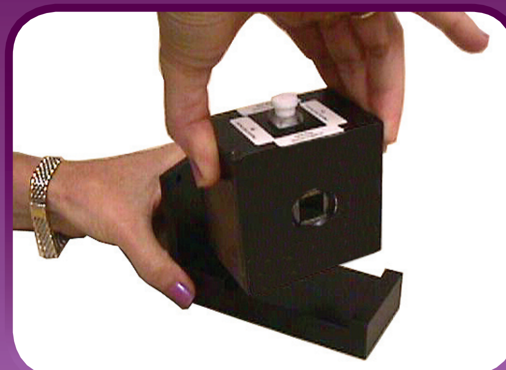
The Olis® MCD Cell Holder



Magnetic Circular Dichroism is Useful on All Light Absorbing Substances.

Even those Which are Not Chiral.

In biochemistry, magnetic circular dichroism[1] is used predominantly in studies of metalloproteins or other substances containing metal ions. Examples of the use of MCD are:

- Determination of a metal center oxidation state and spin state
- Effects of inhibitors/substrate/mutations on the electronic and magnetic properties of the metal center(s)
- Detecting of ligands on ferric heme centers
- Quantification of tryptophan content in regular proteins

Traditional MCD experiments require huge, unwieldy, and expensive electromagnets (often cryogenically-cooled), and thus, special MCD spectrophotometers.

Olis, Inc. offers a tiny, easily handled, inexpensive permanent magnet which can be used in every CD spectrophotometer. The patented DeSa 1.4 Tesla magnet[2] is effectively a rectangular cuvette holder with a powerful magnetic field. This magnetic cell holder is offered as an accessory, just as a Peltier cell holder might be, for the Olis DSM CDs, Jasco CDs, and all other models. The photograph above shows this 1.9 kg magnet being rotated on its axis, so as to reverse the magnetic field.

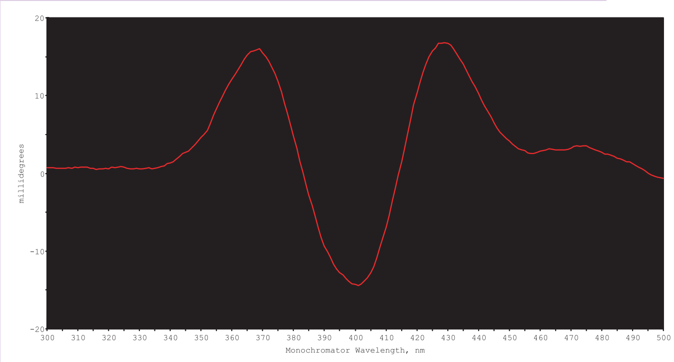


Figure 1

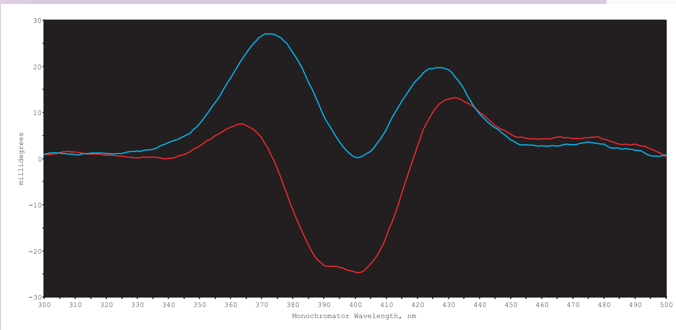


Figure 2

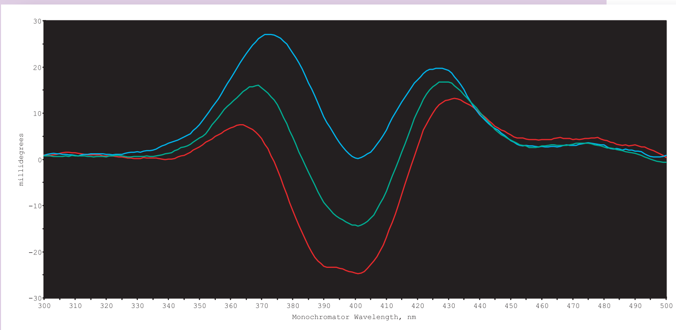


Figure 3

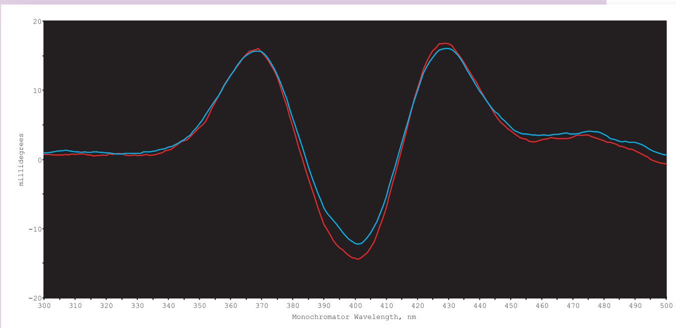


Figure 4

Reverse Field MCD

In the absence of the magnetic field, the Ni-tartrate solution has a characteristic natural CD profile in the region between 300 and 500 nm (Figure 1).

With the magnetic field oriented north and south[2], two significantly different CD profiles are acquired. Figure 2 shows the signal with the north orientation (red), and the signal with the south (blue).

Figure 3 compares the spectra collected with and without a magnetic field. In each case, the observed CD spectrum is the sum of any "natural" CD plus the magnetic CD (MCD) component which may have been induced.

Subtracting these observed CD signals will eliminate or cancel any contribution made by the natural CD.

Subtract: Final Spectrum =
(CD + nMCD) – (CD + sMCD) = 2 nMCD
(CD + sMCD) - (CD + nMCD) = 2 sMCD

Adding these observed spectra will eliminate or cancel any contribution made by magnetic CD.

Add: Final Spectrum =
(CD + nMCD) + (CD + sMCD) = 2 CD

Observed spectra are the terms within the parentheses. And, dividing the final spectra by 2 produces MCD and CD, respectively.

Figure 4 compares the observed natural CD (fig 1) with the calculated natural CD ("Add"). Figure 5, facing page, shows the north (red) and south (blue) MCD as calculated ("Subtract").

Ni (II) tartrate is a sample that exhibits both natural and magnetic CD. Other samples will have negligible natural CD signal and prominent MCD. $CoSO_4$ is one such a compound.

Figure 6 shows the MCD signals of $CoSO_4$. The value of the MCD at 510 nm is used to calculate the magnetic field strength in Tesla according to:

$$\Delta\varepsilon_M = -0.0185\ M^{-1}cm^{-1}\ T^{-1}$$

Here, $\Delta\varepsilon_M$ is the MCD signal presented as differential (L-R) molar extinction.

A third sample, commercially available cytochrome C, is shown in Figure 7. Here,the natural CD and both MCD-s are shown for this heme containing metalloprotein.

Clearly, just as a thermoelectric cell holder added to a CD spectrophotometer opens the world of thermal denaturation studies, so a magnetically active cell holder can open up the world of MCD spectroscopy to a laboratory.

MCD is an under-utilized measurement because of the historic expense and annoyance of working with commercially available MCD spectrophotometers. We hope that the availability of the tiny DeSa magnet will encourage everyone with a CD spectrophotometer to add MCD to their tools for understanding proteins, peptides, nanoparticles, and other light absorbing samples.

Finally, we hope that MCD might be used in pedagogical environments, where inexpensive and informative studies can be done safely and easily by novices.

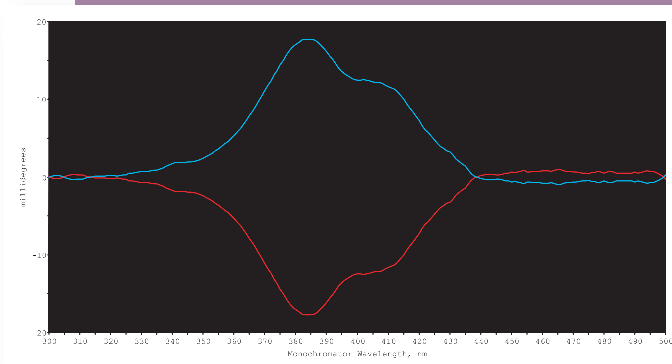


Figure 5

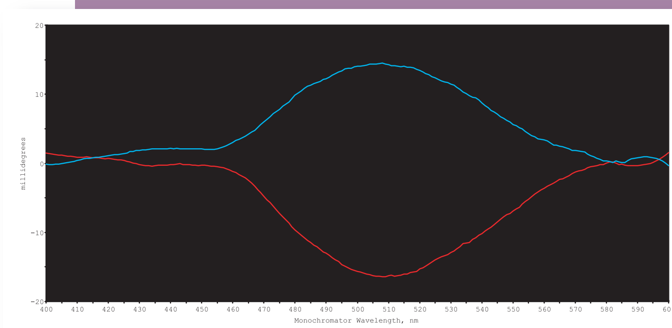


Figure 6

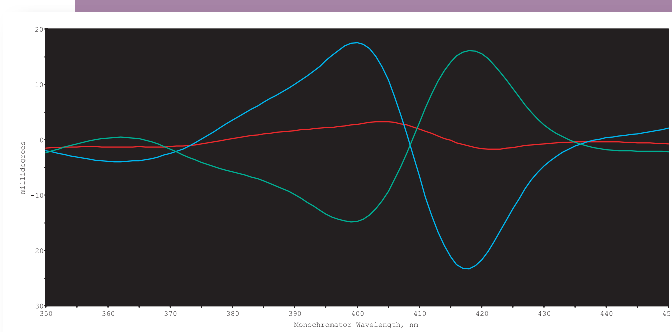


Figure 7

Recommended Links:

http://www.iupac.org/goldbook/MT06778.pdf
http://en.wikipedia.org/wiki/Magnetic_circular_dichroism
http://www.bmb.ogi.edu/users/JWW/MCD05.html

Footnotes from front cover

[1] Magnetic circular dichroism (MCD) is the measurement of circular dichroism of a material which is induced by a magnetic field applied parallel to the direction of the measuring light beam. Materials which are achiral will exhibit MCD (the Faraday effect), since the magnetic field leads to the lifting of the degeneracy of electronic orbital and spin states and to the mixing of electronic states. MCD is frequently used in combination with absorption and CD studies to determine electronic assignments. (1997, 69, 1283 IUPAC Compendium of Chemical Terminology)

[2] Strength of the magnetic field integrated (or averaged) over the volume of the sample. 1.4T is the maximum strength of the magnetic field in the geometric center of the magnet.

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