Christoph Marquardt, Gerd Leuchs & Klaus Mantel

Experimental physics 3 for physicists

FAU Erlangen–Nuremberg, winter term 2018/19

https://www.mpl.mpg.de/divisions/leuchs-division/teaching/

Problem sheet 11

24/25.01.2019

Problem 1: Resonator

A stationary Gaussian resonator mode is characterized by the fact that radius of curvature of the phase fronts of the beam at the mirror position is in accordance with, i.e., equal to, the radius of curvature of the respective mirror. Calculate the waist position and waist width of the adjusted mode at wavelength of $\lambda = 632\,\text{nm}$., given the mirror radii of $R_1 = 20\,\text{cm}$ and $R_2 = \infty$, and mirror distance of $d = 10\,\text{cm}$.

Problem 2: Gaussian beams

In the proposed eLISA-interferometer (evolved Laser Interferometer Space Antenna), there are three satellites in such arrangement that they form a equilateral triangle with side length of 1 million kilometers, moving along the orbit of the earth circling around the sun. (See the sketch below)

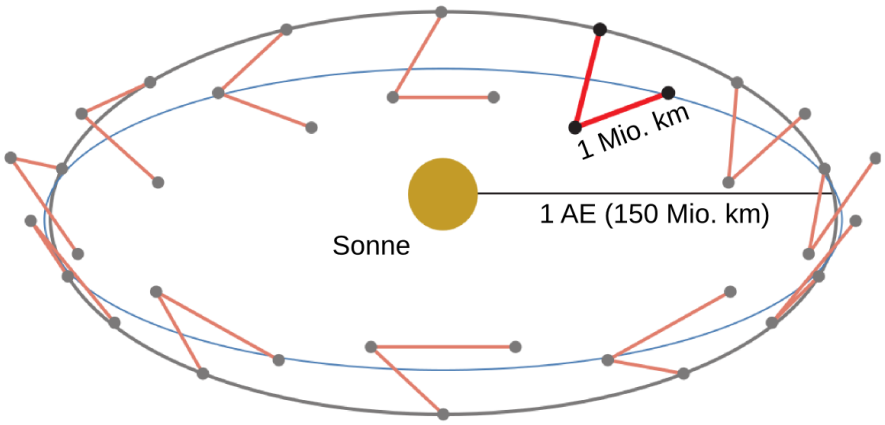

Abb.: Danzmann *et al.*, "The Gravitational Universe" (2012), http://elisascience.org/whitepaper

The satellites would keep their arrangement when free-falling around the sun, forming the largest construction ever made by man. Low-frequency gravitational waves (<1 Hz) can be measured based on the tiny phase shifts of the laser beams between the satellites, which is not measurable on earth because of experimental noise. The laser beams emitted between the satellites have Gaussian profile and a power of $2\,\text{W}$ at a wavelength of $\lambda = 1064\,\text{nm}$. The diameter of the sending telescope is $20\,\text{cm}$. Estimate the power received by a telescope of same size at the other satellite.