time and space

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Editorial

Introducing *Time and Space*

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Time is an essential element in today's world, spreading over multiple applications that range from societal activities up to those requiring the highest precision for scientific purposes. The Einsteinian relativistic theories proved that time and space cannot be decoupled. Four-dimension space–time reference systems are described to represent phenomena on Earth and beyond. Their definitions in the frame of general relativity and the transformations between them have been established by the International Astronomical Union [1,2].

Time and frequency metrology enable activities supported by precise timing and synchronization related to the critical infrastructure on Earth and in space research activities. Optical frequency standards (OFSs), based on different species and transitions developed in many metrology institutes, have surpassed the accuracy achievable by the realization of the current definition of the second by a factor of up to 100 [3], compelling the international metrology community to select one or several of these transitions [4] for a new definition of the SI second. This redefinition can be expected by 2034, provided that a set of conditions are fulfilled; an essential requirement to confirm their performance is comparing their frequencies over all distances and demonstrating their fractional frequency agreement at the 10^{-18} level. This requirement is fulfilled by optical fibre links, over baselines up to about 2000 km [5].

OFSs achieve relative frequency uncertainties of order 10^{-18} and are promising to some emerging applications and innovative fields of research requiring frequency uncertainty between 10^{-15} and 10^{-20}. These include the studies of the structure and composition of the universe, tests of fundamental physics, improving the knowledge of the Earth's potential gravity field, etc.

The space exploitation and exploration make use of the latest technological and scientific achievements. New devices, such as satellites and satellite constellations, strongly impact the fields of communication and Earth observation. Encouraged by the performance of these systems, the time and space communities are challenged by a new era in the Moon's exploration with the establishment of cis-lunar references to enable operations and communications with, around, and on the Moon [6].

Time and Space (ISSN 2813-9526) [7] aims to encourage scientists to publish both theoretical and experimental research, including papers on scientific research and the technological applications of atomic clocks and timekeeping devices and their use in fundamental physics experiments on the ground and in space, relativity, relativistic metrology, and geodesy.

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