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Furax: A Unified Framework for CMB Data Analysis with JAX

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We present Furax, a Python library for solving inverse problems in astrophysical and cosmological data analysis, with focus on CMB observations.

Why JAX? JAX provides JIT compilation, automatic differentiation, and seamless GPU/TPU parallelization essential for large-scale matrix operations in CMB analysis. Its functional programming paradigm enables efficient, composable linear operators.

Why Furax? Modern CMB pipelines require high-performance linear algebra and sophisticated optimization algorithms. Furax provides high-level abstractions while maintaining computational efficiency, with seamless integration into existing tools (TOAST, SOTODLib, Pixell).

What Furax provides: A comprehensive suite of linear operators (block-diagonal, Toeplitz, HEALPix projections), robust mapmaking with preconditioning, observation operators (HWP, polarizers), and component separation methods. The modular architecture enables flexible composition of complex analysis pipelines.

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