Lecture 32 Atmospheric Optics II

Rainbows (continued)

Dispersion separates the colors...

causing the primary rainbow to be red on outside.

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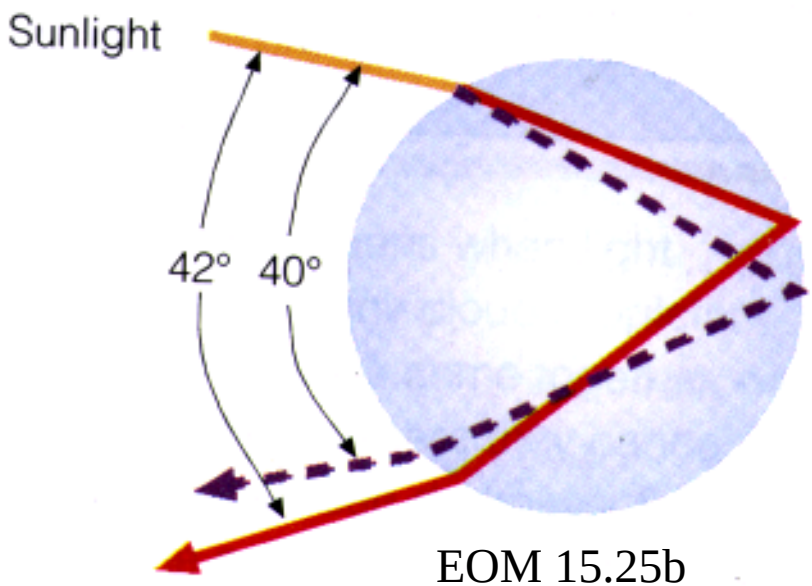
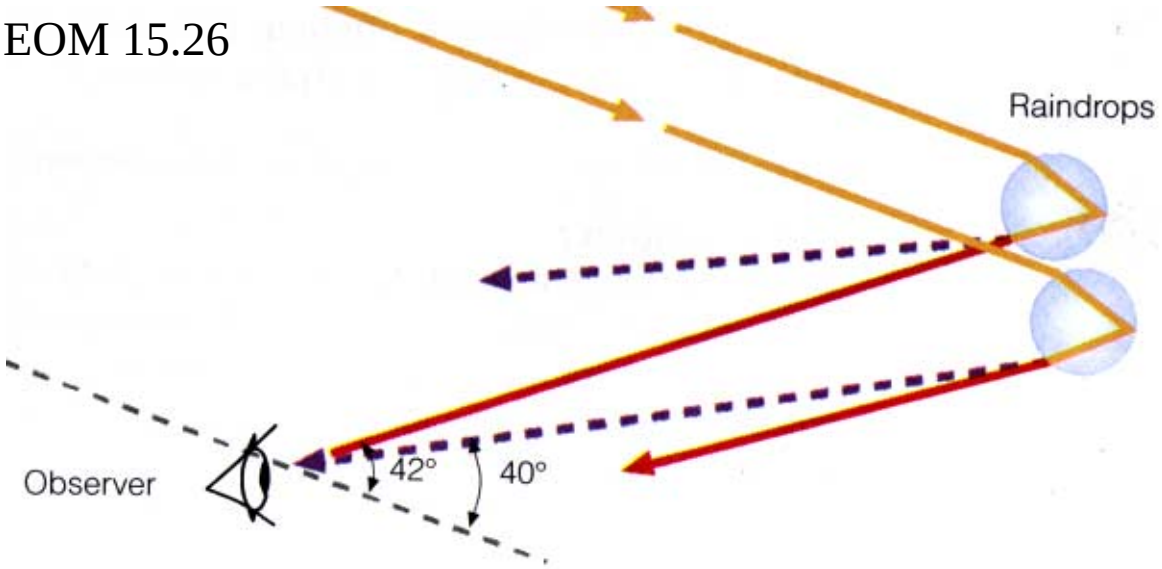


EOM 15.25b

EOM 15.26



Secondary rainbow

- Forms from light that has reflected twice off the inside of the drop, concentrated 51^{o} from antisolar point
- Thus secondary bow is 9^{o} outside the primary bow
- Second reflection reverses the orientation of red and blue rays, so secondary bow has red on inside.

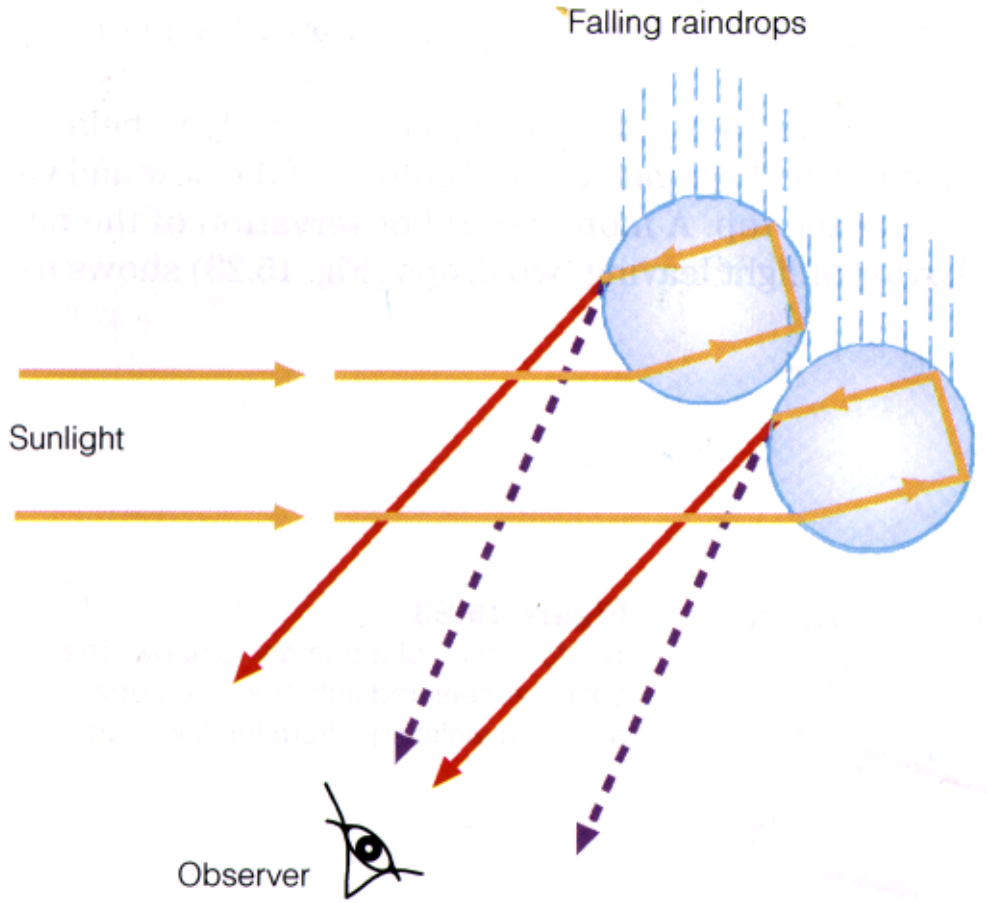
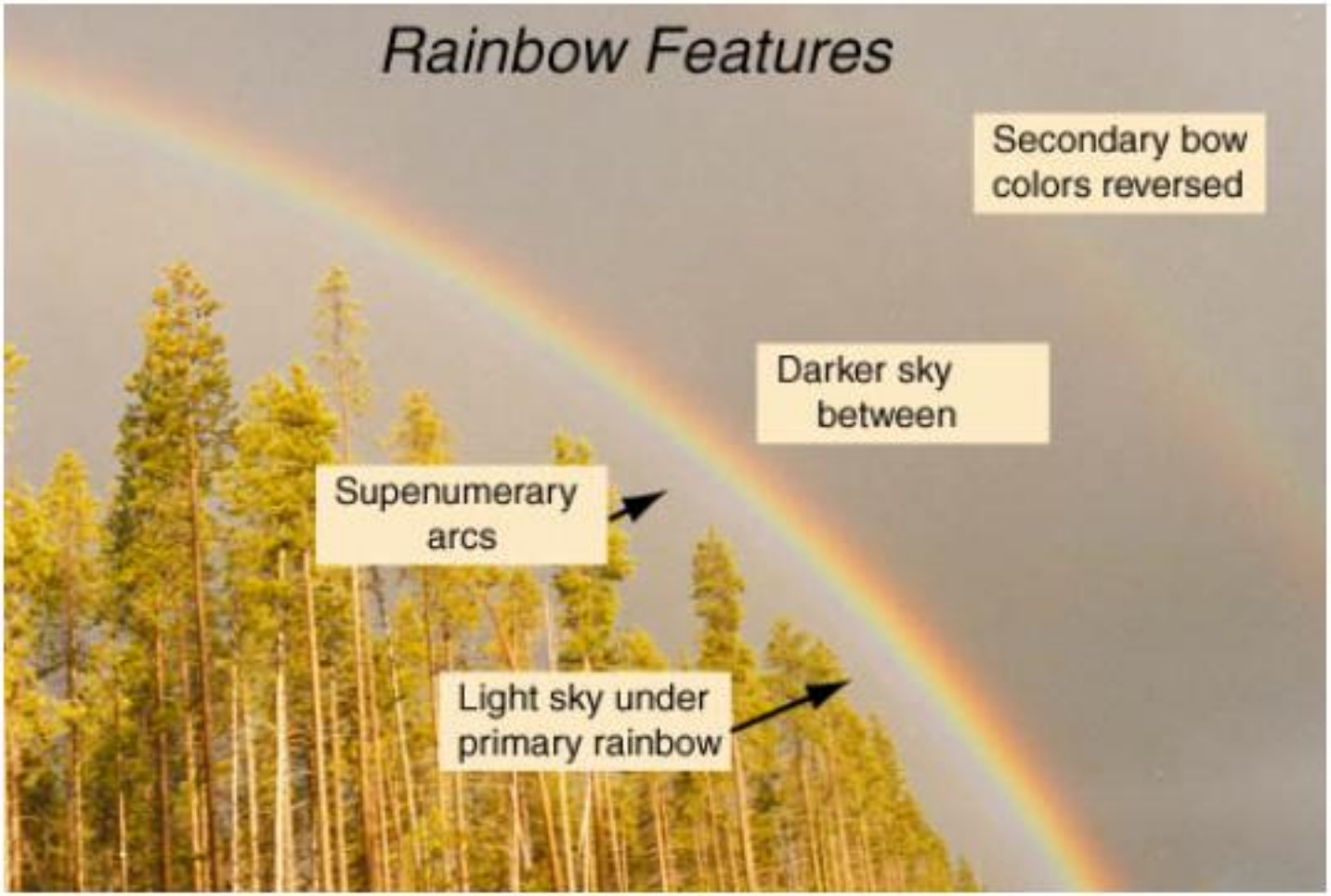
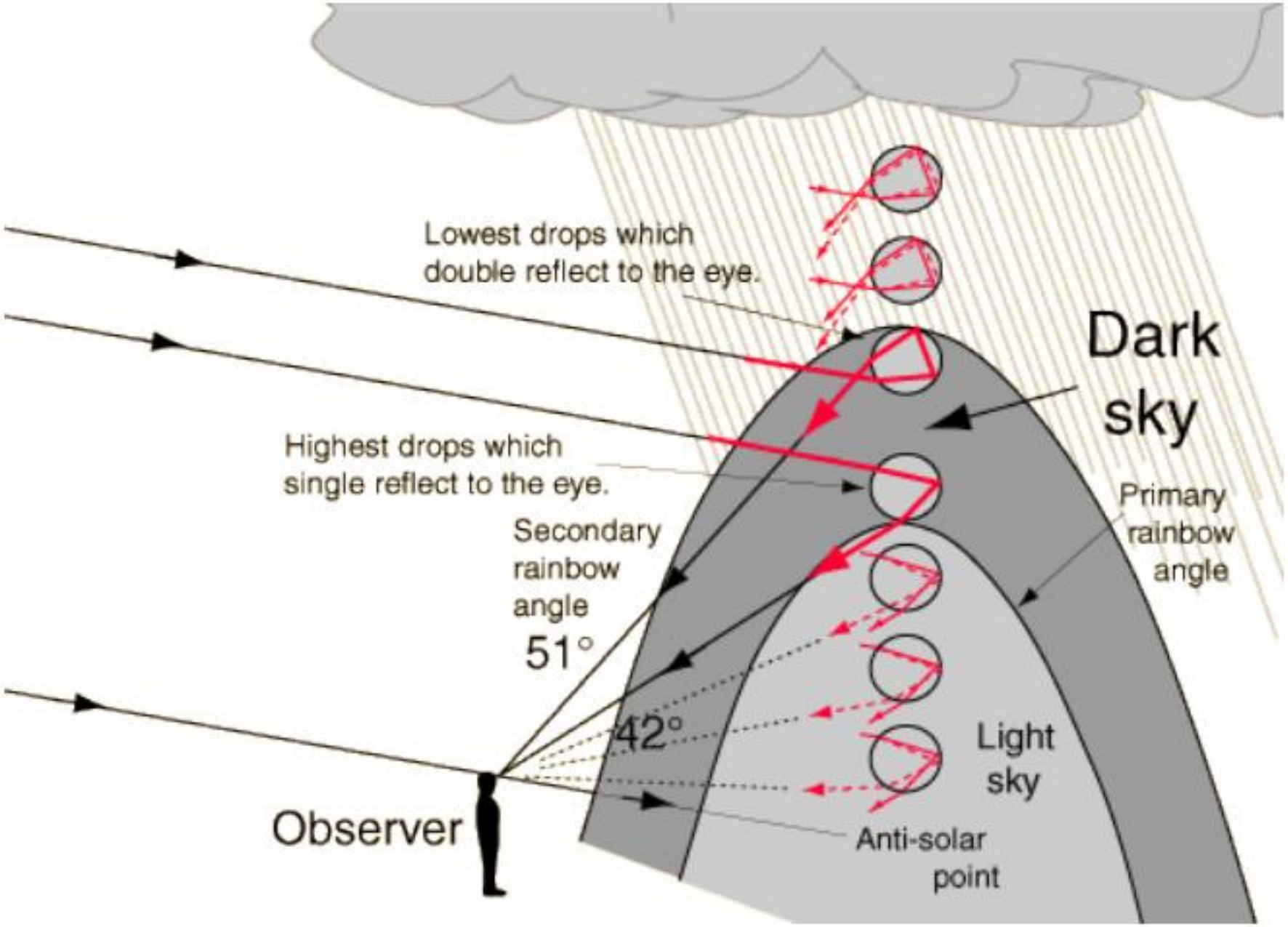


Figure 15.25 (EOM 15.28)
Two internal reflections are responsible for the weaker secondary rainbow.


Rainbow Features
Secondary bow colors reversed
Darker sky between
Supenumerary arcs
Light sky under primary rainbow


Lowest drops which
double reflect to the eye.
Dark
sky
Highest drops which
single reflect to the eye.
Primary
rainbow
angle
Secondary
rainbow
angle
51°
42°
Light
sky
Observer
Anti-solar
point

Ice Clouds and Haloes

Small ice crystals tend to be hexagonal columns or plates-can make haloes

22^o haloes often seen in cirrostratus around moon or sun.; 46^o haloes are rarer.

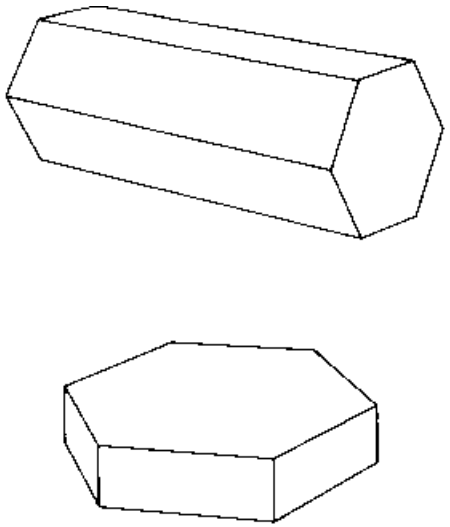


Figure 2-1. Two simple ice-crystal forms: *top*, a columnar or pencil crystal; *bottom*, a plate crystal.

Greenler

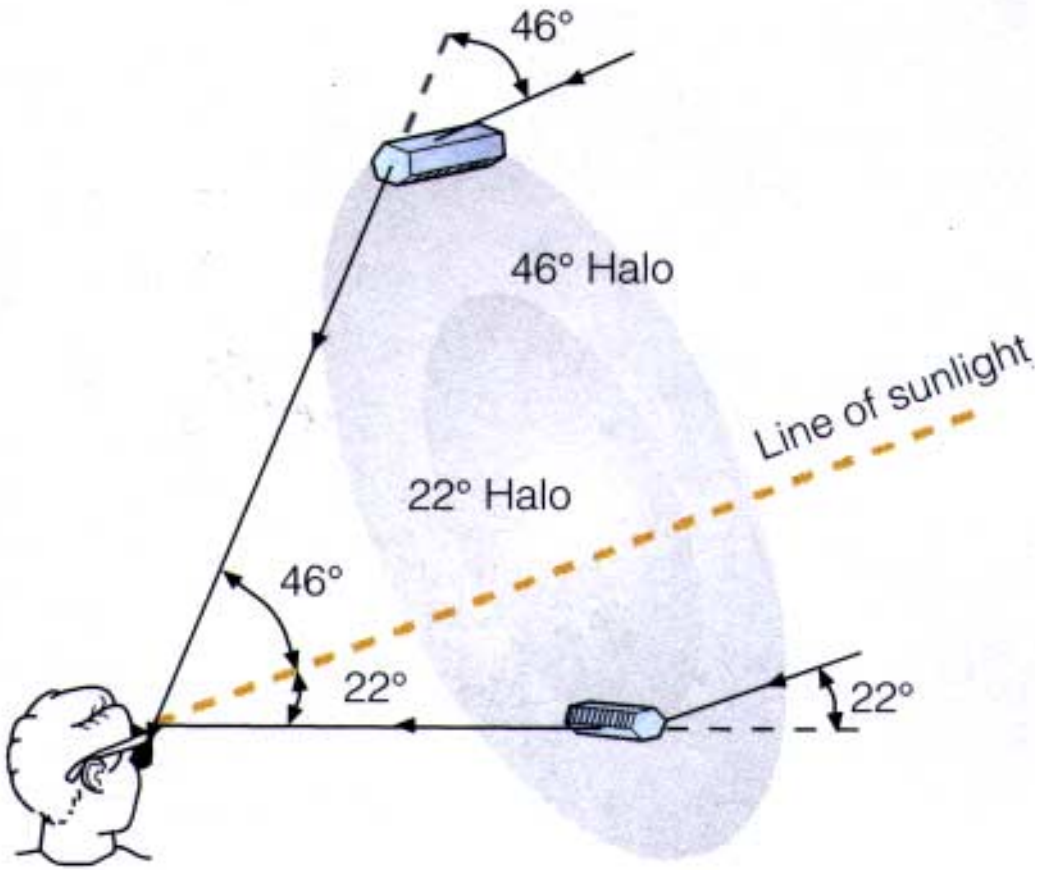
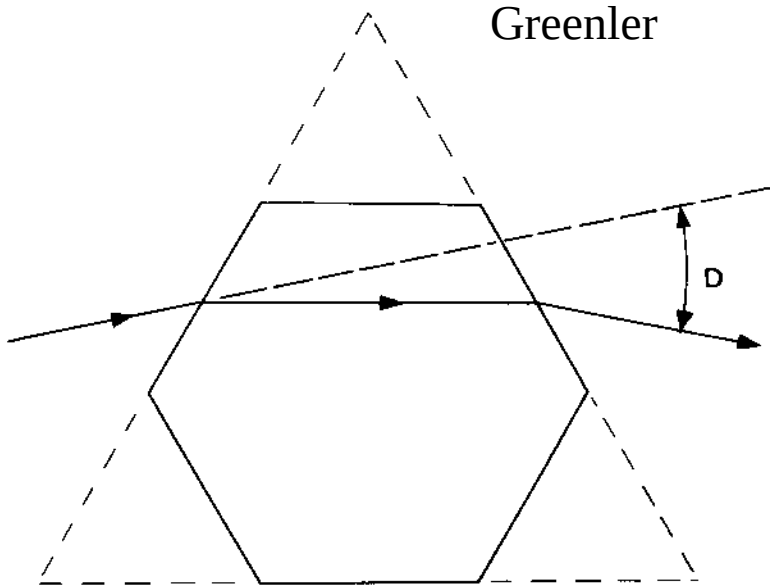


Figure 15.16 EOM 15.18
The formation of a 22° and a 46° halo.

How does refraction create a halo?

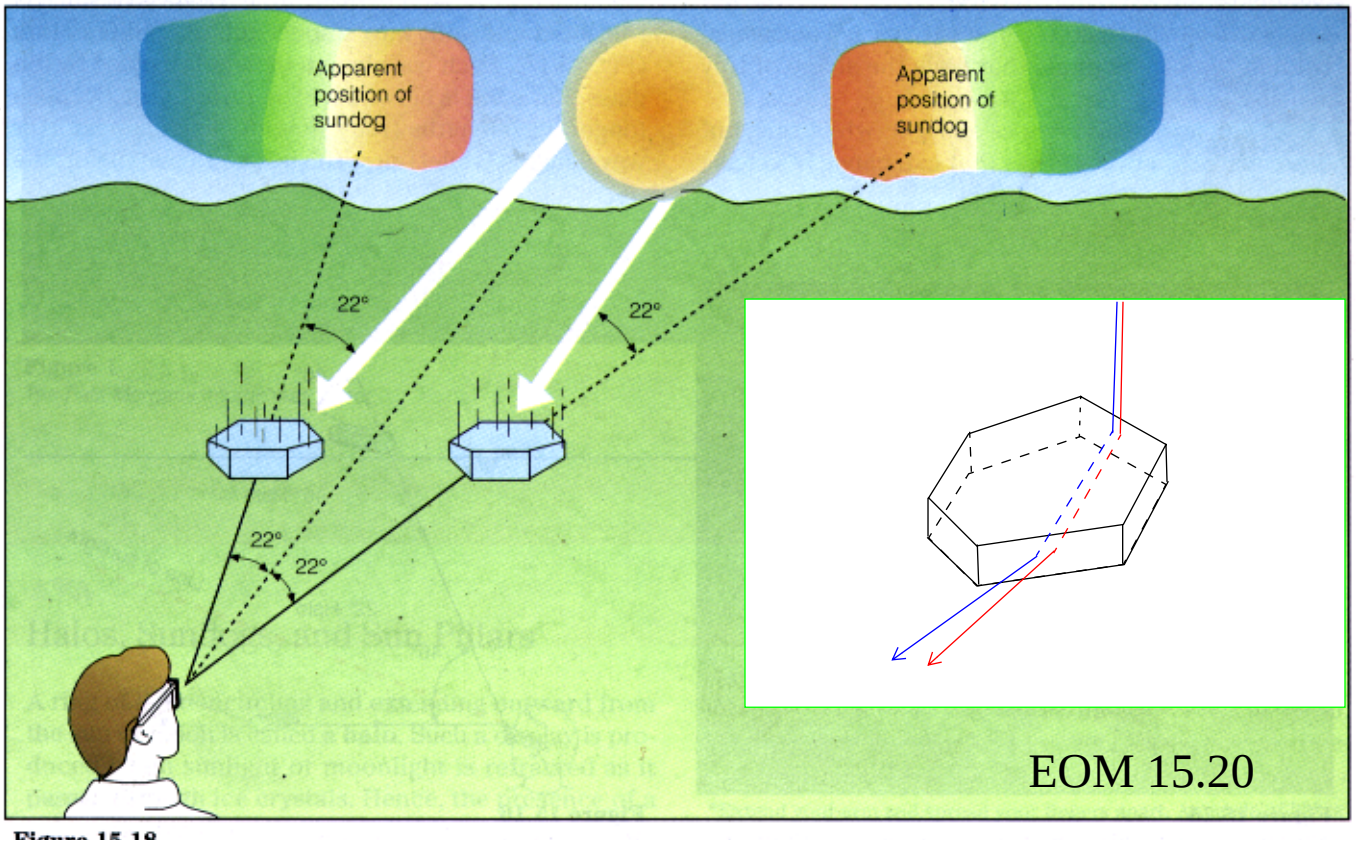
- Refraction angle depends on orientation of crystal with respect to light ray, but a range of orientations refract light 22^{o} or slightly more .



- Hence, some light shining through a cloud of randomly oriented ice crystals will refract 22^{o} or a little more in every possible direction, making a circular halo, a little brighter on its outside.
- Dispersion can slightly separate colors in the halo; blue refracts more so will be on the outside.

Sundogs

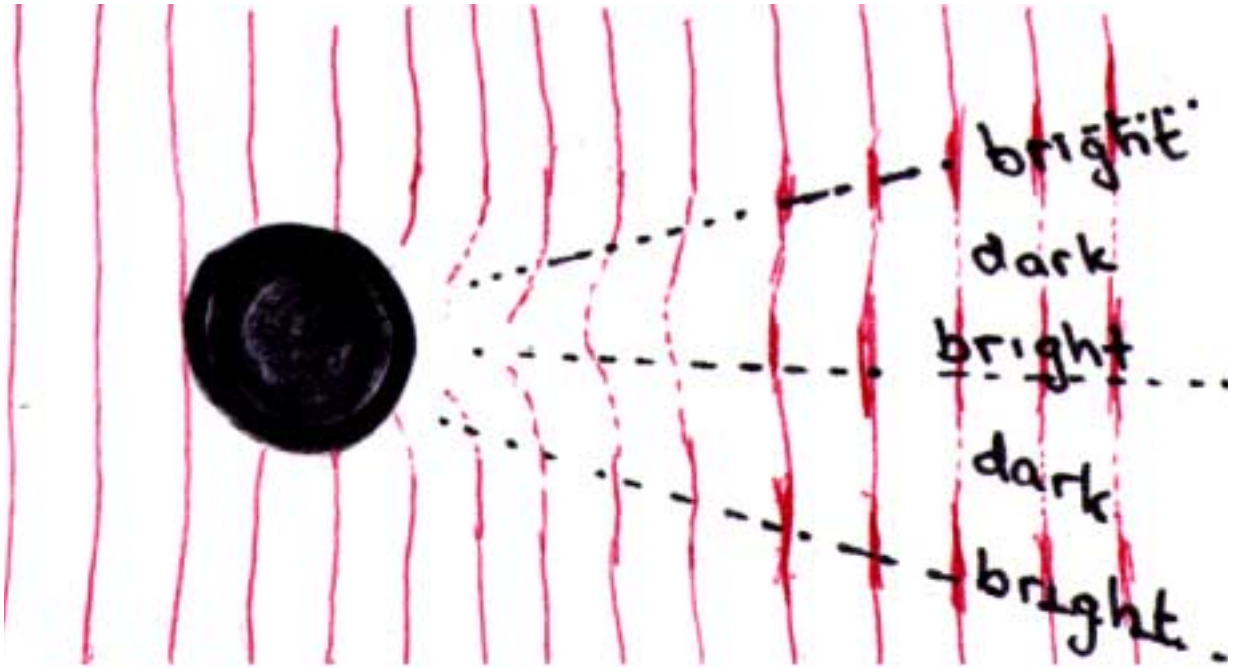
- Thin plates fall like leaves with their flat side down.
- When the sun is near the horizon, it illuminates their narrow horizontal faces
- Some of the sunlight refracts approximately 22 degrees horizontally.
- This appears to us as *sundogs*: bright spots in thin cirrus or cirrostratus cloud 22 degrees horizontally from the sun.



EOM 15.20

Diffraction

Bending of light waves around small objects.



- *Coronas* are bright regions around the moon and sun a couple of degrees in radius created by diffraction around cloud droplets. They are much closer to moon/sun than halos.
- Red (longer wavelength) light diffracts more, so corona slightly reddened on the outside.
- Size of corona depends on size of droplets.
- Light passing through droplets is mainly scattered outside the corona and is not its main cause.
- *Glories* are diffraction-related rings sometimes seen around airplane shadows on cloud layers.