Astronomical Techniques II
Lecture 1: The Big Picture

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Radio Astronomy

- Born in early 1930s - Karl G. Jansky, Bell Telephone Laboratories
- Of the 8 Nobel Prizes awarded to astronomers, 4 have gone to radio astronomers!
  - 1974 : Martin Ryle (Aperture Synthesis) and Antony Hewish (Discovery of Pulsars)
  - 1978 : Arno Penzias and Robert Wilson (Discovery of CMBR)
  - 1993 : Russell Hulse and Joseph Taylor (Discovery of a pulsar in a binary system)
  - 2006 : George Smoot and John Mather (Discovery of blackbody nature and anisotropies in CMBR)
- Formed the cutting edge of technology for much of this period
  - Hardware - low-noise amplifiers, filters, Application Specific Integrated Circuit (ASIC)/ Very Large Scale Integrated Circuits (VLSI)
  - Signal Processing and Algorithms
  - Signal transport and Communications

Radio Astronomy Today

- Attracting >3 Billion USD of investment worldwide
- Many new telescopes across the world
  - Jansky VLA, US (370 MHz – 45 GHz)
  - Atacama Large Millimeter/submillimeter Array, Chile (30 GHz – 900 GHz)
  - Low Frequency Array, Europe (30 – 240 MHz)
  - Murchison Widefield Array (MWA), Australia (80 – 300 MHz)
  - U-GMRT, India (150 – 1600 MHz)
  - Australian SKA Pathfinder, Australia (700 MHz – 1.8 GHz)
  - MeerKAT (Karoo Array Telescope), South Africa (about 700 MHz – 1.6 GHz)
  - Square Kilometer Array, South Africa and Australia (30 MHz – 30 GHz???)

The New *Golden Age* of Radio Astronomy

- Fueled by :
  - Advances in digitial signal processing technology
  - Affordability of computational capacity
- Needs :
  - Advances in calibration algorithms
  - Advances in imaging algorithms
  - Dealing with the Big-Data problem

The Objective of this Course

- To understand the basics of Radio Astronomy and the technique of Synthesis Imaging in reasonable detail.
- We will stay with text-book material, but I will try to give you a sense for where the frontiers of research are in this field.
- Focus on the theoretical principals of RA, not on its practice. Will include some numerical work though.
- Hopefully, pass on some of the excitement and strength of this field.

Course Structure and Assessment

- 14 lectures, usually 2 per week.
- A third lecture scheduled occasionally to make up as needed.
- Assessment
  - Assignments - 60%
    - 2 assignments of equal weight to be given at the end of the third and the fifth weeks.
    - Spend enough time on them, most of the credit comes from here.
    - Will require use of some scripting and plotting software. Make sure you are comfortable with it.
  - End of term exam - 30%, at the end of the seventh week.
  - Participation - 10% (asking/answering questions in class) ??
- Attendance requirement ($\geq$ 80%, i.e. a minimum of 11 out of 14 lectures)
  - Insufficient attenance, cannot take the final exam.

Course Structure and Assessment

- Overnight GMRT trip
  - 17-18 April (Fri-Sat)
- Final Exam
  - 8 May (Fri)

Course website

- http://ncra.tifr.res.in:8081/~div/astro-techII-2015
- All presentations used for the course will be uploaded to this site soon after the lecture.
- div@ncra.tifr.res.in

Textbooks and Reference Material

- Kraus, Radio Astronomy, 2nd Edition
- Synthesis Imaging in Radio Astronomy, ASPCS Vol 6 (1989), Ed. Perley, Scwab and Bridle
- Thompson, Moran and Swenson, Interferometry and Synthesis in Radio Astronomy, any of the editions

Introduction and Expectations

My Expectations

- Take ownership of your learning
  - Have problems... come talk to me
  - Put in the effort to learn
  - Be on time
  - Do your work on time

Questions

Pre-test