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A quantification of long transient dynamics

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The stability of equilibria and asymptotic behaviors of trajectories are often the primary focuses of mathematical modeling. However, many interesting phenomena that we would like to model, such as the "honeymoon period" of a disease after the onset of mass vaccination programs, are transient dynamics. Honeymoon periods can last for decades and can be important public health considerations. In many fields of science, especially in ecology, there is growing interest in a systematic study of transient dynamics. In this work we attempt to provide a technical definition of "long transient dynamics" such as the honeymoon period and explain how these behaviors arise in systems of ordinary differential equations. We define a transient center, a point in state space that causes long transient behaviors, and derive some of its properties. We also define reachable transient centers, which are transient centers that can be reached from initializations that do not need to be near the transient center.