Cylindrical Lenses

Compared to spherical lenses, cylindrical (frequently shortened to "cylinder" or "cyl") lenses are somewhat more complex. Fortunately, many of the concepts described for spherical lenses may be modified for understanding cylindrical lenses.

Compared to spherical lenses, light rays in a cylindrical lens will converge or diverge only along one axis (meridian) because cylindrical lenses have two optical surfaces—a plane and a curved surface (Figure 17-1).

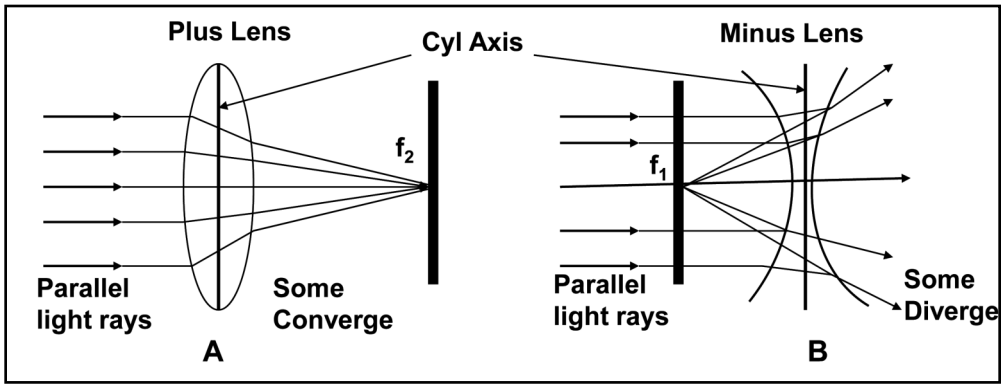

Figure 17-1. Astigmatic images by cylindrical lenses. Light rays in cylindrical lenses either converge or diverge along one axis (meridian), and images produced by cylindrical lenses form a line focus. The image produced by a plus cylindrical lens forms in the plus space of the lens (f_2), where some of the light rays converge (A). The image produced by a minus cylindrical lens appears to come from minus space of the lens (f_1), from where some of the light rays appear to diverge (B). Images in cylindrical lenses are produced parallel to the cylinder axis (Cyl Axis). In the examples shown, the cylinder axis is vertical and the power meridian is horizontal.

The plane surface has no curvature and no power. It is called the cylinder axis and is the location of the image of the curved surface, which is 90 degrees away. The curved surface has curvature and power; it is called the power meridian. Its image does not form a point focus (focal point), but rather a line focus (focal line) along the cylinder axis. Thus, in cylinder lenses, the cylinder axis and cylinder power meridian are oriented at 90 degrees to each other.

The image produced by a plus cylindrical lens forms a line focus in the plus space of the lens, where some of the light rays eventually converge (Figure 17-1A). The image produced by a minus cylindrical lens appears to come from a line focus in the minus space of the lens, from where some of the light rays appear to diverge (Figure 17-1B) (see Chapters 8 and 11).

Images formed by cylindrical lenses in this way are termed *astigmatic images* ("a" means "no" or "not").

Therefore, if a cylinder lens is oriented with its axis at 90, its full power is provided at axis 180. If the same lens is placed at some other axis, the full power will not be provided at 180, but at some other axis. Because of this, the cylinder axis is determined before cylinder power is measured during refractometry.