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Harmonic analysis associated with the linear canonical modified Whittaker transform

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Abstract

In this paper, we develop a new harmonic analysis framework associated with the modified Whittaker-type differential operator L_n^α on the real line. We introduce a new integral transform called the linear canonical modified Whittaker transform F_n^W , which can be viewed as a generalization of the fractional Fourier–Bessel transform within the class of linear canonical transforms [1, 2].

We study several fundamental analytical properties of this transform. In particular, we establish its boundedness on suitable weighted function spaces and derive an explicit inversion formula [3]. A Plancherel-type theorem is also proved, showing that the transform defines an isometric isomorphism between the corresponding weighted L^2 -spaces [4].

Furthermore, we introduce a generalized translation operator associated with the modified Whittaker operator and investigate its main properties. This operator allows us to define a natural convolution product adapted to the transform. We show that the linear canonical modified Whittaker transform converts this convolution into a pointwise product, a fundamental property in harmonic analysis [5].

The results obtained provide a new analytical framework for studying integral transforms related to Whittaker-type operators and extend several classical results from Fourier–Bessel analysis.

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