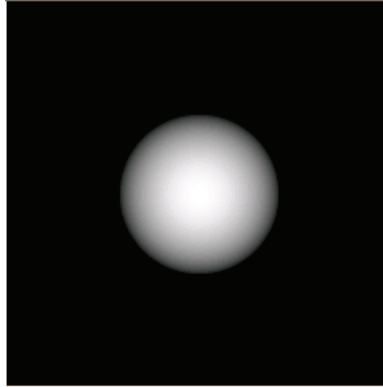


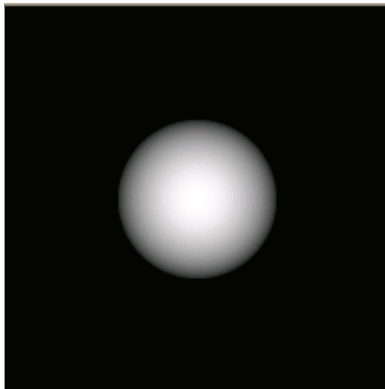
The unnormalized surface normal has the following form

$$N = \begin{cases} \left[ \frac{x}{\sqrt{r^2 - (x^2 + y^2)}}, \frac{y}{\sqrt{r^2 - (x^2 + y^2)}}, 1 \right], & r^2 > (x^2 + y^2) \\ [x, y, 0], & r^2 = (x^2 + y^2) \end{cases}$$

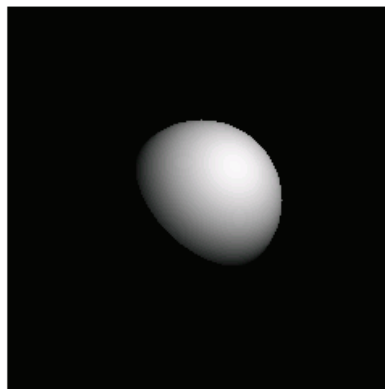
a)  $S = [0, 0, 1]$ ,  $r = 50$ ,  $a = 0.5$ ,  $m = 1$



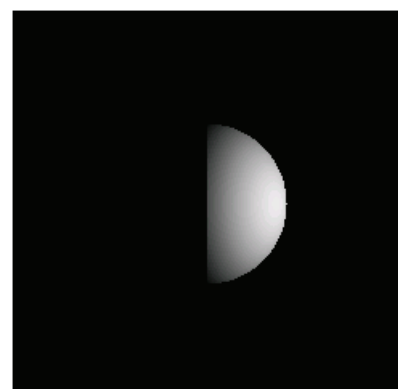
b) Vary S



$S = [0, 0, 1]$



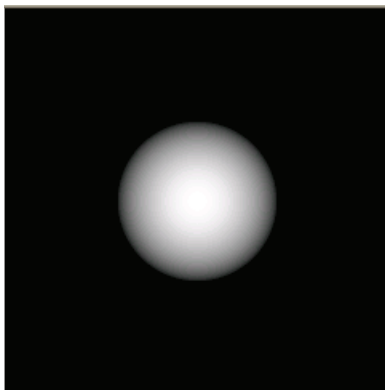
$S = [1/\sqrt{3}, 1/\sqrt{3}, 1/\sqrt{3}]$



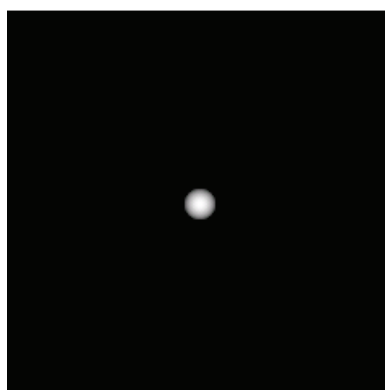
$S = [1, 0, 0]$

As S changes, different parts are illuminated.

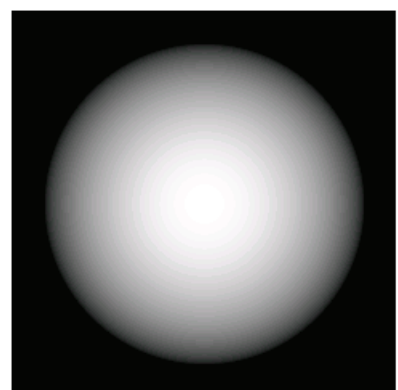
c) Vary r



$r = 50$



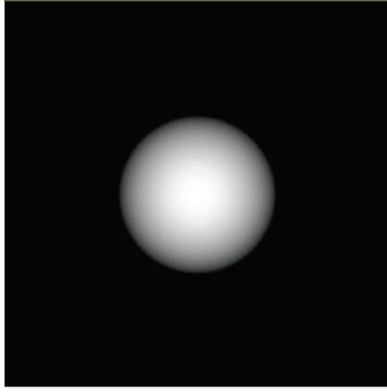
$r = 10$



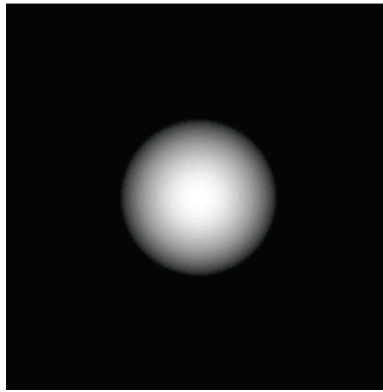
$r = 100$

As r increases, more pixels receive irradiance.

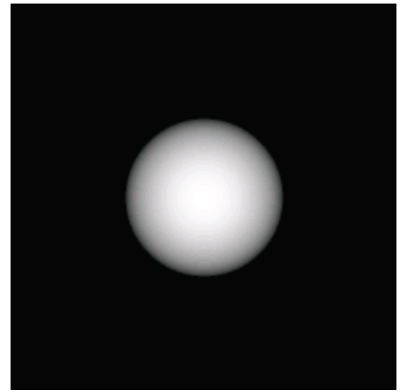
d) Vary  $a$



$a = 0.5$



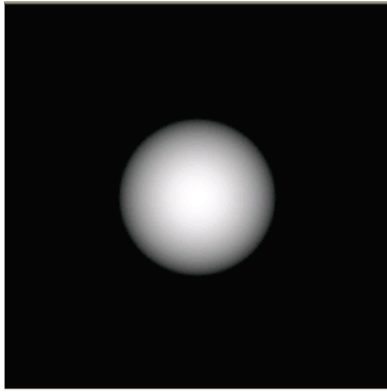
$a = 0.1$



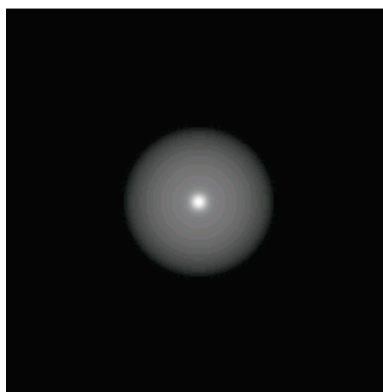
$a = 1$

The larger  $a$ , the more dominant lambertian reflection is. With  $a = 1$ , a sphere looks like a disk.

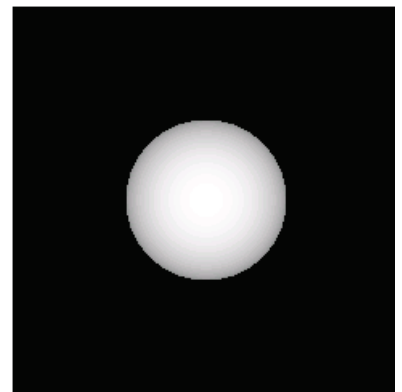
e) Vary  $m$



$m = 1$



$m = 0.1$



$m = 10000$

With large  $m$ , the exponential falls off slowly, making specular effect less evident. With small  $m$ , the exponential falls off quickly, making specular effect more evident.