Quantum Physics

Atomic multipole relaxation rates near surfaces

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The spontaneous relaxation rates for an atom in free space and close to an absorbing surface are calculated to various orders of the electromagnetic multipole expansion. The spontaneous decay rates for dipole, quadrupole and octupole transitions are calculated in terms of their respective primitive electric multipole moments and the magnetic relaxation rate is calculated for the dipole and quadrupole transitions in terms of their respective primitive magnetic multipole moments. The theory of electromagnetic field quantization in magnetoelectric materials is used to derive general expressions for the decay rates in terms of the dyadic Green function. We focus on the decay rates in free space and near an infinite half space. For the decay of atoms near to an absorbing dielectric surface we find a hierarchy of scaling laws depending on the atom-surface distance z.

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