

# Optical Kernel Machine with Programmable Nonlinearity

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Nonlinear optical kernel machines enable parallel processing of complex, nonlinear data, achieving optimal performance when the kernel nonlinearity is tailored to a specific task. However, in conventional nonlinear optical approaches, adjusting the kernel nonlinearity typically requires varying optical power. To overcome this issue, we present an optical kernel with structural nonlinearity that can be continuously tuned at low power. It is implemented in a linear optical scattering cavity with a reconfigurable micro-mirror array. By tuning the degree of nonlinearity with multiple scattering, we vary the kernel sensitivity and information capacity. We further optimize the kernel nonlinearity to best approximate the parity functions from first order to fifth order for binary inputs. Our scheme offers potential applicability across photonic platforms, providing programmable kernels with high performance and low power consumption.