

Warm up: Particle system trajectories

Particle system

Particle : element at a given position + extra parameters (mass, life time, etc)

Called **particles systems** in opposition to

- Rigid bodies - Solid objects with static shape
- Deformable bodies - Continuum material that can deforms

Pro

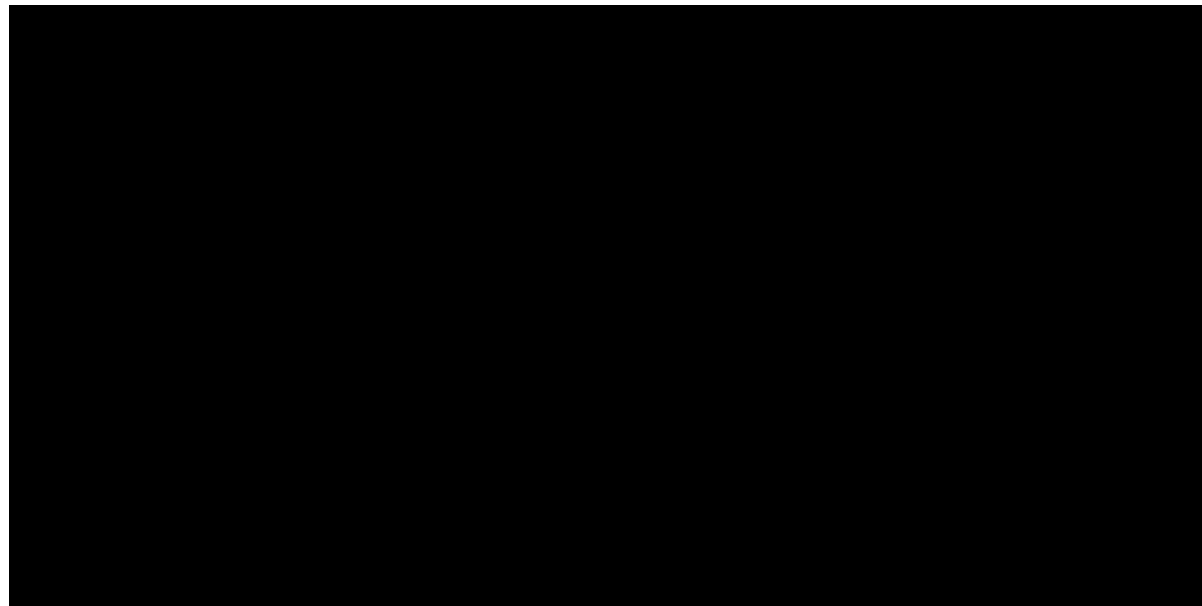
- (+) Lightweight representation (both CPU+memory)
 - (+) Generic flexible model (spatial deformation, no connectivity, etc)
- ⇒ highly used in CG

Cons

- (-) Simple model from physics point of view

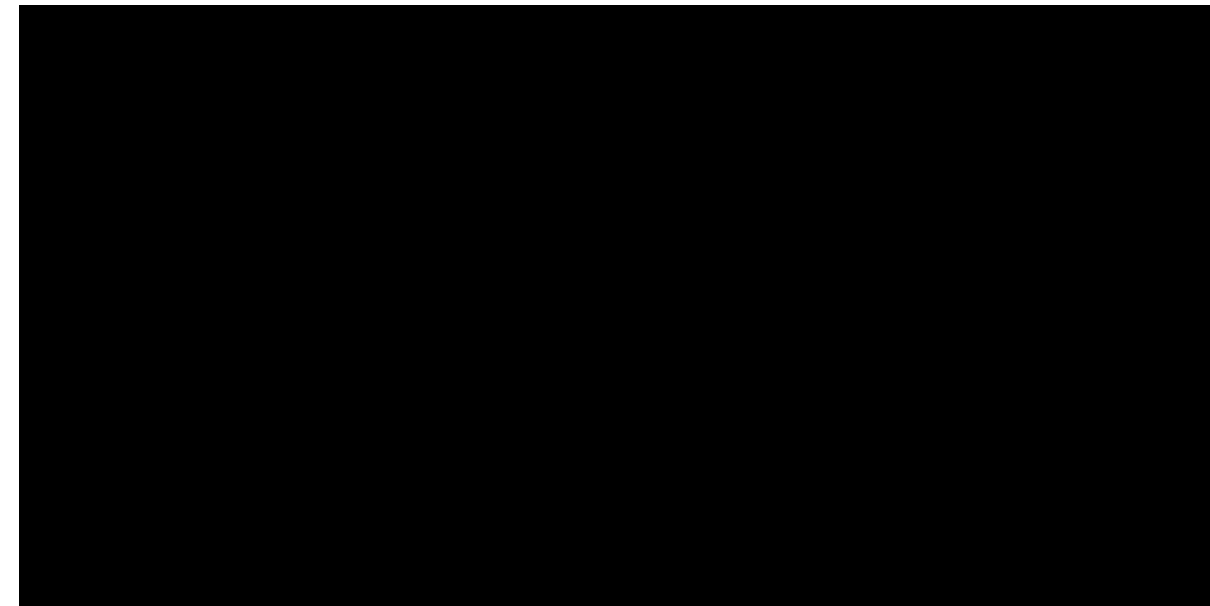
Particles systems History

One of the first animated model in CG



Star Trek II

*[Particle systems - A Technique for Modeling a
Class of Fuzzy Objects, William T. Reeves,
Lucasfilm, 1983] [[pdf](#)]*



Karl Sims, Particle dreams, 1988 [[link](#)]

Example of Particle system

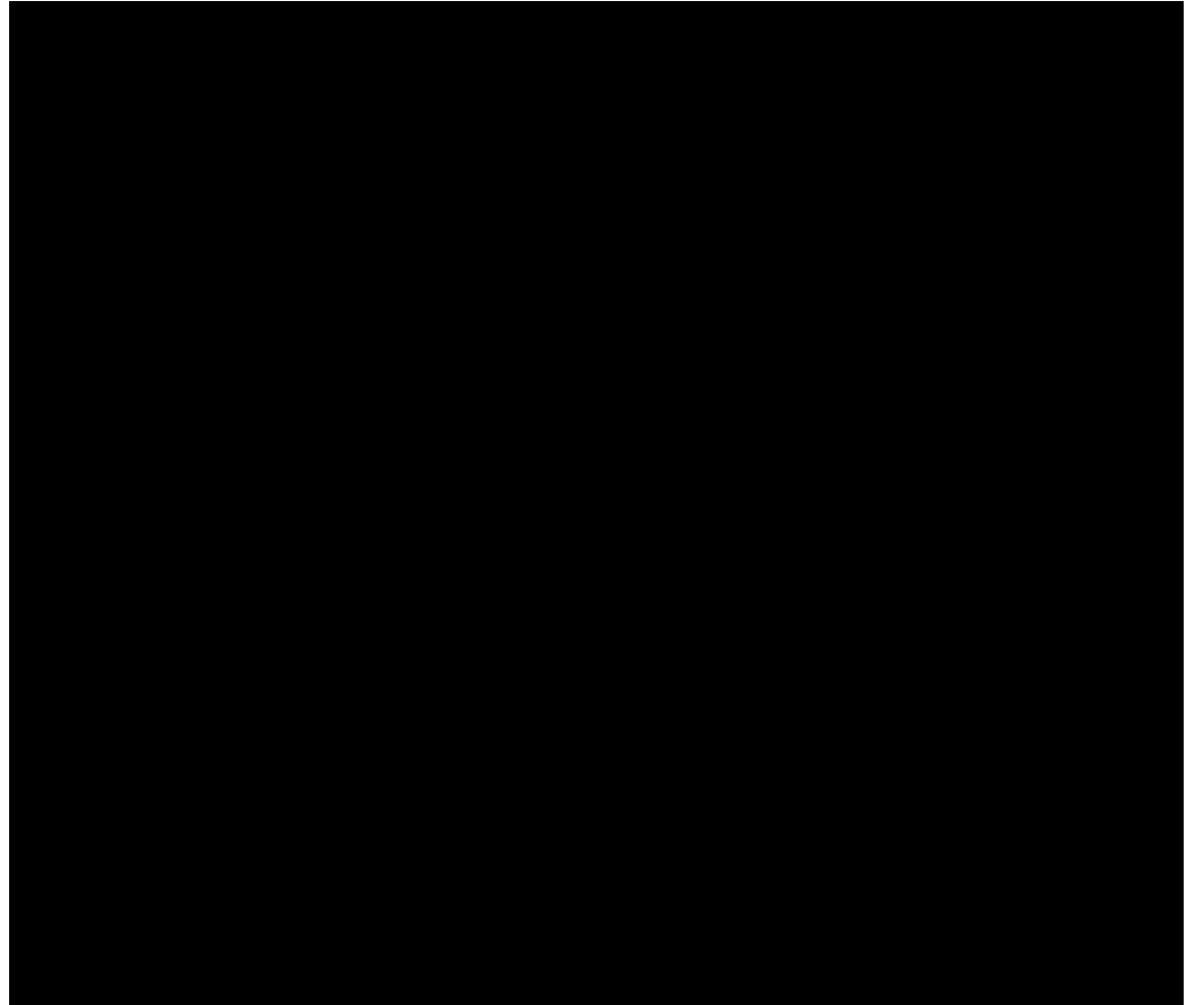
Free fall of spheres under gravity

- Geometrical representation of each particle: sphere
- Equation of motion $p(t) = \frac{1}{2}gt^2 + v_0t + p_0$
- Initial position and speed may be placed at random position.
- Each particle may have a different life time
- *What are the parameters used for p_0 and v_0 in this example?*

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Bouncing spheres

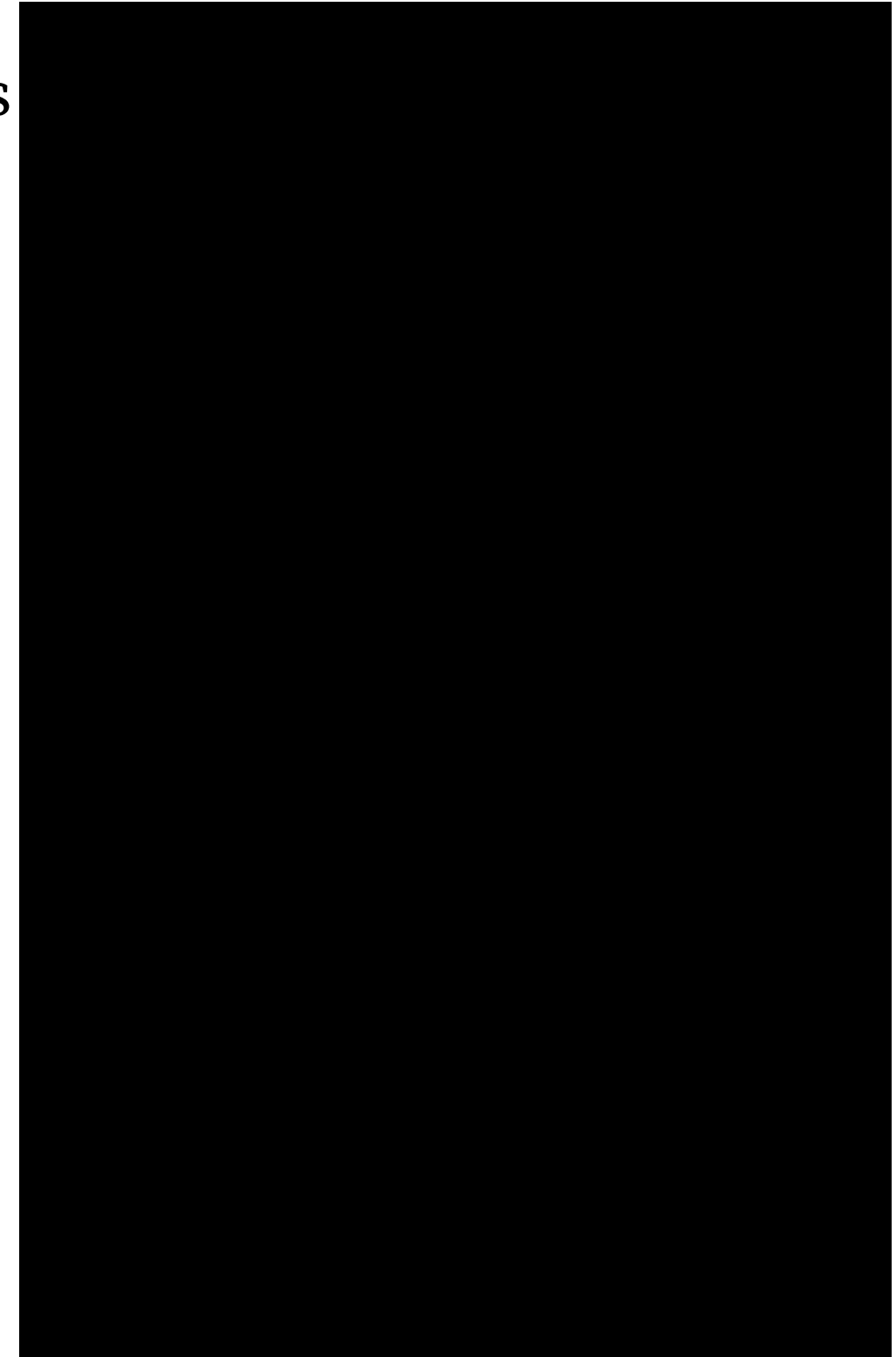
- What is the equation of motion (taking into account the bouncing) ?
- *Consider a particle emitted at time $t = 0$*
- *At what time t_i , the particle touch the floor ?*
- *What is the new speed after impact ?*
- *What is the complete equation of trajectory ?*



General motions

Motion equation is not restricted to physics-based equations

- *What are the parameters associated to each particle ?*
- *What are the corresponding equations of motion ?*

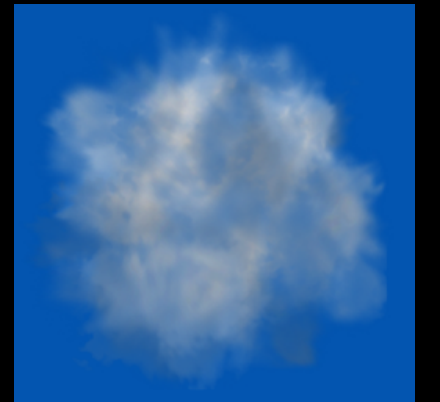


Billboards, Impostors, Sprites

Particles can be displayed as small images/thumbnails

In practice

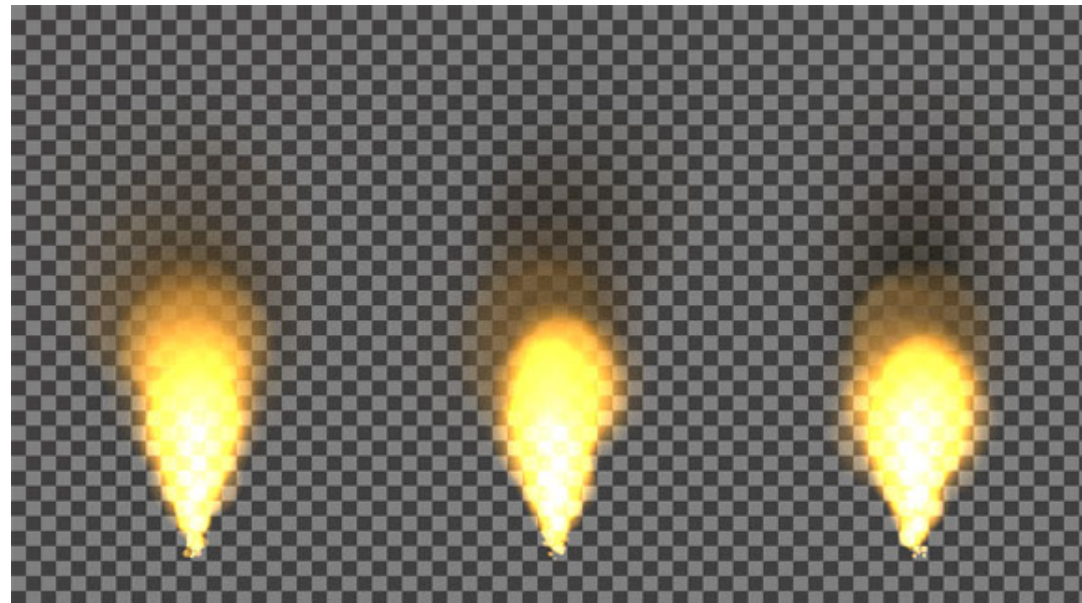
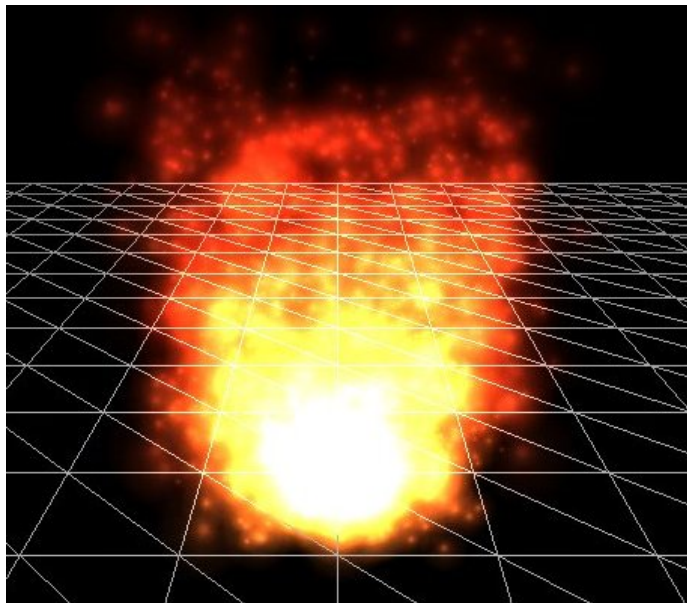
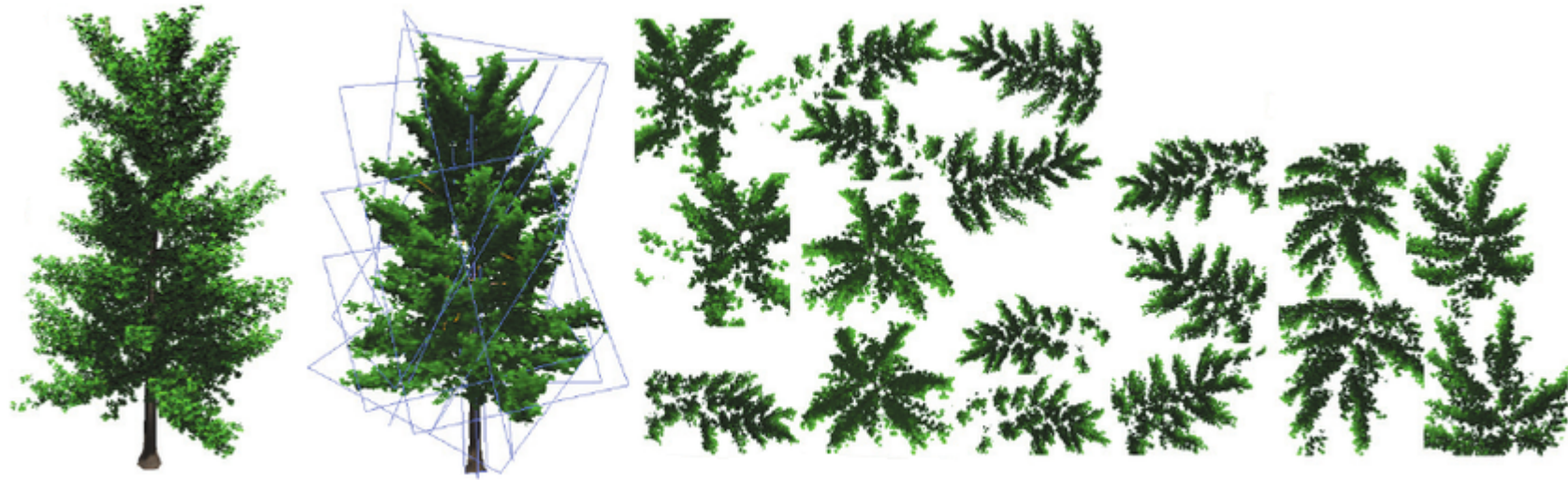
- Each particle is displayed as a quadrangle
- A texture is mapped on the quad
- The texture can contains transparency : quad geometry is invisible
- The quad can be facing the camera at all time (billboard)
- The texture can be animated (sprite)
- Texture can be adapted to the point of view (impostors)



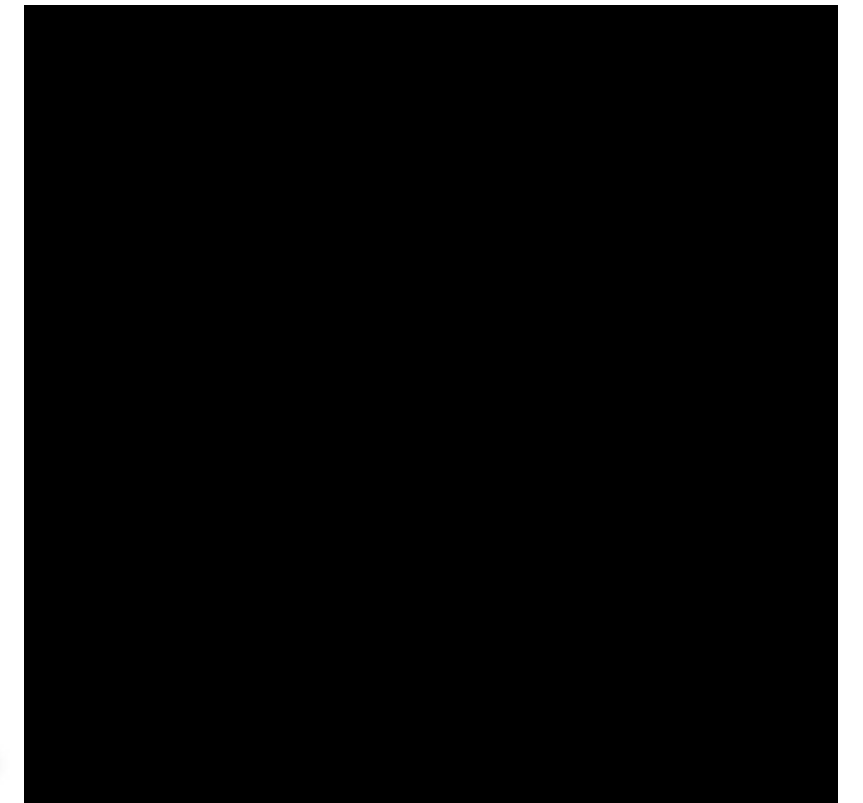
Usage of billboards

Large use of billboards for complex models

Vegetation, fire, smoke, etc.



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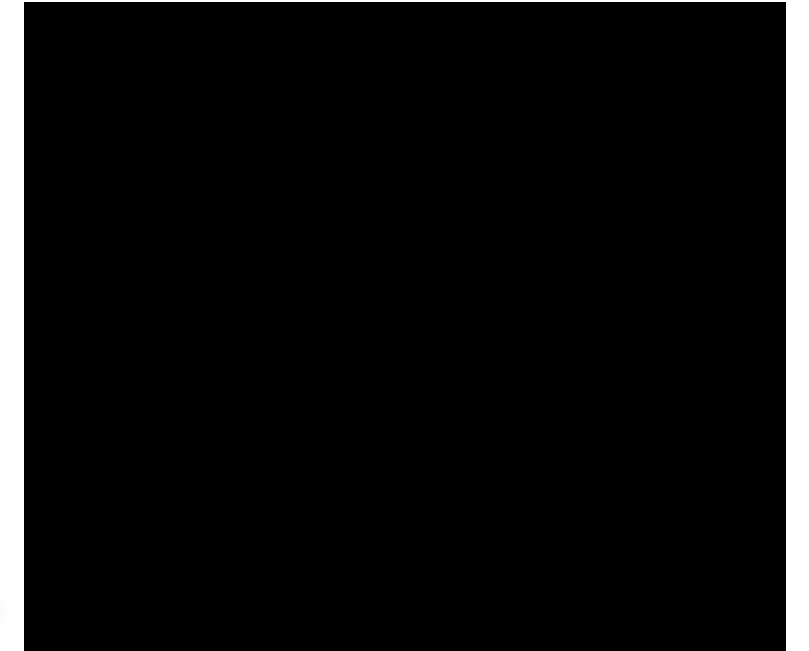


Billboards, Impostors, Sprites

Follow up of the example

How to model the following animation ?

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Use case in production

How to model the *horse heads made of water* ?



The Lord of the Rings

Use case in production

How to model the *horse heads made of water* ?



The Lord of the Rings

Use case in production

Full Making-Of

0:00



The Lord of the Rings