Photorealistic Motion

Fabian Andres Prada Niño

IMPA

Part I: Motivation

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- Explore the tools provided by PBRT to construct and render dynamic scenes

Motion in Photography: Motion Blur

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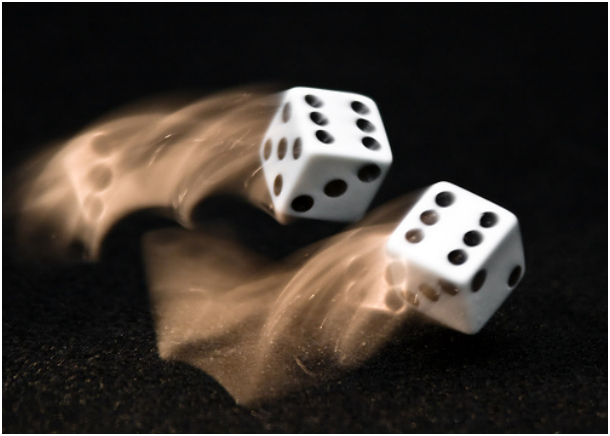

Motion in Photography: Strobe Photography

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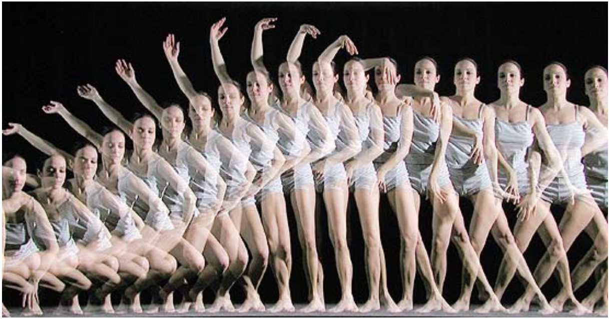

Motion in Photography: Light Painting

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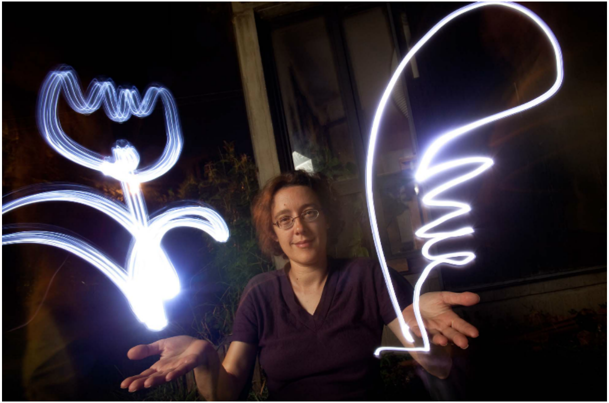


Motion and Ray Tracing. DRT[1]

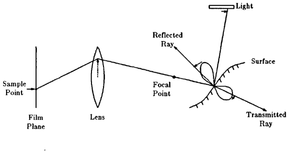
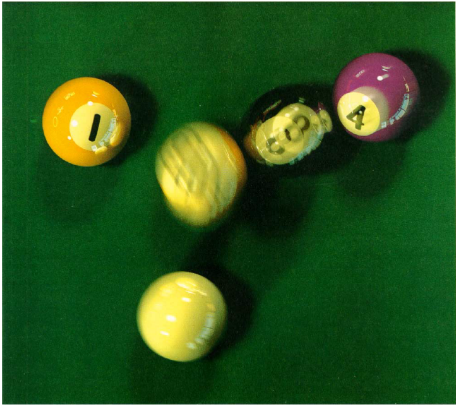
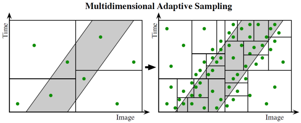
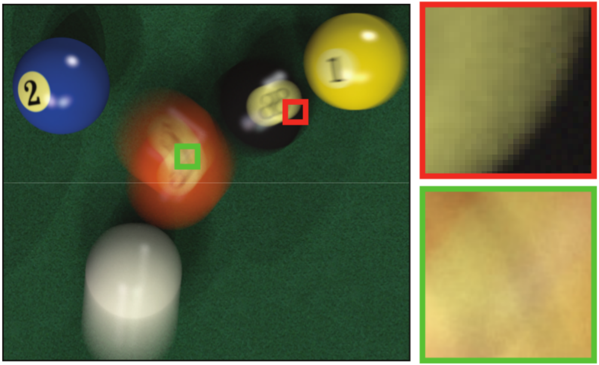


Figure 2. Typical Distributed Ray Path



Motion and Ray Tracing. MAS[1]





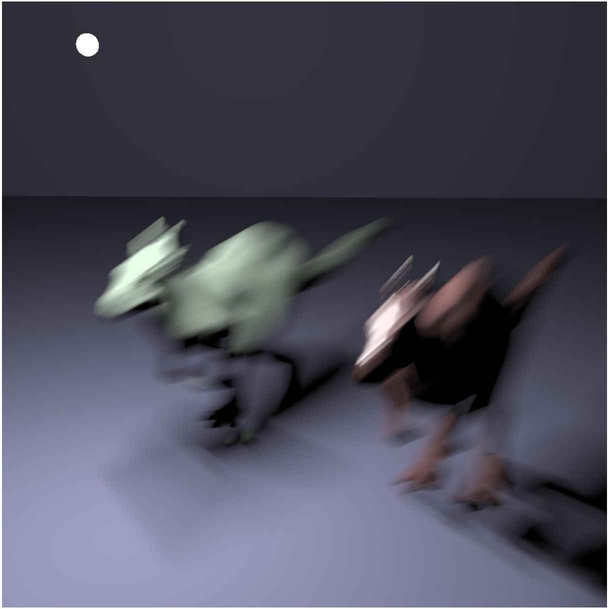
PBRT Features

TransformedPrimitive → AnimatedTransform

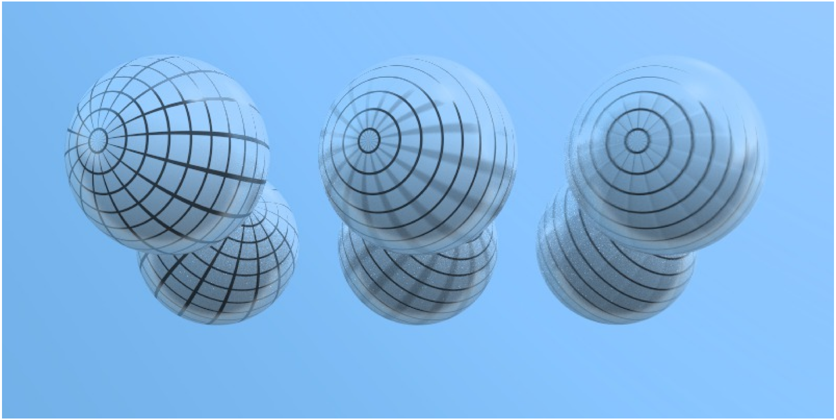
$$\text{AnimatedTransform} \rightarrow \begin{cases} \text{StartTransform} & \rightarrow M_0 = S_0 R_0 T_0 \\ \text{EndTransform} & \rightarrow M_1 = S_1 R_1 T_1 \end{cases}$$

$$\begin{aligned} \text{Transform(t)} &= \text{Interpolate(StartTransform,EndTransform,t)} \\ &= \text{Interp}(S_0, S_1, t) * \text{Interp}(R_0, R_1, t) * \text{Interp}(T_0, T_1, t) \end{aligned}$$

PBRT Example 1



PBRT Example 2



Part II: Implementation

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- Events handle: Flashing and Instants Description.

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- Events handle: Flashing and Instants Description.
- Extension of the motion transformations provided by PBRT.
- Time dependent attributes for light: Intensity and Position.

New Classes

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- LightEvents $\begin{cases}\text{InstantsDescriptor}\\ \text{DynamicSamplerRenderer}\end{cases}$

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- LightEvents $\left\{\begin{array}{l}\text{InstantsDescriptor}\\ \text{DynamicSamplerRenderer}\end{array}\right.$
- DynamicTransforms $\left\{\begin{array}{l}\text{DynamicPrimitives}\\ \text{DynamicLights}\end{array}\right.$

New Classes

- LightEvents $\begin{cases}\text{InstantsDescriptor}\\ \text{DynamicSamplerRenderer}\end{cases}$
- DynamicTransforms $\begin{cases}\text{DynamicPrimitives}\\ \text{DynamicLights}\end{cases}$
- LightIntensity

LightEvents

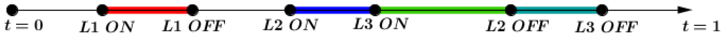
LightEvents : API

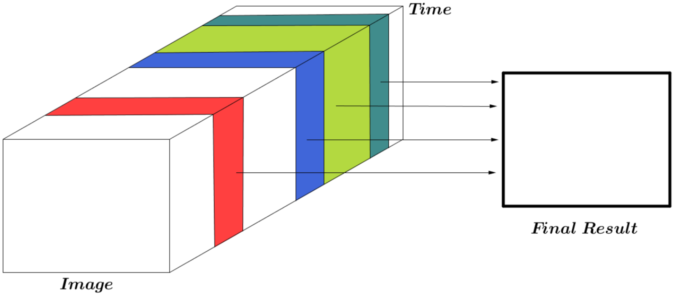
World Begin

LightSource ”spot” ”float tInitial”[0.3] ”float tFinal”[0.6]

World End

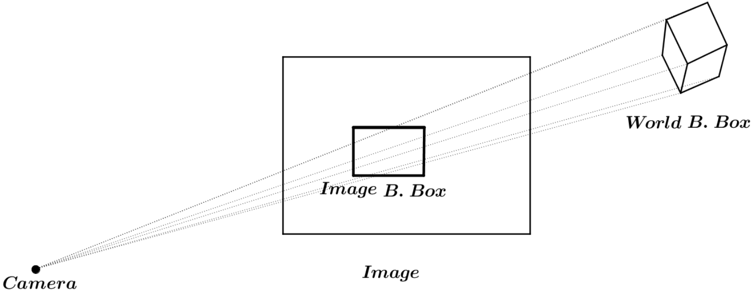
LightEvents Renderization



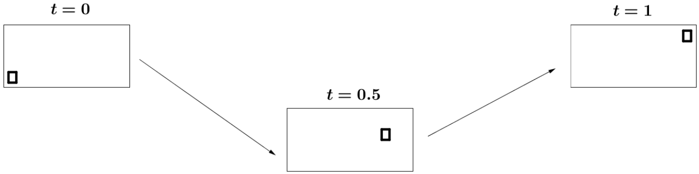


LightEvent Refinement: Instant Descriptor

Instant Descriptor: (Time, Image Bounding Box)



LightEvent Refinement: Subdivision by Image B. Box Movement



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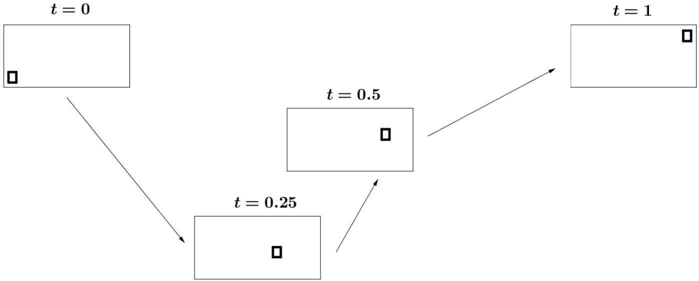

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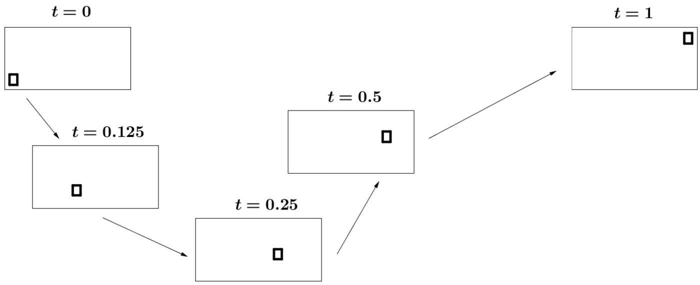


DynamicTransforms

DynamicTransforms : API

```
World Begin

DynamicTransform ”parabolic” ”point initialPosition” [0 1 0]
”vector initialVelocity” [3 0 0] ”vector acceleration” [0 0 10]
”vector axis” [1 1 0] ”float cycles” [5]

AttributeBegin
SetDynamicOn
Shape ”sphere”
SetDynamicOff
AttributeEnd

World End
```

DynamicTransform : Classes Structure

```
class DynamicPrimitive : public Primitive{
⋮
DynamicTransform * dynamics;
}

class Transform{
⋮
friend DynamicTransform;
}

virtual class DynamicTransform{
⋮
virtual void setTransformationMatrix(float time, Transform * t);
}
```

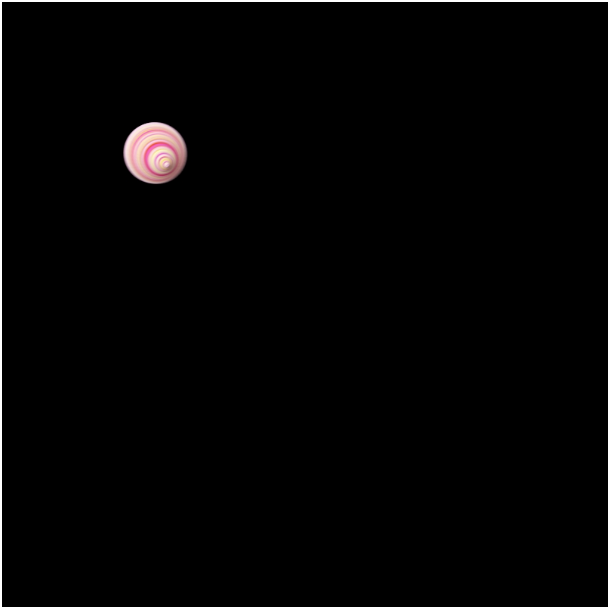
DynamicTransform : Classes Structure

```
class parabolicMovement: public DynamicTransform{
public:
⋮
void setTransformationMatrix(float time, Transform * t);
⋮
private:
Point initialPosition;
Vector initialVelocity;
Vector acceleration;
Vector axis;
float cycles;
}
```

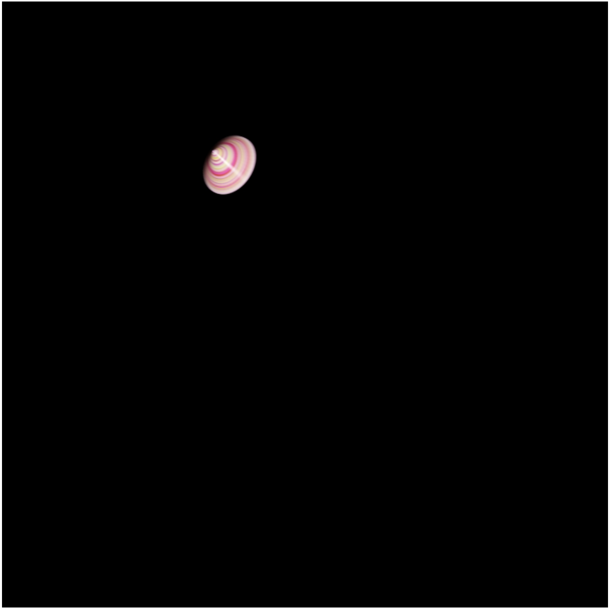
DynamicTransforms : Types

- Parabolic
- Piecewise Linear
- Helicoidal
- Simple Rotational

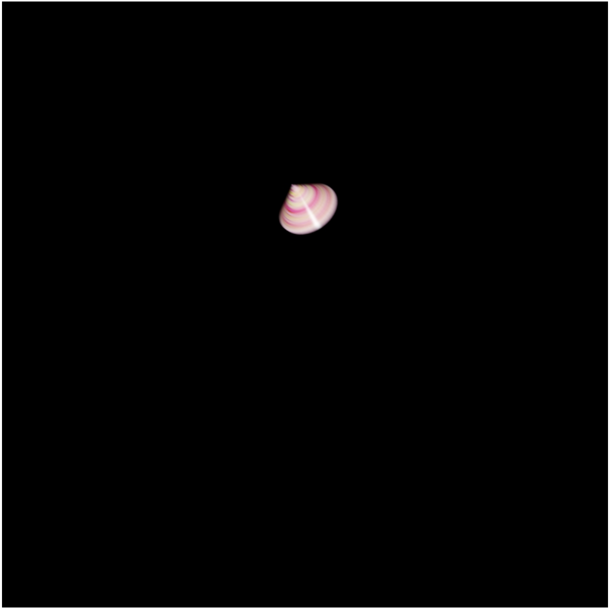
Parabolic



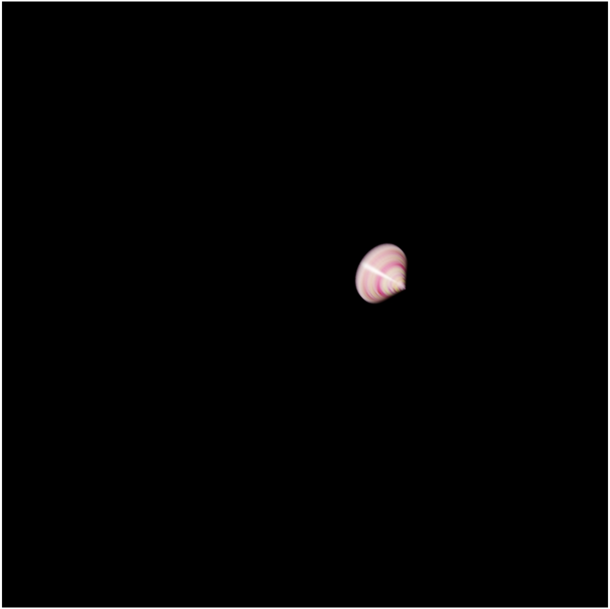
Parabolic



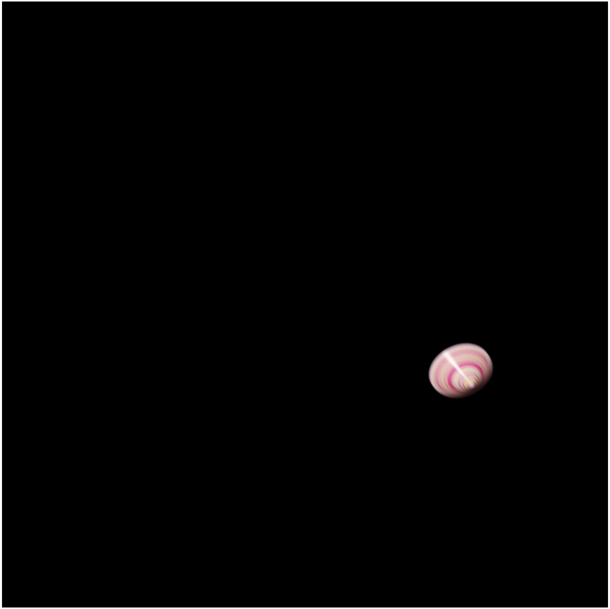
Parabolic



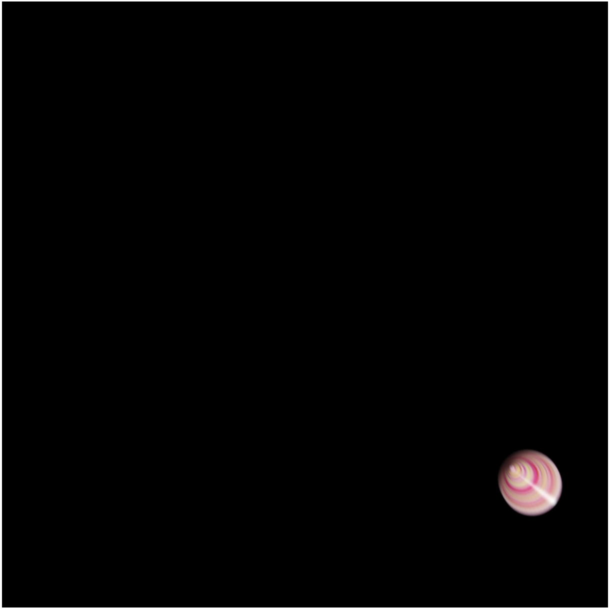
Parabolic



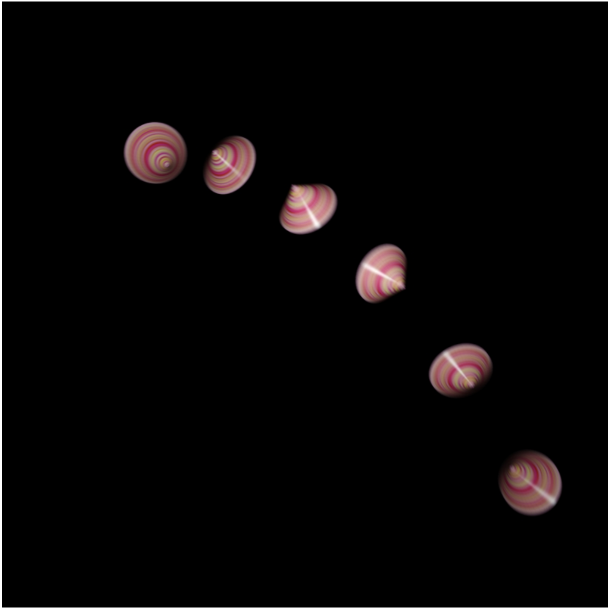
Parabolic



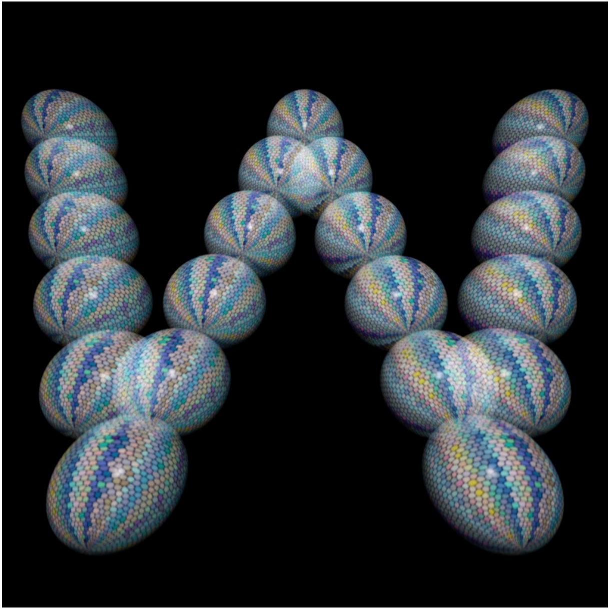
Parabolic



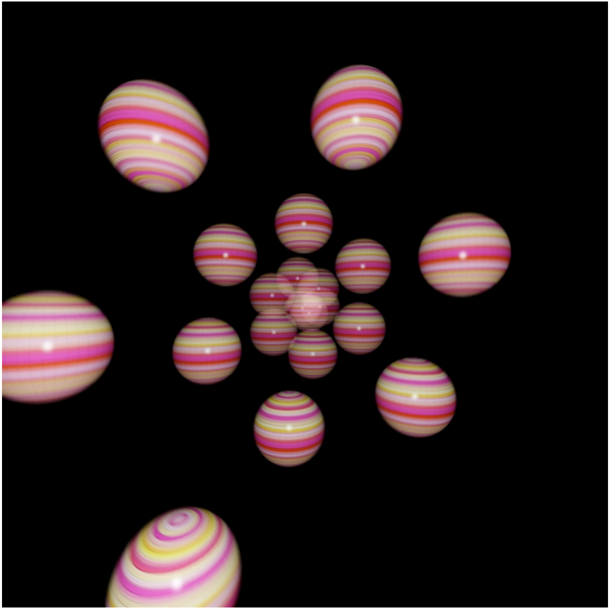
Parabolic



Piecewise Linear



Helicoidal



Simple Rotational

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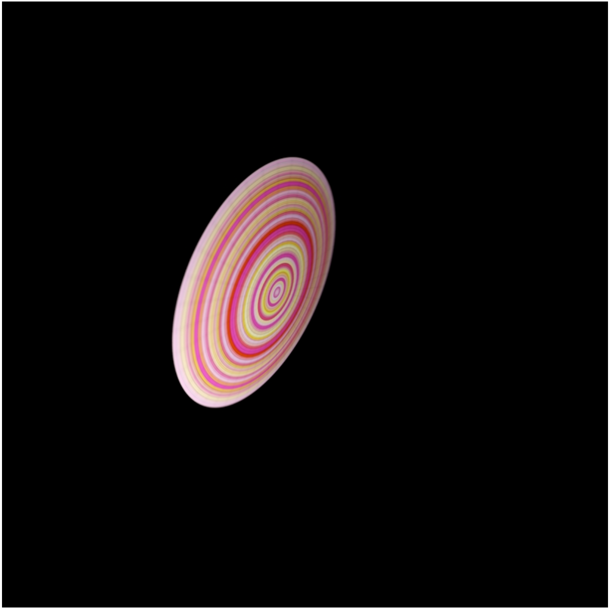

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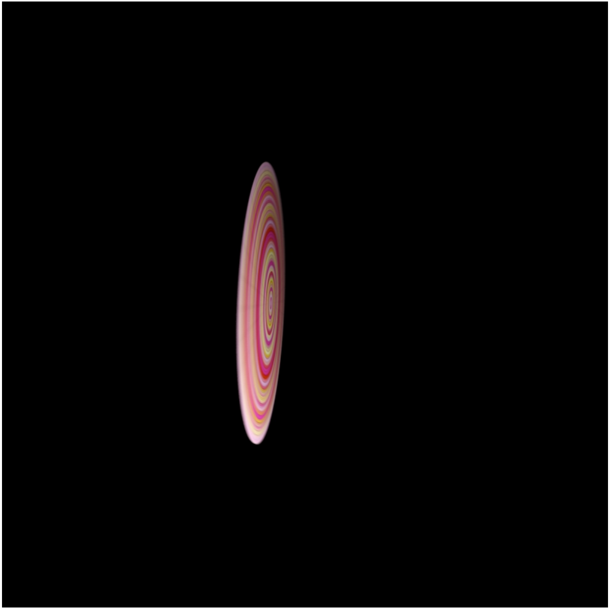

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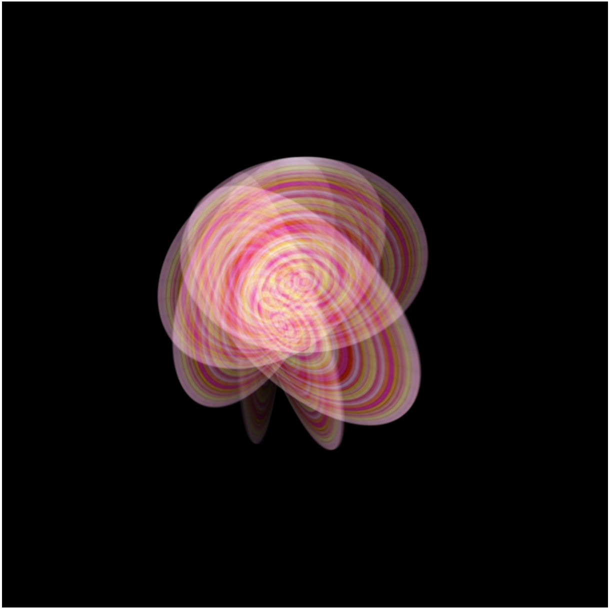


Dynamic Lights

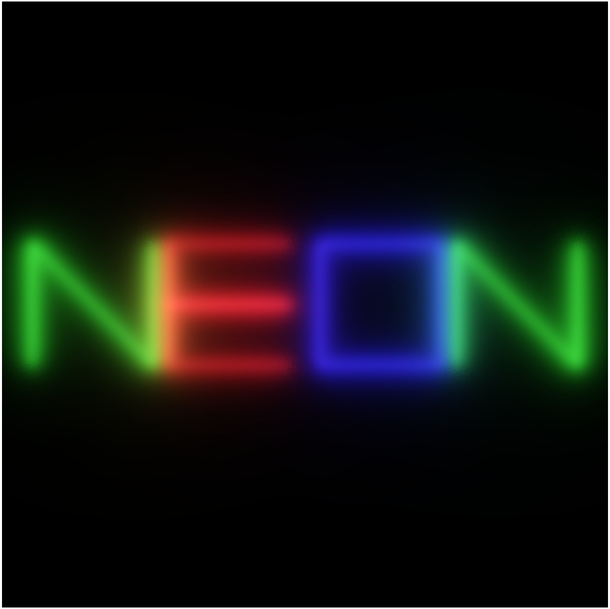
Dynamic Lights: Class Structure

```
class dynamicPointLight:Light{
⋮
DynamicTransform * dynamics;
}

class dynamicSpotLight:Light{
⋮
DynamicTransform * dynamics;
}
```

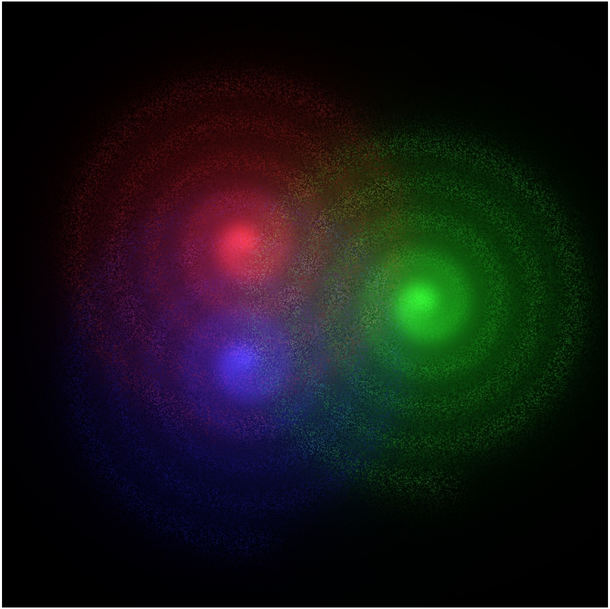
Dynamic Lights: API

```
World Begin

DynamicTransform ”piecewiseLinear” ”float timming” [0 0.5 1]
”float positions” [1 0 0 1 1 0 1 1 1]

SetDynamicOn
LightSource ”dynamicSpot”
SetDynamicOff

World End
```

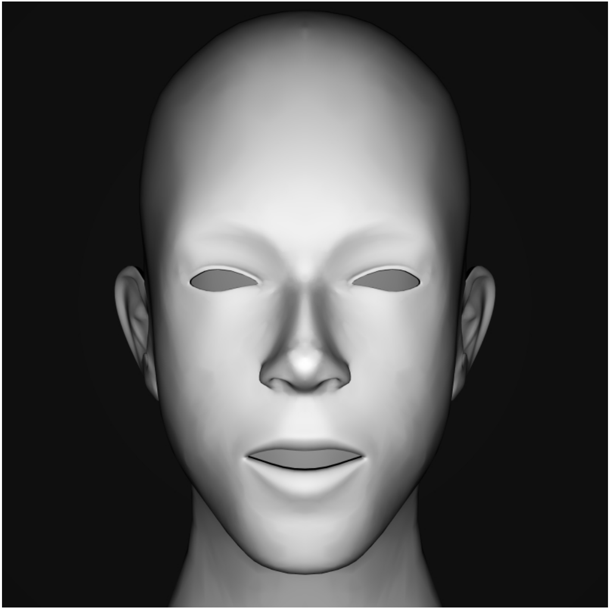
Dynamic Point Light: Example 1



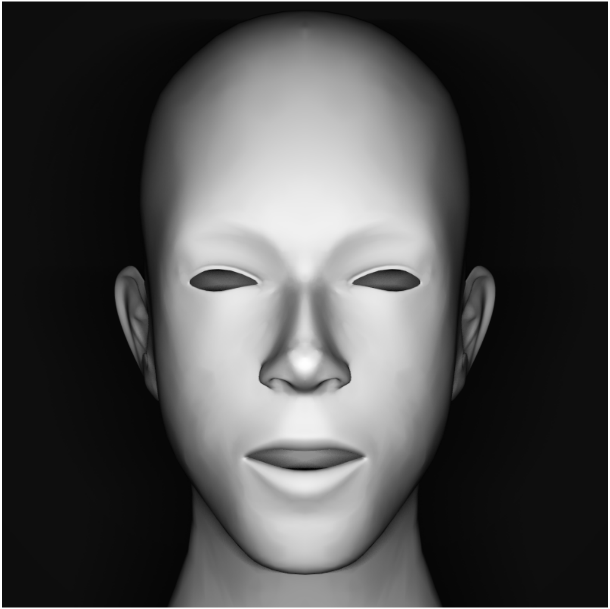
Dynamic Point Light: Example 1



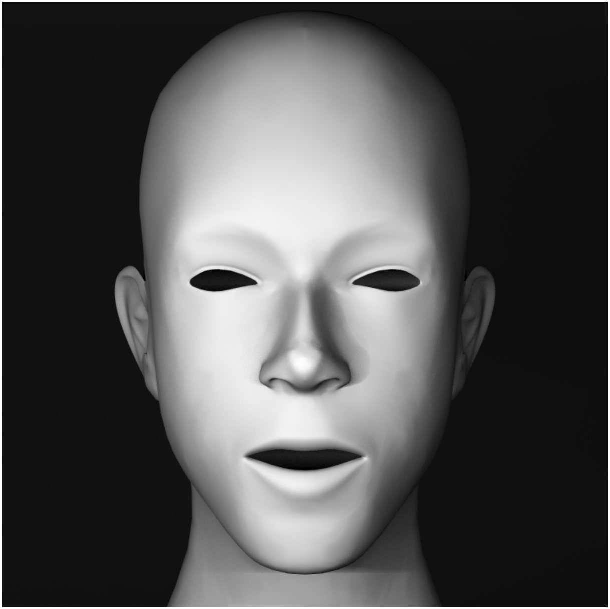
Spot Light. Hard Shadow



Dynamic Spot Light. Soft Shadows : Linear Movement

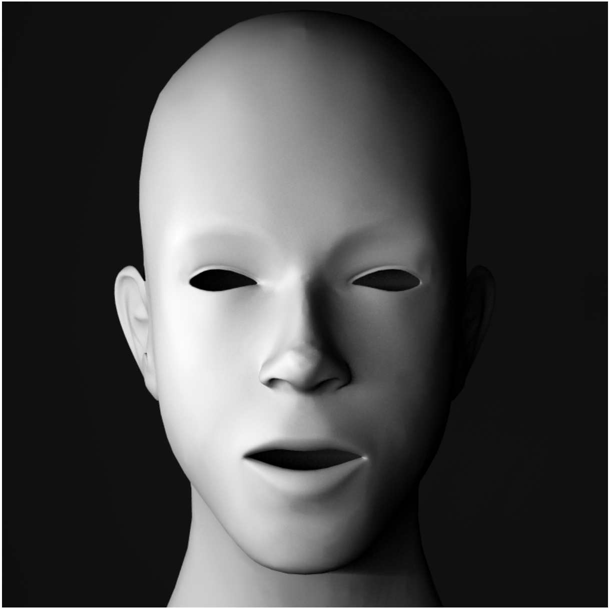


Dynamic Spot Light. Soft Shadows : Accelerated Mov.



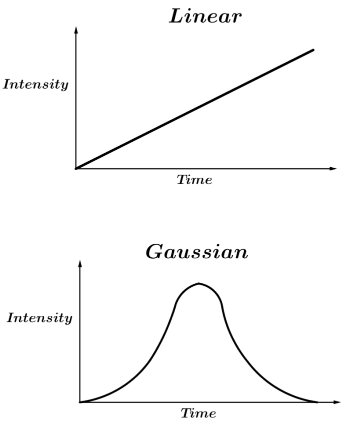
Dynamic Spot Light. Soft Shadows : Complete Rotation

Dynamic Spot Light. Soft Shadows : Quarter Rotation



LightIntensity

LightIntensity: Types



Linear

Hat

Gaussian

Exponential

LightIntensity : API

World Begin

LightIntensity ”gaussian” ”float mean” [0.5] ”float deviation” [0.1]

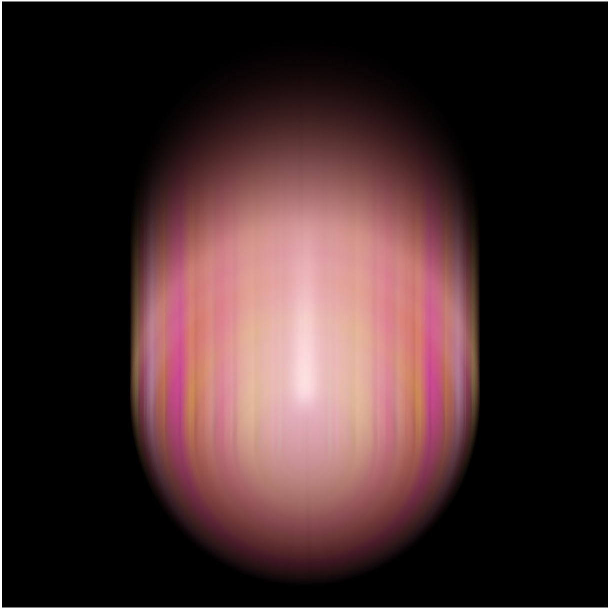
LightSource ”spot”

World End

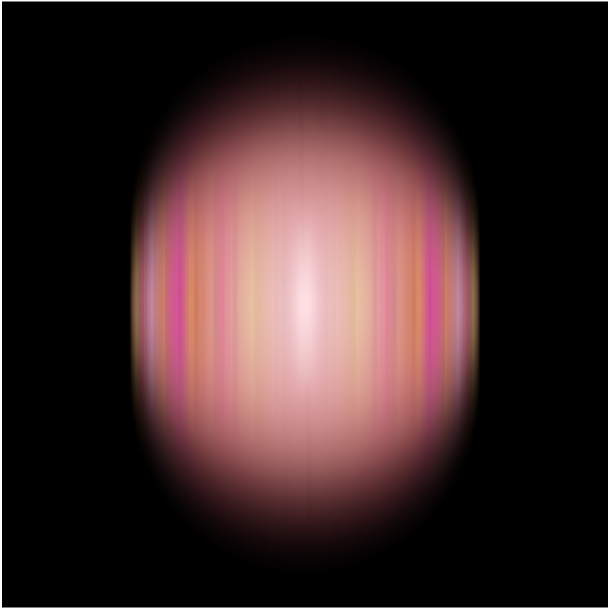
LightIntensity : Class Structure

```
class SpothLight: public Light{
⋮
LightIntensity * intensity;
}


virtual class LightIntensity{
virtual float intensity(float time);
}


class gaussianIntensity: public LightIntensity{
public:
float intensity(float time);
private:
float mean;
float deviation;
}
```

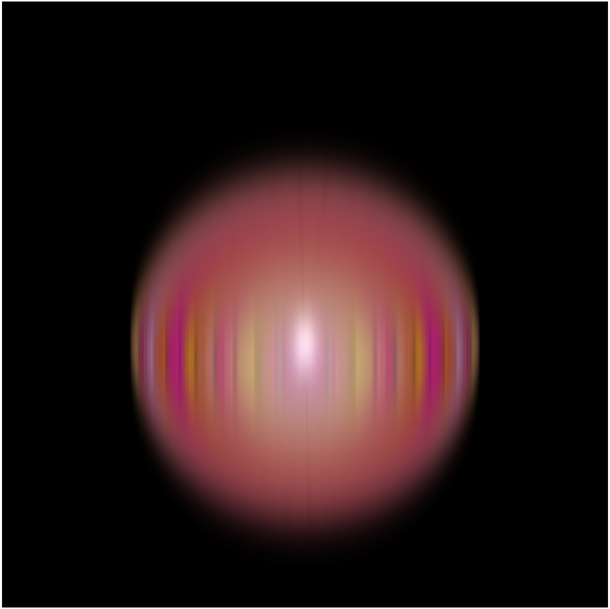
LightIntensity : Linear



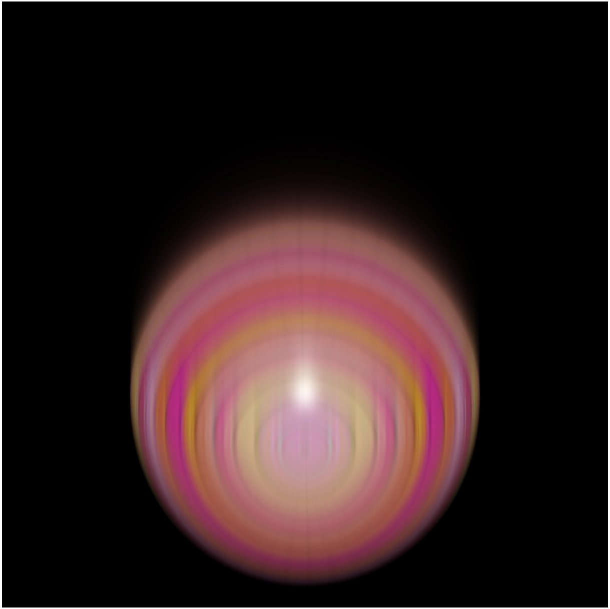
LightIntensity : Hat



LightIntensity : Gaussian

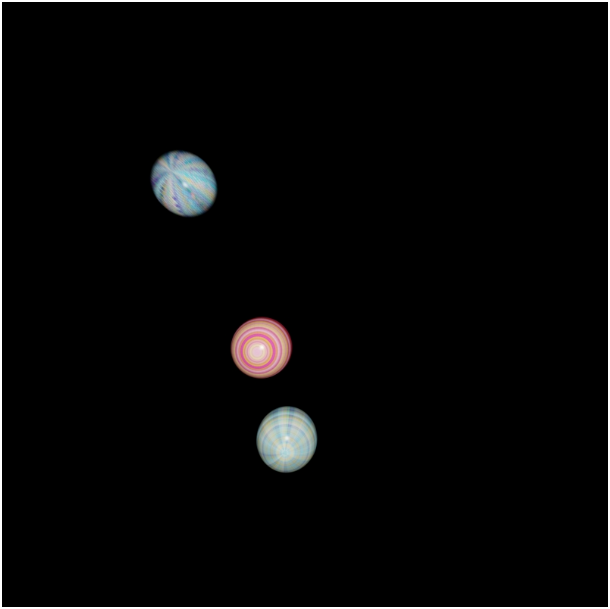


LightIntensity : Exponential

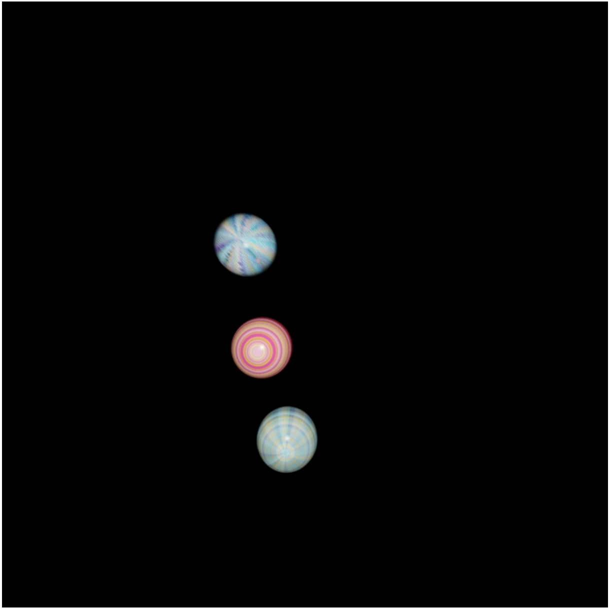


Part III: Additional Scenes

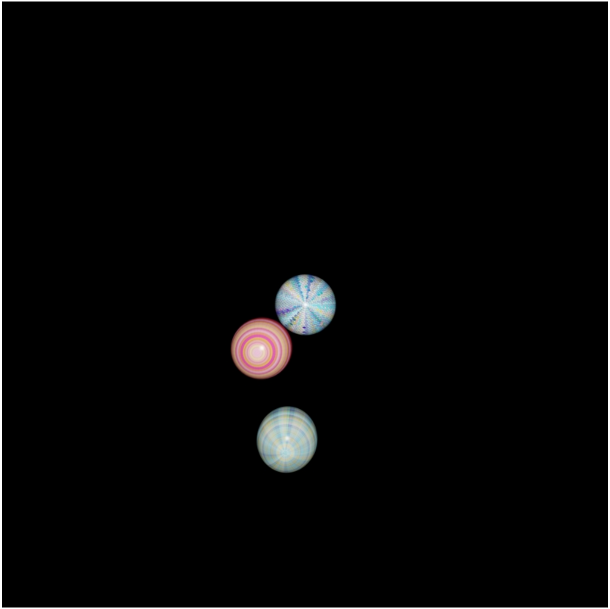
Multi Dynamic Objects



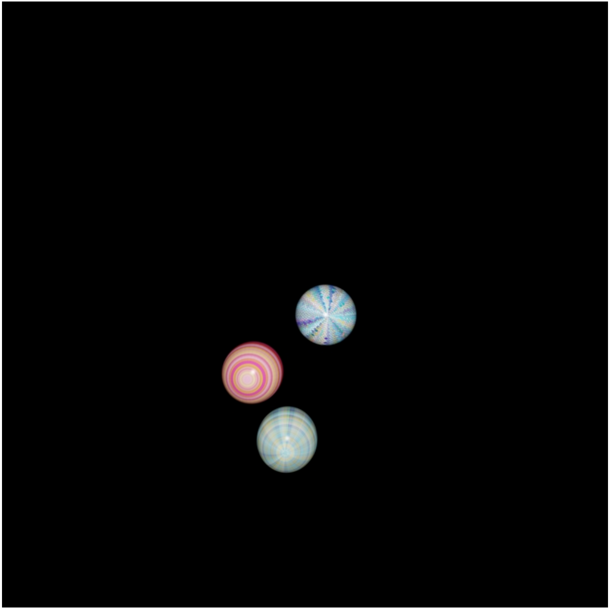
Multi Dynamic Objects



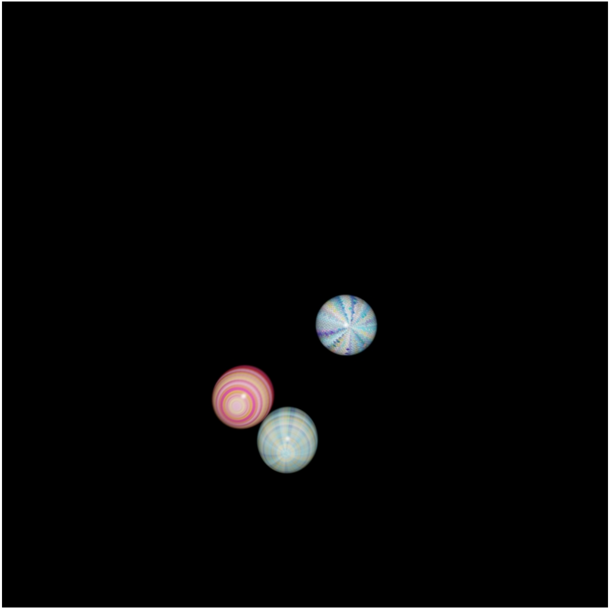
Multi Dynamic Objects



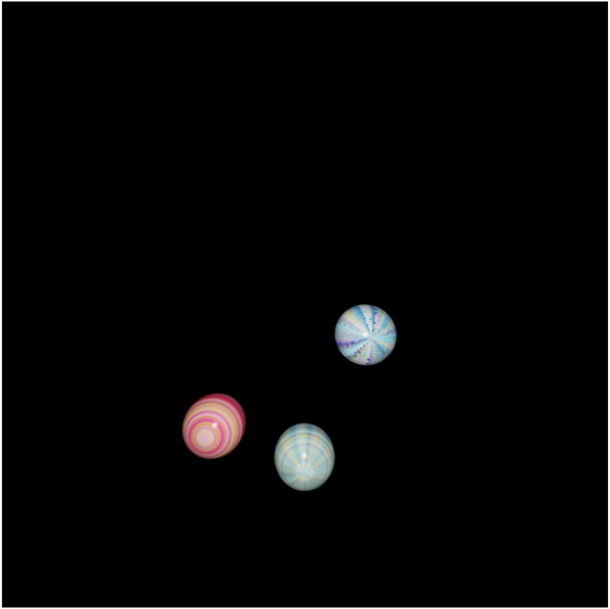
Multi Dynamic Objects



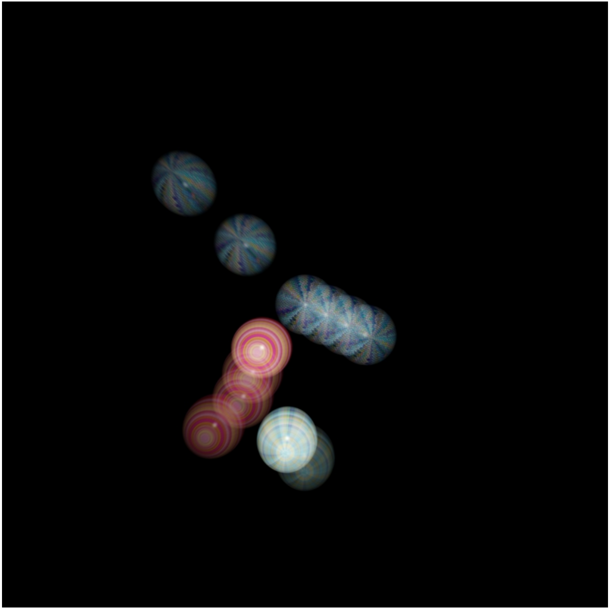
Multi Dynamic Objects



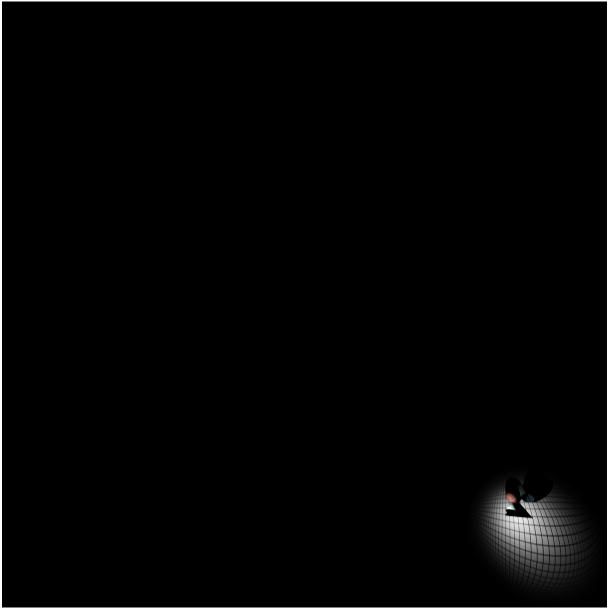
Multi Dynamic Objects



Multi Dynamic Objects



Specular Dynamic Object



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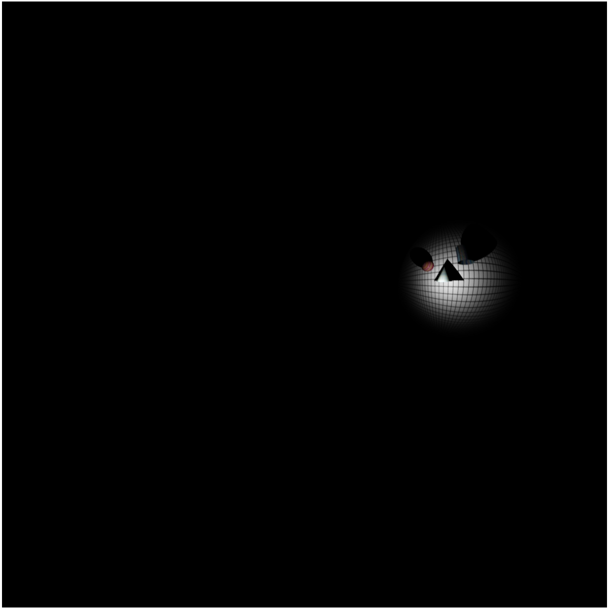
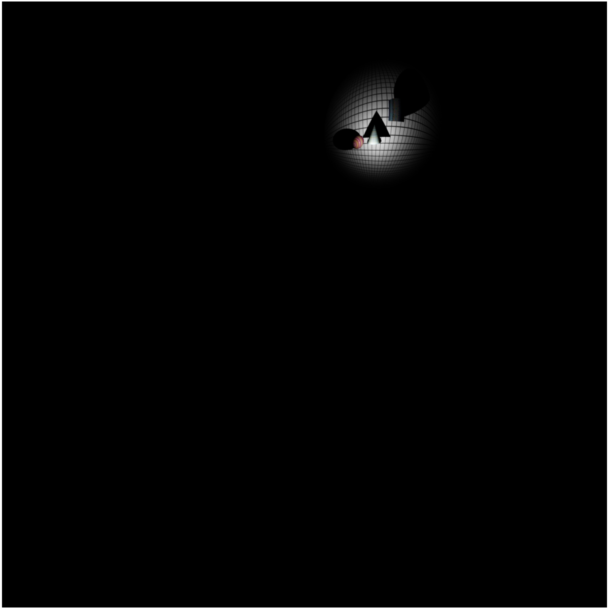
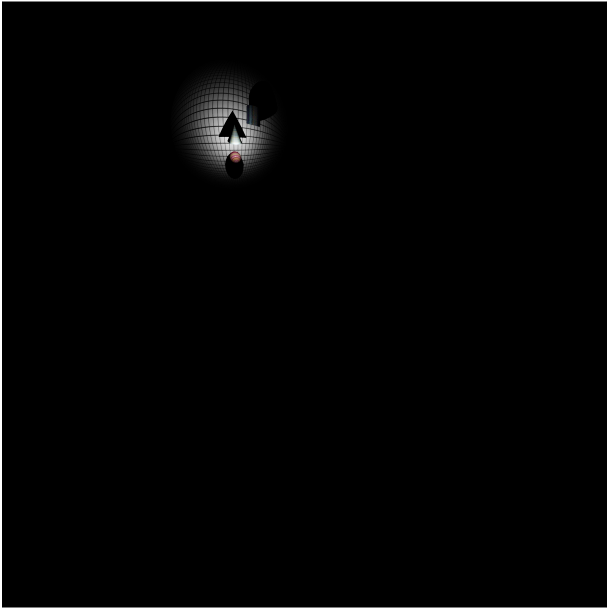


Specular Dynamic Object



Specular Dynamic Object

Specular Dynamic Object



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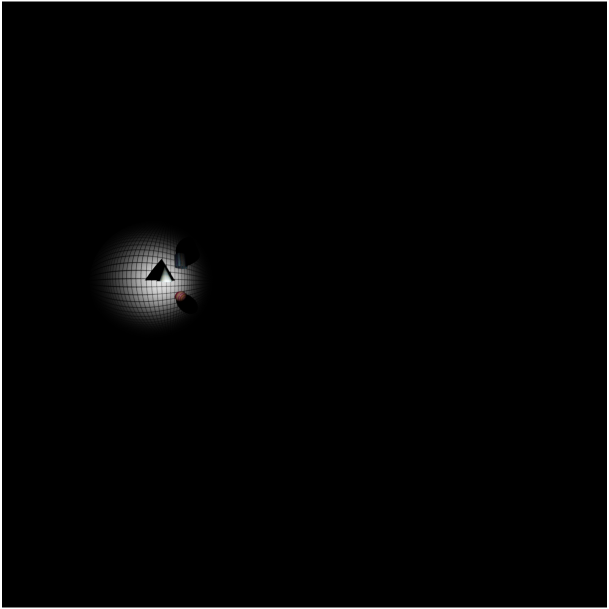
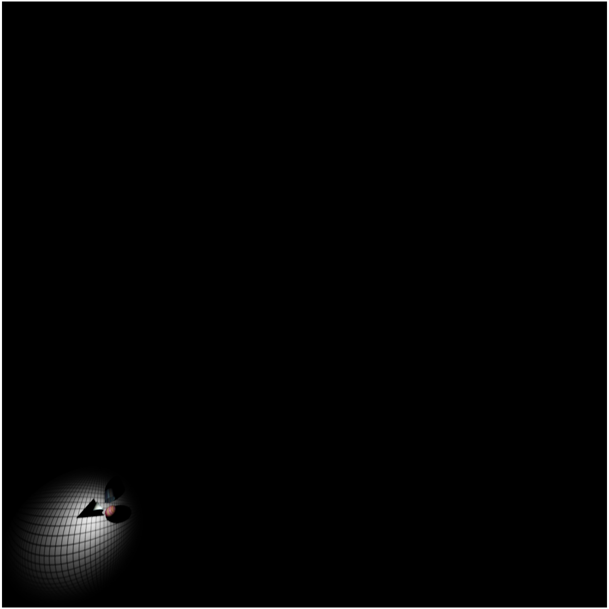
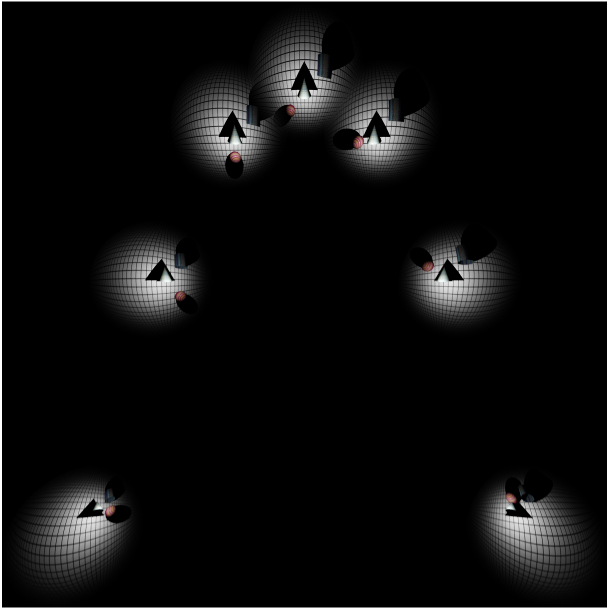


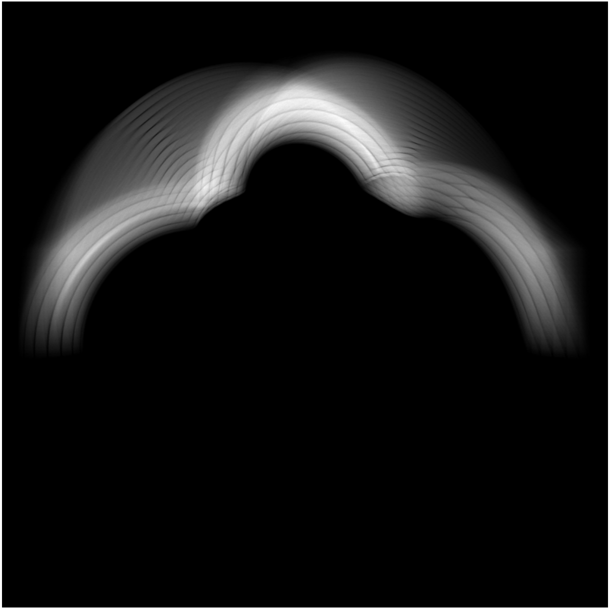
Specular Dynamic Object



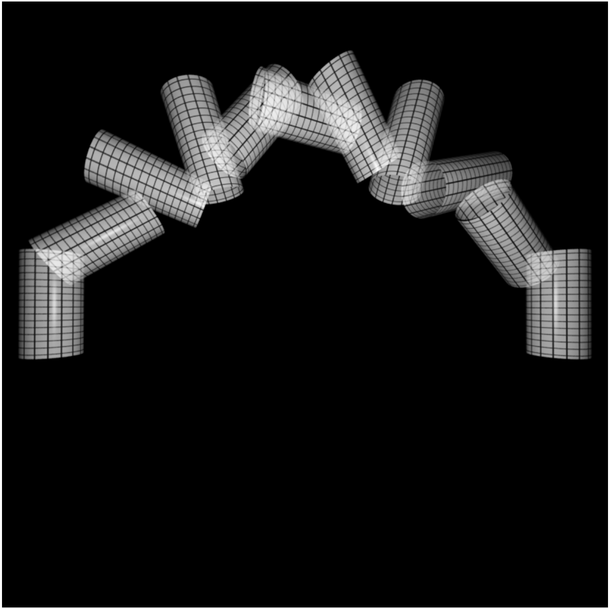
Specular Dynamic Object



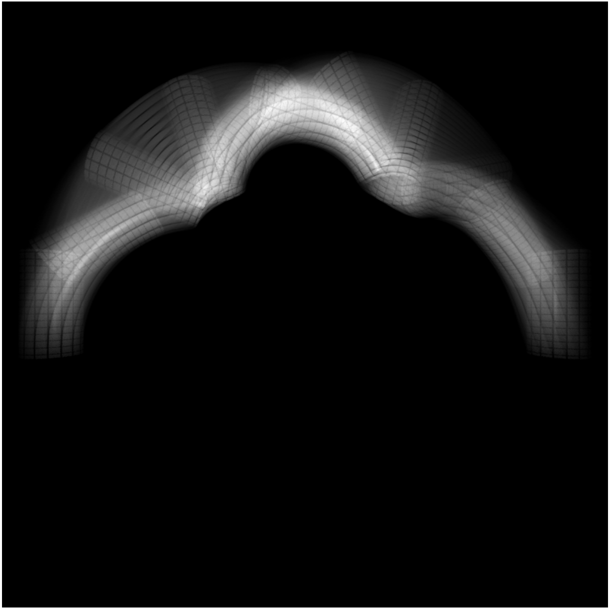
Light Configurations: Permanent



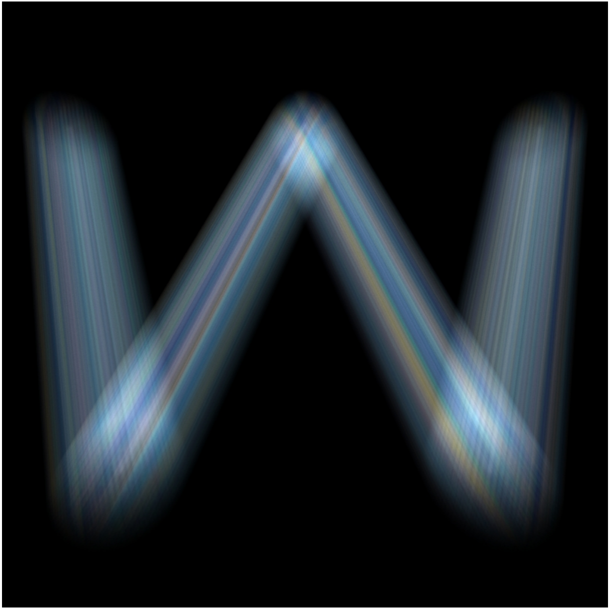
Light Configurations: Flash



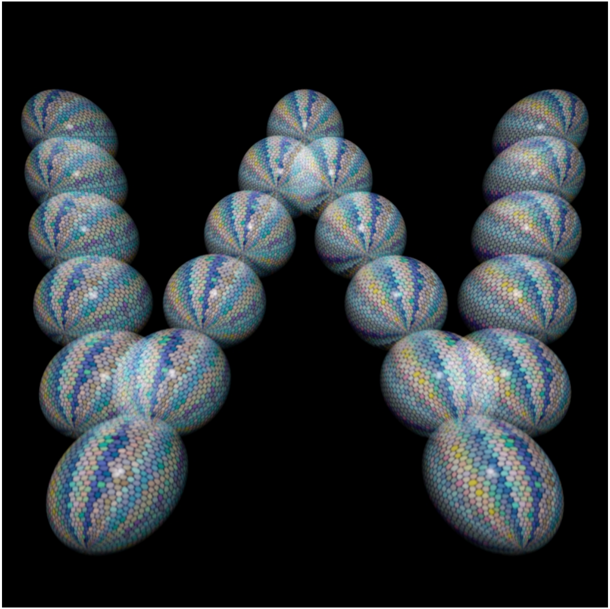
Light Configurations: Flash + Permanent



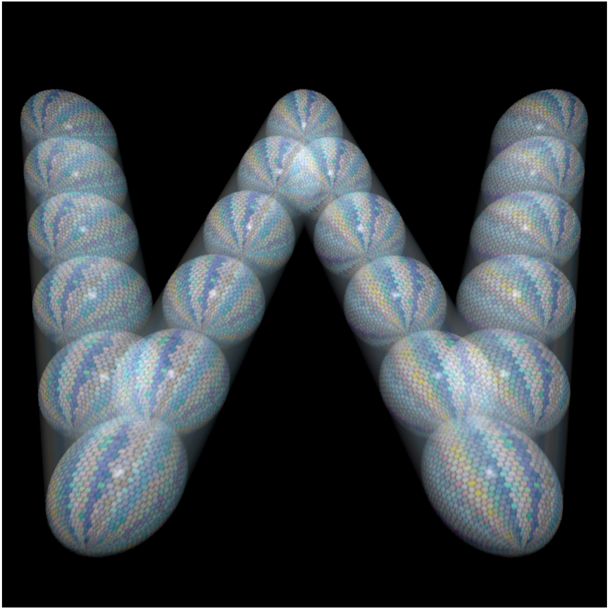
Light Configurations: Permanent



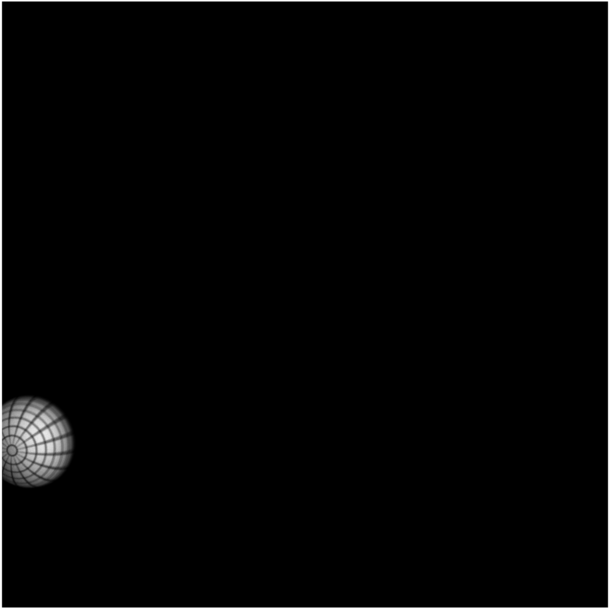
Light Configurations: Flash



Light Configurations: Flash + Permanent



Realistic Camera and Motion



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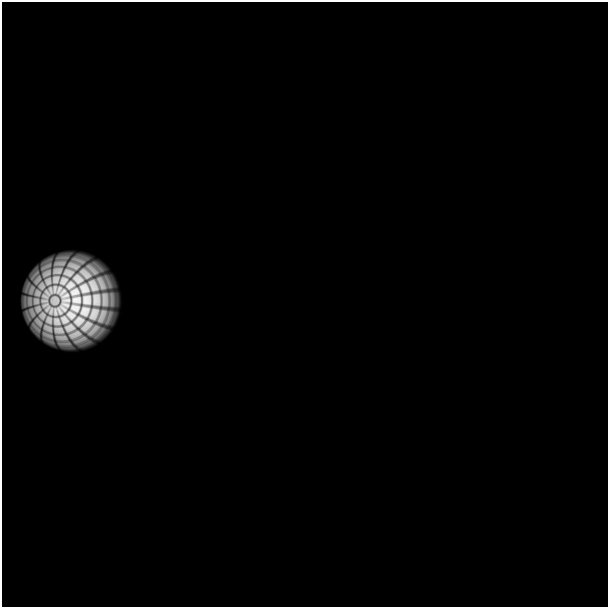

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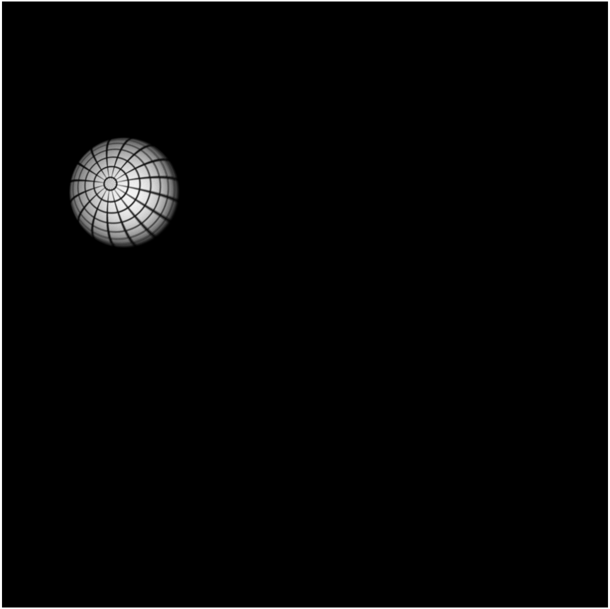
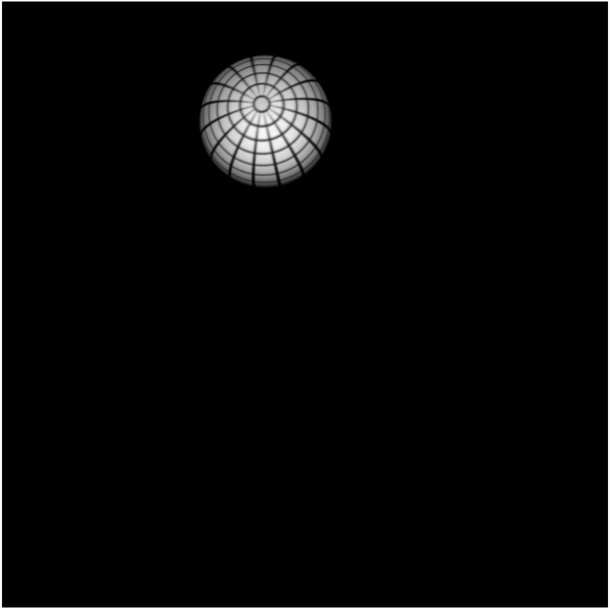
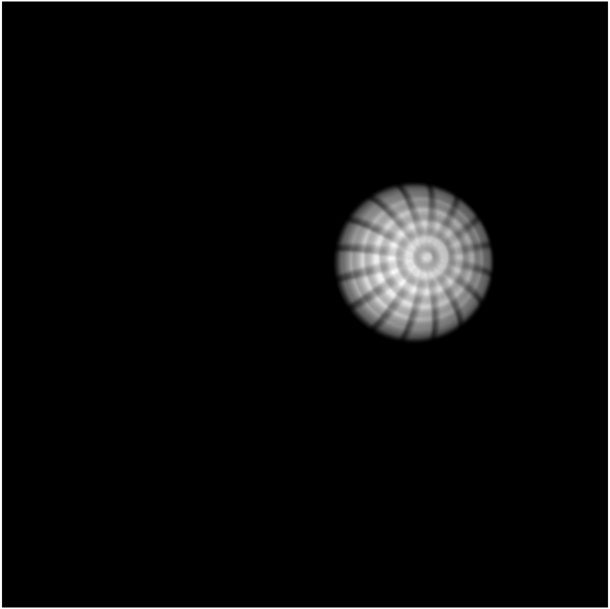


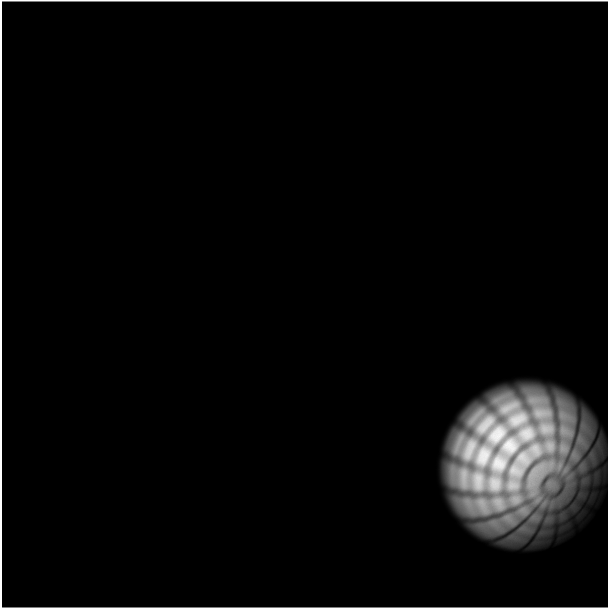
Realistic Camera and Motion



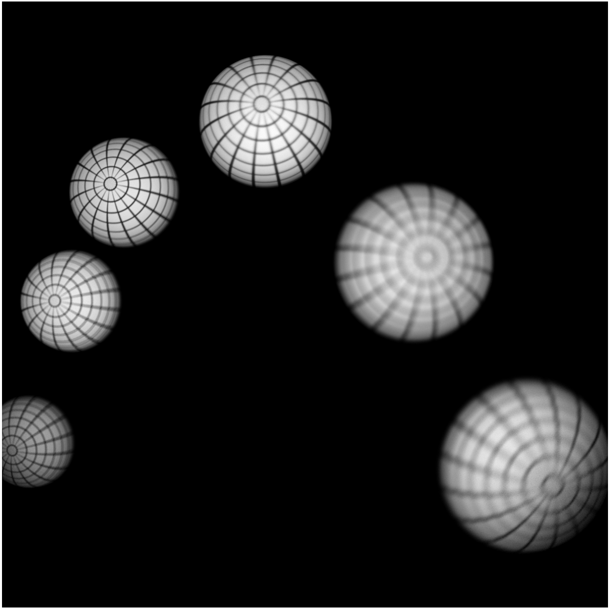
Realistic Camera and Motion



Realistic Camera and Motion



Realistic Camera and Motion



Conclusions

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- Specific acceleration structures for dealing with dynamical objects improves the efficiency of the ray tracing process
- Better sampling and reconstruction strategies are still required to reduce the computational cost of renderization.

Obrigado!

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