

Shadows and the Sun

HENRIKE HOLDREGE



Figure 1



Figure 2

On a walk in a forest with the sun high in the sky we enjoy dappled light gracing the scene. Often enough, when we pay attention, we find that there are patches of brightness on the otherwise shaded ground that have unmistakably the shape of circles or ellipses (see Figures 1 and 2). These vary in size and brightness. They are more or less defined, have sharper or more blurred edges. They can overlap and merge and form even brighter and larger patches of more irregular form. With wind in the trees, the circles move and dance on the forest floor.

Where do these round forms come from? Clearly, they are not outlining tree trunks, branches, leaves, or the irregularly shaped spaces in the forest canopy through which the sun shines into the forest.

Consider a different situation, as shown in Figure 3. Here, a low-growing plant, in direct sunlight, casts its shadow on a rock. The divided leaves of the plant, their toothed margins, and the plant's narrow stem are clearly discernable. The shadow is dark, sharp, and distinct. It shows forms of the plant in detail.

You see in Figure 4 a potted fern that I placed in my yard on a stool in direct sunlight. The white paper on the ground next to it shows the shadow that the plant casts. The fronds of the fern arch up and out. Only two of

them reach so low that they touch the paper. You see them in the upper portion of Figure 5. Here, their shadow is crisp, dark, detailed, and partly angular. It clearly shows forms of the leaf. The sunlight shining through the leaf even colors the shadow green. For the same leaf, the shadow changes for the part that is higher above the ground. Now the shadow is less dark and its boundaries are less defined. There is a light grey fringe, a partial shadow or penumbra, surrounding the darker core shadow. In the lowest portion of the figure, the shadow is even less dark and appears blurred. All outlines are rounded and curved; none of the edges have any angularity. There are tiny

patches of brightness in the midst of grey that have the shape of circles or ellipses.

To explore these shadow phenomena further, you can use your own two hands. Spread the fingers of both



Figure 3



Figure 4

hands and place one above the other in a crisscross fashion so that they form little windows in between your fingers. These windows vary in size and have a more or less rectangular shape. In direct sunlight, the shadow that the hands cast on a surface (we use white paper) in close proximity shows in detail the forms of the fingers

and the angular forms of the little windows in between them. When you move your hands away from the surface, or when another person moves the surface away from you, the image on the surface changes. Figures 6 and 7 show such a situation. Here, the surface is placed several yards from the hands. On the screen, the fingers are barely recognizable, parts have disappeared. The shadow outlines are concave. There are no angular forms. The bright angular windows of varying sizes have given way to circles of brightness. All of them have the same size. By further increasing the distance between surface and hands, the size of the circles will grow. And they have the shape of a perfect circle only when the surface is held perpendicular to the direction of the sun. Otherwise, they assume the shapes of ellipses. What are these bright circles or ellipses?



Figure 6



Figure 5

under the small opening in a tree's crown there is a light-filled space. Being in that space and looking up at the hole, you meet the sun's blinding brightness. That space has the shape of a cone. When intersected by a surface, circles (or ellipses) of brightness appear on the surface — images of the sun.

My husband remembers a solar eclipse that he observed. It was near midday when the sun was partly obscured by the new moon and had the shape of a crescent. On the ground, underneath trees, there were patches of brightness in the shape of that crescent.



Figure 7

For a shadow to occur, three things are needed. First, there must be an opaque or semi-opaque object that can cast a shadow. Second, there must be the luminosity of a defined light source. (When

the sky is overcast and evenly bright, things do not cast shadows. Shadows don't appear when there are no defined light sources that stand out in luminosity against the surrounding sources of illumination.) Third, there must be a surface, or another suitable medium like haze or smoke, that allow shadows to appear.

The space under the crown of a tree with the sun overhead, or the space "behind" or "under" an opaque object in the sun, is a space of differentiated illumination that remains invisible to us unless a suitable surface or medium brings it to appearance. On the surface of white paper, for instance, the sun directly illumines some parts, other parts are blocked or partially blocked from direct sunlight. By moving the paper, we find that in close proximity to the opaque object the shadow is a detailed image of the object. It is dark and surrounded by brightness. With increasing distance from the object, the circular shape of the sun begins to take effect. It carves away from the previously crisp outlines and rounds out all angular corners. Finally, in circles of brightness surrounded by grey, we see images of the sun. For them to appear, the image of the opaque object retreated. For the sharp image of the object to appear, the images of the sun retreat. We see either the one or the other.