Blackbody Radiation Lab

Brandon Lim
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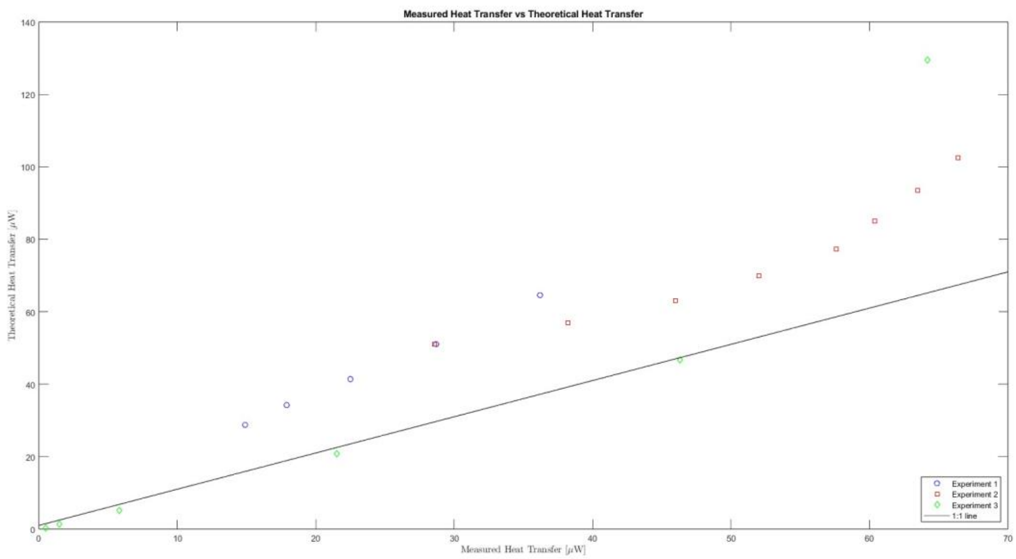

Figure 1a. Measured heat transfer in micro-watts on the x-axis versus theoretically calculated heat transfer in micro-watts on the y-axis. The blue markers represent experiment one, the red markers represent experiment 2, and the green markers represent experiment 3. The solid black line represents a one to one line to show where data points should be if theory and experimental values agree.

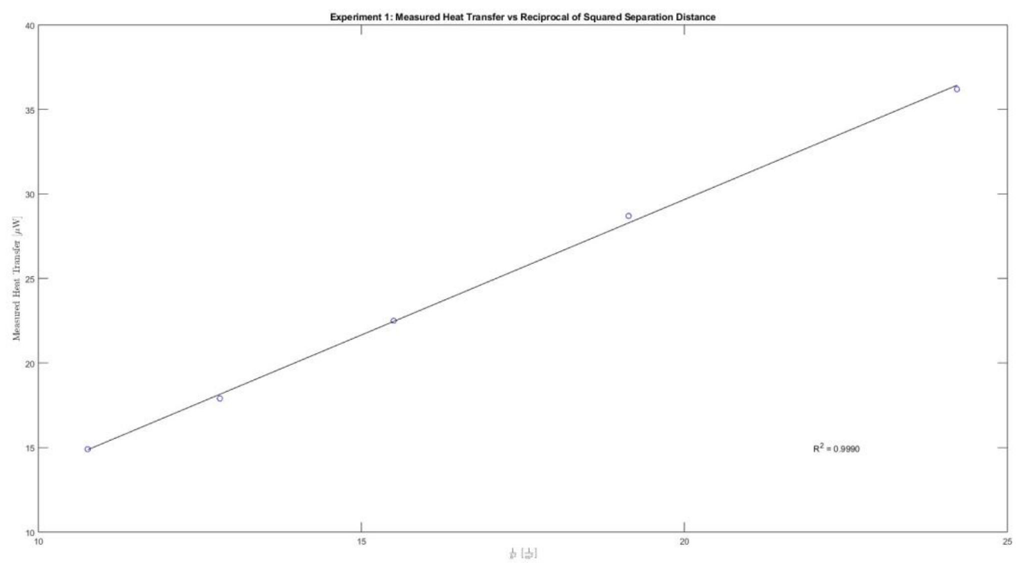

Figure 1b. Measured heat transfer in micro-watts on the y-axis versus reciprocal of squared distance from the source in inverse meters squared on the x-axis. The blue markers represent experiment one values and the black line represents a linear regression. The residuals squared is shown on the plot as well.

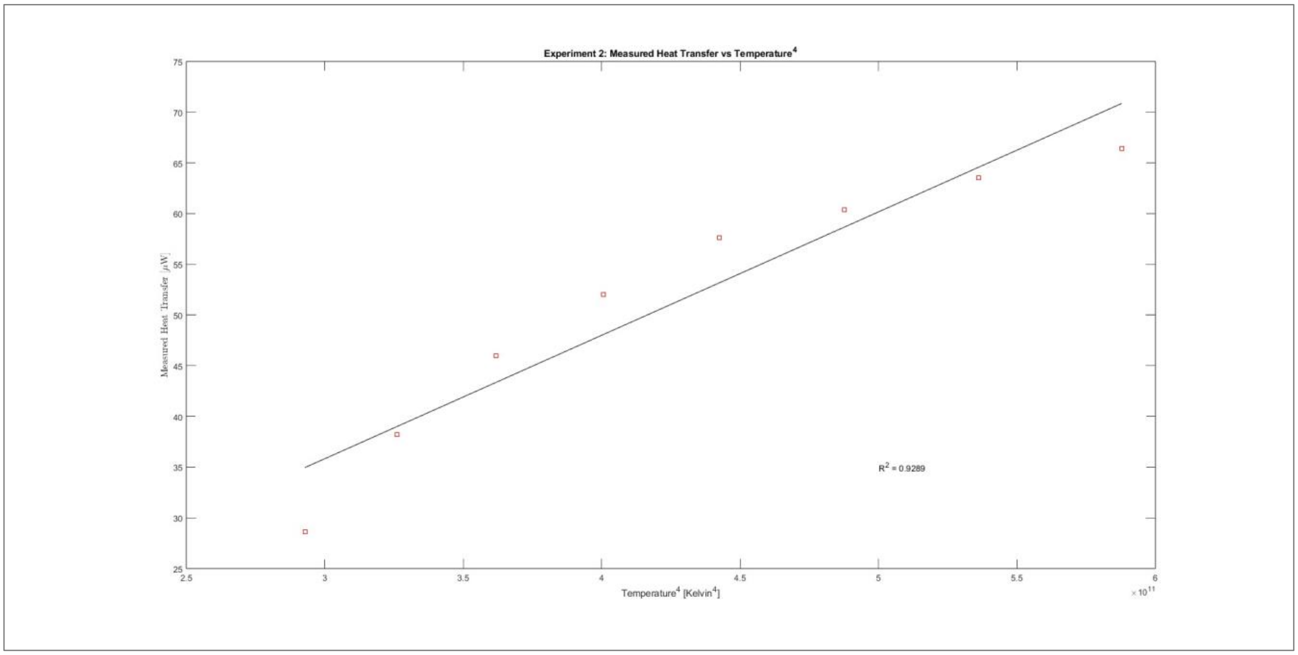

Figure 1c. Measured heat transfer in micro-watts on the y-axis versus blackbody temperature reported in Kelvin to the fourth power on the x-axis. The red markers represent experiment 2 data and the black line represents a linear fit line. The residual squared value is also shown.

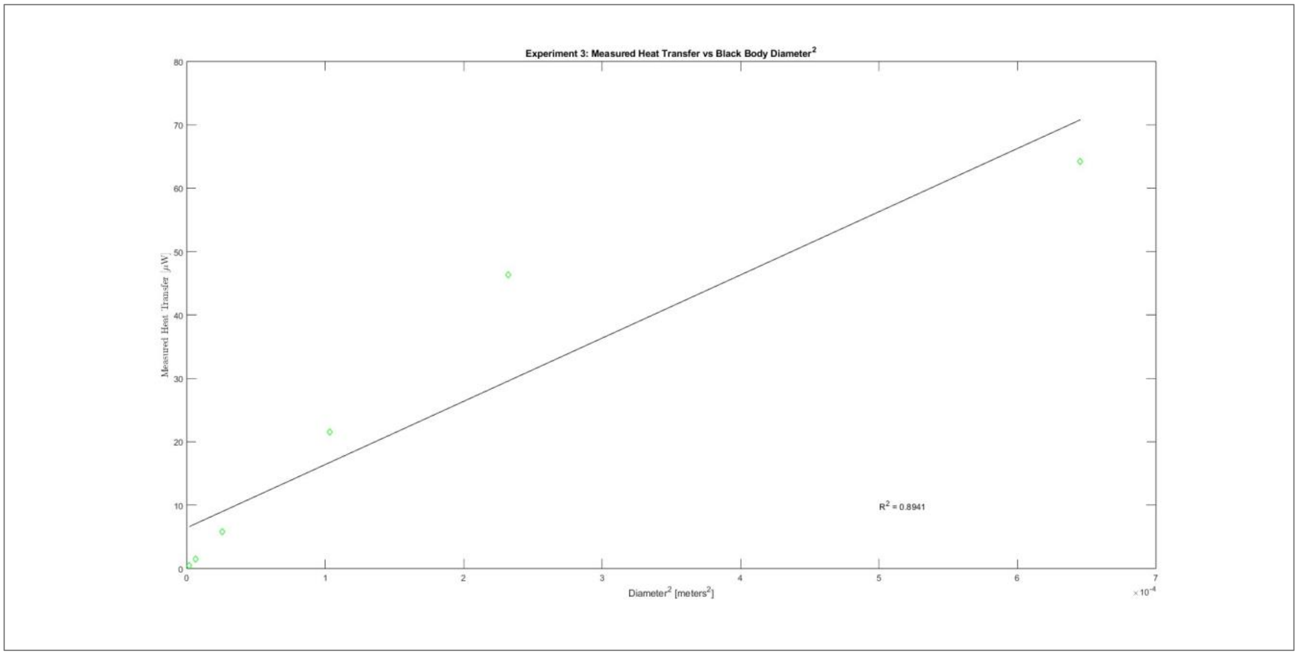

Figure 1d. Measured heat transfer in micro-watts on the y-axis versus black body emission diameter squared in meters squared on the x-axis. The green markers represent experiment 3 data and the black line represents a linear regression. The residual squared value is also shown.

Short-Answer Questions

2a. Quantify the agreement in q between the measurements and theory based on your results in plot 1a. State your answer in terms of an average percent relative difference, $\bar{\epsilon}$, according to the following relationship

$$\bar{\epsilon} = \frac{1}{N}\sum_{i=1}^{N} \frac{|q_{i_{\text{data}}} - q_{i_{\text{theory}}}|}{q_{i_{\text{theory}}}} \cdot 100\% \, ,$$

where N is the total number of data points acquired (over all four experiments). Comment on whether the discrepancy between the measurements and theory seem to be random across the entire q range investigated, or whether there are particular q ranges where the agreement appears better/worse. [2–4 sentences]

2a. The average percent relative difference for the agreement of measured and theoretical heat transfer across all experiments was 33.31%. These agreements seem to be better where the range was investigated as the diviation from the 1:1 line that matches theory with measurement grows at the end of the range.

2b. Given your results in plots in 1a–1d, including your calculated R^2 values for the curve fits, and using your engineering judgment, assess whether the theory adequately supports the measurements, in terms of the expected dependence of q on T, h, and D. Be specific in your explanation of why or why not. [2–3 sentences]

2b. Theory was an adequate assessment of where the heat transfer range would be but it was not completely accurate measurement. This can be seen in plot 1a where the 1:1 line is in close proximity to the data points but not exactly touching them.Theory also was also better at calculating different scenarios and experiments as we saw the residual square value get further away from one going down the experiments.

2c. Assume now that the blackbody cavity in the experiment is replaced with a diffuse "gray body", whose surface temperature can be adjusted uniformly with a heater and thermostat, in a manner similar to what was done in the actual experiment. Describe how you would modify the experimental procedures and/or data analysis in order to determine the unknown emissivity ε of the "gray body". [2–4 sentences]

2c. To find the unknown emissivity of the gray body, the data analysis portion of the experiment can be altered to solve for the unknown emissivity rather than theoretical parameters. This can be down by emitting a known heat transfer from the grey body and measuring it certain distances and criteria just like in this experiment. We then will have all the heat transfer values as seen in equation 14 of the handout with an addition epsilon term on the numerator (emmisivity) that we can solve for.