

Pensieve header: Running through the Kashaev Program.

```
In[*]:= SetDirectory["C:\\drorbn\\AcademicPensieve\\Talks\\CMS-2112"]
```

```
Out[*]:= C:\drorbn\AcademicPensieve\Talks\CMS-2112
```

```
In[*]:= Once[<< KnotTheory`]
```

```
In[*]:= MatrixSignature[A_] := Total[Sign[Select[Eigenvalues[A], Abs[#] > 10^-12 &]]];
Writhe[K_] := Sum[If[PositiveQ[x], 1, -1], {x, List@@PD@K}];
```

```
In[*]:= << BedAndKas.m;
```

```
tex
\begin{frame}
\parbox{0.54\linewidth}{
Lets run our code line by line\ldots
```

```
exec
nb2tex$PDFWidth*=0.6
```

```
pdf
In[*]:= PD[82] = PD[X[10, 1, 11, 2], X[2, 11, 3, 12], X[12, 3, 13, 4],
X[4, 13, 5, 14], X[14, 5, 15, 6], X[8, 16, 9, 15], X[16, 8, 1, 7], X[6, 9, 7, 10]];
```

```
In[*]:= {lhs = Jones[82][q], rhs = Jones[Knot[8, 2]][q], lhs == rhs}
```

 KnotTheory: Loading precomputed data in Jones4Knots`.

```
Out[*]:= {1 + 1/q^8 - 2/q^7 + 2/q^6 - 3/q^5 + 3/q^4 - 2/q^3 + 2/q^2 - 1/q, 1 + 1/q^8 - 2/q^7 + 2/q^6 - 3/q^5 + 3/q^4 - 2/q^3 + 2/q^2 - 1/q, True}
```

```
pdf
In[*]:= K = 82;
```

```
tex
}\hfill\parbox{0.45\linewidth}{\[\scalebox{0.95}{\input{K82.pdf_t}}\]}
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```

```
pdf
In[*]:= XingsByArmpits =
List@@PD[K] /. x : X[i_, j_, k_, L_] => If[PositiveQ[x], X+[-i, j, k, -L], X-[-j, k, L, -i]]
```

```
Out[*]:=
pdf
{X_-[-1, 11, 2, -10], X_-[-11, 3, 12, -2], X_-[-3, 13, 4, -12], X_-[-13, 5, 14, -4],
X_-[-5, 15, 6, -14], X+[-8, 16, 9, -15], X+[-16, 8, 1, -7], X_-[-9, 7, 10, -6]}
```

```
tex
}\hfill\parbox{0.45\linewidth}{\[\scalebox{0.95}{\input{K82Labeled.pdf_t}}\]}
```

```
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```

pdf

```
In[ ]:= bends = Times @@ XingsByArmpits /. _[X] [a_, b_, c_, d_] => Pa,-d Pb,-a Pc,-b Pd,-c
```

Out[]:=
pdf

```
P-16,7 P-15,-9 P-14,-6 P-13,4 P-12,-4 P-11,2 P-10,-2 P-9,6 P-8,15 P-7,-1 P-6,-10 P-5,14 P-4,-14 P-3,12 P-2,-12
P-1,10 P1,-8 P2,-11 P3,11 P4,-13 P5,13 P6,-15 P7,9 P8,16 P9,-16 P10,-7 P11,1 P12,-3 P13,3 P14,-5 P15,5 P16,8
```

pdf

```
In[ ]:= faces = bends // . Px_,y_ Py_,z_ => Px,y,z
```

Out[]:=
pdf

```
P-13,4,-13 P-11,2,-11 P-5,14,-5 P-3,12,-3 P8,16,8 P6,-15,-9,6
P9,-16,7,9 P10,-7,-1,10 P-10,-2,-12,-4,-14,-6,-10 P1,-8,15,5,13,3,11,1
```

tex

```
}\hfill\parbox{0.45\linewidth}{\[\scalebox{0.95}{\input{K82Labeled.pdf_t}}\]}
\end{frame}\begin{frame}
```

exec

```
nb2tex$PDFWidth/=0.6
```

pdf

```
In[ ]:= A = Table[0, Length@faces, Length@faces];
A // MatrixForm
```

Out[]//MatrixForm=
pdf

```
(
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0
)
```

tex

```
\end{frame}\begin{frame}
```

pdf

```
Do[is = Position[faces, #] [[1, 1]] & /@ List @@ x;
A[[is, is]] += If[Head[x] === X+,

$$\begin{pmatrix} v & u & 1 & u \\ u & 1 & u & 1 \\ 1 & u & v & u \\ u & 1 & u & 1 \end{pmatrix} \rightarrow \begin{pmatrix} v & u & 1 & u \\ u & 1 & u & 1 \\ 1 & u & v & u \\ u & 1 & u & 1 \end{pmatrix}],
{x, XingsByArmpits}];$$

```

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```
\end{frame}\begin{frame}
```

pdf

```
In[*]:= x = XingsByArmpits[[1]]
```

Out[*]=

pdf

```
X_[-1, 11, 2, -10]
```

pdf

```
In[*]:= faces
```

Out[*]=

pdf

```
P_-13,4,-13 P_-11,2,-11 P_-5,14,-5 P_-3,12,-3 P_8,16,8 P_6,-15,-9,6
P_9,-16,7,9 P_10,-7,-1,10 P_-10,-2,-12,-4,-14,-6,-10 P_1,-8,15,5,13,3,11,1
```

pdf

```
In[*]:= is = Position[faces, #][[1, 1]] & /@ List@@x
```

Out[*]=

pdf

```
{8, 10, 2, 9}
```

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```
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```

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```
In[*]:= A[[is, is]] += If[Head[x] === X_,
```

$$\begin{pmatrix} v & u & 1 & u \\ u & 1 & u & 1 \\ 1 & u & v & u \\ u & 1 & u & 1 \end{pmatrix}, - \begin{pmatrix} v & u & 1 & u \\ u & 1 & u & 1 \\ 1 & u & v & u \\ u & 1 & u & 1 \end{pmatrix}];$$

```
A // MatrixForm
```

Out[*]//MatrixForm=

pdf

$$\begin{pmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -v & 0 & 0 & 0 & 0 & 0 & -1 & -u & -u \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & 0 & -v & -u & -u \\ 0 & -u & 0 & 0 & 0 & 0 & 0 & -u & -1 & -1 \\ 0 & -u & 0 & 0 & 0 & 0 & 0 & -u & -1 & -1 \end{pmatrix}$$

tex

```
} \hfill \parbox{1.5in}{Recall, $is=\{8,10,2,9\}$}
\end{frame}\begin{frame}
```

pdf

```
In[ ]:= Do[is = Position[faces, #][[1, 1]] & /@ List @@ x;
A[[is, is]] += If[Head[x] === X+,

$$\begin{pmatrix} v & u & 1 & u \\ u & 1 & u & 1 \\ 1 & u & v & u \\ u & 1 & u & 1 \end{pmatrix}, -\begin{pmatrix} v & u & 1 & u \\ u & 1 & u & 1 \\ 1 & u & v & u \\ u & 1 & u & 1 \end{pmatrix}],
{x, Rest@XingsByArmpits}]$$

```

tex

\end{frame}\begin{frame}

pdf

```
In[ ]:= A // MatrixForm
```

Out[]//MatrixForm=

pdf

$$\begin{pmatrix} -2v & 0 & -1 & -1 & 0 & 0 & 0 & 0 & -2u & -2u \\ 0 & -2v & 0 & -1 & 0 & 0 & 0 & -1 & -2u & -2u \\ -1 & 0 & -2v & 0 & 0 & -1 & 0 & 0 & -2u & -2u \\ -1 & -1 & 0 & -2v & 0 & 0 & 0 & 0 & -2u & -2u \\ 0 & 0 & 0 & 0 & 2 & 1 & 2u & 1 & 0 & 2u \\ 0 & 0 & -1 & 0 & 1 & 1-2v & 0 & -1 & -2u & 0 \\ 0 & 0 & 0 & 0 & 2u & 0 & -1+2v & 0 & -1 & 2 \\ 0 & -1 & 0 & 0 & 1 & -1 & 0 & 1-2v & -2u & 0 \\ -2u & -2u & -2u & -2u & 0 & -2u & -1 & -2u & -6 & -5 \\ -2u & -2u & -2u & -2u & 2u & 0 & 2 & 0 & -5 & -5+2v \end{pmatrix}$$

tex

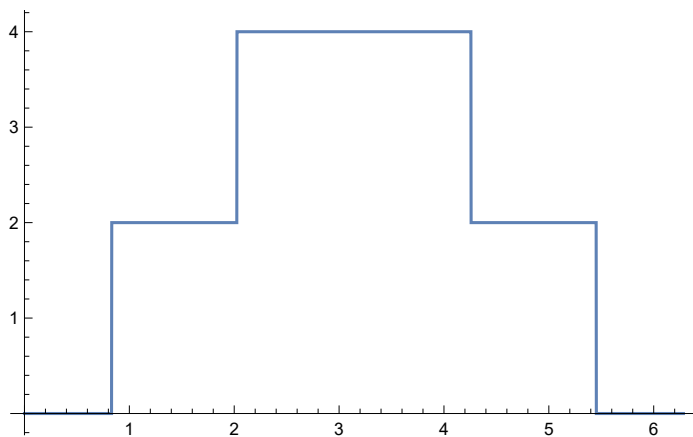
\end{frame}\begin{frame}

pdf

```
In[ ]:= Plot[ω = e^{i t}; u = Re[ω^{1/2}]; v = Re[ω];
(MatrixSignature[A] - Writhe[K]) / 2,
{t, 0, 2 π}]
```

Out[]=

pdf



tex

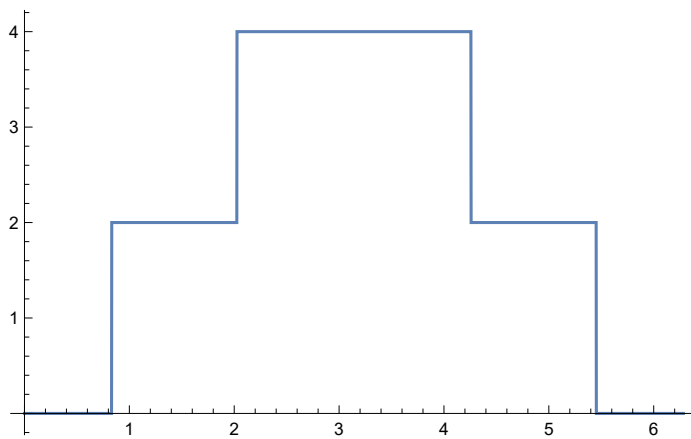
\end{frame}\begin{frame}

pdf

```
In[ ]:= Plot[Bed[Knot[8, 2], ei t], {t, 0, 2π}]
```

Out[]=

pdf



tex

```
\end{frame}
```