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Halos A Wonderful Optical Phenomena Of Nature

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ABSTRACT

A halo is an optical and atmospheric phenomenon produced by light, from the Sun or Moon interacting with millions of tiny ice crystals associated with the cirrus cloud family which are form in the air. Among the best known halo types are the circular halo (properly called the 22° halo), light pillars, and sun dogs, but many others occur; some are fairly common while others are extremely rare. A halo is a ring or light that forms around the sun or moon as the sun or moon light refracts off ice crystals present in a thin veil of cirrus clouds. The halo is usually seen as a bright, white ring although sometimes it can have color.

Keywords : Halo; Cirrus cloud; Refraction; Light pillars; Sun dogs.

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A halo is an optical and atmospheric phenomenon produced by light, from the Sun or Moon interacting with millions of tiny ice crystals associated with thin, high-level clouds (the cirrus cloud family) which are form in the air. This is because temperatures high in the atmosphere where cirrus clouds form are so cold that the clouds are made of ice crystals. Cirrus clouds form from the ascent of dry air, making the small quantity of water vapour in the air undergo deposition into ice (to change from a gas directly into a solid) and provides their white color and form in a wide range of shapes and sizes. Cirrus clouds are so high in the sky typically higher than 20,000 feet and associated with fair weather, which loosely translates to pleasant temperatures and no rain. The best known halo types are the circular halo (properly called the 22° halo), light pillars, and sun dogs. But many others occur. Some are fairly common while others are extremely rare.

Their formation at such high altitudes also means that the combination of moisture in the air and ambient temperatures necessary for cloud formation do not occur until that altitude is reached. At this temperature halos show up as bright circles around a light source. The shape of the halo is circular around the sun or moon. Halos can have many forms. They are from colored or white rings to arcs and spots in the sky. Many of these appear near the Sun or Moon, but others occur elsewhere or even in the opposite part of the sky. Among the best known halos are the circular halo (properly called the 22 degree halo), light pillars, and sun dogs. Some of them are fairly common while others are extremely rare.

Fig. 1

The ring of halo is a ring of light that forms around the sun or moon as the sun or moon light refracts off ice crystals present in a thin covered cirrus clouds. They are made of tiny, ice crystals. When sunlight passes through the ice crystals, light splits or refracts. Then at just the right angle, it causes us to see the halo. The same thin clouds can cause a ring, or halo, around the moon at night. The event caused by both refraction, or splitting of light, and also by reflection, or glints of light from these ice crystals.

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Fig. 2

Depending upon their angles there are different types of halos. 22 degree halo is a halo where light undergoes two refractions as it passes through an ice crystal and the amount of bending depends upon the ice crystal's diameter where a 22 degree halo is a halo whose apparent radius is approximately 22 degree around the Sun or Moon and is formed, because of refraction by hexagonal ice crystals with diameters less than 20.5 micrometers.

Fig. 3

Scientists call them 22 degree halos, because they are about 22 degree from the center of either the sun or the moon, according to Earth Sky. When they form around the sun, they are called solar halos or sun halos. 22 degree halos are fairly common in winter. People often miss them because they are not looking up! If you see thin cirrus clouds in the sky, you might see this halo.

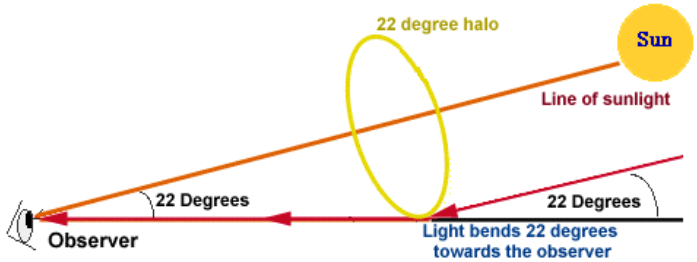

Fig. 4

A 22 degree halo develops when incoming light enters one side of a columnar ice crystals and exits through another side. The light undergoes two different refractions, when it enters the ice crystal and once again when it leaves the ice crystal. The two refractions bend the light by 22 degrees from its original direction, producing a ring of light observed at 22 degree from the sun or moon.

Consequently, an observer sees a ring of light around the sun (or moon) at an angle of 22 degree relative to the light source giving it the name of a 22 degree ring. When 22 degree halo visible around the moon, it is also called as a moon ring or winter halo.

Halos may be shown as almost any colour or combination of colours, but are most often depicted as golden, yellow or white when representing light or red when representing

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flames. But rainbow is something different from halo. The main difference between a rainbow and a halo is that drops of liquid water are "responsible" for the formation of rainbow, and the halo appears due to crystals of water ice. They usually have the shape of a hexagonal ice crystal. Hexagonal ice crystals can be viewed as part of an equilateral 60 degree prism. To understand more clearly I have to explain about hexagonal prism. A hexagonal prism is a 3D-shaped figure with the top and bottom shaped like a hexagon. It is a polyhedron with 8 faces, 18 edges, and 12 vertices where out of the 8 faces, 6 faces are in the shape of rectangles and 2 faces are in the shape of hexagons. Some of the real-life examples of a hexagon prism are pencils, boxes, nuts, etc.

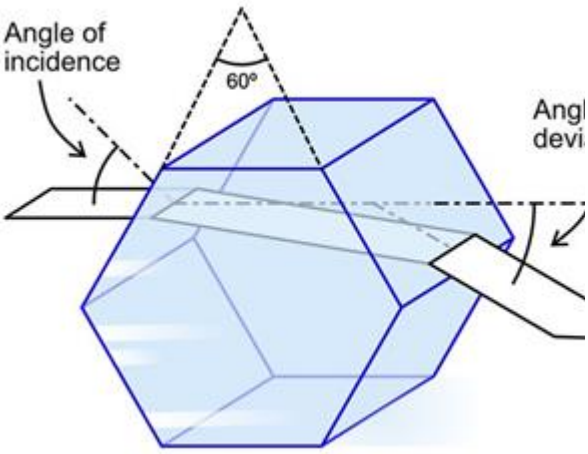

Fig. 5

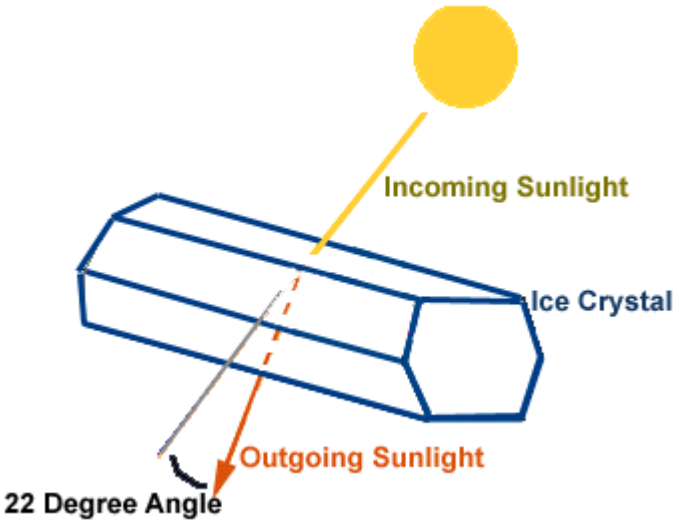

Fig. 6

Halos appear in our skies far more often than do rainbows. They can be seen on average twice a week in Europe and parts of the United States. The 22 degree radius circular halo and sundogs (parhelia) are the most frequent. Ice crystals at all orientations in the sky give a full circle of light around the sun.

Fig. 7

Technically known as parhelia (singular parhelion) they are often white but sometimes quite colorful, looking like

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detached pieces of rainbow, with red on the inside, toward the Sun, and blue on the outside. Technically known as parhelia (singular parhelion) they are often white but sometimes quite colorful, looking like detached pieces of rainbow, with red on the inside, toward the Sun, and blue on the outside.

There are other type of halos are most commonly observed in the atmosphere. 46 degree halo is one of them. A 46° halo is a rare atmospheric optical phenomenon that consists of a halo with an apparent radius of approximately 46° around the Sun or moon. At solar elevations of 15–27°, 46° halos are often confused with the less rare and more colorful supralateral and infralateral arcs, which cross the parhelic circle at about 46° to the left and right of the sun. They are less common than 22 degree halos. But the process by which they form is similar to 22 degree halos.

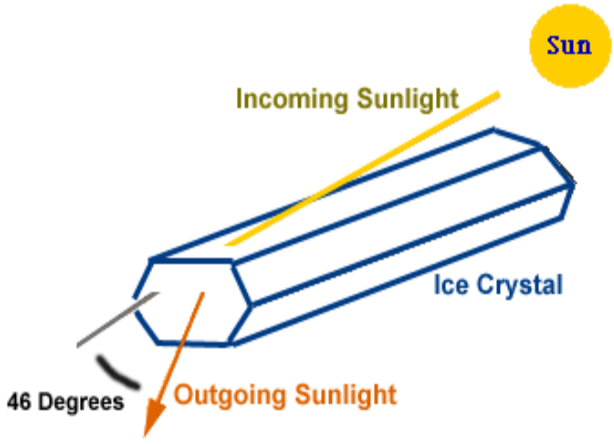

Fig. 8

These ice crystals are hexagonal-shaped columns with diameters between 15 and 25 micrometers and have an appearance resembling tiny pencils.

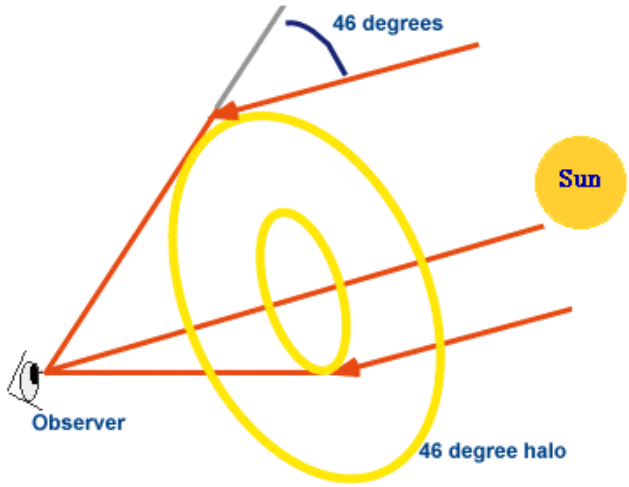

Fig. 9

A 46 degree halo develops when light enters one side of a columnar ice crystal and exits from either the top or bottom face of the crystal. The light is refracted twice as it passes through the ice crystal and the two refractions bend the light by 46 degrees from its original direction. This bending produces a ring of light observed at 46 degrees from the sun or moon.

There is a minimum deviation angle at 22 degree(Fig.5), beams cannot be refracted at smaller angles. This 22 degree minimum angle is also the most probable angle. When light from the sun or moon go through the countless small ice crystals, most beams emerge at 22 degree, and we will thus see a bright ring of this size. The halo is usually seen as a bright, white ring although

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sometimes it can have color. The inside of the halo is dark because beams cannot be refracted at less than 22 degree. Although all ice crystals refract light preferentially 22 degree away from the incoming rays, but different refracted rays reach different observers. Each observer sees a different halo. If anyone notice carefully, they will see that the inner part of the halo is red. That is because ice crystals do not bend red light as much as blue light, so the red halo is slightly smaller than at other colors.

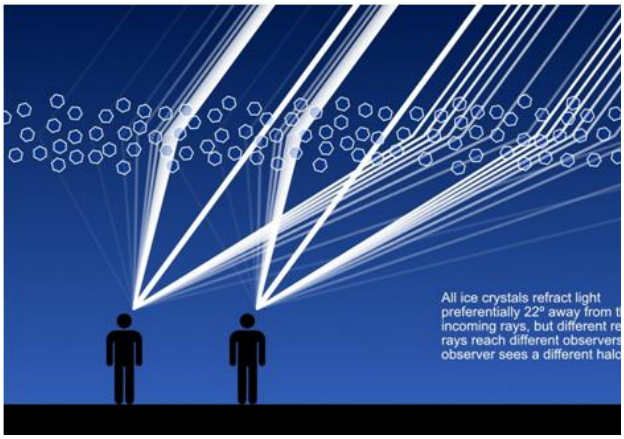

Fig. 10

Fig.11

A 22° halo appeared around the Sun (Fig.11), above PT Semen Padang building at Padang, Indonesia, on October 2, 2009, at 11:09 am.

Fig.12

Complex halo display (22° halo, sun dogs, upper tangent arc, upper and

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lower Sun pillar, parhelic circle, supralateral arc) observed in Les Ménuires (elevation ≈2200 metres), Rhone-Alpes, France on January 23, 2015, during sunset at 04:30 pm(Fig.12).

Fig.13

Sun with Sun dogs at Hoherodskopf, Germany observed (Fig.13) on July 15, 2017. Here we need to know something about Sun dogs. Sundogs are colored spots of light that develop due to the refraction of light through ice crystals. They are located approximately 22 degrees either left, right, or both, from the sun, depending on where the ice crystals are present. The colors usually go from red closest to the sun, out to blue on the outside of the sundog. Sundogs are also known as mock suns or parhelia, which means "with the sun".

Fig.14

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A circumscribed halo (outer ring) together with a comparatively rare 9° halo (inner ring), caused by pyramidal ice crystals. Midsland, the Netherlands, 2019.

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