

Are Fractional Theories and Models Experimentally Corroborable?

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Theories and models based on *fractional differential equations* have been developed in many different fields with the motivation to fit experimental data up to now unfitted by theories and models based on differential equations of integer orders. The experimental estimation of the equation's parameters has a finite precision, and then such parameters emerge to be always rational numbers; as a consequence of this, there is always a pair of fractional and non-fractional equations that admit the same solution. This means that classical theories and models can be generalised into more cumbersome differential equations of integer order, with the same experimental support of the generalisation into fractional differential equations. This makes questionable the corroboration of phenomena with fractional nature. But, notwithstanding this corroboration failure, the fractional generalisation can be checked against a *theoretical suitability criterion* consisting in preserving mathematical and physical characteristics of the original problem, a criterion that is not met by the non-fractional generalisation. This statement is first illustrated for the cases of fractional diffusion and fractional Schrödinger equation. Later the general case of a nonlinear fractional differential equation is analysed in detail. The talk is based on paper [1].

- [1] Pagnini G., Mainardi F.: Are Fractional Theories and Models Experimentally Corroborable? *Foundations of Physics*, 55 (2025), 80.