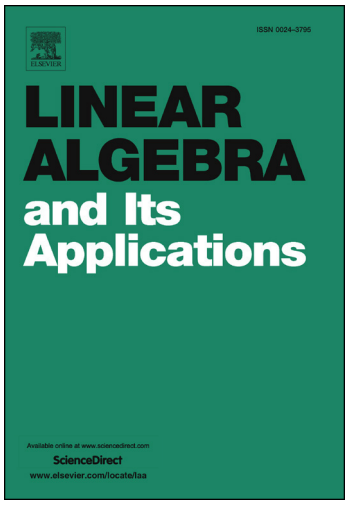

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Fractional pseudospectra and their localizations

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Abstract

Motivated by the growing successful use of fractional differential equations in the modeling of different important phenomena, in this paper we derive tools for practical analysis of the robust asymptotic stability of a (incommensurate) fractional order linear system. First, the concept of fractional pseudospectra is introduced. Second, driven by the simplicity and usefulness of spectral localizations in the analysis of various matrix properties, we introduce adequate localization techniques using the ideas that come from diagonally dominant matrices, in order to localize the fractional pseudospectra. In such way, many theoretical and practical applications of pseudospectra (robust stability, transient behaviour, nonnormal dynamics, etc.) in fractional order differential systems can be linked to the specificity of the matrix entries, allowing one to understand certain phenomena in practice better. Third, we consider the fractional distance to instability in ℓ_∞, ℓ_1 and ℓ_2 norms, and determine efficient lower bounds. Finally, this novel approach is implemented on the realistic model of empirical food web to link the stability (that incorporates hereditary dynamics of living organisms) with the empirical data and their uncertainty limitations.

Keywords: fractional differential equations, pseudospectra, fractional pseudospectra, localization, diagonal dominance, distance to instability, ecosystems modeling, robust stability.
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