1 Particle free fall

1.1 Initial conditions

- $p_0 = (0, 0, 0)$
- $v_0 = (r\cos(\theta_r), v_{0y}, r\sin(\theta_r))$
  - $r, v_{0y} = constant$
  - $\theta_r = rand(0, 2\pi)$

1.2 Bouncing effect

- $p_y(t_i) = 0 \Rightarrow t_i = -2v_{0y}/g_y$
- $v(t_i^-) = (v_{0x}, -v_{0y}, v_{0z})$, $v(t_i^+) = \alpha\, v_0$ with $\alpha \in]0, 1]$
- Complete equation:

$$\left\{ \begin{array}{l} p(t) = 1/2gt^2 + v_0 t, t \in [0, t_i] \\ p(t) = 1/2\, g(t - t_i)^2 + \alpha\, v_0(t - t_i) + p(t_i), t > t_i \end{array} \right\}$$

1.3 Cauldron

- $p_0 = (r\cos(\theta), r\sin(\theta), 0)$, with $r = \sqrt{rand(0, r_{\max}^2)}, \theta = rand(0, 2\pi)$
  - Rem. The square root ensure the uniform sampling of the circle, otherwise we have a higher concentration at the center.
  - Other solution: Take two uniform random variables x, y in the unit square, then check if they are such that $x^2 + y^2 < r_{\max}^2$, and keep only the one inside the circle.
- $p(t) = (a\cos(\omega t + \varphi_0), b\sin(\omega t + \varphi_0), v_{0z}\, t)$
  - Rem. the value φ_0 must be different from sphere to sphere, otherwise all the sphere will have the same phase at the same time (thus all moving in the same direction).

2 Noise

2.1 Terrain

- a: Increase s ($s = 2$)
- b: Decrease N
- c: Decrease α
- d: Increase α
- e: Increase h
- f: Change o

2.2 Animation

- a: $S(u, v) = (u, v, P(u - t))$
  Or more precisely: $P(u - c\,t)$, with c the speed of the propagation.
- b: $S(u, v) = (u, v, P(u - t, v))$
- c: $S(u, v) = (u, v, P(u, v, t))$
- d: $S(u, v) = (u, v, a\,P(b\,u, b\,v, t))$, with $a < 1$ and $b > 1$
- e: $S(u, v) = (u, v, P(u - t) + \alpha\,u\,P(u, v, t))$, with $alpha < 1$
- f: $S(u, v) = (u + P(u + o_1, v, t), v + P(u + o_2, v, t), P(u, v, t))$, o_1 and o_2 are arbitrary offsets that avoid having the same noise in the three coordinates.