ULTIMATE ENERGY RESOLUTION OF A HEMISPHERICAL ANALYZER USING A CYLINDRICALLY SYMMETRIC INJECTION LENS AND VIRTUAL ENTRY APERTURE$^{\diamond}$

T.J.M. Zouros[1,2] and E.P. Benis[3,*]

1) Department of Physics, University of Crete, Heraklion, Crete, Greece
2) Inst. of Electronic Structure and Laser, FORTH, P.O. Box 1527, 71110 Heraklion, Crete, Greece
3) Dept. of Physics, J.R. Macdonald Laboratory, Kansas State University, Manhattan, KS 66506-2604

Today's, modern hemispherical deflector analyzer (HDA) is equipped with a multi-element zoom lens and position sensitive detector (PSD) [as for example in Electron Spectroscopy for Chemical Analysis (ESCA)] and therefore enjoys a very large collection efficiency. The zoom lens focuses the source electrons into the HDA entry, thus increasing the overall collection solid angle. Pre-retardation, also supplied by the lens, is used to further improve the overall energy resolution of the entire spectrometer by decelerating the particles from an initial source energy T down to a much lower energy t just prior to HDA entry.

Recently, we have presented a simple method for obtaining the theoretical ultimate resolution and associated linear lens magnification of the combined lens-HDA spectrometer [1] under the constraints of the Helmholtz-Lagrange law for conjugate object-image pairs. Our results are practical as they are analytic, giving the minimum resolution at the optimal magnification, in terms of basic experimental parameters. Our formulation can be readily used in the design and performance evaluation of such a spectrometer.

A schematic of the relevant geometry is shown in Fig. 1. The drawing has been simplified by approximating the (thick) lens by a thin lens. The vertical dimensions are particularly enhanced. The depicted lens represents a generic lens substitute of the more complicated multi-element lens used in typical ESCA setups.

Here, we report further on our recent results. Our method can in principle be extended with some modifications to include all particle spectrometers utilizing a virtual entry slit whose size is controlled by a cylindrically symmetric lens and should therefore be of general interest to the spectroscopy community at large.

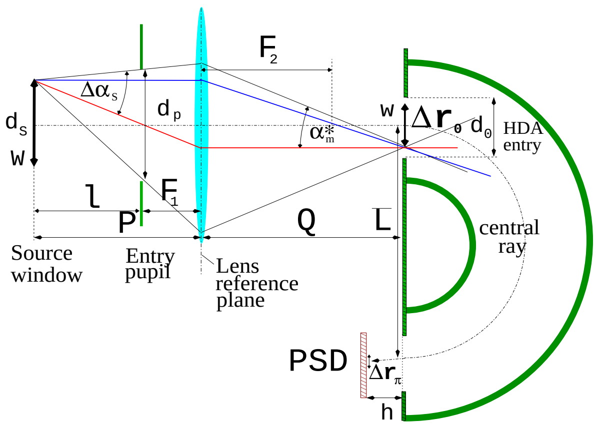

Fig. 1. Schematic geometry of typical lens-HDA spectrometer. The object diameter d_S is focused by the lens and imaged onto the HDA entry plane as $\Delta r_0 = |M_L| d_S$. Pre-retardation changes the energy of the central ray from W at the source to w just prior to HDA entry. For zero beam angle, the pencil half-angle $\Delta\alpha_S$, defined by the entry pupil, is related to $\alpha_m^\star$, via the Helmholtz-Lagrange law, $d_S\, \Delta\alpha_S \sqrt{W} = \Delta r_0\, \alpha_m^\star \sqrt{w}$ [1].

References

[1] T.J.M. Zouros and E.P. Benis, Applied Phys. Let. **86**, 094105 (2005)

*present address: IESL-FORTH, P.O. Box 1527, 71110 Heraklion, Crete.

$^{\diamond}$Supported by the Chemical Sciences, Geosciences and Biosciences Division, Office of Basic Energy Sciences, Office of Science, U. S. Department of Energy.

E-mail : tzouros@physics.uoc.gr