A master stability function for cluster synchronization in networks with adaptation

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Networks of neurons display many features that are sometimes hard to incorporate in dynamical models and numerical simulations. One of these is the presence of adaptation or synaptic plasticity, i.e., a mechanism by which the strength of a connection increases or decreases based on the activity of the neurons at its endpoints. Another one is the emergence of cluster synchronization, which is an intermediate state between complete synchronization (state of highest order) and lack of synchronization (state of lowest order.) We consider a general dynamical model that incorporates adaptation and allows for the emergence of cluster synchronization and develop a dimensionality reduction approach to study the stability of the emerging cluster synchronous states. We show how the method can be used as an effective replacement for time and memory intensive numerical simulations.