

# 3rd Year Assessed Practical - BP02

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Initially checked safety of experiment, we are working with a class 3 LASER attenuated to class 1 by its container.

## 1 Beads

Began with a 1:800 solution of polystyrene beads. These were held by an optical trap. Loose position of the beads is measured by a quadrant photodiode on the far end of the beam. This cannot accurately detect position directly but variations will produce an oscillating signal, with equal frequencies to the movement of the trapped object.

When viewing the focal point of the LASER it is very clear, there is significant scattering and the entire beam is focused on the CCD, causing visible lens effects such as concentric circles around the focal point. If these were not concentric circles it would imply an asymmetry in the system, that the LASER is not co-linear with the camera's optical axis.

Once the beads were trapped, short videos were taken to demonstrate that they no longer moved with the stage. Difficulty here was due to the large drag force on the bead when moving the stage (and so the fluid), this is due to how viscosity scales.

We then measured the frequency of response to driving force and fitted it to our model, the Lorentzian curve. A characteristic frequency of this, the "corner frequency"  $f_c = \frac{\kappa}{2\pi\gamma}$ , was measured against LASER power. This gave us the trap stiffness as we can find viscous drag coefficient  $\gamma = 6\pi\rho a$ . Measurements of stiffness are consistent for large powers as at low powers the amplitude of vibration is large, making the trap non-linear.

## 2 *Vibrio alginolyticus* bacteria

We next tried to measure the properties of single cell molecular motors. The laser holds the cell while the photodiode measures the frequencies in the downstream beam. A large peak can be seen at the flagellum and body frequencies.

## 3 *E. Coli*

The experiment was repeated for *E. Coli* bacteria but to reduce the frequencies and increase scattering cross-sections beads were stuck to the flagella chemically. A measurement of slowdown rate was not taken. The low resolution of the data limited our ability to take measurements of the body frequencies of either species.