
Compact Disk Spectroscopes Revisited!

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The recent article by Tim Knauer¹ indicates again that the CD provides a wonderful learning resource for physics teachers and students. There is much to be learned by examining the nature of the way information is stored and retrieved on the disk as well as the physical medium itself. Books such as Muller's *Upgrading and Repairing PCs*² provide a useful compendium of the properties of the medium as well as the methods of encoding.

Knauer suggests the use of blank disks available from bulk packs to provide a cheap supply of a diffraction grating material; however, most recordable CDs (CD-R) can be delaminated with a minimum of effort to yield both transmission and reflection gratings. The easiest way to remove the coating is as follows: Take a CD-R and place the polycarbonate side down and label side up. Cut around the edge of the CD about 1 mm from the edge, through the top layer to the plastic, using a scalpel or similar sharp knife (see Fig. 1). The cut need only be deep enough to cut through the top lamination. Make a similar circular cut on the inside of the top layer where it meets the inner part of the disk. A sharp edge can be used now to carefully separate the laminate from the polycarbonate base. (The ease of this process may well give some concern to those who use CD-Rs as an archival medium!)

With care the entire top layer can be peeled off leaving a transparent disk. As with any diffraction grating, care should be taken not to touch the surface of the disk. The metalized layer can also be used; however, it is very fragile and needs to be reinforced.

Cellophane tape may also be used to pull the laminate off the disk. In that case the metalized reflection grating stuck to the tape is quite sturdy.

Knauer sections the disk to make spectroscopes of the shoebox form.³ A more exciting use of the disk, which exploits its full light-gathering power, is to use the whole disk as a spectroscope without modification, essentially as shown on the November 2002 *TPT* cover. The method used is similar to that in which the grating is used in reflection mode, a description of which can be found on many websites.⁴

To use the clear grating in transmission mode, hold the disk up to a point light source so that the light is centered in the hole of the CD and the disk is about 20 cm from your eye. Move the disk backward and

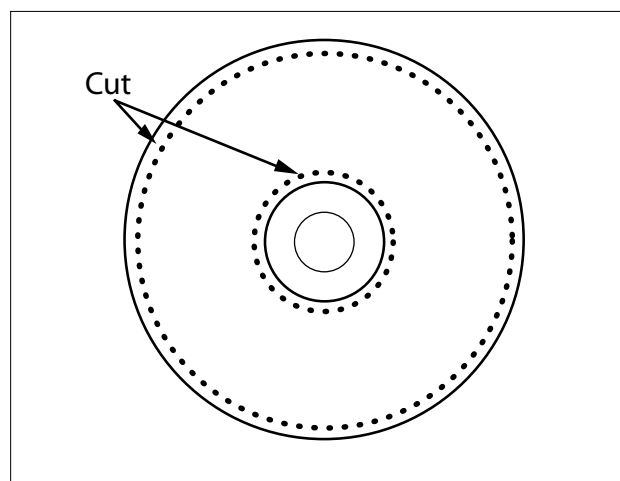


Fig. 1. Cutting pattern for removal of the metalized layer.

forward until complete circles of light can be seen. Moving the disk closer to the eye will allow the second- and third-order diffraction pattern to be seen. Reasonably accurate angular measurements can be made if the distance is adjusted so that a particular colored ring is at the edge of the CD.

The circular spectra of various light sources may be seen in this way — for example, different streetlights in a parking lot or different lights in a room. The grating also can be used to image weak sources, moonlight for example, much more effectively than conventional spectrometers normally available to students.

I have been successful with all types of recordable CDs, including the blue azo dye types. These still work, though the dye remains with the plastic side and filters the light somewhat. If necessary this dye can be removed, without affecting the grating, using isopropanol. Despite much effort, I have not been successful with any commercially recorded CDs nor have I had any luck with re-writable CDs (CD-RW).

The development of these spectrometers occurred when students were asked to determine the spacing on a CD. Although there are many ways to do this, it is perhaps best done with a pocket diode laser held perpendicular to the surface of an undamaged disk and looking at the first-order reflection maxima. An interesting extension to this is to get students to do the same exercise with DVDs. Here the pattern is more spread out, making it a little harder to find than in the first instance. In some cases two close-lying maxima are observed, reflecting the double-layered nature of these disks!

It is also possible to delaminate a recordable DVD disk (DVD-R). The type I found sandwiches the active layer between two polycarbonate layers. A razor blade sandwiched between the two polycarbonate layers will cause the disk to split. Work the blade completely around the disk before levering the two halves apart. With a moderate amount of force, the central part will also split leaving two half-thickness gratings, one clear and the other with the metalized layer! The clear disk can be used in the same manner as above; however, now it needs to be positioned very close to the eye in order to see the diffraction pattern.

References

1. T. Knauer, "A compact disk transmission spectroscope," *Phys. Teach.* **40**, 466–467 (Nov. 2002).
2. S. Muller, *Upgrading and Repairing PC's*, 12th ed. (Que, Indianapolis, 2000).
3. D.S. Falk, D.R. Brill, and D.G. Stork, *Seeing the Light* (Wiley, New York, 1985).
4. For example, <http://fusioned.gat.com/Teachers/Curriculum/Curriculum-HTML/T03S-CD-diffract.html>.

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