

Scissors-and-paste with Λ : The geometric picture

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Abstract

Impulsive gravitational waves are theoretic models of short but violent bursts of gravitational radiation constructed by Roger Penrose in the late 1960-ies using his vivid “scissors-and-paste” approach. Later Aichelburg and Sexl showed that such geometries arise in the ultrarelativistic limit of static sources, indicating them to be an interesting playground for particle scattering at Planck scales. The Aichelburg-Sexl procedure was subsequently generalized by Hotta and Tanaka to include a cosmological constant, and more straight forward constructions of the corresponding *non-expanding impulsive gravitational waves in cosmological backgrounds* were readily given by Griffiths and Podolský. However, the illustrative picture of the “scissors-and-paste” approach was missing.

In this contribution we provide such a geometric construction using the 5-dimensional picture: The (anti-)de Sitter hyperboloid is cut along two null hypersurfaces and the two “halves” are then re-attached with the generators of the hyperboloid joined with an appropriate “warp”. We also explain how this descriptive approach can be made mathematically rigorous despite the intricacies coming along with the low regularity character of the spacetime metrics involved.

This contribution is based on joint work with Jiří Podolský, Robert Švarc and Clemens Sämann.

Keywords: impulsive gravitational waves, junction conditions, non-expanding impulses, continuous vs. distributional metric form

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