Vienna School of Mathematics

PhD Colloquium

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Light cones and what are they made of.
(On the geometric object that contains all the sky.)

Abstract: Theoretical predictions about the universe are typically defined in the four-dimensional spacetime. However, astronomical observations lie on the past light cone (LC), a null three-dimensional hypersurface in it. To compare with data, these predictions must be restricted to the LC, introducing inherently geometric features. Modeling and computing the LC's geometric properties is therefore key to describing the data we have. In this talk, we first define what the light cone is and build intuition for how its flat version can be used to transform the results from N-body cosmological simulations to observational coordinates. We then adopt a more general perspective, treating the LC as a hypersurface of spacetime, and ask what ingredients are need to describe its geometry. We find that the LC can be split into cross-sections whose geometry can be nearly completely characterized by a tetrad that can be propagated along the light rays. This provides a path to numerically sample the LC points and its tangent space. With this approach, we aim to provide a self-consistent framework that naturally includes all effects in observational data arising light propagation through curved spacetime.

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