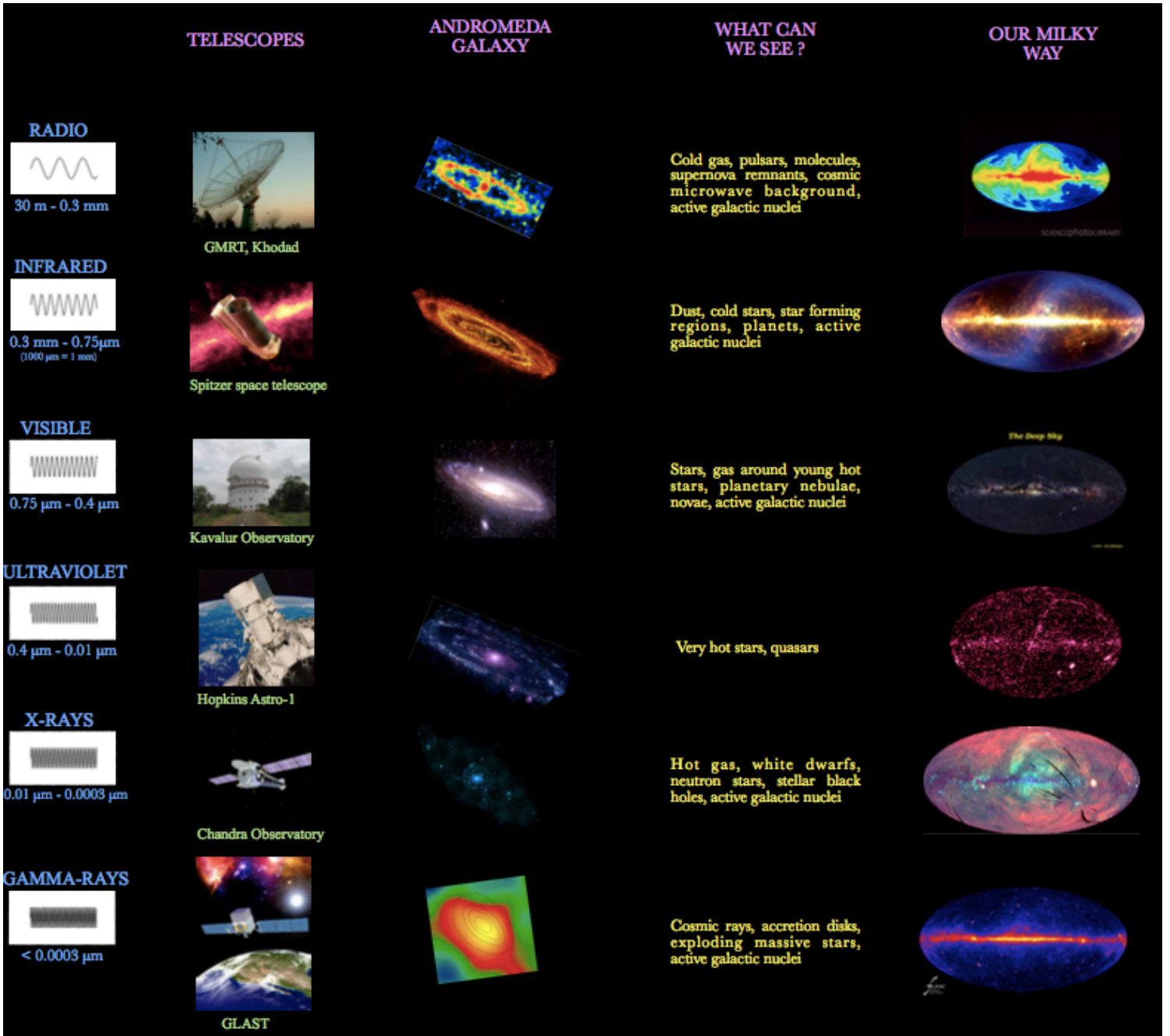
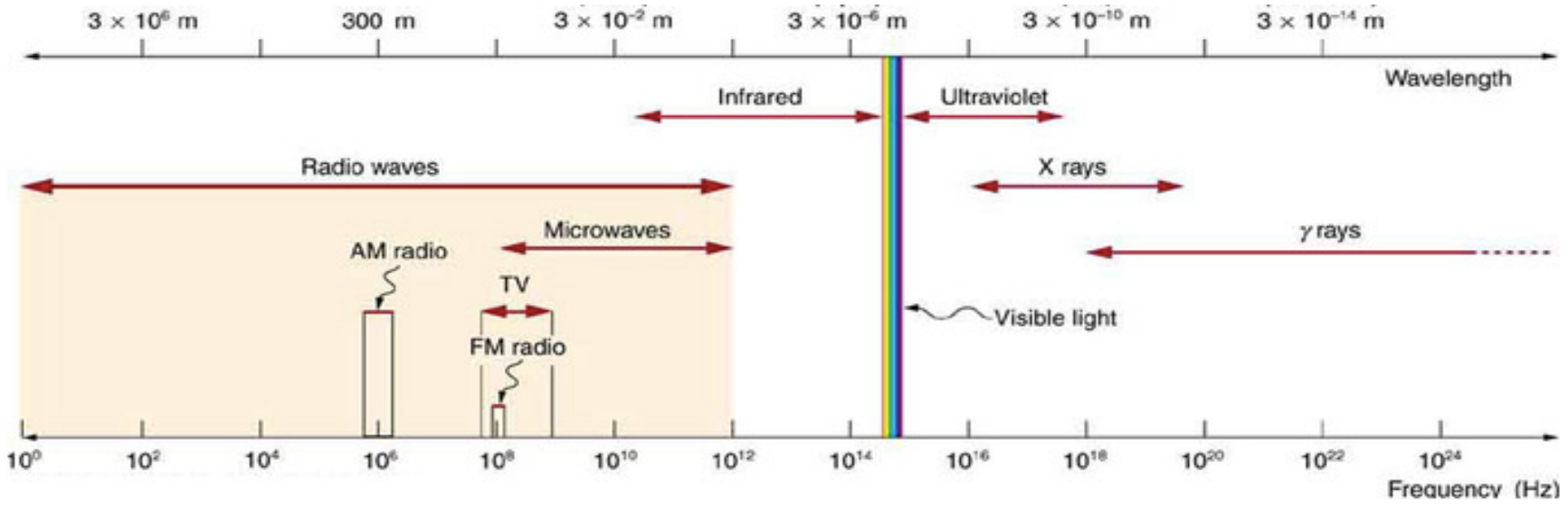

Q&A: Radio Astronomy, GMRT
Career path
Software/simulation
By Jayanta Roy

Multi-wavelength astronomy



Radio Astronomy

EM spectrum



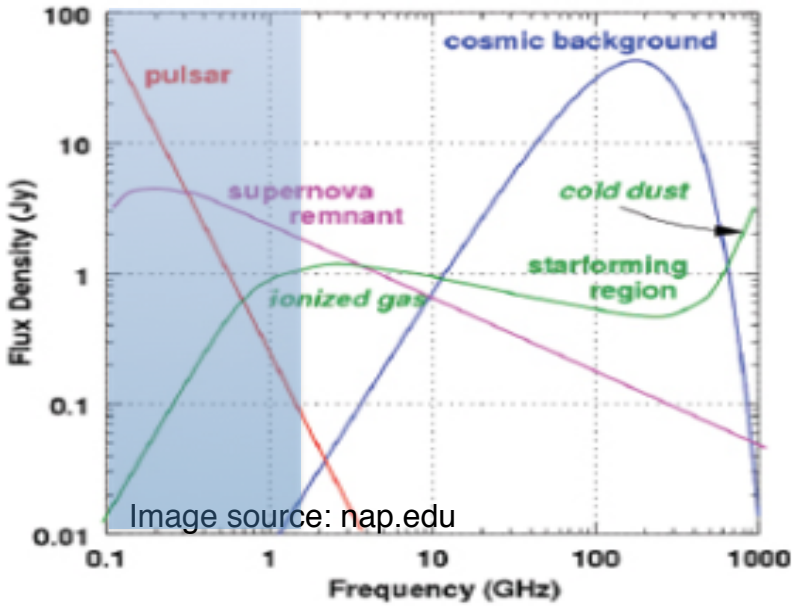


Image source: nap.edu

Objects in radio spectrum

Nobel prizes in astronomy

1967

HANS BETHE (US)

Theory of nuclear reactions and energy production in stars

(ASTROPHYSICS)

1974

MARTIN RYLE (UK) **ANTONY HEWISH (UK)**

Discovery of Pulsars & Aperture Synthesis Technique

(RADIO ASTRONOMY)

1978

ARNO PENZIAS (US) **ROBERT WILSON (US)**

Discovery of Cosmic Microwave Background Radiation

(RADIO ASTRONOMY)

1983

S CHANDRASEKHAR (INDIA) **WILLIAM FOWLER (US)**

Studies of the structure and evolution of stars (Chandrasekhar). and formation of the chemical elements in the universe (Fowler).

(ASTROPHYSICS)

1993

RUSSELL HULSE (US) **JOSEPH TAYLOR (US)**

Discovery of a binary pulsar that has opened up new possibilities for the study of gravitation.

(RADIO ASTRONOMY)

2002

Raymond Davis, Jr (US) **Masatoshi Koshiba (Japan)** **Riccardo Giacconi (Italy)**

Detection of cosmic electrons Pioneering research leading to the discovery of cosmic x-ray sources

(HIGH ENERGY ASTROPHYSICS)

2006

George Smoot (US) **John Mather (US)**

Discovery of the blackbody form and anisotropy of the cosmic microwave background radiation

(RADIO ASTRONOMY)

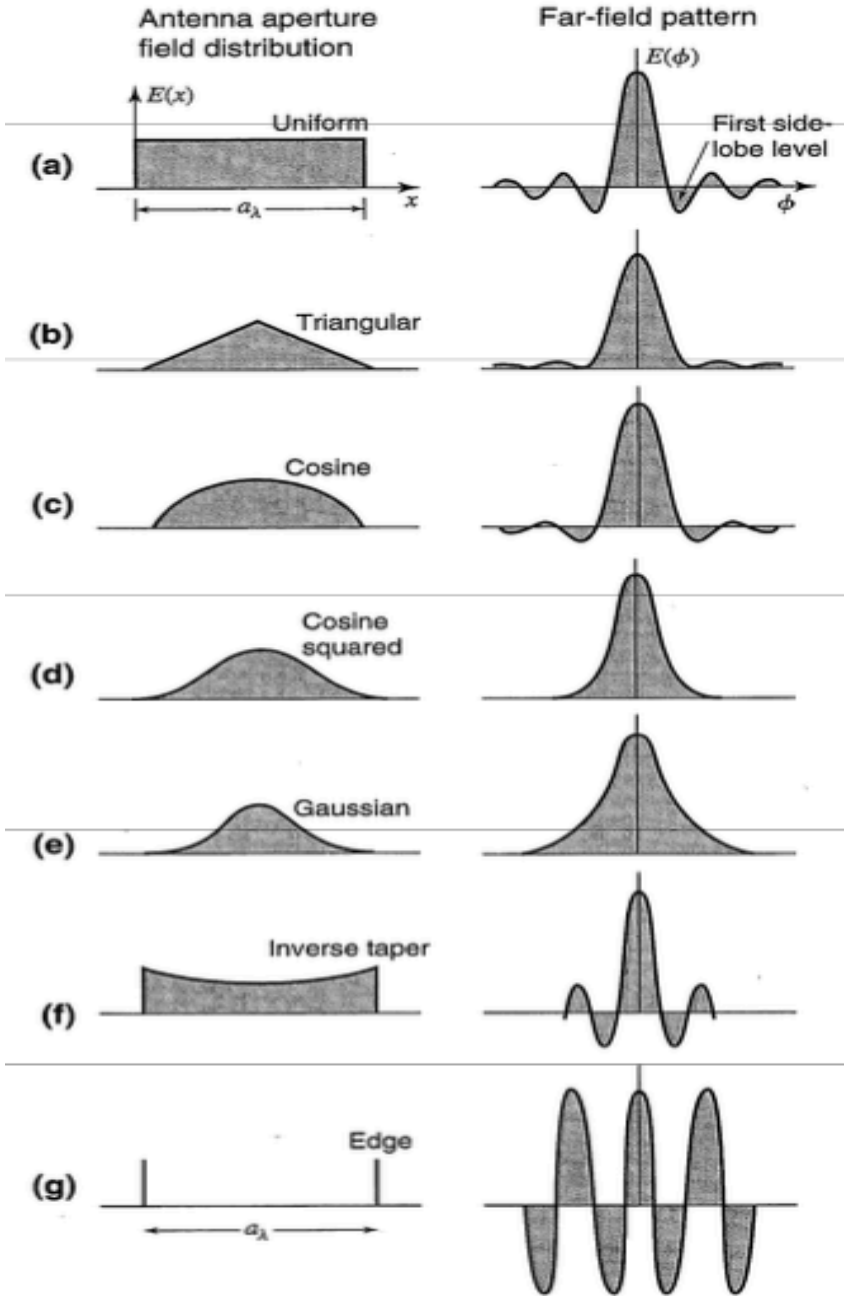
2011

Brian Schmidt (Australia, US) **Adam Reiss (US)** **Saul Perlmutter (US)**

Discovery of the accelerating expansion of the universe through observations of distant supernovae

(OPTICAL ASTRONOMY)

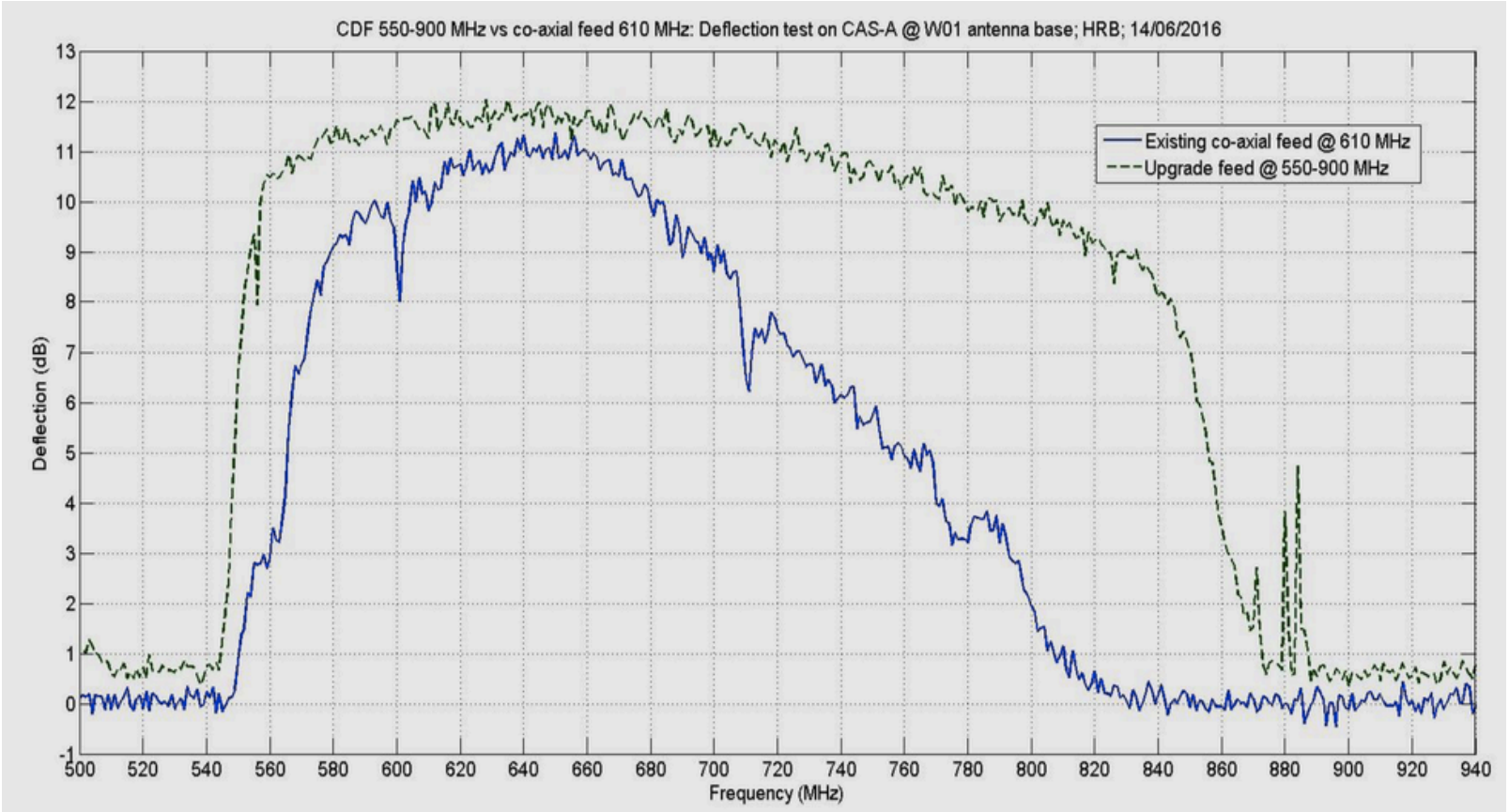
Antenna and its aperture



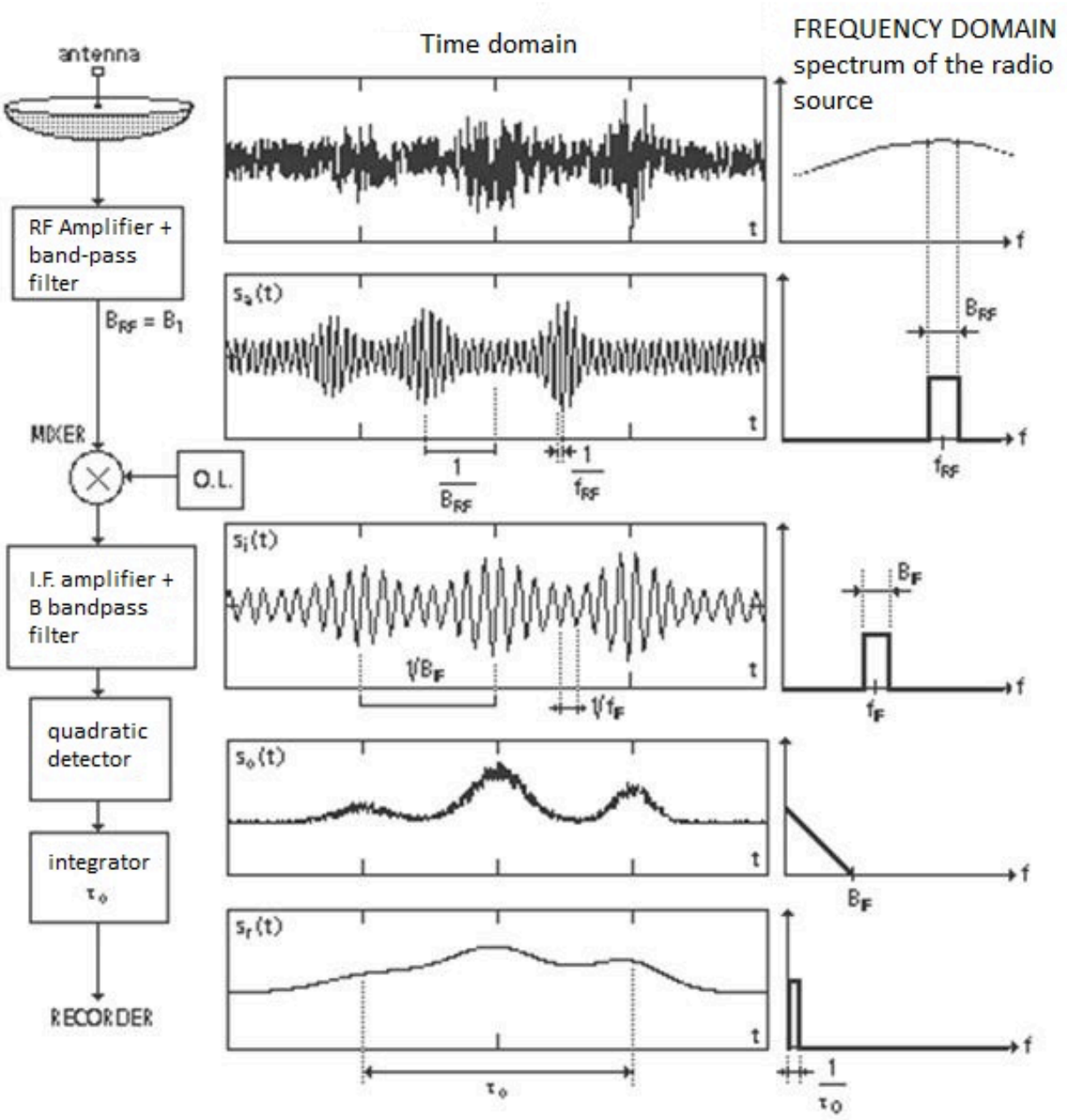
Antenna beam ⟷ Field distribution

FT

Feed bandwidth



Radio Receivers



Sensitivity or radiometre Equation:

$$\Delta T = \frac{T_{sys}}{\sqrt{B_F \tau_0}}$$

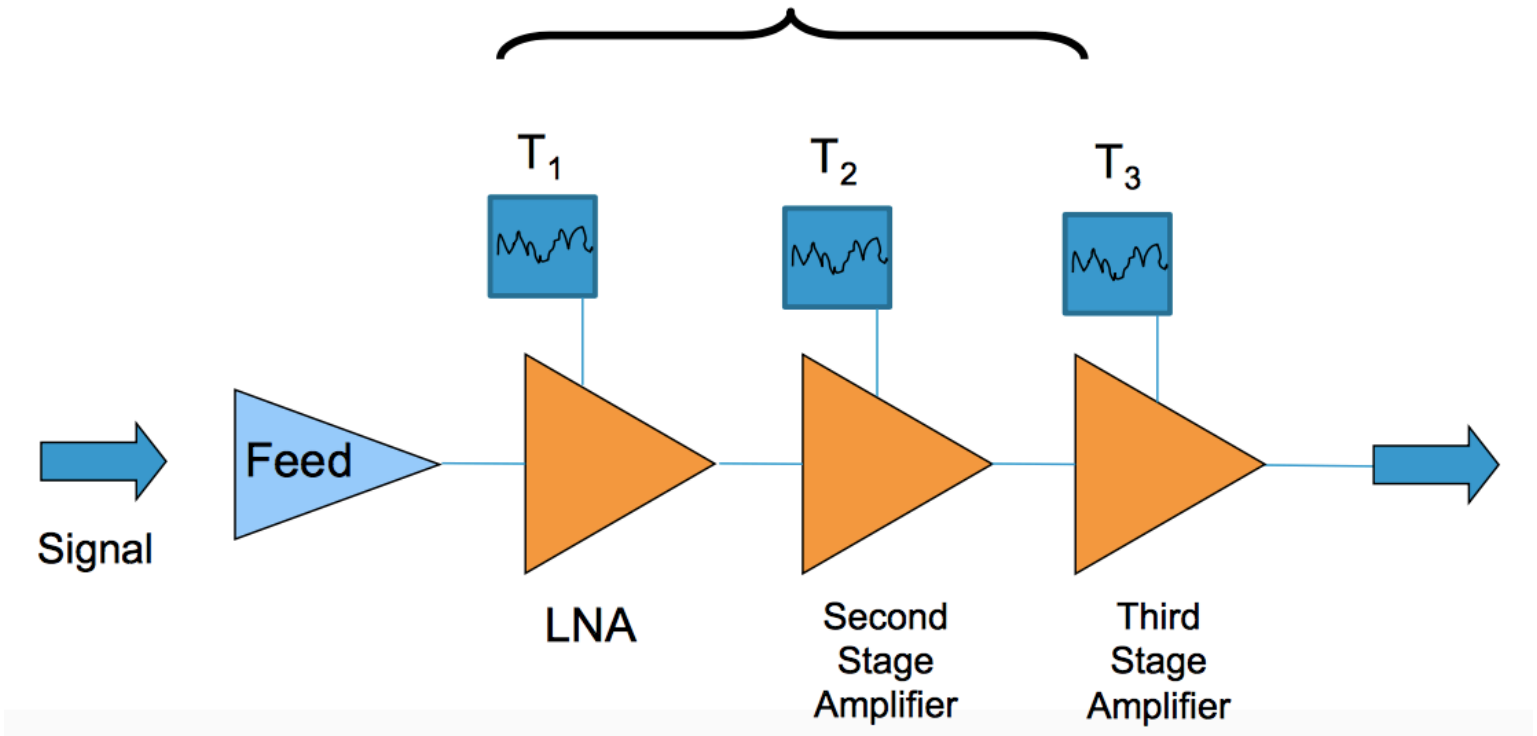
$P_{radio\_source} = S\,A_{eff} = k\,T$ (watts/Hz)

Gain (G) of radio system = T / S (Kelvins/Jy)

$G_{Arecibo}$ = 11 K/Jy
G_{GMRT} = 9 K/Jy or 1.8 K/Jy
G_{GBT} = 2 K/Jy
$G_{Effelsburg}$ = 1.5 K/Jy
G_{Parkes} = 0.74 K/Jy

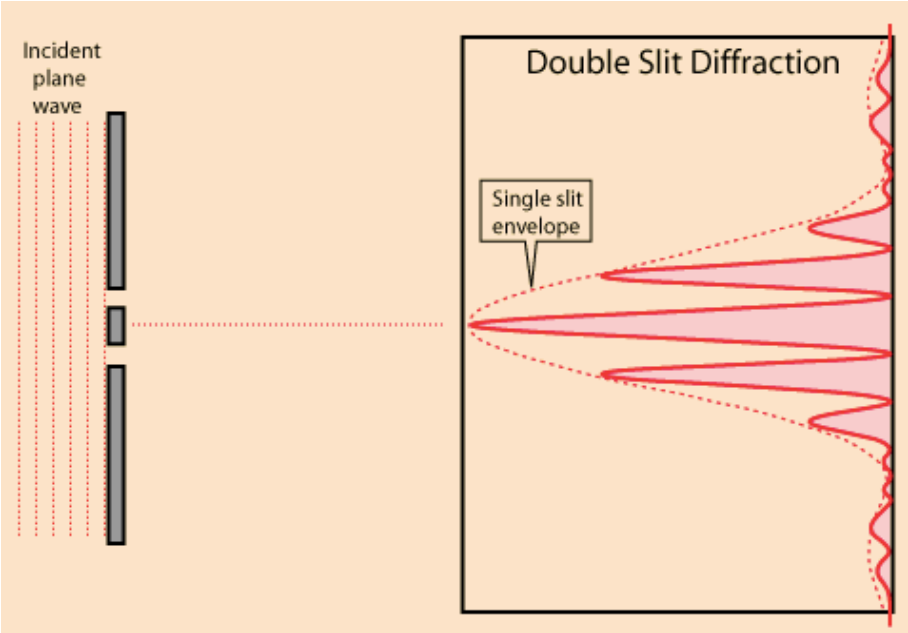
Receiver noise temperature

$$T_{system} = T_1 + \frac{T_2}{Gain_{LNA}} + \frac{T_3}{Gain_{LNA} \times G_2} + \frac{T_4}{Gain_{LNA} \times G_2 \times G_3} \quad \ldots\ldots$$



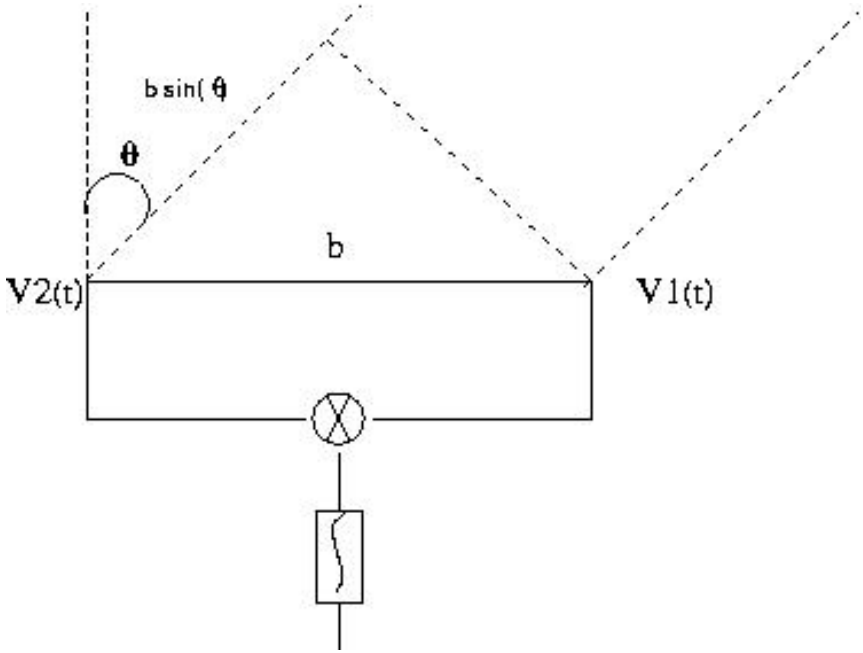
Radio Interferometers

Interference fringe patterns



Diffraction limit of a telescope = 1.22 λ/D

Interferometer measures the spatial coherence function of the incident electric field



Signals arrive at Correlator from different Antennas have different *propagation* and *instrumental* delay.

$\tau = b/C \, \mathrm{Sin}(\theta)$

$d\tau/dt = b/C \, \mathrm{Cos}(\theta) \, d\theta/dt$

NCRA-TIFR entry points

NCRA has 20 faculty, 35 PhD and IntPhD students and 10 post-docs

Joint Entrance Screening Test (JEST): written test followed by interview at TIFR, Mumbai in (advt in Nov and exam in Feb)

IUCAA-NCRA Admission Test (INAT): written test followed by interview at NCRA/ IUCAA, Pune (advt in Aug and exam in Dec)

TIFR Entrance Test: written test followed by interview at TIFR, Mumbai (advt in Sep and exam in Dec)

Visiting Student Research Program (VSRP): Research project in May-June; project evaluation followed by interview for pre-selection for PhD

Radio Astronomy Winter School (RAWs): @ Radio Physics Lab for under-grads to get hands on exposures in radio astronomy in 10 days

Radio Astronomy School (RAS): 2 weeks intensive training for doc and post-doc researchers in astronomy

GMRT archive and proposal system

Archive for getting access to radio data from the GMRT

How to submit a proposal for GMRT observations?

Link: naps.ncra.tifr.res.in

Proposal: Regular (@ 15th Jan for April-Sep and @ 15th July for Oct to Mar)

DDT at anytime

Preparing for observing/proposing

Current spec: http://www.gmrt.ncra.tifr.res.in/gmrt_hpage/Users/doc/GMRT-specs.pdf

Source Rise-Set time calculator: http://gmrt.ncra.tifr.res.in/~astrosupp/obs_setup/rst.html

During observations: Antenna positions (http://gmrt.ncra.tifr.res.in/~astrosupp/gmrtmon/ondisp/ondisp.html)

Antennas data quality (http://gmrt.ncra.tifr.res.in/~astrosupp/gsbmon/gsbmon.html)

Paper archives

NASA ADS (http://adsabs.harvard.edu/abstract_service.html)

Astro-ph (https://arxiv.org/find/astro-ph)

Misc. tools

Coordinate transformation (http://ned.ipac.caltech.edu/forms/calculator.html)

Galactic electron density model (http://119.78.162.254/dmodel/index.php)

Numerical programming with GNU Octave (https://www.gnu.org/software/octave/about.html)

Plotting with GNUPLOT (http://www.gnuplot.info/)

FITS image display using ds9 (http://ds9.si.edu/site/Home.html)

Simulation of FT and interfemeter using Octave (ftp://wm.ncra.tifr.res.in/jroy/IAS_Summer_2018/)