"Momentum Gaps and Laser Stability"
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backward-traveling waves interact through a second-order scattering process. If each guided mode interacts only with the radiation mode perpendicular to the direction of propagation (vertical axis in Fig. 1), a momentum gap will appear in its dispersion relation. Brown and Olofsson showed that, if the coupling strength of counterpropagating waves has a prescribed dependence on carrier density, a small perturbation in carrier density will not perturb the output of the laser. This small-signal perturbation plays a primary role in reflection-induced intensity noise, modulation-induced frequency chirp, and noise due to reflections and instabilities. The effect that the removal of the small-signal perturbation has on the properties of such a laser, including the most fundamental aspects of laser coherence and quantum fluctuations, should be a fruitful area of future research.

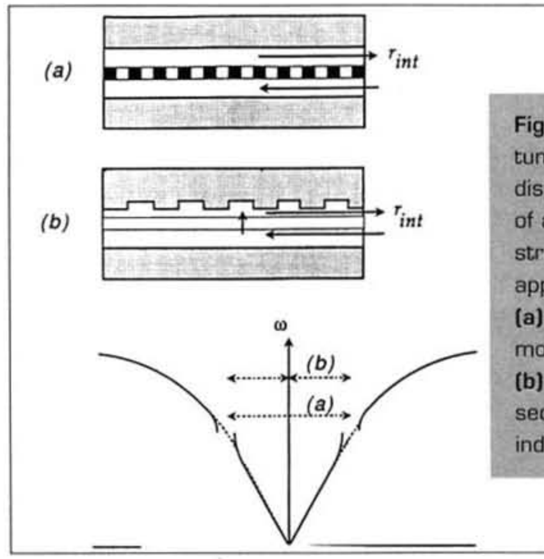

Figure 1. Momentum gaps in the dispersion relation of a periodic structure can appear through **(a)** pure gain modulation or, **(b)** through a second order index modulation.

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PROBES AND SENSORS

Optical Detection of Atoms Near Surfaces

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Since the advent of lasers in the field of atomic or molecular spectroscopy, the investigation of small concentrations of particles a few Angstroms apart from metallic or dielectric surfaces has been a challenge. We have developed a new laser-based method that combines two-photon high-resolution spectroscopy with organized monolayer film growth on planar ($\leq \lambda/1000$) surfaces. Layers of organized fatty acid films are prepared on epitaxially grown metal films on mica, and atoms adsorbed on top of the fatty acid films are examined spectroscopically in an ultrahigh vacuum (UHV), $p_0 \leq 10^{-10}$ mbar, environment.

Working in the UHV avoids contamination of the substrates with unwanted admolecules. The fatty acid mono- or multilayers contain hydrophilic headgroups (chemically bound to the surface), hydrocarbon chains of variable length between 12 and 30 Å, and hydrophobic endgroups (which form an inert surface a few Angstroms distant from the metal surface). Sodium atoms are deposited on top of those layers and are excited from the 3S state via the 3P to the 5S state in a Doppler-free arrangement using two counterpropagating single-mode ring-dye lasers. The resulting 4P→3S UV photons are observed with a photomultiplier background-free as a measure of atomic density and spectral response.

This two-photon method has been used to investigate diffusion and energy transfer of optically excited atoms to metallic surfaces on top of single[1] or multiple[2] spacer layers via a change of electronic lifetime or transition frequency. The method has been applied also to the spectroscopic investigation of atoms bound to dielectric surfaces. Here, cluster formation and laser-induced desorption of atoms from the surfaces can be investigated. Moreover, the influence of the laser radiation itself on the supporting surface (*e.g.*, heating, melting, and the corresponding phase transitions) can be observed in unprecedented detail directly on the surface by using the atoms as probe particles. Thus, besides its importance in fundamental research we anticipate applications of this laser-based technique in direct "on-the surface" investigations of laser material processing as well as in gaining new insights into thermal and optical properties of insulators, semiconductors and metals.

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