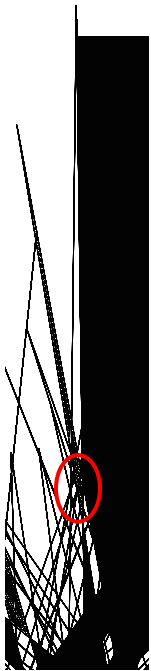


## Ultra-needles and the benefit of Single Line Drawing Mode

(23,11,16,8)

Ultra-needles require first and last lines that create very sharp angles (and hence come from very close to the vertical line without being on the vertical line). Two images are shown: The top has 23 11-line cycles; the bottom has 13 13-line cycles. Both are shown with the first TWO cycles highlighted in red in order to emphasize the conelike nature of how the image is created.

These images are similar to the [porcupine images](#) in that any two lines create a very sharp angle, but porcupine images required  $P$  be the closest number to  $nS/2$  without being that value. Both values of  $P$  are much smaller than  $nS/2$ .



**Top image.** There are 23 bundles of lines meeting about 2/3 of the way to the center. The first line and lines 11 and 12 (which create the needle at vertex 13 (two past the bottom)) are centerlines to these bundles. A close-up of the **bundle** centered on vertex 0 to the left shows that 14 lines (2 lines for each of 7 needles) create these bundles. These bundles create striking open spaces in this ultra-needles image.

**Bottom image.** In this image, the 13 largest bundles are between the 13 vertex spikes. The close-up shows the **bundle** between vertices 0 and 4 and a **bundle** with fewer lines closer to the outside as well as a **bundle** centered on vertex 0 nearer the center.

(52,13,124,19)

**Drawing modes.** If viewed in *Fixed Line Drawing* mode with *Drawn Lines*, with  $DL = 11$  above or  $DL = 13$  below, the images are not as satisfying to watch get drawn as if  $DL = 2$ . Perhaps the best is to use *Single Line Drawing, SLD*, with  $DL = 11$  above or  $DL = 13$  below. When viewed this way, this is like this [rolling out the dough](#) image seen in *SLD* with  $DL = 13$ .

[These bundles are similar to those that occur in multi-jump models such as the [needle fans](#) discussed later in the book.]

