Observational Astrophysics 2 (2008)
Computer Exercise: Fourier Transform Spectrometer

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1 Introduction

The goal of this exercise is to model the intensity signal $I(x)$ coming from a Fourier Transform Spectrometer as a function of the path-length difference for different input spectra. This will help you to better understand Fourier transforms and the practical difficulties one encounters.

2 Artificial Spectra

Create different, artificial spectra from 300 nm to 1100 nm:

1. a single, Gaussian absorption line with a width of 1 nm
2. a single, Gaussian emission line with a width of 1 nm
3. a single, Gaussian absorption line with a width of 50 nm
4. a single, Gaussian emission line with a width of 50 nm
5. 20 Gaussian absorption lines of random strength and at random wavelengths with a width of 1 nm
6. 20 Gaussian emission lines of random strength and at random wavelengths with a width of 1 nm

For the absorption spectra, assume that the continuum intensity is independent of wavelength. For the emission spectra, assume that there is no continuum radiation.

3 Artificial Fourier Transform Spectrometer data

Calculate the FTS signal assuming a maximum pathlength difference $x_{\rm max}$ of 1 cm and a sampling of the signal at intervals of 0.1, 1, 10, and 100 μm for each of the spectra and discuss its form.

4 Reconstructed Spectra

Apply the cosine transform (real part of Fourier transform) to the FTS signals and reconstruct the spectrum. Compare the reconstructed spectra to your input spectra.

5 Apodization

Before applying the cosine transform, multiply the FTS signal with the function $\cos(\frac{\pi x}{2x_{\rm max}})$. What is the impact of this apodization on the retrieved spectra?