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CD-2095: A CRITICAL EVALUATION OF DESIGN CONCEPT

Jasco was the first and still is the only company offering a dedicated CD detector for HPLC (and SFC).
Original name was CD-995, later on it was named CD-1595 and currently it's called CD-2095: these changes reflect the variation of HPLC product lines, rather than any real hardware change.
So far (i.e. in 4 years) about 170 units were delivered, not so many compared to standard CD spectrometers shipped in the same period, but in any case a appreciable number.
About 45% of users are in Japan, the rest is splitted 50-50 between US and Europe, with minor quantities in other areas.
To know more about this product:
a- a few introductory articles appeared in literature[1] [2]
b- other papers were printed evaluating the unit[3] [4] [5]
Many other papers are now in literature, but our aim this time is to give a critical evaluation of the system

Are there alternative ways to measure HPLC-CD?
Yes, of course:
a- earliest and simplest approach was to use modified conventional CD spectrometers, fitting them with a flow cell associated with beam condenser[6] [7]
b- a dedicated diode-array CD was presented in the past[8]
c- modified absorption HPLC detectors were reported[9]
Solution a has still strong merits and is widely used, the main drawbacks are cost and size; b approach had no future since production stopped (or hardly started) many years ago; solution c, which uses a polarizer and a quarter wave plate as in early CD spectrometers, lacks from sensitivity.

Let's go in the technical detail of CD-2095, unit has been designed as a detector for HPLC, not as a small CD spectrometer, this is the main point, so:
-Hg/Xe lamp, since it has the strongest emission between the UV lamps commercially available
+Hg/Xe lamp has no UV emission below220nm, this is regarded as marginal limitation due to type of mobile phases used in HPLC
+strong emission in UV means relatively low emission in the VIS range, so a single monochromator can be used to remove stray-light
+the non-continuous emission spectra is not a serious problem since bandpass used is very large and quality of spectra is not main target
-single monochromator since size must be small
+grating type to reduce the size
+with specially quartz plate coated grating to minimize photochemical long term damage of the surface
-minimum number of optical components (only two lenses)
-Si detector closed to sample cell
+no high voltage around as with photomultiplier tubes
+virtually insensitive to strong incoming light

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[1] Kudo K., Ajima K., Sakamoto M., Saito M., Morris S., Castiglioni E., *Chromatography*, 20, 1, 59, 1999
[2] Brandl F., Pustet N., Mannschreck A., *Internat. Lab.*, 29, 10C, 1999
[3] Hadley M.R., Jonas G.D., *Enantiomer*, 5, 357, 2000
[4] Bertucci C., Andrisano V., Cavrini V., Castiglioni E., *Chirality*, 12, 84, 2000
[5] Kudo K., Iwaya K., Yomota C., Morris S., Saito M., *Enantiomer*, 5, 369, 2000
[6] Drake A.F., Gould J.M., Mason S.F., *J. Chromatogr.*, 202, 239, 1980
[7] Salvadori P., Bertucci C., Rosini C., *Chirality*, 3, 376, 1991
[8] Brandl G., Kastner F., Mannschreck A., Nolting B., Andert K., Wetzel R., *J. Chromatogr.*, 586, 249, 1991
[9] Yamamoto A., Kodama S., Matsunaga A., Hayakawa K., Kitaoka M., *Analyst*, 124, 483, 1999

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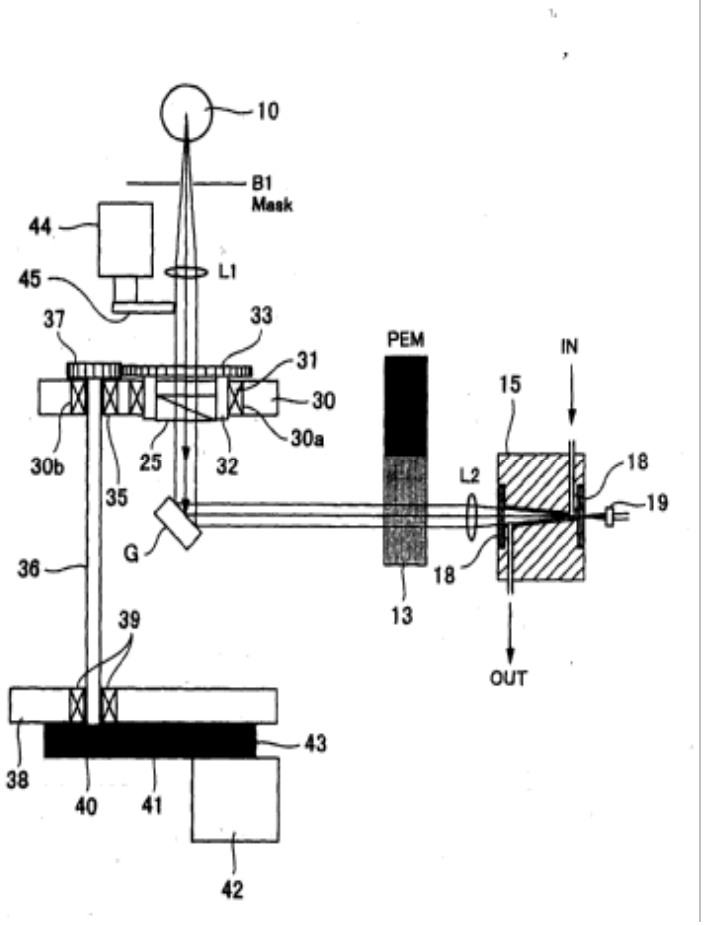

We should consider now how circularly polarized light is generated, the view of the optical drawing will help our understanding.

10 is the Hg/Xe lamp
L1 is the collecting lens
25 is the linear polarizer
G is the grating
13 is the PEM modulator
L2 is the focussing lens
15 is the flow cell
19 is the Si detector

As in conventional CD spectrometers CD-2095 uses the expensive, but sensitive photoelastic modulator approach to create circularly polarized light. In contrast to conventional designs the linearly polarized light is generated by a linear polarizer placed *before* the grating. This solution was adopted mainly to keep the light path as short as possible. Since grating will induce its own linear polarization (in a chromatic way …), the polarizer itself can be rotated by a gears mechanism in order to get zero CD output at a specific wavelength when the mobile phase is flowing through the cell.
Approach is unusual, but effective and can also compensate zero shifts originated by the cell (particularly strong in SFC due to high pressure stress on the windows).
In the drawing you can see also standard 25mm flow cell (other cells for preparative or SFC applications are optionally available and easy to exchange). 25mm has been selected as a long path to assure best sensitivity in most of the cases, the tapered design matches the beam size focussed on the Si detector.
The global result gives a very compact size, the unit can be easily installed nearby any HPLC system.

Electronics is more conventional: a sample and hold amplifier is used for CD signal, while measuring the DC component the absorbance data can be extracted as well. So unit can output simultaneously CD (chiral information) and Abs (mass information) or also the anisotropy factor g, which is very important to detect enantiomeric purity when no chromatographic separation is achieved.
Despite the fact that spectral scanning is possible, as said above the CD-2095 is not a small CD spectrometer, but it has been developed as a CD HPLC/SFC detector, with sensitivity and space limitations as main targets.
We hope that these notes will help you in the understanding on how these rather difficult tasks has been achieved.

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