

Interference Measurements

Jungu Choi

Phys 522

Two level excitation

- E1, M1, E2, ...
- Parity-non-conserving (PNC) transition
- Other electric dipole forbidden transition

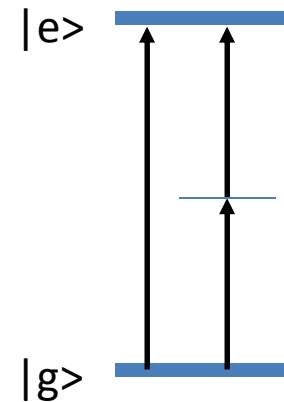
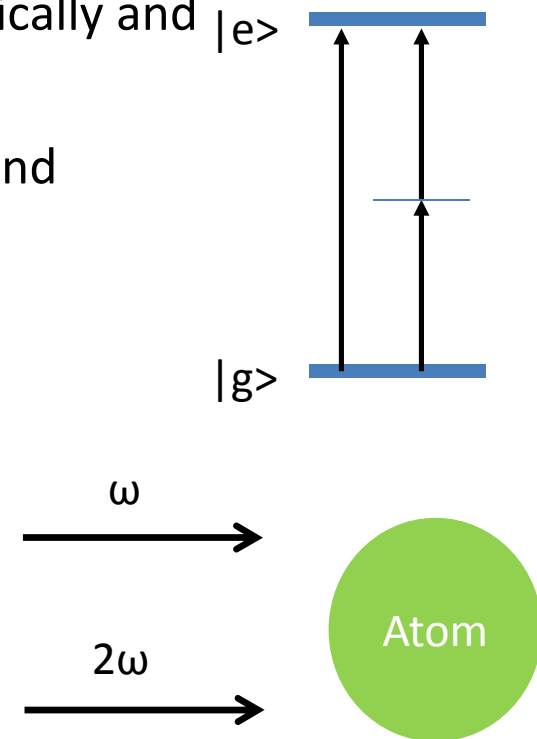


Table 4.1 Classification of radiative transitions. The figures quoted for the Einstein coefficients and radiative lifetimes should be considered only as order of magnitude values for transitions at frequencies around the visible spectral region.

Transition	Notation	Einstein A coefficient	Radiative lifetime	Parity change
Electric dipole	E1	$10^7\text{--}10^9\text{ s}^{-1}$	1–100 ns	yes
Magnetic dipole	M1	$10^3\text{--}10^5\text{ s}^{-1}$	0.01–1 ms	no
Electric quadrupole	E2	$10^3\text{--}10^5\text{ s}^{-1}$	0.01–1 ms	no
Magnetic quadrupole	M2	$0.1\text{--}10\text{ s}^{-1}$	0.1–10 s	yes
Electric octupole	E3	$0.1\text{--}10\text{ s}^{-1}$	0.1–10 s	yes
	\vdots			

Coherent Control

- Single/multi photon transition causes E1, M1, E2, and higher order transitions
- E1 processes can be accurately calculated theoretically and measured experimentally.
- E1-forbidden transitions are difficult to measure and calculate due to small amplitude.
- Coherent control and interference allows for measurement of ratio of these.

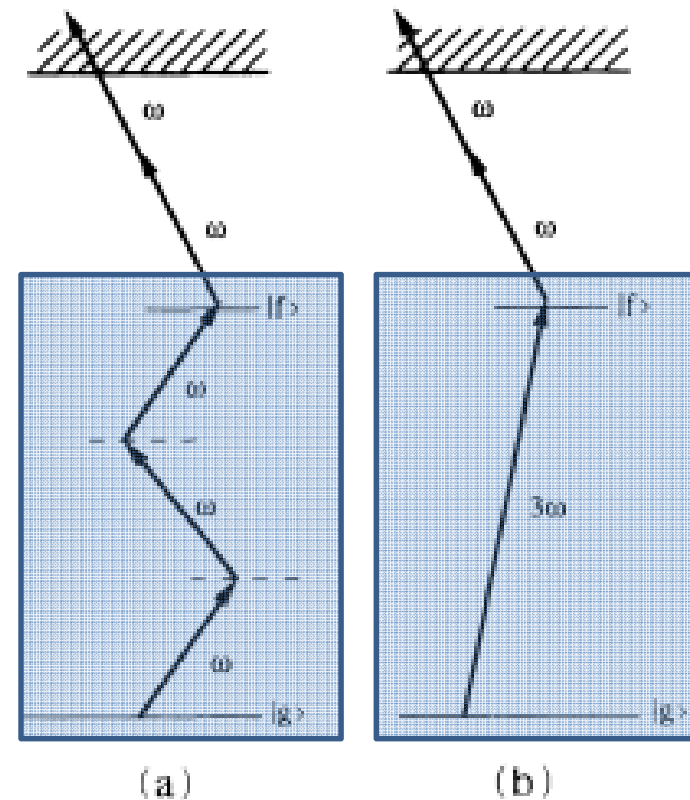
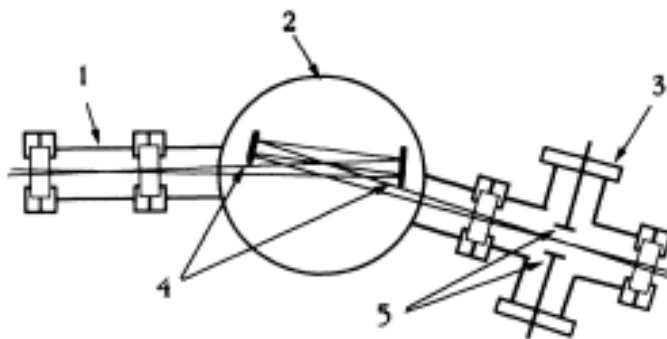


Selection Rules

- Selection rules apply to E1, M1, E2, ..., and others separately.
- Fine sublevels (F)
- Zeeman magnetic sublevels (m)

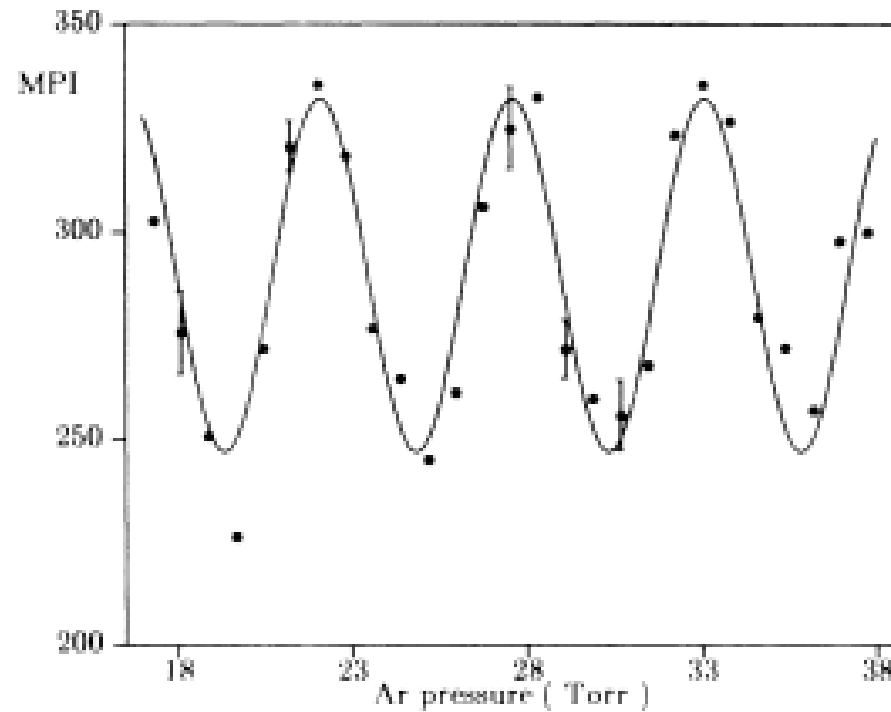
Mercury

- $g \rangle \rightarrow f \rangle : 6s^1S_0 \rightarrow 6p^1P_1$
- Two photon Ionization
- Path-way 1: Driven by 3 photons at 554 nm
- Path-way 2: Driven by a single-photon at 185 nm
- Interference between Path-way 1 and 2 by control of the relative phase.



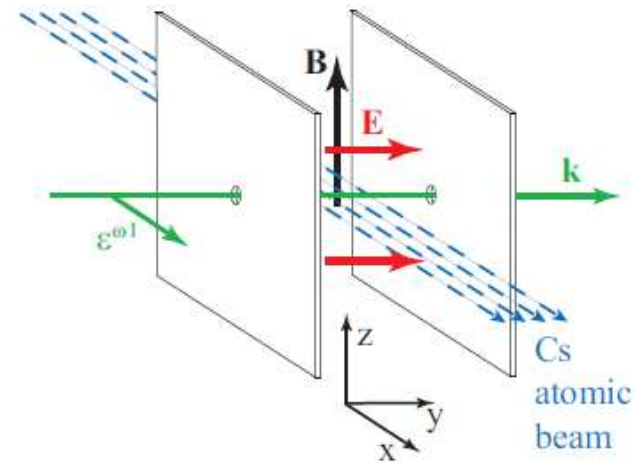
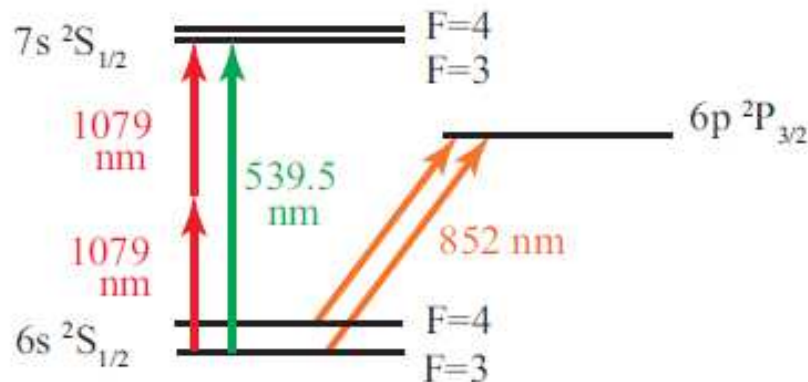
Results: sinusoidal relations

- Signal variation as a function of the relative phase between the two lasers



Cesium 133

- $6s^2S_{1/2} \rightarrow 7s^2S_{1/2}$ (E1 forbidden transition)
- Two-photon allowed transition (E1 allowed and strong)
- Stark induced (proportional to applied DC field) transition (E1-forbidden and weak)
- M1 transition (weak)
- Observed interference between M1 and Stark induced transitions by varying DC electric field.



Results

- Almost linear relations for the normalized amplitude versus applied voltage.
- The slope from the plot is proportional to the ratio of two transition amplitudes.

