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Title:All-optical wavelength shifting in a semiconductor laser using resonant nonlinearities
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Abstract:For future ultrafast all-optical networks, new optical devices are required that can directly manipulate communication channels and shift their wavelength over the bandwidth of an optical fibre (50THz)(1,2). Solutions based on nonlinear processes have been proposed, but these suffer from having only low efficiencies as a result of low nonlinear susceptibilities(3). Here, we demonstrate all-optical wavelength conversion of a near-infrared beam using a resonant nonlinear process within a terahertz quantum cascade laser(4). The process is based on injecting a low-power continuous-wave near-infrared beam in resonance with the interband transitions of the quantum cascade laser. This results in an enhanced nonlinearity that allows efficient generation of the difference and sum frequency, shifting the frequency of the near-infrared beam by the frequency of the quantum cascade laser. Efficiencies of 0.13% are demonstrated, which are equivalent to those obtained using free electron lasers. As well as having important implications in its application in ultrafast wavelength shifting, this work also opens up the possibility of efficiently upconverting terahertz radiation to the near-infrared and enables the study of high terahertz-optical field interactions with quantum structures using quantum cascade lasers.
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