# Demonstration of Schlieren Imaging

## Single Mirror Shadowgraph / Schlieren Optics Setup

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# Mirrors on the Shelf in Demo Lab


# What is Schlieren

Schlieren - schlie·ren ˈshlir-ən. : small masses or streaks in an igneous rock that differ in composition from the main body. : regions of varying refraction in a transparent medium often caused by pressure or temperature differences and detectable especially by photographing the passage of a beam of light

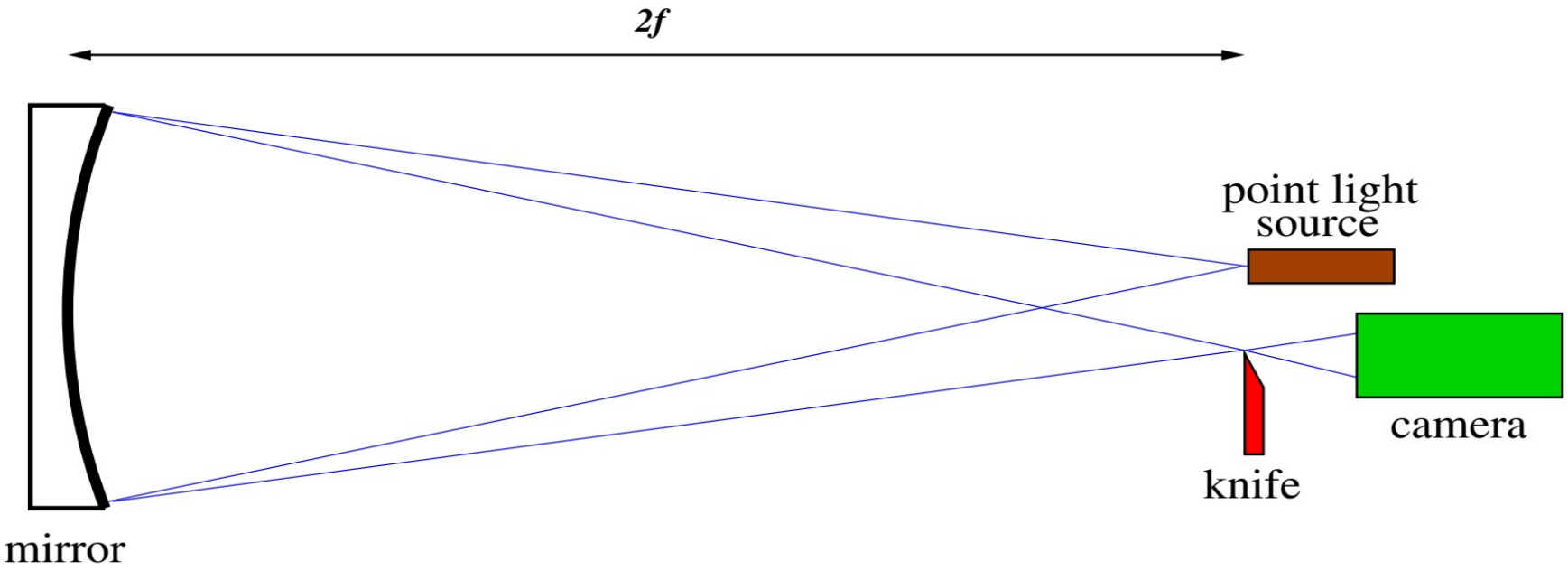
(*Merriam-Webster dictionary*)

- originates from the German word *schliere* which means streak.
- historically used to refer to inhomogenous sections or imperfections in glass

# Refraction

- Light bends in material of varying density
- Slows down (speeds up) in more dense (less dense) media
- More to less dense, light bends away from normal
- Less to more dense, light bends toward normal
- Shadowgraph and Schlieren optics are very sensitive to small changes in density (index of refraction)

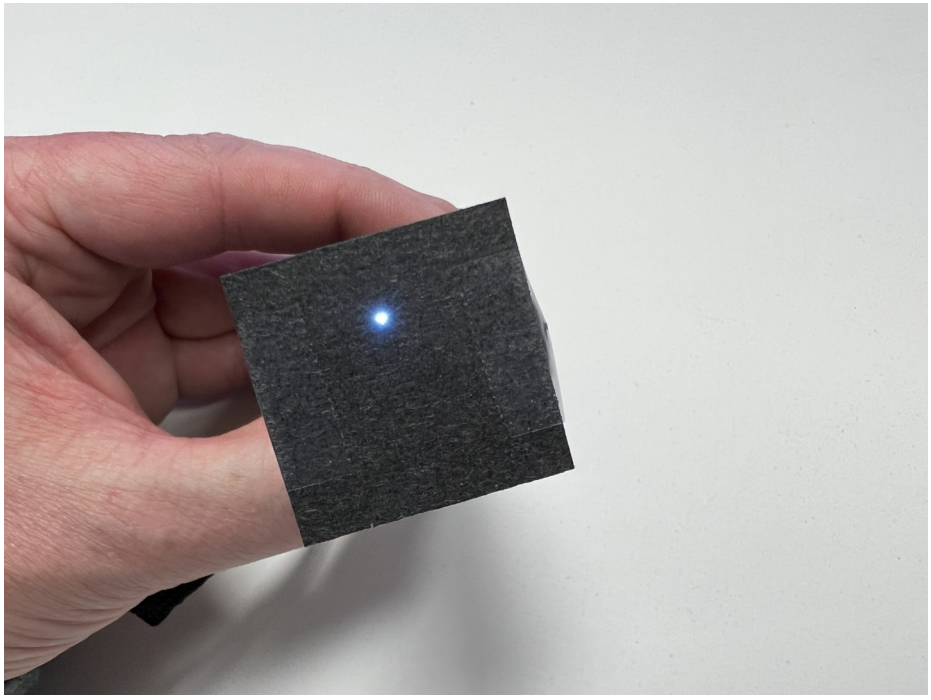
# Single Mirror Optics Setup



# Components

- **Light** - point light source (PLS), bright, small aperture
- **Mirror** – optics grade (telescope), large diameter, long focal length
- **Camera** – human eye, smartphone, camcorder, DSLR with telescopic lens, etc.
- **Mask** – knife edge, gradient or color filter at focal point

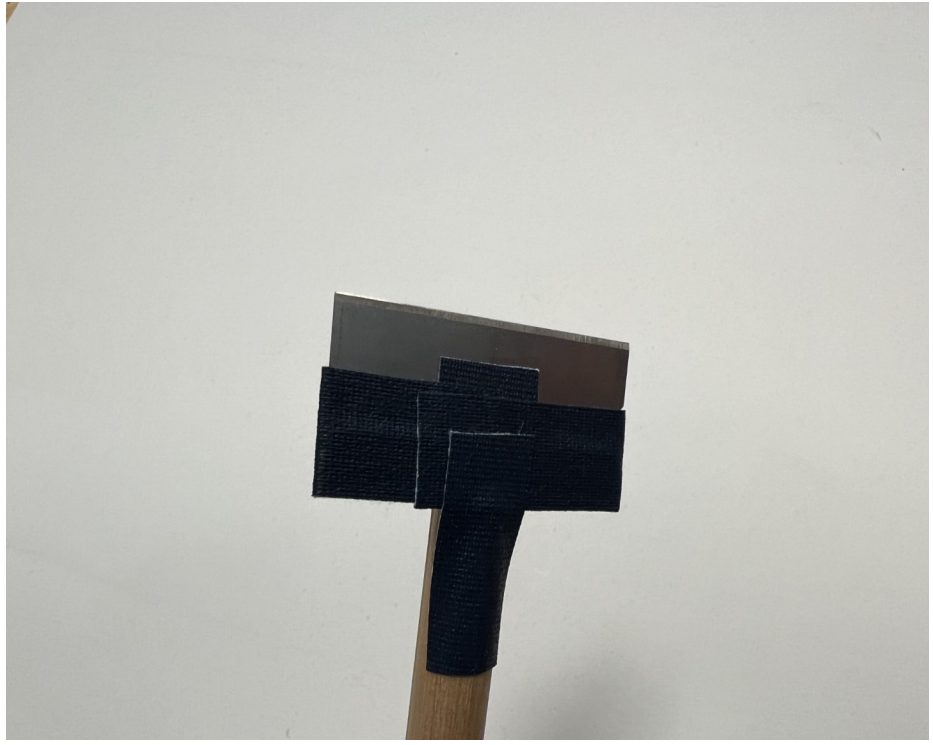
# Point Light Source

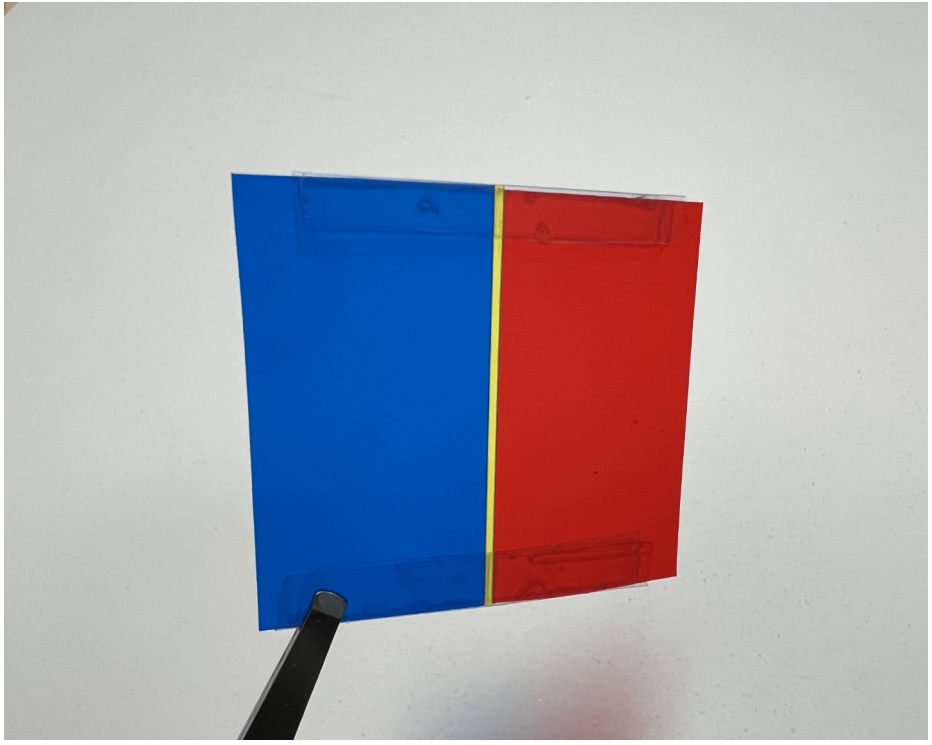


# Mirror

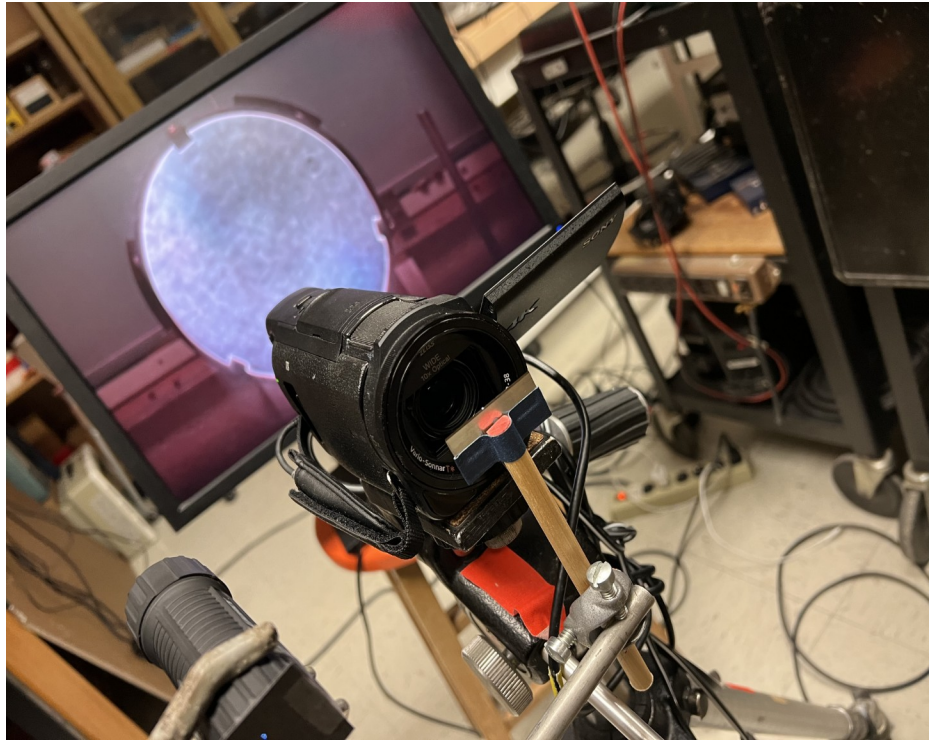
- Edmunds Scientific brand
- Aluminized Telescope quality
- Spherical concave focusing
- F/8 with 64-inch focal length
- Mounted in holder & tripod for adjustability

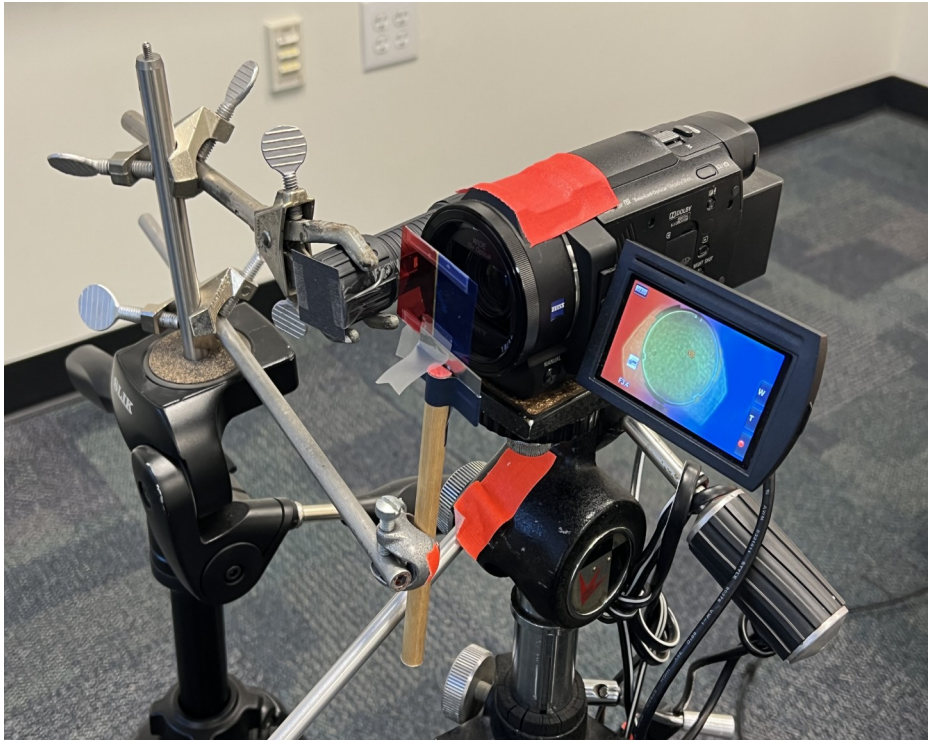
# Masks



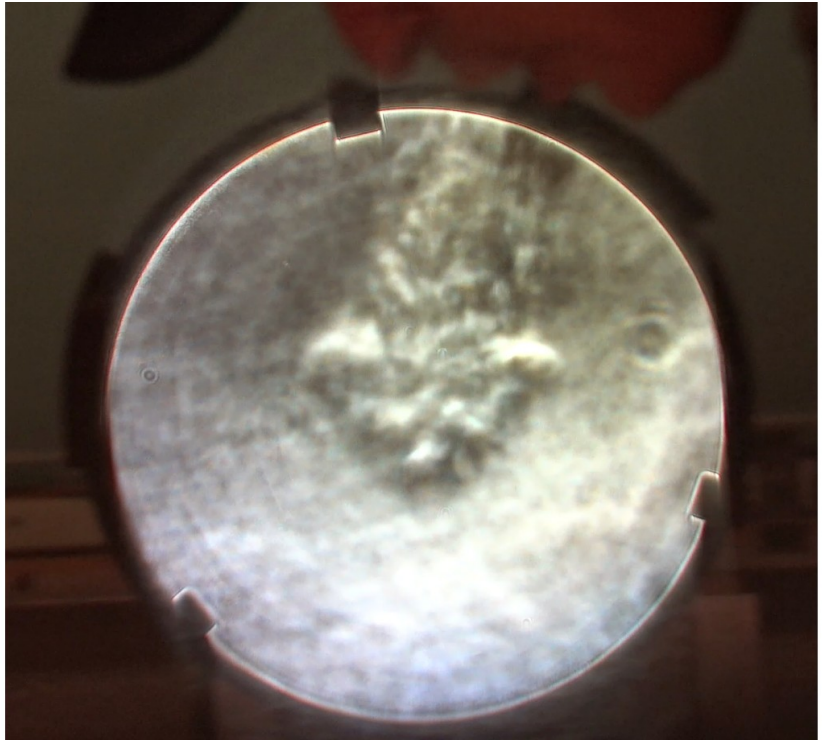


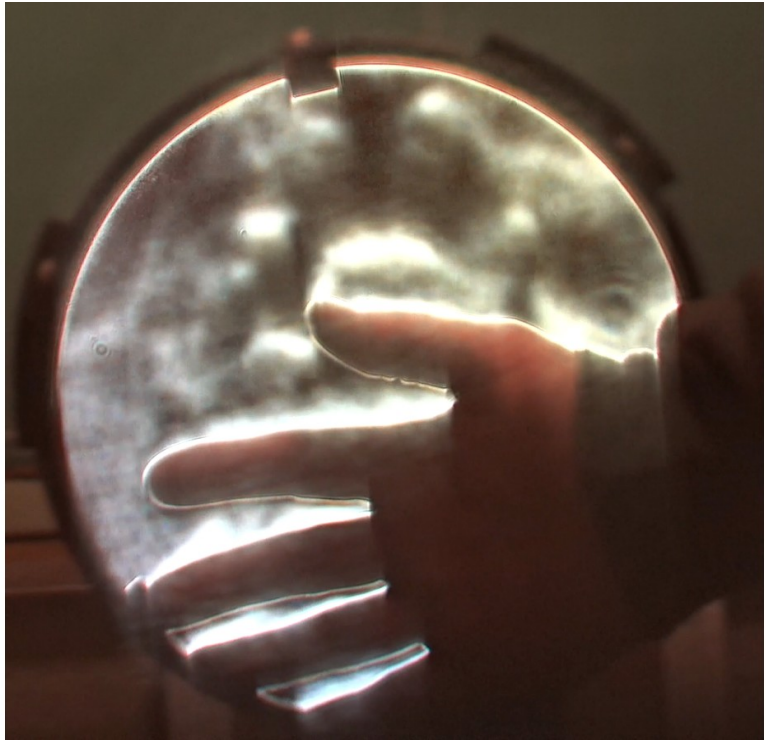
# Camera



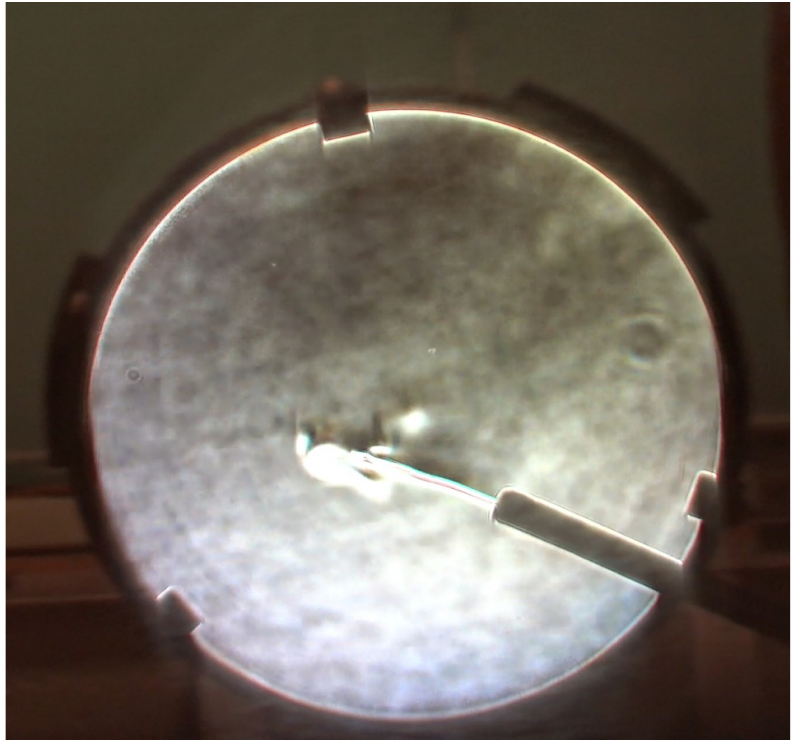


# Breath & Hand





# Butane Gas & Lighter Flame



# References


- Settles, Schlieren and Shadowgraph Techniques: Visualizing Phenomena in Transparent Media. Springer (2001)
- Gearhart and MacIsaac, A Practical Classroom iPad Shadowgraph System, Phys. Teach. 58, 8 (2020)
- Miller & Loebner, Smartphone Schlieren, (2016) https://www.arxiv-vanity.com/papers/1609.04298/
- websites and youtube videos . . .