October 28, 2015, Wednesday

Session [VI–A] Space-Time Navigation

Chair TBA

14:15 Using light as a thread for space navigation *Angelo Tartaglia*

Abstract
Light rays are like the weft in a tissue. Being null geodesics they are the same for all freely falling observers and they everywhere reproduce the 'shape' of space-time. I shall review the different strategies that can be implemented in order to use electromagnetic signals for positioning and navigation far from the terrestrial environment. In general periodic signals from reference sources will be associated with local proper time measurements. The possibility to use signals exchanged among a constellations of spacecrafts for the purpose of reconstructing the local structure of space time will also be discussed, using a technique similar to the Regge calculus. Strong gravitational fields in the surroundings of singularities will be considered. In general it will be shown that the navigation in high curvature regions can be performed associating both the local mapping of space-time by a grid of null geodesics and the relativistic positioning technique.

15:00 Setting up an Autonomous Relativistic Positioning System *Uroš Kostic*

Abstract
To construct a Global Navigation Satellite System (GNSS) in a strong gravitational field, e.g. around a black hole, it is not possible to use the approach of current GNSS, which rely on global reference frames fixed to e.g. the Earth (via the ground stations). Instead, it proves useful to give the constellation of satellites the possibility of constituting by itself a primary and autonomous positioning system, without any a priori realization of a (terrestrial) reference frame. Here we will show how to construct such a system, an Autonomous Basis of Coordinates (ABC), via emission coordinates in the perturbed space-time of a Schwarzschild black hole .

15:30 The Time Transfer Function as a fundamental tool of space-time navigation: Range, Doppler and astrometric observables *Christophe Le Poncin-Lafitte*

Abstract
We will show how the Time Transfer Function can be used in the relativistic modeling of range, Doppler and astrometric observables, which are the basic observables used in space-time navigation. We will present a method to compute these observables for Solar System applications up to second post-Minkowskian order directly from the space-time metric without explicitly solving the null geodesic. The resulting expressions involve integrals of some functions defined by the metric tensor taken along a straight line between the emitter and the receiver of the electromagnetic signal. Some examples are given within the context of future space missions.

16:00 **Light trajectories and space-time navigation: what can we learn from Gaia?** *Mariateresa Crosta*

Abstract

Missions like Gaia demand the proper treatment of gravity when compiling stellar maps to μas accuracy, which implies taking into account the general relativistic effects due to the local dynamical gravitational fields encountered by the light while propagating from the star to the observer. Therefore, a fully relativistic inverse ray-tracing requires highly accurate astrometric models in accordance with the geometrical environment affecting light propagation itself and the precepts of the theory of measurement in General Relativity.
This will provide not only a new relativistic rendition of stellar charts and fiducial anchors for the space-time navigation, but also an alternative thinking on how our local "zero" redshift position plays a fundamental role in the reconstruction of the space-time architecture around us.

16:30 COFFE BREAK