

6–10 July, 2026, Santiago de Compostela, Spain.

A bridge between Stieltjes differential equations and ordinary differential equations

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Abstract

Stieltjes differential equations provide a flexible framework that unifies differential, difference, and time-scale equations, and are particularly suitable for modelling phenomena with discontinuities or latent dynamics. However, the measure-theoretic nature of this setting often introduces significant technical difficulties, even when addressing problems that are straightforward in the classical theory of ordinary differential equations.

In this talk, based on [2], we present a method to overcome these difficulties by establishing a connection between Stieltjes differential equations and ordinary differential equations. This connection is achieved through suitable isomorphisms between the associated function spaces. As a consequence, we show that certain Stieltjes differential problems can be transformed into equivalent integral and differential problems in the classical Lebesgue setting. This allows us to transfer known results from the theory of ordinary differential equations to the Stieltjes framework in a direct and efficient way.

As applications of this approach, we prove a version of Binding's existence theorem for equations of the form $x'_g = f \circ x$, see [1], in the Stieltjes setting, and we establish a compact embedding result for the associated Sobolev spaces.

References

- [1] P. Binding, The differential equation $x' = f \circ x$, *J. Differential Equations* **31** (1979), 183–199.
- [2] F. A. F. T., On the connection between Stieltjes differential equations and ordinary differential equations, *J. Math. Anal. Appl.* **546** (2025), 129248.

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