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Extracting Point Source Spectra / Recovering Extended Object Spectra Using Richardson-Lucy Restoration

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Long slit spectra of astronomical objects either contain point sources, characterized by a known Point Spread Function (PSF), which is often wavelength dependent, and extended sources, such as nebulae, whose spatial extent is not a priori known. The analysis of long slit spectra consists in separating the spectrum into either: the point source(s), free of the background ("extraction"); or the extended source(s), free of contaminating point source spectra. Depending on the scientific aim, one or both of these data are of interest, such as the spectrum of the central star of a planetary nebula AND the line and continuum spectrum of the nebula with the star removed. In the simple case of a point source with a background gradient, the spectrum of the point source can be simply extracted by subtracting a background fit by a low order function and summing (perhaps with weights, as in optimal extraction) the point source signal at each spectral element in the cross-dispersion direction. When the background is complex or there are many point sources, there is no guide as to how to fit the extended source spectrum beneath the point sources. Simple methods can give a poor estimate of the spectra of point sources and the spectrum of the background in the vicinity of the stars. The application of image restoration algorithms to the spatial component of long slit spectra offers a potential solution.

Several methods based on the well known restoration technique in imaging, the Richard-Lucy (R-L) iterative deconvolution method (Lucy 1974, ApJ, 79, 745), are under development. The background and the point sources are treated as separate channels and an entropy constraint is applied to reduce the effect of the restoration of the point sources on the underlying background. Each dispersion element is handled independently. This method is well adapted to PN long slit spectra. An extension of this method for the case when the spectrum of the extended structure does not change with spatial position uses this as a constraint in the R-L restoration. Typical applications are to spectrometry of crowded stellar fields and accurate sky subtraction for point sources (e.g. PN in external galaxies). A web page giving details and simulated spectra is available at: http://www.stecf.org/~jwalsh/specres/ and the methods are implemented as IRAF routines, publically available in the IRAF.stecf.specres package.