

## Brocken's amazing spectrum

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On board an aircraft or at the top of a mountain, it is sometimes possible to observe on fog or clouds the shadow of this aircraft, or an object such as a cross, or the shadow of the observer himself. It's a Brocken spectrum. This shadow is sometimes surrounded by a coloured light circle similar to a rainbow; we are then confronted with a **Brocken spectrum with glory** or **anthelion** (see [Atmospheric Halos](#)). This relatively rare appearance, at the origin of beliefs in supernatural phenomena or superstitions, was the subject of a poetic narration by Baudelaire in *Les Paradis artificiels*.



*Figure 1. Brocken's spectrum of the photographer with glory. [Source: Diverticimes - [www.diverticimes.com](http://www.diverticimes.com)]*



*Figure 2. Brocken's shadow of a glider with glory. [Source: Diverticimes - [www.diverticimes.com](http://www.diverticimes.com)]*

Brocken's name is that of the highest point in the Harz chain in central Germany where this phenomenon was first observed and described by the naturalist Johann Silberschlag in 1781 and then in more detail by M. Hane in 1797. Each of the authors of this article clearly observed him, EB at the top of the cable car of the small Matterhorn above Zermatt on the Italian-Swiss border on a day when the Sun was shining on the Italian side while the fog was rising on the Swiss side, RM during a hike in the Champsaur massif.

When can we observe a **Brocken spectrum**? The Sun must be clear on one side, a cloud must be present on the other and an object or personage must be placed between the two. The shadow is only visible in the vicinity of the Sun-observer-cloud axis. Its dimensions are proportional to the distance between the object and the fog. In addition, since it is formed on water droplets that move with the cloud, the shadow seems to move and deform. The movements of a person observing his Brocken shadow are

then reproduced and more or less distorted.

The **multicoloured light circle** around the shadow, or **glory**, is not always visible; its formation is due to the backscattering (diffusion in the opposite direction to incident radiation) of sunlight by water droplets from the cloud mass. The dispersion phenomenon already seen for the rainbow is responsible for the observed colors. The angular aperture of the halo, close to  $10^\circ$ , is much smaller than that of the primary rainbow arc ( $41^\circ$ ) and, unlike the latter, its diameter depends on the size of the droplets: the smaller they are, the larger the aperture of the halo. A rainbow is generated by drops with a diameter of about a millimeter and its formation is simply explained by geometric optics. On the other hand, for glories, the very fine droplets responsible for the phenomenon have a diameter of about  $10\ \mu\text{m}$  and the wave nature of light takes place. We are then dealing with a diffusion Mie's of the light, whose theory is difficult.

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