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Preface

The possibility of time travel, both in the past and into the future of a given observer, has left the realm of pure imagination to come into physical plausibility, starting with the seminal works by Chandrasekhar and Carter, followed by those of de Felice, Clarke, Thorne, and Novikov and several others. The early work by de Felice and collaborators showed how physically possible trajectories can be grown under conditions of time reversal in the Kerr metric, in the presence of naked singularities (Gen. Rel . & Gravity, 9155-163, 1978, Gen. Rel & Gravity, Gen. Rel Grav, 16 889, 197810335-341, 1979, The Nuovo Cimento 65B 224-232, 1981, Gen. Rel & Gravity 16139-148, 1984). A strong impetus to the deepening of such studies came also from the findings of K. S. Thorne, Novikov and collaborators, who revealed the possible presence of wormholes (Phys. Rev. D 44 1077, 1991, Phys. Rev. Lett. 61 1446, 1988, Int. J. Mod Phys. D4 557, 1995). The central theme in all of these works was the study of causality and, in particular, the need for an anomalous time behavior able to preserve causality itself in spite of apparent violations. The difficulty of the subject combined with a persistent skepticism about the physical plausibility of this phenomenon repeatedly slowed progress in this area of advanced research.

Despite of all this, recent developments have opened new perspectives for the "realization" of a time machine (Phys. Rev. Lett. 106, 040403, 2011) related to the issue of quantum non-locality (Phys. Rev. 47, 777, 1935, Physics, 1: 195-200, 1964) resulting from entanglement (Proceedings of the Cambridge Philosophical Society, 31, 555-563, 1935; 32, 446-451, 1936; Rev. Mod. Phys. 81, 865-942, 2009) and, in particular, to the phenomenon of teleportation (Nature 390, 575-579, 1997, Phys. Rev. Lett. 80, 1121-1125, 1998). The topological nature of spacetime in the framework of Quantum Mechanics suggests that both causality and locality need to be analyzed at a fundamental level, also by allowing the existence of entities that are more elementary than the spatial dimensions of everyday life. The interplay of these entities influences the very nature of time, and their dynamics could lead to the understanding of the emergence of the arrow of time.

Focusing on these issues would help unveiling the ultimate nature of causality, its role in fundamental physics and in the evolution of the Universe. This would allow for a better comprehension of the "direction" of large scale structure, including complex formation such as that of black holes or hierarchical structures like the Galaxy, with obvious implications on the process of mapping the Universe on local and global scales, which must remain consistent with the theories of General Relativity and Quantum Mechanics.

Finally, a complex subject like time travel cannot be dealt with without a multidisciplinary vision: for this reason the conference hosted short contributions devoted to the historical, artistic, novel, philosophical, and psychological aspects in the perception of time-machine.