

THE HALO SIMULATION PROGRAM

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3. Choose the orientation of the crystal: Suppose, for example, that the crystals are to be “columns with tilts of x degrees.” First orient the crystal so that it has two prism faces horizontal but is otherwise randomly oriented. For singly oriented columns, rotate the crystal randomly about its axis. Then tip the crystal axis so that it makes an angle with the horizontal plane. This angle — the tilt — is given by a normal distribution having mean zero and standard deviation x .

Thus, to say that the crystals have tilts of x , means not that the tilts are exactly x , but rather that their standard deviation is x . A table of values for the standard normal distribution shows that 68% of the crystals would be within x of horizontal, and 95% within $2x$ of horizontal.

For Parry oriented columns the procedure is the same, except that the rotation angle — the amount of rotation about the crystal axis — is given by a normal distribution having mean zero and preassigned standard deviation, instead of being chosen randomly.

4. Choose a point on the crystal for the incoming ray to hit: Construct a disk with diameter equal to the longest diagonal of the crystal, and place it perpendicular to the incoming light and shading the entire crystal. Position the incoming ray so that it passes through a randomly chosen pinhole on the disk. This determines where, if at all, the incoming ray hits the crystal. If the ray misses the crystal, return to step 2. That is, choose another crystal shape, another crystal orientation, etc. (So crystal shape and orientation, but not size, can affect the chance that the crystal will be hit by the incoming ray.)

“Ray under consideration” will refer either to the incoming ray from the sun or to one of the ray segments within the crystal. At the present step, the ray under consideration is the incoming ray.

5. Follow the ray under consideration until it meets a crystal face, and calculate the reflected and transmitted rays, together with their Stokes parameters and beam cross sections. The intensities shown in the ray path diagrams in the text are products of the first Stokes parameter, the beam cross section, and the relevant refractive index.

One of the two reflected and transmitted rays is the outgoing ray from the crystal. The other is within the crystal and becomes the (next) ray under consideration.

6. Plot a dot on the celestial sphere in the direction opposite to that of the outgoing ray: The dot is the point lit by the outgoing ray. Plot it with probability equal to the intensity of the outgoing ray: choose a random number between zero and 1, and plot the dot if the intensity exceeds the chosen number. The density of dots in the simulation therefore indicates halo intensity.

7(a). If the intensity of the ray within the crystal exceeds 0.00001 and if the ray has suffered fewer than 100 internal reflections, return to step 5. That is, follow the ray path to the next crystal face and calculate new reflected and transmitted rays.

(b). If not, return to step 1. That is, choose another incoming ray, another crystal shape, another orientation, etc.

When the desired number of dots has been plotted, terminate or else repeat, using a different set of crystal shapes and orientations.