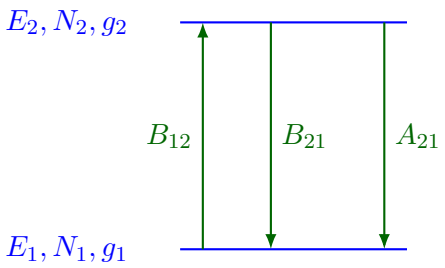
Prof. Stephan Fritzsche
TPI and HI Jena
— Theoretical Atomic Physics —

1. Dezember 2015
Winter Term

Homework (3)

Task 1: Two-Level System

In this task, we want to analyze the two-level system presented in the lecture.



Here, we assume that both levels are not degenerate, such that we have $g_1 = g_2 = 1$.

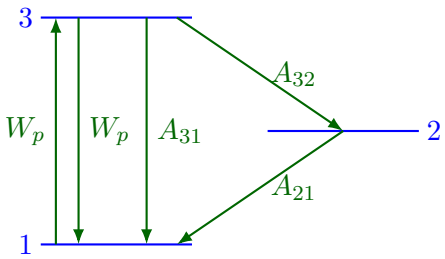
a) Show that the population of the excited level can be at most half of the total number of atoms

$$N_2 = \frac{N}{2} = \frac{N_1 + N_2}{2}$$

b) Analyze the two limiting cases where pumping is very strong ($\rho \gg 1$) and very weak ($\rho \ll 1$) and explain how the population of the excited level depends on the pumping intensity.

Task 2: Three-Level Laser

a) In this problem, we want to analyze a three-level laser system.



The laser transition should be $2 \to 1$, while the pumping transition is $1 \to 3$. Find the condition on the atomic transition rates required to achieve a population inversion. Then, find the minimum threshold for the pumping rate required to create an inversion.

Task 3: Lifetime of the Hydrogen 2P State

a) Calculate the lifetime of the $|210\rangle$ state of hydrogen.

b) Repeat for the $|21 \pm 1\rangle$ state.

c) Calculate the natural width $\Delta E/E$ of this transition.