Preface

Talk with M. Hermite. He never evokes a concrete image, yet you soon perceive that the more abstract entities are to him like living creatures.

Henri Poincaré, quoted in G. Simmons "Calculus Gems"

As time goes on it becomes increasingly evident that the rules which the mathematician finds interesting are the same as those which Nature has chosen.

Paul Adrien Maurice Dirac, in The Relation between Mathematics and Physics

During more than 20 years dedicated to the study of differential equations with singularities, I have crafted what I call *my zoo of singular creatures*. The inhabitants of this zoo are mathematical models with some kind of singular nonlinearity, in the sense that it becomes infinite when the state variable approaches a certain point. One might say that the zoo is a reversed version of Plato's cavern, being the mathematical models' shadows or caricatures of real phenomena in the natural world. Singularities are purely mathematical artifacts, but they are important in the modeling of real-world processes because the main physical forces in nature are singular.

Everyday I spend some time in my zoo, contemplating the creatures (some of them are very exotic) and studying their behavior and interconnections. Also, I enjoy hunting new creatures in the related literature. As soon as I find a new model, I add it to my collection. Of course, I am not alone. In this endeavor I have the inestimable collaboration of many colleagues and friends who give me advice if they catch a glimpse of a new creature somewhere. Besides, there is a limited yet enthusiastic community of mathematicians and physicists who share my interest in models of this sort. I have learnt virtually everything I know in this field from them.

Taking such delight in my activity in the zoo, I decided that it would be a good idea to present some of the more interesting models in a short monograph. In order to have a reasonable size, I decided to restrict my exposition to those models featuring a periodic dependence on coefficients—these are my favorite ones, since in the study of dynamical behavior one is led to very interesting mathematical questions that are difficult to solve. For the same reason, most of the proofs are only

sketched, giving the pertinent references. The emphasis is therefore more on the interpretation of results with respect to the specific model under study, and the identification of open problems and reasonable conjectures. The bibliography is far from exhaustive, comprising a somewhat personal selection. My apologies in advance if the reader misses some significant reference.

I hope that this monograph will prove to have some practical utility as a guide for researchers interested in this beautiful field.

Granada, May 2014 Pedro J. Torres

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