BIPM/IAU Joint Committee on relativity for space-time reference systems and metrology

Report by Gérard Petit, BIPM, chairman of the Joint Committee

The Joint Committee on Relativity for space-time reference systems and metrology (JCR) was created by Resolution B3(1997) of the International Astronomical Union and approved by the Comité International des Poids et Mesures (CIPM) at its 86th meeting in September 1997. Its tasks are "to establish definitions and conventions to provide a coherent relativistic frame ……. and to develop the adopted definitions and conventions for practical application by the user". The web site of the JCR (www.bipm.fr/WG/CCTF/JCR) was established in 1997 and updated with the headlines of the JCR work.

The JCR has worked in collaboration with the IAU Working Group on relativity for celestial mechanics and astrometry (RCMA) on the problems of astronomical relativistic space-time reference frames. The RCMA has specified a consistent framework for defining the barycentric and geocentric celestial reference systems at the first post-Newtonian level. Because new clock technology and space missions will necessitate the application of this framework for time and frequency measurements in the solar system, the JCR focused on these applications. After discussion at the IAU Colloquium 180 in March 2000, the report of the JCR and of the RCMA were presented at the 24th IAU General Assembly in the Joint Discussion 2 "Towards models and constants for sub-microarcsecond astrometry" in August 2000. The Resolutions prepared by the RCMA were adopted as Resolution B1.3 "Definition of Barycentric celestial reference system and of Geocentric celestial reference system" and Resolution B1.4 " Post-Newtonian Potential Coefficients". The Resolutions prepared by the JCR were adopted as Resoution B1.5 " Extended relativistic framework for time transformations and realisation of coordinate times in the solar system" and Resolution B1.9 "Re-definition of Terrestrial Time TT".

- Resolution B1.5 concerns time transformations and the realization of coordinate times in the solar system, strictly applying the extended conventional framework for the barycentric system specified in Resolutions B1.3 and B1.4. It provides explicit formulations for the time transformations, together with their domain of validity and the uncertainty they allow to obtain (0.2 ps in time, 5×10^{-18} in frequency). It also aims at removing some ambiguities in the IAU(1991) formalism by providing clear definitions, based on differential formulas, for the constants expressing the mean rates between coordinate times.

- Resolution B1.9 provides a new definition of Terrestrial Time TT using a fixed conventional value for its rate with respect to the geocentric coordinate time TCG. By removing the reference to the geoid, it removes uncertainties in the realization of TT originating from the intricacy and temporal changes inherent to the definition and realization of the geoid. This will be particularly important with future high accuracy clocks in space.

The adoption of these Resolutions completes an important part of the original objectives of the JCR, concerning time and frequency applications. Therefore the BIPM has proposed to the IAU to terminate the Joint Committee and to continue to collaborate in the framework of the RCMA working group. To reflect the increasing importance of metrology, including under this term all astro-geodetic measurements applied to space-time reference systems, the BIPM proposed that the name of the RCMA be extended to RCMAM: "Relativity in Celestial

Mechanics, Astrometry and Metrology", and that its membership be extended accordingly. These proposals were adopted by the Executive Committee of the IAU in January 2001.

References

1. Soffel M., Klioner S., Petit G., Wolf P., "New relativistic framework for the realization of space-time reference frames and its application to time and frequency in the solar system", *Journées 1999 Systèmes de Référence Spatio-Temporels and Lohrman Colloquium*, pp. 34-47, 2000.
2. Petit G., Report of the BIPM/IAU Joint Committee on Relativity for space-time reference systems and metrology, *Proc. IAU Colloquium 180*, pp. 275-282, 2000.

Membership of the JCR:

N. Ashby, C. Boucher, V.A. Brumberg, T. Damour, R.J. Douglas, E. Groten, B. Guinot, C. Han, S.A. Klioner, S.M. Kopeikin, J. Kovalevsky, D.D. McCarthy, G. Petit (chairman), B.W. Petley, J. Ray, J.C. Ries, M.V. Sazhin, P.K. Seidelmann, M.H. Soffel, E.M. Standish, P. Wolf.