Nitrogenlaser

Project-oriented Physics Lab for Undergraduate Students

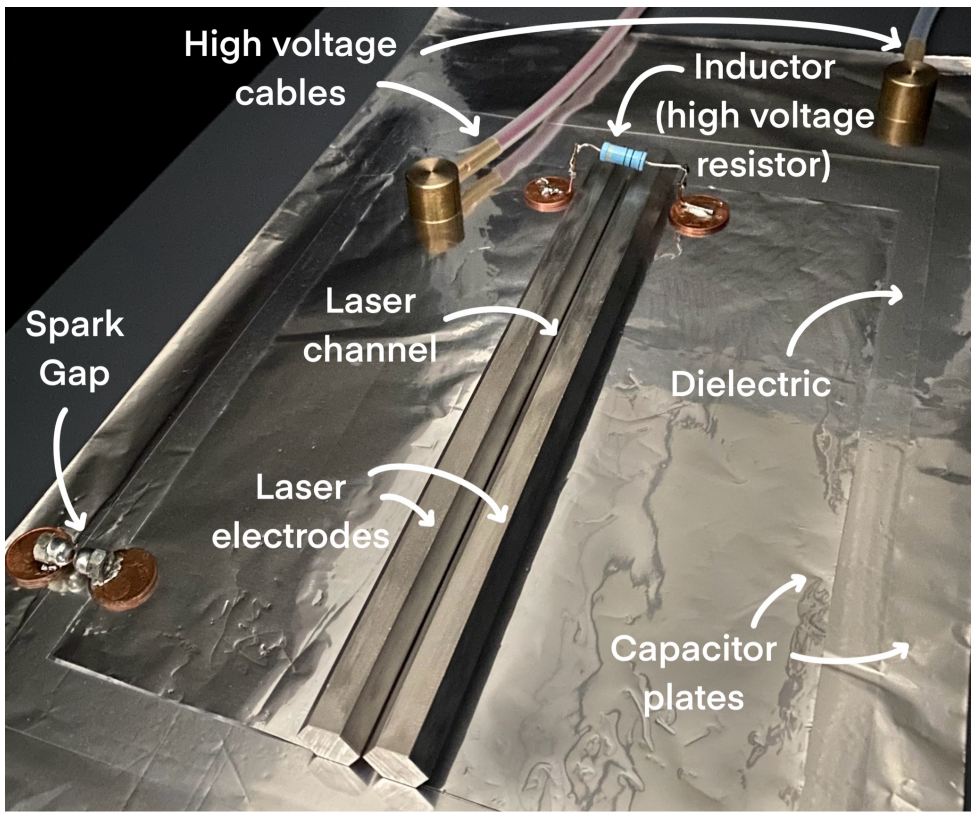
Physics Lab ETH zürich

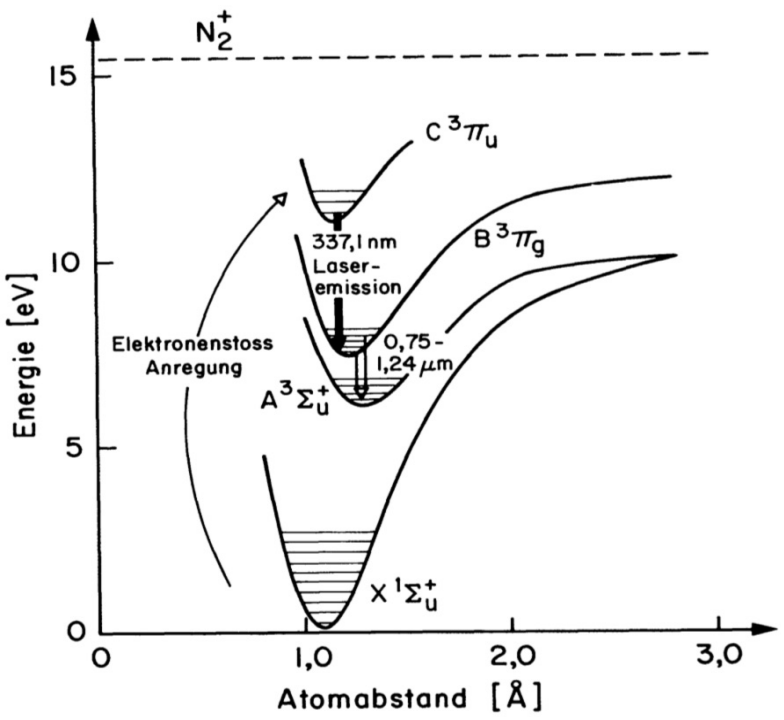
Goals

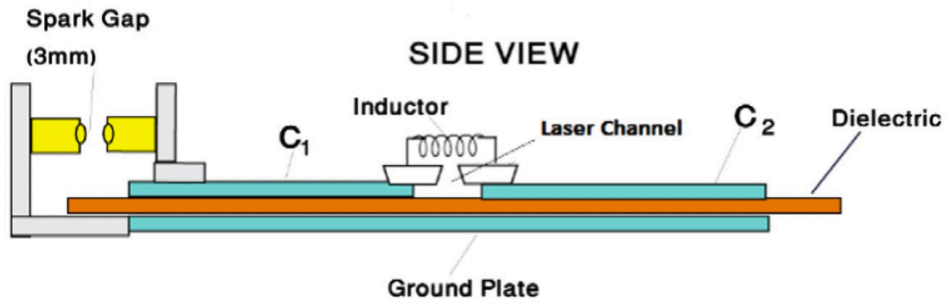
- Construction of a nitrogen laser that emits a pulsed laser beam
- Measuring the wavelength and analysing the relationship between pulse frequency, voltage and spark gap distance

Setup

- High-voltage source charges the aluminium foil capacitor
- One upper plate discharges instantly via the spark gap
- The second plate discharges through many sparks along the entire laser channel
- The sparks accelerate free electrons in the air
- High-energy electrons collide with nitrogen molecules and put them in an excited state
- Spontaneous emission generates photons with a wavelength of 337.1 nm
- Stimulated emission amplifies the light activity and generates a laser beam







Additional information

- the setup only emits pulsed laser light, because the lower laser level is meta-stable: the population inversion cannot be maintained permanently
- the literature mostly refers to this as a nitrogen superemitter because there is no optical cavity with resonator mirrors
- light with a wavelength of 337.1 nm is not visible to the human eye, which is why we used a fluorescent screen to make the beam visible

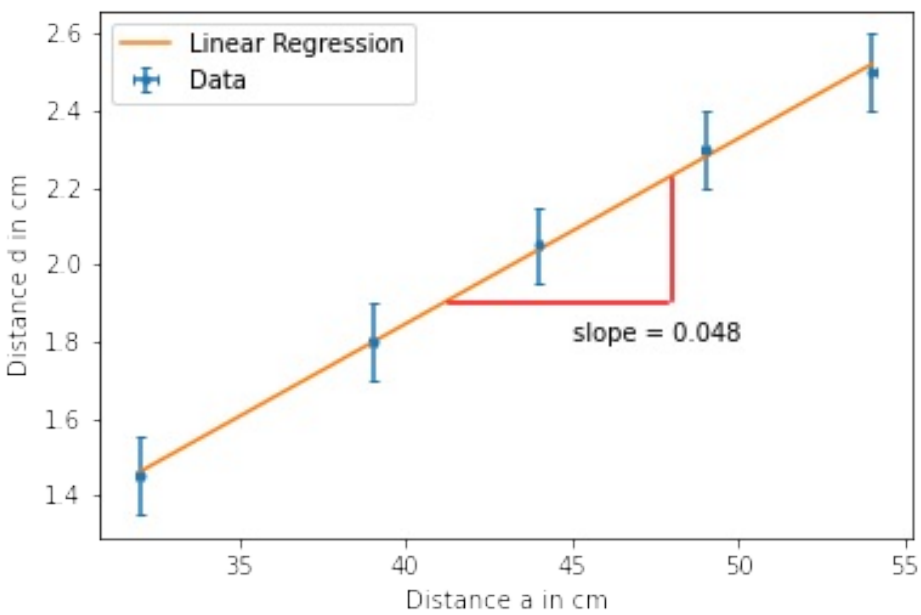
Data Analysis and Results

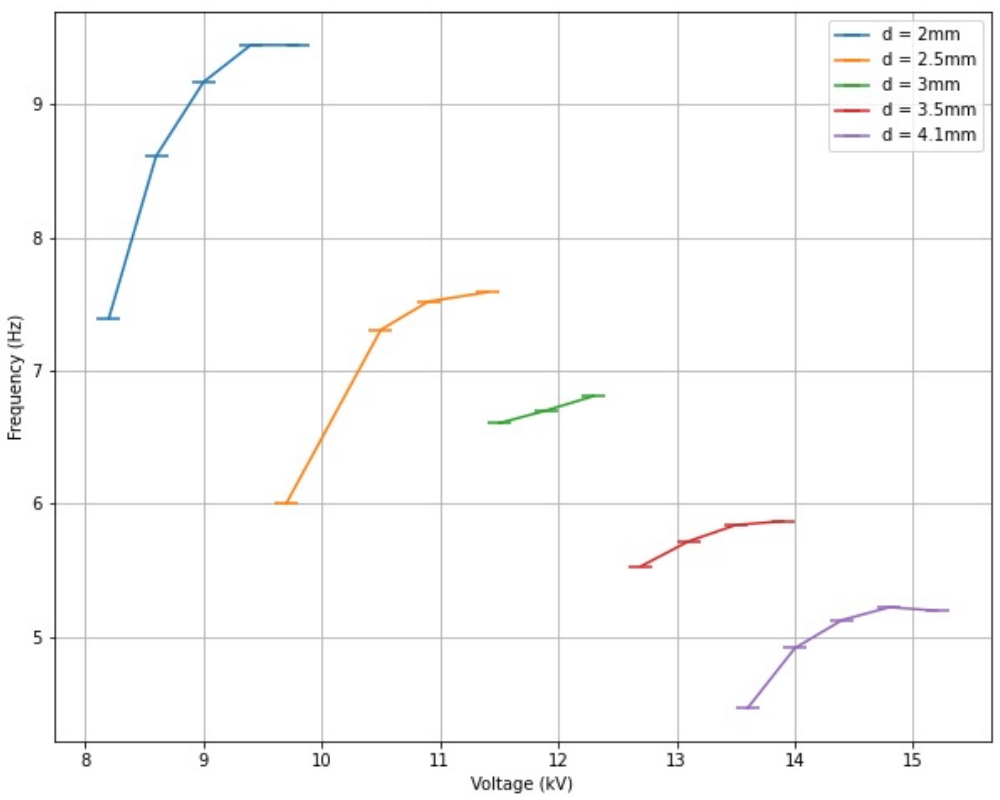
1. Wavelength

We received the following data points after measuring a (the distance between laser and screen) and reading d (the distance between the 0th and 1st maxima on the screen) with a slope of 0.048 ± 0.001 which we to calculate a wavelength of 342.7nm ± 7.2nm of the laser.

2. Relation Spark Frequency, Spark Gap Distance and Voltage

We recorded the sparks of different spark gap distances at different voltages and extracted its frequencies.
One can see that at a constant spark gap distance the frequency increases for rising voltages and has an upper bound. Furthermore, the larger the spark gap, the greater the voltage must be for regular sparks and the frequency decreases for increasing distances.





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