metrology in Germany

The keyword which has stayed with PTB since its founding in 1887 (at that time: Physikalisch-Technische Reichsanstalt, PTR) is: accuracy. More precisely: measurement accuracy.

After a 125-year success story, PTB will be celebrating its anniversary with events starting in March 2012 – with this scientific symposium scheduled on the day before a larger political ceremonial act in the Braunschweiger Stadthalle (Braunschweig Civic Centre).

From the beginning, PTR was characterized by a close relationship between science and the economy. The two “fathers of the PTR” represent this concept: The industrialist Werner von Siemens, who initiated its founding, and the scientist Hermann von Helmholtz, as its first president.

This special association also becomes evident on October 17, 2012 in Berlin, when PTB will extend invitations to lectures at the Audimax of the TU Berlin and to the official dedication of its restored Observatory.

March 28, 2012 (Braunschweig)

Ceremonial event for the 125th anniversary

If you have received an invitation to the ceremonial event on March 28, please remember to bring your entrance ticket! For security reasons, we can only admit guests holding tickets.

About dressing gowns, mice, and the number “42”



So, you ask yourself, where do these session titles come from and what is all the fuss about “42”? Well, it is about a trilogy (in five books) written by Douglas Adams of which the first book is called “The Hitchhiker’s Guide to the Galaxy”. Reading it you will learn that a hyper-intelligent pan-dimensional species built a computer to answer the “ultimate question of life, the universe and everything”. After 7½ million years of computation, it found the answer – which is 42. It also pointed out that its programmers did not know the proper question.

So a more complex computer had to be built to calculate the question; it is frequently mistaken for a planet called the Earth. It is run by the pan-dimensional operators that are projected into our dimension as white mice. Note that they conduct tests on ape-descendent life forms under laboratory conditions by running down mazes in the wrong direction and recording their reactions!

Unfortunately, a few minutes before the program is completed, the Earth is demolished. The protagonist of the book escapes in his dressing gown, equipped with an immensely useful towel, to explore the marvels of the galaxy. During his travels he is guided by “The Hitchhiker’s Guide to the Galaxy” on which DON’T PANIC is written in large friendly letters. Its revised entry for the Earth is, by the way, “mostly harmless”, being a notable improvement over the original one (“harmless”). He also encounters various robotics products of the Sirius Cybernetics Corporation (motto: “share and enjoy”) ranging from friendly doors to inquisitive drink dispensers...

And what is the connection to metrology? Hm, aren’t we all looking for answers? (And peanuts are good for you if you have been through a matter transference beam!)

Program

All talks will be 42 minutes long and suited for a general audience. Admission is free.

Session 1: 9:00 a.m. – 10:30 a.m.

The metrologist's guide to the Galaxy

A new definition of the SI for the new century,
I. Mills / UK

Measuring the Universe with Einstein's gravitational waves,
K. Danzmann / Germany

Break for something almost, but not quite, entirely unlike tea or coffee

Session 2: 11:00 a.m. – 12:30 p.m.

Don't panic – may metrology be with you

Metrology down to Earth: What is it good for?
M. Chambon / France

Impact of metrology for "stuff" – chemistry, biology and materials,
W. May / USA

Lunch break (served right in the conference center, not at the end of the Universe)

Session 3: 2:00 p.m. – 3:30 p.m.

Mostly harmless

Who in the Universe needs dosimetry?
U. Ankerhold / Germany

Towards improved reliability in laboratory medicine: Universal metrological traceability,
L. Siekmann / Germany

Break for something almost, but not quite, entirely unlike tea or coffee

Session 4: 4:15 p.m. – 5:15 p.m.

Share and enjoy

The Metre Convention and its role in the 21st century,
M. Kühne / Germany

Closing remarks:
J. Ullrich / Germany

5:15 p.m. Helmholtz Prize Award Ceremony

The ceremony will be held in German. Simultaneous interpretation into English will be available via headphones that can be obtained at the entrance to the conference hall.

Musical introduction

Salonorchester Hannover Grammophons

Introduction

Prof. Dr. Joachim Ullrich
Chair of the administrative board of the Helmholtz-Fonds and President of PTB

Laudation

Prof. Dr. Cornelia Denz
Westfälische Wilhelms-Universität Münster, member of the jury

Presentation of the Helmholtz Prize

Musical intermezzo

Salonorchester Hannover Grammophons

Lecture by the laureates

Dipl.-Phys. Sven Sturm

Musical finale

Salonorchester Hannover Grammophons

Informal reception
Finishes: about 7:30 p.m.

Speakers and talks

Ian Mills:

A new definition of the SI for the new century

Abstract: The International System of Units, the SI (Système international d'unités), plays a fundamental role in all the quantitative sciences, both in the basic foundations of physical theory and in all the applications of science in everyday life. The importance of the SI in both fundamental physics and in our daily lives will be discussed. In this talk the way in which the SI is defined will be reviewed, and the revisions to the definition and presentation of the SI that are at present proposed in Resolution 1 of the 24th General Conference on Weights and Measures, CGPM (Conférence Générale des Poids et Mesures), will be discussed.

Prof. Dr. Ian Mills is Emeritus Professor of Chemical Spectroscopy at the University of Reading in the United Kingdom. He is President of the Consultative Committee for Units (CCU) at the International Bureau of Weights and Measures (BIPM). His research activities were mostly in the field of high resolution molecular spectroscopy. However, his present work is now mainly concerned with revising the definitions and presentation of the International System of Units, particularly for the base units kilogram, ampere, kelvin, and mole, in terms of the fundamental constants of nature. Professor Mills was elected a Fellow of the Royal Society of London in 1996.

Karsten Danzmann:

Measuring the Universe with Einstein's gravitational waves

Abstract: For thousands of years, we have observed the Universe with light. But more than 96% of the Universe is dark and probably forever hidden from optical measurements. How can we make measurements on this dark side

of the Universe? Can we possibly hear the Universe? At first sight this appears impossible, but there is a kind of wave that our ears would react to, if they were only sensitive enough: gravitational waves! Einstein predicted the existence of gravitational waves: They are minute distortions of space and time, created by rapidly accelerating large masses like coalescing binary stars or supernovae and propagating at the speed of light. So far, they have never been directly detected. Several kilometer-size laser-interferometric gravitational wave detectors are currently operating on the Earth, and one of them is GEO600 near Hannover. They will soon be joined by space detectors with arm-lengths of millions of kilometers. The observation of these mysterious waves requires modern laser technology and measurements at the quantum mechanical detection limit.

Prof. Dr. Karsten Danzmann is Director at the Max Planck Institute for Gravitational Physics and Director of the Institute for Gravitational Physics of the Leibniz Universität Hannover. He initiated the installation of the gravitational wave detector GEO 600 close to Hannover and is the European leader of the LISA space mission that will establish a satellite-based gravitational wave detector with million-kilometer arms.

Maguelonne Chambon:

Metrology down to Earth: What is it good for?

Abstract: From time immemorial, 3000 BC up to now, measurements and metrology have been present in our daily lives, in private or professional contexts, and their influence is felt everywhere. Metrology allows us to take informed decisions in a large variety of fields, and sometimes the consequences are quite important. The history of change in industry and society shows that new ideas, research and inventions often have been connected to precise measure-

ments and have driven economic progress. This talk will take you along on a trip from the galaxy down to the Earth, into the world of metrology, and will try to convince you, if it is not yet the case, that metrology is a necessary and essential part of your life.

Dr. Maguelonne Chambon is Director for Scientific Research and Technology at the French national metrology institute LNE and a member of the Board of Directors of EURAMET e.V., the organization of the European national metrology institutes.

Willie E May:
Metrology for "stuff" – chemistry, biology and materials science

Abstract: Mankind has long recognized the need for measurement science and standards to support construction, manufacturing and trade. During the past 125 years, National Metrology Institutes have developed sound programs for physical metrology focused on the realization of SI units for time, mass, length, temperature, electricity, etc. But modern society also requires confidence in the comparability of measurements regarding the composition, structure and properties of diverse types of "stuff" to underpin sound decisions about things that affect the quality of our everyday lives. E.g., these decisions guide actions that affect the safety and quality of our food, air and drinking water; the accuracy of medical tests and efficacy of treatment decisions; appropriate composition of materials to provide functional properties, performance and reliability of "stuff" needed in a wide range of sectors such as transportation, housing, manufacturing, etc. This talk will focus on the need, growth and impact of programs focused on metrology in chemistry, biology and materials science within NIST and NMIs around the world.

Dr. Willie E May is Associate Director for Laboratory Programs and the principal deputy for NIST, whose mission is "to promote U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology in ways that enhance economic security and improve our quality of life". Prior to his current position, Willie May served as the Director of NIST's Material Measurement Laboratory which serves as the U.S. national reference laboratory for measurements in the chemical, biological, and materials sciences.

Ulrike Ankerhold:
Who in the Universe needs dosimetry?

Abstract: Ionizing radiation can be helpful, e.g. in diagnostic radiology or for combating cancer, but it can also be harmful. This paradox is reflected in the two fields in dosimetry: radiation protection dosimetry to ensure the health of occupationally exposed workers and dosimetry for the medical application of ionizing radiation to restore the health of patients. An overview of both fields with the different measuring quantities and units as well as their challenges will be given.

Dr. Ulrike Ankerhold is the head of PTB's "Dosimetry for radiation therapy and diagnostic radiology" department. After gaining her doctorate in molecular spectroscopy with synchrotron radiation, she joined PTB in 1997. Ulrike Ankerhold headed the "Photon dosimetry" group in the "Radiation protection" department for many years before she took over her current position.

Lothar Siekmann:
Towards improved reliability in laboratory medicine: Universal metrological traceability

Abstract: The concept of measurement traceability provides the most important strategy in

achieving standardization in laboratory medicine aimed at comparable measurement results regardless of the method, of the measurement procedure (test kit) and of the laboratory where analyses are carried out.

The implementation of the traceability concept obviously requires establishing internationally accepted

- reference measurement procedures,
- reference materials, and
- reference measurement laboratories.

Accordingly accredited reference (calibration) laboratories have been established which provide reference measurement services for setting target values for the external quality assessment of routine laboratories. This is a powerful tool to demonstrate the traceability of test results or sometimes deficiencies of individual laboratories and test kits. It can be demonstrated that the introduction of this concept considerably improves the comparability and reliability of laboratory results – ultimately for the benefit of the patients.

Prof. Dr. Lothar Siekmann is Emeritus Professor at the Institut für Klinische Biochemie of the Rheinische Friedrich-Wilhelms-Universität Bonn, which he led for several years. He developed the principle of isotope dilution mass spectroscopy and reference measurement procedures in clinical chemistry. Lothar Siekmann is also a member of PTB's "Kuratorium" (the Advisory Board) and a member or the chairman of several national and international committees including the German Society of Clinical Chemistry (DGKL).

Michael Kühne:

Units for the universe or "The Metre Convention and its role in the 21st century"

Abstract: In 1875 representatives of seventeen nations signed the diplomatic treaty known as

the "Convention of the Metre" with the aim of establishing an internationally agreed system of units for trade and science based on the metre and the kilogram. The signatories also created the Bureau International des Poids et Mesures (BIPM) as a permanent scientific laboratory with a mission to ensure uniformity of measurements. While in the 20th century metrology primarily served the needs of industry and science, today it also needs to address the "Great Challenges" of the 21st century, in particular, climate change monitoring, health and food safety. To address these challenges, the BIPM, which now has 55 Member States with a further 34 states and economies participating as Associates, is also providing metrological support to national metrology institutes and international organizations to help address these needs.

Prof. Dr. Michael Kühne is the Director of the BIPM. Its mission is to ensure world-wide uniformity of measurements and their traceability to the International System of Units (SI). Before Michael Kühne joined the BIPM in 2009, he was a member of the presidential board of PTB. During his scientific career he has worked in the areas of radiometry, in particular with synchrotron radiation, and thermometry.

Joachim Ullrich: **Closing remarks**

Prof. Dr. Joachim Ullrich is the new president of PTB. He was a director at the Max Planck Institute for Nuclear Physics in Heidelberg. He invented the "reaction microscope", a method for the complete kinematic characterization of all products in atomic or molecular reactions, and pioneered science at free-electron lasers, novel sources of extremely intense, ultra-short X-ray pulses.



Helmholtz Prize 2012

To support science and research, the Helmholtz-Fonds e. V. and the Stifterverband für die Deutsche Wissenschaft e.V. award the Helmholtz Prize for precision measurements in physics, chemistry, and medicine.

Since 1973 outstanding scientific and technological research on the subject of metrology has been honoured with the Helmholtz Award. A jury of renowned and independent scientists selects the winner from the submitted papers.

Eligible papers for the award have come out of research performed in Europe or by collaborations with participants performing their research in Germany. The proposal must contain an original result that was obtained recently. The subject can be experimental or theoretical, applied or of fundamental interest.

This year, the Helmholtz Prize for precision measurements was awarded to *Dipl.-Phys. Sven Sturm*, *Dipl.-Phys. Anke Wagner* and *Prof. Dr. Klaus Blaum* of the Max Planck Institute for Nuclear Physics, Heidelberg.

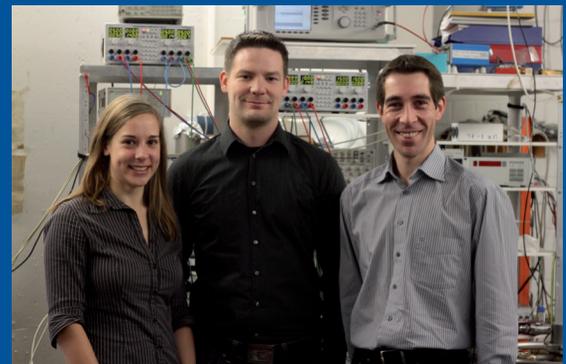
The award recognizes their measurement of how magnetic an electron is in hydrogen-like silicon. Hydrogen-like atoms are atoms from which all but one electron have been removed. The measure for magnetism of the electron is

the g -factor, which can also be calculated very precisely by means of the theory of quantum electrodynamics (QED).

Due to the interaction of the very strong electric field generated by the highly charged nucleus of the atom with its single electron, contributions to the QED calculation that would not contribute under different experimental conditions are substantial. This allows for testing QED with high precision against experimental data and thus for a better understanding of electro-magnetic forces. Actually, QED has passed the test! With such tests we gain a better understanding of fundamental forces in the universe.

The laureates had to develop and build a sophisticated arrangement of three ion traps to investigate a single silicon ion. These traps were cooled close to absolute zero temperature and contained an exceptionally good vacuum so that the laureates could measure with a single individual atom for several months.

Each measurement involved the transport of the ion over a distance of several centimeters to probe its interaction energy with an external magnetic field with a newly developed measurement procedure.



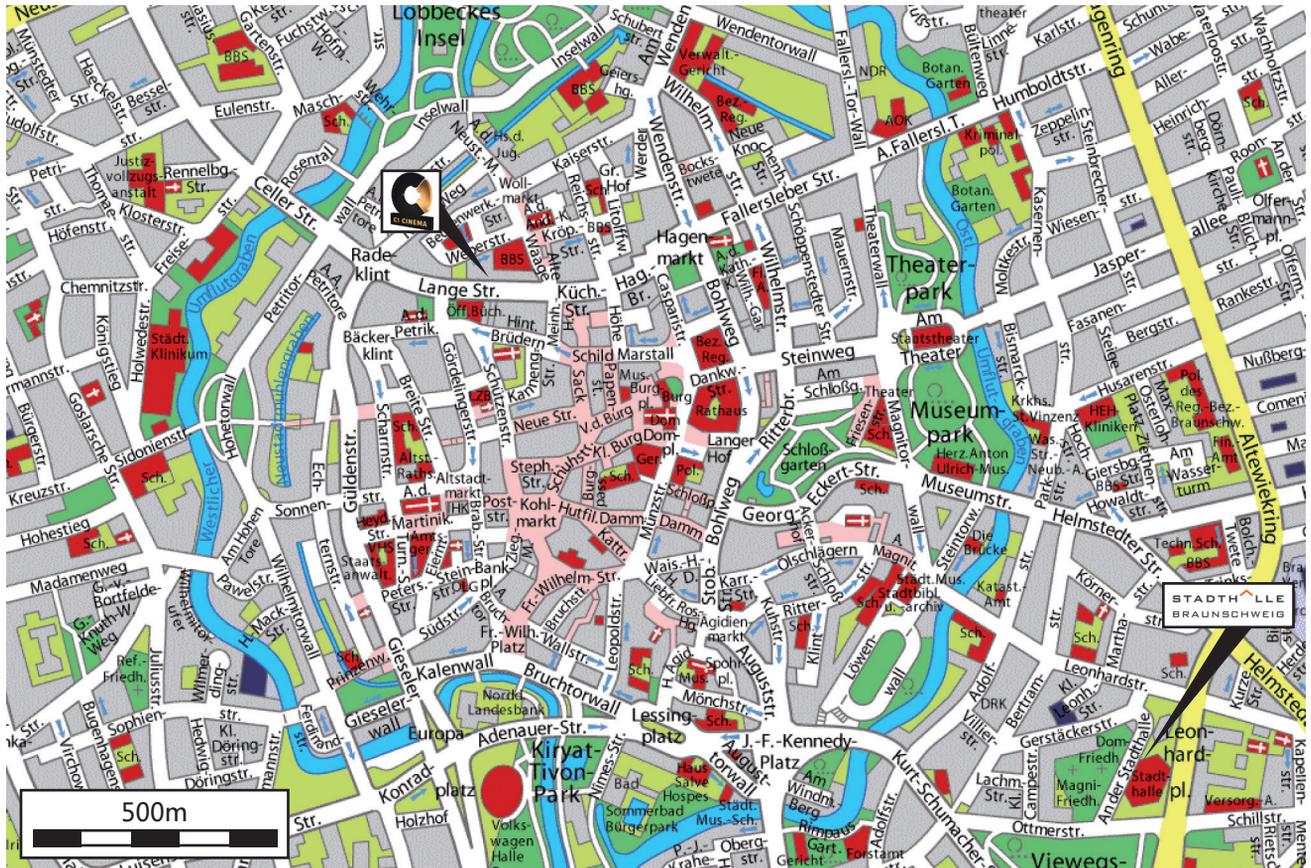
Laureates of the Helmholtz Prize 2012: *Dipl.-Phys. Anke Wagner*, *Dipl.-Phys. Sven Sturm*, and *Prof. Dr. Klaus Blaum* of the Max Planck Institute for Nuclear Physics.

Evening event: The movie

If you have not yet decided how you want to spend the evening of March 27, we suggest that you watch the movie *"The Hitchhiker's Guide to the Galaxy"*. We have reserved an auditorium in the movie theater "C1 Cinema", Lange Straße 60 (0180 501 26 60) for 8:15 p.m. Admission is free and reserved for symposium participants. You can get your cinema ticket at the registration desk or the information stand during the conference.

The cinema is marked on the map below; it is roughly a twenty-minute walk from the Stadthalle, the symposium venue.

Town map



DON'T PANIC



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