Contribution ID: **54** Type: **talk**

A time machine allowing travel to the past by free fall

Tuesday, 24 September 2019 11:25 (20 minutes)

This talk illustrates a model of spacetime with closed timelike curves proposed in a recent paper (D. Fermi and L. Pizzocchero, Class. Quantum Grav. 35 (2018), 165003, 42pp). This spacetime is diffeomorphic to R4 and carries an ad hoc metric; it consists of a flat outer region and of a "time machine", formed by a toroidal interface and by an inner flat region. The timelike geodesics of this model, representing motions in free fall, can be analyzed qualitatively and computed analytically by quadratures; in this way, it is shown that a freely falling observer can start from the outer Minkowskian region, travel across the time machine and then return to its initial position at an earlier time, as evaluated by an inertial frame for the outer region with a clock fixed in the initial position. With a suitable choice of the initial conditions, the amount of time travelled in the past according to this fixed clock can be made arbitrarily large, while keeping non large the duration of the trip according to the traveller's clock; quantitative examples are given.
The price for the above features of the model is the violation of the standard energy conditions in the interface of the time machine. Another problem are the tidal forces experienced by the traveller within this interface: as shown by a quantitative analysis, these are non destructive for a human being only if the size of the machine (and of the interface) is astronomical. A time machine of this size also has a non large interfacial mass-energy density, much smaller (in absolute value) than the density of water; the energy density is much below the Planck scale even for a machine of size comparable with the human scale, which ensures that the treatment of these objects via classical physics is correct.

Presenter: Prof. PIZZOCCHERO, Livio (Dipartimento di Matematica, Universit'a degli Studi di Milano and INFN, Sezione di Milano)

Session Classification: The Mathematical side of Causality