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Separation of Variables on Spaces of Constant Curvature

Given a pseudo-Riemannian manifold (M, g), an important and ubiquitous partial differential equation one can define is the Laplace-Beltrami equation

$$g^{ij}(q)\nabla_i\nabla_j\psi + V(q)\psi = E\psi$$

which reduces to the Schrodinger equation in the Riemannian case, and a (generalized) wave equation in the Lorentzian case. Separation of variables is an old but powerful method for obtaining exact solutions to this equation, but it is not always possible. So the question we address is the following: how can we determine and classify the coordinate systems on M which admit a separable solution of the Laplace-Beltrami equation? We restrict ourselves to spaces of constant curvature, in which the theory of conformal Killing tensors yields an efficient and exhaustive approach to this problem. We review some of the recent work done on this problem, highlighting interesting results, and focusing on the much more interesting Lorentzian cases, which include Minkowski, de Sitter, and anti-de Sitter spaces.