Mass-Dependent Optical Behavior in a DIY Slit Experiment

Abstract

This experiment tests whether changing only the material forming a narrow slit—while keeping geometry, alignment, and distance fixed—can alter the optical pattern captured by a smartphone camera. A six-year-old performed the setup and data collection. The results clearly show repeatable, material-dependent changes in the central optical lobe. Heavier materials produced a narrower, more intense lobe; lighter materials produced a broader one. These findings suggest that mass alone influences the outcome in this configuration.

Background & Motivation

Slit experiments are typically used to study how light spreads and interferes. In standard explanations, geometry matters, but the mass of the material forming the slit is not expected to change the pattern. This project asked a simple question: if we hold the geometry constant and change only the material, does the optical pattern change? The experiment was intentionally designed so that a young child could perform the setup and capture the images safely and consistently.

Hypothesis

If two cubes of different materials (and therefore different mass) are used to create an identical slit geometry, the resulting optical pattern will change in measurable ways—even though the alignment remains the same.

Materials

- Smartphone camera
- Light source (LED flashlight or laser)
- Pairs of cubes made of different materials (e.g., aluminum, titanium, zirconium, copper, tungsten)
- Stable phone stand
- Measuring tape or fixed distance marker
- Dark background box
- Image analysis script (automated measurement of lobe width, intensity, flux, and centroid)
- Notebook for observations

Experimental Setup

Two cubes of the same material were placed side-by-side to create a narrow slit. A smartphone camera was positioned a fixed distance away. A light source was aimed at the slit, and all images were captured from the same position. Only the material of the cubes was changed between runs; the geometry stayed the same. A dark backdrop provided consistent contrast. The child performing the experiment placed each pair of cubes in position and triggered the camera shots.

Procedure

1. Position the smartphone at a fixed distance from the slit location.

2. Place the first material pair of cubes to form the slit.

3. Turn on the light source and capture several images.

4. Remove the cubes and capture baseline images with no slit.

5. Replace with the next material pair, keeping geometry unchanged.

6. Repeat image capture for all materials.

7. Store all images and process them using the same analysis script.

8. Record all measurements in tables.

Data Collection

Images were processed using an automated script that measured:

• central lobe width

• peak intensity

• inner and outer flux

• FWHM radius

• W10 radius

• centroid drift

All measurements were performed consistently across materials and distance blocks. The full dataset (results_set1.rtf) includes every measurement for all captured frames.

Results

Across all sets, heavier materials produced:

• narrower central lobes

• higher peak intensities

• lower outer-fraction values

Lighter materials produced:

• wider lobes

• lower peak intensities

These changes occurred even though the geometry and alignment remained unchanged. The material mass was the only variable.

Discussion

The results show a clear and repeatable relationship between the mass of the slit material and the shape of the resulting optical pattern. Because geometry and alignment were held constant, this suggests that mass plays a measurable role in shaping the distribution of light in this setup. These findings are unexpected under classical optics assumptions. The consistency across materials and distances indicates that the effect is not noise or chance. A child was able to perform the experiment cleanly, demonstrating the simplicity and repeatability of the method.

Errors & Limitations

• Minor hand-placement differences between material swaps

• Smartphone sensor noise

• Light source flicker

• Natural environmental drift over time

• Limited resolution of the camera

• Only a few materials tested per distance block

Despite these limitations, the material-dependent pattern changes were large enough to be unmistakable and repeatable.

Conclusion

Changing only the mass of the slit-forming material produced measurable and consistent differences in the optical pattern. The experiment supports the hypothesis that mass influences the distribution of light even in a simple DIY setup. A six-year-old successfully performed the procedure, demonstrating that the effect can be observed with accessible tools. The complete dataset is included for replication and further analysis.

Appendix

See attached file: results_set1.rtf (full raw experimental measurements).

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