Transactions IAU, Volume XXVIB
Proc. XXVIth IAU General Assembly, August 2006
K.A. van der Hucht, ed.

DOI: 00.0000/X000000000000000X

COMMISSION 31 **TIME**
(TIME)

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PROCEEDINGS BUSINESS SESSION, August 21 2006

1. Introduction

Most of the commission's three 90-minute time slots at the General Assembly were devoted to a series of 20 and 50 minute presentations, informally termed "Time and Astronomy". The first part of the session was dedicated to time and general relativity. The second part of the session was dedicated to pulsar timing.

2. Appointment of Officers for 2006-2009

Drs P. Defraigne and R. Manchester were elected as President and Vice-President of the Commission for the next term, 2006-2009.

3. Scientific session: Time and Astronomy

S. Pireaux presented a basic approach for relativistic equations for future space missions. For spacecraft motions, this approach integrates the relativistic equations of motion numerically with respect to the appropriate metric instead of making relativist corrections to a Newtonian integration. For light, a basic relativistic approach towards laser-links is also relevant to future space missions.

E. Fomalont and S. Kopeikin presented the astrometric test of General Relativity, based on the bending of electromagnetic waves by a moving gravitating body. This was performed by the Very Long Baseline Array in two recent experiments, based on Jupiter and the Sun passing nearly in front of radio sources. They confirmed General Relativity, to a precision 3 times better than previous VLBI measurements, and the technique promises yet another factor of 3 improvement in the future.

R. Nelson outlined the fundamental concepts of relativistic time transfer and described the details of the mathematical model. The approximate magnitudes of various relativistic effects for clocks onboard the GPS satellites, other representative satellites in Earth orbit, and a clock on the surface of Mars or on the Moon were summarized. A clock on Mars would display period variations with respect to those on earth, with amplitude of 13 ms.

The resolution B3, proposed by the IAU WG on Nomenclature for Fundamental Astronomy for the re-definition of Barycentric Dynamical Time, TDB, was then explained by N. Capitaine and discussed by the assembly, with emphasis on the role of TT as a coordinate time, of which TAI or TT(BIPM) are realizations.

G. Petit proposed a comparison between stability of the pulsar time scales and the present stability of TAI and TT; TT(BIPM) has presently accuracy and long-term instability at about 1x10-15 over the recent years. A pulsar's long-term stability may reach a few 10-15, but due

to interstellar medium, gravitational effects, geodetic precession, etc., it seems unlikely that a time scale based on pulsars would supersede atomic time scales. However G. Petit emphasized the role of pulsars as the main users of the very long term stability of atomic time scales and in providing possible flywheels to transfer the current accuracy of atomic time to the past, or to the future (if needed).

R. Manchester presented the first results of the Parkes Pulsar Timing Array of which the goal is to detect gravity waves passing over the Earth. As pulsar timing is most sensitive to gravitational waves with frequencies in the nanoHertz region, the most likely astronomical sources gravitational waves that can be detected are binary super-massive black holes in galaxy cores. He noted that the great success of the Parkes pulsar survey should be superseded by an order of magnitude when the Square Kilometer Array comes on line, and the large number of pulsars expected to be discovered may make it possible to create a stable pulsar time scale.

C. Alley presented in detail the Yilmaz theory of Gravity, and its differences with respect to the Einstein theory. This theory adds gravitational binding energy to the stress-energy tensor with the result that black holes do not exist, and the speed of light remains c in a rotating frame. This results in the proper time being independent of latitude, which appears to be more consistent with recent isotropy of one-way speed of light experiments. He is planning a repeat of his one-way speed of light measurement, this time using dark fibers instead of lasers through the lower troposphere.

S. Sheikh and D. Matsakis presented the possibilities of spacecraft position determination using pulsar x-ray signal measurements. The brightest x-ray pulsar by far is in the Crab nebula. If valid timing information from radio observations can be made available, it is possible to use the Crabs X-ray emissions to measure orbits to an accuracy of 500 meters.

I. Stairs proposed some long-term pulsar timing results from Arecibo and Green Bank, as well as some recent scientific results obtained from this database, ranging from neutron-star masses to gravity-wave background limits. She also discussed issues relevant to connecting pulsar data over the several-year observational gaps when Arecibo was redesigned.

Y. Ilyasov presented the millisecond pulsar timing activities at Kalyazin and the resulting database of processed pulsar Times of Arrival (TOA) with refer to the Solar system barycenter for about 10 years period. Although data were single-frequency, he could use second-frequency data from other observatories to model interstellar dispersion.

M Sazhin discussed the stability of a pulsar time scale based on the long term millisecond pulsar timing, considering the influence of the propagation conditions along the pulsar signal way and the influence of microlensing on the TOA, which put natural limits on a pulsar time scale's stability.

4. Laboratory reports

The BIPM time section report was presented by F. Arias, and the report of the time department of NICT was presented by M. Hosokawa. The BIPM reports an overall frequency accuracy of TAI is about 10-15. NICT, formerly CRL (Japan), was recently reorganized. They have great improved their infrastructure and timescale algorithms, so that UTC(NICT) has also improved.

5. Commission Web Pages

Most of the viewgraphs that were presented in the session can be found on Commission 31s web pages, which as of this submission are in the process of being relocated to the Royal Observatory of Belgium.

Demetrios Matsakis
President of the Commission