The resonance transition of an atom can be induced without electromagnetic radiation: An atom moving in a periodic static field experiences a periodic perturbation and can make a resonance transition. We consider this resonance phenomenon can be used as a useful technique for atomic spectroscopy and control. We have already demonstrated sharp resonance lines [1] and coherent control [2] for atomic spins of Rb atoms in periodic magnetic fields (magnetic lattices) with a relatively large period (~1 mm).

To make a field period smaller, down to a micrometer scale or below, one has to avoid collisions of atoms with a solid surface producing a periodic field, otherwise atoms would suffer decoherence due to the collisions during their interaction with a periodic field. One possible solution would be the oblique incidence of an atomic beam into a transmission grating. Some fraction of atoms will pass through the grating without collisions, while experiencing a periodic perturbation. We produced this type of grating by vapor-depositing magnetic material (Ni or CoCoO) on a polyimide film with slits. Each slit is 150 µm in width, separated by 150 µm. We observed magnetic resonance spectra for a spin-polarized Rb atomic beam passing through the magnetic grating. As predicted by the calculation shown in the figure, the resonance spectra strongly depended on the direction of magnetization of the magnetic film.


Fourier components of a transverse magnetic field an atom with a velocity of \( v \) experiences during passing through a magnetic lattice with a period of \( a \); the incident angle is 80 degree (glancing incidence).