# Towards a Physically Plausible Constrained Shader Graph System for Predictive Rendering

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## Goal

Surface modeling for predictive rendering purposes.

## Problems

- How to ensure the physical plausibility of a modelled surface?
- Support for uncommon but sometimes necessary material properties that affect object appearance: polarization & fluorescence.

## Current Tools

- Shading languages: Offer too much freedom – it is easy to create physically meaningless constructs.
- Shader graphs:
  - More high-level approach: They restrict the user to pre-defined building blocks – less interference with the used rendering algorithm, more suitable for predictive rendering.
  - Still no guarantee of physical plausibility in current tools.
  - Important physical properties are missing.

## Assuring Physical Plausibility

- Test after modeling: time-consuming, complex, non-conclusive, hard to repair harmful shaders
- Restrict the toolset: only safe building blocks and safe operations on them are available.

## Restricted Shader Graph Approach

We provide only:

- Texture generation tools.
- Pre-defined analytical surface models known to be physically plausible.
- Safe surface blending operators.

## Polarisation Support

- Internally, we use Stokes Vectors and Mueller Matrices to model light and attenuation.
- These are never manipulated directly by the user, but generated by the shader graph building blocks, and combined via operators.

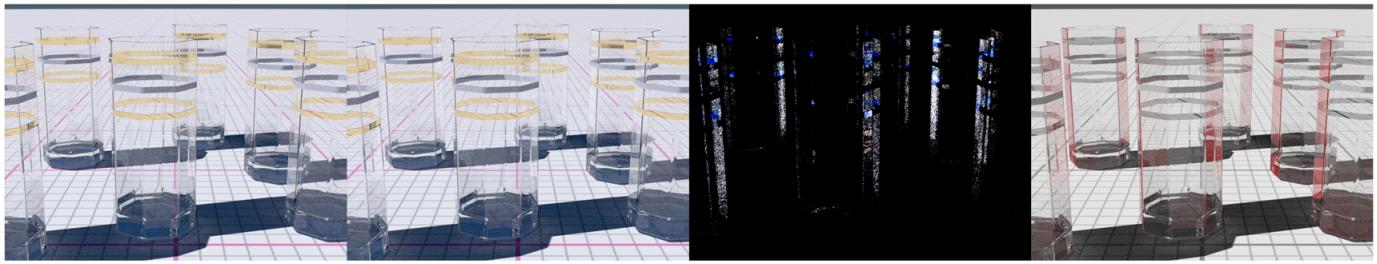

Figure 1: **First two from left:** textured glass objects rendered without (left) and with (second from left) polarisation support. **Third from left:** difference image. **Right:** polarisation visualisation.

## Fluorescence Support

- Internally: a re-radiation matrix is added to the light attenuation structure when needed.
- Manipulation of fluorescence parameters (intensity, Stokes shift) via shader graph parameters.

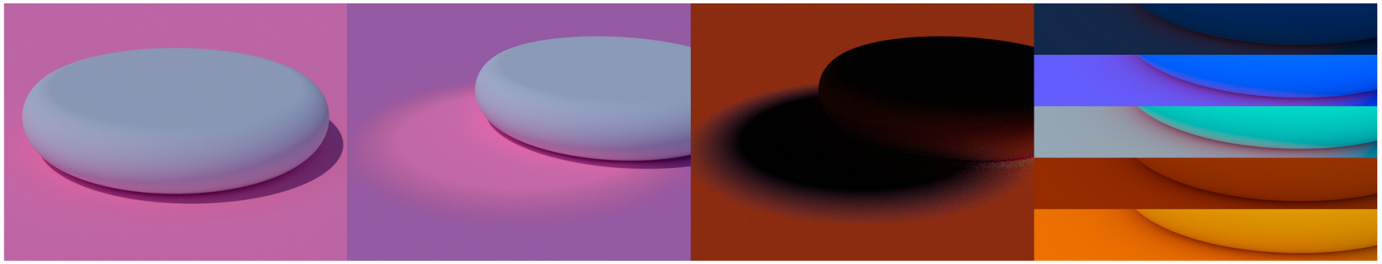

Figure 2: **Left:** a simple scene in which the ground is covered with a pink fluorescent material, and the pill-shaped object is neutral, non-fluorescent white. Illumination is via a physically plausible skylight that contains a UV contribution. **Second from left:** with our shader graph system, it is very easy to plausibly model the bleaching effect that is commonly caused in real fluorescent dyes by prolonged sunlight exposure. In this image, the bright spot in the pink surface was protected from bleaching by being underneath the white object, which has been moved to reveal it. The spot can be simply defined as an area in which the intensity of the fluorescence effect is retained, while the base reflectance is decreased. **Third from left:** difference image between the previous scene rendered with and without the bleaching effect. **Right:** a part of the scene under various narrow-band lights, to demonstrate the wavelength shift induced by the fluorescent material.

## Conclusion

- Physically plausible shader graph construction.
- New properties available: fluorescence, polarisation (internal details safely hidden from the user).
- Usage conceptually similar to existing shader graph editors.

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