



**Westfälische
Hochschule**

Gelsenkirchen Bocholt Recklinghausen

Lecture 'Computer Graphics'

ILLUMINATION

...and a bit of shading

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Visual Computing (<https://vc.w-hs.de>)

Department of Business Studies and Information Technology
Campus Bocholt



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Latin Original¹:

(§. 21.) Diximus vero, quod & vulgo notiffimum.

1°. Duas pluresue candelas plus illuminare quam unica.

2°. Obiectum lumini propius admotum clarius fieri.

3°. Lumen oblique incidens in superficiem, eam minus illuminare.

English²:

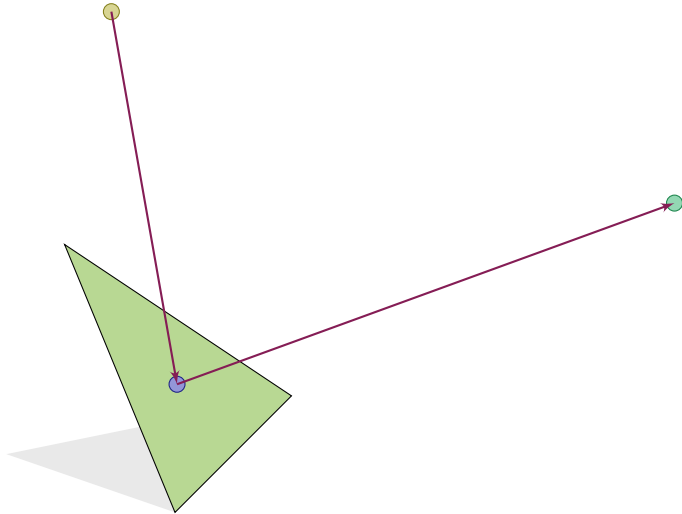
(21.) We have stated what is commonly well known:

1) Two or more candles illuminate more than a single one.

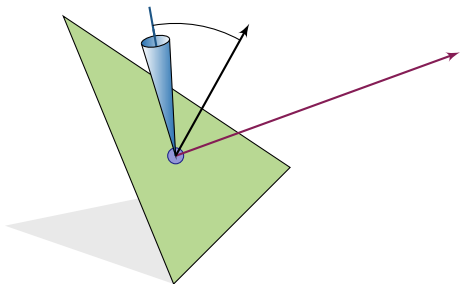
2) An object brought closer to a light source becomes brighter.

3) Light striking a surface at an oblique angle illuminates it less.

¹I. H. Lambert: Photometria sive de mensura et gradibus luminis, colorum et umbrae. 1760.



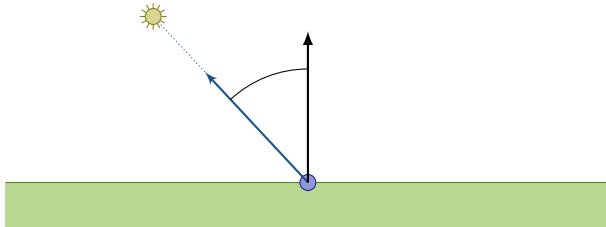
$$L(\mathbf{x}_2 \rightarrow \mathbf{x}_3) = g(\mathbf{x}_2 \rightarrow \mathbf{x}_3) \left(\epsilon(\mathbf{x}_2 \rightarrow \mathbf{x}_3) + \int_{\mathbf{x}_1} \rho(\mathbf{x}_1 \rightarrow \mathbf{x}_2 \rightarrow \mathbf{x}_3) L(\mathbf{x}_1 \rightarrow \mathbf{x}_2) \cos \theta_i d\sigma_i \right)$$



³James T. Kajiya: The Rendering Equation. In SIGGRAPH Comput. Graph. 20(4). 1986.

Lambert Reflection Model

Simplifications



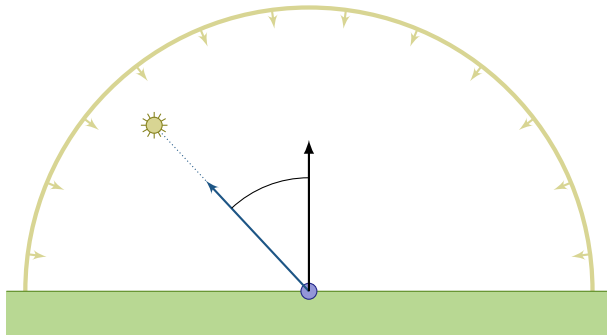
k_d :

c_i :

$\mathbf{l}_i$:

c_x :

Lambert Reflection Model + Ambient Illumination



k_a :

k_d :

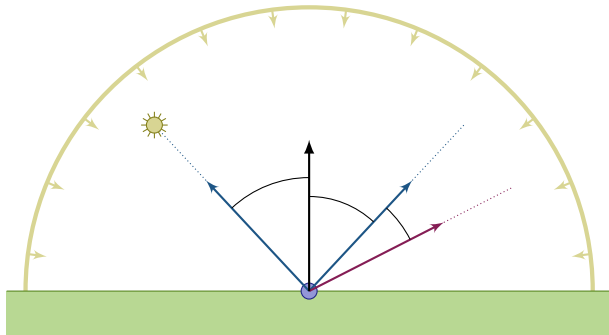
c_a :

c_i :

$\mathbf{l}_i$:

c_x :

Phong Reflection Model⁴



k_a :

k_d :

k_s :

p :

c_a :

c_i :

$\mathbf{l}_i$:

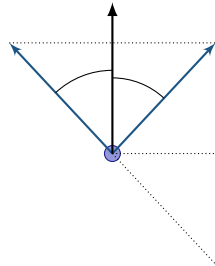
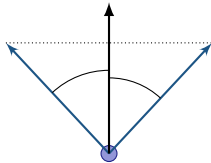
$\mathbf{r}_i$:

$\mathbf{v}$:

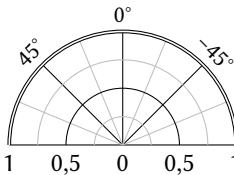
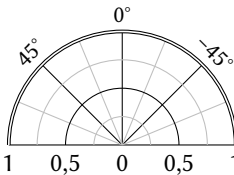
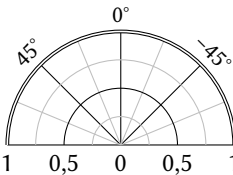
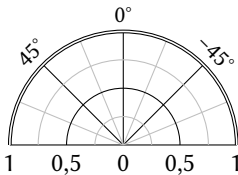
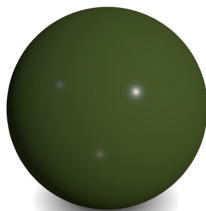
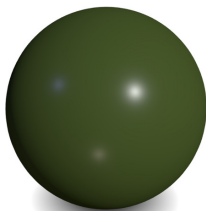
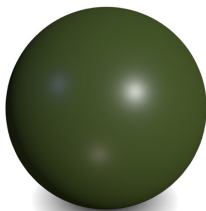
c_x :

⁴Bui Tuong Phong: Illumination for computer generated pictures. In Commun. ACM, 18(6). 1975.

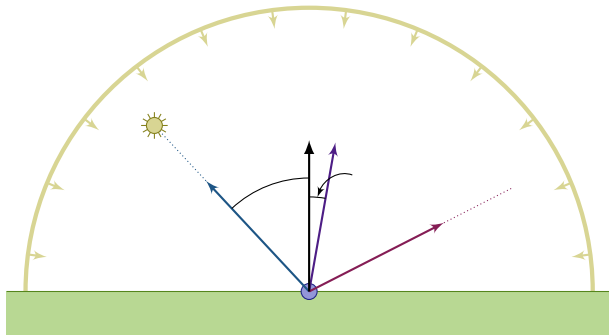
Reflection Vector



Phong Exponent



Blinn-Phong Reflection Model⁵



k_a :

k_d :

k_s :

p :

c_a :

c_i :

$\mathbf{l}_i$:

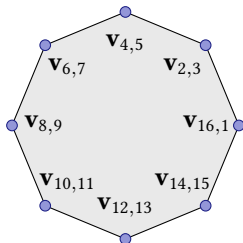
$\mathbf{h}_i$:

$\mathbf{v}$:

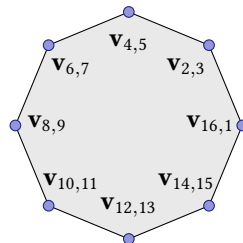
c_x :

⁵J.F. Blinn: Models of Light Reflection for Computer Synthesized Pictures. In SIGGRAPH Comput. Graph. 11(2). 1977.

Face Normals



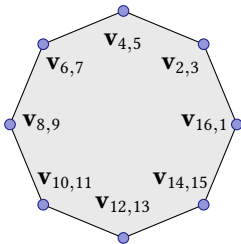
Vertex Normals



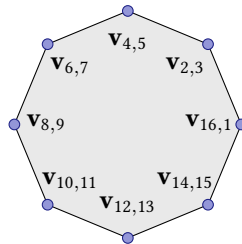
Fragment-Based Shading

Phong Shading

Face Normals

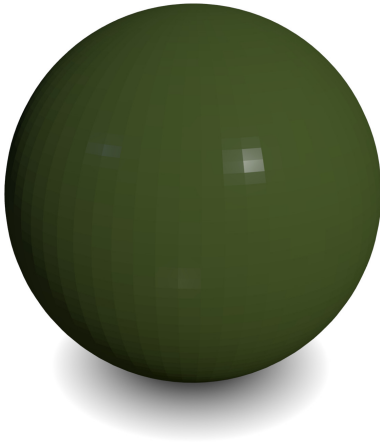


Vertex Normals

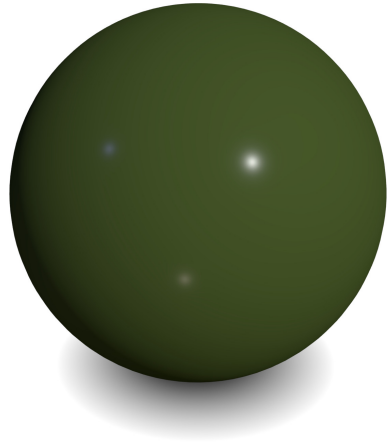


Face Normals vs. Vertex Normals

Face Normals



Vertex Normals



Light Sources

Point Light



Spot Light



Directional Light



Area Light



- ▶ Rendering Equation
- ▶ Reflection Models
- ▶ Gouraud vs. Phong Shading
- ▶ Vertex vs. Face Normals
- ▶ Light Sources

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