

SimpleX Radiative Transfer

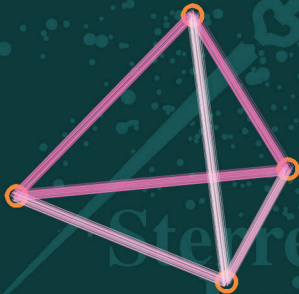
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The SimpleX Method: Transport on a Voronoi-Delaunay Grid

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The SimpleX Method



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- [1] Transport medium represented by a point distribution
- [2] Points serve as nodes in a Delaunay triangulation
- [3] Markov transport on the resulting grid

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Transport medium represented
by a point distribution

Medium = gas & dust (rad hydro)

Medium = wires & beams (web)

Medium = vacuum (lattice QCD)

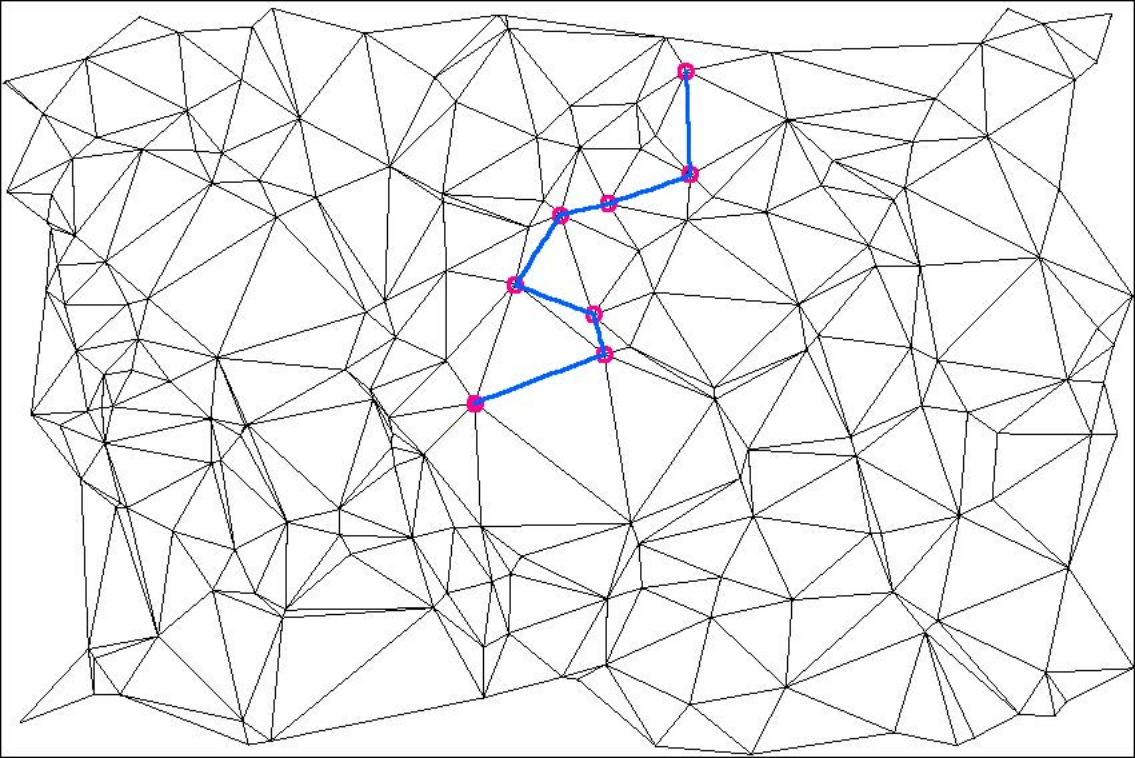
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Transport medium represented
by a point distribution

Represented: $n(\infty) = \rho$

Represented: $n = f(\rho)$

$f(\rho)$ chosen to optimize transport

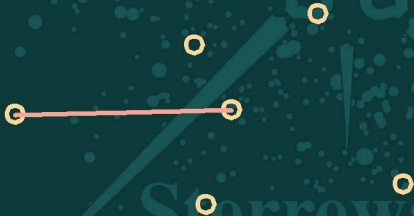


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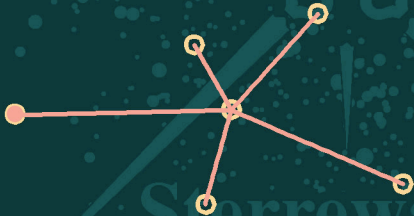
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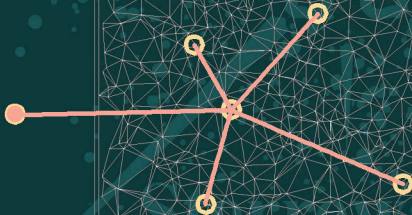
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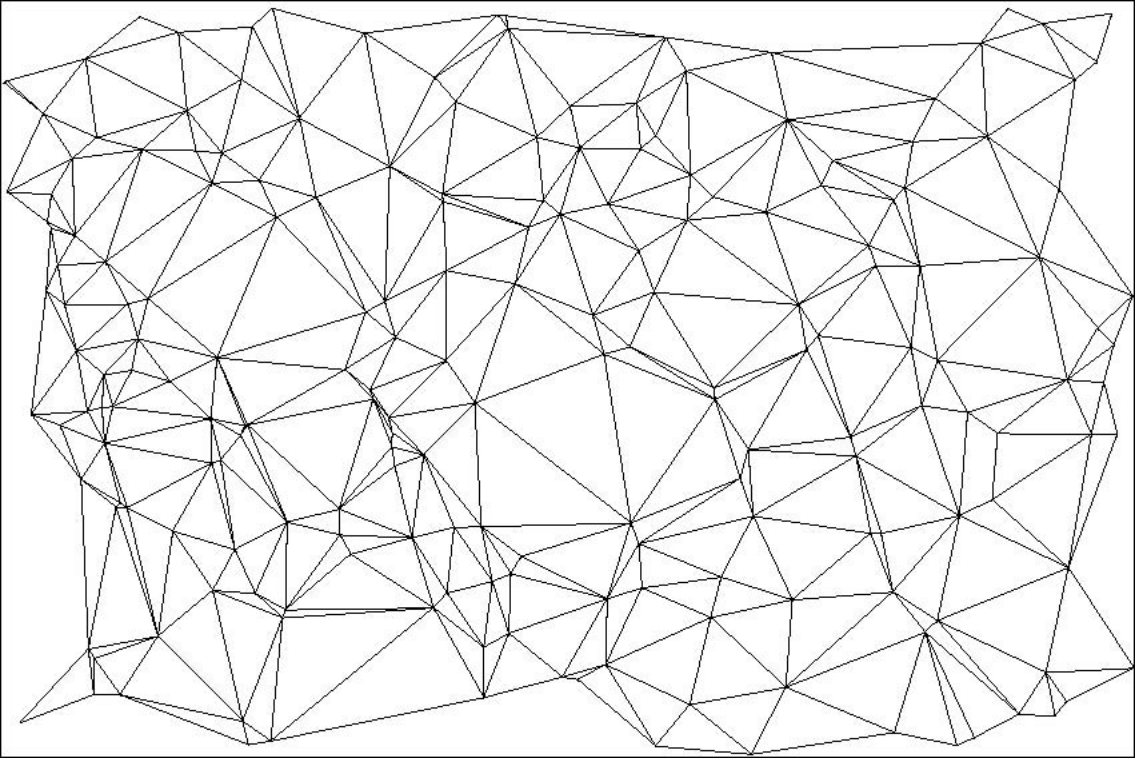
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Mean free path λ in a density field ρ with particle mass m and collision cross section σ is

$$\lambda = \frac{m}{\rho\sigma}$$

Delaunay length L in a point process with density n and spatial dimension D is

$$L = \alpha n^{-1/D}$$

Setting $\lambda = L$ gives

$$n = \left(\frac{\alpha\sigma}{m}\right)^D \rho^D$$

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Radiative transfer:
medium represented
by the point distribution

$$\mathbf{n} = \rho^{\text{D}}$$

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$$\mathbf{n} = \rho^D$$

mean Delaunay length
equal to mean free path

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Diffusion time t with speed v between N collisions over a macroscopic distance L is

$$t = N \frac{\lambda}{v} = \left(\frac{L}{\lambda} \right)^2 \frac{\lambda}{v} = \frac{L^2}{\lambda v}$$

If we require L to be the Delaunay length, then

$$n = \left(\frac{\alpha^2 \sigma}{v t m} \right)^{D/2} \rho^{D/2}$$

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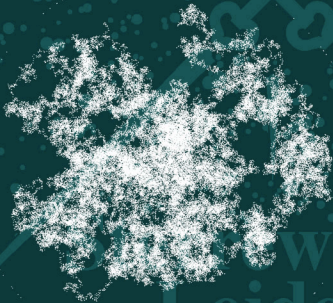
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$$\mathbf{n} = \rho^{D/2}$$

mean Delaunay length
equal to diffusion length

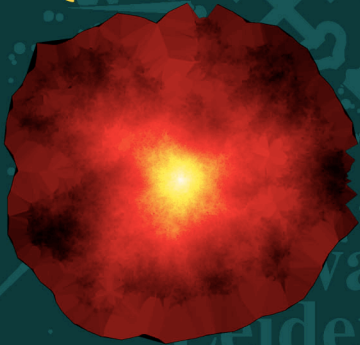
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