Expansivity and Shadowing for Operators on Banach Spaces

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In the early 1970's Eisenberg and Hedlund investigated relationships between expansivity and spectrum of operators on Banach spaces. In our work we give characterizations of various types of expansivity in terms of limit theorems. Using these characterizations, we establish relationships between notions of expansivity and hypercyclicity, supercyclicity and Li-Yorke chaos. For instance, we prove that a uniformly expansive operator cannot be Li-Yorke chaotic (hence it cannot be hypercyclic), but every infinite-dimensional separable Banach space supports a supercyclic uniformly expansive operator. In the case that the Banach space is c_0 or ℓ_p, $1 \leq p < \infty$, we give complete characterizations of various notions of expansivity for weighted shifts. As an application we give an example of an expansive operator which is hypercyclic. We also establish new relationships between notions of expansivity and spectrum. Moreover, we study the notion of shadowing and some of its variations for operators on Banach spaces. Using spectral theory, we expand earlier work of Mazur and Ombach concerning hyperbolicity and the shadowing property of normal operators on Hilbert spaces. Finally, we solve a basic problem in linear dynamics by proving the existence of nonhyperbolic operators with the shadowing property.

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