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Opening address

Causality is a fundamental law of physics, which must be preserved without exceptions. This stringent requirement contributes to the foundation of our understanding of the physical world as much as do the conservation of energy and of angular momentum and of the absoluteness of the light velocity in vacuum. Because of this imperative constraint, the occurrence of physical phenomena like a *time-machine* which could in principle lead to a violation of causality, have been up to now disregarded as an admissible reality. The time-machine, in its strong version, admits time-loops which would allow an observer to travel arbitrarily far into his own past, meet his younger grandpa and persuade him to have a different life braking the causal chain and leading to a non causal time-loop. The unexpected outcome of some solutions of Einstein equations (like Kerr solution) and now scientifically well grounded, is the existence of time-machines consistently with all laws of physics.
This result can be either rejected as unphysical or considered as a new and stimulating trend to discover how Nature reacts to avoid causality violation.
Aim of the meetings on "time-machine factory" is to motivate research along this second line of thought.

Prof. Fernando de Felice

Entanglement was defined by Erwin Schrödinger *the* characteristic trait of Quantum Mechanics. Its consequences, among which quantum non-locality, have prompted a deep scientific and epistemological debate about the very foundations of Quantum Mechanics as fundamental theory. Entanglement has recently assumed a central role both in the development of quantum technologies (as quantum information, quantum computation, quantum imaging and metrology, …) and in the discussion concerning fundamental aspects of physics as time loops, black-holes, entropy, etc.
To make the point of these studies and their relation with other connected areas of physics is a second aim of the workshop.

Dr. Marco Genovese

Time is indeed a fundamental ingredient to describe physical phenomena in the universe. In a consistent General Relativistic framework we know that it is a geometrical parameter whose specific value, the duration, depends on the observer, even though the presence of the light cones in a sense breaks a perfect equivalence with space distances. In any case duration, in order to be used for practical purposes, needs be measured and the only way we have is to compare any given phenomenon with another one, assumed as a reference. We expect a good reference to be endowed with a cyclic behaviour and we find it at two dramatically different scales: on one side we have atomic phenomena and quantum mechanics, which lead to the atomic clocks; on the other we have the angular momentum conservation in such massive objects as neutron stars, which leads to pulsars. In both cases we have good and stable clocks. Once the problem of reliable measurement has been solved, time is indeed similar to length and may be used to work out the geometrical properties of space-time. An interesting application based on the measurement of proper time intervals between the arrival times of successive pulses from a set of independent clocks, whose space-time position is known, is a Relativistic Positioning and Navigation system. In general the propagation of light and local proper time measurements are excellent probes for exploring the large scale, i.e. cosmic, structure of the universe.

Prof. Angelo Tartaglia