Transparent boundary conditions for wave propagation in human lungs
(joint work with P. Joly and A. Semin)
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In this work we consider the problem of the sound propagation in bronchial network, approximated by a fractal one-dimensional tree. Mathematically, this phenomena is modelled by a weighted wave equation. The principal difficulty for the numerical resolution of this problem is the 'infiniteness' of the geometry. Our goal is to construct efficient transparent boundary conditions, which would allow us to truncate the computational domain to a (finite) subtree.

The construction of such transparent conditions relies on the approximation of the Dirichlet-to-Neumann (DtN) operator. In particular, we study the properties of its symbol, which, as we prove, is a meromorphic function that satisfies a certain non-linear functional equation. Based on its properties, we present, analyze and compare three stable methods for the approximation of the DtN: approximation by local operators, approximation by non-local operators stemming from rational expansions of the DtN symbol, and, finally, the convolution quadrature based approximation.