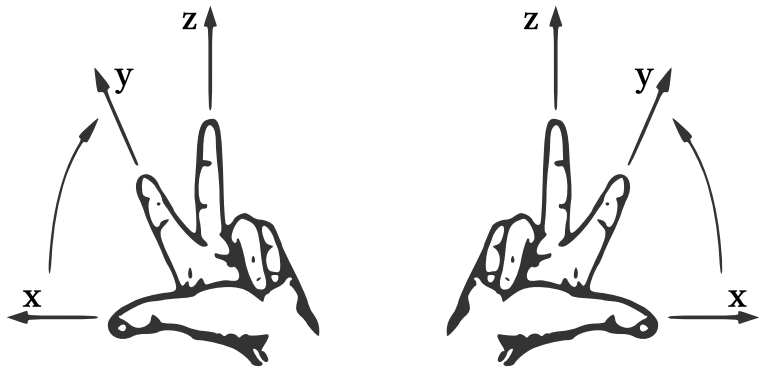

Figure 5.1. The left hand and the right hand, each holding a set of axes: thumb x, index finger y, middle finger z, as in Vygodsky's drawings 144 and 145. The curved arrow is the quarter turn from x to y: in the mathematically positive sense for the right hand, the negative sense for the left. Drawing by Qniemiec, Wikimedia Commons, released into the public domain (CC0); the original German captions are omitted.

M. Ya. Vygodsky's *Handbook of Higher Mathematics*, in the twelfth Moscow edition of 1977.[2] On page 129, in §94, he sets up the coordinate axes of space, and he draws them on two actual hands, in his drawings 144 and 145. Figure 5.1 shows the same two hands in a cleaner modern drawing.

He says three things about them. The first is a definition, and it is more careful than it looks. A set of axes is called *right* when the quarter turn that carries the positive X axis onto the Y axis looks counterclockwise *seen from the side of the Z axis*. If the same turn looks clockwise, the system is *left*. The second is his Remark 1: the two systems

> нельзя совместить так, чтобы совпали соответственные оси,

which is to say, they cannot be brought together so that matching

through Grigori Perelman, and through wanting to understand what he did.

[2] М. Я. Выгодский, Справочник по высшей математике, издание двенадцатое, стереотипное. Москва: Наука, Главная редакция физико-математической литературы, 1977, §94, "Прямоугольная система координат в пространстве", p. 129, drawings 142–145. Translations on this page are mine.