SESSION K1: SYMPOSIUM OF THE FUNDAMENTAL CONSTANTS AND PRECISE TESTS OF PHYSICAL LAWS TOPICAL GROUP: FUNDAMENTAL CONSTANTS AND PRECISE TESTS OF PHYSICAL LAWS II

Thursday afternoon, 19 April 1990; North Salon at 13:30; R. Ritter, presiding

13:30

K1 1 Accurate Measurement of the Antiproton Inertial Mass. GERALD GABRIELSE, *Harvard University.*

14:06

K1 2 Tests of General Relativity with Precise Gyroscopes in Earth Orbit.* JOHN P. TURNEAURE, *Stanford University.*

The Gravity Probe-B Relativity Gyroscope Experiment is being developed to measure two effects predicted by Einstein's General Theory of Relativity: the geodetic and frame-dragging precessions of gyroscopes in orbit about a massive spinning body.[1] Four gyroscopes will be placed in a 650 km high polar orbit about the earth, and their precession rates will be measured relative to the distant stars.[2] The goal of the experiment is to measure the precession rates over 1 yr to 0.005% (geodetic) and 0.5% (frame-dragging). This requires that the gyroscopes be read out to $5x10^{-9}$ rad in 5 hr and that they have a drift due to disturbance torques of less than $5x10^{-10}$ rad/yr. The gyroscopes may also be used to extend gravitational redshift measurements to a clock based on the gyroscope rotation rate. The frequency of the gyroscope clock would be compared with that based on atomic clocks both of which experience the same annual variation of the sun's gravitational potential due to the eccentricity of the earth's orbit. A 0.01% measurement of the gravitational redshift would require a fractional frequency stability of about $3x10^{-14}$ over 1 yr. This talk will describe these precise tests of general relativity and the required precise gyroscopes which will be operated at 2 K in a cryogenic environment and in a drag-free earth orbit.

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[1]L. I. Schiff, Phys. Rev. Lett. 4, 215 (1960).
[2]J. P. Turneaure, C. W. F. Everitt, B. W. Parkinson, et al., Advances in Space Research 9 (9), 29 (1989).

14:42

K1 3 High Accuracy Determination of the Fine Structure Constant via Measurement of the Proton Gyromagnetic Ratio.*
EDWIN R. WILLIAMS, *National Institute of Standards and Technology.*

The latest experiment at NIST to measure the gyromagnetic ratio of the proton in H_2O, γ_p', by the low field method has an uncertainty of 0.11 ppm for γ_p'(low).[1] Using this experimental result a value for the fine structure constant α^{-1} = 137.0359840(51) (0.037 ppm) can be calculated.[2] The uncertainty in α is limited by the uncertainty in the γ_p' experiment. The most difficult part of this experiment was constructing a 2.1-m long solenoid with a precision of a few μm, then measuring its critical dimensions to 0.05 μm. Instead of measuring the wire locations, we measured the location of the current placed in each winding turn using the magnetic field produced by the current in that turn. We accurately measured the solenoid current in terms of the Josephson volt and Quantum Hall resistance. The resultant magnetic field was uniform to 1 in 10^7 over 7 cm diameter sphere. The precession frequency was measured using NMR. When this value of α is compared with that obtained from the electron magnetic moment anomaly, a_e, using Dehmelt et al.'s results and Kinoshita's calculation we have one of the most precise tests of QED theory.[3] The difference between the values of α obtained from a_e and γ_p' is (0.054 ± 0.038 ppm).

* Contributions by NIST not subject to copyright in the USA. The contributions by G. R. Jones, Jr. , S. Ye, R. Liu, H. Sasaki, P. T. Olsen, W. D. Phillips, H. P. Layer, B. N. Taylor, R. F. Dziuba and R. L. Steiner are appreciated.

[1] E. R. Williams, et al. IEEE Trans. Instrum. Meas. 38, 233 (1989).
[2] M. E. Cage, et al. IEEE Trans. Instrum. Meas. 38, 284 (1989).
3 T. Kinoshita, IEEE Trans. Instrum. Meas. 36, 201 (1987).

15:18

K1 4 Recent Developments in Laser Interferometric Gravitational Wave Detectors.*
RONALD W. T. DREVER, *California Institute of Technology.*

The development of interferometric gravitational wave detectors has led to new concepts in the design of laser interferometers for high strain sensitivity, and to proposals for construction of gravitational wave detection