



Final States in DIPSY

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Low x, Ischia Island 8-13/9 2009

Work done with Gösta Gustafson and Leif Lönnblad.

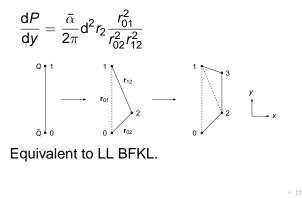
Introduction

- Dipoles do very well at inclusive cross sections.
- Exclusive final states are not as easy.
- DIPSY is a very detailed initial state dipole evolution model.
- We are prepared to move on to final states!



Evolution in rapidity

A colour dipole emits a gluon in transverse space with probability





Introduction Mueller's Dipole Model Inclusive cross sections DIPSY Exclusive Final States, A typical evolution

Interaction

A Born level calculation gives the collision amplitude for a pair of dipoles from different states:

$$f_{ij} = rac{lpha_s^2}{2} \ln^2 \left(rac{r_{13}r_{24}}{r_{14}r_{23}}
ight)$$

With the eikonal approximation, the total unitarised probability then becomes

$$t\equiv 1-e^{-\sum f_{ij}}.$$

Gösta Gustafson will talk more about how to get elastic and diffractive cross sections.

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Mueller's Dipole Mode DIPSY A typical evolution

Modifications in DIPSY

Energy conservation

- Keep track of p_{μ} for all partons.
- Small dipoles \leftrightarrow high p_T .
- Gives dynamic cutoff for small emissions.

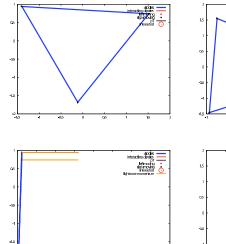
Non-linear 2 \rightarrow 2 swing:

Saturation in evolution.

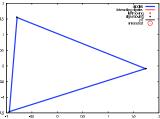
Confinement

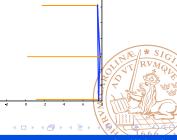
Supression of too large dipoles.

DIPSY A typical evolution Results



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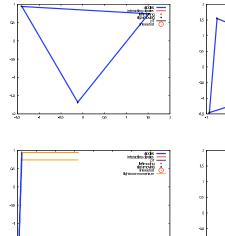


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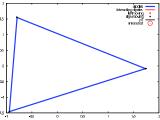
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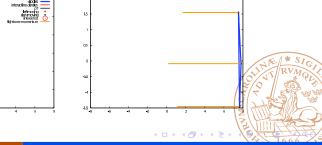
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DIPSY A typical evolution Results



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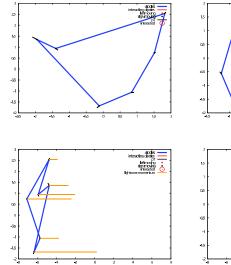


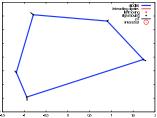
Final States in DIPSY

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DIPSY A typical evolution Results

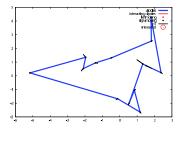


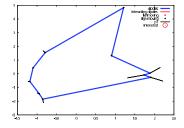


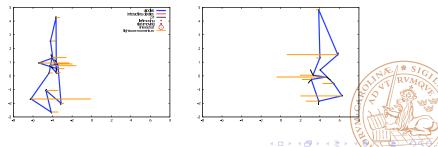


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DIPSY A typical evolution Results

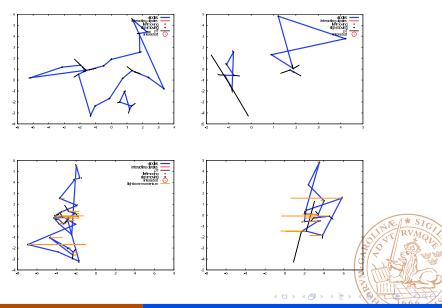




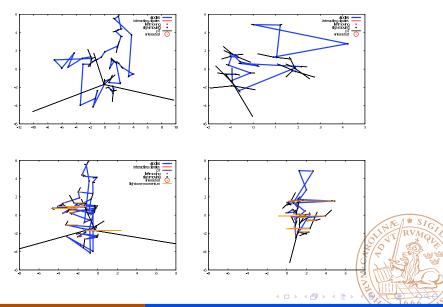


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DIPSY A typical evolution Results



DIPSY A typical evolution Results



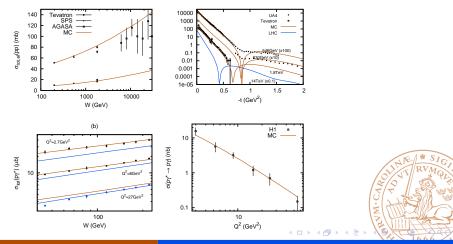
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Introduction DIPSY
Inclusive cross sections A typical evolution
Exclusive Final States, Results

Some sample results

pp and γ^*p : total, elastic and diffractive cross section.



Final States in DIPSY

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Basic Idea Modifications A typical Event

Final States

Want to use all the information about the particles in the generated initial states.

Can not take them as they are though.

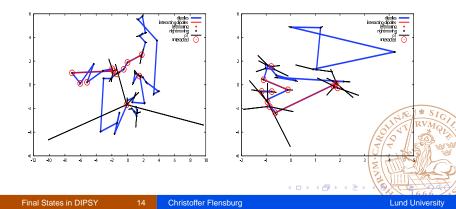
More complicated than expected, but we are getting close now

Basic Idea Modifications A typical Event

Selecting Interactions

Eikonal appproximation \rightarrow Poissonian distribution.

Can use f_{ij} to get scattering probabilities for each individual dipole pair.

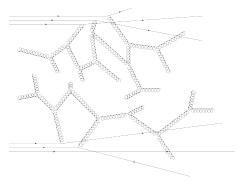


nclusive cross sections^{*} Exclusive Final States Heavy lons Basic Idea Modifications A typical Event

Virtual Partons

Emissions that do not interact cannot get on shell since they are ordered in virtuality.

Must be virtual emissions, should be reabsorbed.

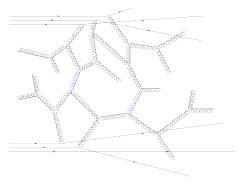


Basic Idea Modifications A typical Event

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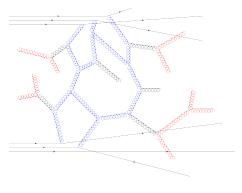


nclusive cross sections^{*} Exclusive Final States Heavy lons Basic Idea Modifications A typical Event

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Modifications

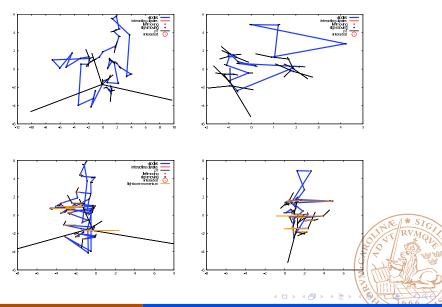
Interaction Probability and p_T

- ▶ Interaction distance $r \Leftrightarrow \text{momentum } p_T = 1/r$.
- ► Interaction amplitude $f_{ij} = \frac{\alpha_s^2}{2} \ln^2 \left(\frac{r_{13}r_{24}}{r_{14}r_{23}} \right)$ gives exact *r* distribution.
- Interaction amplitude f_{ij} = 8α²_s sin² (^{r·r₁₂}/_{r²}) sin² (^{r·r₃₄}/_{r²}) gives exact p_T amplitude. Better.

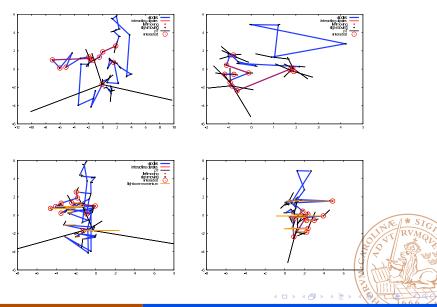
Require that colour connected partons should be p_+ and p_- ordered.

- Prevents double counting with final state radiation.
- Does not contribute much to total cross sections.

Modifications A typical Event preliminary results



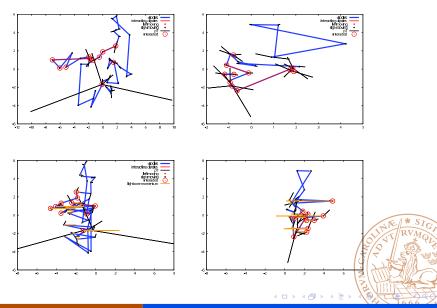
Modifications A typical Event preliminary results



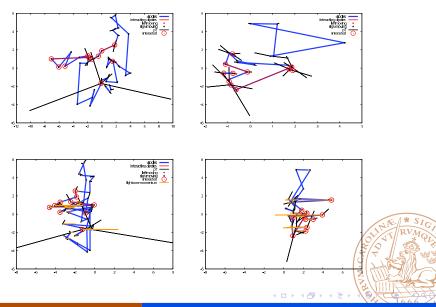
Final States in DIPSY

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Modifications A typical Event preliminary results



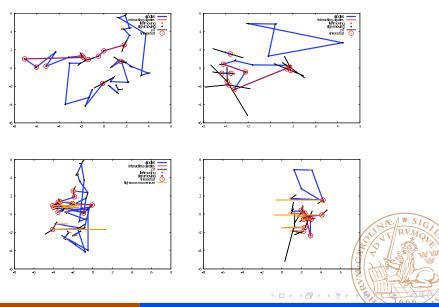
Modifications A typical Event preliminary results



Final States in DIPSY

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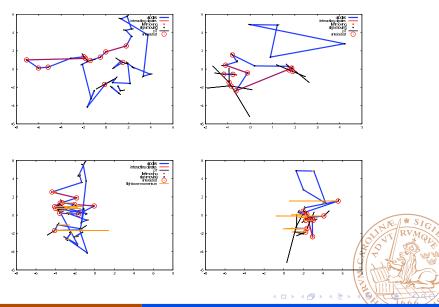
Modifications A typical Event preliminary results



Final States in DIPSY

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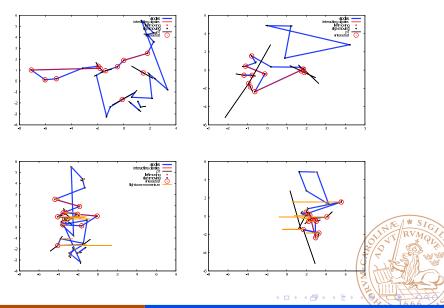
Modifications A typical Event preliminary results



Final States in DIPSY

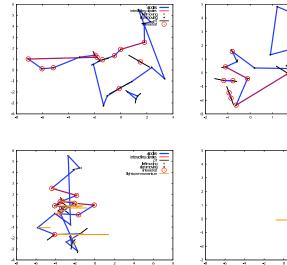
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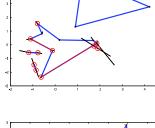
Modifications A typical Event preliminary results



Exclusive Final States

A typical Event



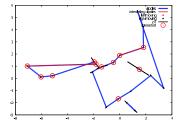


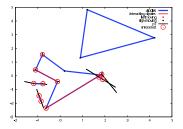
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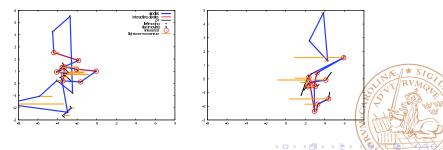
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Modifications A typical Event preliminary results

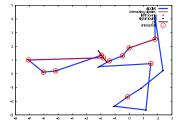


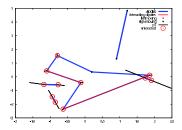


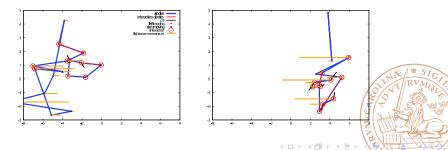


Final States in DIPSY

Modifications A typical Event preliminary results

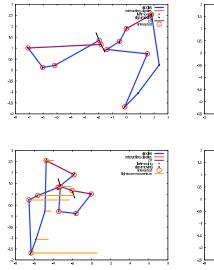


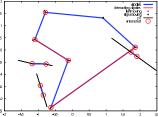




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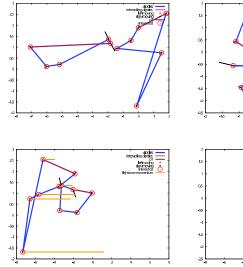


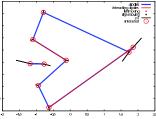
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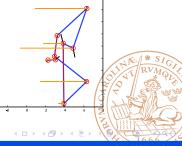
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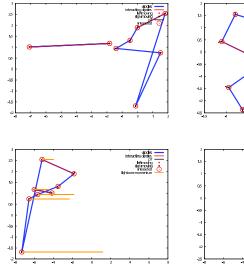
Modifications A typical Event preliminary results

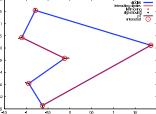






Modifications A typical Event preliminary results





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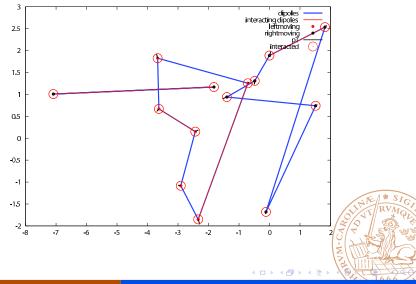
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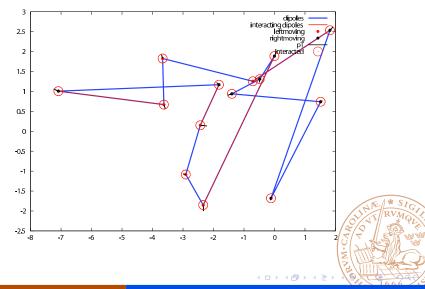
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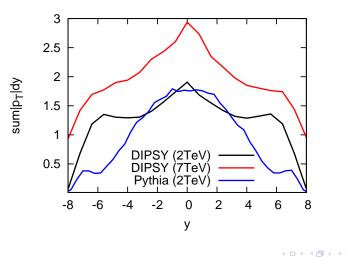
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Final States in DIPSY

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Preliminary results



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* SIC

Heavy lons: A new field

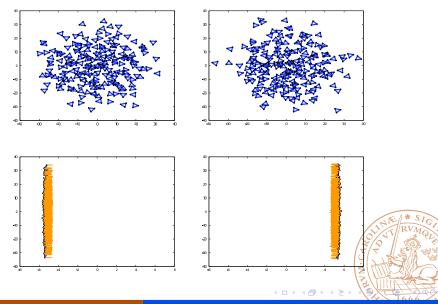
Distribution of nucleouns from collaborators András Ster and Tamás Csörgő.

Then evolve, collide and absorb as for pp.

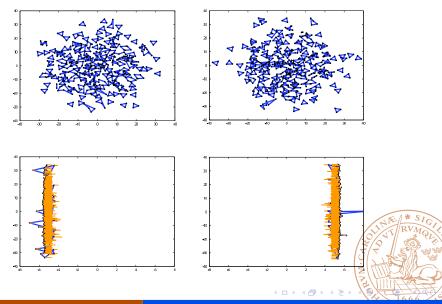
In principle same dynamics as Colour Glass Condensate.

- DIPSY uses finite size nucleus.
- DIPSY works at limited energies, for example at RHIC and LHC.

Exclusive Final States^{*} Heavy lons introduction A typical Event Preliminary result

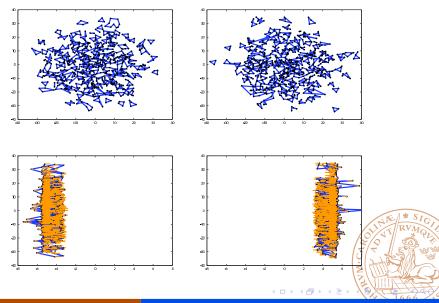


Exclusive Final States^{*} Heavy lons introduction A typical Event Preliminary result



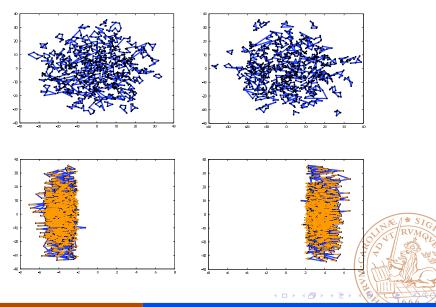
Final States in DIPSY

introduction A typical Event Preliminary result

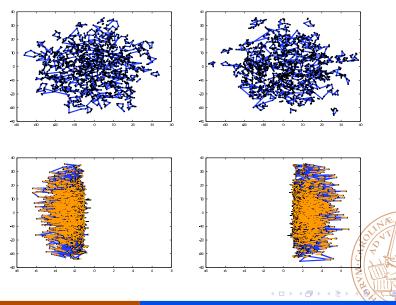


Final States in DIPSY

introduction A typical Event Preliminary result



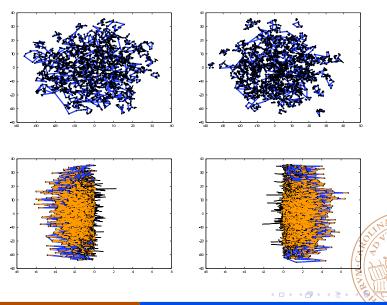
introduction A typical Event Preliminary result



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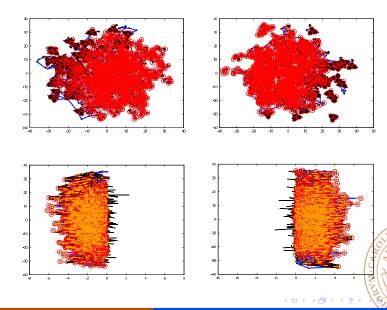
introduction A typical Event Preliminary result



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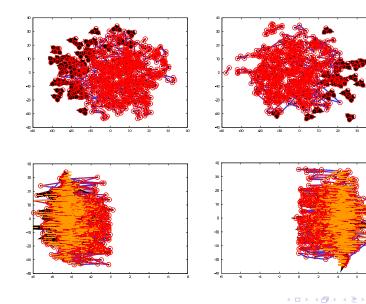
introduction A typical Event Preliminary results



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introduction A typical Event Preliminary result



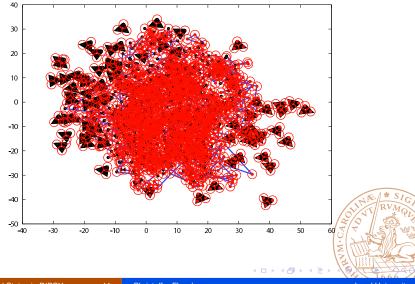
Final States in DIPSY

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Exclusive Final States introduction Heavy Ions A typical Event Conclusions, Preliminary results

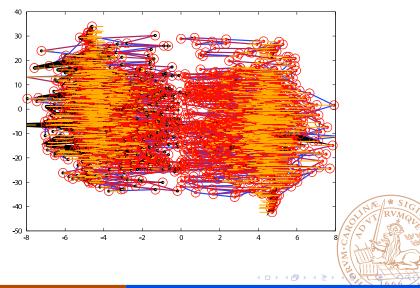


Final States in DIPSY

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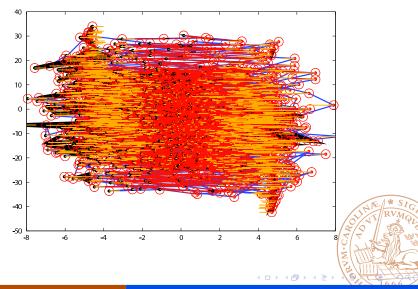
Exclusive Final States intr Heavy lons A to Conclusions

introduction A typical Event Preliminary result



Final States in DIPSY

Exclusive Final States[°] Heavy lons Conclusions, Preliminary results



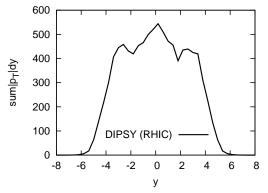
Final States in DIPSY

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lusive Final States A Heavy Ions

A typical Event Preliminary results

VERY preliminary results



Have p_{μ} , x_{T} and colour flow for every parton in the nucleus just after the collision.

Can then be plugged into final state models, as for example hydrodynamics.

Final States in DIPSY

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Conclusions

- Evolution of dipoles in space and rapidity.
- Inclusive cross sections match wide set of data very well with few parameters.
- Exclusive final states complicated, but almost sorted out now!
- Applications in Heavy lons.



small dipole absorb

Dipoles come with relative weight of $1/r^2$ in evolution as seen from emission amplitude.

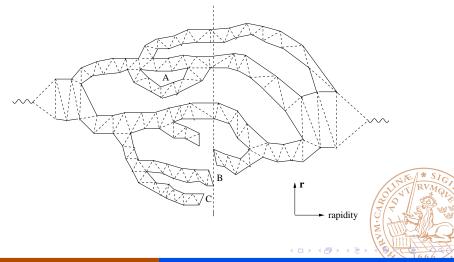
high p_T events should come with weight of $d^2 p_T / p_T^4 = d^2 r$.

So small dipoles in evolution (giving large p_T) are too frequent.

Solution: Absorb small dipoles. Keep with a propbability $p \propto r_{small}^2$. Then final weight for small dipoles will be d^2r as we want.

Heavy lons Conclusions backup slides

Virtual Partons



Final States in DIPSY

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Divergent mueller evolution

No problem since small dipoles are unlikely to interact.

Infinitely many small dipoles, but finite total interaction probability.

Inconvenient for monte carlos though.

