International prize "Tullio Levi-Civita" for the Mathematical and Mechanical Sciences

We are pleased to announce that the *2023 Levi-Civita Prize for the Mathematical and Mechanical Sciences* will be presented to

Thomas Buchert

for his innovative research in Relativistic Cosmology, which has been a challenging stimulus for a new significant interplay between mathematical cosmology and observational cosmology. Thomas Buchert is a full professor of the second exceptional class at the University Claude Bernard in Lyon, France, working at the École Normale Supérieure in Lyon. Internationally recognized as a leading theorist in cosmology, his research interests are multifaceted and span from work on mathematical aspects of General Relativity, exploring Riemann-Cartan geometry, integral geometry, singularity theory, non–trivial topologies, and Hodge-de Rham theory, to their applications to the dynamical theories of large–scale cosmic structure, scalar field cosmologies, Quintessence, Dark Energy, Dark Matter, and Inflation. His contribution to theoretical cosmology is particularly significant, addressing the global properties of world models, averaging problems, and cosmological backreaction. His analysis of statistical cosmology with innovative mathematical techniques exploiting integral-geometric and homology concepts has brought a deep understanding of cosmic structures' dynamical and statistical morphology. These results significantly impacted observational cosmology, particularly in analyzing galaxy surveys, supernova surveys, and the Cosmic Microwave Background. He is the author of more than 100 peer-reviewed research papers, more than 60 invited papers and conference contributions. In this rich and varied research landscape, three original works, pioneering what are nowadays mainstream activities, emerge as particularly significant examples of Thomas Buchert's contribution to general relativity and its applications to modern cosmology:

A. The Lagrangian theory of self-gravitating Newtonian continua and the formation of structure in the Universe: Thomas Buchert introduced the Lagrangian representation for self-gravitating Newtonian flows and the associated Lagrangian perturbation theory. He generalized the theory to the framework of General Relativity using Cartan formalism and established relations to exact solutions of Einstein equations (the Szekeres classes I and II).

B. The introduction of the Minkowski Functionals into cosmology as morphometric tools to analyze observational data: He applied these integral-geometric tools, with their rich mathematical background, to numerous observational data, including the development of numerical codes. He also extended the functionals to vector and tensor valuations and later included homology concepts in the analysis of observational data. Many groups have employed these tools, including the Planck team.

C. The generalization of cosmological models and the averaging problem in relativistic cosmology in relation to the issue of Dark Energy and Dark Matter, resulting in a set of cosmological equations for Inhomogeneous Cosmology known as the Buchert Equations. His original and innovative research earned him an ERC Advanced Grant (2017–2023) for coordinating a team of about 10 researchers hosted at École Normale Supérieure in Lyon to deepen the understanding and role of inhomogeneities in General Relativity. Nowadays, Buchert equations are considered a straightforward way to control inhomogeneities in cosmology, governed by backreaction terms that contribute to Dark Energy on large scales and Dark Matter on small scales. The concept of emerging curvature that Buchert introduced in his seminal work has led to important clues that can be significant to the understanding of the nature of Dark Energy and the vividly discussed Hubble tension.

Prof. Buchert's work has had an internationally recognized high impact on relativistic cosmology, and the Scientific Committee of the *Levi-Civita Prize in Mechanical and Mathematical Sciences* is honored to propose Thomas Buchert as the recipient of the 2023 prize edition.