# Bacteriophage–sheath widening and base plate change

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http://homepage.mac.com/whitby/

http://web.me.com/whitby/Octahedron/Welcome.html

## References

**1. Octahedron1stEd.pdf** by Robert William Whitby

The octahedral periodicity of the atomic elements and its implications, 500 pages
http://homepage.mac.com/whitby/FileSharing103.html

**2. Bacteriophage injector** by Robert William Whitby

<This paper shows how an octahedral assembly consisting of rings connected by hinged legs acts as a contractile sheath. When fitted with a tube, the assembly mimics the DNA/RNA injector of the bacteriophage.>
http://homepage.mac.com/whitby/BiologicalViruses/FileSharing193.html

**3. Study reveals new information on how viruses enter cells** Purdue News 30 January 2002

<As the virus sinks down onto the surface, the baseplate undergoes a change – shifting from a hexagon to a star-shaped structure. At this time, the whole tail structure shrinks and widens, bringing the internal pin-like tube in contact with the outer membrane of the E. coli cell.>
<"We found that the baseplate is shaped like a cup or small dome," Rossmann says. "Previously it was believed that the baseplate was a rather flat structure.">
http://news.uns.purdue.edu/UNS/html4ever/020130.Rossmann.T4.html

**4. OctaViews&Dimensions.pdf** by Robert William Whitby

The file shows the principal views of the octahedron in various orientations and expresses mathematically their exact dimensions.
http://homepage.mac.com/whitby/Math/FileSharing194.html

## References–Michael G. Rossmann

The Rossmann papers listed here can be downloaded in PDF format from the website–
http://bilbo.bio.purdue.edu/~viruswww/Rossmann_home/publ/index.shtml#429

**425.** Rossmann, M. G., V. V. Mesyanzhinov, F. Arisaka, P. G. Leiman. 2004. **The bacteriophage T4 DNA injection machine.** Curr. Opin. Struct. Biol. 14(2):171-80

<The baseplate switches from the hexagonal to the star conformation> page 178, column 2

**424.** Fokine, A., P. R. Chipman, P. G. Leiman, V. V. Mesyanzhinov, V. B. Rao, M. G. Rossmann. 2004. **Molecular architecture of the prolate head of bacteriophage T4.** Proc. Natl.

Acad. Sci. U.S. 101:6003-6008

**397.** Kanamaru, S., P. G. Leiman, V. A. Kostyuchenko, P. R. Chipman, V. V. Mesyanzhinov, F. Arisaka, M. G. Rossmann. 2002. **Structure of the cell-puncturing device of bacteriophage T4.** Nature (London). 415:553-557**.**

## Introduction

### Sheath widening

The hinging legs extend radially outward accounting for the widening of the injector sheath. Figure 4 shows the geometry of the widening. [See References 2 and 3.]

### Baseplate changes

When viewed axially, the fully extended legs of the bacteriophage injector appear as a hexagon. When folded, they appear as a six pointed star. [See Figures 1, 2, and 3.][See Reference 3 and Rossmann reference 425.]

### Baseplate–dome shape

The inner bottom face of each of the six yellow 2-octahedra which form the bottom ring define a hexagonal pyramid. Each of the faces makes an angle of atn[sqr(2)] with the axis of the injector. [See Figure 5.][See Reference 4.]

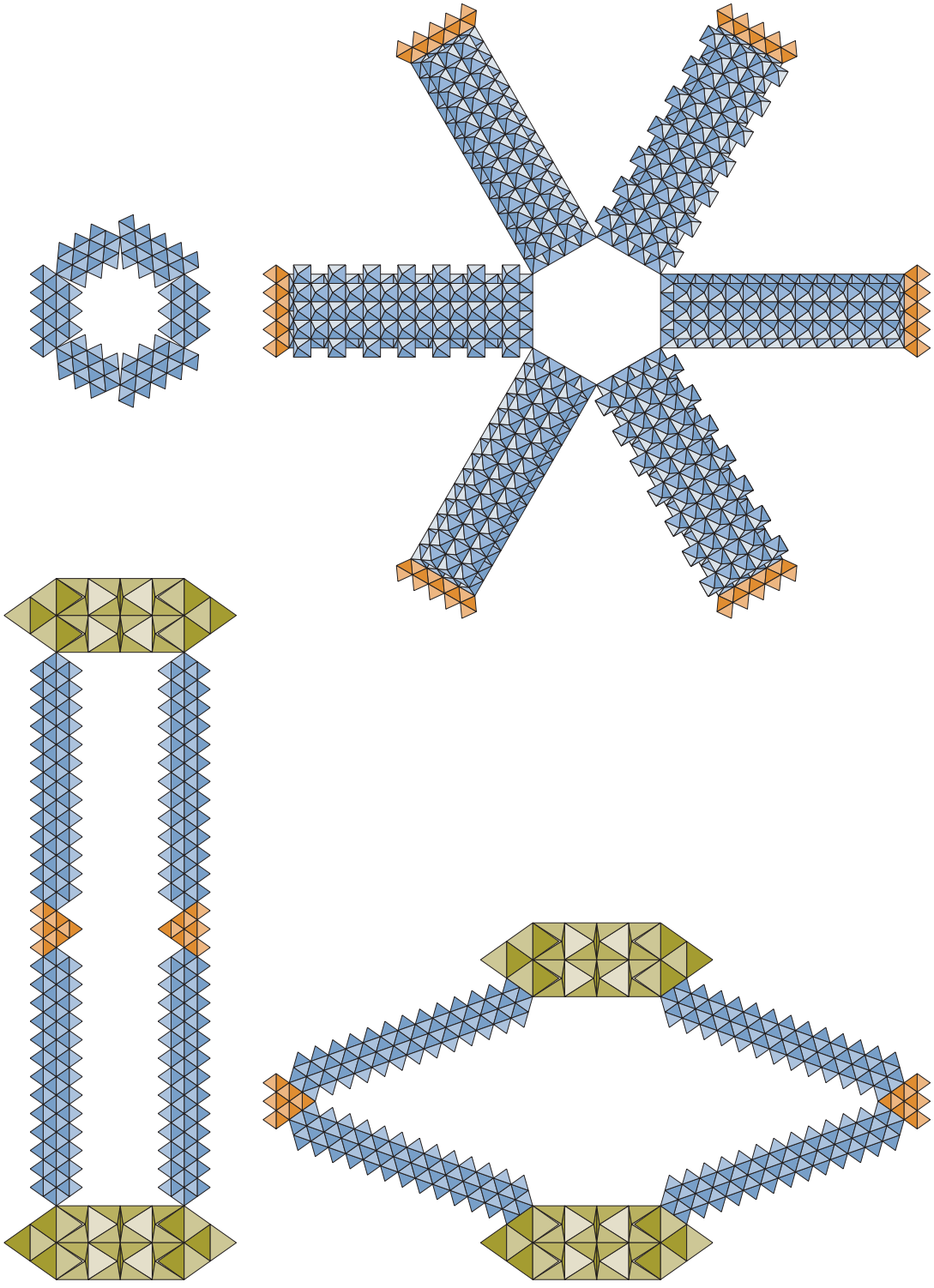

**Fig. 1 Bacteriophage injector with longer legs**

The figure shows a segment of injector sheath with elongated legs. The legs are fully extended on the left; the legs are fully folded on the right. The legs are viewed axially at top and radially at bottom.

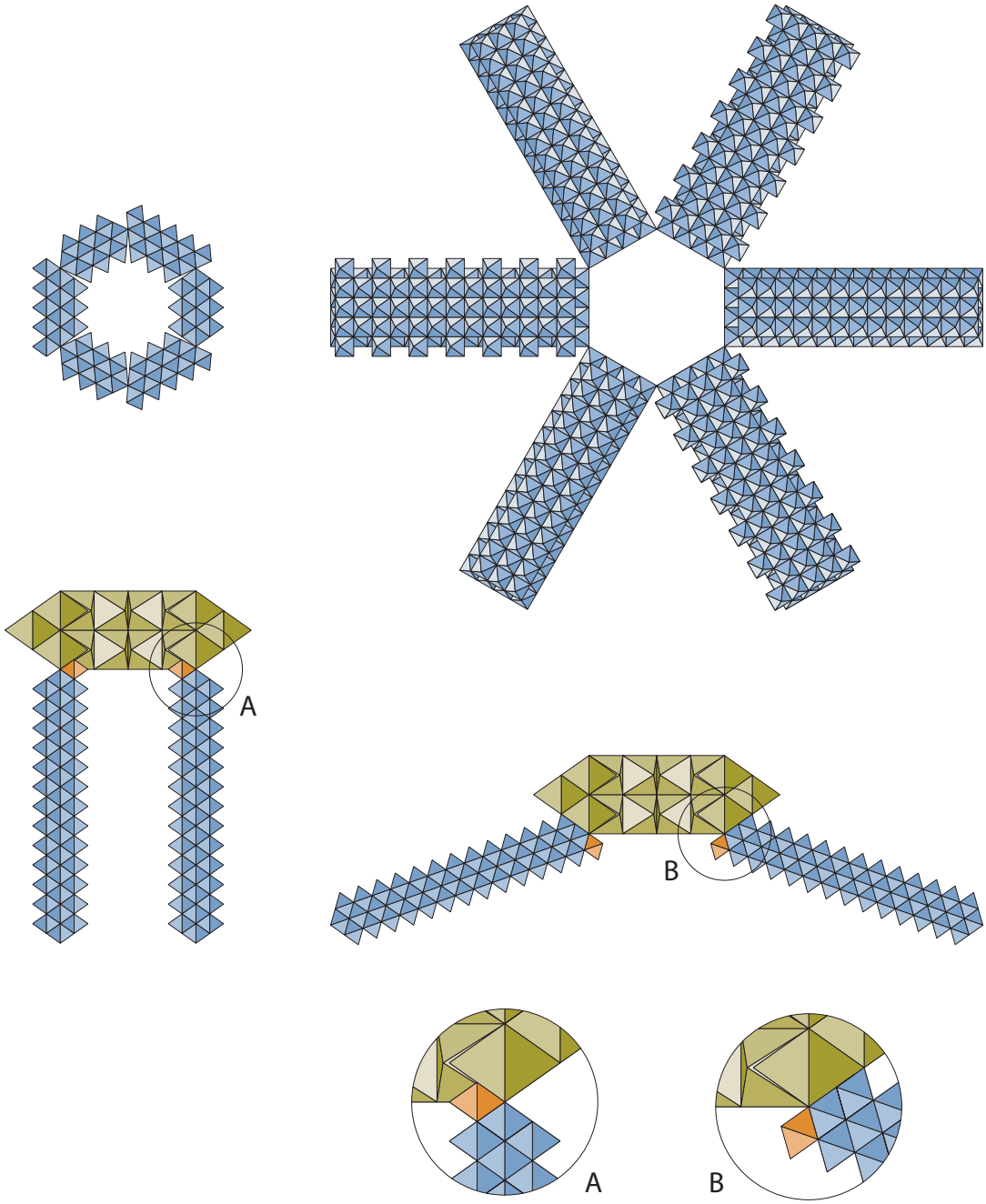


**Fig. 2 Terminal legs–hinge stops**

The figure shows how a simple leg can be prevented from folding towards the axis. The red colored octahedron which is part of the leg acts a a stop. The insets labelled **A** and **B** show the hinge of the leg at its limits. The two simple legs of a compound leg are connected to a doubly hinged joint which is fitted with stops.

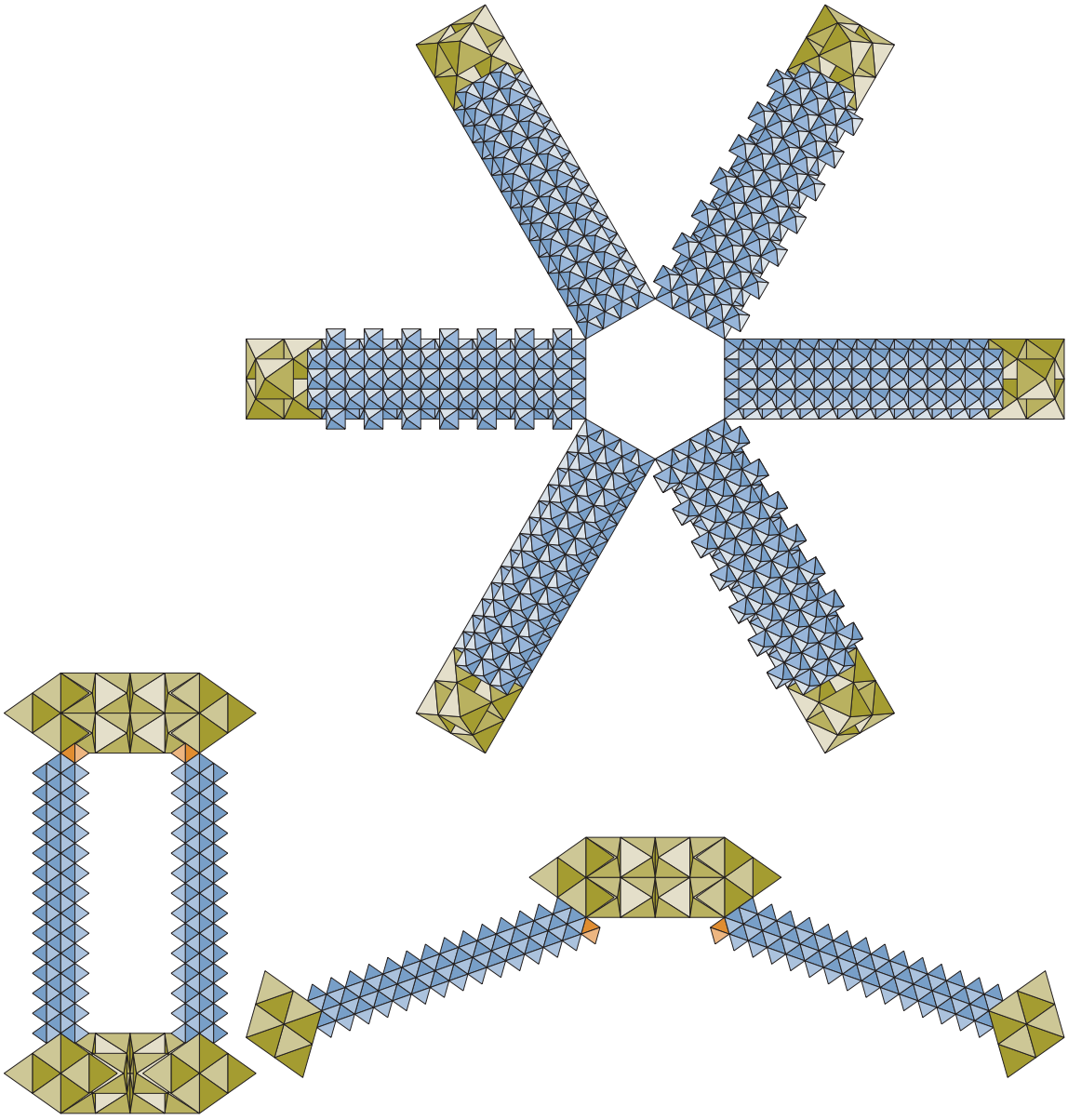

**Fig. 3 Baseplate separation**

The figure shows an assembly consisting of two rings of six 2-octahedra each connected by six simple legs. Each of the six legs is hinge joined to a 2-octahedron of the upper ring and rigidly joined to a 2-octahedron of the bottom ring.

At bottom left, the legs are parallel to the axis of the assembly.

At bottom right, the legs are hinged outward from the axis of the assembly. The 2-octahedra of the lower ring have remained attached to the legs.

At top, the axially viewed outwardly hinged legs have a star-shaped appearance.

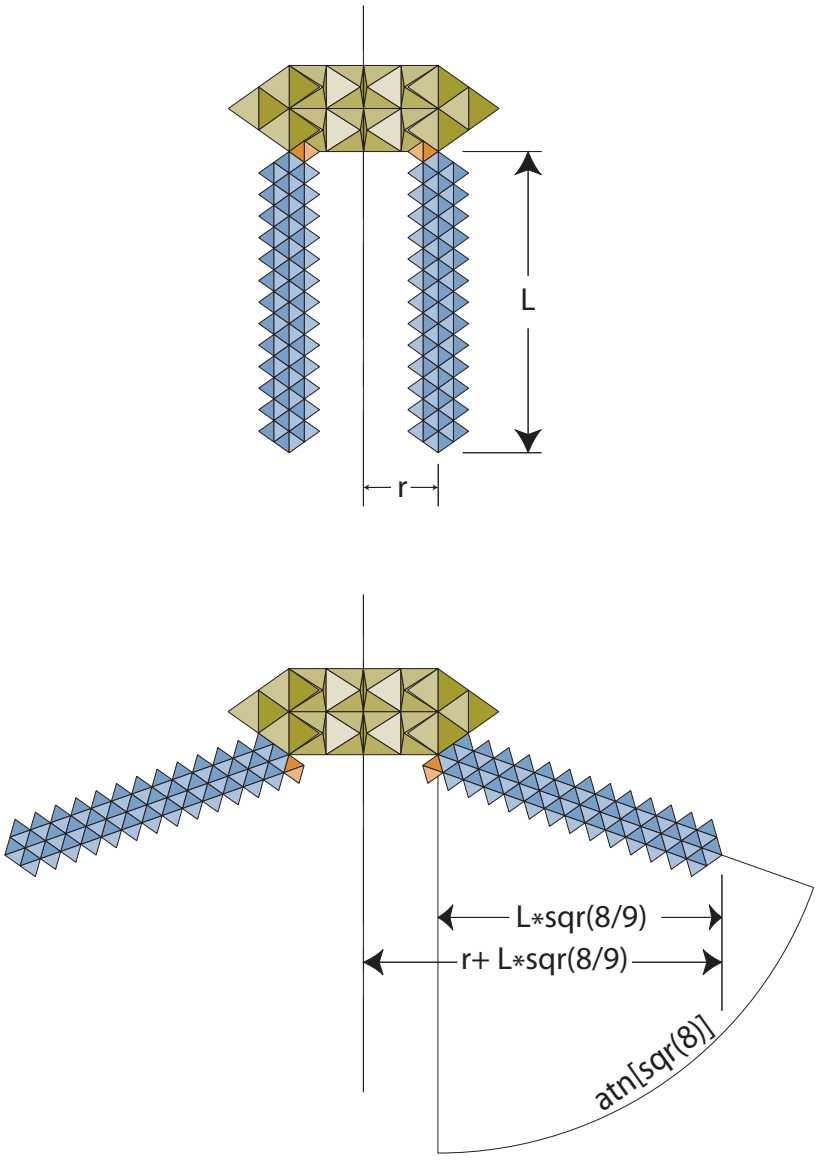


**Fig. 4 Geometry of sheath widening**

At bottom, the figure shows the geometry of the outwardly hinged leg. The unhinged leg is shown at top. This demonstrates the cause of the observed widening of the sheath of the injector.

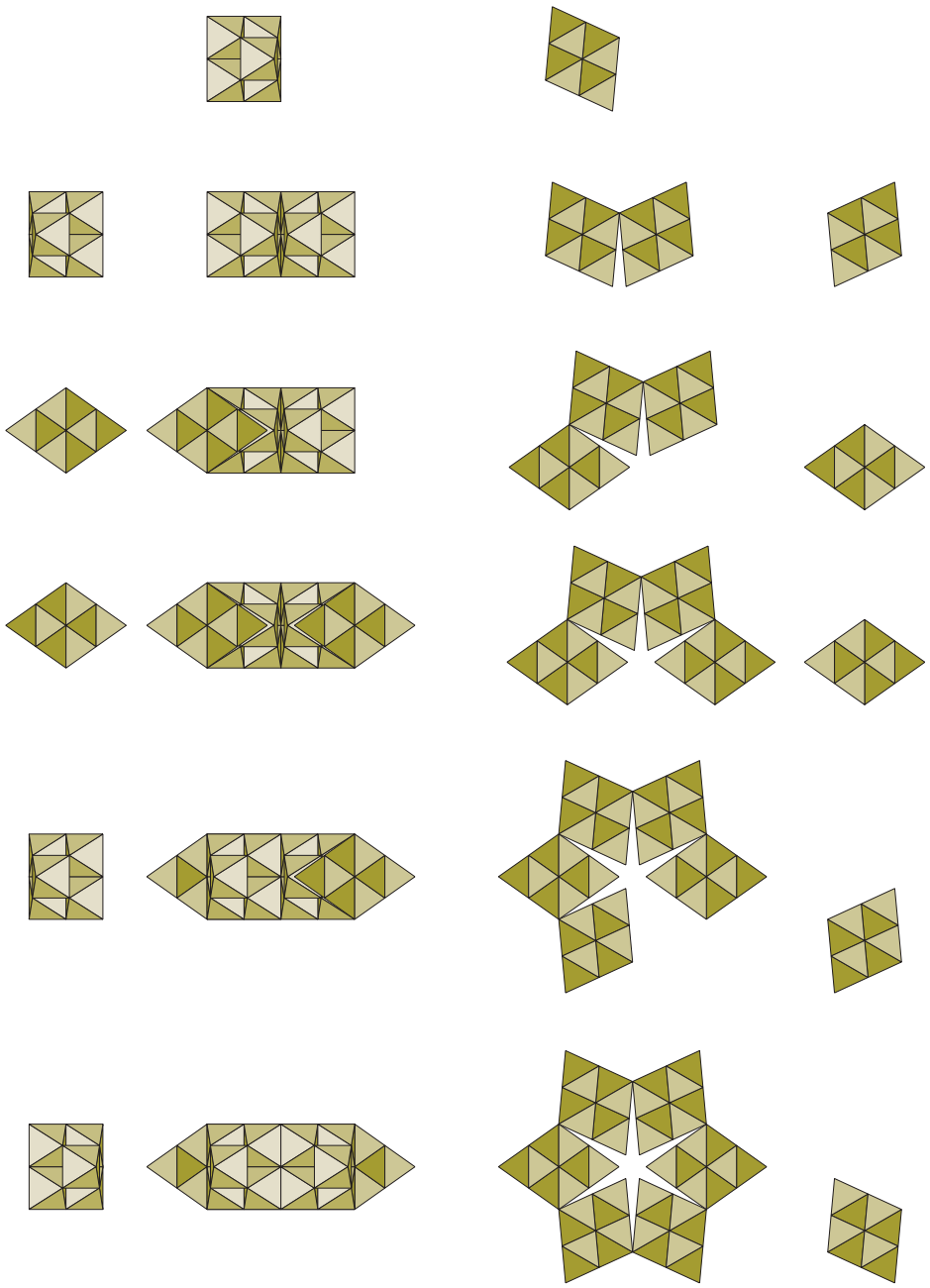

**Fig. 5 Ring of six hinged 2-octahedra**

The figure shows how six 2-octahedra assemble as a hinged ring. On the left, the assembly is viewed radially; on the right, the assembly is shown axially. The assembly begins with the 2-octahedron shown at the top. It progresses with the addition of the successive addition of the individual 2-octahedra shown separately in the outer columns. Each 2-octahedron is shown in the orientation required to form the ring. The third and fourth 2-octahedra on the left show the slope of the cup-forming faces relative to the axis of the ring.