Computational Astrophysics

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Fast Fourier Transfer

1. Write a general FFT code for 2^N data points. Make sure of use correct pair of even and odd data point at the 1^{st} stage to begin.

(a). Use the data points A=[0, 0, 1, 0, 0, 0, 0, 0] for N=3. Show the result of FFT. Also do an inverse FFT to get back A.

2. Do a FFT of f(t) = cos(6π t) for Δt=0.5, 0.25, 0.15, 0.1 respectively.

(a) Plot $|f(\omega)|^2$ vs frequency ω.

(b) What could be the optimum choice of Δt and duration T to produce a good FFT?

Auto-Correlation

3. This lab session is based on recovery of signal from a noisy data using auto-correlation. Collect the observed data (data_cor) with time resolution 0.05 sec. Write a small code to execute an auto-correlation of the data and perform the following tasks:

(a) Plot the observe data and convince yourself that it is a noisy data.

(b) Plot auto-correlation results for total time duration of 5 sec and 10 sec on the same figure with the data. Is there any qualitative differences between two results?

(c) Perform the auto-correlation of the observed data using FFT: $[p \odot p] = \mathcal{F}^{-1}|P(\omega)|^2$
Confirm that your results validates the result from (3b).

The formula for auto-correlation of a time time dependent signal p(t) is given as:

$$p \odot p \approx \frac{1}{T}\int_0^T p^*(\tau)p(\tau + t)\, d\tau,$$

where T is the duration of the correlation.