Exercises

1. We have seen that two photon number states with different number of photons are orthogonal, i.e. $\langle m|n\rangle=0$ for $m\neq n$. Given two coherent states $|\alpha\rangle$ and $|\beta\rangle$ with $\alpha\neq\beta$, are they orthogonal?

2. A coherent light beam of wavelength 633nm and power 0.1 pW is emitted by a He-Ne laser. a) Calculate the average photon flux coming out of the laser and the standard deviation of the number of photons emitted in 1s. b) You now count the number of photons with an avalanche photodiode having 40% quantum efficiency. You can count photons only for 100ms; What is the statistical error on the beam intensity?

3. A pulsed diode laser operating at 800nm emits 10^8 pulses/s. The average power measured on a slow response power meter is 2mW.
   (a) On the assumption that the laser light has Poissonian photon statistics, calculate the mean photon number and its standard deviation per pulse.
   (b) Now the laser beam is attenuated by a factor 10^9. Calculate the mean photon number per pulse, the fraction of the pulses containing one photon and the fraction containing more than one photon.