

# Low-Cost Experiments in STEM Education



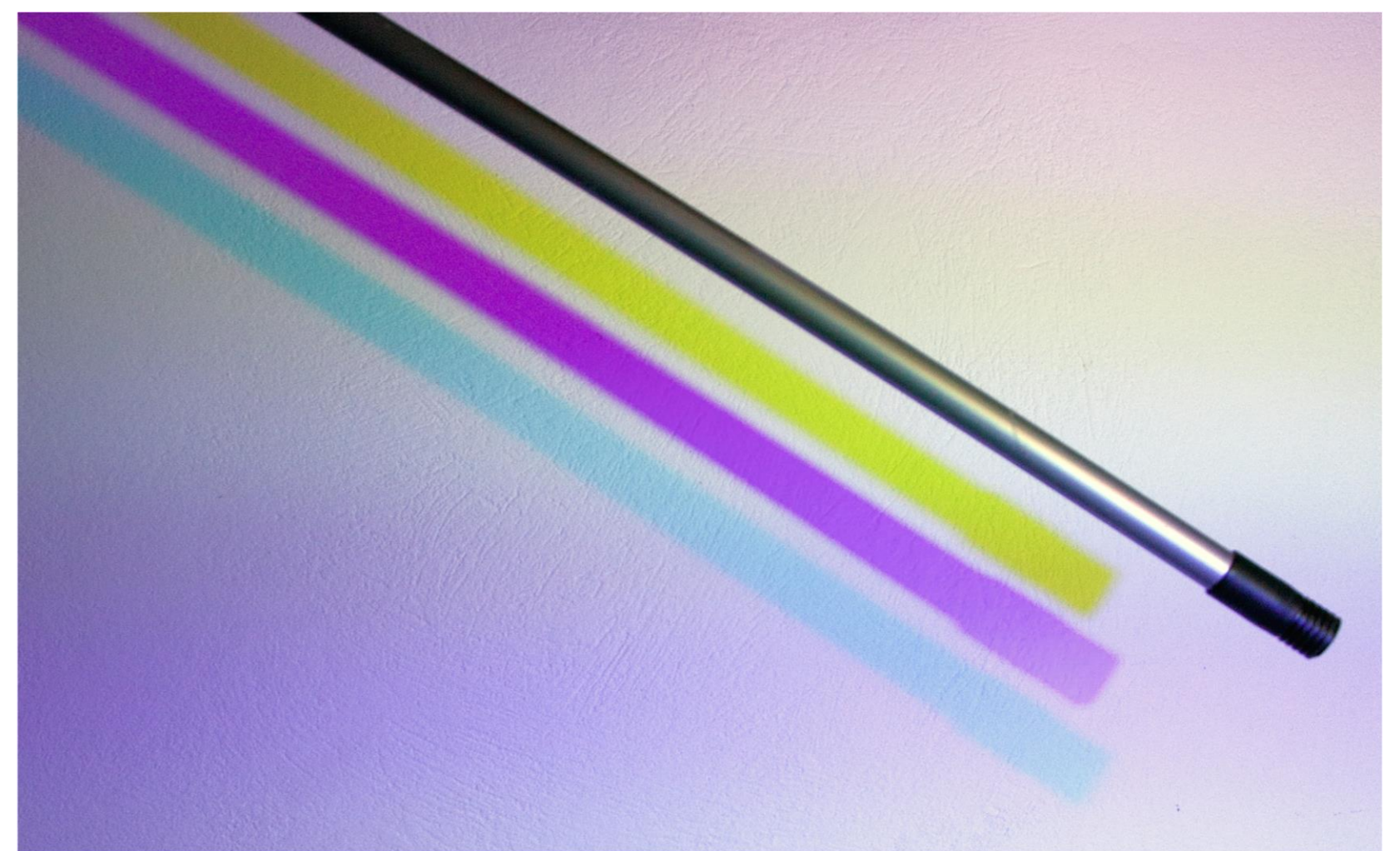
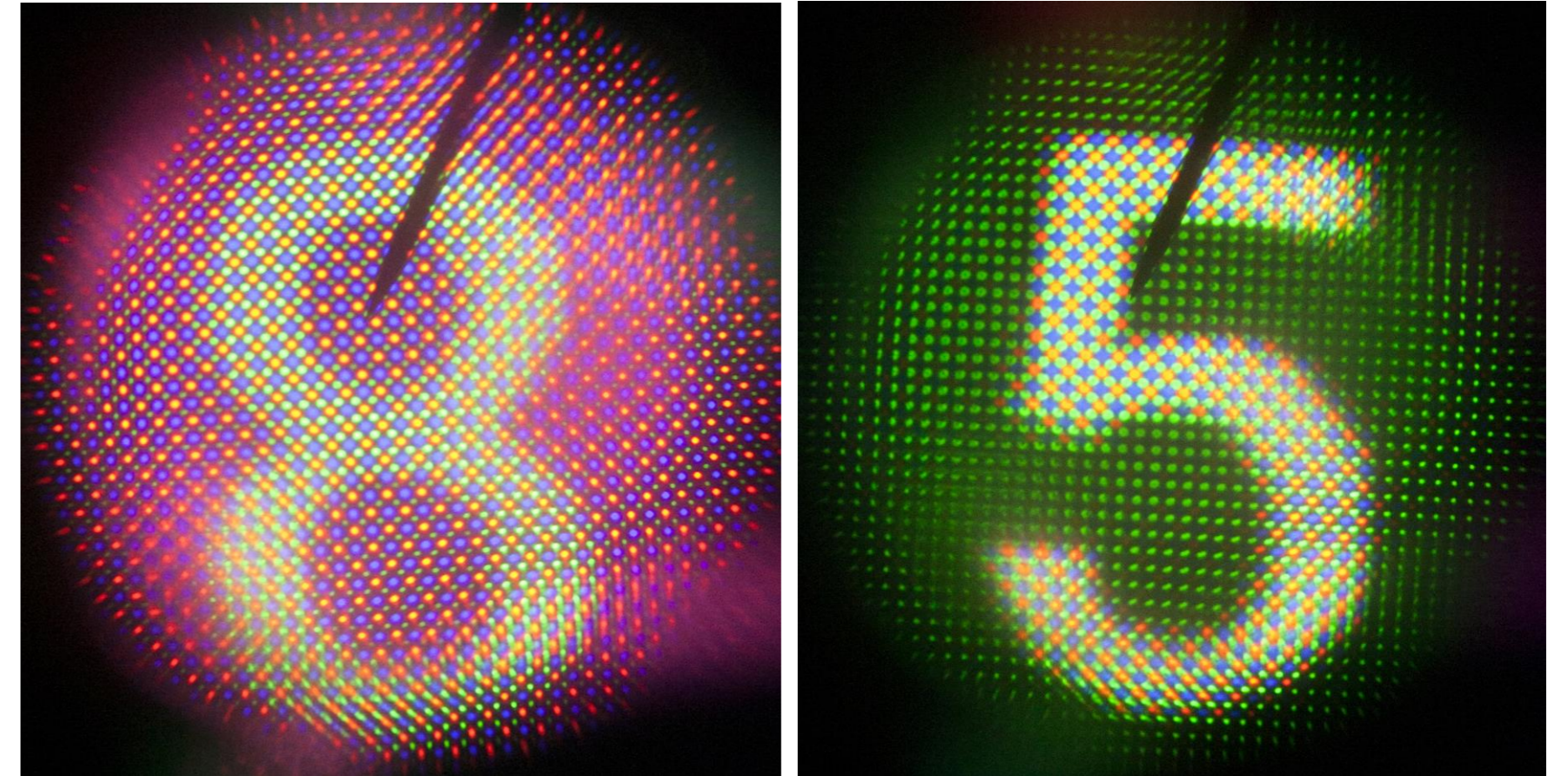
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## About color vision

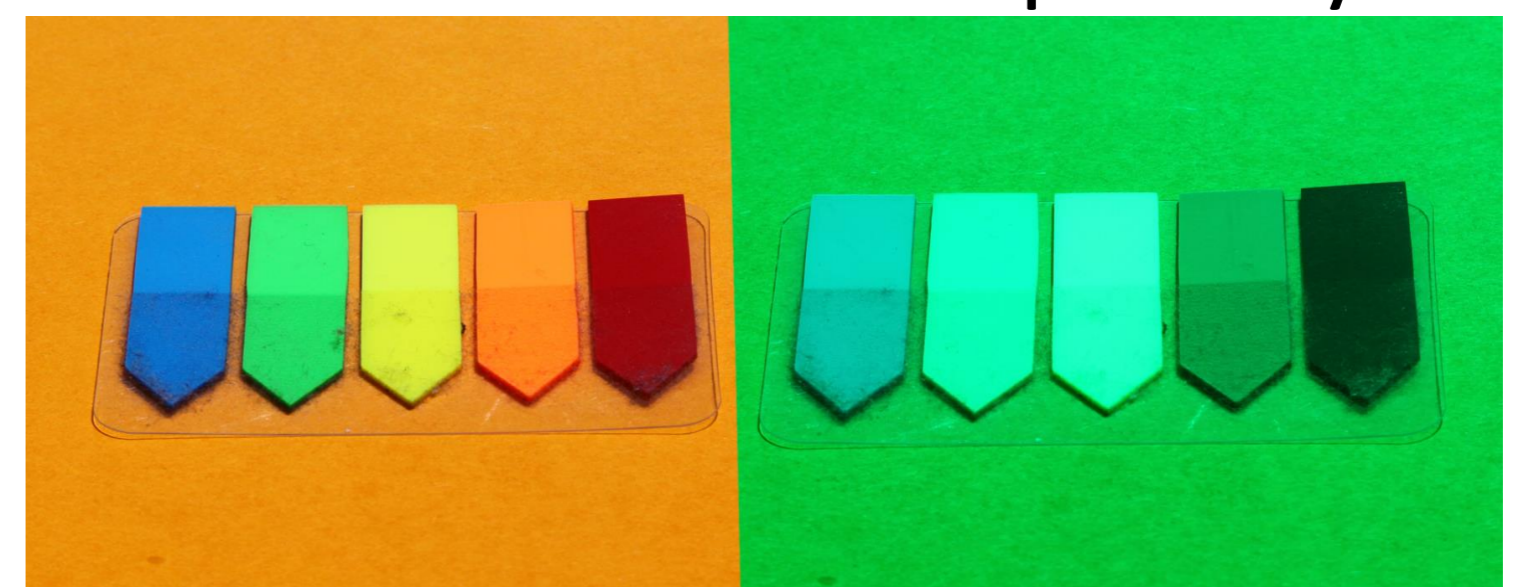
### Where physics, physiology and technology meet

The trichromatic theory, built in the 19th century by pioneers Young and Helmholtz, explains the perception of colors as the result of the function of specialized photoreceptors in the human retina called cones.

There are three main types of cones, each sensitive mainly to different wavelengths of light, corresponding to the primary colors of red, green, and blue. Color reproduction on digital screens is based, in turn, on these three primary colors, as revealed when you view parts of your mobile screen through a microscope.



An object illuminated by three lamps (red, green, and blue) has three shadows, whose colors are different from those of the lamps. Why?



Wanting to demonstrate the problems faced by those with color vision deficiency (CVD), we cover various colored objects with a green transparency. It is clear that we now struggle to distinguish them. With the help of a color sensor and an Arduino microcontroller, we can detect the color of an object to assist individuals with CVD.

Three LEDs (red, green and blue) light up alternately for 5 ms each. When the assembly is not moving we observe white color, but when it is rotated we observe repeatedly red, green, and blue colors. Why?

**Conclusion:** These and others activities constitutes a flexible and user-friendly educational material of low cost concerning color and its relationship with physics, physiology, and technology.

Additionally, efforts have been made to address the inclusion of students with color vision deficiencies in the educational process.