An optical diode made from a `flying' photonic crystal

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Optical diodes controlling the flow of light are of principal significance for optical information processing 1. They transmit light from an input to an output, but not in reverse direction. This breaking of time reversal symmetry is typically achieved via non-linear 2,3 or magnetic effects 4, which imposes limits to all-optical control 5-7, on-chip integration 7-11, or single-photon operation 12. Here, we propose an optical diode which requires neither magnetic fields nor strong input fields. It is based on a flying photonic crystal. Due to the Doppler effect, the crystal has a band gap with frequency depending on the light propagation direction relative to the crystal motion. Counter-intuitively, our setup does not involve the movement of any material parts. Rather, the flying photonic crystal is realized by optically inducing a spatially periodic but moving modulation of the optical properties of a near-resonant medium. The flying crystal not only opens perspectives for optical diodes operating at low light levels or integrated in small solid state devices, but also enables novel photonic devices such as optically tunable mirrors and cavities.

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