Atoms and Clusters
WS 10/11

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Problem Set 5

(5.1) Some numbers. Complete the following table, in which the excursion amplitude $\hat{x} = e\hat{E}/m\omega^2$ and the velocity amplitude $\hat{v} = e\hat{E}/m\omega$ refer to the oscillation of a free electron in the electric field of amplitude $\hat{E}$.

	field strength $\hat{E}$ [V/m]	intensity I [W/cm^2]	excursion $\hat{x}$ [Å]	pond. potential [eV]	$\hat{v}/c$
248 nm-laser (KrF)				5700	
800 nm-laser (Ti:Sa)		$3.51 \cdot 10^{16}$			
1060 nm-laser (Nd)	$3 \cdot 10^{12}$				
sun light (at 550 nm)		0.1			

(5.2) Mirror in two waves. A planar mirror of area S and finite thickness has the mass M and perfectly reflecting surfaces. Two plane electromagnetic waves of intensities I_1 and I_2 are impinging at normal incidence on the two surfaces.

(i) Find the total force on the mirror and the direction of its acceleration if $I_1 > I_2$.

(ii) Now let $I_1 = I_2 = I$ and assume that the mirror is moving with velocity V perpendicular to its surfaces. Find the force on the mirror in the system where it is at rest.

(iii) Discuss the motion of the mirror that results from the force found in (ii) for $V \ll c$.

(5.3) Thomson scattering. Show that the classical total cross section for Thomson scattering at free electrons is the same as the one obtained from the quantum calculation performed in the lecture.
Hint: Use the expression for the total power radiated by an accelerated electron (Larmor formula),

$$P = \frac{e^2 a^2}{6\pi\varepsilon_0 c^3}, \qquad \text{[SI units]}$$

where a is the acceleration, and consider a free electron in an electric field $\boldsymbol{E}(t) = \hat{\boldsymbol{E}} \cos \omega t$.