

CM/AMO Seminar

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**“On the influence of resonance photon scattering on
atom interference”**

Time: Tuesday, March 3, 4PM

Location: 335 West Hall

Abstract: Modern quantum interferometry uses the solutions of time-dependent Schrodinger's equation for particles interacting with gratings of various types. These characteristics make modern theories of quantum interference essentially different from earlier theories. We write this solution in the form in which probability amplitude of particles transverse momenta is very essential. This form encompasses near and far field and describes all features of particle diffraction and interference in a unified way. It is particularly useful in explaining the experiment of Chapman *et al.* [*Phys. Rev. Lett.* **75**, 2783 (1995)] in which single photons were scattered off atoms which passed through the first grating of a three-grating Mach-Zehnder interferometer. By measuring the transmission of atoms through the third grating, the influence of the photon scattering processes on the atom interference was investigated. Authors found revivals of contrast for $d_p / \lambda_i > 0.5$, where d_p is the distance between atomic paths at the scattering locus and λ_i the scattered photon wavelength. This result induced a controversial discussion about the question: Is the complementarity more fundamental than the uncertainty principle? In our explanation, wave and particle properties are compatible, since both are present and play a role. An analytic expression for the dependence of the contrast on the ratio d_p / λ_i was derived for all values of this ratio. This theoretical result is in fairly good agreement with the measured contrast. The distribution of transferred momenta during photon scattering causes the initial decrease of the contrast and several subsequent revivals with decreasing maxima. There is no loss of coherence of the single atom wave function. Our approach essentially differs from the approaches based on the principle of complementarity. These approaches predict the loss of contrast at $d_p / \lambda_i \cong 0.5$ and face the problem to explain the existence of revivals.