Coupling of geometrical transformations and modal methods for waveguides of complex shape

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We develop modal methods for the acoustic propagation in 2D rigid waveguides of complex shape : non zero curvature, variable cross section, waveguides containing restrictions with circular arc shape (Lorentz waveguides)...To recover a standard multimodal formulation, a geometrical transformation is applied. Then the geometry is simplified, a straight waveguide is obtained, but the equations are complicated, a wave equation with variable coefficients is derived. A first difficulty is to define a « good » transformation, leading to regular coefficients. In particular, in the case of walls with portions of circular shape, we show that the good transformation is not the intuitive one. A second difficulty is that the homogeneous Neumann boundary condition becomes a Robin-like condition after the geometrical transformation. This degrades the convergence rate of the modal method and we show that an enriched modal method is able to recover a good convergence. An extension to the case of a half waveguide with a complex end-wall shape is also presented.