GETTING A NUMBER OUT OF A QCD AMPLITUDE

Ryan Moodie

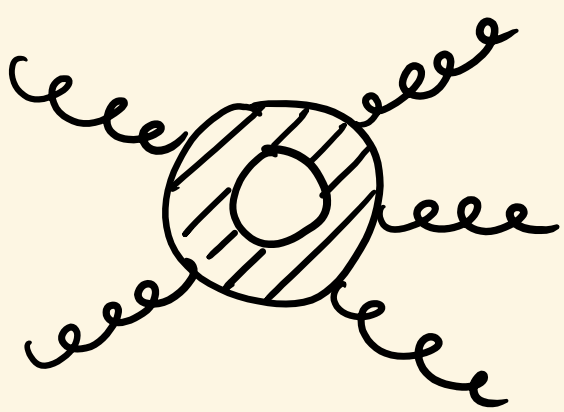
OUTLINE

- Tree level
- Higher order corrections
- Infrared divergences
- Loops
- Computation

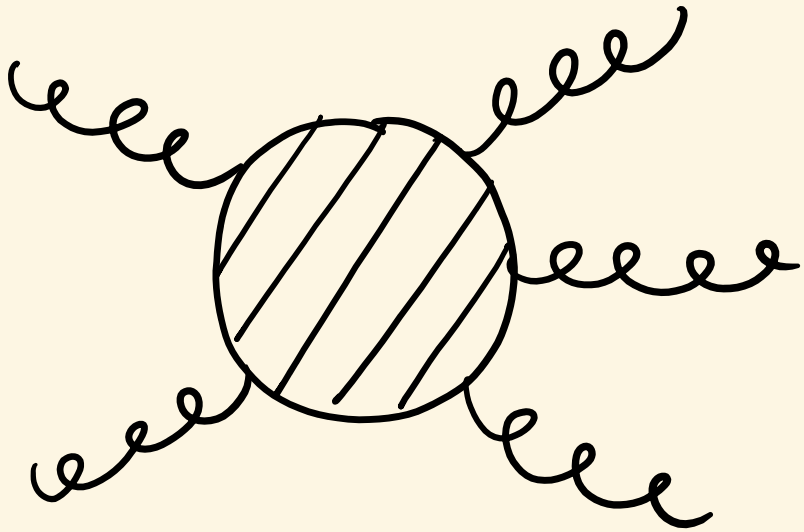
AIM

AIM

$$\int_V d\Phi \left| \right|^2 \longrightarrow R$$



TREE LEVEL



HELICITY SUM

$$\frac{1}{4} \sum_{h_i \in \{+,-\}}$$

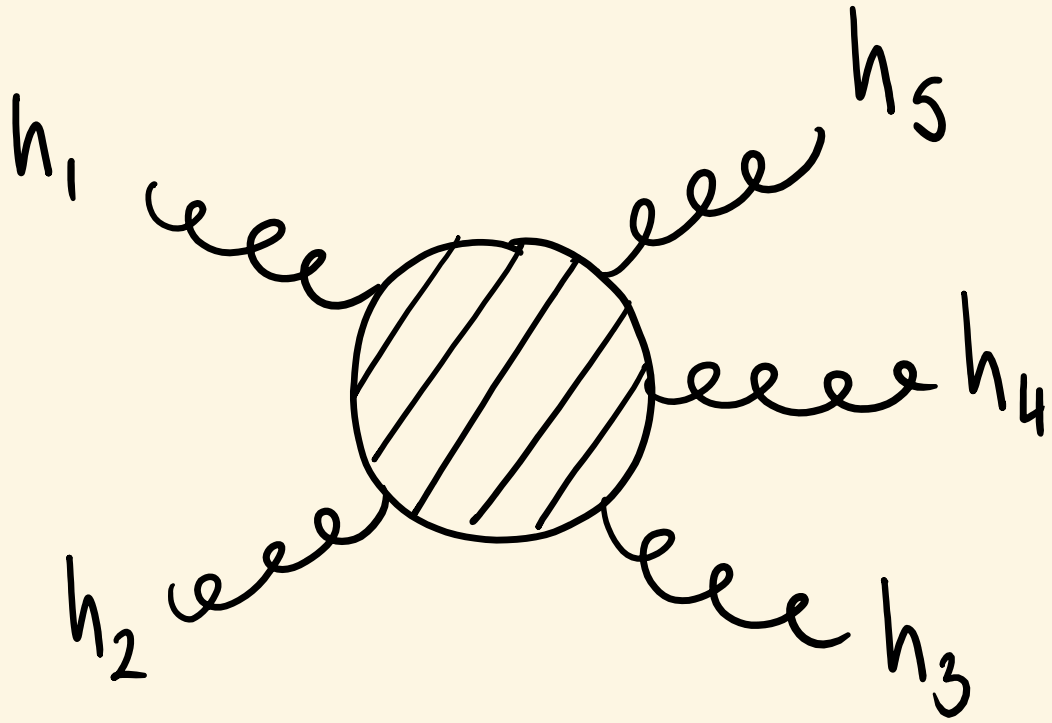
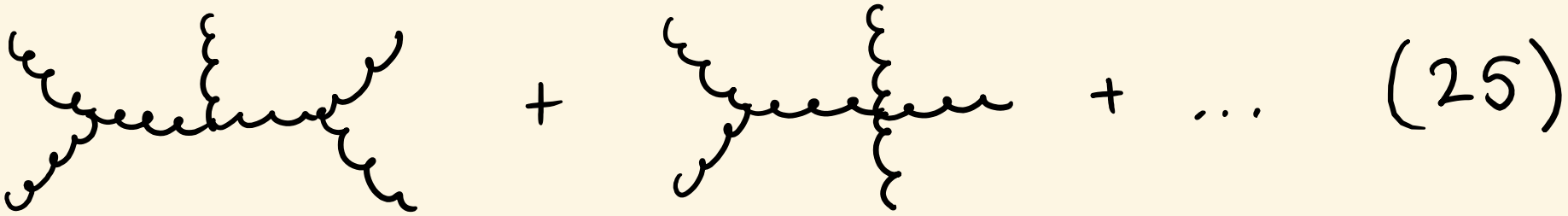
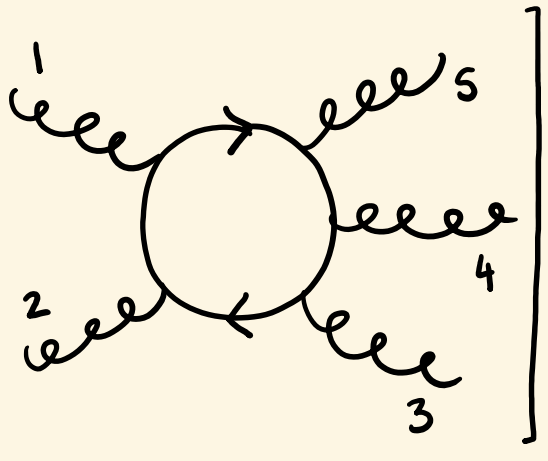


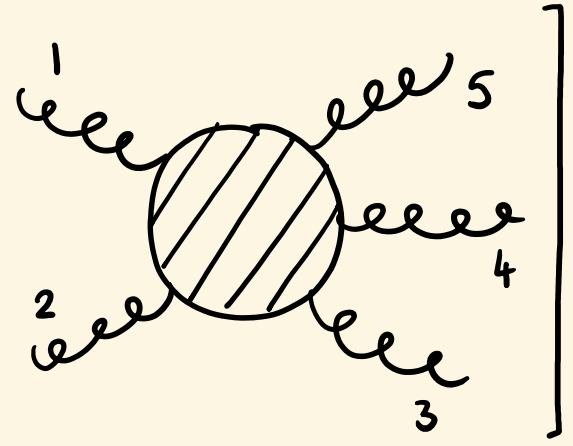
DIAGRAM SUM



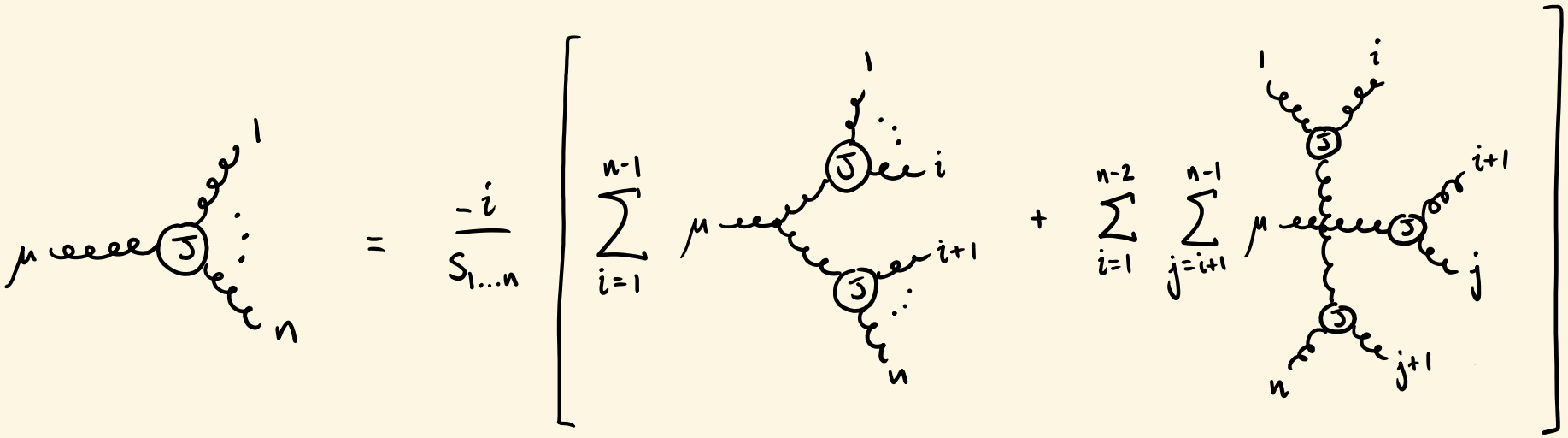
COLOUR SUM

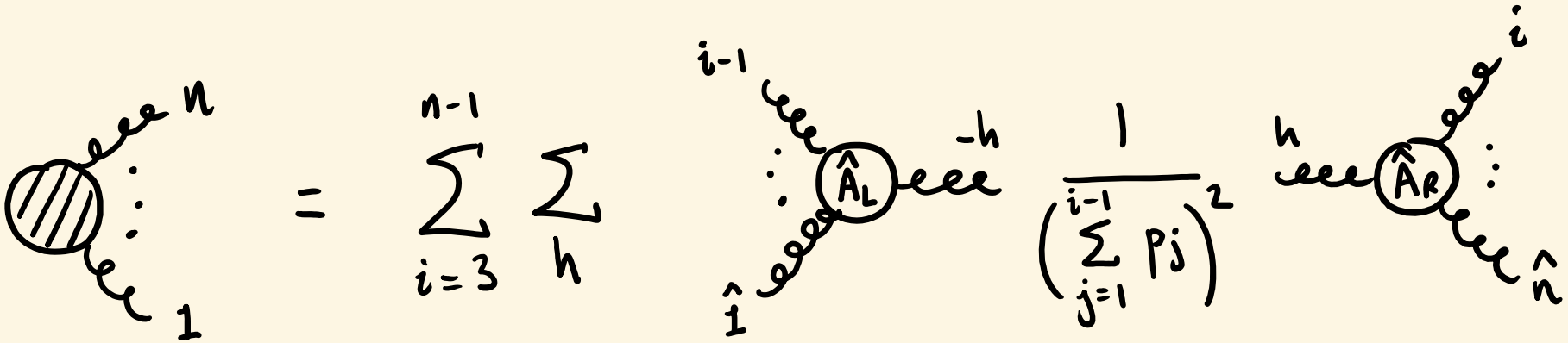
$$\sum_{\sigma} \mathrm{col}\left[\;\right] \mathrm{kin}\left[\;\right]$$





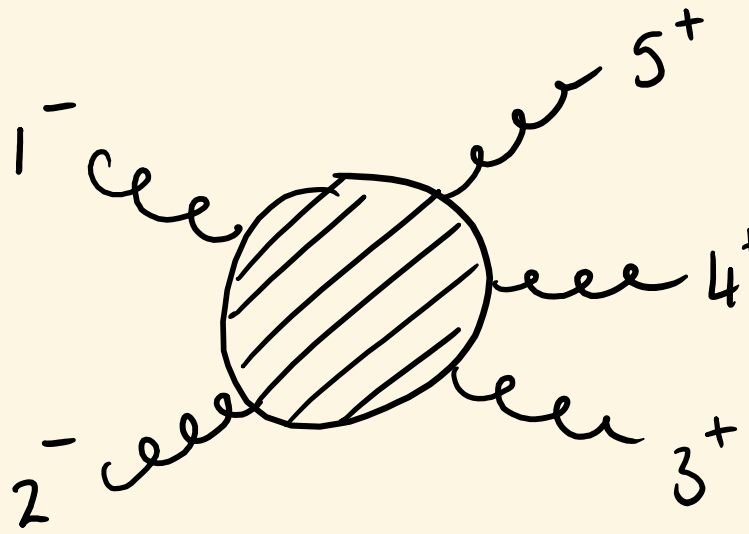
RECURSION


μ
J
1
n
=
-i / S1…n
n-1
Σ
i=1
i
i+1
+
n-2
Σ
i=1
n-1
Σ
j=i+1
j
j+1


n
1
=
n-1
Σ
i=3
Σ
h
i-1
-h
Â_L
î
1
(Σ_{j=1}^{i-1} Pj)^2
h
Â_R
i
n̂

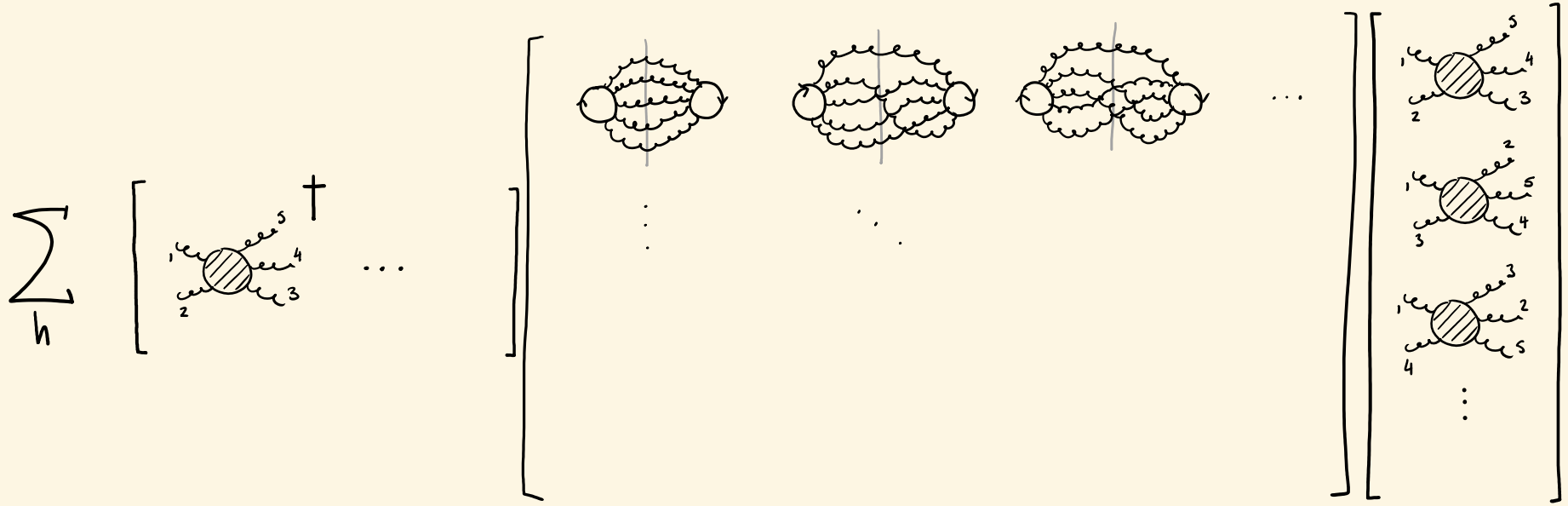
SPINOR HELICITY

$$\psi = \begin{pmatrix} |\,\rangle \\ |\,] \end{pmatrix}$$



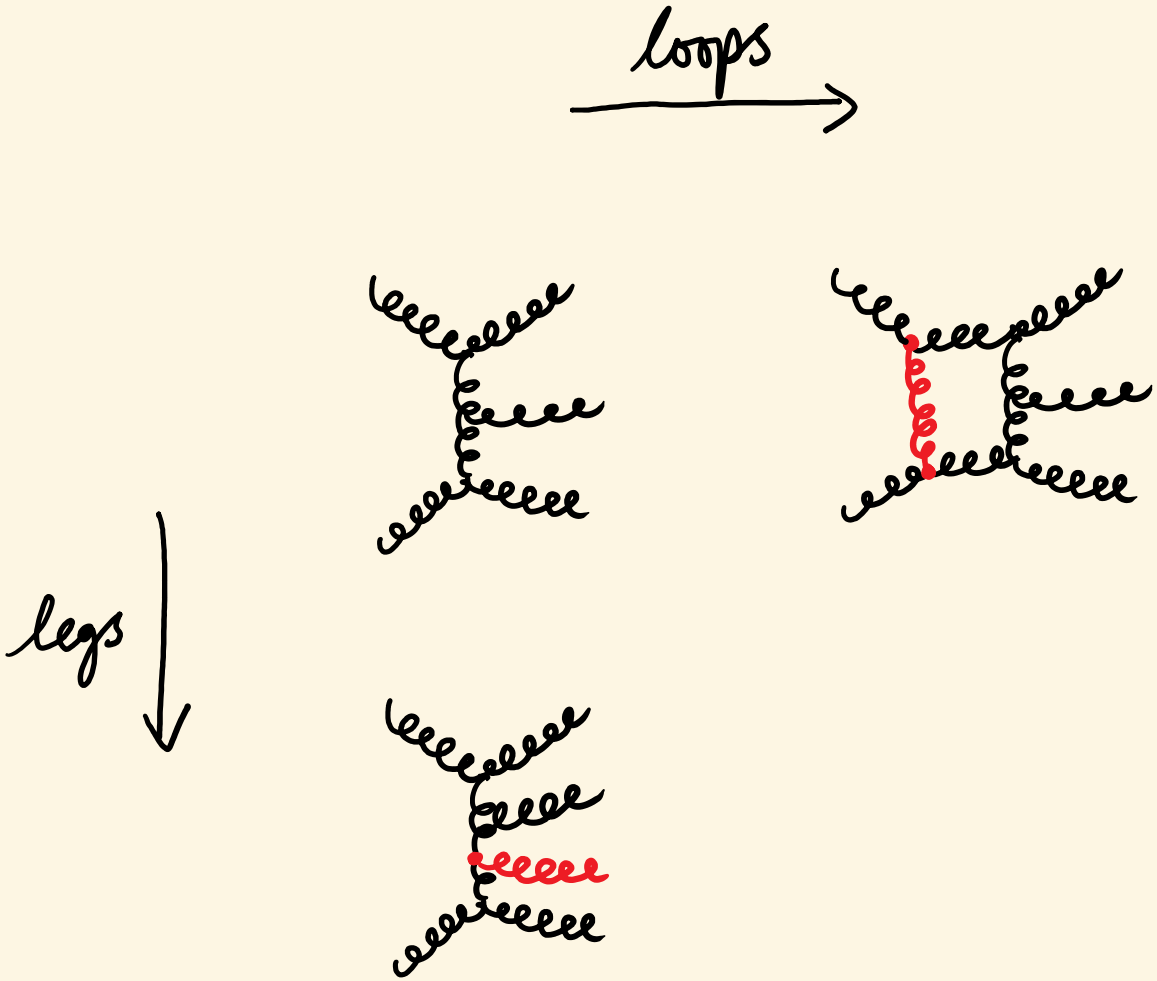
$$= \frac{\langle 12\rangle^4}{\langle 12\rangle\langle 23\rangle\langle 34\rangle\langle 45\rangle\langle 51\rangle}$$

AMPLITUDE SQUARED



HIGHER ORDER CORRECTIONS

NEXT-TO-LEADING-ORDER



CROSS-SECTION

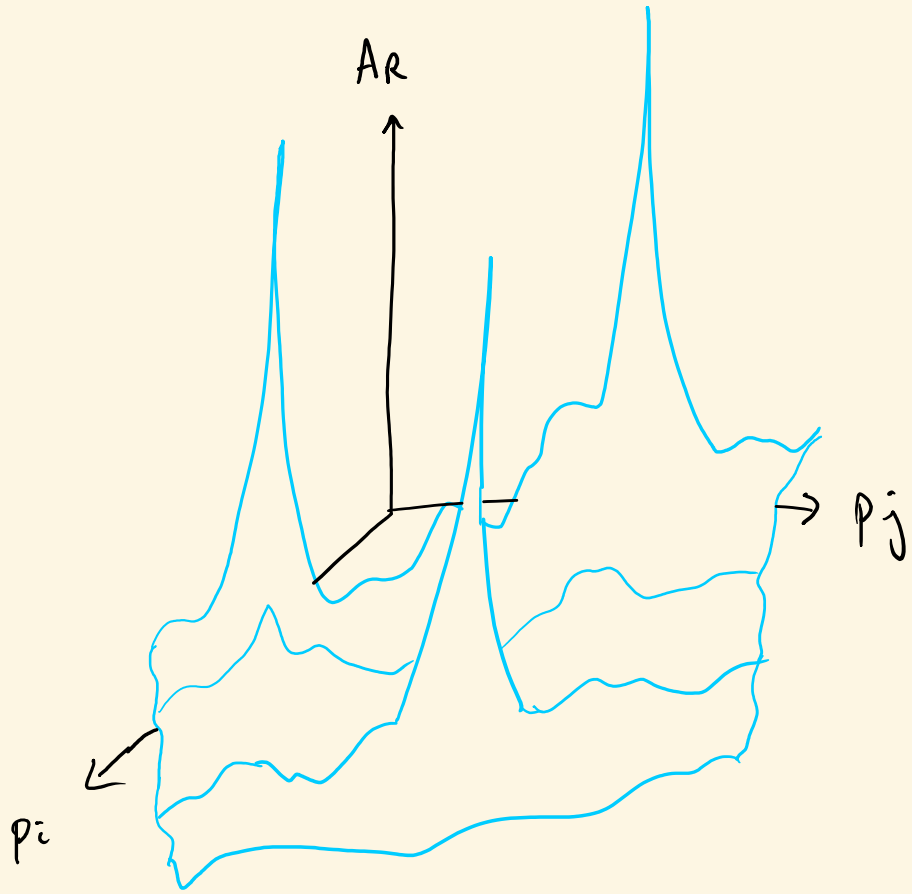
$$\int d\Phi_5 \left[\left| \right|^2 + 2\,\mathrm{Re}\left(\right)^{\dagger} \right] + \int d\Phi_6 \left[\left| \right|^2 \right]$$

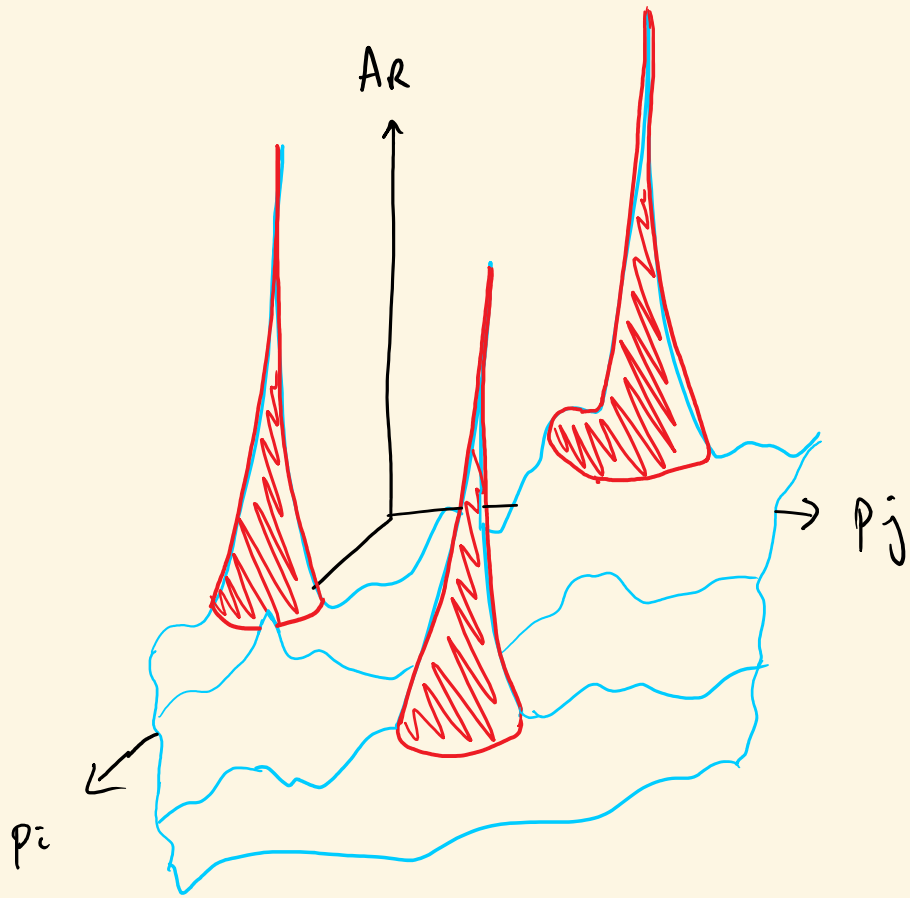
INFRARED DIVERGENCES

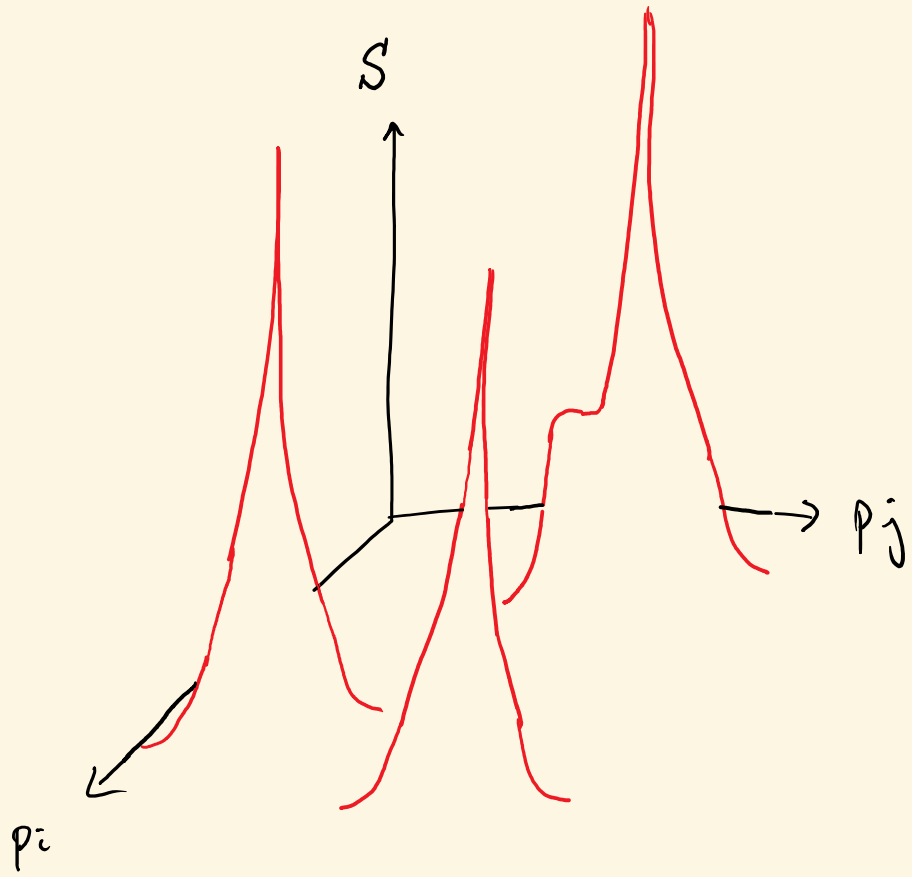
SUBTRACTION SCHEME

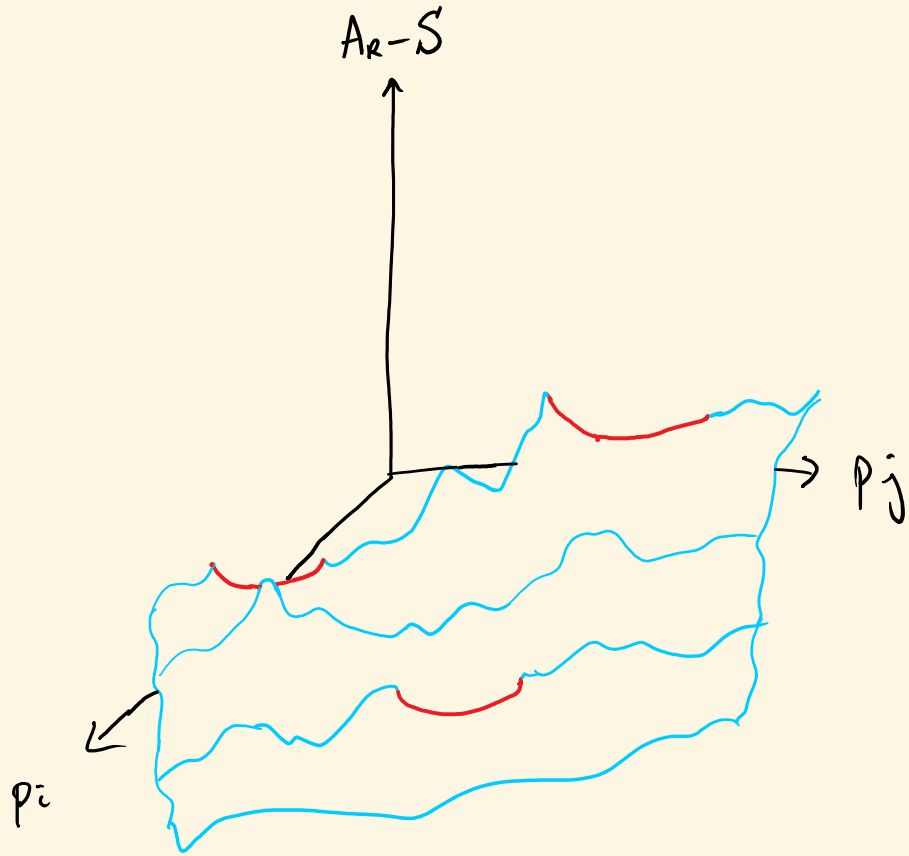
$$\int d\Phi_5 \left[\left| \right|^2 + 2\,\mathrm{Re}\left(\right)^{\dagger} + I \right]$$

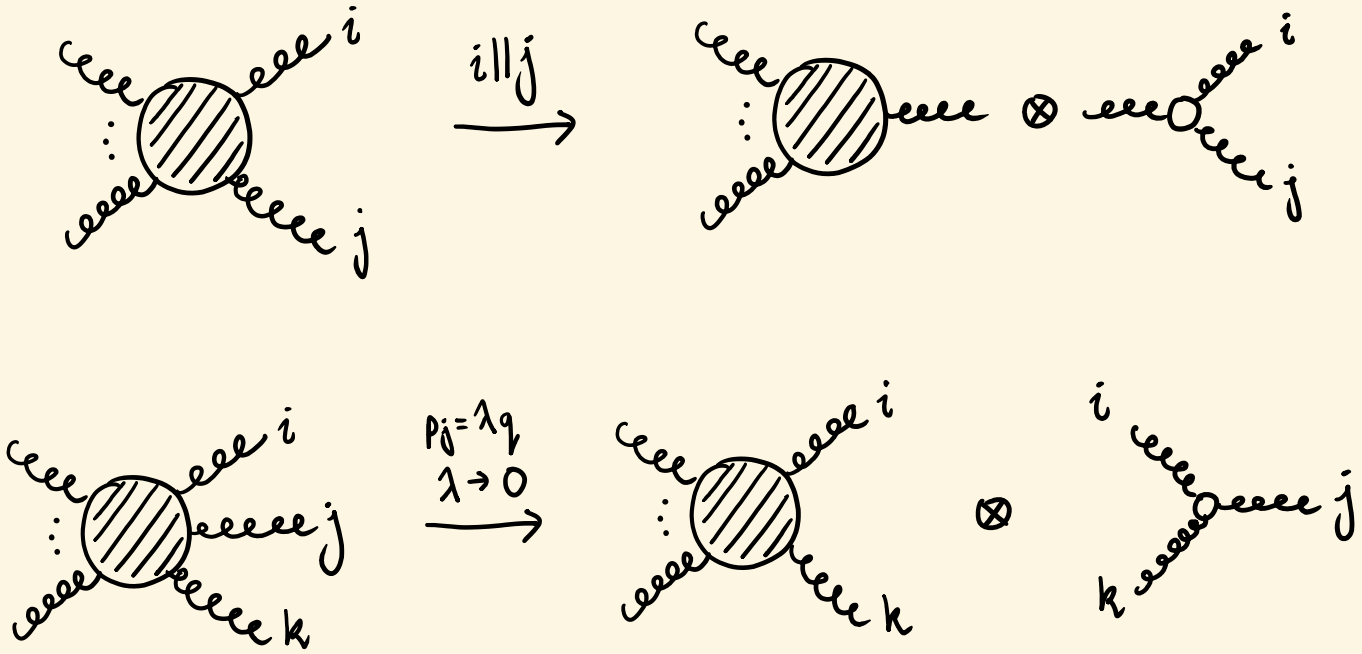
$$+ \int d\Phi_6 \left[\left| \right|^2 - S \right]$$


AR
pj
pi


AR
Pj
Pi

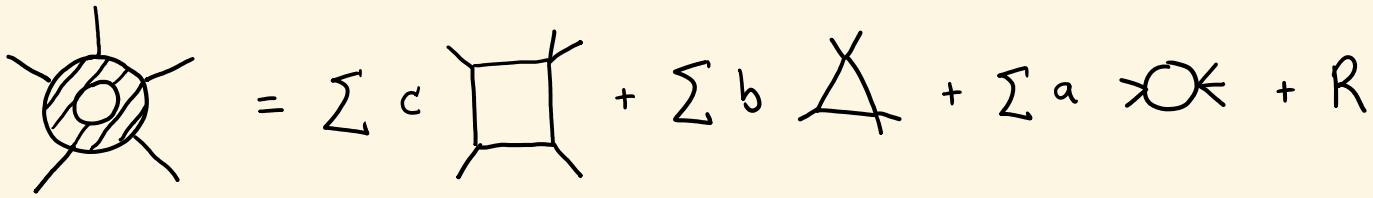

S
pj
pi


$A_R - S$
p_j
p_i


i
j
i || j
i
j
i
j
k
$p_j = \lambda q$
$\lambda \to 0$
i
k
⊗
i
j
k

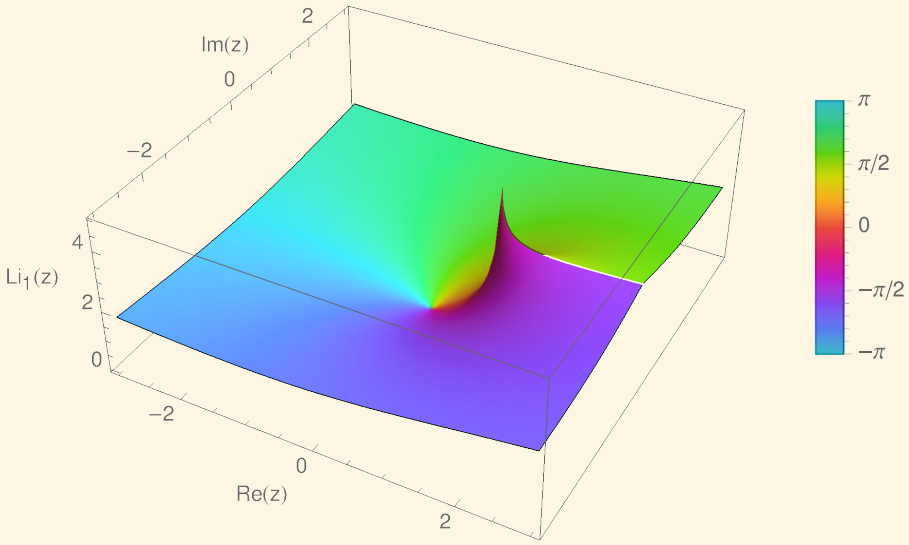
LOOPS

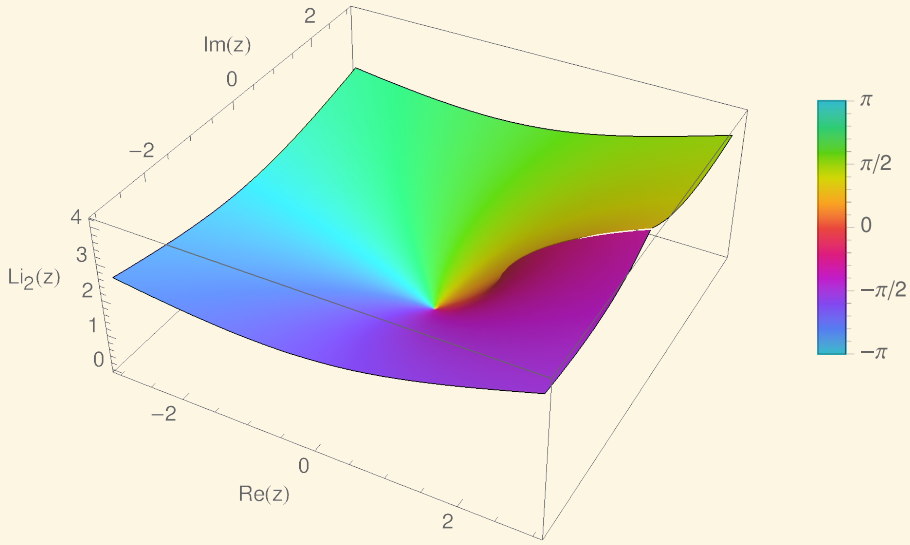
ALGEBRAIC



- Integrand reduction
- Coefficients
  - Generalised unitarity
  - OPP
- Master integrals
  - Integration-by-parts identities
  - Laporta

ANALYTIC





- Polylogarithms
- Laurent expansion

COMPUTATION

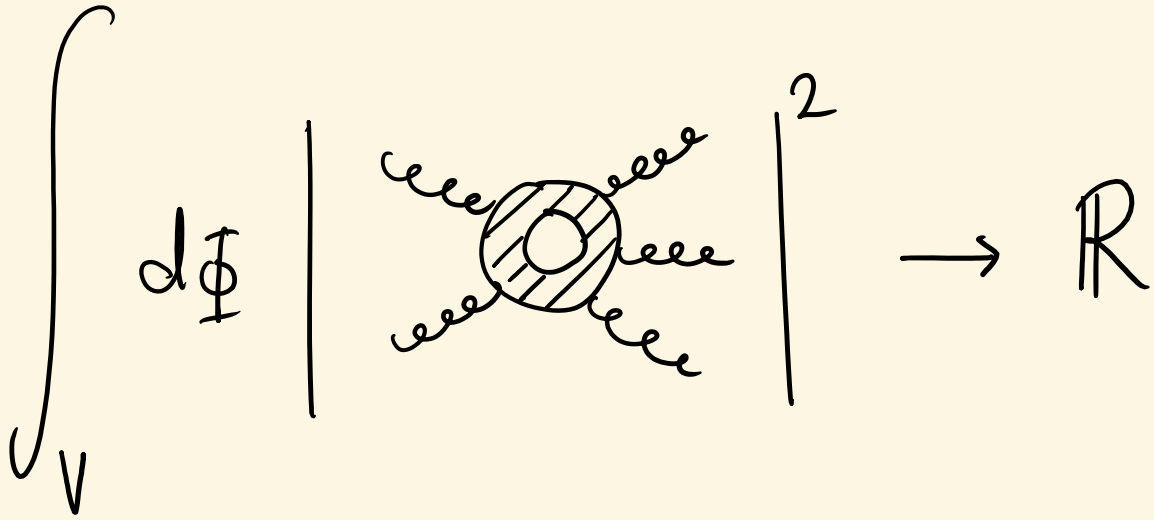
TECHNIQUES

- Large intermediate numbers
  - Finite fields
    - Momentum twistor variables
- High performance
  - `FORM`
  - `C++`

OVERVIEW

OVERVIEW

- Calculation organisation
- Infrared regulation
- Loop reduction
- Computation



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