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A Differentiable Physics Model for Automated Inverse Design in Optics

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Designing complex optical coatings, such as dispersion-managed mirrors for ultrafast lasers, is a high-dimensional inverse problem traditionally relying on iterative, expert-guided methods. We present a machine learning framework that automates this process by employing an autoencoder with a differentiable, physics-based decoder. This decoder, which analytically solves Maxwell's equations via the Transfer Matrix Method, allows the network to learn the design mapping from target specifications alone. The framework successfully generated a multi-objective dispersive mirror design with performance metrics that match those produced by established commercial optimization software, offering a powerful alternative for rapid and automated design exploration.

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