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## **On the Mathematical Justification of the total Quasi-Steady State Approximation in Enzyme Kinetics**

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### **Abstract:**

The total quasi-steady state (tQSSA) approximation was introduced by Borghans et al. in the Nineties of the last Century and has shown to be very useful for the approximation of the solutions of the system of differential equations describing enzyme kinetics (in particular, phosphorylation and dephosphorylation).

As the standard quasi-steady state (sQSSA) approximation, introduced in the pioneering papers by Michaelis and Menten (1913) and Briggs and Haldane (1925), the tQSSA can be interpreted as the leading order approximation of an asymptotic expansion in terms of a suitable perturbation parameter  $\varepsilon$  (see the papers by Heineken et al. (1967) and Segel and Slemrod (1989) for what concerns the sQSSA and Schauer and Heinrich (1979), Schnell and Maini (2002) and Dell'Acqua and Bersani (2012) for the tQSSA).

In this communication we report some recent results of our research group, showing that:

- i) the tQSSA can be interpreted as the center manifold of the system describing the reaction, satisfying a Tychonoff-like theorem;
- ii) as the sQSSA, despite of some their peculiarities, the tQSSA can be studied by means of Renormalization Group (RG) techniques, introduced in Theoretical Physics and adapted to the study of singular perturbation problems by Chen et al. in 1996.