# Accurate Diffuse Lighting from Spherical Gaussian Lights

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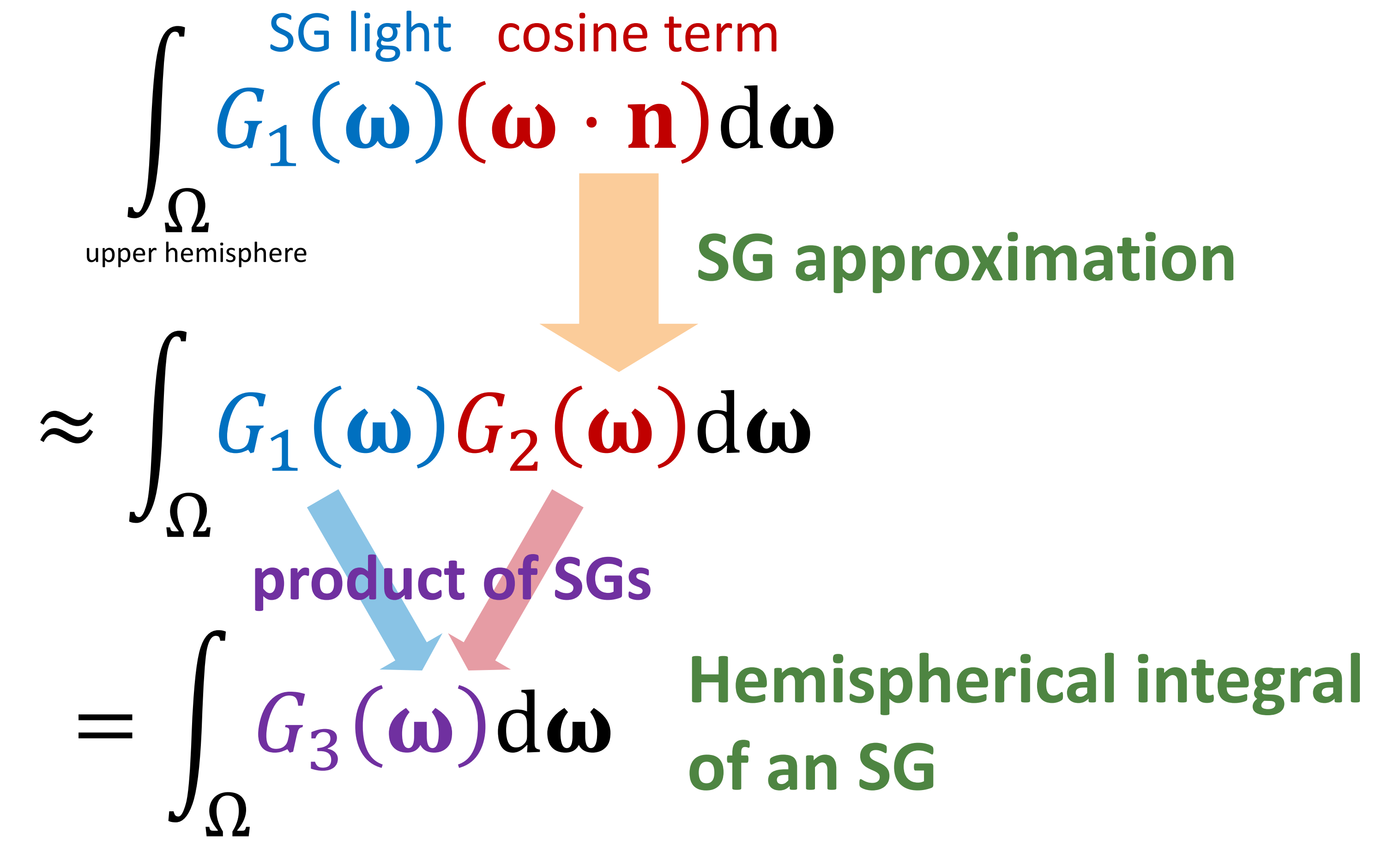
(a) Rendering using our method for a scene lit by a sharp spherical Gaussian (SG) light close to a wall (3840×2160 screen resolution, AMD Radeon$^{\mathrm{TM}}$ RX 6900 XT GPU).
(b-d) Visualizations of symmetry mean absolute percentage errors (SMAPEs). For a sharp SG light, the approximation error of Meder and Brüderlin [2018] (c) is relatively large especially at grazing angles. Our approximation (d) produces a **smaller error than the previous methods** (b-c).

## 1. Introduction

Spherical Gaussian (SG) lights are an efficient approximation for area lights, environment maps, and indirect illumination [Tokuyoshi 2015]. Although diffuse lighting from an SG light is given by the product integral of the SG and clamped cosine, it does not have a closed-form exact solution. Therefore, efficient approximation is required for real-time applications. We present **more accurate approximation** than state-of-the-art methods for diffuse lighting. By using our method, we are able to improve the quality of real-time SG lighting.

## 2. Integral for SG Lighting



SG light cosine term

$$\int_{\Omega} G_1(\boldsymbol{\omega})(\boldsymbol{\omega}\cdot\mathbf{n})\mathrm{d}\boldsymbol{\omega}$$

upper hemisphere

SG approximation

$$\approx \int_{\Omega} G_1(\boldsymbol{\omega})G_2(\boldsymbol{\omega})\mathrm{d}\boldsymbol{\omega}$$

product of SGs

$$= \int_{\Omega} G_3(\boldsymbol{\omega})\mathrm{d}\boldsymbol{\omega}$$

Hemispherical integral of an SG

Dynamic indirect illumination using virtual SG lights [Tokuyoshi 2015]. Although Pettineo and Hill [2016]'s fitted irradiance is faster than Meder and Brüderlin [2018] and our method, it can produce undesirable black splotches. **Our method does not produce such artifacts, and it is more accurate and slightly faster than Meder and Brüderlin.**

## 3. Our Approximation

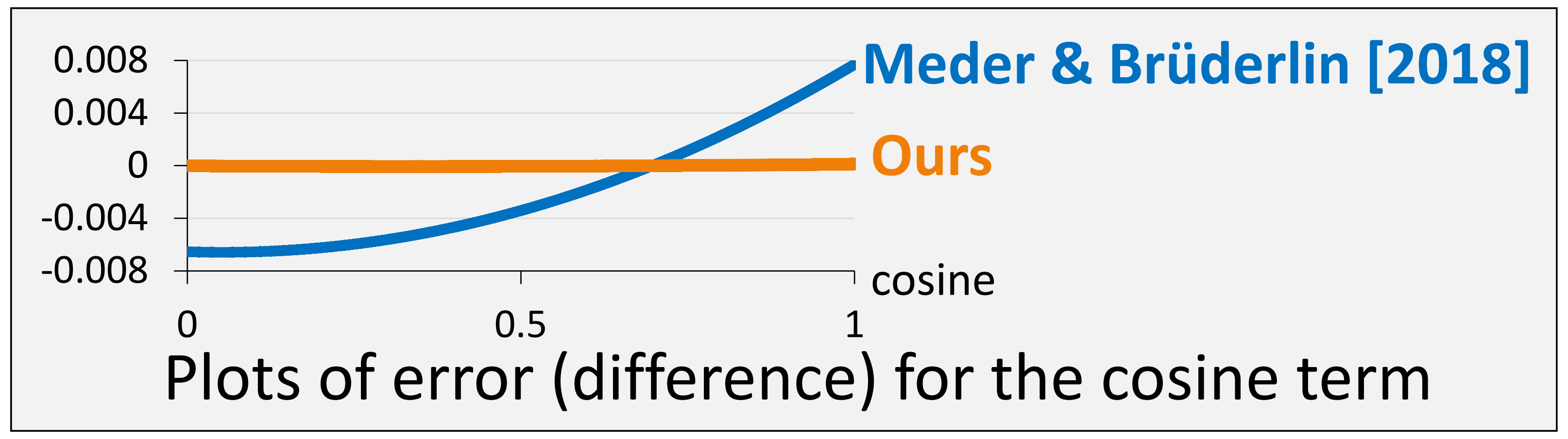
### SG approximation for the cosine term

- First-order Taylor approximation
- Normalization with the hemispherical integral

$$\boldsymbol{\omega}\cdot\mathbf{n} \approx \frac{\lambda(G(\boldsymbol{\omega};\mathbf{n},\lambda)-1)}{2\mathrm{e}^{\lambda}-2-2\lambda}$$

**Trade-off: approximation error ↔ numerical error**

We obtain a near-optimal sharpness $\lambda = 0.0008456087$ by **minimizing the sum of the approximation error and a numerical error bound**.



Plots of error (difference) for the cosine term

### Hemispherical integral of an SG

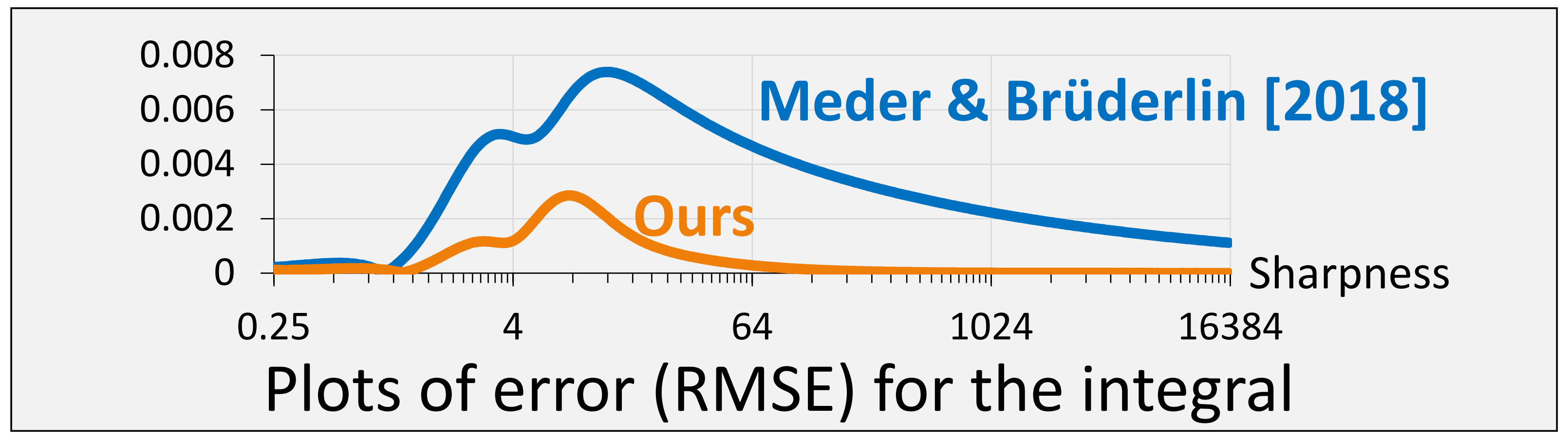
- Approximation using a normalized sigmoid function

Previous work: logistic function

Ours: **CDF of a Gaussian on a plane**

∵ sharp spherical Gaussian ≈ planar Gaussian

Normalization is **simpler** than the logistic function ☺



Plots of error (RMSE) for the integral

## References

J. Meder and B. Brüderlin. 2018. Hemispherical Gaussians for Accurate Light Integration. In ICCVG' 18. 3–15.
M. Pettineo and S. Hill. 2016. SG Series Part 3: Diffuse Lighting From an SG Light Source. https://therealmjp.github.io/posts/sg-series-part-3-diffuse-lighting-from-an-sg-light-source/
Y. Tokuyoshi. 2015. Virtual Spherical Gaussian Lights for Real-time Glossy Indirect Illumination. CGF 34, 7, 89–98.