UNIVERSITY OF KONSTANZ
Department of Physics
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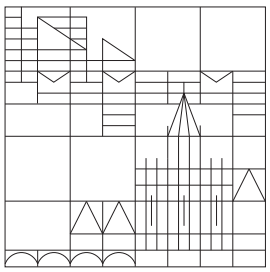

http://tinyurl.com/qo2019

Quantum Optics
Winter semester 2018/2019 - Exercise sheet 6
Distributed: 03.12.2018, Discussion: 10.12.2018

Problem 1: Thermal states of light.

Starting from the expectation value of the photon number operator for thermal states, $\langle n(\omega)\rangle$, derive the expression for the energy density $\rho(\omega)$ in empty space.

Problem 2: Wigner function.

Considering a squeezed state with a real squeezing factor, calculate the corresponding Wigner function.

Problem 3: Higher-order squeezing.

Considering the Hermitian operators corresponding to the real and imaginary parts of the (single-mode) squared field amplitude, $X_1 = (\hat{a}^2 + \hat{a}^{\dagger 2})/2$ and $X_2 = (\hat{a}^2 - \hat{a}^{\dagger 2})/2i$, show that the squeezing condition is given by:

$$\langle \Delta X_i^2 \rangle < \langle \hat{a}^\dagger \hat{a} \rangle + \frac{1}{2}.$$