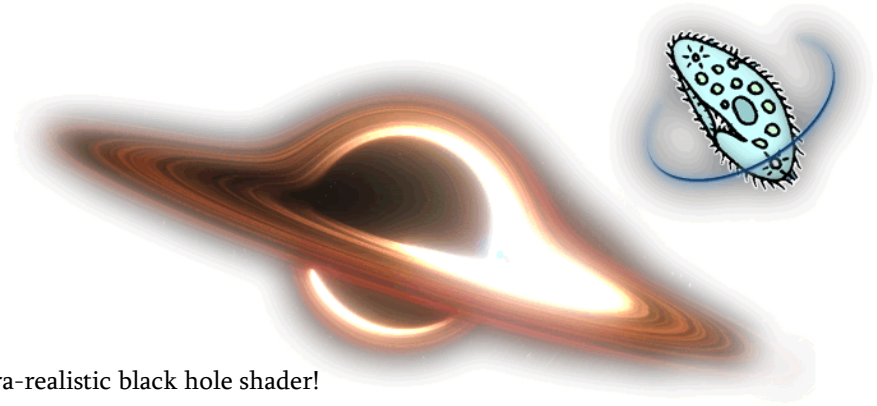

SCINGULARITY

by problemecium

Thank you for purchasing the SCINGULARITY ultra-realistic black hole shader!
Please read this document for information on its intended use and for answers to common issues.

Basic Use:

- Create a material that uses the Black Hole shader; this is used for black holes, wormholes, and standalone gravitational lenses.
- Attach the material to a "Quad" object somewhere in the scene.
- If the black hole effect is not visible, try toggling "Flipped Projection Correction".
- If a wormhole effect is desired, set the "Wormhole Exit" cubemap texture and check "Is Wormhole".
- If a standalone gravitational lens is desired, such as for a distant galaxy, slide "Lens Only" to 1.
- Set "Lensing Cutoff Value" to the largest value possible that still looks acceptable.
- If an accretion disk is desired, set its radius and assign a texture to it.
- Set the accretion disk parameters as desired.

Shader variables:

- Wormhole Exit: A cubemap representing the world visible through the wormhole. This can be a render texture paired with a camera somewhere else in the scene that uses Camera.RenderToCubemap to provide a live view of its surroundings, or it can be a static cubemap.
- Is Wormhole: The "Wormhole Exit" cubemap will only be visible if this box is checked; otherwise a black sphere will be rendered to represent an event horizon.
- Lens Only: Whether to render a full black hole (0) or only a gravitational lens effect (1). The value can be tweaked arbitrarily between 0 and 1 for less realistic eye candy effects.
- Lensing Cutoff Value: The minimum gravitational lens strength the shader will render. A value of zero will cause the entire scene in all directions to be subject to the effect, while a high value will restrict the effect to only a small region around the black hole.
- Accretion Disk Radius: The distance the accretion disk will extend from the *center* of the black hole, in multiples of the Schwarzchild radius. A value of at least 1 is necessary for the accretion disk to appear if "Lens Only" is zero.
- Accretion Disk Texture: A texture to affect the color and opacity of the accretion disk. Note that the final color of the disk takes into account both this texture and the disk's temperature (see below).
- Accretion Disk Twist: The degree of "twisting" effect visible in the accretion disk. A value of 0 will result in a disk with material falling straight into the black hole, while a high value will result in material that circles it many times on the way toward it.
- Accretion Disk Base Temperature: The approximate blackbody spectrum of the hottest material in the disk. A value of 0 represents a cold disk that does not glow at all; a value of 1 represents a disk that glows white-hot at the center; a value higher than 1 represents an extremely hot disk in which the center glows blue.
- Accretion Disk Animation Speed: The speed at which material travels from the edge of the disk to the center. This roughly follows the speed of light and thus represents the approximate size of the black hole; a low value represents a very large black hole while a high value represents a very small black hole.
- Accretion Disk Redshift Effect: The degree to which the material in the disk will have its apparent color affected by its velocity relative to the viewer (see this page). Material moving toward the camera will appear

blue-shifted and brightened, while material moving away will appear red-shifted and dimmed; the closer it is to the event horizon, the faster material will move and thus the more intense this effect becomes. Set this value to 0 to disable this feature.

- Flipped Projection Correction: Whether to attempt to correct for rendering issues related to flipped projections on certain graphics hardware. Toggle this value if the black hole effect is invisible at first.

Notes:

- The black hole object does not need to be attached to a camera.
- The shader is *not compatible with orthographic camera projections*! To use it in a scene with an orthographic camera, use a second camera that uses a perspective projection (see "Scingularity Orthographic Demo" demo scene).
- For best results, use a "Quad" object to render the black hole. Other mesh shapes will still work, but depending on their geometry and normals, the effect may fail to render or perform very poorly. Note that the gravitational lens effect will *not* follow the 3D shape of the object to which it is assigned.
- Depending on your scene setup, the Mesh Renderer attached to the lack hole object may need to have reflection probes enabled, and the object may additionally need a Reflection Probe attached, in order for the gravitational lens to render properly (see "Scingularity Demo" demo scene).
- The black hole object can have any position, rotation, or scale, but for best results a uniform scale should be used (the X, Y, and Z scale values should all be the same).
- The gravitational lens will not affect objects that render after the black hole does. For best results, objects that orbit the black hole should be assigned to the "Transparent" render queue so that they and the black hole are rendered in order of depth. It may also be necessary to assign a shader with a Transparent render type even if the objects are meant to be opaque.
- The accretion disk is two-dimensional and does not represent any thickness whatsoever. Use a particle system if a thick accretion disk is desired, but note that very close to the event horizon the particles will not be rendered in a realistic manner.
- Wormholes created with this shader will not automatically transport the player to their exit location; a separate script must be used for this (see "Scingularity Wormhole Demo" demo scene).
- The shader has not been tested on all graphics hardware. Currently it has been verified to work with Windows and DirectX and with WebGL. If the shader malfunctions, please send a bug report that includes your operating system and graphics card manufacturer.

Known issues:

- The gravitational lens effect may abruptly disappear if the camera is pointing away from the black hole object due to Unity's built-in "Frustum Culling" feature. The "Disable All Frustum Culling" script included in this package can be used to circumvent this: attach it to any camera that needs to render the effect regardless of its orientation, for example a first-person camera attached to a player orbiting very close to a black hole or traveling into a wormhole.
- A "fringe" may appear in the accretion disk if the "Lensing Cutoff Value" is very high or the "Accretion Disk Radius" is very large. I am currently exploring solutions to this issue. In the meantime, it can be circumvented by decreasing either value.
- A subtle "seam" may appear in the accretion disk if the black hole is rotated very far from the default "zero" orientation. I am currently exploring solutions to this issue, but so far it has been unavoidable.
- If the camera and the black hole object both have the default "zero" orientation, a single line of extra pixels may appear outside the accretion disk. Rotate either the camera or the black hole to remove this issue.

For further information and to submit bug reports, contact the developer via my publisher page on the Unity Asset Store.