SSM
Scuola Superiore Meridionale

**Course title:**

***Relativistic position as a way of probing gravitational field***

**Duration** [number of hours]**: 12**

**PhD Program** [MERC/MPS/SPACE]**: SPACE**

**Name and Contact details of unit organizer(s):**

**Prof:** *Lorenzo Fatibene*
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**Course Description** [max 150 words]**:**

The course aim is to set up a framework based on Lagrangian and Hamiltonian mechanics to describe exactly the motion of particles and light in a region near a self-gravitating systems (a planet, a star, or a black hole), in a non-perturbative way, without introducing any Newtonian limit or any weak field assumption.

Then we discuss positioning systems from a purely relativistic viewpoint, showing we can design them so that they self-calibrate (i.e.~they are able to describe both the position of the user as well as the (exact) motions of the satellites themselves).
We do not assume a priori orbital navigation nor a priori synchronizations at a distance of the clocks they transport.

By doing that we also provide a geometric framework for optimal Hamiltonian control theory which is a useful tool in many different contexts.

**Syllabus** [itemized list of course topics]**:**

**1)** Basic GR
**2)** Lagrangian mechanics
**3)** Hamiltonian mechanics and generating functions of canonical transformations. (can be reviewed)

**Assessment:**

Oral seminar of a topic discussed during the course
or a simulation of a situation using Mathematica or Maple or...

**Suggested reading and online resources:**

1. http://www.fatibene.org/book.html
2. https://arxiv.org/pdf/1805.04741.pdf (and references quoted therein)
3. Notes provided by the Teacher.