Computer Graphics

Lecture 10 – Particle Systems

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Particle Systems

- Particles are small images or meshes that are displayed and moved in great numbers by a particle system.
- Each particle represents a small portion of a fluid or amorphous entity and the effect of all the particles together creates the impression of the complete entity.
- **Examples:** clouds, fire, rain, smoke, etc.

Particle Systems

- Each particle has a predetermined lifetime (few seconds), during which it can undergo various changes (form, color, transparency, etc.).

- The system emits particles at random positions within a region of space according to an emission rate, which indicates roughly how many particles are emitted per second.

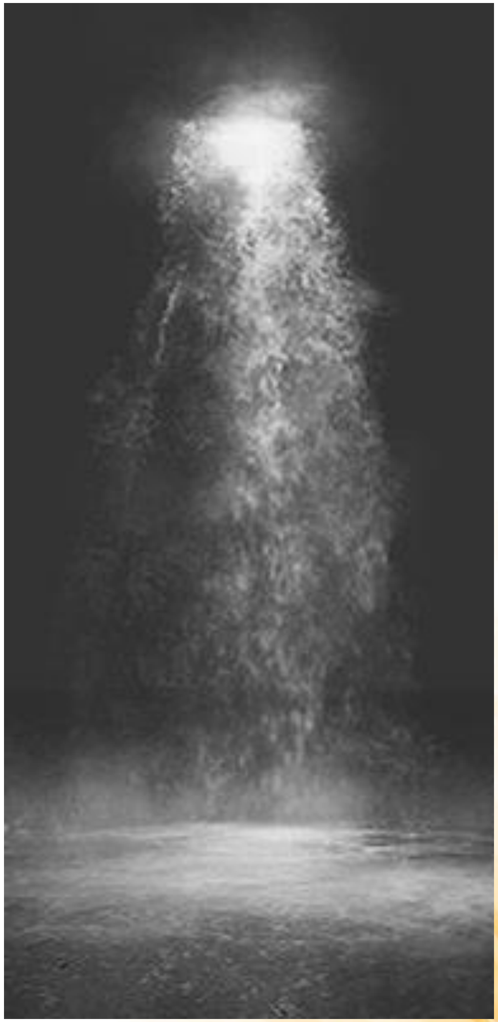
- The particle is displayed until its time is up, at which point it is removed from the system.

Particle Systems

- The emission and lifetime affect the overall behavior of the system but the individual particles can also change over time.

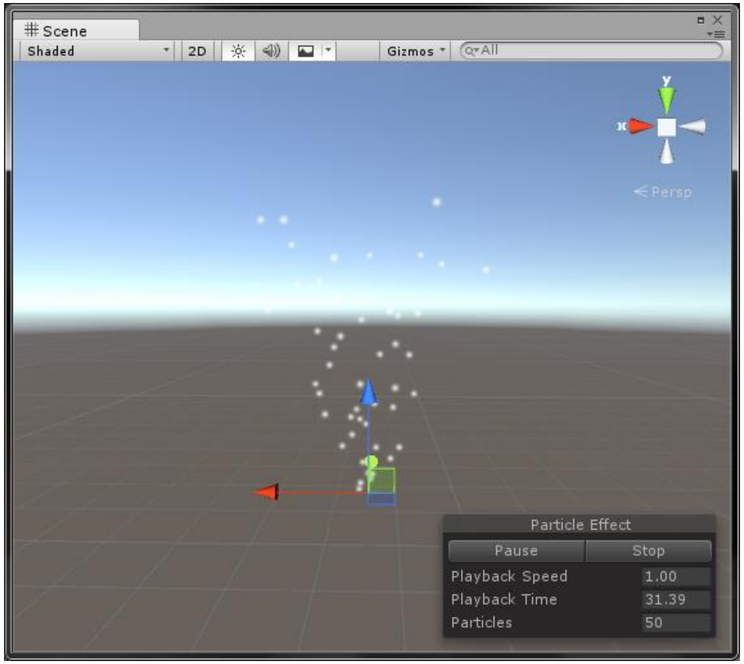
- Each particle has a velocity vector that determines the direction and distance the particle moves.

- The velocity can be changed by forces and gravity applied by the system itself or when the particles are blown around by a wind zone on a Terrain.



Particle Systems in Unity

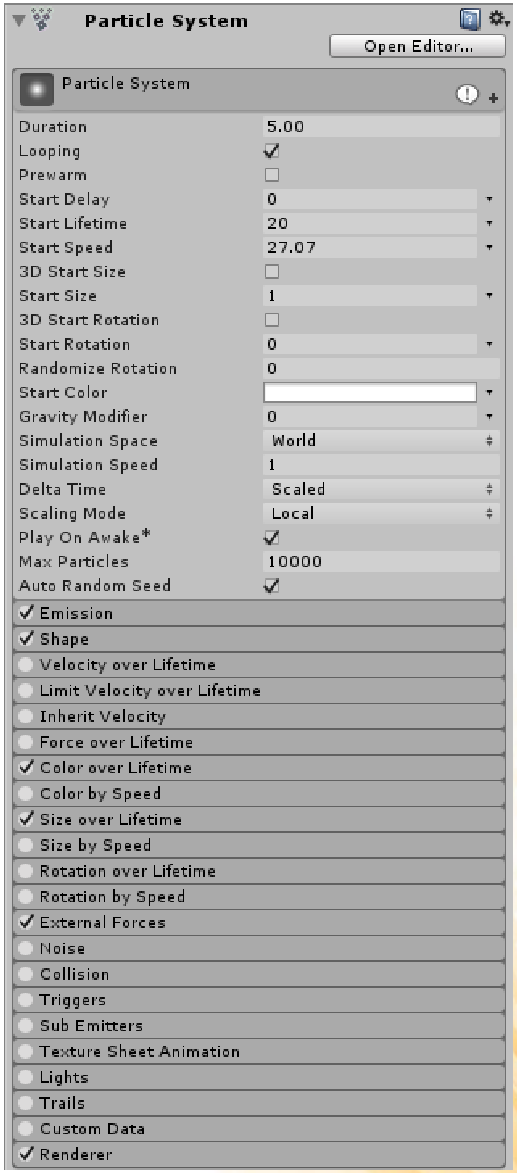
- **Create a new particle system:** GameObject -> Effects -> Particle System (or Component -> Effects -> Particle System).



Particle Effect

Pause | Stop

Playback Speed	1.00
Playback Time	31.39
Particles	50



Particle System

Duration	5.00
Looping	☑
Prewarm	☐
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	☐
Start Size	1
3D Start Rotation	☐
Start Rotation	0
Randomize Rotation	0
Start Color	
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
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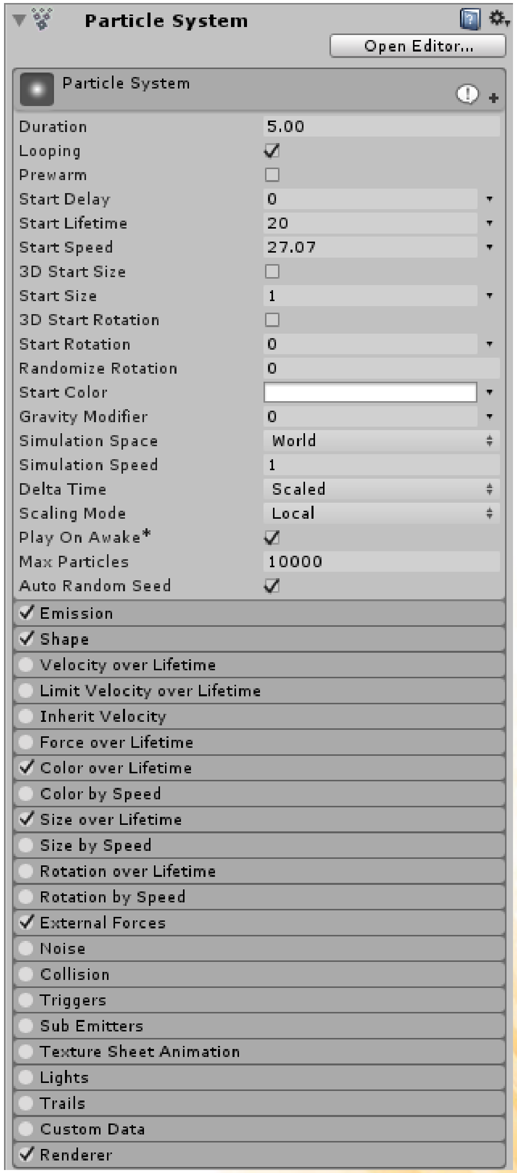
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Particle Systems in Unity

- **Properties:**
  - **Duration**: length of time the system runs;
  - **Looping**: if enabled, the system starts again at the end of its duration time (loop);
  - **Prewarm: if** enabled, the system is initialized as if it had already completed a full cycle;
  - **Start Delay:** delay in seconds before the system starts emitting once enabled;
  - **Start Lifetime:** the initial lifetime for particles;
  - **Start Speed:** the initial speed of each particle;
  - **Start Size:** initial size of each particle;



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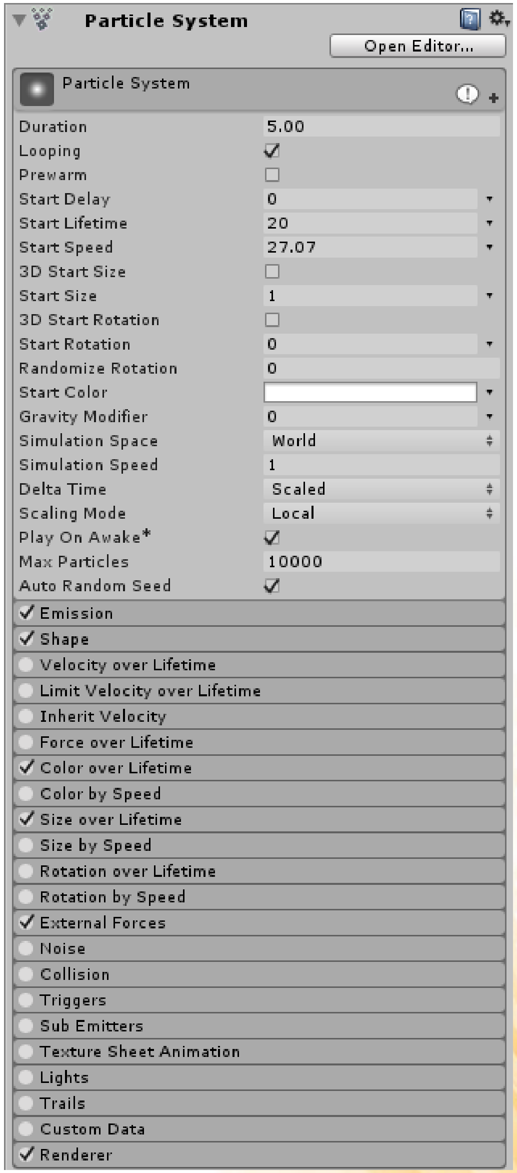
✓ Renderer

Particle Systems in Unity

- **Properties:**
  - **Start Rotation:** initial rotation angle of each particle;
  - **Randomize Rotation Direction:** causes some particles to spin in the opposite direction;
  - **Start Color**: initial color of each particle;
  - **Gravity Modifier:** scales the gravity value (set in the physics manager);
  - **Play on Awake: i**f enabled, the Particle System starts automatically when the object is created;
  - **Max Particles:** maximum number of particles in the system at once;



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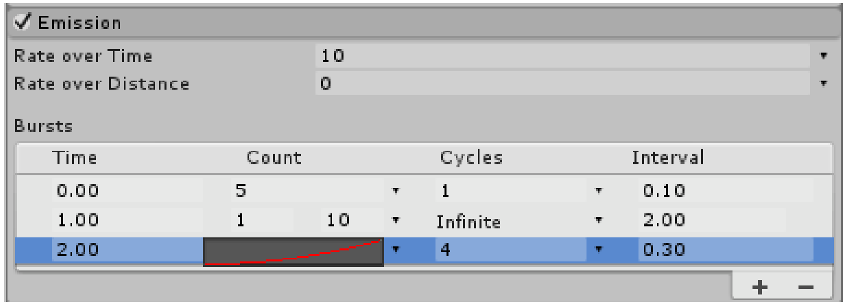
- ✓ Renderer

Particle Systems in Unity

- **Properties (Emission):**
  - Affects the rate and timing of Particle System emissions.



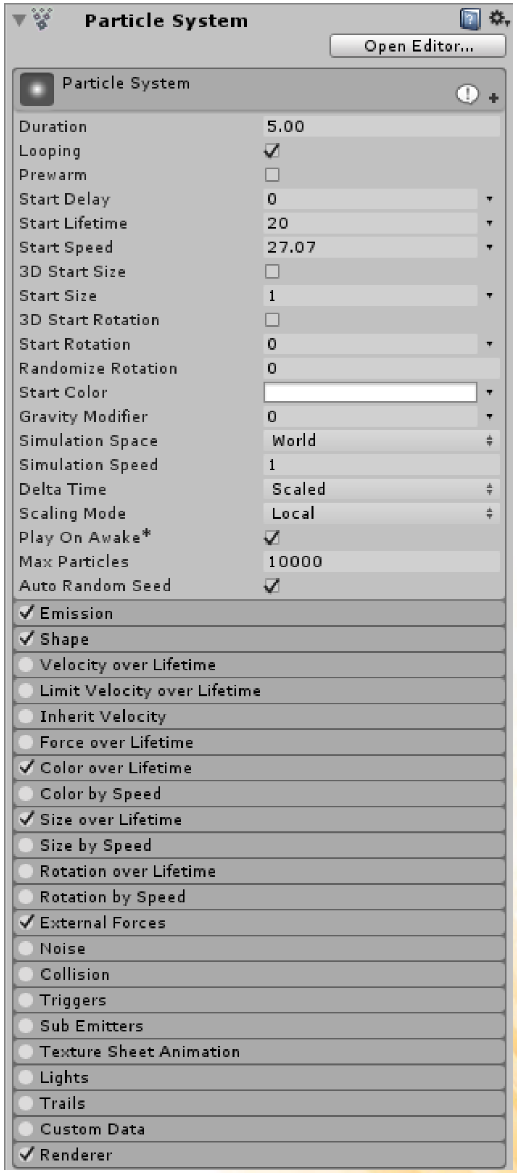
✓ Emission

Rate over Time	10
Rate over Distance	0

Bursts

Time	Count	Cycles	Interval
0.00	5	1	0.10
1.00	1 10	Infinite	2.00
2.00		4	0.30

  - **Rate over Time**: number of particles emitted per unit of time;
  - **Rate over Distance**: number of particles emitted per unit of distance moved;
  - **Bursts**: allow burst of particles to be emitted at specified times;



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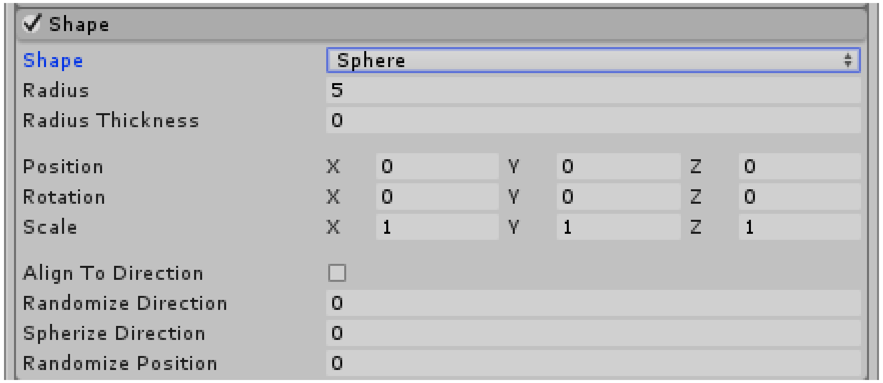
Particle Systems in Unity

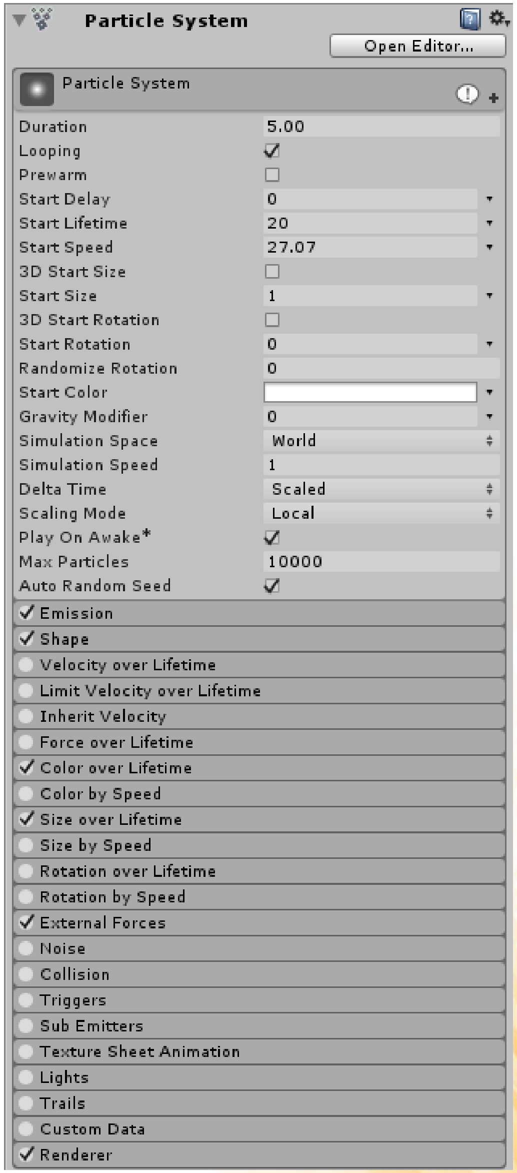
- **Properties (Shape):**
  - defines the shape (the volume or surface) from where particles are emitted.



✓ Shape

Shape	Sphere					
Radius	5					
Radius Thickness	0					
Position	X 0		Y 0		Z 0	
Rotation	X 0		Y 0		Z 0	
Scale	X 1		Y 1		Z 1	
Align To Direction	□					
Randomize Direction	0					
Spherize Direction	0					
Randomize Position	0					

  - **Shape**: shape of the emission volume;
    - Sphere, Hemisphere, Cone, Box, Donut, Mesh, MeshRenderer, Skinned MeshRenderer, Circle and Edge.



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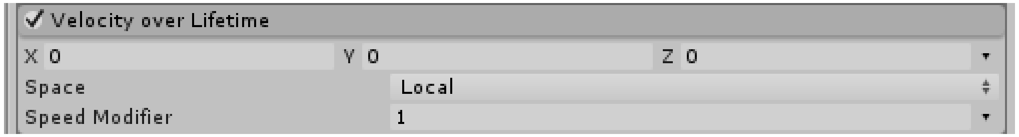
Other Properties: http://docs.unity3d.com/Manual/PartSysShapeModule.html

Particle Systems in Unity

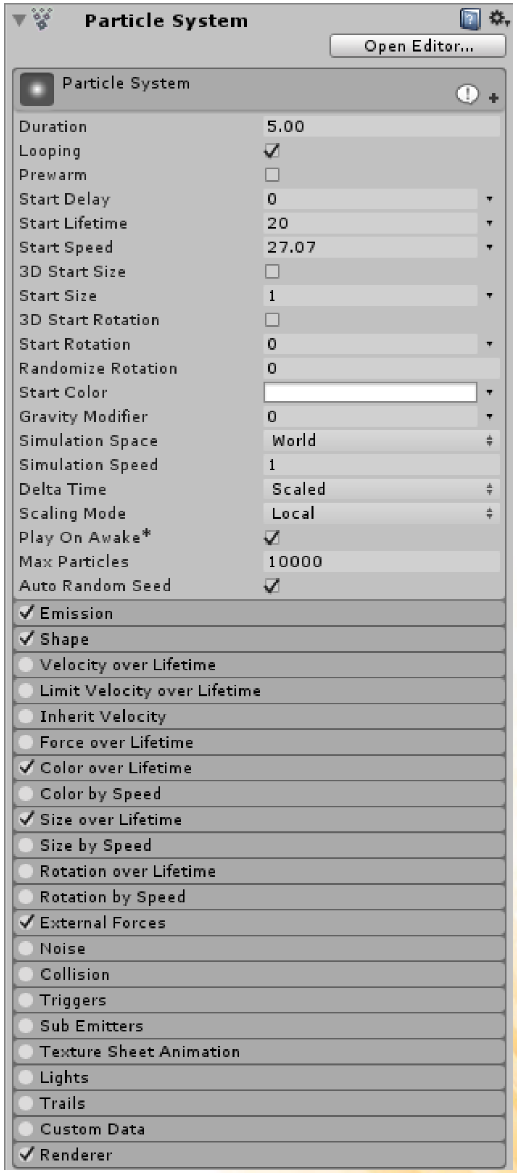
- **Properties (Velocity Over Lifetime):**
  - Control the velocity of particles over their lifetime.



☑ Velocity over Lifetime

X 0	Y 0	Z 0
Space	Local	
Speed Modifier	1	

  - **X, Y e Z**: Velocity in the X, Y and Z axes;
  - **Space**: local or world space;
  - **Speed Modifier:** applies a multiplier to the speed of particles, along their current direction of travel.



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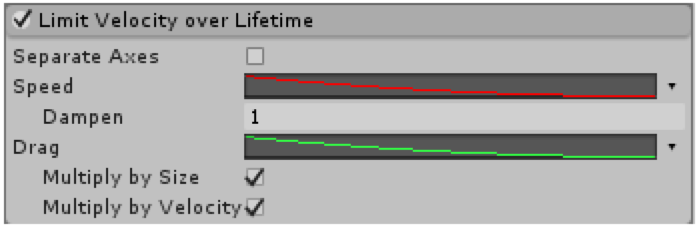
✓ Renderer

Particle Systems in Unity

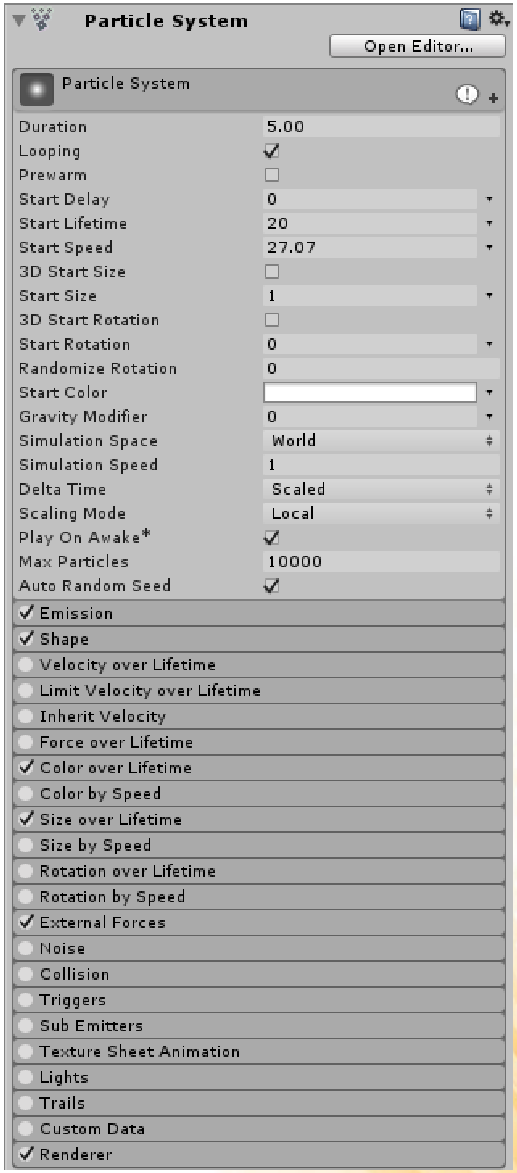
- **Properties (Limit Velocity Over Lifetime):**
  - Controls how the speed of particles is reduced over their lifetime..



☑ Limit Velocity over Lifetime

Separate Axes	□
Speed	
Dampen	1
Drag	
Multiply by Size	☑
Multiply by Velocity	☑

  - **Speed**: sets the speed limit of the particles. (constant, curve, random);
  - **Dampen**: fraction by which a particle's speed is reduced when it exceeds the speed limit;
  - **Drag**: applies linear drag to the particle velocities.
  - *Examples: air resistance, fireworks explosion.*



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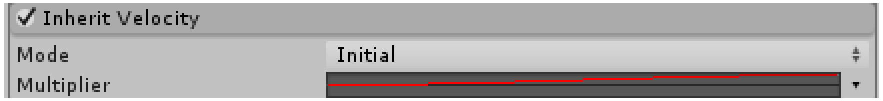
☑ Renderer

Particle Systems in Unity

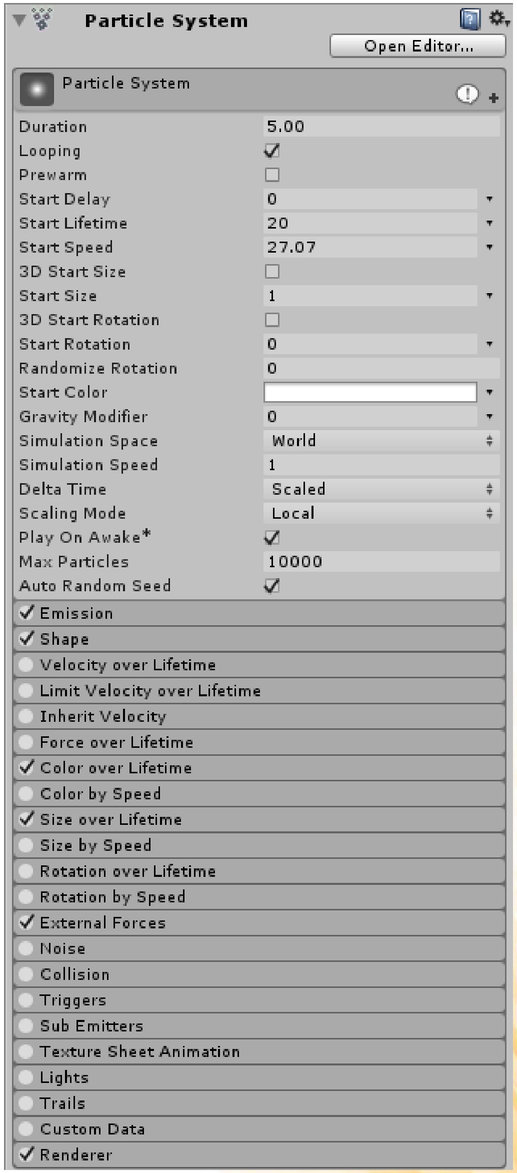
- **Properties (Inherit Velocity):**
  - Controls how the speed of particles reacts to movement of their parent object over time.



✓ Inherit Velocity

Mode	Initial
Multiplier	

  - **Mode**: how the emitter velocity is applied to particles (current ou initial);
  - **Multiplier**: proportion of the emitter's velocity that the particle should inherit;
  - *Examples: dust clouds from a car, smoke from a rocket, steam from a steam train's chimney.*



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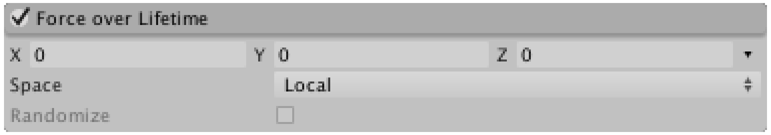
✓ Renderer

Particle Systems in Unity

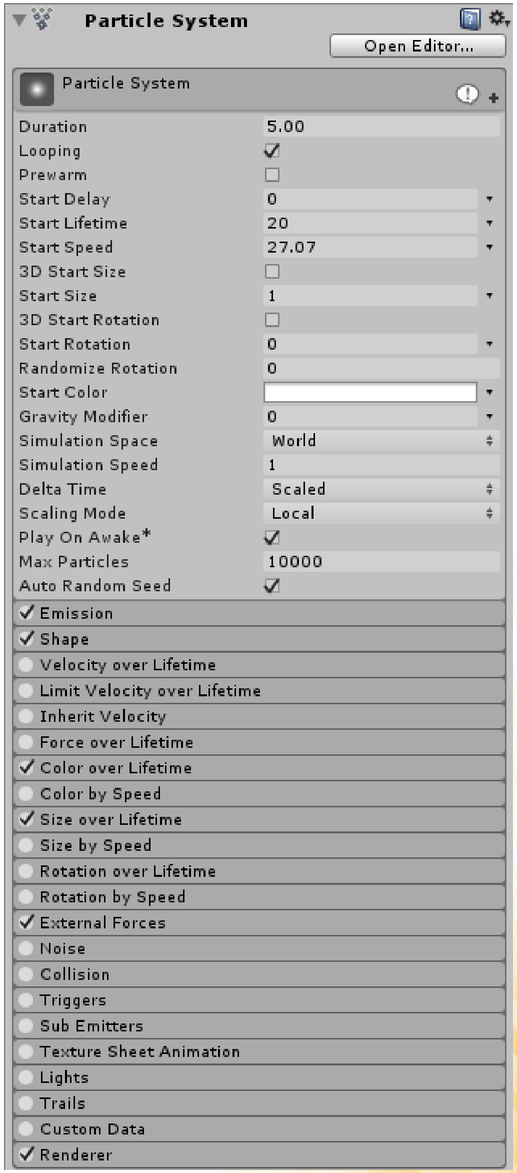
- **Properties (Force Over Lifetime):**
  - Defines how particles are accelerated by forces (such as wind or attraction) over time.



✓ Force over Lifetime

X	0	Y	0	Z	0
Space	Local				
Randomize	□				

  - **X, Y e Z**: force applied to each particle in the X, Y and Z axes.;
  - **Space**: local or world space;
  - **Randomize**: random turbulence and erratic movement.
  - *Example: smoke accelerates slightly as it rises from a fire, carried up by the hot air around it.*



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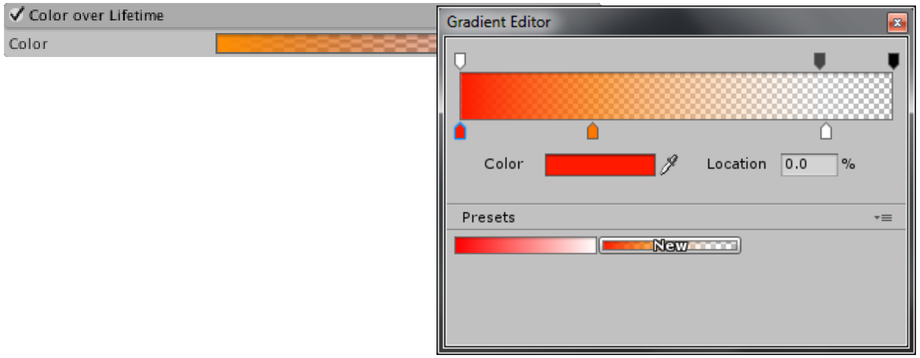
Particle Systems in Unity

- **Properties (Color Over Lifetime):**
  - Specifies how a particle's color and transparency changes over its lifetime.



✓ Color over Lifetime

Color

Gradient Editor

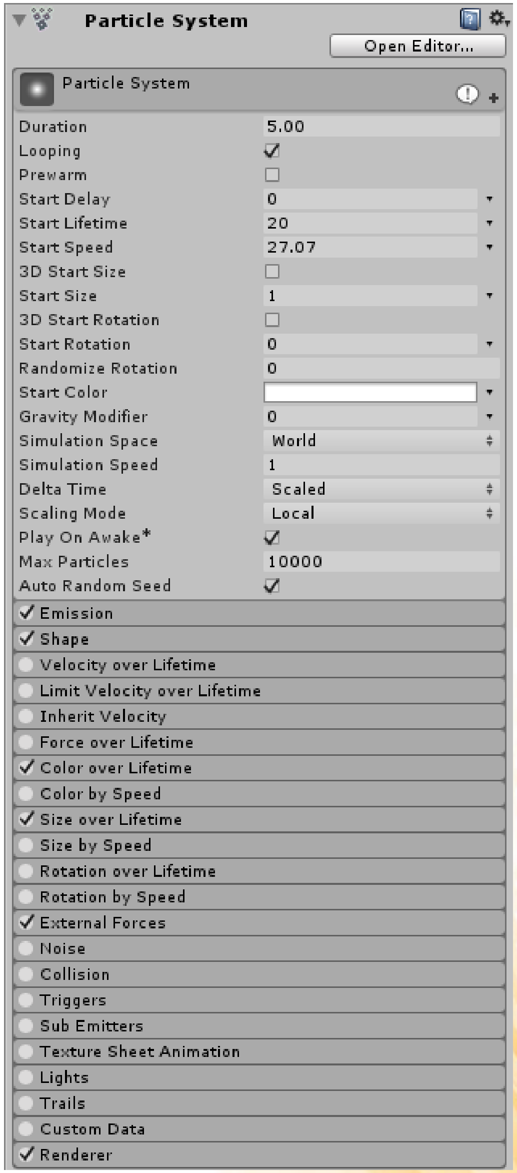
Color

Location 0.0 %

Presets

  - **Color**: color gradient of a particle over its lifetime;

  - *Examples: hot sparks, fireworks and smoke particles, magic spells, etc.*



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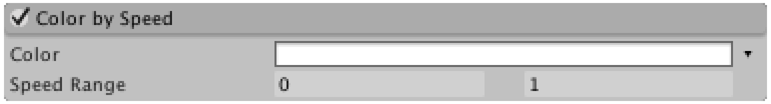
Particle Systems in Unity

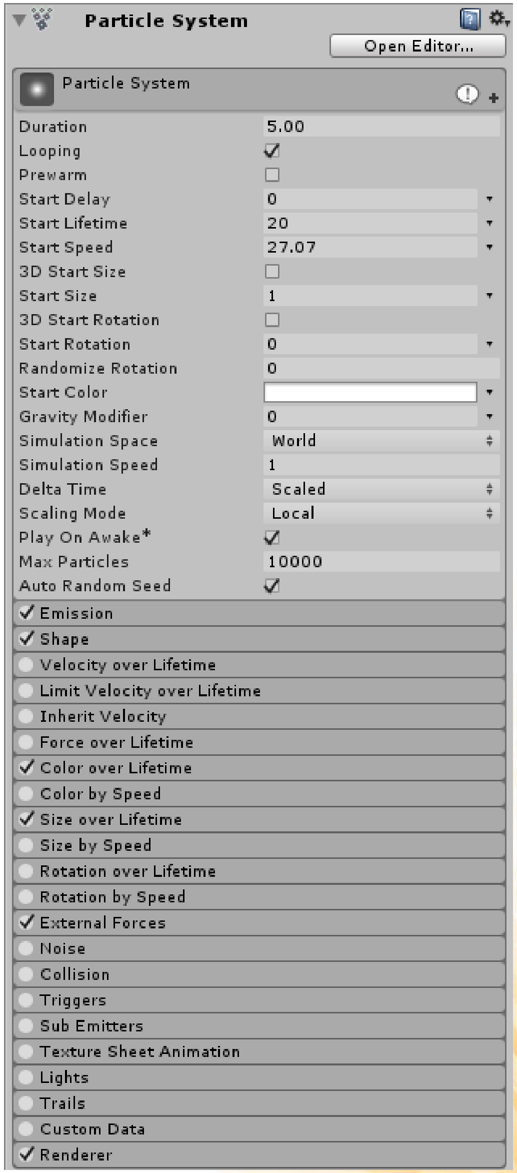
- **Properties (Color By Speed):**
  - Color of a particle that change according to its speed in distance units per second.



✓ Color by Speed

Color		
Speed Range	0	1

  - **Color**: color gradient of a particle defined over a speed range;
  - **Speed Range**: low and high ends of the speed range to which the color gradient is mapped;
  - *Example: Burning particles tend to burn more brightly when they move quickly through the air, but then dim slightly as they slow down.*



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Open Editor...

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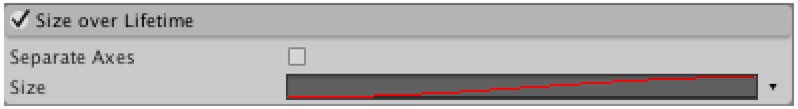
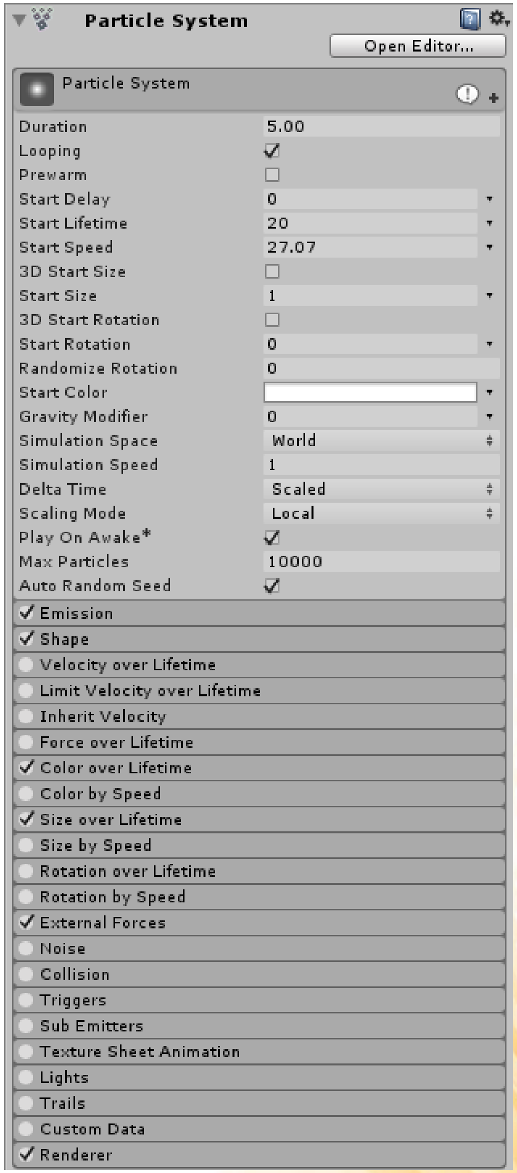
  - Specifies how the size of particles changes over their lifetime.



✓ Size over Lifetime

Separate Axes	☐
Size	

  - **Size**: curve which defines how the particle's size changes over its lifetime;
  - *Examples: smoke tends to disperse and occupy a larger volume over time. Flame particles of fireballs created by burning fuel, tend to expand after emission but then fade and shrink as the fuel is used up and the flame dissipates.*



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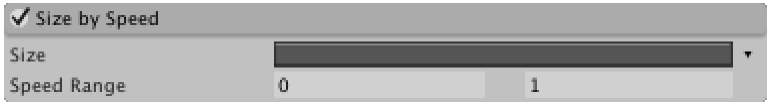
✓ Renderer

Particle Systems in Unity

- **Properties (Size by Speed):**
  - Specifies how particles change size according to their speed in distance units per second.

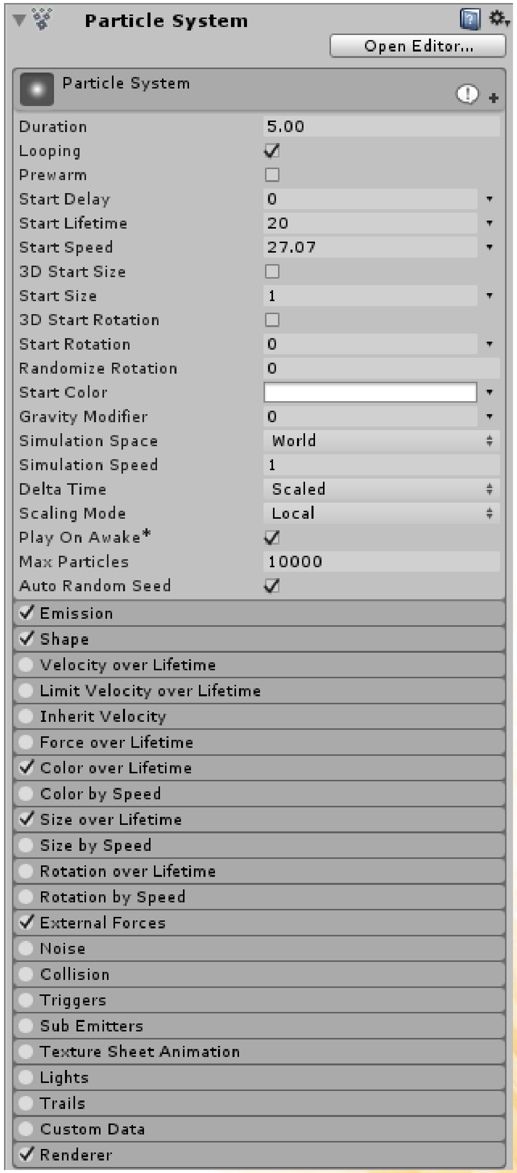


✓ Size by Speed

Size

Speed Range 0 1

  - **Size**: curve defining the particle's size over a speed range;
  - **Speed Range**: low and high ends of the speed range to which the size curve is mapped;
  - *Example: small pieces of debris accelerate more by an explosion than larger pieces.*



Particle System

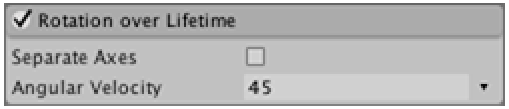
Particle System

Duration 5.00
Looping ☑
Prewarm □
Start Delay 0
Start Lifetime 20
Start Speed 27.07
3D Start Size □
Start Size 1
3D Start Rotation □
Start Rotation 0
Randomize Rotation 0
Start Color
Gravity Modifier 0
Simulation Space World
Simulation Speed 1
Delta Time Scaled
Scaling Mode Local
Play On Awake* ☑
Max Particles 10000
Auto Random Seed ☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Particle Systems in Unity

- **Properties (Rotation over Lifetime):**
  - Configure how particles rotate as they move over their lifetime.

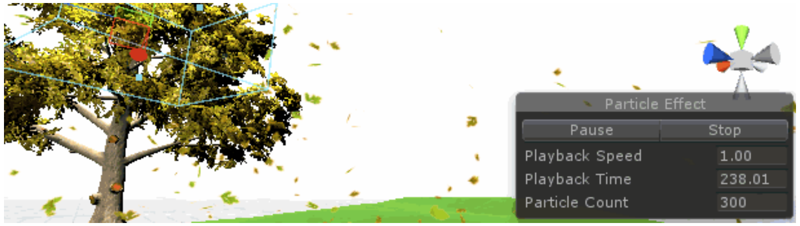


✓ Rotation over Lifetime

Separate Axes	☐
Angular Velocity	45 ▾

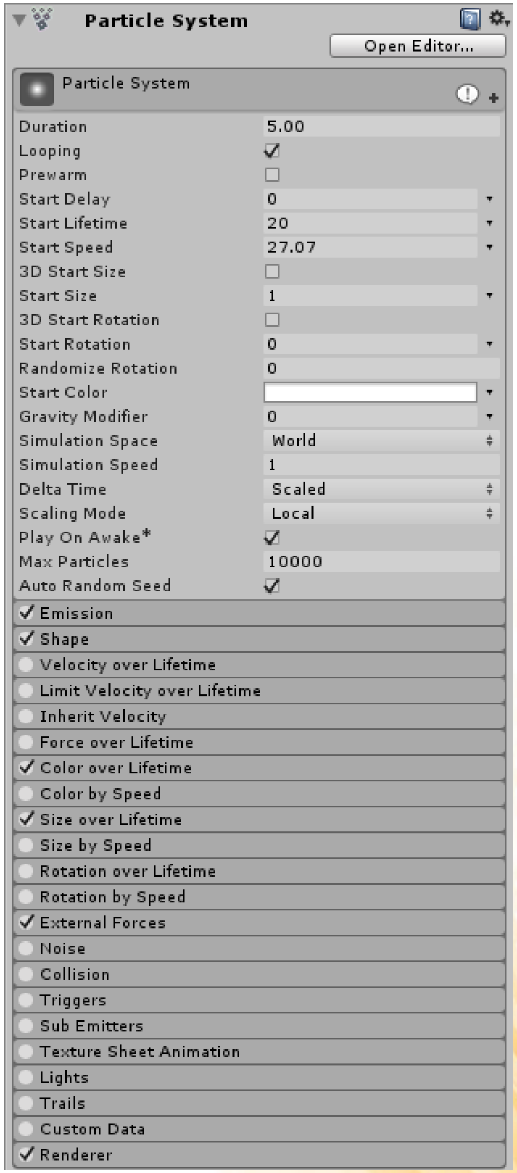
  - **Angular Velocity**: Rotation velocity in degrees per second;

  - *Example: Leaves falling.*



Particle Effect

Playback Speed	1.00
Playback Time	238.01
Particle Count	300



Particle System

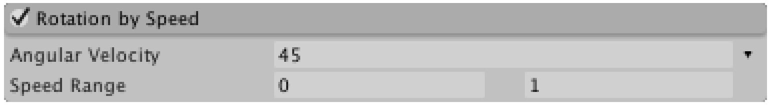
Particle System

Duration	5.00
Looping	☑
Prewarm	☐
Start Delay	0 ▾
Start Lifetime	20 ▾
Start Speed	27.07 ▾
3D Start Size	☐
Start Size	1 ▾
3D Start Rotation	☐
Start Rotation	0 ▾
Randomize Rotation	0
Start Color	▾
Gravity Modifier	0 ▾
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Particle Systems in Unity

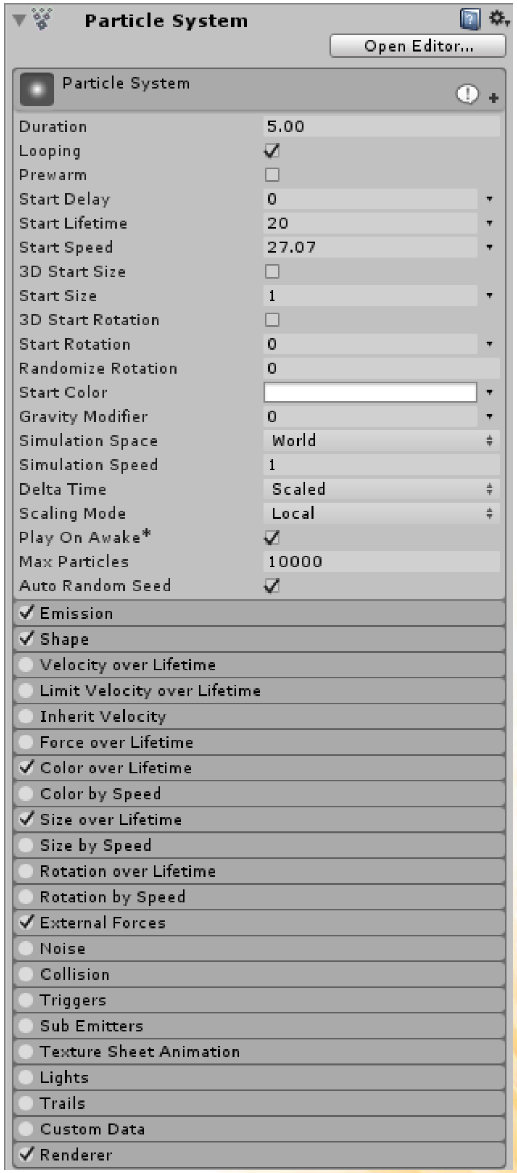
- **Properties (Rotation by Speed):**
  - Specifies how the rotation of the particle change according to their speed in distance units per second.



✓ Rotation by Speed

Angular Velocity	45	
Speed Range	0	1

  - **Angular Velocity**: rotation velocity in degrees per second;
  - **Speed Range**: low and high ends of the speed range;
  - *Example: rocks from a landslide.*



Particle System

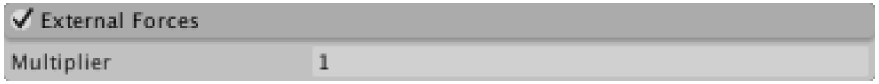
Particle System

Duration	5.00
Looping	☑
Prewarm	□
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	□
Start Size	1
3D Start Rotation	□
Start Rotation	0
Randomize Rotation	0
Start Color	□
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Particle Systems in Unity

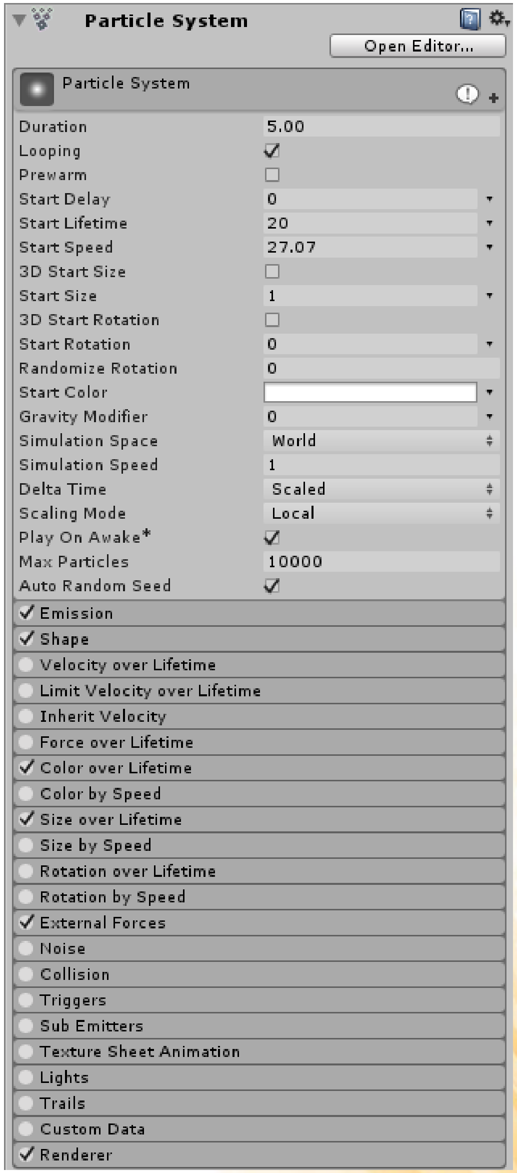
- **Properties (External Forces):**
  - Modifies the effect of wind zones on particles emitted by the system.



☑ External Forces

Multiplier 1

  - **Multiplier**: scale value applied to wind zone forces;
  - *Example: terrain wind zones (which affect the movement of trees on the landscape) can blow particles from the system.*



Particle System

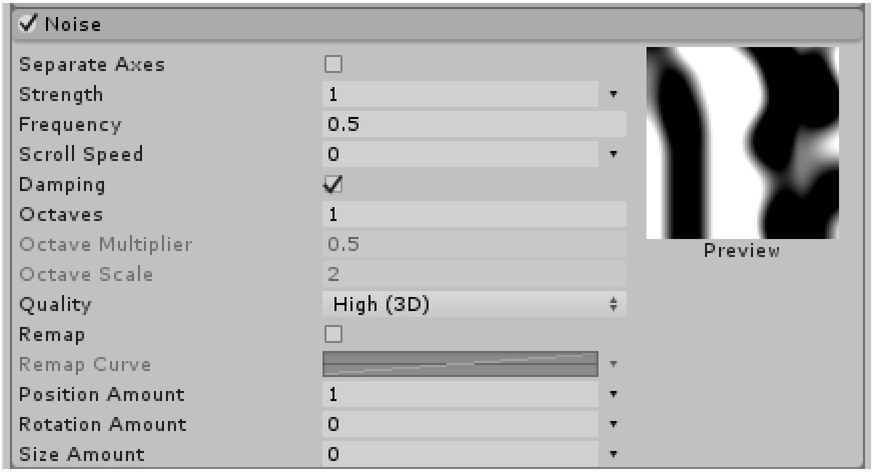
Particle System

Duration 5.00
Looping ☑
Prewarm □
Start Delay 0
Start Lifetime 20
Start Speed 27.07
3D Start Size □
Start Size 1
3D Start Rotation □
Start Rotation 0
Randomize Rotation 0
Start Color
Gravity Modifier 0
Simulation Space World
Simulation Speed 1
Delta Time Scaled
Scaling Mode Local
Play On Awake* ☑
Max Particles 10000
Auto Random Seed ☑

☑ Emission
☑ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
☑ Color over Lifetime
○ Color by Speed
☑ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
☑ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
☑ Renderer

Particle Systems in Unity

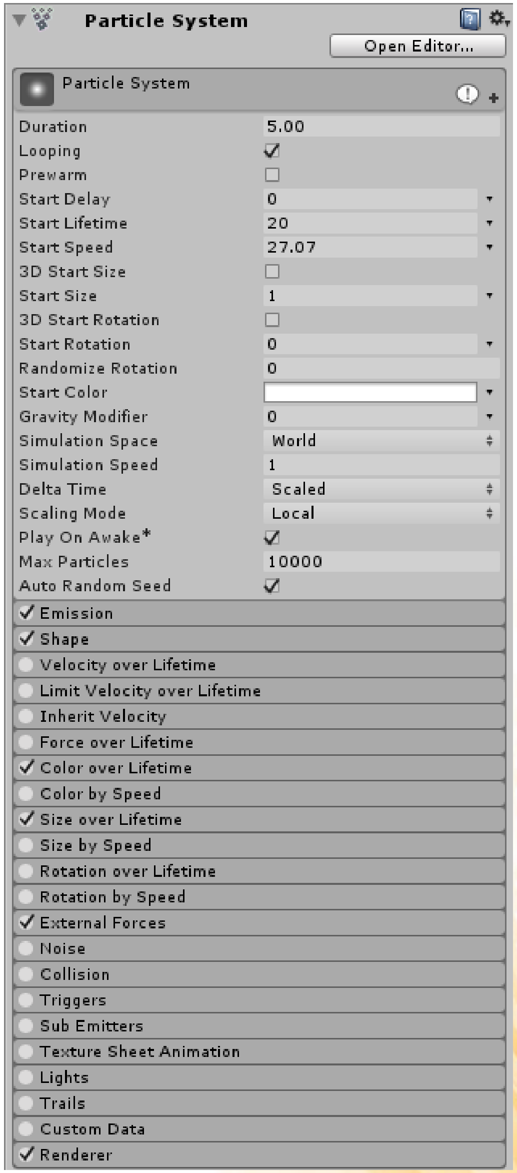
- **Properties (Noise):**
  - Adds turbulence to particle movement.



✓ Noise

Separate Axes	□
Strength	1
Frequency	0.5
Scroll Speed	0
Damping	☑
Octaves	1
Octave Multiplier	0.5
Octave Scale	2
Quality	High (3D)
Remap	□
Remap Curve	
Position Amount	1
Rotation Amount	0
Size Amount	0

  - *Example: how embers from a fire move around, or how smoke swirls as it moves.*



Particle System

Particle System

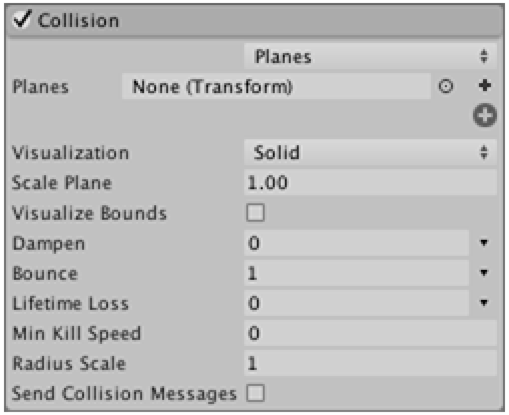
Duration	5.00
Looping	☑
Prewarm	□
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	□
Start Size	1
3D Start Rotation	□
Start Rotation	0
Randomize Rotation	0
Start Color	□
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Properties: https://docs.unity3d.com/Manual/PartSysNoiseModule.html

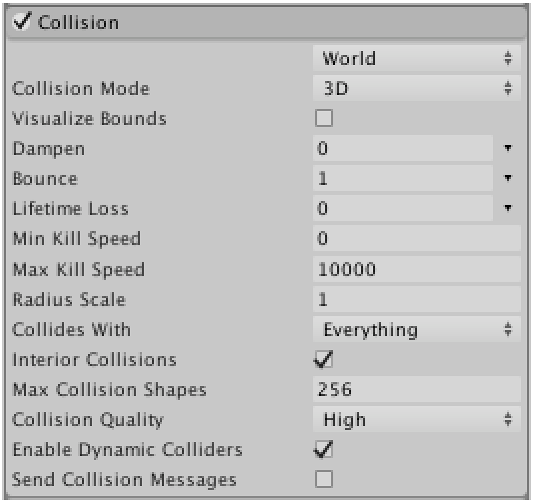
Particle Systems in Unity

- **Properties (Collision):**
  - Controls how particles collide with GameObjects in the Scene.



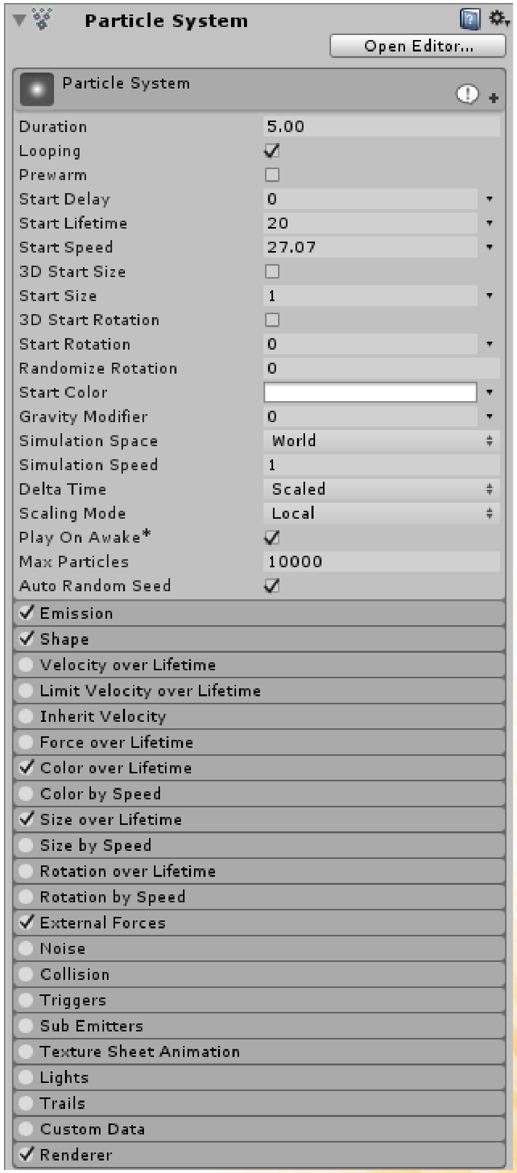
✓ Collision

	Planes
Planes	None (Transform)
Visualization	Solid
Scale Plane	1.00
Visualize Bounds	□
Dampen	0
Bounce	1
Lifetime Loss	0
Min Kill Speed	0
Radius Scale	1
Send Collision Messages	□



✓ Collision

	World
Collision Mode	3D
Visualize Bounds	□
Dampen	0
Bounce	1
Lifetime Loss	0
Min Kill Speed	0
Max Kill Speed	10000
Radius Scale	1
Collides With	Everything
Interior Collisions	☑
Max Collision Shapes	256
Collision Quality	High
Enable Dynamic Colliders	☑
Send Collision Messages	□



Particle System

Particle System

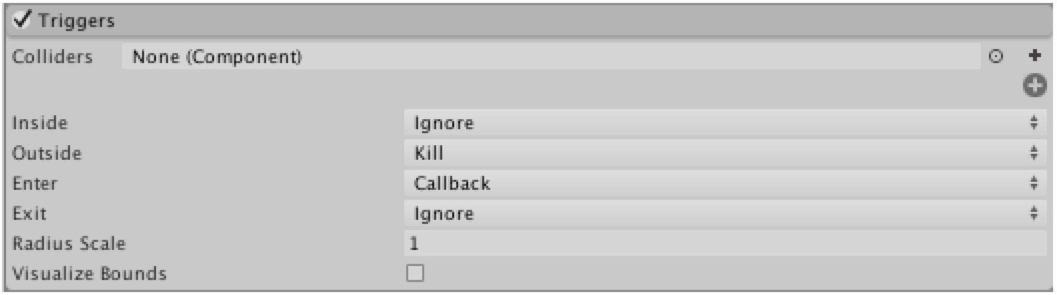
Duration	5.00
Looping	☑
Prewarm	□
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	□
Start Size	1
3D Start Rotation	□
Start Rotation	0
Randomize Rotation	0
Start Color	
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Properties: http://docs.unity3d.com/Manual/PartSysCollisionModule.html

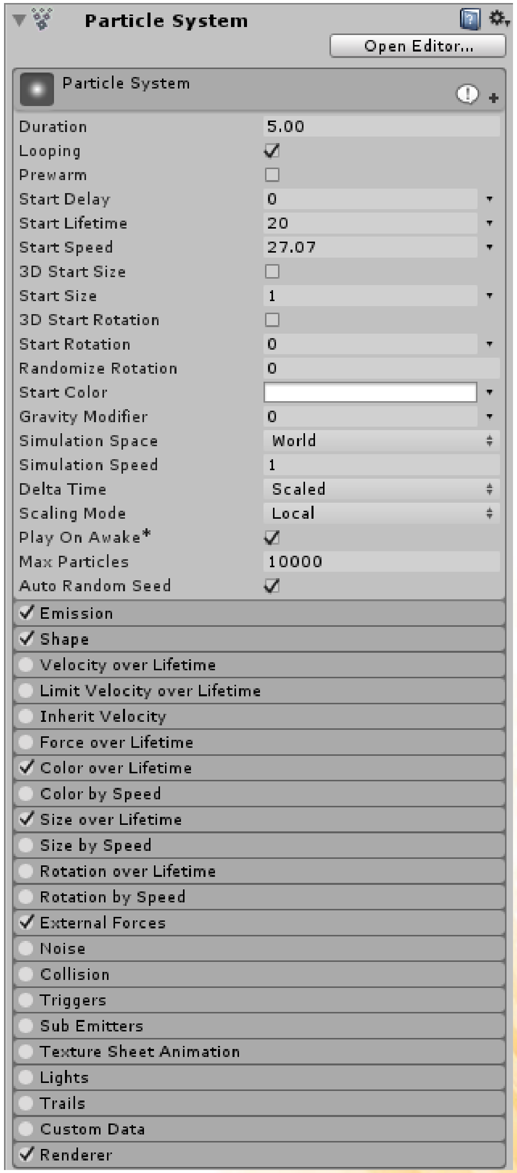
Particle Systems in Unity

- **Properties (Triggers):**
  - Allow particles to trigger a Callback whenever they interact with one or more Colliders in the Scene.



✓ Triggers

Colliders	None (Component)
Inside	Ignore
Outside	Kill
Enter	Callback
Exit	Ignore
Radius Scale	1
Visualize Bounds	□



Particle System

Particle System

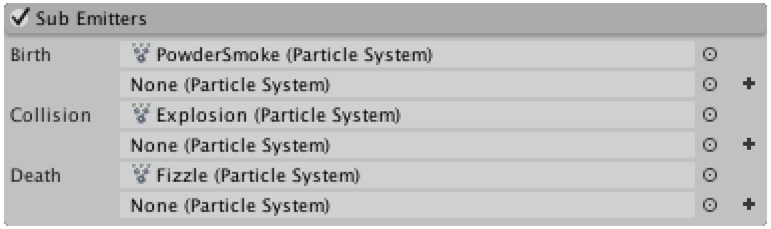
Duration	5.00
Looping	☑
Prewarm	□
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	□
Start Size	1
3D Start Rotation	□
Start Rotation	0
Randomize Rotation	0
Start Color	□
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Properties: http://docs.unity3d.com/Manual/PartSysTriggersModule.html

Particle Systems in Unity

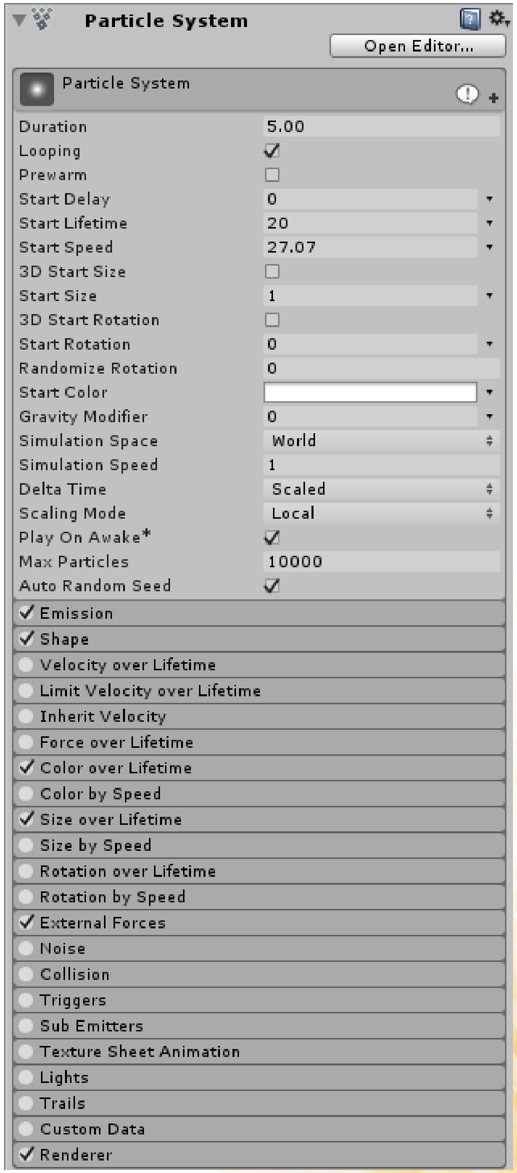
- **Properties (Sub Emitters):**
  - Allows the set up of sub-emitters, which are additional particle emitters that are created at a particle's position at certain stages of its lifetime.



✓ Sub Emitters

Birth	PowderSmoke (Particle System)
	None (Particle System)
Collision	Explosion (Particle System)
	None (Particle System)
Death	Fizzle (Particle System)
	None (Particle System)

  - *Example: a bullet might be accompanied by a puff of powder smoke as it leaves the gun barrel, and a fireball might explode on impact*



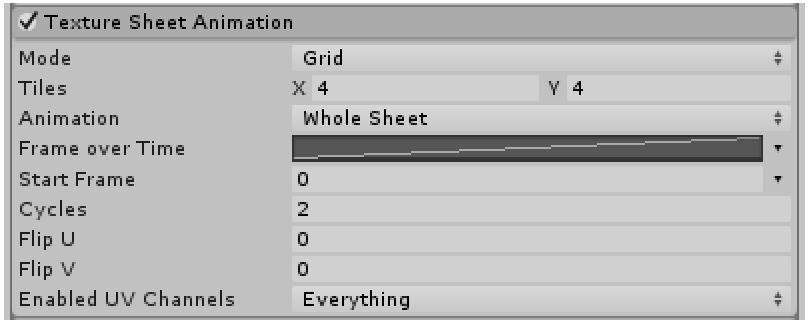
Particle System

Duration	5.00
Looping	☑
Prewarm	□
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	□
Start Size	1
3D Start Rotation	□
Start Rotation	0
Randomize Rotation	0
Start Color	
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Particle Systems in Unity

- **Properties (Texture Sheet Animation):**
  - Defines the particle texture as a grid of separate sub-images that can be played back as frames of animation.

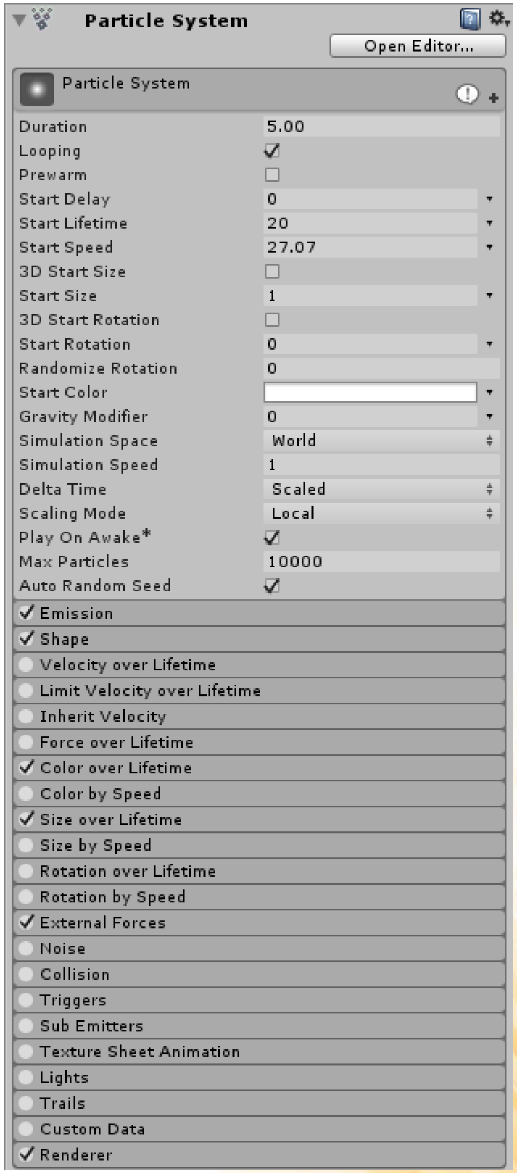


✓ Texture Sheet Animation

Mode	Grid
Tiles	X 4 Y 4
Animation	Whole Sheet
Frame over Time	
Start Frame	0
Cycles	2
Flip U	0
Flip V	0
Enabled UV Channels	Everything

  - *Example: flames may flicker and insects in a swarm might vibrate or shudder as if flapping their wings.*

Properties: http://docs.unity3d.com/Manual/PartSysTexSheetAnimModule.html



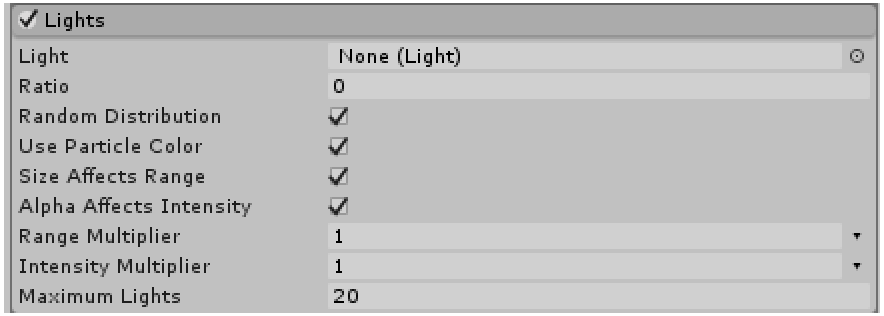
Particle System

Duration	5.00
Looping	☑
Prewarm	☐
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	☐
Start Size	1
3D Start Rotation	☐
Start Rotation	0
Randomize Rotation	0
Start Color	□
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

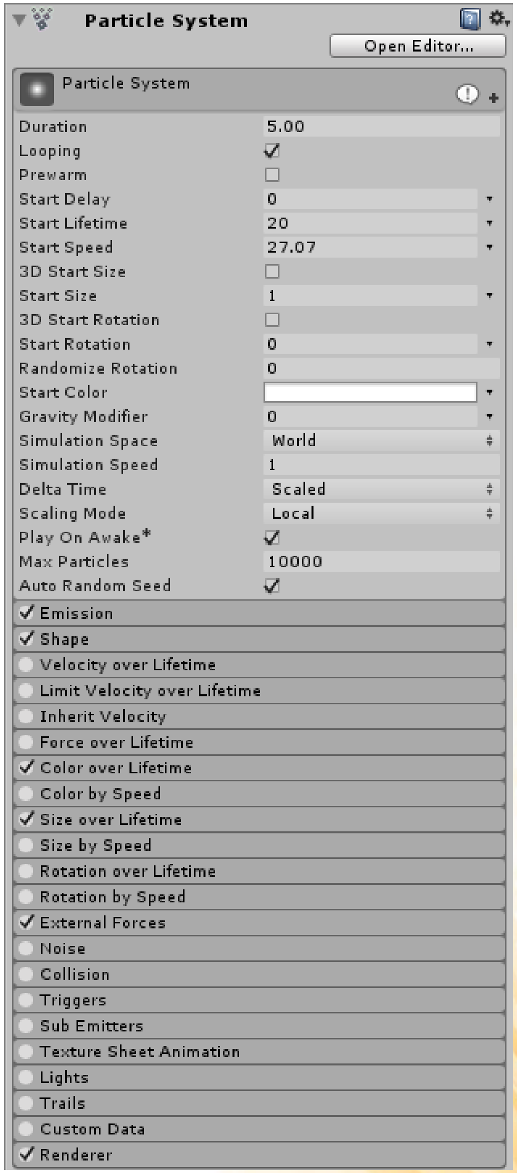
Particle Systems in Unity

- **Properties (Lights):**
  - Adds real-time lights to a percentage of the particles.



✓ Lights	
Light	None (Light)
Ratio	0
Random Distribution	✓
Use Particle Color	✓
Size Affects Range	✓
Alpha Affects Intensity	✓
Range Multiplier	1
Intensity Multiplier	1
Maximum Lights	20

  - *Example: fire, fireworks or lightning.*



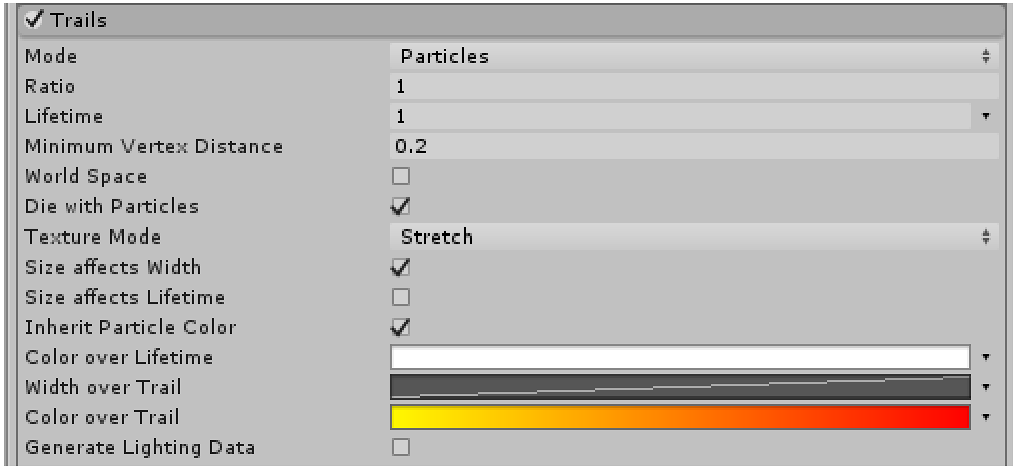
Particle System	
Duration	5.00
Looping	✓
Prewarm	□
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	□
Start Size	1
3D Start Rotation	□
Start Rotation	0
Randomize Rotation	0
Start Color	
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	✓
Max Particles	10000
Auto Random Seed	✓

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Properties: https://docs.unity3d.com/Manual/PartSysLightsModule.html

Particle Systems in Unity

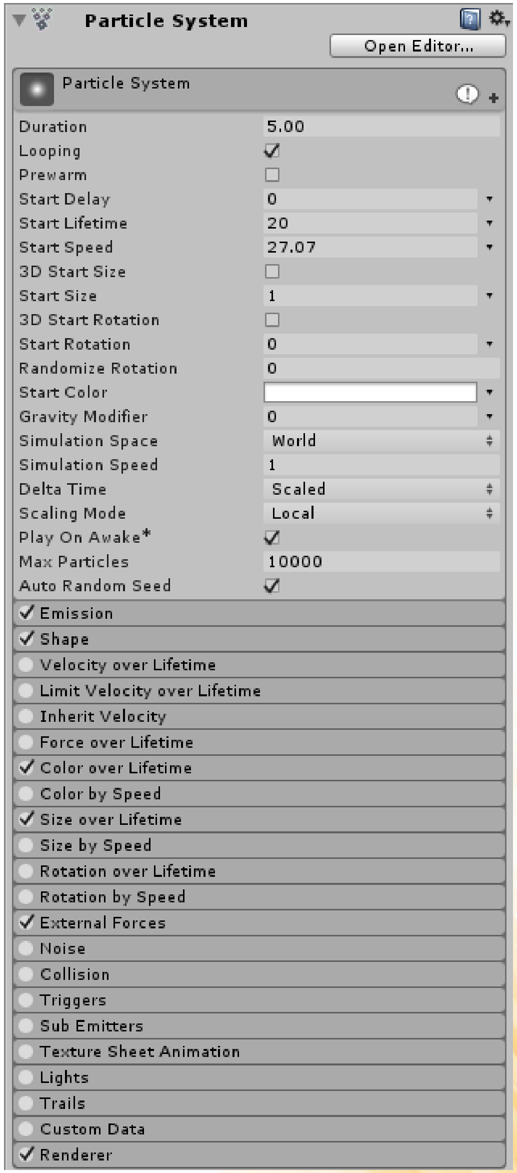
- **Properties (Lights):**
  - Adds trails to a percentage of the particles.



☑ Trails

Mode	Particles
Ratio	1
Lifetime	1
Minimum Vertex Distance	0.2
World Space	☐
Die with Particles	☑
Texture Mode	Stretch
Size affects Width	☑
Size affects Lifetime	☐
Inherit Particle Color	☑
Color over Lifetime	
Width over Trail	
Color over Trail	
Generate Lighting Data	☐

  - *Example: bullets, smoke, and magic visuals.*



Particle System

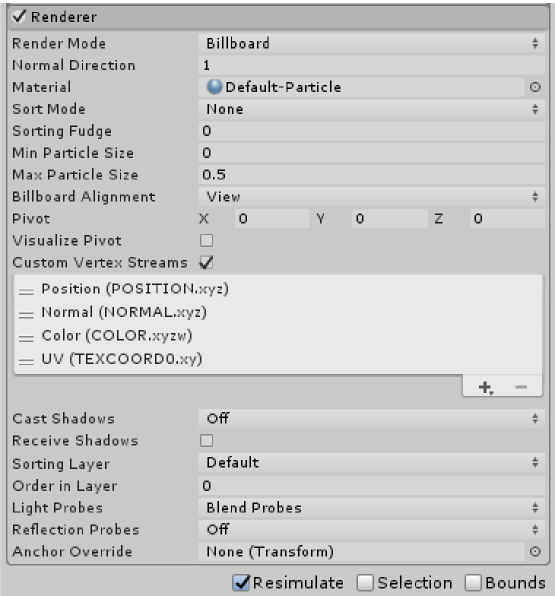
Duration	5.00
Looping	☑
Prewarm	☐
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	☐
Start Size	1
3D Start Rotation	☐
Start Rotation	0
Randomize Rotation	0
Start Color	
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Properties: https://docs.unity3d.com/Manual/PartSysTrailsModule.html

Particle Systems in Unity

- **Properties (Render):**
  - Determine how a particle's image or Mesh is transformed, shaded and overdrawn by other particles.



☑ Renderer

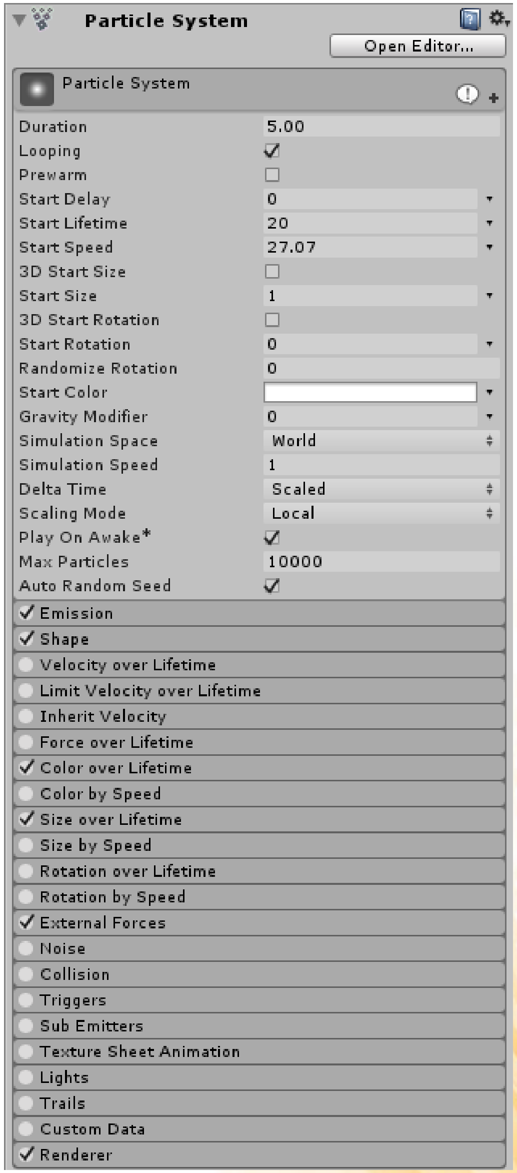
Render Mode	Billboard
Normal Direction	1
Material	Default-Particle
Sort Mode	None
Sorting Fudge	0
Min Particle Size	0
Max Particle Size	0.5
Billboard Alignment	View
Pivot	X 0 Y 0 Z 0
Visualize Pivot	☐
Custom Vertex Streams	☑

Position (POSITION.xyz)
Normal (NORMAL.xyz)
Color (COLOR.xyzw)
UV (TEXCOORD0.xy)

Cast Shadows	Off
Receive Shadows	☐
Sorting Layer	Default
Order in Layer	0
Light Probes	Blend Probes
Reflection Probes	Off
Anchor Override	None (Transform)

☑ Resimulate ☐ Selection ☐ Bounds

  - **Render Mode:** Billboard, Stretched Billboard, Horizontal Billboard, Vertical Billboard or Mesh



Particle System

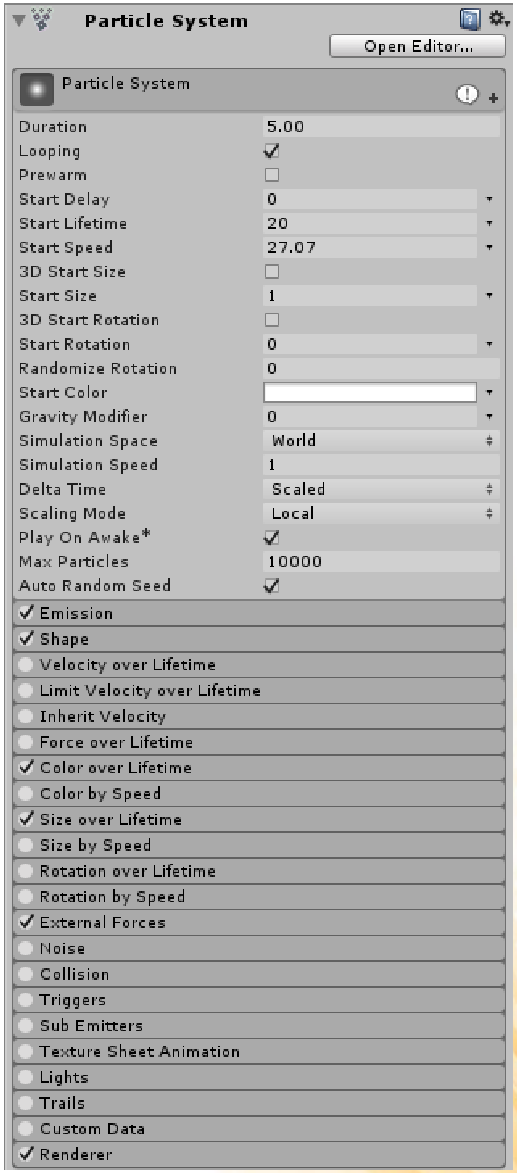
Particle System

Duration	5.00
Looping	☑
Prewarm	☐
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	☐
Start Size	1
3D Start Rotation	☐
Start Rotation	0
Randomize Rotation	0
Start Color	
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

☑ Emission
☑ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
☑ Color over Lifetime
○ Color by Speed
☑ Size over Lifetime
○ Size by Speed
○ Rotation over Lifetime
○ Rotation by Speed
☑ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
☑ Renderer

Particle Systems in Unity

- **Properties (Render):**
  - **Material:** material used to render the particles;
  - **Sort Mode:** order in which particles are drawn (and therefore overlaid);
  - **Cast Shadows:** if enabled, the particle system creates shadows when a shadow-casting Light shines on it;
  - **Receive Shadows:** dictates whether shadows can be cast onto particles;
  - **Min Particle Size:** the smallest particle size (regardless of other settings), expressed as a fraction of viewport size;



Particle System

Particle System

Duration	5.00
Looping	☑
Prewarm	☐
Start Delay	0
Start Lifetime	20
Start Speed	27.07
3D Start Size	☐
Start Size	1
3D Start Rotation	☐
Start Rotation	0
Randomize Rotation	0
Start Color	□
Gravity Modifier	0
Simulation Space	World
Simulation Speed	1
Delta Time	Scaled
Scaling Mode	Local
Play On Awake*	☑
Max Particles	10000
Auto Random Seed	☑

✓ Emission
✓ Shape
○ Velocity over Lifetime
○ Limit Velocity over Lifetime
○ Inherit Velocity
○ Force over Lifetime
✓ Color over Lifetime
○ Color by Speed
✓ Size over Lifetime
○ Size by Speed
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✓ External Forces
○ Noise
○ Collision
○ Triggers
○ Sub Emitters
○ Texture Sheet Animation
○ Lights
○ Trails
○ Custom Data
✓ Renderer

Other properties: http://docs.unity3d.com/Manual/PartSysRendererModule.html

Exercise 1

1) Create new particle systems to simulate the following effects:

   a) Rain

   b) Fire Torch

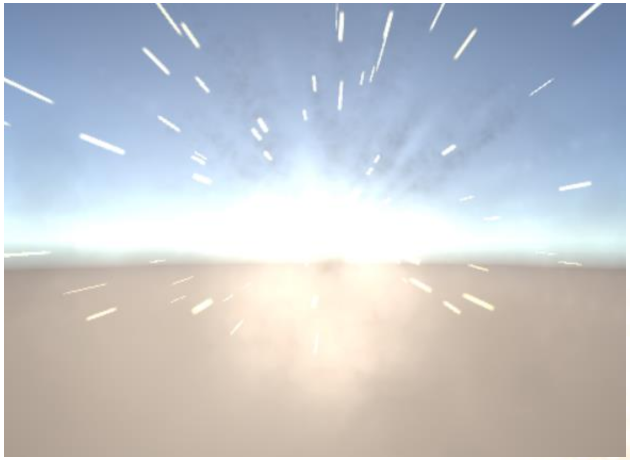
   c) Volumetric Fog/Mist

   d) Explosion

Unity Standard Particle Systems

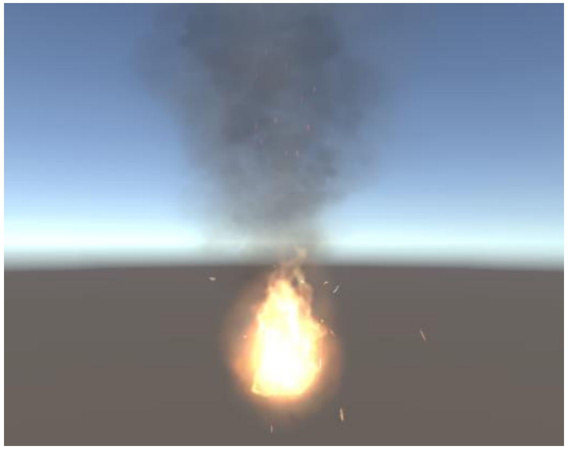
- Unity comes with a very useful set of particle systems:
  - **Import Package -> Particle Systems**

- **Explosion**: powerful effect which uses sub emitters to leave streaks of smoke arcing out from the central effect.

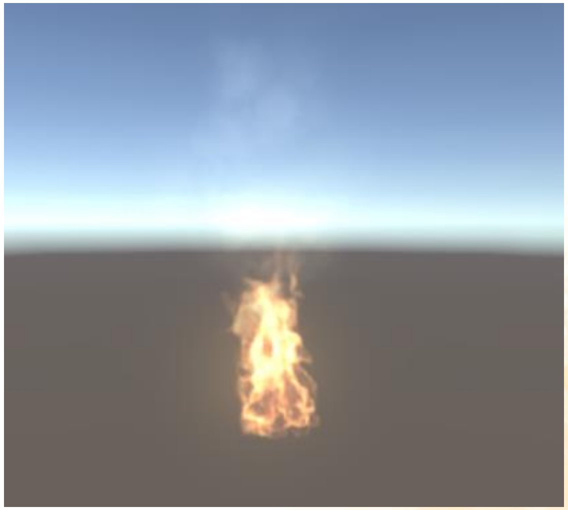


Unity Standard Particle Systems

- **FireComplex**: uses a combination of many particles, including spritesheet animation, sparks and smoke.



- **FireMobile**: designed for fast performance on mobile, this effect is a minimal version of the FireComplex.



Unity Standard Particle Systems

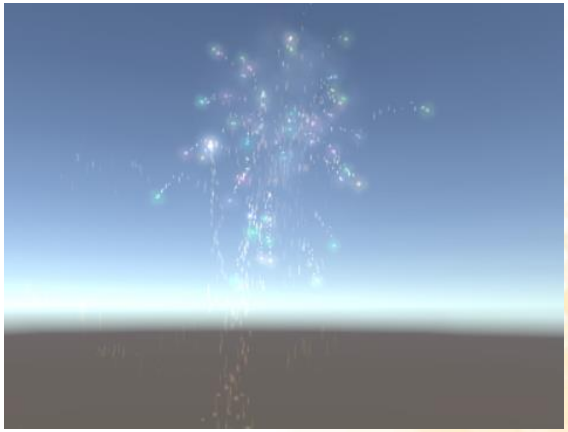
- **Duststorm**: demonstrates how to cover a wide area with a single particle effect. The emission zone is a large box that covers the area, and a single particle effect generates rolling clouds across the scene.

- **Steam**: a single-system effect, which generates rushing steam (vapor) emitting from the surface on which it is placed.

Unity Standard Particle Systems

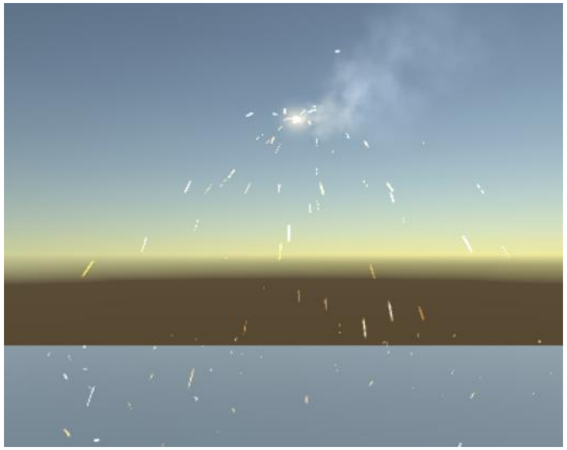
- **Hose**: water hose particle system that demonstrates a number of things, including particle stretching (in the direction of the water travel), flow rate controlled by a script, and particles interacting with physics objects using the particle collision callback feature.

- **Fireworks:** demonstrates how chaining together many sub-emitters to create a complex visual effect.



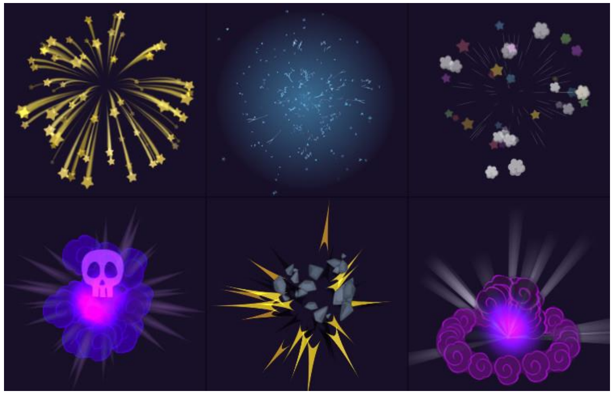
Unity Standard Particle Systems

- **Flare:** shows the world collision feature available to particles, resulting in hundreds of bouncing sparks showering across the floor.

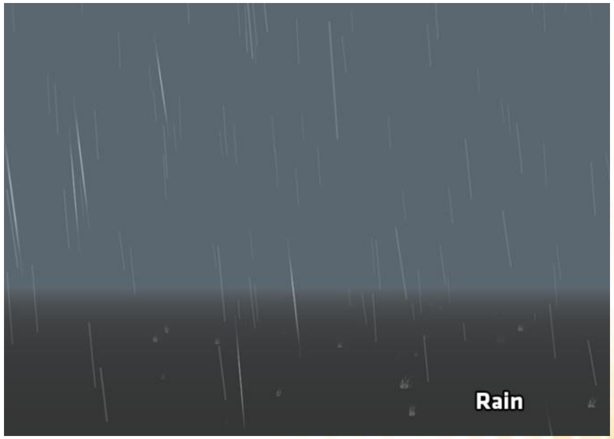


Free Asset Store Particle Systems

- Cartoon Effects:
  - https://assetstore.unity.com/packages/vfx/particles/cartoon-fx-free-109565



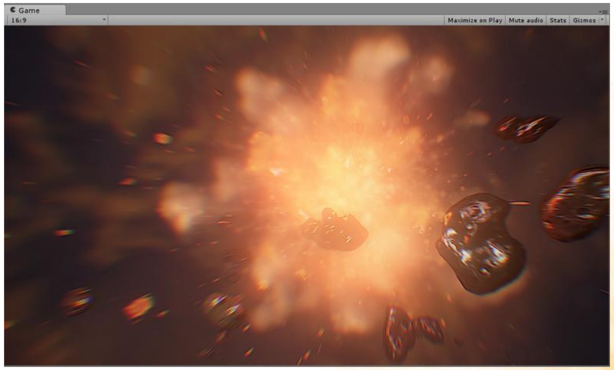
- Water Effects:
  - https://assetstore.unity.com/packages/vfx/particles/environment/water-fx-pack-19248



Free Asset Store Particle Systems

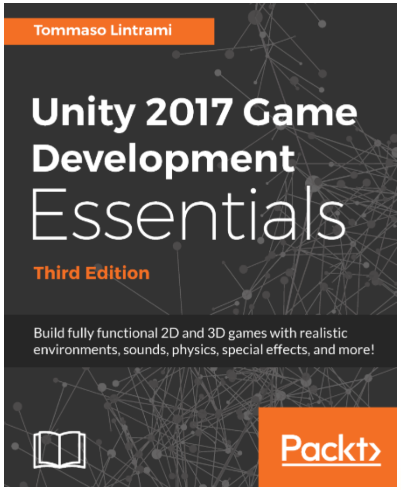
- Sky Effects:
  - https://assetstore.unity.com/packages/vfx/particles/environment/sky-fx-pack-19242

- Fire and Explosions Effects:
  - https://assetstore.unity.com/packages/vfx/particles/fire-explosions/inferno-vfx-50735



Further Reading

- Lintrami, T., Goldstone, W. (2018). **Unity 2017 Game Development Essentials** (3rd ed.). Packt Publishing.
  - **Chapter 11: Unity Particle System;**



Tommaso Lintrami

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- **Web:**
  - https://docs.unity3d.com/Manual/PartSysWhatIs.html
  - https://docs.unity3d.com/Manual/PartSysMainModule.html