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Palazzo della Carovana

Piazza dei Cavalieri

# Colloqui della Classe di Scienze

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SCUOLA  
NORMALE  
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**BRUNO COPPI**

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*Complexity in the Universe and Down to Earth*

**Abstract:**

The access to Space both with observational instruments (e.g. optical, X and  $\gamma$  rays) and in situ measurements e.g. over distances of the order of the size of the Heliosphere (about 100 astronomical units) together with the development of new relevant technologies have given us new perspectives on the limitations of what we can explain of the Universe in view of all the novel phenomena discovered. In particular, most of our efforts have been devoted to a reductionistic approach in our earthbound investigations of physical phenomena leaving us relatively unprepared to deal with the macroscopic complexity of the Universe. Objects such as jets with extreme collimations and lengths, black holes manifesting themselves with a variety of effects and radiation emissions, gamma ray bursts, etc. are relevant examples. The least sophisticated plasma theory to deal with these phenomena requires dealing with a 7-dimensions space analysis. Only relatively modest advances have been made in its application to astrophysics.

Self-organization processes have been identified in magnetically confined laboratory plasmas, the most notable being the "profile consistency" of the electron temperature. These processes have to play an important role in astrophysical objects such as accretion structures around black holes and are in need of a theoretical effort commensurate with their importance.

Far less elementary complexities to be dealt with on Earth are associated with societal issues such as the interaction of the energy needs with those of climate and economics. In this context, the lack of a scientifically well founded and adequate effort to develop novel sources of nuclear energy and fusion burners in particular, considering that the science involved is strongly coupled to astrophysics, is discussed.