QUANTUM OPTICS
Sommersemester 2008

Blatt 10
Abgabe am 8. Juli 2008

1. The micromaser field in steady-state

With the help of formula (470) ($\bar{p}_0$ is just determined by normalization) and (471) of the script, calculate and plot the normalized variance

$$\sigma \equiv \frac{(\langle n^2\rangle - \langle n\rangle^2)}{\langle n\rangle^{1/2}}$$

as a function of the pump parameter $\Theta = \frac{1}{2}\sqrt{N_e}g\tau$ for $N_e = 200$ and thermal photons at 10mK, 100mK and 1K. To simplify the calculations, you can assume resonance $\omega = \omega_0$. What is noticeable?

2. Observation of sub-poissionian photon statistics in the Cavity-QED microlaser

Read *Choi et al.*, PRL **96**, 093603 (2006) and answer the following questions:

1. What is the advantage of an one-atom-laser ($\nu = 5 \cdot 10^{14}$ Hz) compared to an one-atom-maser ($\nu = 50$ GHz)?
2. Why does an one-atom-maser has to be cooled?
   And down to which temperature? (Hint: how big should $\bar{n}_{th}$ be?)
3. How is the interaction time between atom and cavity adjusted?
   How can the cavity be tuned?
4. What is the evidence for lasing?
5. Why does the gain function of the microlaser differ from the gain function of an usual laser (Fig. 2a)?
6. Why does the photon statistic of the microlaser change from sub-poissionian to super-poissionian?

(Note: you can find the paper at the quantum optics course-homepage, additional material to chapter 9)