Efficient light with the help of mathematics

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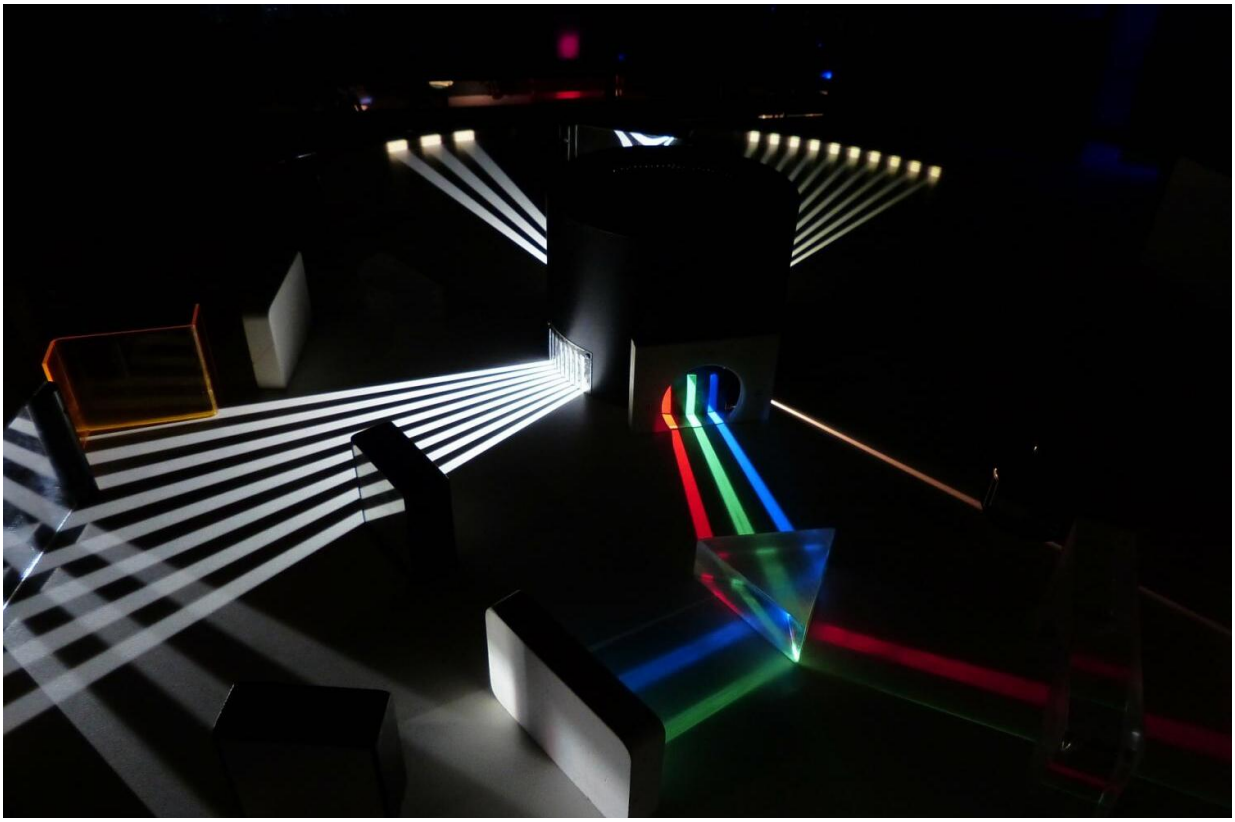

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How do you make sure that light gets to the right place without loss of energy? To do that, lamps often use mirrors and lenses. But how do you adjust them properly to get the correct light output? Lotte Romijn investigated how to get light from a to b as efficiently as possible with the help of a mathematical algorithm, for very complicated target light

outputs. She will obtain her doctorate on 19 October from the Faculty of Mathematics and Computer Science.

Imagine: you're driving down the road in the dark. But just as you're whizzing through the corner, an oncoming car blinds you as it passes. Everyone knows how irritating it is to see stars when the light is shining right in your eyes. At such a moment the light of the headlights does not end up on the road, but in the middle of your face and that is quite inconvenient. TU/e researcher Lotte Romijn investigated how you can get light from point a to point b in an efficient manner with the help of fundamental mathematics.

Complicated lamps

Lamps have taken on increasingly complicated shapes in recent years. The TU/e researcher knows that better than anyone. Lotte Romijn grew up in Eindhoven, the city of lights. Her grandfather worked for Philips. "It is therefore extra special to be doing a PhD on this subject," says the researcher. Her research immediately shows that the simple incandescent lamp from her grandfather's time is a thing of the past. "More and more LED lighting has been added. And with it, optical components in lamps such as reflectors and lenses can have more complicated shapes. Because LEDs do not require high temperatures, you can use plastic in all sorts of shapes," says Lotte Romijn. It provides a range of lighting possibilities. On the street: for street lighting or in the car. In the theater, at home and in satellites. But all that light in those lamps with a freer shape has to go from point a to point b efficiently, without losing energy.

Different lighting applications

The TU/e researcher used fundamental mathematics to figure out exactly how to do that. She used an existing algorithm for this, but adapted it to

be able to test many different shapes and light sources as possible. "So that you can use the algorithm more generically. Then you don't have to come up with a new algorithm for each separate lamp shape. By making the algorithm easier to use with different types of lighting applications."

Streetlights with a different peanut shape and headlights that shine only on the road instead of your face or your oncoming vehicle are thus easier to make. "Hopefully my research will make it easier to produce these kinds of lights with a distinct shape in the future."

The research was published in *SIAM Journal on Scientific Computing*.

More information: L. B. Romijn et al, An Iterative Least-Squares Method for Generated Jacobian Equations in Freeform Optical Design, *SIAM Journal on Scientific Computing* (2021). DOI: 10.1137/20M1338940

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