

Pleated sheets—bridges and loops

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

References

SheetFormingSChains.pdf

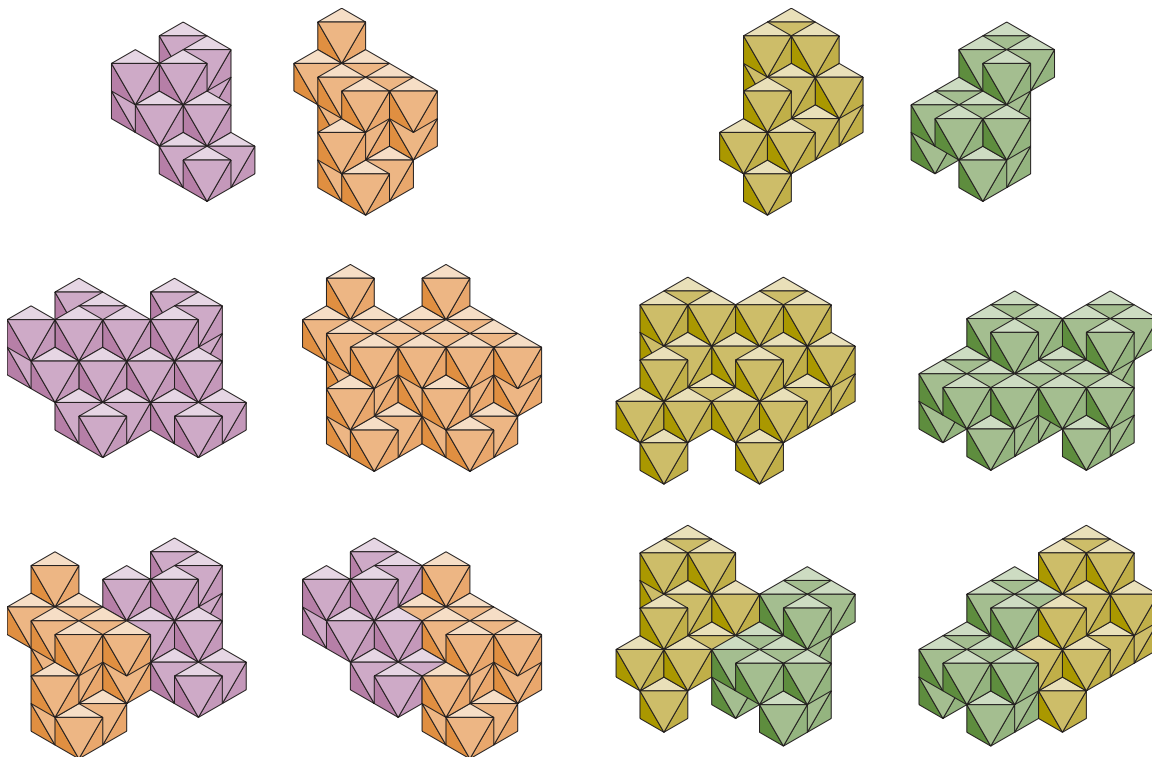
AlphaJoinedSheets.pdf—Sheets of connected parallel strands in parallel planes

PleatedSheets.pdf

Octahedron1stEd.pdf

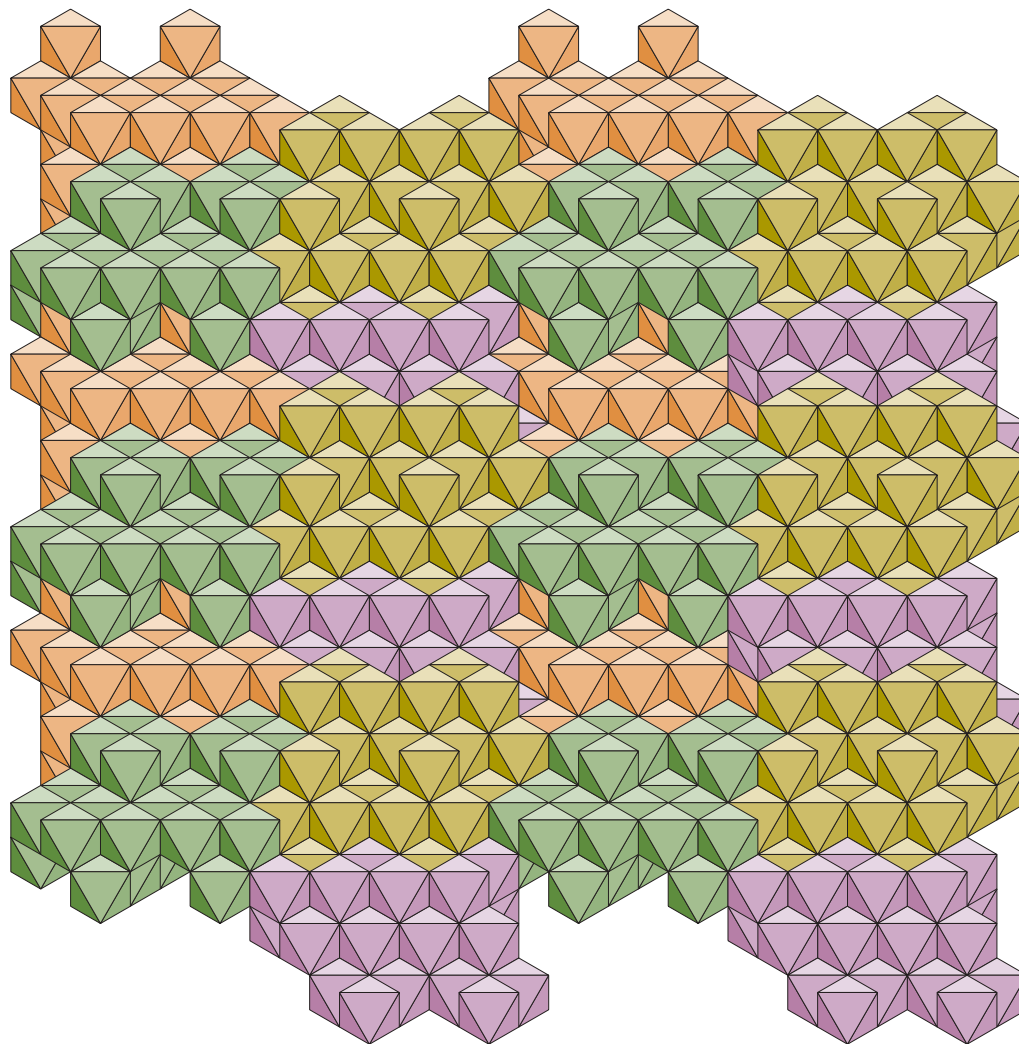
Introduction

This document looks at the portions of a protein chain which serve to link those of its strands which are involved in the formation of a single pleated sheet. The book Octahedron1stEd.pdf is the basic reference and two bookmarks under INTERCHAIN JOINS—“Pleated sheet” and “A sheet offset”—are pertinent. The document PleatedSheets.pdf deals specifically with the possible join adjacencies at the termini of sheet participating strands.



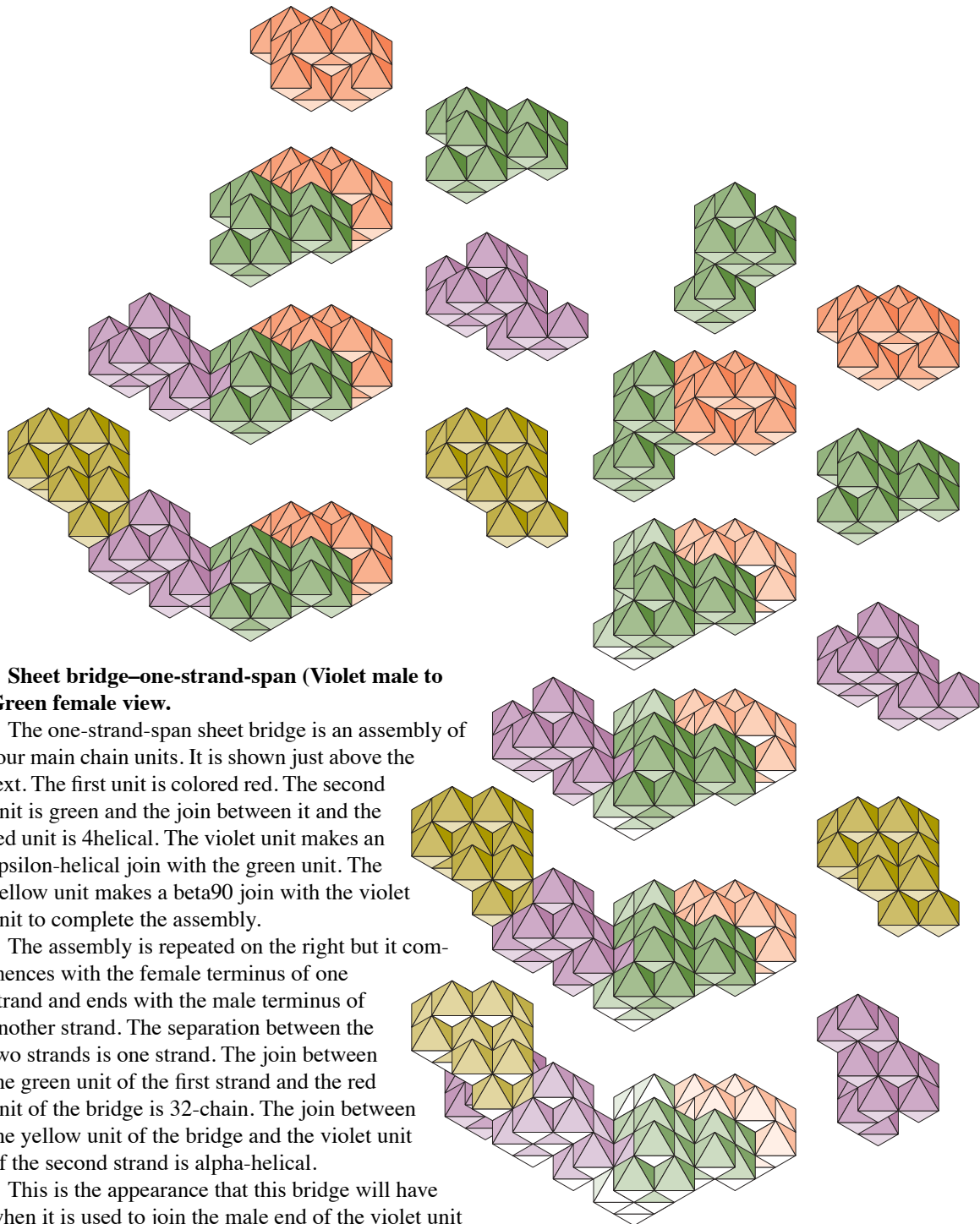
Sheet-join pairings of main chain units

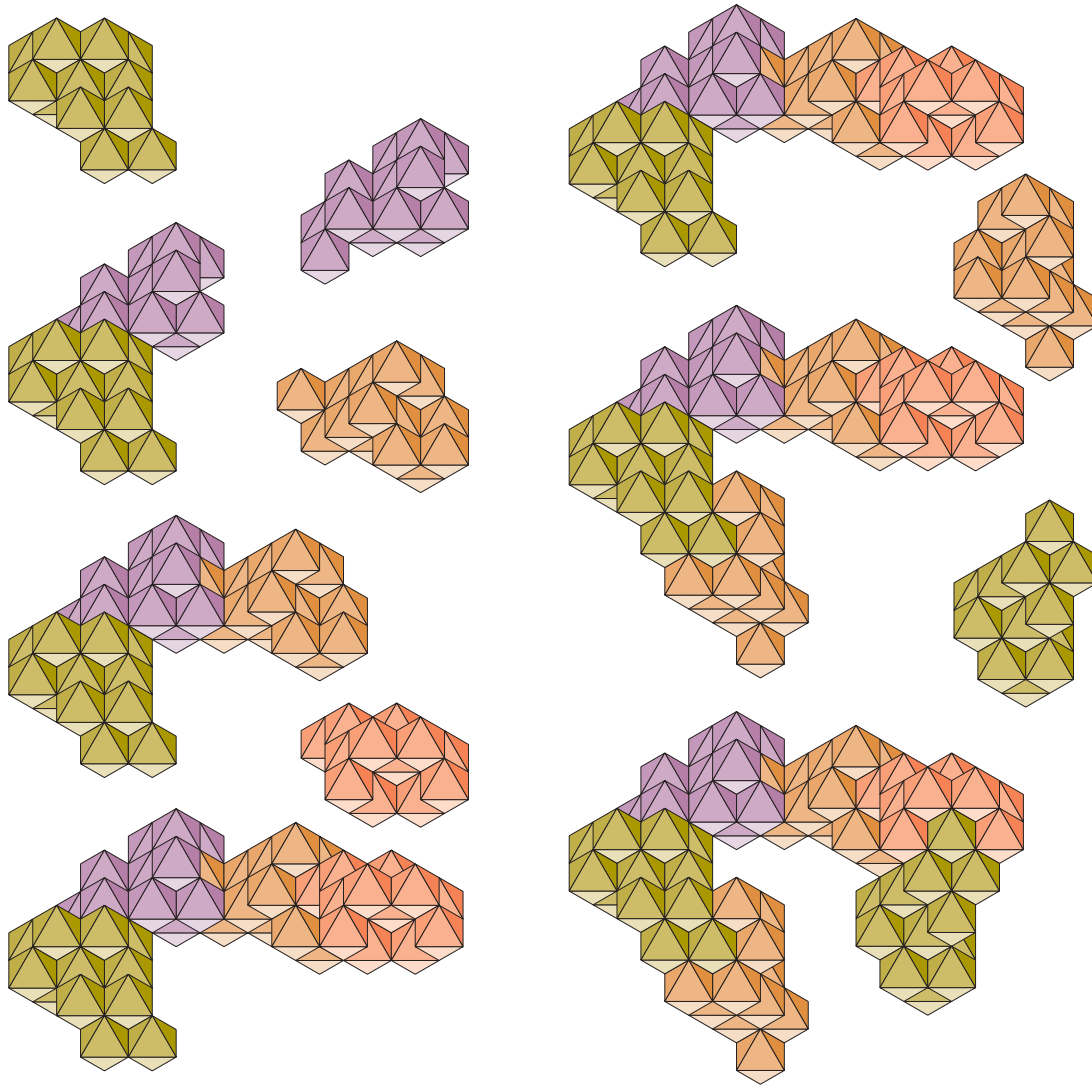
The four orientations of the main chain units used in the formation of a pleated sheet are shown in the top row of the figure. Each orientation has its own color. The units are shown in parallel pairings in the middle row. The bottom row shows the possible anti-parallel pairings.



Pleated sheet consisting of four anti-parallel pairs of parallel strands

The color coded orientations of the main chain units shown in the previous figure are maintained here. The eight-strand sheet consists of four pairs of parallel strands. Adjacent pairs are anti-parallel. If side chains were present, the side chains of the violet and orange units would be directed away from the viewer and the side chains of the yellow and green units would be directed towards the viewer.

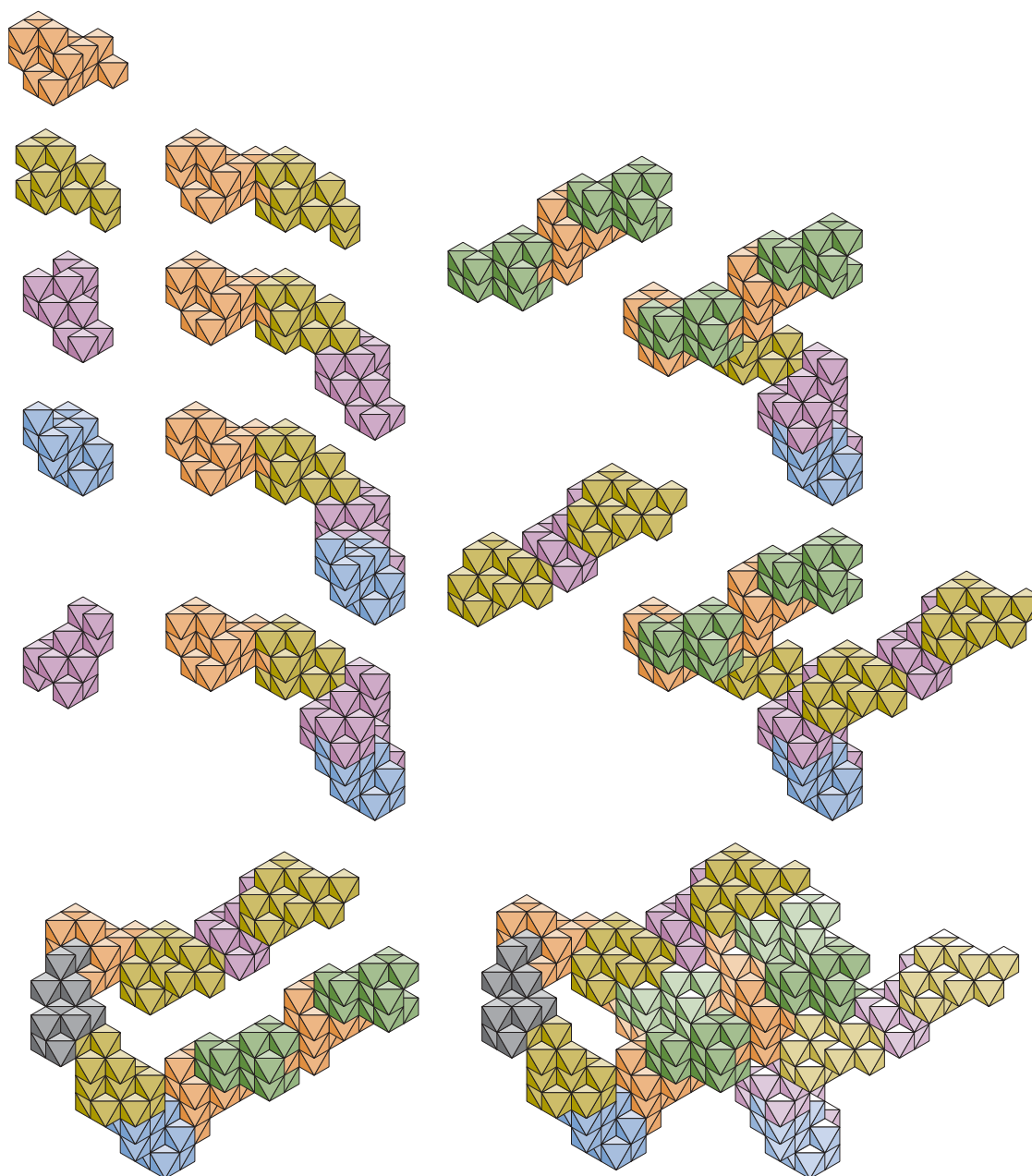




Sheet bridge—one-strand span (Yellow male to Orange female view.)

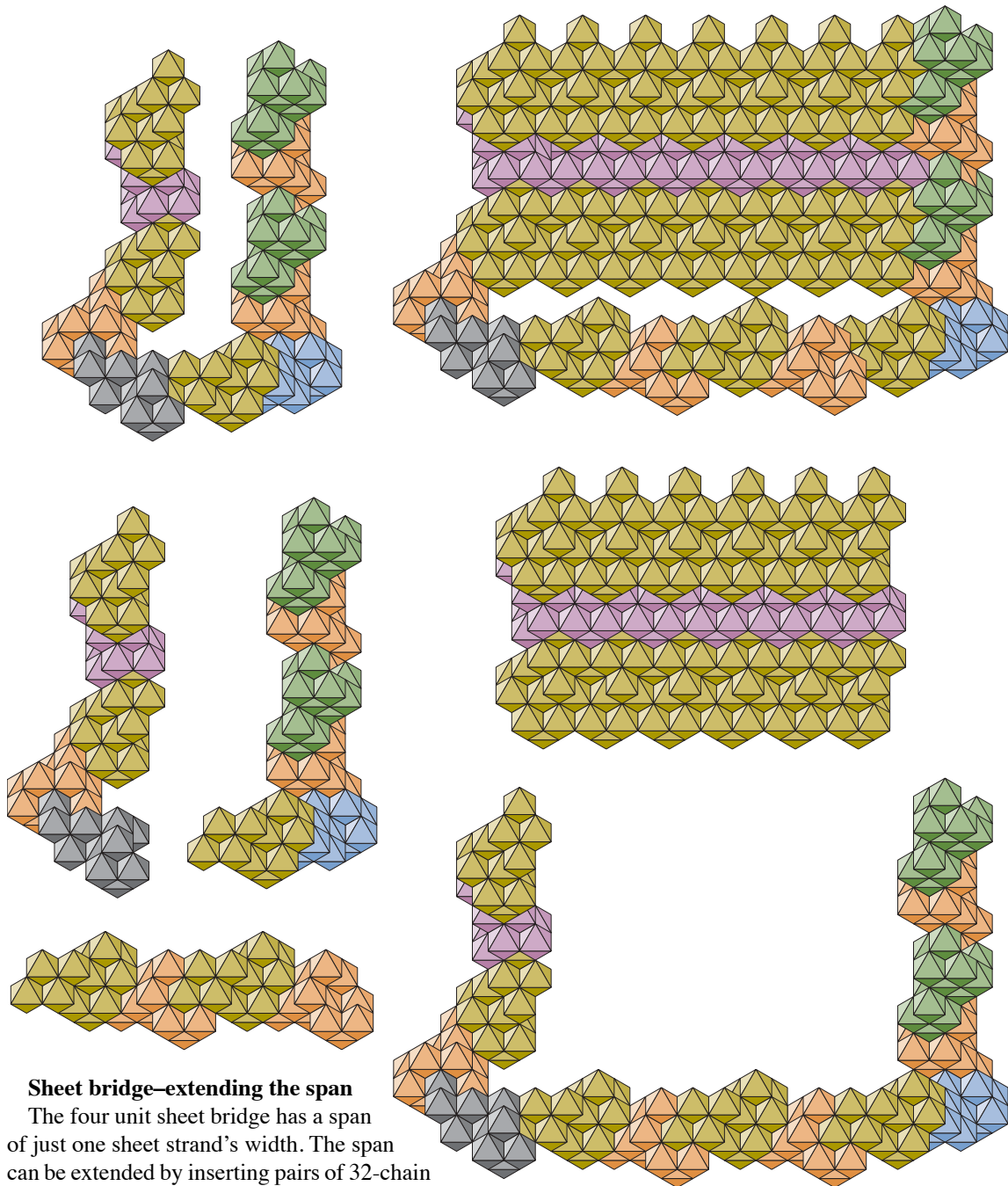
This bridge is identical to the bridge of the last figure except for its orientation. The assembly of the bridge itself is shown on the left. The violet unit makes a 4-helical join with the yellow unit. The orange unit makes an epsilon-helical join with the violet unit. The red unit makes a beta90 join with the orange unit to complete the bridge.

The yellow unit of the bridge makes a 3₂chain join with the female terminus of an orange unit. The red unit at the female terminus of the bridge makes an alpha-helical join with the yellow unit at the male terminus of a yellow-violet strand.



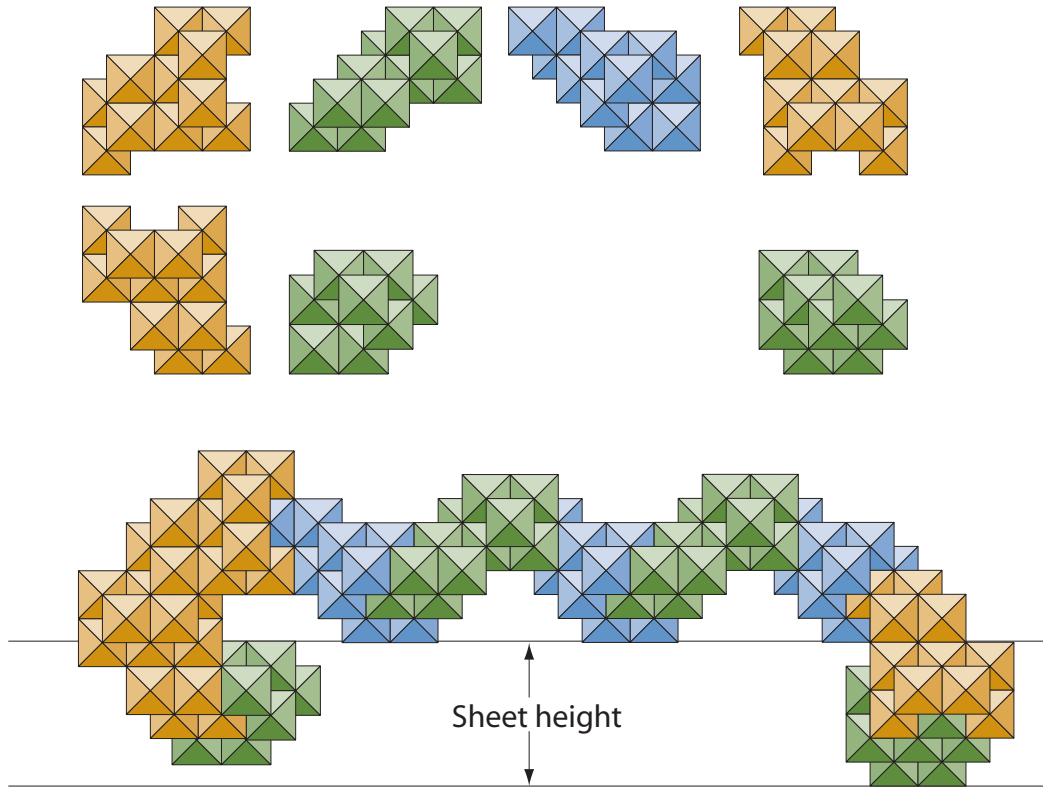
Sheet bridges—overpass and underpass

The figure shows the assembly of a sheet bridge joining the male end of a green unit to the female end of a violet unit from another viewpoint. On the top left, the building of the four unit bridge commences with the orange unit making a beta90 join with the yellow unit. The violet unit makes an epsilon join with the yellow unit. The blue unit makes a 4-helix join with the violet unit to complete the bridge assembly. The blue unit of the bridge makes a 3₂-chain join with the violet unit at the terminus of a yellow-violet chain. At the top right, the orange unit of the bridge makes an alpha-helical join with the green unit of the green-orange chain and the violet unit is rejoined to its beta180-strand. In the bottom row of the figure, two bridged pairs of beta180-strands are sheet joined. The bridge assembled here passes under the orange-green strand of the other bridged pair. The bridge of the other pair would pass over a central strand if it were present. It is seen that the bridges act as both underpasses and overpasses in the same sheet.



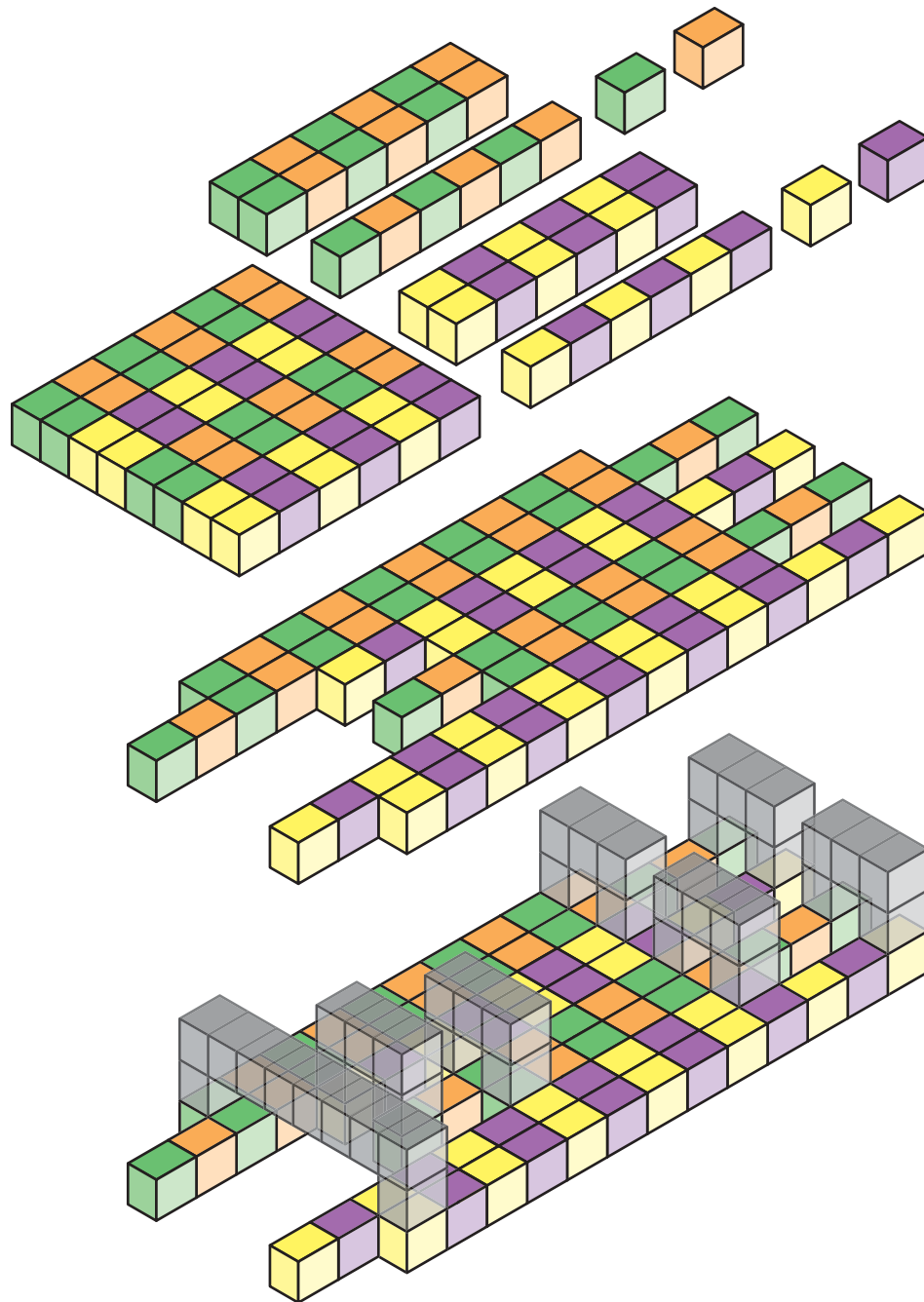
Sheet bridge—extending the span

The four unit sheet bridge has a span of just one sheet strand's width. The span can be extended by inserting pairs of 32-chain joined units. Each pair adds two and a half strand widths to the span. By inserting two pairs of 32-chain joined units, the span will just accommodate six strands—the original strand plus five strands due to the 32-chain extension. The figure shows how the extension is effected. At the top left is a pair of bridged strands. Just below it, the bridge has been separated at the black-yellow join. The two pair 32-chain is at the bottom of the left column awaiting insertion. At the bottom right, the extended bridge with strands is shown. Above the extended bridge is a sheet of six parallel strands. At the top right, bridge and six strand sheet are assembled as an eight strand sheet.



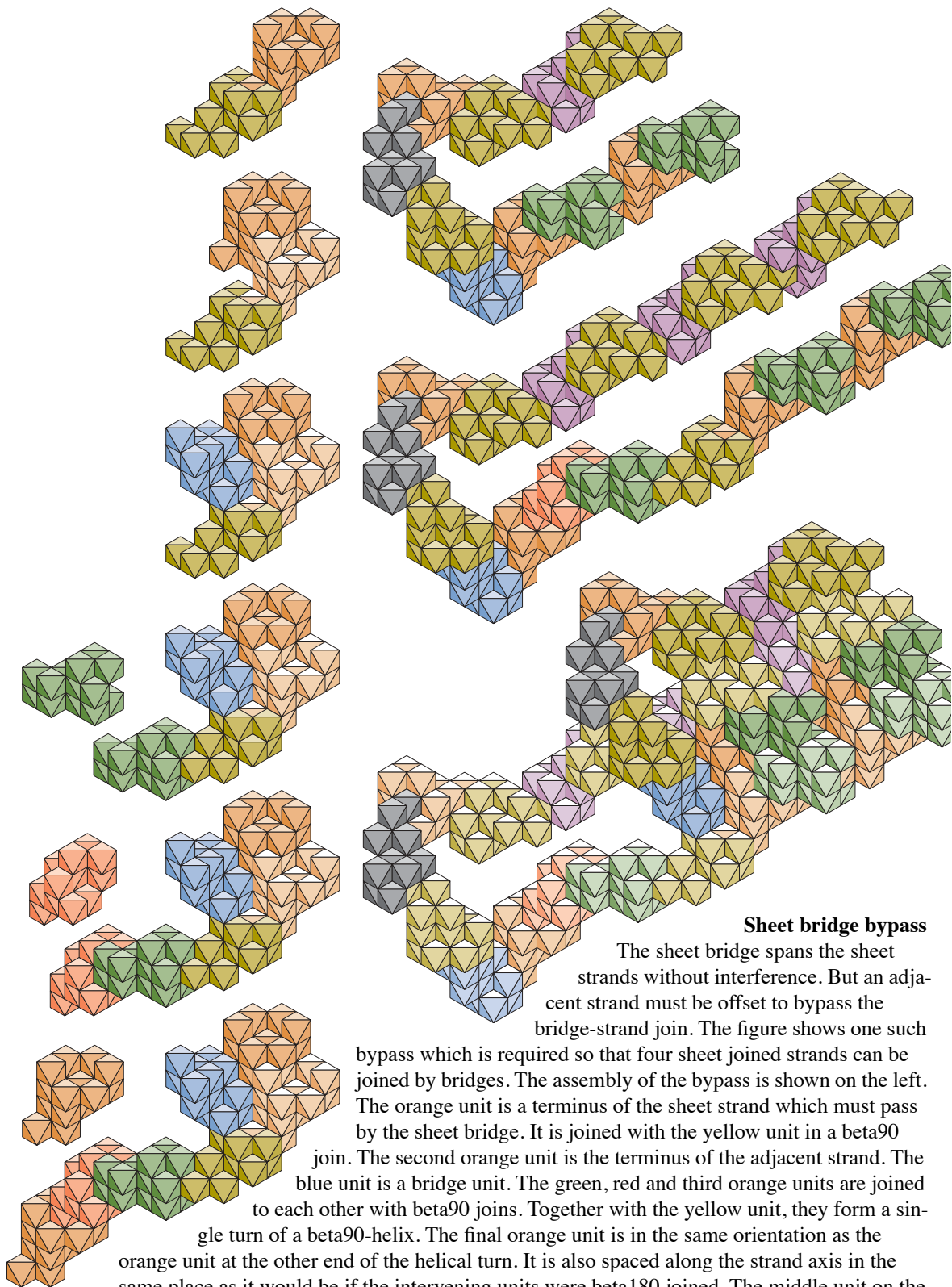
Extended span sheet bridge—view parallel to sheet strand axes

The figure shows the orientations of the main chain units used in the bridge assembly as well as the terminal units of the beta180-strands to which it is connected. This span will accommodate six sheet-joined strands in any combination of parallel or anti-parallel associations. The bridge can be extended further in five strand-width steps by the addition of two pairs of 32-chain joined units for each step giving a series of spans—1 6 11 16 21....



Sheet bridge arrangement for an eight-strand pleated sheet

Beginning in the upper right, colored blocks representing the main chain units in sheet forming orientations assemble as chains and pairs of parallel chains. The parallel pairs alternate in anti-parallel fashion to form an eight strand sheet. In the middle of the figure, strands of the sheet have been extended to provide locations for the placement of the seven bridges required to convert the separated strands into a single chain—six one-strand span bridges and one six-strand bridge. The placement of the bridges is shown at the bottoms of the figure.



Sheet bridge bypass employing an extension of the bridge.

The strand which must bypass a bridge-strand join is on the left in this assembly. The one in the previous figure was on the right. The bypass is achieved by the upper orange unit on the left which is 32-chain joined with the yellow unit above it as well as the yellow unit below it. This is the same configuration used in the sheet offset shown in *Octahedron*. This offset puts the ensuing units of the strand on a plane which is different from that of the sheet. To permit the chain to return as part of the sheet, the offset must be countered by an additional 32-chain joined unit in the return strand of the chain. This is accomplished by the yellow unit between the two orange units in the sequence following the blue unit on the bottom right. These offsets require the bridge between them to be extended by a pair of 32-chain joined units. This assembly uses three bridges altogether, one at the top and two at the bottom. The top bridge and the extended bridge at the bottom create a cyclic peptide. The third bridge joins the remaining two strands of the sheet into a second chain. The yellow unit which is topmost in the figure and the yellow unit which is rightmost are the termini of this chain.

