

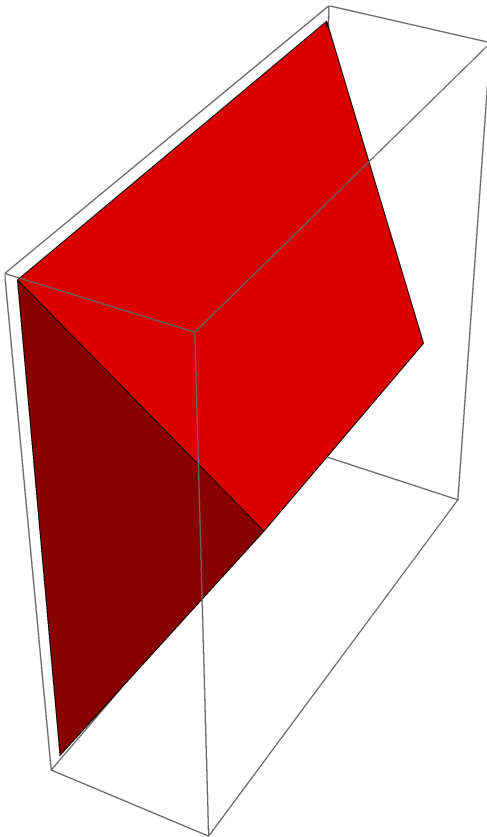
Pensieve Header: Making a Dodecahedral Link. See also <http://www.math.toronto.edu/drorbn/Gallery/-KnottedObjects/Knotted532.html>.

```
SetDirectory["C:\\drorbn\\AcademicPensieve\\2011-12"];
```

```
g = N[GoldenRatio]
```

```
1.61803
```

```
Graphics3D[{{
  Hue[0],
  Polygon[{{1, 1, 1}, {1, -1, 1}, {1, -1, -1}, {1, 1, -1}}],
  Polygon[{{1, 1, 1}, {1, -1, 1}, {g, -1/g, 0}, {g, 1/g, 0}}],
  Polygon[{{1, 1, -1}, {1, -1, -1}, {g, -1/g, 0}, {g, 1/g, 0}}],
  Polygon[{{1, 1, 1}, {1, 1, -1}, {g, 1/g, 0}}],
  Polygon[{{1, -1, 1}, {1, -1, -1}, {g, -1/g, 0}}]
}}]
```

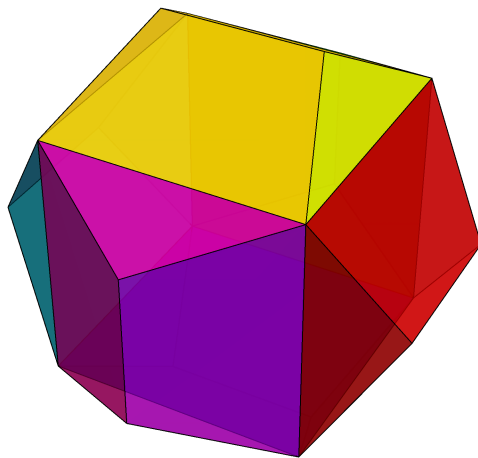


```

roof[s_, j_] := {
  Polygon[{{1, 1, 1}, {1, -1, 1}, {1, -1, -1}, {1, 1, -1}}],
  Polygon[{{1, 1, 1}, {1, -1, 1}, {g, -1/g, 0}, {g, 1/g, 0}}],
  Polygon[{{1, 1, -1}, {1, -1, -1}, {g, -1/g, 0}, {g, 1/g, 0}}],
  Polygon[{{1, 1, 1}, {1, 1, -1}, {g, 1/g, 0}}],
  Polygon[{{1, -1, 1}, {1, -1, -1}, {g, -1/g, 0}}]
} /. {x_?NumberQ, y_?NumberQ, z_?NumberQ} -> RotateLeft[{s x, y, z}, j]

Graphics3D[{
  Opacity[0.7],
  Hue[0/6], roof[1, 0], Hue[1/6], roof[1, 1], Hue[2/6], roof[1, 2],
  Hue[3/6], roof[-1, 0], Hue[4/6], roof[-1, 1], Hue[5/6], roof[-1, 2]
}, Boxed -> False]

```



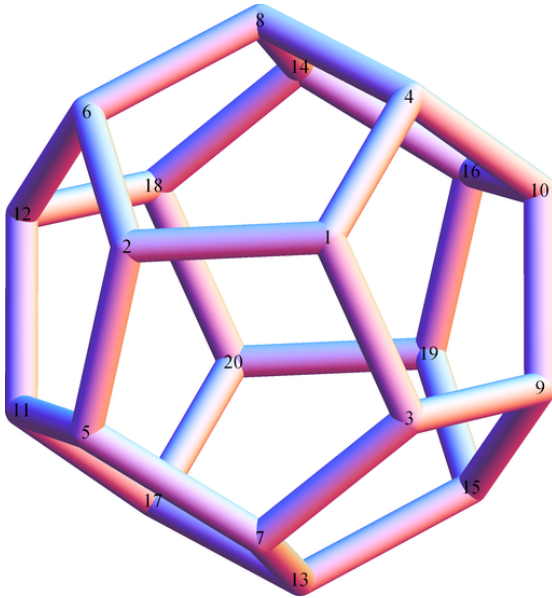
```

vs = Sort[Flatten[{
  Outer[Vertex, {1, -1}, {1, -1}, {1, -1}],
  Outer[Vertex, {0}, {1, -1} g, {1, -1}/g] /.
  v_Vertex => {v, RotateLeft[v], RotateRight[v]}
}]] /. Vertex ->
List
{{-1.61803, -0.618034, 0}, {-1.61803, 0.618034, 0}, {-1, -1, -1}, {-1, -1, 1},
{-1, 1, -1}, {-1, 1, 1}, {-0.618034, 0, -1.61803}, {-0.618034, 0, 1.61803},
{0, -1.61803, -0.618034}, {0, -1.61803, 0.618034}, {0, 1.61803, -0.618034},
{0, 1.61803, 0.618034}, {0.618034, 0, -1.61803}, {0.618034, 0, 1.61803}, {1, -1, -1},
{1, -1, 1}, {1, 1, -1}, {1, 1, 1}, {1.61803, -0.618034, 0}, {1.61803, 0.618034, 0}}

d[v1_, v2_] := Sqrt[(v1 - v2).(v1 - v2)];
es = {};
Do[
  If[d[vs[[i]], vs[[j]]] == Sqrt[1 + (1 - g)^2 + (1 - 1/g)^2],
    AppendTo[es, Edge[i, j]],
    {i, 1, 19}, {j, i + 1, 20}
];
es
{Edge[1, 2], Edge[1, 3], Edge[1, 4], Edge[2, 5], Edge[2, 6], Edge[3, 7], Edge[3, 9],
Edge[4, 8], Edge[4, 10], Edge[5, 7], Edge[5, 11], Edge[6, 8], Edge[6, 12],
Edge[7, 13], Edge[8, 14], Edge[9, 10], Edge[9, 15], Edge[10, 16], Edge[11, 12],
Edge[11, 17], Edge[12, 18], Edge[13, 15], Edge[13, 17], Edge[14, 16], Edge[14, 18],
Edge[15, 19], Edge[16, 19], Edge[17, 20], Edge[18, 20], Edge[19, 20]}

```

```
MakeImage["DodecahedralSkeleton", Graphics3D[{  
  Table[Text[i, vs[[i]]], {i, 20}],  
  es /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.1],  
}, Boxed -> False, ViewPoint -> {-30, -6, -7}  
]]
```

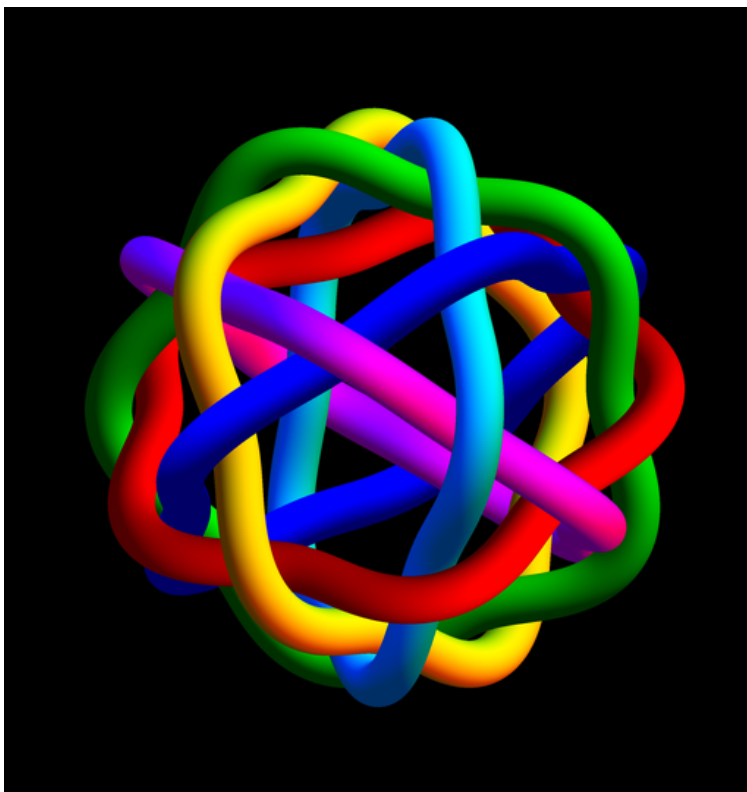


```

Wiggle[nvs_, rvs_] := Module[{n, r, b},
  n = Total[vs[[nvs]]] / Length[nvs];
  r = Total[vs[[rvs]]] / Length[rvs];
  b = Cross[n, r]; b = Sqrt[r.r] * b / Sqrt[b.b];
  Tube[
    Line[Table[
      (1 + 0.1 Cos[5 t]) (Cos[t] r + Sin[t] b),
      {t, 0, 2 Pi + 10^-6, 2 Pi / 720}
    ]], 0.15
  ]
];

MakeImage["DodecahedralLink-1", Graphics3D[{
  JoinForm["Round"],
  Hue[0/6], Wiggle[{1, 2, 6, 8, 4}, {3, 7}],
  Hue[1/6], Wiggle[{1, 3, 9, 10, 4}, {5, 7}],
  Hue[2/6], Wiggle[{1, 2, 5, 7, 3}, {4, 10}],
  Hue[3/6], Wiggle[{2, 6, 12, 11, 5}, {7, 13}],
  Hue[4/6], Wiggle[{6, 12, 18, 14, 8}, {2, 5}],
  Hue[5/6], Wiggle[{4, 8, 14, 16, 10}, {1, 2}]
}], Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> Black
]]

```



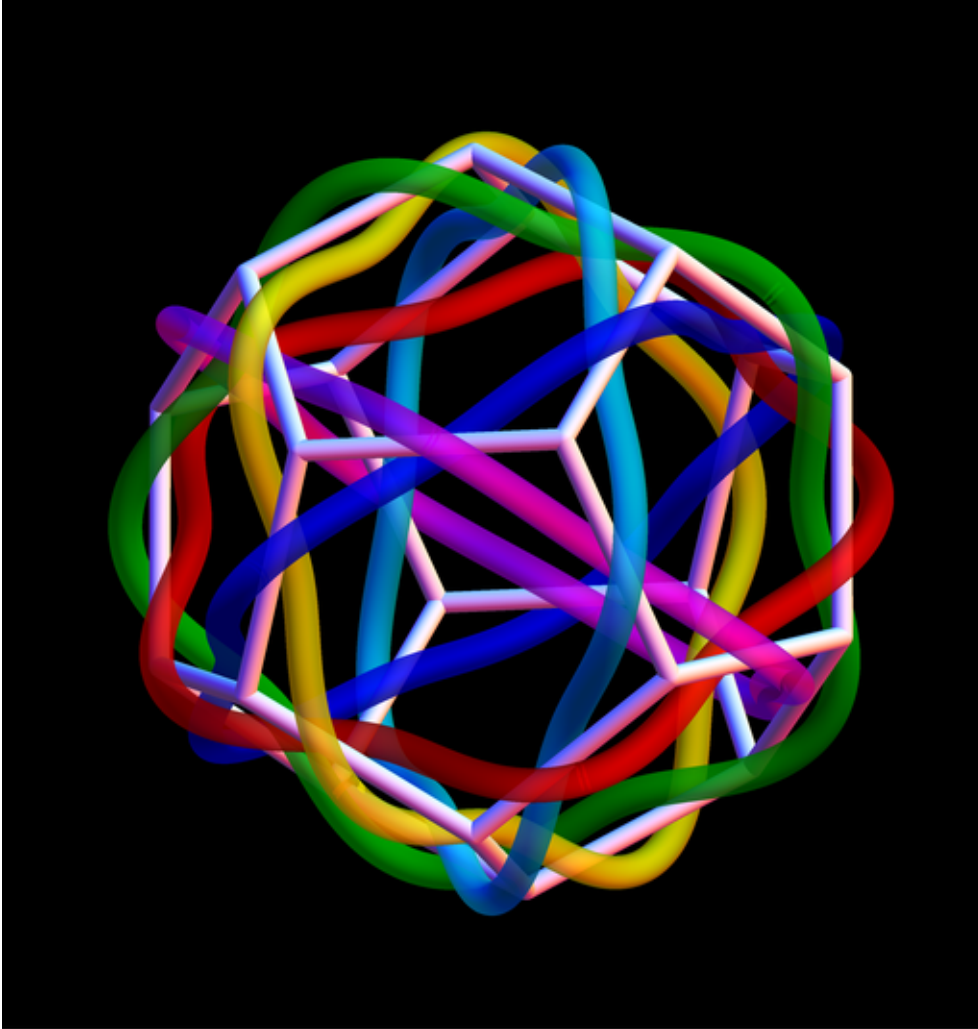
```
$Image["DodecahedralLink-1"];
```

```

Wiggle[nvs_, rvs_] := Module[{n, r, b},
  n = Total[vs[[nvs]]] / Length[nvs];
  r = Total[vs[[rvs]]] / Length[rvs];
  b = Cross[n, r]; b = Sqrt[r.r] * b / Sqrt[b.b];
  Tube[
    Line[Table[
      (1 + 0.1 Cos[5 t]) (Cos[t] r + Sin[t] b),
      {t, 0, 2 Pi + Pi/120, 2 Pi/720}
    ]], 0.08
  ]
];

MakeImage["DodecahedralLink-2", Graphics3D[{
  JoinForm["Round"], CapForm[None], Opacity[0.6],
  Hue[0/6], Wiggle[{1, 2, 6, 8, 4}, {3, 7}],
  Hue[1/6], Wiggle[{1, 3, 9, 10, 4}, {5, 7}],
  Hue[2/6], Wiggle[{1, 2, 5, 7, 3}, {4, 10}],
  Hue[3/6], Wiggle[{2, 6, 12, 11, 5}, {7, 13}],
  Hue[4/6], Wiggle[{6, 12, 18, 14, 8}, {2, 5}],
  Hue[5/6], Wiggle[{4, 8, 14, 16, 10}, {1, 2}],
  Opacity[1], White, CapForm["Round"],
  es /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.05]
}], Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> Black
]]

```



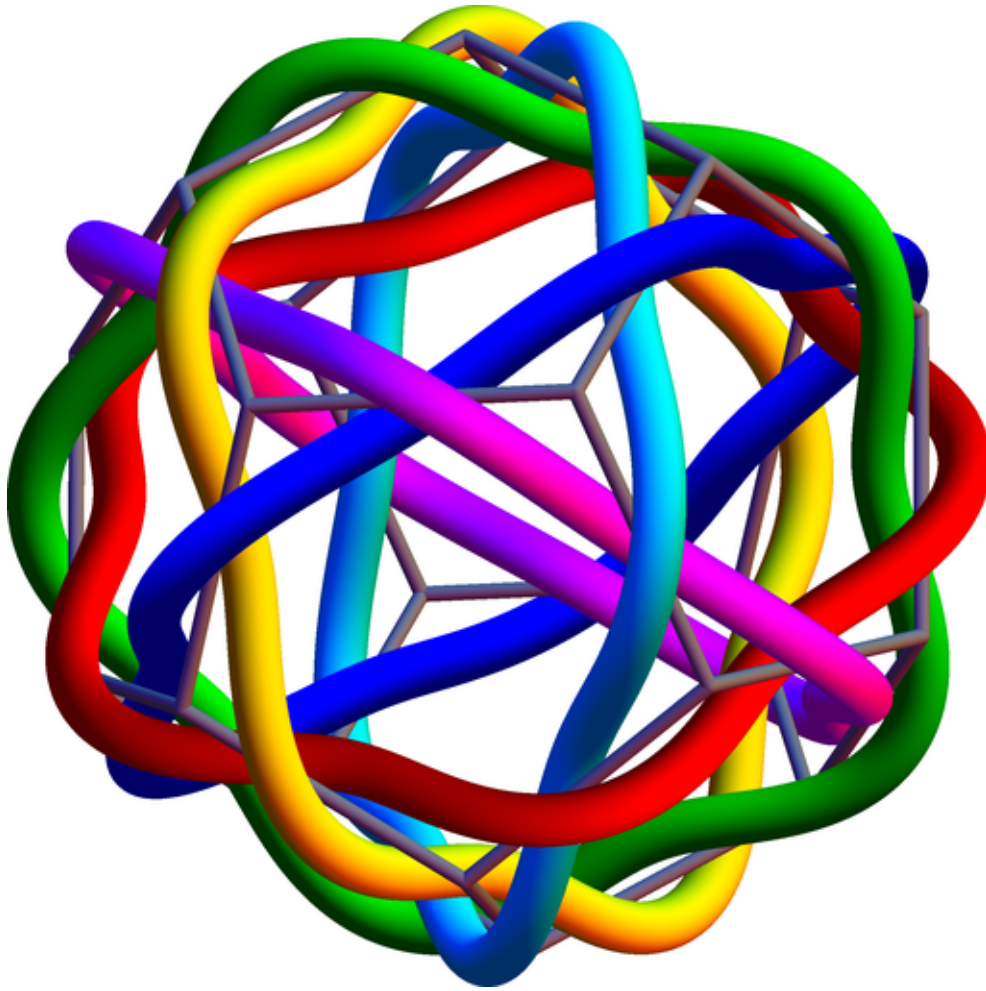
```
$Image["DodecahedralLink-2"];
```

```

Wiggle[nvs_, rvs_] := Module[{n, r, b},
  n = Total[vs[[nvs]]] / Length[nvs];
  r = Total[vs[[rvs]]] / Length[rvs];
  b = Cross[n, r]; b = Sqrt[r.r] * b / Sqrt[b.b];
  Tube[
    Line[Table[
      (1 + 0.1 Cos[5 t]) (Cos[t] r + Sin[t] b),
      {t, 0, 2 Pi + Pi/120, 2 Pi/720}
    ]], 0.1
  ]
];

MakeImage["DodecahedralLink-3", Graphics3D[{
  JoinForm["Round"], CapForm[None], Opacity[1],
  Hue[0/6], Wiggle[{1, 2, 6, 8, 4}, {3, 7}],
  Hue[1/6], Wiggle[{1, 3, 9, 10, 4}, {5, 7}],
  Hue[2/6], Wiggle[{1, 2, 5, 7, 3}, {4, 10}],
  Hue[3/6], Wiggle[{2, 6, 12, 11, 5}, {7, 13}],
  Hue[4/6], Wiggle[{6, 12, 18, 14, 8}, {2, 5}],
  Hue[5/6], Wiggle[{4, 8, 14, 16, 10}, {1, 2}],
  Opacity[1], Gray, CapForm["Round"],
  es /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.03]
}, Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> White
]]

```

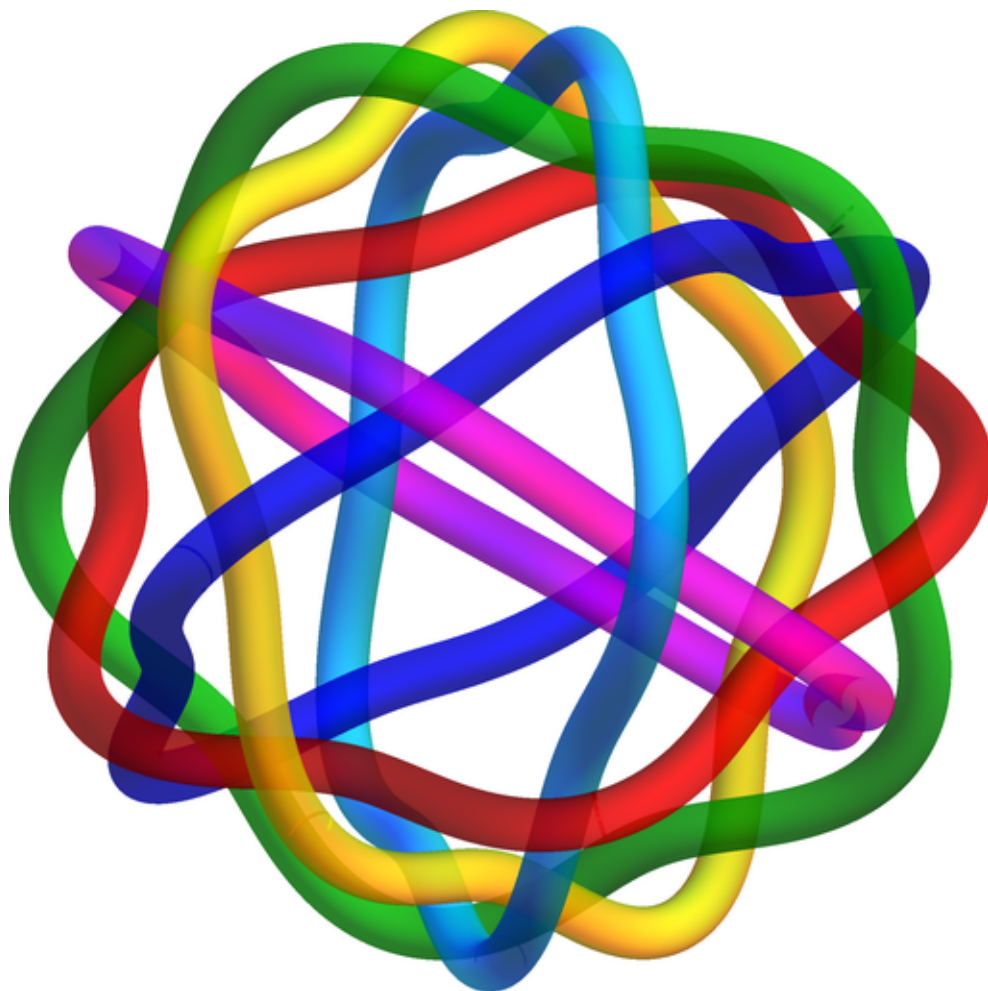



```

Wiggle[nvs_, rvs_] := Module[{n, r, b},
  n = Total[vs[[nvs]]] / Length[nvs];
  r = Total[vs[[rvs]]] / Length[rvs];
  b = Cross[n, r]; b = Sqrt[r.r] * b / Sqrt[b.b];
  Tube[
    Line[Table[
      (1 + 0.1 Cos[5 t]) (Cos[t] r + Sin[t] b),
      {t, 0, 2 Pi + Pi/240, 2 Pi/720}
    ]], 0.1
  ]
];

MakeImage["DodecahedraLink-4", Graphics3D[{
  JoinForm["Round"], CapForm[None], Opacity[0.6],
  Hue[0/6], Wiggle[{1, 2, 6, 8, 4}, {3, 7}],
  Hue[1/6], Wiggle[{1, 3, 9, 10, 4}, {5, 7}],
  Hue[2/6], Wiggle[{1, 2, 5, 7, 3}, {4, 10}],
  Hue[3/6], Wiggle[{2, 6, 12, 11, 5}, {7, 13}],
  Hue[4/6], Wiggle[{6, 12, 18, 14, 8}, {2, 5}],
  Hue[5/6], Wiggle[{4, 8, 14, 16, 10}, {1, 2}]
}, Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> White
]]

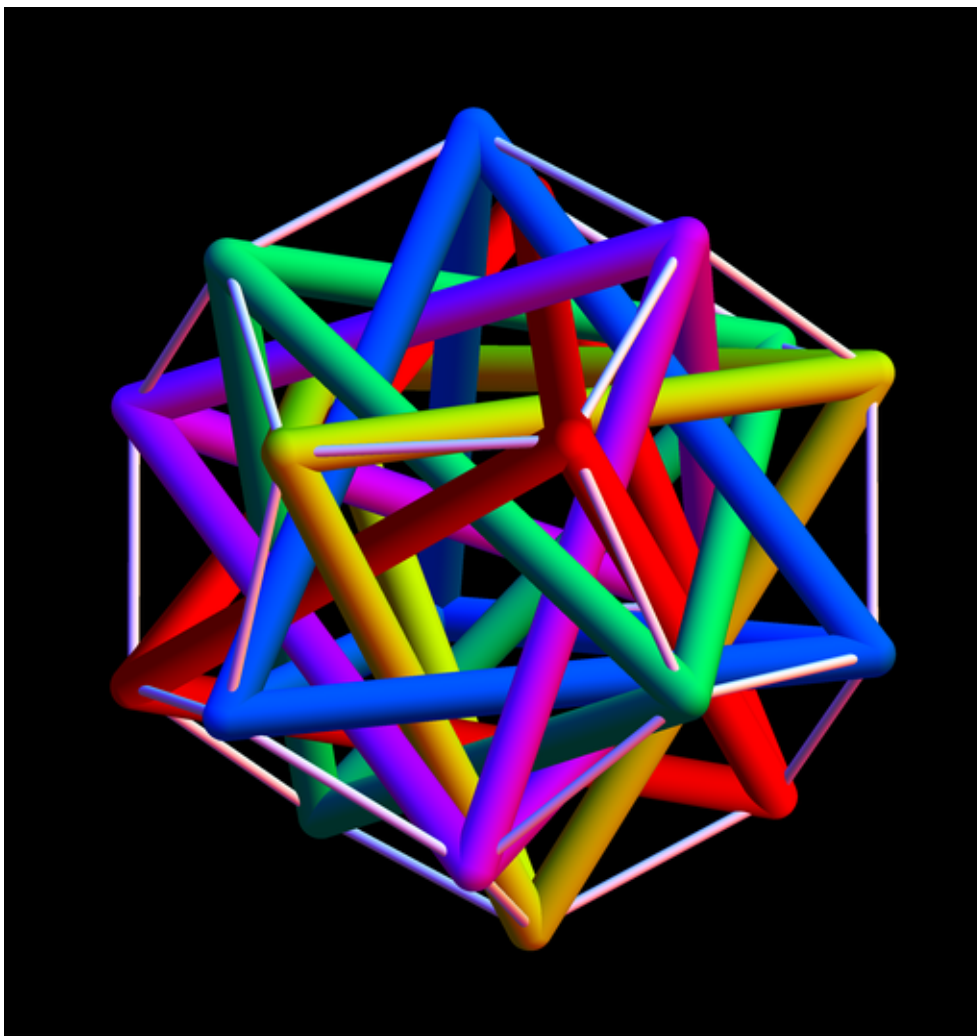
```



```

Tetrahedron[i_, j_, k_, l_] := {
  Tube[vs[{{i, j}}], w], Tube[vs[{{i, k}}], w], Tube[vs[{{i, l}}], w],
  Tube[vs[{{j, k}}], w], Tube[vs[{{j, l}}], w], Tube[vs[{{k, l}}], w]
};
MakeImage["FiveTetrahedra-1", Graphics3D[{
  w = 0.1;
  Hue[0/5], Tetrahedron[1, 11, 14, 15],
  Hue[1/5], Tetrahedron[2, 18, 10, 13],
  Hue[2/5], Tetrahedron[6, 17, 16, 3],
  Hue[3/5], Tetrahedron[8, 5, 20, 9],
  Hue[4/5], Tetrahedron[4, 12, 7, 19],
  White, es /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.025]
}, Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> Black
]]

```



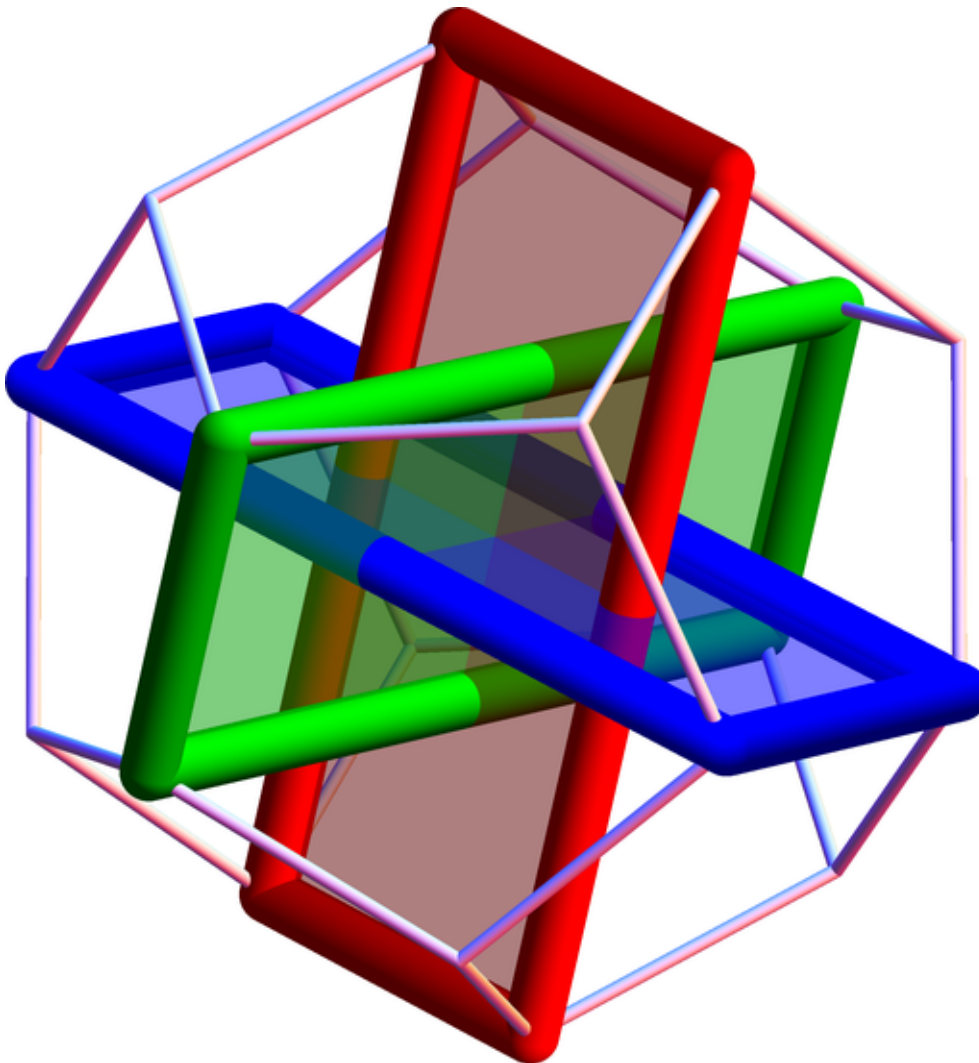
```
$Image["FiveTetrahedra-1"];
```

```

rectangle[i_, j_, k_, l_] := {
  Tube[vs[{{i, j}}], w], Tube[vs[{{j, k}}], w],
  Tube[vs[{{k, l}}], w], Tube[vs[{{l, i}}], w],
  Opacity[0.5],
  Polygon[vs[{{i, j, k, l}}]],
  Opacity[1]
};

MakeImage["EmbeddedBorromean", Graphics3D[{
  w = 0.1;
  Hue[0/3], rectangle[4, 8, 17, 13],
  Hue[1/3], rectangle[2, 5, 19, 16],
  Hue[2/3], rectangle[3, 9, 18, 12],
  White, es /. Edge[i_, j_] -> Tube[{vs[[i]], vs[[j]]}, 0.025]
}], Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> White
]]

```

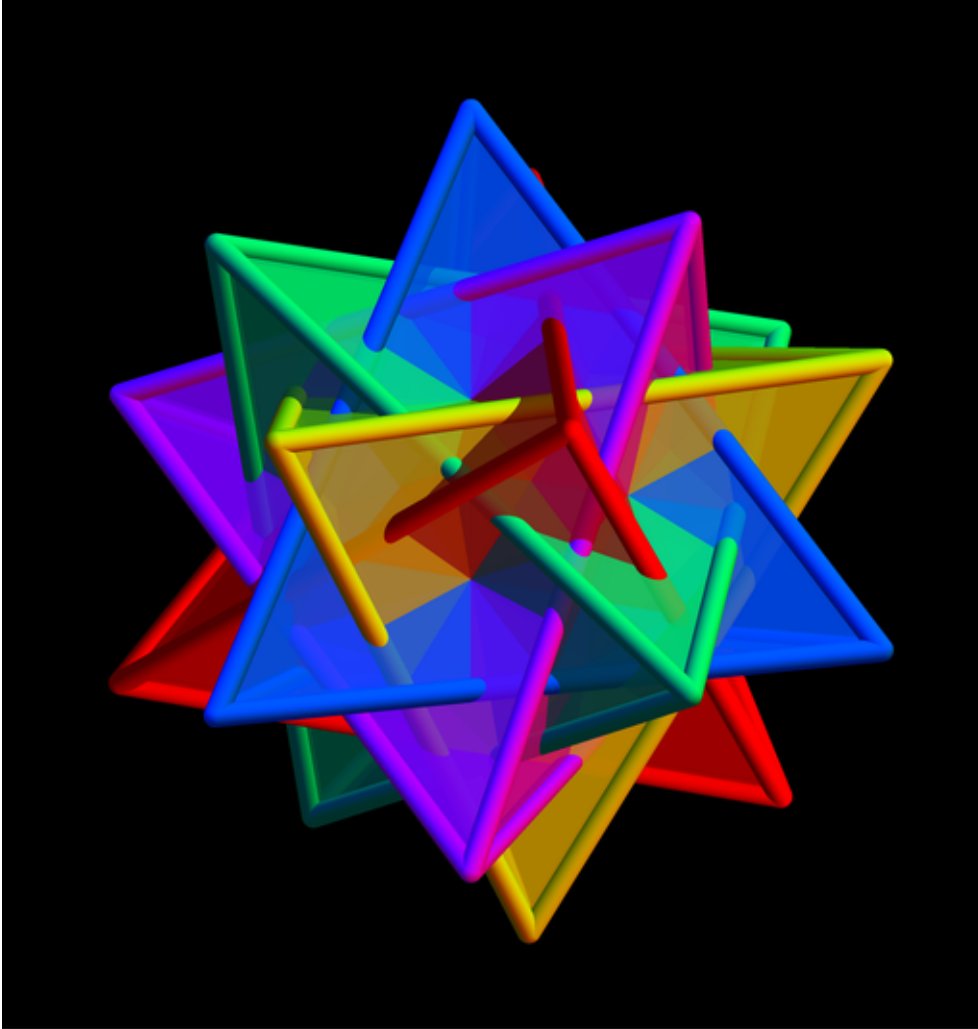


```

Tetra[i_, j_, k_, l_] := {
  Tube[vs[{{i, j}}], w], Tube[vs[{{i, k}}], w], Tube[vs[{{i, l}}], w],
  Tube[vs[{{j, k}}], w], Tube[vs[{{j, l}}], w], Tube[vs[{{k, l}}], w],
  Opacity[0.75], EdgeForm[],
  Polygon[vs[{{j, k, l}}]], Polygon[vs[{{i, k, l}}]],
  Polygon[vs[{{i, j, l}}]], Polygon[vs[{{i, j, k}}]],
  Opacity[1]
};

MakeImage["FiveTetrahedra-2", Graphics3D[{
  w = 0.05;
  Hue[0/5], Tetra[1, 11, 14, 15],
  Hue[1/5], Tetra[2, 18, 10, 13],
  Hue[2/5], Tetra[6, 17, 16, 3],
  Hue[3/5], Tetra[8, 5, 20, 9],
  Hue[4/5], Tetra[4, 12, 7, 19],
  (* White, es /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.0125] *)
}], Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> Black
]]

```

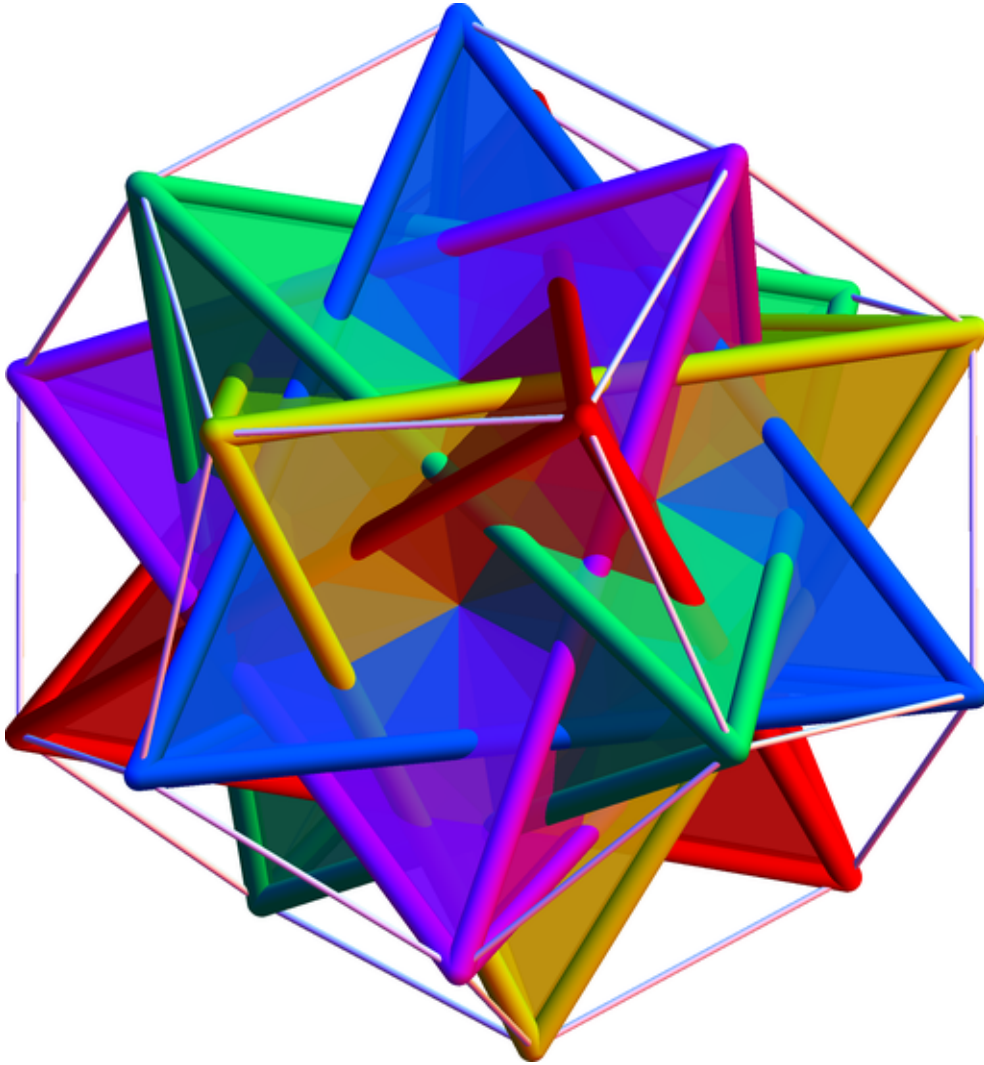


```

Tetra[i_, j_, k_, l_] := {
  Tube[vs[{{i, j}}], w], Tube[vs[{{i, k}}], w], Tube[vs[{{i, l}}], w],
  Tube[vs[{{j, k}}], w], Tube[vs[{{j, l}}], w], Tube[vs[{{k, l}}], w],
  Opacity[0.75], EdgeForm[],
  Polygon[vs[{{j, k, l}}]], Polygon[vs[{{i, k, l}}]],
  Polygon[vs[{{i, j, l}}]], Polygon[vs[{{i, j, k}}]],
  Opacity[1]
};

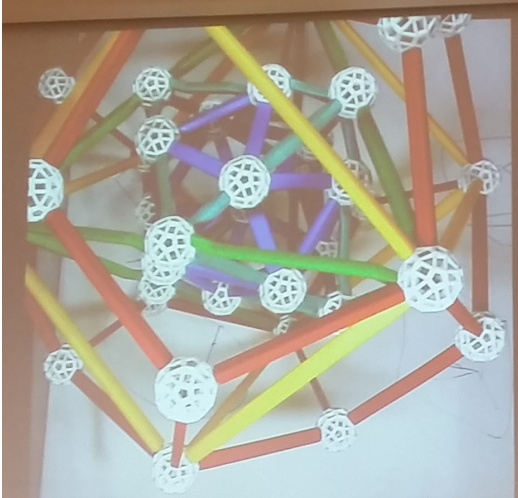
MakeImage["FiveTetrahedra-3", Graphics3D[{
  w = 0.05;
  Hue[0/5], Tetra[1, 11, 14, 15],
  Hue[1/5], Tetra[2, 18, 10, 13],
  Hue[2/5], Tetra[6, 17, 16, 3],
  Hue[3/5], Tetra[8, 5, 20, 9],
  Hue[4/5], Tetra[4, 12, 7, 19],
  White, es /. Edge[i_, j_] => Tube[{vs[{{i}}], vs[{{j}}]}, 0.0125]
}, Boxed -> False, ViewPoint -> -{30, 6, 7}, Background -> White
]]

```

The Cosmogram

From Conway's Feb 24, 2016 lecture:

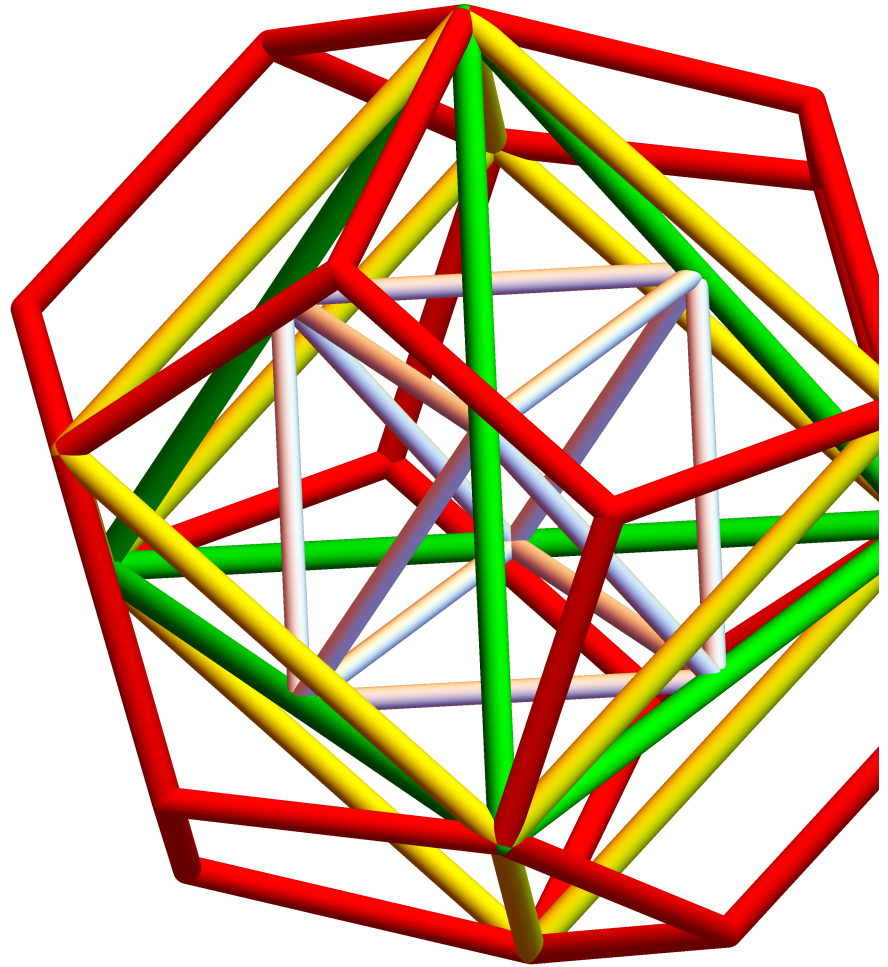


Also search “zometool kepler’s obsession”.

```

ws = {Edge[2, 10], Edge[2, 13], Edge[10, 13], Edge[2, 18],
      Edge[10, 18], Edge[13, 18]} /. Edge[i_, j_] => (vs[[i]] + vs[[j]]) / 2;
Graphics3D[{
  Red, es /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.05],
  Yellow, {
    Edge[2, 3], Edge[3, 10], Edge[10, 8], Edge[8, 2], Edge[2, 11], Edge[11, 13],
    Edge[13, 3], Edge[13, 19], Edge[19, 10], Edge[19, 18], Edge[18, 8], Edge[18, 11]
  } /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.05],
  Green, {
    Edge[2, 10], Edge[2, 13], Edge[10, 13], Edge[2, 18], Edge[10, 18], Edge[13, 18]
  } /. Edge[i_, j_] => Tube[{vs[[i]], vs[[j]]}, 0.05],
  RGBColor[64, 224, 208], {
    Edge[1, 2], Edge[1, 3], Edge[1, 4], Edge[1, 5], Edge[6, 2], Edge[6, 3],
    Edge[6, 4], Edge[6, 5], Edge[2, 3], Edge[3, 5], Edge[5, 4], Edge[4, 2]
  } /. Edge[i_, j_] => Tube[{ws[[i]], ws[[j]]}, 0.04],
}, Boxed -> False, ViewPoint -> {-30, -6, -7}
]

```



```

ws = {Edge[2, 10], Edge[2, 13], Edge[10, 13], Edge[2, 18],
      Edge[10, 18], Edge[13, 18]} /. Edge[i_, j_] => (vs[[i]] + vs[[j]]) / 2;
Graphics3D[{
  RGBColor[64, 224, 208], {
    Edge[1, 2], Edge[1, 3], Edge[1, 4], Edge[1, 5], Edge[6, 2], Edge[6, 3],
    Edge[6, 4], Edge[6, 5], Edge[2, 3], Edge[3, 5], Edge[5, 4], Edge[4, 2]
  } /. Edge[i_, j_] => Tube[{ws[[i]], ws[[j]]}, 0.04],
}, Boxed -> False, ViewPoint -> {-30, -6, -7}
]

```

