

## Klein Bottle

See Möbius Strip first. The non-orientable surfaces are *one-sided*, and this can best be understood, if one starts from a Möbius Strip.

Imagine that we modify a torus by rotating a figure-eight instead of a circle. If we color the two sides of this surface differently, then one loop of the figure-eight has one color and the other loop the other. One can make such a surface in the Surface menu, by taking the Lemniscate as the meridian curve in the entry “User Defined (Rotation)”. This is in fact the default. The present Klein Bottle is obtained with one further modification: rotate the meridian figure-eight in its plane by 180 degrees while the plane is rotated. One can see the figure-eight better if in “Set u,v ranges” one sets  $v_{\min} = 0.5$ . Use “Distinguish Sides by Color” in this cut open view. One can see this in a morph with  $aa = 3$ ,  $u_{\min} = 0$ ,  $u_{\max} = 2\pi$ ,  $v_{\min} = 0$ , and  $0.5 \leq u_{\max} \leq 2 * \pi$ . The default morph starts from the Möbius Strip  $-0.1 \leq u \leq 0.1$ ,  $0 \leq v \leq 2 * \pi$ ,  $aa = 3$  and increases the width of the Möbius Strip until it closes to the Klein Bottle at  $-\pi \leq u \leq \pi$ .

H.K.