

MEASUREMENT TECHNIQUES

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CONTENTS

FUNDAMENTAL PROBLEMS IN METROLOGY

Variation of Constants in the Extended Standard Model. Part 2. Experimental Constraints on the Possible Variations – S. A. Kononogov, V. N. Mel'nikov, and V. V. Khrushchev	923
A New Scheme for Processing Output Data from Resonant Gravitational Antennas – A. V. Gusev, V. N. Rudenko, and I. V. Tsybankov	929
Theoretical Principles of Inflationary Quantum Metrology – A. F. Kotyuk and A. V. Khromov	934

GENERAL PROBLEMS OF METROLOGY

AND MEASUREMENT TECHNIQUE

Power and Robustness of Criteria Used to Verify the Homogeneity of Means – B. Yu. Lemeshko and S. B. Lemeshko	950
Selection of the Structure of a Model in Processing the Results of Measurements in Control Systems – N. N. Karabutov	960
The Problem of Confidence Probability – S. F. Levin	967
Practical Implementation of the Method of Weight Functions for the Construction of Estimators of the Distribution Density Function – V. M. Lazarev and A. V. Yashin	976
Automation of the Process of Testing Statistical Hypotheses by Means of the Von Mises and Pearson Criteria – A. N. Chepushtanov	980
A Set-Theoretic Model in the Problem of Evaluating the Characteristics of Information-Measurement Systems – V. V. Pitsyk, E. G. Gamayunov, and D. Yu. Zhdanov	985

NANOMETROLOGY

Metrology and Standards in Nanotechnology – V. I. Troyan, M. A. Pushkin, V. N. Tronin, V. D. Borman, and P. A. Krasovskii	992
A Test Object with Three Certified Linewidth Dimensions for a Scanning Electron Microscope – M. A. Danilova, V. B. Mityukhlyav, Yu. A. Novikov, Yu. V. Ozerin, A. V. Rakov, and P. A. Todua	998

OPTOPHYSICAL MEASUREMENTS

The Calibration of a System for Measuring the Transmission of the Atmosphere for Laser Radiation – A. A. Kovalev, A. A. Liberman, S. A. Moskalyuk, and S. V. Seregin	1004
Modeling of the Effect of the Temperature Field Configuration in a Fluid on the Refraction of Laser Radiation – K. M. Lapitskii	1007
Problems of the Metrological Backup of Instruments for Measuring Luminescence Characteristics – N. P. Muravskaya and I. V. Malenkov	1012

CONTENTS

(continued)

MECHANICAL MEASUREMENTS

The Limits of Metrological Correctness of the Struya Shaper – V. P. Starikov

and N. A. Vladimirova 1018

ELECTROMAGNETIC MEASUREMENTS

Measurement of the Physical Properties of Dispersed Weakly Magnetic Samples to Estimate

Their Stability – V. I. Pudov and A. S. Sobolev 1025

RADIO MEASUREMENTS

The Transient Heat Process in a Microcalorimeter with a Microwave Power Converter

– A. I. Mekhannikov 1031

ACOUSTIC MEASUREMENTS

The Estimation of the Power Spectrum of a Signal – A. F. Kurchanov

..... 1035

PHYSICOCHEMICAL MEASUREMENTS

Measurement of Ozone over a Wide Range of Concentrations Using Semiconductor NiO

Gas Sensors – V. S. Demin, A. N. Krasovskii, A. M. Lyudchik, V. I. Pokatashkin,
I. L. Grigorishin, and O. N. Kudanovich 1038

INTERNATIONAL COLLABORATION

The 23rd General Conference on Weights and Measures – V. N. Krutikov, T. D. Kanishcheva,

S. A. Kononogov, L. K. Isaev, and N. I. Khanov 1045

Significance would be attached to observation of time variations in the fine-structure constant α_s , but in the framework of the theory of relativity, it is possible that the time variations in that constant lead to ones in other constants for the coupling and the fundamental masses. This must be borne in mind in interpreting existing and planned experiments [3, 16, 19].

This paper is a continuation of [19], in which the first three sections give constraints on the time variations in the fine-structure constant α_s as implied by laboratory experiments, astrophysical data, and geochemical data from the Oklo reactor. In the fourth section, we consider the inclusion in the NIST at the phenometrical level of weak gravitational interactions. In conclusion, we assess the possible effects of those variations on the basic metrological characteristics of primary standards for the units of certain physical quantities, which is of interest in connection with the proposals for new definitions of the kilogram, ampere, kelvin, and mole to be discussed at an international meeting in 2011.

1. Constraints on possible time variations in the NIST constants from astrophysical data. Observations of the spectra of remote astrophysical sources provide information on the positions of atomic energy levels in the time of emission. There are, however, numerous sources of systematic error, which restrict the attainable accuracy in measuring the time changes of the atomic constants, and which should if possible be allowed for [5]. Recent observations on these sources indicate a possible increase in α_s with time. Quasar spectra have been analyzed by means of a telescope on Hawaii. More than 100 quasars have been examined with parameters $0.2 < z < 3.7$, and it has been observed [20] that

$$\Delta \alpha_s / \alpha_s = (-0.37 \pm 0.11) \cdot 10^{-2} \quad (1)$$