New surface waves in gradient-index metasurfaces

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Controlling electromagnetic (EM) waves freely is a dream for researchers. While manipulating propagating waves (PWs) or surface waves (SWs) has separately become possible using transformation optics, a bridge that can link PWs with SWs at will has not yet been found and is highly desired to make the full control over EM waves possible. Here, we demonstrate that a specific gradient-index meta-surface can convert a PW to an SW with theoretically 100% efficiency. Distinct from conventional devices such as prism or grating couplers, here the momentum mismatch between PW and SW is compensated by the reflection-phase gradient of the meta-surface, and perfect PW-SW conversion can happen for any incidence angle larger than a critical value. Experiments, including both far-field and near-field characterizations, are performed to verify this idea in the microwave regime, which are in excellent agreement with full-wave simulations. In addition, we demonstrated that such new SWs bounded on the meta-surfaces, which are driven by incident PWs, can be guided out to flow as surface plasmons on another system supporting eigen surface EM modes. Our findings may pave the road for many applications, including flat lens, high-efficiency surface plasmon couplers, anti-reflection surfaces, light absorbers.

Fig. 1. Driven surface wave on a gradient-index metasurface

References