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标题: Experimental observation of electron-hole recollisions
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来源出版物: NATURE 卷: 483 期: 7391 页: 580-583 DOI: 10.1038/nature10864 出版年: MAR 29 2012
在 Web of Science 中的被引频次: 1
被引频次合计: 1
引用的参考文献数: 30
摘要: An intense laser field can remove an electron from an atom or molecule and pull the electron into a large-amplitude oscillation in which it repeatedly collides with the charged core it left behind(1-4). Such recollisions result in the emission of very energetic photons by means of high-order-harmonic generation, which has been observed in atomic and molecular gases(5-7) as well as in a bulk crystal(8). An exciton is an atom-like excitation of a solid in which an electron that is excited from the valence band is bound by the Coulomb interaction to the hole it left behind(9,10). It has been predicted that recollisions between electrons and holes in excitons will result in a new phenomenon: high-order-sideband generation(11,12). In this process, excitons are created by a weak near-infrared laser of frequency f(NIR). An intense laser field at a much lower frequency, f(THz), then removes the electron from the exciton and causes it to recollide with the resulting hole. New emission is predicted to occur as sidebands of frequency f(NIR) + 12nf(THz), wheren is an integer that can be much greater than one. Here we report the observation of high-order-sideband generation in semiconductor quantum wells. Sidebands are observed up to eighteenth order (+18f(THz), or n 59). The intensity of the high-order sidebands decays only weakly with increasing sideband order, confirming the non-perturbative nature of the effect. Sidebands are strongest for linearly polarized terahertz radiation and vanish when the terahertz radiation is circularly polarized. Beyond their fundamental scientific significance, our results suggest a new mechanism for the ultrafast modulation of light, which has potential applications in terabit-rate optical communications.
入藏号: WOS:000302006100035
语种: English
文献类型: Article
KeyWords Plus: SIDE-BAND GENERATION; HIGH-HARMONIC-GENERATION; IONIZATION; RADIATION; PHYSICS; GASES; ATOMS; FIELD
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出版商: NATURE PUBLISHING GROUP
出版商地址: MACMILLAN BUILDING, 4 CRINAN ST, LONDON N1 9XW, ENGLAND
Web of Science 分类: Multidisciplinary Sciences

学科类别: Science & Technology - Other Topics
IDS 号: 915EF
ISSN: 0028-0836
29 字符的来源出版物名称缩写: NATURE
ISO 来源出版物缩写: Nature
来源出版物页码计数: 4