Prof. Yashwant Gupta

Title : Some Challenges in Signal Processing and Computing in Astrophysics

Abstract:

Computational astrophysics is an integral part of the modern day astronomer's tool-set. The applications of high-end computing in astrophysics range from large scale numerical simulations of various aspects of the formation and evolution of stars, galaxies and the Universe itself, to real-time processing of large streams of data from modern telescopes working in different parts of the electromagnetic spectrum, and to sophisticated off-line analysis of the large volumes recorded data from such telescopes that is required to unlock the secrets of the Universe. This talk will cover some aspects of these applications, with selected examples of each kind. Special emphasis will be on real-time and off-line processing of data in the field of Radio Astronomy.

Radio Astronomy today uses large arrays of radio antennas that process celestial signals with bandwidths of hundreds of MHz. In order to extract the weak celestial signals from the receiver and sky noise present at the inputs of such radio telescopes, sophisticated processing of the signals is needed, first in the analog domain and then at the final stage, in the digital domain. Using the Giant Metrewave Radio Telescope (GMRT) as a case study, we will see how the requirements of high input data rates (~ 2 Gsamples/sec) and large real time computation load (~ 200 GFlops) are met with a combination of dedicated hardware and general purpose computing platforms. We will also look at the example of off-line analysis task of searching and detecting the weak signals from Pulsars -- exotic neutron stars that represent an extreme state of matter. Future projections for real time processing and computing, based on the ongoing world-wide efforts for building new radio telescopes, extend the requirements to data rates up to ~ 600 GSamples/sec and real time computation loads up to ~ 500 TFlops! Some possible approaches to tackling these challenges will be discussed.