

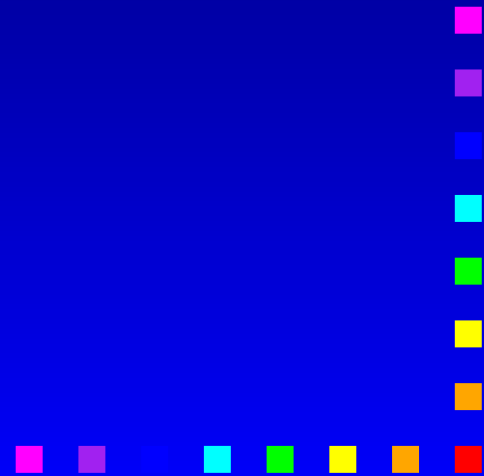
Formation and Dynamics of Strings in Gauge Theories

Amitabha Lahiri

In-House Meeting 2004, Jan 28-29, 2005
S. N. Bose National Centre for Basic Sciences

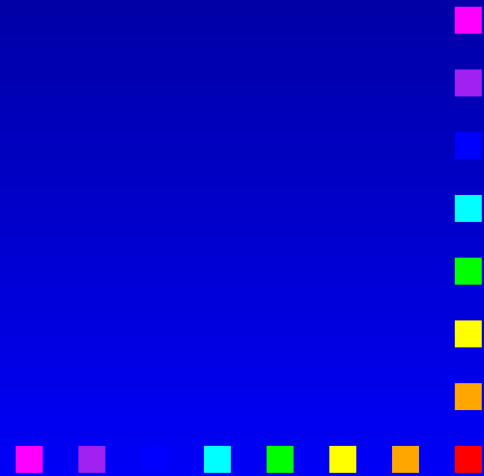


Overview



Overview

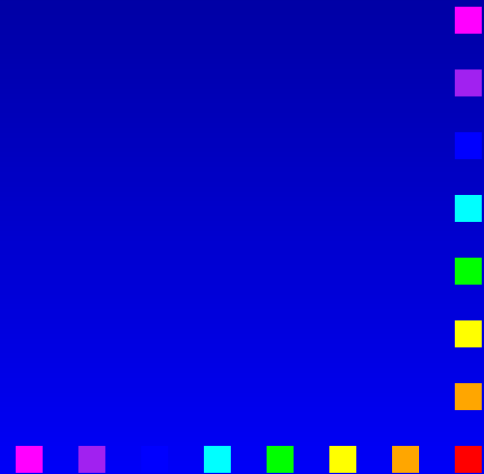
Context



Overview

Context

Symmetry

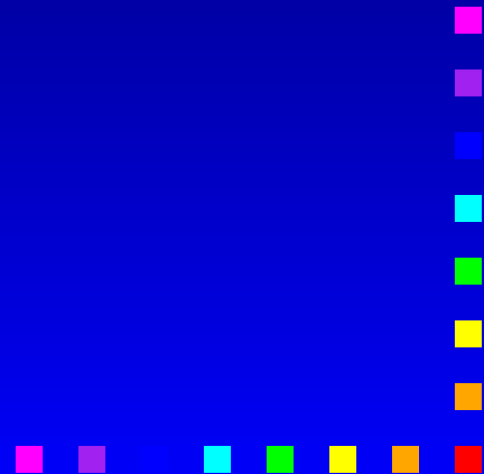


Overview

Context

Symmetry

Parallel Transport



Overview

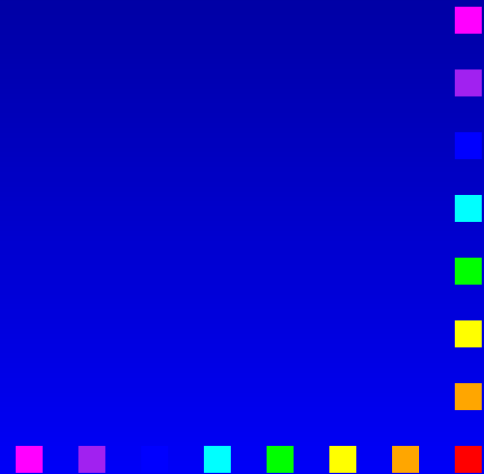
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Parallel Transport

Formation of Strings

♣ with C.Chatterjee



Overview

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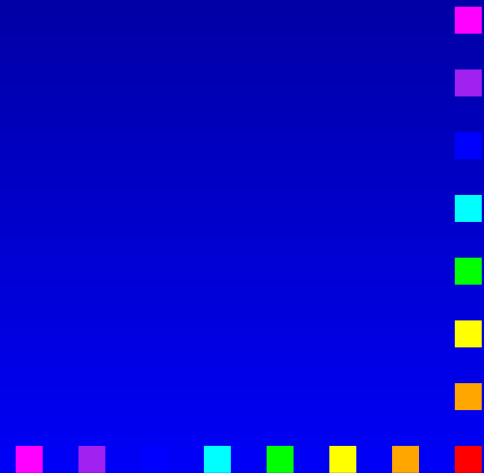
Parallel Transport

Formation of Strings

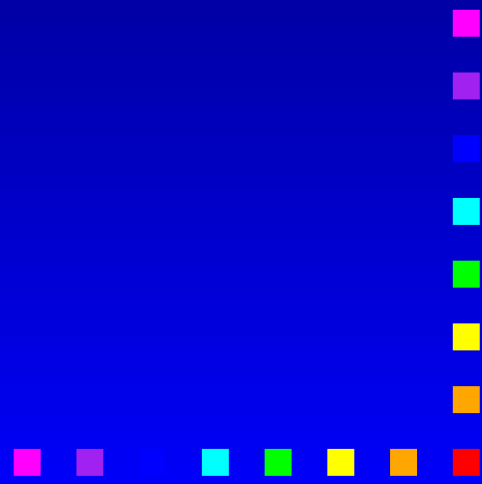
♣ with C.Chatterjee

Dynamics from holonomy

♣ with S.Chatterjee

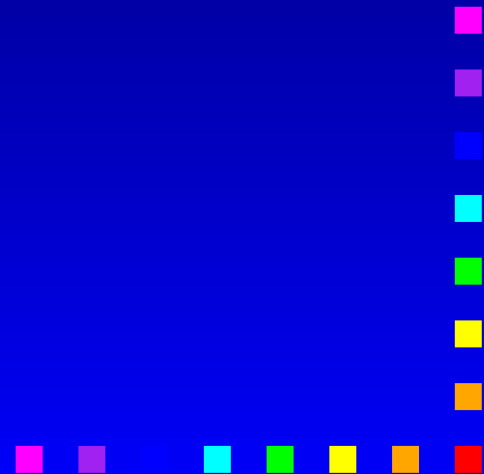


Why Strings?



Why Strings?

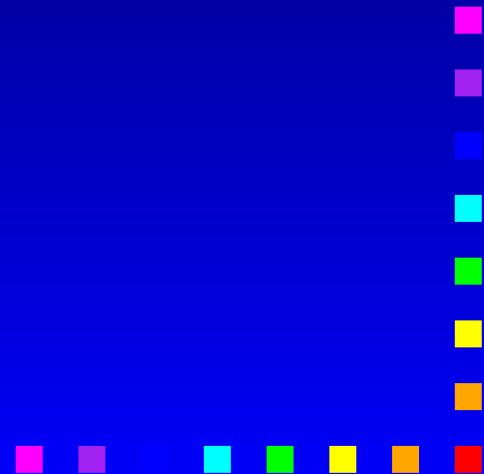
Strong Interactions \rightleftharpoons QCD



Why Strings?

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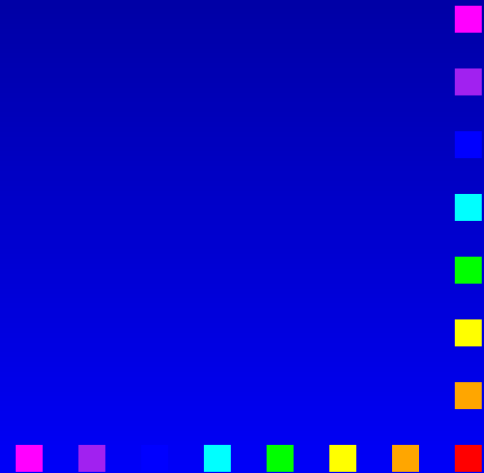
Good at High Energies



Why Strings?

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Good at High Energies \Leftrightarrow Asymptotic Freedom (1973)

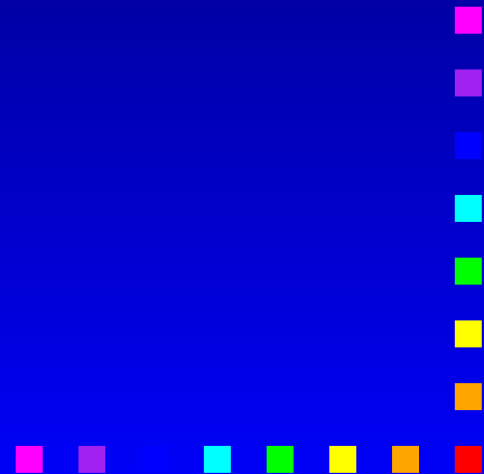


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Low Energy \longrightarrow Confinement (Observed)



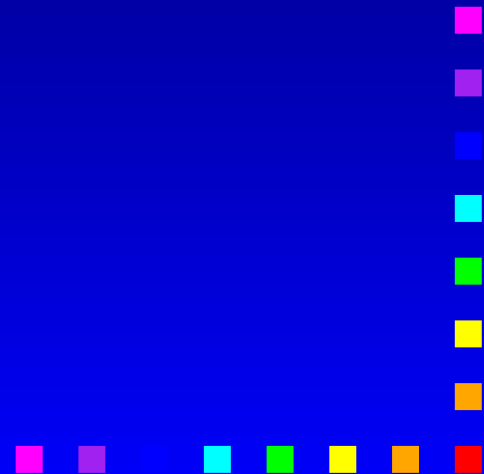
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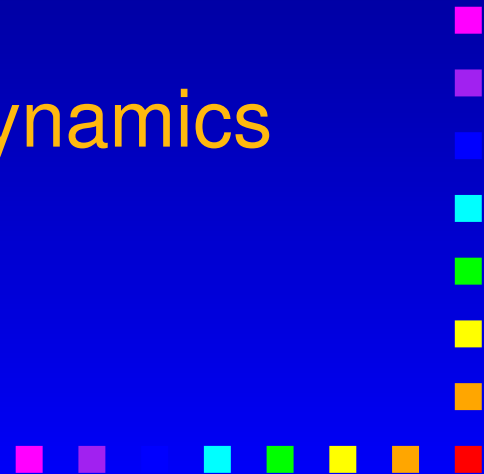
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String \longrightarrow New Variables \longrightarrow New Dynamics



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Does not work \longrightarrow New Approach needed



Why Strings?

Strong Interactions \rightleftharpoons QCD

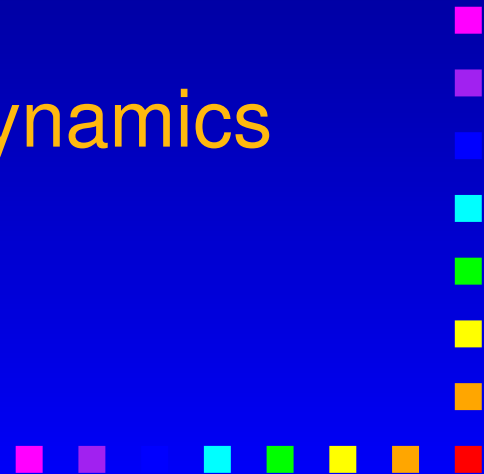
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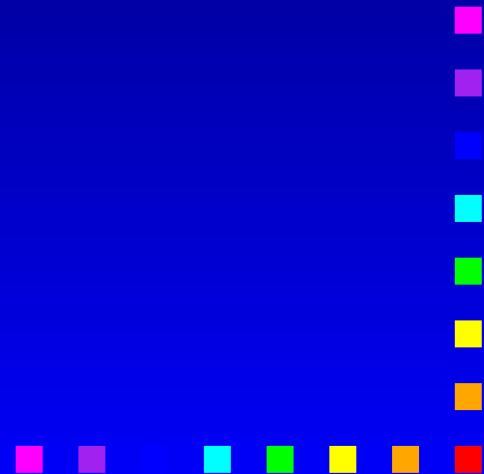
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String \longrightarrow New Variables \longrightarrow New Dynamics

Fresh Look at Charged Strings

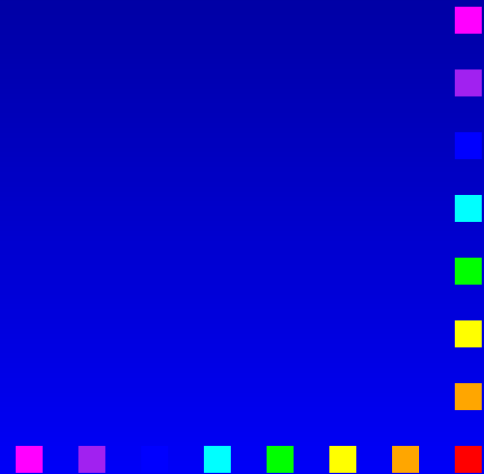


Issues of Symmetry



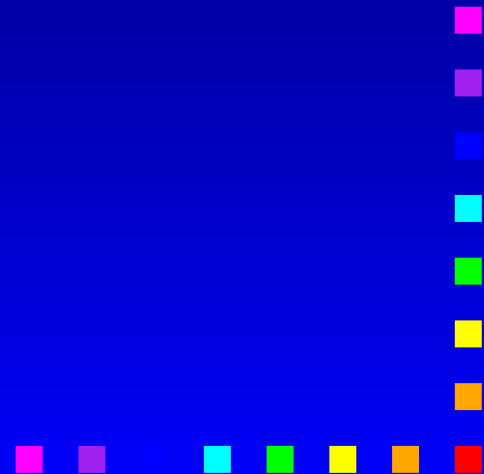
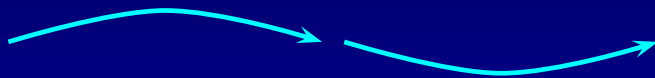
Issues of Symmetry

Point particles (Fields) \longleftrightarrow Symmetry Group



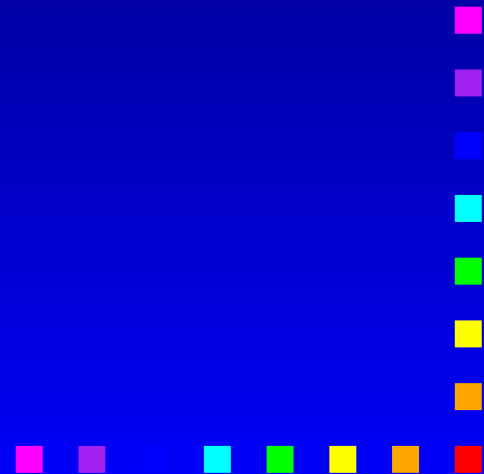
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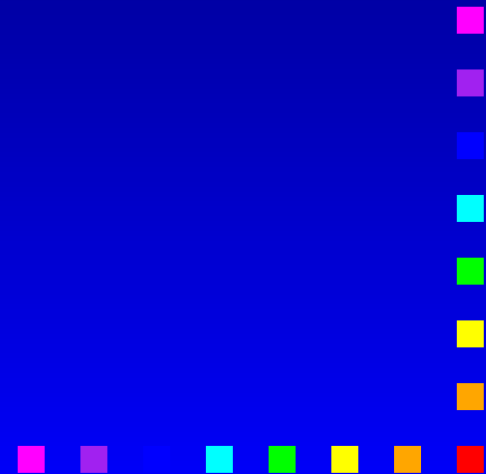
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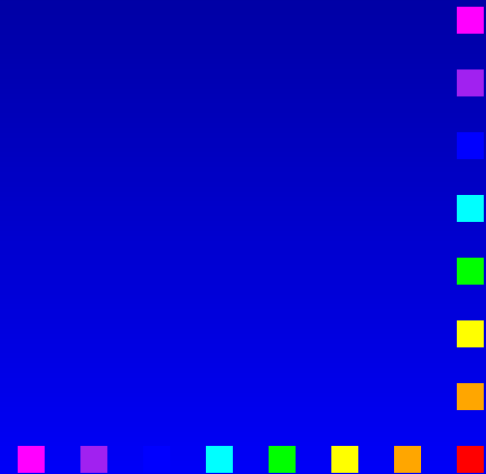
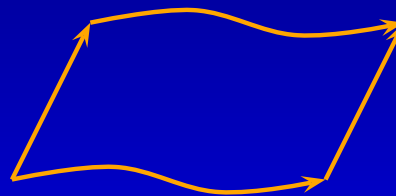
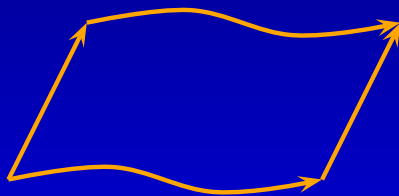
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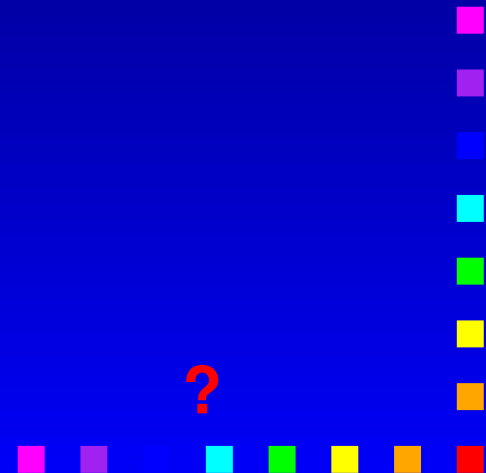
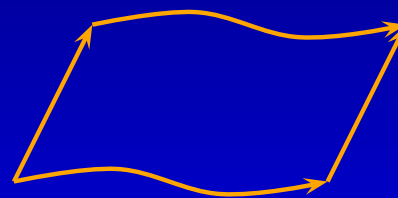
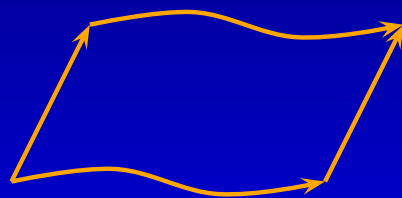
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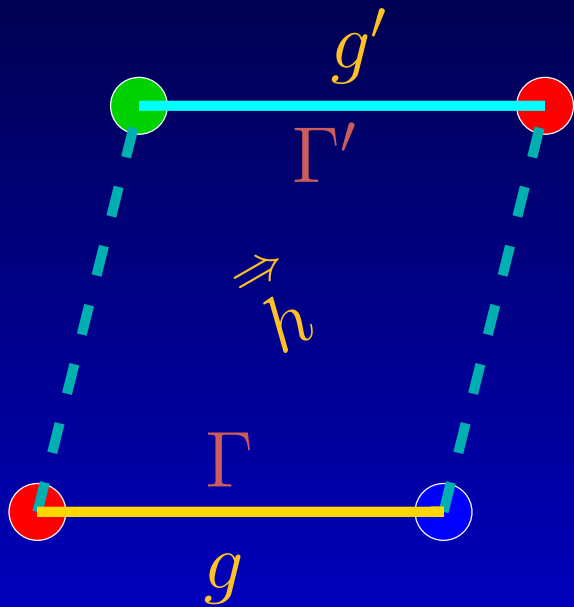


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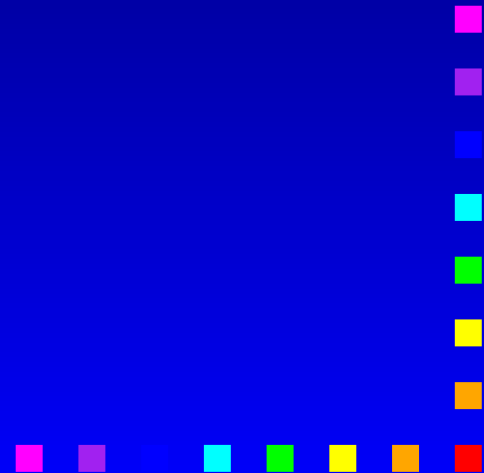


Transport and Holonomy

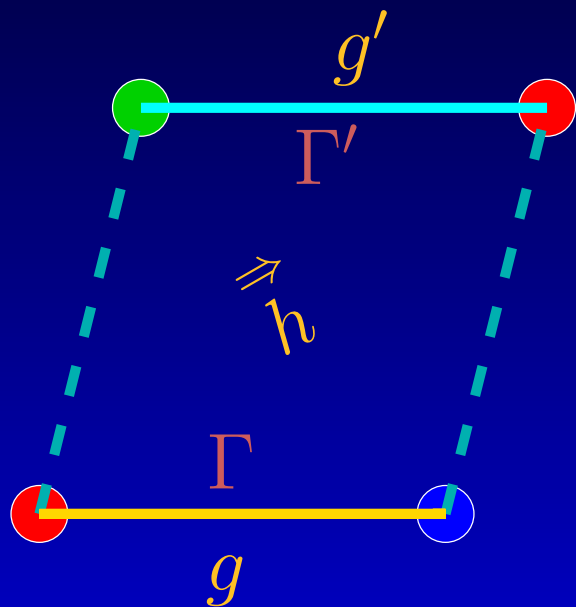


$$g = P \exp i \int_{\Gamma} A$$

$$g' = P \exp i \int_{\Gamma'} A$$



Transport and Holonomy



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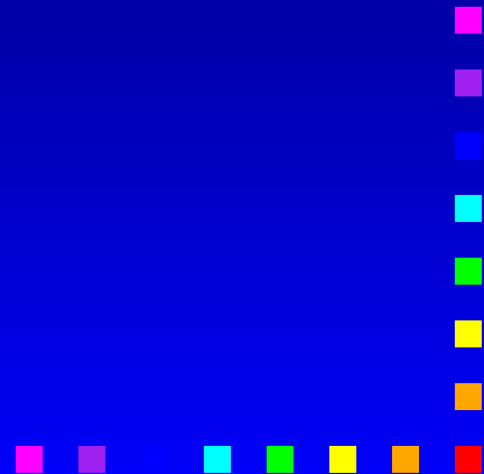
$$g' = P \exp i \int_{\Gamma'} A$$

Associate the pair (h, g) with this surface



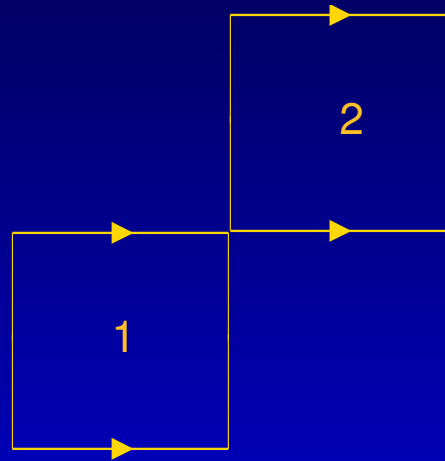
Composing Surfaces

Composition along edge or corner

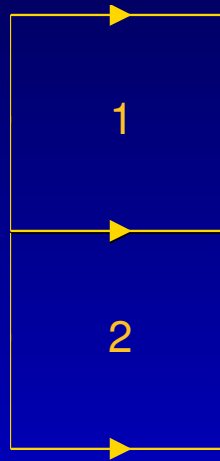


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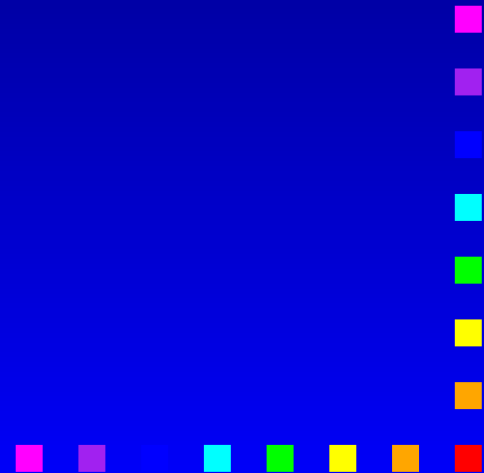
Composition along edge or corner



$$(h_1 g_1 h_2 g_1^{-1}, g_1 g_2)$$

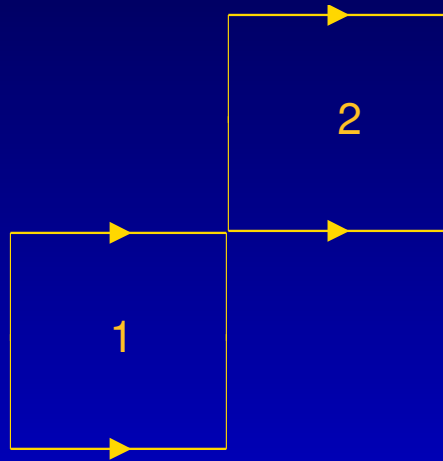


$$(h_2 h_1, g_1)$$

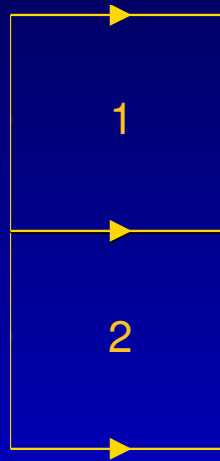


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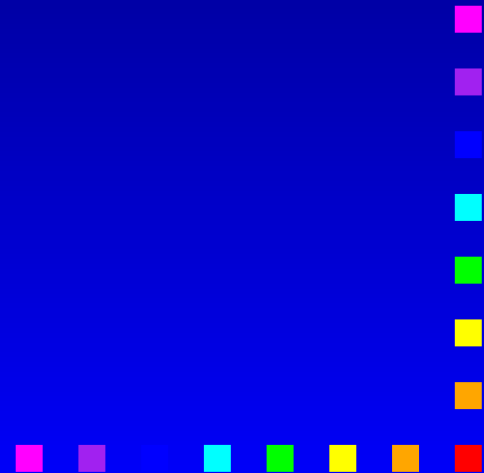


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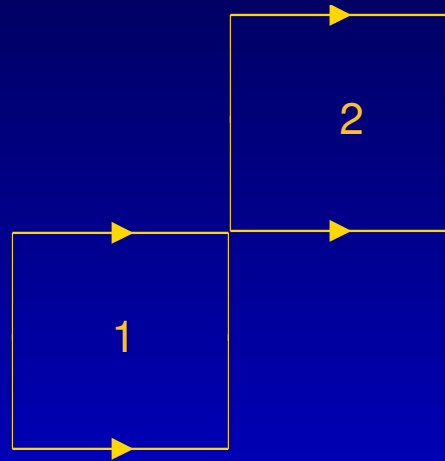
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Generalized Symmetry

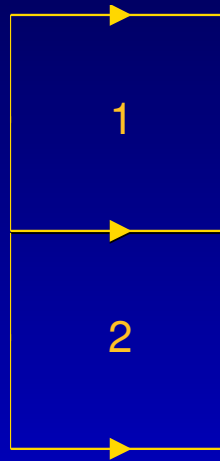


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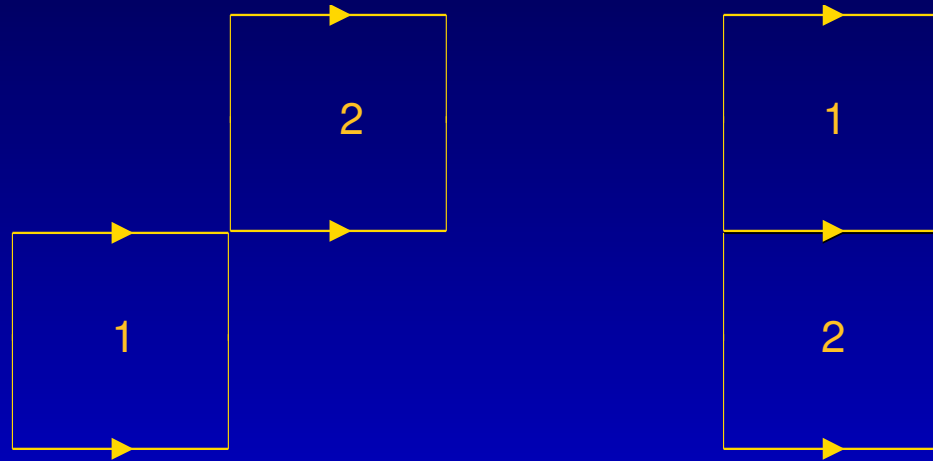


$$(h_2 h_1, g_1)$$

Generalized Symmetry \rightarrow Categorical Group

Composing Surfaces

Composition along edge or corner

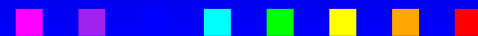


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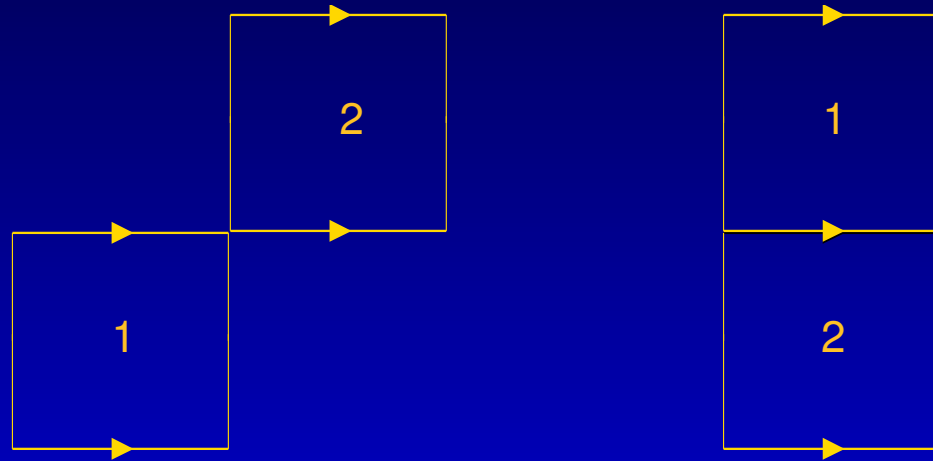
Generalized Symmetry \rightarrow Categorical Group

Symmetries \Rightarrow Action?



Composing Surfaces

Composition along edge or corner



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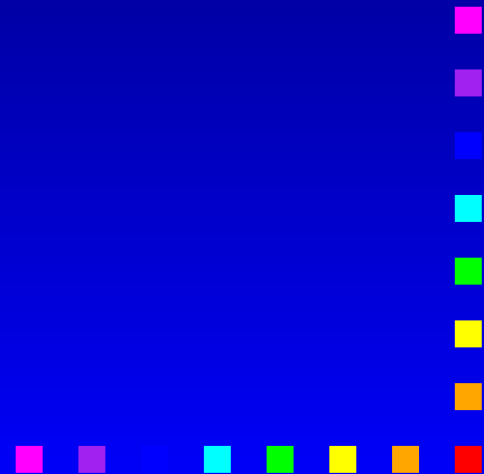
Generalized Symmetry \rightarrow Categorical Group

Symmetries \Rightarrow Action? \Rightarrow Variables?



String = Flux Tube

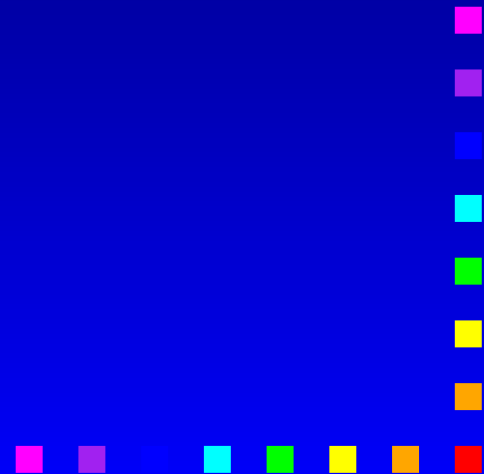
with C. Chatterjee



String = Flux Tube

with C. Chatterjee

$q\bar{q}$ at ends of tube of flux

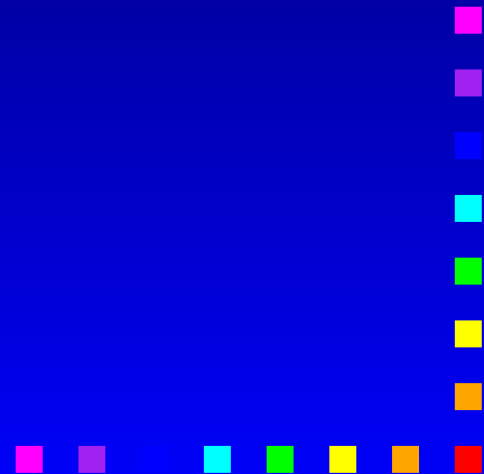


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Corresponding (Classical) Solution?



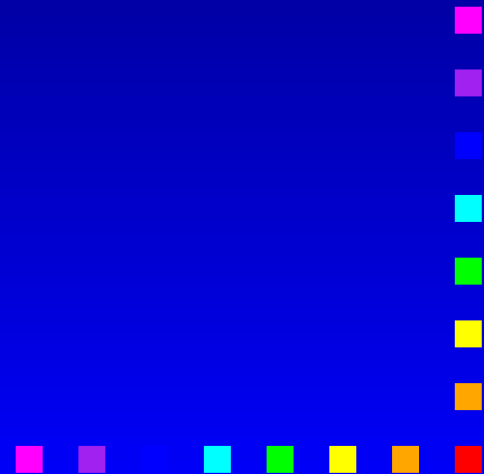
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Corresponding (Classical) Solution?

Try a DUAL picture



String = Flux Tube

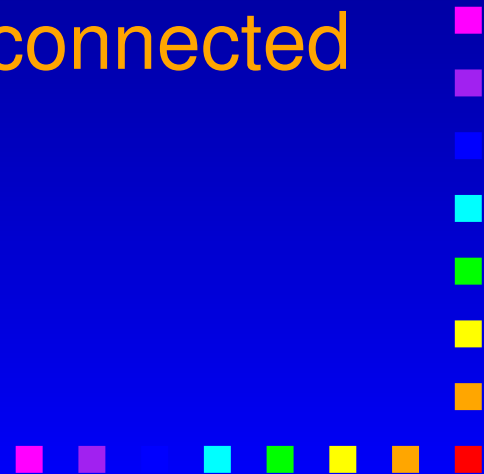
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Corresponding (Classical) Solution?

Try a DUAL picture

(Magnetic) Monopole-anti-monopole connected
by a tube of magnetic flux



String = Flux Tube

with C. Chatterjee

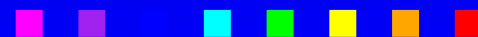
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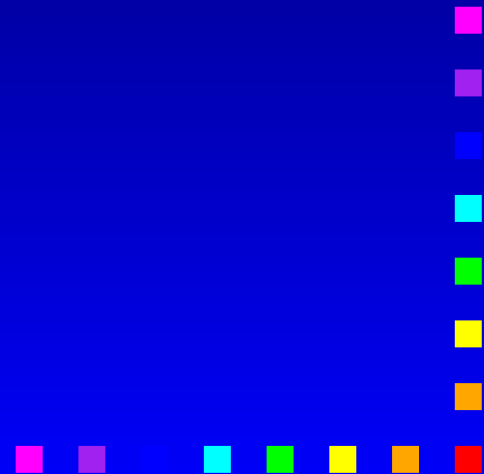
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Simpler models first – utilize Higgs mechanism



Dynamics

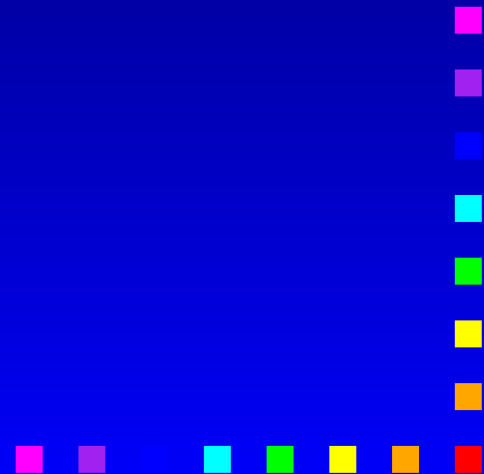
with S. Chatterjee



Dynamics

with S. Chatterjee

Assume correct variables have been found

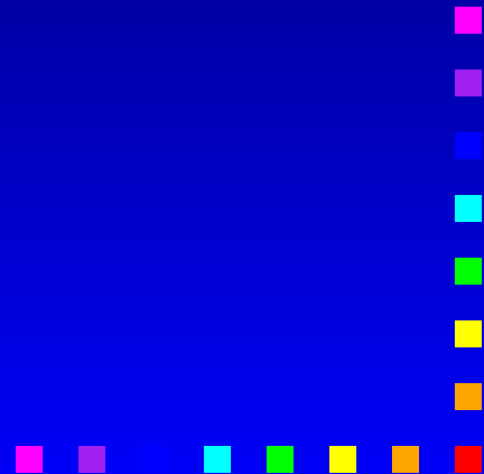


Dynamics

with S. Chatterjee

Assume correct variables have been found

Symmetry \Rightarrow Dynamics?



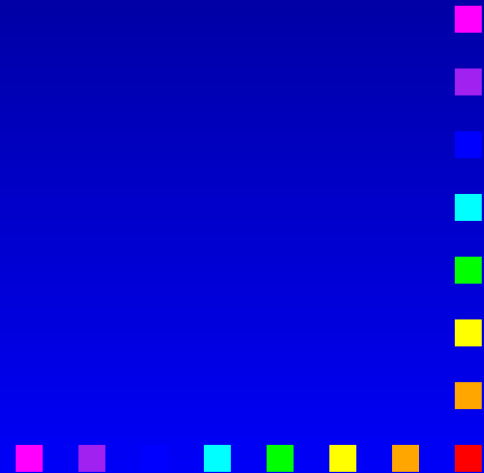
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Symmetry \Rightarrow Dynamics?

Try Simpler Systems: Particles/Fields



Dynamics

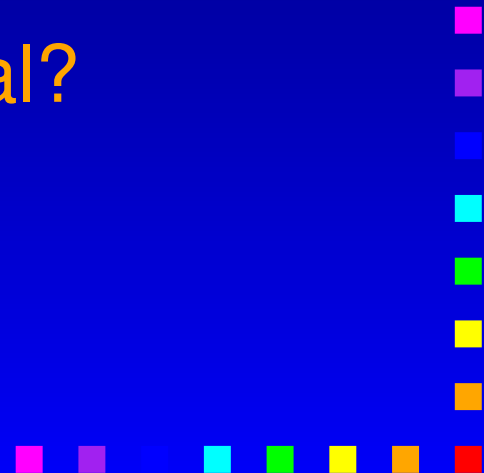
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Try Simpler Systems: Particles/Fields

Sum over Holonomies \Leftrightarrow Path Integral?



Dynamics

with S. Chatterjee

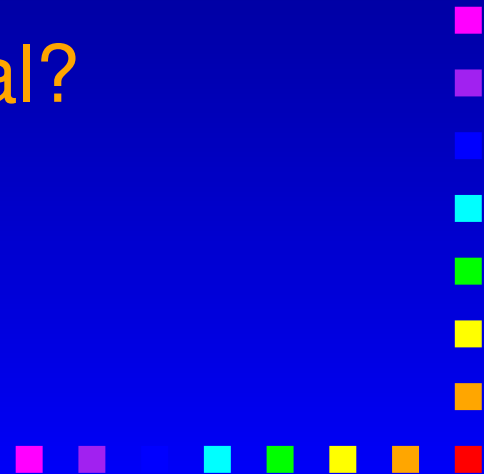
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Sum over Holonomies \Leftrightarrow Path Integral?

Geometry \Rightarrow Action?



The Plot Thickens ...

