

Popular Description

“A laser is a solution seeking a problem” stated one of the inventors of the laser to the New York Times [1]. Since then, lasers have gone on to be omnipresent in large areas of science, technology and more recently medicine but also in our every day life, whether in form of DVD- and CD-players, barcode scanners or communication. In recent years there has been an increased interest for stabilized lasers – lasers emitting light with a particularly narrow spectrum, i.e. one precise colour, also known as wavelength of the light. While techniques are available to sufficiently narrow the spectrum of a laser for most applications in a lab environment, a lot of work needs to be done to have a cost-efficient, robust and portable device that will work reliably in more demanding environments. Such a device would open up the implementation of new quantum-based technologies in medicine, which is the main concern for this work, as well as other areas of our daily life.

One potential method in stabilizing the laser wavelength uses light guides, so-called optical fibers, to delay a part of the laser output, so that the current output can be compared to what it was previously. To achieve this, the output is split to travel through one long optical fiber and one much shorter optical fiber before it is recombined again. If there is a difference in wavelengths, an error signal is generated and a feedback loop signals the laser how to correct its output.

However, the generated error signal depends not only on the wavelength and its change but also on the delay time. The delay time is dictated by the difference in length between the short path and the long path that the light can take. Unfortunately, optical fibers are very sensitive to temperature changes. A temperature change will lead to the system generating an error signal when in fact the wavelength might have stayed the same. This leads to the wavelength wandering off with time. Thermal insulation is not enough to solve this problem as a stability of less than 0.0001°C would be required.

This thesis presents a new approach to solve this problem. Since it is the difference in fiber length, and not the absolute lengths, which generates a false error signal, this problem may be solved by methods that keep the difference constant. One way to achieve this is by choosing fibers that have a thermal sensitivity ratio corresponding to their length ratio e.g. the short arm might be half as long but double as sensitive to temperature. In conclusion, the difference in path of both optical fibers stays the same. This work explores this option using fibers with different coatings to achieve different thermal sensitivities with particular regard to metal-coated fibers due to their advantageous properties. The design presented is temperature insensitive and may thus make stabilized lasers more accessible for their future applications in medicine and elsewhere.

[1] Developer of the Laser calls it a ‘a solution seeking a problem’; President of Konrad Spends Spare Time Gardening and Fixing TV Sets (1964, May 6th), *New York Times*, pp. 69.

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