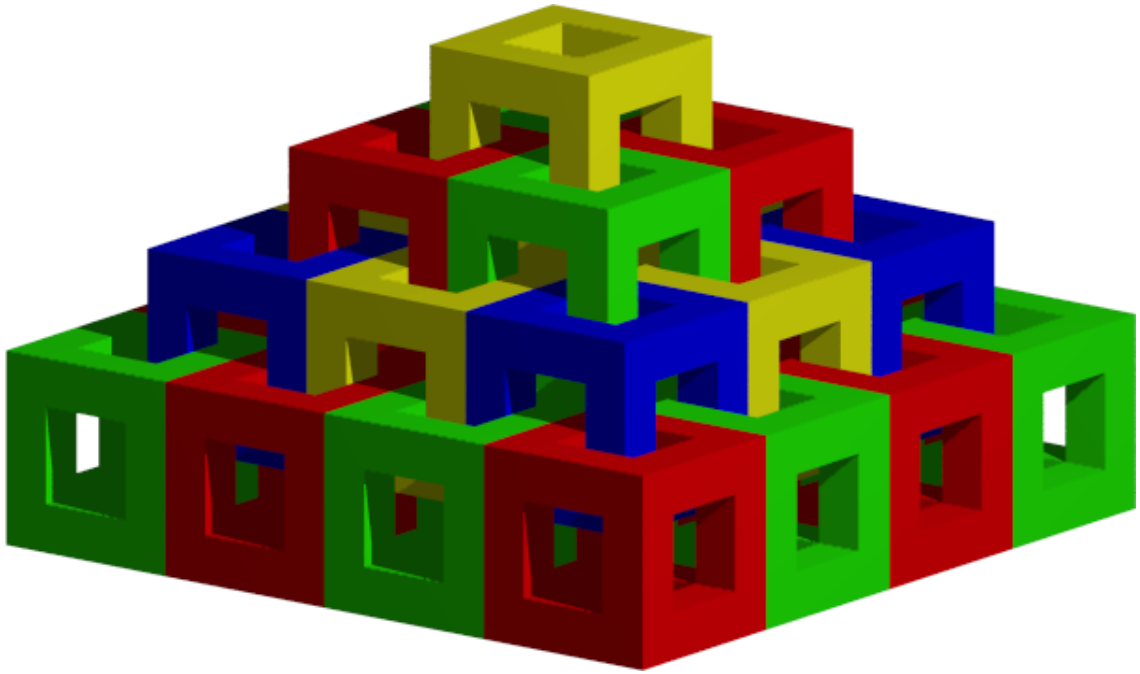
Hans Walser

Halbe Würfel



www.walser-h-m.ch/hans/Vortraege/20190207

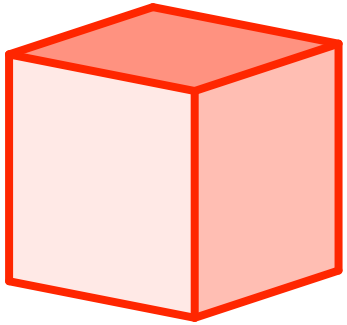
Halbe Würfel

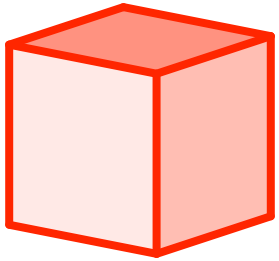
Einheitswürfel

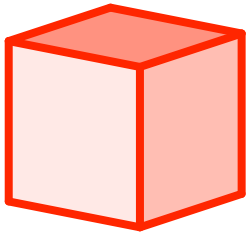
halbes Volumen

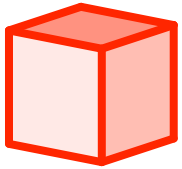
halbe Oberfläche

halbe Kantenlänge









Kantenlänge 1

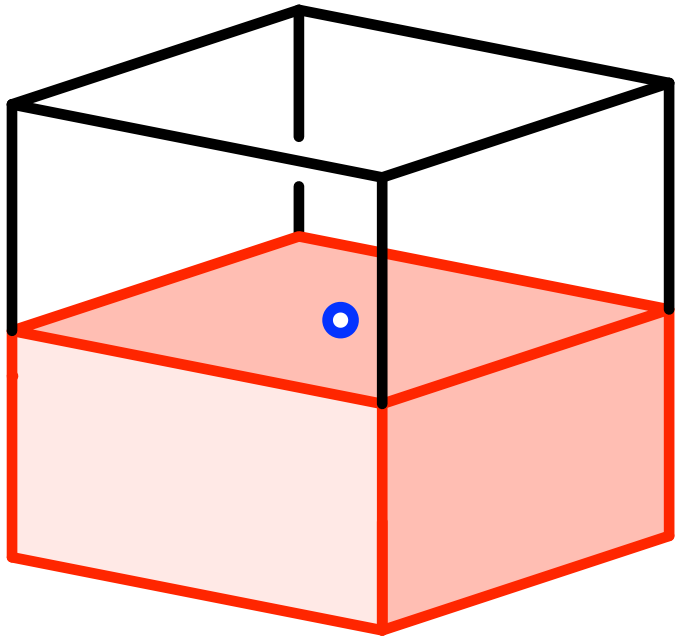
$\sqrt[3]{\frac{1}{2}} \approx 0.79$

$\sqrt[2]{\frac{1}{2}} \approx 0.71$

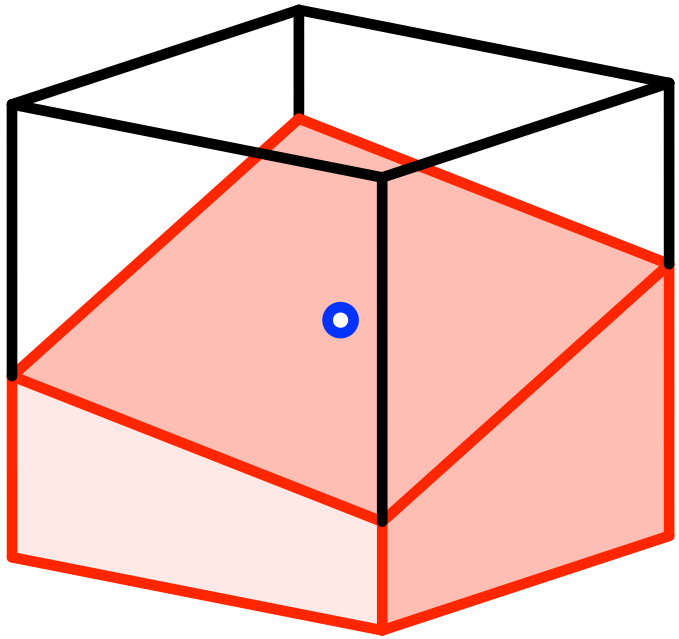
$\sqrt[1]{\frac{1}{2}} = \frac{1}{2}$

Nicht mit Zirkel und Lineal möglich

Volumen-Halbierung

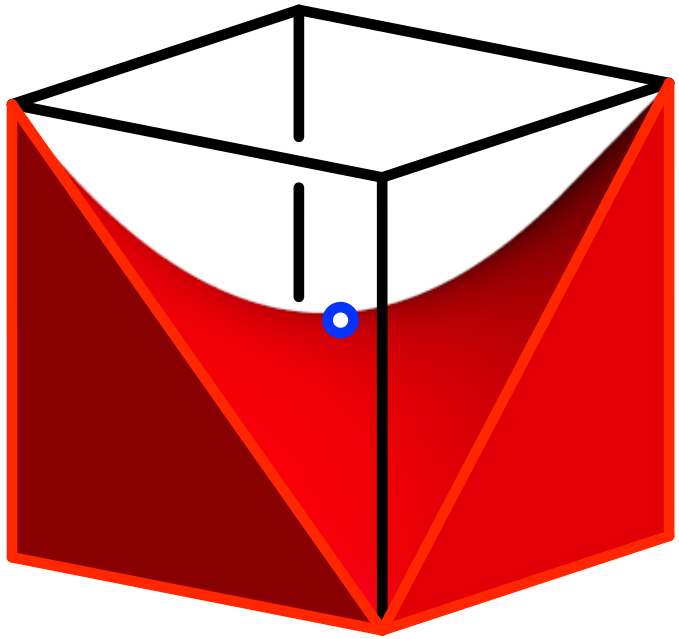


Volumen-Halbierung



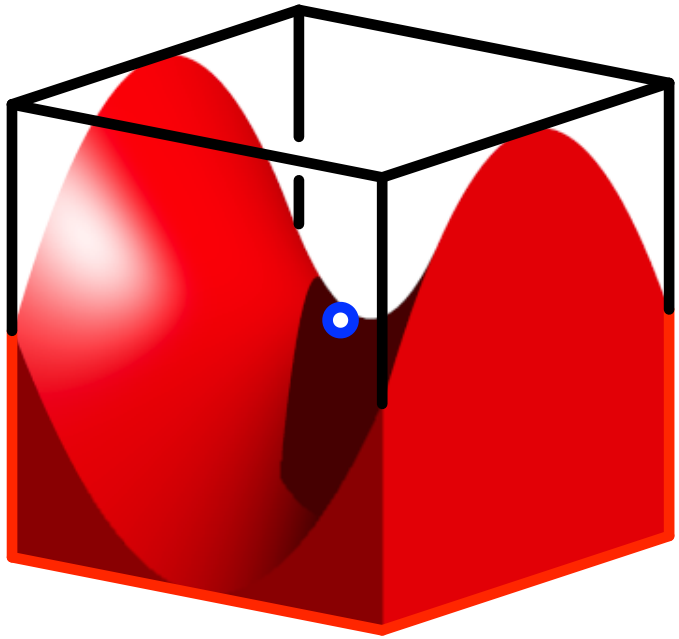
Gegenstück punktsymmetrisch und spiegelbildlich

Volumen-Halbierung



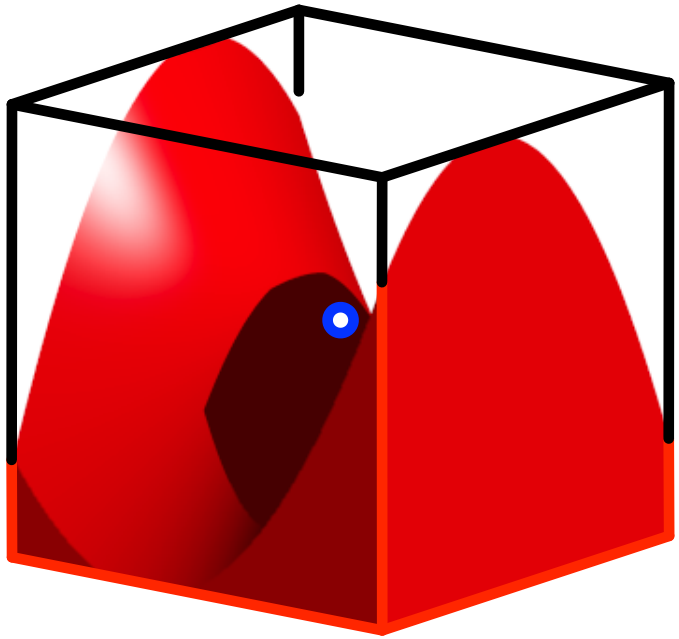
HP-Fläche

Volumen-Halbierung



HP-Fläche

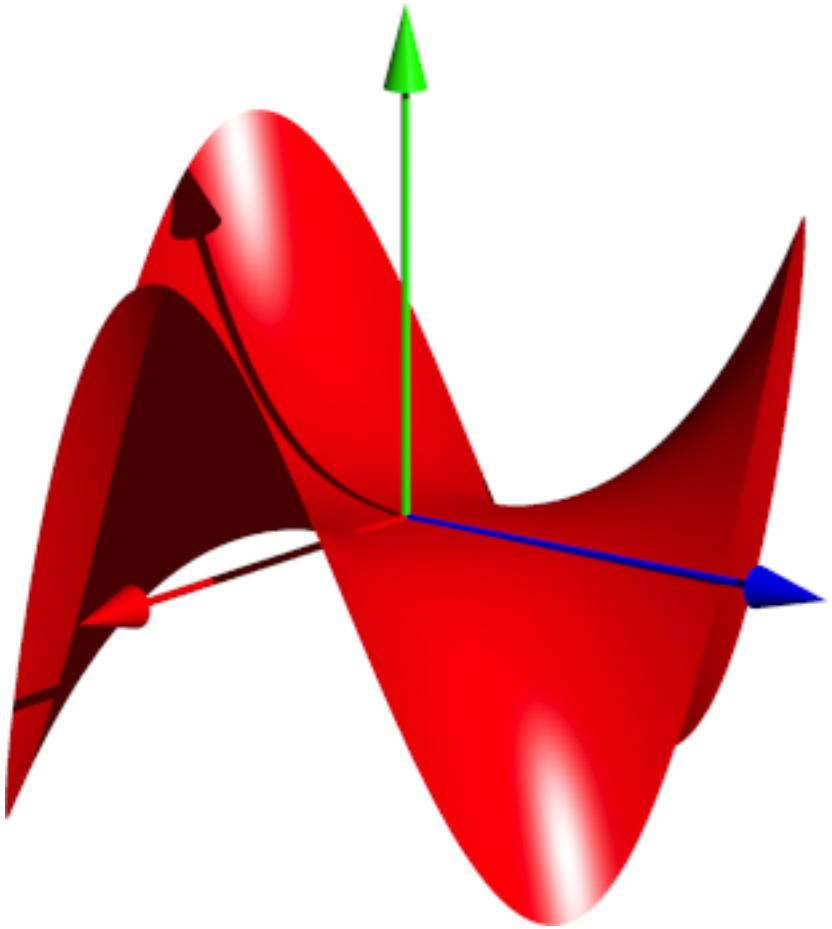
Volumen-Halbierung



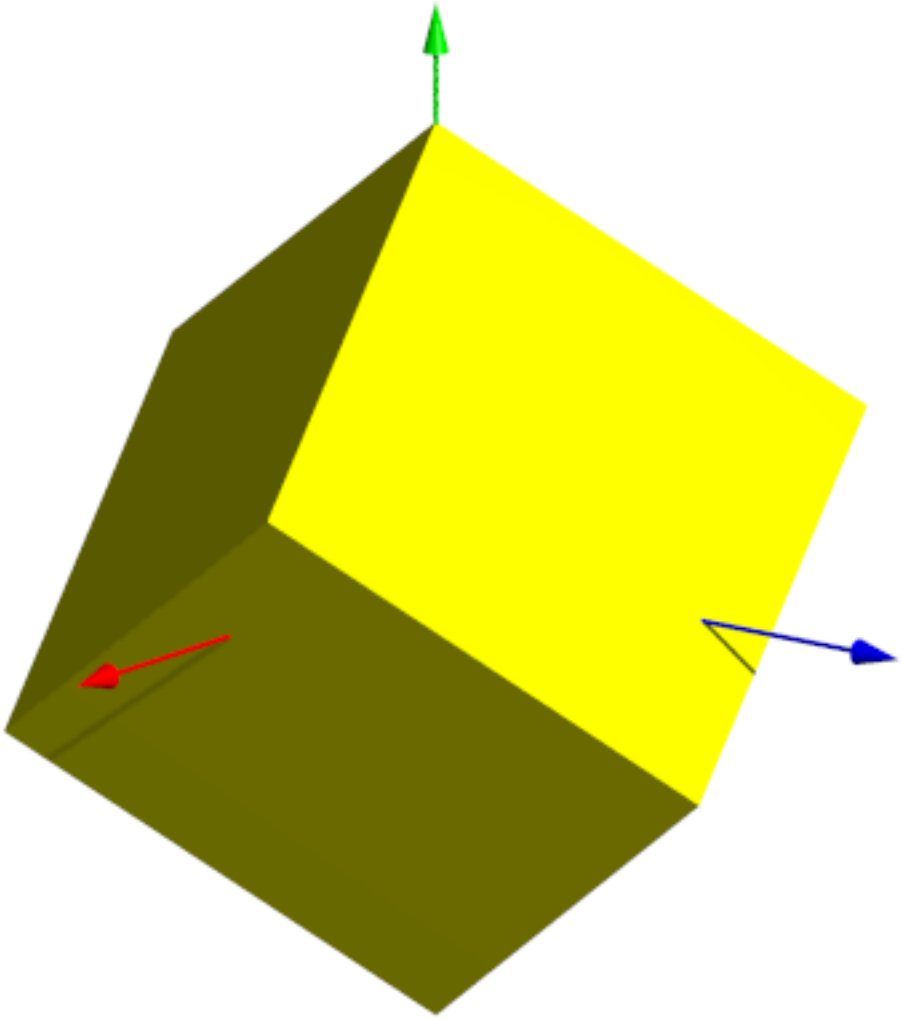
Gegenstück punktsymmetrisch und spiegelbildlich

Affensattel

$$z = x^3 - 3xy^2$$



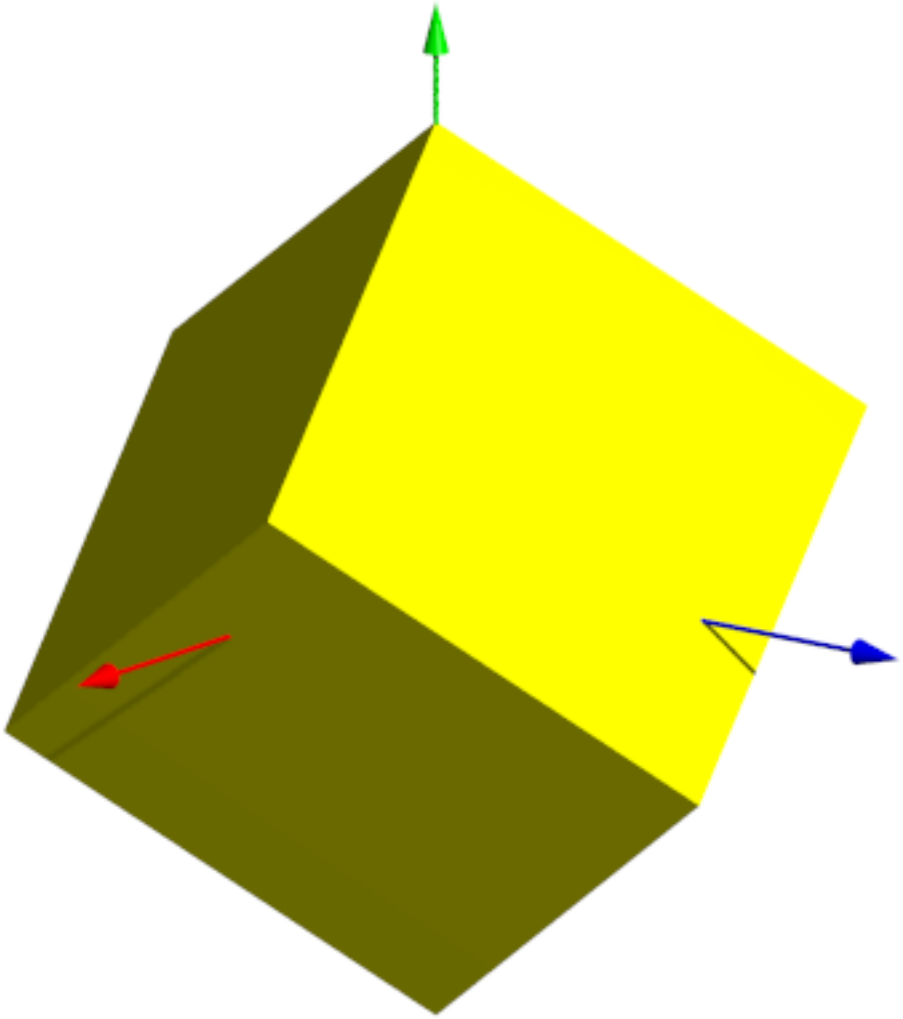
Würfel auf Ecke



Würfel auf Ecke

Indifferentes Gleichgewicht

Würfel auf Ecke



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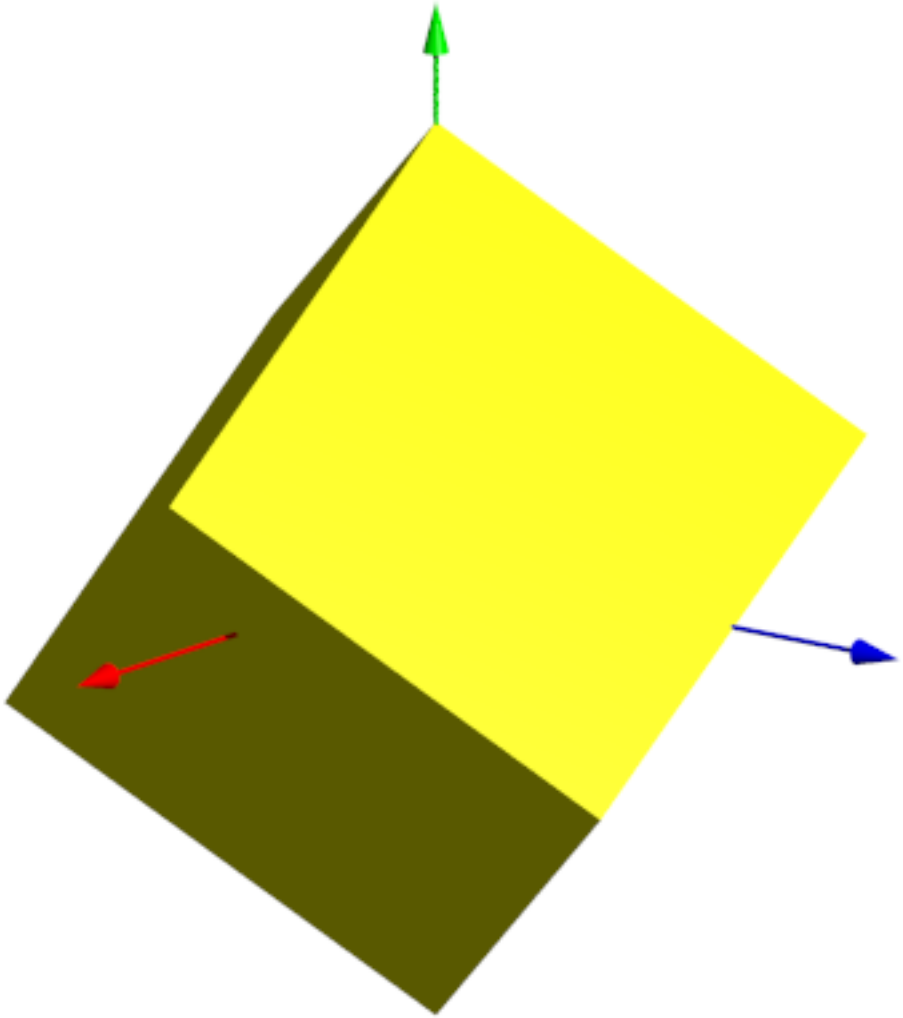

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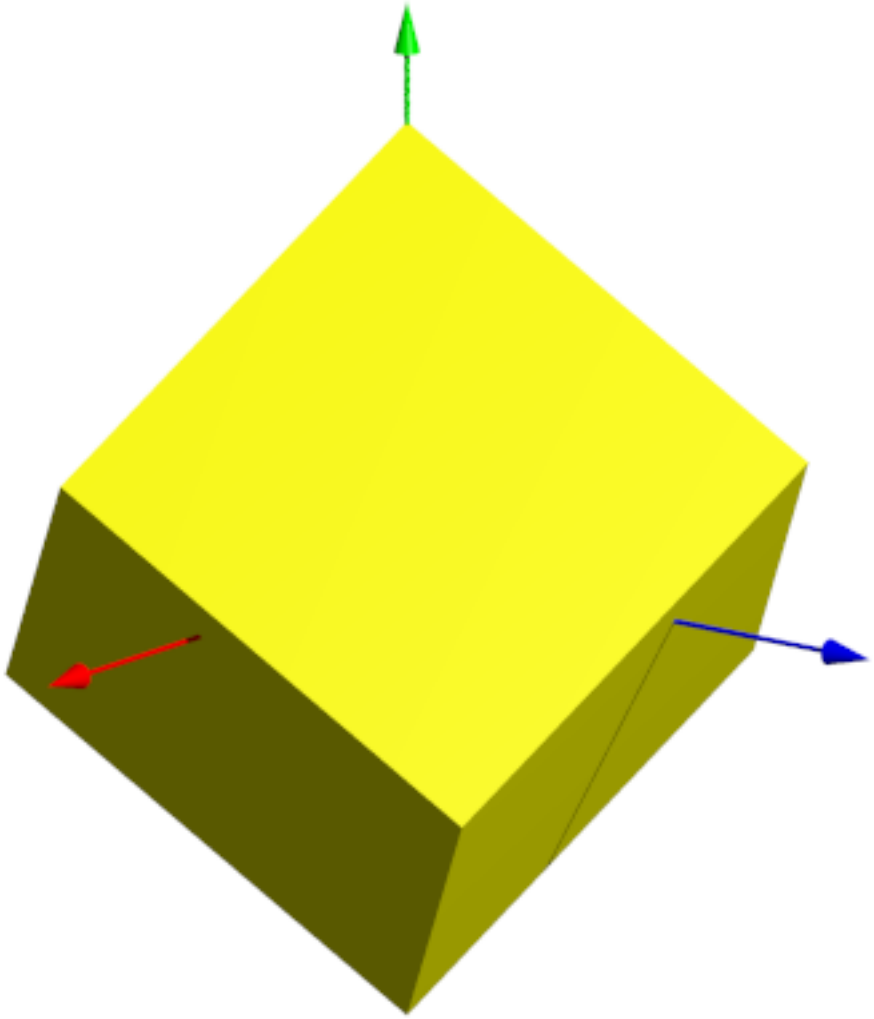

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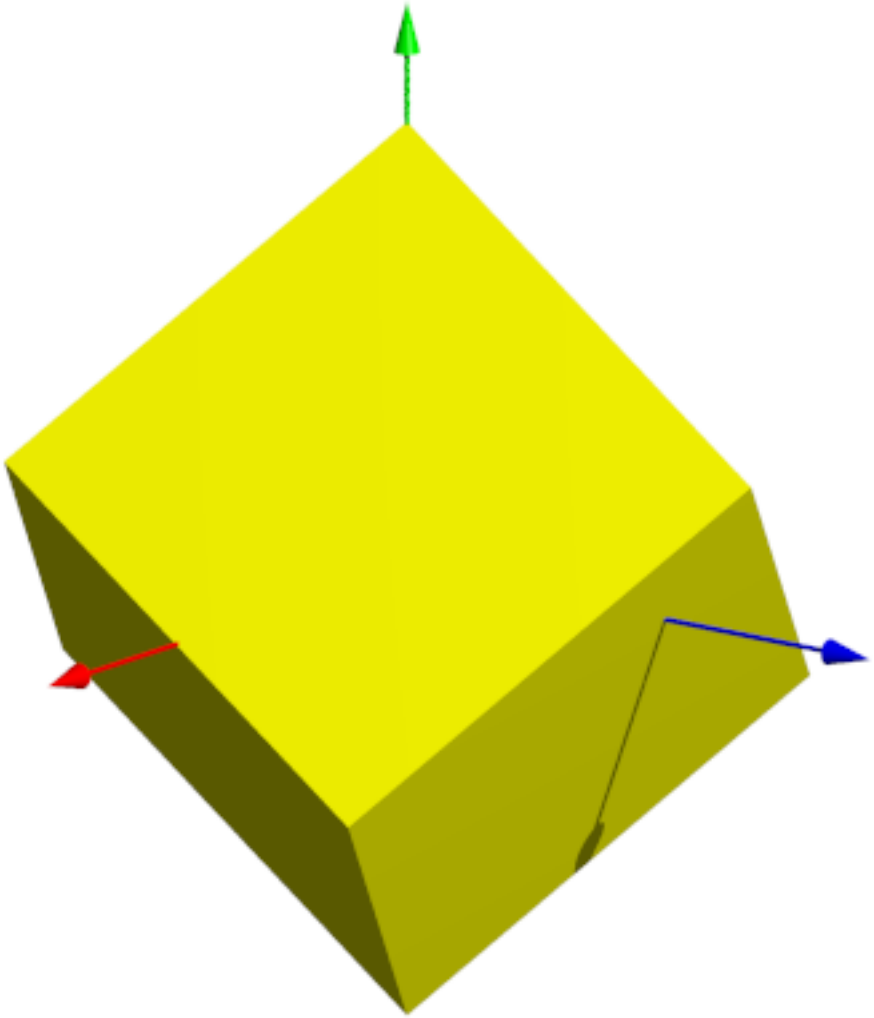

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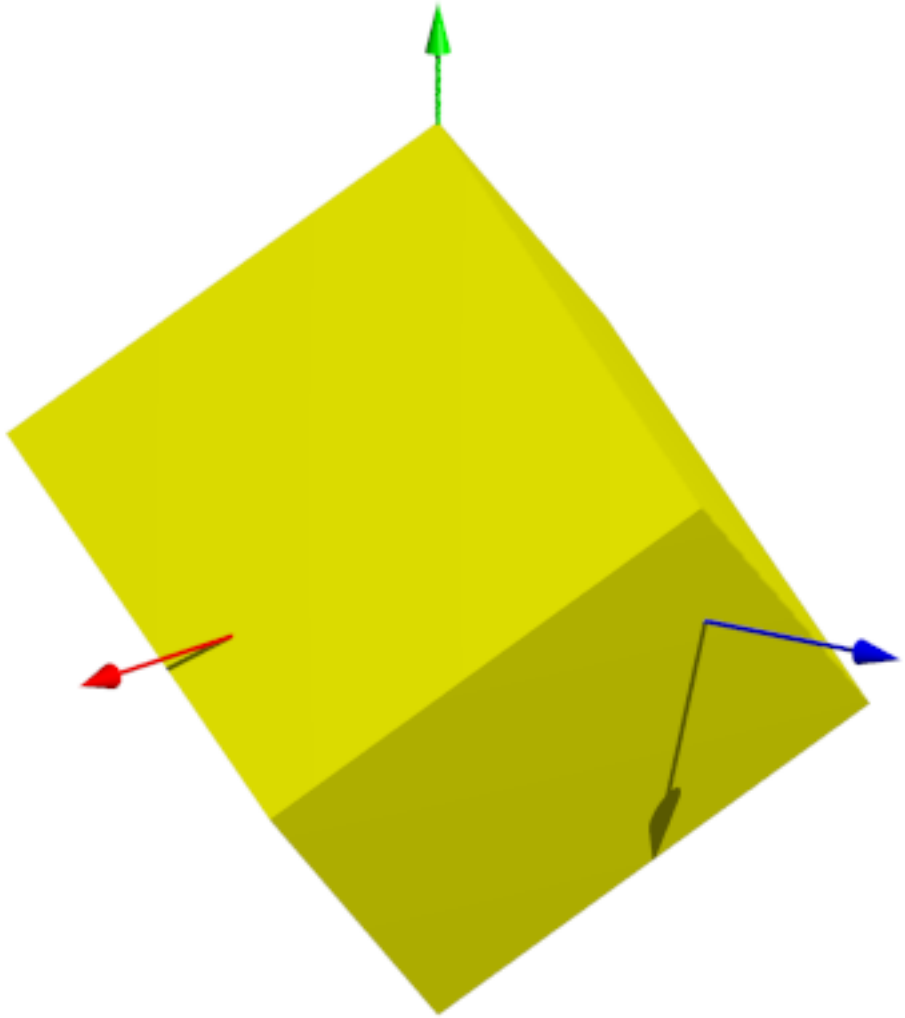

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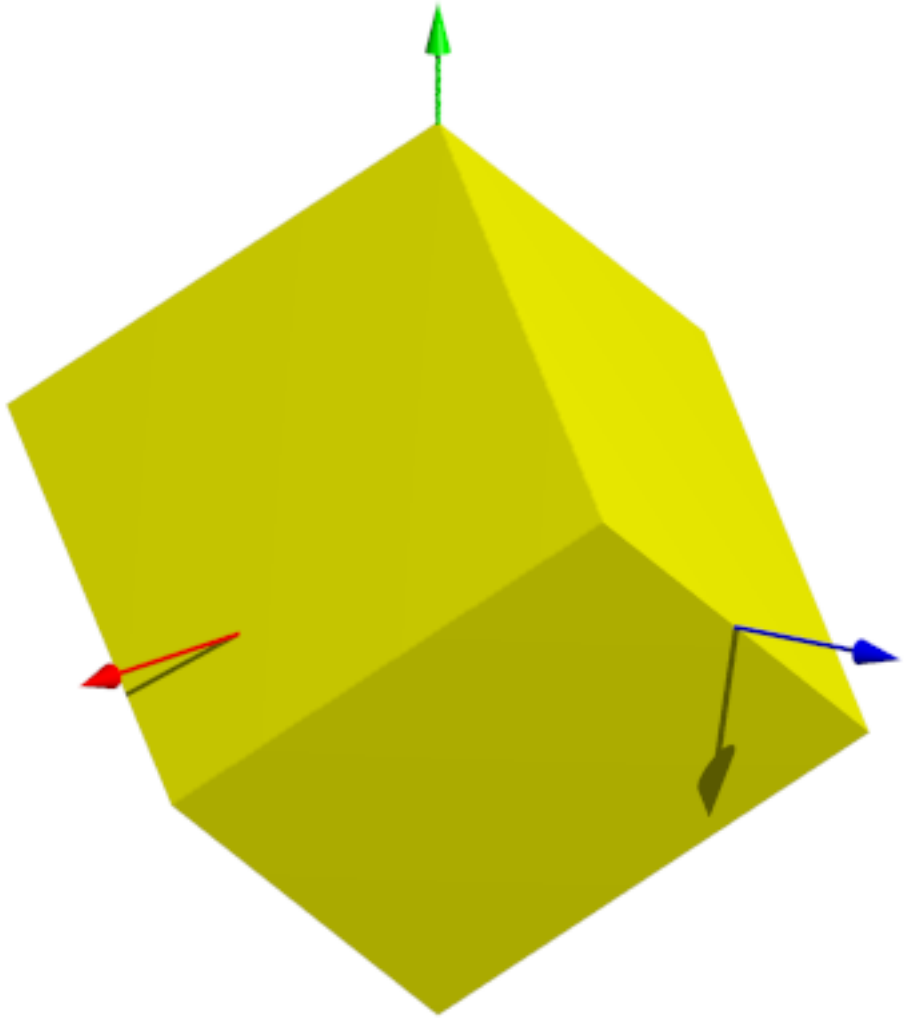

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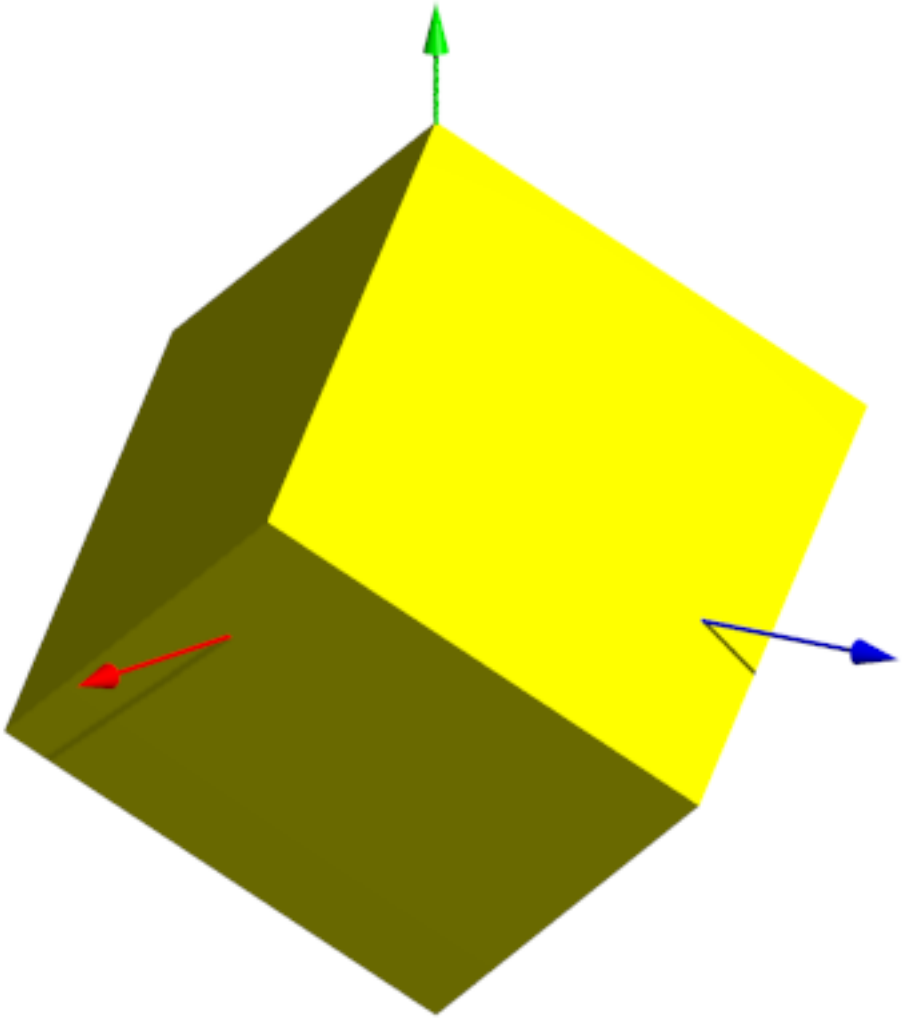
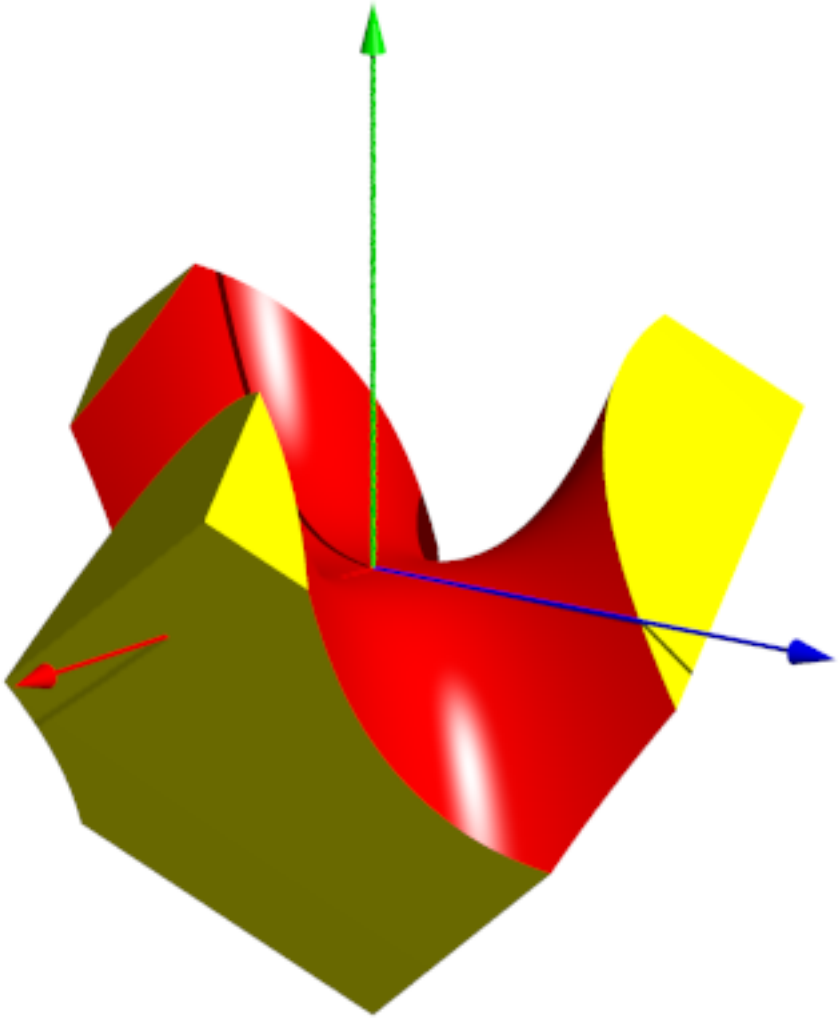


Schnitt mit Affensattel



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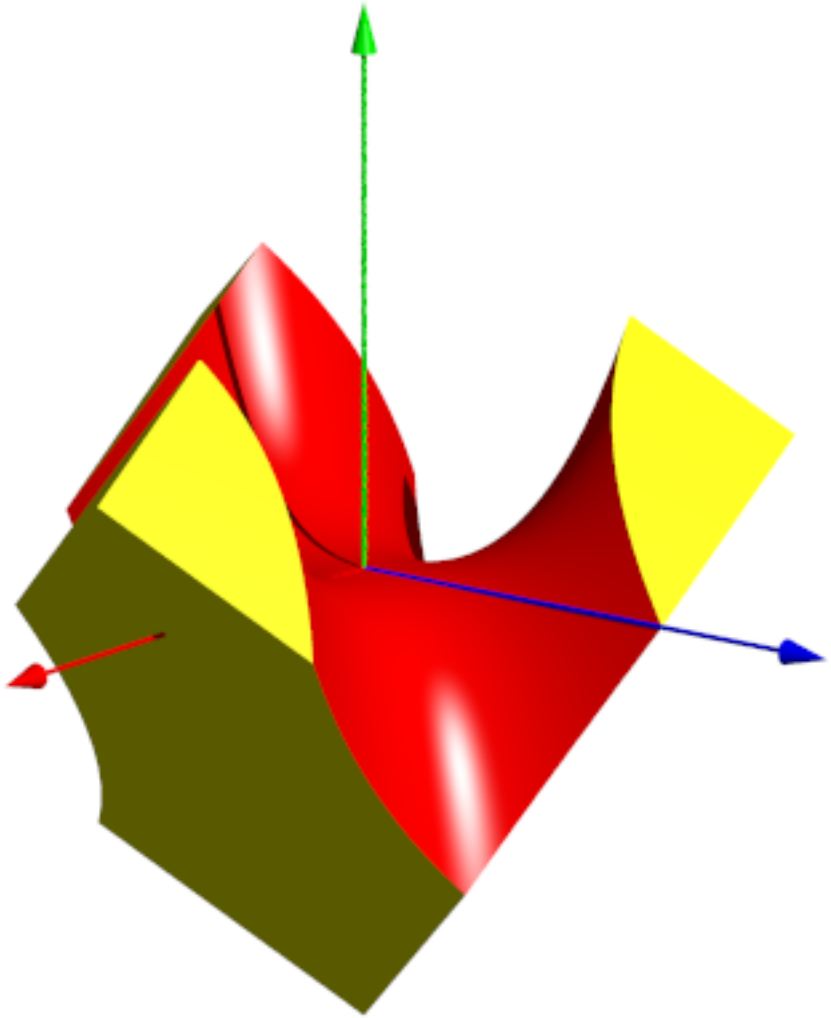

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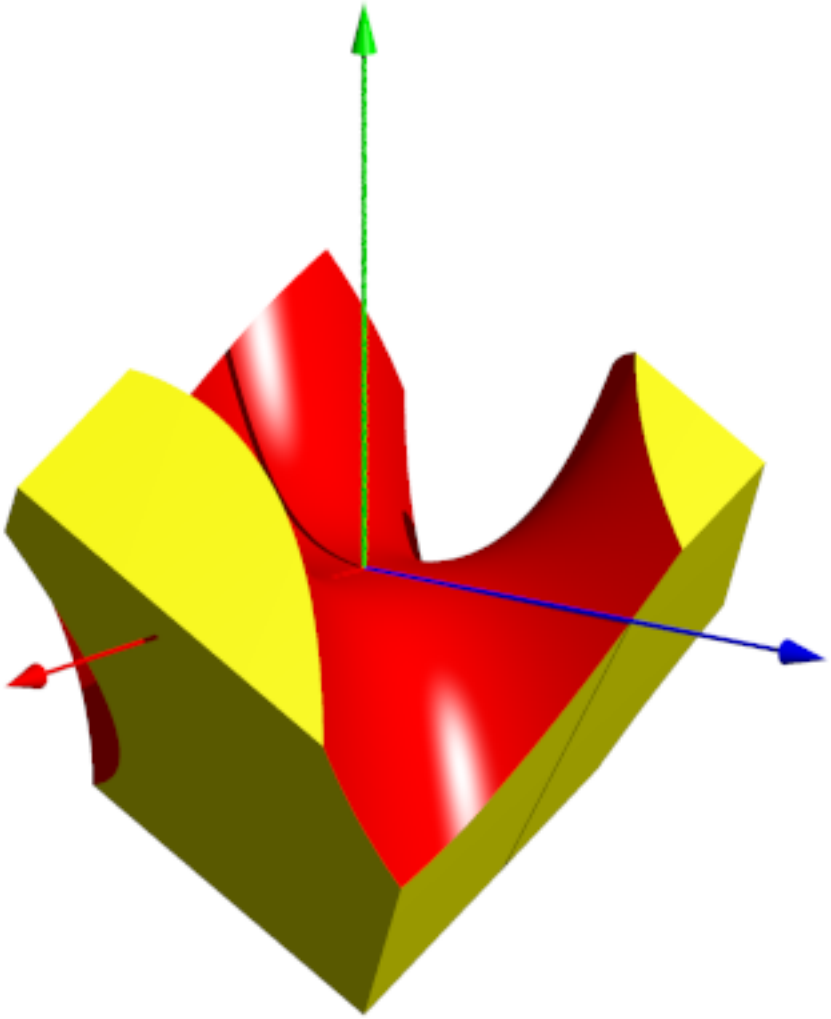

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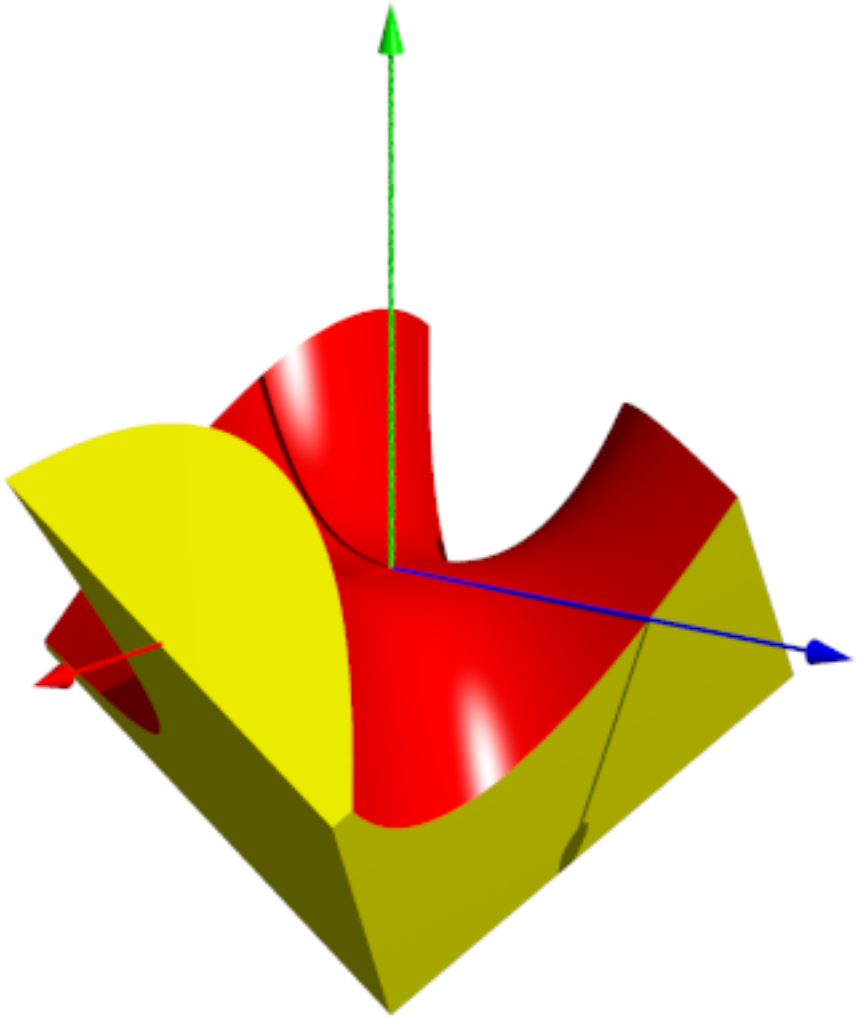

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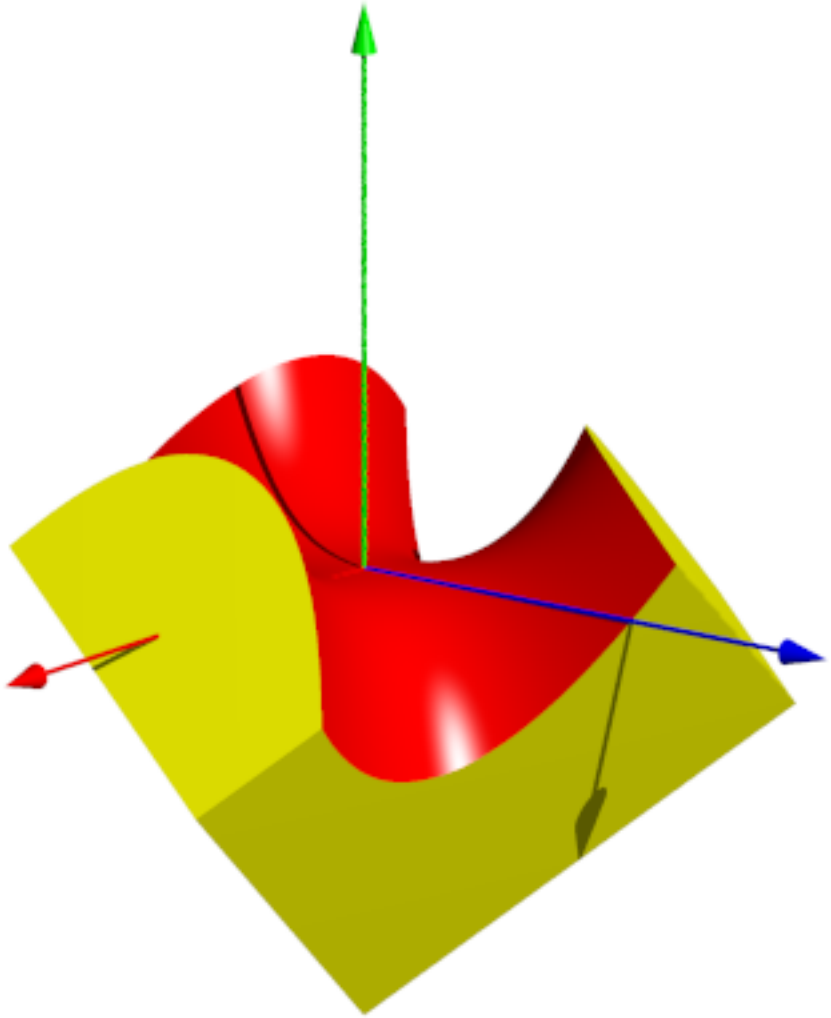

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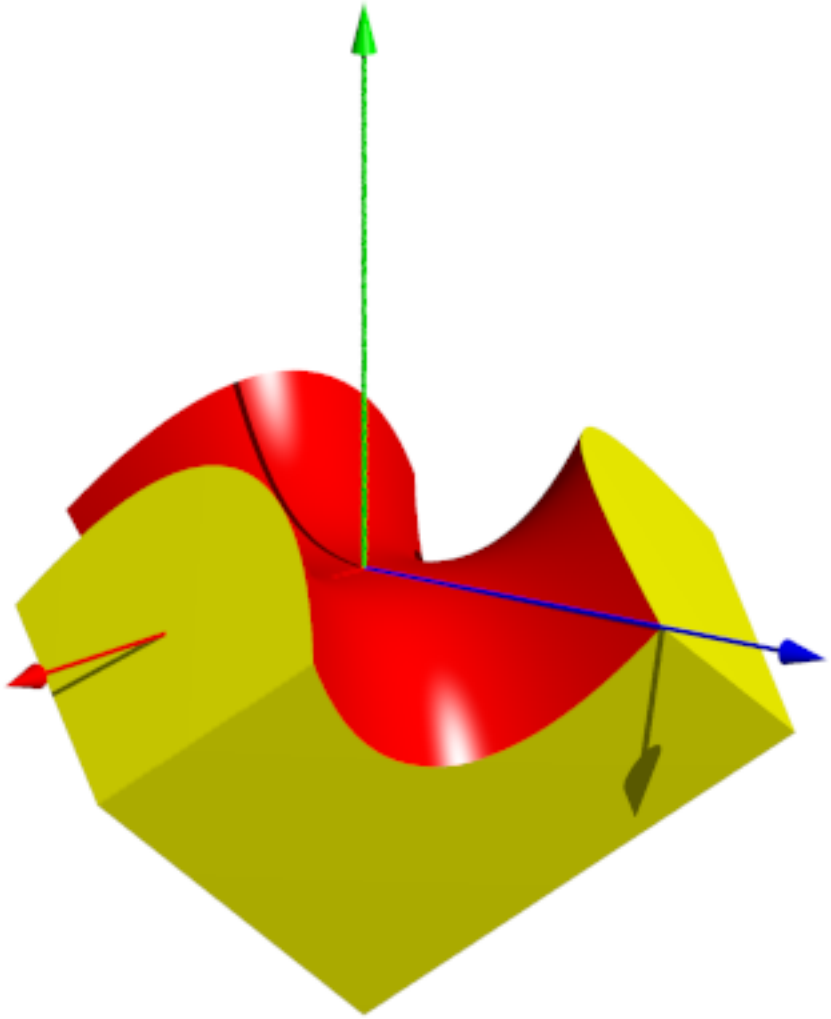
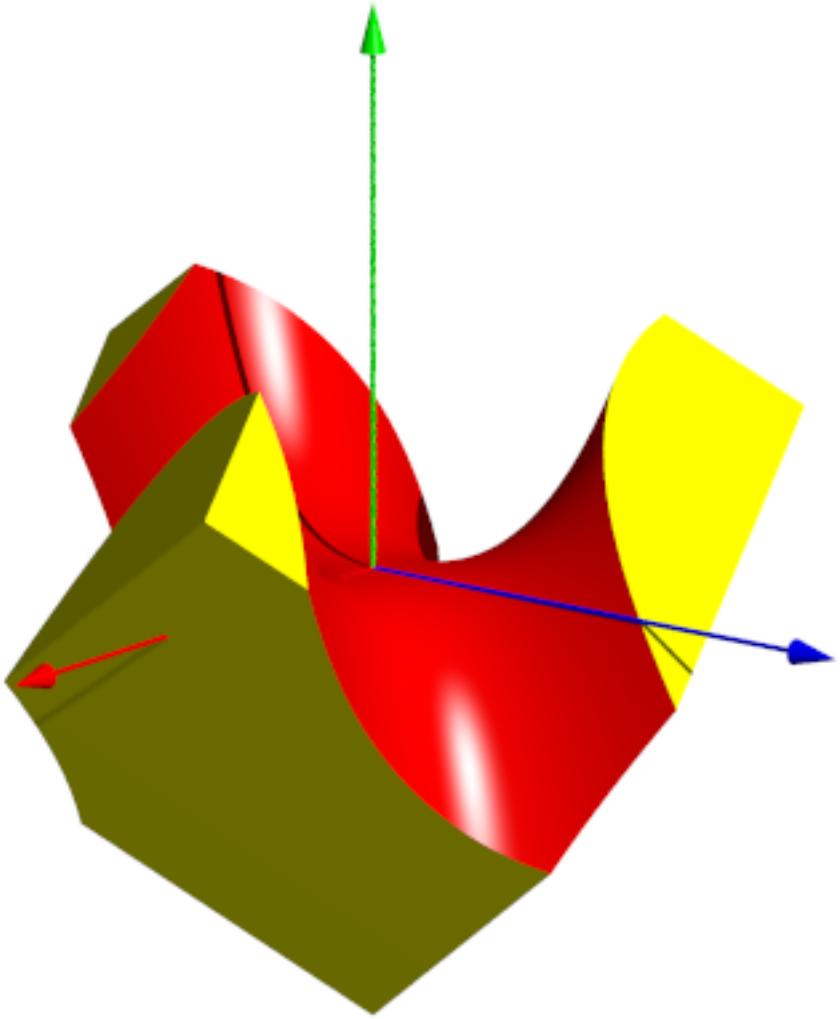


Hohe Symmetrie

Schnitt mit Affensattel



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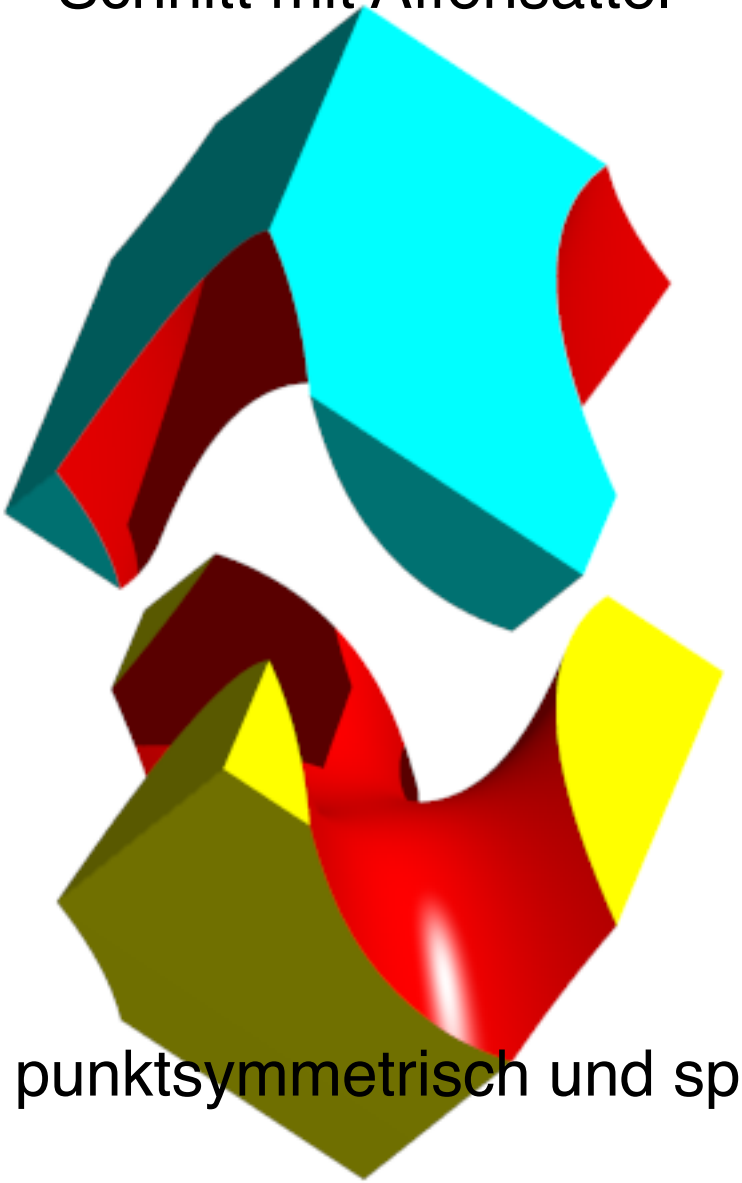
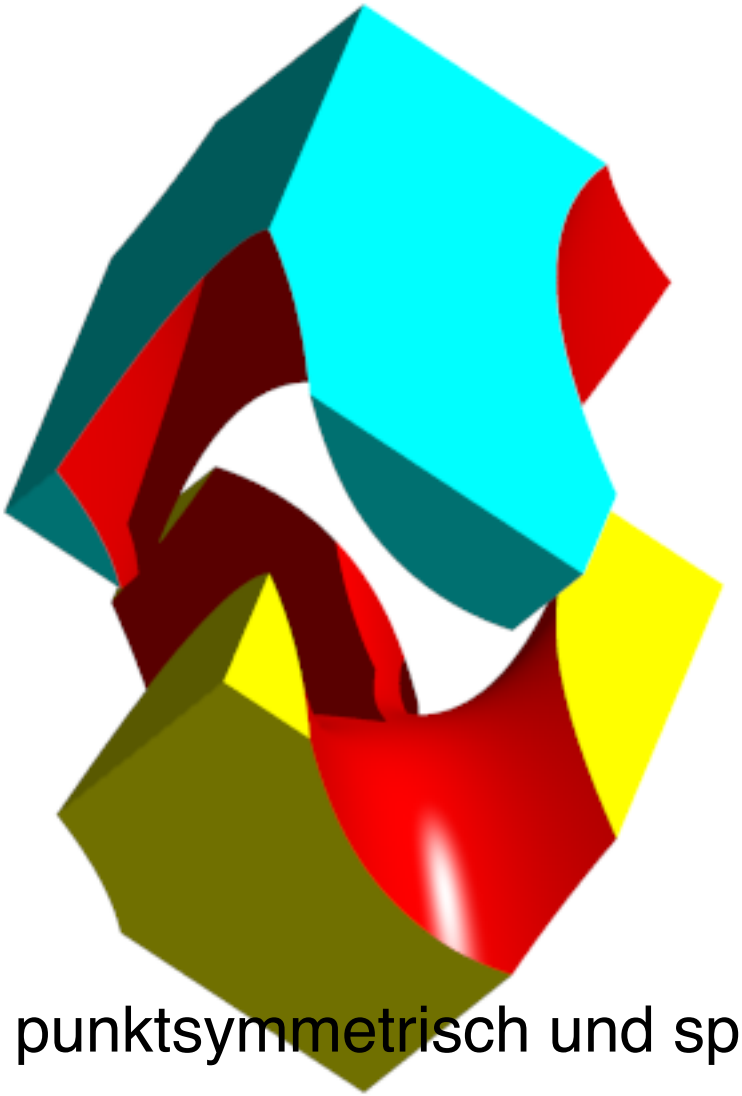


Gegenstück punktsymmetrisch und spiegelbildlich

Schnitt mit Affensattel



Gegenstück punktsymmetrisch und spiegelbildlich

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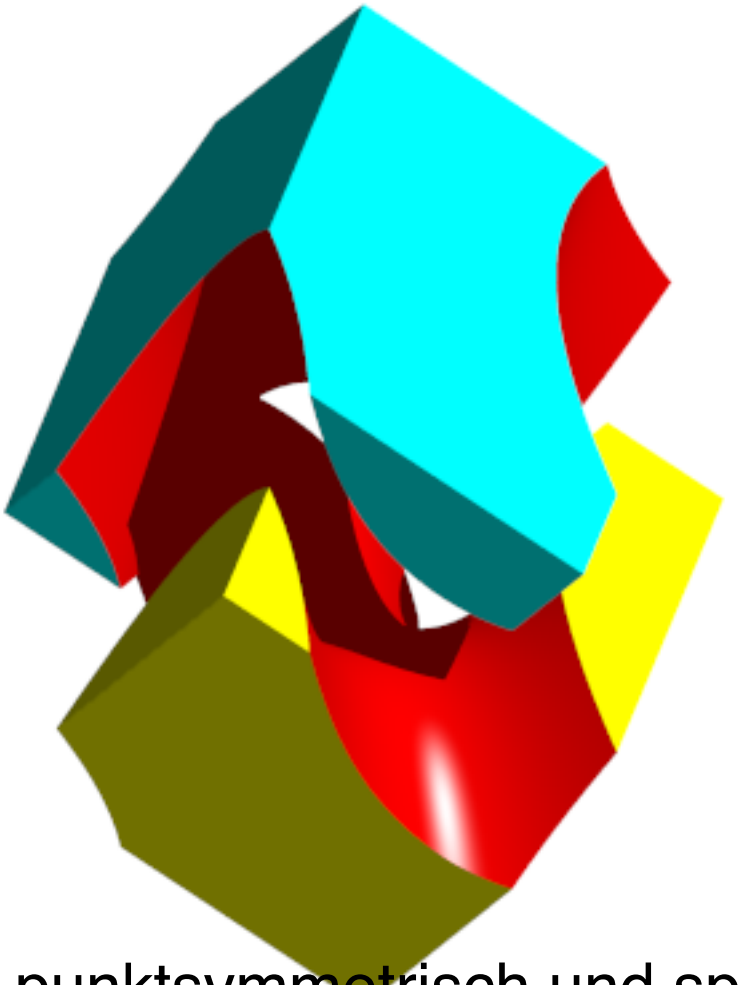

Gegenstück punktsymmetrisch und spiegelbildlich

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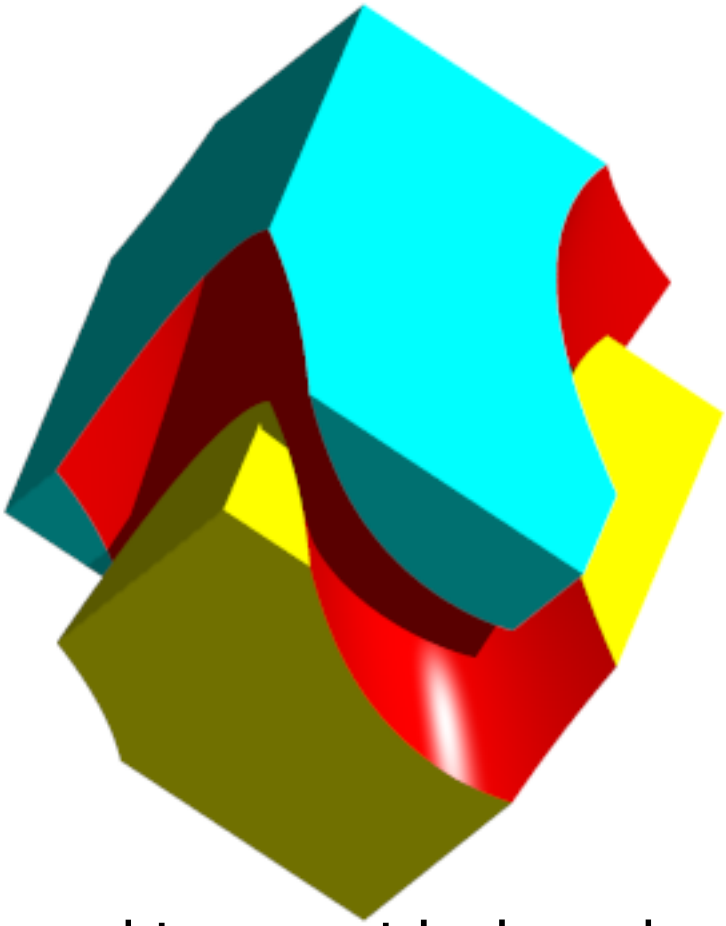

Gegenstück punktsymmetrisch und spiegelbildlich

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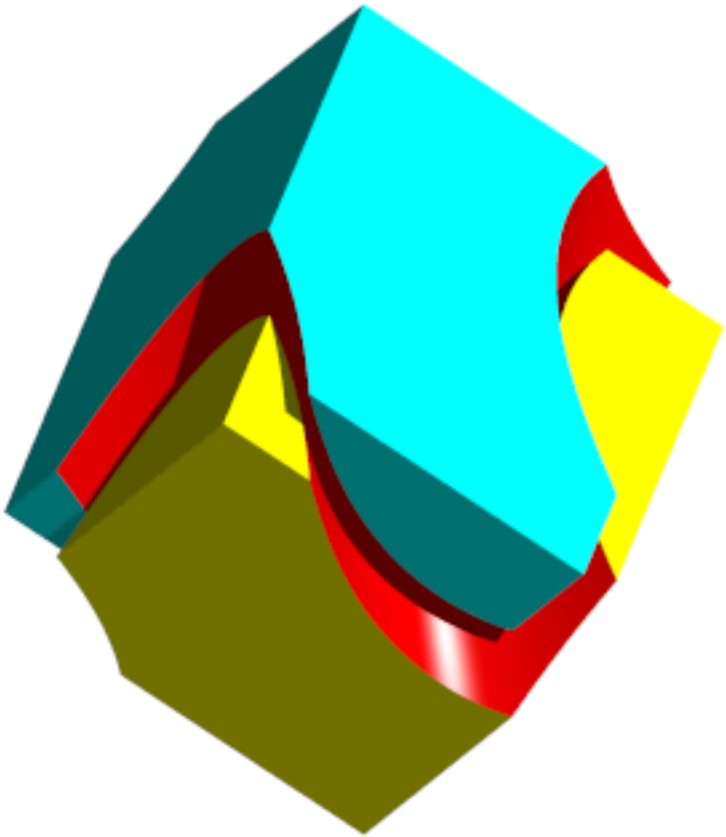

Gegenstück punktsymmetrisch und spiegelbildlich

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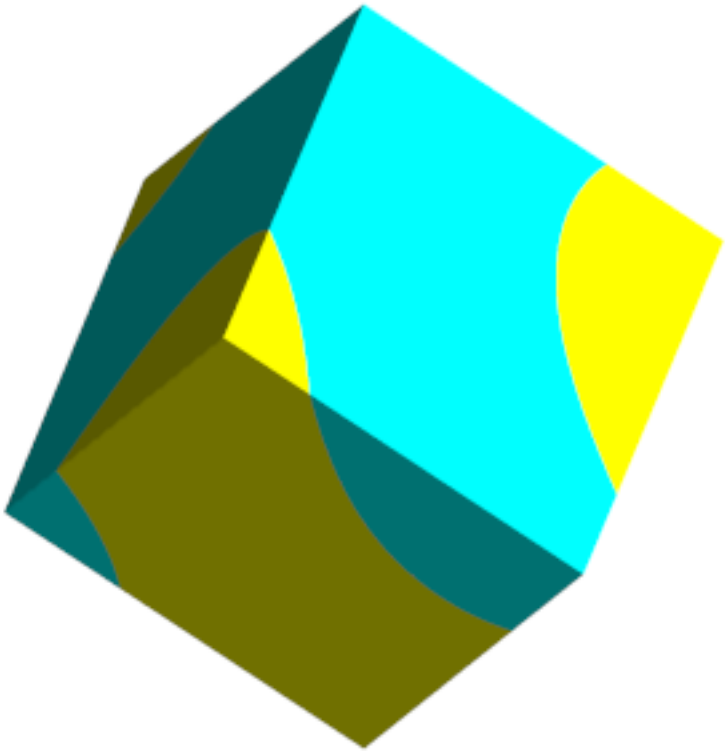
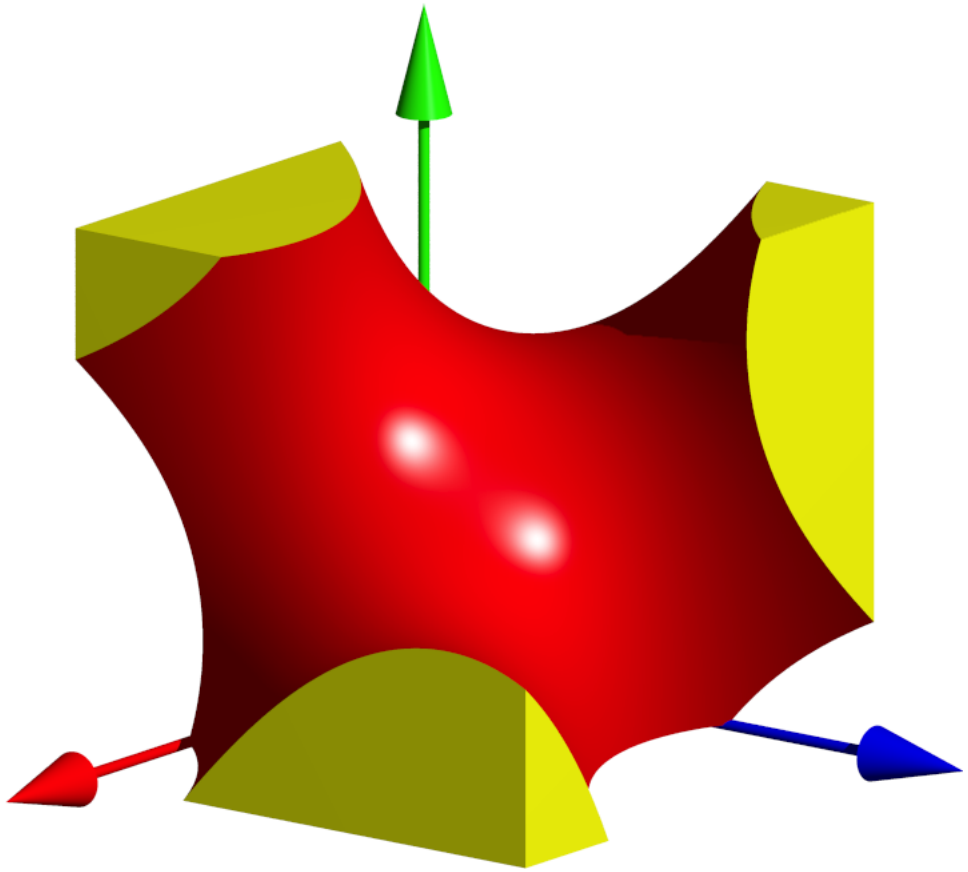


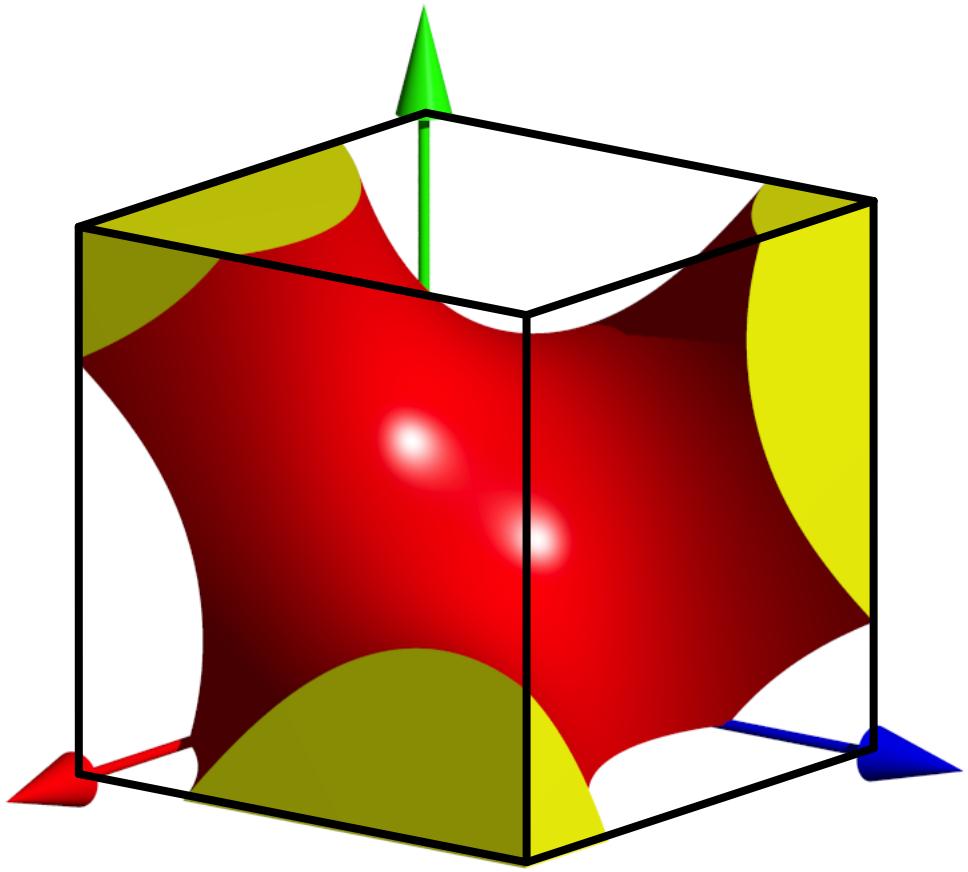
Gegenstück punktsymmetrisch und spiegelbildlich

Einpassen ins Koordinatensystem



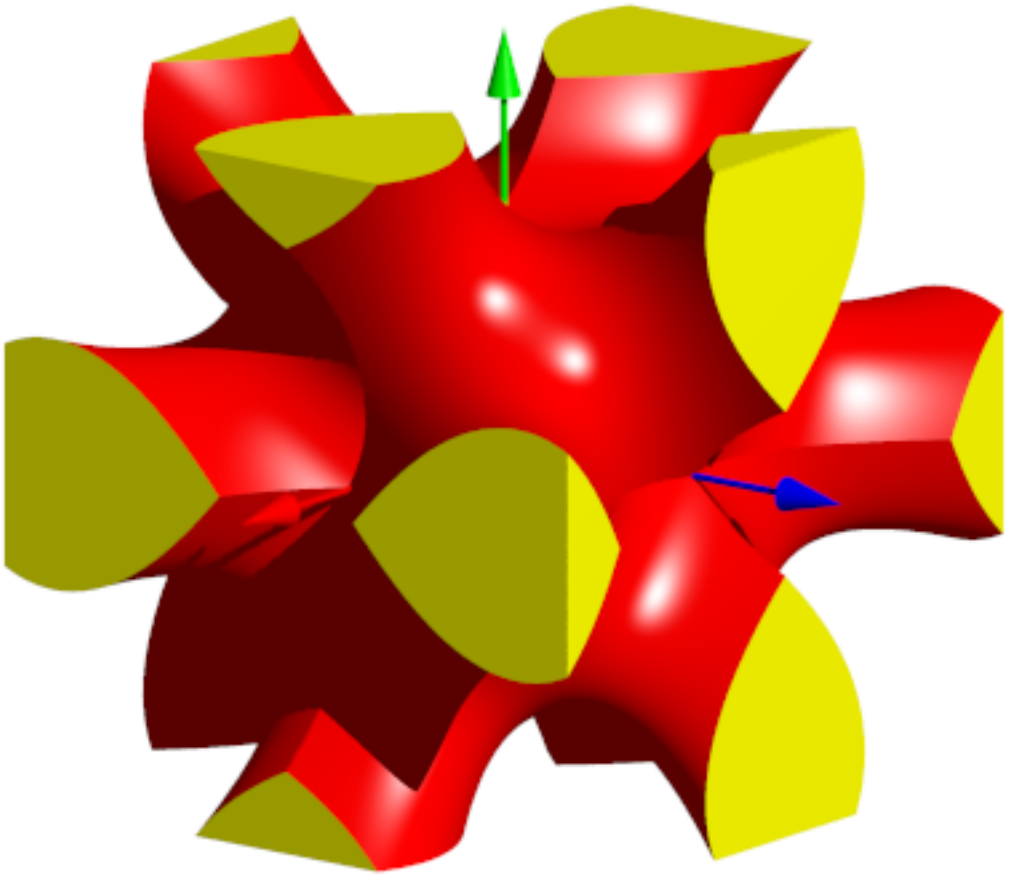
Halber Würfel

Einpassen ins Koordinatensystem



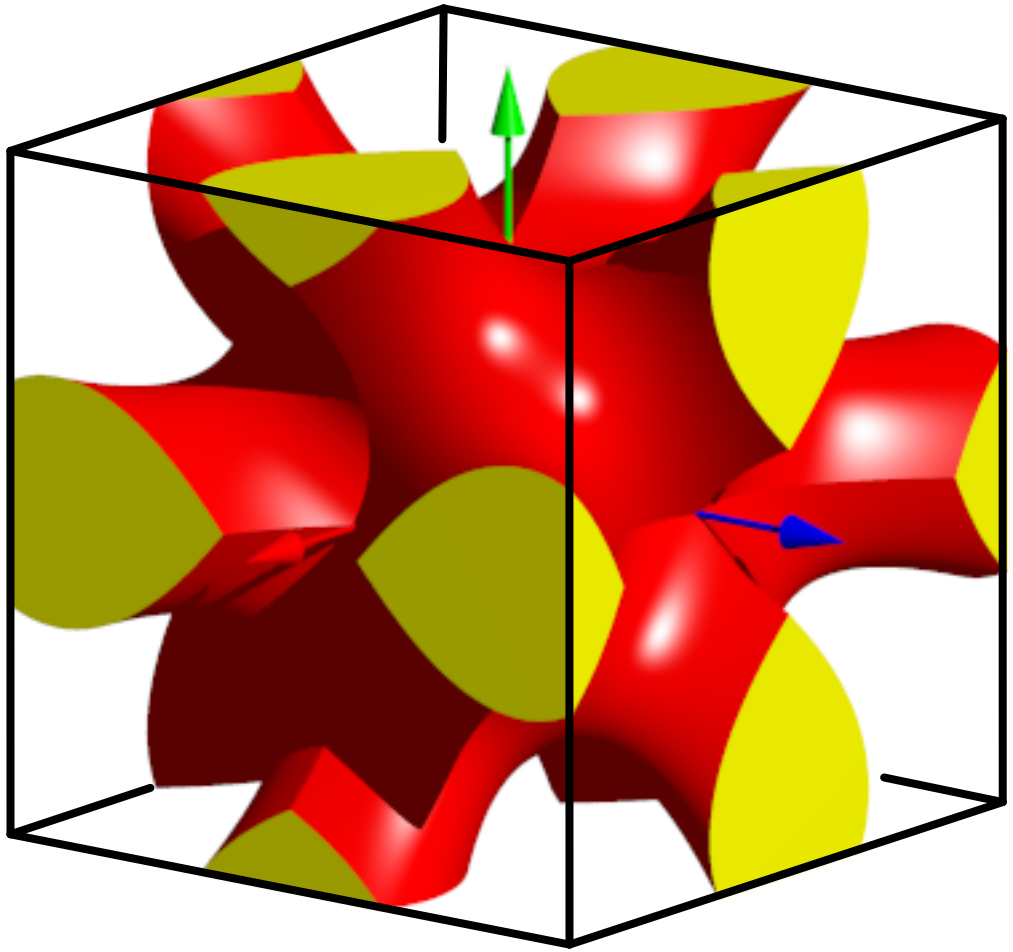
Halber Würfel

Spiegeln an Koordinatenebenen



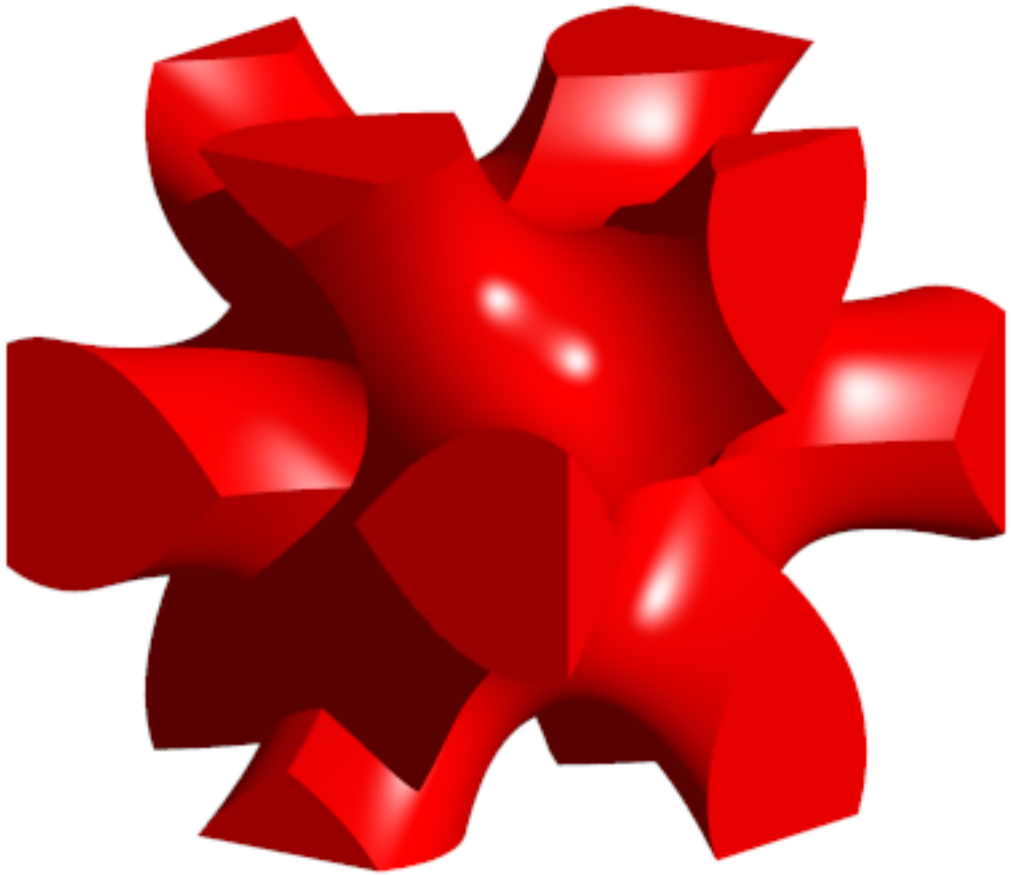
Halber Würfel

Spiegeln an Koordinatenebenen



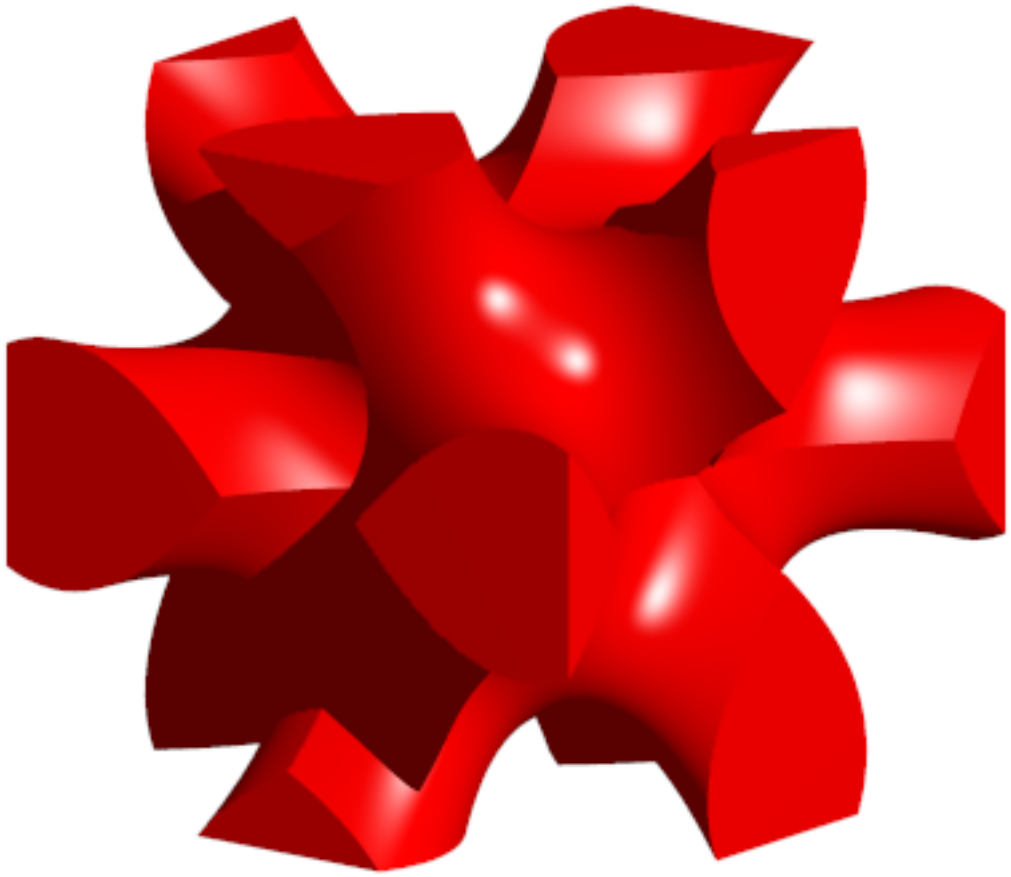
Halber Würfel

Spiegeln an Koordinatenebenen



Zwölf-Füßler

Raumfüller



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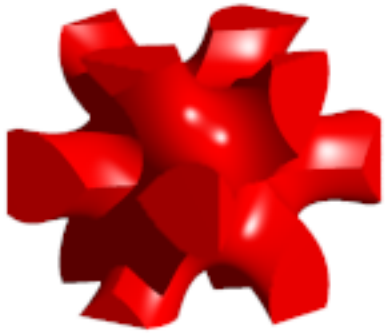
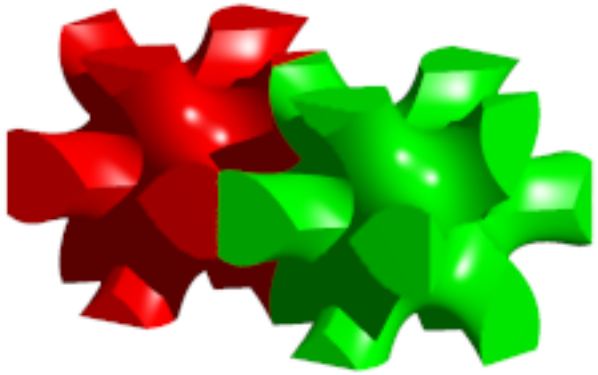


Raumfüller



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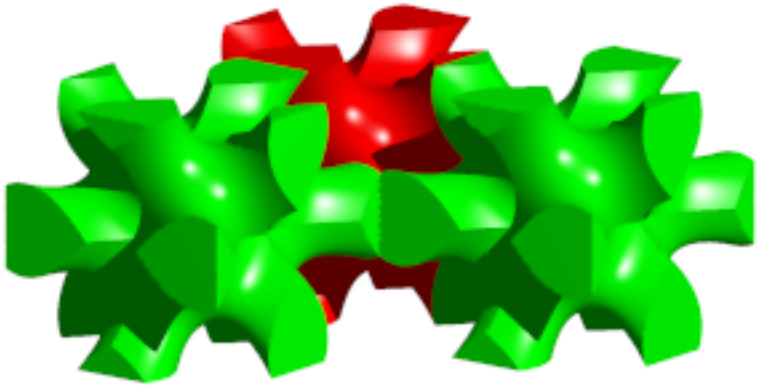

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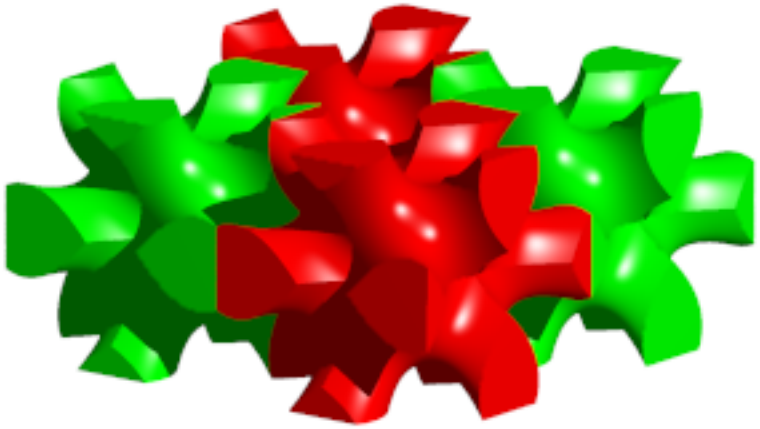

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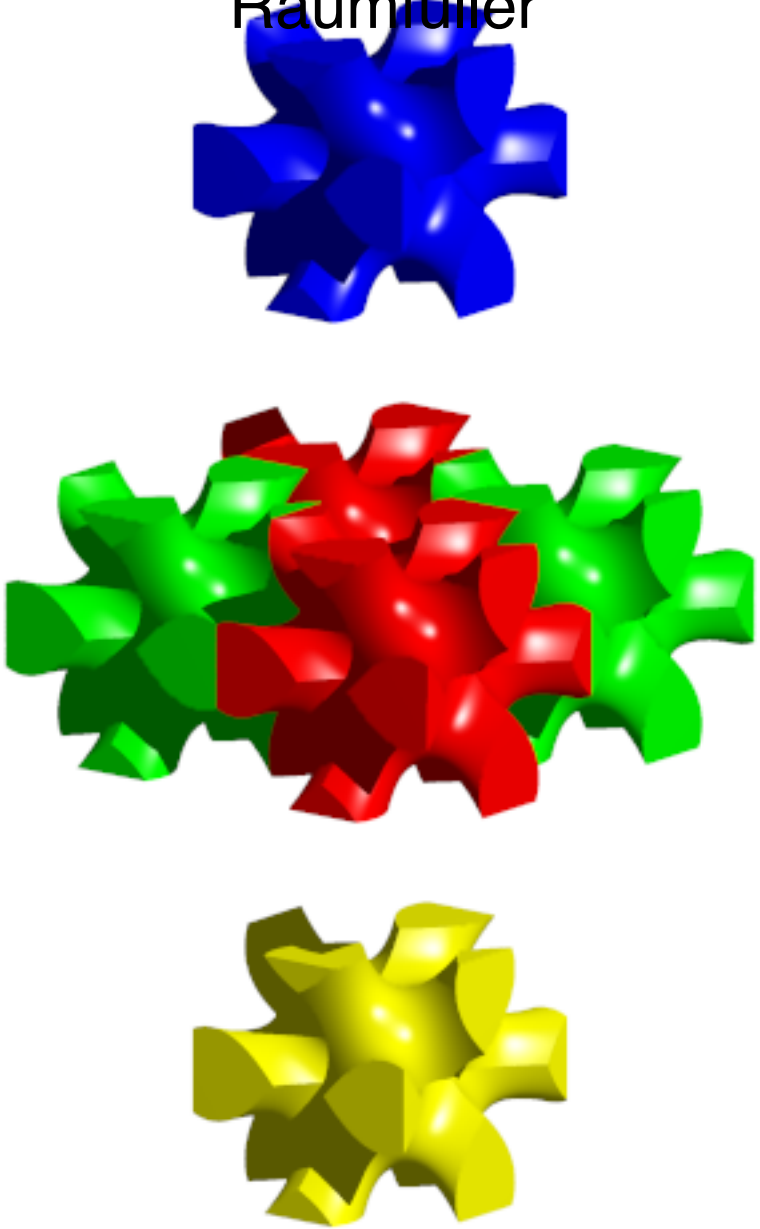

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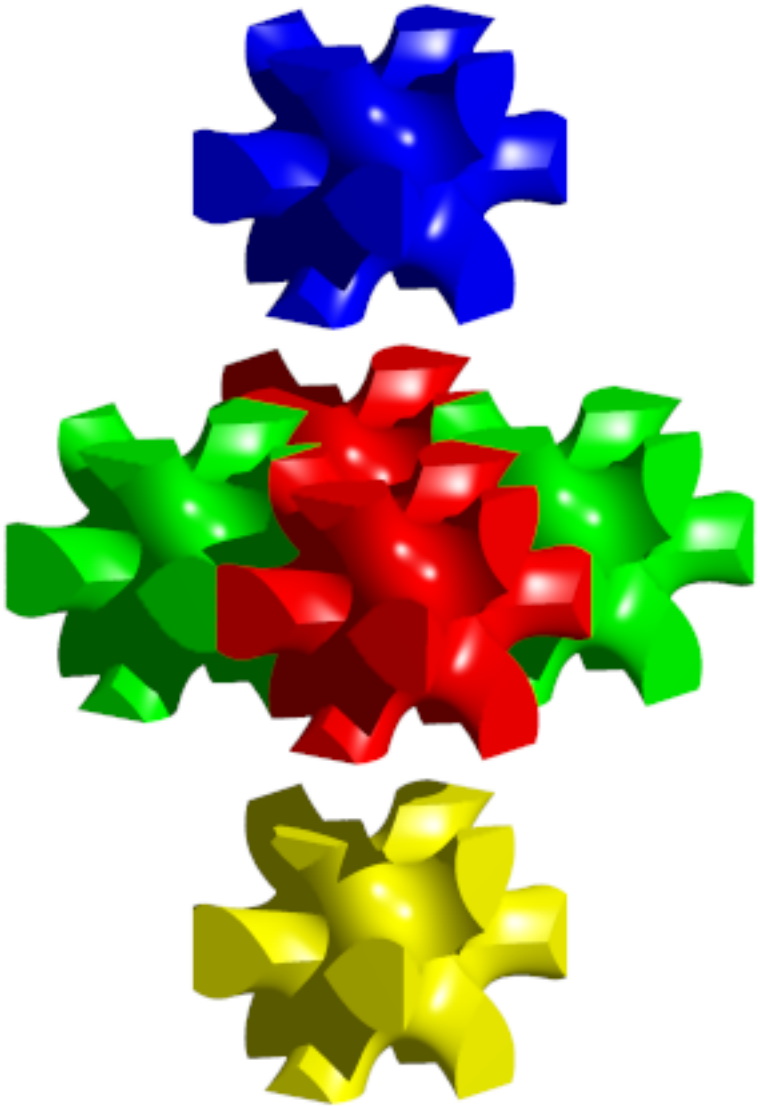

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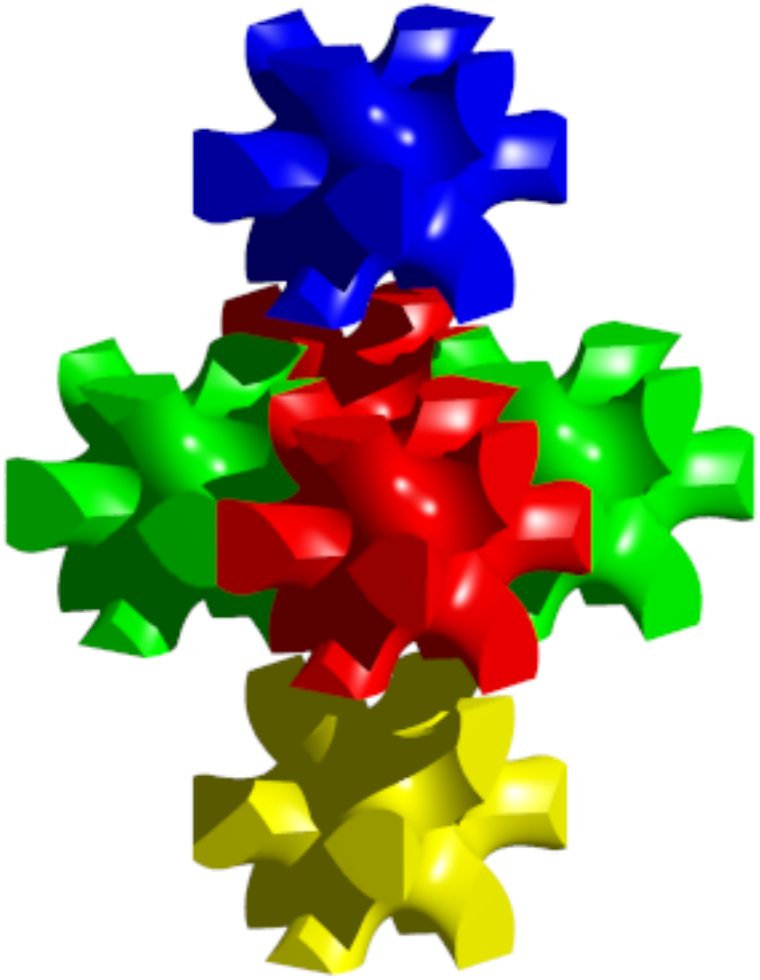

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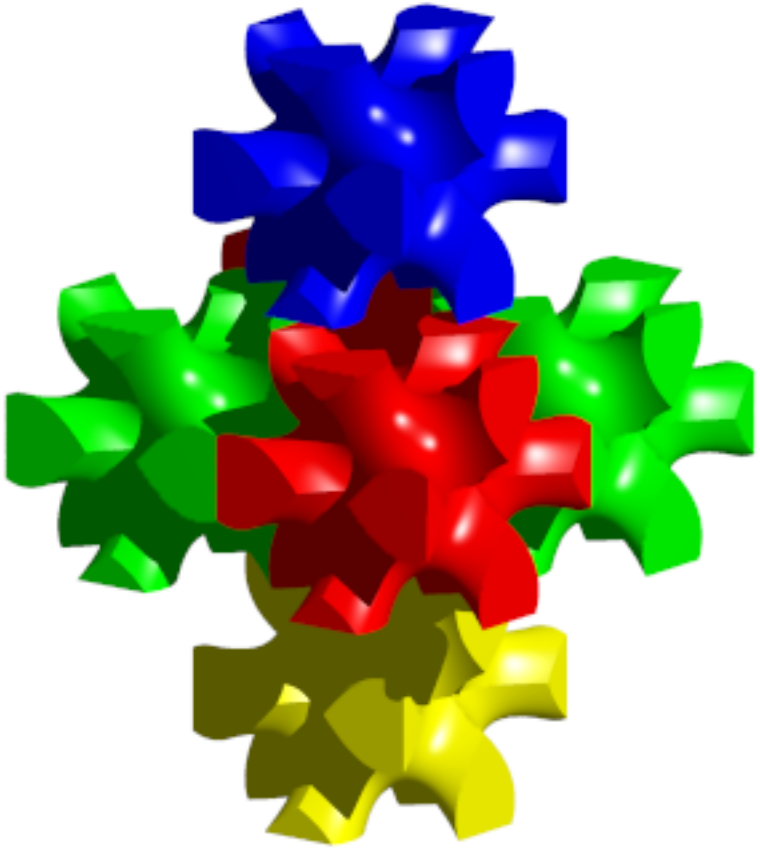
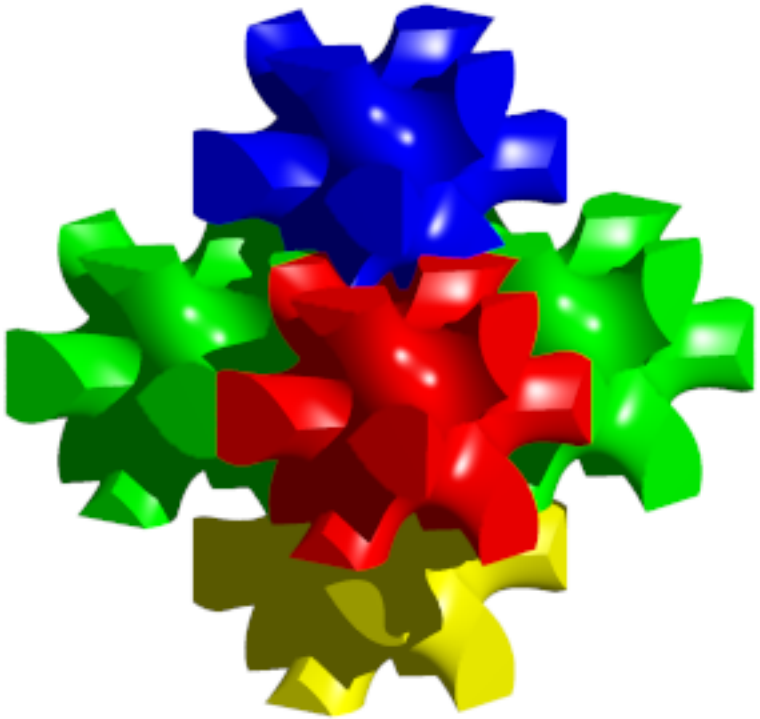


Kollision

Raumfüller



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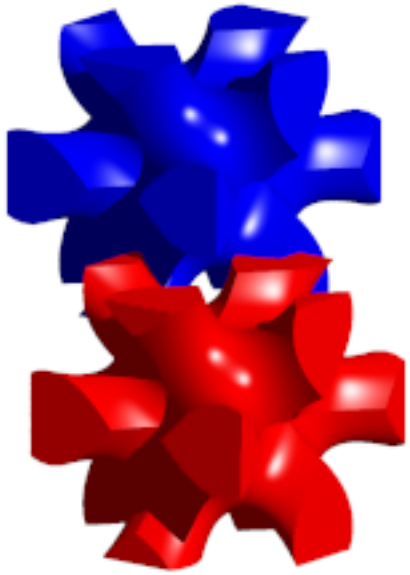
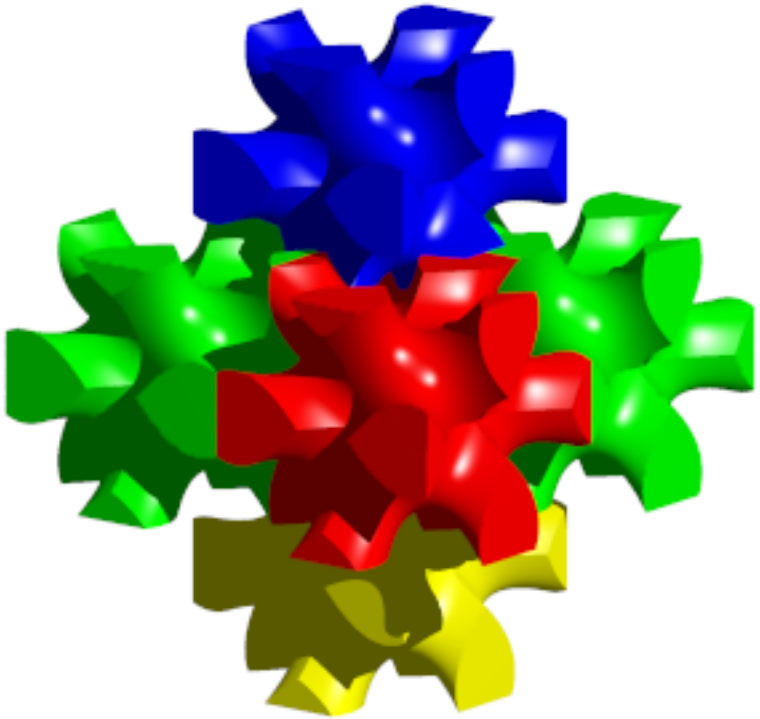


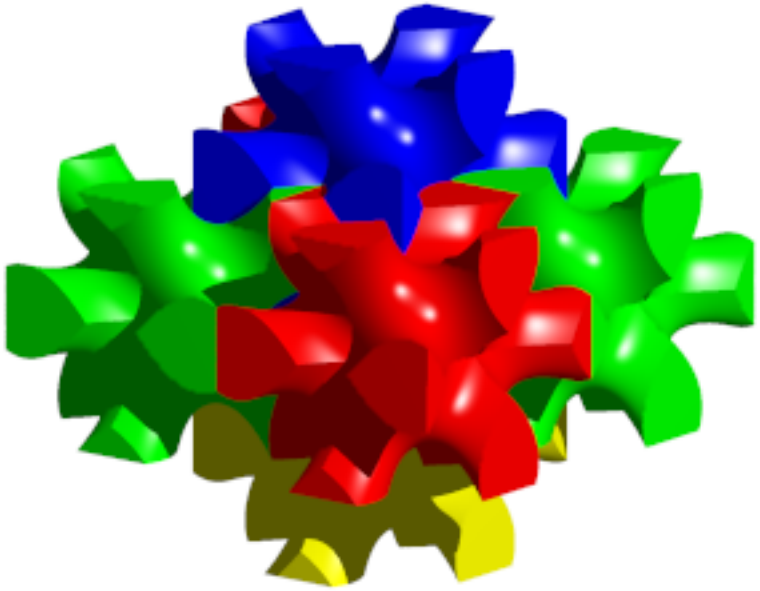
Raumfüller

Nicht leerer Durchschnitt

Raumfüller



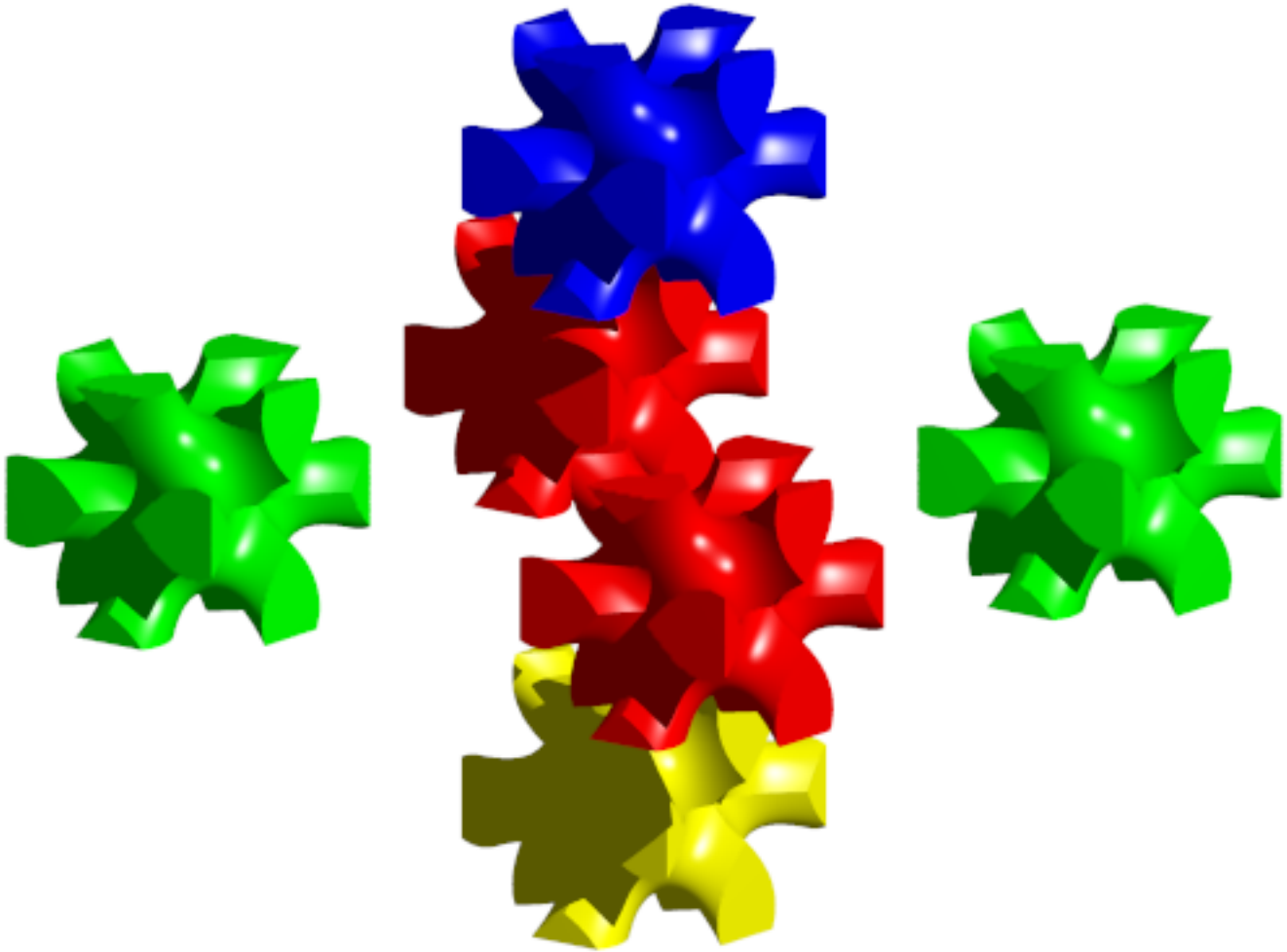
Raumfüller



Passt

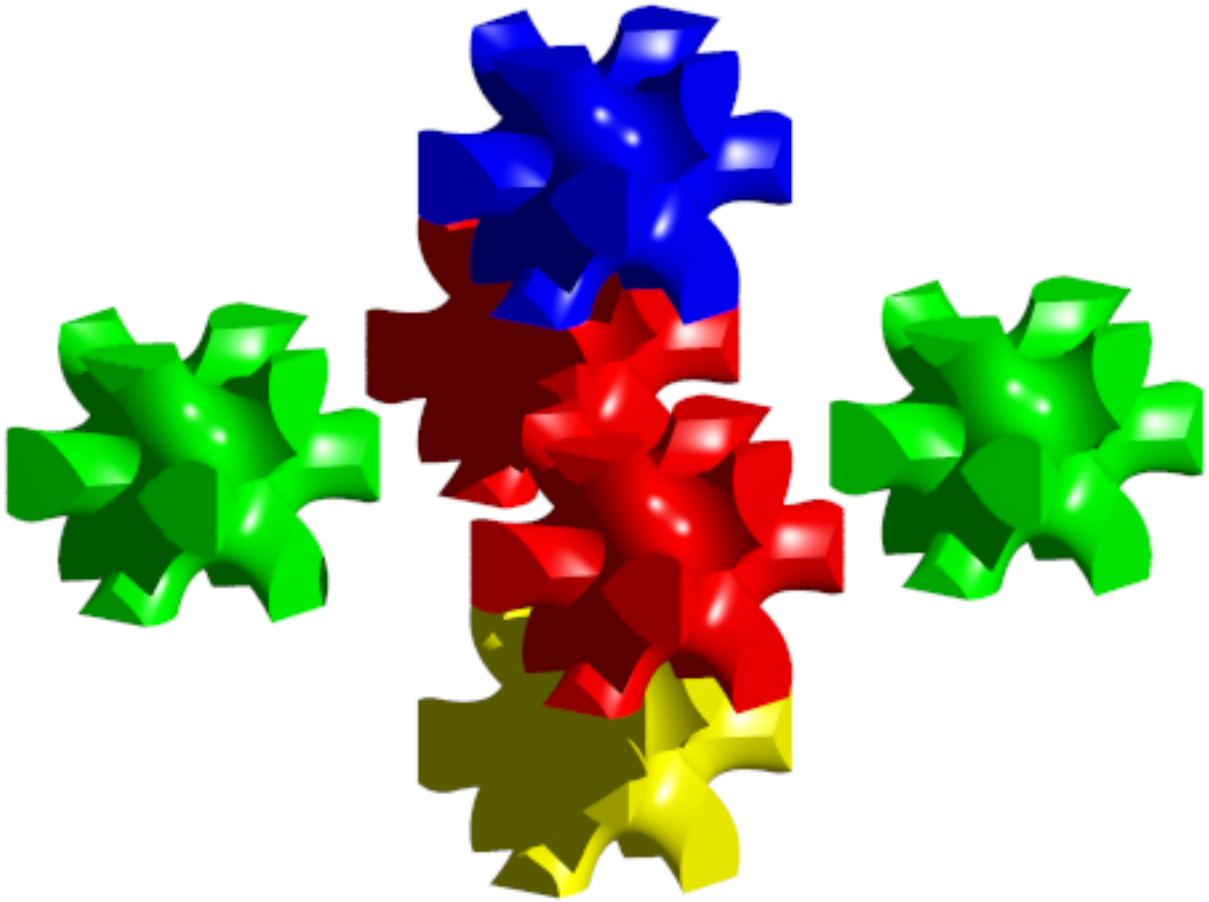
Lässt sich aber so nicht einpassen

Raumfüller



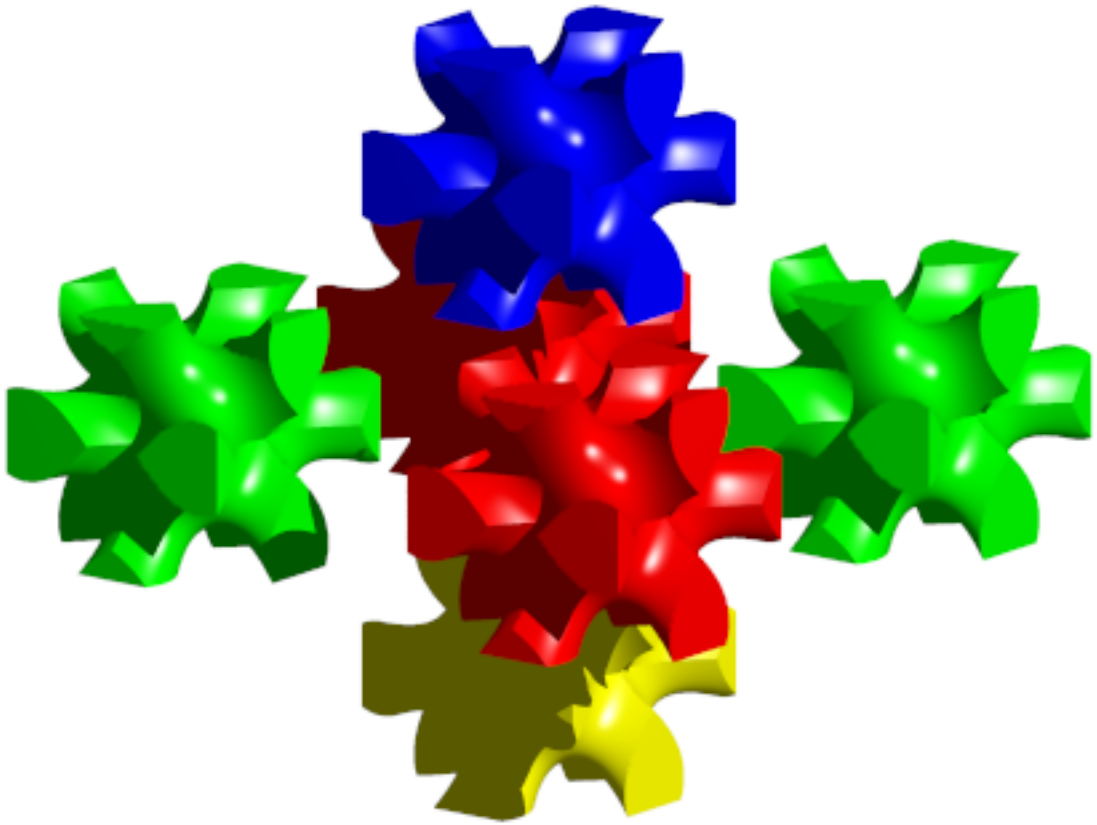
Neubeginn: Ganz weit außen

Raumfüller



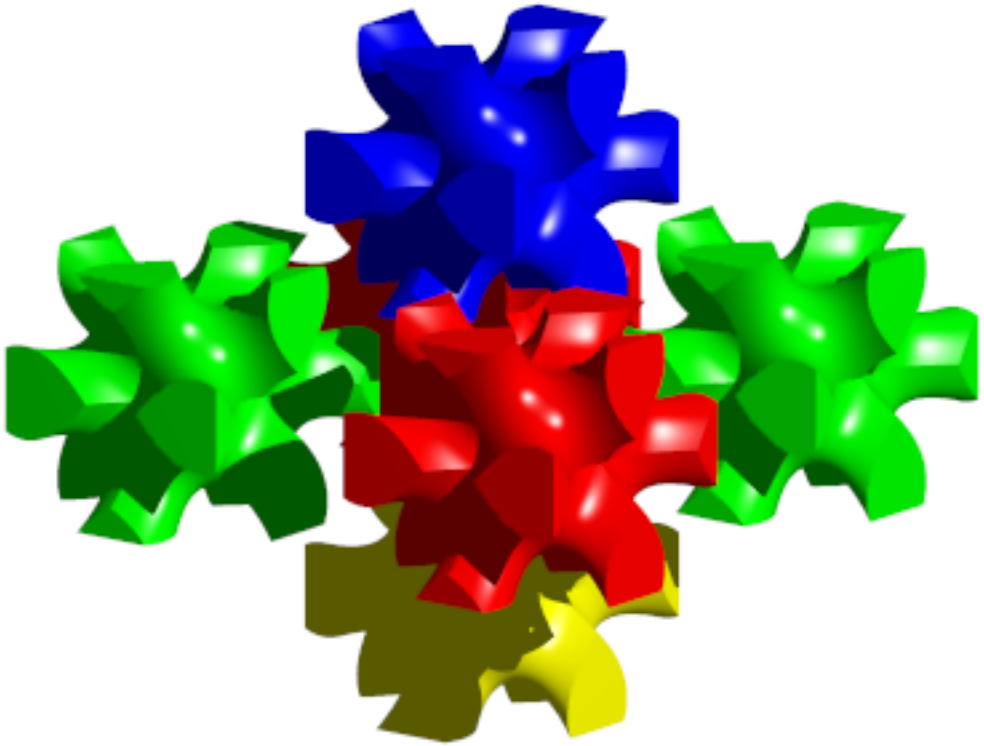
Simultanes Einpassen

Raumfüller



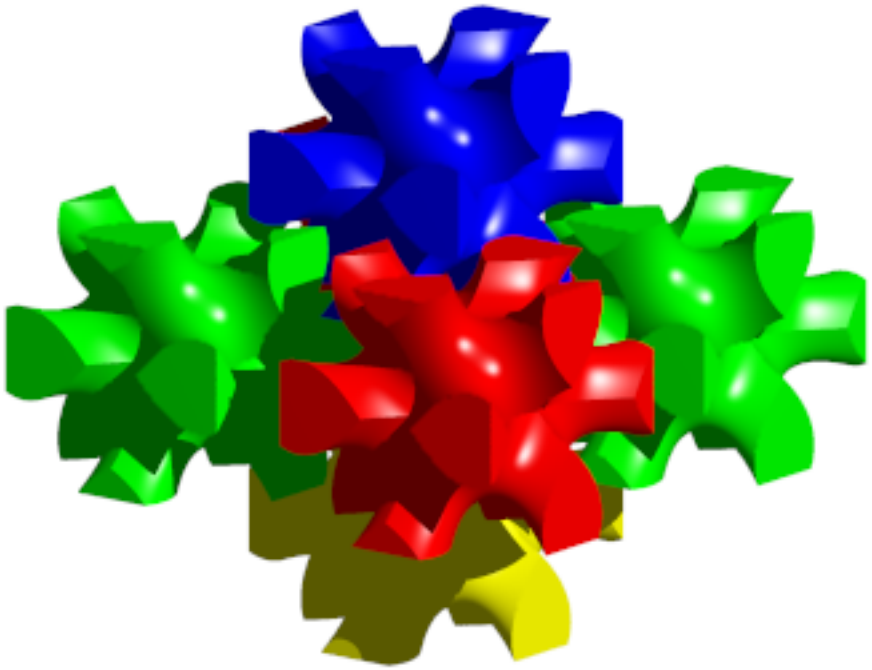
Simultanes Einpassen

Raumfüller



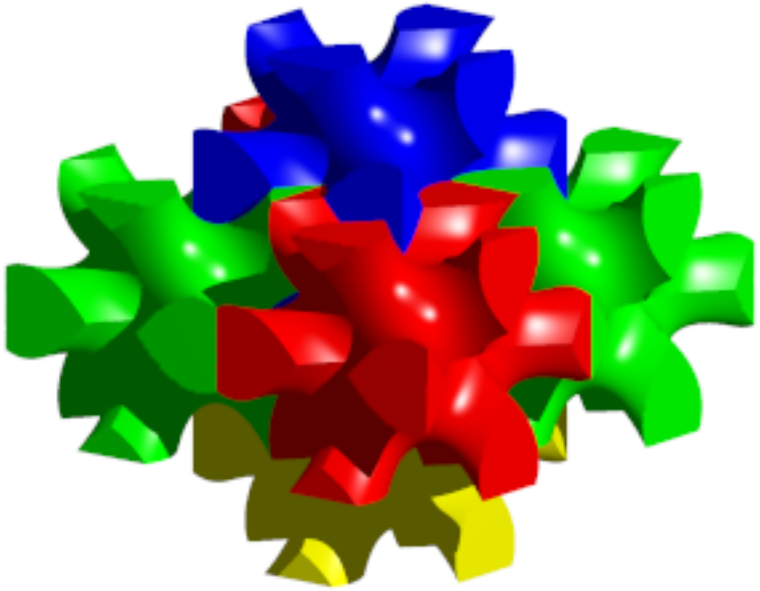
Simultanes Einpassen

Raumfüller



Simultanes Einpassen

Packung im Raum



passt

Simultanes Einpassen

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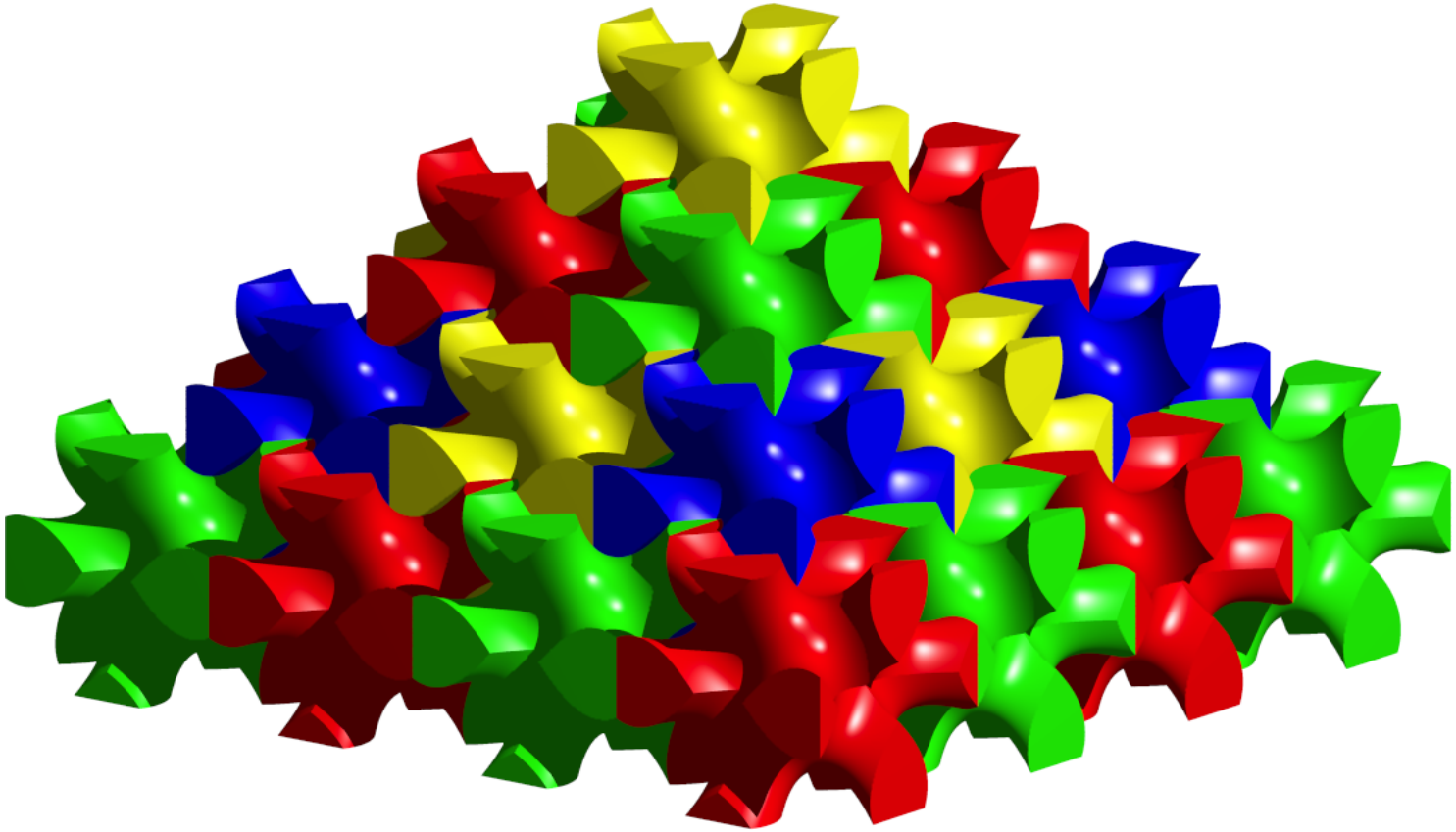
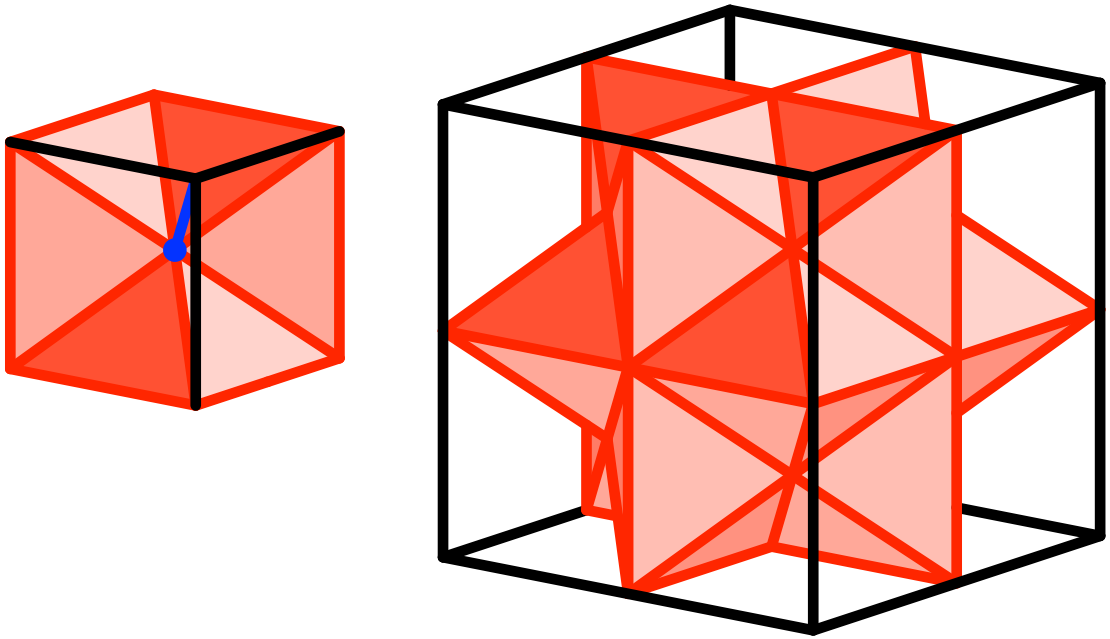
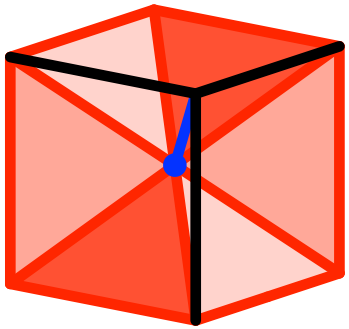


Simultanes Einpassen

Kantiger Affensattel
Würfelhalbierung





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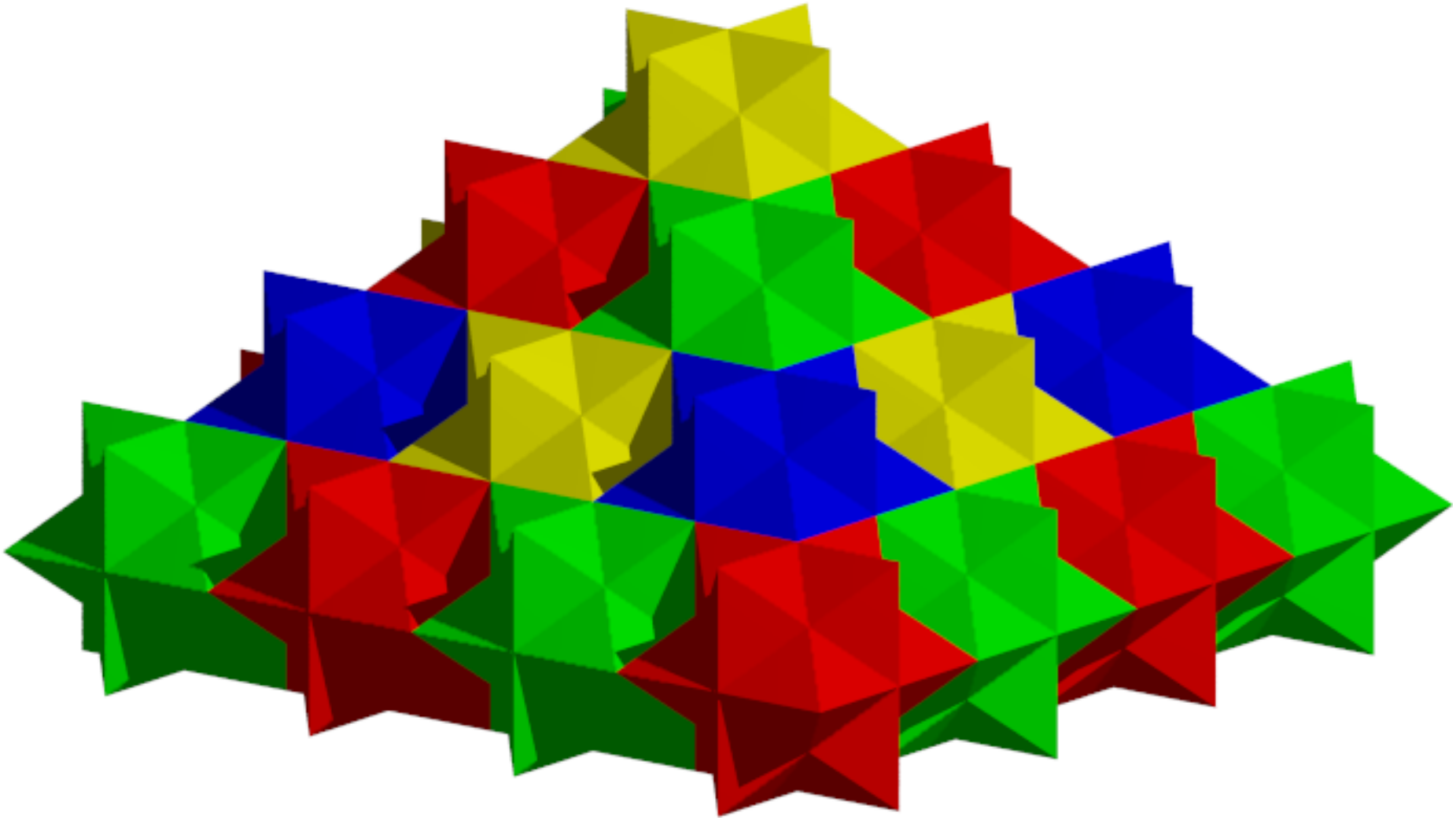

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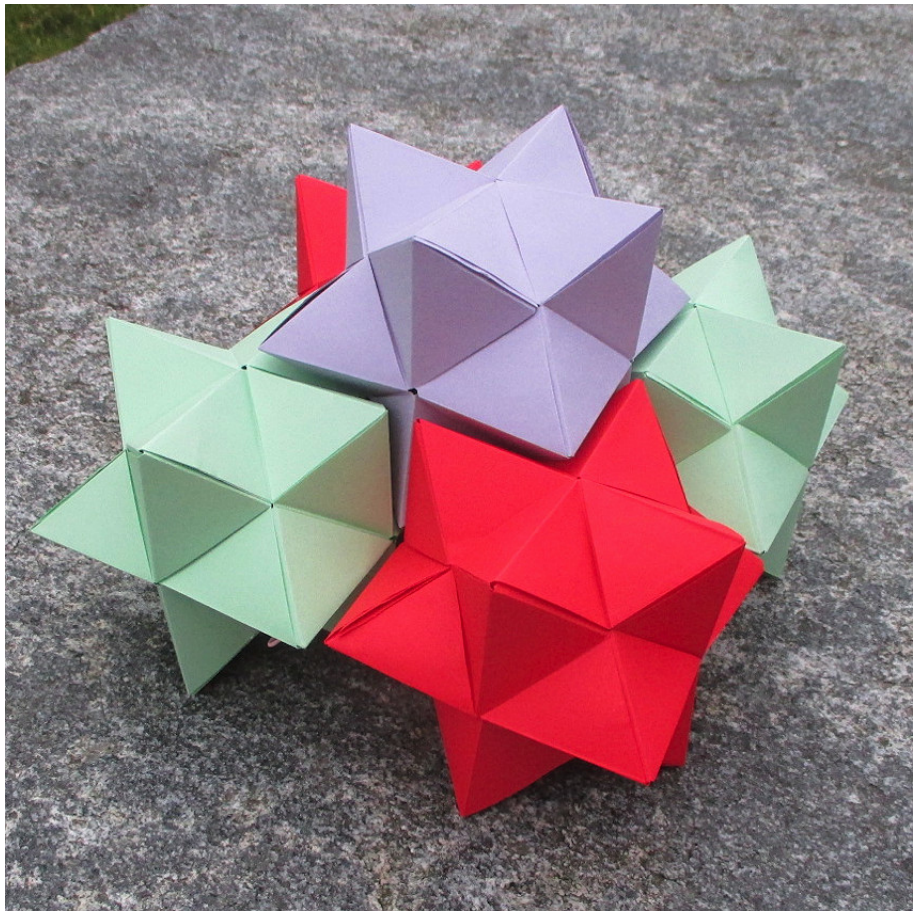
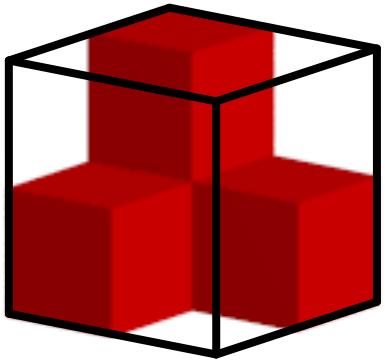


Kantiger Affensattel

Würfelhalbierung



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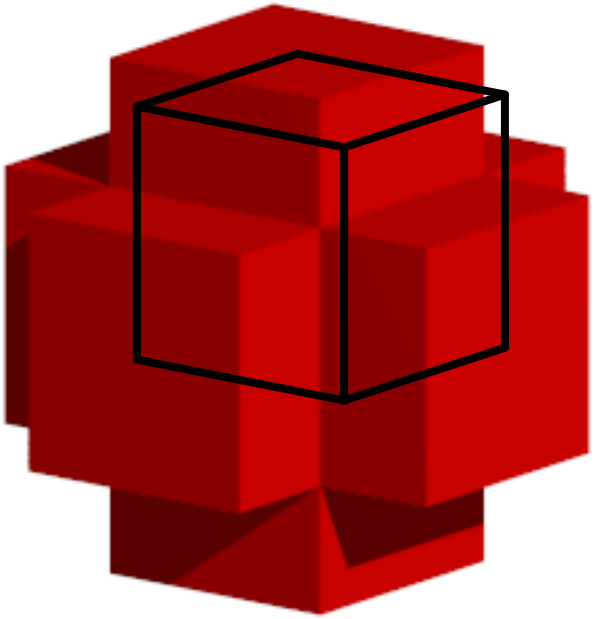

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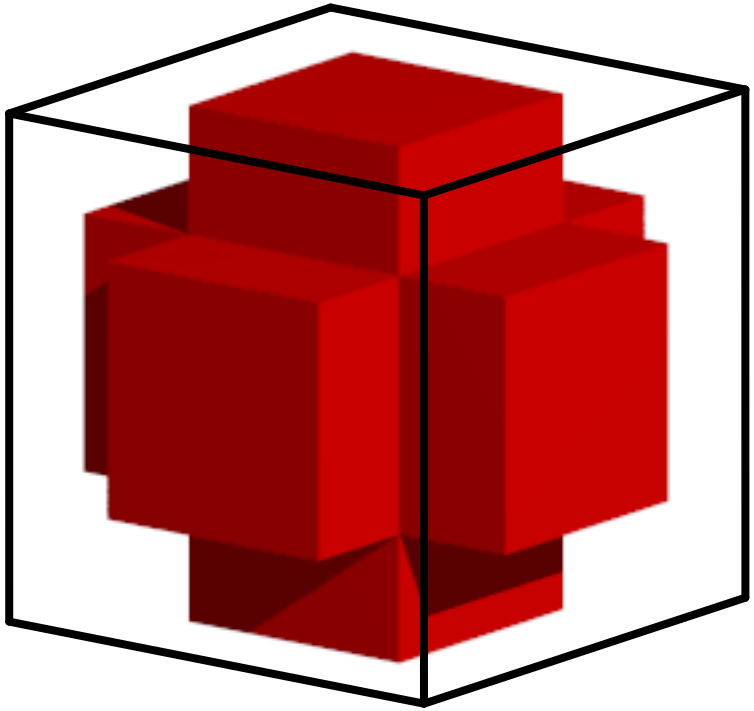

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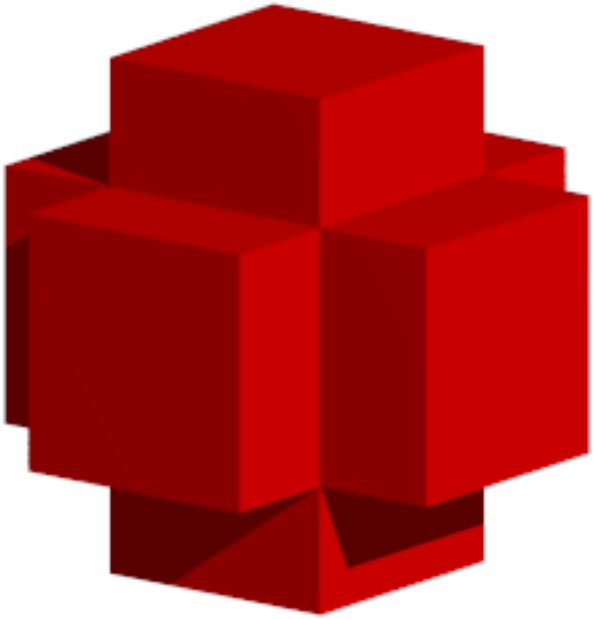
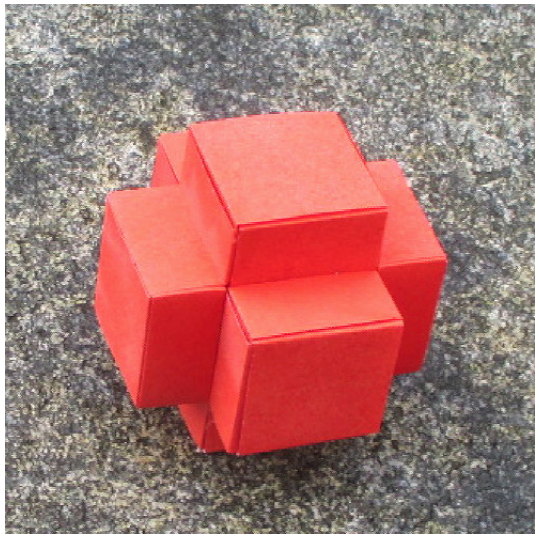


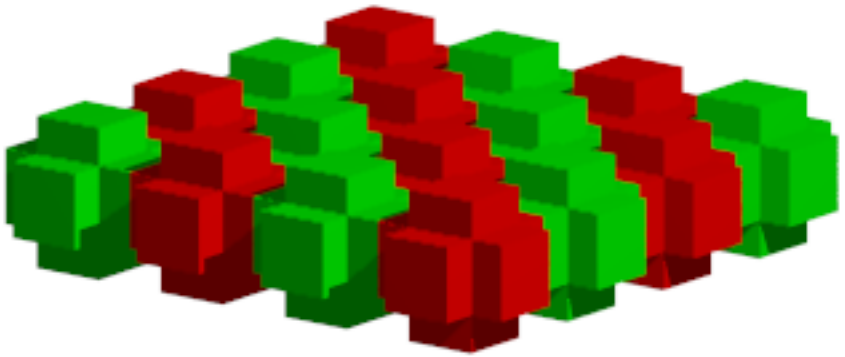
„Es is halt a Kreiz! A Kreiz is'! O mei!“
(Thomas Mann, *Buddenbrooks*)

Würfelhalbierung



3d-Kreuz

Packung im Raum



Problemloses Aneinanderfügen

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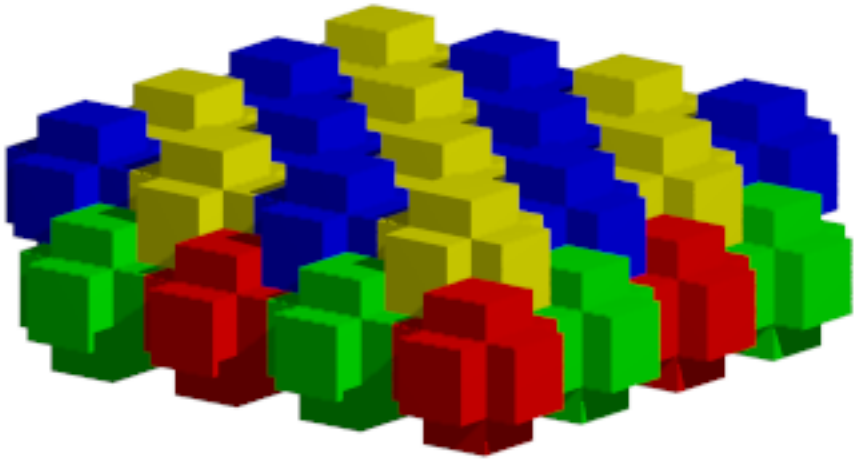

Problemloses Einpassen

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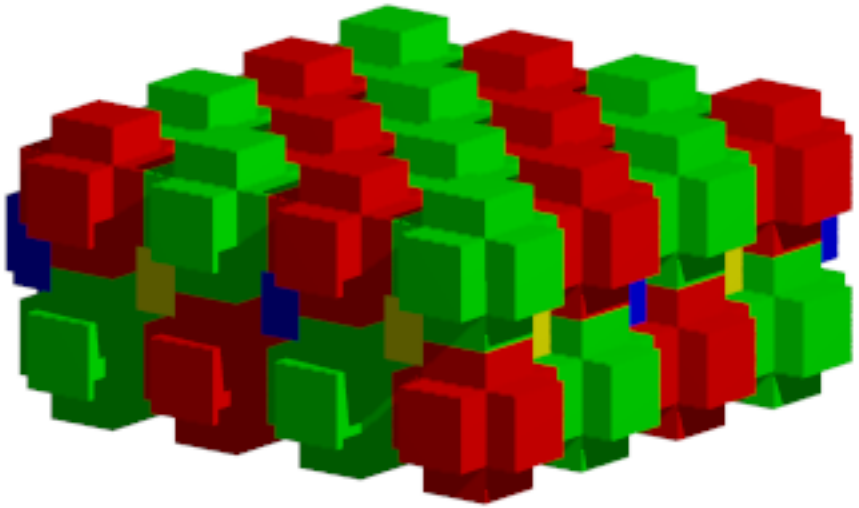

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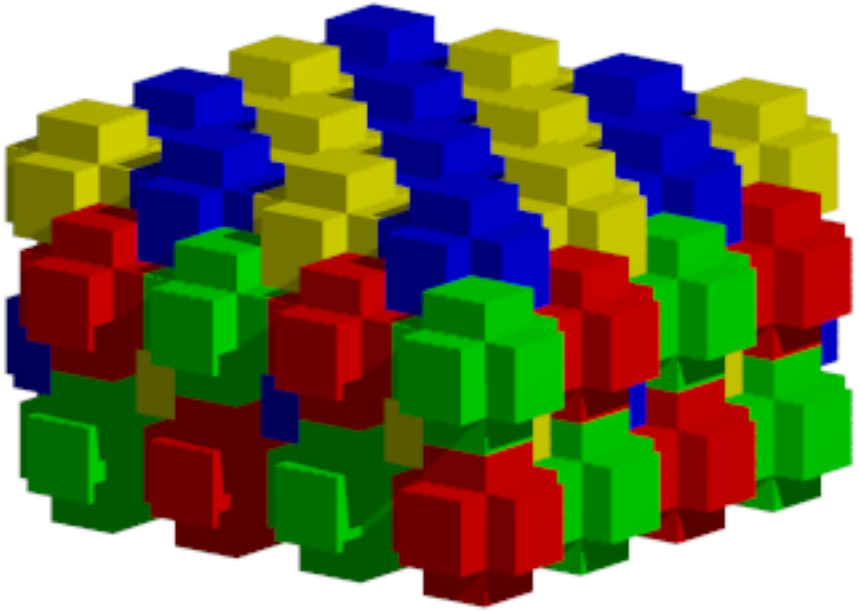

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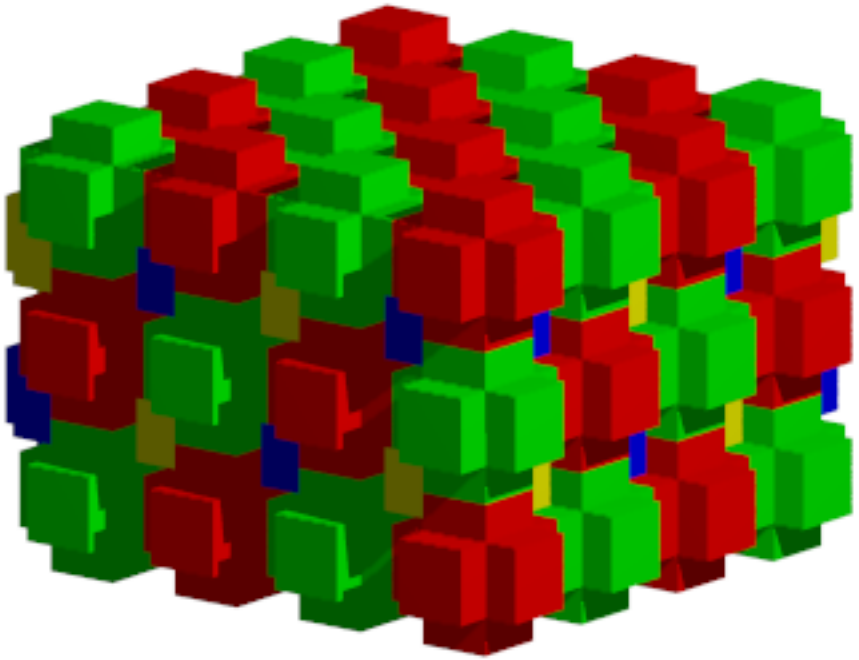

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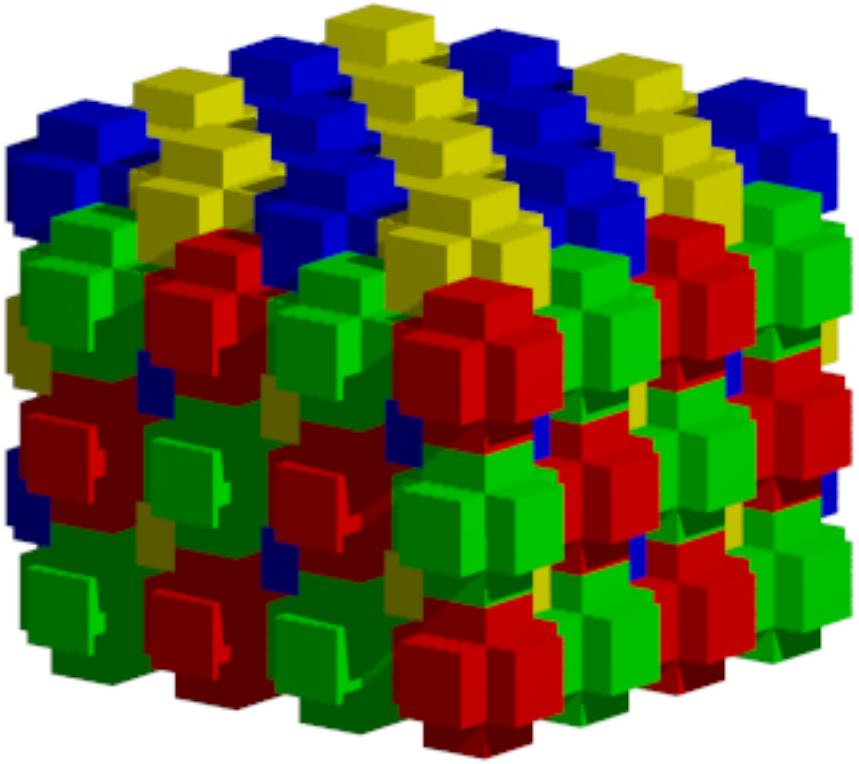

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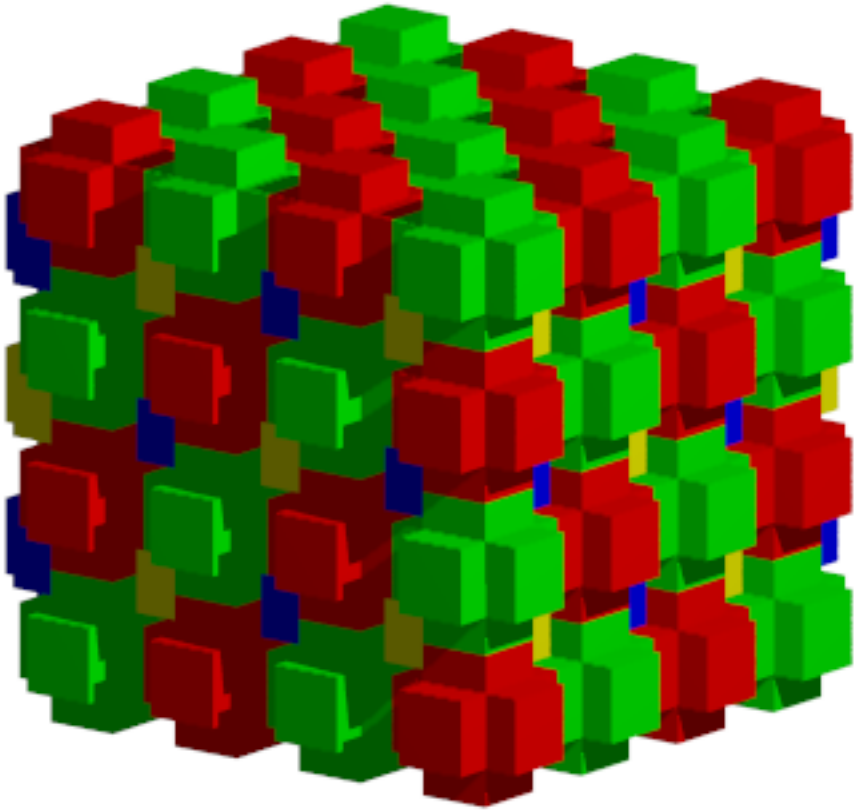

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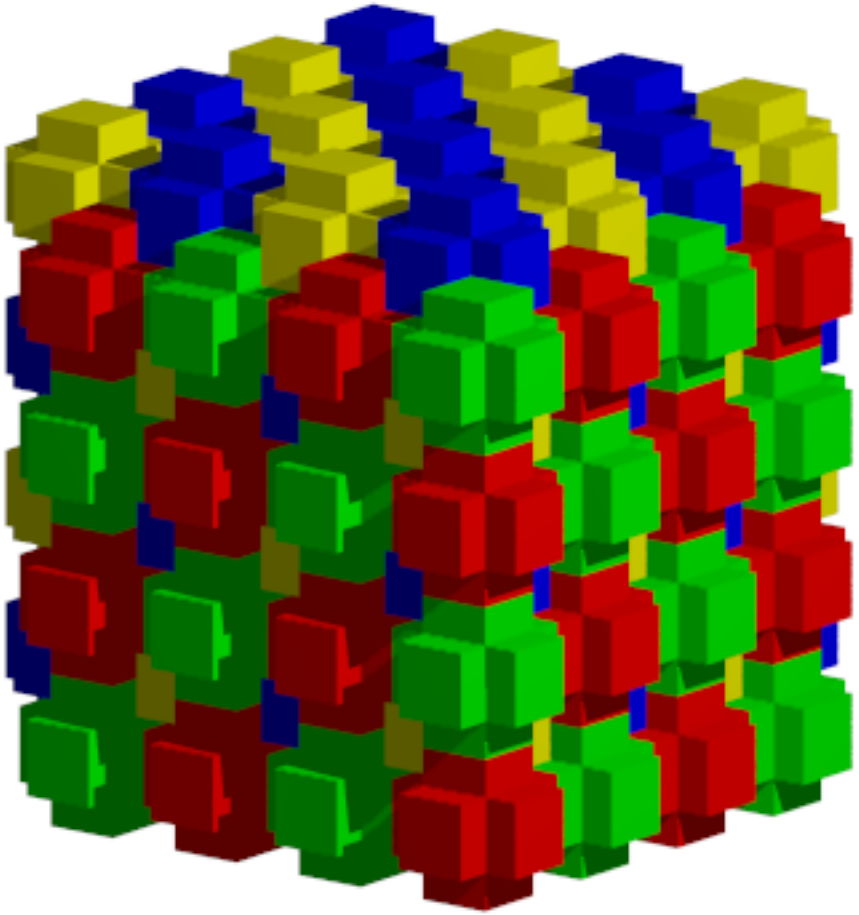

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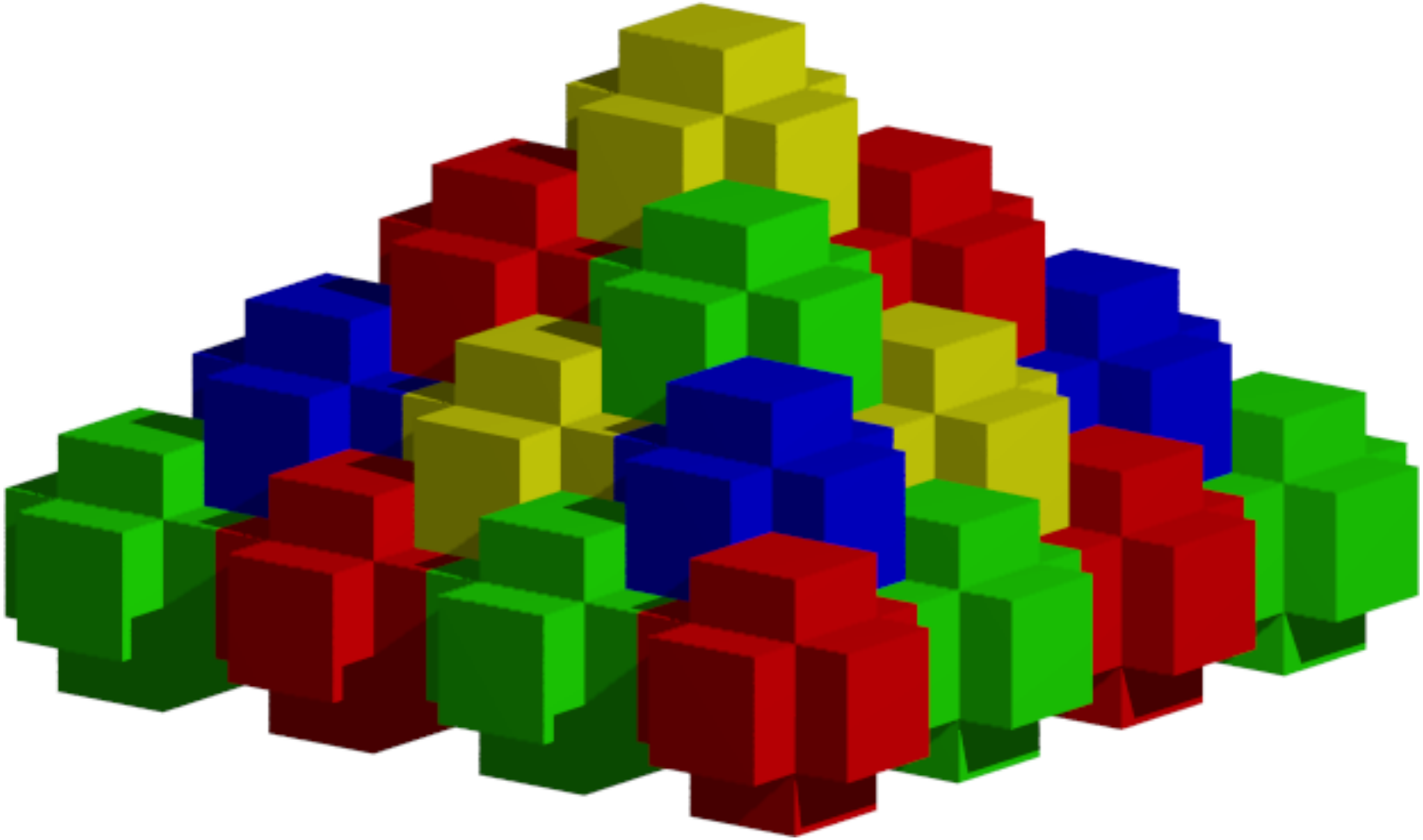

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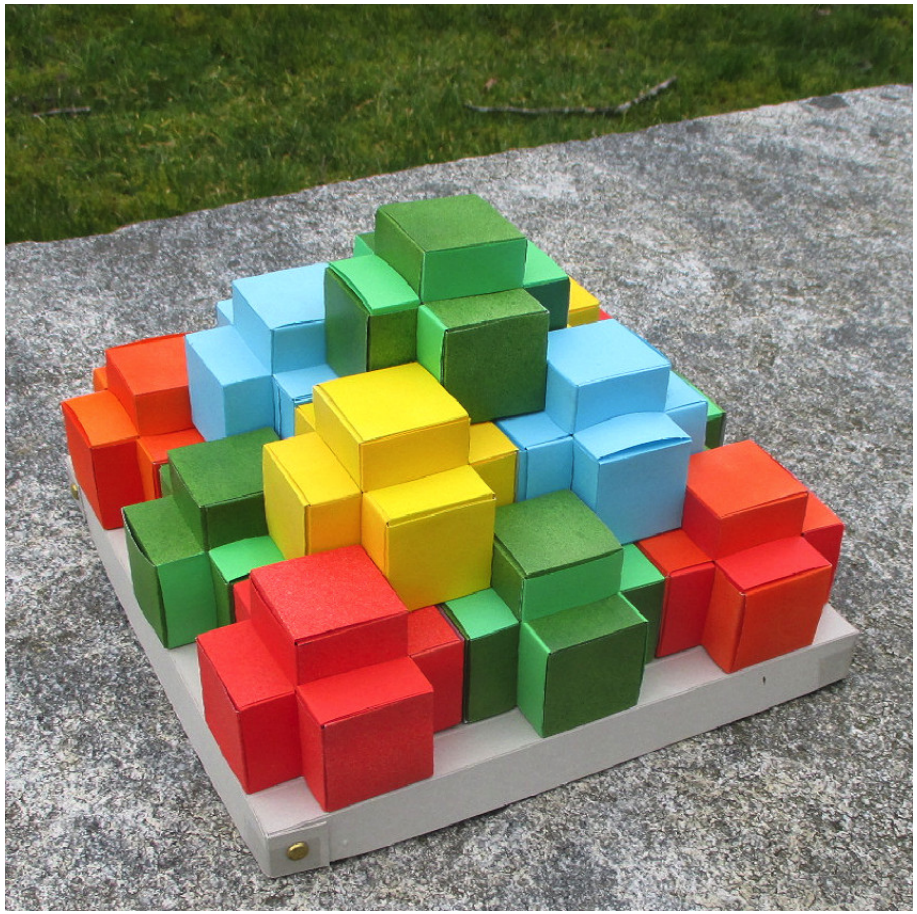

Problemloses Einpassen

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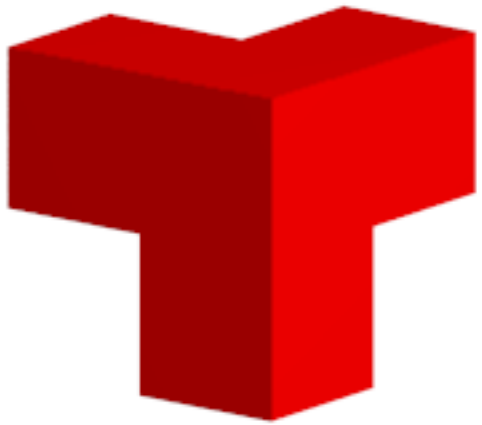

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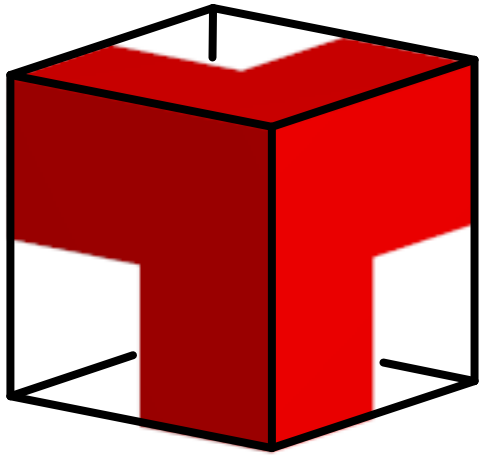

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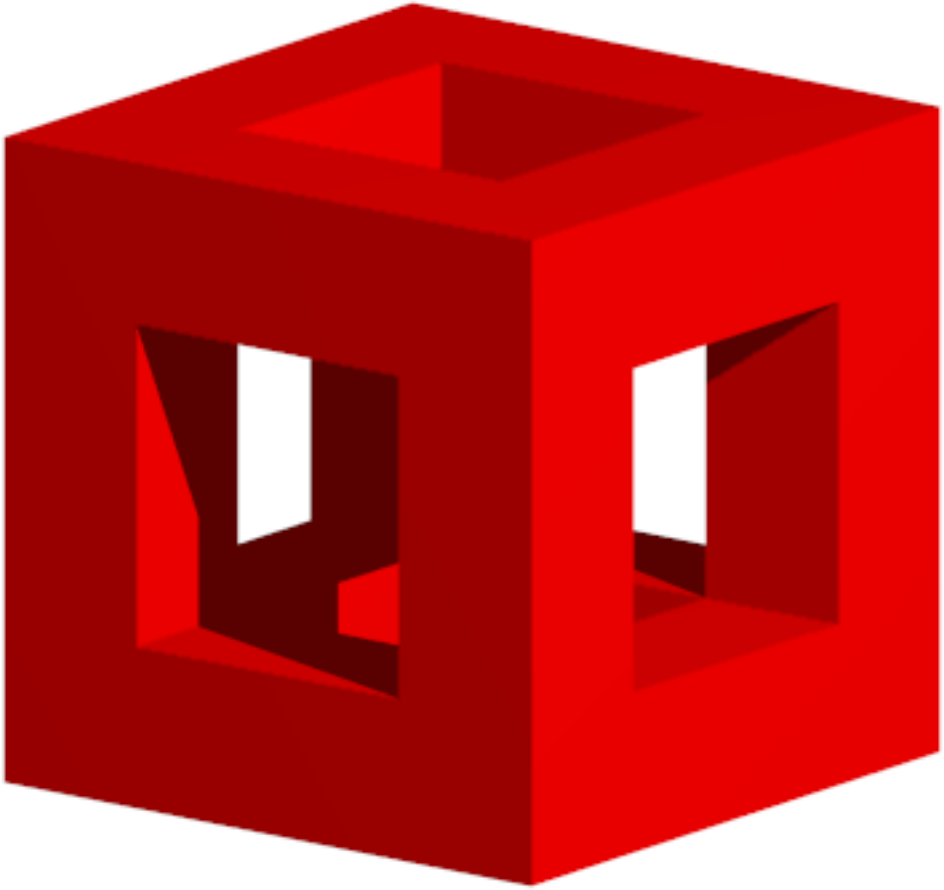

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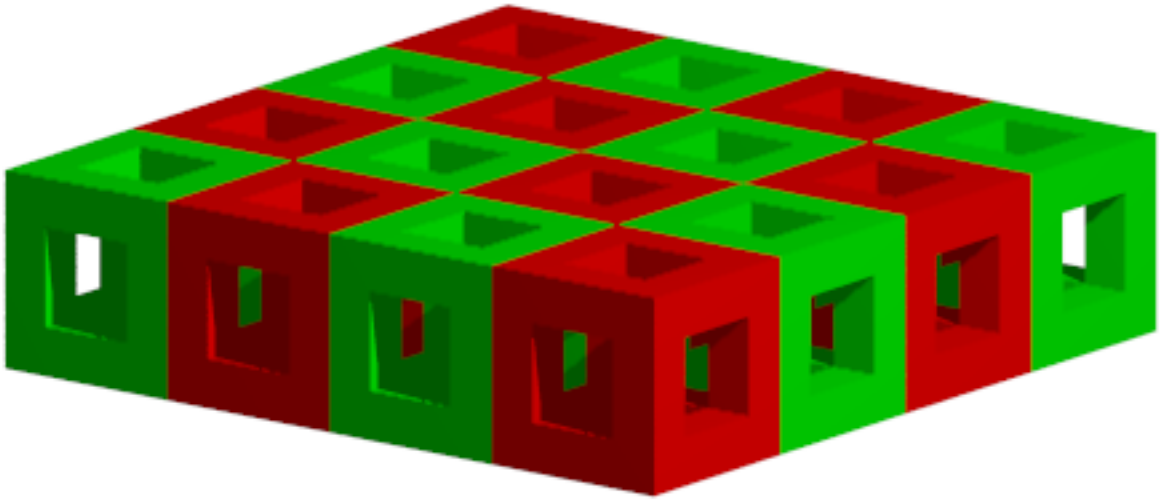

Passt

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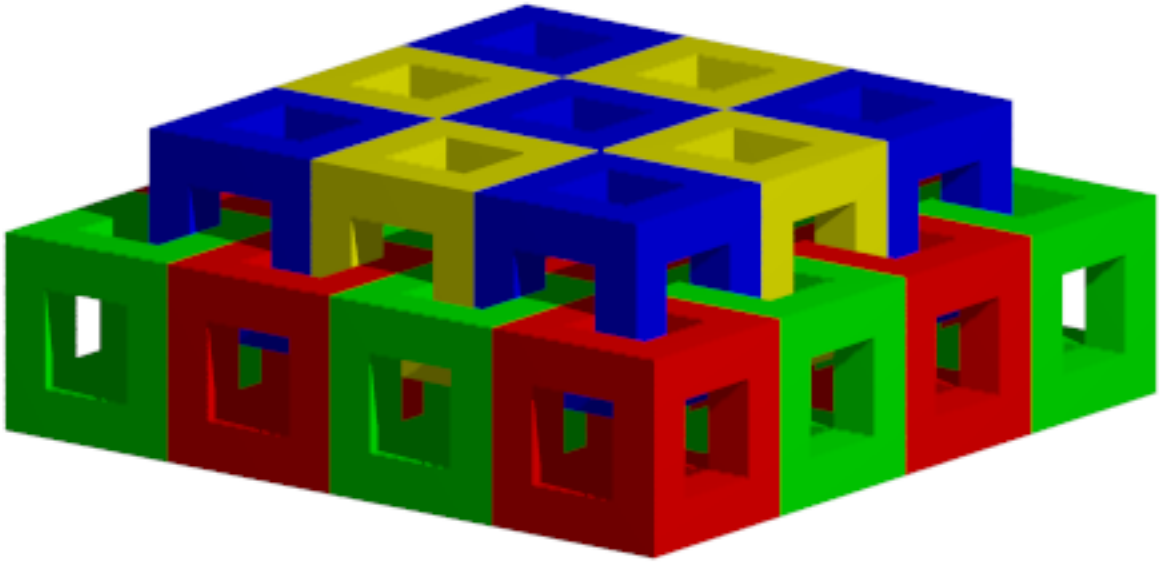
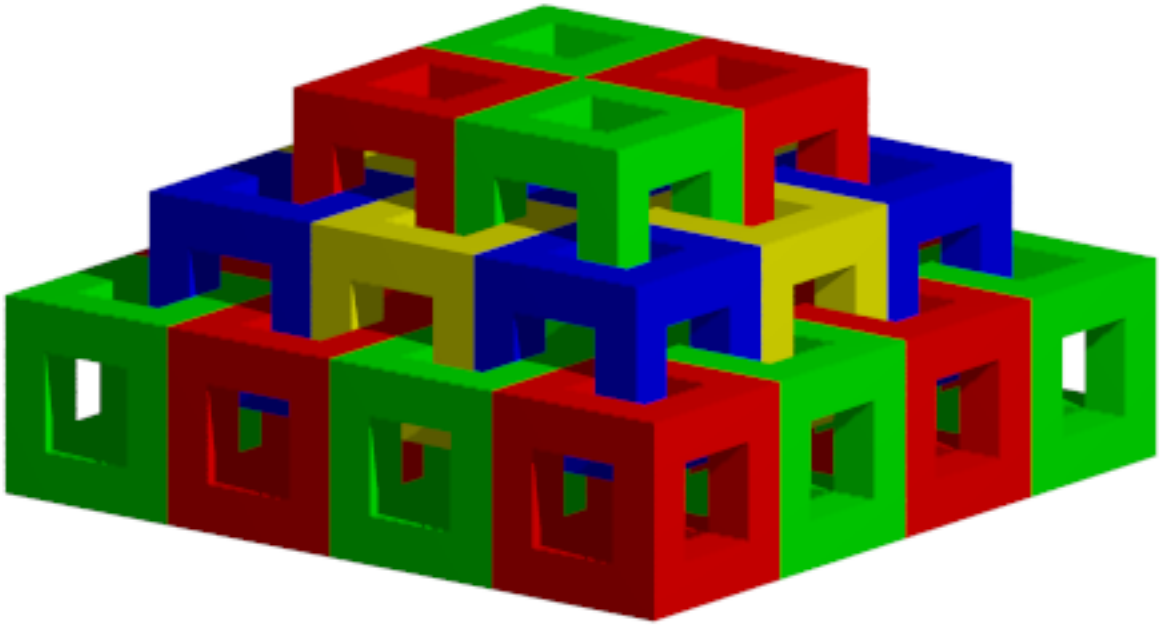


Passt. Einpassen unmöglich

Packung im Raum



Passt. Einpassen unmöglich

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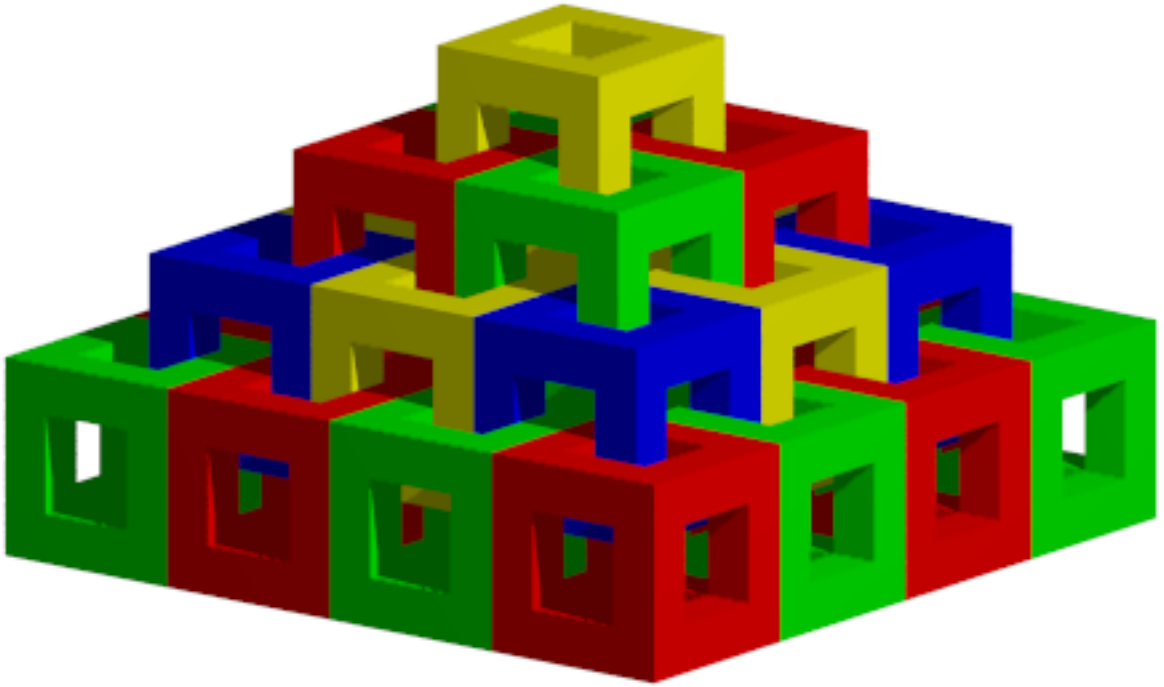
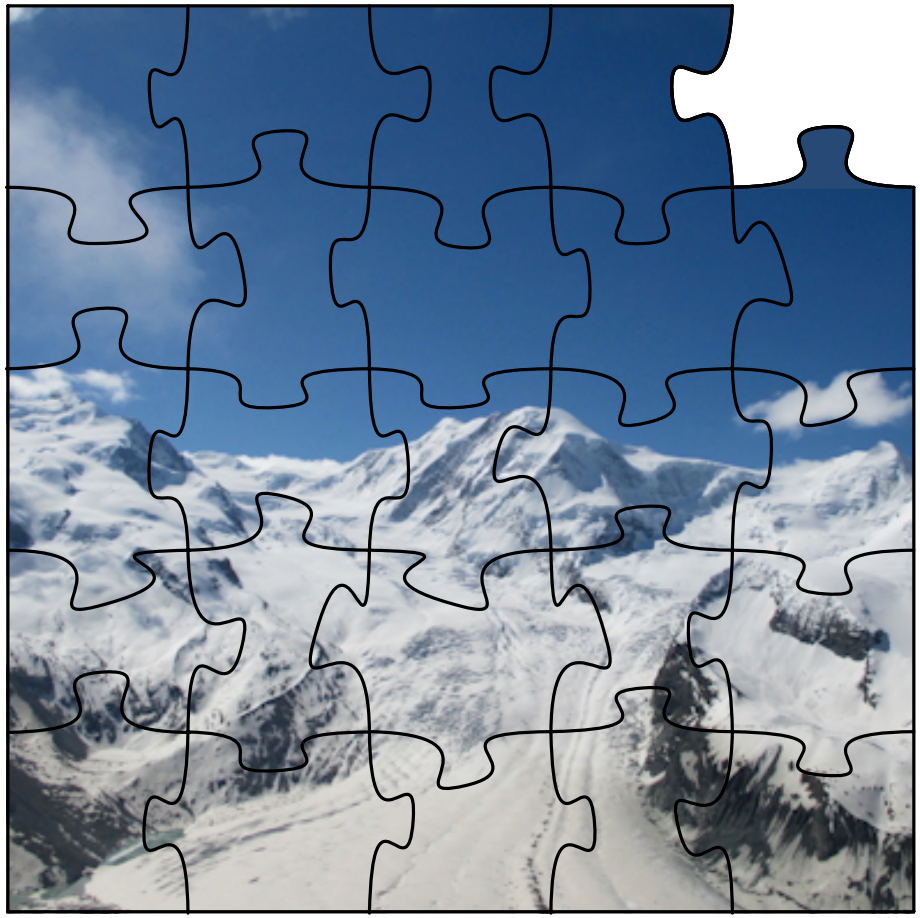
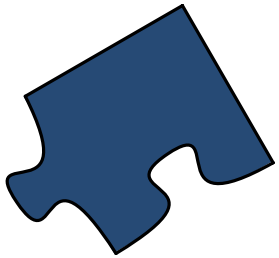


Passt. Einpassen unmöglich

Ebenenfüller





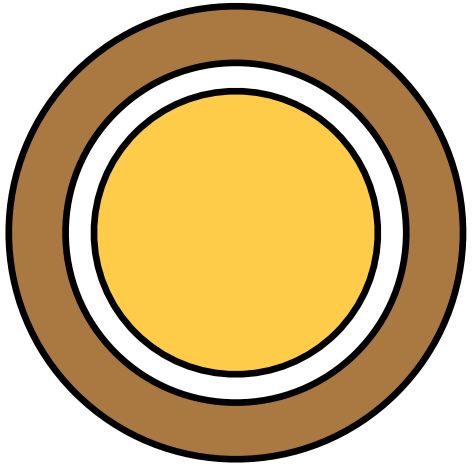
Passt. Einpassen in der Ebene unmöglich

Knacknuss ohne Nussknacker

Wie kommen wir zum Kern,
ohne die Schale zu zerstören?

Knacknuss ohne Nussknacker

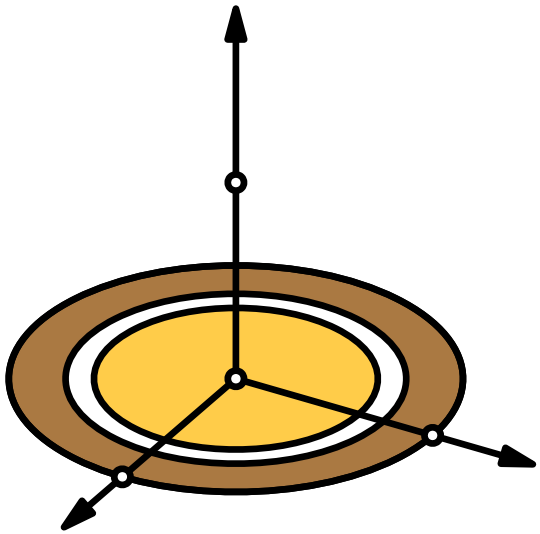
Analoges 2d-Problem



Wie kommen wir zum Kern,
ohne die Schale zu zerstören?

Knacknuss ohne Nussknacker

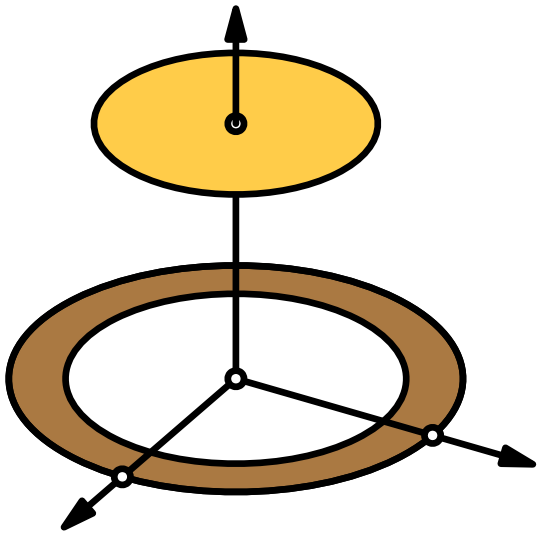
3d-Einbettung



Wie kommen wir zum Kern,
ohne die Schale zu zerstören?

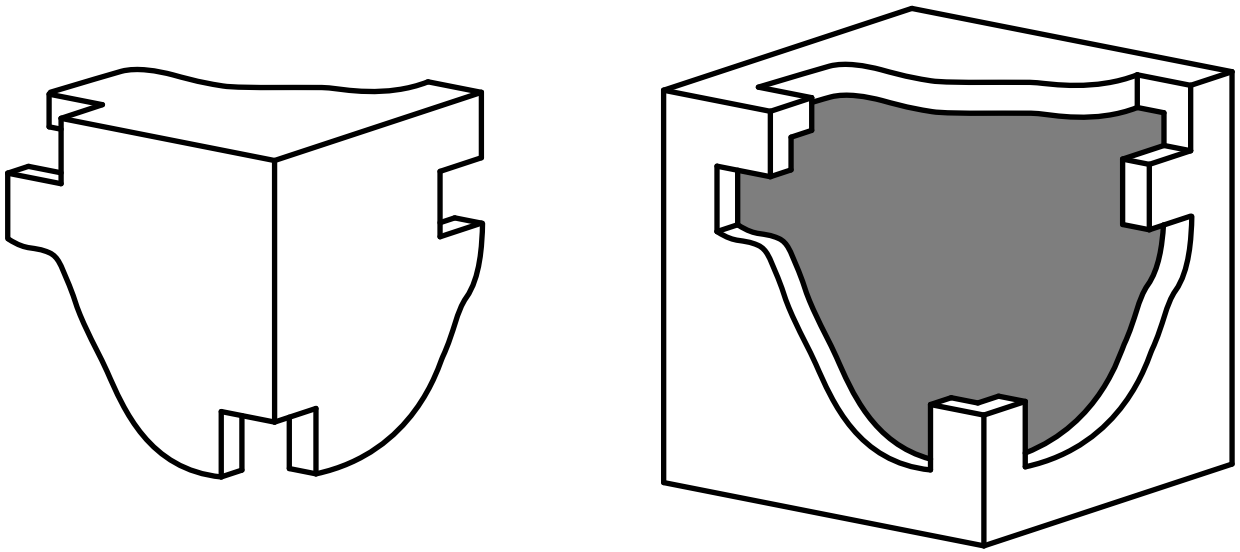
Knacknuss ohne Nussknacker

Kern herausnehmen



Wie kommen wir zum Kern,
ohne die Schale zu zerstören?

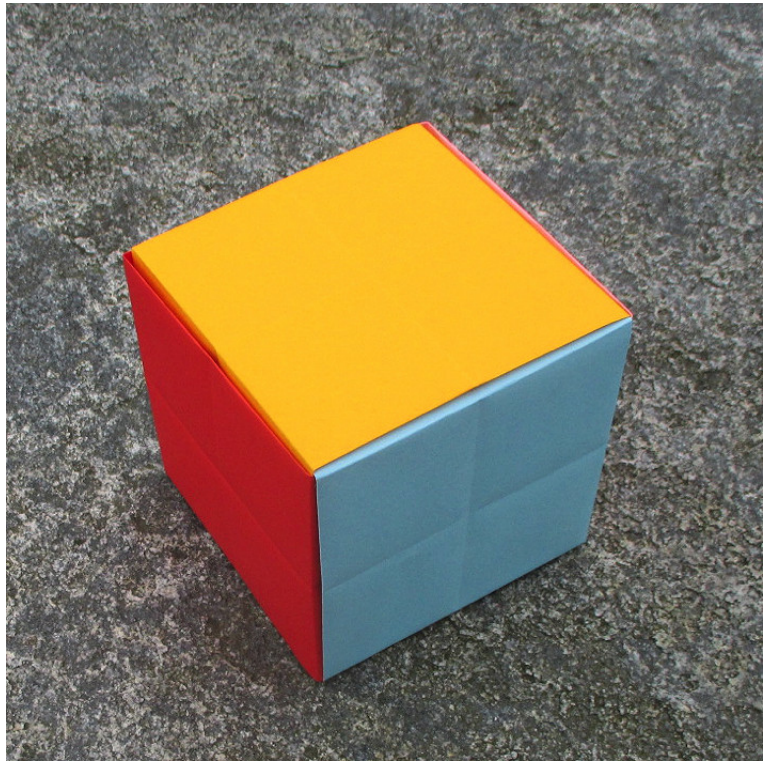
Lückenfüller



Passt. Einpassen unmöglich

Origami im Raum

Origami im Raum

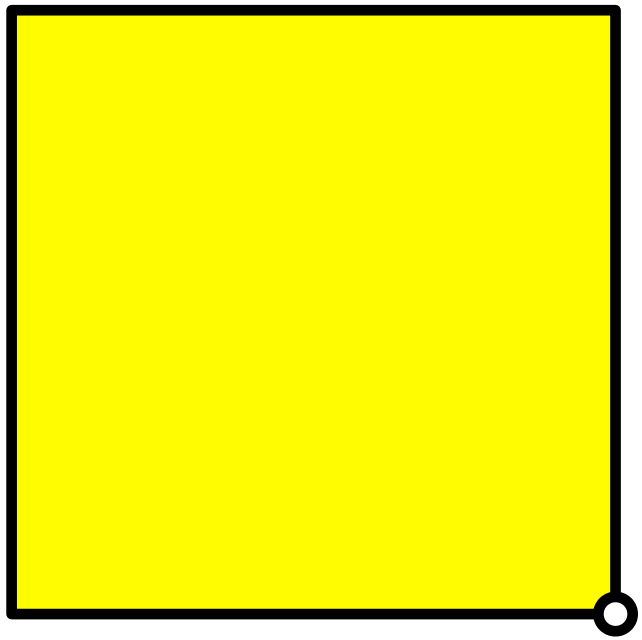


So nicht

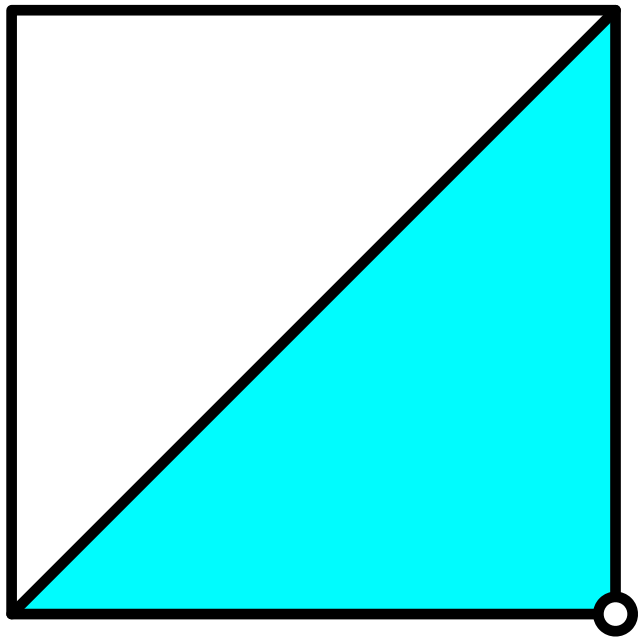
Origami im Raum

So nicht

Origami in der Ebene

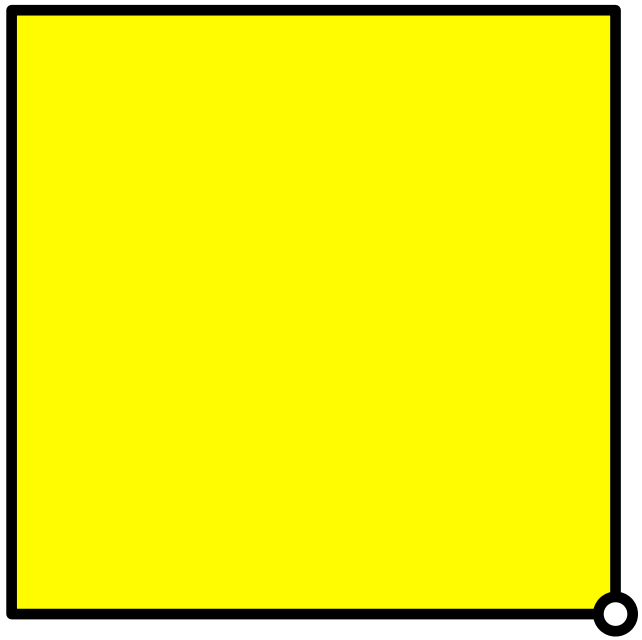


Origami in der Ebene



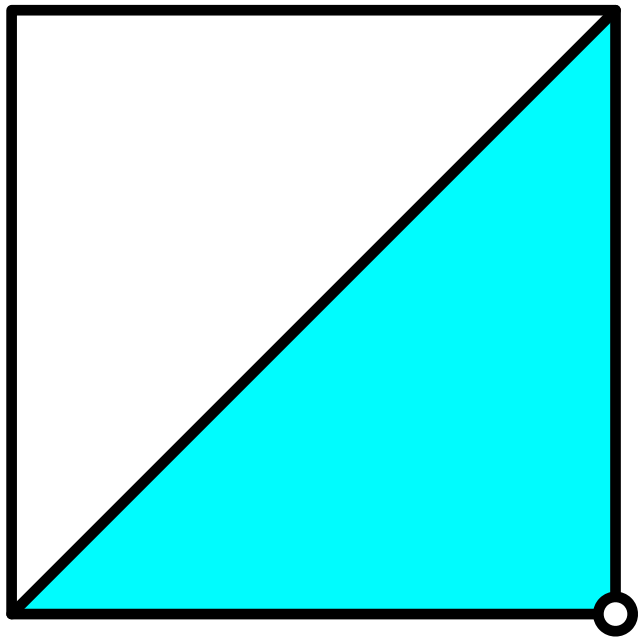
Ecke auf diametrale Ecke

Origami in der Ebene



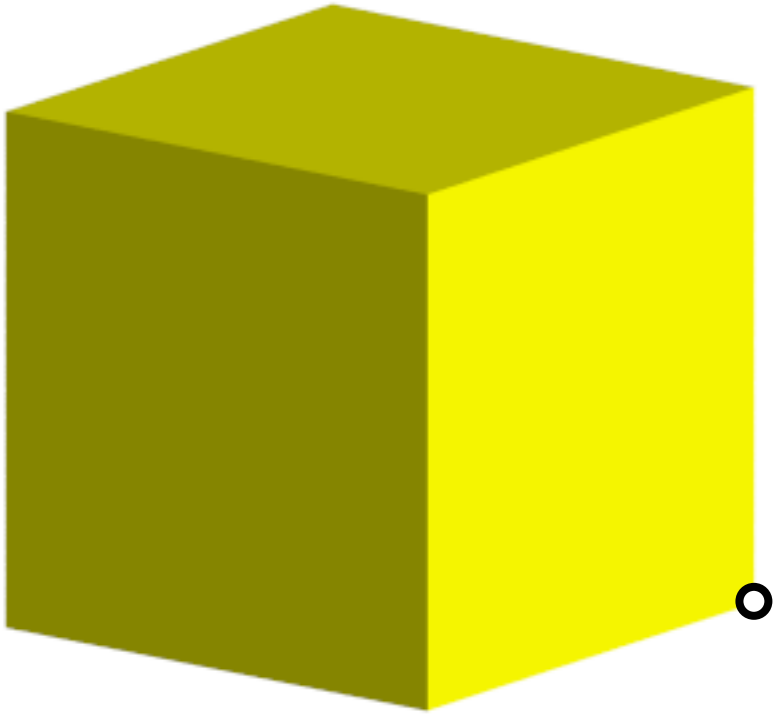
Origami in der Ebene
setzt den dreidimensionalen Raum voraus

Origami in der Ebene



Ecke auf diametrale Ecke

Origami im Raum

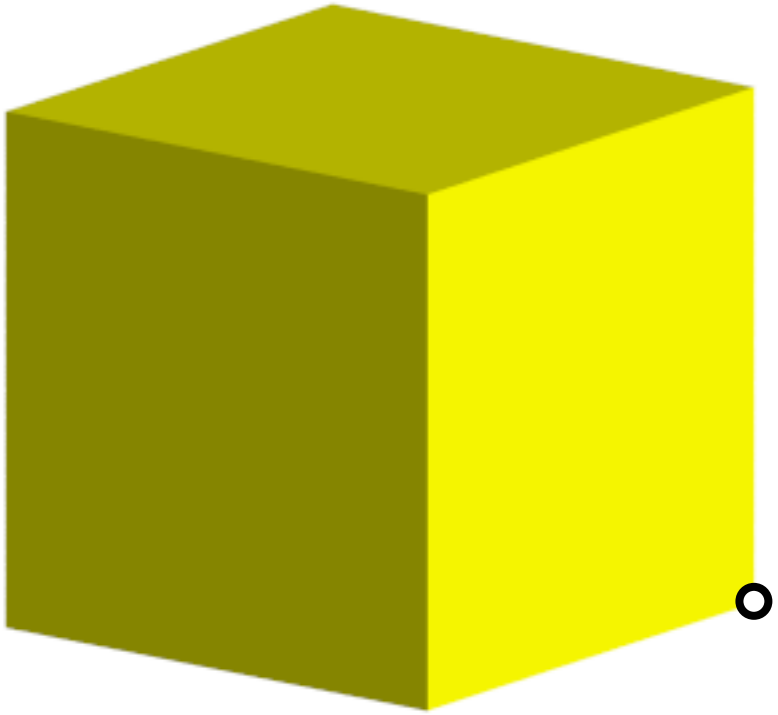


Ecke auf diametrale Ecke

Origami im Raum

„Falten“ im vierdimensionalen Raum

Origami im Raum



„Falten“ im vierdimensionalen Raum

Origami im Raum

„Falten“ im vierdimensionalen Raum

Origami im Raum

„Falten“ im vierdimensionalen Raum

Origami im Raum

„Falten“ im vierdimensionalen Raum

Origami im Raum

„Falten“ im vierdimensionalen Raum

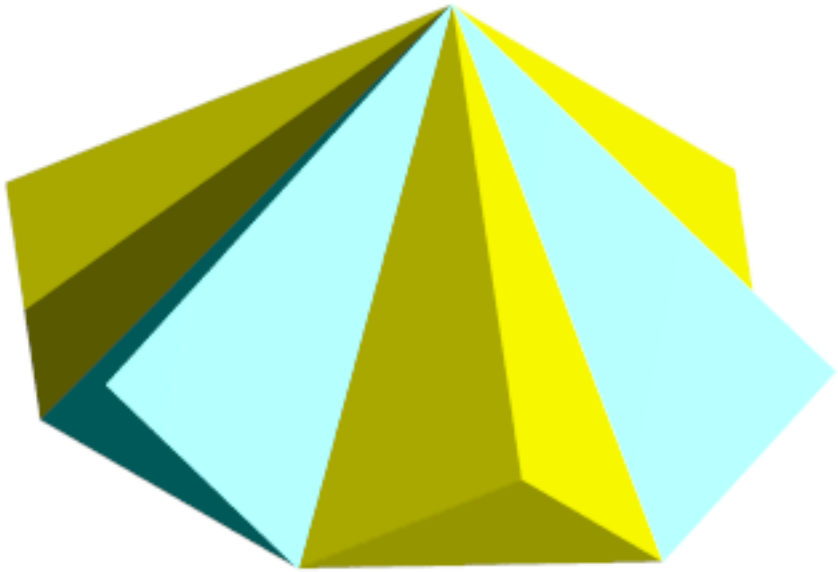
Origami im Raum

„Falten“ im vierdimensionalen Raum

Origami im Raum

„Falten“ im vierdimensionalen Raum

Origami im Raum

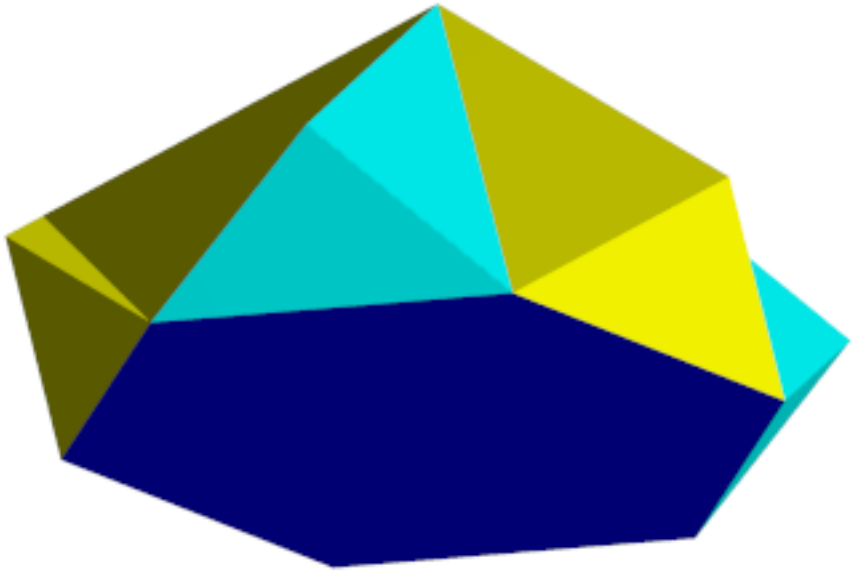


„Falten“ im vierdimensionalen Raum

Origami im Raum

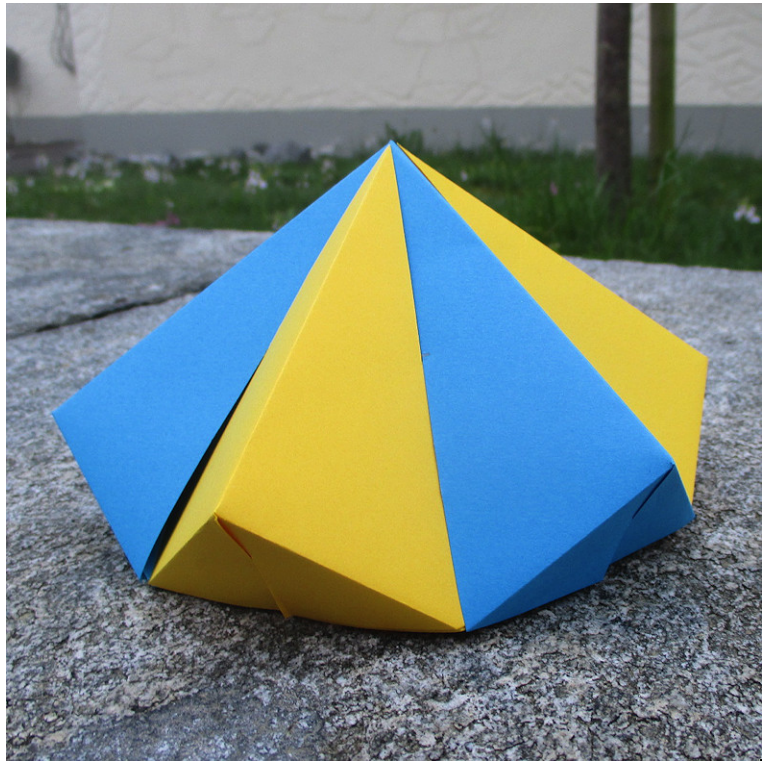
„Falten“ im vierdimensionalen Raum

Origami im Raum



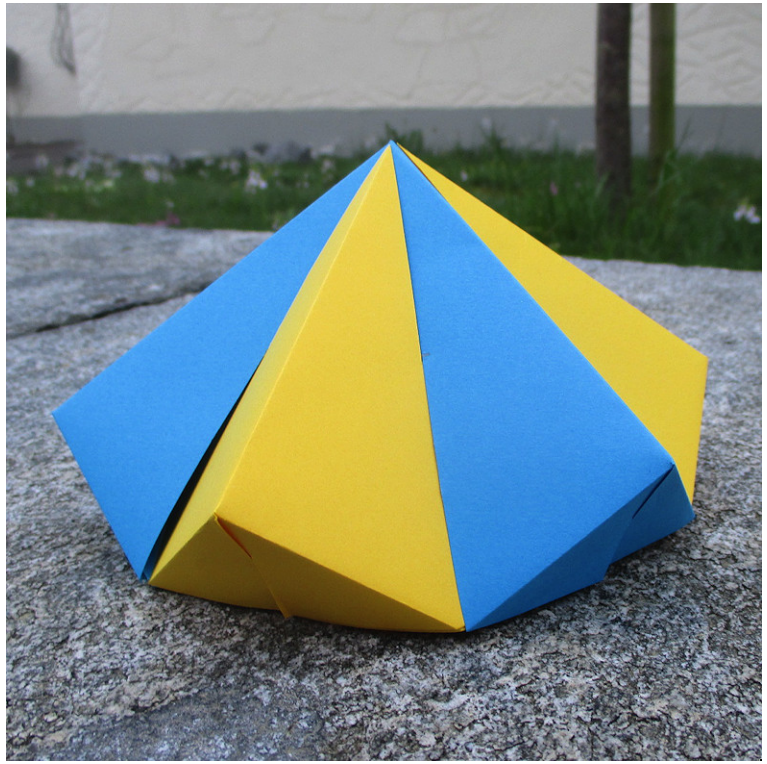
„Falten“ im vierdimensionalen Raum

Origami im Raum



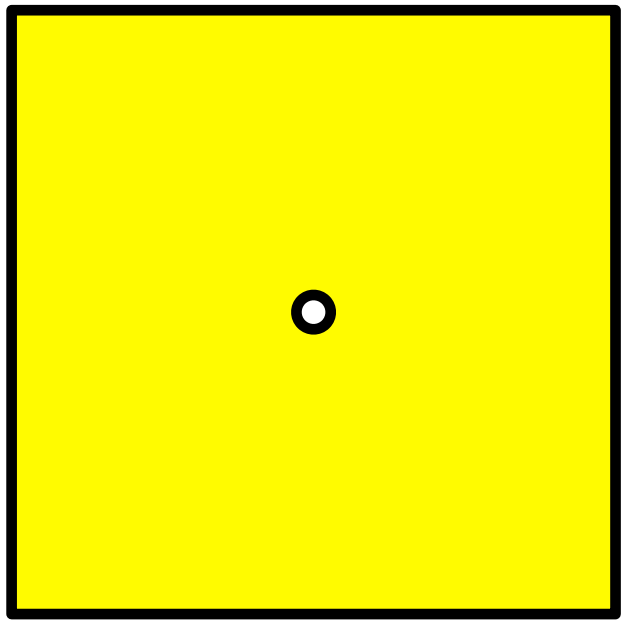
Papiermodell

Origami im Raum



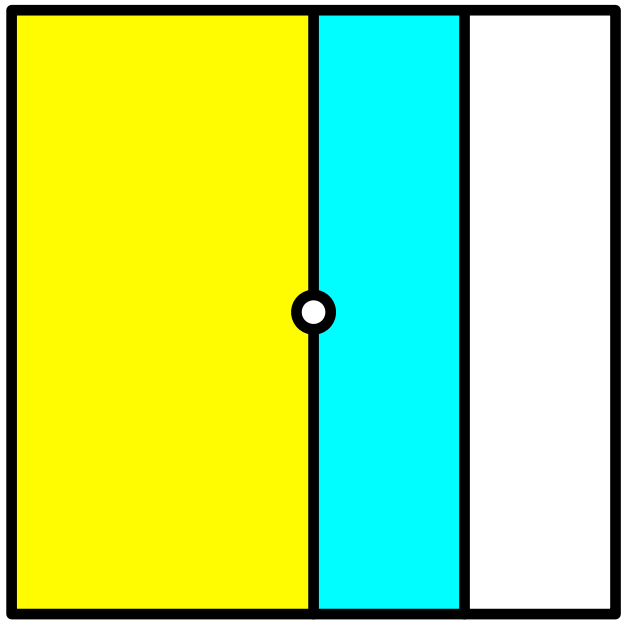
www.walser-h-m.ch/hans/Miniaturen/O/Origami_im_Raum2/Origami_im_Raum2.htm

Origami in der Ebene



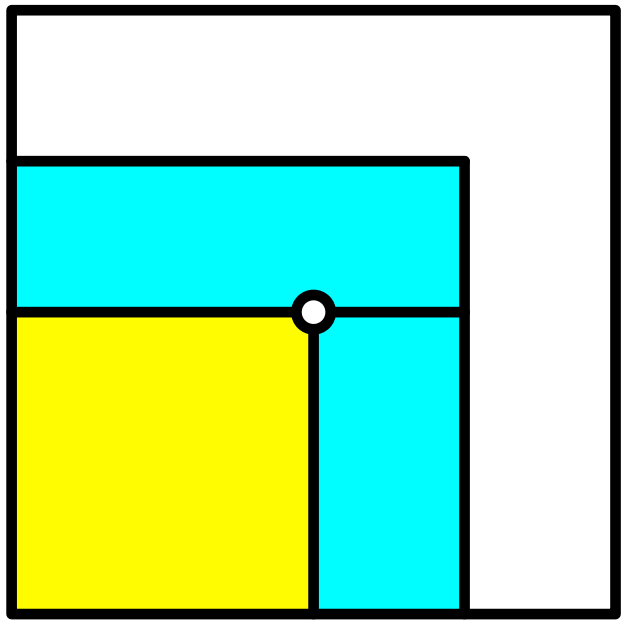
Origami in der Ebene
Kantenmitten einfalten

Origami in der Ebene



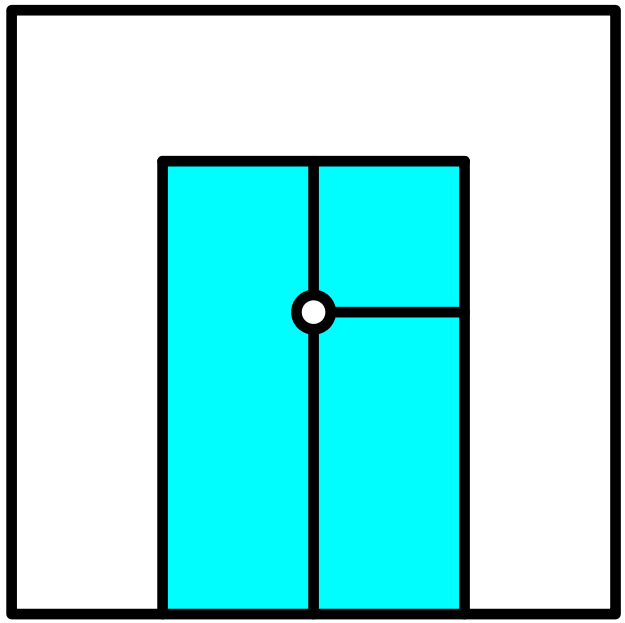
Origami in der Ebene
Kantenmitten einfalten

Origami in der Ebene



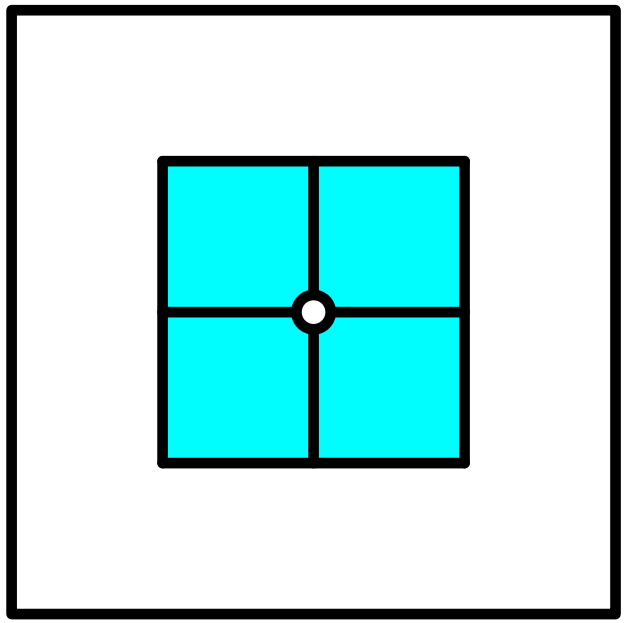
Origami in der Ebene
Kantenmitten einfalten

Origami in der Ebene



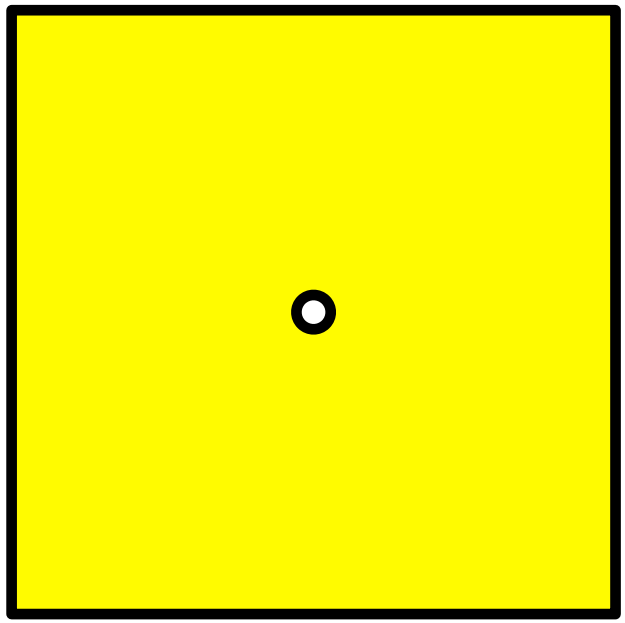
Origami in der Ebene
Kantenmitten einfalten

Origami in der Ebene



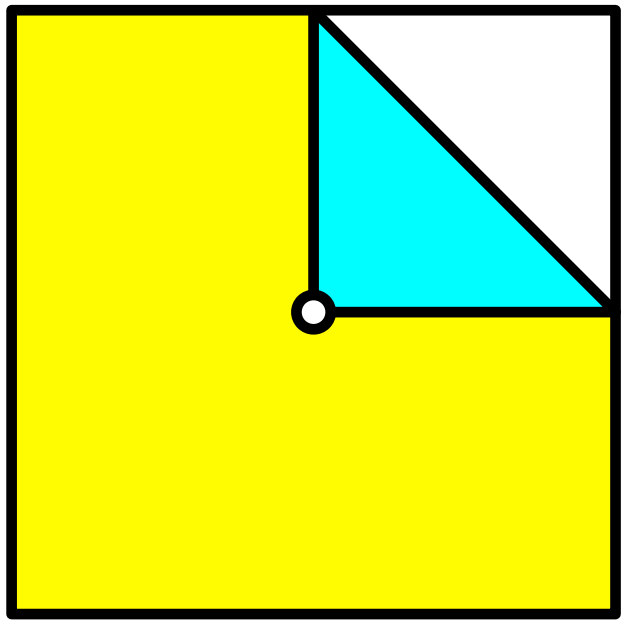
Origami in der Ebene
Kantenmitten einfalten

Origami in der Ebene



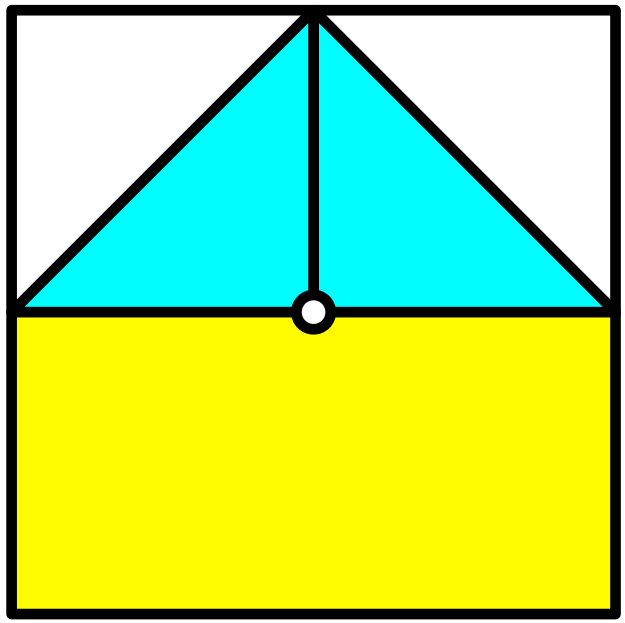
Origami in der Ebene
Ecken einfalten

Origami in der Ebene



Origami in der Ebene
Ecken einfalten

Origami in der Ebene



Origami in der Ebene
Ecken einfalten

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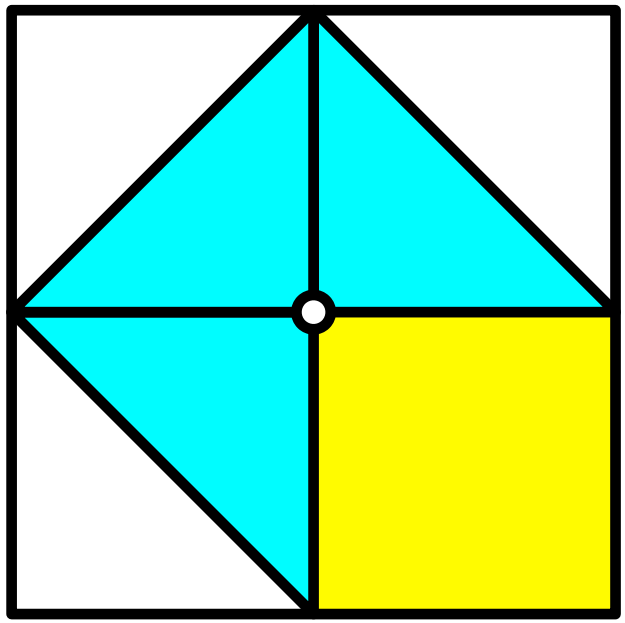

Origami in der Ebene
Ecken einfalten

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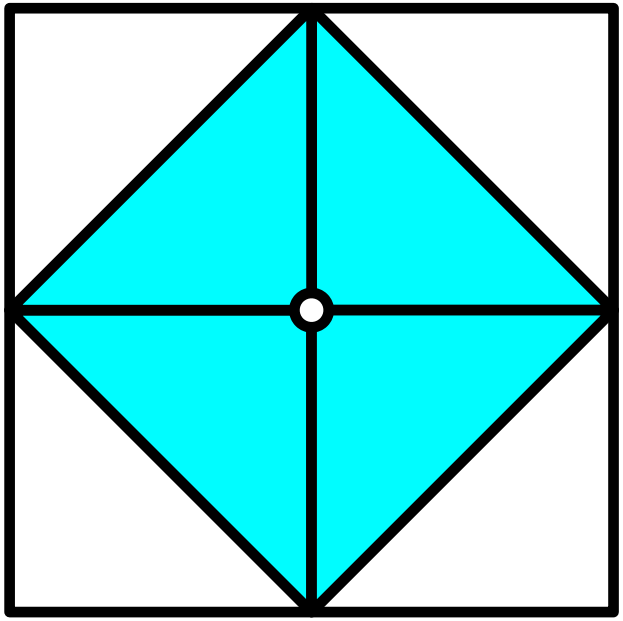
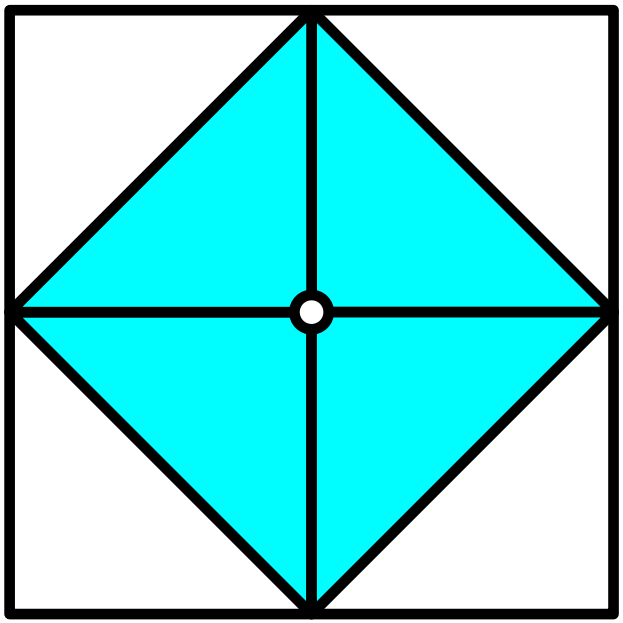


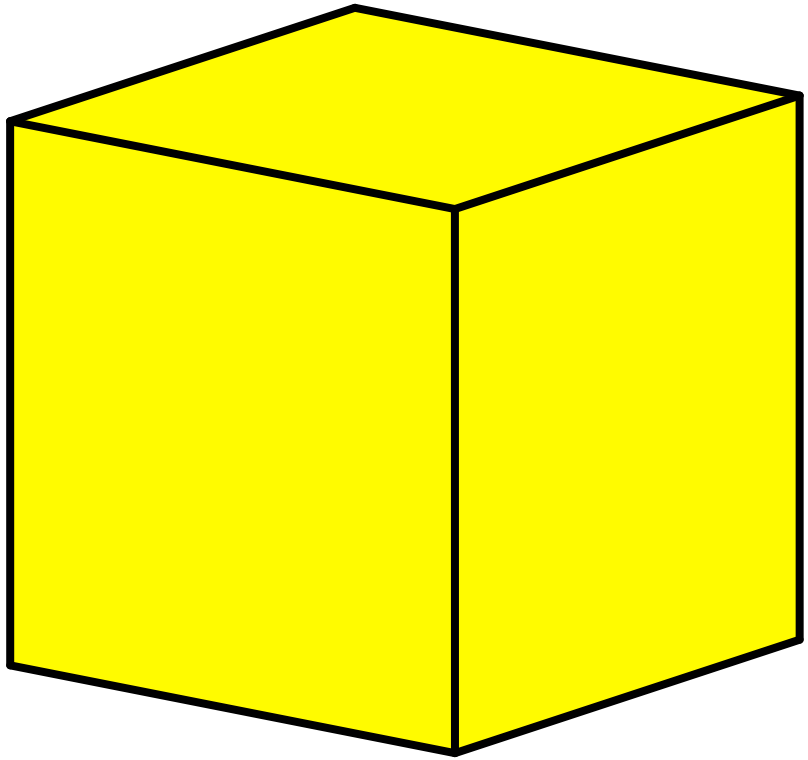
Origami in der Ebene
Ecken einfalten

Origami in der Ebene



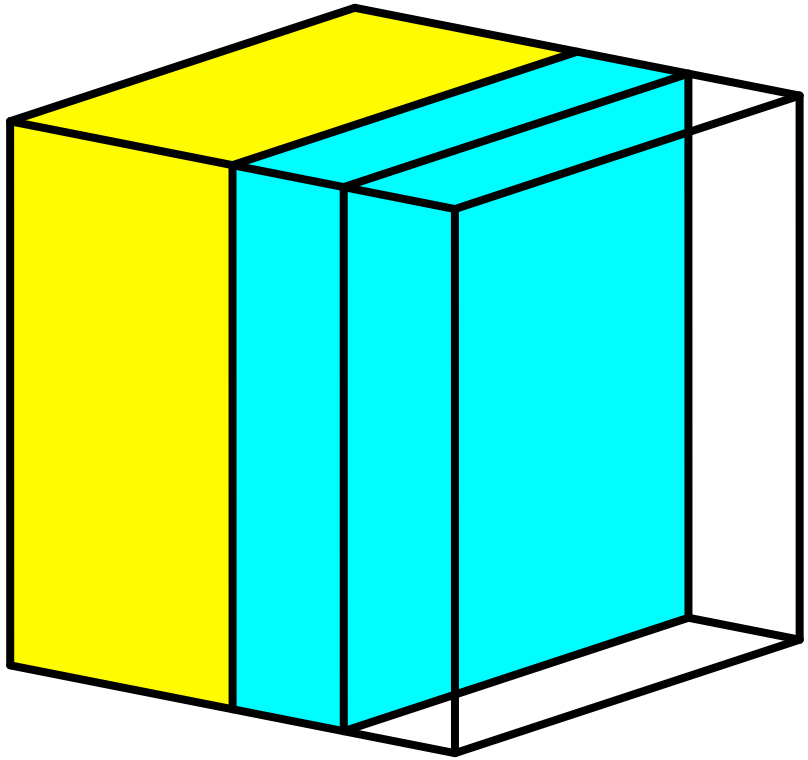
Origami in der Ebene
setzt den dreidimensionalen Raum voraus

Origami im Raum



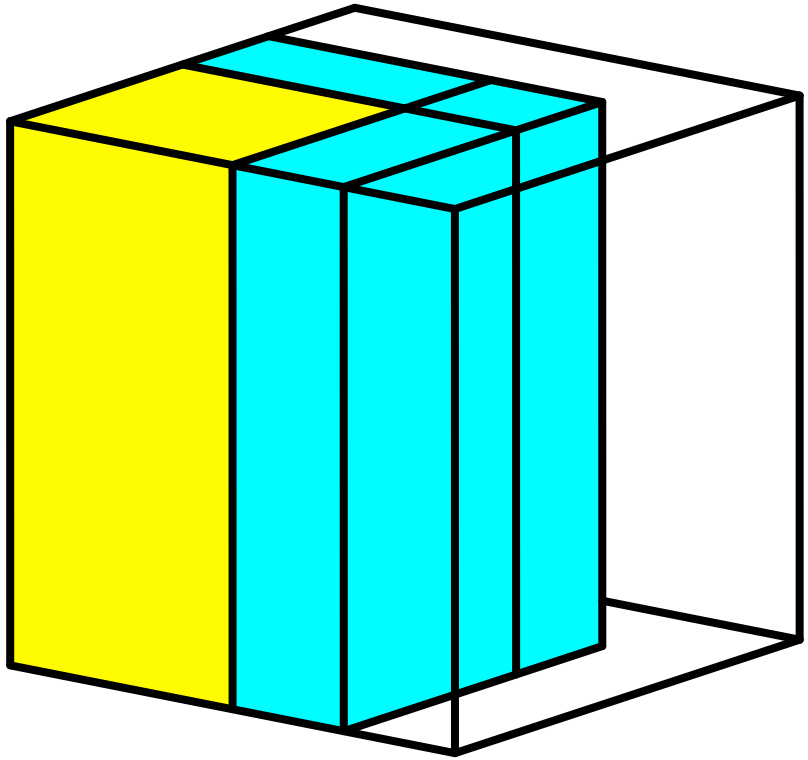
„Falten“ im vierdimensionalen Raum

Origami im Raum



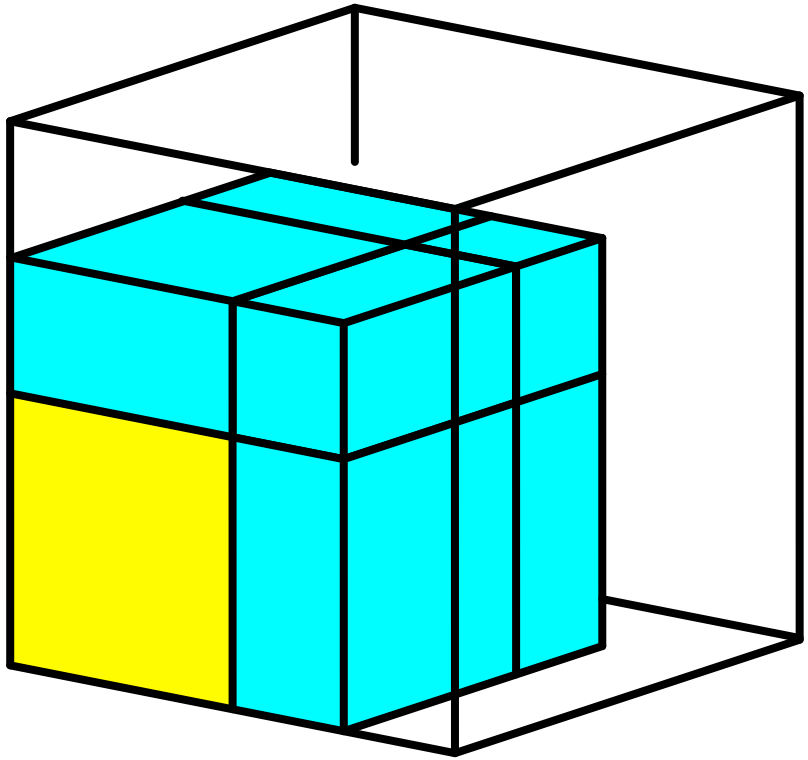
Seitenflächenmitten einfalten

Origami im Raum



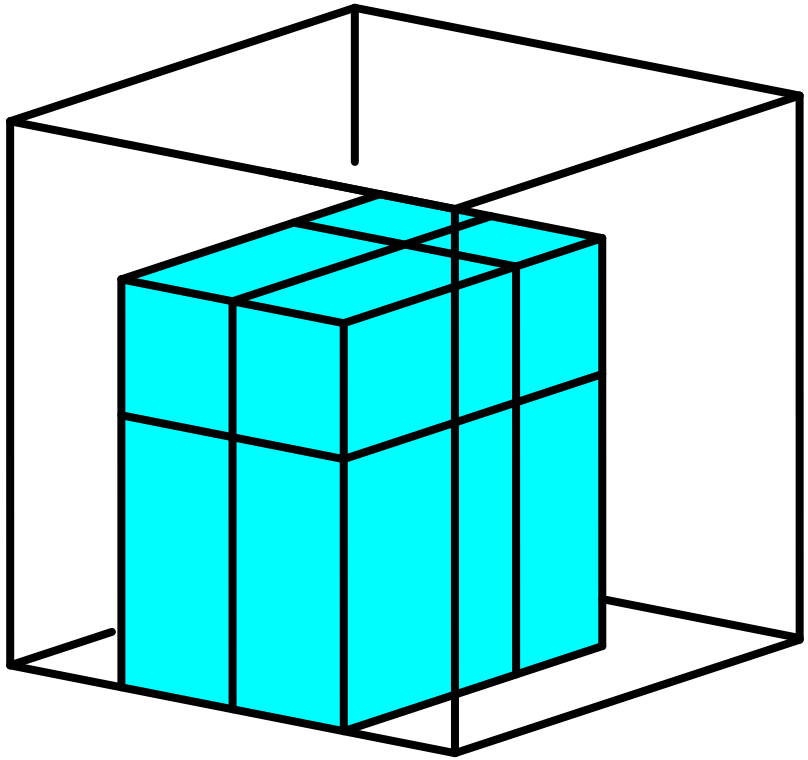
Seitenflächenmitten einfalten

Origami im Raum



Seitenflächenmitten einfalten

Origami im Raum



Seitenflächenmitten einfalten

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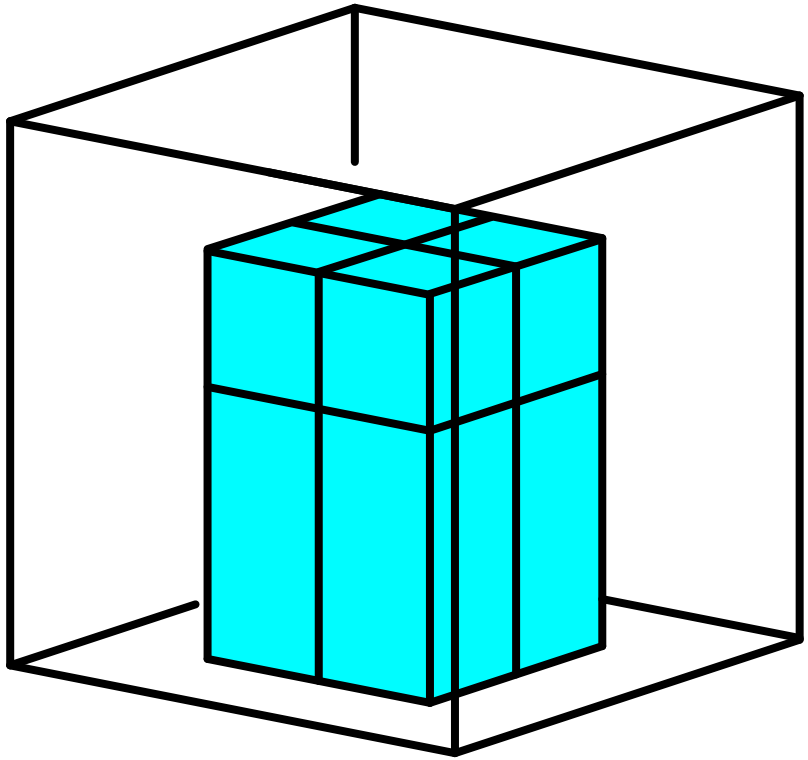

Seitenflächenmitten einfalten

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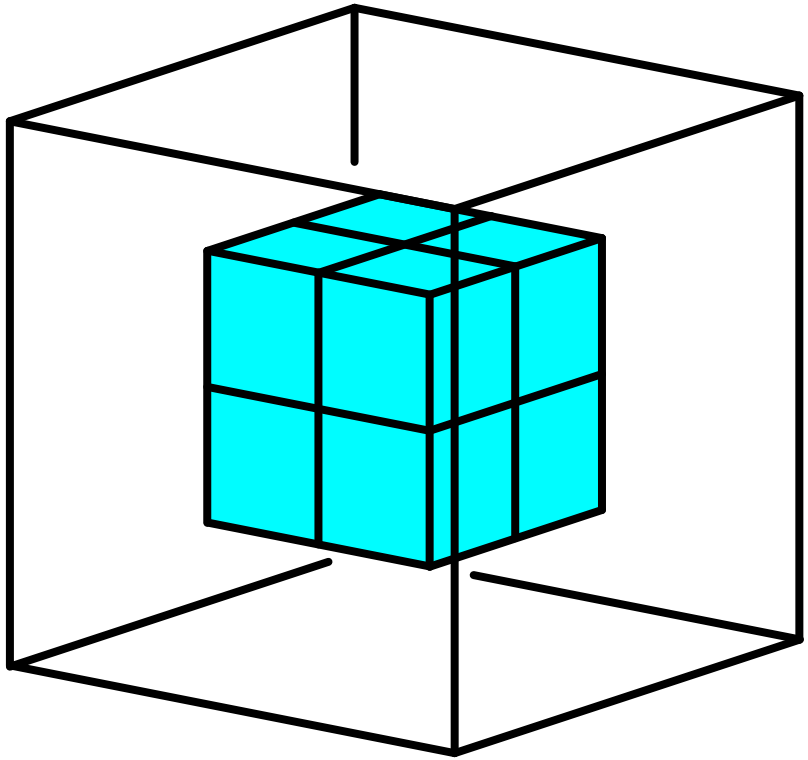

Seitenflächenmitten einfalten

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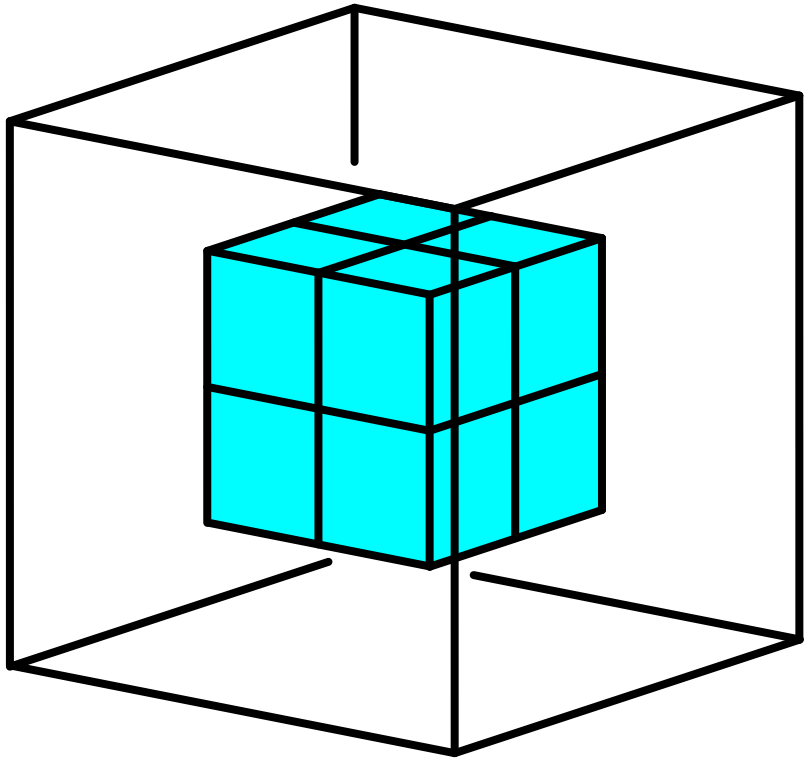
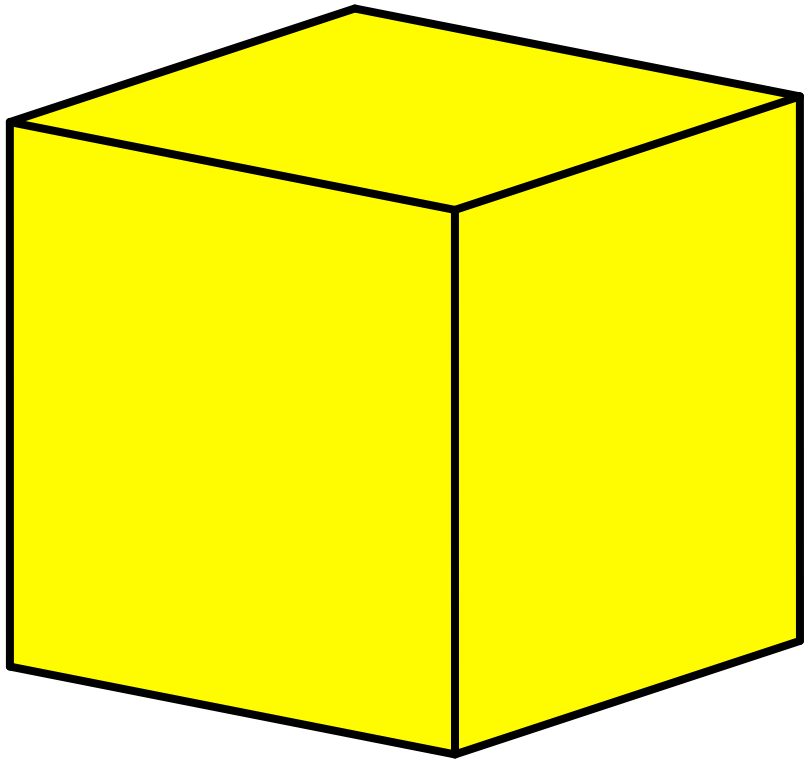


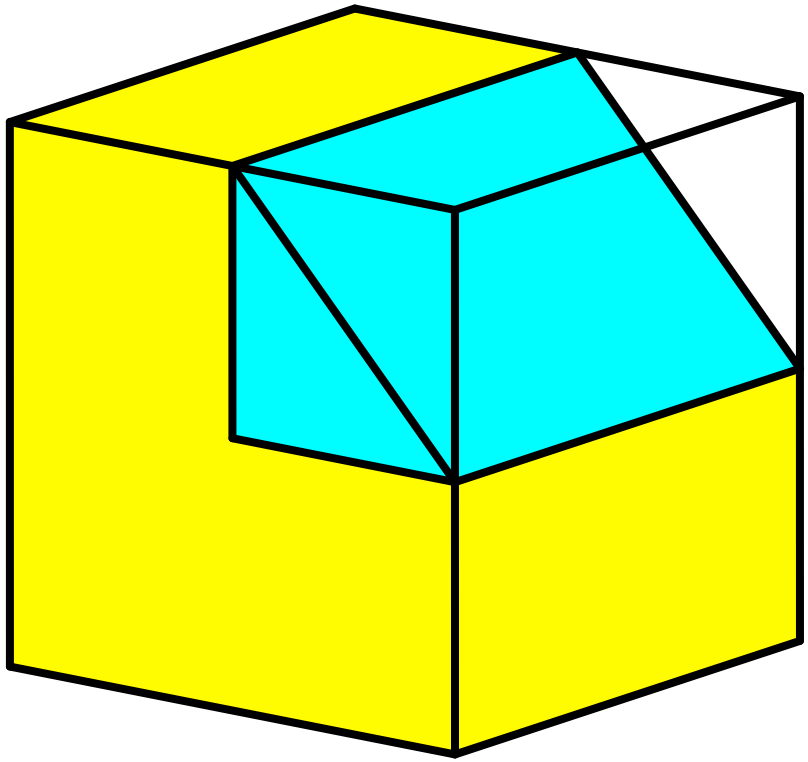
Seitenflächenmitten einfalten
Achtelvolumen

Origami im Raum



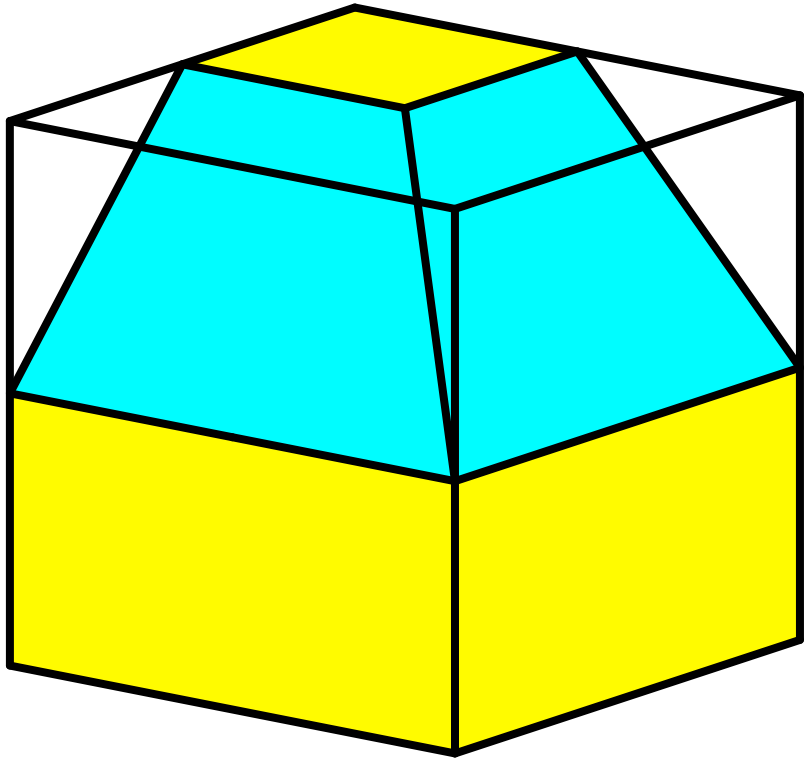
„Falten“ im vierdimensionalen Raum

Origami im Raum



Kantenmitten einfalten

Origami im Raum



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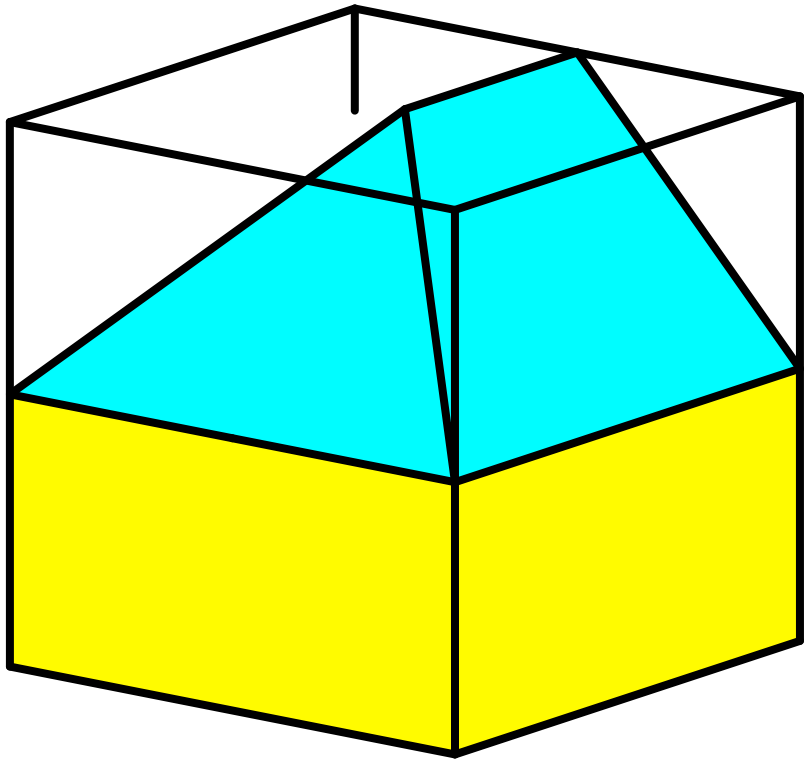
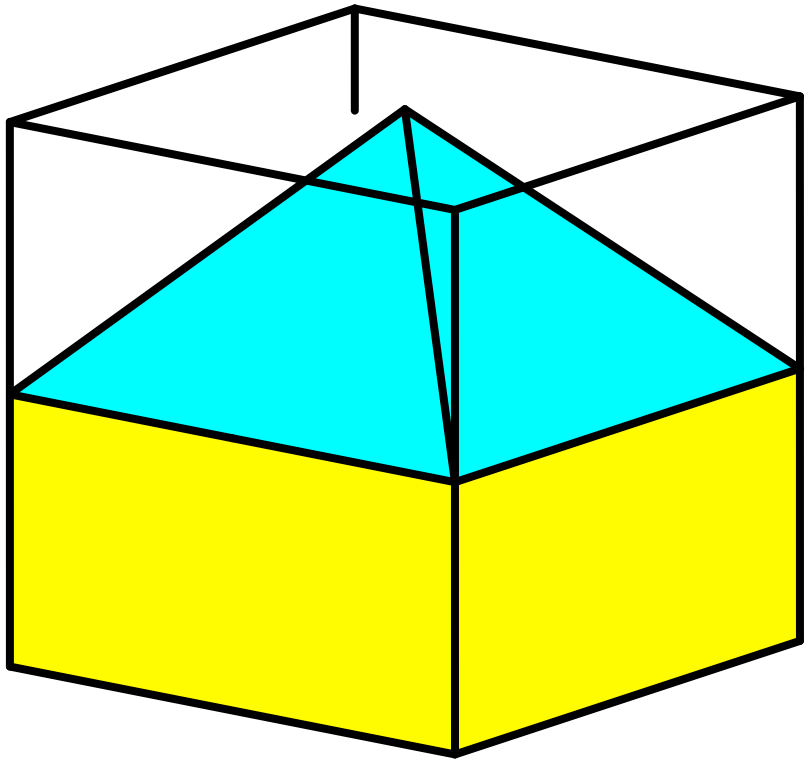


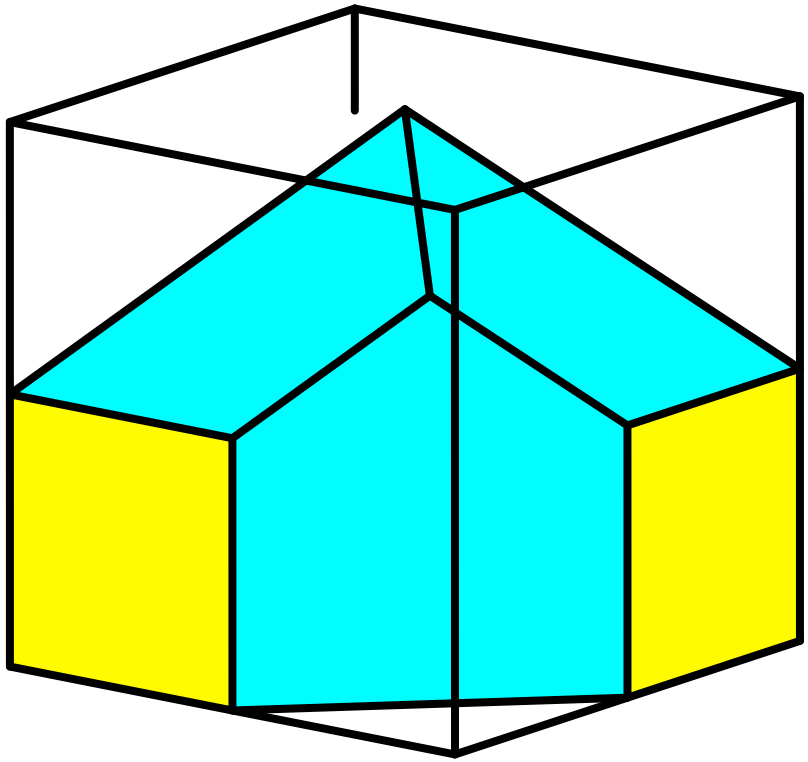
Kantenmitten einfalten

Origami im Raum



Kantenmitten einfalten
Haus mit Walmdach

Origami im Raum



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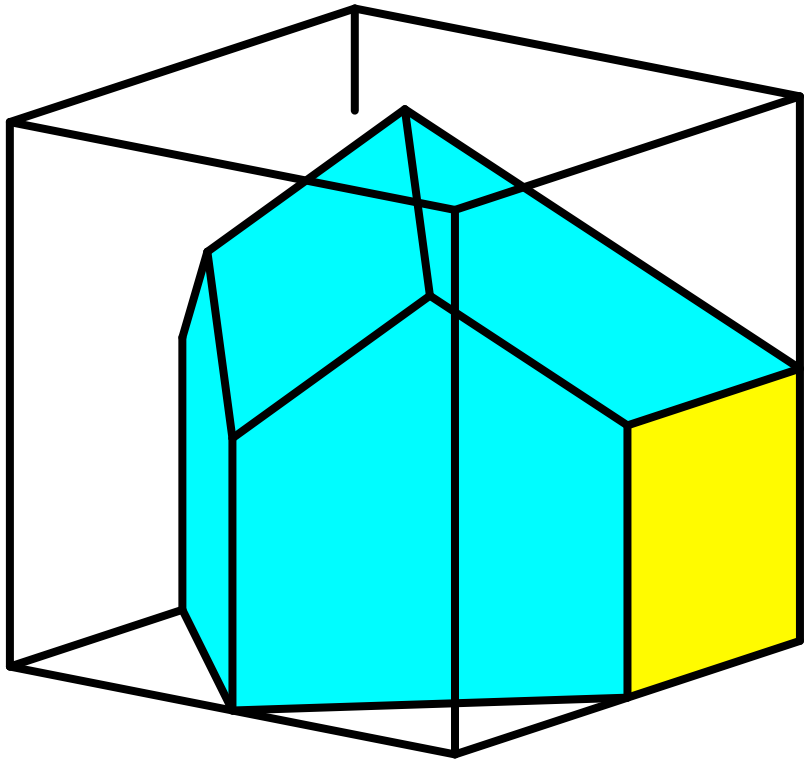
Origami im Raum



Kantenmitten einfalten

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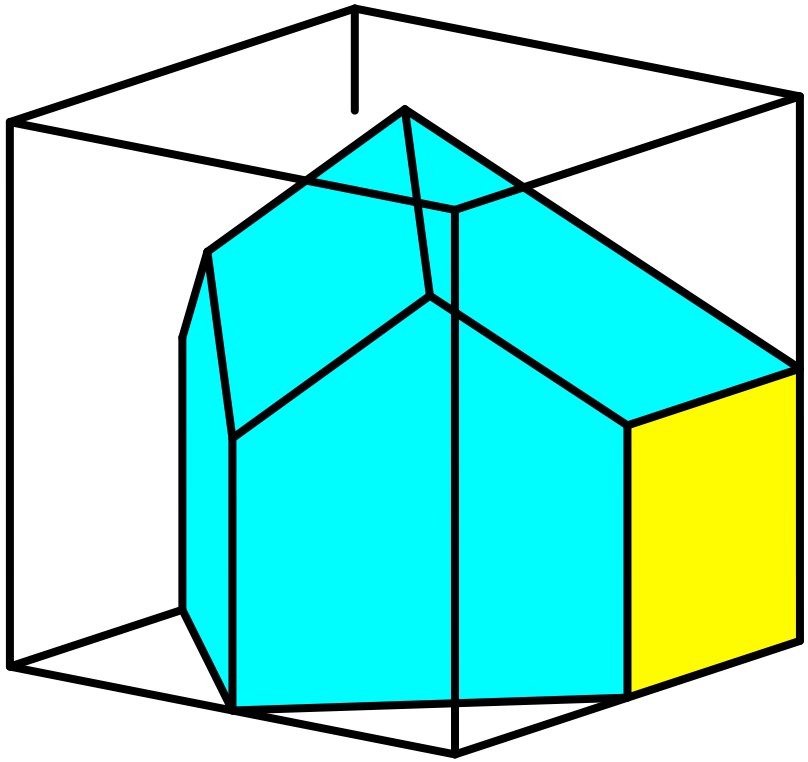

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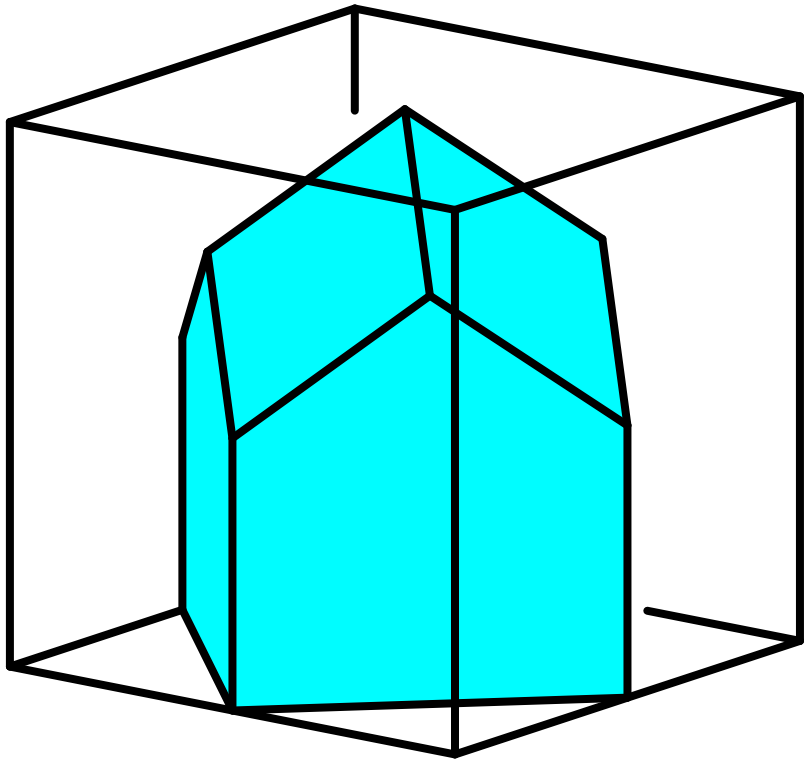
Origami im Raum



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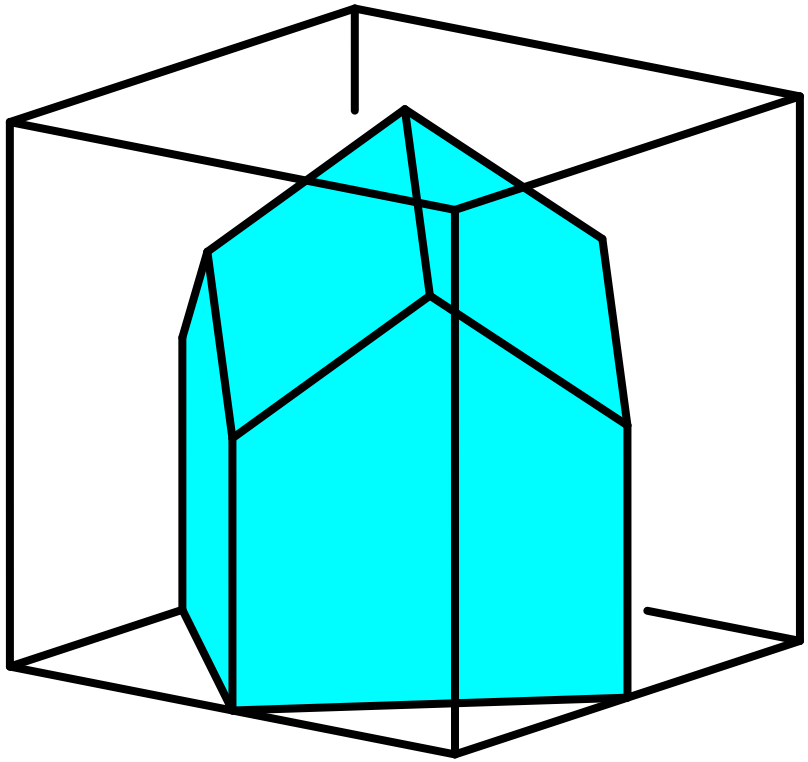

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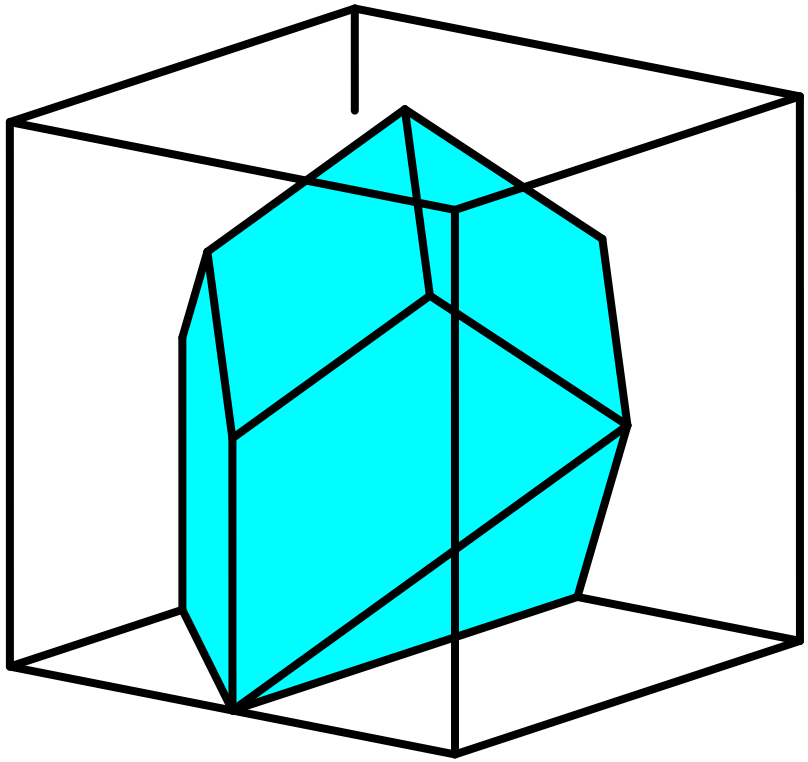

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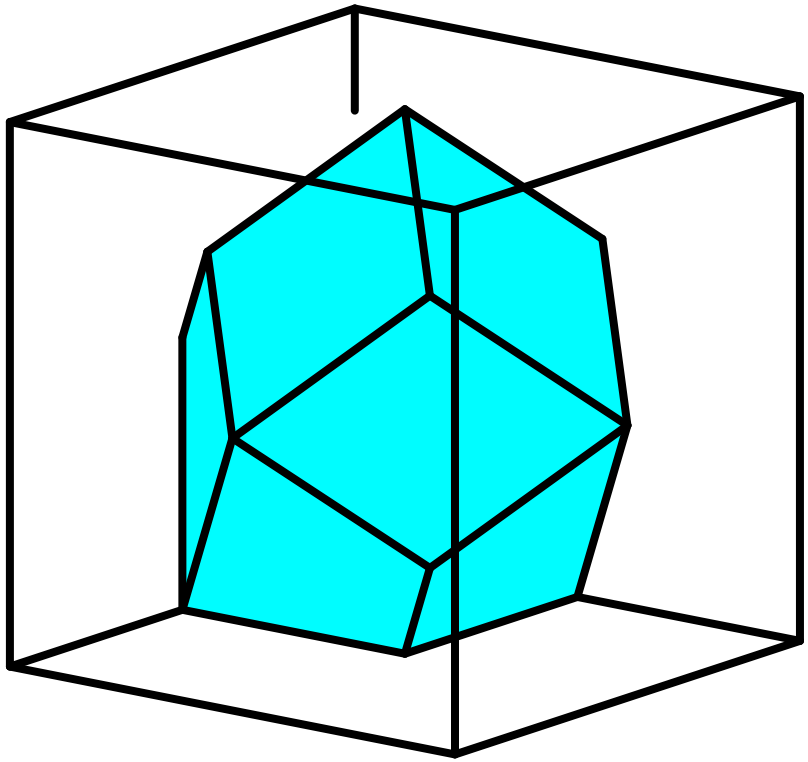

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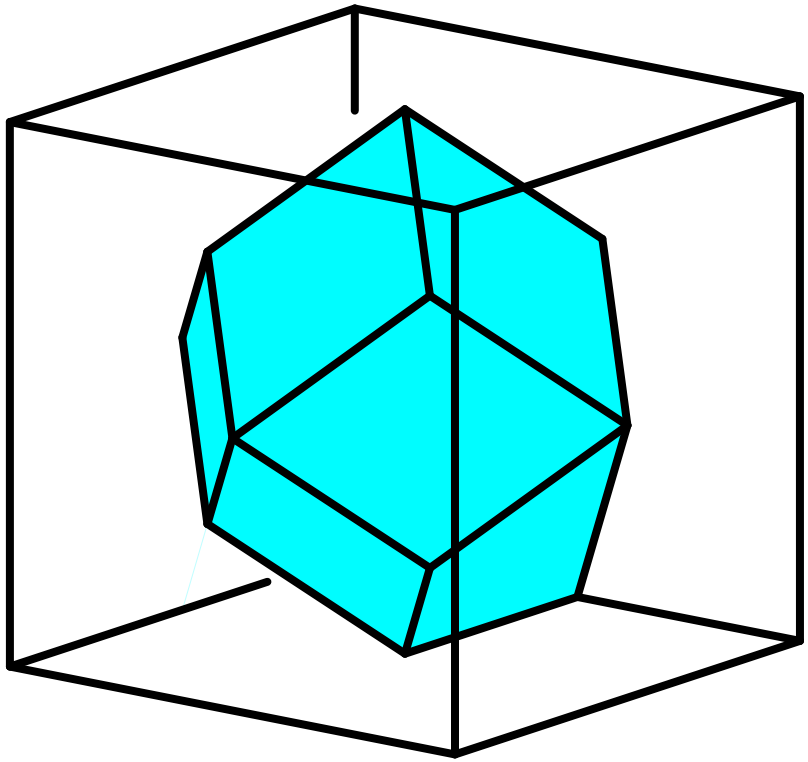
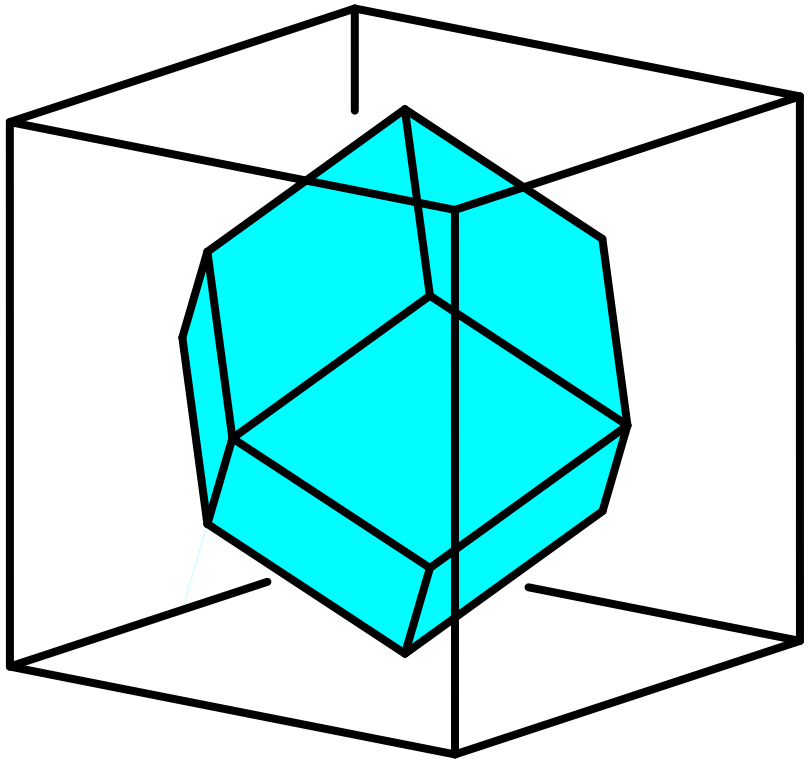


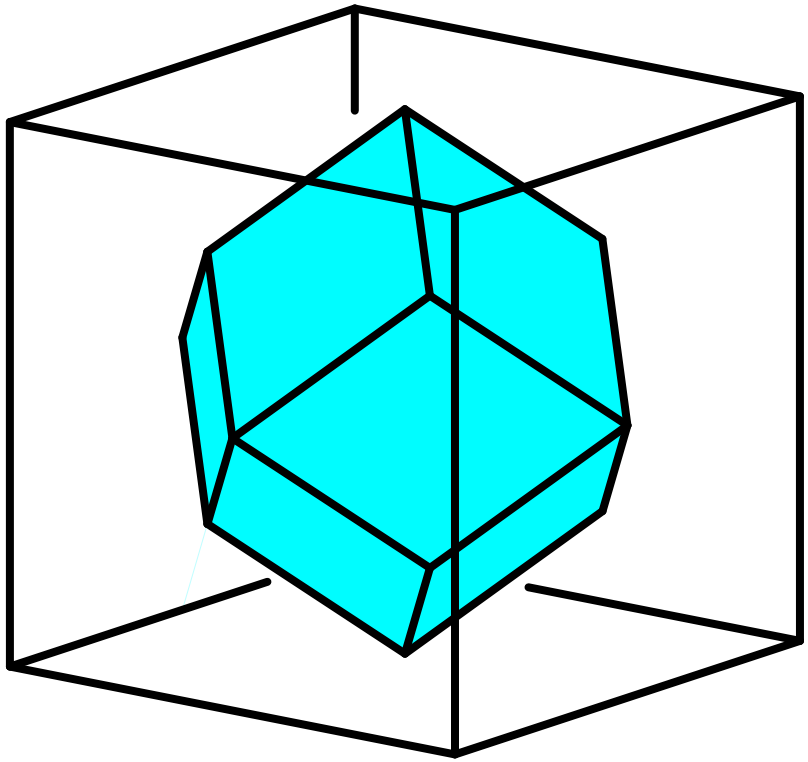
Kantenmitten einfalten

Origami im Raum



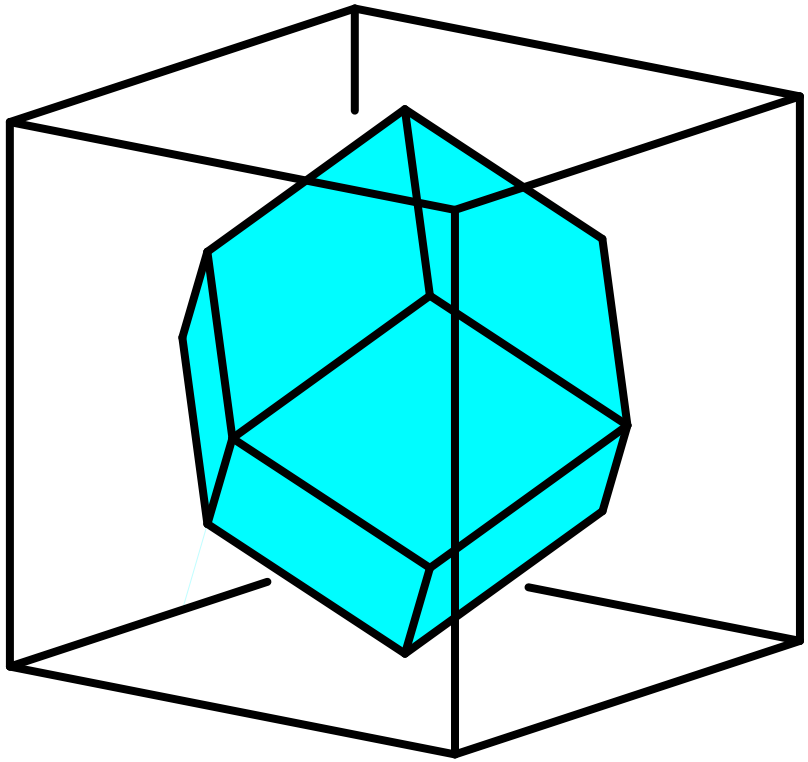
Kantenmitten einfalten

Origami im Raum



Rhombendodekaeder. Viertel des Würfelvolumens

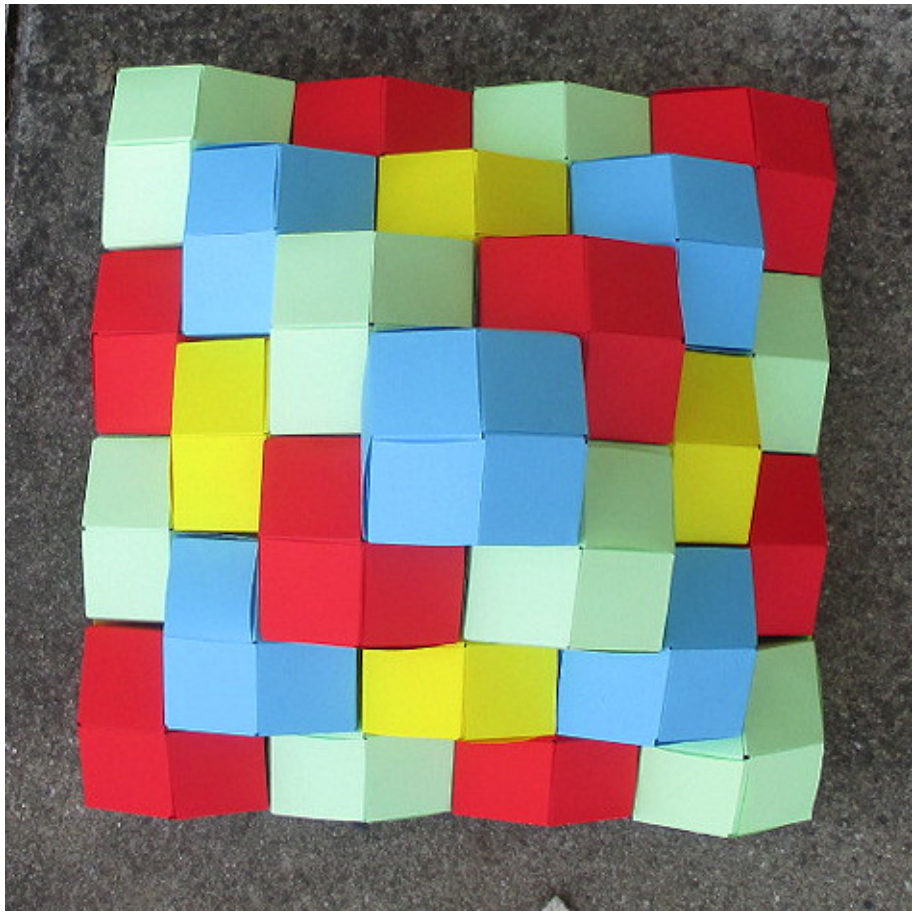
Oben vier spitze Winkel



Rhombendodekaeder. Viertel des Würfelvolumens

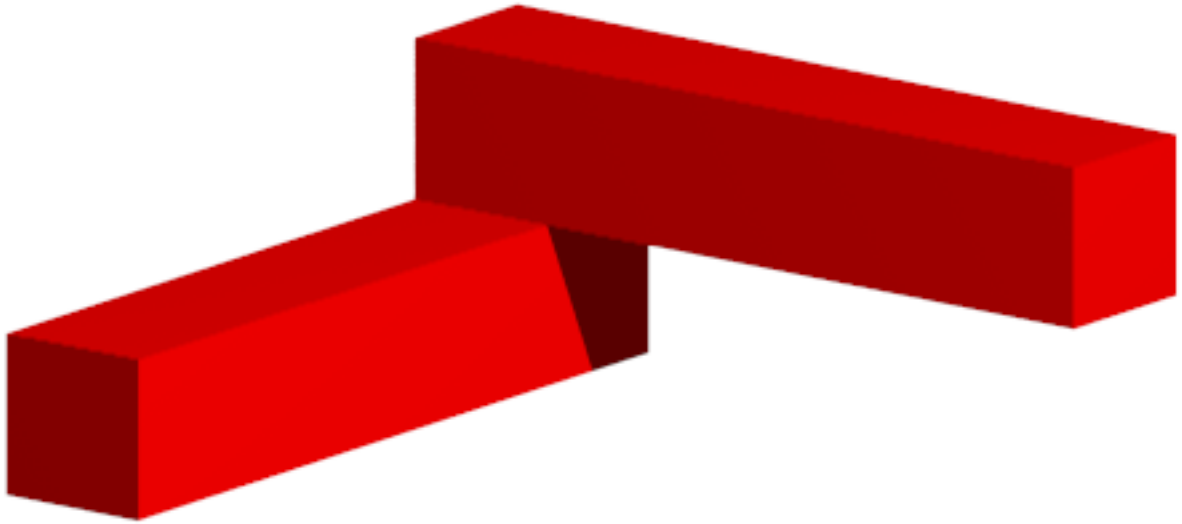
Das Rhombendodekaeder ist ein Raumfüller

Das Rhombendodekaeder ist ein Raumfüller

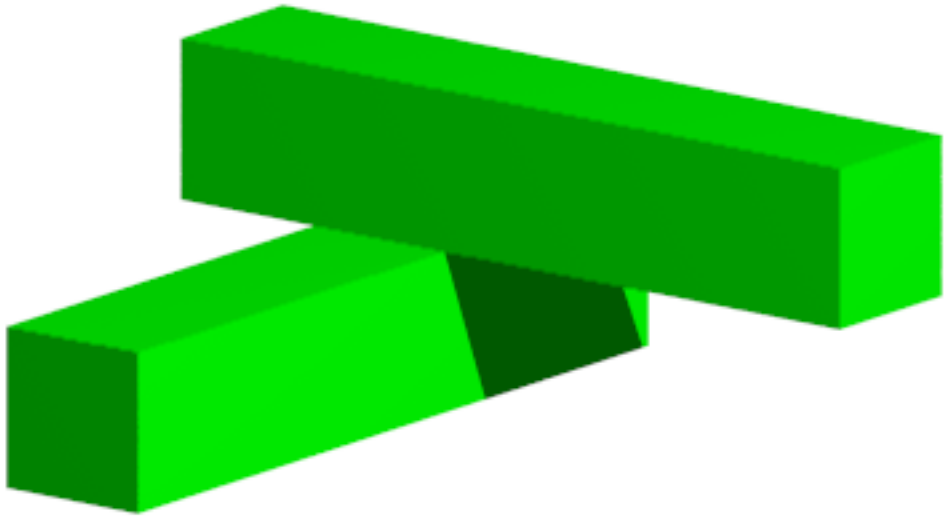


Sicht von oben. Wie viele Farben braucht es?

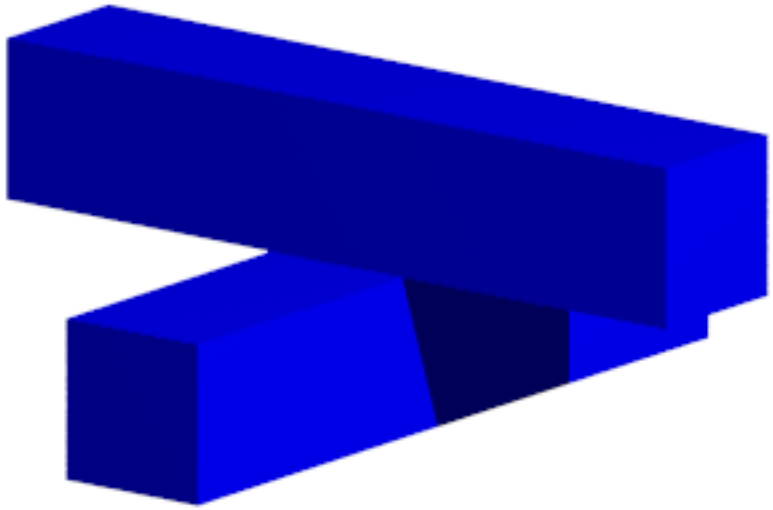
Exkurs: Anzahl Farben im Raum?



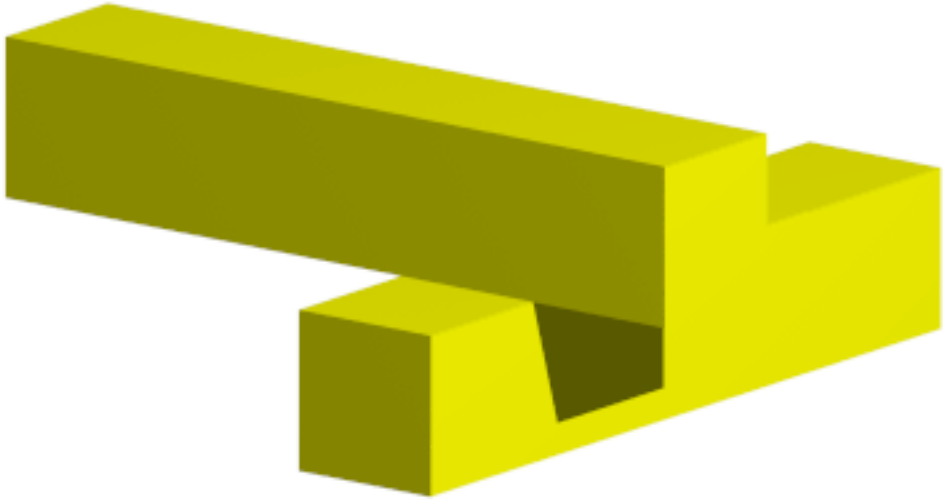
Exkurs: Anzahl Farben im Raum?



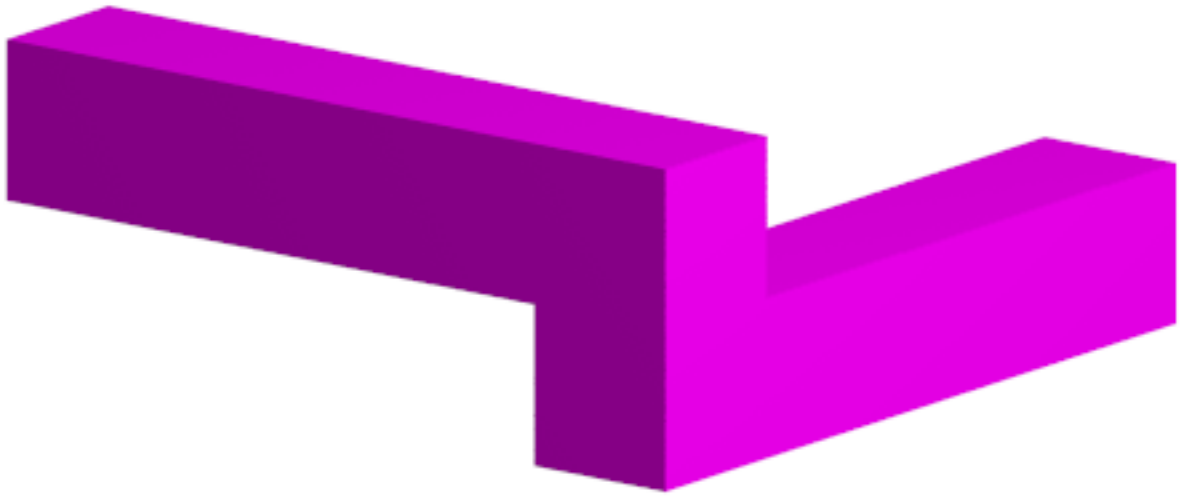
Exkurs: Anzahl Farben im Raum?



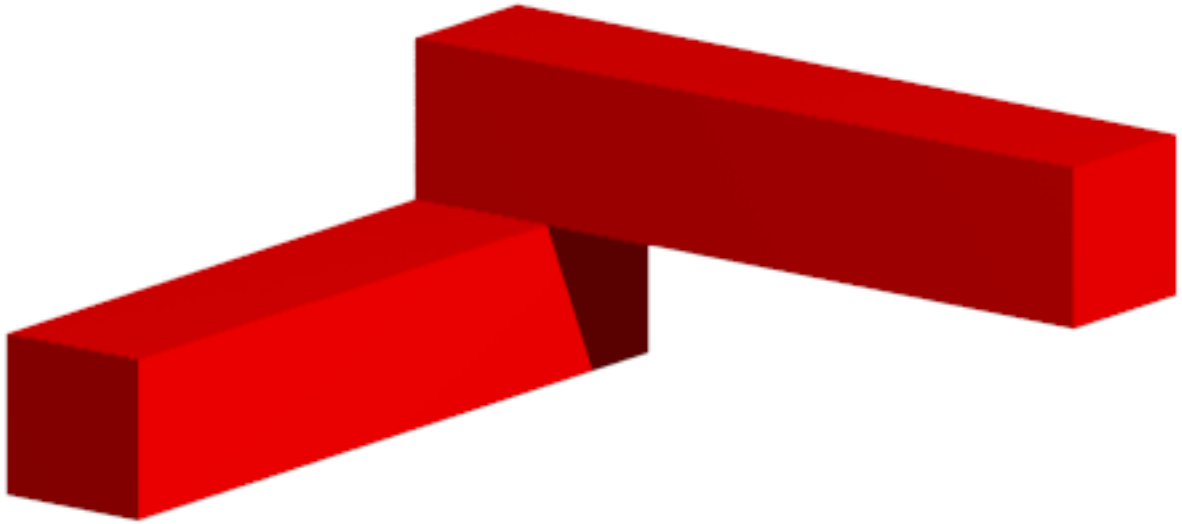
Exkurs: Anzahl Farben im Raum?



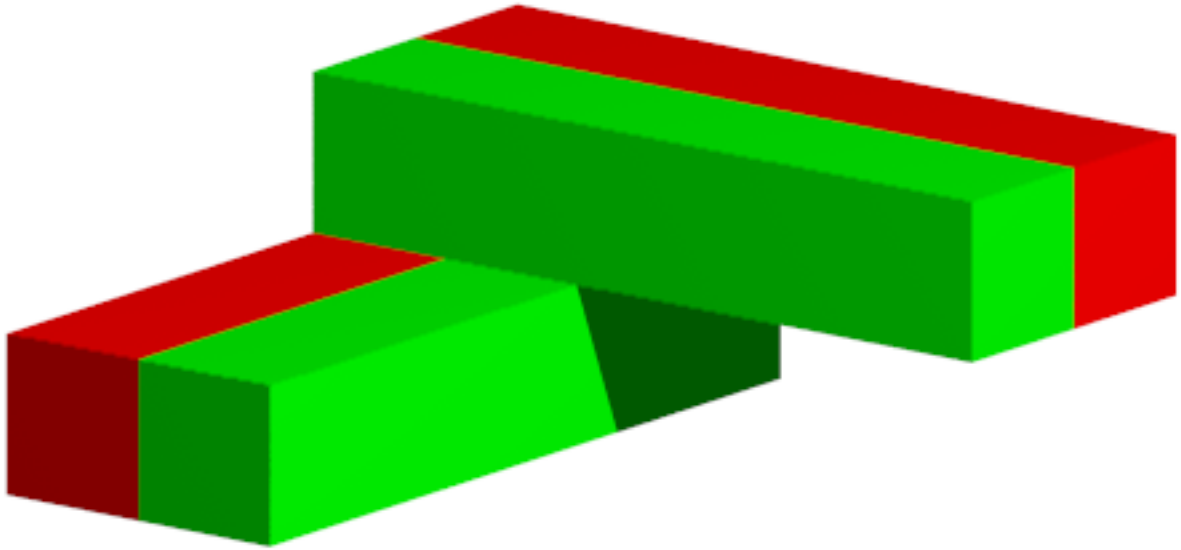
Exkurs: Anzahl Farben im Raum?



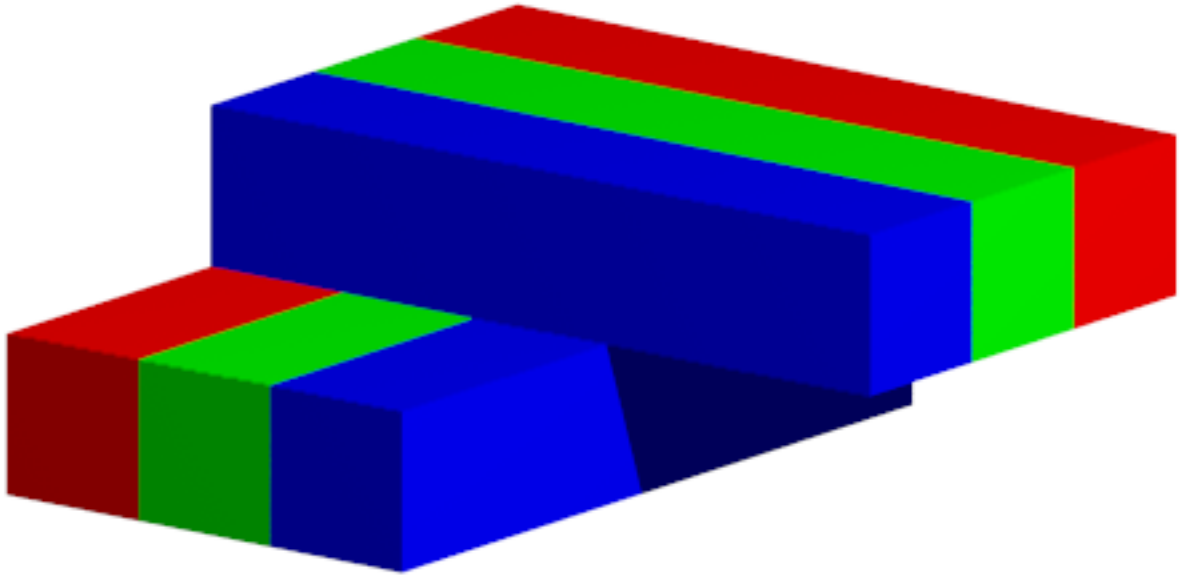
Exkurs: Anzahl Farben im Raum?



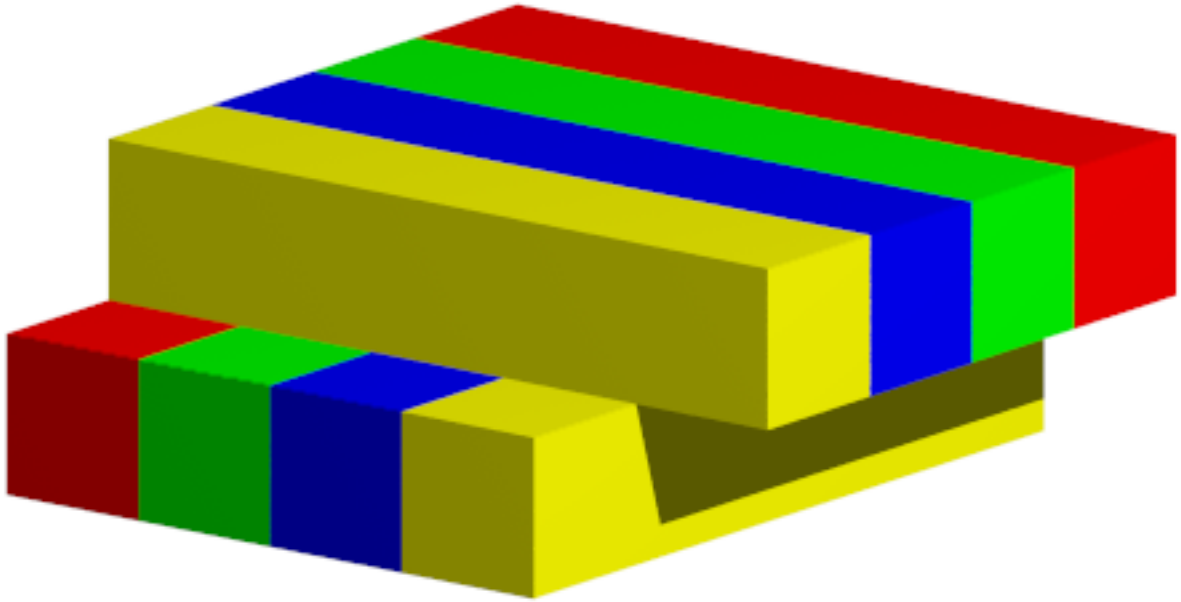
Exkurs: Anzahl Farben im Raum?



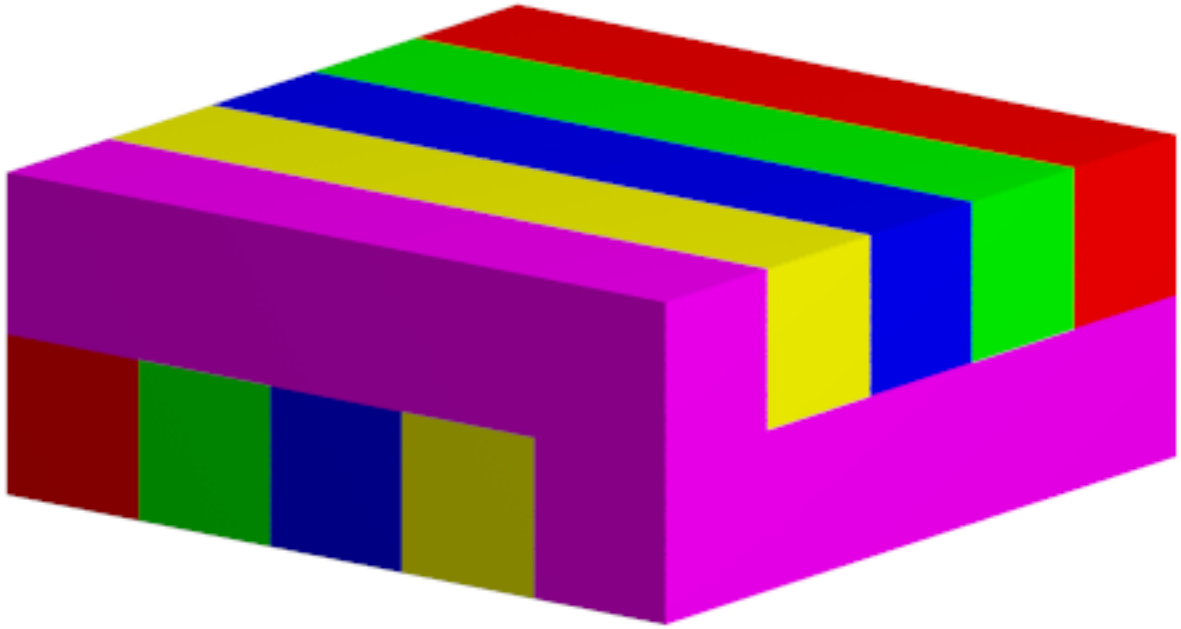
Exkurs: Anzahl Farben im Raum?



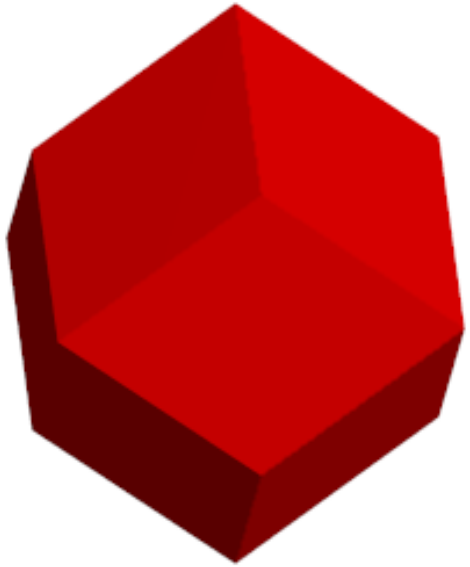
Exkurs: Anzahl Farben im Raum?



Exkurs: Anzahl Farben im Raum?

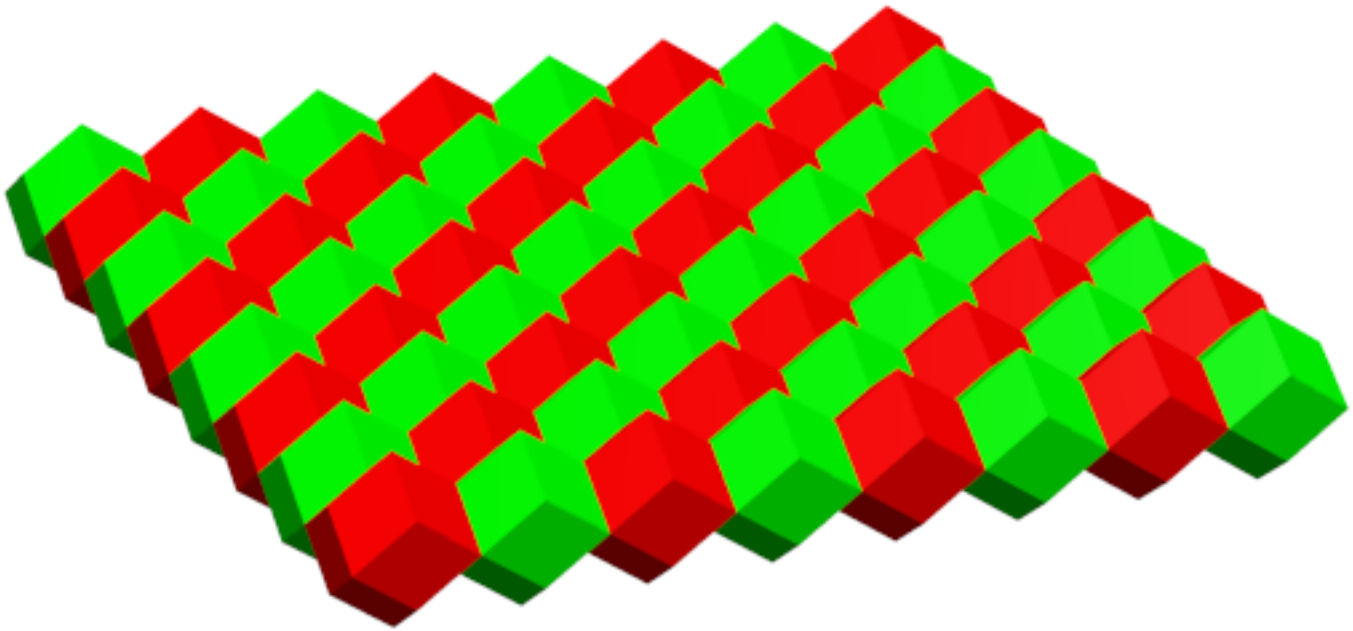


Oben vier spitze Winkel

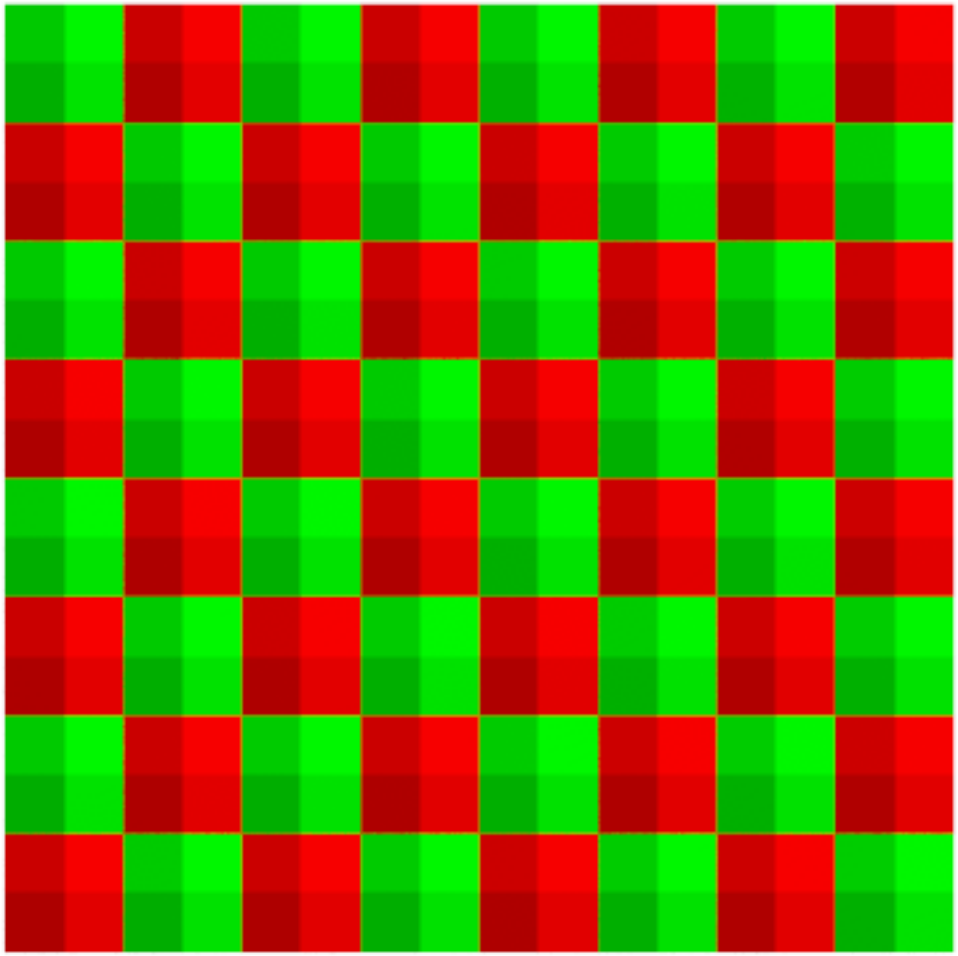


Rhombendodekaeder

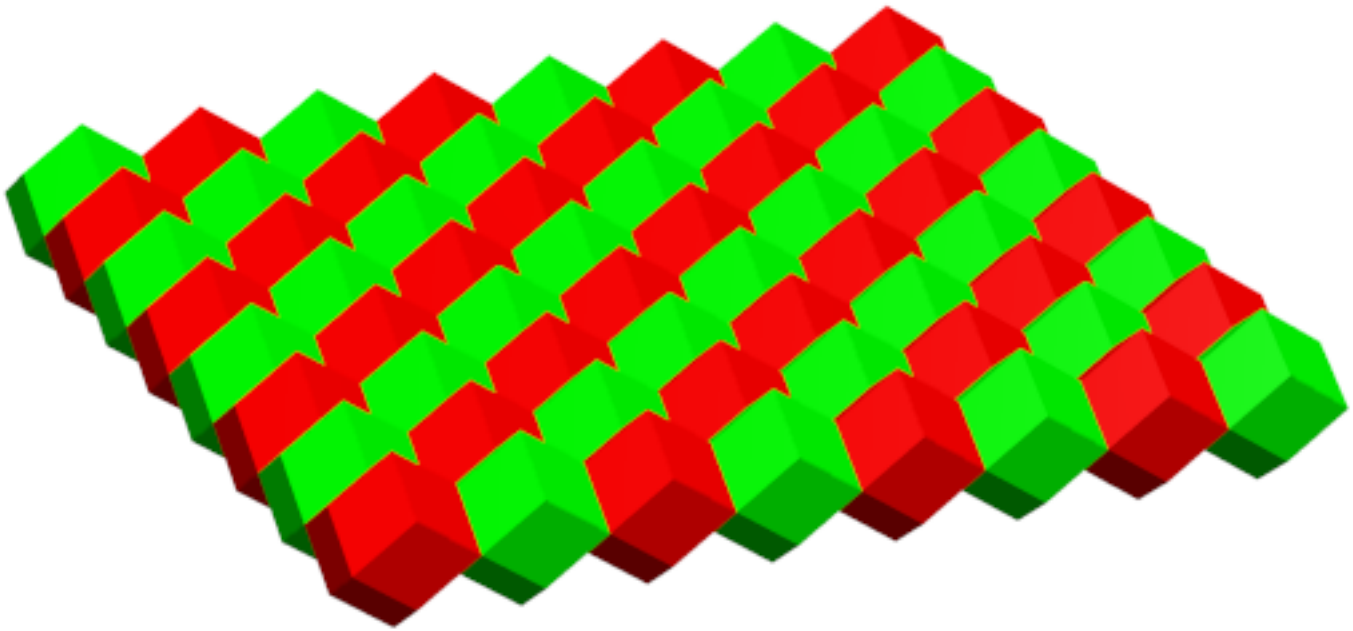
Das Rhombendodekaeder



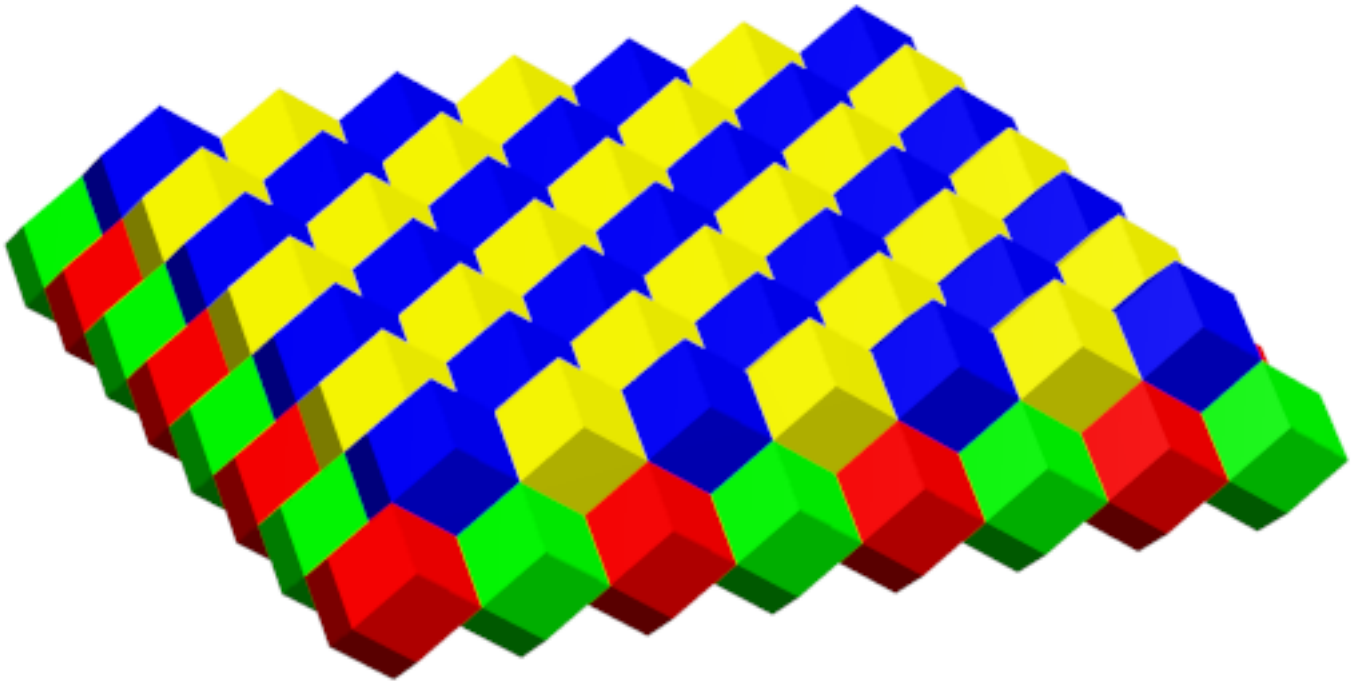
Das Rhombendodekaeder



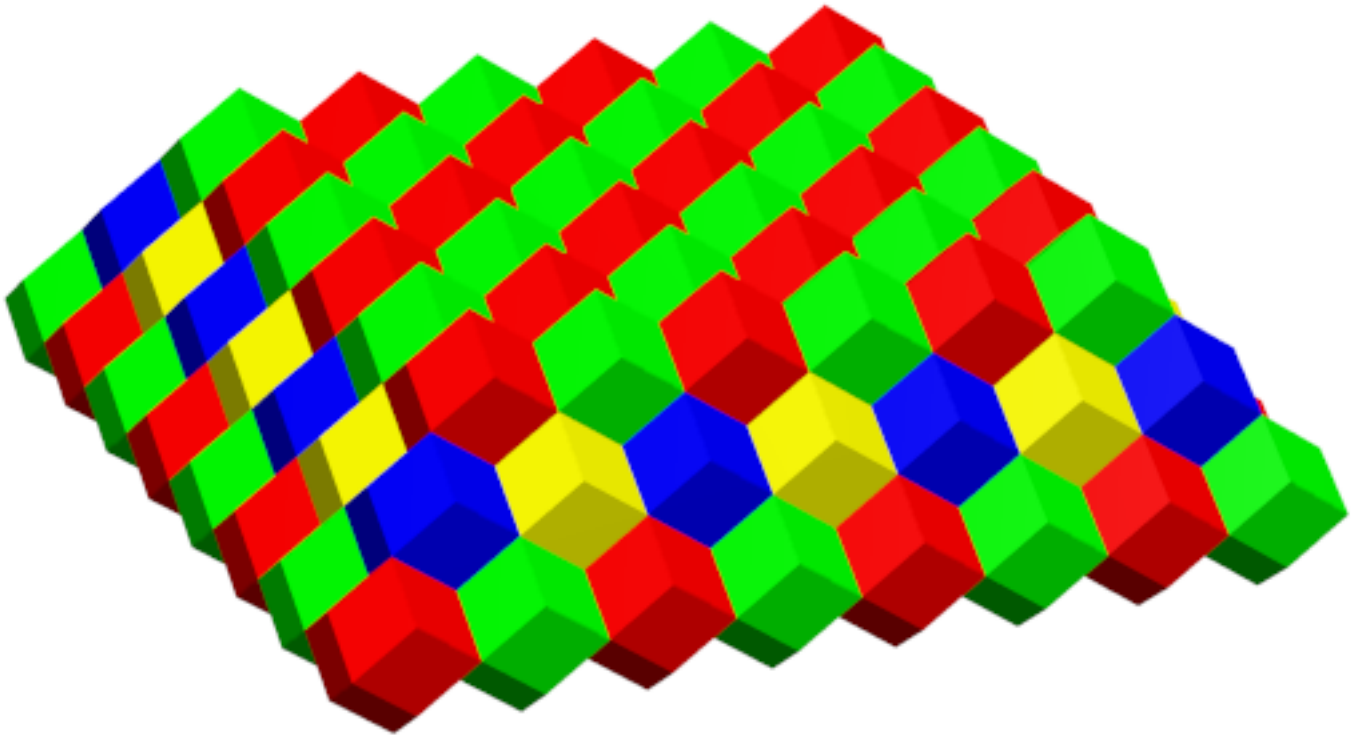
Das Rhombendodekaeder



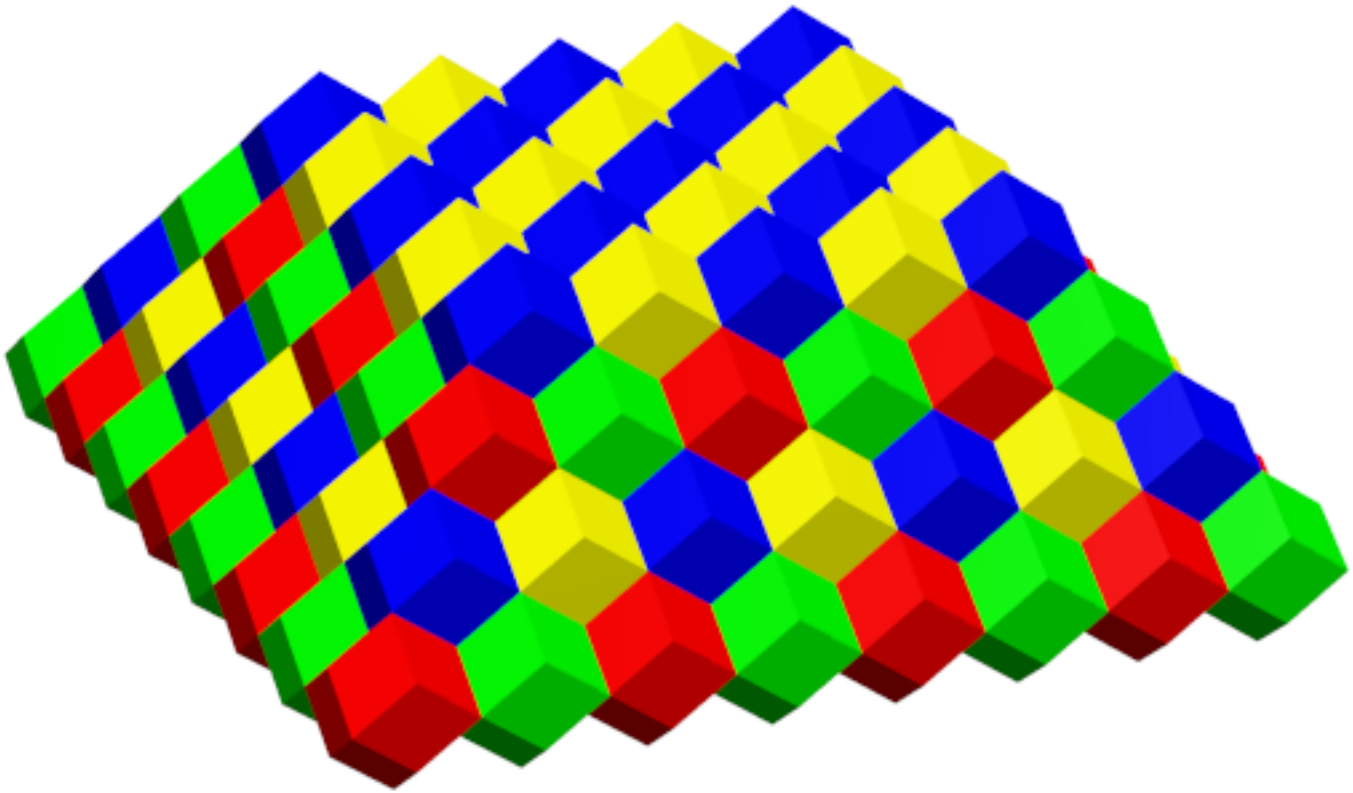
Das Rhombendodekaeder



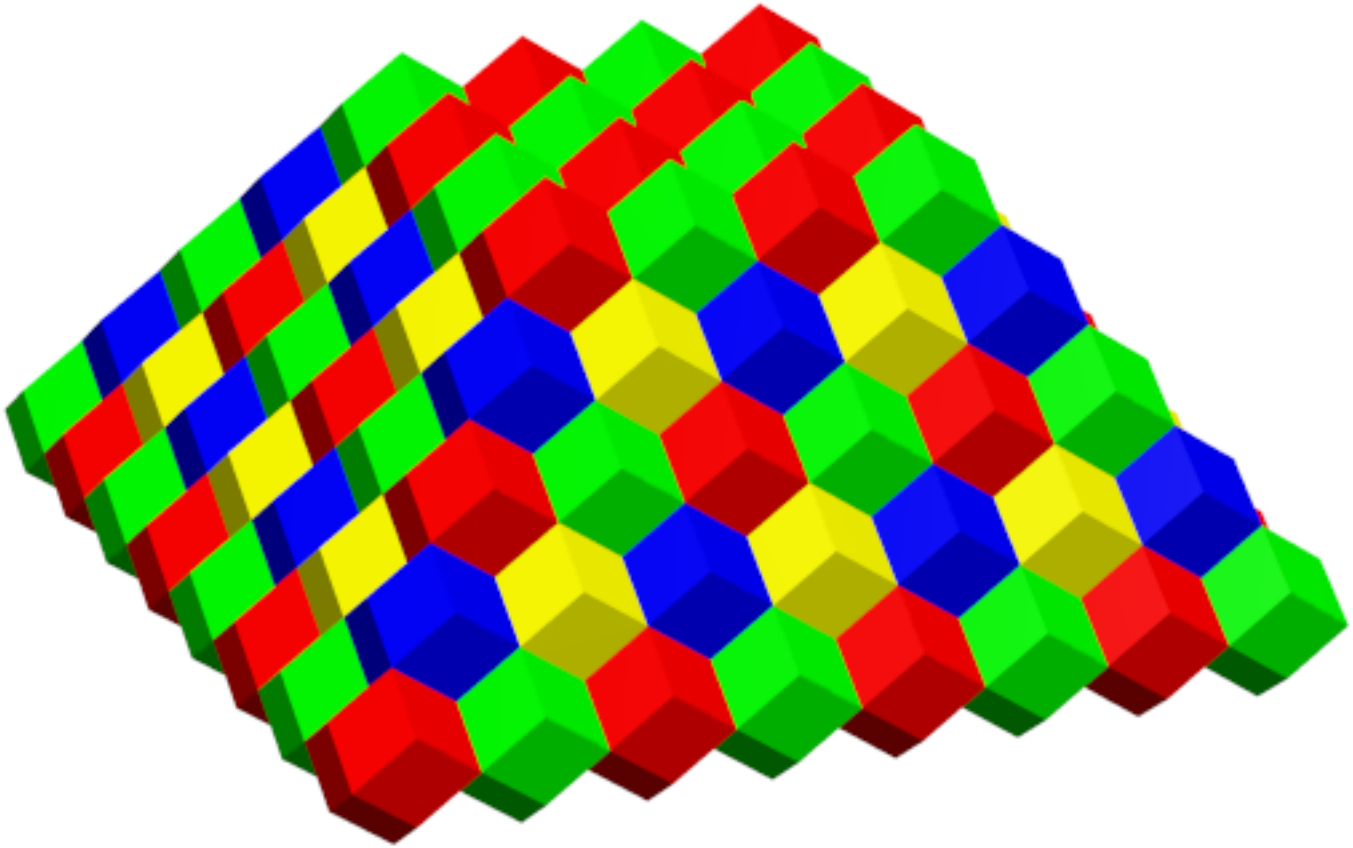
Das Rhombendodekaeder



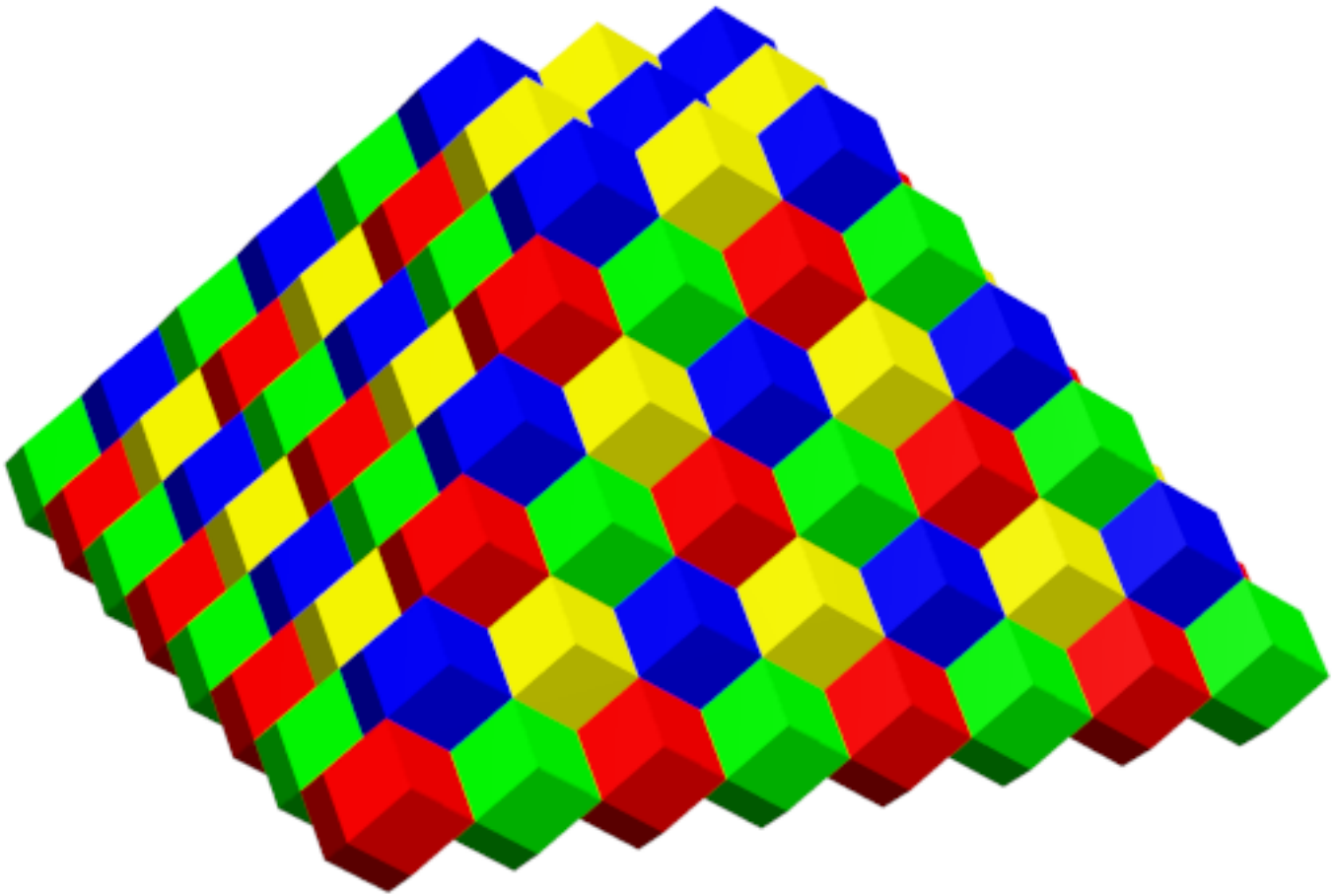
Das Rhombendodekaeder



Das Rhombendodekaeder



Das Rhombendodekaeder



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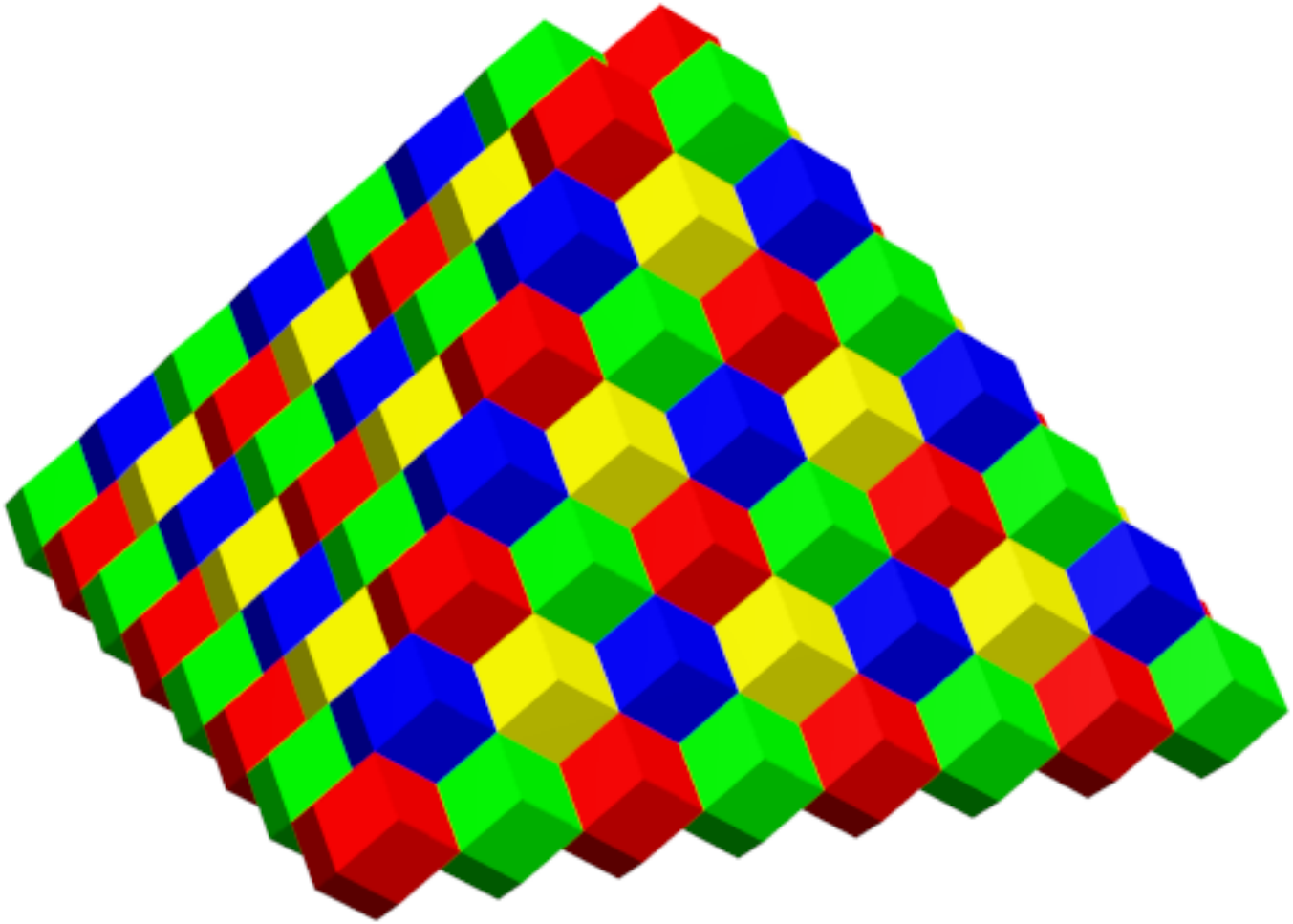
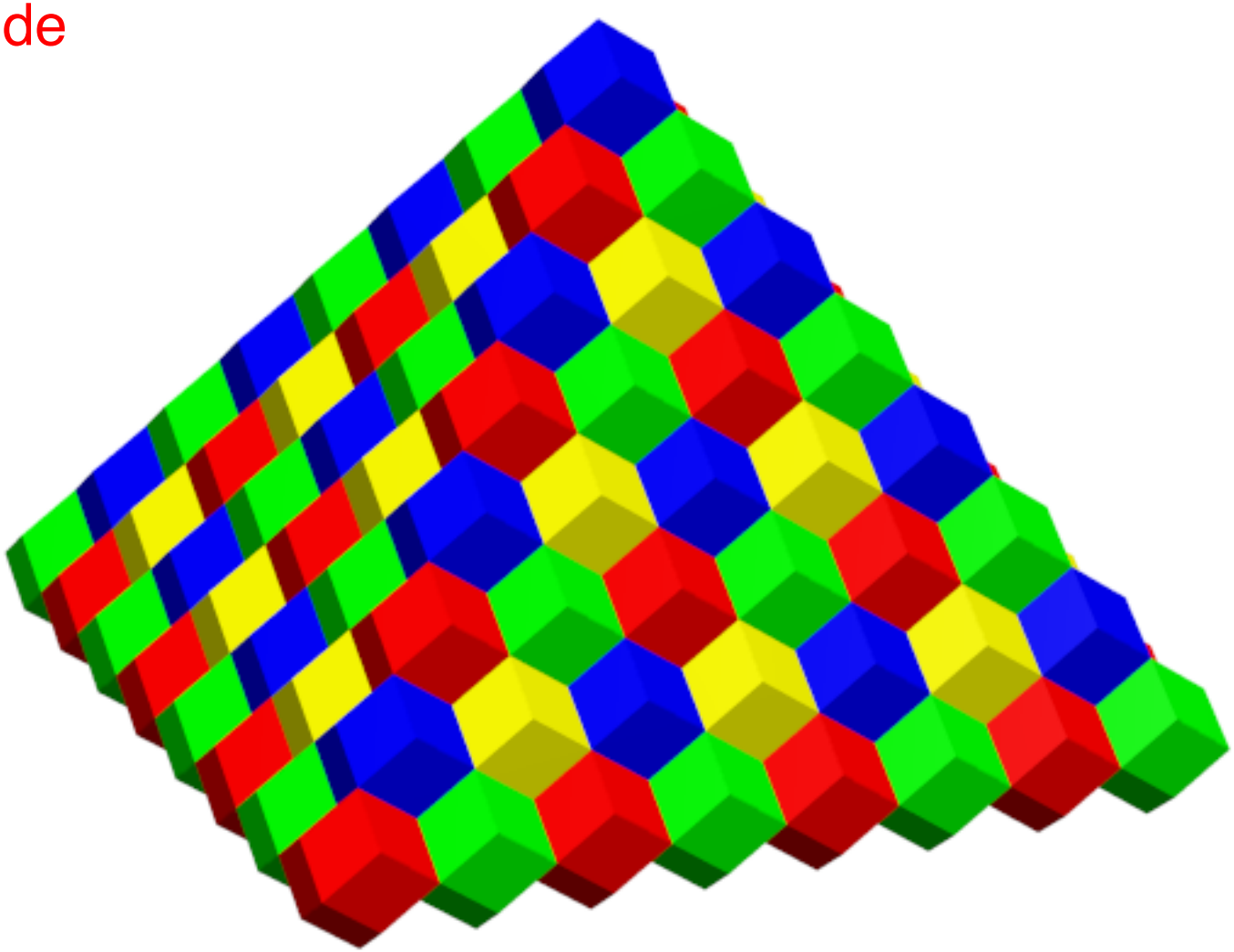
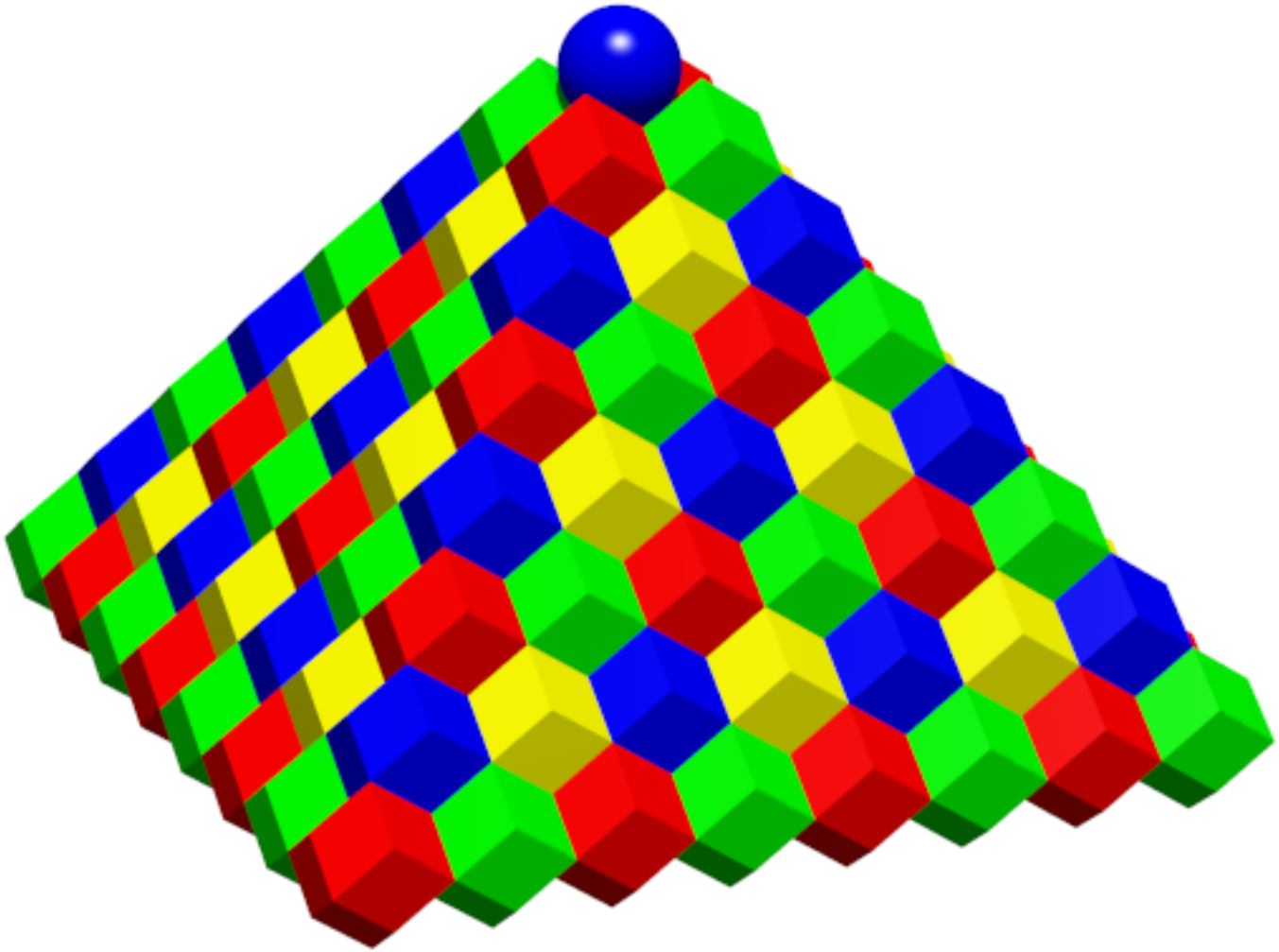


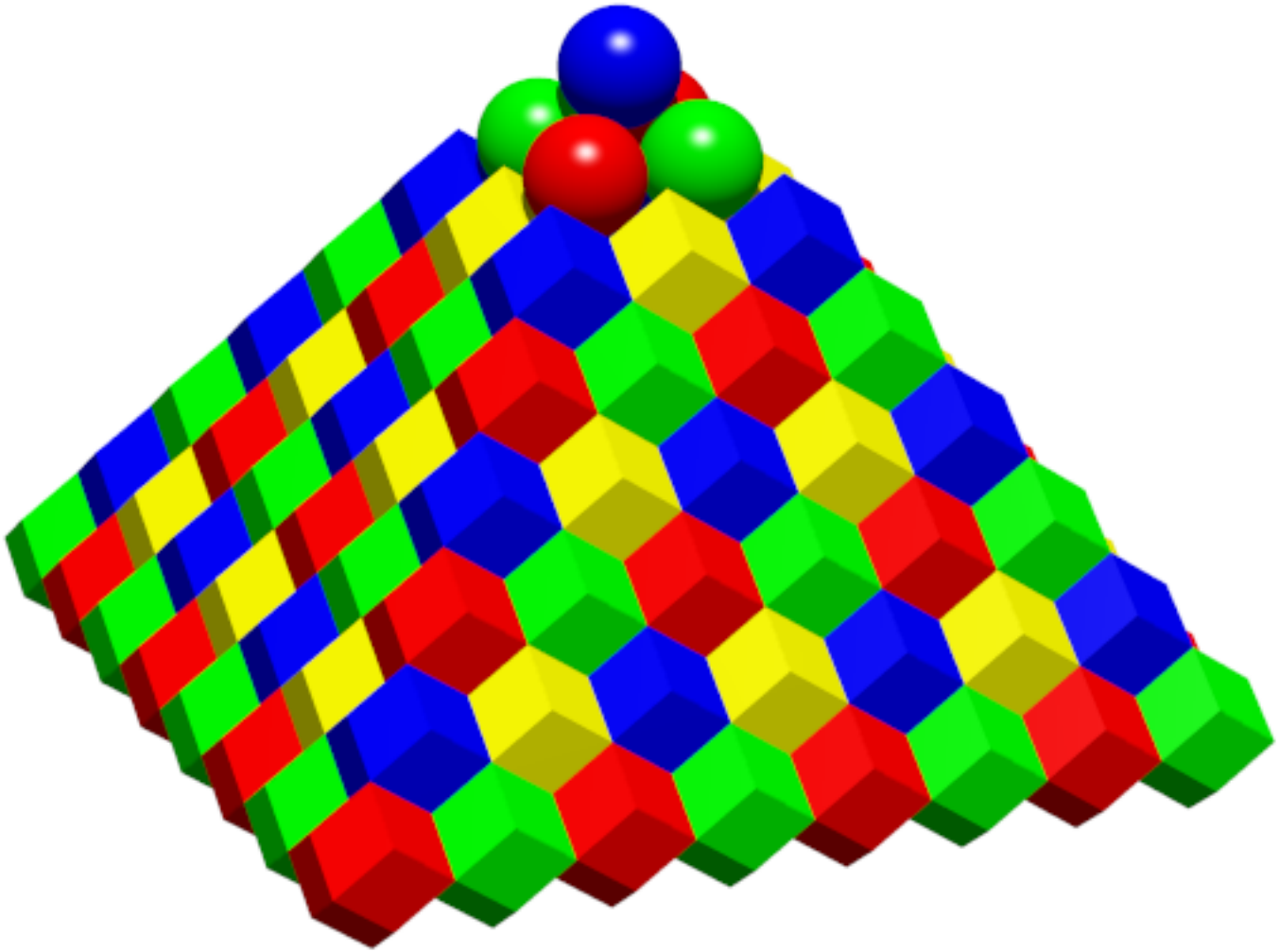
Das Rhombendodekaeder

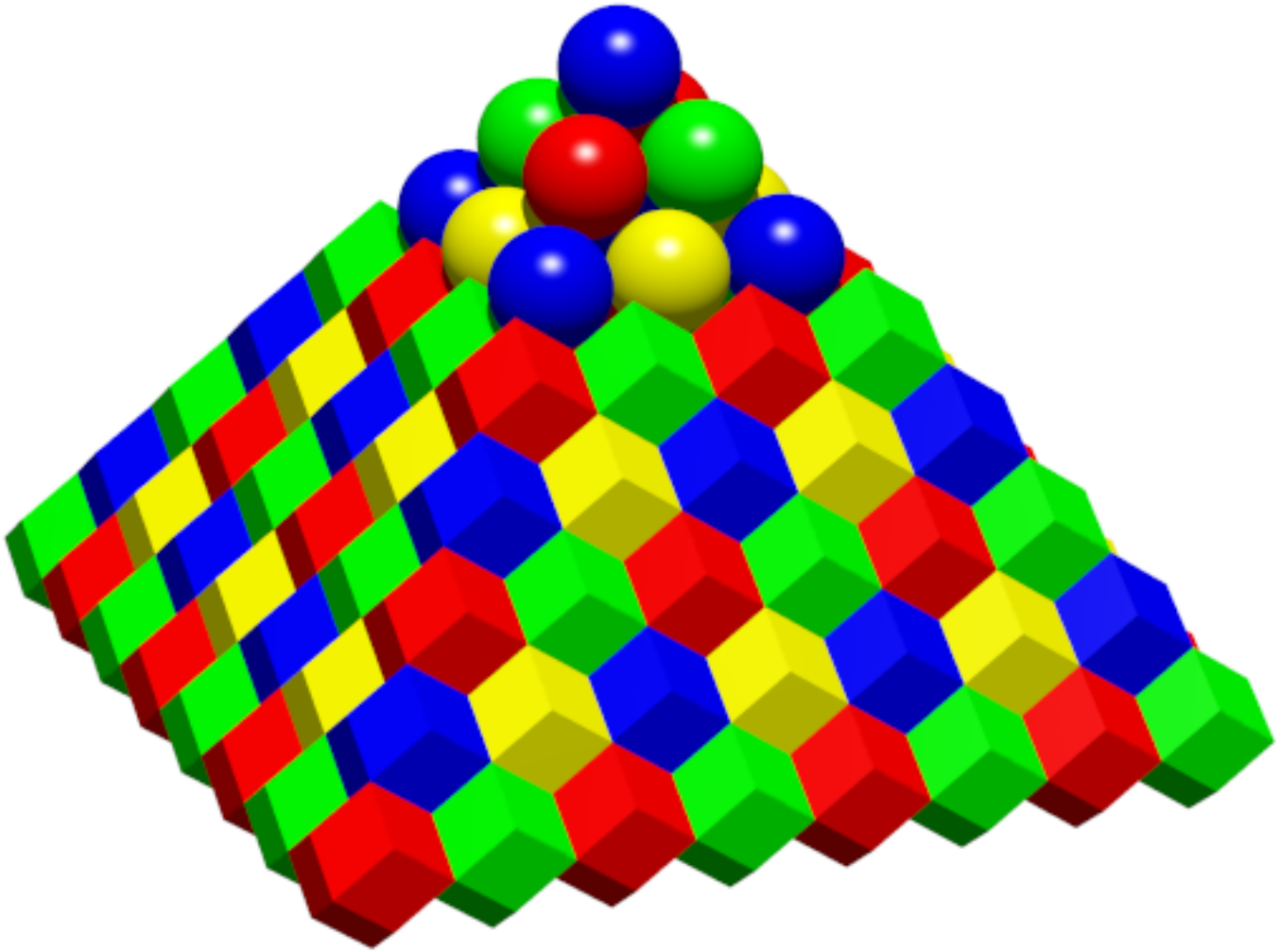
Pyramide

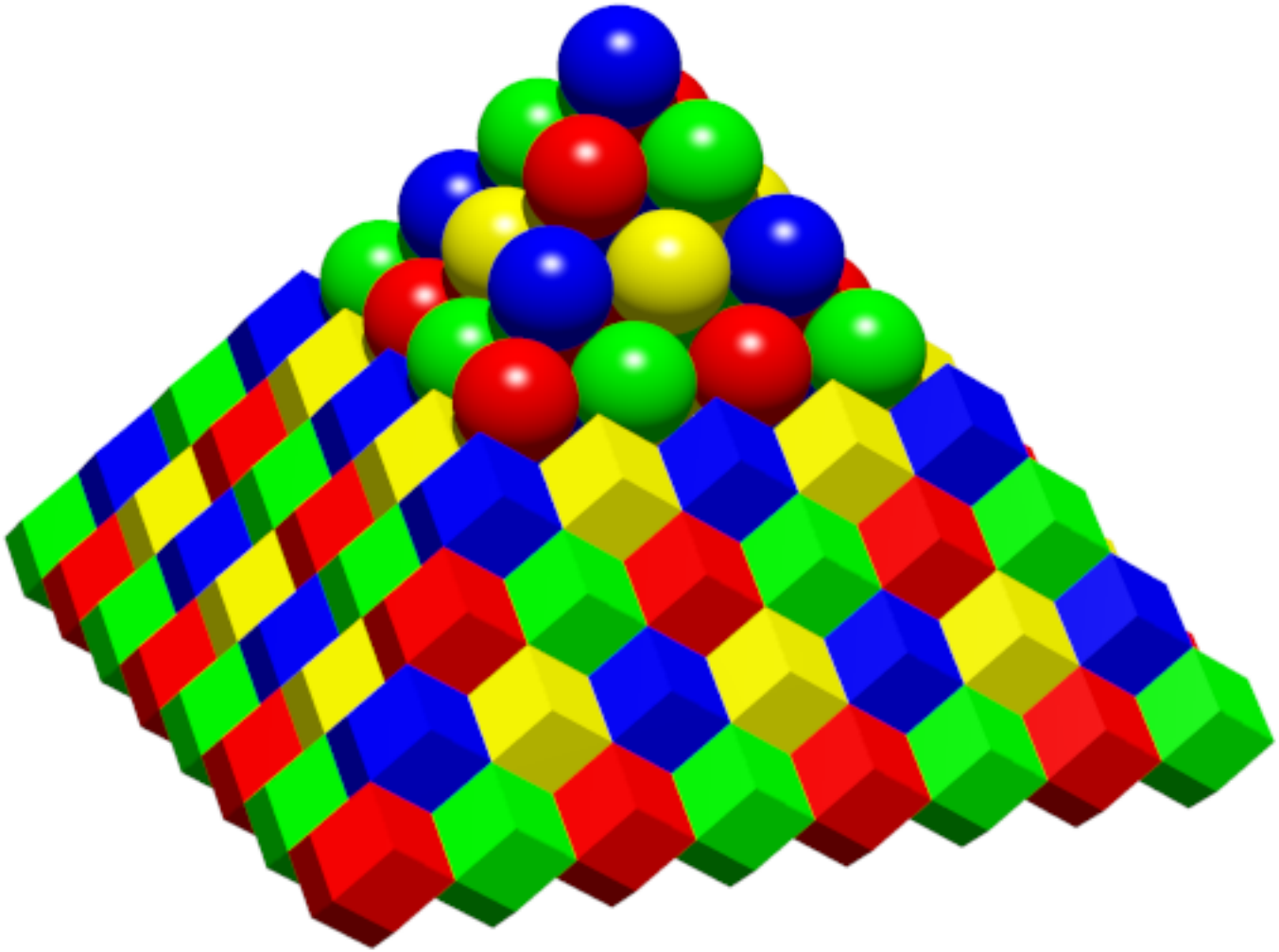


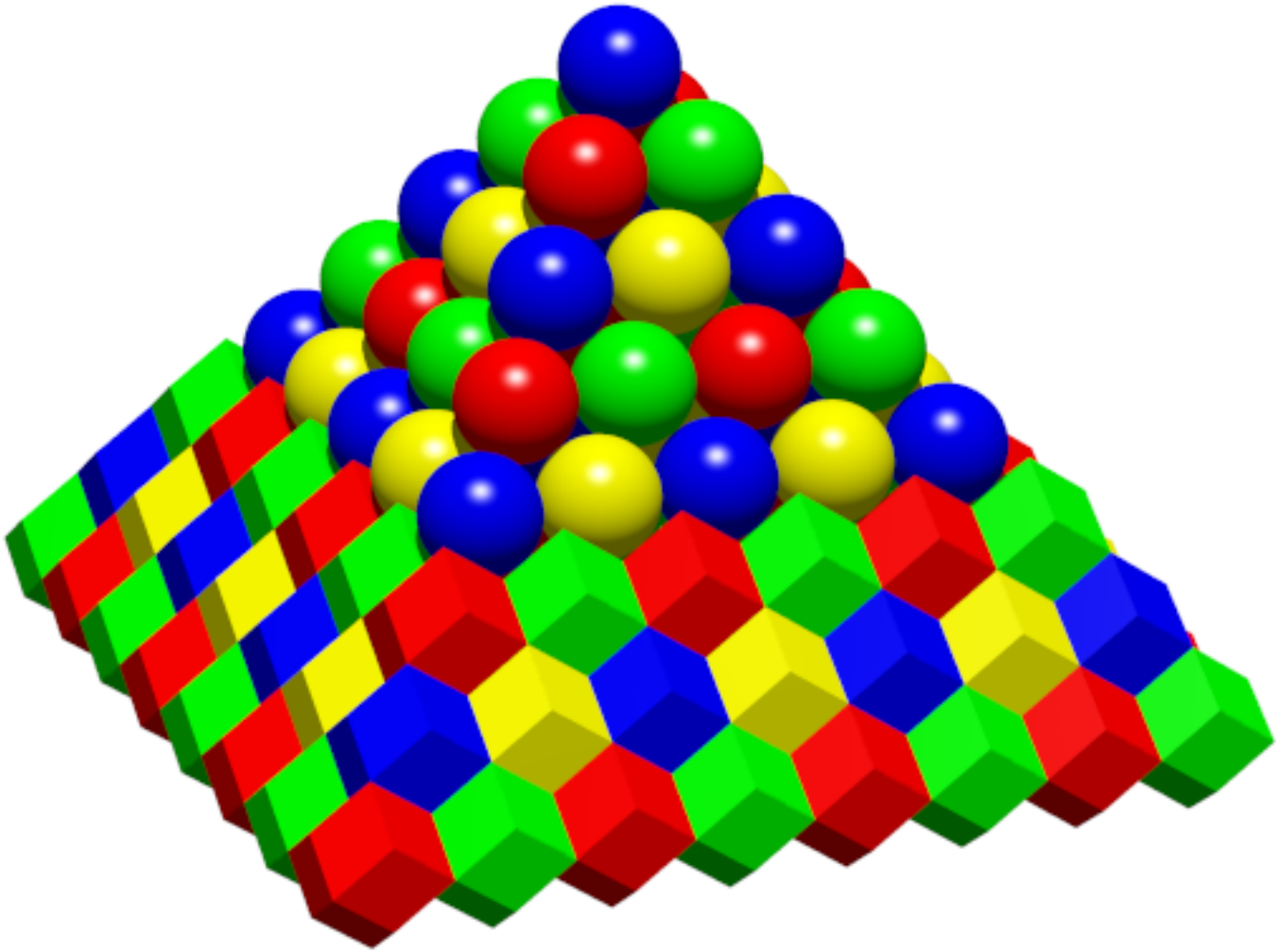
Inkugel

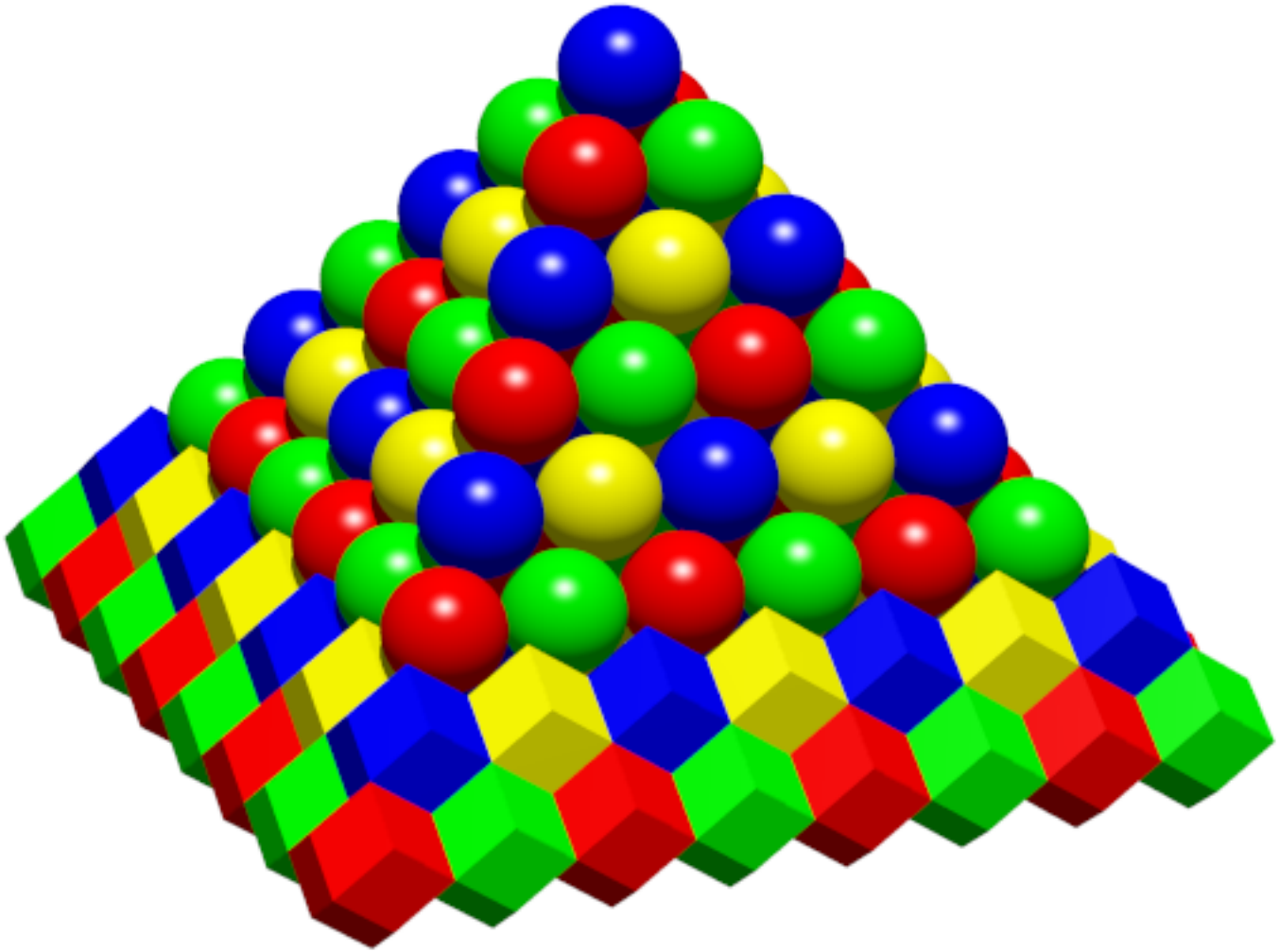


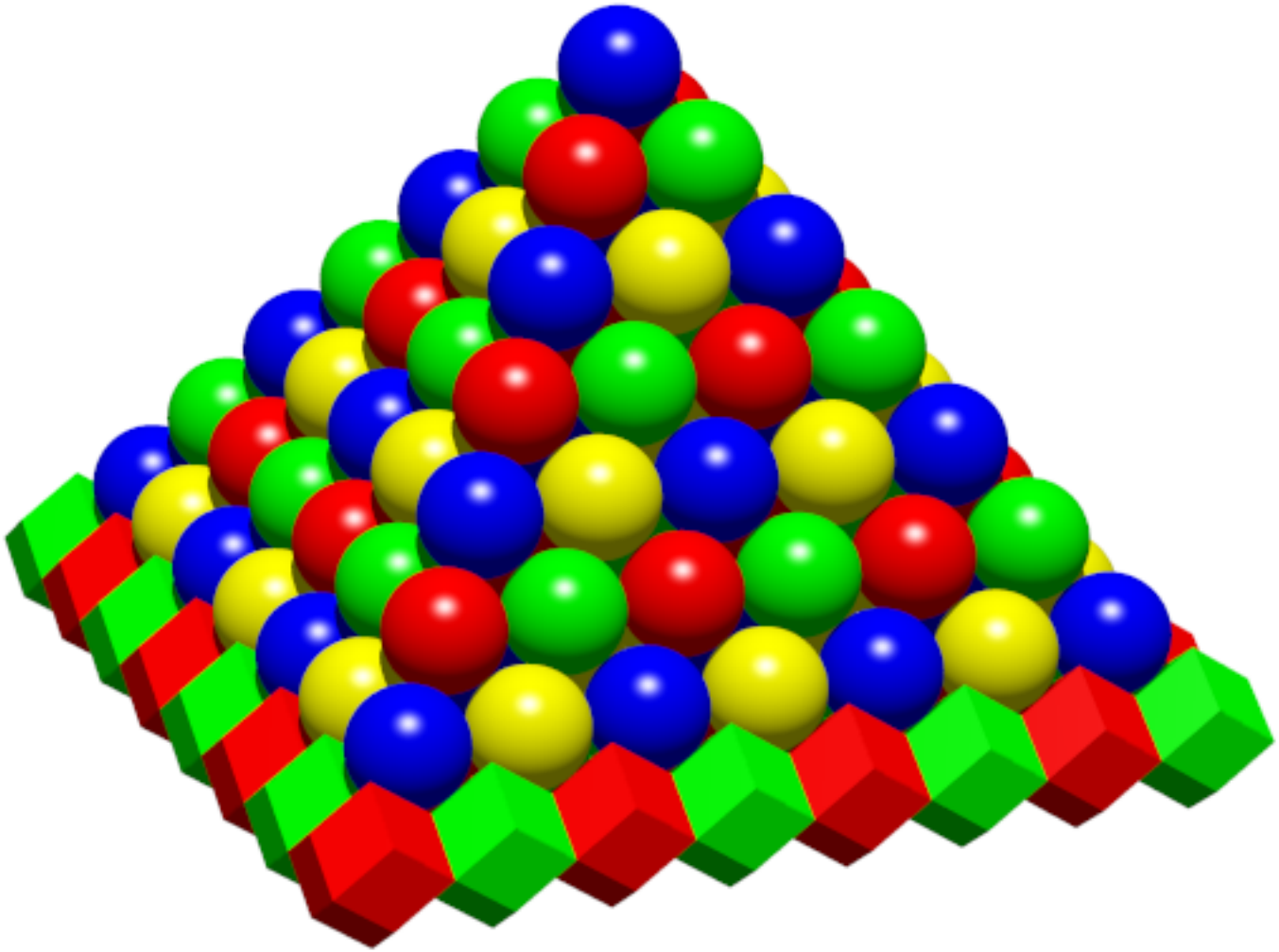




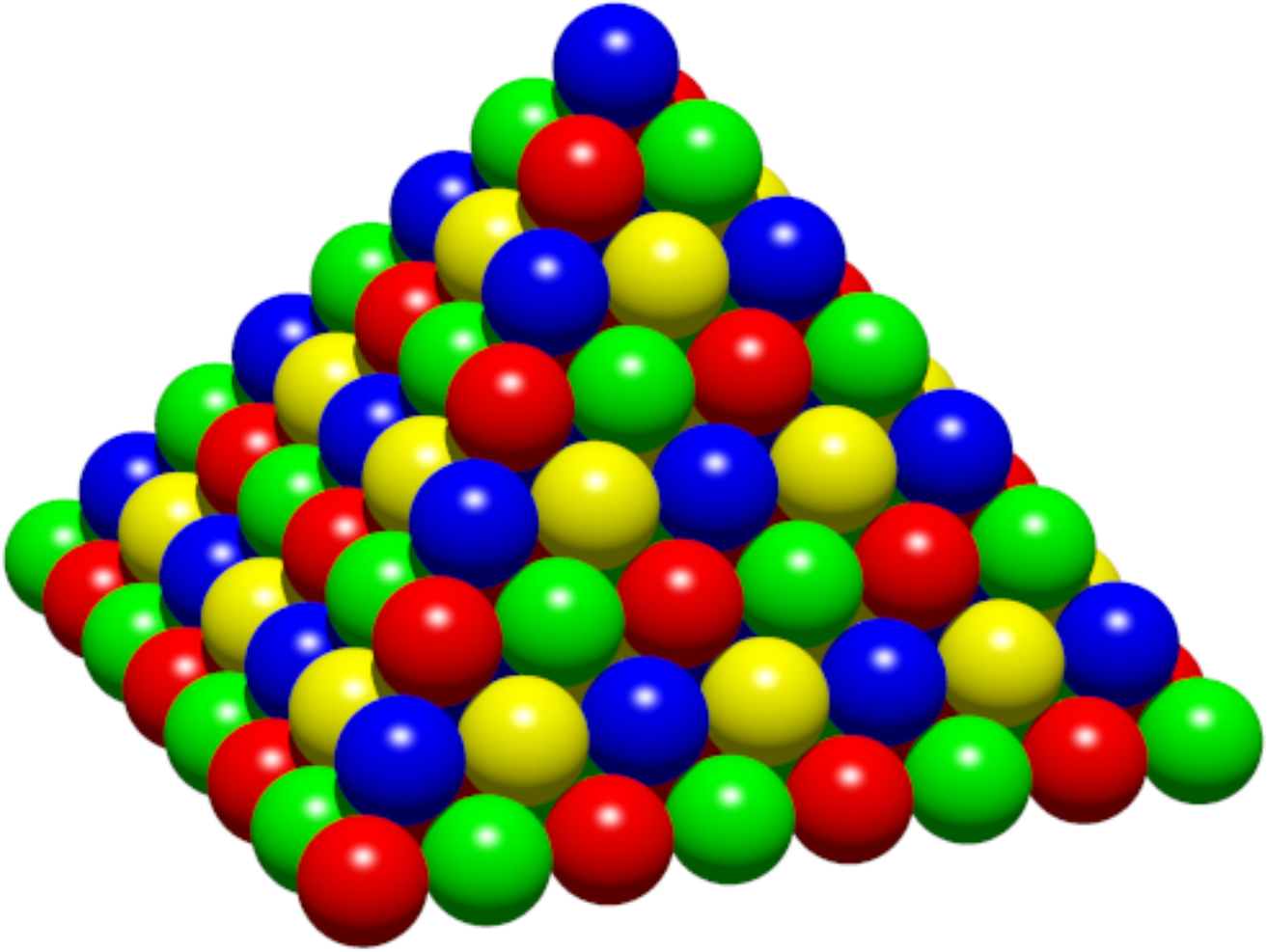








Kugelpyramide

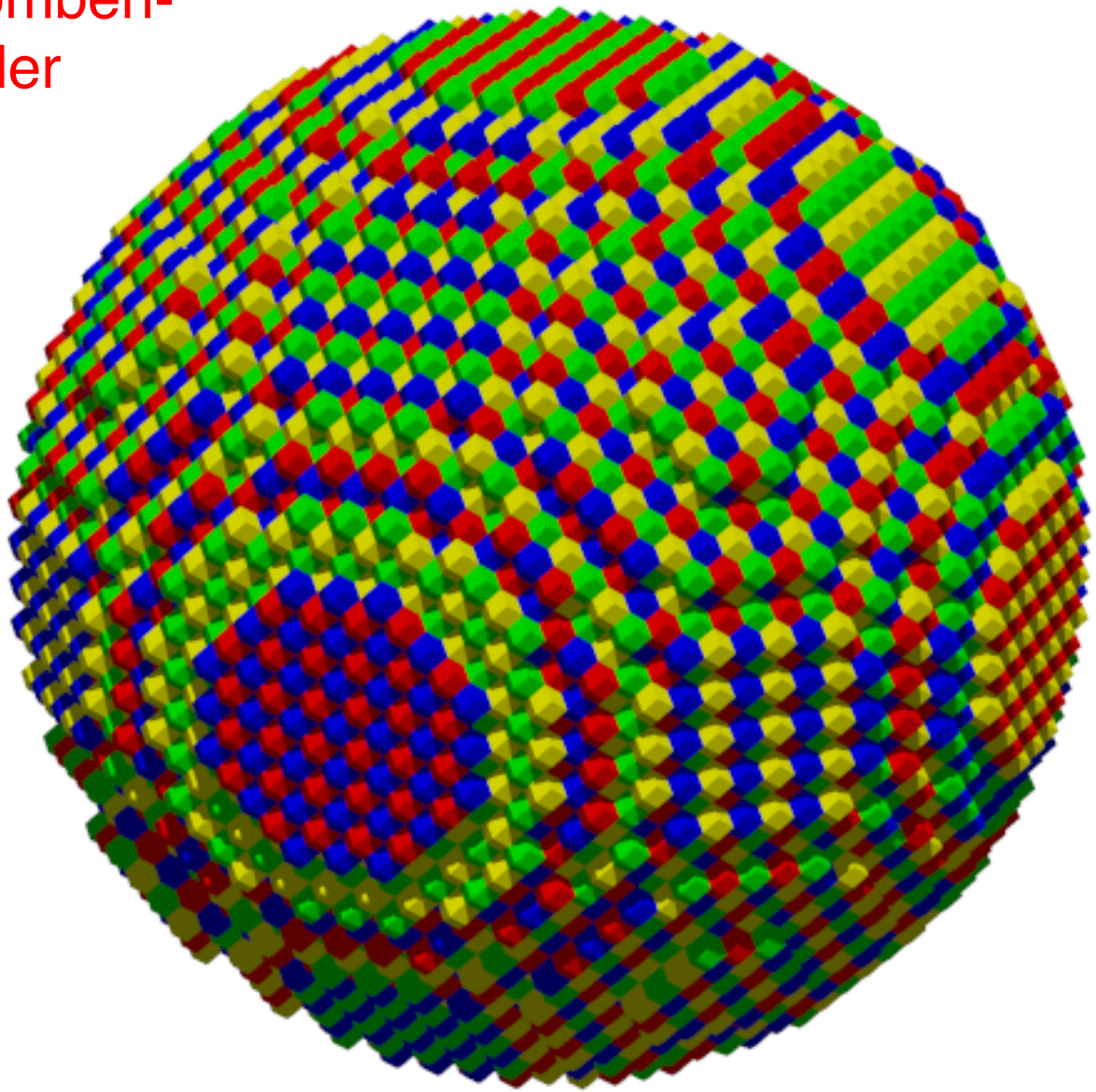


Dichteste Kugelpackung (Kepler 1611, Hales 1998-2014)

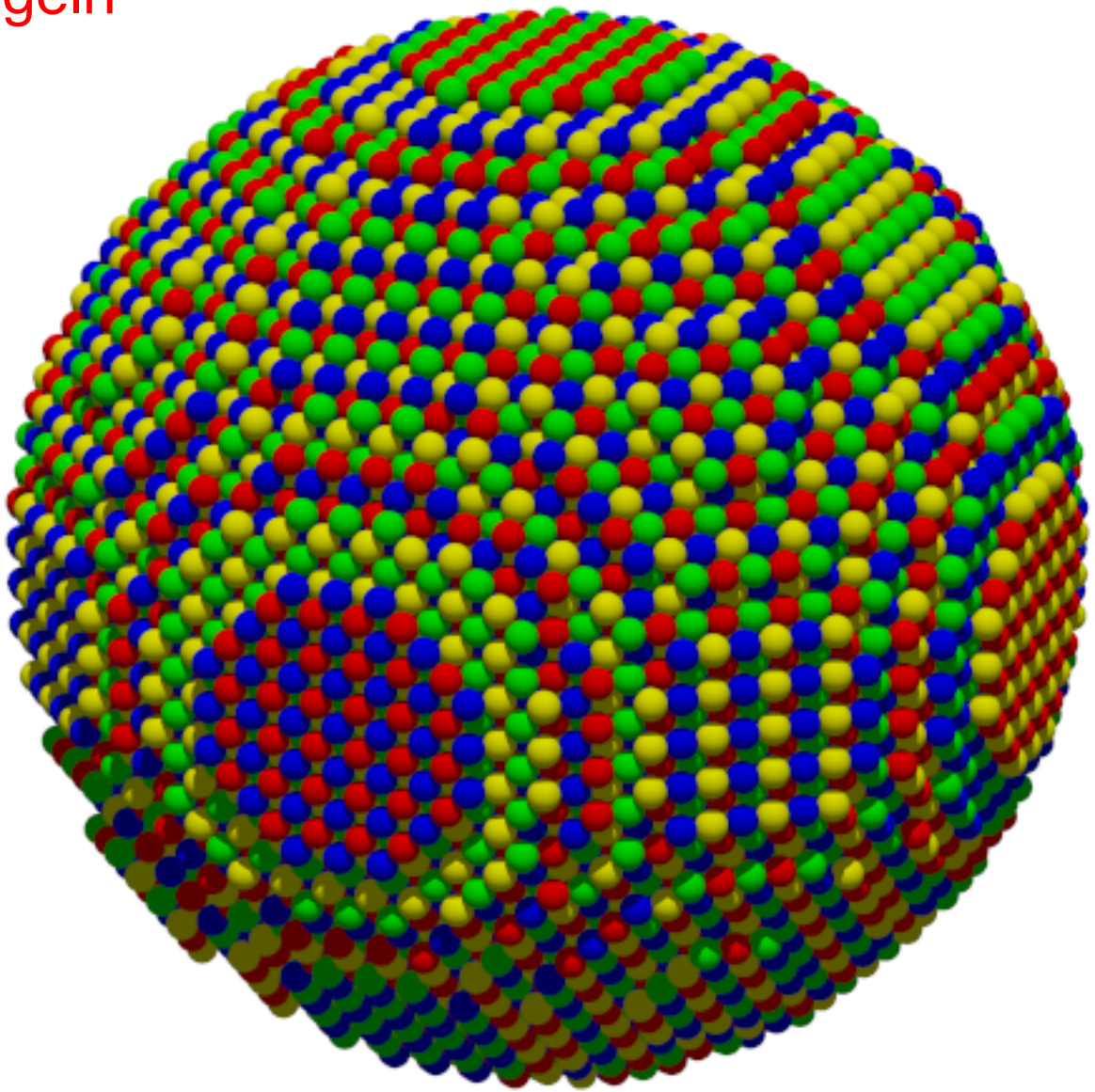
Kugelpyramide

Dichteste Kugelpackung (Kepler 1611, Hales 1998-2014)

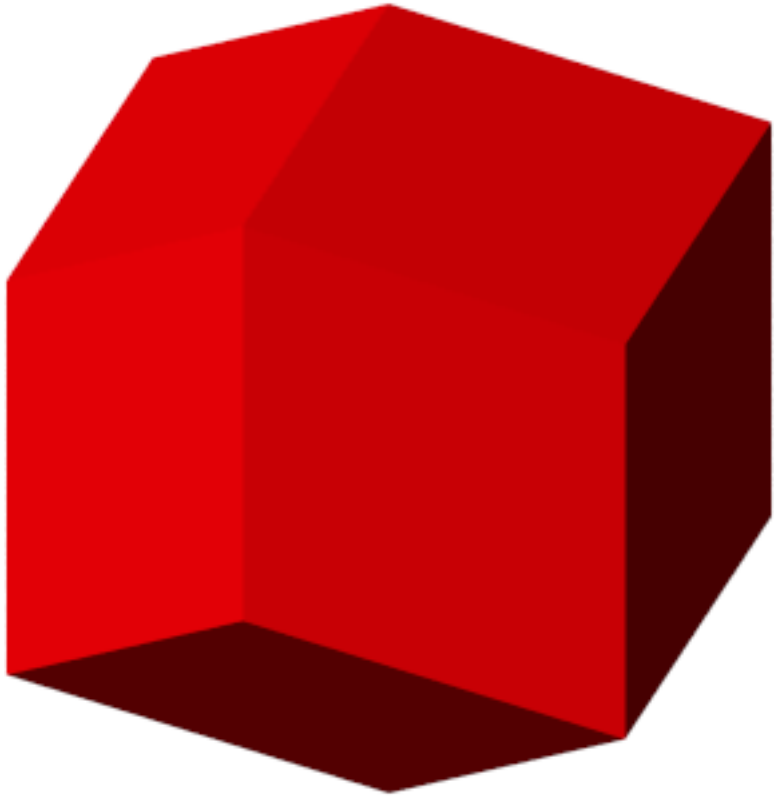
3564 Rhomben-
dodekaeder



3564 Inkugeln

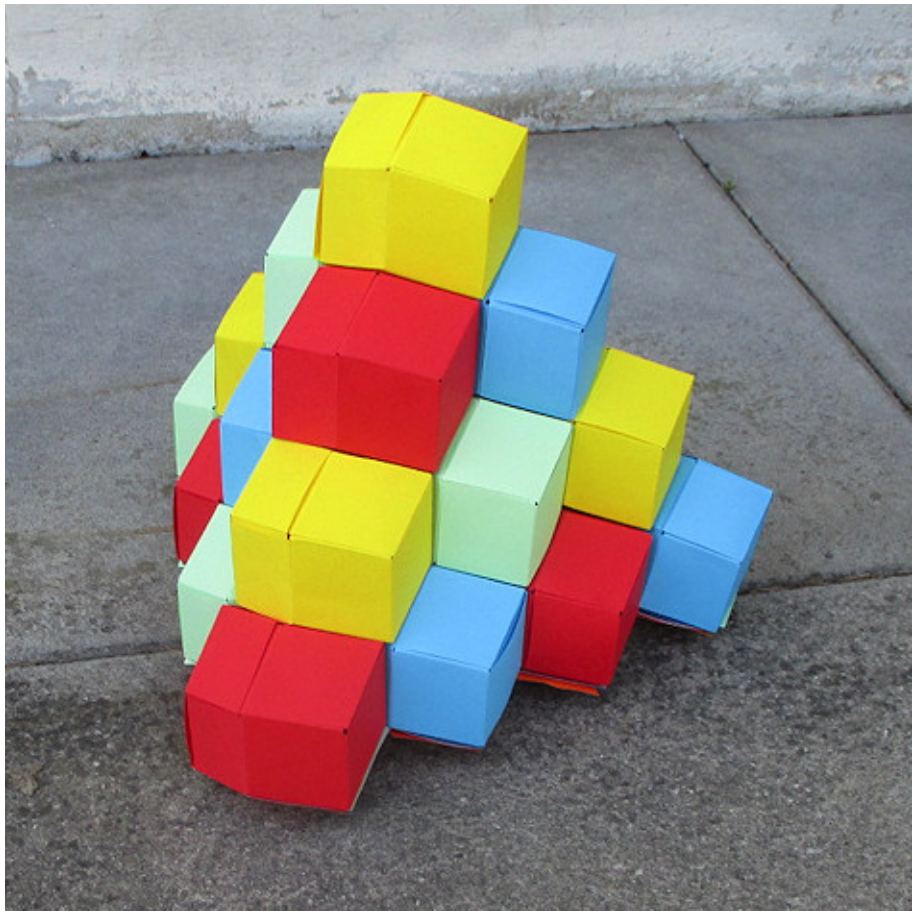


Rhombendodekaeder



Oben drei stumpfe Winkel

Das Rhombendodekaeder ist ein Raumfüller



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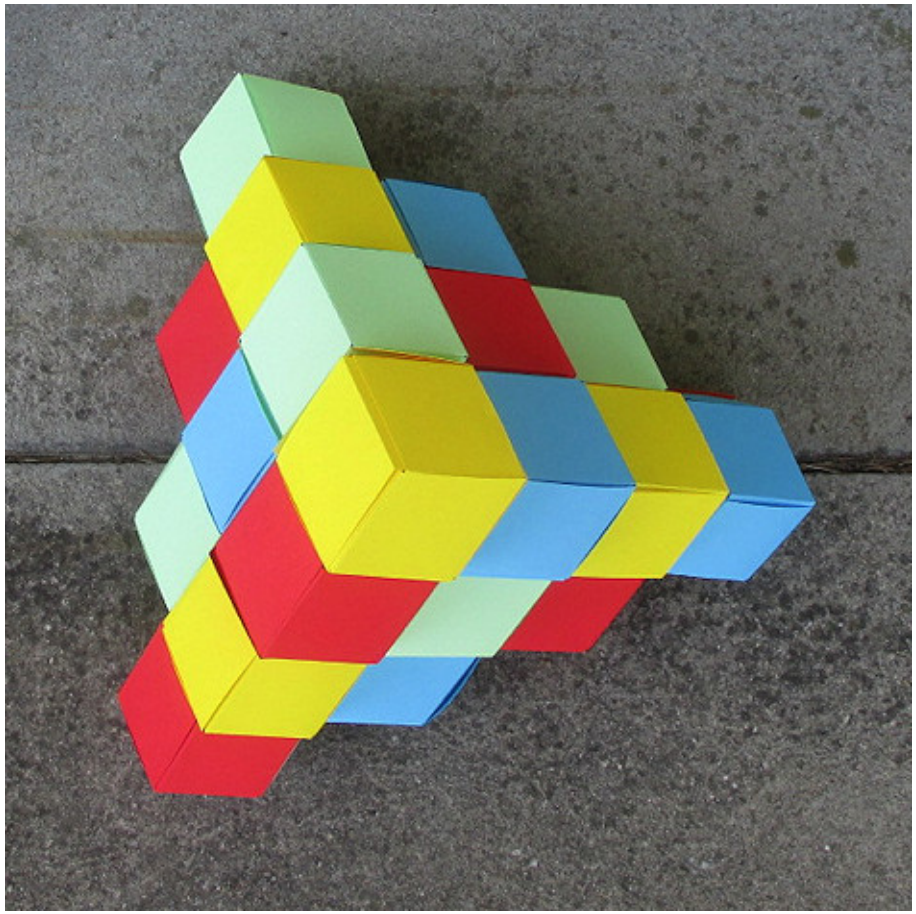

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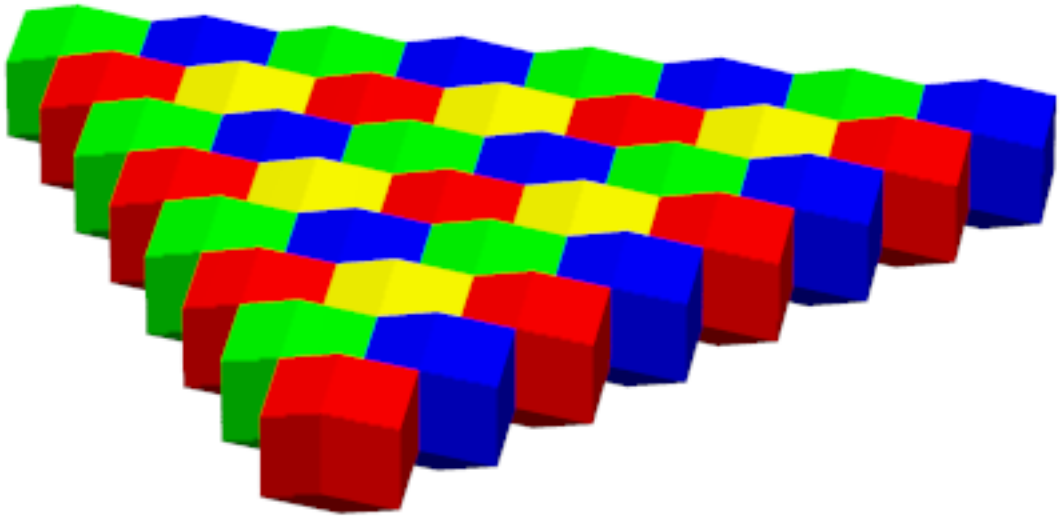

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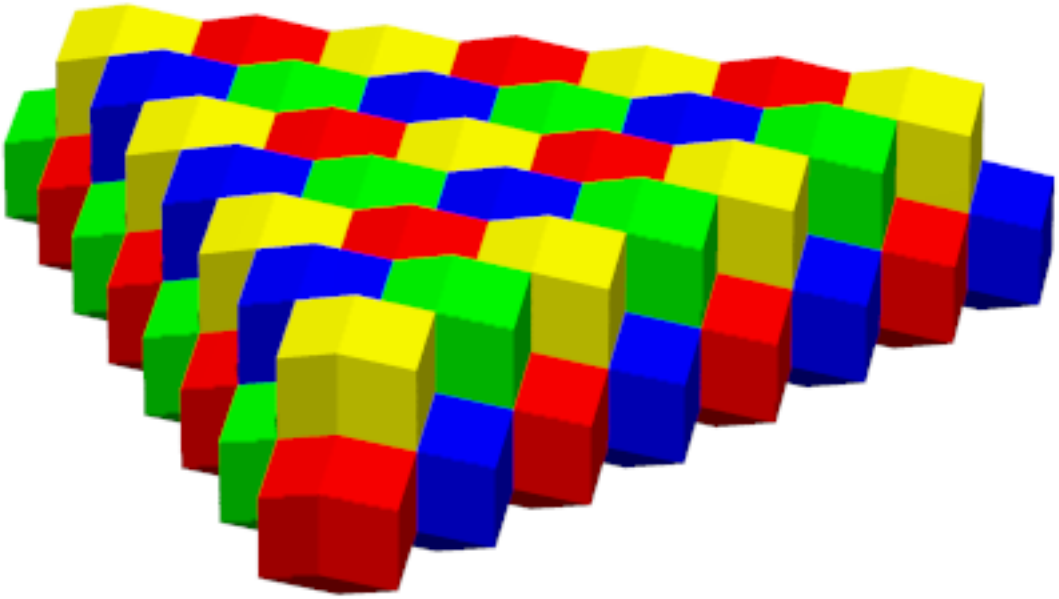

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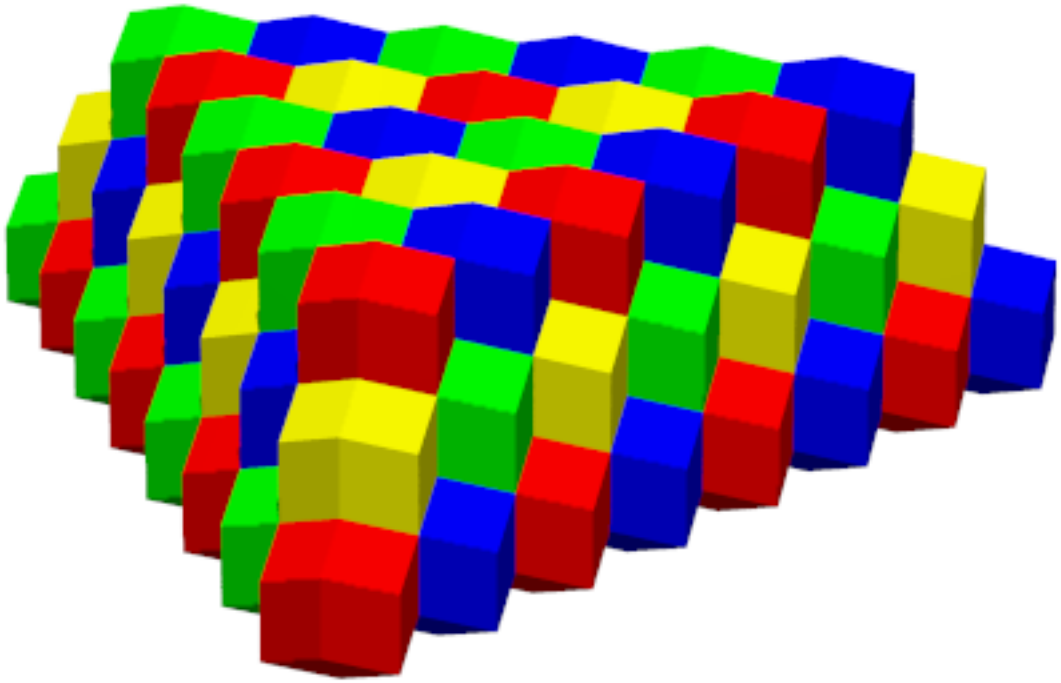

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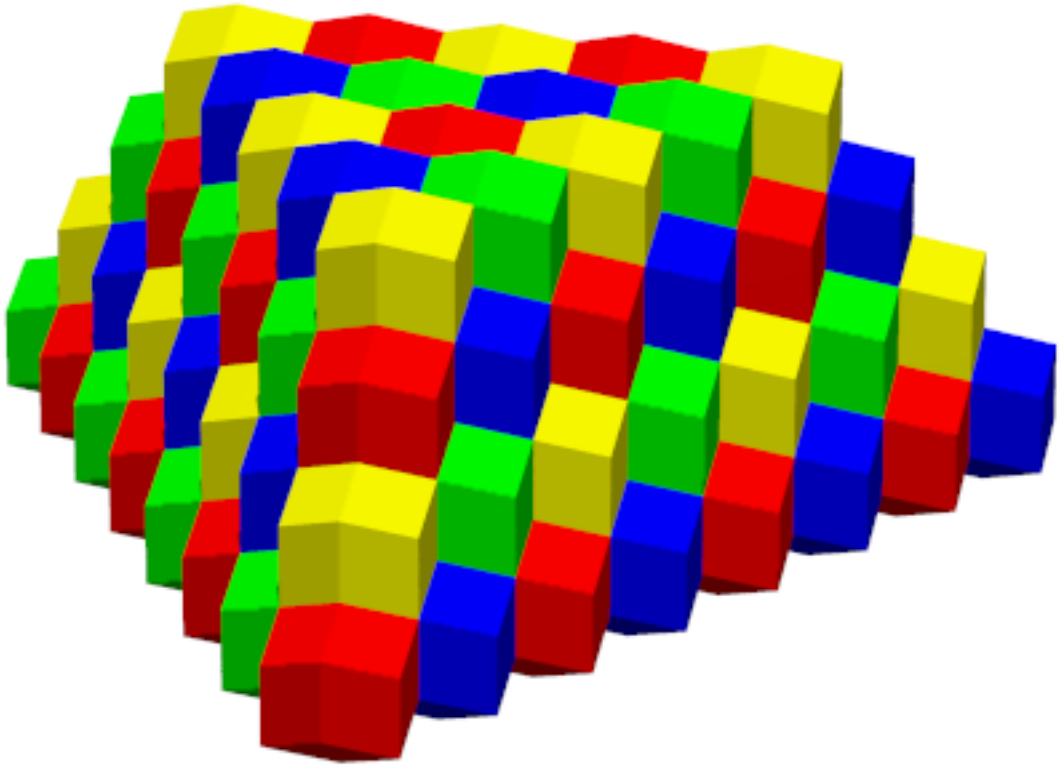

Oben drei stumpfe Winkel

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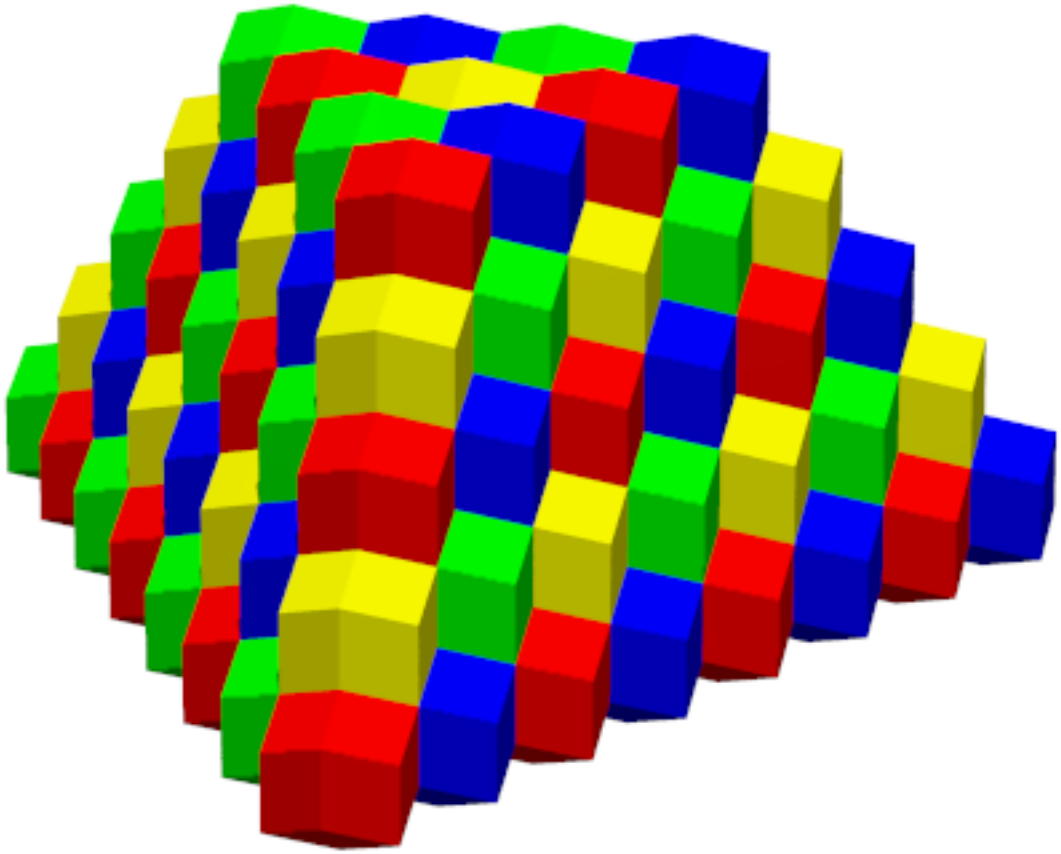

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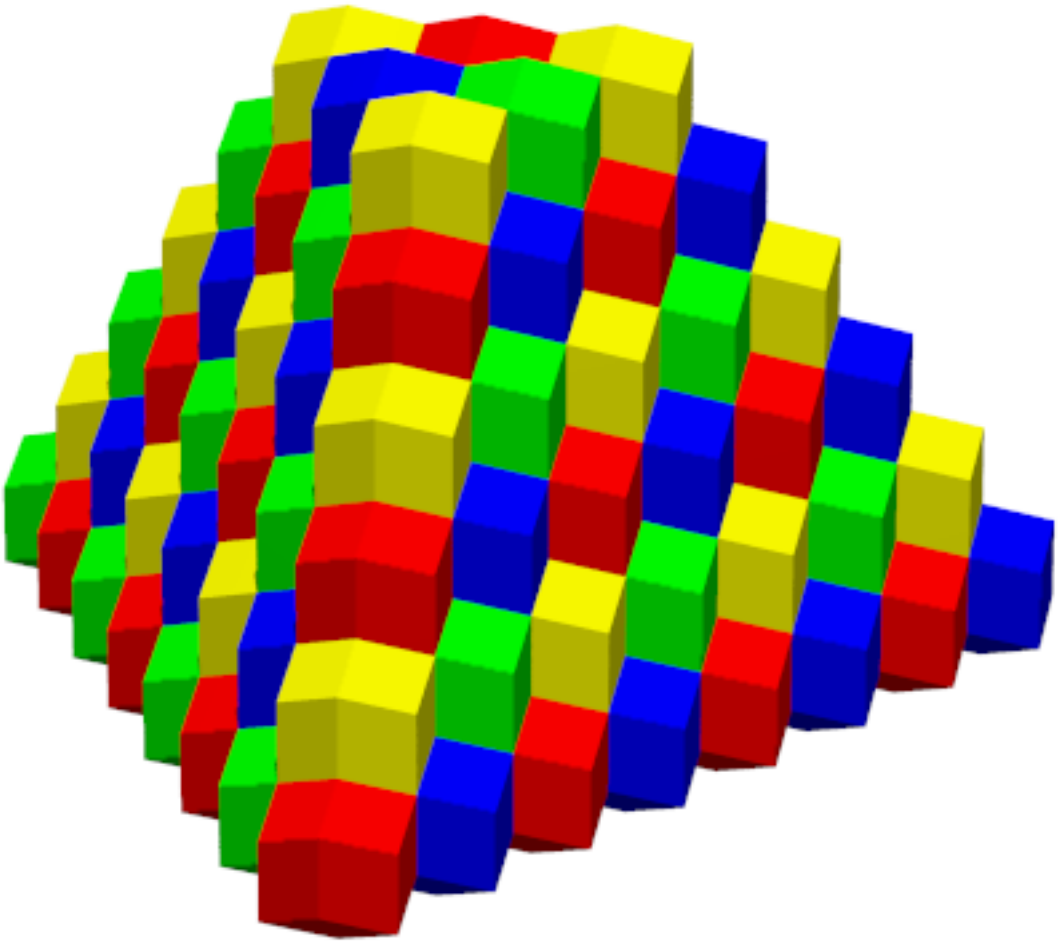
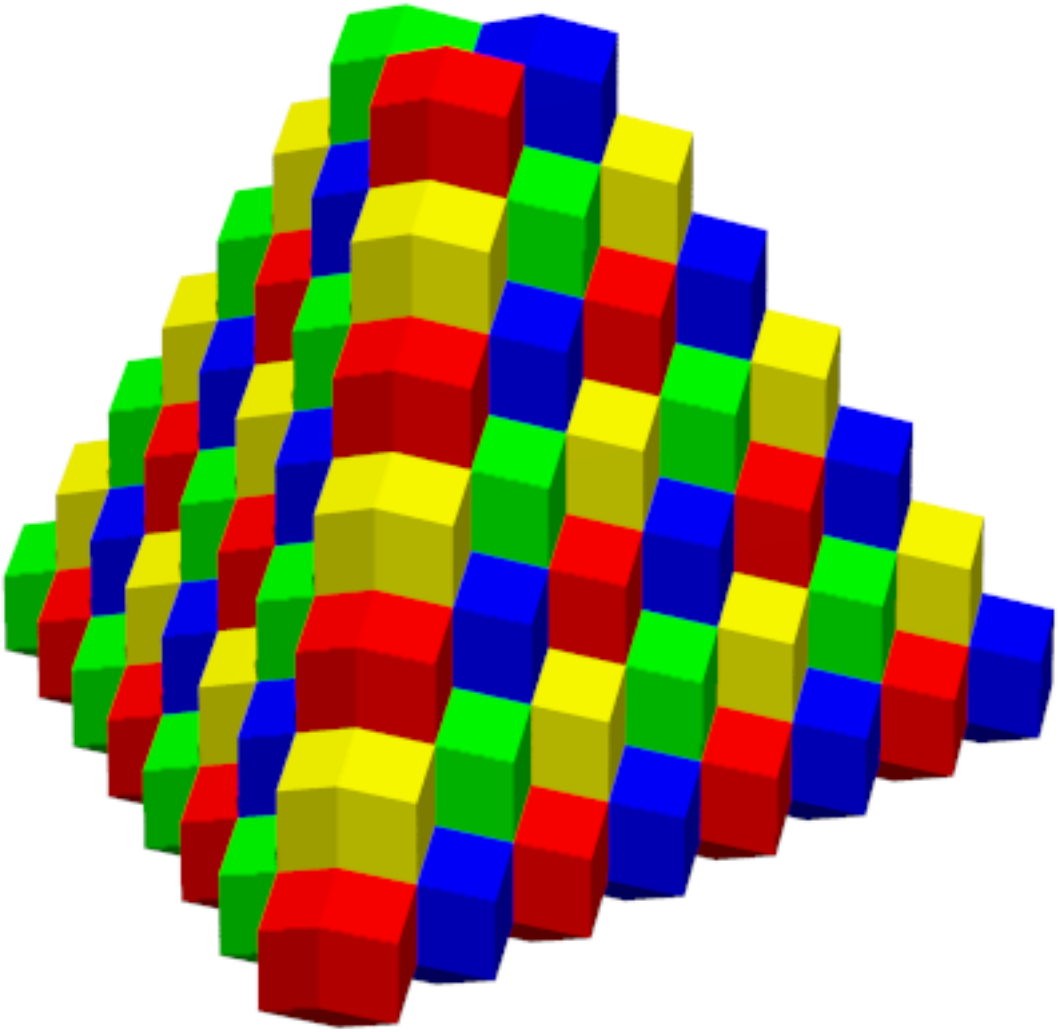


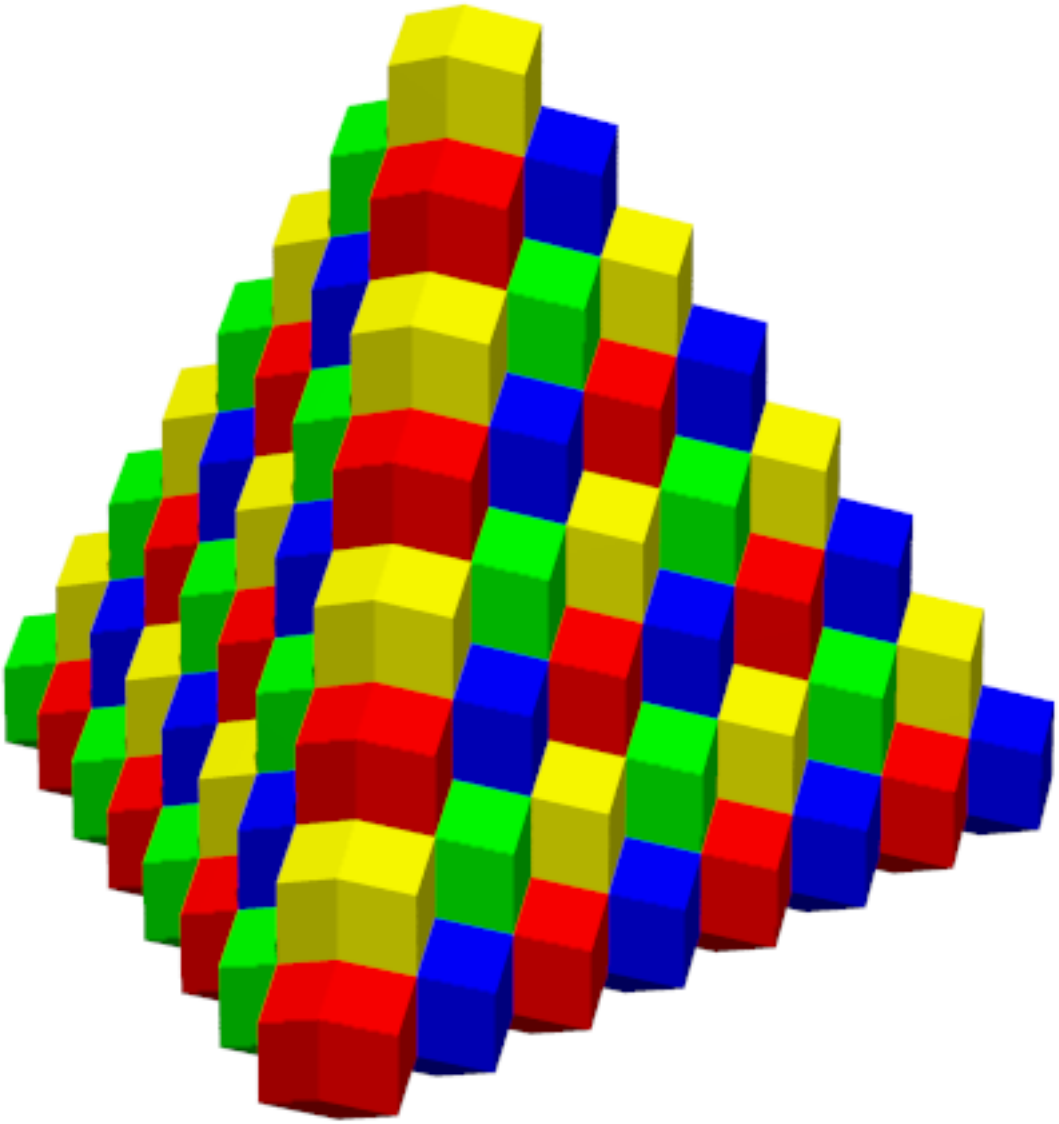
Oben drei stumpfe Winkel

Das Rhombendodekaeder ist ein Raumfüller



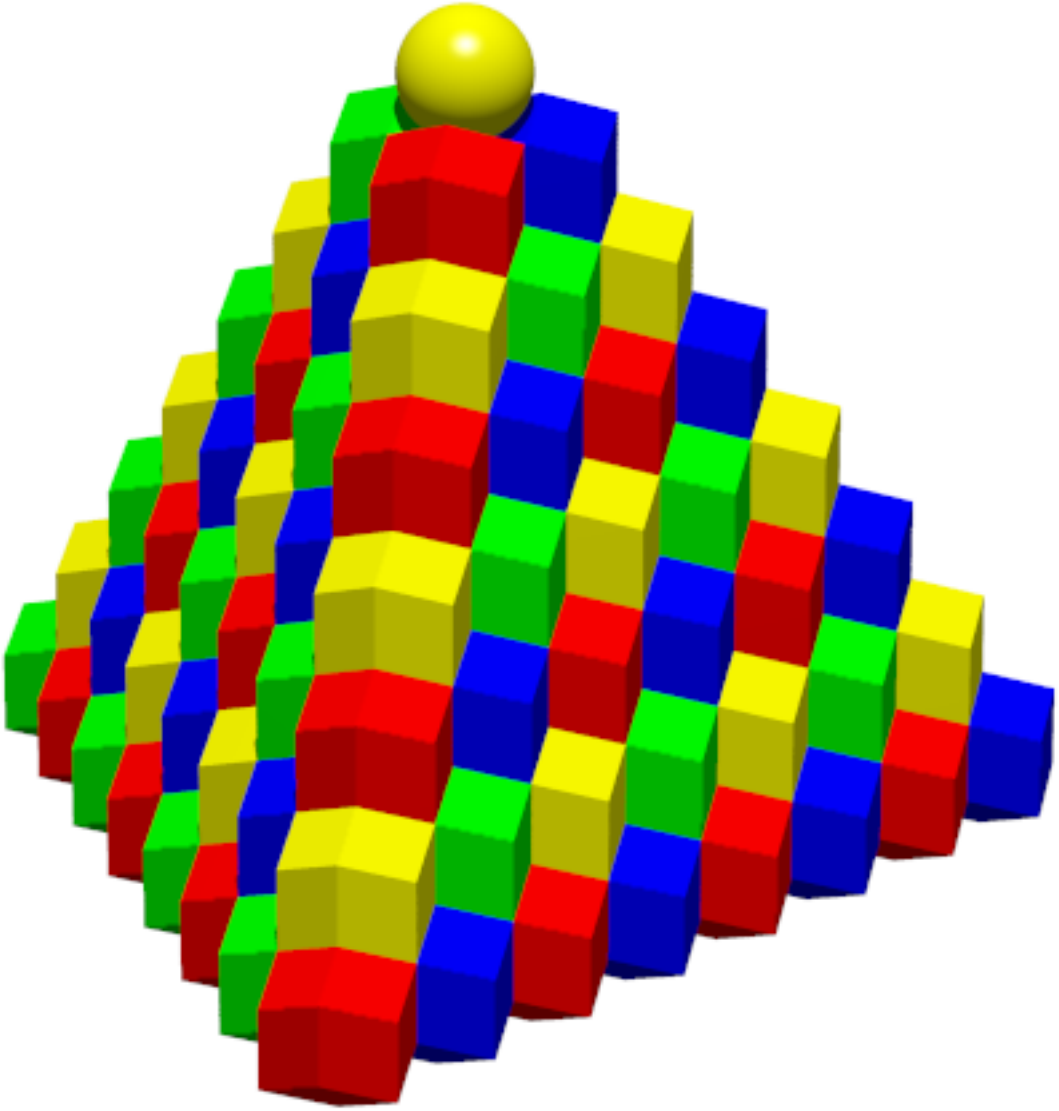
Oben drei stumpfe Winkel

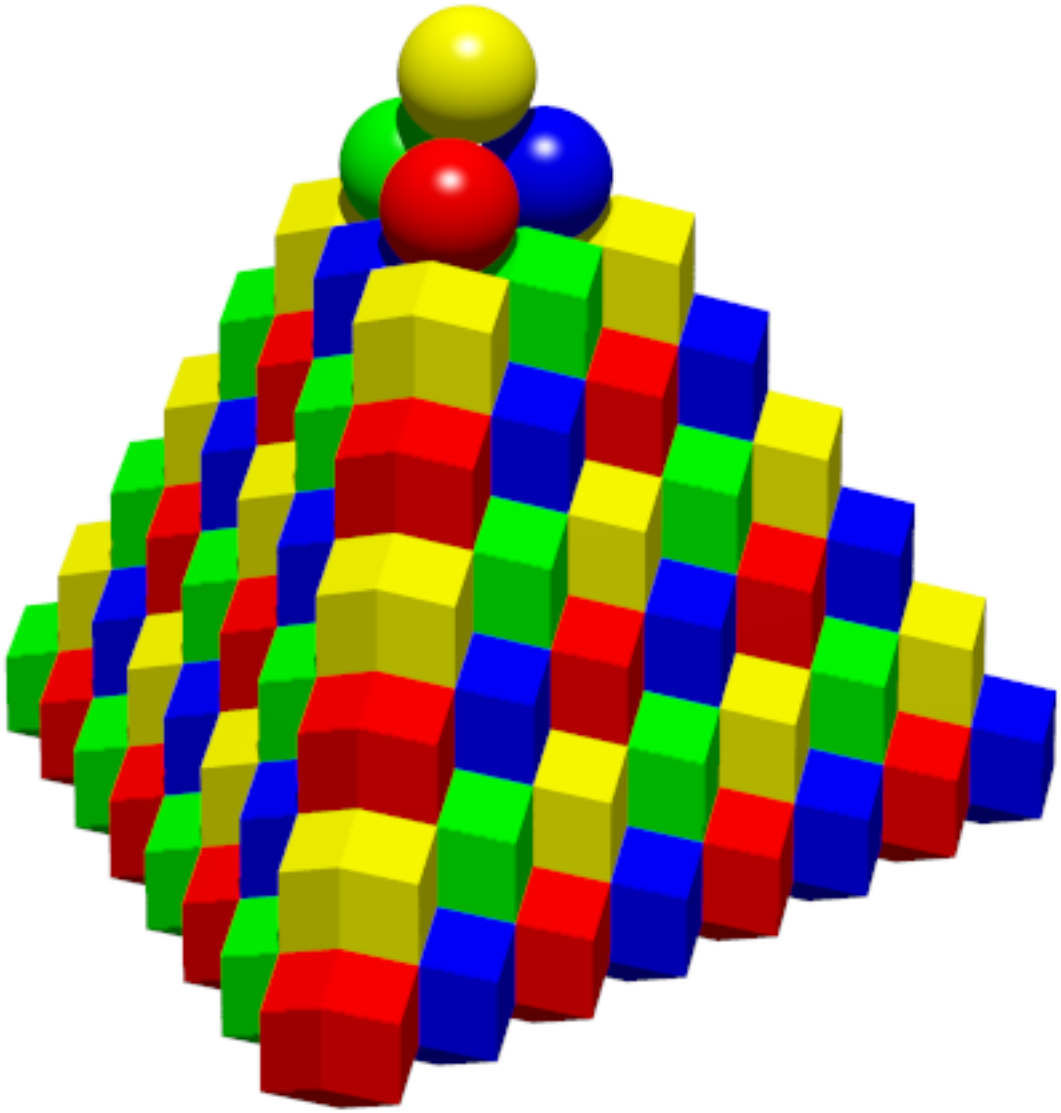
Tetraeder

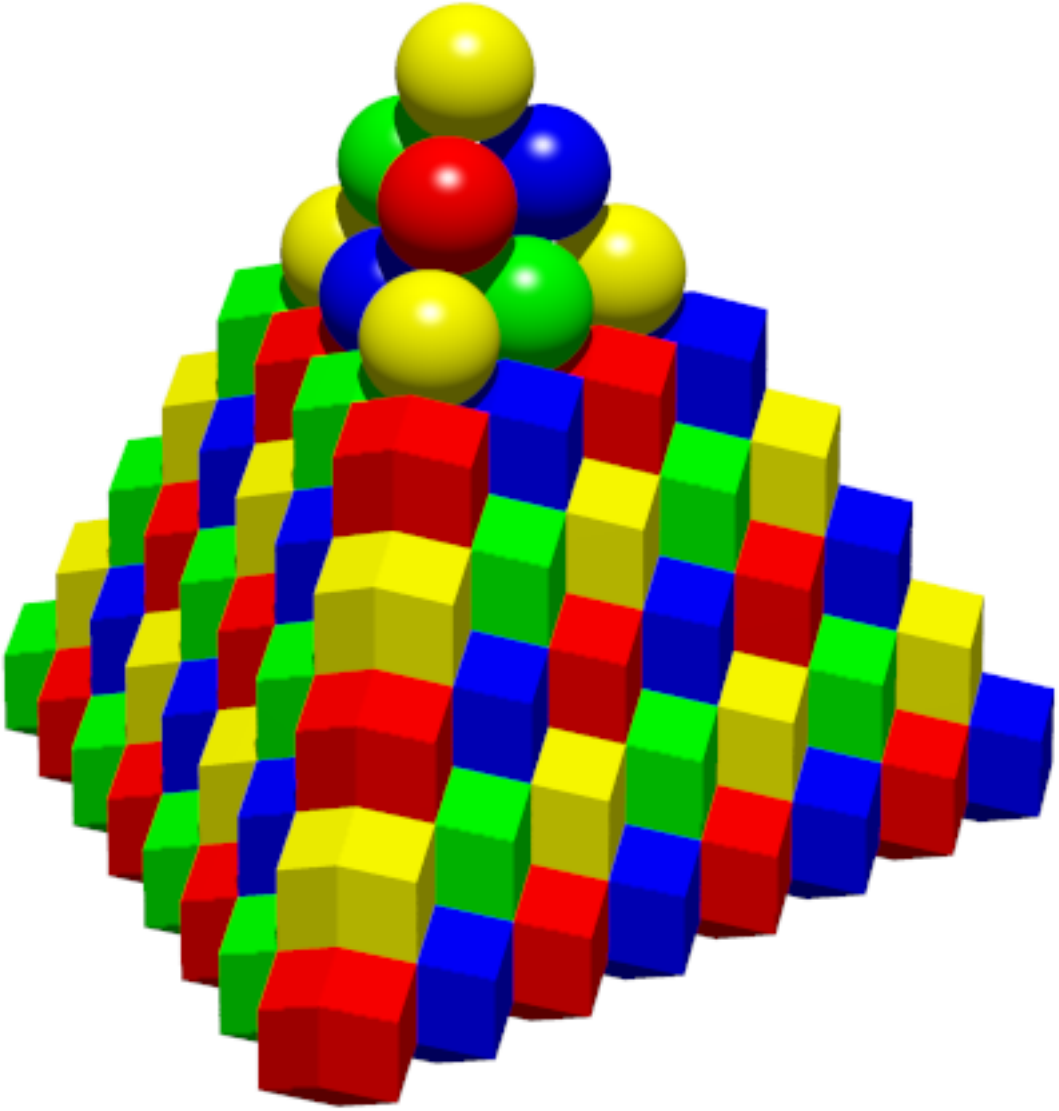


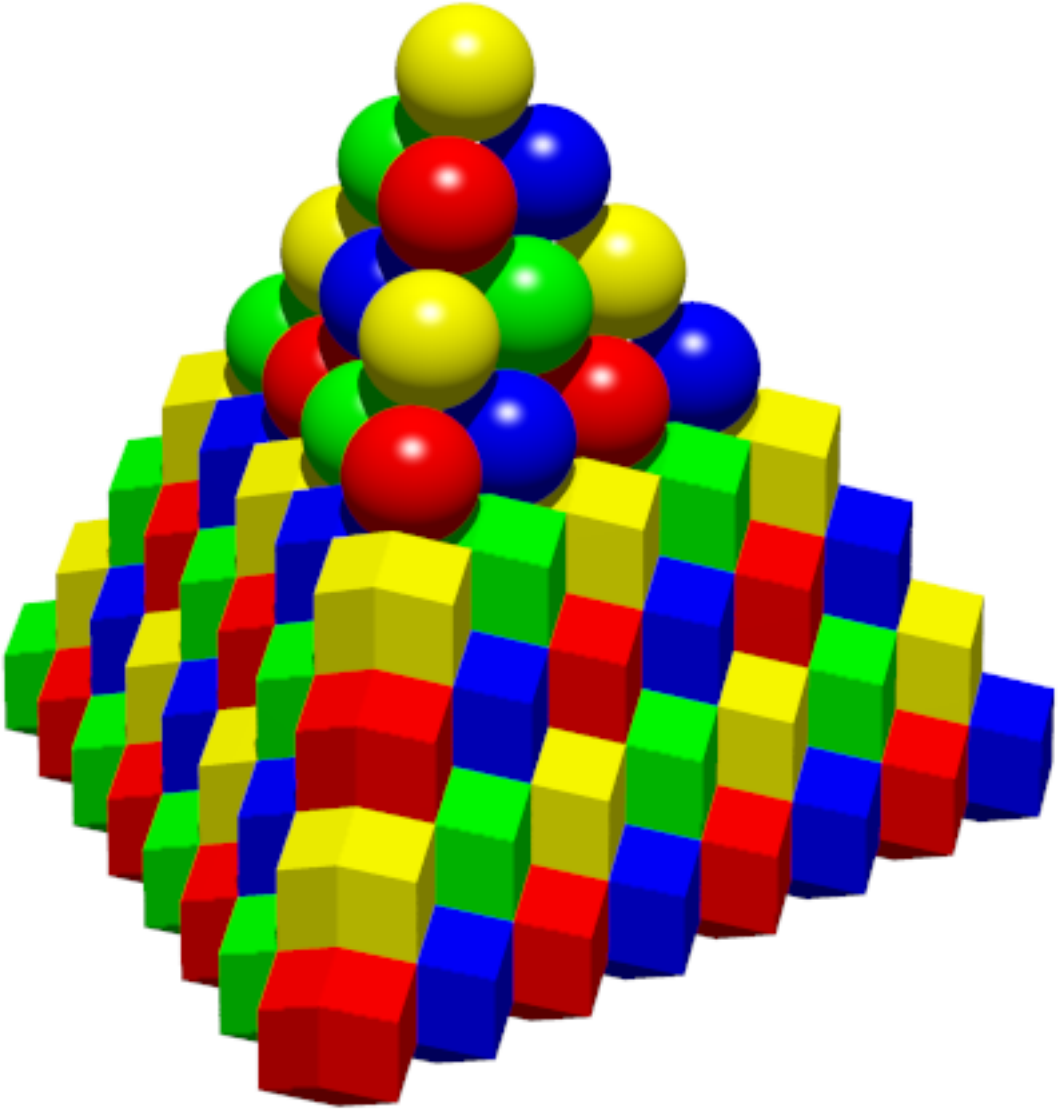
Oben drei stumpfe Winkel

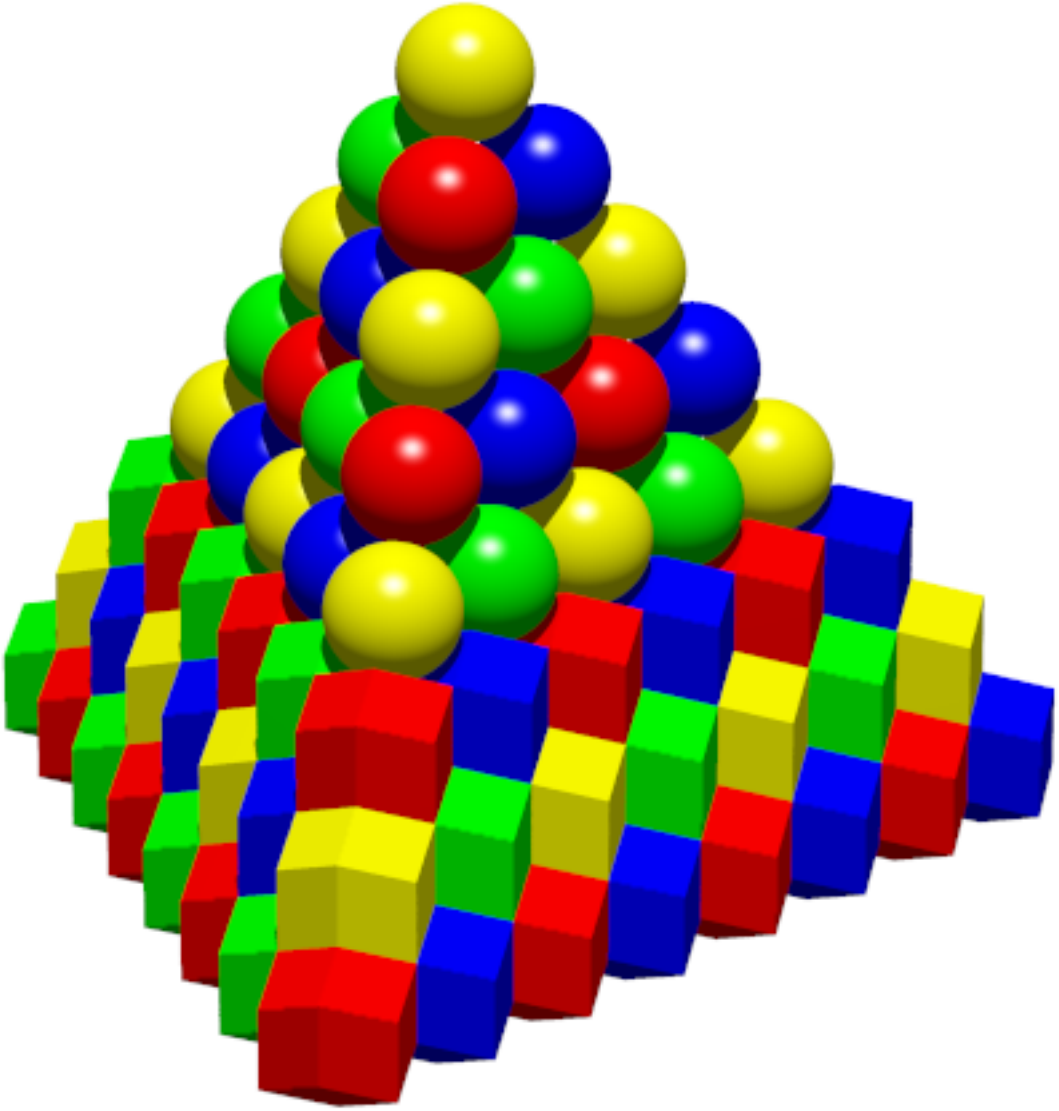
Inkugel

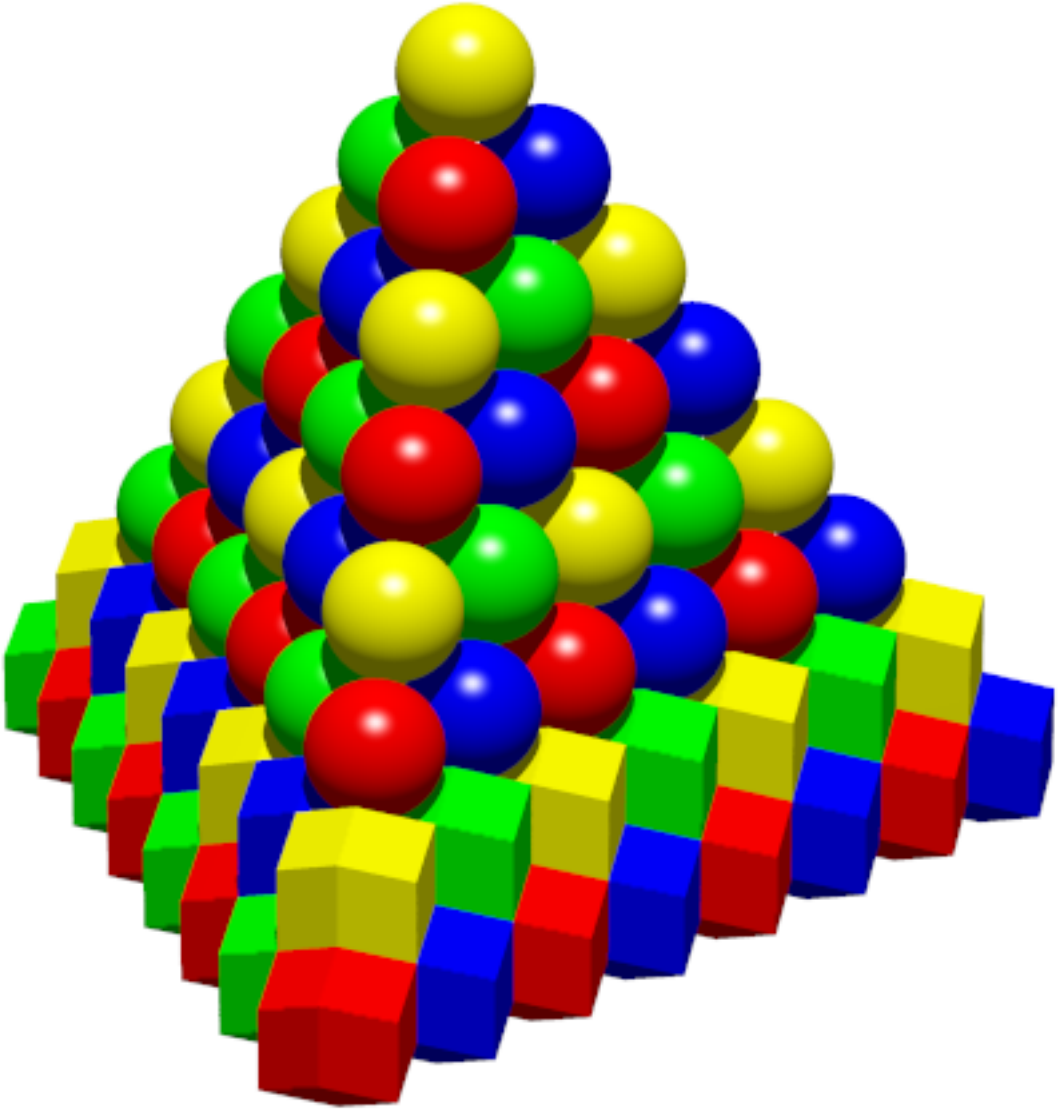


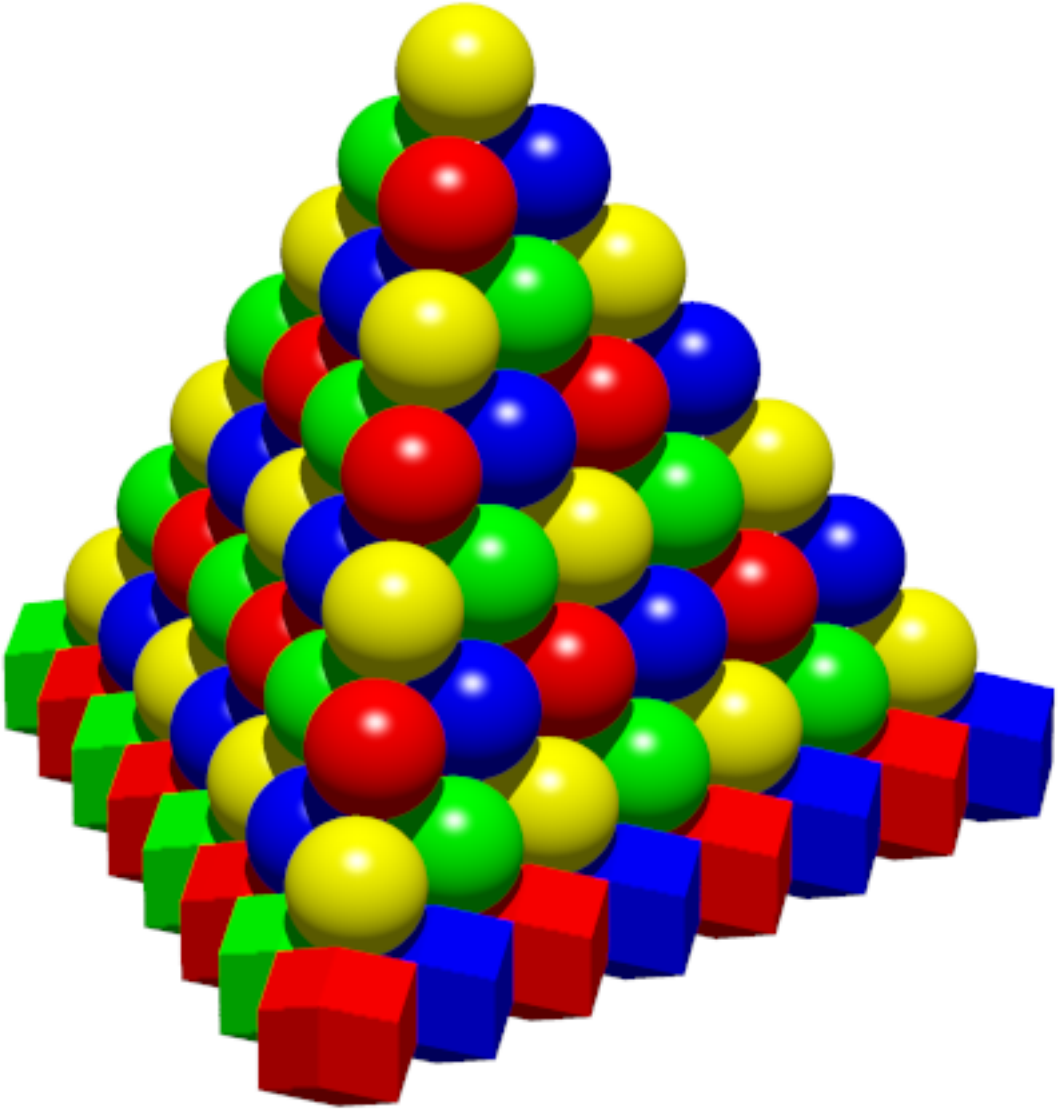




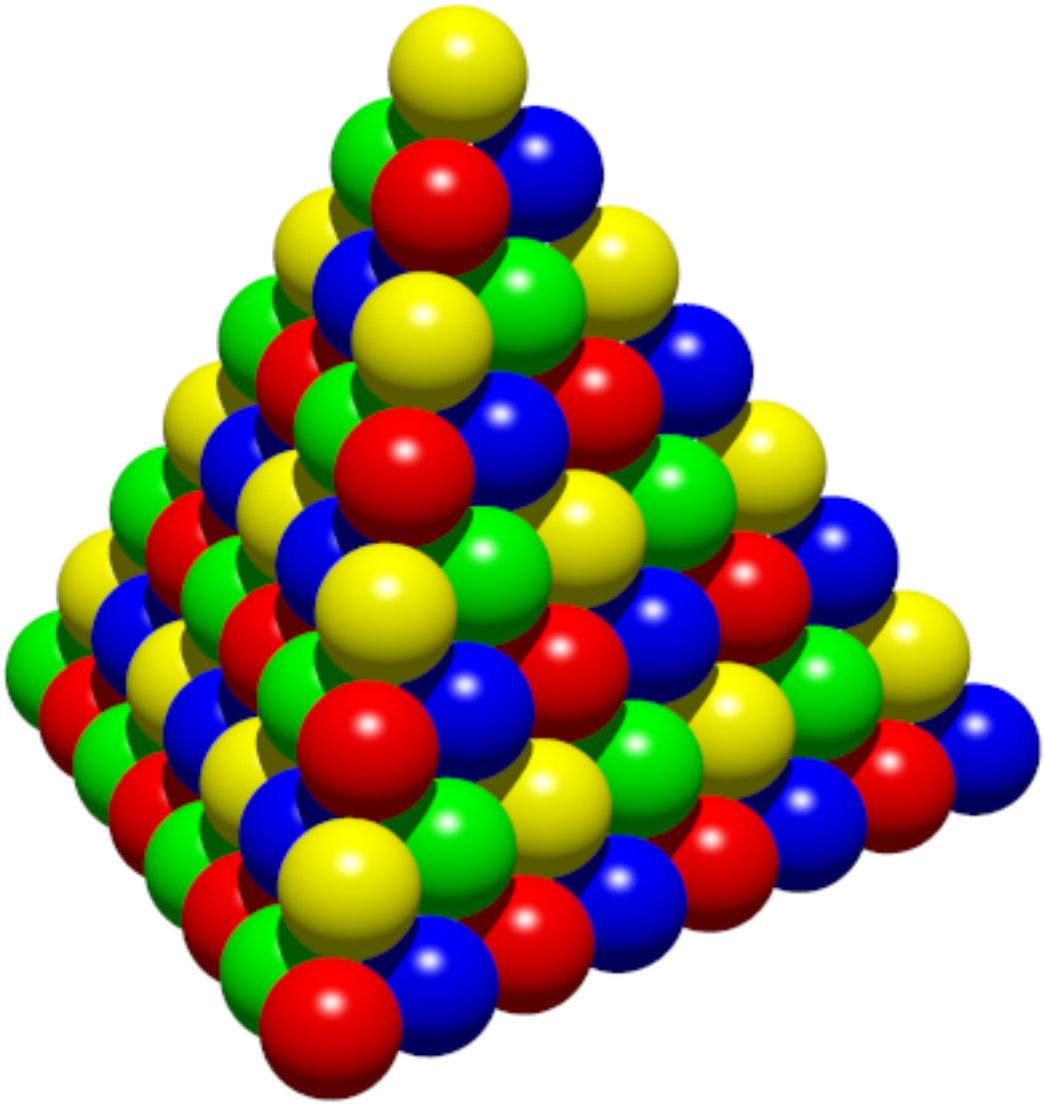






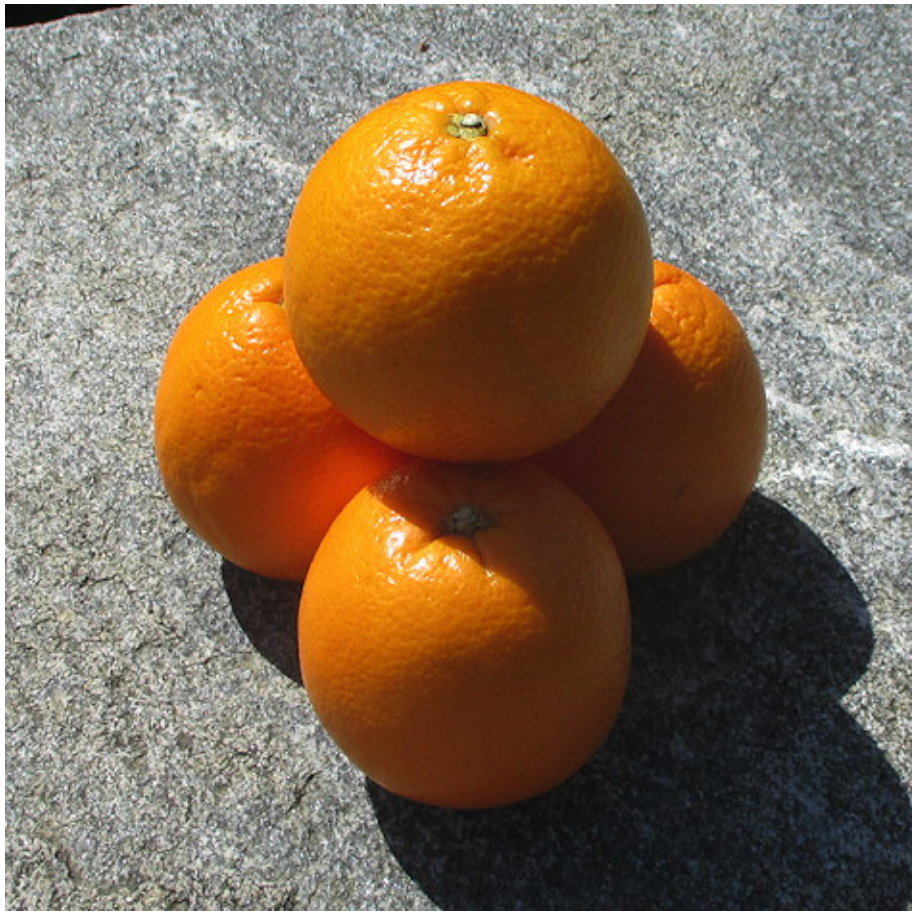


Kugel-Tetraeder



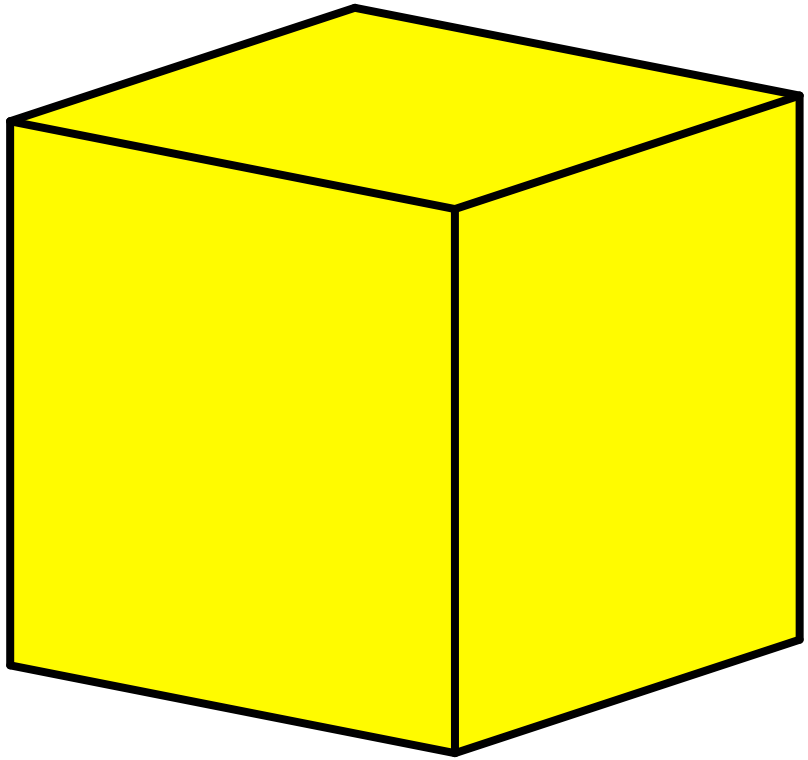
Dichteste Kugelpackung (Kepler 1611, Hales 1998-2014)

Kugel-Tetraeder



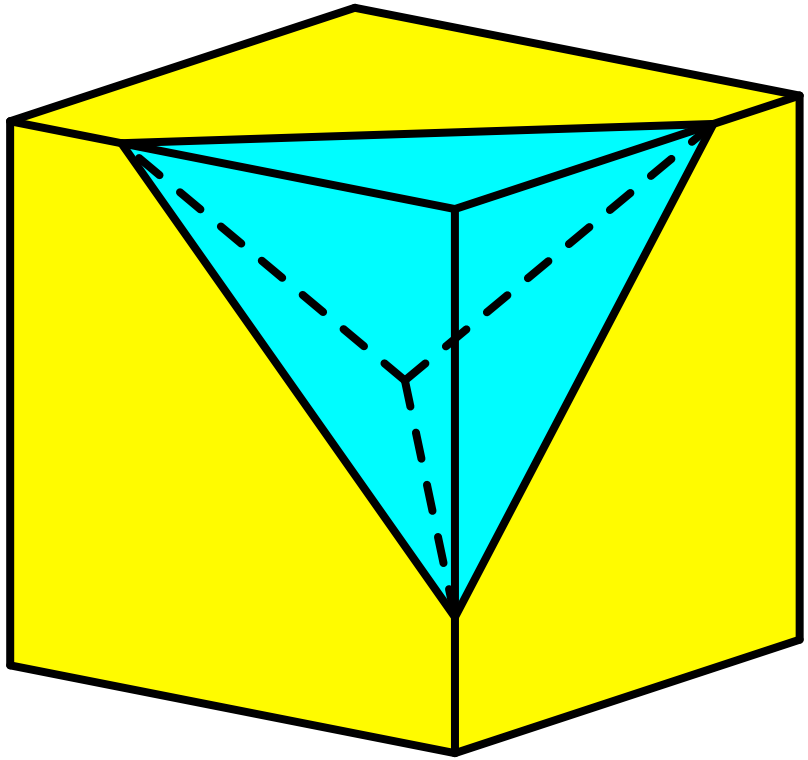
Dichteste Kugelpackung (Kepler 1611, Hales 1998-2014)

Origami im Raum



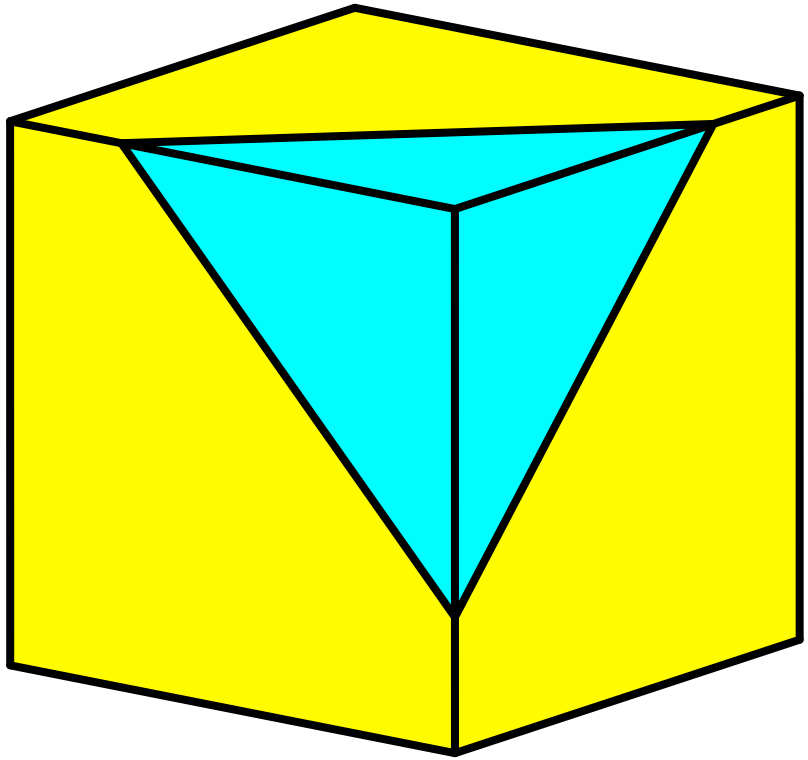
„Falten“ im vierdimensionalen Raum

Origami im Raum



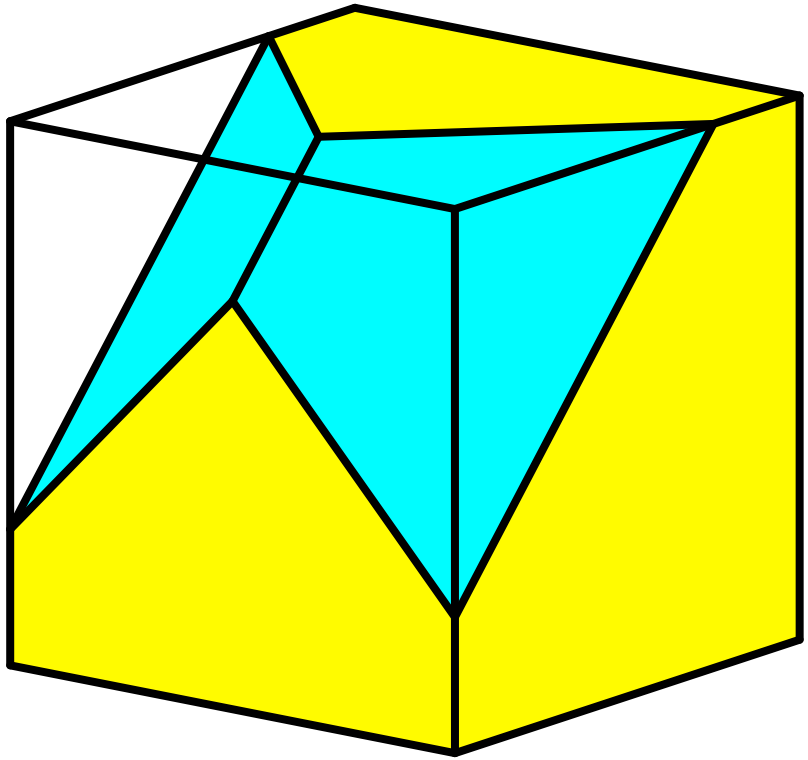
Ecken einfalten

Origami im Raum



Ecken einfalten

Origami im Raum



Ecken einfalten

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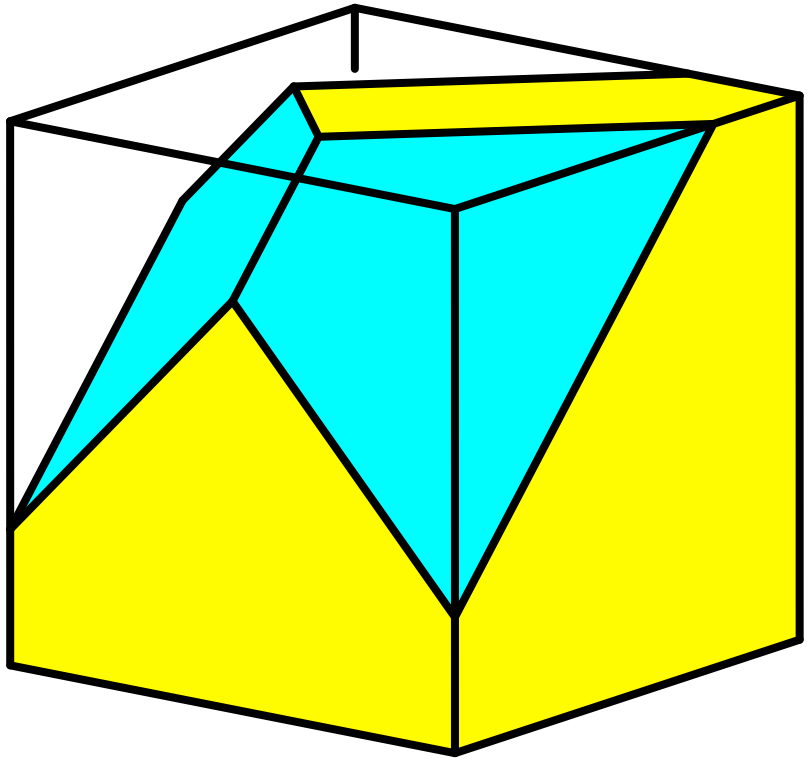
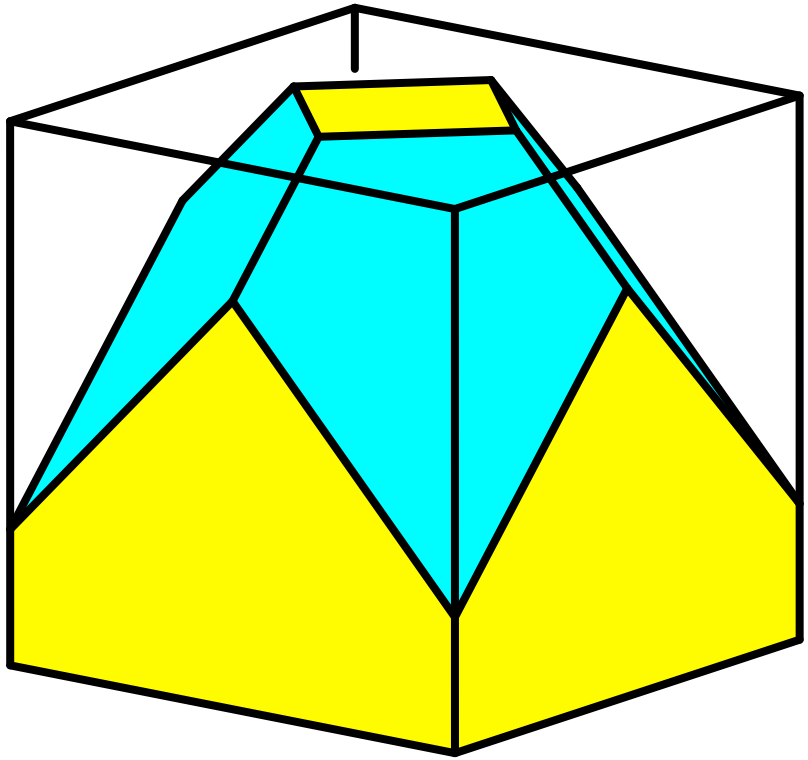


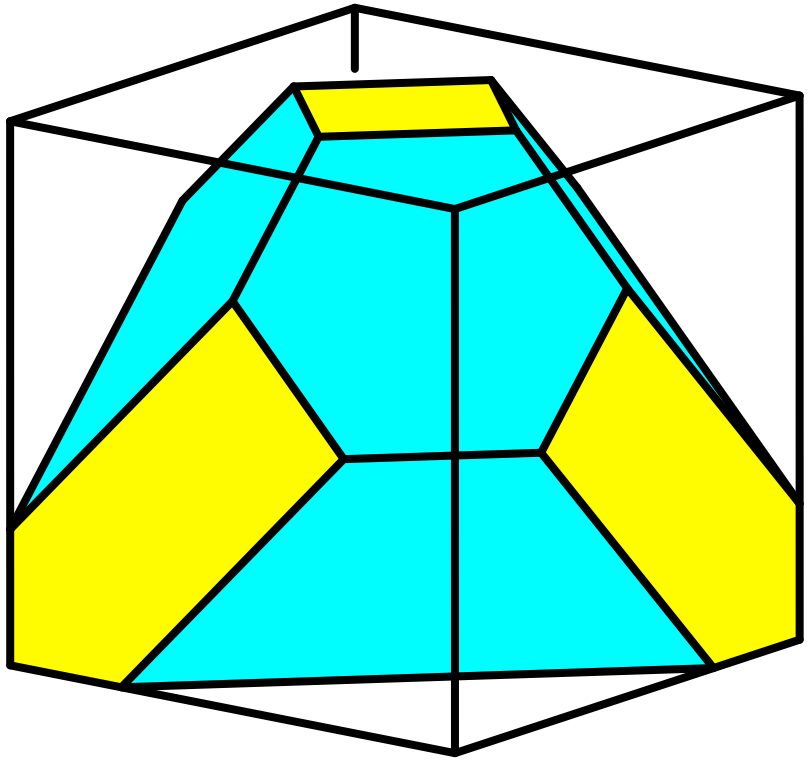
Ecken einfalten

Origami im Raum



Ecken einfalten

Origami im Raum



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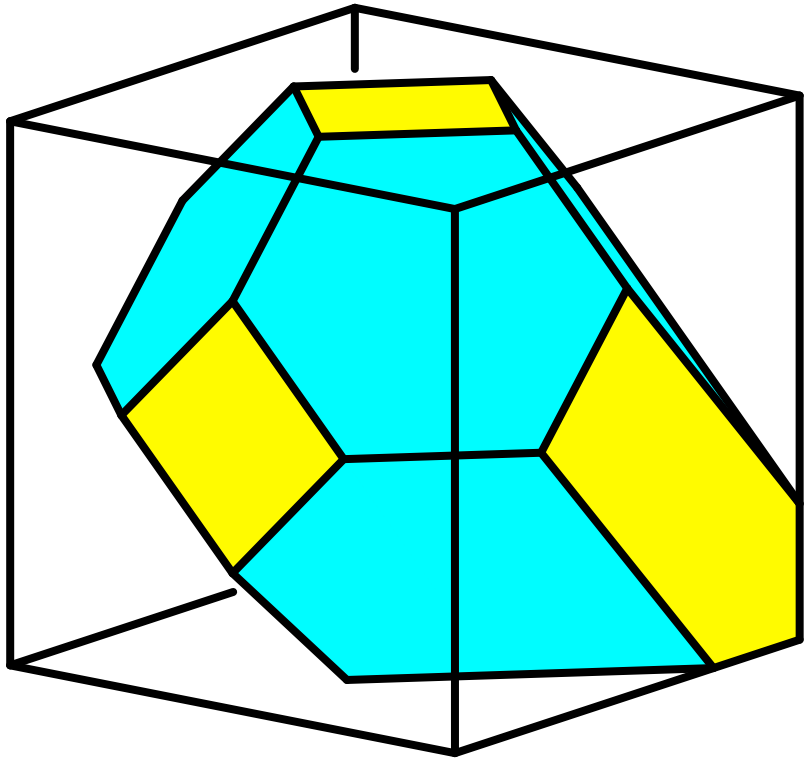
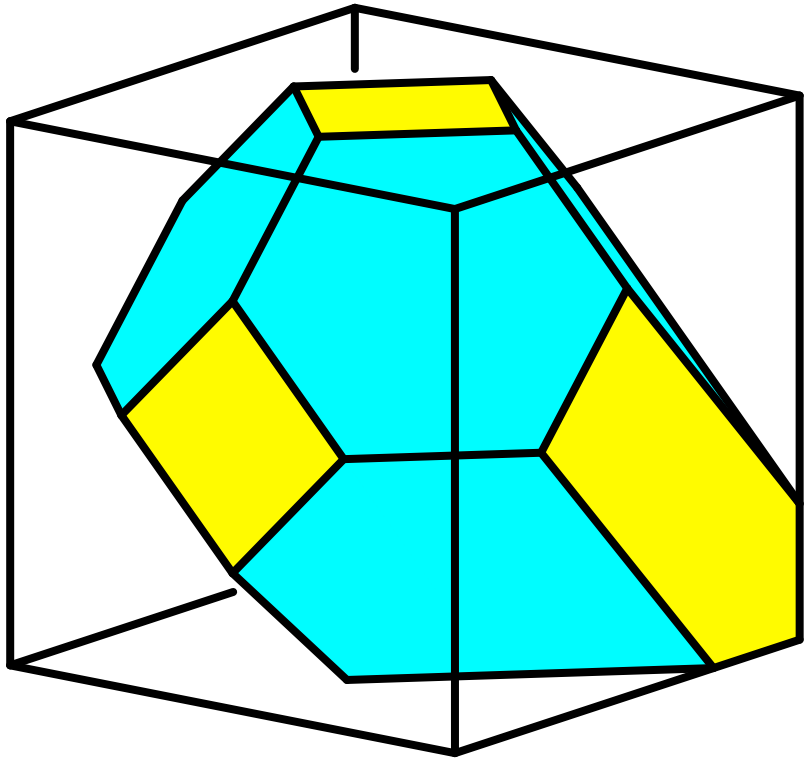


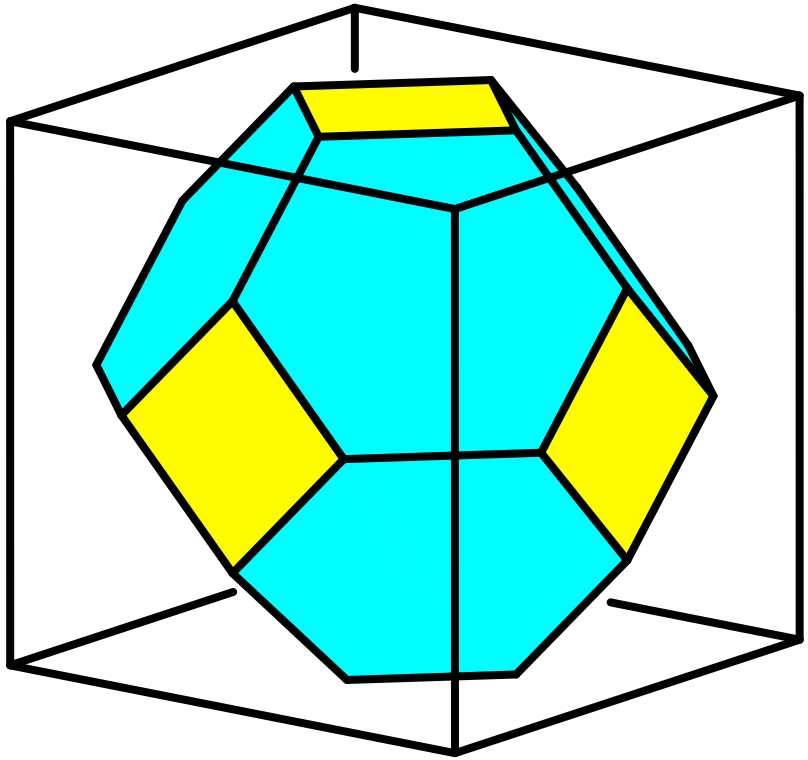
Ecken einfalten

Origami im Raum



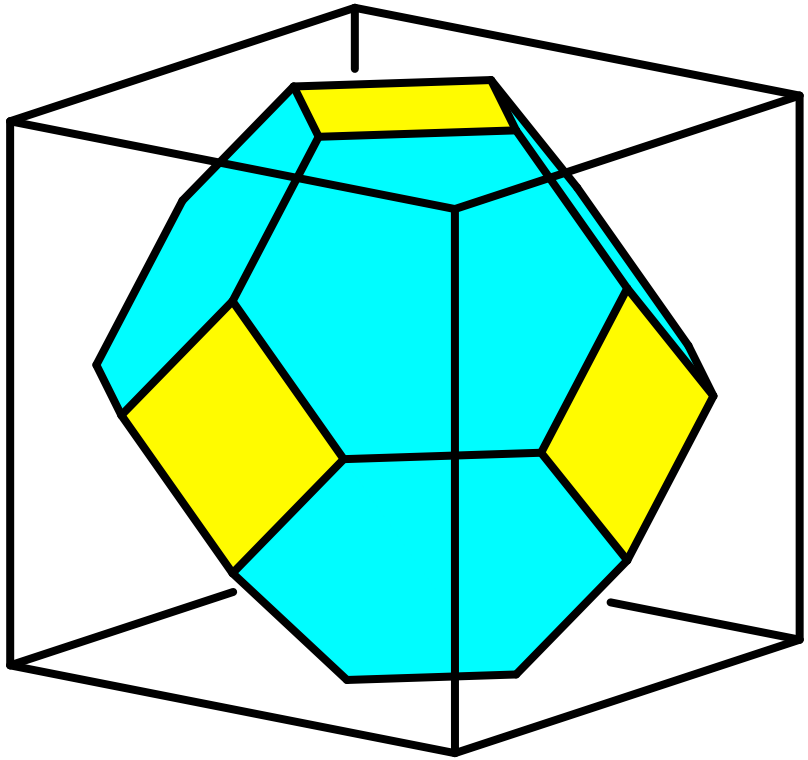
Ecken einfalten

Origami im Raum



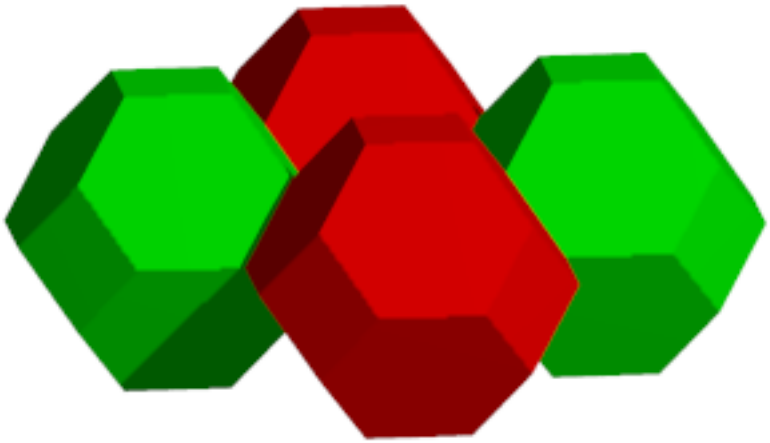
Ecken einfalten

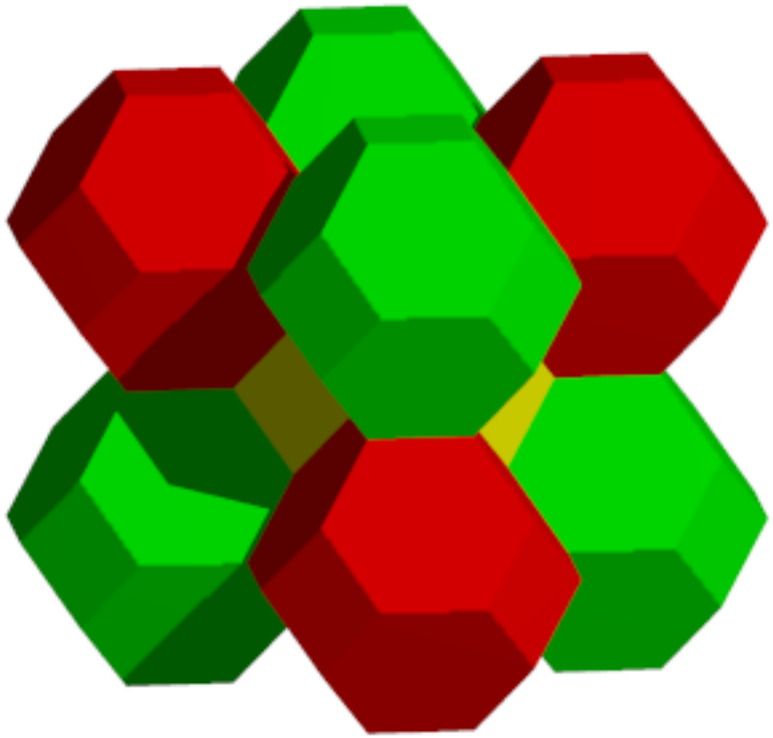
Origami im Raum



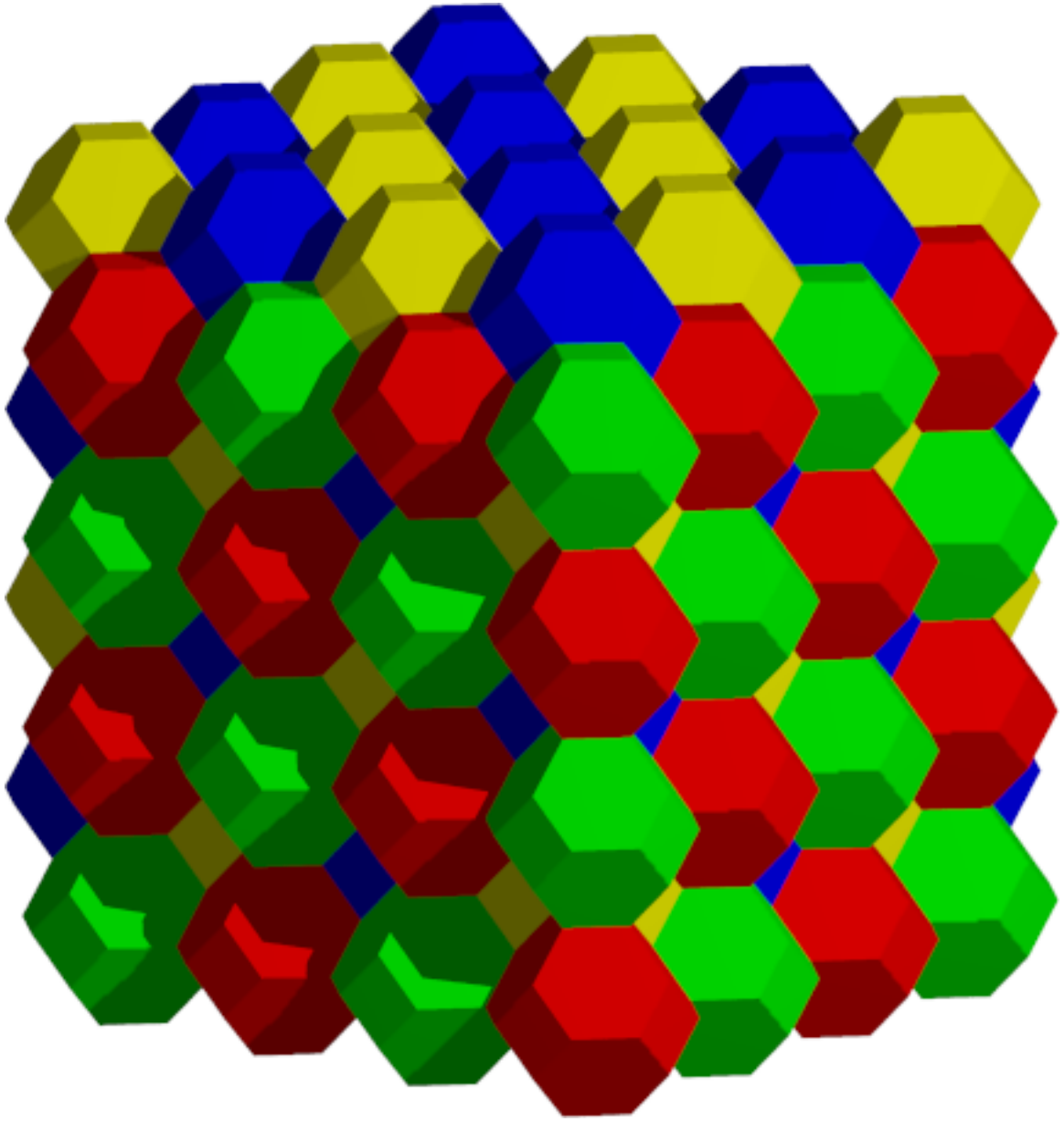
Abgestumpftes Oktaeder. Halbes Würfelvolumen

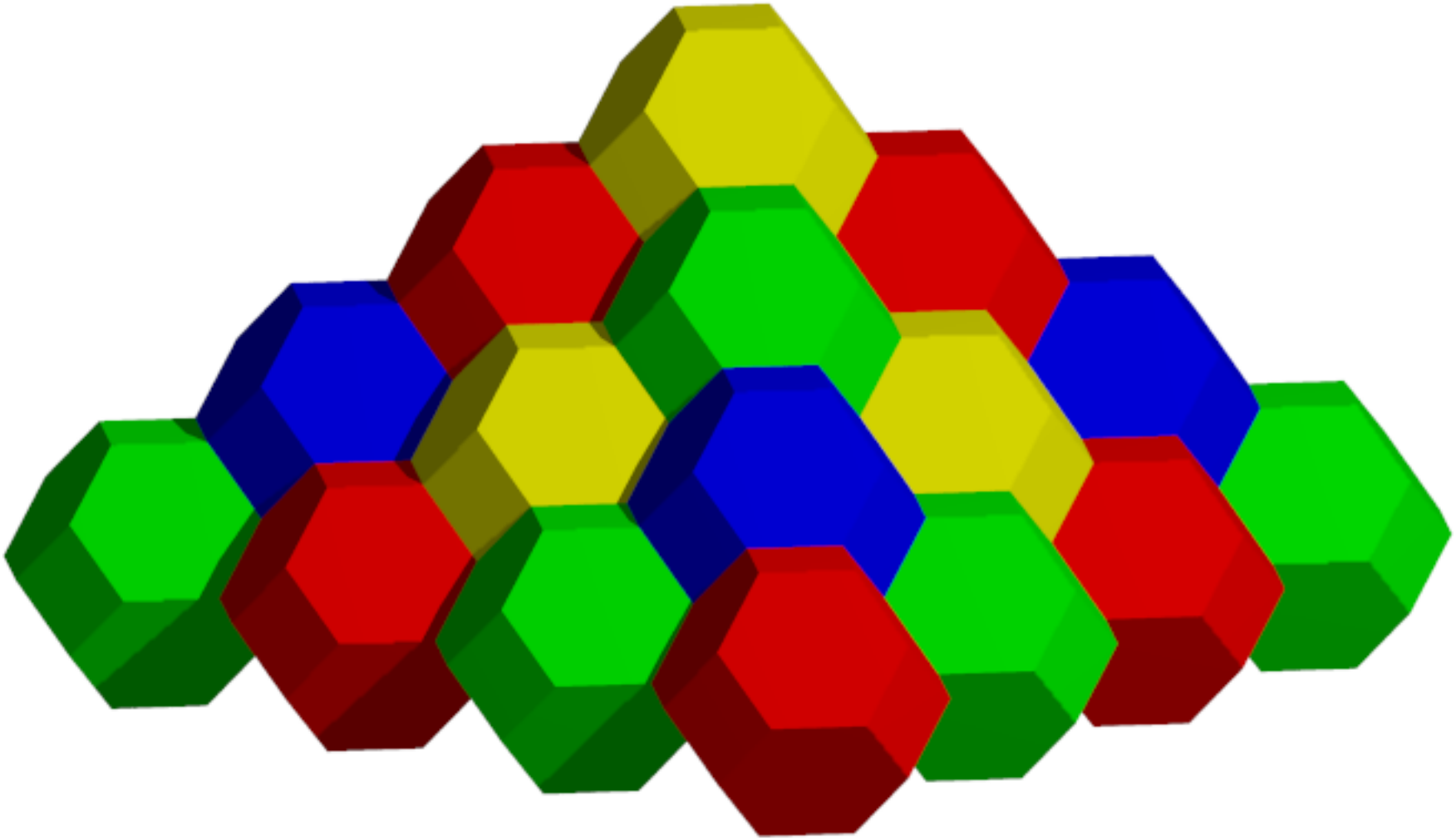
Abgestumpftes Oktaeder. Halbes Würfelvolumen





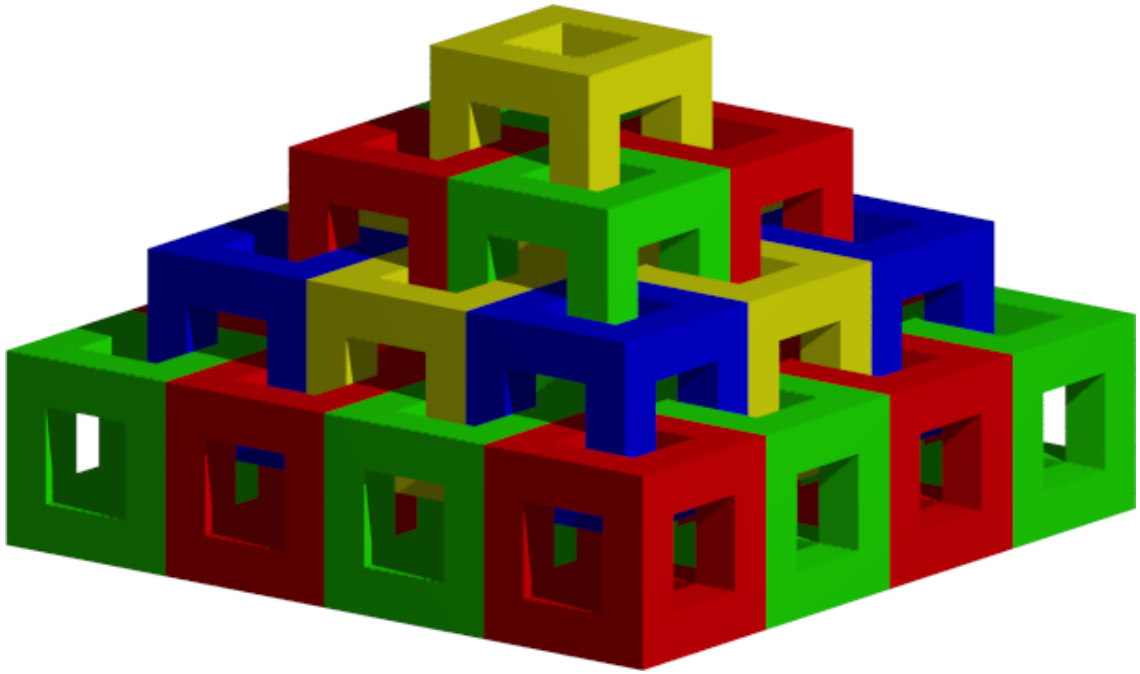
Kubisch raumzentrierte Packung





Kubisch raumzentrierte Packung

Danke



Kubisch raumzentrierte Packung