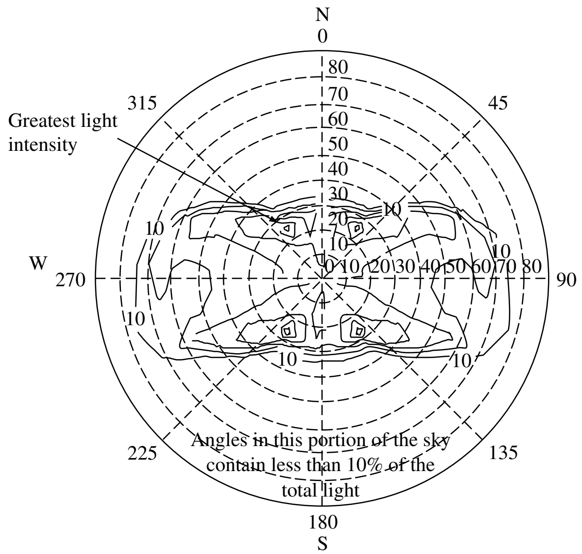

Figure 11.33 Yearly average distribution of incident light as seen by a module with tilt angle equal to the latitude of 34° south. Reproduced from Bowden S, Wenham S, Green M, "High Efficiency Photovoltaic Roof Tiles with Static Concentrators", *Proc. 12th European Photovoltaic Solar Energy Conference*, 1893–1896 (1994) with permission by WIP

potentially another factor of 2X concentration. Bifaciality alone can yield a concentration of 2X by providing for cusps that direct light to the cell [61]. Goetzberger reviewed various static concentrator options and proposed a combination of all of the above that attains a concentration of 12X [62]. Figure 11.34 illustrates the possibilities.

Another approach to static concentrators is the dielectric prism, which relies on total internal reflection. This concept has been refined by incorporating grooves on the back surface, which improves the light trapping [63]. Concentration ratios of around 4X are achieved. Figure 11.35 illustrates the concept.

To date, no firm has succeeded in commercializing static concentrators. Apparently, no concept examined so far appears to offer compelling advantages over a standard flat-plate module. It is a fruitful line of research to see if a cost-effective design can be found. The concentrator must have wide acceptance angle (over 30° in one direction and near 90° in the perpendicular direction) and have reasonable concentration (say, over 2X). Both of these are clearly possible. In addition, however, the device must not cost more to implement than the cell area replaced, and must not significantly degrade the module performance compared to a flat-plate. Therein lies the challenge. Until it is clear that such a device is impossible, the payoff is sufficient to warrant continued search.

11.4.9 Innovative Concentrators

The methodology of nonimaging optics has been extended to a large variety of new and innovative designs. Many of these are covered in the text *Solar Cells and Optics for Photovoltaic Concentration* [2]. One recent and particularly interesting case is the RXI